

CHAPTER 7

DEVELOPMENT, OPERATION AND MAINTENANCE OF A HYDROPOWER RESOURCES DATABASE

CHAPTER 7 DEVELOPMENT, OPERATION AND MAINTENANCE OF A HYDROPOWER RESOURCES DATABASE

The following describes the development of a HRD (Hydropower Resources Database) system in this study. The database referred to in this study is a centralized system for integrating, managing and searching through location and other information, and is not an aggregation of electronic organized data.

7.1 EXISTING HEP POTENTIAL SITE DATA

Existing HEP (Hydro Electric Power) potential data was prepared by the DOE (Department of Energy), NEA (National Electrification Administration) and NPC (National Power Corporation). However, this data is managed and saved as Microsoft-Excel data without any form of centralized management.

A list of collected data is shown below again. (For details, see Section 4.3.)

Table 7.1-1 Collected Data for Existing Hydropower Potential Sites

| No. | Data | Number of Sites | Data Source |
|-----|--|-----------------|-------------|
| 1 | Potential sites by private sector (Awarded) | 125 | DOE |
| 2 | Potential sites by private sector (Applying) | 244 | DOE |
| 3 | Potential sites for mini hydropower (>100kW, <10MW) | 94 | DOE |
| 4 | Potential sites for major hydropower (>10MW) | 60 | DOE |
| 5 | Potential sites investigated by NEA | 905 | NEA |
| 6 | Potential sites by NPC's inventory survey | 145 | NPC |
| 7 | Potential sites by JICA's master plan for Palawan | 7 | JICA |
| 8 | Potential sites by JBIC project in the Ifugao terrace paddy fields | 3 | JICA |

As described in Section 4.3, the data format of each data varies, with some containing efficient information and some not. Furthermore, much of the data in these data sets is redundant. The database seems difficult to effectively utilize under such circumstances. Therefore, it is important to integrate this data and centrally manage the database.

The following figure shows how information and data format differ from data to data.

The data items were reviewed in consideration of the collected data/information and the results of the discussion with the REMB (Renewable Energy Management Bureau, DOE), and integrated into the standardized format.

No.1 Awarded

HYDROPOWER SERVICE CONTRACTS (SIGNED)
As of February 2010

| Region | Project | Location | Project Capacity (MW) | Financial Commitment Estimated Cost (Pb. Pay) in Millions |
|--------|---|----------------------|-----------------------|---|
| COA | Chasing Hydroelectric Power Project | Arak, Benguet | 20 | 180 |
| | RES Hydroelectric Power Project | Bahan, Benguet | 30 | 120 |
| | Lansuy Hydroelectric Power Project | Bahan, Benguet | 30 | 90 |
| | Luna Laha Hydroelectric Power Project | Bahan, Benguet | 20 | 80 |
| | Min-a-ohk Hydroelectric Power Project | Bugay, Benguet | 30 | 540 |
| | Sakangan Hydroelectric Power Project | Bugay, Benguet | 20 | 112 |
| | Agua Hydroelectric Power Project | Kibara, Benguet | 30 | 180 |
| | Naitakang B Hydroelectric Power Project | Kibara, Benguet | 40 | 140 |
| | Rapangan HEP | Kiyanga, Benguet | 20 | 95 |
| | Rapangan B HEP | Kiyanga, Benguet | 30 | 95 |
| | Huang 1 Hydroelectric Power Project | La Trinidad, Benguet | 20 | 148 |
| | Huang 2 Hydroelectric Power Project | La Trinidad, Benguet | 30 | 230 |
| | Huang 3 Hydroelectric Power Project | La Trinidad, Benguet | 45 | 475 |
| | Huang 4 Hydroelectric Power Project | La Trinidad, Benguet | 40 | 285 |
| | Amphawa Hydroelectric Power Project | Sakay, Benguet | 30 | 103 |
| | Alcoba Hydroelectric Power Project | Talaba, Benguet | 40 | 40 |
| | Isana H Hydroelectric Power Project | Talaba, Benguet | 10 | 22 |
| | Chopin-Na Oak Hydroelectric Power Project | Hagbi, Triana | 10 | 40 |
| | Santolaga Hydroelectric Power Project | Santolaga, Triana | 10 | 40 |
| | Amboang Oak Hydroelectric Power Project | Santolaga, Triana | 10 | 40 |
| | Suhay Hydroelectric Power Project | Palak, Igo | 20 | 140 |
| | Pual B Hydroelectric Power Project | Palak, Igo | 20 | 140 |
| | Pual C Hydroelectric Power Project | Palak, Igo | 20 | 140 |
| | Upper Tabuk HEP | Tabuk, Igo | 40 | 48 |
| | TOTAL | | 268 | 258 |

LIST OF HYDROPOWER POTENTIAL SITES IDENTIFIED IN CARAGA REGION

| PROVINCE | MUNICIPALITY | SITE | HEAD (M) | Q (CMS) | P (KW) | SOURCE | |
|--------------------|--------------|--------------------|-------------|---------|---------------|---------------------|---------------------|
| AGUSAN DEL NORTE | Talaogon | Laminga | 38.00 | 0.50 | 150 | NEA Potential Sites | |
| | | Molokogon | 68.00 | 0.50 | 270 | NEA Potential Sites | |
| | | Amog | 60.00 | 0.40 | 190 | NEA Potential Sites | |
| | | Andanan RIS 1 +000 | 2.50 | 7.90 | 160 | NEA Potential Sites | |
| | | Andanan RIS 2 +060 | 3.00 | 7.90 | 190 | NEA Potential Sites | |
| | Algezan | Wawa | 12.00 | 3.30 | 320 | NEA Potential Sites | |
| | | | | | 3,880 | NPC Lists | |
| | | | | | 5,160 | | |
| AGUSAN DEL NORTE | Olot B | Bustillo | - | - | 2,180 | NPC | |
| | | Bustillo | - | - | 3,580 | NPC | |
| | | Bustillo | 11.00 | 4.50 | 400 | NEA Potential Sites | |
| | | Bustillo | 212.00 | 4.02 | 7,260 | CCO | |
| | | Sibagat | Wawa | 68.00 | 0.80 | 430 | NEA Potential Sites |
| | | Bayagan | Andanan | 32.00 | 2.80 | 720 | NEA Potential Sites |
| | | San Luis | Laminga | 47.00 | 0.50 | 190 | NEA Potential Sites |
| | | Jatonga | Bogobut | 120.00 | 0.30 | 280 | NEA Potential Sites |
| | | Jatonga | Lake Mainit | 21.00 | 6.50 | 9,500 | NEA Potential Sites |
| | | Jatonga | Pugay E | - | - | 8,800 | NPC Lists |
| | Cabasaran | Pugay E | 60.00 | 3.30 | 1,900 | NEA Potential Sites | |
| | | | | | 32,900 | | |
| SURIGAO DE L NORTE | Mainit | Matingay Falls | 40.00 | 1.20 | 400 | NEA Potential Sites | |
| | | Blodohan Falls | 70.00 | 0.30 | 140 | DOE | |
| | | Lorito | 128.00 | 0.36 | 320 | LMPIC | |
| | | Claver | 60.00 | 20.00 | 10,000 | NEA Potential Sites | |
| | Bancag | Bancag | 25.00 | 0.80 | 160 | NEA Potential Sites | |
| | | | | | 11,020 | | |
| SURIGAO DE L SUR | Bisitig | Tinyan Falls | 35.00 | 3.00 | 800 | NEA Potential Sites | |
| | | Bobohan | 8.00 | 5.20 | 320 | NEA Potential Sites | |
| | | Tago | 35.00 | 10.70 | 3,000 | NEA Potential Sites | |
| | | San Agustin | Hubo 1 | 60.00 | 4.00 | 1,800 | NEA Potential Sites |
| | | Morid | Caracan | 60.00 | 18.00 | 8,000 | NEA Potential Sites |
| | | Carascal | Pankian | 40.00 | 9.60 | 2,600 | DOE |
| | | Carilian | Caracan | 44.00 | 7.10 | 2,500 | NEA Potential Sites |
| | | Carilian | Bayoy Creek | 80.00 | 0.10 | 170 | NEA Potential Sites |
| | San Miguel | Tago E | - | - | 5,700 | NPC | |
| | | | | | 25,910 | | |
| | | | | | 74,090 | | |

Fig. 7.1-1 Data as Recorded

Table 7.1-2 Organized Information for the Database

| Status | Item | Number of Sites | Data Source |
|---|--|-----------------|---|
| Contract Hydro Electric Power Potential Sites | C01 Potential sites by private sector (Awarded) | 124 | - Potential sites by private sector (DOE Awarded) |
| | C02 Potential sites by private sector (Applying) | 244 | - Potential sites by private sector (Applying) |
| Existing Facilities (Hydropower etc.) | E01 Existing mini hydropower plants | 53 | - Existing mini hydropower plant (DOE) |
| | E02 Existing hydropower plants | 19 | - Existing hydropower plants (DOE) |
| | E03 Other facilities | 46 | - Dam in the Philippines (NWRB) - Water and Flood (DPWH) |
| New Hydro Electric Power Potential Sites | J01 JICA potential site with site reconnaissance | 47 | Outcome of map study |
| | J02 JICA potential site | 205 | Same as above |
| Existing Hydro Electric Power Potential Sites | P01 Potential sites of mini hydropower (<10MW) | 118 | - Potential sites of mini hydropower (DOE) - Potential sites by JICA's master plan for Palawan - Potential sites by JBIC project in the Ifugao terrace paddy fields |
| | P02 Potential sites of major hydropower (>10MW) | 56 | Potential sites of major hydropower (>10MW) (DOE) |
| | P03 Potential sites investigated by NEA | 905 | Potential sites investigated by NEA |
| | P04 Potential sites by NPC's inventory survey | 145 | Potential sites by NPC's inventory survey |
| Additional Hydro Electric Power Potential Sites | T01 Temporary site in pending state | Uncertain | Temporary category for pending (status undecided) sites due to lack of specific or significant information |

As for C01 and C02, applications from developers for these sites are examined by the REMB. This data will be important for future HEP development planning. Development of these sites will be continuously ongoing in the future, though F/S (Feasibility Study) is not completed. Therefore, this data was distinguished from other data (P01 – P04) in the database.

As for data of E01-03, many of the sites have no information on location. Therefore, the JICA study team asked the REMB-DOE to collect additional information on the surroundings of the power plants from ECs (Electric Cooperatives).

J01 and J02 fall into the data category of newly selected HEP potential sites, which are highly promoted projects and were included in the database as a new category distinguished from others. Concerning J02, site reconnaissance was conducted by JICA (Japan International Cooperation Agency) study team.

Information on P01 and P02 originally belongs to the DOE. Information on recently investigated mini-HEP potential sites such as JICA's study in Palawan and JBIC's study in Ifugao was integrated into this category (P01).

Many sites are included in P03, but information is limited. However, this data will not be excluded from the database at the request of the DOE.

Many sites are included in P04 and there is sufficient basic information. However, the results of economic evaluation must not be applicable because P04's study was done long ago (1987). Therefore, this data was included in the database as an individual category that was not integrated into P03 and P04.

T01 is a temporary item for potential sites that are in a pending state. This temporary status should be applied to sites that are difficult to define due to a lack of specific or significant information.

7.2 OUTLINE OF THE DATABASE SYSTEM

7.2.1 Outline of the System

The basic conditions required of the database to provide information from the DOE on HEP potential sites and to promote HEP development to mainly private developers/investors in the future are shown below.

- Centralizes management of HEP existing sites and potential sites all over the Philippines.
- Categorizes sites by data source, development progress and developers, etc.
- Easy to update or add data on HEP existing sites and potential sites
- Easy to search, sort or present data of each site
- Easy to comprehend and effectively use in presentations with visualized GIS (Geographic Information Systems) data
- Various data for planning and design on HEP such as topography and hydrology

It is desirable that information on existing facilities and HEP potential sites in the database be supported in order for REMB-DOE staff to promote investment in HEP development by developers.

The outlines of this database are shown in below figures.

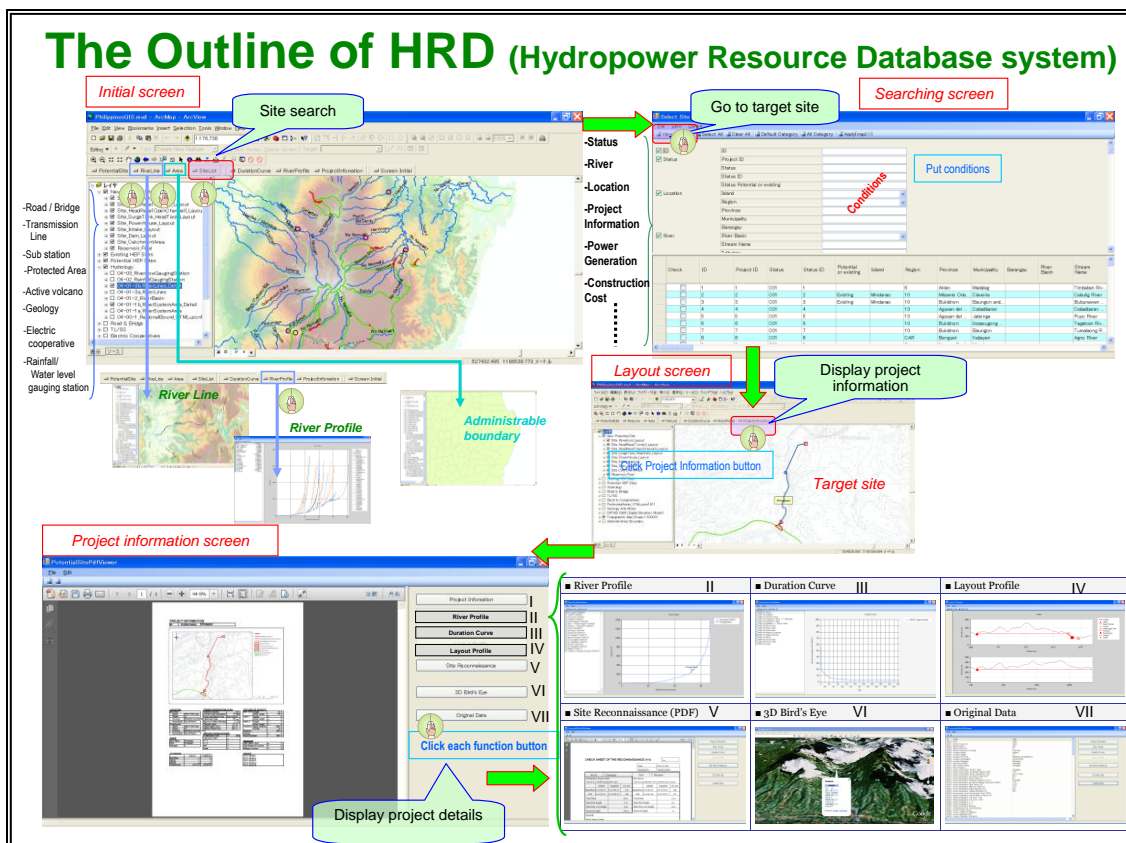


Fig. 7.2-1 Outline of the Database (Image of Obtaining Project Information)

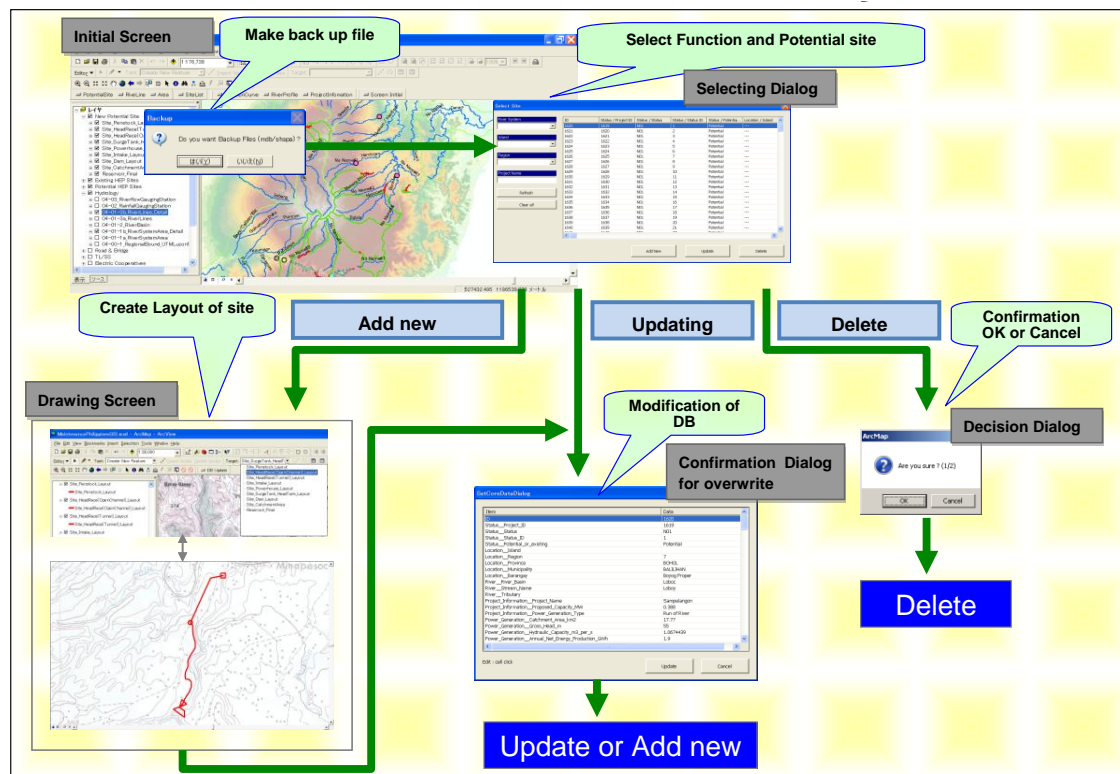


Fig. 7.2-2 Outline of the Database (Image of Updating Project Information)

7.2.2 Major Outputs of the Database

(1) Location Map of HEP Potential Sites All Over the Philippines

Existing and under-construction HEP plants and potential sites are displayed on a river system map that serves as the base map. A basic outline of a potential site can be also displayed by clicking the site on the map.

