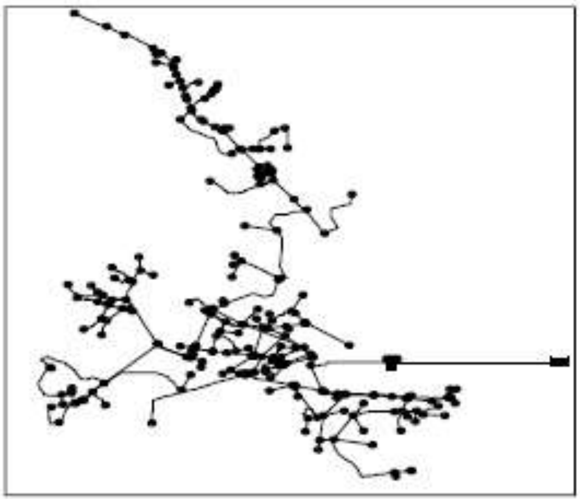
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER, IRRIGATION AND ELECTRICITY

RURAL PIPED SYSETM WATER SUPPLY OPERATION AND MAINTENANCE MANAGEMENT



Module – D. Session - C

A Trainer's Manual for Asset Management for Water Supply System

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Remember!

A preventive maintenance program will enable you to maximize the useful lives of your assets and can help you avoid problems and cut down or delay replacement costs. Adapt this manual for developing and implementing a preventive maintenance program

Things to Keep in Mind

- Assets that are **more important** to your ability to deliver safe water should have a higher priority because these assets affect public health.
- Assets with **short remaining useful lives** should have a higher priority because you will have to replace these assets soon.
- Assets for which there is **less redundancy** should have a higher priority because your system will have trouble continuing to operate without them.

PART - A: TECHNICAL OPERATION & MAINTENANCE MANAGEMENT

MODULE NO.	SESSION	SESSION TITLE	ESTIMATED TIME (Hours)
MODULE – A	Session – A	Facilitator's Guide for Rural Water Supply Operation & Maintenance Management	4
	Session – B	Introduction to the training: objectives and expectations	2
	Session – C	Introduction of Rural Piped System and Pastoral areas Water Supply Technologies	2
MODULE – B	Session – A	Description of Water Sources for Water Supply	2
MODULE – C	Session - A	Introduction of Rural Piped System Operation and Maintenance	2
	Session - B	O&M Requirements for Water Sources to Water Supply	4
	Session - C	O&M Requirements for Intakes	4
	Session - D	O&M Requirements for Electro-Mechanical Equipment	32
	Session - E	O&M Requirements for Pipelines	8
	Session - F	O&M Requirements for Storage Tanks/Service Reservoir	4
	Session - G	O&M Requirements for Consumer Points	4
Sub Total for this Module			**58**
MODULE – D	Session -A	Spare Parts Supply and Management	36
	Session - B	Equipment and Tools Management	8
	Session - C	**Asset Management**	**16**
MODULE - E	Session – A	Water Audit and Leakage Detection	16
MODULE - F	**Session – A**	**Water Quality Monitoring and Surveillance**	**24**
MODULE - G	Session – A	O&M Requirements for Solar Energy	4
	Session –B	O&M Requirements for Wind Energy	4

MODULE - H	Session – A	O&M Requirements for Sand Dam	6
	Session – B	O&M Requirements for Haffir & Berkads	6
	Session – C	O&M Requirements for Rain Water Harvesting	8
		TOTAL	**196**

MODULE – D. SESSION-C: ASSET MANAGEMENT FOR WATER SUPPLY SYSTEM

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Acronyms and Abbreviations

AM	Asset Management
AMP	Asset Management Plan
CIP	Capital Improvement Plan
CPI	Commodity Price Index
GTP	Growth and Transformation Plan
LOS	Level of Service
O&M	Operation and Maintenance
RPS	Rural Piped System
UAP	Universal Access Plan
WSS	Water Supply Service

1 SESSION – C: ASSET MANAGEMENT FOR WATER SUPPLY SYSTEM

MODULE - D	TECHNICAL OPERATION AND MAINTENANCE REQUIREMENTS
1.1. Session Outline	This session covers the following core topics: ▪ Introduction to Asset Management ▪ Asset Inventory ▪ Existing Schemes Operating Condition Survey ▪ Review of Maintenance Procedures ▪ Fixed Asset Valuation ▪ Stock Physical Inventory ▪ Level of Service ▪ Critical Assets ▪ Life Cycle Costing ▪ Long-Term Funding Strategy ▪ Implementation
1.2. Appropriate Facilitator	Supply administrator, electromechanical engineer or technician with experience on asset management.
1.3. Objective	At the end of the session, the participants will able to: ▪ Understand the principles of water supply asset management ▪ Use different methods of asset management ▪ What are different tools for reducing risks & improving competitiveness in the sector ▪ •Gain insight in the role of a data base and data mining
Output	▪ Understood the asset inventory, registration and valuation ▪ Gained knowledge on the analysis of criticality of assets ▪ Learned about the life cycle cost requirements and analysis ▪ Understood the different types of funding for asset managment

Timing	Approximately 24 hours
Methodology	▪ Presentation, discussion and group exercises ▪ Demonstrate different recording and reporting formats for Asset management system
Materials	Flip charts, markers, pens, even overhead projector and for practical demonstration, different laboratory equipment and materials.
Session Guide and Content	
1.4. Introduction	The training facilitator should start with the introduction to Asset Management with the following content: All water supply service systems are made up of assets, the assets that are either buried or visible on the ground. These are the physical components of the system and can include: pipe, valves, tanks, pumps, wells, hydrants, treatment facilities, buildings and any other components that make up the system. The assets that make up a water supply system generally lose value over time as the system ages and deteriorate. Along with this deterioration, it may be more difficult to deliver the type of service that the water supply services customers want. Costs of operation and maintenance will increase as the assets age. Then, the water supply services (WSS) may be faced with excessive costs that it can no longer afford. There is an approach to managing the assets of the system that can assist the WSS with making better decisions on managing these aging assets. This approach is called **asset management.**
1.5. Definition of Asset Management	**What is an Asset?** ▪ Something you own that has value ▪ There can be assets that gain value overtime…. ▪ or lose value over time    **1. Infrastructures Assets (Buried)** ▪ Water pipes 

- Sewers
- Valves

2. Infrastructure Assets (Above Ground)

- Reservoirs
- Treatment plants
- Buildings

3. Non-Infrastructure Assets (Above Ground)

- Vehicles
- Meters; WQ instruments
- Stop Cocks
- SCADA

What is Asset Management? (expressed with the following definitions)

1. Maintaining a desired level of service (what you want your assets to provide) at the lowest life cycle cost (best appropriate cost - not no cost).

2. Asset management is an integrated approach to optimizing the life cycle of our assets beginning at conceptual design, through to usage, decommissioning and disposal.

3. "Process of guiding the planning, acquisition, use, maintenance of assets and optimizing the potential of service delivery and managing related risks and costs over the full life cycle of the assets"

4. "a way of looking at investment choices in a comprehensive fashion: more than engineering and construction, but including economic, financial, and social realities"

5. "a new paradigm where O&M, utility efficiency, least cost expansions, financial viability, utility governance/ management and consumer attention, affordability and willingness to pay are of prime importance"

6. "A structured holistic approach to aligning and managing over time the performance of physical assets as a corporate resource with business objectives and drivers "

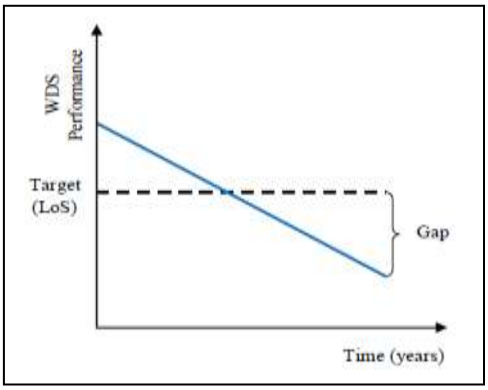
Asset Management is a tool:

It can be used to help assure that utility services are provided in a sustainable, cost - effective way.

1.6. Need for Asset Management

Explain the need for Asset Management with the following chart:

- Assets are aging
- System unable to deliver the required level of service
- Need for better decisions on managing aging assets – AM
- Increasing O & M costs
- Limited financial resources
- Stringent regulations
- Increasing demand for higher levels of service (LoS)
- Minimize risk and consequence of asset failure
- To provide assurance to stakeholders (accountability)



1.7. Asset Information:

Asset information is a combination of **data** about physical assets used **to inform decisions** about how they are managed.

Good Asset Information (AI) enables better decisions on optimal asset maintenance or renewal frequency.

These decisions are based on AI on:

- the asset's location,
- condition,
- probability and consequence of failure,
- work option specifications and costs,
- resource availability,
- Compliance with regulatory requirements.

1.7.1. What Asset Information is needed?

- Physical asset data – what assets are owned/operated and what are their technical characteristics?

