ADDIS ABABA UNIVERSITY
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AN INFORMATION SUPPORT SYSTEM FOR WATER AND SEWERAGE SERVICE MANAGEMENT WITH PARTICULAR REFERENCE TO ADDIS ABABA WATER AND SEWERAGE AUTHORITY

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An Information Support System for Water and Sewerage Service Management,

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ABSTRACT

Addis Ababa Water and Sewerage Authority (AAWSA) was established to provide potable water for the residents of Addis Ababa and to discharge waste water from the city. The Authority uses different facilities for providing its services. The water distribution and sewer network systems are among the facilities which cover large geographical area, and need day-to-day maintenance and operation. AAWSA needs and uses different types of mapped and recorded sources of information for managing the water distribution and sewer network systems. In relation to the management of the water distribution and sewer network systems, a survey has been conducted to assess the information needs of the users, and the support of the existing information services. The major problems in getting adequate information have been identified. The methods employed for the purpose of data collection include questionnaire method, interview method, observational study, and literature survey. The results of the study generally indicated that the users need various internally generated mapped and recorded information for different managerial, operational, and planning purposes. The survey indicated also that the users had problems in getting timely access to reliable and adequate information, and the existing information services were deficient in meeting their requirements.

To improve the services of existing information systems and to create conducive condition for the users to get timely, relevant and reliable information, the study has proposed the development of two separate but closely linked systems: the library system; and the computer-based information support system. For the computer-based information support system, the required application systems have been identified. The detailed logical design of the application systems, and the detailed logical and physical database designs have been carried out. The

prototype databases and a user interface have been designed to demonstrate that the applications are implementable and user-friendly. Specific recommendations for the improvement of the information services of the AAWSA Library, and for the implementation of the computer-based information support system have been made.

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List of Abbreviations

AAWSA	Addis Ababa Water and Sewerage Authority
AWWA	American Water Works Association
CIS	Computer Information Service of AAWSA

CHAPTER 1

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM AND ITS JUSTIFICATION

1.1.1 Water Resource Management and Information

All individuals and the societies they constitute need information to perform their respective functions and activities. Timely, reliable and pertinent information about past experience, existing conditions, and future trends is required in order to efficiently and effectively plan and perform activities so as to achieve objectives. To get timely, reliable, and pertinent information, information has to be systematically collected, organized, processed, presented in the appropriate form and format, and disseminated to users.

In the planning, implementation, and operation of socio-economic development activities in any country giving adequate consideration to information / data related to the natural resources of the country is essential (Grigg 1985). Water resources is amongst the most valuable resources of any country.

Management of water resource is a critically important human activity (Grigg 1985). The quality and availability of water determine levels of public health, food production, the productivity of industry, the production of energy, and other important aspects of the quality of life.

Management of water is meant people's control of water as it passes through its natural cycle, with attention to maximize economic, social, and environmental benefits. Since planning is one of the most important tasks of management, it follows that planning

for water management is a critical activity. Effective water planning is sometimes difficult due to lack of sufficient data / information (AWWA 1976).

Water planning is needed at different levels and for different purpose of water management. Planning is needed to site a new water supply reservoir or a waste water treatment plant. Planning is also needed to develop integrated multipurpose development plans for a river basin. Planning is required to schedule short or long term maintenance on existing water utilities and infrastructure, and planning is needed to develop best policies to satisfy future demand in terms of construction, and more are part of the general water planning.

It is well known that success of any planning is dependent on availability of adequate information (Temtem 1993) . Planning is an information intensive process, and its success is dependent on information. Hence, the importance of information in the water resource management is unquestionable.

Walker, in his book entitled Water Supply, Treatment and Distribution (Walker 1978), pointed out that data and information management for water is a dynamic and important part of the overall water management. Data collection is sometimes given low priority by short sighted officials. It is true, however, that if there is no effective planning and development, data are not needed. Infact, both effective planning at the executive level and good information management are absolutely necessary.

Reliable information on the condition and trends of a country's water resources, such as surface water, water in the unsaturated zone and ground water, water use and users, and quantity and quality of water infrastructures are required for a number of purposes. These purposes include assessing the resource and its potential for supplying the current and foreseeable demand, protecting people and property against water related hazards, planning, designing and operating water projects and services. In order to get this reliable information, information system should be established and data should be collected and stored on all aspects of water resource (ICWO 1992). Water related information can be handled by a number of information systems at organizational , national, and international .

Generally water resource management can be considered as a man- environment system which transforms inputs of physical resources into desired output of water services. In order to produce the required output, the following management aspects need to be considered (Porter 1978) :

(1) The development of water resources;

(2) The allocation of resources among potential users;

(3) The maintenance of the water supply system; and

(4) The recycling of water to facilitate reuse.

All of these assume an adequate information service that provids factual data/information about current supplies and demands, and current utilities and their

performance to provide adequate service and to find ways of meeting future demand. We, therefore , need a Water management information (Support) System.

Water resource management tasks are classified into many categories. One of these categories is water supply for domestic, municipal and industrial use, and collection, processing, and disposal of waste water. This is commonly called as water supply and sewerage service.

Water supply and sewerage management system as a sub-system of water resource management system transforms input of physical resources into output of water services.

The system:

- develops water sources from ground water, spring and river in the form of dam or other meaness;
- allocates water to the domestic , municipal, and industrial users by developing distribution system facilities;
- maintains and upgrade the distribution system facilities and water sources to secure adequate and continuous service;
- develops waste collection and processing system to facilitate water reuse and to reduce environmental pollution ; and
- needs information system which support the water and sewerage service management by providing adequate information for planning , operation, control, and other managerial functions.

Since the required information system supports the water and sewerage service management in order to achieve its goals, we can call this information system as " Water and Sewerage Service Management Information Support System".

1.1.2 Water Supply and Sewerage Service Management and Information

The major objective of any water and sewerage service management or organization is to provide the users with potable water and to discharge sewerage . Addis Ababa Water and Sewerage Authority (AAWSA) is a water and sewerage service management system that aims to serve the city of Addis Ababa, capital of Ethiopia. In order to achieve the above mentioned objective, the system uses information for different managerial, operational, and planning purposes. Some of these are described below.

Demand for water and sewerage service increase from time to time due to different factors. The major factors are: increase in population, change in the leaving standard due to improvement in education, income, and housing characteristics, and expansion and development of industries (Tesfaye 1984). In order to meet future demand. planners need different types of data/information on the past and present conditions.

Estimation of future water requirements on the basis of population growth is difficult because accurate population figures are secured by census which are conducted periodically such as every 10 years or more. Major changes can occur in the mean time, and most water

and sewerage service systems usually serve areas not coextensive with political subdivisions. As a consequence, planners prefer to base future estimates upon information on past demands in the various consumer classification (Domestic, commercial, municipal, and industrial) rather than on population estimates (AWWA 1972).

Data/information on past water consumption, number of customer served in different areas, and service categories are base for planners to estimate future demand. In order to get these data and information any water and sewerage service system or organization should keep accurate, continuous , easy to access, and up-to-date records of the number of customers served in the various service categories and amount of water that goes to the various classes of consumers and areas.

Information is also a very important element to conduct preventive and corrective maintenance activities in a water and sewerage service management. Water and sewerage service systems have above and under ground facilities such as water mains, pumps, valves, hydrants, water meters, reservoirs , sewer mains, manholes, connection boxes, and service lines. Having adequate information, for instance, concerning such as: installation, location, and maintenance history on each facility helps the system to schedule and conduct effective preventive and corrective maintenance which is necessary to:

- prevent failure of facilities,
- detect and eliminate weak links in the system,
- determine the type and quantity of materials and replacement parts to be stockpiled for repairs,

- analyze how distribution facilities stand up in actual operations,
- maintain good public relations by making needed repairs before damages and interruption of service occur,
- ristribute work load more advantageously,
- reduce the cost of maintenance , and
- reduce leakage of water.

A permanent record of water and sewerage assets in the form of properly prepared maps and statistical records is as necessary as is a permanent and detailed accounting of financial expenditures. The above ground structures can easily be inspected and inventoried. The under ground structures, which comprise the greatest part of capital investment, can be inventoried from properly recorded information (AWWA 1976) . Under ground facilities and structures cannot be included in the inventory of the property if there is no information system that stores and presents adequate information. The money spent on unrecorded record of underground structures or structures whose record is inaccessible is lost as far as receiving a return upon that part of the investment is concerned.

Information is an important element for efficient operation of a water and sewerage service. Day-to-day operation of the distribution system requires information that shows, in proper detail, the location and valving of existing mains. This is necessary to allow the economical connection of new extensions (AWWA 1962). A manager or a superintendent needs accurate information and picture of the system he operates. Information and picture of the system enable to determine which areas are inadequately supplied and why, whether

the mains in an area are capable of supplying the water which might be required to fight a major configuration, where fire hydrants are improperly spaced , where trouble should be looked for when pressures are found to be sub- normal , and to determine the best routes for installing new feeder mains.(Berhanu 1983).

Summary and detailed information on each facilities such as, water meters, valves, and manholes are required by the water and sewerage service management operators for control and continuous service. For example, different types of water meters installed in a distribution system to measure water consumption , production and flow into different areas. Water meters are subject to wear and require periodic test and service depending on meter size, type, make, and function. To schedule and conduct the periodic test and service, information on the following is necessary: (1) manufacturer of the material, (2) material size, (3) installation place of the material and date, and (4) material maintenance history.

Generally information requirement for water and sewerage service planning and operation can be broad and wide ranging as we allow. For instance , the corresponding information system will have to respond to such questions as :

- How much water is produced ? When ?
- How much water is consumed ? Where ? When?
- How much water is required / available ? When ? Where ?
- What are the existing infrastructures and utilities? Where ?

When installed ? What type and size ? When maintained ? When maintenance, repair or test is needed ?

- Which utility is critical and requires periodic inspection ?
- Which part of the network is frequently subjected to leakage ? What are the causes ?
- Which valve (s) isolate specific part of the city ?
- How many customers ? What types ?

Answering even these basic questions requires a complex data and information management system. It attests to the importance of information support system which utilizes the present and future capabilities of information technology (IT) for collecting, organizing, storing, processing and disseminating the required information.

AAWSA, as one of the water and sewerage service management systems, needs pertinent information to provide its service effectively and efficiently and needs information system that generates this pertinent information.

1.1.3 Need for Information Support System

Addis Ababa Water and Sewerage Authority (AAWSA), to provide its service to the city of Addis Ababa, uses two dams, two water treatment plants, huge water distribution network that covers all areas of the city and its surroundings, many distribution storage and

pumping stations, sewer network that covers major areas of the city, and a sewer treatment plant. The water distribution network consists of pipes, valves, water meters, fire hydrants and other fixtures. The sewer network consists of pipes, manholes, connection boxes and services lines. The water distribution network and the sewer network consumes a large amount of capital investment from the total investment in water and sewerage service, and all the components need day to day control, service, test, and maintenance.

Mapped and recorded information is a vital part of any water distribution system. Without them no utility can operate efficiently and the utility is dependent upon the memories of employees who are in the organization for a long time. In this case, with each retirement much valuable information can be lost.

Inorder to carry out its mandate, AAWSA needs different types of information on logical and physical structures, production and consumption, and the status of the utilities. For this purpose, the Authority maintains different types of documents and records of its day-to-day operation. Some of the documents and records are :

- Engineering documents, drawings and maps which represent, specify and document the water and sewer networks, structures and other fixtures.
- Documents produced during major construction and maintenance projects research and study reports, procedure and operation manuals, and other reports and documents.
- Measurement records such as water consumption, production and pressure.

- Installation, maintenance, inspection, test, leakage, and retirement records.
- Customer records.

At present, in AAWSA almost all information related to the water distribution system and the sewer network system are processed manually, and there is no formal system or organizational unit that formally collects, stores or controls the above mentioned internally generated sources of information. These sources of information are scattered throughout AAWSA without any mechanism for locating them. Lack of control over the sources of information made retrieving or locating specific information nearly impossible or searching for particular information consumes large amount of professional working time. Furthermore, information on water distribution and sewer network systems are kept in the form of maps (symbols and codes) and records (words and figures). This makes extraction and manipulation of data, to produce integrated information much difficult.

For instance , the problem in the existing information system has been identified in a study conducted on the Authority (Shawel 1991). The study identified that at present no scheduled or planned maintenance work is performed. Instead, failures are being corrected as they occur due to lack of information system that generates information on selected components of the water distribution network based on the nature of the component and the time since the last service was made. Moreover, the study indicated that due to the lack of preventive maintenance and other related factors, at present 30 to 40 percent of the total water production is subjected to leakage, however, if there was an efficient and effective

information system that could provide information for preventive maintenance, the amount of leakage could be reduced to 20 to 25 percent (Shawel 1991).

Due to the limitation of manual data/information processing and the size and complexity of the existing information sources and information need, it is difficult for the existing system to generate timely, reliable, consistent and integrated information for users. Some of the major limitations that we can observe include the following:

- It is difficult to get statistical and detailed information on the amount of water distributed and consumed in each subdivision of the city (Region, keftegna and kebele) which is helpful:
  - (1) to forecast future water demand for each subdivision of the city;
  - (2) to understand seasonal variation of water consumption and to schedule the water production based on seasonal needs;
  - (3) to know the amount of water leakage and to identify areas where much leakage is observed; and
  - (4) to plan construction and control of sewer network.(This is because, the amount of water consumption is directly proportional to sewerage output)

- It is difficult to get integrated information on items, such as, type and size of pipes, installation date, location, and number of customers on each parts of the water distribution and sewer network. This information is however, required to conduct and schedule maintenance, inspection, upgrading and replacement activities.

- While valve is an important component of the water distribution system for interrupting water flow during damage, maintenance, new connection, and rationing, there is no organized and easily accessible valve information that indicates the location of valves to interrupt water flow to particular subdivision of the city or to any part of the network. When problem arises in this connection, the current practice is to look for that particular individual (operator assigned to that area) or search for a map that document the structure to get this information.

- Some components of the water distribution system, and sewer network system such as, water meter, valve, manhole, and connection box need periodic test and inspection depending on the size of the material, location and relative importance of the components. The existing system does not support users with the proper information for these periodic test and inspection activities.

- It is difficult to produce year-to-date or month to-date statistical and management report on installation, retirement, test, inspection and maintenance of pipes, valves, meters, fire hydrants, manholes, pumps, and distribution storage.

- It is difficult to locate the documents of previously completed projects.

- It is difficult to locate and retrieve the maps, drawings and engineering documents relating to AAWSA installations.

From the above discussions, it is justifiable to conduct a study to develop an information system that would overcome the limitation of the existing information system and would satisfy the future information needs. The proposed information system will be based on the existing computer resources of AAWSA. This will be used for collecting, storing, processing, retrieving and reporting information related to the water distribution and sewer collection system. The potential benefits from the proposed system would be as follows:

(1) To exercise better control over the under ground utilities and other infrastructures;

(2) To reduce day-to-day maintenance cost;

(3) To ensure good public relation;

(4) To conduct scheduled and planned preventive maintenance more efficiently;

(5) To control leakage and thereby saving a considerable amount of money;

(6) To improve efficiency of the staff; and

(7) To improve control over the internally generated documents.

In addition to the limitation of the existing information system , Addis Ababa like any other cities in developing countries, has a rapid growth of population and rapid expansion in residential area. This growth and expansion will make the water distribution and sewer collection system more complex and information related to these system will become large and large.

Computers have become an essential part of organizational information processing because of the power of the technology and the volume of data to be processed. Application of computers to information processing began in 1954 when one of the first

Computers was programmed to process payroll (Davis and Olson 1984). Today, computerized processing of transaction data is a routine activity of large organization. Moreover, computerized information processing supports knowledge work, including managerial activities and decision making. Computers in a water and sewerage service organization have wide range of application from simple data processing for preparing customer bills to a complex engineering work such as network design and analysis.

Use of computers in Africa as tool for information processing is not a new phenomenon, computer was introduced in Africa as early as the 1960s, almost 6 years after the first computer was used for information processing. In Ethiopia most organizations installed computer for information processing in the last 20 years (Sandy 1993).

Addis Ababa water and sewerage Authority began using computer in 1985 by establishing an organizational unit called computer information service (CIS). During the last 10 years, a number of computer applications have been developed and implemented by CIS. However, almost all implemented applications except the customer billing system designed to process financial related information. Upto now no effort has been made to utilize the existing computer resource to support the activities on water distribution and sewerage collection. The proposed system will utilize the Authority's computer resources.

1.2 OBJECTIVES OF THE STUDY

1.2.1 General Objective

The general objective of this research is to assess the current status of information system and to design a prototype information support system that provides appropriate information and data to the planners, executives, operational workers and other professionals involved in water distribution system and sewer network management.

1.2.2 Specific Objectives

To achieve this general objective, the following specific objectives have been derived:

(1) To asses the information needs of the different users and organizational units within AAWSA.

(2) To identify existing information systems, services, and sources.

(3) To asses the present status, application, capacity and utilization of computer technology in AAWSA.

(4) To asses the status and services of the AAWSA library.

(5) To identify the existing major problems in accessing information/ data particularly in managing water distribution system and sewer network system.

(6) To identify subsystems of water supply and sewerage management

information support system.

(7) To design prototype data bases for some of the identified subsystems.

1.3 SCOPE AND LIMITATION OF THE STUDY

Due to the shortage of time and other resources, this study does not cover all aspects of information required by the water supply and sewerage service management. It is limited to information required for managing water distribution system and sewer network system. The two systems are selected based on the following facts:

(1) They consume the large amount of money from the total investment;

(2) Almost all components need periodic test, maintenance, and control ;

(3) They cover large geographical area; and

(4) Almost all components are buried under the ground.

The study is also limited only to the assessment of the status of existing information system, identifying the major problems , and proposing computerized and non-computerized solutions.

The proposed system will be implemented at the AAWSA. This implies that the operating staff, the user group, infrastructure and facilities will be that of the AAWSA.

1.4 METHODOLOGY

1.4.1 Sources of Data

The following have been used as sources of data:

(1) The employee of the AAWSA who are directly involved in water service, sewerage service, engineering and planning work and other supporting staffs and decision-makers such as data processing personnel, librarians, and top management.

(2) Existing distribution system and sewer network system documents, Maps and drawings. Various management reports, work orders, maintenance, inspection and test reports, and other pertinent documents such as past studies, manuals of procedures, etc.

(3) Companies involved in different project work for AAWSA and other water resource management organizations.

(4) Data base of the Authority.

1.4.2 Data Collection

1.4.2.1 Questionnaire Method

A questionnaire was designed to collect general information on information requirement and level of the present information service from AAWSA staff. The questionnaire was distributed to 20 AAWSA employees involved in distribution system and sewer network management, operation and planning. The sample of questionnaire used is annexed in the appendix I .

1.4.2.2 Interview Method

Intensive and repetitive interview and discussion were held with different AAWSA staffs and other professionals. The interview and discussion were made to understand a) activities of water distribution system and sewer network system; b)the information need; and ; c) the sources of information and problems in accessing existing information.

Additionally significant activities and operations of the Authority were observed and its important facilities were inspected.

1.4.3 Literature Survey

Different literature's and reports were surveyed to have background theoretical and practical information about the problem under study. The survey also made to understand and identify required data base data elements, input and output formats and process and procedures.

CHAPTER 2

BACKGROUND INFORMATION

2.1 THE CITY OF ADDIS ABABA

Addis Ababa, the capital and the largest city of Ethiopia was established during the time of Emperor Menelik II by Queen Taitu (wife of the emperor) in the year 1886 (Pankhrust 1961). Geographically, Addis Ababa is located at 9° N and 38° E. The elevation of the city ranges between 2333 meters above sea level at Bole international air port and 2979 meter above sea level at Entoto. According to the Ethiopian Mapping Authority (1988, p62), the areal expanse of the city is about 500 sq. km, with almost a compact shape, covering 20 km east-west and 25 km north-south extent.

The functional land-scape of the present Addis Ababa, although not well defined, can be categorized into four main divisions, i.e, the educational and administrative zone in the east, the commercial and government business sector in the central part, the site of the main market (Mercato) in the west, and the industrial and residential sector in the south west.

Administratively, Addis Ababa is divided into five regions (Ketenas); twenty five higher (Kefetgna); and two hundred eighty four kebeles.

Addis Ababa is not only the political and commercial center of Ethiopia, but also the base for the head quarters of Organization of the African Unity (OAU), the United Nation Economic

Commission for Africa (UNECA), and also of several other regional and inter-governmental organizations. A map of Addis Ababa, and its metropolitan boundary is presented in figure 2.1.

According to the recent publication of the Central Statistical Authority, the population of Addis Ababa in 1994, was estimated to be 2,712,400 (Central Statistical Authority 1990). This population needs to be supplied with potable water in sufficient quantity and acceptable quality.

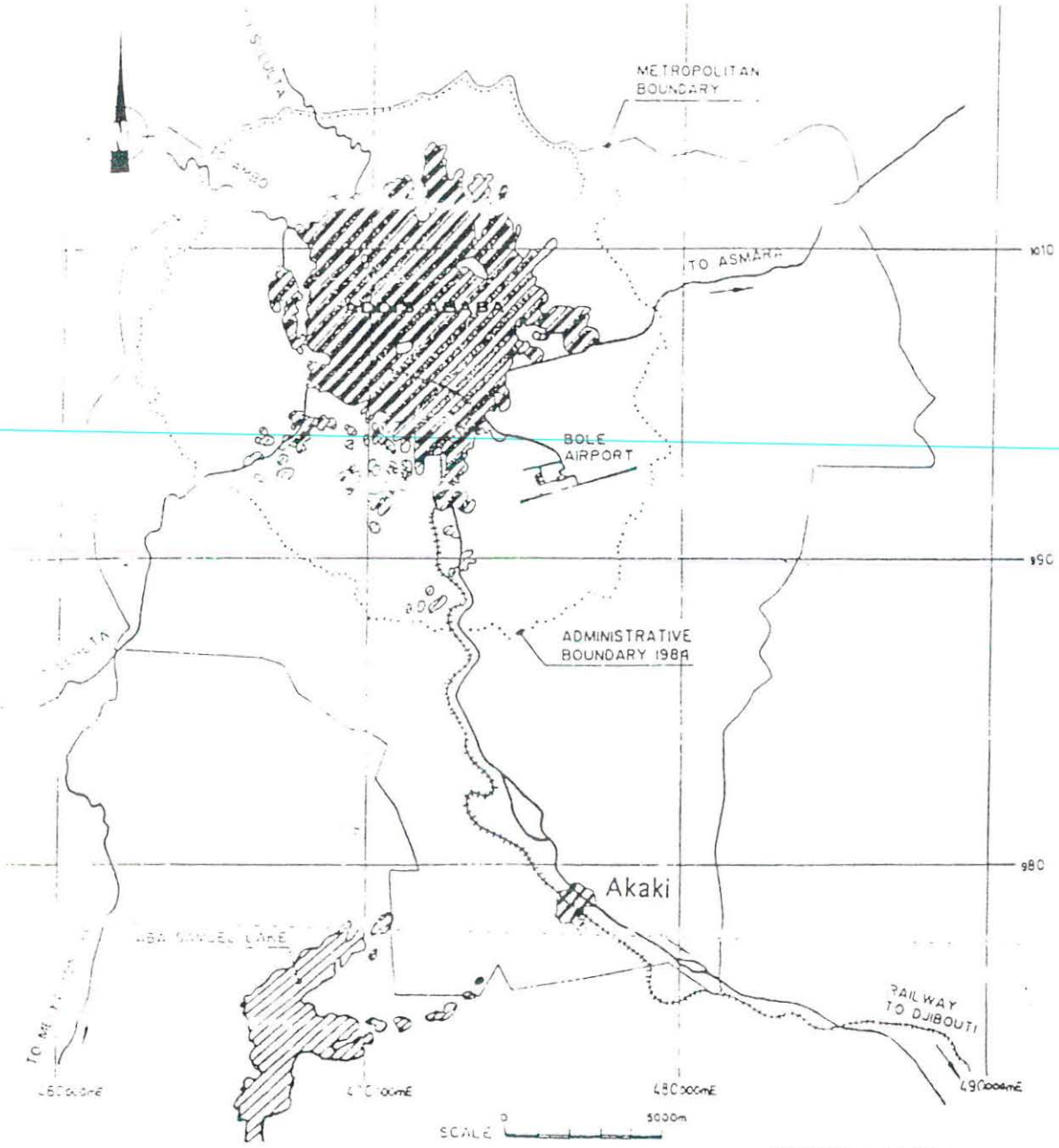
2.2 HISTORICAL BACKGROUND OF WATER SUPPLY AND SEWERAGE SERVICE IN ADDIS ABABA

Unlike many cities in the world, Addis Ababa was not established near perennial rivers or lakes, which ensures a constant water supply. Due to this shortcoming, i.e, the lack of water resources, the city has to live with a severe shortage of water from time to time (Tesfaye 1984).

During the early periods of the establishment of Addis Ababa, water was obtained from streams, springs and hand dug wells for a variety of purposes without any form of treatment (Seleshi 1961). During that time, these sources were enough to satisfy the quantity of water needed by the small population of Addis Ababa. But when the population increased, and when the leaving standard of the population changed due to modernization and education, shortage of water became a serious problem.

According to Kiros (1987, 13), the development of modern water supply in Ethiopia dates back to the time of Menelik II, when the first supply system was introduced in 1893 in

FIGURE 2.1: Addis Ababa and its Metroplitiant Boundary



SOURCE: AAWSA 1994

Addis Ababa. This introduction marked an important land-mark in the history of water supply of Addis Ababa in particular, and Ethiopia in general. The traditional and modern water supply systems went together till recently. The traditional water supply lost its importance slowly from time to time, due mainly to high degree of pollution of the sources caused by the crowded population and complex activities in the city.

Before the Italian occupation, the provision of safe and adequate water to the city's population was the responsibility of the Ministry of Public Works. For this purpose, it was also made responsible for the utilization of local rivers, streams and springs through the construction of water distribution systems.

During the period of Italian occupation (1935-1940), the Gefersa dam was constructed; and it was the first source of treated water in the water supply history of Addis Ababa.

After the Italian invasion, the responsibility of water supply to the city of Addis Ababa was passed over to the Municipality of Addis Ababa. By that time, demand for water was far more than the supply. To solve the problem of this heavy demand, the Municipality set up a Water Service Department in 1942. In 1969, the Department become the autonomous Addis Ababa Water and Sewerage Authority (AAWSA) (Tesfaye 1984).

As pure drinking water is one of the basic necessities, AAWSA made a great effort to supply the city with pure water since its establishment. The Authority, in addition to water supply, provides the sewerage service to keep the city clean and to reduce environmental pollution. The sewerage service consists of collecting waste water from source areas; and

conveying that to a disposal site. The liquid waste requires treatment before it can be discharged into a body of water; or otherwise disposed off without endangering the health of the people, or causing any other offensive conditions. The Authority started providing the sewerage service by vacuum trucks. In 1988, proper sewer lines network was laid in some parts of the city; and the sewerage service connections were started in 1989.