(2) Location Map of HEP Potential Sites on 1/50,000 Scale Topographic Map

The intake, powerhouse and waterway layout of existing and under-construction HEP plants and potential sites are displayed on a 1:50,000 topographic map and SRTM (Shuttle Radar Topography Mission) and a basic outline of a selected potential site can be displayed. In addition to the data/information mentioned above, catchment areas, roads, transmission lines, substations, environmental conservation areas and so on are shown.

(3) Summary Table of HEP Potential Sites

Location map, catchment area, flow duration curve, head, power discharge, power output, generating energy, outline of main structures, preliminary construction cost, environmental and social obstacles, etc. are summarized in a table. Economic and financial indices such as unit cost per kW, unit cost per kWh, EIRR (Economic Internal Rate of Return), FIRR (Financial Internal Rate of Return), etc. also can be displayed. Furthermore, reconnaissance reports, site photographs, etc. of each site where site reconnaissance was conducted (for 47 sites) will be stored in the database.

(4) Plan around the HEP Potential Site and Profile along the Waterway and Penstock

Preliminary project plans of the potential site and profiles along the waterway and penstock can be displayed on a 1:50,000 topographic map.

(5) List of Basic Outlines for HEP Potential Sites

The list can indicate potential sites by priority rank, preliminary construction cost, scale of power output, region and so on. Existing facilities are also displayed in this system.

(6) River Profiles of River Systems of HEP Potential Sites

River profiles of the river system where existing and under-construction HEP plants and other HEP potential sites are found up and downstream can be displayed.

(7) Site Reconnaissance Reports for HEP Potential Sites

Site reconnaissance reports, which indicate reconnaissance routes, existing roads, specific data, pictures, etc., will be prepared for potential sites where site reconnaissance was conducted.

(8) Bird's-eye View of HEP Potential Sites

Bird's-eye views that show the vicinity in a 3-dimensional view will be prepared for "Hydro Electric Power Potential Sites identified in this study: J01, J02." (Collaboration with Google Earth)

7.3 FUNCTIONS AND STRUCTURES OF THE DATABASE SYSTEM

7.3.1 Structure of the System

HRD was developed on basis of Arc GIS (GIS software with general versatility developed by ESRI Inc.) and Microsoft ACCESS which is suitable for huge data processing and easy to convert from existing potential data of Microsoft EXCEL. This system consist of 3 components; “GIS data (Shape files)”, “Core Data (Database Files)”, and “Relevant Data (Program Data)””. A conceptual view of the system structure and data structure are shown below.

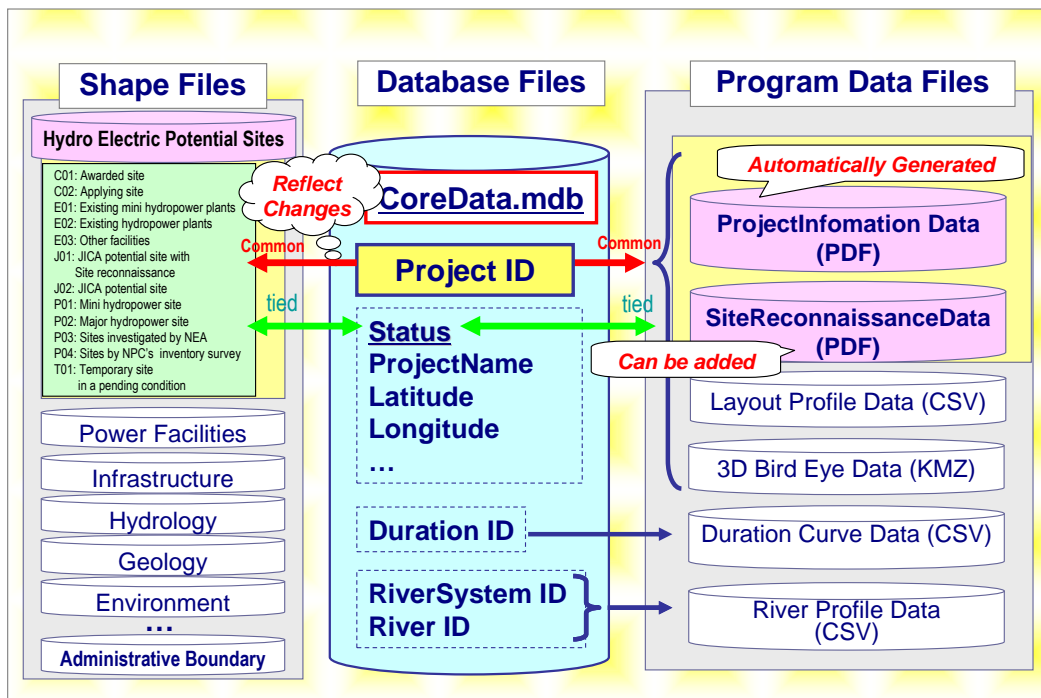


Fig. 7.3-1 Conceptual View of Data Structures and Relations

7.3.2 Data Contents of the System

(1) Core Data (Database Files)

Various information of hydro electric power resources described in chapter 7.1 was integrated into the centralized database. This database file is defined as “Core Data” in the HRD.

The items and structure were decided according to requests and needs of DOE, and stored as Microsoft ACCESS format (.mdb) in the HRD

The data stored in this “Core Data” was developed based on the existing database of DOE including insufficient information. After the installation of HRD system, the information of hydroelectric power resources will be added or updated by DOE staffs.

Table 7.3-1 “Core Data” Categories

| Category | Item |
|--------------------------|---|
| Status | Project ID, Status |
| Project Information | Project Name, Max Output, Power Generation Type |
| Location | Region, Province, Municipality, Barangay |
| River | River Basin, River Name |
| Coordinates | Coordinates of Intake and Powerhouse |
| Elevation | Intake Elevation, Tailrace Elevation |
| Owner | Project Owner, Contact Address |
| Contract Information | Contract No., Registration Number, Signed Date, Type of Contract |
| Power Supply | User or Purchaser, EC Area |
| Project Study | Project Study Type, Study Date, Study Sponsor, Study Author, Site Reconnaissance |
| Reservoir | HWL, LWL, Reservoir Volume, Effective Reservoir Volume |
| Hydrology | Catchment Area, Maximum Discharge, Firm Discharge, Flood Discharge |
| Power Generation | Gross Head, Effective Head, Efficiency, Firm Output, Plant Factor, Annual Power Generation |
| Main Facilities | Dam/Weir, Headrace, Surge Tank/Head tank, Penstock, Powerhouse, Access road, Turbine, Generator, Substation, Transmission |
| Project Evaluation | Construction Cost, Unit Cost, EIRR, FIRR |
| Socio-Environment | Protected Area, Volcano Area |
| Geology | Geology |
| Commissioning | Year Commissioned |
| Annual Energy Generation | Annual Energy Generation |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|------------|-----|------|---------|----------|---------------------|-------------------|-----------------------|--------------|-------------|---------------------|
| Project ID | Sta | Stat | Role | Island | Region (as in Dept) | Province | Municipality | Barangay | River Basin | Stream |
| 1 001 | | 1 | | | 8 | Aklan | Iloiloag | | | Timogpan River |
| 2 001 | | 2 | Establa | Mindanao | 10 | Isabela Oriental | Claveria | | | Cebuog River |
| 3 001 | | 3 | | Mindanao | 10 | Bukidnon | Bangon and Sibona | | | Bukunpan River |
| 4 001 | | 4 | | | 13 | Agusan del Norte | Casabonan | | | Casabonan River |
| 5 001 | | 5 | | | 13 | Agusan del Norte | Lubong | | | Pulo River |
| 6 001 | | 6 | | | 10 | Bukidnon | Impasugong and Sumiao | | | Tagapan River |
| 7 001 | | 7 | | | 10 | Bukidnon | Bangon | | | Tumbogog River |
| 8 001 | | 8 | | | CAR | Benguet | Koban | | | Agno River |
| 9 001 | | 9 | | | 8 | Negros Occidental | Silunga | | | |
| 10 001 | | 10 | | | 7 | Negros Oriental | Dumaguete | | | Balanak Lake |
| 11 001 | | 11 | | | 8 | Negros Occidental | Kasamban | | | Imabogan River, Udo |
| 12 001 | | 12 | | | 8 | Negros Occidental | Kasamban | | | Imabogan River, Udo |
| 13 001 | | 13 | | | 8 | Negros Occidental | Mindasac | | | Hamban River |
| 14 001 | | 14 | | | 8 | Negros Occidental | Mindasac | | | Himoghan River |
| 15 001 | | 15 | | | 8 | Iloilo | Igoras | | | |
| 16 001 | | 16 | | | 8 | Antique | San Remigio | | | Ilanina River |
| 17 001 | | 17 | | | 8 | Antique | San Remigio | | | Ilanina River |
| 18 001 | | 18 | | | CAR | Benguet | Alok | | | Ominog River |
| 19 001 | | 19 | | | 8 | Iloilo | Riasin | | | Tigum River |
| 20 001 | | 20 | | | 8 | Iloilo | Igoras | | | Tigum River |
| 21 001 | | 21 | | | 8 | Iloilo | Igoras | | | Tumbogog River |
| 22 001 | | 22 | | | 8 | Iloilo | Igoras | | | Turbo River |
| 23 001 | | 23 | | | 8 | Antique | San Remigio | | | |
| 24 001 | | 24 | | | 8 | Antique | San Remigio | | | |
| 25 001 | | 25 | | | 8 | Antique | San Remigio | | | |
| 26 001 | | 26 | | | CAR | Benguet | Tapanan Sur, Tuba | | | |
| 27 001 | | 27 | | | CAR | MT. Province | Babab | | | Amudogog River |
| 28 001 | | 28 | | | CAR | MT. Province | Bang | | | Chabing River |
| 29 001 | | 29 | | | CAR | MT. Province | Babab | | | Bababog River |
| 30 001 | | 30 | | | CAR | Benguet | | | | Bugabog River |
| 31 001 | | 31 | | LUZON | | Zamboanga | Igan | | | |
| 32 001 | | 32 | | | 4-B | Oriental Mindoro | Bato | | | |
| 33 001 | | 33 | | | | Iloilo | Sanog | | | |
| 34 001 | | 34 | | | CAR | Benguet | Kasaban | | | |
| 35 001 | | 35 | | | | 7 | Negros Oriental | Valencia | | |
| 36 001 | | 36 | | | | 7 | Negros Oriental | La Libertad | | |
| 37 001 | | 37 | | | CAR | Kalinga | Pasi | | | |
| 38 001 | | 38 | | | CAR | Kalinga | Pasi | | | |
| 39 001 | | 39 | | | CAR | Kalinga | Babalan | | | |
| 40 001 | | 40 | | | | 7 | Negros Oriental | Baton | | |
| 41 001 | | 41 | | | | 7 | Negros Oriental | San Catalina | | |
| 42 001 | | 42 | Establa | LUZON | CAR | Benguet | Baton | | Balli River | Blabogog River |
| 43 001 | | 43 | Establa | LUZON | CAR | Benguet | La Trinidad | | | |

Fig. 7.3-2 View of “Core Data”

(2) GIS data (Shape Files)

GIS data was stored in HRD based on information collected as described in Chapter 4. These data are stored as Shape Files (.shp) of Arc GIS which express shapes of information in points, lines and polygons (arbitrary figures) on GIS application. The data list stored in the database is shown below.

Table 7.3-2 (1) Basic Data List to Be Stored in the Database

| No. | Data Item | File Name(*.shp/.shx/.dbf/.prj) | Remarks |
|--------------------------------------|--|--|--|
| 1. Hydropower Potential Sites | | | |
| 1-1 | Point of project sites | C01_Awarded.shp C02_Applying.shp E01_Existing_Mini.shp E02_Existing_Major.shp E03_Existing_Others.shp J01_JICA_Potential_with_SR.shp J02_JICA_Potential.shp P01_Potential_Mini.shp P02_Potential_Major.shp P03_Potential_NEA.shp P04_Potential_NPC.shp Temporary.shp | Point Point Point Point Point Point Point Point Point Point Point Point |
| 1-2 | Project layout | Catchment_Area.shp Dam_Layout.shp HeadRace(OpenChannel)_Layout.shp HeadRace(Tunnel)_Layout.shp Intake_Layout.shp Penstock_Layout.shp Powerhouse_Layout.shp Reservoir_Final.shp Structure_Layout.shp SurgeTank_HeadTank_Layout.shp TailRace_Layout.shp Waterway_Layout.shp | Polygon Polygon Polygon Polygon Polygon Line Polygon Polygon Polygon Line Line Line |
| 1-3 | Additional information of reconnaissance survey | 50_SR_Access_Road.shp 50_SR_Trail.shp 50_SR_Waypoints.shp | Line Line Point |
| 2. Power facilities | | | |
| 2-1 | Location of transmission lines and substations (existing, under construction or consideration) | TransLine.shp | Line |
| 2-2 | Substations | Substation.shp | Point |
| 2-3 | Location of high-voltage distribution lines (existing, under construction or consideration) | SubCable.shp | Line |
| 3. Infrastructure | | | |
| 3-1 | Roads and bridges | LRS.shp Bridges.shp | Line Point |
| 4. Hydrology | | | |
| 4-1 | River system areas and river lines | RiverSystemArea.shp RiverBasin.shp RiverLines.shp RiverSystemArea_Detail.shp RiverLines_Detail.bds.shp | Polygon Polygon Line Polygon Line |
| 4-2 | Rainfall gauging stations | RainfallGaugingStation.shp | Point |
| 4-3 | Riverflow gauging stations | RiverflowGaugingStation.shp | Point |
| 4-4 | Water resources region | WRR_Area.shp | Polygon |
| 4-5 | Climate region | ClimateRegion_Area.shp | Polygon |
| 4-6 | Annual rainfall distribution | AnnualRainfall_Area.shp | Polygon |
| 5. Electricity Demand Area | | | |
| 5-1 | Electrification cooperative (Dissolved) | EnergizedCoopSystem_Dissolved.shp | Polygon |
| 5-2 | Electrification cooperative (EC) | EnergizedCoopSystem.shp | Polygon |

Table 7.3-2 (2) Basic Data List to Be Stored in the Database

| No. | Data Item | File Name(*.shp/.shx/.dbf/.prj) | Remarks |
|-----------------------------------|--|---|--|
| 6. Social environment | | | |
| 6-1 | Environmental protection area | ProtectedAreas.shp | Polygon |
| 7. Geology | | | |
| 7-1 | Geological map | Geology.shp | Polygon |
| 7-2 | Active faults | Faults.shx | Line |
| 7-3 | Active volcanoes | ActiveVolcanoes.shp ActiveVolcanoes_Buffer.shp | Point Polygon |
| 8. Administrative Boundary | | | |
| 8-1 | Political boundaries (state boundaries, city boundaries) | RegionalBound.shp ProvincialBound.shp MunicipalBound.shp BarangayBound.shp | Polygon Polygon Polygon Polygon |
| 9. Topography | | | |
| 9-1 | SRTM | phi-dem-utm.img | Raster |
| 9-2 | 1/50,000 | Map_50,000_Geodatabase.gdb | Raster |

1) HEP potential site data

The number of project sites which have coordinates (longitude, latitude) is 654 sites including 252 sites identified by JICA study team among the total of 1,952 sites registered in this database system. Project sites without information of coordinates are set at the center of barangay or municipality. The situation of information shortage about coordinates is described in the database. The waterway layouts including the intake, powerhouse, and waterway routes are also prepared by GIS data for the projects which project layouts are available.