- Location and spatial links - where is the asset and how does it relate to other assets?
- Work Management Data - what work has been /will be performed on this asset?
- Performance Data – how does this asset contribute to serviceability targets?
- Condition Data - what is the residual life of the asset?
- Cost Data - how much does the asset cost to buy and operate? Also
- Frequency of use – how often the information is needed in order to support the business process
- Type – the asset type the data required for
- Specific attributes and units – the age of an asset in years
- Precision and accuracy – e.g. how exact measurements need to be and to what extent can inaccuracy be tolerated.

1.7.2. What Asset Information do we have?

a. What Information do we currently have?

- Entity issues – data about these things is not captured
- Attribute issues – a piece of data, about this thing is not captured
- History issues – data is currently captured but there is no history
- Relationship issues – data is captured but there is no relationship between data sets
- Accessibility issues – data is available in the organization but difficult to access

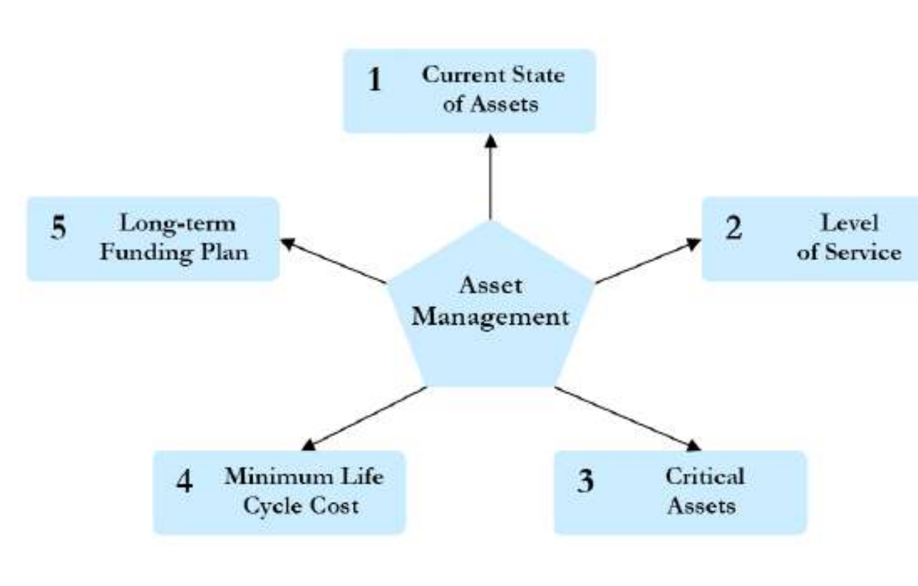
b. What is the quality level of the information?

- Clarity
- Completeness
- Consistency -
- Correctness
- Integrity -
- Uniqueness

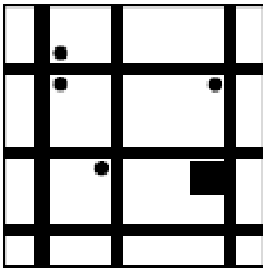
	c. Consequences and Impact of Information Gaps
1.8. Benefits of Asset Management	The benefits of asset management include, but are not limited to the following: ▪ Better operational decisions ▪ Improved emergency response ▪ Greater ability to plan and pay for future repairs and replacements ▪ Increased knowledge of the location of the assets ▪ Increased knowledge of what assets are critical to the WSSO and which ones aren't ▪ More efficient operation ▪ Better communication with customers ▪ Rates based on sound operational information ▪ Increased acceptance of rates ▪ Capital improvement projects that meet the true needs of the system.
1.9. General Guide for Asset Management	Expectations are not high for finding a complete, accurate and current inventory and evaluation of fixed assets in the various water supply system. Because buried asset are difficult to identify and Original cost records are likely to be sparse. Complete physical inventories will be required. Extensive amounts of estimation will presumably be required, starting probably with setting the initial cost. Realistic depreciation rates will need to be determined and applied; this implies first establishing useful life and salvage values. A systematic procedure must then be proposed for maintaining fixed asset values on a continuing basis. This will involve both systems and methods. The sub-tasks for asset valuation are: ▪ Analyze the present fixed asset records, ▪ Review methods of recording assets, calculating estimated life, arriving at salvage values, and setting annual depreciation charge, ▪ Establish procedures and conduct a physical inventory of assets with useful lives of over one year and determine or estimate their original cost, ▪ Identify basis for capitalization and method of valuation, ▪ Relate capitalized book value to replacement value, to the extent that it can be estimated, ▪ Prepare a fixed asset register.

1.10. Core Components of Asset Management

Discuss the five core components of asset management as:



1.10.1. Current State of Assets



Where is it?

What Do I Own?

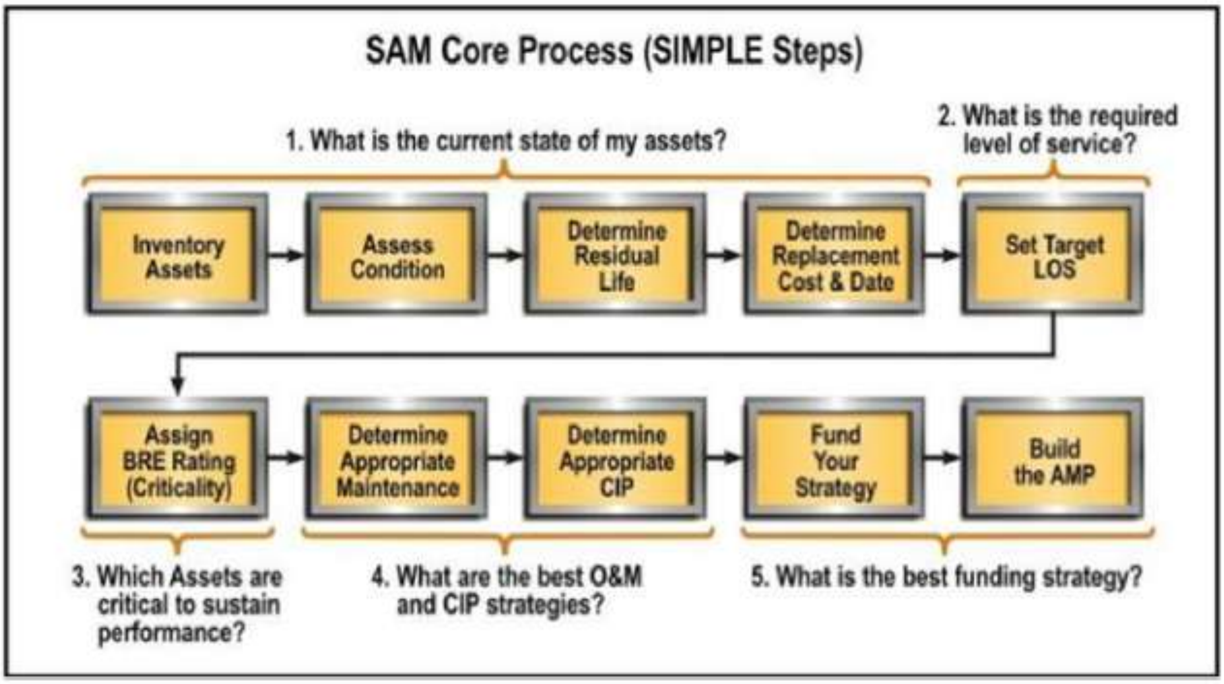
What is the useful life?

What condition is it in?

What is its Value?

Each of these is explained in the following sections.

Explain the simple Asset Management Core Process



1.11. Asset Inventory

Explain the needs that WSS Offices will ask these types of questions for asset inventory:

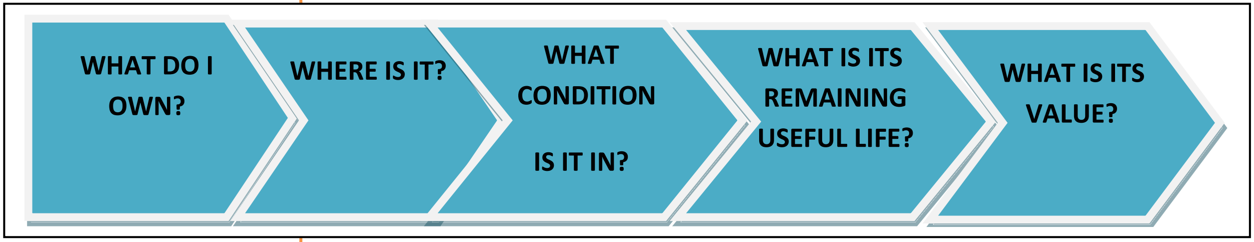


Table 1-1: Asset Inventory Example

Example System Inventory Worksheet						
Date Worksheet Completed/Updated: 8/14/02						
Asset	Expected Useful Life	Condition	Service History	Adjusted Useful Life	Age	Remaining Useful Life
Well 1 (1993)	30	Good		30	9	21
Well 1 pump	10	Good	Rehab (1996)	10	9	1
Well 2 (1993)	30	Good		30	9	21
Well 2 pump	10	Good	Rehab (1998)	10	9	1
Pumphouse (1993)	30	Good		30	9	21
Electrical components	10	Some corrosion	Rehab (1994)	10	9	1
Chlorinator (1993)	10	Good	Rehab (1998)	5	3	2
Storage tank 1 (1993)	40	Good	Rehab (2000) - $17,000	40	9	31
Storage tank 2 (1993)	40	Good	Rehab (2000) - $17,000	40	9	31
Storage tank 3 (2000)	40	Almost new		40	2	38
Distribution System:						
Hydrants (15)	40	Unknown		40	9	11
Valves (45)	40	Unknown	6 valves don't work	40	9	11
6-inch (PVC)	60	Unknown		60	9	51
4-inch (PVC)	60	Unknown		60	9	51
2-inch (PVC)	60	Unknown	Repair breaks (2/year)	60	9	51

1.11.1. What do I own?

The most fundamental question a Water Board, Manager, or Operator can ask is ***"what assets do I have?",*** but it is not always easy to answer.