2.3 EXISTING WATER SUPPLY AND SEWERAGE SERVICE UTILITIES

2.3.1 Water Supply

A complete water supply system includes water works for the collection, treatment, and pumping for the transmission and distribution of the water from the original source to the consumers' meter. Water works for the collection of water include the construction of dams,wells,and the development of springs. Water works for the treatment of water include the process of aeration, screening, coagulation, sedimentation, filtration, disinfection, softening and the removal of undesirable constituents. Water works for pumping of water include the process of transmission and distribution of water.

Transmission lines are large pipes that carry the treated water from treatment works to the distribution systems; whereas, the distribution system includes pipes and other components, such as reservoirs, meters, hydrants, valves, pumps, etc. Pipes of different size and materials are used for transmission and distribution of water. To ensure safety, to permit inspection,and to facilitate operation and maintenance, pipelines are provided with gate valves,check valves, blow off valves, air valves and manholes.

2.3.1.1 Sources

The main sources of water supply for the city of Addis Ababa and its surroundings are Gefersa and Legedadi impounding dams built in 1930s and 1970s respectively. The Authority's records show that the raw water extraction from the Gefersa and Legedadi dam is 31,500 and 154,500 cubic meter per day respectively. Both dams have water treatment plants which have the capability to treat the extracted raw water.

2.3.1.2 Transmission Lines

The Gefersa transmission line consists of two 400 mm diameter pipe lines each extending 18 km. The transmission lines have the capacity of transmitting 30,000 cubic meter of water per day. The Legedadi transmission line contains two pipe lines, one with 1400 mm diameter and the other with 1200 mm diameter. Each transmission line has a length of 30 km. The legedadi transmission line has a capacity of transmitting 150,000 cubic meter of water per day.

2.3.1.3 The Distribution System

After water is treated and transported to the terminal points through transmission lines, it goes to the ultimate users through the facilities of the distribution system. The distribution system consists of the pipe line network, water meters,valves, fire hydrants, pumps and reservoirs.

2.3.1.3.1 Distribution Subsystems

The city's distribution system is divided into eleven independent subsystems based on the city's topography to make operational control practical and smooth. Each one of the subsystems works independently in the distribution of water to the consumers. There are connecting valves that separate the subsystems. All the connecting valves are closed to confirm separation; but can be opened to transfer water from one subsystem to another in case of emergency. All the subsystems have commanding reservoirs and get supply form these reservoirs through gravity and pumping. The eleven independent subsystems are grouped into two, based on the source of supply, Gefersa and Legedadi (Figure 2.2). The Gefersa supply has three subsystems. They are:

(1) Core-kolfie subsystem,

(2) St. Paul subsystem, and

(3) Rufael subsystem.

The rest eight subsystems get supply from Legedadi. They are:

(1) Legedadi subsystem,

(2) Janmeda subsystem,

(3) Teferi Mekonnen subsystem,

(4) Entoto subsystem,

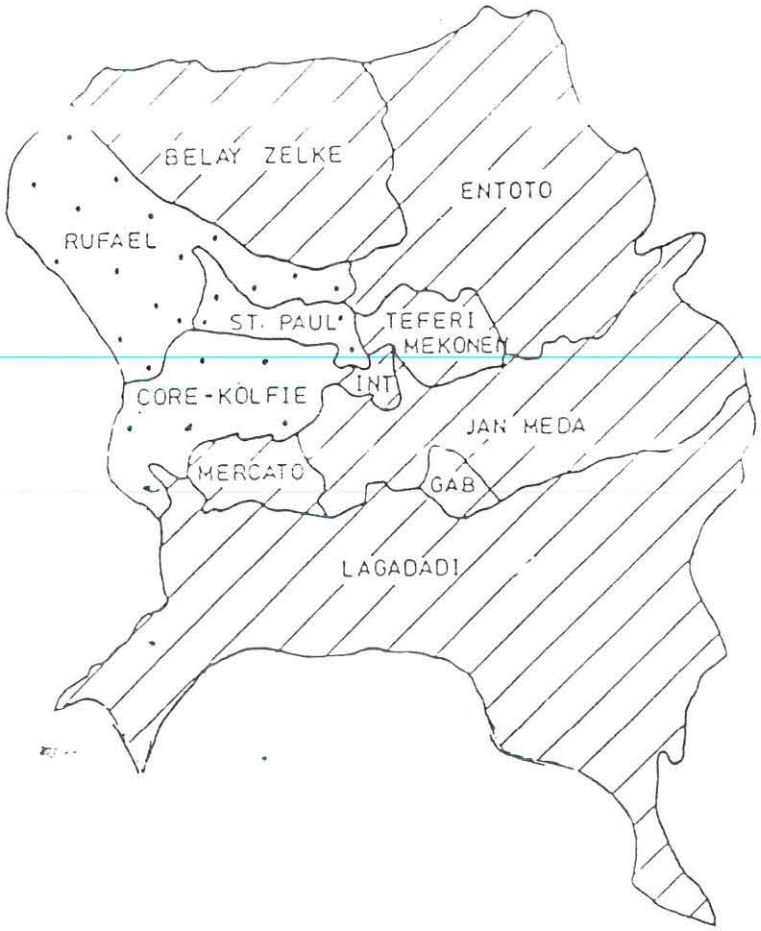
(5) Belay Zeleke Subsystem,

(6) Interconnection subsystem,

(7) Gebriel subsystem, and

(8) Mercato subsystem.

FIGURE 2.2: ADDIS ABABA WATER AND SEWERAGE AUTHORITY WATER SUPPLY SUBSYSTEMS



Gefersa Supply

1. Core-Kolfie S.S
2. Rufael S.S
3. St. Paul S.S

LegeDadi Supply

1. Lege Dadi S.S
2. Jan Meda S.S
3. Gebriel S.S
4. Mercato S.S
5. Interconnection S.S
6. Teferi Mekonnen S.S
7. Entoto S.S
8. Belay Zeleke S.S

KEY

Gefersa

Legadadi

SOURCE: AAWSA 1994

2.3.1.3.2 The Pipe Lines

Water is transmitted from sources to centers of community through pipelines. Pipes that are used to distribute water to communities create a distribution system in the city. Pipes of various materials and size are used in the distribution system. The most common types of pipe used in distribution system are: cast-iron pipes, concert pipes, and cement-lined iron pipes. In the distribution system, pipes have different life-years depending upon the material they are made from, the internal water pressure, and the external environment.

In Addis Ababa, more than 3,000 km of pipe lines of different sizes and types have been laid. The diameter of the pipes vary from 10 mm to 900 mm; and the major types of pipe installed are made of castiron, PVC, and galvanized steel. Depending on the diameter of the pipes, the network is divided into primary lines and secondary lines. Primary lines consist of pipes with diameter of 100 mm and above, whereas the secondary lines consist of pipes with less than 100 mm in diameter.

2.3.1.3.3 Water Meters

The most common uses of water meters are for calculating the cost according to use, for estimating the development of water consumption in various areas, and for measuring water leakage. Depending on their function, water meters vary in size, make, and operation. At present, AAWSA has 48 large water meters that are used to measure the amount of raw water extracted, treated, and distributed to various parts of the city. There are, also, more than 132,000 small and medium size meters that have been installed for measuring the water consumption by individual customers.

2.3.1.3.4 Valves

Valves are essential controlling elements in water distribution system. They are used for:

- stopping water flow during damage, maintenance, and new connection;
- isolating part of the city for rationing of water when there is shortage of water, or when there is contamination;
- reduction of water pressure;
- dewatering pipe lines for repair, or to blow off any sedimentation; and
- preventing back flow of water.

Many valves of different sizes have been installed in the AAWSA's distribution system for the purpose of regulating, or starting, or stopping water flow. Some of the valves have boxes to protect them from damage, and to make them easily accessible.

2.3.1.3.5 Fire hydrants

There are 230 fire hydrants. They are of different sizes and types. These have been installed at strategic locations throughout the city to provide water in sufficient quantity for fire fighting.

2.3.1.3.6 Reservoirs

The uneven topography of the city necessitated the building of a dozen of reservoirs on predetermined places of relatively high elevation. There are 38 reservoirs under the supervision of AAWSA. The reservoirs have a total storage capacity of 77,390 cubic meter of water. The capacity of the reservoirs ranges from 30 to 10,000 cubic meter.

2.3.1.3.7 Pumping Stations

Many areas of the city entirely depend on the gravity for water distribution. Those areas do not need any pump. However,the Authority installed 52 pumps in 13 stations to supply water to elevated areas; and to equalize water pressure through the network.

2.3.2 Sewerage Service

The sewerage service includes (1) the collection of waste water from source areas; (2) conveying it to sewerage treatment plants; (3) treating sewerage; and (4) discharging it. AAWSA provides the sewerage service by using vacuum trucks and the sewer network for collection of west water; and by using a sewerage treatment plant to treat the collected waste water.

Sewer network consists of pipe lines, manholes, and connection boxes. Manholes are used to control the flow of sewerage in the network. The connection boxes are points in the sewer network where customers can make connection.

2.3.2.1 Vacuum Trucks

Most of the households in Addis Ababa, get sewerage services by vacuum trucks. There are 31 vacuum trucks in the Authority, with capacities ranging from 6 to 8 cubic meter.

2.3.2.2 Sewerage Treatment Plant

The Authority's sewerage treatment plant is situated at kaliti, south of Addis Ababa. The treatment plant is capable of treating 18,000 cubic meter of sewerage per day.

2.3.2.3 Sewer Network

More than 110 Km of sewer lines have been laid in the central part of the city. The diameter of the sewer lines vary from 200 mm to 600 mm. Like the water lines, the sewer lines are also of different types.

2.4 WATER CONSUMPTION AND CUSTOMERS

Water consumption in Addis Ababa is increasing like its population. The average water consumption in the year 1992 was 29.2 liter per capita per day. But it was 19.0 liter per capita per day in 1987. Table 2.1 shows (1) the population from 1987 to 1992, (2) the total daily water consumption, and (3) the increase in average water consumption per capita per day.

At present, AAWSA has 132,350 customers of water supply and sewerage service. The customers are classified into three groups as, domestic, municipal, and government customers. Table 2.2 shows the number of customers every year from 1987 to 1994.

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Table: 2.1
Water Consumption in Addis Ababa

YEAR	POPULATION	WATER CONSUMED PER DAY IN liter	PER CAPITA CONSUMPTION ITS/DAY
1987	1,620,000	30,843,000	19.0
1988	1,686,000	33,712,200	20.0
1989	1,769,000	34,210,800	19.3
1990	1,851,000	39,990,600	21.6
1991	1,927,000	48,456,900	25.2
1992	2,026,000	59,130,000	29.2

SOURCE: Planning, Programming and Budget Service, AAWSA 1994

Table: 2.2
NUMBER OF CUSTOMERS

YEAR	CUSTOMERS
1987	96,648
1988	101,839
1989	108,274
1990	115,395
1991	122,274
1992	127,174
1993	130,842
1994	131,984

SOURCE: AAWSA COMPUTER DATA BASE.

ADDIS ABABA WATER AND SEWERAGE AUTHORITY (AAWSA) AND ITS INFORMATION NEEDS

3.1 OBJECTIVES OF AAWSA

Addis Ababa Water and Sewerage Authority (AAWSA) is an autonomous public organization. It has its own separate juridical personality. The mandate of AAWSA was enunciated in Article 5 of order No. 68/1971. The objectives of the authority are as follows:

(1) To supply potable water for (i) drinking and other domestic purpose, (ii) sanitation of streets and disposal of sewage, (iii) protection against, the quenching of fire and other forms of combustion, (iv) industrial and commercial use, and (v) public parks, public swimming pools, and similar services;

(2) To conserve and safeguard from undue exploitation of underground water and prevent its contamination; and

(3) To ensure the sanitary disposal of sewage by providing a system of sewers or otherwise.

AAWSA, to achieve the objectives, produces potable water by developing water sources and treatment plants; allocates potable water to the domestic, municipal,industrial, and commercial users by developing water distribution facilities; secures adequate and continuous service by maintaining and upgrading the distribution system facilities, water sources, and treatment plants; and ensures the sanitary disposal of sewage by developing and maintaining waste water collection network and processing plants.

3.2 ORGANIZATIONAL STRUCTURE

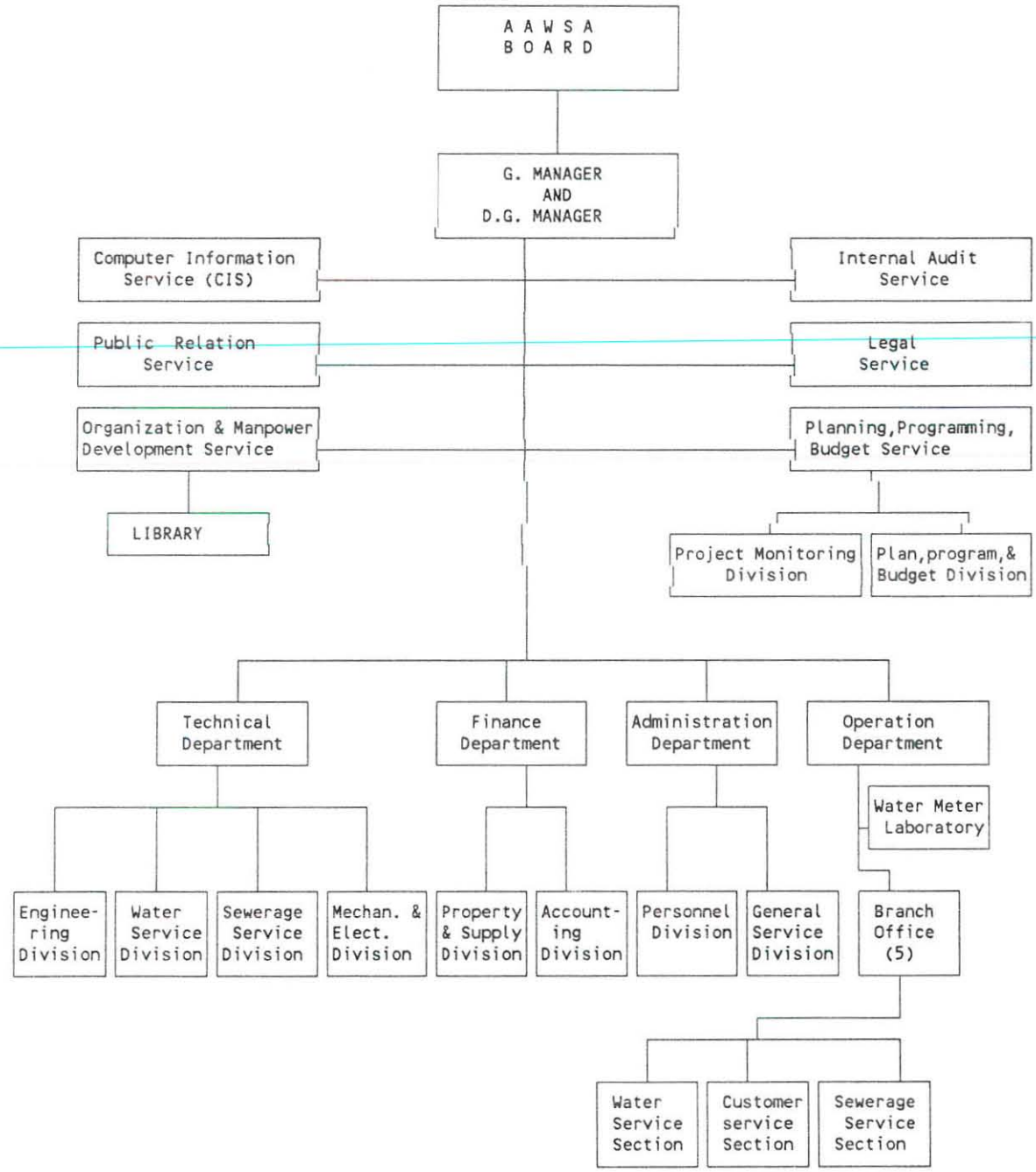
Inorder to perform the activities required to achieve its objectives, AAWSA is departmentalized into a number of organizational units. As presented in figure 3.1, AAWSA consists of four departments, six service units, five branch offices, and ten divisions. Each of these departments, services, branch offices, and divisions has its own duties and responsibilities.

The organizational subunits have a number of administrative routines to perform. They are concerned with management of resources, namely, human, finance, and facilities. They also perform planning and control activities in order to undertake their respective duties and responsibilities. These organizational subunits generate a variety of information, and they also continuously use information. Information is also a binding agent that holds the organizational subunits together.

The information needs of the different organizational subunits vary depending on their duties and responsibilities. Some information/data are used only by one subunit, whereas some are used by two or more organizational subunits.

From the organizational structure of AAWSA, we can observe that Technical and Operation Departments are core organizational units which are directly involved in water and sewerage service. The rest of the organizational subunits are designed to support the overall

Figure 3.1 Addis Ababa Water and Sewerage Authority
Organizational Structure



Source: The organization and Manpower Development Service, AAWSA

activities of the authority. The Computer Information Service (CIS) and the Library are among the supporting subunits. They are designed to collect, store, process, and disseminate information in the organization.

3.2.1 Organizational Subunits Responsible for Management of Water Distribution and Sewer Network Systems

Technical and Operation Departments are directly responsible for the management of the water distribution system and sewer network system. Management of the two systems includes operation, maintenance, extension and expansion, and administration of the system.

The Technical Department through its divisions of Water Service, Sewerage Service, and Engineering performs the following major tasks:

- repair, rehabilitate, replace, modernize, extend, and expand primary water lines;
- undertake routine inspection in order to ensure the operation of different distribution system components in acceptable and prescribed manner;
- test, repair, maintain, install, replace, and rehabilitate distribution system components;
- inspect leakage throughout the distribution system and control it;
- repair, maintain, rehabilitate, and modernize sewer network;
- periodically clean sewer lines, manholes, and connection boxes;
- ensure the proper functioning of sewer network; and

- study the consumption and distribution of water in the various sub-networks and parts of the city.

In relation to the management of water distribution system and sewer network system, the Operation Department with its five branch offices, and the Water Meter Laboratory, performs the following major tasks:

- repair, rehabilitate, replace, modernize, extend, and expand secondary water lines;
- undertake leakage detection and control jobs;
- ensure fair and equitable water distribution among all beneficiaries in the event of water shortage;
- carry out water pipe and sewer pipe connection to customers;
- test, repair, install, and replace water meters; and
- ensure the proper functioning of the distribution system and sewer network system components.

3.3 INFORMATION REQUIREMENT

An information system should meet the information needs of the organization it serves. Information requirement study is a corner-stone for developing an efficient and effective information system that meets the needs of users. This section presents the specific purposes for which information is required for managing the water distribution system and sewer network system of AAWSA as identified by the survey.

Information needs of AAWSA for managing water distribution system and sewer network system can be classified into the following major categories on the basis of specific purposes:

(1) Information for planning and implementing the expansion and extension of the system;

(2) Information for planning and scheduling preventive maintenance activities;

(3) Information for planning and conducting maintenance work such as, repair, replacement, and rehabilitation;

(4) Information for controlling leakage;

(5) Information for day-to-day operation;and

(6) Information for evaluating performance; and for other administrative purposes.

To satisfy the above mentioned information needs, different types of information are required in mapped and recorded form. As was discovered from the survey, the major types of information required are as follows:

(1) Population Information

The present and future trends of population of an area to be served have a great importance for estimating the total quantity of water required and waste water to be discharged from the area. The economic and educational status of the people and the housing characteristics also affect demand for water and sewerage service. The quantity of water required and waste

water to be discharged are a basic information for determining the size and type of materials to be used or installed.

The following population and population related information are required on each subdivision of the city for planning and implementing water distribution system and sewer network system expansion and extension:

- Population and trends of population growth,
- Population density,
- Economic and educational statue of the population, and
- Housing characteristic and distribution.

(2) Information on Water Use

Past records of water use in different service categories (domestic, commercial, municipal, industrial, and fire protection)
are required to estimate future demand and to plan and implement expansion and extension work on the existing system.

The following types of information are required on water use and user:

-the number of customers served in various categories,and

-the amount of water that goes to each category.

(3) Information on other Organizational Utilities

Information on other organizational utilities such as, electric network, telecommunication network, and road network are required to coordinate work and to avoid damage on these utilities. Some of these types of information are:

-layout of present and planned streets,

-layout of present and planned electric network, and

-layout of present and planned telecommunication network.

(4) Information on Water Distribution and Consumption

Water distribution and consumption data are the main sources for determining the amount of unaccounted-for water. The major reasons of water loss in the network are leakage, illegal connection,and unmetered supply. Data collected on water distributed and consumed in each distribution subsystem in the different parts of the city are required to calculate the amount of water loss, identify the cause, and to take appropriate measures.

(5) Information on Water Pressure

An adequate distribution system must be able not only to furnish the necessary flow of water to various points in the system but also to furnish each customer with sufficient pressure at his connection to satisfy his normal requirements. Excess pressure causes pipe line failures and leakage. On the other hand, when pressure in the distribution system is low, sufficient water cannot reach the customers and some meters fail to register correctly the water flow. Hence, both high and low water pressures have their own disadvantages. Excess pressure is reduced by

installing pressure reduction valves at appropriate places. Low pressure is also increased by installing pumps or constructing reservoirs at relatively elevated places.

Continuous pressure records of different points in the distribution system is used to identify areas suffering from excess or low pressure and to take appropriate measure. Pressure records consist the following data:

- pressure measurement place,
- water pressure, and
- date and time of measurement.

(6) Water Leakage Information

Leakage information is vital for long-time operation of a distribution system. Leak records kept over a period of time allow a superintendent to know whether he is using proper materials in the system, whether certain mains have deteriorated to a point requiring replacement, and whether the causes of the breaks are improper installation, outside agencies, high pressure, or some other factors.

To identify the cause of leakage, and to plan maintenance and repair work, a leakage-record which contains the following information is required.

- leakage place,
- cause of leak,
- date and time of leak, and
- amount of water subjected to leak.

(7) Information on Water Lines (Pipes)

Because pipes are buried underground, recorded information is required to locate them during new connection, maintenance, and expansion. Recorded information is also required to identify the pipes that completed their life-time, and to schedule rehabilitation work. Data on the existing pipes are also needed to plane and implement network extension and expansion. The following type of data are required on water lines:

- location of the pipe,
- pipe size, type and length, and
- depth of pipe from the ground and type of soil.

(8) Information on Water Meters

Water meters differ from each other by size, function and material from which they are made. They are subjected to wear and deposition that cause a meter to over or under register. Water meters need periodic test and repair depending on their size, function and location. Information on each water meter is required to:

- schedule periodic meter test and repair,
- identify and replace meters frequently subjected to wear, and
- retire or replace meters that completed their life time.

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- schedule periodic meter test and repair,
- identify and replace meters frequently subjected to wear, and
- retire or replace meters that completed their life time.

Data required to generate information for undertaking the above mentioned tasks are:

- installation data, such as, location, function, size, make and installation date of each water meter;
- maintenance data, such as, problem type, cause, type of repair made, and repair date;
- test or inspection period; and
- estimated life.

(9) Information on Valves

Valves are essential controlling element in water distribution system. To keep valves clean and operational, to extend valve life, and to pointout inaccessible, inoperable and closed/opened valves, periodic inspection and maintenance has to be made. Valve inspection period depends on the size, function, location, and relative importance of valve. According to the standard set by AWWA (1962), gate-valves with diameter larger than 12 inch should be inspected at least once every six month. Gate-valves having 12 inch and smaller diameter should be inspected at least once every year. Critical valves should be inspected at least twice every year.

The authority needs detailed information on each valve for the following purposes:

- to schedule valve inspection based on valve size, function, location, and last date of inspection;
- to locate valve at any future time; and
- to identify valve(s) that regulate water flow to specific part of the city or subdivisions of the network.

Data required for generating valve information are:

- the type and size of valve;
- the function of valve;
- the date it was placed in service;
- its location in the system;
- the date of inspection;
- the condition of the valve;
- date and types of repair;
- direction and number of rotation for opening and closing;
- areas or part of network regulated by the valve; and
- degree of importance and condition of the valve location.

(10) Information on Fire Hydrant

Fire hydrants are installed essentially for emergency use; and should have a regularly scheduled checking program. Fire hydrants are particularly vulnerable to damage and failure, because they are exposed. Like other valves they need periodic inspection at lest twice a year. Proper and reliable records of fire hydrant installation, operation, and maintenance are required to conduct periodic inspection, to easily locate them, and to ensure their proper functioning.

The data required for generating appropriate fire hydrant information consists of the following items:

- the hydrant location,

- the mark and size,
- the date of installation,
- the number and size of mains feeding the hydrant,
- date of last inspection, and the condition of hydrant,
- date of last repair, and kinds of repairs undertaken,
- static and flow pressure test reading, and
- minimum pressure required.

(11) Information on Reservoirs

Reservoir is an essential element in the water distribution to make supply available when needed, and to stabilize water flow and pressure. Information on each reservoir is required to make proper distribution, to plan and implement network extension and expansion, and for the maintenance of the reservoir. Information required on reservoirs consists of the following data:

- location and elevation,
- capacity and shape,
- construction date and materials,
- source of water (dam,spring,well,or other reservoir),
- how does it get water (through pumping or gravity),
- which subdivisions of the city does it supply to,
- which valve(s) control inflow and outflow of water,
- number and type of meter and other apparatus used to measure water flow and water level, and

- amount of water reserved for fire fighting or other purposes.

(12) Information on Pumps

Pumps are used in water distribution system to force water from one part of the system to the other. Satisfactory service from pumps can be obtained only when a proper preventive maintenance program is carried out by knowledgeable and attentive operators based on appropriate information. Properly recorded installation and maintenance history information is needed to evaluate pump performance, to make appropriate repair work, and to order appropriate spare-parts.

The installation information consists of data, such as, serial number, size, type, manufacturer, drive type, installation date, function, recommended frequency of routine maintenance, and data on stuffing box. The maintenance history record consists of data, such as, maintenance date, condition, defect noted and cause, cost of repair, number and cost of spare-parts used, and other related data.

(13) Information on Sewer Lines

Like the water lines, sewer lines are buried under the ground. They differ in size and material from which they are made. Similar to their size and type, sewer lines have different useful life-time in the sewer system. The life time of sewer lines depends also on environmental conditions such as soil type, sewage type, and the location of sewer. Properly recorded information on sewer lines are required to:

- locate sewer line at any time;
- identify deteriorated lines or lines that completed their life time, for planning and scheduling rehabilitation work;
- analyze the present performance and to plan sewer line expansion and extension; and
- allocate proper material for maintenance and repair work.

Some of the data required on sewer line are:

- special data, such as, grid point, location and slope;
- pipe data such as type, lengths, size, and estimated life time;
- installation data, such as, installation date, soil type, and depth;
- number and type of sewer customers; and
- other data, such as, length of service line, number, type, and location of manholes and connection boxes.

(14) Information on Manholes

The opening constructed in a sewer line for the purpose of permitting a man to enter for inspection and cleaning of sewer line is called manhole. To ensure adequate flow of sewage in the sewer network, manholes require periodic inspection, repair and cleaning. Information on manholes is required for different purposes. Some of these purposes are as follows:

- Since manholes are openings to the ground, most of the time they are filled with garbage, covered with different materials, or damaged. Past record of problems is used to identify those manholes which face problems frequently to take appropriate measure.