2) Grid facilities

GIS data for routes of transmission lines and location of substations was prepared from the information provided by NGCP (National Grid Corporation of the Philippines). The transmission data is stored for each category of voltages (69 kV, 115 kV, 138 kV, 230 kV and 500 kV). GIS data of transmission lines and substations was prepared in this study by tracing the map of transmission lines (Fig. 4.4-1) because NGCP could not provide GIS data because of security issues.

3) Infrastructure

GIS data of roads and bridges were provided by FCSEC (Flood Control Sabo Engineering Center, DPWH). These data are based on 1/250,000 topographic maps.

4) Hydrology

Basic GIS data of river lines and river basin areas based are provided by FCSEC. However the accuracy of these data is not necessarily high because these data are based on 1/250,000 topographic maps. Therefore, GIS data of river lines and river basin areas for target areas are developed by tracing 1/50,000 topographic maps in this study. GIS data for location of rainfall gauging stations and riverflow gauging stations were prepared based according to documents obtained from PAGASA (Philippine Atmosphere, Geophysical and Astronomical Services Administration, DOST) and BRS (Bureau of Research and Standards, DPWH) respectively. The basic data of these gauging stations are shown in Fig.4.7-1 and Fig.4.7-5 respectively in Chapter 4.

Furthermore, the GIS data of climate regions, water resources regions, and annual rainfall distributions are also prepared by tracing the maps shown in Fig. 3.4-1, Fig. 3.4-2, and Fig. 4.7-2, respectively. The area of GIS data for discharge-duration curves which are distinguished by these data is also included in this database (For further information, refer the 4.7.5 in Chapter 4, Table 4.7-5 and Fig. 4.7-7).

5) Electricity demand area

As for electricity demand area, GIS data for boundaries of ECs and PIOUs (Private Investor-Owned Utilities) are developed by tracing the map shown in Fig. 2.3-1.

6) Social environment

As for social environmental information, GIS data was developed by tracing the distribution map of nature conservation areas provided by DENR (Department of Environment and Natural Resources) as shown in Fig. 4.9-2.

7) Geology

As for geological information, the GIS data of geology was developed by tracing the geological map (Fig. 4.8-1) provided by MGB (Mines and Geosciences Bureau, DENR). The GIS data of active faults was developed by tracing the distribution map of active faults and trenches provided by PHIVOLCS (Philippine Institute of Volcanology and Seismology, DOST) as shown in Fig. 4.8-3. Furthermore, the GIS data of active volcanoes was prepared from the list provided by PHIVOLCS (Table 4.9-1). The distribution of active volcanoes is shown in Fig. 4.9-6.

8) Administrative boundary

As for administrative boundaries, GIS data of areas for Regions, Provinces, Municipalities, and Barangays were provided by FCSEC. These data are based on the information in 2002.

9) Topography

As for topographic data, SRTM and 1/50,000 topographic maps were prepared for GIS data. The data of SRTM was downloaded from the Web site of USGS (United States Geological Survey). The 1/50,000 topographic data was provided by FCSEC and arranged to the database.

(3) Relevant Data (Program Data)

Program data files are necessary for executing subsystems which display relevant data on projects, site reconnaissance reports, layout profiles, 3D bird's eye views, duration curves and river profiles. To display this information, each program loads relevant data from the respective program files by connecting relational information in the "Core Data" using an ID key. Most of them are developed by "Visual Basic" or "Visual Basic Application".

Table 7.3-3 Program Data Files and Relevant Functions

| No. | Function | Program name | Program Data |
|-----|----------------------------|----------------------------------|---|
| 1 | HRD Main System | Philippines GIS. mxd | - |
| 2 | Site Search Function | SelectSiteList.exe | - |
| 3 | Duration Curve Viewer | DurationCurveViewer.exe | Duration Curve Data (CSV) |
| 4 | River Profiles Viewer | RiverProfilesViewer.exe | River Profiles Data (CSV) |
| 5 | Project Information Viewer | PotentialSitePdfViewer.exe | Project Information Data (PDF) Site Reconnaissance Report(PDF) |
| 6 | Layout Profile Viewer | LayoutViewer.exe | Layout Profile Data (CSV) |
| 7 | 3D Bird Eye | "GoogleEarth.exe" | 3 D Bird's eye Data (KMZ) |
| 8 | Maintenance System | Maintenance Philippines GIS. mxd | - |

The HRD system consists of the below execution programs and data files.

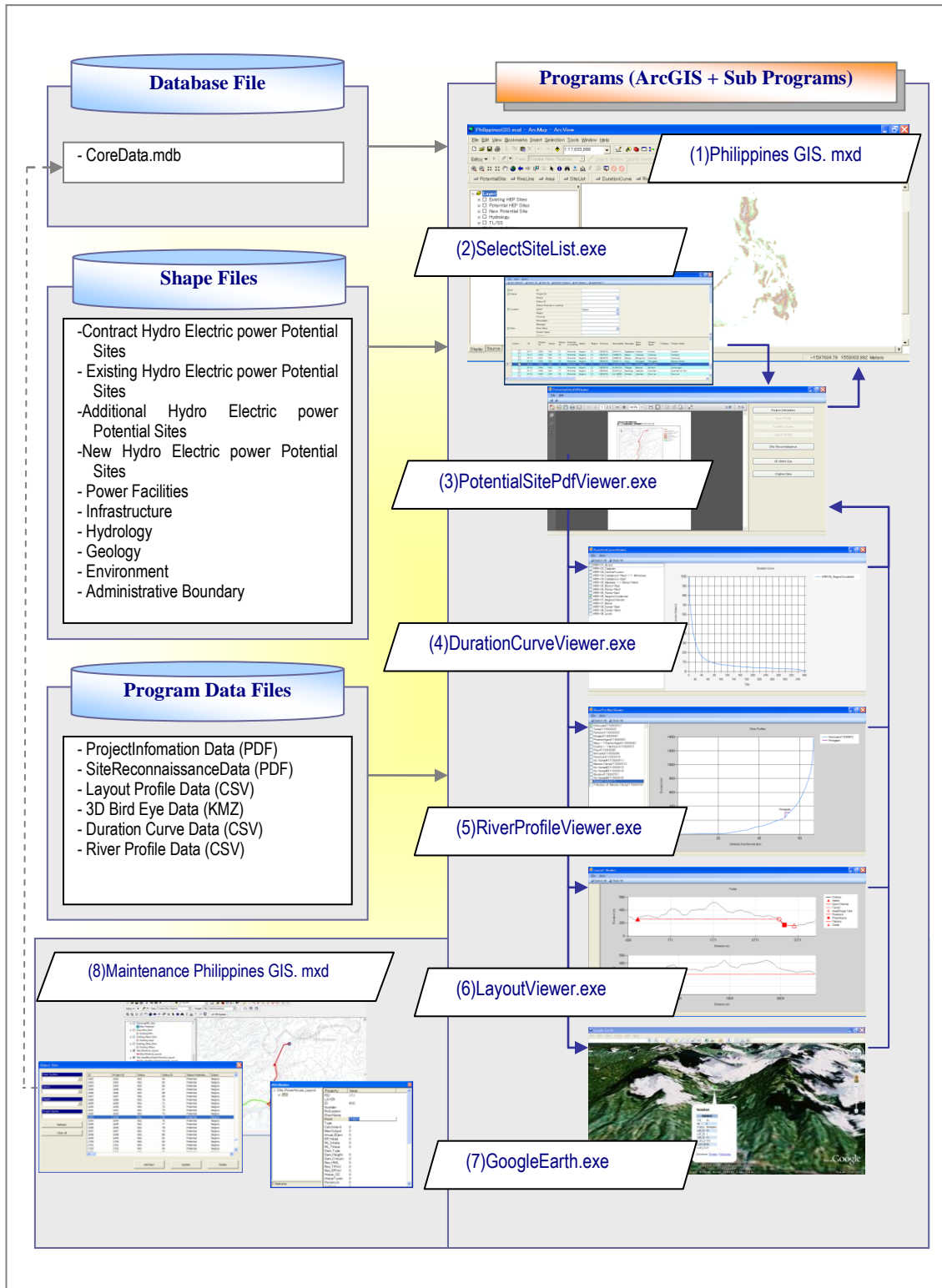


Fig. 7.3-3 Program Configuration and Relevant Data Files

7.3.3 Database Functions

Screen images and functions of the HRD system are shown below.

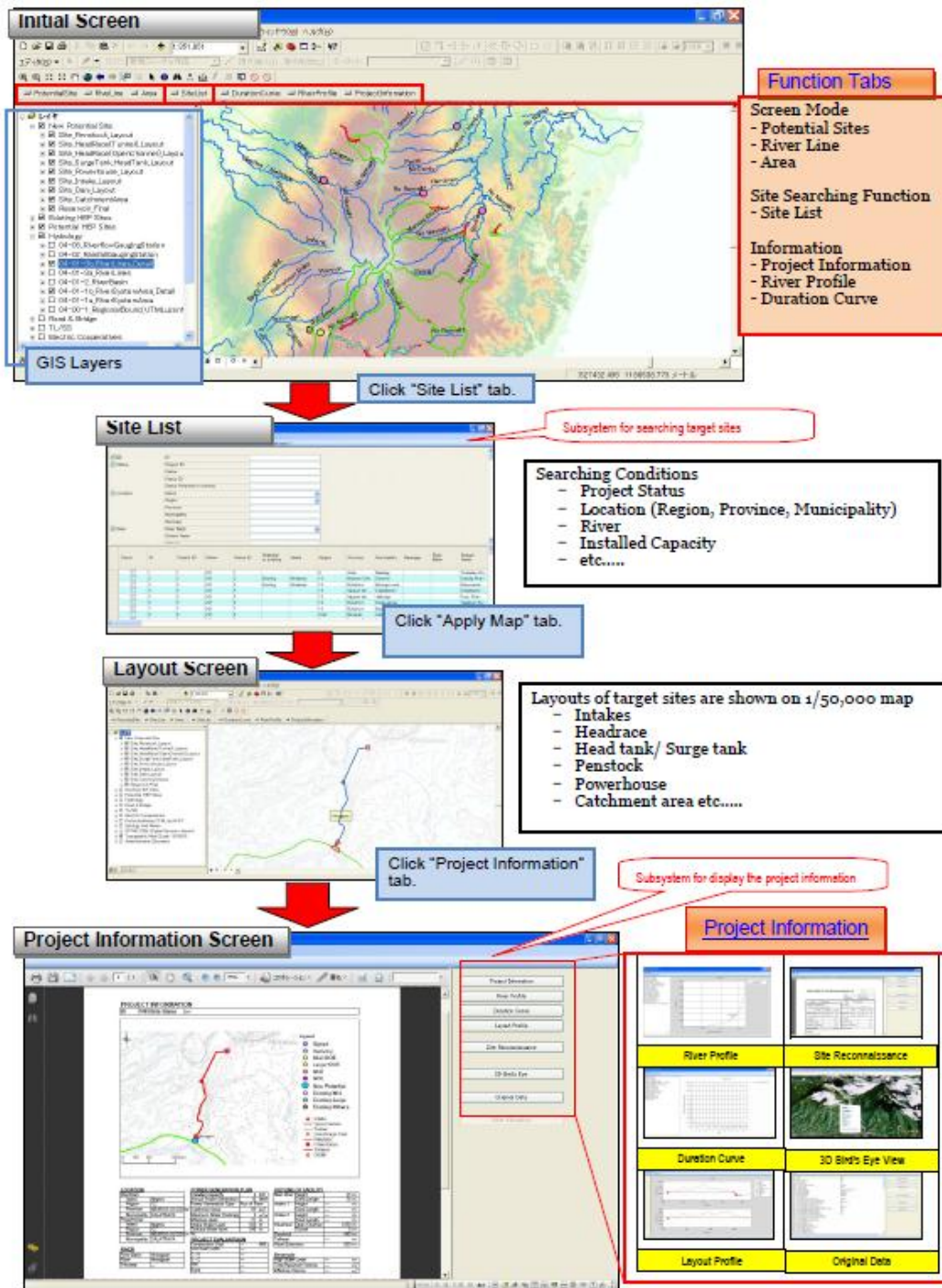


Fig.7.3-4 Operating Procedure of HRD

(1) Site Search

1) Display the Map

Information of GIS layers such as potential sites, hydrological information, infrastructure information, environmental information, and topographic maps can be displayed on the initial screen of HRD system. The examples of initial screen and potential sites on the topographic maps are shown below.