The difficulties arise from several factors:

a) Some of the assets are underground and can't be seen;

b) Assets generally are put in at different times over a long period of time;

c) Records regarding what assets have been installed may be old, incomplete, inaccurate, or missing; and staff turnover in operations and management may limit the historical knowledge of system assets.

It is important to recognize that the system is only trying to form the best inventory it can and develop an approach to adding to or improve the database over time.

To develop the initial inventory, several approaches can be used and these are listed below. However, the WSS should be as creative as possible with other approaches to obtaining this information.

- Determine who was operating, managing and/or owning the system at the time of the major construction periods (when a large number of assets were put in.) Interview these individuals and gather as much information as possible regarding their recollections of what assets were installed and where they were installed. If there are maps of the system, these can be used during the discussions.
- Examining any as-built or other engineering drawings of the system
- Visual observations of above-ground or visible assets (e.g., pumps, reservoirs, manholes, treatment works)
- Interviewing community residents who may have lived in the area during construction and who are familiar with the construction activities (especially helpful in very small towns in which the residents were actively involved in developing the utility),
- Estimates on buried assets using above ground assets as a guide (e.g., using manholes to estimate locations, size, and type of pipe between the manholes; using isolation valve locations to estimate buried water pipe locations).

Several approaches may be necessary to get a good start on the asset inventory. A WSS office should use as many approaches as it deems necessary to get the best initial inventory of assets.

1.11.2. Where are my assets?

The next question in inventorying the assets is where are they?

This component involves two steps:

1. Mapping the assets and
2. Putting a location in the inventory.

In terms of mapping, the most important factor is to have a visual picture of the asset locations, especially the buried assets.

It is important to be able to group assets by their category (i.e., all valves, all hydrants) and by their location (all assets on Main Street.)

1.11.3. What is the condition of my assets?

As an example, pipelines can be evaluated using leak detection technology. A ranking system as described below may still be used with this higher-level data, or a more sophisticated numbering system can be used. Example of these types of ranking systems is presented in Table 1.2 below.

Table 1-2: Ranking System of Condition Assessment of Asset

Condition Rating	Description
5	Unserviceable
4	Significant Deterioration
3	Moderate Deterioration
2	Minor Deterioration
1	New or Excellent Condition

1.11.4. What is the remaining life of my assets?

All assets will eventually reach the end of their useful life. Some assets will reach this point sooner than other assets.

In addition, depending on the type of asset, it will either reach that point through amount of use or length of service. For example, a pump will wear out sooner if it is used more and will last longer if it is used less. The actual age of the pump is not as important as the amount of work the pump has done.

On the other hand, pipe assets wear out based more on the length of time in the ground. If a pipe is in the ground for decades it has had considerable time to contact the soil around it and the water within it and may start to corrode.

i) There are many additional factors that will affect how much life a given asset has. Factors such as poor installation, defective materials, poor maintenance, and corrosive environment will shorten an asset's life,

ii) While factors such as good installation practices, high quality materials, proper routine and preventative maintenance, and non - corrosive environment will tend to lengthen an asset's life.

Additional information regarding useful lives is contained in Annexes.

1.11.5. What is the Value of the Assets?

The first thing that should be known the cost of initially installing the assets.

This cost has no other importance than historical information or it can be used by a system that depreciates the costs of assets over time.

However, the installation cost does not have a direct bearing on what it will cost to replace that asset when it has reached the end of its useful life.

If estimation is done, the possible approaches include:

- If the system has had recent improvements, such as pipe replacement, information regarding the cost per linear foot can be used.
- If a neighboring system that is similar has had work done, costs obtained in their project may be used.
- Organizations that complete a large number of construction projects per year may be able to provide estimates. Suppliers, Consultants and Contractors.
- Bureau of Water, Zone and Woreda Water Offices.
- Construction magazines periodically publish unit costs for construction. These costs can be used as a starting point and revised as necessary to cover costs in other areas.

Over time, as more systems begin completing asset management strategies, WSS offices can share information, such as unit costs/replacement costs with each other.

1.11.6. Organizing the Asset Inventory

There are many options regarding how to manage the asset inventory data. Specific options include:

Discuss the merits and demerits of the different options of asset inventory mechanisms.

- Commercially available software for asset inventory
- Generic database software
- Spreadsheet software
- Hand written inventory

1.12. Existing Schemes Operating Condition Survey	Explain the survey that will be conducted as a basis for inventory of fixed assets and also with the view to rehabilitation programme. Major equipment units only will be categorized as follows: a. Not operating and infeasible to repair b. Operating but in need of thorough renovation c. Operating but in need of partial repair d. Satisfactory condition (but with possible need of preventive maintenance). Further, survey details including an asset registry indicated in **Form 1-1** or **Form 1-2**. **1.12.1. Survey of Mechanical Equipment** This survey includes pumps, motors, alternators, diesel engines, control panels, piping, vehicles and auxiliary equipment in the various plants of each scheme. The survey comprises the following: ▪ Visual and functional inspection of operating equipment; ▪ Hydraulic and mechanical tests of equipment and comparison of results with that expected of new equipment ▪ Visual inspection of inoperable equipment (including dismantled equipment) to be restored, repaired or replaced; ▪ Checking of installed equipment manuals available on-site. **1.12.2. Survey of Electrical Equipment** This survey includes alternators, waterworks transformers (if any), switchboards, control panels, etc in the various plants of each scheme. The survey comprises the following: ▪ Measuring of insulation transformers including auxiliary equipment (breakers, cubicles, cables, protection relays, auxiliary control circuits) ▪ Examination of transformer protection' devices (bucholtz, thermostat) as well as oil level, oil dielectric characterization, silica gel breathers, etc ▪ Examination and testing of all electrical motors (including auxiliary equipment) and measurement of electrical parameters; ▪ Inspection and testing of other electrical items; ▪ Visual inspection of inoperable equipment (including dismantled equipment) to be restored, repaired or replace; ▪ Checking of all installed equipment manuals available on-site.

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1.12.3. Survey of Treatment Plant

The survey is to include:

- Visual examination of plants;
- Water quality sampling of raw and treated water;
- Assess condition of treatment unit processes;
- Mechanical and electrical equipment surveys as in sections.

1.12.4. Survey of Transmission and Distribution Systems Conditions

This survey relates to rising and gravity mains, reservoirs and related control devices. The survey includes:

- Visual and functional inspection of rising and gravity mains as well as reservoirs;
- Undertaking pipeline pressure loss tests (if connections for pressure gauges are available)
- Checking of pressure and discharge at the outlets of mains (where possible).

1.12.5. Survey of Structures

This survey includes:

- Visual inspection of all concrete structures (condition, water tightness, etc)
- Visual inspection of all cast iron, steel and other structures (condition, water tightness, etc)
- Visual inspection of carpentry, metal-work and paint-work of structures (including fencing, lighting, etc)
- Inspection of access road condition.

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1.13. Review of Maintenance Procedures

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During the condition and operational survey of plant and equipment of each scheme, the survey team will:

- Examine the adequacy of stocks of spares and stores procedures;
- Examine the routine and periodic maintenance regime and procedures;
- Review numbers and qualification of assigned personnel;
- Examine the condition of vehicles, workshop and auxiliary equipment (including their maintenance).

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1.14. Fixed Asset Evaluation

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There are numerous reasons for undertaking valuation of assets, these are:

- to determine depreciated value of the assets for purposes of tariff setting, and

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- Towards developing strategy for refurbishment and or eventual replacement of assets.

1.14.1. Methodologies

The training facilitator explains the methodologies applied in determination of fixed asset values.

The several methodologies commonly used as indicators of value for assets are:

- Historical cost less depreciation;
- Inflation-adjusted historical cost less depreciation;
- Liquidation, or salvage, value;
- Capitalized earnings; and
- Discounted cash flow

1.14.2. Procedures

The following are the procedures to be followed to determine the asset evaluation:

- **Define fixed Asset**

A fixed asset is defined as an asset of a permanent nature whose useful life extends beyond the year in which it is purchased.