- There are different types of manholes, and manhole covers. Some of the manholes are as deep as 4 meters but have no built-in ladders; whereas some manholes with depth of less than two meters have built-in ladders. Some of the manhole-covers are too heavy to remove and replace manually, and require as many as four to five labourers or a special vehicle. Information on each manhole about size, location, cover type, depth, availability of ladder, and the likes area required for allocating appropriate machinery, equipment,manpower, and time required during maintenance, cleaning new connections, and inspection. Information is required also for scheduling periodic inspection; and cleaning the manholes; and for locating them during new connection, maintenance, and cleaning.

(15) Information on Installation and Retirement

Information about installation and retirement of each component of the water distribution and sewer network systems is required for the following purposes:

- for comparing the actual performance with the plane; and
- for keeping a permanent record of assets in the water distribution and sewer network systems.

Installation and retirement records of each component are to contain the following data.

- installation or retirement date;
- type, size, length, and function; and
- place of installation or retirement.

3.4 INFORMATION USERS

Information requirements of an individual within an organization vary with his/her managerial level. At the lower operating levels, information which help to make day-to-day operating decisions are needed. At the top levels, however, information is needed to support long-range planning, and policy decisions. Thus, because of the types of decisions they must make, individuals at the top and lower levels generally tend to need different degrees of summarization and are inclined to use information obtained from different sources.

In AAWSA, users of information relating to water distribution system and sewer network system can be classified into three categories based on their respective managerial level. These categories are:

- top level management,
- middle level management, and
- lower level management and technicians.

The top level management consists of Board members, the general manager, the deputy general manager, department heads, service heads, and senior experts. Members of this category spend most of their time in strategic planning in relation to with such activities as large scale construction, expansion and extension work; major maintenance work which include complete rehabilitation and reconstruction work; and setting appropriate tariff based on the value of water work properties.

Top level management needs highly summarized internally generated information such as inventory of each component of the distribution and sewer network systems by age, size, length, type and area. This category of users also use most of the time externally generated information.

The middle level management consists of division heads, branch heads, section heads, engineers, supervisors, and other professionals within the technical and operation departments. These categories of users are involved in the planning and scheduling annual activities, budgeting,

and controlling and evaluating performance. The middle level management utilize information for the following purposes:

- to identify components to be maintained, inspected, replaced, and tested within the year.
- to identify areas which need new installation extension, or expansion;
- to schedule the annual maintenance, inspection, replacement, test, installation, extension, and expansion work;
- to prepare and allocate machinery, equipment, manpower and money; and
- to prepare technical plan such as map, drawing, and material specification.

The last category of information users, the low level management and technicians, utilize detailed maintenance, installation, and technical information. This category of users, most of the time, utilize information for:

- locating each under and above ground components,
- determining the proper functioning of each components,
- using appropriate equipment and material, and
- making appropriate maintenance and repair.

3.5 SOURCES OF INFORMATION

3.5.1 Introduction

Objective of an organizational information system is to provide information within an organization when and where it is needed. To achieve this objective, the information system identifies the information need or requirement of the organization or individuals within the organization. In addition to identifying the information requirement, the system is required to understand and identify the pertinent sources of information. Identifying the sources of information are used for preparing surrogatesof the source. The sources of information and their surrogates need to beo be organized in order to provide the right information at the right time.

In general sources of information are categorized into three varieties as documentary source, institutional sources, and human sources. On the other hand, from particular organization point of view, sources of information are categorized into two, as internal sources and external sources. Internal sources of information constitute individuals and organizational subunits within the organization and variety of documents generated in the organization from its day-to-day activities. External sources are the generators and distributors of information located outside the organization.

The next section presents the major sources of information for managing the water distribution and sewer network systems of AAWSA as obtained from the survey.

3.5.2 Major Sources of Information

The Authority needs and uses different types of information for managing the water distribution system and the sewer network system. These information are originated form variety of sources. Some of these information are directly used without any processing, and some of them require additional processing to be convenient for the users. The information sources can be classified into external sources and internal sources.

External Sources: In relation to the water distribution system and sewer network system, the external sources provide the Authority with socio-economic, population, topological, topographical, hydrological, and other related information. The major generators and distributors of these items of information are the following institutions:

- The Central Statistical Authority;
- The Water Resource Commission;
- The Municipality of Addis Ababa;
- The National Urban Planning Institute;
- The Ethiopian Electric Light and Power Authority;
- The Ethiopian Telecommunication Authority;
- The Ethiopian Mapping Authority; and
- The Ministry of Health.

Internal sources: Large amount of information is produced within AAWSA from its day-to-day activities. These information are produced in map, drawing, and record forms. Internal sources of information consist:

- Engineering documents, drawings and maps which represent, specify, and document the water and sewer network, structures and other fixtures;
- Documents produced during major construction and maintenance projects, research and study reports, and procedure and operation manuals;
- Installation, maintenance, inspection, test, leakage, and retirement records;
- Periodical measurement records of water consumption, production, pressure and flow;
- Technical information that accompany the purchase of pumps, meters, valves, and other major items;
- Customer records; and
- Planning and management reports.

3.6 INFORMATION SERVICES AND APPLICATION OF COMPUTER

Information service system come to existence to insure and promote the utilization of existing information to help generation of new information in research work and to support the process of decision making. To insure and promote the utilization of existing information, information service systems collect, organize,process, store, retrieve and disseminate information and data. The common information service systems are:

- Libraries,
- Documentation centers,

- Data centers,
- Information analysis and consolidation centers,
- Archives, and
- Museums.

In government and business organizations, libraries and computer centers are the major types of information service systems that provide information to support operation, management, and decision-making functions. Specially computers have become an essential part of organizational information processing because of the power of the technology and the volume of data to be processed.

AAWSA, like many organizations, has its own information service centers, namely the AAWSA library and the computer information service. The Authority also utilize different types of computers for processing various information. This section presents the result of the survey made on the two information service centers and applications of computers. The major objective of this survey is to assess the current status and potential of the existing information services in supporting the activities of water distribution and sewer network systems management.

3.6.1 The AAWSA Library

The AAWSA Library is located at the head office. It is a small library run by one librarian. The library is established primarily to serve employees of AAWSA, but external users can use the library with special permission from the general manager or head of Organization and Manpower Development Service.

The collections of the library, as estimated by the librarian, are:

- 1000 books on various subject areas (Civil engineering, Sanitary engineering, Chemistry, Environment, Computer Science, Management, Accounting and Language).
- 600 elementary and high school text books.
- 1200 Amharic and English fictions.
- Various types of newspaper and newsletters.
- Periodicals published by AAWSA and other organizations in Addis Ababa.

The library obtain these documents in three ways:

- by purchasing books, periodicals and newspaper from local market;
- by donation from different embassies and international organizations; and
- from organizations that distribute their periodicals for free.

The library provides circulation service for spot reading and loan. The documents in the library organized by subject and language. But the library doesn't have catalogue, holding list, indexes or other bibliographic records.

Generally the current service of the AAWSA Library is not adequate for many reasons. Some of its limitations are:

- the current collections are not adequate source of information for operation, management and decision-making function within AAWSA.
- the library doesn't collect internally generated documents such as document produced by different study, maintenance and construction projects, and map, drawing and engineering documents that represent the water distribution and sewer network systems;
- at present it is difficult to access a document form the collection due to lack of catalogue and other bibliographic records.

3.6.2 Computer Information Service (CIS)

Computer Information Service (CIS) is one of the organizational subunits of AAWSA. CIS was established in 1985 to undertake all computer related activities. The task of CIS includes system analysis, design and implementation; data collection, storing and processing; dissemination of information; and ensuring data securing and proper functioning of hardware and software.

CIS is the major information service center of AAWSA, where internally generated data is stored, processed, and various information for managerial and operational decisions are obtained. This section presents the available computer resources of the organization and the degree of their utilization in CIS and assesses the existing applications and the potential of the resources for supporting activities related to water distribution and sewerage collection.

3.6.2.1 Hardware

CIS has two types of computers, HP-3000 minicomputer and IBM compatible microcomputers.

Minicomputer: This computer is HP 3000 927LX minicomputer with:

- 32 Mbyte memory
- 1.5 Gbyte disk
- 2.0 Gbyte digital data storage (DDS)
- console terminal
- 6 modem ports
- 8 direct ports
- 8 RS 422 ports
- LAN card

MicroComputer: There are three HP Vectra 486/33 IBM compatible micro computers with:

- 4 Mbyte RAM
- 127 Mbyte hard disk
- 3.5",1.44 Mbyte floppy disk drive
- 5.25" 1.2 Mbyte floppy disk drive
- Maths coprocessor
- HP VGA color monitor with supper VGA controller
- enhanced key board

- mouse

- 2 serial and 1 parallel port

Printers: CIS has three printers.

- one HP 2567 high speed line printer (1200 lpm);
- one HP 2563a line printer which can print 300 lpm; and
- one HP laser jet 4 printer.

Terminals: There are 10 HP 700/96 dummy terminals which are used for different purposes.

- three terminals are used by system development and programming unit for developing and maintaining applications;
- one terminal is used by the CIS head for controlling applications and software;
- four terminals are used for data entry; and
- two terminals are used by systems operators for processing applications, on-line enquiries, and backup.

Tape Drive and other hardware: There is one 1600 bpi, 9 truck magnetic tape drive. The tape drive, in addition to the digital data storage (DDS) drive, is used for backup, and for importing and exporting data and software.

CIS also has:

- one CD-ROM drive with panasonic sound bluster;
- one voltage stabilizer; and

- three UPS (power saver).

3.6.2.2 Software

No commercial application software is in use by CIS. All existing applications have been completely developed in-house.

Programming languages (for minicomputer): The following programming languages are available in CIS.

- COBOL II/ix
- FORTRAN 77/ix
- BASIC
- SPL (this language is specific to HP 3000 computers)
- C/ix
- Cognose Power House 4Gl DBMS

Among the above listed language, COBOL is the only programming language currently utilized for developing applications. The rest are not used by CIS.

Operating systems (for minicomputer):

- MPE/ix
- Netware/ix LAN operating system (not on use)

Database software (for minicomputer):

- Turbo Image: it is network oriented database management system that supports on-line and batch processing of complex set of data.

- KSAM: KSAM is file management software that is used for creating and manipulating indexed sequential files.

Program Development Tools:

- VPLUS: it is a tool that allows the programmer to design "fill-in-blank" forms which are displayed on a computer terminal for data entry and display of information.

- SORT-MERGE: sorts files according to specified key fields.

Micro computer software:

- Windows 3.0
- MS-DOS 6.0
- HP mouse
- Advancelink
- Word perfect 6.0 for windows
- MicroSoft word 6
- PC power ver. 11

Database software (for minicomputer):

- Turbo Image: it is network oriented database management system that supports on-line and batch processing of complex set of data.

- KSAM: KSAM is file management software that is used for creating and manipulating indexed sequential files.

Program Development Tools:

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Micro computer software:

- Windows 3.0
- MS-DOS 6.0
- HP mouse
- Advancelink
- Word perfect 6.0 for windows
- MicroSoft word 6
- PC power ver. 11

- ALPAS Amharic word processor

- AutoCad ver. 12

3.6.2.3 Existing Applications

All existing applications have been developed by staff of CIS on minicomputer using COBOL, VPLUS and TURBO IMAGE. No application have been developed on the microcomputers. At present all the microcomputers are used for word processing functions. The existing applications are:

- General Accounting and Budget system: This system tracks all financial transactions and budget data to generate financial information and for controlling expenses;
- Inventory Control System: Store requisitions and purchase orders are tracked by this system in order to maintain inventory of the stock in various stores;
- Customer Billing System: This system keeps a water and sewer customers records, and water consumption. It prepares water bills and generates various information about customers, water consumptions and bill amounts;
- Payroll system: This system processes monthly employee payment and generates payroll related information;
- Account Receivable system: This system keeps track of amounts owed to or payable by AAWSA by/to its employees and other individuals or organizations;

- Fixed Assets Control System: This system keeps records of AAWSA's fixed assets and calculate their depreciation; and
- Encoders Performance Monitoring System: The purpose of this system is to collect efficiency statistics concerning the data entry clerks.

3.6.2.4 Manpower

The Computer Information Service has:

- one senior systems analyst;
- one programmer analyst;
- two programmers;
- two system operators;
- three data entry clerks;
- one operation and production supervisor.
- four data preparation and control clerks; and

3.6.2.5 Evaluation

During the last 10 years a number of computer applications have been developed and implemented by CIS. However, almost all implemented applications, except the customer billing system, are designed to process financial related information. Up to now no effort has been made to utilize the existing computer resources to support management in water distribution and sewage collection, the core activities of AAWSA.

Even if CIS has a large amount of hardware and software resources, they are not fully utilized. It is possible to say all microcomputers are not utilized, only the minicomputer is used for developing and implementing applications. Software packages except COBOL, IMAGE, and VPLUS, are not used for formal information processing and application development. As presented in Table 3.1, from the available 1.5 Gbyte or 1500 Mbyte disk space of the mini-computer only 322 Mbyte is used.

From the above discussion we can observe that, CIS has sufficient computer resources for developing computer based applications that would support the management of water distribution and sewage collection.

Table: 3.1

Mini-computer disk space utilization

	Disk space in Mbyte
Disk space used	
Applications:	
General Accounting and Budget System	42
Inventory Control System	40
Customer Billing System	55
Payroll System	18
Account Receivable System	6
Fixed Asset System	7
Encoders Per. Mon. System	4
System Overhead:	
Operating system and utilities	60
System development and maintenance	90

Total disk space used	322
Total disk space	1,500
Available free disk space	1,178

Source: Computer Information Service of AAWSA

3.6.3 Types and Purposes of Utilization of Computer in Other Organizational Units

Nine microcomputers and one lap top computer are presently in use in different organizational subunits of AAWSA. The micro computers are of two family, five HP Vectra 486/33 and three IBM 286. Each HP vectra computer has 3.5" disk drive, 5.25" disk drive, VGA color monitor, 4 Mbyte RAM, 127 Mbyte hard disk, and one parallel and two serial parts. Each IBM computer has 3.5" disk drive, 2 mbyte RAM, 80 mbyte hard disk,and one parallel and two serial parts. There are also three EPSON LQ 1050 and four EPSON LQ 2550 dot matrix printers. The distribution and their purposes are presented in Table 3.2.

The available Software packages are:

- Word Perfect 6-0
- Micro Soft Word 6
- Wordperfect 5-1
- Alpas Amharic word Processor
- Debase IV
- Auto CAD V.12.
- WATNET-3 (Special Software Package Designed for Analysis and Simulation of water network).

AAWSA has already purchased all necessary software and equipments for connecting the microcomputers and the CIS minicomputer in local area network (LAN). When LAN is implemented, users in various department can access applications and data store on the minicomputer, and share other resources such as the laser printer.

Table: 3.2

Distribution of micro computers and their function.

Location	Purpose	Number of Computer	Number of Printers
Finance Dpte.	-Spread Sheet -Word processing	1	1
Technic Dpte.	-Comp.aided design -Word Processing	1	1
Budget Div.	-Spread Sheet -Word Processing	1	1
GM. Office	-Word Processing	1	1
Project Div.	-Word Processing -Spread Sheet -Comp.aided design -Net work Analysis	5	3
	TOTAL	9	7

3.7 LIMITATION OF THE EXISTING INFORMATION SERVICES

The existing information systems are not in a position to provide all required information for managing the water distribution and Sewer Network Systems of AAWSA. The major limitations of the existing information systems are presented below.

(1) Although AAWSA maintains a large collection of maps, drawings, engineering documents, and project reports related to the water distribution and sewer network systems, there is no strong centralized control over this resource. Various documents are found in several different locations throughout AAWSA without any mechanism to locate them. Because of this:

- it is difficult to locate and retrieve a document;
- it is difficult to control the circulation of document; and
- it is difficult to make proper protection and preservation over these valuable resources.

(2) All the technical, measurement, installation, maintenance, inspection, test,and repair data about each component of the water distribution and sewer network systems are maintained and processed manually at different locations within AAWSA. Due to the size and complexity of the data and the limitations of the manual data processing it is difficult to generate accurate, complete, concise and timely, reports such as:

- water distribution and consumption in various subdivisions of the city and parts of the distribution systems;
- the number, size, length, and type of water distribution and sewer network systems' components installed and retired;
- maintenance history and installation information of each component;
- maintenance, inspection and test work order for selected components based on the nature of the component and the time elapsed since the last service;
- pressure and flow statistics;
- valve location and isolation information; and others.

(3) Information on each water distribution and sewer network systems component is kept in the form of maps and records. At present it is nearly impossible to extract and manipulate data from the two different sources to produce integrated information and there is no means which facilitates cross reference between these sources.

Some of the problems observed due to the limitations of the existing information system are as follows:

- at present no scheduled or planned preventive maintenance work is performed, instead failures are being corrected;

- planning expansion, extension and installation work is difficult due to lack of information that shows the trend of water consumption and new installation in each subdivisions of the city;
- it is difficult to locate some under and above ground components;
- it is difficult to identify valve(s) which interrupt water flow to particular subdivision of the city or parts of the network;
- critical information, such as, location of mains, vales and water meters, which are not recorded, but found in the memories (minds) of few long time employees are lost at times when these employees terminate working for the Authority.
- it is difficult to get accurate information on physical assets which represent the water distribution and sewer network system.

To overcome the above mentioned limitations of the existing information services, to increase the useability of internally generated documents, to exercise better control over information sources, and to provide right information at the right time in the right form to the users of water distribution and sewer network information, the researcher recommends the following solutions:

(1) the services of AAWSA library should be upgraded and the library should collect, organize, store, retrieve and circulate all internally generated documents such as maps, drawings, sketch, and project reports; and

(2) since AAWSA has a large amount of computer resources and a number of experienced data processing professionals, computer-based applications should be developed for the selected sub-systems of the water distribution and sewer network systems. Propostions (1) and (2), taken together would help to bring about an improved information system which can create condisive condition for users to get timely, relevant and reliable information efficiently and effectively.

CHAPTER 4

PROPOSED INFORMATION SUPPORT SYSTEM

4.1 INTRODUCTION

Chapter three discussed the nature of users and their information requirements, and sources of information. In addition, the existing information services and their limitations were also discussed.

This chapter will present the identified computerized and non-computerized solutions, to overcome the current limitations of the information services, and to provide better service to the users of water distribution and sewer network information.

The proposed information system involves the development of two separate but closely linked subsystems: the library system and the computer-based information support system. Since AAWSA has a library which cannot perform the desired functions, the present work proposes some measures to improve the existing service. Specifically the library system has to improve the use and control of maps, drawings, sketches, engineering and other documents that contain detailed information about each component of the water distribution and sewer network. Although it has been recognized that the library has to develop database(s) of these materials using an appropriate text retrieval system, for example Micro-CDS/ISIS, this study could not concentrate on this aspect particularly due to lack of time. However, general measures to be taken to improve the current situation have been mentioned in this chapter.

The objectives of the proposed computer-based information support system is to collect, store and process factual data (installation, maintenance, inspection, measurement, test and retirement data) about each component of the water distribution and sewer network to generate information for planning, decision making and other managerial functions.

Design and development of the proposed computer-based system involves two major categories of tasks: logical design and physical design of the system. This chapter deals with the logical design of the system, whereas the physical design part will be discussed in the next chapter.

4.2 UPGRADING THE LIBRARY SERVICES

As indicated in chapter three, AAWSA library is not in a position to support the need of its users. Valuable internally generated documents are scattered throughout AAWSA, without any mechanism to locate and control them.

To increase usability of the internally generated documents, to improve control of these valuable documents, and to provide better services, AAWSA should upgrade the status and responsibility of its library. The AAWSA library should take the following responsibilities and duties:

(1) to develop a mechanism for collecting all internally generated documents, such as:

- maps, drawing, and engineering documents,

- project and study reports,

- procedure and operation manuals, and

- reports, from construction, maintenance and study projects, and various organizational subunits;

(2) to organize and arrange documents in a manner that is simple to retrieve, cost-effective to store and accommodate, and conducive to the documents' proper protection and preservation;

(3) to provide by giving identification number for each document;document retrieval mechanism, by preparing catalogue and indexes, and

(4) to identify and maintain list of authorized users, to ensure that only authorized persons are given access to the documents;

(5) to provide long and short range loan service and control document in circulation so that they are returned within the stipulated period and in proper condition;

(6) to prepare and make available brief description of contents of internally generated documents for easy reference;

(7) to publicize to potential users the range of technical documents, designs, maps, sketches, etc. that are available;

(8) to arrange for photocopy and other reproduction schemes for endangered documents;

(9) to arrange for rebinding and/or repair works when the need arises.

4.3 THE PROPOSED COMPUTER-BASED SYSTEM

4.3.1 Objectives

At present AAWSA has a large amount of computer resources that are not utilized. On the other hand, water distribution and sewer network information users do not get the right information at the right time and in the right form. Therefore, identifying and implementing computer based application that can collect, organize and generate information pertaining to the water distribution and sewer network will be of great help to the user community. Such a computer based system will be able to:

- Properly utilize the existing computer resources;
- Provide accurate and timely information that will support operation, decision making and planning activities;
- Save the time of professionals which at the moment is spent mostly on routine data processing and information searching, and
- Avoid duplication of work.

The application systems will track all installation, maintenance, test, measurement, and other pertinent data of each water distribution and sewer network systems except for pumps and reservoirs. The systems will generate the major information required for managing the water distribution and sewer network system which include:

- Information on water use,
- Information on water distribution,

- Water leakage information,
- Information on water meter,
- Information on valve,
- Information on fire hydrant,
- Information on manhole, and
- Information on installation and retirement.

4.3.2 Structure of the Proposed System

Five computer-based application systems have been identified which will provide factual information on water distribution and sewer network. The databases for the application systems will be developed using data/information generated from the day-to-day operation.

The identified computer based applications are:

(1) Water network information subsystem;

(2) Valve information subsystem;

(3) Water meter information subsystem;

(4) Fire hydrant information subsystem; and

(5) Sewer network information system

The first four applications form water distribution information systems.

4.4 DESIGN OF THE PROPOSED COMPUTER-BASED SYSTEM

4.4.1 Water Distribution Information System (WDIS)

4.4.1.1 Objectives

After water is treated and transported to the terminal point, it goes to the ultimate users through the facilities of the water distribution system. The water distribution system consists of the pipe line network,valves, water meters, fire hydrants, reservoirs, and other fixtures. Various types of information are required on the distribution system by different users to provide adequate and continuous water service. The water distribution information system (WDIS) is intended to collect, process, store, and generate information that is required for managing the water distribution system of AAWSA.

WDIS should have a database to record the installation, maintenance, inspection, test, and physical description data about each component, installed under and above ground, of the water distribution system. The system should also have a database to record measurement and leakage data of the distribution system.

All installation, maintenance, measurement, physical description, and other pertinent data about each component are to be collected by the system and stored in the database. The system manipulates the stored data to generate different operational and management report.

In general, the major objectives of WDIS are as follows.

- to maintain permanent records of physical assets which form the distribution system;
- to maintain permanent records of maintenance, inspection, and test history of each component;
- to maintain permanent records of water pressure, production, distribution, and leakage;
- to generate detailed and summarized information about each component by size, function, type, installation date, maintenance date, inspection date, and location;
- to generate preventive maintenance and inspection work order for selected components of the distribution system based on different information such as, location, installation date, function, type, size, and last date of servicing of the component;
- to provide different statistical information such as water consumption and distribution, leakage, installation, and retirement;
- to provide a mechanism for cross referencing each component to the map, chart, or diagram that document the component structure;
- to provide a means for cross referencing to other systems which contain detailed cost, technical, or customer information; and
- to generate different reports that serve for material inventory and calculation of deprecation values.

4.4.1.2 Structure of WDIS

The structure of WDIS is presented in Figure 4.1. The system is divided into four subsystems. Each of these subsystems have link with each other by various key data items. The water distribution information system subsystems are:

- Water network subsystem,
- Valve subsystem,
- Fire hydrant subsystem, and
- Water meter Subsystem.

The system also has three code files that are accessed by each subsystem. The code files are used to reduce the time required to access critical data and maintain data consistency in each subsystem. The code files are Area Code File, Subsystem Code File, and Chart of Water Distribution and Sewer Network Code.

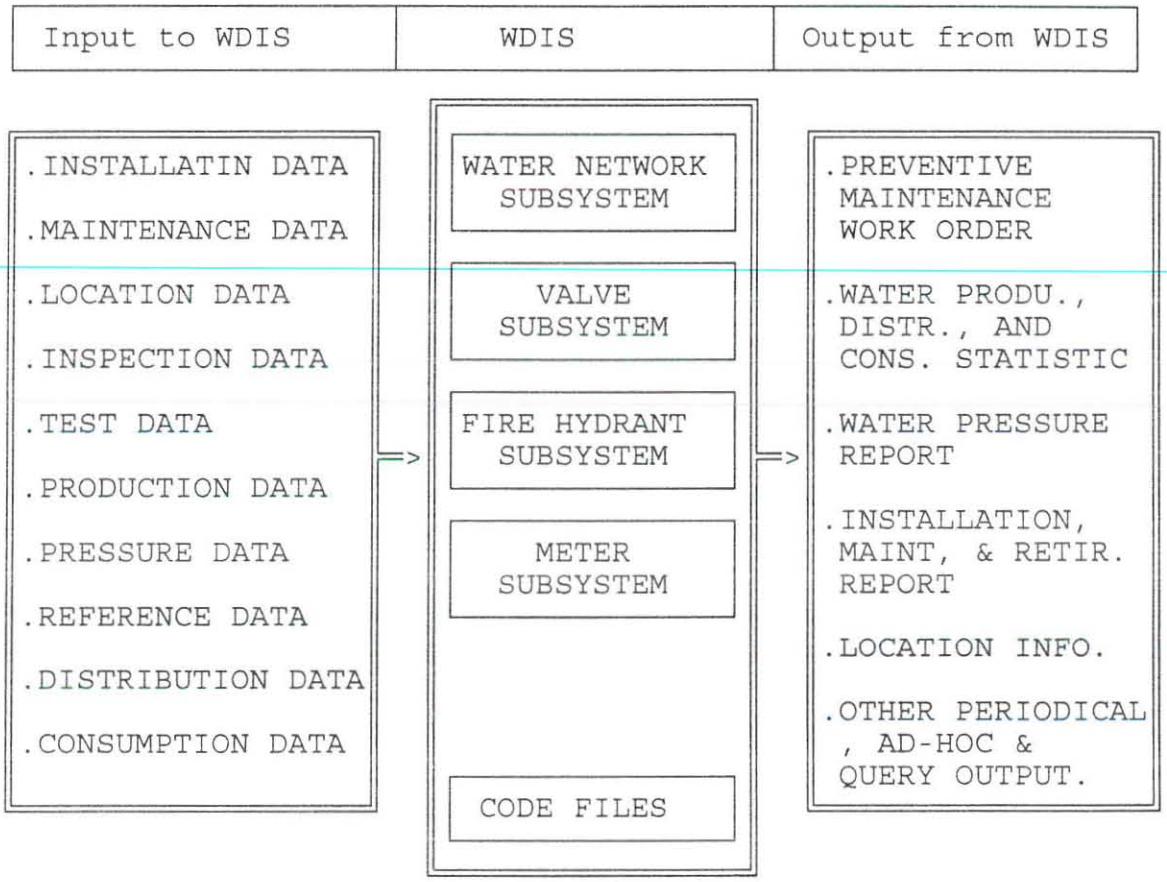
Area Code File: This file contains the codes and descriptions of each administrative subdivision of Addis Ababa (Region, Keftegna, and Kebele) and identification number of map or document that contain detailed information about each division.