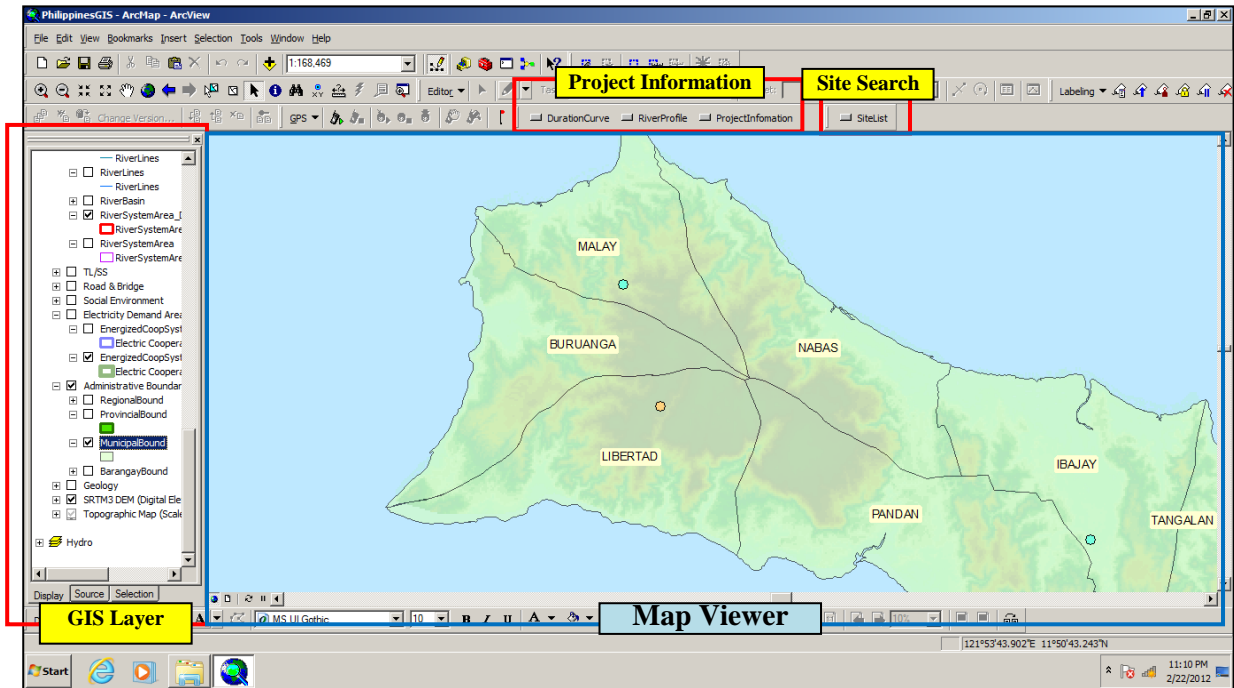


Fig.7.3-5 Initial Screen

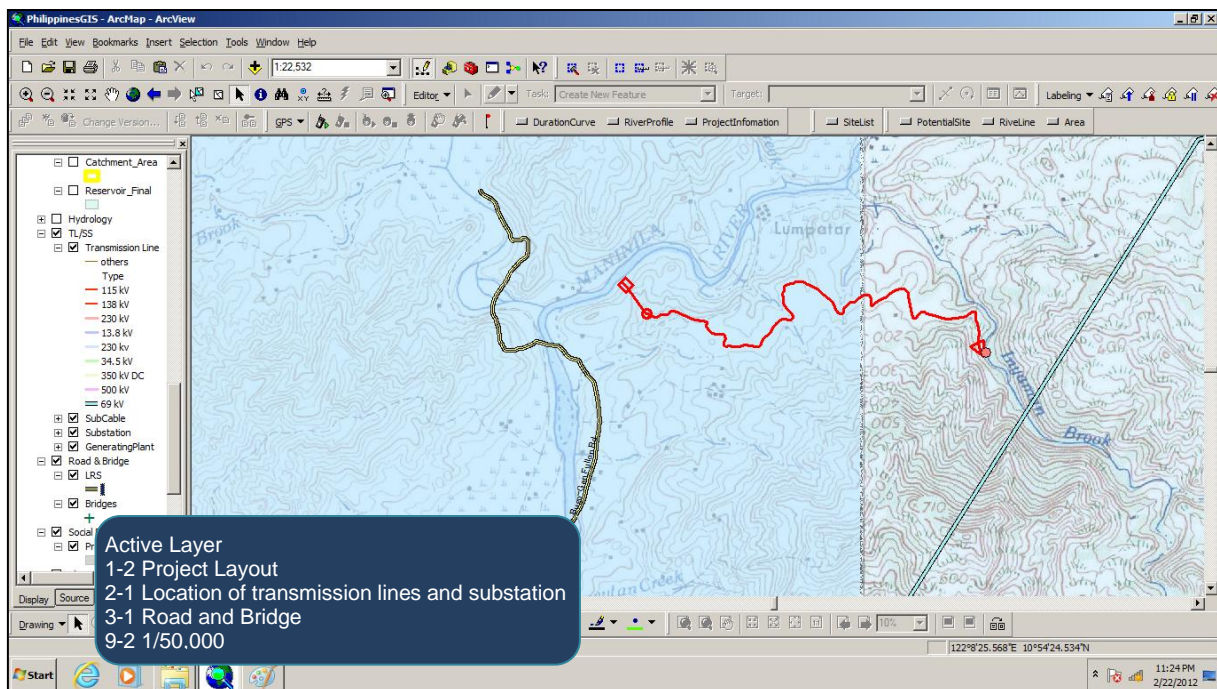
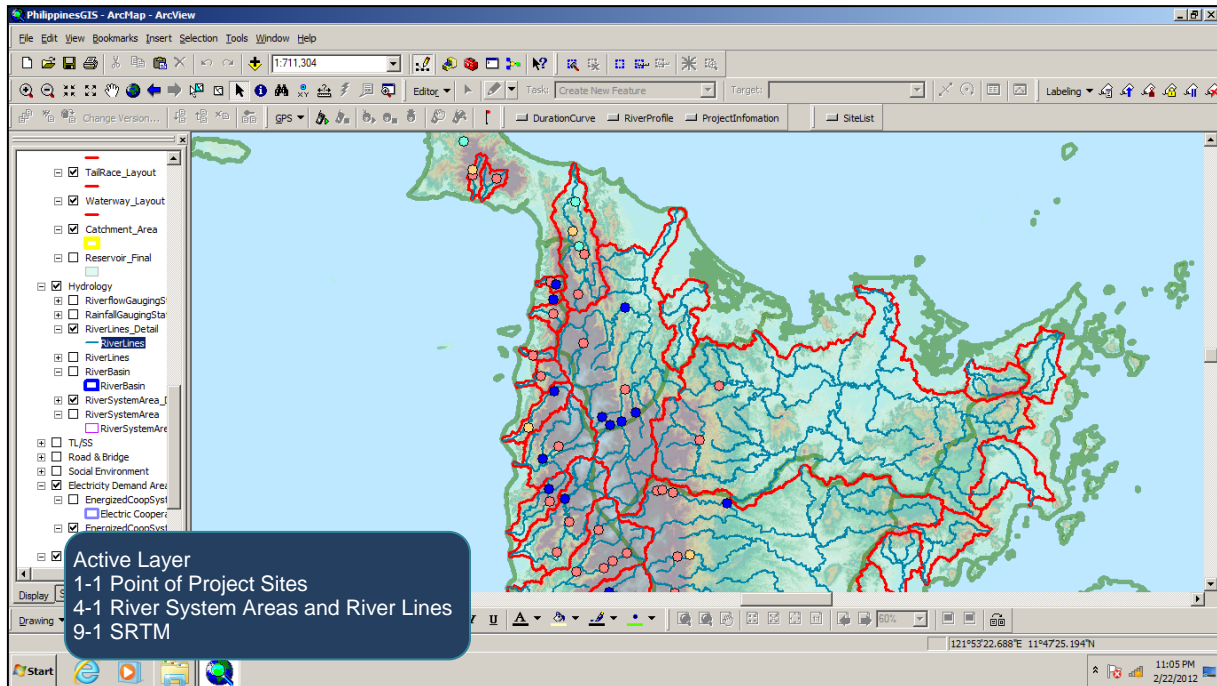


Fig. 7.3-6 Display the Maps

2) Site Search

Potential sites can be searched by the button “Site List” located under the tool bar. User can refine target sites by various searching conditions. As shown in Fig. 7.3-6 below, users can search potential sites by inputting search condition such as “Project ID”, “Project Status”, “Name of the Project”, “Island”, “River Name”, “Maximum Output” etc. Search conditions to be input are shown in above Table 7.3-1.

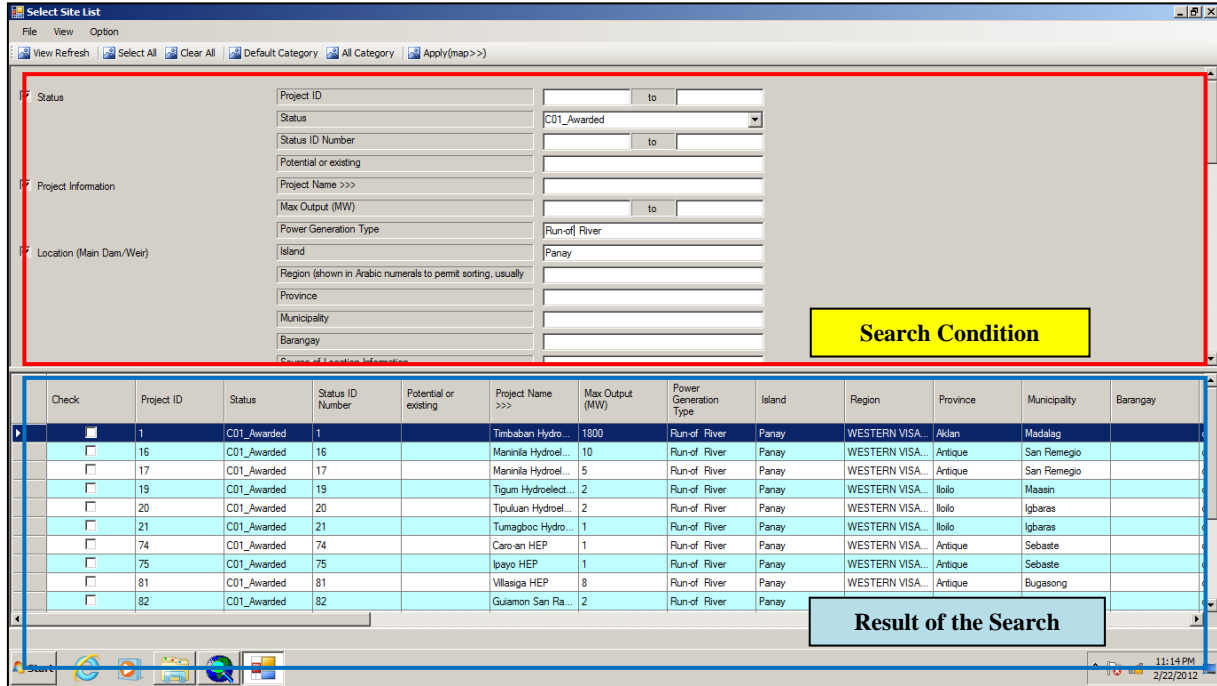
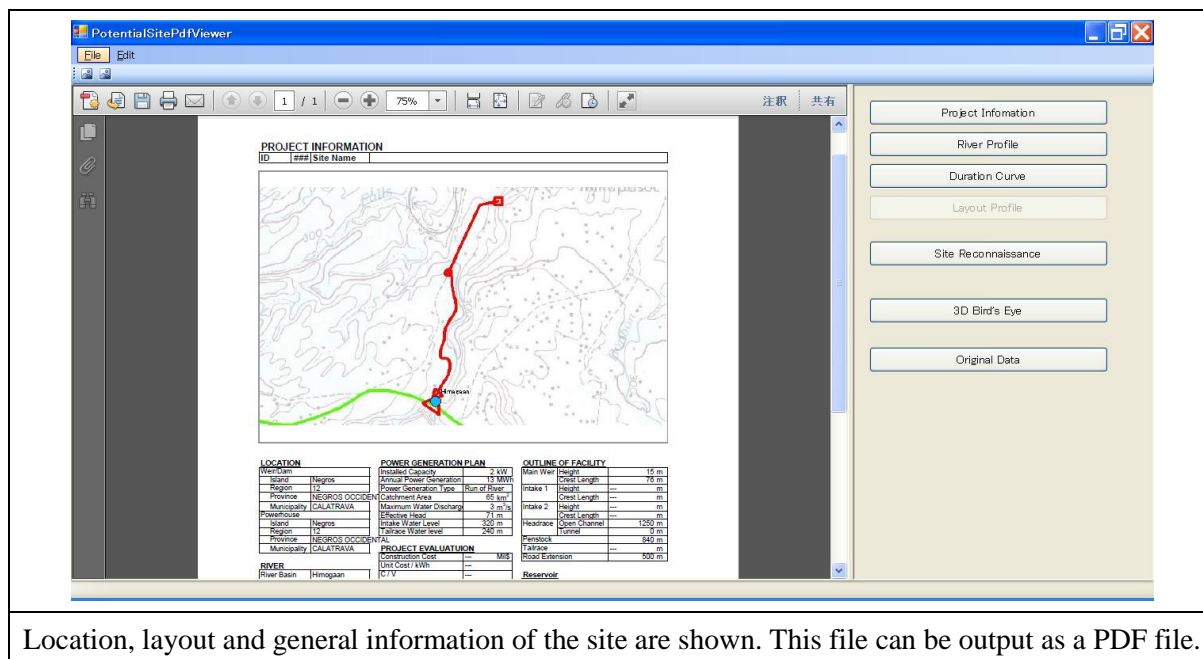


Fig.7.3-7 Site Search Window

(2) Project Information

1) Project Information

Project information sheets for the project are prepared as PDF data which are connected to this database. Users can display these project information sheets by selecting the project sites.



Location, layout and general information of the site are shown. This file can be output as a PDF file.

Fig.7.3-8 (1) Project Information

2) River Profiles

River profiles data were developed based on 1/50,000 topographic maps as shown in 4.7.2 of Chapter 4, and stored as CSV data. Users can display these river profiles graphs which connected with relevant rivers and projects by selecting the river or selecting the projects. The location of the project also can be displayed on the river profiles graphs by registering the project location on the river profile data.

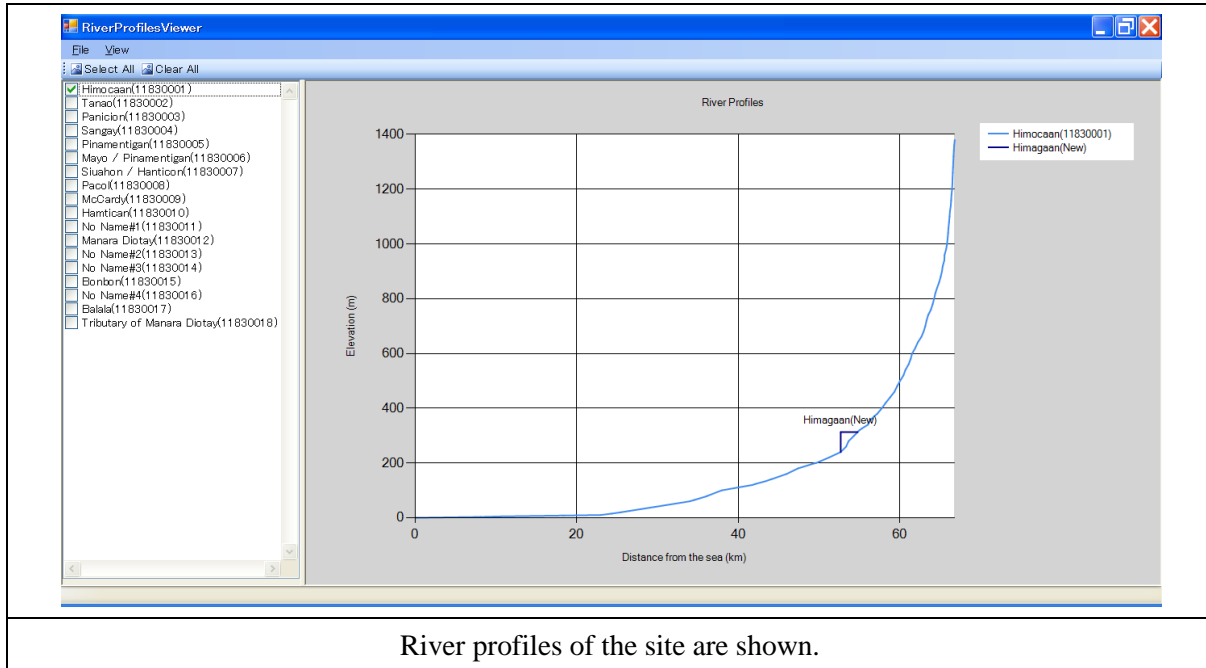
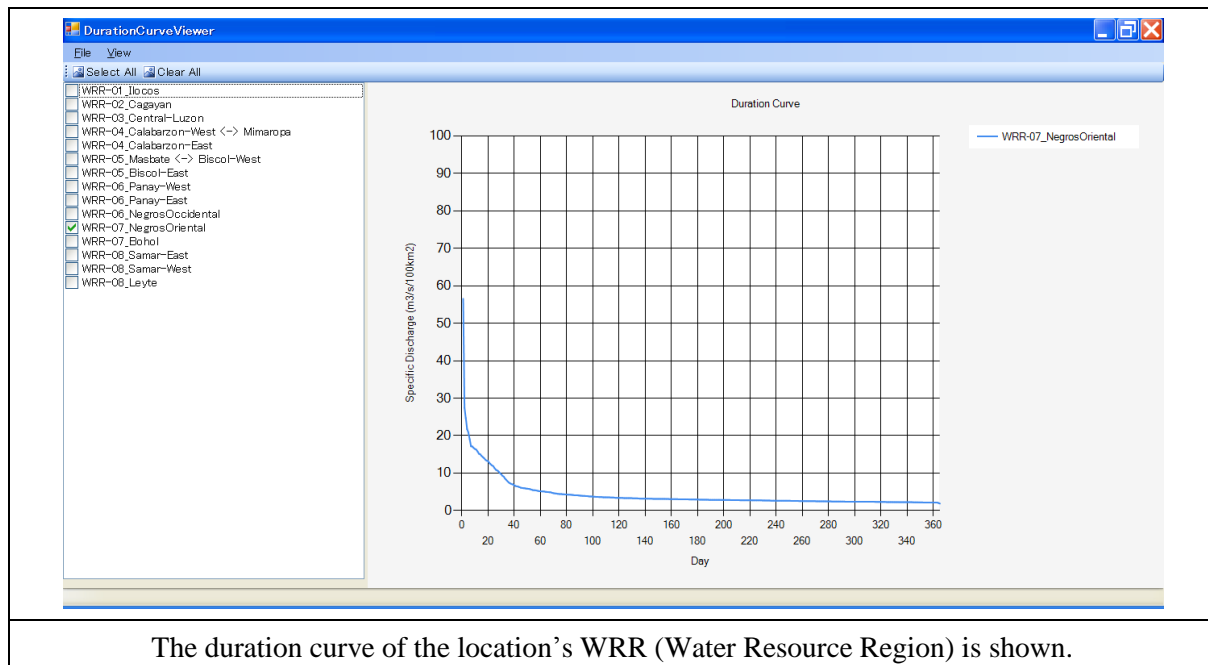


Fig.7.3-8 (2) River Profiles

3) Discharge-Duration Curve

Data of discharge-duration curves as described in 4.7.5 of Chapter 4 and 5.6.4 of Chapter 5 are stored by CSV format in this database system. Users can display these data in this system by connecting these data to the relevant projects.