In this study only new purchase are capitalized. The threshold for capitalization in this study recognizes the Government of the Federal Republic of Ethiopia current financial regulation, which establishes the level as Birr 200.

- **Conduct site visit to each schemes and collect data**

Visit each project town. Inspect the water works facilities (intake works, treatment plants, pumping station, reservoirs, warehouses etc). Involve maintenance heads and plant operators in the survey. Review existing data, including drawings and manuals, if available. Use form 1-1 or Form I - 2 for listing and recording the assets.

- **Determine the economic life of each asset**

Review each of the assets as to their condition and estimate their continued life expectancy.

This process ensures that the residual costs could be determined and incorporated in forecasted recurrent expenditures for inclusion in the tariff base.

- **Determine the Costs of each Asset**

Determine the original costs of each asset; if data is not available, collect costs of identical items from various sources and compare each item to price lists gathered from various sources.

Since current prices are not readily available for all items include the pricing, date in the data as well as the price. This additional information allows the prices to be compared to inflation tables and the values updated to current cost.

- **Determine the inflation rates (Factors)**

As discussed above, asset prices are gathered from a number of sources and of differing time period. In order to bring the values to current values, inflation factor data are gathered and reviewed. The three sources of available data are listed below.

- Central Statistics Authority
- International Financial Statistics
- National Bank of Ethiopia

Based on the Commodity Price Index (CPT) data gathered, calculate and prepared inflation table which is composed of the year, inflation index and inflation factory derived from the index.

- **Compute Depreciation of the Fixed Assets**

The process of expensing assets over their estimated useful life is termed depreciation. A number of methods are employed including straight line, declining balance, sum of the digits, accelerated, etc. The most common method used for assets in the water sector is straight line and is the method recommended in this study.

The following depreciation rates per annum (refer Annex Table 1-1) are the most commonly used rates in the water sector. However, as with all methodologies for depreciation, the factors employed are best estimates.

1.14.3. Fixed Asset Registry

Fixed asset register cards with format as per Form 1-3 attached should be maintained in which assets are individually identified by number which also appears on the asset itself so as to facilitate physical control.

The fixed asset register card should define the date, description, cost and location of each asset as well as a year by year record of deprecation and the net book value.

Normally there should be a separate fixed asset card for each individual asset but where several similar assets are purchased at the same time they may be given consecutive identification number and be recorded on the same cared.

1.15. Stock Physical Inventory

1.15.1. General

A sound stock control system requires the stock record cards in quantity and value be maintained independently of stores by the accounts section, that the quantity balances be regularly agreed with the stores stock cards and that the value balances be agreed with the stock ledger account balances. However, where stock recording is incomplete, then reliance will have to be placed on the year end physical inventories to establish the quantities of stock on hand for evaluation and inclusion in the annual accounts.

Before physical inventories are taken the quantity balances according to the accounts section stock record cards must be agreed with the balances on the stores stock cards or storekeeper's stock cards and all differences identified and adjusted in order to ensure that the stock record card balances are correct for comparison with the physical counts

1.15.2. Procedures

Physical inventory taking must be properly organized and controlled, as follows, if accurate results are to be obtained.

- Stock items should be clearly identified as to stock number, description, size etc. and well arranged in stock number order so as to facilitate counting.
- Adequate cut-off procedures must be in forced to ensure that records are completely updated at the time of the stock taking. Movement of materials during stock taking must be stopped or most carefully controlled to prevent items being omitted from the count or counted more than once.
- Stock taking sheets Form-4 should be in standard form, pre-numbered and prepared in advance with the stock numbers and descriptions, but not the quantities of the items at be counted. The issue and return of the stock taking sheets must be controlled by accounting for all numbers by persons independent of the storekeepers and stock counters.
- Written instruction, approved by a responsible official, should be issued to all persons concerned with the stock taking, dealing each person's responsibility and the way in which the stock taking is to be carried-out.
- Stock should be counted by teams consisting of one person with adequate knowledge to properly identify the items of stock and make the count and a second person to record the results of the count on the stock taking sheets and check its accuracy by making a recount. Storekeepers should be available to assist but must not participate in counting items for which they are responsible.
- Broken, defective or obsolete items must be clearly recorded as such on the stock taking sheets and scheduled separately for consideration by management.
- Supervisors should make test counts and ensure that all items have been counted and the counts recorded
- Physical stock taking of voluminous or slow moving items such as spare parts should be taken one or two months before the year end, leaving only high value fast moving items to be counted at the yearend as this will facilitate timely preparation of the annual financial statements.

- Similarly physical stock taking of no financial inventory items should be made before the year-end, as the purpose of such inventories is only to confirm the existence of the stock and correctness of the memorandum stock records.

1.15.3. Stock Valuation

The valuation of stock at the close of a financial year is very important, because since stocks form part of the assets of the business, accurate stock figures are necessary if a correct balance sheet is to be presented. Several different methods of stock valuation are used. Goods are valued at:

Table 1-3: Depreciation Rate

S.No	Facilities	Civil		Mechanical & Electrical		Remarks
		Asset Life (Year)	Depreciation per annum	Asset Life (Year)	Depreciation per annum	
1	River Water Intake	50	2%	15	6.67%	
2	Boreholes	25	4%	10	10%	
3	Borehole Pumps	-	-	5	20%	
4	Spring	50	2%	-	-	
5	Impounding Reservoir	50	2%	-	-	
6	**Water Treatment Plant**					
6.1	Clarifiers/Sedimentation Tank	50	2%	15	6.67%	
6.2	Chemical Dosing Plant	50	2%	10	10%	
6.3	Chemical Dosing Pumps			5	20%	
6.4	Filtration Plant	50	2%	15	6.67%	
7	Pumping Station	50	2%	15	6.67%	
8	**Service Reservoirs**					
8.1	Reinforced Concrete	50	2%	15	6.67%	
8.2	Masonry	50	2%	15	6.67%	
8.3	Steel	20	5%	15	6.67%	
9	**Transmission and Distribution Pipes**					
9.1	Ductile Iron	40	2.5%			
9.2	Steel	40	2.5%			
9.3	uPVC	25	4%			
9.4	Polyethylene (PE)					
10	Pipe Fittings			25	4%	
11	Valves			15	6.67%	
12	Water Meters			15	6.67%	
13	**Buildings**					
13.1	Concrete/Masonry	50	2%			
13.2	Mud House (Chika bet)	20	5%			
13.3	Galvanized Iron Sheet House	10	10%			
13.4	Fence Barbed Wire/C.I.S	5	25%			
14	Office Furniture/Equipment			10	10%	
15	Vehicle/Cycle			5	25%	
16	Loose Tools			4	25%	

1.16. Level of Service

1.16.1. Introduction

A Level of Service Agreement (LOS) defines the way in which the Water Boards, Managers, and Operators want the system to perform over the long term. The LOS can include any technical, managerial, or financial components the system wishes, as long as all regulatory requirements are met. The LOS will become a fundamental part of how the system is operated.

1.16.2. Why a Level of Service Agreement?

Give explanation regarding each of these items is presented as follows:

- Communicate the system's operation to the customers (residential, industrial, institutional or commercial)
- Determine critical assets
- Provide a means of assessing overall system performance
- Provide a direct link between costs and service
- Serve as an internal guide for system management and operations staff
- Provide information for system annual report or annual meeting presentation
- Reduce system costs through customer involvement
- Customer Communication
- Determine Critical Assets
- Provide a Means for Assessing Overall System Performance
- Breaks will be repaired within 6 hours of initiation of repair 95% of the time.
- Customer complaints will be responded to within 24 hours, Monday through Friday.
- Losses will be kept to less than 15% as measured by volume of pumped each month – cubic meter sold each month.
- System will meet all federal and regional regulations.

All of these items are measurable if the system collects the appropriate data. Assume the system has the following data from its past year of operation.

- 250 breaks occurred, 230 were fixed in less than 6 hours
- 30 complaints were received, all 30 responded to within 24 hours

- Losses over the year as follows: July 12%, August 10%, September 19%, October 14%, November 9%, December 13%, January 9%, February 10%, March 12%, April 9%, May 10%, June 12%
- System met all regulations; no violations
- Provide a Direct Link Between Costs and Service
- Serve as an Internal Guide to System Operation and Management
- Provide Information for Annual Report or Meeting
- Savings Due to Customer Involvement

- **What is the Minimum Starting Point for the LOS?**

All systems must operate within the federal MoWIE and Regional Water Bureaus' regulations and requirements (Refer GTP and other guidelines).

- **What else should be included in the LOS?**

The maximum level of the LOS is defined by the maximum capabilities of the assets. A system cannot include something within a LOS that the system is not capable of doing.

As an example, if the system wishes to include the provision of fire flow in its LOS, but it only has 2 and 4 inch lines with no fire hydrants, there is no way the system can provide fire flow.