Subsystem Code File: This file contains the Addis Ababa water distribution subsystems' codes, descriptions, and identification number of map or document that contain detailed information about each subsystem.

Chart of Water Distribution and Sewer Network Code File: This file contains the proper descriptions of various codes used in water distribution and sewer network information system databases and in input sheets.

The Input, output and processing requirements, the data dictionary, and the database structure of each of the WDIS subsystems are presented in the following sections.

Fig 4.1: The Structure of AAWSA WDIS



4.4.1.3 Water Network SubSystem

4.4.1.3.1 General Description

The objective of Water Network subsystem is to record and generate information related to the water line (pipes), water pressure, and leakage. All data related to pipe installation, maintenance, and retirement; water leakage and pipe breakage; and periodic water pressure reading would be collected by the system. The system would have a database for storing the collected data. The system would manipulate the stored data using the appropriate programs to generate different management and operational reports.

To create a database for the water network the first thing to be done was delineating a boundary between each unit of the network. For this purpose the existing maps of the water distribution system had been investigated and the following information were obtained:

(1) The water distribution network of Addis Ababa is divided into 11 subsystems;

(2) Each subsystem is divided into a number of segments;

(3) Each segment has start and end nodes and the nodes have unique identification codes. The identification codes consist a maximum of three numeric, alphabetic, or combination of numeric and alphabetic characters;

(4) Any segment in the distribution system can be uniquely identified by its start and end node codes;

(5) Each segment has a separate map that documents its detailed structure;

(6) Distance between the start and end nodes of each segment varies from 100 meter to 1000 meter; and

(7) The size and type of pipes within a segment are the same.

Based on the above observation, a water distribution system segment is taken as a basic water network unit. Water Network Unit (WNU) is the smallest portion of the water network that would be used for creating a database and for collecting data about the water network.

The following data would be collected and stored about each water network unit (WNU) by the system to generate pipe, pressure, leakage, and maintenance information.

- Identification Data
  - . subsystem code
  - . WNU code
- Location and Address data
  - . Keftegna
  - . Kebele
  - . Specific location of the start node and direction of the segment from the start node
- Reference Data
  - . Map or document number that contains detailed information about the WNU

. Reference number of construction or installation work order that document detailed cost and other technical information

- Pipe Data

. type of pipe

. diameter of pipe

. Length of pipe in the WNU

- Installation Data

. installation date

. depth of pipe from the ground

. Soil corrosivity

. Elevation (maximum and minimum)

. Number of apparatus fixed to the WNU

- Leakage Data

. Leakage date

. Cause of leakage

. Quantity of water subjected to leak

- Pressure Data

. date and time of pressure measurement

. measured pressure

- Maintenance Data

. date of maintenance

. maintenance work order number

. reason of maintenance

. type of pipe replaced/retired

. length of pipe replaced / retired

. number of apparatus replaced/retired

. number of apparatus added

. size of pipe replaced/retired

The system could generate the following major information and reports.

- Various detailed and summarized pipe report by size, type,installation date, maintenance date, service year, keftegna, kebele, soil type and combination of them;
- Preventive maintenance work order for pipes that completed their life time and part of the network which is frequently subjected to leakage;
- Quantity of water subjected to leakage;
- Areas suffering from high or low water pressure;
- Maintenance history and installation report;
- Reference data for accessing maps and work orders; and
- Pipe location report.

4.4.1.3.2 Input Requirements

Four types of inputs are identified to create and update the water network information subsystem database. The inputs are to be prepared by the Technical Department and be submitted to the Computer Information Service(CIS). The following input sheets are to be used in collecting the inputs.

1 New-Installation Input Sheet (WNIF-1)

This sheet is used to input identification, location, reference, pipe, and installation data about each WNU. Data about each WNU will be collected from maps, charts and engineering documents, and will be filled into this pre-printed input sheet. The New-Installation Input sheet should contain at least the following data:

- Installation work order or reference number;
- Water Network unit (WNU) code;
- Subsystem code;
- Address of WNU (Keftegna and Kebele);
- Street name where WNU can be found;
- Distance of WNU start node form reference (in meter);
- Permanent reference point to locate WNU;
- Direction of start node from reference (code);
- Direction of end node from start node (code);
- Map, Chart, or document number;
- Type of pipe (code);

- Length of pipe in WNU (in meter);
- Diameter of pipe (in millimeter);
- Installation date (ddmmyy);
- Depth of pipe from the ground (in cm);
- Soil corrosivity (code);
- Maximum elevation of pipe in WNU (from sea level in meter);
- Minimum elevation of pipe in WNU (from sea level in meter);
- Number of apparatus fixed to WNU; and
- Number of joints within WNU.

2 Pressure Reading Input sheet (WNIF-2)

This sheet is used to input periodic pressure measurement data collected from different WNU. The sheet should contain at least the following data.

- Date of reading;
- Time of reading;
- WNU code;
- Subsystem code;
- Address (Keftegna and Kebele);
- Water pressure (in Kg/m^2).

3 Water Leakage Input Sheet (WNIF-3)

Water leakage input sheet is used for collecting water leakage data for the system. The sheet should contain at least the following data:

- Date of leakage or breakage;
- WNU code;
- Subsystem code;
- Address (Keftegna and Kebele);
- Source of Leakage (code);
- Cause of leakage (code);
- Method of location (code);
- Visibility of leakage at surface (code);
- Quantity of water subjected to leakage (m^3); and
- Date of repair (ddmmyy).

4 Maintenance Data Input Sheet (WNIF-4)

Pipe retirement, maintenance, and replacement data are collected and input to the system by this sheet for each WNU. The sheet should contain at least the following data:

- Date of maintenance (ddmmyy);
- WNU code;
- Subsystem code;

- Address (Keftegna);

- Maintenance work order number;

- Type of maintenance (code);

- Type of pipe replaced;

- Diameter of pipe replaced;

- Length of pipe replaced (in meter);

- Number of fitting replaced; and

- Number of fitting installed.

4.4.1.3.3 Output Requirements

The system would generate different periodic and ad-hoc reports and on screen query outputs. Some of the major outputs would be:

- Edit proof list;

- Maintenance history report;

- Preventive maintenance work order;

- Pressure report;

- Leakage statistics; and

- Other pipe related summary and statistical reports.

4.4.1.3.4 Process Requirements

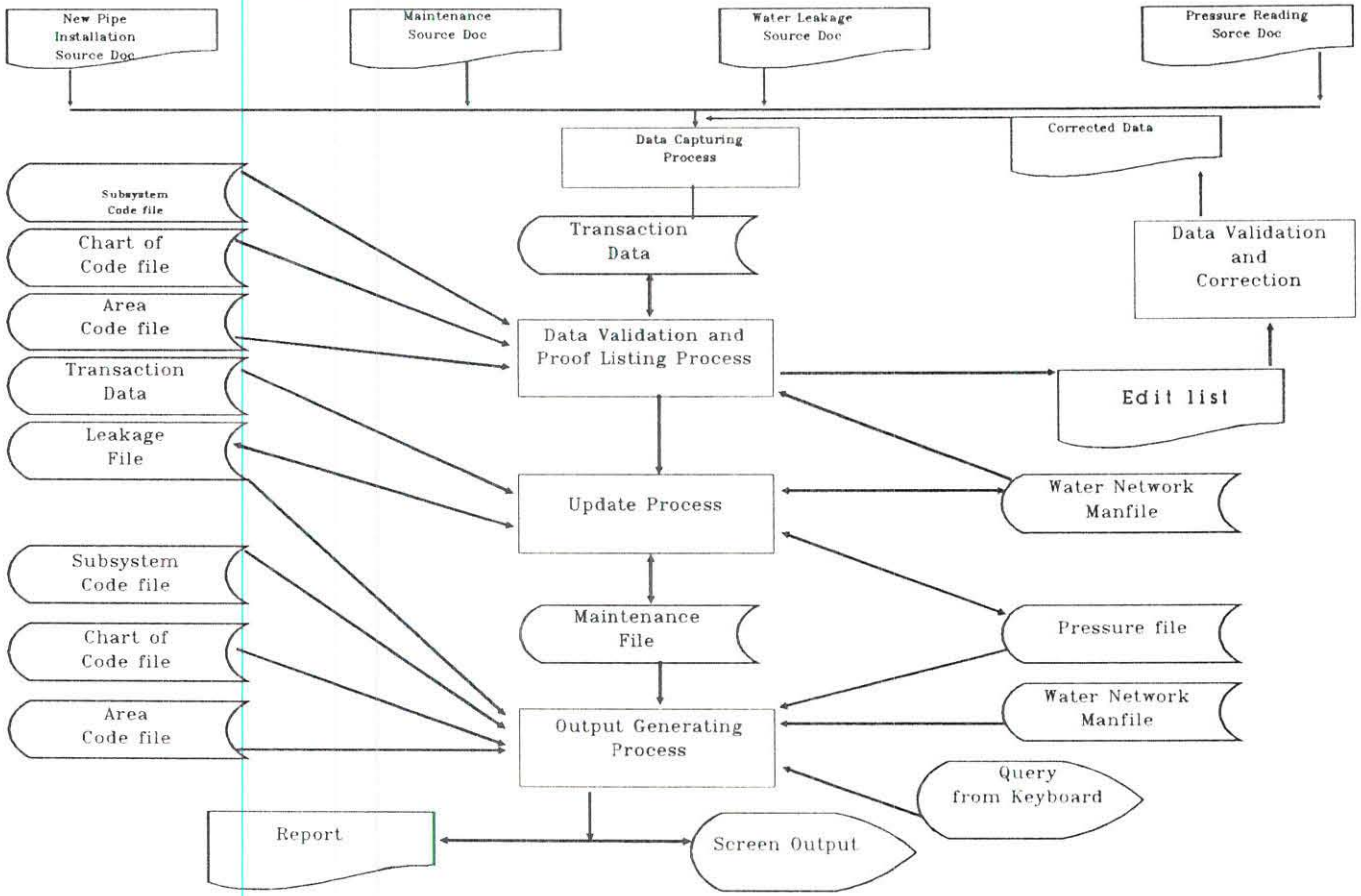
The water network information subsystem would have the following processes to generate the required information (the general process flow is presented in figure 4.2).

- Data Entry Subprocess That provides data entry and view screen for each type of input, validates the correctness of some input data during data entry, and creates transaction file;
- Edit Listing Subprocess That checks the correctness of data in the transaction files using various code files and entries in a database and produces printed output (edit list) for all input data (with warning message for erroneous data);
- Update Subprocess Which is used for updating the water network subsystems database using transaction files;
- Report Generating Subprocess Generates various printed or on-screen outputs.

4.4.1.3.5 Database Structure

This section presents the identified entities, data items, data files, and database structure of the water network information subsystem. From the data incorporated with each WNU, four entities were identified. The entities are: Water Line, Pressure, Leakage, and Maintenance. Figure 4.3 shows the relation among entities. Corresponding to entities, the following four data files are recommended to store all relevant data about each WNU.

Fig 4.2: Water Network Subsystem Process Flow Diagram



Data File Name	Description
WATRMSTR	To store all detailed identification, location, reference, pipe and stallation data, and other summarized data about each WNU. (attributes of Water-Line)
WATRPRSR	To store pressure reading data of each WNU.(attributes of pressure)
WATRLKAG	To store detailed water leakage and pipe breakage data of each WNU. (attributes of Leakage)
WATRMANT	To store detailed pipe retirement, replacement, and repair data of each WNU. (attributes of maintenance)

Data definitions of each data file are given in Table 4.1, 4.2, 4.3, and 4.4 (record identifier of each data file is marked with "*"). A relationship among the four data files or the structure of the water distribution information subsystem database is presented in Fig. 4.4.

Figure 4.3: Entities in Water Network Unit (WNU) and Relation Among Them

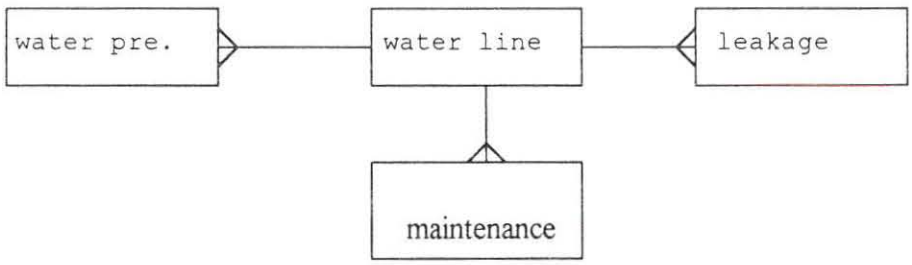


Table 4.1: Data Definition of WATRMSTR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
WNUCODE*	C	6	WNIF-1	Water Network Unit (WNU) Code(Segment start and end node code)
SUBSYSCD	N	2	WNIF-1	Water distribution subsystem code
MAPNO	C	3	WNIF-1	Map or document number
WRKORDNM	C	10	WNIF-1	Const. or installation workorder number
KEFTEGNA	N	2	WNIF-1	Area address code
KEBELE	N	2	WNIF-1	Area address code
STREET	C	20	WNIF-1	Principal or intersection street name
REFERENC	C	20	WNIF-1	Relative permanent reference point to locate WNU start node
DISTANCE	N	3	WNIF-1	Distance of WNU start node form REFERENCE
DIRCTNST	N	3	WNIF-1	Direction of WNU start node from REFERENCE
DIRCTNED	N	3	WNIF-1	Direction of WNU end node from start node
PIPETYP	N	3	WNIF-1	Code for type of pipe installed in WNU
PIPELNG	N	3	WNIF-1	Length of pipe in WNU
PIPEDMTR	N	3	WNIF-1	Diameter of pipe
INSTDATE	N	6	WNIF-1	Installation date
PIPEDPTH	N	3	WNIF-1	Average depth of pipe from the ground
SOILCRSV	N	3	WNIF-1	Code for soil corrosivity
MAXELVN	N	4	WNIF-1	Maximum elevation of pipe in WNU
MINELVN	N	4	WNIF-1	Minimum elevation of pipe in a WNU
NUMAPPR	N	2	WNIF-1	Number of apparatus fixed to WNU
NUMFING	N	2	WNIF-1	Number of fitting in WNU
PRESRACT	N	4	WNIF-1	Acceptable or designed water pressure in WNU
LEAKSTAT	N	2	WNIF-3	Number of leakage observed in WNU
MANTDATE	N	6	WNIF-4	Last date of maintenance or inspection (yymmdd)
Record size		118		

Note: i - Field type code **C:** Alpha-numeric character
N: Numeric character
A: Alphabetic character

ii - Field size is in character

Table 4.2: Data definition of WATRPRSR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
WNUCODE*	C	6	WNIF-2	WNU code where pressure in measured
RDDATE *	N	6	WNIF-2	pressure reading date (yymmdd)
RDTIME	N	2	WNIF-2	Pressure reading time
PREASSUR	N	6	WNIF-2	Water pressure
Record size		20		

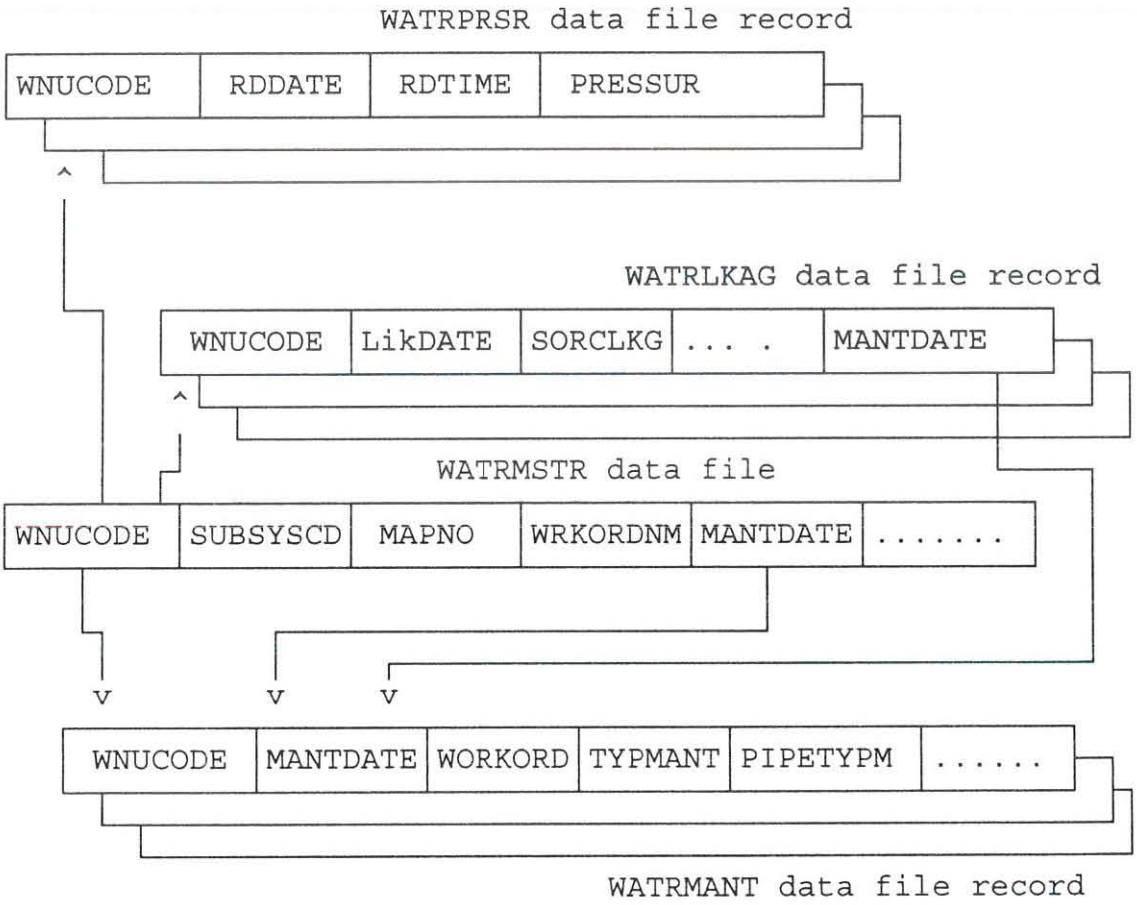
Table 4.3: Data Definition of WATRLKAG Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
WNUCODE*	C	6	WNIF-3	WNU code
LIKDATE*	N	6	WNIF-3	Date of leakage or breakage (yymmdd)
SORCLKG	A	2	WNIF-3	Source of leakage code
CAUSLKG	A	2	WNIF-3	Code for cause of leakage
LCTNLKG	A	2	WNIF-3	Code for leakage method oflocating
VSBLTLKG	A	2	WNIF-3	Code for visibility of leakage
WATRLOSS	N	4	WNIF-3	Quantity of water loss
MANTDATE	N	6	WNIF-3	Date of repair (yymmdd)
Record size		30		

Table 4.4: Data Definition of WATRMANT Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
WNUCODE	C	6	WNIF-4	WNU Code
MANTDATE	N	6	WNIF-4	Date of maint.(yymmdd)
WRKORDNM*	C	10	WNIF-4	Maint. workorder number
TYPMANT	A	2	WNIF-4	Maintenance type code
PIPETYPM	A	2	WNIF-4	Type of pipe replaced
PIPELNGM	N	3	WNIF-4	Length of pipe replaced
PIPEDTRM	N	3	WNIF-4	Diameter of pipe replaced
NUMFTNGM	N	2	WNIF-4	Member of fitting replaced
RSNMANT	A	2	WNIF-4	Reason of maintenance code
Record size		36		

Fig 4.4: Structure of Water Network Subsystem Database



4.4.1.4 Valve Subsystem

4.4.1.4.1 General Description

Valves are an essential component of water distribution system that controls water flow. They need regular inspection and maintenance. Thus, timely and accurate valve information is needed by different users to easily locate valves on the ground and to schedule the regular inspection and maintenance activities.

The objective of the valve information subsystem is to collect, store, and process valve related data and to generate accurate and timely valve information. The system would track all valve installation, maintenance, inspection, isolation, and other pertinent data and store in a database. The system also manipulates the stored data using various computer programs and software packages to generate different information which is used for planning, decision making, and day-to-day operation.

The system would generate different periodic and ad-hoc reports, and query outputs. Some of the outputs would be:

- Location of valve(s) that is/are used for interrupting water flow to specific part of the network during maintenance, new connection, and damage;
- Location of valve(s) which isolate specific subdivision of the city for rationing water during water shortage;

- Location of valve(s) which is(are) used for dewatering, pressure reducing, and blow-of-air in specific subdivision of the network;
- Valve inspection schedule based on type, function, size, location, and relative importance of valves;
- Valve maintenance work order based on the status, and condition of valve-box;
- Valve maintenance and installation report; and
- Different summary and detailed report of valve by size, installation date ,type, maintenance date, function, location, and other parameters.

The following data would be collected and stored about each valve by the system to generate valve information:

- Identification data
  - . valve identification number
  - . WNU code where valve is fixed
  - . water distribution subsystem code
- Location and Address data
  - . keftegna code
  - . kebele code
  - . specific location of valve
- Reference data
  - . number of map that documents detailed information about the valve

. reference number of installation work order which contains detailed cost and technical data

- Valve data

. manufacturer of valve

. size of valve

. type of valve

. direction to open

. number of turns (to open or close)

- Installation data

. installation date

. normal position of valve (closed or opened)

. type of valve box cover

. depth of valve nut from valve box cover

. function of valve

. relative importance or criticality of valve

. safety condition of valve location

- Maintenance data

. date of maintenance

. maintenance work order number

. part of valve maintained

. type of maintenance

. reason of maintenance

- Inspection data

. date of inspection

. valve found (fully closed/opened or partially closed/opened)

. condition of valve packing

. condition of valve stem

. condition of valve nut

. condition of valve box

. condition of valve box cover

. gears condition

. valve status (functional or not)

- Valve Isolation data

. subsystem code that is isolated

. region code that is isolated

. keftegna code that is isolated

. kebele code that is isolated

. isolation type made by the valve

4.4.1.4.2 Input Requirements

The following four types of inputs are identified to collect and input data to the system. The inputs will be prepared by the Technical Department and submitted to the computer information service. Computer information service data entry clerks will enter the data from the source to the computer.

1 Valve Master Data input sheet (VLIF-1)

This input sheet is used to input identification, location, reference, valve, and installation data about each valve. Data about each valve will be collected from valve plate map, valve closer or section map, valve installation work order and other engineering documents and filled on pre-printed Valve Master Data Input Sheet. The Valve Master Data Input Sheet would contain at least the following data:

- valve identification code;
- installation work order number;
- WNU code;
- distribution subsystem code;
- plate or closure map number;
- address codes (keftegna and kebele);
- principal or intersection street name where valve found;
- permanent reference point for locating valve;
- distance of valve from reference point (in meter);
- distance of valve from reference point (direction code);
- make of valve (manufacturer name);
- type of valve (code);
- size or diameter of valve (in millimeter);
- direction to open (code);
- number of turns to open or close;

- normal position of valve (opened or closed);

- function of valve (code);

- criticality of valve (code);

- condition of valve location code (safe or risk);

- valve box cover type code (if any); and

- depth of nut from the cover (in centimeter).

2 Routine Valve Inspection Sheet (VLIF-2)

This sheet is used to input the periodic valve inspection data. This form will be prepared by the system for selected valves based on valve inspection policy of the technical department and will be filled by field workers during valve inspection. The sheet should contain at least the following data:

- date of inspection;

- valve identification code;

- WNU code;

- subsystem code;

- address (keftegna and kebele code);

- status of valve (functioning or not);

- condition of valve (code);

- condition of packing (code);

- condition of stem (code);

- condition of nut (code);

- condition of valve-box (code);

- condition of valve-box cover (code);

- gears condition; and

- reference number that uniquely identify each inspection of valve.

3 Routine Valve Maintenance Sheet (VLIF-3)

This sheet is used to input valve maintenance data. This sheet is an original document filled by the field technician during valve maintenance. The form should contain at least the following data:

- date of maintenance;

- maintenance work order number;

- valve identification number;

- WNU and subsystem code;

- address code (keftegna and kebele);

- type of maintenance or condition of packing(cod);

- type of maintenance or condition of stem (code);

- type of maintenance or condition of nut (code);

- type of maintenance on box or its condition (code);

- type of maintenance on cover and its condition

4 Valve Isolation Input Sheet (VLIF-4)

This sheet is used to input valve isolation data. The data will be collected from valve plate map, installation work order or from field survey. The input sheet should contain at least the following data:

- valve identification code;
- subsystem code which is isolated by the valve;
- region code which is isolated by the valve;
- keftegna code which is isolated by the valve;
- kebele code which is isolated by the valve;
- isolation made by the valve code (full isolate, partial isolate or isolate with others); and
- reference number that uniquely identify each input sheet.

4.4.1.4.3 Output Requirements

The system would generate different types of outputs based on the input data. The major required outputs are:

- Edit report: list of input data with error message (if there is input data error) for cross checking the input data with the source and correcting errors.
- Inspection work order: valve inspection work order based on size, location, type, function, and last service date.
- Maintenance work order: for valves not in a good condition and for valves frequently subjected to damage.

- Valve List: list of selected valves with their full identification, reference, installation, and location information to be used by field workers.
- Valve maintenance and installation summary and detailed report (by size, area, type, and other parameters)
- on screen and printed valve isolation report.

4.4.1.4.4 Process Requirements

The following four major processes are required to transfer input data to the required output, and the general process flow is presented in Figure 4.5.

- Data Entry Subprocess: this subprocess is used to input data from the input sheet to the computer. This process will provide "fill-in-blank" form for data entry, will validate some inputs during data entry, and will create transaction data file.

- Edit listing subprocess: this subprocess is used for checking the correctness of the data in transaction file using various code files and entry in the database. The system will generate edit report with warning message for erroneous data.

- Update Subprocess: this subprocess is used to update valve information subsystem database using clean transaction data.

- Output generating subprocess: this subprocess is used to generate various printed periodicals and as required reports and on screen or printed query outputs about valve isolation.

4.4.1.4.5 Database Structure

This section presents the identified entities, data items, and database structure of the valve information subsystem. From the data incorporated with each valve, four entities were identified. The entities are: Valve, Cover(Box), Area, and Maintenance. The relation among the entities are presented in Figure 4.6. Corresponding to the entities the following four data files are recommended to store all relevant data.

Data File Name	**Description**
VALVMSTR	To store all detailed identification, location, reference, valve and installation data, and other summarized data about each valve. (attributes of Valve)
VALVCOVR	To store valve-box cover data for those valves which have valve box.(attributes of Cover)
VALVAREA	To store valve isolation data about each subdivision of the city and water distribution subsystem. (attributes of Area)
VALVMANT	To store maintenance history data each valve. (attributes of Maintenance)

Data definitions of each data file are given in Table 4.5, 4.6, 4.7, and 4.8 (Record identifier of each data file is marked with "*"). Relationship among the five data files or the structure of the valve information subsystem is presented in figure 4.7.