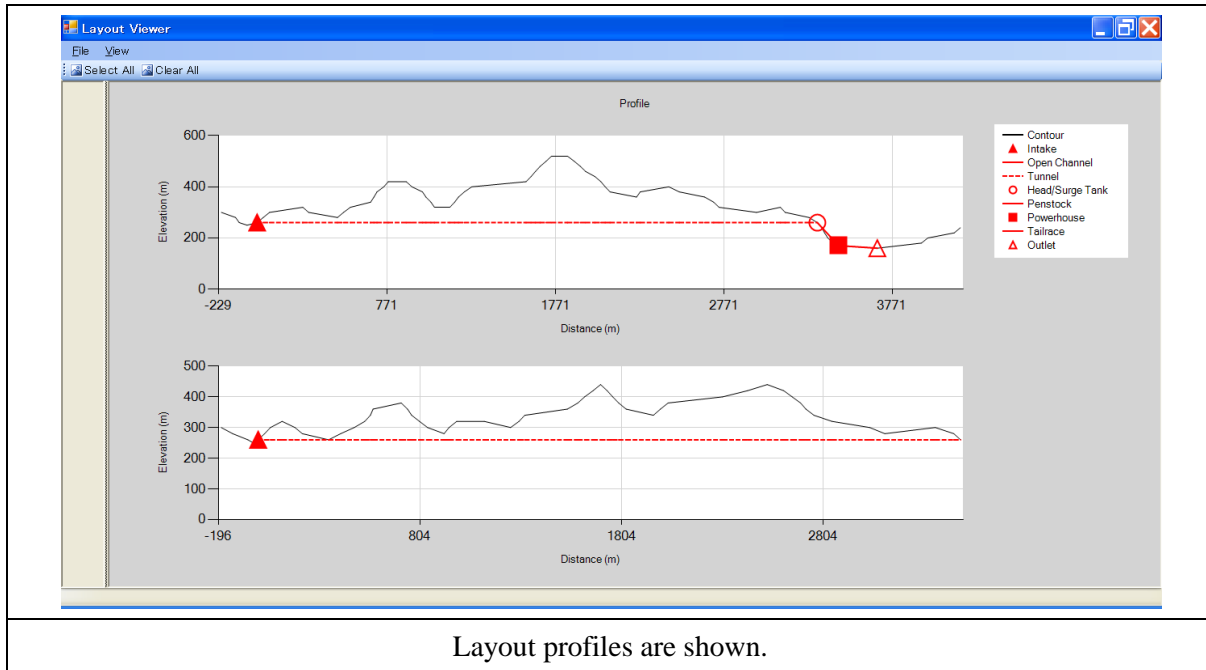


The duration curve of the location's WRR (Water Resource Region) is shown.

Fig.7.3-8 (3) Discharge - Duration Curves

4) Waterway Profiles

Longitudinal profiles among the waterways were developed based on 1/50,000 topographic maps, and stored as CSV data in this system. Users can display the waterway profiles at the window of the project information by connecting these data with the project.

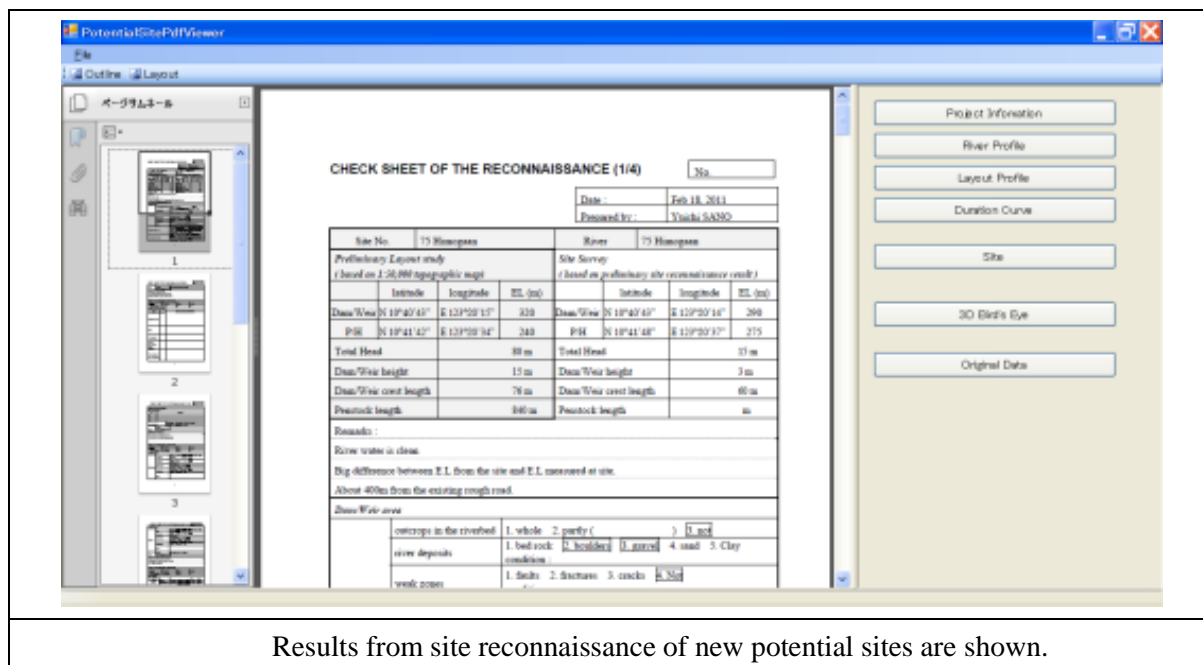


Layout profiles are shown.

Fig.7.3-8 (4) Waterway Profiles

5) Site Reconnaissance Report

Site reconnaissance reports can be displayed in this system by preparing as PDF data and stored at the designated directory. As of February 2012, 47 site reconnaissance reports as described in section 5.6 of Chapter 5 are prepared in this system



Results from site reconnaissance of new potential sites are shown.

Fig.7.3-8 (5) Site Reconnaissance Reports

6) 3D bird Eye View

3D bird's eye view data was prepared by Google Earth and stored as KMZ data in this system. Users can display 3D bird's eye view by Google Earth by selecting this function at the window of the project information connected to these KMZ data.

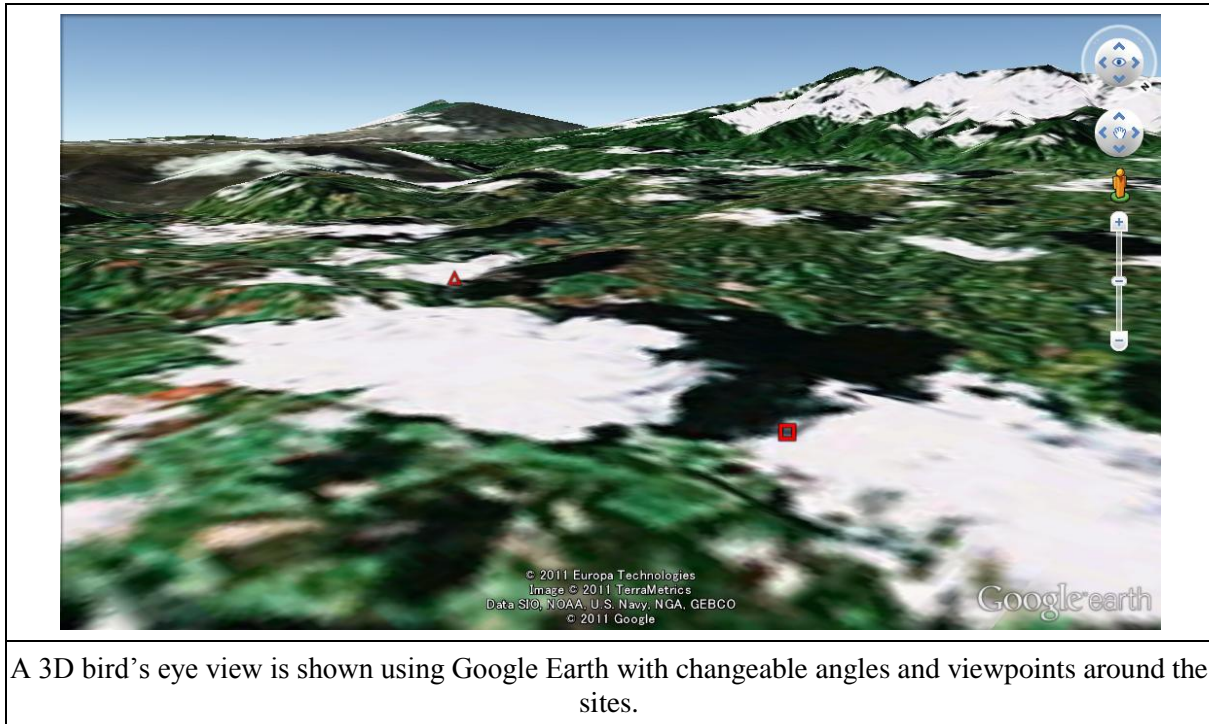


Fig.7.3-8 (6) 3D Bird's eye of Google Earth

(3) Updating and Adding Project Information

Screen images and functions of updating features are shown below. After opening the maintenance function, users can select three types of operations: “Add new,” “Update” or “Delete”. For instance, when users select “Update,” they can update a record in the project information using a “Selecting Dialog.” Once users select an item to update, they overwrite the character in small boxes and save the changes.

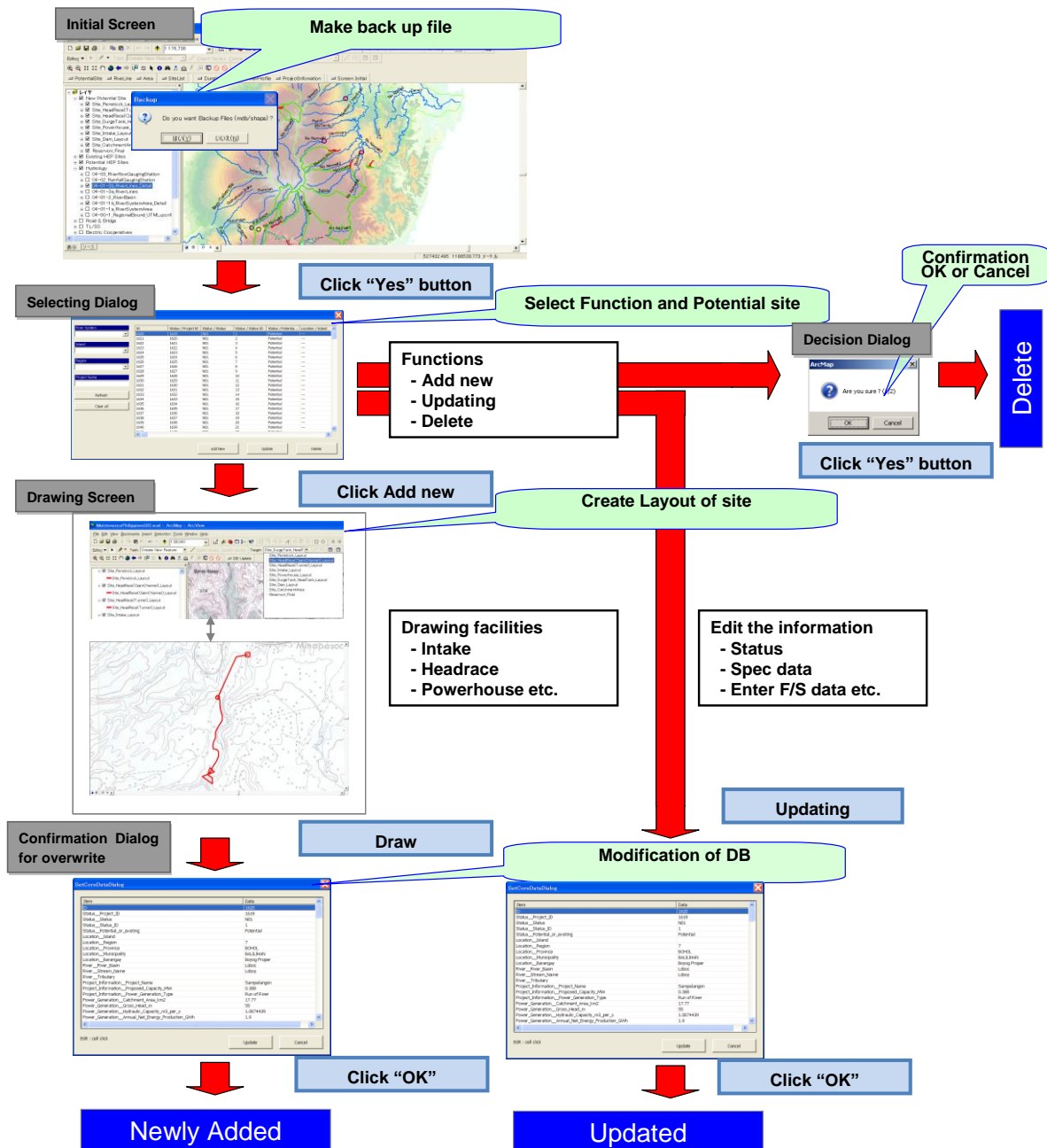


Fig. 7.3-9 Operating Procedure of Maintenance Function

1) Updating the project information

It is possible to update (add new, updating, and delete) the project information by inputting necessary data on the input window of the system. When the information of the coordinates (Longitude, Latitude) is updated, the GIS point data of the project will be updated automatically because these point data is recognized as the location of the intake in this system. When updating the project information is finished in this process, the Project Information Sheet will be updated / newly created automatically in this system.

2) Updating the project layout

Updating / newly creating the project layout (facilities layouts, waterway route, etc.) can be executed by basic functions of Arc GIS. After saving this operation, the Project Information Sheet will be updated automatically.