Examples of items that can be included in the Level of Service include, but are not limited to the following:

- Number of breaks per km that are acceptable
- Length of time from report of a leak or break until repair
- Amount of notification (and method) prior to a scheduled shut down
- Amount of notification (and method) prior to a non -scheduled but nonemergency shutdown
- Quantity of unplanned interruptions in service verses planned interruptions
- Number of hours to fix the pipe break once on site
- System losses maintained at less than X% overall Maximum system flow will be X m3/day
- No detection of Total coli form or E. Coli at the source
- Water pressure will be maintained throughout the system at X m water column
- Rates will be raised annually to avoid rate shock in the system
- Rates will be reviewed annually
- Storage capacity will be maintained at X cubic meter total

	▪ No water outage will be longer than X hours total ▪ Customers will be notified of planned system outages at least X hours or X days before the interruption ▪ Customers will be notified at least X minutes prior to shut down for an emergency condition, unless life threatening conditions cause a need for immediate shut down ▪ Water conservation will be instituted to reduce average daily use by X percent in Y years. **1.16.3. How can the public be involved in the LOS?** Ideally, the public or customers of the WSS/Utility would be actively involved in the development of the LOS. This involvement could be done through customer form, focus group meetings, surveys, public meetings, or other means. An example may be the length of notice prior to a schedule or non-emergency, unscheduled shut down. In this case, it is important to understand how much notice the customers would want and in which way it would be best to notify them. The customers are in the best position to indicate how and when to be notified. **1.16.4. Can the LOS be changed Over Time?** Yes, that it will change and adjust over time, the LOS may need to be adjusted from time to time. This adjustment may be required because the system may discover that it is too costly to operate the system at the levels previously defined, Or the adjustment may be necessary due to new rules or regulations that require a change (like UAP or GTP), Additionally, the customers may feel that they desire a different level of service. (per capita demand, fire flow, pressure etc),
1.17. Critical Assets	**1.17.1. General** Not all assets are equally important to the system’s operation; some assets are highly critical to operations and others are not critical at all. Certain assets or types of assets may be critical in one location but not critical in another. Explain this idea with examples. A system must examine its own assets very carefully to determine which assets are critical and why. **1.17.2. Determining criticality** Explain the two important questions that are used in determining criticality:

1) The first is how likely the asset is to fail, and
2) The second is the consequence if the asset does fail.

Criticality has several important functions, such as allowing a system to manage its risk and aiding in determining where to spend operation and maintenance cost and capital expenditures.

As a first step in **determining criticality**, a system needs to look at what it knows about the likelihood that a given asset is going to fail.

The data available to assist in this determination is: The training facilitator explains each of the following factors to be understood in determining the criticality of the asset.

a) asset age,
b) condition assessment,
c) failure history,
d) historical knowledge,
e) experiences with that type of asset in general, and
f) Knowledge regarding how that type of asset is likely to fail.

- An asset may be ***highly likely to fail*** if it is old, has a long history of failure, has a known failure record in other locations, and has a poor condition rating.
- An asset may be ***much less likely to fail*** if it is newer, is highly reliable, has little to no history of failure and has a good to excellent condition rating.

In terms of the consequence of failure, it is important to consider all of the possible costs of failure. **The costs include:**

a) Cost of repair,
b) Social cost associated with the loss of the asset,
c) Repair/replacement costs related to collateral damage caused by the failure,
d) Legal costs related to additional damage caused by the failure, environmental costs created by the failure, and
e) Any other associated costs or asset losses.

The consequence of failure can be high if any of these costs are significant or if there are several of these costs that will occur with a failure.

Explain the above mentioned costs as:

1.17.2.1. Cost of Repair

When an asset fails, it will be necessary to fix the asset in some way.

Depending on the type of the asset and the extent of the failure, repair may be simple or extensive.

Example:

A small leak in a pipe can be repaired with a clamp. A chlorine pump can be replaced with a spare pump or perhaps the diaphragm can be replaced inside the pump. A failure of a well may be much more involved and may require much more extensive repair efforts.

The cost of the repair of the failed asset should be considered in the analysis of the consequence of failure.

If the asset can be repaired easily and without a tremendous cost, then there is a lower consequence. If the cost of repair is higher, then the consequence of the failure is also greater.

1.17.2.2. Social Costs Related to the Loss of the Asset

When an asset fails, there may be an inconvenience to the customer.

In some cases, this inconvenience may be minor, while in other cases, the social costs may be much higher.

Example 1:

If a pipe must be repaired in a residential area, there may be a few customers who are out of water for a short period of time. This outage would constitute an inconvenience, but would not be a severe situation.

Example – 2:

On the other hand, if the system has very few isolation valves so that any repair on the system requires the whole system to be shut down, the inconvenience to the customers is much greater.

In the first example (simple repair in residential area that shuts off a few customers), the cost of the consequence of failure related to the social cost is low. In the second case where the whole system must be shut down to make any repair, the cost of consequences related to social costs is much higher.

1.17.2.3. Repair/Replacement Costs Related to Collateral Damage Caused by the Failure

When an asset fails, in some cases damage may be caused to other assets unrelated to the water or wastewater system.

Example

1. A water line fails causing a sinkhole which then causes damage to the foundation of a building or a house or causes major sections of a road to collapse. In addition, cars may be damaged in the sinkhole.

The damage from the pipe failure without the sinkhole would be fairly minimal. With the sinkhole, there is collateral damage including the road, the building or house, or cars.

The WSS/utility will be held responsible for this collateral damage, **so the costs related to this type of failure need to be considered in the assessment of costs of the consequence of failure.**

1.17.2.4. Legal Costs Related to Additional Damage Caused by Failure

In some cases, individuals or businesses may sue the WSS/utility for damages or injuries caused by an asset failure.

These costs would be in addition to the costs of repairing and replacing damaged property or other assets.

Example:

If a driver is driving down the road and a water line fails causing a sinkhole that the driver then falls into causing an injury, the driver may sue the WSS/utility to cover the costs associated with the injury and loss of work time.

1.17.2.5. Environmental Costs Related to the Failure

Some types of asset failures can cause environmental impacts. The costs related to these impacts may not always be easy to assess in monetary terms. However, some attempt should be made to establish some type of monetary value to the environmental consequences.

1.17.2.6. Reduction in Level of Service

The assets must be in working order to deliver the level of service desired by the water system and its customers.

If the assets fail, the ability to deliver the desired level of service may be compromised.

An asset that has a major impact on the ability to meet the LOS would be considered more critical to the system than an asset whose failure would not have a significant impact on the LOS.

1.17.2.7. Other Costs Associated with Failure or Loss of Asset

The costs in this category are any other costs that can be associated with an asset failure that are not adequately defined within the categories above.

Example:

1. A cost associated with loss of confidence in the water supply system or loss of the system's image. Certain types of failures may negatively impact the public's confidence in the water supply system and this may have a cost to the system.
2. Loss of income related to the inability to provide service for a period of time, loss of the service itself, or health impacts to workers or customers.

1.17.3. Assessing Criticality

Assessing criticality requires an examination of the likelihood of failure and the consequence of failure as discussed above.

The assets that have the *greatest likelihood of failure* and the *greatest consequences* associated with the failure will be the assets that are the *most critical*.

Explain the most critical assets that fall into three main categories:

- Assets that have a very high likelihood of failure with low consequence
- Assets that have a very high consequence with a low likelihood
- Assets that have a medium likelihood and medium consequence

A technique such as a ranking table as presented below can be a good place to start in assessing criticality.

Table 1-4: Assessing Criticality

Multiplied		**Consequence (Cost) of Failure** Low … High					
			1	**2**	**3**	**4**	**5**
Probability of Failure	**Very Low**	**1**	1	2	3	4	10
	Low	**2**	2	4	6	8	15
	Moderate	**3**	3	6	9	12	20
	High	**4**	4	8	12	16	25
	Very High	**5**	5	10	15	20	30

Explanation of the above Table.

To use this table, estimate the probability of failure from 1 to 5 with 5 being very high probability of failure and 1 being a very low probability of failure. Then assess the consequence of failure from 1 to 5 in the same manner. Using the number for probability of failure, move across the row until the column associated with the number for consequence of failure is reached. Alternatively, move down the column for the consequence of failure until the row for probability of failure is reached. Locate the number that is in the box where the row and column intersect. That is the number for criticality for that asset.

Example-1: look at the following scenario:

- Asset: DN 300 Ductile Cast Iron pipe; constructed in 1970, so 45 years old
- Service History: Numerous breaks in the past 5 years
- Service Area: Serves 3 major subdivisions, but there are loop lines available and only residential customers
- Likelihood of failure: 4 – pipe has broken many times, but when repaired it was still in reasonable condition
- Consequence of failure: 2 – There are loop lines so not all customers will be out of water. Repair costs are moderate. Line isn't in a critical roadway so repair is relatively easy.

Using the chart, move across the row for 4, until the column for 2 is reached. The number in the box is 8. Therefore, **8 is the criticality factor** for this asset. (See table below.)