Fig 4.5: Valve Subsystem Process Flow Diagram

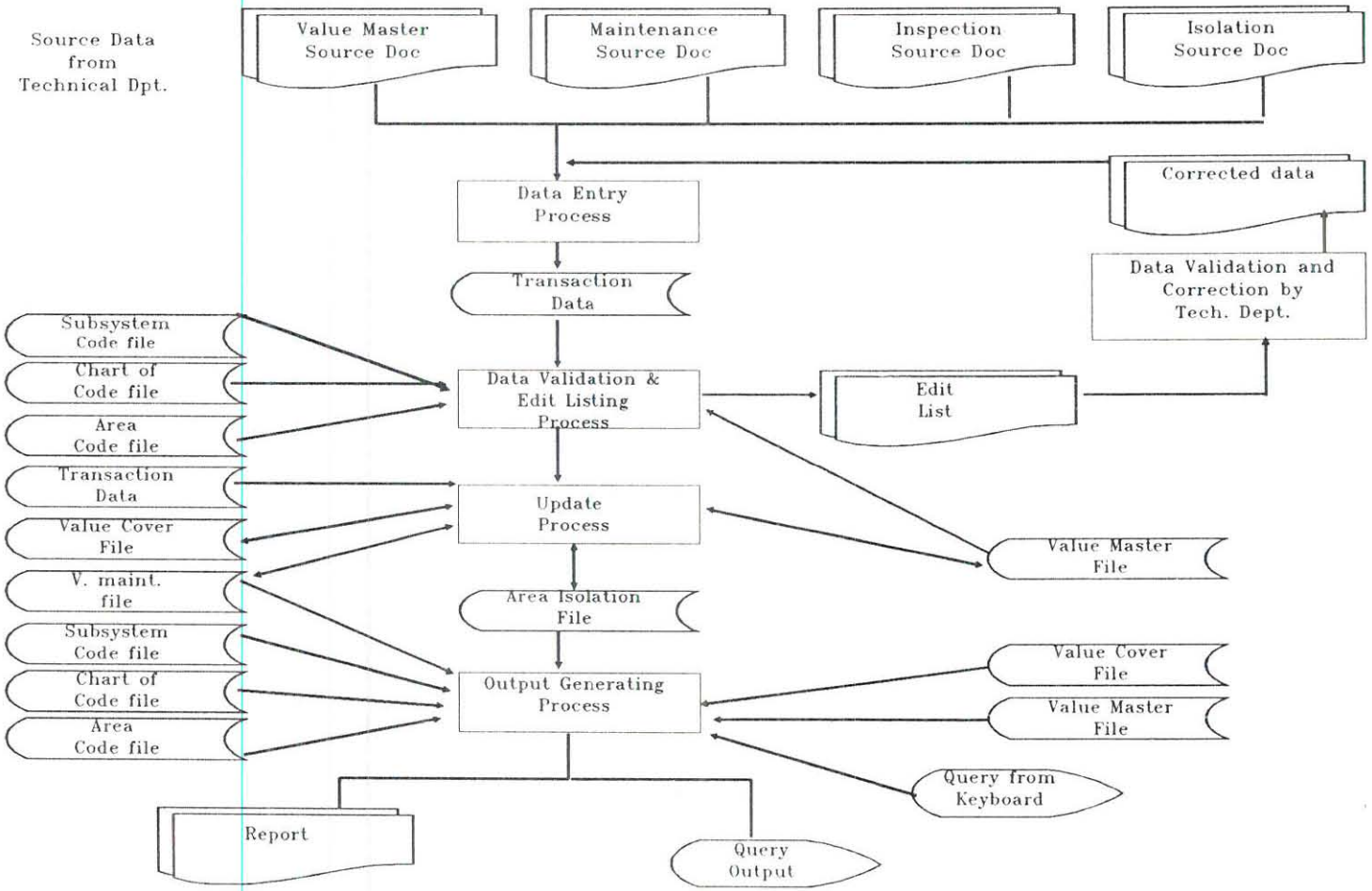


Figure 4.6: Entities of Valve and Relation Among Them

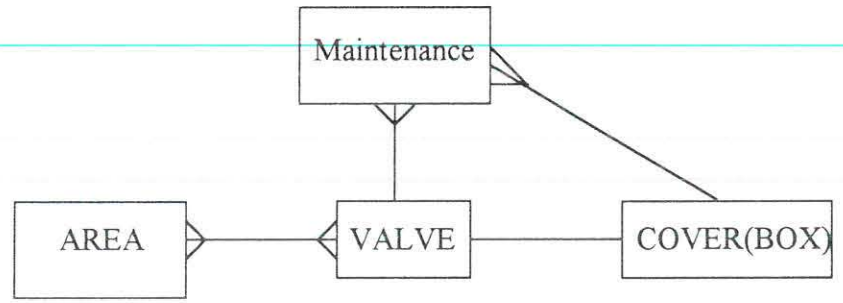


Table 4.5: Data Field Definition of VALVCOVR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
VALVENO*	C	6	VLIF-1	valve identification number
COVERT	C	10	VLIF-1	valve-box cover type
DEPTHNUT	N	2	VLIF-1	Depth of valve nut from cover
Record Size		18		

Table 4.6: Data Definition of VALVAREA Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
REFNO*	C	10	VLIF-4	input sheet number
SUBSYSCD	N	2	VLIF-4	distribution subsystem code isolated
REGIN	N	1	"	code of regin isolated
KEFTEGNA	N	2	"	code of keftegna isolated
KEBELE	N	2	"	code of kebele isolated
ISOLTNTP	A	2	"	isolation type code
VALVENO	C	6	"	valve identification number
Record Size		25		

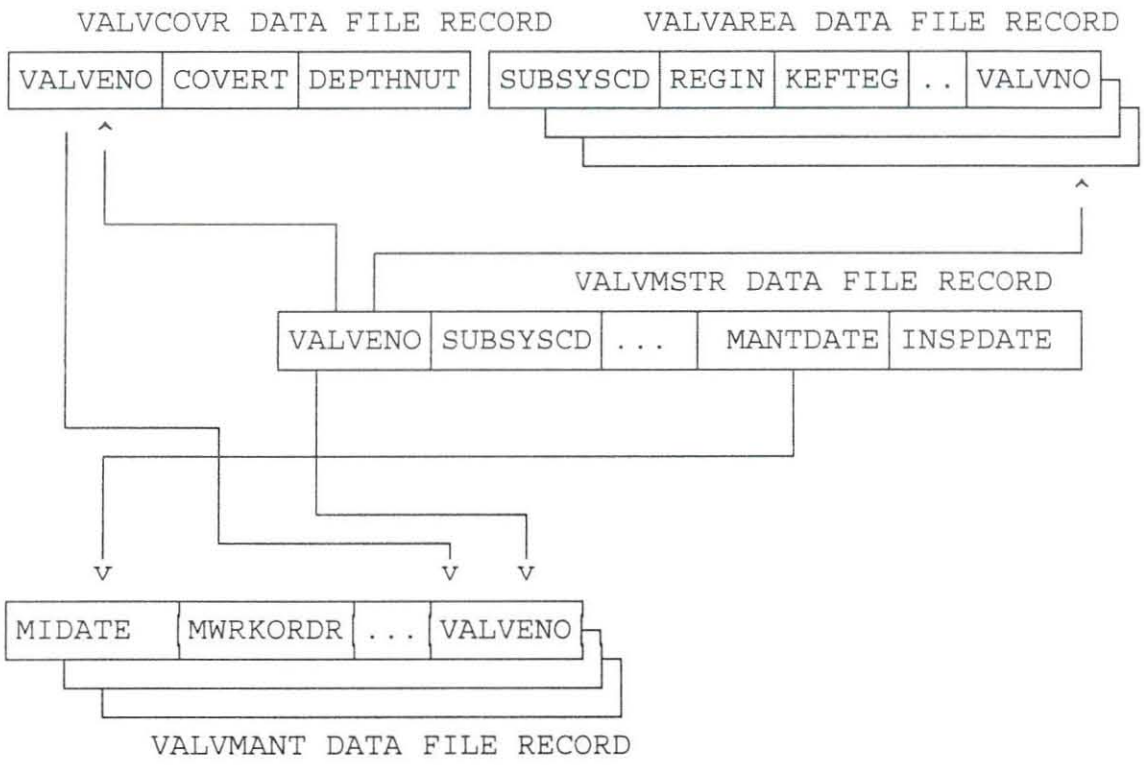
Table 4.7: Data Definition of VALVMSTR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
VALVENO*	C	6	VLIF-1	Valve identification number
WNUCODE	C	6	"	WNU code where valve found
SUBSYSCD	N	2	"	water Dist. subsystem code
MAPNO	C	3	"	plate or closure map number
WRKORDNO	C	10	"	installation work order #
KEFTEGNA	N	2	"	area address code where valve found
KEBELE	N	2	"	area address code where valve found
STREET	C	20	"	principal or intersection street name where valve found
REFERENC	C	20	"	relatively permanent reference point to locate valve
DISTANCE	N	3	"	distance of valve from reference
DIRCTN	A	2	"	direction of valve from reference (code)
MAKE	C	10	"	valve manufacture name
TYPE	A	2	"	valve type (code)
DIAMTR	N	3	"	diameter of pipe
OPENDIR	A	2	"	direction to open (code)
NUMTURN	N	2	"	number of turns to open or close
NORMPSN	A	2	"	normal position of valve in network (code)
FUNCTON	A	2	"	function of valve (code)
INSTDATE	N	6	"	installation date (yymmdd)
SAFTYCON	A	2	"	valve location cond. (code)
CRITCLYT	A	2	"	relative importance of valve (code)
VALVBOX	A	2	"	existence of valve box
STATUSV	A	2	VLIF-2	status of valve (functional or not)
MANTDATE	N	6	VLIF-3	last valve maintenance date
INSPDATE	N	6	VLIF-2	last valve inspection date
Record Size		125		

Table 4.8: Data Definition of VALVMANT Data File Record

Field Name	Field Type	Field Size	data Source	Field Description
MIDATE	N	6	VLIF-2,3	valve insp./maint date
WORKORD*	C	10	"	work ord. no.
OPRNTY	A	2	"	operation type
STATUSV	A	2	"	status of valve code
VLVFOUND	A	2	"	condition of valve (code)
PKNGCND	A	2	"	condition of packing (code)
STEMCND	A	2	"	condition of stem
NUTCND	A	2	"	condition of nut
BOXCND	A	2	"	condition of box
COVECND	A	2	"	condition of cover
VALVENO	C	6	"	valve identification code
Record Size		38		

Fig 4.7: Structure of Valve Subsystem Database



4.4.1.5 Water Meter Subsystem

4.4.1.5.1 General Description

The most common use of water meter is for setting costs according to use. However, meters serve in many other ways. Main-line meters are used to measure water flow into different areas and thereby provide information for system control. Meters measure the flow in and out of reservoirs and the inffluent to and effluent from treatment plants, they also provide information for production and distribution. Meters also allow the authority to determine how efficiently it is operating. If large amounts of water are unaccounted for, the authority can begin a survey to determine where the water loss is occurring. On the other hand water meters are subject to wear, deterioration; and over a period of time lose their peak efficiencies. Thus, timely and accurate meter information is needed by different users to know water production, distribution and consumption, and to conduct and schedule periodic meter test.

At present AAWSA has 132,498 water meters. Based on their function the existing water meters are categorized into customer and non-customer meter. Customer meters are used to measure the amount of water consumed by each water customer. Non-customer meters are used for measuring the amount of water produced from various water sources, and the amount of water distributed to different parts of the city. Non-customer meters further classified into four categories as main-line meter, subsystem meter, reservoir meter and source meter.

Main-line meters are those water meters fixed at different part of the water network to measure the amount of water distributed to specific part of the city.

4.4.1.5 Water Meter Subsystem

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Main-line meters are those water meters fixed at different part of the water network to measure the amount of water distributed to specific part of the city.

Subsystem meters are those water meters fixed at the inflow point of each of the eleven water distribution system. These meters are used to measure water distributed in each water distribution subsystem.

Reservoir meters are those water meters fixed at the inflow and outflow point of reservoirs. These meters are used for measuring the amount of water flow to and from reservoirs.

Source Meters are the water meters fixed at water treatment plants' spring water sources, and well water sources. These meters are used to measure the amount of raw water intake and the amount of potable water produced.

Total number of water meters are ad follow:

Category of meter	Number of meter
Customer meter	132,350
Non-customer meter	
Main-line meter	42
Subsystem meter	11
Reservoir meter	74
Source meter	21
Total	132,498

Objective of the Water Meter subsystem is to collect, store, and process water meter and meter reading data to generate various water consumption, production and distribution, and water meter information. The system would track all meter reading data (except for customer

meters, because customer meter reading data is collected by the existing customer billing system for preparation of water bill), and meter installation, location, maintenance and test data and would store it in a database. The system would have various in-house developed computer programs for processing the stored data to generate different meter reading and water meter related information. The system has also to be linked with the existing customer bill system to access water consumption data or to provide detailed customer meter information.

The water meter information subsystem would generate different operational and management reports such as:

- Water production report of different sources (treatment plants, springs and wells);
- Water distribution report by subsystems and subdivisions of the city;
- Water consumption report by customer categories, subdivisions of the city and subsystems;
- Water meter maintenance and test schedule based on size, location, types, life-year, and last service date;
- Summarized and detailed report on water meter installation, maintenance, test and retirement;
- Water loss report in various subsystems and subdivisions of the city; and
- Different meter reading and water meter related statistics using different parameters.

The following data would be collected and stored by the system to generate water production, distribution, and consumption, and water meter information.

- Water Meter data (for customer and non-customer meter)
  - . Water meter number
  - . Manufacturer of meter
  - . Meter diameter/size
  - . Number of meter's digit
  - . Meter type
  - . Life-Year of meter
- Installation data
  - . Installation date
  - . Meter function (customer, main-line, reservoir, subsystem or water source)
  - . Area covered for main-line meter
- Reading data (for none- customer meters)
  - . Reading date
  - . Meter reading (m^3)
- Test and Maintenance data
  - . Test/maintenance date
  - . Maintenance workorder number
  - . Meter problem (code)
  - . Maintenance activity type (code)
  - . Recommendation

4.4.1.5.2 Input Requirements

The following types of input forms are identified for collecting required data. The first will be prepared by operation department (for customer meters) and Technical Department (for non-customer meters). The last input will be prepared by the AAWSA water meter laboratory. The input source documents will be submitted to Computer Information Service.

1 Water Meter Master Data Input Sheet (WMIF-1)

This input sheet is used to input customer and non-customer meter and installation data. Data about each meter will be collected from installation workorder, document accompanied with the purchase of meters, and distribution maps. Water Meter Master Data Input Sheet would contain at least the following data:

- Meter identification number;
- Installation work order number;
- First time installation or reinstallation manufacturer name;
- Meter type (code);
- Diameter or size of meter (in millimeter);
- Number of meters-digit;
- Expected life-year of meter;
- Installation date;
- Meter function (customer);
- Customers number, Name and Address (for customer meters);

- Location of meter, area controlled by a meter, and WNU code (for main line meters);
- Water source code and name, and use of meter (inflow outflow) (for water source meter);
- Subsystem code and location of meter (for distribution subsystem meter); and
- Reservoir code and name, and use of meter (inflow outflow) (for reservoir meter).

2 Non-customer Meter Reading Input Sheet (WMIF-2)

This input form is used to collect meter reading data from each non-customer meter. Each meter will have one input form that serves at least for twelve period of reading. The data will be collected bi-monthly because customer meter reading is collected bi-monthly by the existing customer billing system. The input sheet will contain at least the following data:

- Meter number;
- Meter function;
- Location of meter;
- Reservoir, WNU or Subsystem Name and Code;
- Reading date;
- Reading; and
- Meter overflow code.

3 Routine Meter Test/Maintenance Input Sheet (WMIF-3)

This form is used for collecting routine meter test and maintenance data from the water meter laboratory. This input form will contain the following data:

- Meter number;
- Customer name, Contract number and Address for customer meter or location and function for non-customer meter;
- Maintenance or Inspection date;
- Workorder number;
- Problem identified (code);
- Maintenance activity (code); and
- Recommendation by technician.

4.4.1.5.3 Output Requirements

The system would generate different types of water production, distribution, consumption and meter information. The major required output are:

- Edit report list of input data with error message (if there is input data error). It is used to cross check the input data with source and for correcting error;
- Water production report of treatment plant, spring and well;
- Water production, distribution and consumption comparison report;
- Meter test work order based on the size, type and last service date of meter;
- List of water meters frequently subjected to ware and those meter completed life time; and

- Meter test and installation summary, and detailed report (by size, type, installation date, and other parameters).

4.4.1.5.4 Process Requirements

Like other systems, the Water Meter Subsystem would have the following four major processes:

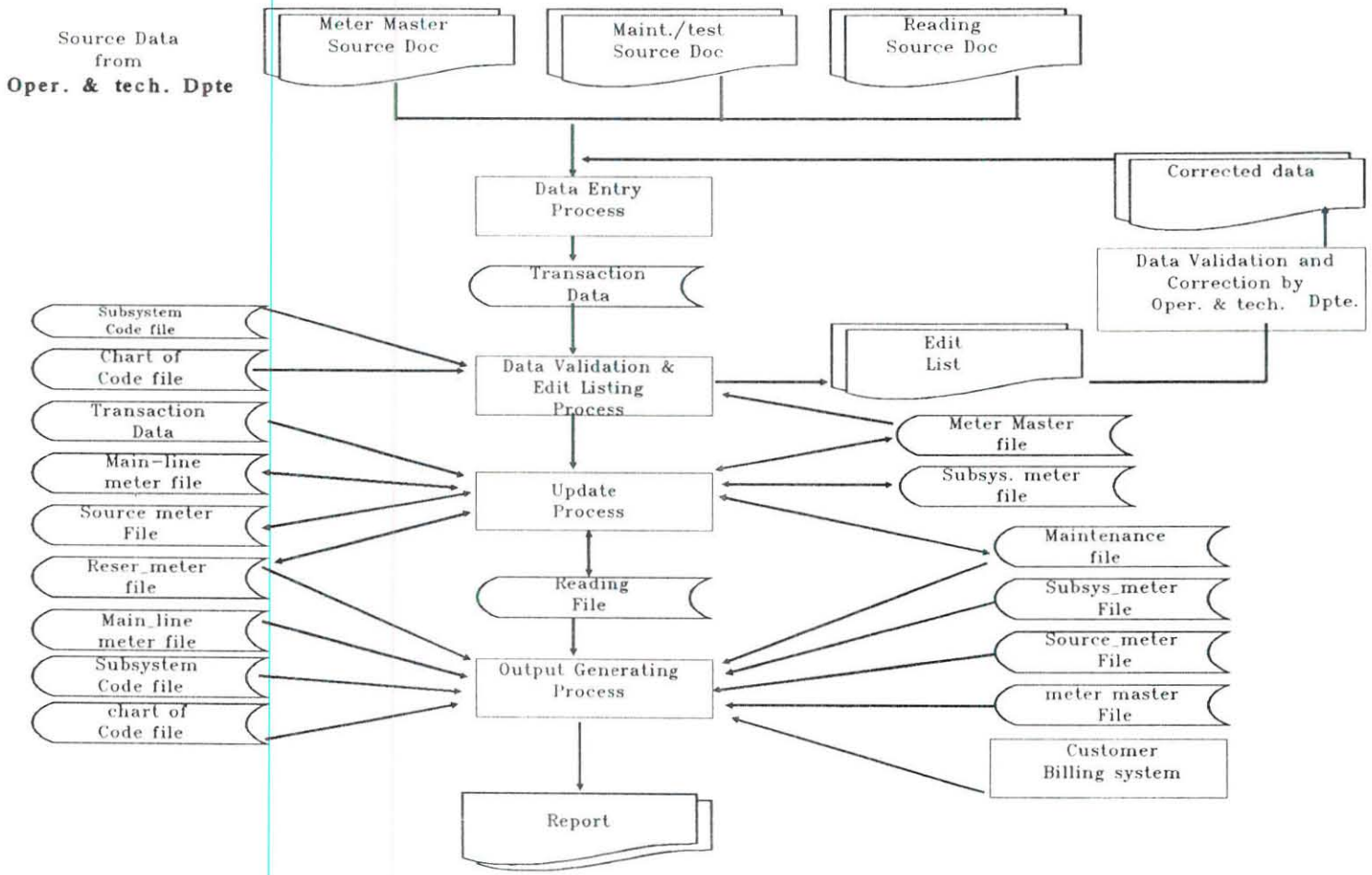
- Data Entry subprocess;
- Edit listing subprocess;
- Update subprocess; and
- Report generation subprocess.

The general process flow of the water meter information subsystem is presented in Figure 4.8.

4.4.1.5.5 Database Structure

This section presents the identified entities data items, data files, and database structure of the water meter information subsystem. Four entities were identified to maintain information related to water meter. The entities are; Meter, Reading, Test, and Use. The relation among the entities are presented in Figure 4.9.

Fig 4.8: Water Meter Subsystem Process Flow Diagram



To maintain data indipendency and to avoide repeating group, record corresponding to one of the entities are normalized. The following seven data files are recommended to store all water meter and reading data.

Data file name	Description
METERMSTR	To store customer and non-customer meter installation and other meter related data.
METERTEST	To store meter maintenance and test data.
MAINMETR	To store main-line meter location, area coverage and other related data.
SUBSSMETER	To store subsystems-Meter location and other related data.
SORSMETR	To store water source meter location and function data.
RSRVMETR	To store Reservoir meter location and function data.
READMETR	To store detailed main-line, subsystem, source and reservoir meter reading data.

Data definitions of each data file records are given in Tables 4.9,4.10, 4.11, 4.12, 4.13, 4.14, and 4.15 (record identifiers are marked with "*"). The relation among the data files or the structure of the water information subsystem database is presented in Figure 4.10.

Figure 4.9: Entities of Water Meter and Relation Among Them

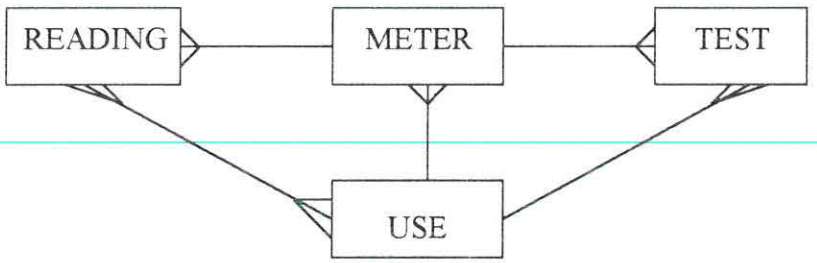


Table 4.9: Data Definition of METERMSTR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
METERNO*	N	10	WMIF-1	Meter identification number
MFMAKE	C	20	WMIF-1	Manufacturer or make name
MSIZE	N	3	WMIF-1	Meter size (in mm)
MDIGIT	N	2	WMIF-1	Number of reading digit
MTYPE	A	2	WMIF-1	Meter type code
MFUNCTN	A	2	WMIF-1	Meter function code
WORKORDR	C	10	WMIF-1	meter installation work-no.
FINSTDT	N	6	WMIF-1	First installation date
LINSTDT	N	6	WMIF-1	last installation date
LIFEYEAR	N	2	WMIF-1	Expected lifetime (in year)
STATSM	M	2	WMIF-1	Status of meter, working, or removed)
RMDATE	N	6	WMIF-1	Date of removal
MTDATE	N	6	WMIF-3	Last date of maintenance/ Test
Record Size		71		

Table 4.10: Data Definition of METERTEST Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
METERNO	N	10	WMIF-3	Meter number
MTDATE	N	6	WMIF-3	Test /mant date
MWRKORR*	C	10	WMIF-3	Maint workorder number
MPROBLEM	A	2	WMIF-3	Problem of meter (code)
MAINTYP	A	2	WMIF-3	Maintenance Type code
RECOMDTN	A	2	WMIF-3	Result of Test & Maint(recommendation)
Record size		30		

Table 4.11: Data Definition of MAINMETR Data File record

Field Name	Field Type	Field Size	Data Source	Field Description
MAINLNC*	N	3	WMIF-1	Main line code
MLOCATN	C	30	WMIF-1	Location of main line meter
ARECURD	C	30	WMIF-1	Area controlled by meter
METERNO	N	10	WMIF-1	Meter number
YRTDTRD	N	10	WMIF-3	Year-to-date water distributed to the area
Record size		81		

Table 4.12: Data Definition of SUBSSMETR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SUBSYSCD*	N	3	WMIF-1	Subsystem code
MLOCATN	C	30	WMIF-1	Meter Location
METERNO	N	10	WMIF-1	Meter number
YRTDTRD	N	10	WMIF-3	Year-to-date water distributed to the subsystem
Record Size		53		

Table 4.13: Data Definition of SORSMETR Data file Record

Field Name	Field Type	Field Size	Data Source	Field Description
SOURCD*	N	3	WMIF-1	Code of source of water
SOURSNM	C	20	WMIF-1	Name of water source
METERNO	N	10	WMIF-1	Meter number
METRUSE	A	1	WMIF-1	use of meter (in or outflow)
YRTDTRD	N	10	WMIF-1	Year to date inflow outflow
Record Size		44		

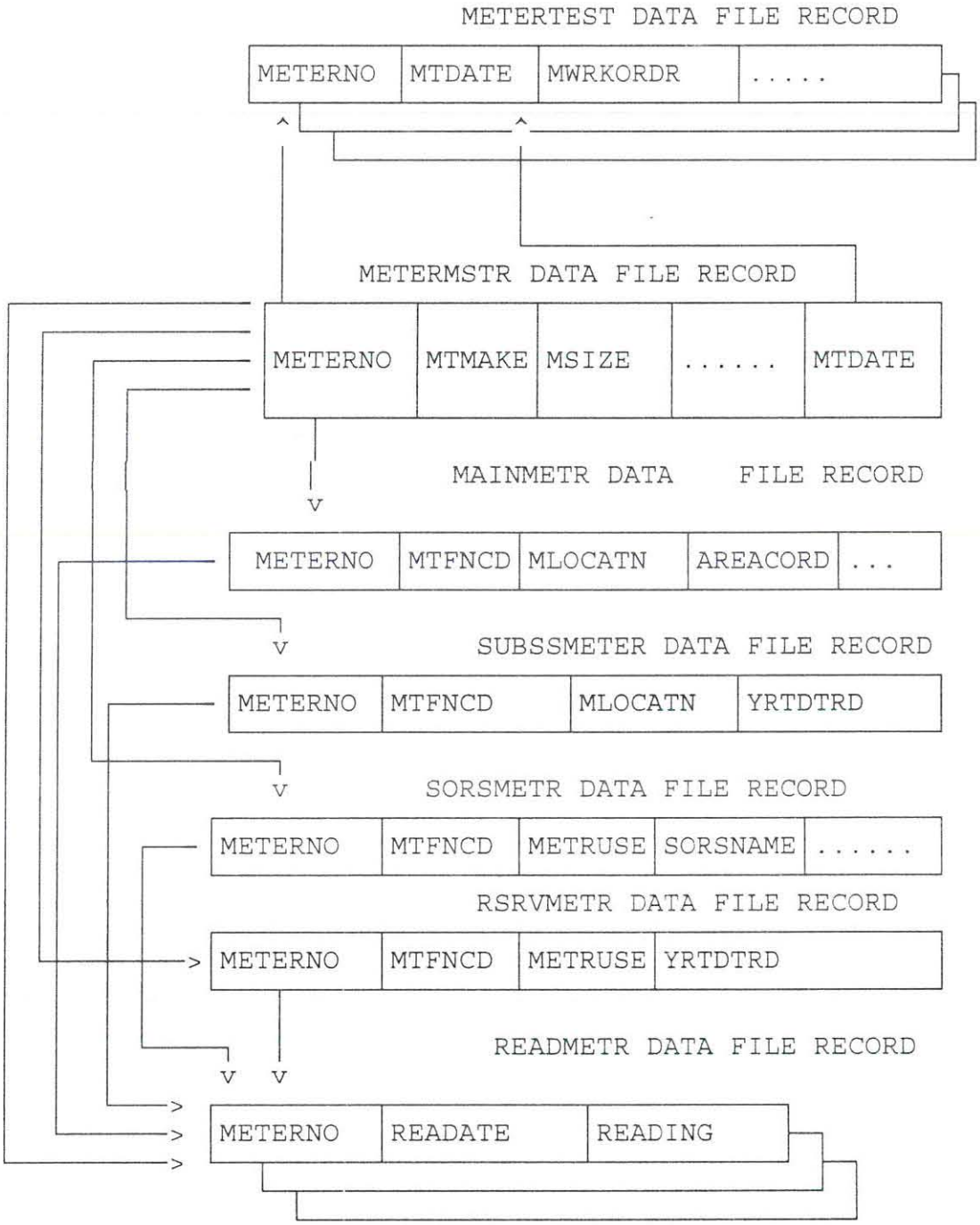
Table 4.14: Data Definition of RSRVMETR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Definition
RESRVCOD*	N	3	WMIF-1	Code of Reservoir
METERNO	N	10	WMIF-1	Meter Number
METERUSE	A	1	WMIF-1	Use of meter (inflow or outflow)
YRTDRD	N	10	WMIF-3	Year-to-date inflow or outflow
Record Size		14		

Table 4.15: Data Definition of READMETR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Definition
METERNO*	N	10	WMIF-3	Meter number
READATE*	N	6	WMIF-3	Meter Reading date
READNG	N	10	WMIF-3	Meter Reading
Record Size		29		

Figure 4.10: Structure of Water Meter Subsystem Database



4.4.1.6 Fire Hydrant Subsystem

4.4.1.6.1 General Description

The objectives of fire hydrant subsystem are:

- to maintain permanent record of fire hydrant installation data;
- to maintain permanent record of fire hydrant inspection and maintenance data;
- to generate hydrant inspection and maintenance work order;
- to generate hydrant inspection and maintenance schedule that serve for planning annual maintenance, replacement and inspection work; and
- to generate various installation, maintenance and inspection summary and detailed information which serves for different operational and managerial functions.