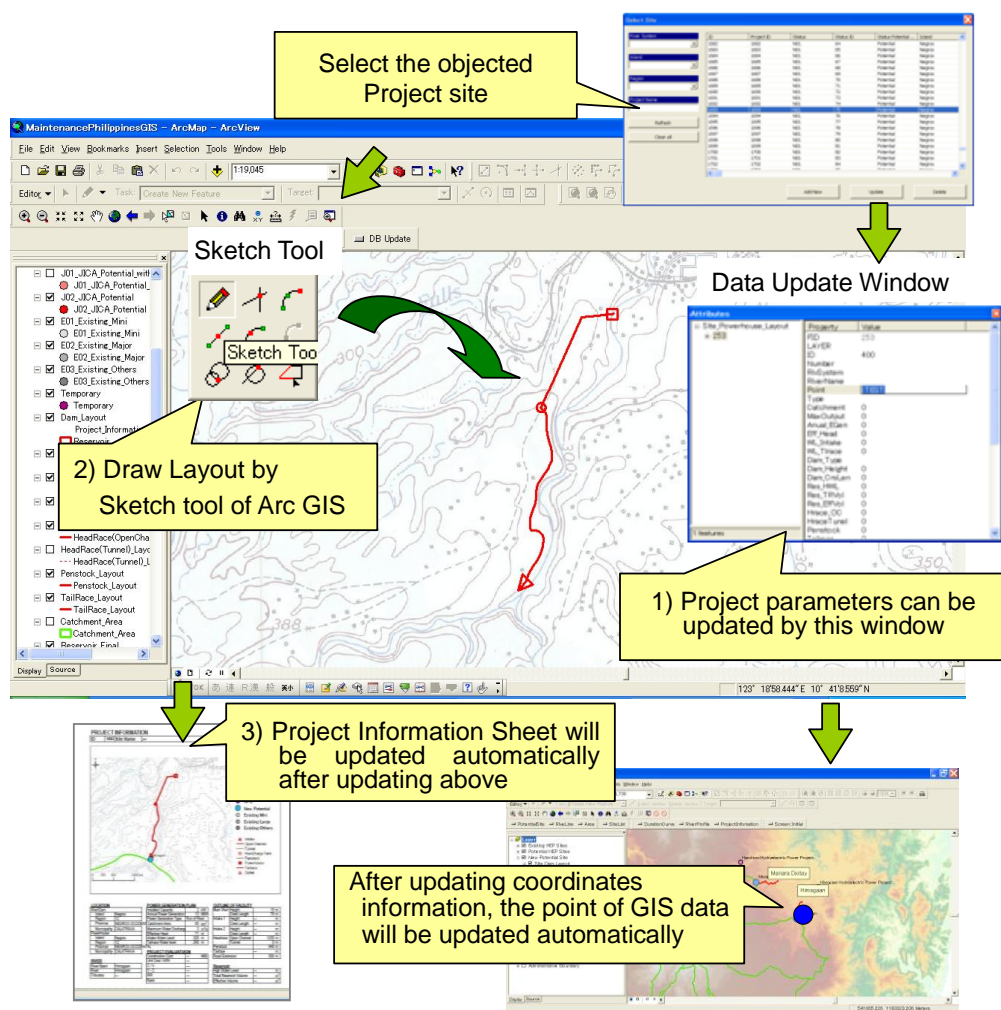


Fig. 7.3-10 Image of Updating the Project Site

3) Updating the relevant information

a) Project Information Sheet

Project Information Sheets are stored as PDF files (as described above in 7.3.2). As described in above 1) and 2), PDF file of Project Information Sheet will be produced automatically after updating the project information and the project layouts.

b) Site Reconnaissance Report

The site reconnaissance report should be prepared as PDF file. By storing the PDF file at the designated directory, the report will be available on the system.

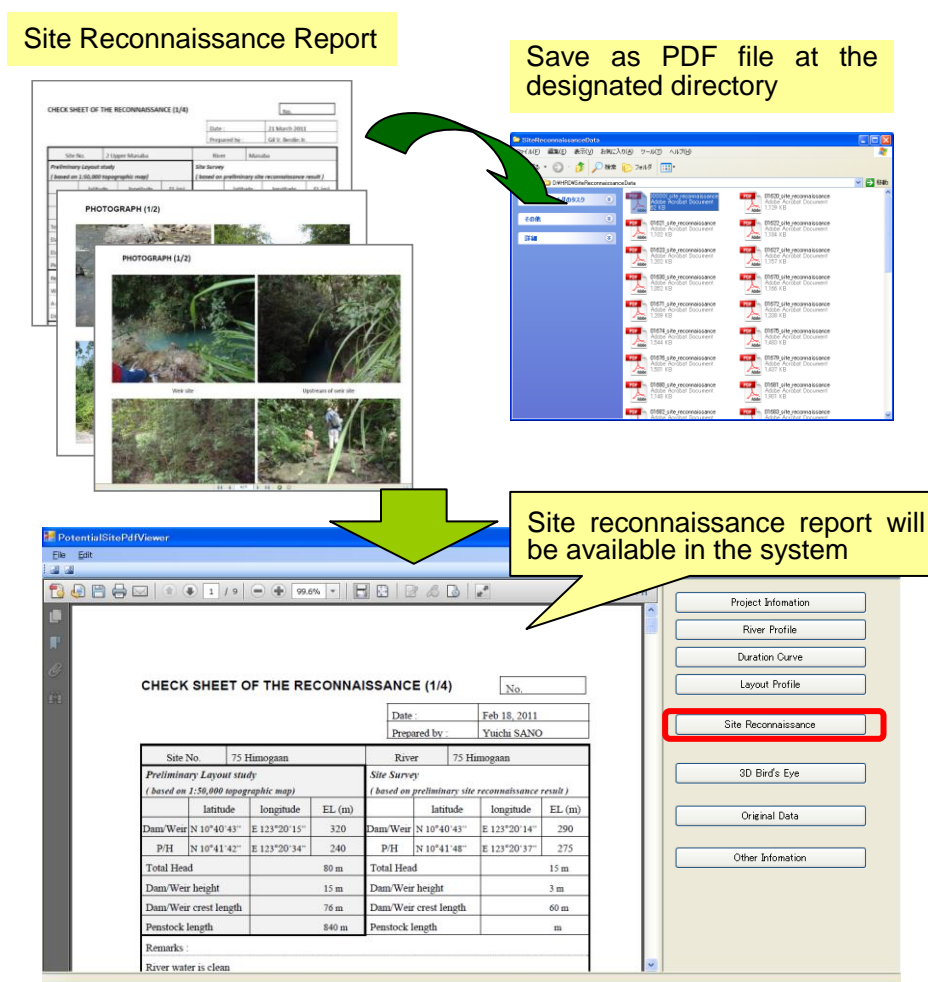


Fig. 7.3-11 Image of Updating Site Reconnaissance Report

c) Waterway Profiles

As described in the above 7.2.3 (3), the waterway profiles data should be prepared as CSV data. These data can be updated by updating / adding the CSV data and connecting with the project information by the project ID, and will be available on the system.

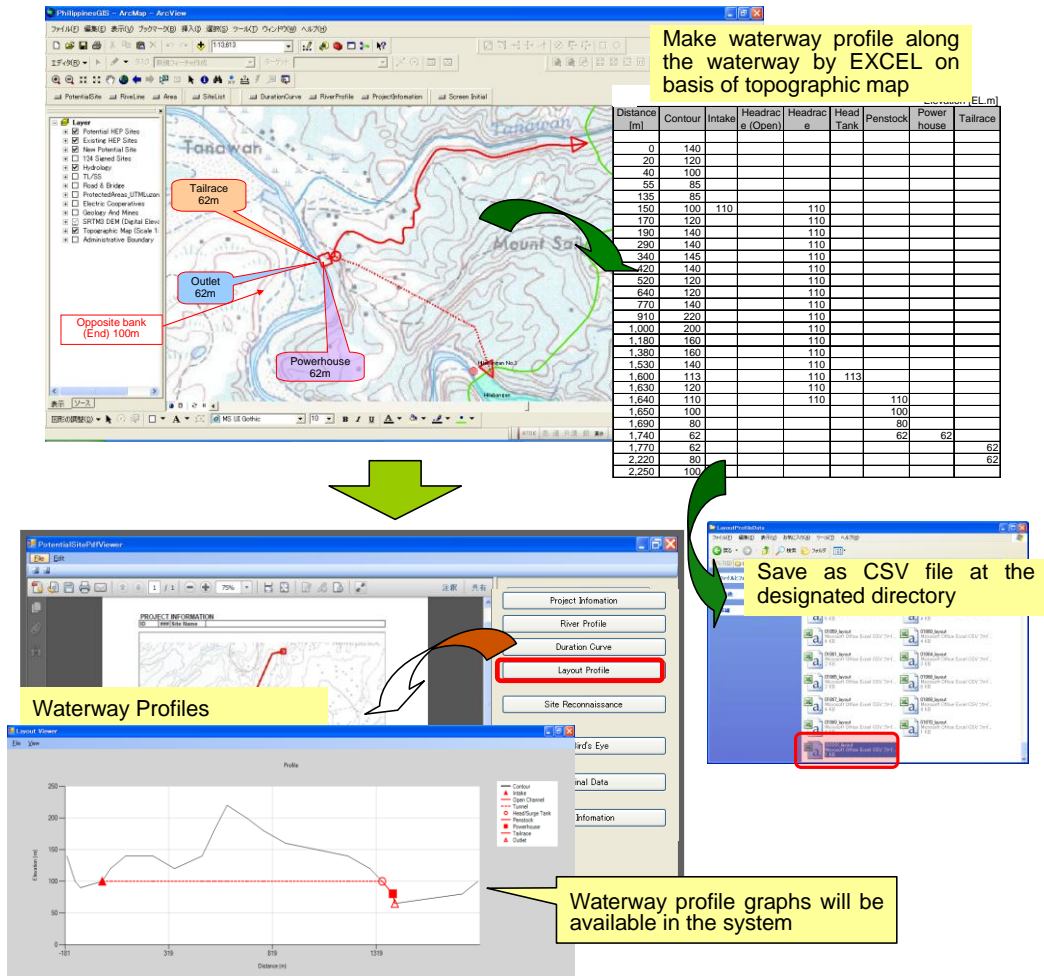


Fig. 7.3-12 Image of Updating Waterway Profiles

d) River Profiles

As described in the above 7.2.3 (3), the river profiles data should be prepared as CSV data. These data can be updated by updating / adding the CSV data and connecting with the project information and / or the river ID of the project and / or the GIS data of the river, and will be available on the system.

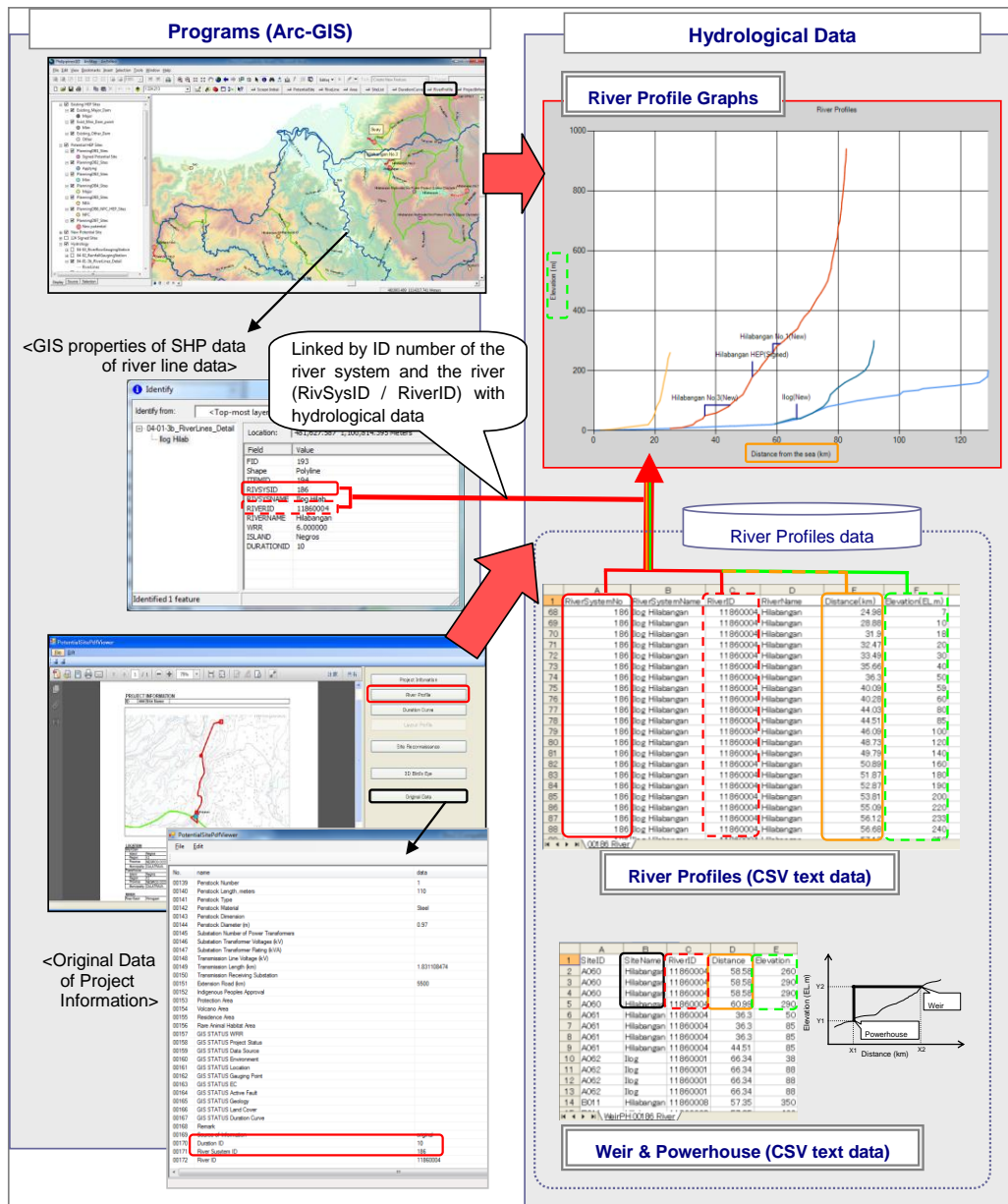


Fig. 7.3-13 Image of Updating River Profiles

e) Discharge – Duration Curve

As described in the above 7.2.3 (3), the discharge – duration curve data should be prepared as CSV data. These data can be updated by updating / adding the CSV with the Duration ID and connecting with the project information in the corresponding duration ID, and will be available on the system.

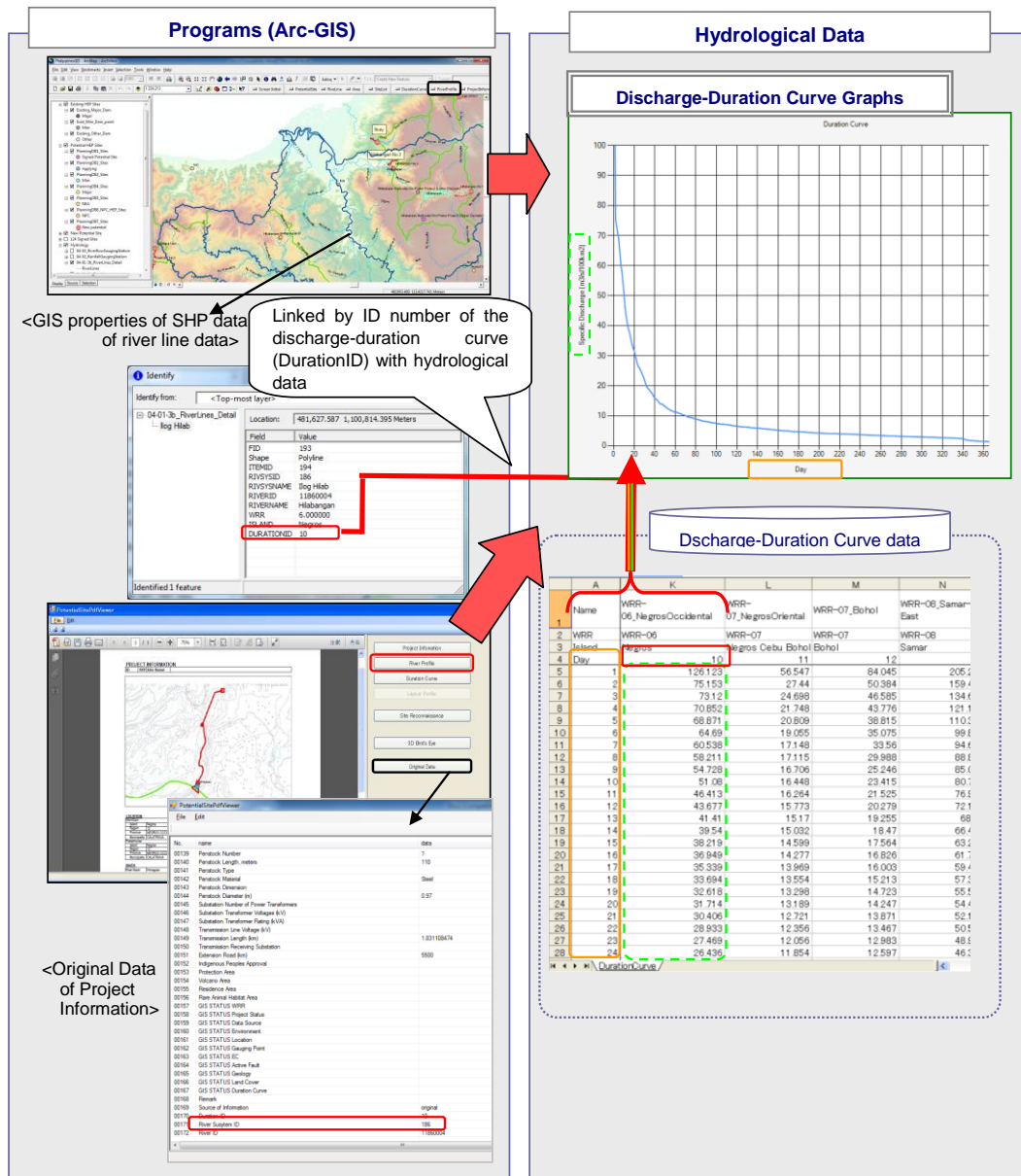


Fig. 7.3-14 Image of Updating Discharge – Duration Curves

Screen images and functions of maintenance features are shown below. After opening the maintenance function, users can select 3 types of operations: “Add new,” “Update” or “Delete”. For instance, when users select “Update,” they can update a record in the project information using a “Selecting Dialog.” Once users select an item to update, they overwrite the character in small boxes and save the changes.