Table 1-5: Example-1 of Assessing Criticality

Multiplied		Consequence (Cost) of Failure Low → High					
			1	**2**	**3**	**4**	**5**
Probability of Failure	**Very Low**	**1**	1	2	3	4	10
	Low	**2**	2	4	6	8	15
	Moderate	**3**	3	6	9	12	20
	High	**4**	4	8	12	16	25
	Very High	**5**	5	10	15	20	30

Example-2: look at the other scenario:

- Asset: Chlorine pump
- System uses hypochlorite so chlorine pump pumps liquid chlorine solution into the system for disinfection
- System has both spare parts and a spare pump
- Chlorine pump has failed due to many factors several times in the past 10 years
- Chlorine is checked once per week
- Likelihood of failure: 4 – pump has failed many times
- Consequence of failure: 4 – A failure in a chlorine pump has the potential to be a major consequence. However, the consequence is mitigated by the presence of a spare pump and spare parts. Because the pump may fail for a significant period of time before the failure is known (up to 1 week because the levels are only checked once per week), the consequence is not substantially reduced by the spare parts and pump.

- Using the chart, move across the row for 4, until the column for 4 is reached.
- The number in the box is 16. Therefore, **16 is the criticality factor** for this asset. (See table below.)

Table 1-6: Example-2 of Assessing Criticality

Multiplied		Consequence (Cost) of Failure Low High					
			1	**2**	**3**	**4**	**5**
Probability of Failure	**Very Low**	**1**	1	2	3	4	10
	Low	**2**	2	4	6	8	15
	Moderate	**3**	3	6	9	12	20
	High	**4**	4	8	12	16	25
	Very High	**5**	5	10	15	20	30

In looking at the two assets, the *chlorinator is much more critical than the piece of pipe*. If all assets are viewed in this way, an analysis can be done to determine the criticality number for each one and then the results can be compared to see which assets are more critical than others.

1.17.4. Criticality analysis over time

The condition of the asset will change over time as will the consequences related to failure. Costs of repair may go up, the community may grow, new roads may be built or similar factors may occur that cause the consequence of failure to change.

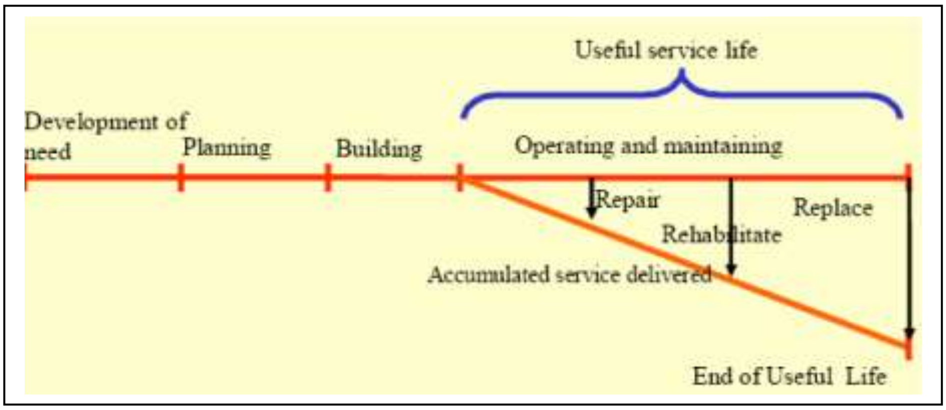
Therefore, it is necessary to periodically review the criticality analysis and make adjustments to account for changes in the likelihood of failure and the consequence of failure.

If an asset that was critical primarily due to its likelihood of failure fails and is replaced with a new asset, the criticality number will go down since the likelihood of failure is much less.

1.18. Life Cycle Costing

1.18.1. General

The training facilitator shall describe the general description of the life cycle costing of an asset with the aid of the following chart.



There are several components of developing a lifecycle strategy for asset management plans. Most small communities can easily begin with one or two of these components

Lifecycle Asset Management focuses on management options and strategies considering all relevant economic and physical consequences, from initial planning through to disposal.

The Lifecycle components include:

- Asset Planning
- Asset Creation/Acquisition/Design
- Financial Management
- Asset Operation and Maintenance
- Asset Condition and Performance Monitoring
- Asset Rehabilitation/Renewal
- Asset Disposal
- Asset Audit and Review

It does not make sense to try to begin with all eight components at once. Therefore, this manual will guide communities through the basics of the components that can easily be started.

1.18.2. Options for dealing with assets over time

There are four basic options for dealing with the actual assets over time:

1. Operate and maintain the existing assets
2. Repair the assets as they fail
3. Rehabilitate the assets

4. Replace the assets

These options are intimately connected to each other. Choosing to do more or less of one impacts how much of the others is done, whether or not the other is done at all, or the time frame in which one of the others is done.

For example, choosing to spend more on operating and maintaining assets will decrease the need to repair the asset and will increase the amount of time until the asset is replaced.

Choosing to rehabilitate an asset will eliminate the need to replace the asset in the short term and will increase the amount of time until the asset ultimately need to be replaced.

The rehabilitation will also reduce the amount of operation and maintenance that needs to be done and reduce the need for repairs.

Each of these options has its own costs and considerations. The expenditure of funds becomes a balance between monies spent in each of these four categories. The purpose of asset management is to try to determine the optimal way to spread the money between each of these categories, while maintaining the LOS desired.

Generally, the *most expensive option is replacement of the assets*. Therefore, keeping the assets in service longer, while still meeting LOS conditions, will usually be the most economical for the utility over the long term.

The three other options: maintenance of the asset, repair of the asset, and rehabilitation are options that can be used to keep the asset in service longer. Each of the options is discussed further in the sections below.

1.18.2.1. Asset Operation and Maintenance

Operation and maintenance (O&M) functions relate to the day -to-day running and upkeep of assets and are particularly relevant to short-lived dynamic assets (such as pumps) where deterioration through lack of regular maintenance may result in rapid failure.

Properly operating and maintaining assets is critical to the success of the overall program. Operation and maintenance is directly linked to Level of Service and Critical Components.

- Establishing standardized O&M procedures achieves maximum asset life and reduces O&M costs.
- Standardizing O&M procedures helps WSS/utility personnel to operate all assets within acceptable operational levels and ensures that each person is following the same routines.
- By standardizing the operations of all assets, maximum asset life can be obtained (assuming that periodic maintenance is

performed as required).

O&M procedures can be categorized as operational, maintenance and (where applicable) laboratory.

Operational procedures can be classified as:

- **Standard Operating Procedure:** most common, typically used during normal operations, day-to-day
- **Alternate Operating Procedure:** Used when operational conditions require that an asset or process be modified or taken off-line, scheduled, periodic
- **Emergency Operating Procedure:** used in emergency conditions, incorporated into overall emergency plan developed for facility

Maintenance procedures can be classified as:

- **Corrective Maintenance Procedures:** used by field technicians for the breakdown and repair of assets that are malfunctioning (e.g., replace broken bearing)
- **Preventative Maintenance Procedures:** developed to prevent breakdown and prolong asset life (lubrication or overhaul)
- **Reliability-centered Maintenance Procedures:** developed to assist maintenance managers in predicting asset failures and lessening effects on facilities (asset condition monitoring or failure modes and effects analyses)

Laboratory procedures can be classified as:

- **Equipment-related Procedures:** developed on the basis of how to operate the equipment and what maintenance and/or calibration the equipment requires
- **Sampling-related Procedures:** developed around sampling routines and specify to the laboratory technician when, where, and how samples should be taken

Several choices exist for who develops O&M procedures.

- New facilities or assets: engineering firm or designer, supply vendors, contract professional technical writer
- Existing facilities or assets: existing staff, technical writer

In order to develop O&M procedures the reference materials located along with this manual as Part C and D. Reference materials include O&M Manuals, process and instrumentation drawings, vendor submittals, specifications, pictures, design data, design drawings, as –built drawings, and interviews with experienced staff.

Developing operational procedure s includes:

- Titling the procedure appropriately, so it is easily identified. (e.g., “Shutdown of Alum Feeder Number 4”)
- Introduction: lists associated information such as the reason for the

procedure, responsible parties, desired outcomes, safety procedures, special equipment requirements and notification requirements

- Steps and/or Activities: Step 1, Shut power off at the breaker located on the wall labeled Alum Pump
- Note any cautions or hazardous conditions with each step or activity before the activity is performed

Maintenance procedures are generally developed using vendor -supplied information. Using a template with fields for the vendor to complete, such as the Work Maintenance Management System (WMMS), has proven successful for many utilities.

Two factors can adversely affect the development of procedures:

- **Costs:** The costs of developing procedures in a new facility are typically covered in the capital improvement plan (CIP) budget. If this budget is limited, facility managers must determine which procedures are critical and work with their staff and an outside source, if needed, to develop the critical procedures first. Remaining procedures can then be spread out over time to minimize budgetary effects.
- **Time:** The other key factor is time. For an existing facility where staff may already be stretched thin, it becomes impractical to include the development of O&M procedures into daily routines. The use of a third-party O&M group or even a dedicated staff member can reduce the time requirements on the O&M staff while developing procedures.