To achieve the above objectives, the system has to track all fire hydrant installation, replacement, maintenance and inspection data and store in a database. The system would also used to manipulate the stored data using various computer programs to generate the required outputs.

The following data would be collected and stored by the system to generate fire hydrant information:

- Identification data
  - . fire hydrant identification number that is unique for each fire hydrant
  - . WNU code where fire hydrant is fixed
  - . water distribution subsystem code

- Reference data

    . installation work order number

- Hydrant data

    . make of hydrant

    . size of hydrant

    . type of hydrant

- Installation data

    . date of installation

    . size of main feeding the hydrant

    . static water pressure required

    . flow water pressure required

- Location data

    . keftegna code

    . kebele code

    . street name

- Maintenance data

    . maintenance date

    . maintenance work order number

    . part of hydrant maintained

    . type of maintenance

    . resource of maintenance

- Inspection data

. inspection date

. caps condition

. chain condition

. paint condition

. nut condition

. nozzle condition

. static pressure

. residual pressure

. flow pressure

. status of hydrant

4.4.1.6.2 Input Requirements

The following three types of input sheets are identified for collecting the required data. The inputs will be prepared by the Technical Department and submitted to the Computer Information Service. Computer Information Service data entry clerks will enter the data from the source to the computer.

1 Fire Hydrant Master Data Input sheet (FHIF-1)

This input sheet is used to input identification, location, reference, and installation data about fire hydrant. This form should be filled by Technical Department during each fire hydrant installation. Fire hydrant master data input sheet should contain at least the following data:

- hydrant number;
- installation work order number;
- WNU code;
- distribution subsystem code;
- address (keftegna and kebele);
- street name where hydrant found;
- make of hydrant;
- size of hydrant;
- type of hydrant;
- date of installation;
- size of main;
- static pressure required; and
- flow pressure required.

2 Routine Fire Hydrant Inspection Sheet (FHIF-2)

This sheet is used to input the periodic fire hydrantinspection data. This form will be filled by the Technical Department Fire hydrant inspector during their inspection. The sheet should contain at least the following data:

- date of inspection;
- fire hydrant number;
- address (keftegna and kebele);
- street name;

- caps condition code;

- chain condition code;

- paint condition code;

- nut condition cond;

- nozzle condition;

- static pressure;

- residual pressure;

- flow pressure; and

- hydrant status.

3 Fire Hydrant Maintenance Report (FHIF-2)

This form is used to input fire hydrant maintenance and replacement data. This form is an original document filled by the technician during hydrant maintenance. The form should contain the following data:

- date of maintenance;

- work order number;

- hydrant number;

- address (keftegna and kebele);

- street name;

- types of maintenance;

- part maintained; and

- reason of maintenance.

4.4.1.6.3 Output Requirements

The would generate various reports that include:

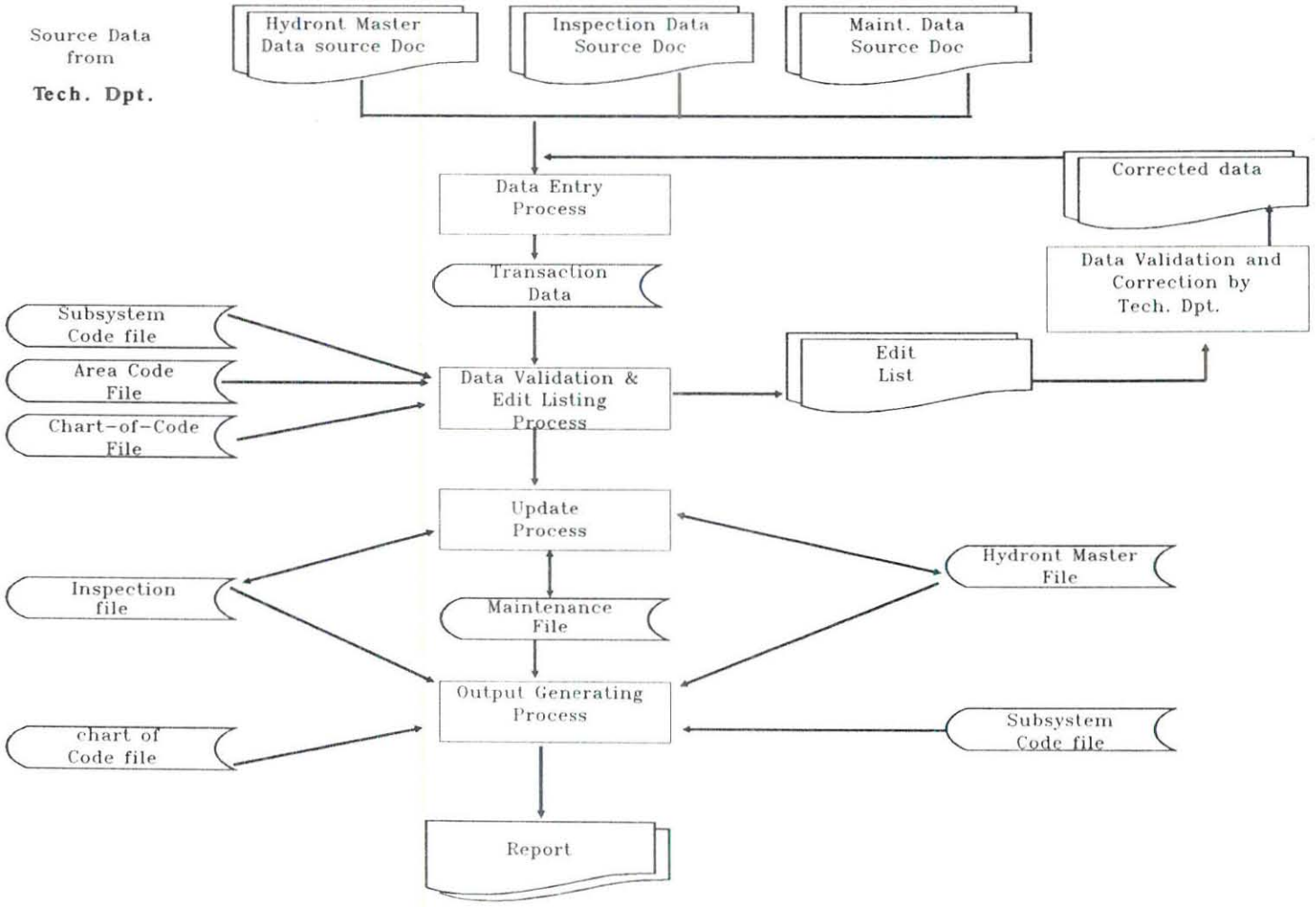
- Edit proof list;
- Hydrant installation and maintenance summary and detailed report (by size, type, location, installation date, maintenance date and other parameters);
- Hydrant inspection schedule and work order;
- List of hydrant not functioning or not in a good condition; and
- Hydrant maintenance schedule and work order.

4.4.1.6.4 Process Requirements

The following four major processes are required to transfer input data to the required output. The general process flow diagram of the fire hydrant information subsystem is presented in Figure 4.11.

- Data Entry Subprocess: This subprocess will provide "fill-in-blank" form for data entry, and will create transaction data file.
- Edit Listing subProcess: This subprocess will be used for checking the correctness of the data in the transaction file using the various code files and entry in the database.
- Update subProcess: This subprocess will update fire hydrant information subsystem database using clean transaction data.
- Output Generation Subprocess: This subprocess will generate periodic and as required reports.

Fig 4.11: Fire Hydrant Subsystem Process Flow Diagram



4.4.1.6.5 Database Structure

This section presents the identified data items, data files, and database structure of the fire hydrant information subsystem. The following three data files are recommended to store all the relevant data.

Data File Name	Description
HDRTMSTR	To store all detailed identification, location, reference, installation, and other summarized data about each fire hydrant.
HDRTMAIT	To store maintenance history data of each valve.
HDRTINSP	To store detailed inspection data of each fire hydrant and its parts.

Data definition of each data file record are presented in tables 4.16, 4.17, and 4.18 (record identifiers are marked with "*"). The relation among the data file or the database structure is presented in Figure 4.12.

Table 4.16: Data Definition of HDRTINSP Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
INSPDATE*	N	6	FHIF-2	Hydrant inspection date
CAPCOND	A	2	FHIF-2	Condition of cap (code)
CHINCOND	A	2	"	Condition of chain (code)
NUTCOND	A	2	"	Condition of nut (code)
NOZLCOND	A	2	"	Condition of nozzle (code)
PANTCOND	A	2	"	Painting condition (code)
STATPRSR	N	3	"	Static pressure
RSDLPRSR	N	3	"	Residual pressure
FLOWPRSR	N	3	"	Flow pressure
STATUSM	A	2	"	Status of hydrant (code)
HYPRTNO*	N	4	"	Hydrant identification number
Record Size		31		

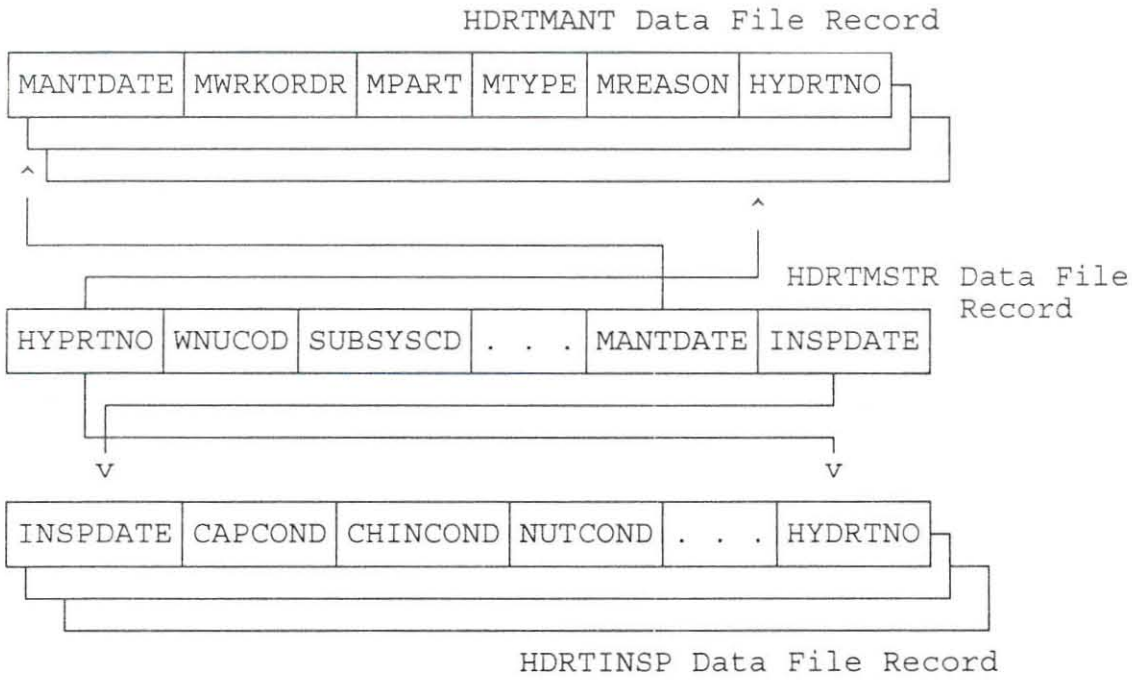
Table 4.17: Data Definition of HDRTMSTR Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
HYDRTNO*	N	4	FHIF-1	Hydrant number
WNUCODE	C	6	FHIF-1	WNU code where hydrant found
SUBSYSCD	N	3	"	Dist. subsystem code
KEFTEGNA	N	2	"	Area code where hydrant found
KEBELE	N	2	FHIF-1	Area code where hydrant found
STREETN	C	30	FHIF-1	Street name hydrant found
WRKORDN	C	10	"	Installation work order
MAKEM	C	20	"	Manufacturer name
TYPEM	A	2	"	Type of hydrant
SIZEH	N	3	"	Size of hydrant
SIZEM	N	3	"	Size main feeding hydrant
STATPRSR	N	3	"	Acceptable static pressure
FLOWPRSR	N	3	"	Acceptable flow pressure
STATUSM	A	2	FHIF-2	Status of hydrant functioning or not)
MANTDATE	N	6	FHIF-3	Last maintenance date
INSPDATE	N	6	FHIF-2	Last inspection date
Record Size		111		

Table 4.18: Data Definition of HDRTMAIT Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
MANTDATE	N	6	FHIF-3	Date of maintenance (yymmdd)
MWRKORDR*	C	10	"	Maintenance work order number
MPART	A	2	"	Part maintained (code)
MTYPE	A	2	"	Type of maintenance (code)
MREASON	A	2	"	Reason of maintenance (code)
HYDRTNO	N	4	"	Hydrant identification number
Record Size		26		

Fig 4.12: Structure of Fire Hydrant subSystem Database



4.4.2 Sewer Network Information System (SNIS)

4.4.2.1 General Description

The objectives of sewer network information system (SNIS) are to:

(1) provide detailed and summary information on the number, size, type and location of manholes and connection boxes;

(2) provide information about the length, type, size and location of main lines and service lines;

(3) provide information about customers and customer onnection to the network; and

(4) provide information about manhole and main line maintenance and inspection.

Data about manholes, main lines, connection-boxes, service lines and customers would be collected by SNIS. SNIS would have a database for storing the collected data. The system would also manipulate the stored data using various computer programs and software packages to generate different management and operational reports.

To create a database for the SNIS the first thing to be done was delineating a boundary between each unit of the sewer network. For this purpose the existing maps and engineering documents of the sewer network system had been investigated, and sewer service division employees had been consulted. From the investigation and discussion the following information was obtained:

(1) The sewer network of Addis Ababa has three components, sewer lines, manholes and connection boxes;

. Sewer lines are different underground pipes used for the disposal of sewage. The total length of sewer lines are 110 km. The sewer lines are further classified as sewer main, service line, and customer line. Sewer line between two manholes are called sewer main. Sewer line between manhole and connection box is called service line. In sewer network system customer line is connected only to connection box and this sewer line is called customer line;

. Manholes are opening constructed in sewer line to provide an access for a man for inspection and cleaning of sewer mains; to allow joining of sewer mains in case of change in direction or level or both; to lay sewer mains in convenient lengths; to achieve the ventilation of sewer mains; and to allow connection of service line to mains;

. Connection boxes are small manhole where customer made connection;

(2) Sewer main is divided into segments by the manhole;

(3) Sewer main between two manholes is straight;

(4) Distance between two consecutive manhole varies from 75 meters to 300 meters;

(5) Size and type of sewer mains between two consecutive manholes are the same;

(6) Each manhole has a unique five digit identification code.

(7) Manholes have cover and the cover is above ground. Some of the manhole covers are easy to remove and replace and others are not. The manholes are different in depth and some of them have built-in-ladder;

(8) More than one connection boxes can be connected to each manhole;

(9) More than one customer can make connection to each connection box;

(10) Type and size of service line between a manhole and connection box is the same;

(11) Type and size of each customer line is the same; and

(12) Each sewer has a separate map that documents detailed information about the sewer main and the corresponding manhole.

Based on the above observation, sewer main between two consecutive manholes which include the manhole at the in flow side is taken as a basic sewer network unit. Sewer Network Unit (SNU) is the smallest portion of the sewer network that would be used for creating database and collecting data about the sewer network. Each SNU can be uniquely identified by the identification code of the manhole within the SNU. Because each SNU has one manhole at the inflow side.

The following data would be collected and stored about each Sewer Network Unit (SNU) by the SNIS, to generate sewer line, manhole, connection box, maintenance, inspection, and customer information.

- Identification data
  - . Sewer Network Unit (SNU) code (manhole identification code) used for uniquely identifying each SNU.
- Location and address data
  - . keftegna
  - . kebele
  - . specific location of the manhole and direction of the main line from the manhole

- Reference data

  . map or document number that contains detailed information about the SNU

  . reference number of construction or installation work order that documents detailed cost, and other technical information

- Main line, service, and customer pipe data

  . type of pipe

  . diameter of pipe

  . length of pipe in the SNU

- Manhole data

  . manhole type

  . cover type

  . depth of manhole

  . ladder (availability)

  . cover removability

  . relative importance of manhole (criticality)

  . safety condition of manhole location

- Main line installation data

  . main line code which is used to uniquely identify each main line within SNU

  . installation date

  . average depth of main line from the ground

  . soil corrosivity

  . elevation of main line at the inflow and outflow sides from sea level

. number of fitting

- Connection box data

. identification code used uniquely for identifying each connection box within SNU

. distance from manhole

. direction from manhole

. elevation from sea level

- Service and customer line installation data

. installation date

. number of fitting

- Customer data

. customer contract number

. customer name

. customer address (keftegna, kebele, and house number)

. customer category

. customer group

. average customer's sewerage output

- Main, service and customer line maintenance data

. date of maintenance

. maintenance work order number

. reason for maintenance

. type of pipe replaced/retired

. length of pipe replaced/retired

. size of pipe replaced/retired

. number of apparatus added and replaced

- Manhole inspection data

. inspection date

. manhole condition

. sewage flow condition

. cover condition

. ladder condition

- Manhole maintenance data

. maintenance date

. maintenance workorder number

. maintenance on cover, ladder, and manhole

. reason of maintenance

Input forms used to collect these required data; the major output of the system, major process requirements, and the structure of the sewer network database is presented in the following sections.

4.4.2.2 Input Requirements

The following seven types of data input sheets are identified for collecting data about the sewer network system of AAWSA. The input will be prepared by sewerage service division of the technical department, and the sewerage service section of each branch office, and will be

submitted to the computer information service. Computer information service data entry clerks will enter the data from source document to computer.

1 Sewer Main Data Input Sheet (SNIF-1)

This input sheet is used to input identification and installation data about sewer main line.

Source: Sewerage service division of the technical department

Source of Data: Map, engineering document and installation workorder

Required Data: Sewer main data input sheet should contain at least the following data items:

- Main line installation work order number;
- Sewer network unit (SNU) code (manhole code);
- Main line identification code;
- Address (Keftegna and Kebele code);
- Map, Chart, or document number;
- Direction of main line from manhole;
- Type of pipe (code);
- Diameter of pipe (in millimeter);
- Length of pipe (in meter);
- Installation date (ddmmyy);
- Depth of pipe (in centimeter);
- Soil corrosivity (code);
- elevation at the inflow side (in meter from sea level; and

- Number of fitting used.

2 Manhole Data Input Sheet (SNIF-2)

This input sheet is used to input identification, installation and location data about each manhole.

Source: Sewerage Service Division;

Source of Data: Map, engineering document and installation workorder;

Required Data: Manhole Data Input Sheet should contain at least the following data items:

- SNU Code (manhole code);
- Manhole location Address (Keftegna and Kebele code);
- Street name where manhole has been found;
- Permanent reference point to locate manhole;
- Distance of manhole from reference(in meter);
- Direction of manhole from reference (code);
- Manhole type (code);
- Cover type (code);
- Cover removability (code);
- Depth of manhole (in centimeter);
- Relative importance of manhole (code);
- Condition of manhole location (code); and
- Installation data.

- Number of fitting used.

2 Manhole Data Input Sheet (SNIF-2)

This input sheet is used to input identification, installation and location data about each manhole.

Source: Sewerage Service Division;

Source of Data: Map, engineering document and installation workorder;

Required Data: Manhole Data Input Sheet should contain at least the following data items:

- SNU Code (manhole code);
- Manhole location Address (Keftegna and Kebele code);
- Street name where manhole has been found;
- Permanent reference point to locate manhole;
- Distance of manhole from reference(in meter);
- Direction of manhole from reference (code);
- Manhole type (code);
- Cover type (code);
- Cover removability (code);
- Depth of manhole (in centimeter);
- Relative importance of manhole (code);
- Condition of manhole location (code); and
- Installation data.

3 Connection Box and Service Line Data Input Sheet (SNIF-3)

This input sheet is used to collect data about connection box and service lines.

Source: Sewerage Service Division;

Source of Data: Map, engineering document and installation workorder;

Required Data: The input sheet should contain at least the following data items:

- manhole code where service line is connected;
- connection box code that identifies each box contained in SNU;
- manhole address and specific location;
- installation work order;
- distance of box from manhole (in meter);
- direction of box from manhole;
- type of service line pipe (code);
- diameter of service line pipe (code);
- length of service line pipe (code);
- number of fitting; and
- installation date.

4 Customer Data Input Sheet (SNIF-4)

This input sheet is used to collect detailed data about each sewer customer and customer's sewer line.

Source: Sewerage Service Section of branch office;

Source of data: Customer contract agreement file and customer line installation work order;

Required data: The input sheet should contain at least the following data items:

- installation work order number;
- customer contract number;
- manhole code;
- connection box code;
- manhole address and location;
- customer address (keftegna, Kebele and house number);
- customer category (code);
- customer group (code);
- date of installation;
- length of customer line (in meter);
- type of customer line;
- diameter of customer line; and
- number of fittings.

5 Manhole Inspection Data Input Sheet (SNIF-5)

This input sheet is used to collect the periodic manhole inspection data.

Source: Sewerage Service Division;

Source of data: Filled by manhole inspector during manhole inspection;

Required data: This input sheet should contain at least the following data items:

- date of inspection (ddmmyy);
- manhole code;
- manhole address and specific location;
- manhole condition (code);
- sewerage flow condition (code);
- cover condition (code); and
- ladder condition (code).

6 Manhole Maintenance Data Input Sheet (SNIF-6)

This input sheet is used to collect the manhole maintenance data.

Source: Sewerage Service Division;

Source of data: manhole maintenance work order;

required data: This input sheet should contain at least the following data items:

- date of maintenance (ddmmyy);
- maintenance work order number;
- manhole code;
- manhole address and specific location;
- type of maintenance on cover (code);
- type of maintenance on ladder (code);
- type of maintenance on manhole; and
- reason for maintenance.

7 Main and Service Line Maintenance Data Input Sheet (SNIF-7)

This input sheet is used to collect main line and service line replacement, retirement and maintenance data.

Source: Sewerage Service Division;

Source of Data: service and main line maintenance work order;

Required Data: The input sheet should contain at least the following data items:

- sewer line maintained (main or service);
- maintenance date (ddmmyy);
- SNU code;
- address and location of manhole;
- connection box code (for service line maintenance);
- location of connection box (for service line maintenance);
- type of sewer line replaced (code);
- type of sewer line retired (code);
- diameter of sewer line replaced;
- diameter of sewer line retired;
- length of sewer line replaced;
- length of sewer line retired;
- number of fitting replaced; and
- number of fitting added.

4.4.2.3 Output Requirements

The sewer network information system would generate different information that support the day-to-day operation, planning and decision making activities. The major users of the information are: Technical Dpte. (specifically sewerage service and engineering division) branch offices (specifically sewerage service section), the AAWSA management, and the plan, program and budget service.

The required outputs of the system would include:

- Edit report: List of input data with error message (if there is input data error) that is used to cross check data entered to the computer with the source and to correct erroneous data;
- Manhole inspection work order: Inspection work order for selected manholes based on manhole type, location, importance, and last service date;
- Maintenance work order:for manholes not in a good condition or for manholes frequently subjected to damage;
- SNU List: list of selected main line, manhole, service line, and connection box with their full identification, reference, installation, and location information to be used by field workers;
- Summary and detailed report of sewer line by age, size, function, area and other parameter;
- Summary and detailed report of manhole by cover type, depth, area, age and other parameter;

- Maintenance, retirement, replacement and installation summary and detailed report;
- Detailed and summary report of customer by address, category, group, installation date and other parameter; and
- Customer connection information to particular connection box, manhole or sewer network unit (SNU).

4.4.2.4 Process Requirements

To generate sewer network information a number of application programs have to developed by standard programming languages. In general we can categorize the application into four sub processes. The major processes required, to transfer the input data to desired output are:

- Data entry subprocess: Application programs which provides screen form for data entry and view, validate some input data during data entry; and create transaction file;
- Edit listing subprocess: Application programs used for checking the correctness of data in the transaction file using various code files and entries in the database. This subprocess will also generate edit report with warning message for errors;
- Update Subprocess: Application programs used to update sewer network information system database using clean transaction data; and

- Output generation subprocess: Application programs used to generate different periodic and as well as ad-hoc reports; and to receive query to produce printed or on screen output.