7.4 DATABASE OPERATION AND MAINTENANCE

7.4.1 Organizations and Roles

The organizational structure of the DOE is shown in Fig.7.4-1. Organizations concerned with HRD facilitation and utilization are listed below.

- (1) HOEMD (Hydropower and Ocean Energy Management Division, DOE), REMB
- (2) TSMD (Technical Service and Management Division, DOE)
- (3) ITD (Information Technology Division, DOE)

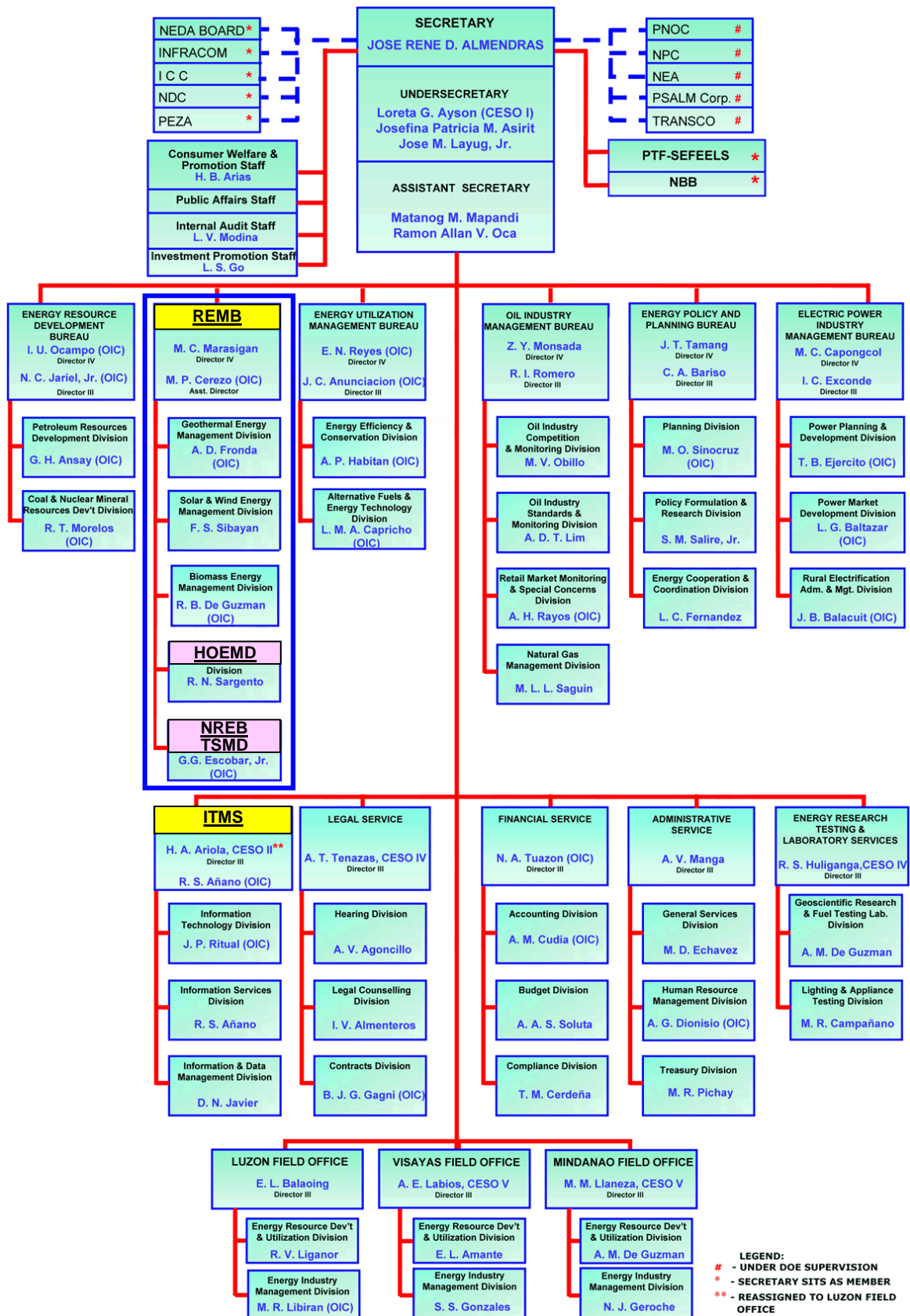


Fig. 7.4-1 Organization of DOE

(1) HOEMD

The mission of HOEMD is to formulate and implement policies, plans and programs related to the accelerated development, transformation, utilization and commercialization of hydropower and ocean energy resources. The organization and functions of HOEMD are as shown below.

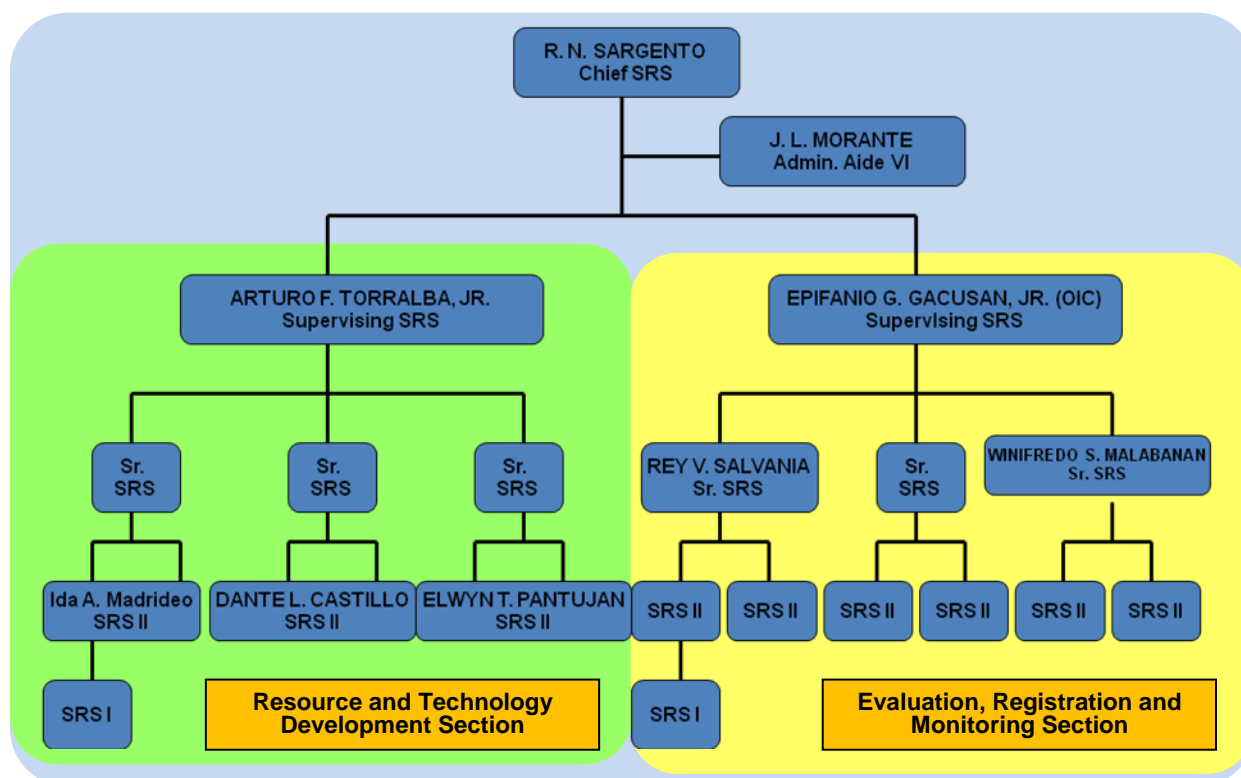


Fig. 7.4-2 Organization of HOEMD

HOEMD consists of two sections: Resource and Technology Development Section and Evaluation, Registration and Monitoring Section. In the DOE plan, HOEMD consists of twenty one staff members, however only nine persons are working today.

Table 7.4-1 Functions of HOEMD

| Section | Functions |
|---|---|
| Resource and Technology Development Section | <ul style="list-style-type: none"> - Formulate, develop and evaluate programs and policies of hydropower and ocean energy technologies. - Conduct hydrologic, geological, topographic, oceanographic and economic surveys, feasibility studies and research programs. - Maintain a database inventory of hydropower and ocean energy potential, and update the database regularly for the commercialization and ranking of hydropower and ocean energy sites. - Conduct socio-economic and environmental impact studies on hydropower and ocean energy development, and recommend mitigating measures to lessen harmful effects to the environment. - Provide technical assistance and sustainable solutions in relation to the development and operation of hydropower and ocean energy facilities. - Conduct seminars, training courses, technical briefings, workshops, focus group discussions and tri media campaigns. |
| Evaluation, Registration and Monitoring Section | <ul style="list-style-type: none"> - Formulate policies and oversee the implementation of policies, guidelines and standards for hydropower and ocean energy development. - Supervise and monitor activities of governmental and private institutions on hydropower and ocean energy projects, and provide guidance for better understanding of the government's regulatory functions, policies and programs. - Maintain a database inventory of hydropower and ocean energy facilities for monitoring and developing hydropower and ocean energy generation statistics. - Conduct socio-economic and environmental impact studies on hydropower and ocean energy development, and recommend mitigating measures to lessen harmful effects to the environment. - Issue registration and accreditation to RE equipment manufacturers, fabricators and suppliers. - Coordinate with various government agencies, LGUs, Academe, NGOs, private sector businesses and other stakeholders. - Conduct seminars, training courses, technical briefings, workshops, focus group discussions and tri media campaigns. |

HOEMD has recently worked on registration and monitoring of RE-contracts (Renewable Energy Contracts) projects. HOEMD has registered 124 HEP projects and received appropriately 250 applications for RE-contracts as of September 2011. One hundred of the 244 applications have already been approved and will be registered as RE-contracts (as of September 2011). The procedures of RE-contracts are shown below. The registration of a project is qualified based on the check list of financial and technical conditions. The results of F/S are approved using evaluation sheets.

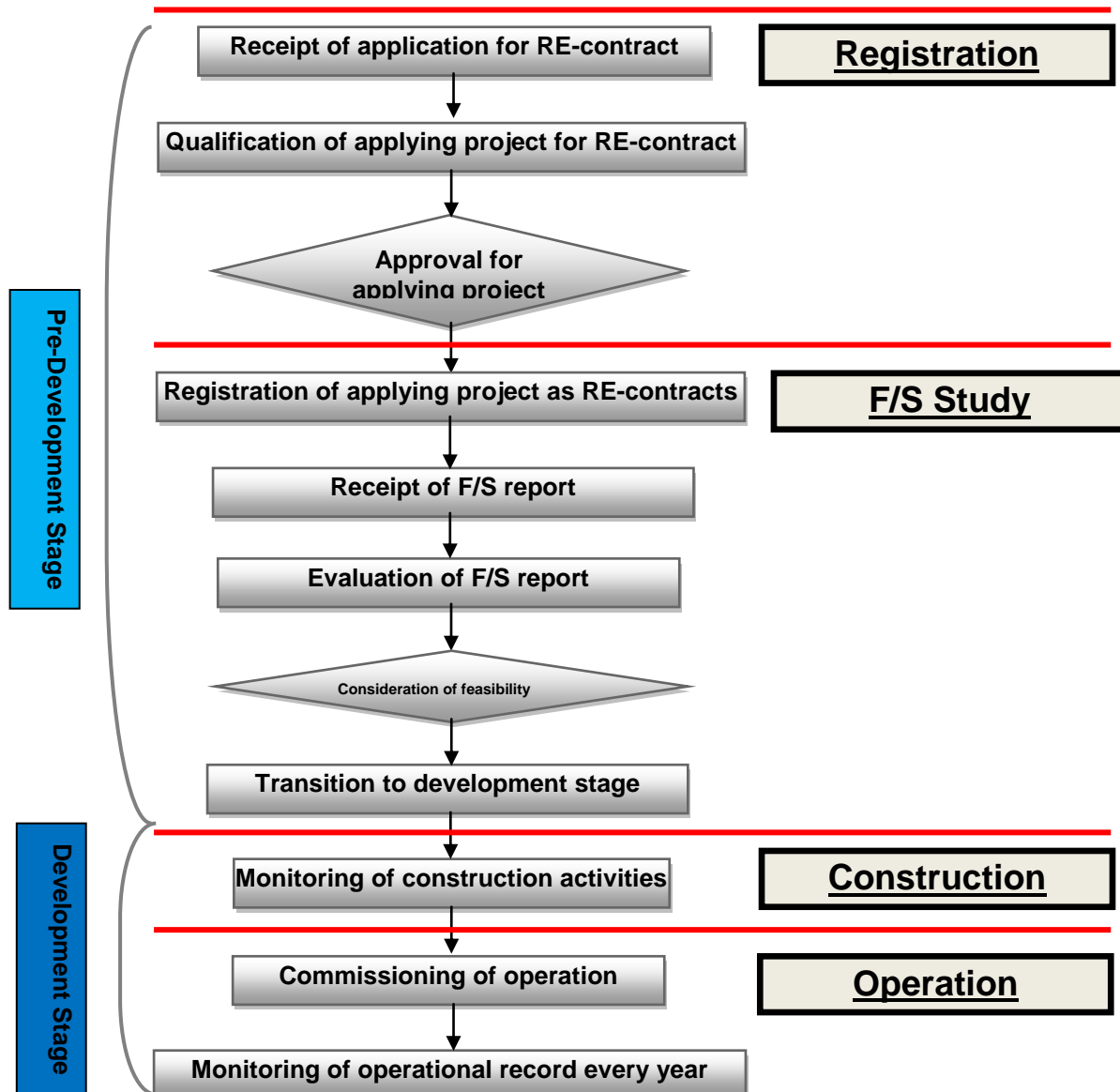


Fig. 7.4-3 Procedures on RE-contracts

| REQUIREMENTS CHECKLIST (RENEWABLE ENERGY SERVICE/OPERATING CONTRACT UNDER RA NO. 9513) | | | |
|---|-----------|----|---------|
| Name of Applicant | | | |
| Company/Business Name | | | |
| Name of Project | | | |
| Particulars | Submitted | | Remarks |
| | Yes | No | |
| Pre-Development Contract APPLICATION/PROPOSAL | | | |
| 1. Letter of Intent/Application; | | | |
| 2. Duly accomplished RE Contract Application Form; Duly accomplished RE Contract Application Form; and | | | |
| 3. Map showing the applied area (RE area of application; in case of ocean, solar, wind, and geothermal, must conform with the DOE Blocking System). | | | |
| LEGAL REQUIREMENTS | | | |
| 1. Individual or Single Proprietorship | | | |
| a. Birth Certificate- duly authenticated by National Statistics Office (NSO); | | | |
| b. Business Permit- certified true copy; and | | | |
| Department of Trade and Industry | | | |

Fig. 7.4-4 Checklist of Requirements

| PROJECT PROFILE | | | |
|--|--|--|---------|
| 4.5 MW Ibulao River Mini-hydro Project | | | |
| PARTICULARS | | DESCRIPTION | REMARKS |
| Location (Sillo, Barangay, Municipality, Province) | | Brgy. Bagingue, Kiangran, Itugao | |
| Coordinates: Intake / Elevation | | Lat: 16° 46' 56" Long: 121° 07' 27" Crest Elev.: 429.00 m. | |
| Coordinates: Powerhouse / Elevation | | Lat: 16° 46' 56" Long: 121° 07' 27" Tailwater Elev.: 416.00 m. | |
| Name of River: Ibulao River | | | |
| Hydrology | | Proposed SCHEME of DEVT. | |
| Drainage Area | | 509.58 sq.kms. | |
| Design Discharge/% exceedance | | 50.0 CMS at 28% availability factor | |
| Firm Discharge/% exceedance | | 10.5 CMS at 90% | |
| Mean Discharge | | 35 CMS at 50% (approx.) | |
| Flood Discharge/ no. of years | | 573.69 CMS/100 yrs (Log Pearson) | |
| Head | | 12 meters | |
| Gross Head | | 12 meters | |
| Net Head | | 10.8 meters | |
| Capacity Installed | | 4.5 MW | |
| Efficiency (Turbines & Generator) | | 85.00% | |
| Plant Factor | | 58.70% | |

Fig. 7.4-5 F/S Evaluation Sheet

(2) TSMD

The TSMD is a division of the NREB (National Renewable Energy Board). The TSMD is in charge of overall activities regarding renewable energy.