The application of standardized maintenance procedures can reduce asset downtime and ensure lifetime productivity. The application of standardized laboratory procedures is essential for a good quality - assurance/quality-control program.

1.18.2.2. Operation and Maintenance and Critical Assets

One of the purposes for identifying critical assets is to allow the WSS/utility to make more informed decisions regarding the use of its operation and maintenance costs.

Figure 1-1 below shows the relationship between likelihood of failure and consequence of failure for assets. The letters A through D represents different categories of assets. Assets in category A have a low likelihood of failure and a low consequence of failure, while those in category D would have a high likelihood of failure and a high consequence if they do fail.

The expenditures on operation and maintenance, or O&M, would vary for these various categories of assets. Those in category A should have lower expenditures on O&M and less investment into condition assessment, while those in category D should have much more expenditure on O&M and more investment into condition assessment. Table 1-6 contains a summary of this information.

Figure 1-1: Relationship between likelihood of failure and consequence of failure

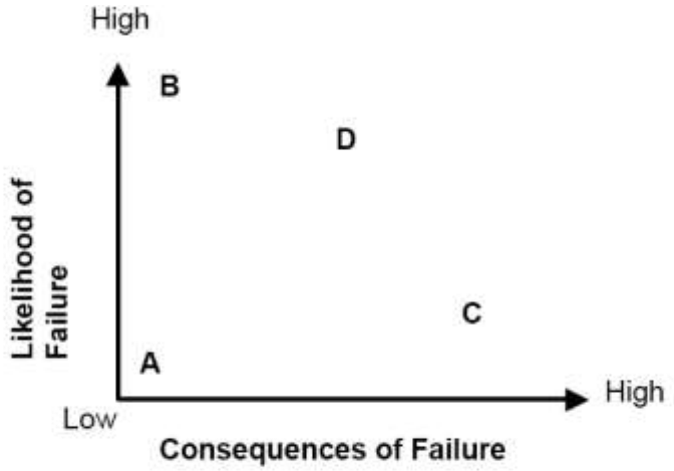


Table 1-7: Summary of O&M Expenditures and Criticality

Letter from Graph 8-1	Likelihood of Failure	Consequence of Failure	Relative Amount Spent on O&M	Relative Amount Spent on Condition Assessment	Example of an Asset that Could be in this Category
A	Low	Low	Low	Low	4 year old PVC pipe in a residential area
B	High	Low	Moderate	Moderate	60 year old steel pipe in a residential area
C	Low	High	Moderate	Moderate	Encased pipe under a railroad track
D	High	High	High	High	60 year old steel pipe under a major arterial road

In deciding how to spend O&M and condition monitoring dollars, the system should perform an assessment similar to the one above, putting specific types of assets or asset categories in the boxes instead of A through D. Then the O&M program and condition monitoring program can be structured so that expenditures are made on the most appropriate assets.

Thought of another way, if the system had ETB 2,500 to spend on Operation and maintenance and the only assets were A, B, C, and D as shown on Figure 1 -1, the money should be spent in a manner similar to Table 1 -8 below.

Table 1-8: Operation and Maintenance Expenditure by Criticality

Asset	O&M ETB Out of a $2,500 Birr Expenditure	Percentage of the Total Expenditure
A	$125	5%
B	$375	15%
C	$750	30%
D	$1250	50%

The table shows how the money is spent between the different categories of assets. The most money is spent on the assets with the greatest failure potential and greatest consequence.

1.18.2.3. Repair of Assets

In addition to operating and maintaining the assets, systems will need to plan for the repair of assets as they fail.

Systems need to consider how long they will keep an asset in service prior to replacement of the asset. To some extent, these two items – repair and replacement - are off-setting.

If more resources (personnel and money) are spent on repair, there will be a decreased need for replacement. On the other hand, if greater resources are applied to replacing the assets, fewer resources will be applied to repair.

There is a balance between how much to spend in each category: maintenance, repair, and replacement to achieve the most efficient system.

In developing a water supply system repair schedule, the WSS/utility must determine its own approach to repairing verses replacing assets. The utility will need to decide when it is spending more money (including personnel hours) to repair the asset than it would cost to replace the asset.

1.18.2.4. Rehabilitation of Assets

When an asset fails, or approaches failure, the typical thought process is that of replacing the asset with a new asset.

There is another option for some water supply system assets; assets may be rehabilitated rather than an outright replacement. Rehabilitation brings the assets back to a useable condition without actually replacing them.

In many cases, it may be cheaper to rehabilitate the asset rather than replacing it; it may extend the life span of the asset considerably and may reduce other impacts related to asset replacement. An example of a rehabilitation approach is slip lining a wastewater pipe that is nearing the end of its useful life. The pipe can be lined without having to dig the original pipe out of the ground, thus possibly reducing the costs of installation and the inconvenience of the construction.

1.18.2.5. Replacement of Assets

Eventually, all assets will need to be replaced. They will reach a point where the asset can no longer be kept in service through maintenance or repair or where the asset is no longer capable of meeting the LOS, either economically or at all. At that point, the asset will need to be replaced. Replaced assets can either be part of a replacement schedule or a capital improvement plan.

In both cases, the assets are replaced. The main difference is that the replacement schedule includes those items that are routinely replaced, smaller Birr replacements, and items replaced using the water or wastewater system revenues or reserve funds.

The capital improvement plan indicates items that are major expenditures that do not routinely occur and that generally require outside funding for at least a portion of the project. Further information regarding each of these types of replacements is presented below.

Replacement Schedule

A replacement schedule should be developed that indicates those assets that will be replaced within the next 20 years that will be funded out of system revenues.

The schedule will contain assets that are smaller Birr amount or routinely recurring and should include assets that will be paid for out of system revenues. A couple of examples of these types of assets are: water meters and chlorine pumps. Additional assets, such as small diameter water distribution piping, valves, and hydrants can also be included.

This schedule can also be expanded to include programmed maintenance or repair, making it a Repair and Replacement Schedule. The types of activities that can be included here are major, programmed repair elements, such as a storage tank inspection annually and a tank overhaul (repaint, structural testing, cleaning) or leak detection every 3 years. This Schedule does not replace the operation and maintenance schedules discussed above. It merely reflects those elements that are major budget items and that will occur routinely, but much less often than daily, weekly, or monthly. These are generally items that are annually or greater in schedule and that constitute a major budget expenditure.

The schedule should include all of the recurring and non-recurring items for a 20 year period. The Repair and Replacement Schedule should be updated annually so that it is always 20 years long.

The type of information to include on a Repair and Replacement Schedule includes:

- Year
- Item
- Description
- Estimated Cost
- Method of Estimation
- One time or Recurring
- Time Period of Reoccurrence

Annex-F contains an example table for a Repair and Replacement Schedule. It is absolutely critical that the items in the Repair and Replacement Schedule be entered into the rate setting process. These items must be funded out of system revenues, so they must be accounted for in the annual budget and in the rates. The Schedule will probably not be uniform from year to year in terms of amount of expenditure. To address this issue, the system may wish to set an annual annuity payment to cover the Repair and Replacement Schedule expenses over the long term.

Some years, the payment would be greater than that year's expenses, so money would go into a Repair and Replacement Reserve. Other times, the amount collected would be less than required so the additional funds would come from the reserve account. The annual annuity set would have to be sufficient to cover all of the expenses over the 20 year period. It may need to be increased over time if expenses increase and it can be decreased if it turns out too much money was dedicated to this purpose.

Capital Improvement Planning

A long-term capital improvement plan should look at the WSS's/utility's needs for the future. Ideally, the planning period would be at least 20 years, with a minimum of 5 years. It is understood that the specific expenditures and needs of the utility in the latter years, say 15 to 20 years, are more speculative than the needs for the first 5 to 10 years, particularly the first 5 years. However, the inclusion of the needs for this longer time period will provide a better opportunity for the water supply system to plan for its capital needs. There are several categories of capital improvements that must be considered. The categories are listed below.

- **Capital needs related to Future/Upcoming Regulations:** The state and federal regulatory agencies periodically issue new rules and regulations that may require water supply systems to invest in new technologies to meet the requirements. For example, when the fluoride standard was reduced from 15 mg/l to 1.5 mg/l, many water systems will required to consider capital needs to meet this standard. The capital needs may be related to treatment facilities, distribution system changes, connections with other sources, development of new sources, or any other type of capital project to meet the standard. Systems ought to be aware of upcoming regulations and consider the costs that may be associated with compliance so that money can be set aside to help pay the costs.

- **Capital needs related to major asset replacement:** Some assets can be repaired within the repair and replacement schedule, while others will be major expenditures that will have to be replaced under the capital improvements program. Assets such as storage tanks, treatment facilities, and major portions of the distribution or collection system could fall into this category.

- **Capital needs related to system expansion:** Over time, the system may expand due to growth in the area or through serving customers. This type of expansion may involve new distribution or collection pipes, additional storage, additional water source, or additional treatment.