The process flow diagram of the sewer network information system is presented in figure 4.13

4.4.2.5 Database Structure

This section presents the identified entities, data files, data items, and database structure of sewer network information system. From the data incorporated with each sewer network unit (SNU), eight entities were identified. The entities are: manhole, mainline, connection-box, customer, manhole-inspection, manhole-maintenance, main line-maintenance, and service line-maintenance. Figure 4.14 shows the relationships among the entities.

Corresponding to the entities the following eight data files are recommended to store all data related to each SNU.

ENTITY	DATA FILE NAME	DATA FILE DESCRIPTION
MANHOLE	SNWMANM	To store manhole installation, location and identification data, and other summarized data about each SNU.
MAIN LINE	SNWMAIN	To store main line pipe and installation
CONNECTION-BOX	SNWBOX	To store service line and onnection Box data

ENTITY	DATA FILE NAME	DATA FILE DESCRIPTION
CUSTOMER	SNWCUST	To store detailed sewer customer data
MANHOL-INSPECTION	SNWMHISP	To store periodic manhole inspection data
MANHOLE-MAINT.	SNWMHMUT	To store manhole maintenance data
MAIN-LINE MAINT.	SNWMLMNT	To store main line retirement, replacement and maintenance data
SERVICE-LINE MAINT.	SNWSLMNT	To store service line retirement, replacement and maintenance data.

Data definition of each data file record is given in tables 4.19 through 4.26 (record identifiers are marked with "*"). The relationship among the eight data files record is presented in figure 4.15.

Figure 4.13: Sewer Network Information System
Process Flow Diagram

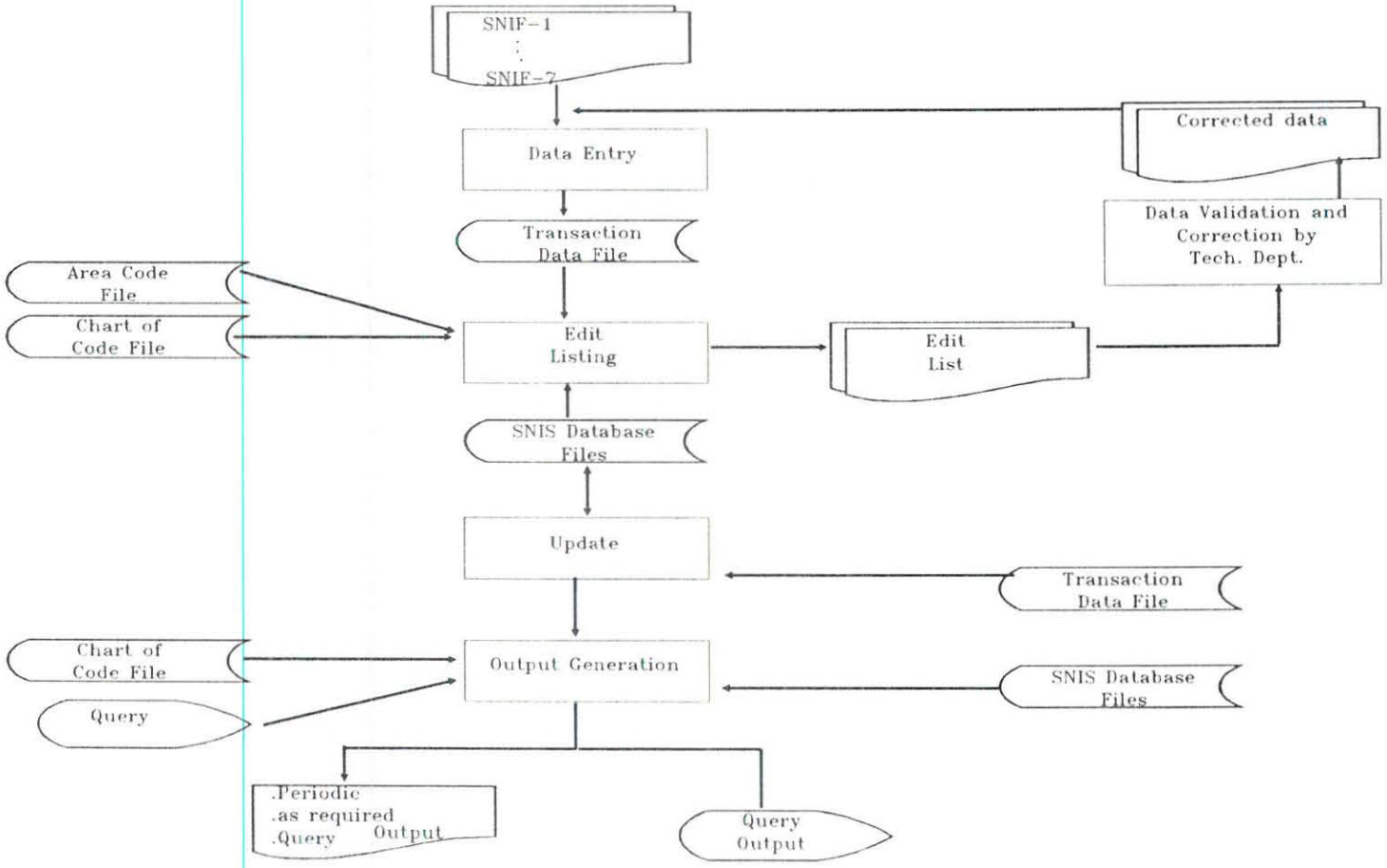


Figure 4.14: Entities in Sewer Network Unit (SNU) and Relationships Among Them

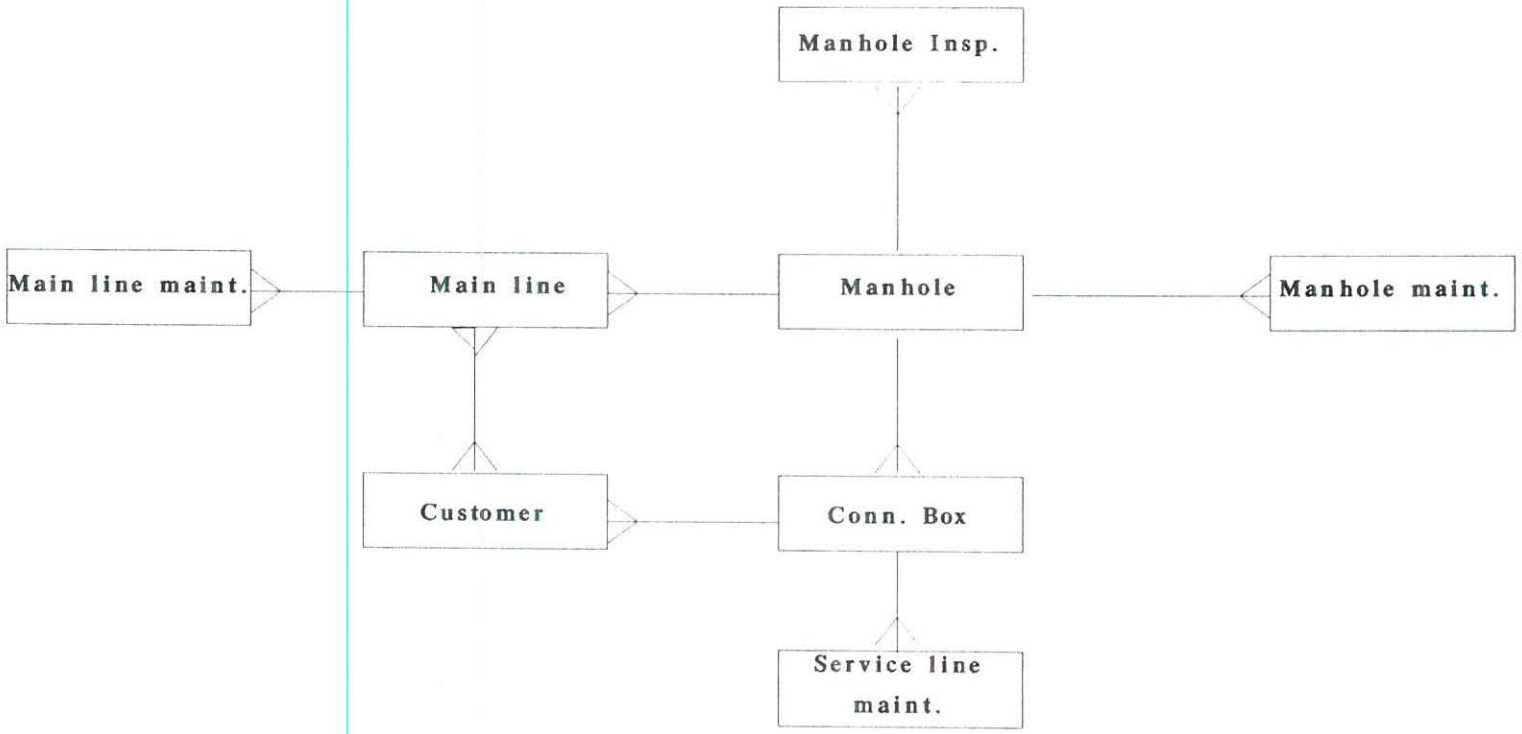


Table 4.20: Data Definition of SNWMAIN Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SNUCODE*	N	5	SNIF-1	Sewer Network Unit (SNU) code
MIANLCOD*	N	1	SNIF-1	(Identification code of main line within SNU
MAPNO	C	3	SNIF-1	Map or document number
WRKORDNM	C	10	SNIF-1	Installation workordr number
DIRCTN	N	3	SNIF-1	Direction of main line from manhole (code)
TYPE P	N	3	SNIF-1	Type of pipe (code)
SIZE P	N	3	SNIF-1	Diameter of pipe
LENGTH	N	3	SNIF-1	Length of main line
INSTDATE	N	6	SNIF-1	Main line installation date
DEPTHP	N	3	SNIF-1	Depth of pipe
SOILCR	N	3	SNIF-1	Soil corrosivity (code)
ELVNINF	N	4	SNIF-1	Elevation (at inflow)
ELVNOUT	N	4	SNIF-1	Elevation (at outflow)
NUMFLG	N	3	SNIF-1	Number of fitting used
MNTDATE	N	6	SNIF-7	Last maintenance date of main line (yymmdd)
Record size		60		

Table 4.21: Data Definition of SNWBOX Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SNUCODE*	N	5	SNIF-3	SNU code where box connected
BOXCODE*	N	2	SNIF-3	Connection box identification code
WORKORDN	C	10	SNIF-3	Work ordr number
INSTDATE	N	6	SNIF-3	Installation date (yymmdd)
DISTNC	N	3	SNIF-3	Distance of Box from manhole
DIRCTN	N	3	SNIF-3	Direction of Box from manhole (code)
TYPEP	N	3	SNIF-3	Service line pipe type (code)
SIZEP	N	3	SNIF-3	Service line diameter
LENGTHP	N	3	SNIF-3	Length of service line
NUMBFT	N	3	SNIF-3	Number of fitting in s.line
MNTDATE	N	6	SNIF-7	Last S.line maint.date
NUMCUST	N	2	SNIF-4	Number of customer connected to the box
LENGCUST	N	4	SNIF-4	Length of customer line connected to the box
Record Size		53		

Table 4.22: Data Definition of SNWCUST Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
CONTRCT*	N	7	SNIF-4	Customer contract number
SNuCODE	N	5	SNIF-4	SNU code where customer connected
BOXCODE	N	2	SNIF-4	Box code where customer connected
KEFTEGNA	N	2	SNIF-4	Address code customer
KEBELE	N	2	SNIF-4	Customer address code
HOUSNO	N	4	SNIF-4	Customer house number
WORKORDR	C	10	SNIF-4	Customer line installation W.O.#
INSTDATE	N	6	SNIF-4	Cust-line inst-date
CUSTCAT	N	3	SNIF-4	Cust. category (code)
CUSTTYP	N	3	SNIF-4	Cust Type (code)
LNGCSTL	N	3	SNIF-4	Length of cust.line pipe
TYPEP	N	3	SNIF-4	Type of cust.line pipe
SIZEP	N	3	SNIF-4	Diameter of cust.line pipe
NUMFING	N	3	SNIF-4	Number of fitting in cust.line
Record Size		56		

Table 4.23: Data Definition of SNWMHISP Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SNUCODE	N	5	SNIF-5	SNU code
INSPDATE	N	6	SNIF-5	Inspection date (yymmdd)
MMCOND	N	3	SNIF-5	Manhole condition(code)
CVCOND	N	3	SNIF-5	Cove condition (code)
SWCOND	N	3	SNIF-5	Sewerage flow condition (code)
LDCOND	N	3	SNIF-5	Ladder condition (code)
Record Size		23		

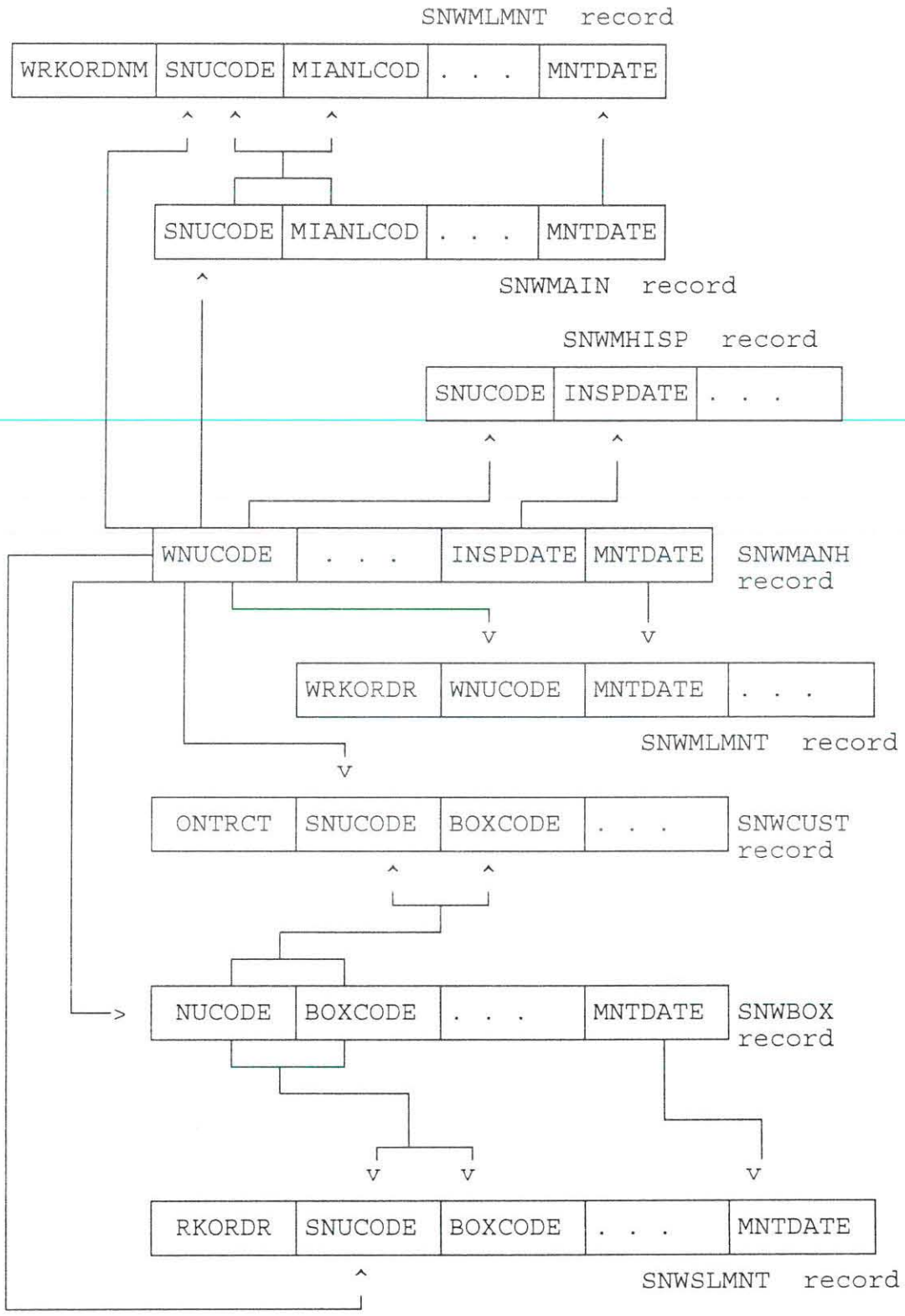
Table 4.24: Data Definition of SNWMHMUT Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SNUCODE	N	5	SNIF-6	SNU code
WORKORD*	C	10	SNIF-6	Maint.workordr number
MNTDATE	N	6	SNIF-6	Maint.date (yymmdd)
MNTCVR	N	3	SNIF-6	Type of maint.on cover (code)
MNTLDR	N	3	SNIF-6	Type of maint.on ladder (code)
MNTMNH	N	3	SNIF-6	Type of maint.on manhole (code)
MNTRSN	N	3	SNIF-6	Reason for maint. (code)
Record Size		33		

Table 4.25: Data Definition of SNWMLMNT Data File Record

Field Name	Field Type	Field Size	Data Source	Field Description
SNUCODE	N	5	SNIF-7	SNU code
MAINLCOD	N	1	SNIF-7	Main line code
WRKORDR*	C	10	SNIF-7	Maint.workorder number
MNTDATE	N	6	SNIF-7	Maint.date
TYPEPR	N	3	SNIF-7	Type of main line replaced (code)
TYPEPT	N	3	SNIF-7	Type of main line retired (code)
SIZEPR	N	3	SNIF-7	Diam. M.Line pipe replaced (code)
SIZEPT	N	3	SNIF-7	Diam.M.Line pipe retired (code)
LENGTHPR	N	3	SNIF-7	length of pipe replaced
LENGTPT	N	3	SNIF-7	Length of pipe retired
NUBFITRP	N	3	SNIF-7	Number of fitting replaced
NUBFITED	N	3	SNIF-7	Number of fitting Added
Record Size		46		

Figure 4.15: Structure of SNIS Database



4.4.3 IMPLEMENTATION

AAWSA has computer center where computer based applications are developed and implemented. Therefore, the identified application systems will utilize the AAWSA computer Information Service resources. Thus,

- The proposed application systems will be implemented at the Computer Information service, on the HP-300 minicomputer
- The existing software of the minicomputer will be used for developing the applications. That means,
  - . VPLUS is used for developing data entry and VIEW Screen forms;
  - . TURBO IMAGE DBMS is used for developing and organizing database; and
  - . COBOL, TURBO IMAGE utilities, and other software are used for processing and output generation.

Input for the proposed systems will be prepared by the Technical and Operation Department, and submitted to the Computer Information Service. Data correction and Validation will also responsibility of the Technical and Operation Department. Computer Information Service will take the responsibility of data entry, master file update, report generation and report distribution.

CHAPTER 5

PROTOTYPE VALVE INFORMATION SYSTEM

5.1 INTRODUCTION

In the previous chapter the design aspect of the proposed Computer-based information support system has been discussed. This chapter present the prototype valve information subsystem (one of the proposed computer-based system). Due to the shortage of time prototype of the other subsystems could not be developed. However, as all the proposed subsystems have similar data base structure, and process, input and output requirement, the prototype valve subsystem will show that the rest of the subsystems can also be developed and implimented in the same way.

The design of the proposed computer based system was done by taking into consideration the existing AAWSA Computer resources. Specifically the TURBO IMAGE DBMS, COBOL programming language, VPLUS screen form designing package, and the HP300 mini-computer were taken into consideration.

The major reason for considering the existing resources are: (1) to maintain compatibility between the existing systems and the proposed system that will facilitate data exchange, and (2) to utilize the existing computer and human resources which save considerable amount of money. However, for the demonstration purpose the prototype databases of the valve information system have been developed using dBASE IV. In addition, dBASE IV programming facility has also

been used for developing user interface and other procedures used for data entry, file maintenance, report generation and query processing.

5.2 DATABASE OF VALVE INFORMATION SUBSYSTEM

As presented in the previous chapter, the data relating to valve are stored in four data files. The data files are: VALVMSTR, VALVCOVR, VALVAREA and VALVMANT (for detailed description of the data files, please refer to section 4.4.1.4.5). For the prototype valve information system, four data base files have been created using dBASE IV that correspond to each data file. dBASE is a data base management system (DBMS) software package which performs the function of defining, creating, revising, and controlling data base files. dBASE also provides facilities for retrieving data, generating reports, revising data definitions, updateing data, and programming facilities for building application.

Since the data files files for the valve information subsystem (in section 4.4.1.4.5) were created by taking into consideration the TURBO IMAGE RDBMS software, minor modifications had to be made on the field type and field name to create database files using dBBASE IV.

- The database files are:

(1) VALVMSTR. DBF (key data item is VALVE-NO)

(2) VALVCOVR. DBF (key data item is VALVE-No)

(3) VALVAREA. DBF (key data item is REFNO)

(4) VALVMANT. DBF (key data item is MIDATE)

- link:

The four database files are linked with each other with VALVE-NO in order to retrieve data stored in different file or to allow simultaneous manipulation of all data relevant to a single valve.

5.3 INPUT FORMS

Data preparation for input to the database is via a paper input forms (Figure 5.1, 5.2, 5.3 and 5.4). These forms are also used for maintenance of the databases(deletion and change) records.

5.4 PROGRAM DEVELOPMENT

Eigte dBase programs were written to:

- create easy-to-use and "user friendly" menu driven system;
- Create data entry screen form that validates data during data entry;
- Update the data files;
- Generate printed and on-screen output by retrieving data from different databases; and
- process query and to generate query output.

Figure 5.1: Valve Master Data Input Sheet

PAGE:_____ FORM: VLIF-1

VALVE MASTER DATA INPUT SHEET

(SYSTEM: Water distribution SUBSYSTEM: VALVE)

UPDATE MODE: ☐ (A:Add M:Modify D:DELETE)

I- VALVE IDENTIFICATION AND LOCATION DATA

Valve No: ☐ WNU code ☐ Subsystem code ☐

Plate Map No: ☐ Section Map no: ☐ Intersection map no: ☐

Address: Kefetegna: ☐ Kebele: ☐

Street Name: ☐

Reference: ☐

Distance from reference: ☐ (in meter) Direction from reference ☐

II VALVE DATA

Make: ☐ Size: ☐ (in mm) Type: ☐ (code)

Direction to open: ☐ (L or R) Number of turns: ☐

III AS BUILT DATA

Date of Installation: ☐ N.position: ☐ (code) Place: ☐

(ddmmyy)

Importance/criticality: ☐ (code) Function: ☐ (code) EX.COVER: ☐

IV COVER DATA

Cover type: ☐ Depth of Nut from cover ☐ (in cm)

Prepared by: Name: _____ Date:_____ Sig.:_____

CODE TABLE

DIRECTION FUNCTION	POSITION	POSITION	TYPE	
NO - North	QA - open	Y: Safe	OA Diaphragm	OP Area
NE - N-East	QB - p.closed	N: Not safe	OB Globe	OQ Pressure
ET - East	QC - Closed	**CRITICALITY**	OC Ball (R)	OR Air
SU - South		RA - high	OD Butterfly (R)	OS Customer
SW - S. West		RB - medium	OE Cone (R)	OT Subsys.
WT - West		RC - low	OF Plug (R)	OU Dewater
			OG Sluice (G)	OZ Other
			OH Shear (G)	
			OM Others	

Figure 5.2: Routine Valve Inspection Data Input Sheet

FORM: VLIF-2

ROUTINE VALVE INSPECTION SHEET

INSPECTION REF NO: [ ]

VALVE NO [ ] OPERATION: EA

WNU: [ ] D.SUBSYSTEM CODE: [ ]

LOCATION: KEFETEGNA _____ KEBELE _____
ON_____

street, _____meter _____of_____

Type_____, position _____, open _____ turns.

Ref. No.	Date of Inspect	Valve Found Code	Condition code of					Remark & Insp.sign	Data Entry Rem.k mar
			Packing	Stem	Nut	Box	cover		

CODE TABLE

V.FOUND
TA OK
TB p closed/opend
TC F. "

PACKING
TA OK
TO Tightened

NUT
TA. OK
TH Missing

BOX
TA OK
TI Buried
TH protrude.

SETN
TA Ok
TF Bent /broken
TG Rest

COVER
TA Ok
TH missing
TF broken or bent

Figure 5.3: Routine Valve Maintenance Data Input Sheet

FORM: VLIF-3

ROUTINE VALVE MAINTENANCE DATA INPUT SHEET

Valve No: _____ Maint. Date: _____
ddmmyy

Maint. work order no: _____ OPERATION: EC

WNU CODE: _____ D. Subsystem Code: _____

STREET _____ KEFETEGNA _____ KEBELE _____

V. TYPE _____

MAINTENANCE DATA

Packing: ☐ (TA,TD or TE) STEM: ☐ (TA,TF, or TE)

Valve Nut: ☐ (TA,TF or TE) VALVE BOX: ☐ (TA,TE,TI,TJ,TK or TL)

COVER: ☐ (TA,TH,TF OR TE)

Prepared by: Name_____ Date _____ Sign _____

CODE TABLE		
TA - OK	TO - Tightened	TE - Replaced
TF - Bent/Broke	TH - Missing	TI - Buried
TJ - Protrund	TK - Cleaned	TL - enlarged

Figure 5.4: Valve Isolation Data Input Sheet

FORM: VLIF-3

Page:_____

VALVE ISOLATION DATA INPUT SHEET

REFERENCE NO. [ ]

UPDATE MODE [ ] (A,M,or D)

Valve No: [ ]

Isolated Distribution Subsystem code: [ ]

Isolated Area:

Region: [ ]

Kefetegna: [ ]

Kebele : [ ]

Isolation Type : [ ] (UA-FULL, UB-Partial, UC with others)

Prepared by: Name _____ Date _____ Sig. _____

5.4.1 User Interface

Inorder to facilitate optimem use of the information system, particularly by people who have very less exposure to computers, the system should be "user fiendly". To achieve this, number of popup menus have been developed using dbase IV programming facilities. Each menu has a menu-bar; an option can be selected by highlighting the required option using the menu-bar.

MAIN MENU (Figure 5.5): This is the water distribution system master menu which presents all its subsystems and related code files. The selection of the option "Valve" initiates the "MENU ONE" (Figure 5.6), the first menu of the valve information system.

MENU ONE: (1) Selection of the "UPDATE AND VIEW" option initiates the data file selection menu presented in figure 5.7. Selection of one of the data files from the data file selection menu initiates the data entry and viewing form, and data base file maintenance options for the selected database file.

(2) Selection of the " OUTPUT REPORT" option initiates the output selection menu presented in Figure 5.8. Selecting one of the output type generates printed report.

(3) Selection of the menu "ISOLATION ENQUIRY" option initiates valve subsystem query processor.