(3) ITD-ITMS

The ITMS (Information Technology Management Service) is in charge of information technology and management, such as communication infrastructure of the DOE, technical assistance on information technology, management of websites and so on. The ITD (Information Technology Division) is a division of the ITMS and composed of three sections: Information Systems, Database Administration and Network Administration.

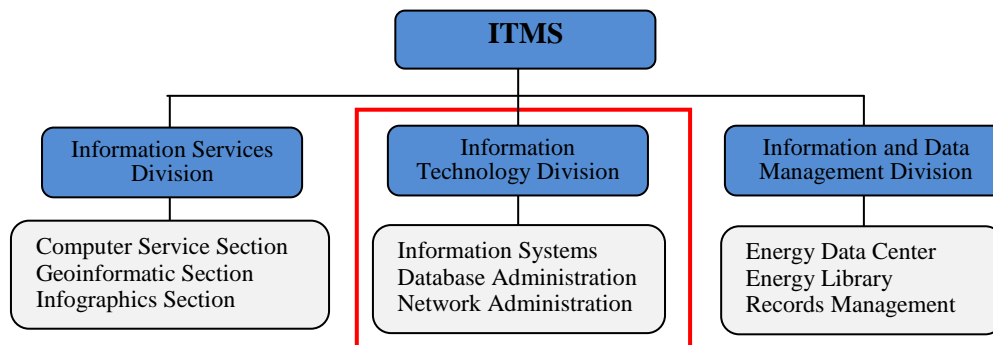


Fig. 7.4-6 Organization of ITMS

7.4.2 Organizations and Roles for Data Provision

The following three divisions coordinate and play each a role in the operation, maintenance and management of the HRD system. The roles of each division are described below.

(1) HOEMD (Hydropower & Ocean Energy Management Division)

- HRD system operation and maintenance
- Update of RE-contracts information
- Supervision from registration and development to operation of HEP
- Data provision of HEP projects to developers
- Establishment of an information desk
- Face-to-face service for developers
- Facilitation of new potential sites identified by JICA study
- Holding of seminars

(2) TSMD (Technical Service Management Division)

- Technical assistance for facilitation of new identified sites and management of RE-contracts information
- Preparation of documents for data provision

(3) ITMS (Information Technology Management Services)

- Technical assistance for Arc GIS operation and management of the HRD
- Update of documents on the DOE website

The following diagram shows the roles and relevancy of the DOE-REMB sections as described above.

DOE website provides updated HEP information to all investors. To obtain more detailed and new information, investors inquire with HOEMD and interview face-to-face with the person in charge. The information desk at HOEMD accepts inquiries, and the information manager provides interactive services for transferring information via HRD operation. The ITMS helps creating materials with geographical information to be stored in the HRD, and updates the information on the DOE website. The TSMD holds information activities for promoting HEP development and provides relevant data to investors.

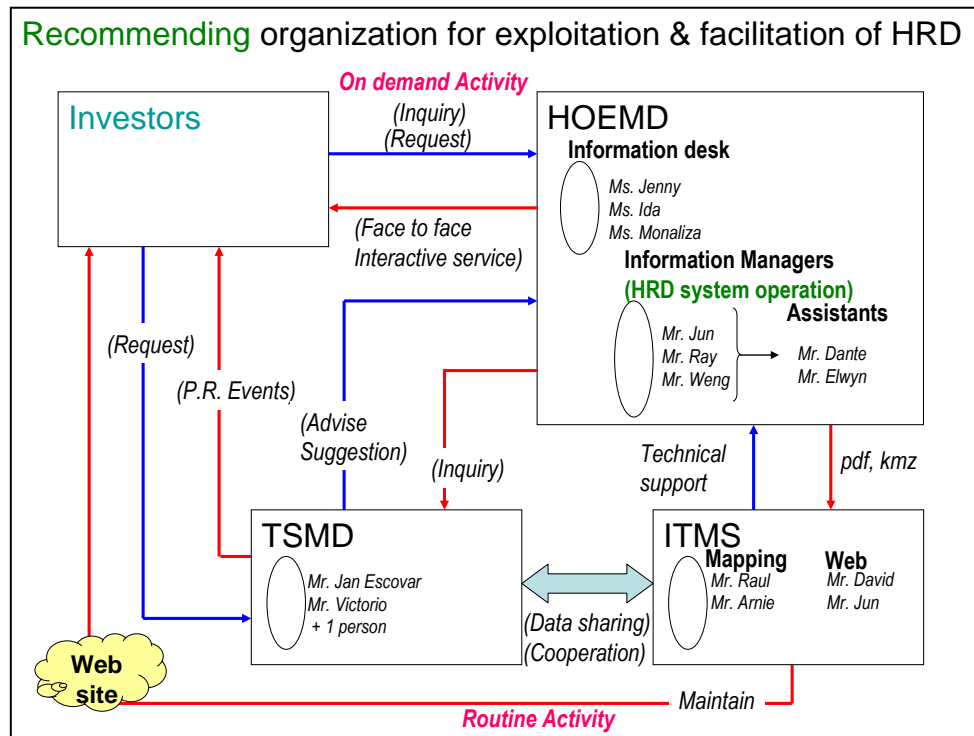


Fig. 7.4-7 Outline of Use & Facilitation of the HRD

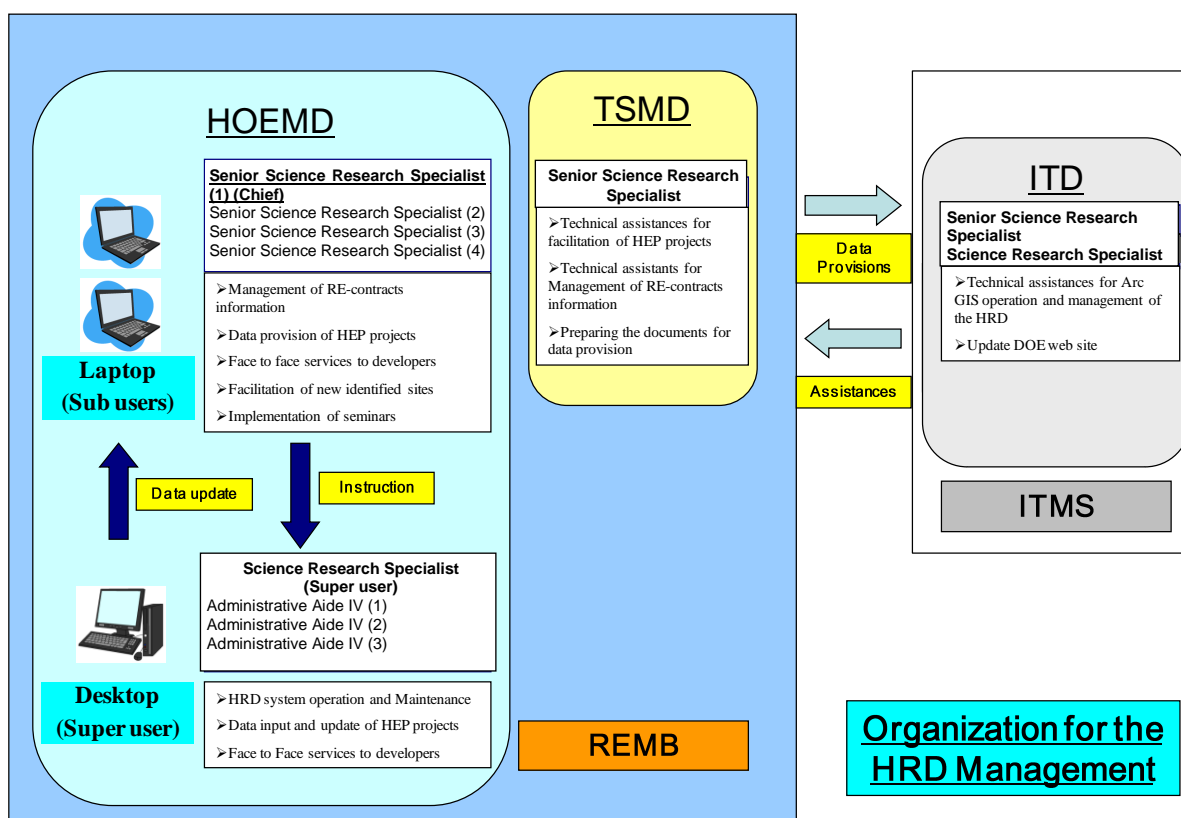


Fig. 7.4-8 Organization and Roles in HRD Management



7.4.3 Installed Equipment

The JICA study team introduced one desktop PC and two laptop PCs for the HRD to the HOEMD of the DOE-REMB. Maintenance tools for managing the HRD are installed only on the desktop PC handled by an administrator and only the administrator can update and add the HEP projects information.

Table 7.4-2 Location of Installed PCs

| No. | Installed PC | Location | User | | Affiliation |
|-----|---|--|--|--|-------------|
| | | | Main User | Sub User | |
| 1 | Desktop PC (PERSONA PACKAGE i7) | Science Research Specialist | Science Research Specialist | - | HOEMD |
| 2 | Laptop PC (No.1) (HP Pavilion DV3-4210TX) | Senior Science Research Specialist (2) | Senior Science Research Specialist (2) | Senior Science Research Specialist (1) | HOEMD |
| 3 | Laptop PC (No.2) (HP Pavilion DV3-4210TX) | Senior Science Research Specialist (3) | Senior Science Research Specialist (3) | Senior Science Research Specialist (4) | HOEMD |

Table 7.4-3 Roles and Specifications of Installed Equipment

| PC | Role | Specifications |
|---------|---|---|
| Desktop |  <p>Super User</p> <ul style="list-style-type: none"> - System operation and maintenance - Updating HEP projects information and GIS files - Distribution of updated files to sub users - Backing up system files | <p><u>PERSONA PACKAGE i7</u></p> <p>Processor: Intel Core i7-950 Memory: 4GB DDR3 Memory Hard Drive: 1TB Hard Drive Optical Drive: Samsung DVDRW Video Card: 1GB PCI-E Video Card Monitor: Acer S19HQLF 19" LED Monitor Operating System: Windows 7 Professional (32bit)</p> <p><u>Arc View ver. 9.3.1</u></p> |
| Laptop |  <p>Sub Users</p> <ul style="list-style-type: none"> - To be used for presentations at seminars | <p><u>HP Pavilion DV3-4210TX</u></p> <p>Processor: 1.73 GHz Intel Core i7-740QM Processor Memory: 4 GB 1066 MHz DDR3 Video Graphics: ATI Mobility Radeon HD 6370 Graphics with 1 GB DDR3 dedicated Display: 33.8 cm (13.3") diagonal High-Definition LED HP BrightView Display (1366 x 768) Hard Drive: 640 GB SATA Hard Multimedia Drive SATA optical drive: Operating System: Windows 7 Professional (32bit)</p> <p><u>Arc View ver. 9.3.1</u></p> |

7.4.4 Users Manual for System Operation and Maintenance

The JICA study team prepared the user’s manual at right, to make it easier for HOEMD staff when they are using the HRD system in their work.

This user’s manual consists of 7 chapters. The table of contents are shown below.

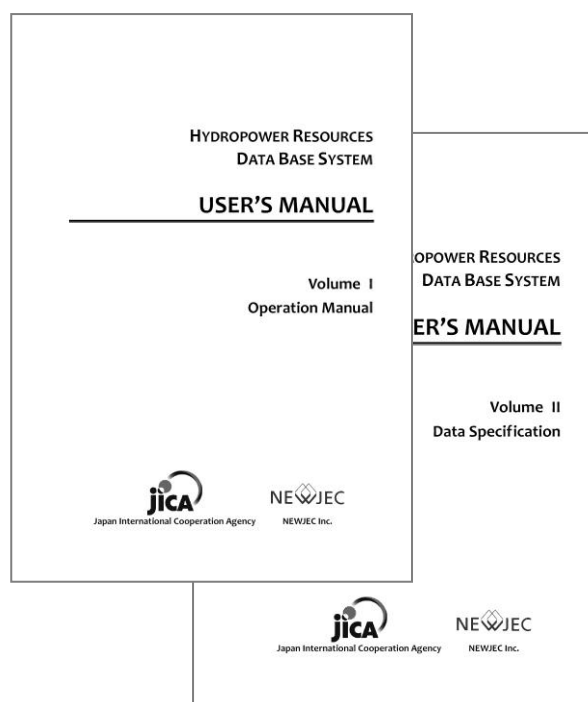


Fig. 7.4-9 View of User’s Manual for HRD System

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7.4.5 Security Policy

The security policy for the HRD system was discussed and agreed to between the DOE and JICA study team as shown below.

- The HRD system shall be installed in a desktop PC and two laptop PCs provided by JICA in this project until handover. After handover, the DOE will consider the distribution of the HRD system to the parties concerned.
- The HRD-installed PCs shall not be connected to the internet or other networks except the JICA- REMB WiFi network.
- The operation and maintenance of the HRD shall observe the security policy of the DOE.

In addition, the JICA study team recommends to users of the HRD system to observe the security policy shown below.

- The User of the HRD system (hereafter referred as to “the User”) must not use the HRD-installed PC (hereafter referred as to “the PC”) for private purposes.
- The User must pay attention not to leak information.
- The User must not commit crimes such as illegal access, infringement of copyrights or cheating.
- The User shall agree and sign this security policy.

The security policy shown above shall be agreed and signed by the users when the HRD system is handed over.

7.4.6 Operation and Maintenance Cost of the HRD

Updates to the GIS software, Arc view ver. 9.3.1, installed in the three computers is not considered. The HRD system and operational checks will be necessary in the case of version updates of Arc View. The DOE shall continue operation and maintenance using this version of the HRD system. In principle, the operation and maintenance of the HRD system shall be done by DOE staff. Hardware troubles and regular servicing shall come out of the DOE budget. Therefore, the cost of operation and maintenance of the HRD system shall be borne by DOE.