Figure 5.5: Master Menu

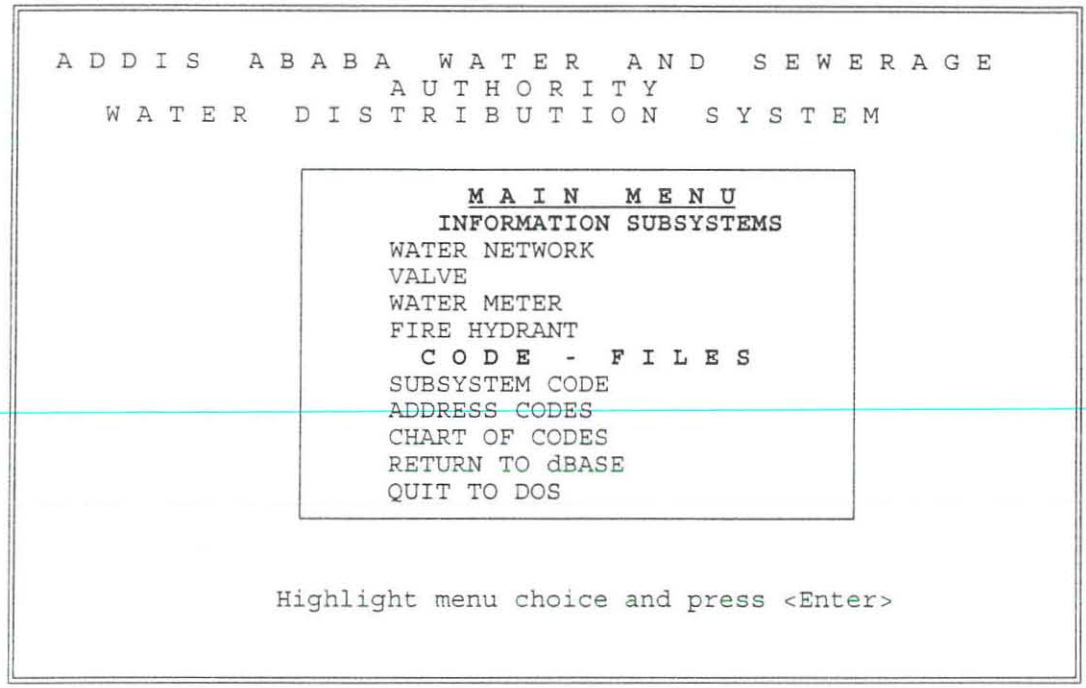


Figure 5.6: First Menu of Valve Information Subsystem

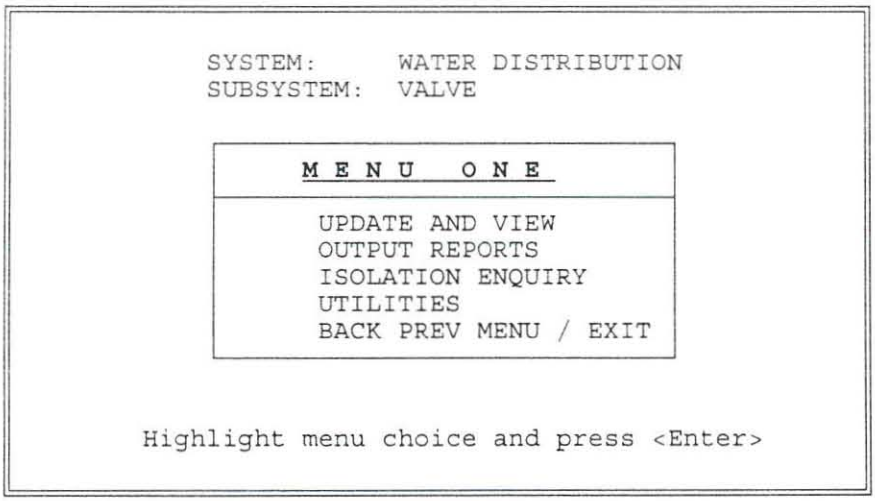


Figure 5.7: Data File Selection Menu

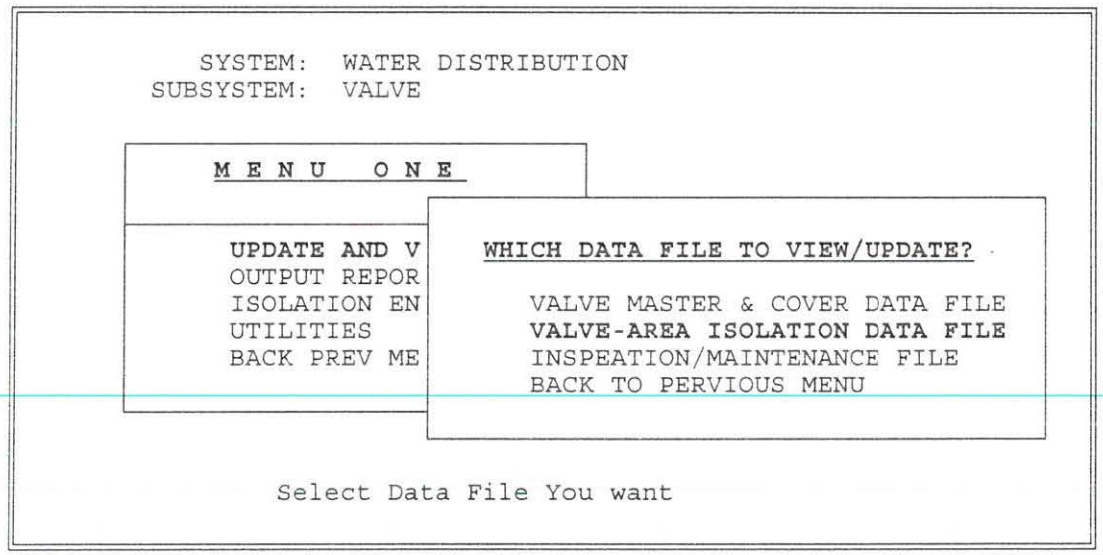
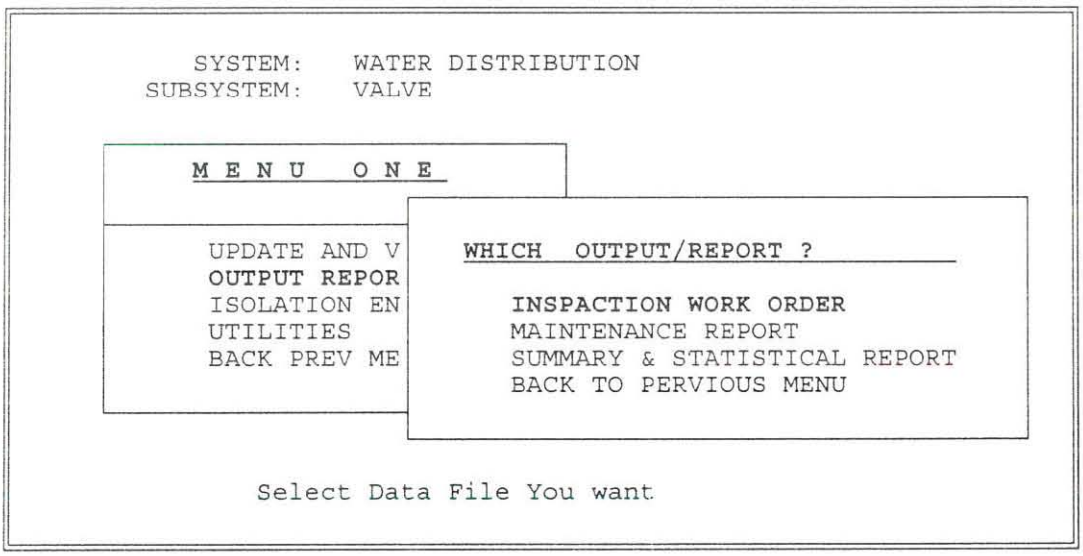


Figure 5.8: Output Selection Menu



5.4.2 Data Entry and DataBase File Maintenance

Selecting one of the file from data file selections menu (Figure 5.7) initiate data entry and viewing form and database file maintenance option menu. For example, the selection of "VALVE Master & Cover Data File" initiates the valve master and cover data file update and view screen" (Figure 5.9) This screen is used for:

- Adding new record to the data files (using " Add record" option),
- Searching and retrieving records from the data files, and
- Data modification and deletion (using "edit record" and "delete record" options).

At this point there is validation of different data item such as:

- uniqueness of the VALVE-NO;
- range check for address codes; and
- code check for direction, criticality, position, and type.

5.4.3 Valve-Isolation Query

Valve is an important component of the water distribution system for interrupting water flow during damage, maintenance and new connection, and for rationing water during shortage of water. Valve-Isolation query has been designed to provide timely valve information that indicates the location of valve(s) used to interrupt water flow to particular subdivision of the city or any part of the network.

The query is designed to find location information of valve which isolates (interrupt) water flow to:

- specific region (zone) of the city,
- specific Keftegna within a region,
- specific Kebele within a region, and
- specific kebele within a Keftegna.

The query also finds area(s) interrupted and the type of interruption made by a given valve.

Selection the "ISOLATION ENQUIRY" option from "MENU ONE" (Figure 5.6) initiates the "VALVE-ISOLATION QUERY SCREEN". Searches can be performed though the following keys:

- Region (zone) code,
- kefetegna code,
- Kebele code,
- Valve no, and/or
- Isolation type.

The output of a query is displayed on screen, but if the user needs a printed output it can be sent to printer or the output can be saved in a file by selecting the appropriate option from the menu.

5.4.3.1 Sample Query

To get information about valve that fully isolates (interrupt) water flow to Keftegna 11, Kebele 10.

(1) Select "Query by Address" from option menu,

(2) Enter the appropriate data on the query entry form as:

Region; 0

Kefetegna; 11

Kebele; 10

Isolation Type; UA

The result of the query displayed on the screen.

5.4.3.2 Sample Query Output

The query output (screen) of the previous query is presented in figure 4.10. Printed output of the same query is presented in figure 4.11.

5.4.4 Sample Output

The system can generats various printed outputs. Selection of one of the output option from the output selection menu (Figure 5.8) intiates the report generation process. For instance, selection of the "MAINTENANCE REPEPORT" option intiates printng of the following report.

- List of valve that needs maintenance (figure 5.12)
- Maintenance workorder for valve which is not in a good condition

Figure 5.9: Valve Master & Cover Data Entry, View and Update Screen Form

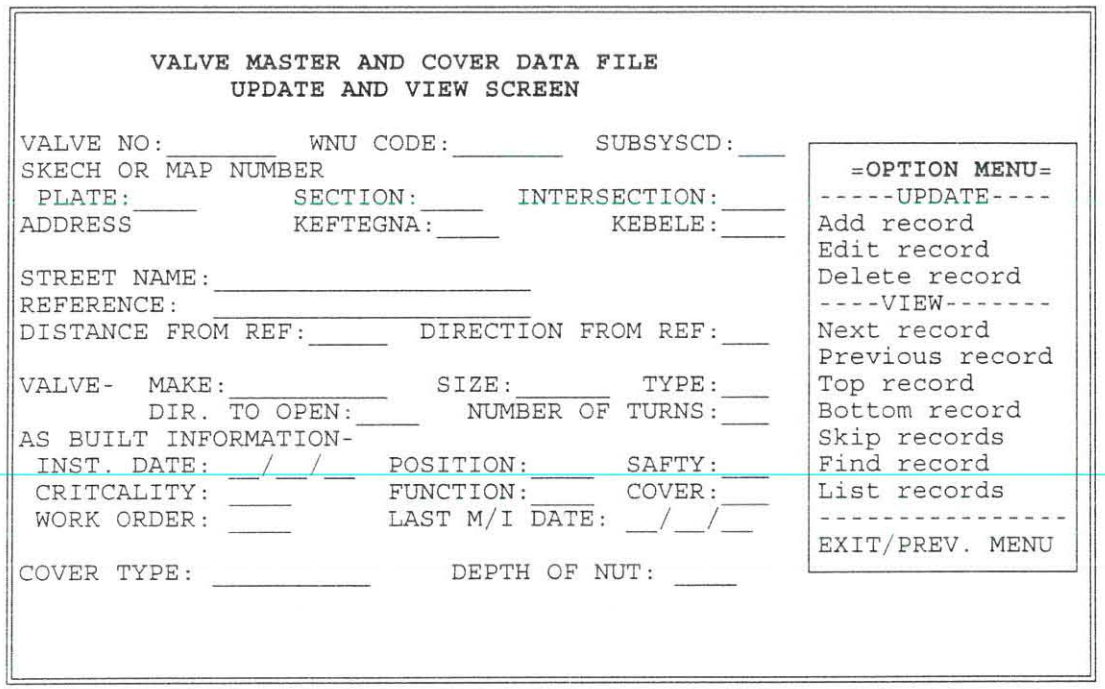


Figure 5.10: Query Output (screen)

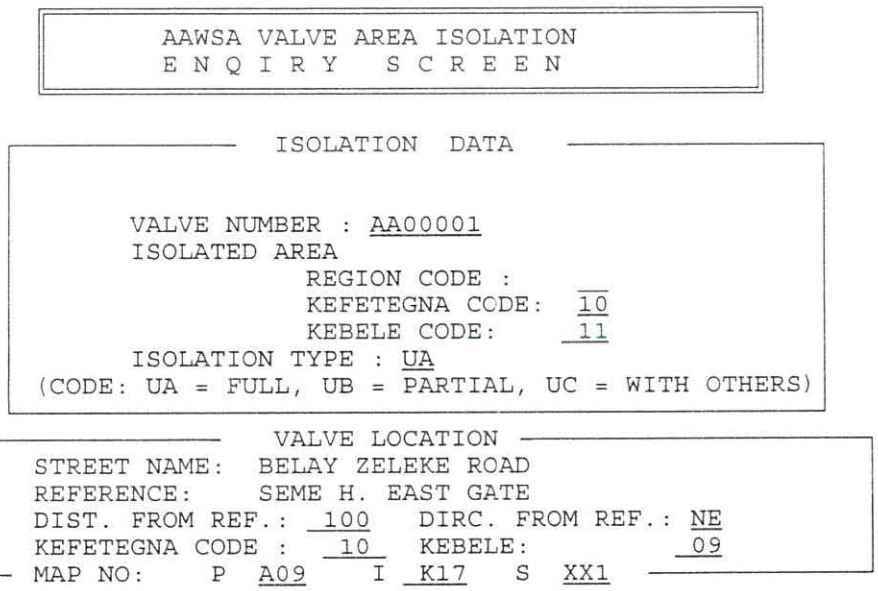


Figure 5.11: Query output (printed)

ADDIS ABABA WATER AND SEWERAGE
AUTHORITY
VALVE AREA ISOLATION REPORT
DATE: 05/16/95

ISOLATED AREA:
REGION: __ KEFTEGNA: 10 KEBELE: 11
ISOLATION TYPE: FULL

VALVE DESCRIPTION
VALVE NUMBER: AA00001
STREET NAME: BELAY ZELEKE ROAD
REFERENCE: SEMEN H. EAST GATE
DIRECTION OF VALVE FROM REFERENCE: NE
DISTANCE OF VALVE FROM REFERENCE : 100
ADDRESS KEFETGA:10 KEBELE: 09
SIZE OF VALVE: 120 (mm)
FOR DIREAILED INF. REFERE:
PLATE MAP: A09 INTERSECTION MAP: K17
SECTION MAP: XX1

Figure 5.12 : Sample output (list of valve that needs maintenance)

Page: 1 Date: 05/16/95

ADDIS ABABA WATER AND SEWERAGE AUTHORITY
LIST OF VALVES THAT NEED MAINTENANCE

SEQ. NO.	VALVE NO	LAST M/I DATE	SIZE IN mm	PROBLEM TYPE				
				PACK.	STEM	NUT	BOX	COVER
1	AA00001	10/02/95	100	X		X		
2	TG00001	22/10/94	150	X	X		X	

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY AND CONCLUSION

Addis Ababa Water and Sewerage Authority (AAWSA) was established to provide potable water for the residence of Addis Ababa and to dispose waste water. AAWSA, to provide its service, uses two dams, two water treatment plants, a huge water distribution network that covers all areas of the city and its surroundings, a sewer network that cover major areas of the city, and a sewer treatment plant. Among the facilities used for providing water and sewerage service, the water distribution and sewer networks have above-ground and under-ground components that need periodic maintenance, test and operation.

AAWSA needs and uses different types of mapped and recorded information for managing the water distribution and sewer network systems. The management of the water distribution and sewer network systems includes:

- Planning and implementing expansion and extension;
- Planning and scheduling preventive maintenance activities;
- Conducting maintenance work;
- Controlling leakage; and
- Evaluating performance and other day-to-day routine activities.

In relation to the management of the water distribution and sewer network systems, a survey is conducted to:

- assess the information needs of different users;
- assess the support of the existing information services;
- identify the major problems in accessing information; and
- propose alternative solution to overcome the existing problems.

The major findings of the surveys may be summarized as follows:

. AAWSA needs different types of mapped and recorded information for estimating future demand, conducting preventive maintenance, locating under-ground and above-ground facilities, controlling unaccounted-for water, providing water with adequate flow and pressure, and making proper inventory of the above-ground and under-ground facilities.

. AAWSA utilize largely the internally generated information. The internal sources of information include:

- maps, engineering documents, project and study reports, and procedure manuals;
- factual data originating from day-to-day activities, such as, installation, maintenance,inspection and test; and
- factual data orginated from periodic measurement records of water consumption, distribution, production, pressures and flow.

. AAWSA has two information service centers, the AAWSA Library and the Computer Information Service (CIS). The Library does not collect internally generated documents which are the major sources of information.

. Except for the customer billing system, all applications developed at CIS do not support the activities of water distribution and sewer network management. But CIS has a large amount of unutilized computer capacity. For instance, out of the available 1500 Mbyte disk space on the mini-computer, only 322 Mbyte is utilized.

. At present, in AAWSA almost all items of information related to the water distribution system and the sewer network system are processed manually; and there is no formal system or organizational unit that formally collects, stores or controls the internally generated sources of information. These sources of information are scattered throughout AAWSA without any mechanism for locating them. The lack of control over the sources of information makes retrieving or locating specific information nearly impossible; and searching for particular piece of information consumes large amount of professional working time. Furthermore, The items of information on water distribution and sewer network systems are kept in the form of maps (symbols and codes) and records (words and digits). This makes extraction and manipulation of data, to produce records of integrated information much difficult.

. Some of the problems observed due to the inadequacy of the existing information system are as follows:

- At present no scheduled or planned preventive maintenance work is performed; instead failures are being corrected.
- Planning for expansion, extension and installation work is difficult due to the lack of information that shows the trend of water consumption and new installation in each subdivisions of the city.
- It is difficult to locate some under-ground and above-ground components.
- It is difficult to identify the valve(s) which interrupt(s) water flow to particular subdivision of the city or parts of the network.
- With each retirement (of employees) much information is lost. Because some critical information (such as the locations of mains, valves and meters) which are not recorded are found only in the memories (minds) of a few veteran employees.
- It is difficult to get the accurate information about the physical assets which represent the water distribution and sewer network systems.

These observations led to a conclusion that AAWSA urgently needs a computer-based information support system that would support the day-to-day activities of the technical and supervisory staff, and at same time would facilitate the job of planners and decision makers.

The study has proposed the development of two separate but closely linked subsystems: the library system and the computer-based information support system. However, due to lack of time, automation of the library system could not be undertaken. For the computer-based information support system, the required application systems have been identified. The detailed logical design of the application systems, and the detailed logical and physical database design have been carried out.

The prototype database and user interface have been designed to demonstrate that the logical design of the system can be transferred into the framework of any RDBMS, though the chosen software for demonstration differ from the one in possession of AAWSA. Nonetheless, the study shows ample evidence of making use of the logical design of the different subsystems for their physical implementation on the RDBMS software available at AAWSA in order to develop a fully computer-based information support system for the organization.

6.2 RECOMMENDATIONS

The following recommendations, if implemented by AAWSA, would enhance the level of information support for the water distribution and sewer network systems.

1 For the Library System

. The library should organize the documents in a manner that is simple to retrieve, cost-effective to store and accommodate, and conducive to proper protection and preservation of the documents.

. The library should publicize the range of its collection of technical documents to ensure their us by their potential users.

. The library should develop its bibliographic database(s) by using an appropriate text retrieval system. These bibliographic databases should be linked with other in-house factual databases to facilitate data exchange.

2 For the Proposed Computer-based Information Support System

. A steering committee is to be established before the proposed computer-based system is implemented. The steering committee is to consist of representatives from Computer Information Service (CIS), Technical Department, and Operation Department; and it is to be chaired by a person from any other department with in AAWSA.

. The System is to be implemented in the Department designated as the Computer Information Service (CIS) on its HP-3000 mini-computer.

. The Technical Department and Operation Department are to take the responsibility of preparing the profiles for factual databases.

. New professional positions are to be created at the Technical Department and Operation Department, which would have the following responsibilities:

- the preparation of input data, as well as their editing and correction;

- the transfer of input data to the Computer Information Service (CIS), and

- The collection and distribution of periodic and ad-hoc reports generated by the Computer Information Service (CIS). the employees carrying out these tasks would act as a link between the Computer Information Service (CIS) and the user departments.

. The Computer Information Service (CIS) is to take the responsibility for data entry, file update and report generation.

. Arrangements are to be made for getting the users of the proposed computer-based information support system adequately trained in using the system for carrying out their duties and responsibilities.

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ANNEX

QUESTIONNAIRE TO ASSESS INFORMATION NEED

Mark `X' when against your choice

PART 1: GENERAL

1. Department/service of the respondent: _____

Section of the respondent: _____

Position of the respondent: _____

Years with the organization: _____

2. Your academic qualification is

a. below 12 grade

b. 12 grade

c. technical school or comprehensive diploma

d. college/university diploma

e. B.A./B.Sc.

f. M.A./M.Sc./postgraduate diploma

g. Ph.D.

3. Your area of specialization (if you have B.A/B.Sc and above)

_____

_____

4. What is your specific duty in the organization?

_____

_____

5. The type(s) of information/data you frequently use/need are

(if possible please rank them)

a. On existing infrastructures and utilities

[ ] Data on primary water line network

[ ] Data on secondary water line network

[ ] Data on sewer line network

[ ] Data on reservoirs

[ ] Data on valves

[ ] Data on pumps

[ ] Data on water meter

[ ] Data on dam

[ ] Data on treatment plant

[ ] Data on transmission line

[ ] others (specify) _____

[ ] _____

b. None-infrastructure/utilities data

[ ] water consumption data

[ ] water production data

[ ] population and socio-economic data

[ ] hydrological data

[ ] customer data

[ ] information on other institution's infrastructure/utilities such as electric,telecommunication, and road networks

[ ] others (please specify) _____

[ ] _____

6. For what purpose do you use/need information/data?

(if more than one, rank them)

[ ] planning new construction

[ ] planning/scheduling preventive maintenance

[ ] planning/scheduling production and distribution

[ ] controlling/preventive activities (problem solving)

[ ] planning new connection

[ ] inventory

[ ] for other managerial activities & decision making

[ ] for general awareness

[ ] others (please specify) _____

[ ] _____

7. What are your major source(s) of information/data for your day to day activities?

(please rank them if you have more than one answer)

[ ] maps, charts and diagrams.

[ ] manuals, reports, and previous study or project outputs.

[ ] work orders, maintenance reports and day to day activity reports.

[ ] customer, production and consumption records.

[ ] books and ordinals (externally generated).

[ ] long time employees.

[ ] external institutions.

[ ] (others please specify) _____

8. From where (most of the time) do you get this information/data?

[ ] from the organization library.

[ ] computer information service database.

[ ] from archive or other formal information stores in different departments and sections.

[ ] from different offices and employees in the organization (informal stores).

[ ] external library or institutions.

[ ] others (please specify) _____

9. Which type of information is more important for your day to day activities?

[ ] internally generated

[ ] externally generated

10. Do you get adequately internally generated information/data or document (map, chart, diagram, etc...) timely when you need.

a. completely

b. partially

c. to a little extent

11. Do you get relevant information from library.

a. yes

b. no

(if response is 'No' go to 13)

12. If response is yes, does the library meet your information need

a. completely

b. partially

c. to a little extent

13. Why do you think your library does not satisfy your need?

[ ] inadequacy of collection

[ ] inadequacy of library staff

[ ] difficulty of access

[ ] others (please specify)

14. If the existing sources of information and information about the source of information stored at a central place do you think that you could get better information.

a. yes

b. no

15. Do you think that using computer could increase your access to information?

16. Are you kept informed of new reports, study/project outputs and other internally generated information?

a. well informed

b. not much

c. not at all

17. Are you kept informed of new publications on water and sewerage and related areas generated outside of the organization?

a. well informed

b. not much

c. not at all

18. If well informed, how important are such publications to your work?

[ ] very important

[ ] not so crucial

[ ] not important

19. How do you come across the information on such publications?

[ ] formally through established ways

[ ] informally though your personal contacts

[ ] others (please specify)_____

[ ] _____

20. Name not more than four external organizations from which you get information/data

a. _____

b. _____

c. _____

d. _____

21. At what level do you need non-utility/infrastructure information (such as, consumption data, population data, etc...)

a. region

b. awraja

c. woreda (keftegna)

d. kebele

e. below kebele

22. How often you need non-utility information?

a. all the time

b. some time

c. rarely

d. not at all

PART II : The following questions are on utilities and infrastructure (water network, sewerage network, reservoirs, water meters, and valves).

23. Do you need installation data?

a. all the time

b. some time

c. rarely

d. not at all

24. Do you need maintenance history data?

a. all the time

b. some time

c. rarely

d. not at all

25. Do you need location information? (location of particular pipe, location of valves which control particular area, etc...)

a. all the time

b. some time

c. rarely

d. not at all

26. If you have other information need please write them.

_____

_____

_____

27. For what purpose do you need the information?

(please write what you think)

_____

_____

_____

28. Do you get installation information?

a. all the time

b. some time

c. rarely

d. not at all

29. Do you get maintenance history information of each utilities?

a. all the time

b. some time

c. rarely

d. not at all

30. Do you get information which indicate location of each utility.

a. all the time

b. some time

c. rarely

d. not at all

31. Do you get information on time?

a. all the time

b. some time

c. rarely

d. not at all

32. Do you get adequate and complete information?

a. all the time

b. some time

c. rarely

d. not at all

33. Do you get reliable information?

a. all the time

b. some time

c. rarely

d. not at all

34. Are you satisfied with information you get?

a. yes

b. no

35. If you are not satisfied, what do you think are the possible reason?

[ ] lack of organization

[ ] un-availability of sufficient information/data

[ ] difficulty of access

[ ] difficulty in integration and processing information manually

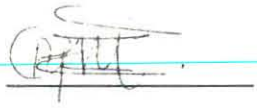
[ ] others (please specify)_____

36. If relevant information about each component stored in a computer data base, do you think that it will increase the usability of existing information?

a. yes b. no

DECLARATION

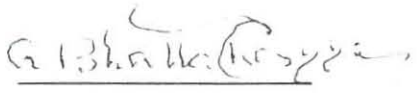
This thesis is my original work and has not been presented for a degree in any other university.



Abera Melese

May 24, 1995

The thesis has been submitted for examination with our approval as unversity advisors.



Professor G. Bhattacharyya

May 24, 1995

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May 24, 1995