- **Capital needs related to system consolidation or regionalization:** Some systems may find it advantageous to consolidate or regionalize with other nearby systems. In some cases, this type of regionalization may involve additional assets, such as sources, pipes, and storage or treatment facilities.

- **Capital needs related to improved technology:** Systems may wish to replace assets because the technology of the assets originally installed is out of date and needs to be modernized or because technology improvements will allow improved customer service or enhanced efficiencies. An example of this type of capital needs is a SCADA system that electronically controls the system's operations.

System managers need to consider all of these types of needs when developing a long term Capital Improvement Plan (CIP). Each item needed by the system for each of the applicable categories for a 20 year time horizon needs to be identified. At a minimum, the following information should be identified for each item.

- Description of the project
- Brief statement regarding the need for the project
- Year project needed
- Is the year needed flexible or absolute
- Estimate of project cost
- How costs were estimated
- Funding source(s) considered/available for this type of project
- Changes in overall operations that may occur as a result of the project (include operator requirements, additional O&M costs,

regulatory changes, any efficiency that may be gained, etc.)

- Impact of the project on LOS

Some of the expenses related to capital improvements may be funded out of the system's revenues rather than solely outside sources. If system revenues are to be used either to offset costs or as a debt repayment stream, the budgets and rates must reflect the costs.

Annex-G contains an example table that can be used to develop the CIP.

Annual review of asset replacement projects

Asset replacement projects will be included in the Repair and Replacement Schedule and the Capital Improvement Plan. It is a good idea to review both of these documents on an annual basis to determine if all of the listed projects are indeed necessary.

Sometimes another look at the project list may reveal that some projects can safely be pushed back for several years or may not be needed due to changing conditions. The projects were projected out several years in advance, so conditions may have changed eliminating or reducing the need for the project. Alternatively, the projects may also have changed in terms of specifically what technology or approach is best. As an example, the system may have anticipated growth in a certain area and budgeted for line extensions into that area 10 years into the future. However, over time, it may turn out that development did not occur or the patterns were different than expected. The extension project can then be eliminated from the budget.

The types of questions to examine in the completion of this type of review include the following:

- Is the reason/need for the project still valid?
- Have the costs changed since originally projected?
- Is there a better approach or a better technology that can be used to address the need?
- Can the project be safely delayed?
- Does the project need to be completed sooner?
- Is there a method of rehabilitation that could be used rather than replacement to save costs?
- Would it be more reasonable to reduce the LOS than increase the asset's capability?
- Will funding be available for the project?

Each year the overall Repair and Replacement Schedule and Capital Improvement Plan must be revised to reflect completion of the current years projects or the new schedule for those projects if they were not completed, any changes to the projects on the list, and to add the additional year at the end of the project period to keep the list at 20 years.

1.19. Long Term Funding Strategy

1.19.1. General

The first four components of the asset management strategy lead a system to discover what actions are most appropriate to take to manage the system at the desired level of service at the lowest life cycle cost. The final factor in the asset management strategy is determining the best manner in which to fund the operation and maintenance, repair, rehabilitation, and replacement of assets. There are several sources of funding available to a system, so it is important to evaluate the item needing funding and the various options.

1.19.2. Funding Sources Available

The sources of funding for the overall operation and maintenance of a water supply system, including asset repair, replacement, and rehabilitation include the following:

- System revenues from:
- User fees
- Connection fees
- Stand-by fees
- Late fees
- Penalties
- Reconnect charges
- Developer impact fees
- System reserve funds
- Emergency reserves
- Capital improvement reserves
- Debt reserves
- Non-System revenues:
- Federal grants
- Federal loans
- Regional grants
- Regional loans
- Federal or regional loan/grant combinations

1.19.3. Rates and Asset Management

System revenues are a major component of an asset management plan. The system revenues will fund the operation and maintenance of the system; there generally are no outside funding sources for routine operation and maintenance of a WSS/ utility. In addition, the rates will need to fund reserve accounts for emergencies, repairs, and debt coverage (for any loans.)

	A well-developed rate structure will take into account needs for the water system for the current year as well as needs for the water system in future years, through reserve accounts. For example, if the water system is anticipating a new regulation that will require additional treatment, the system should be collecting money through the rates to help pay for the needed equipment. The rate structure should also anticipate routine replacements of parts, particularly those parts that wear out regularly. For example, if the system replaces its chlorinator every 5 years, the rates should cover this expense, rather than seeking regional or federal funding to cover these types of needs. There are many sources of rate setting assistance, including trainings and free rate setting programs. Any approach that includes all costs of operation, considers the long term view, includes reserve accounts, and considers conservation or other WSS/utility goals is acceptable. **1.19.4. Long-Term Funding Plan** As stated in One WASH Program 5 year funding strategies need to be prepared. This document should be consulted as a resource in the development of the long-term funding strategy needed for the asset management plan.
1.20. Implementation	**1.20.1. The "Just Do It" Philosophy** The asset management program described in this document is based on the "just do it philosophy." A system should be able to jump right into asset management and start doing it without a tremendous amount of preparation or resources. Over time, a system will increasingly improve its asset management program and will increase its knowledge base and the quality of its data. A system may wish to increase its level of sophistication and may input a greater degree of resources – personnel or money – as it improves over time. However, the most important thing is for a system to get started on a more systematic manner of operating its WSS/utility. Asset management is firmly rooted in common sense and good business practices. As such, any activities the system undertakes in the area of asset management will improve the system's overall operation. The more sophisticated and cohesive the program, the more improvement, but improvement will occur even at a lower level of asset management activity. WSSs/Utilities do not need to worry about making mistakes with asset management. Asset management is meant to be on-going and improved over time. If the program is not working properly or needs to be changed, the system can change it. **1.20.2. The Sustainable Process** As stated in the Section 2 of this manual, asset management needs to

become *the way you do business.* As such, as long as the system is operational, the system should be engaged in asset management. The system must view this process as never ending. The asset management program should improve and change over time, as the system's needs change but it will never be something that is "complete" and should not be thought of in that way.

1.20.3. The Asset Management Plan

The system may wish to compile its approaches to asset management into a single document discussing each element and how that is handled. The document, however, must be flexible and should contain an explanation of how the system is doing each component, not the actual data obtained from each component. The actual data should be in a format that is continually changeable (e.g., computer data base, map that can be drawn on, etc.)

The Asset Management Plan should be thought of as a "road map" to explain how the system is going to do each component and how the system will continue with asset management over the long-term, but should not be thought of as "the answer."

The data that is part of the Asset Management Plan should be updated continually as the system performs its operational duties (e.g., as breaks are repaired information is gathered.) This type of updating should not require the overall plan to be revised. The

Asset Management Plan should be periodically reviewed (annually or biannually or perhaps every 3 years) to determine if the overall methodology used for each component has changed in any way. If so, the document should be revised and redistributed. If not, the document can be left in its current status until the next review.

The Asset Management Plan document does not need to be lengthy. The goal is to make it easy to understand and useable by the employees or volunteer workers for the utility.

1.20.4. Asset Management Plan Review

If Asset Management becomes a requirement of funding or an activity that can provide additional points towards the application or a higher ranking for a particular project, funding agencies may wish to review the asset management plans to determine if it contains all the required elements. A checklist that can be used for this purpose is provided in Annex- F. Annex- F also contains an example of a checklist filled out on a fictitious water system.

Annexes

Annex A: Water Supply Asset Registry

No.	Facilities	Description	Built Year (E.C)	Cost (Birr)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Annex B: Asset Valuation Spread sheet Form-1

No.	Description	Unit	Qty	Year of Acquisition GC	Unit cost	Base year GC	Remaining Life (Yrs)	Current Replacement cost	Total Asset Life	Deprecation Date	Net Book Value	Annual Deprecation

Annex C: Fixed Asset Inventory Sheet Form-2

As of ____________ 20 ______

Location _______________________

____

Type of Item

Page: _______ of _______

Date of Inventory

____

S.No	Code No.	Date of Acquisition	Description	I.D. No. Plat no. Part No.	Location	Quantity		Unit Cost	Quantity Variance		Cost Variance		Remarks
						Physical Count	Fixed Asset Reg. Balance		Short (8 -7)	Excess (7 - 8)	Short (10x9)	(11x9)	
1.	2	3	4	5	6	7	8	9	10	11	12	13	14

Counted by: 1. ________________________. For Physical Count 1: ______________ Calculated by: ____________ Approved By:___________

2. ________________________ (User)

3. ________________________ 2. ________________________ Checked By: ____________________

Name and Signature Name and Signature

Annex D: Stock Inventory Sheet Form-3

As of ___________ 20 ______

No.____________________

Location _____________________

Type of Item ______________

Page: _______ of _______

Date of Inventory _________

S.No	Code No.	Description	Weight, Size or Part no.	Unit	Unit Cost	Bin Card Balance	Quantity		Value		Quantity Variance		Cost Variance		Remarks
							Physical Count	Stock Card Balance	Stock card (6X9)	Physical (6X8)	Short	Excess	Short (10x9)	Excess (11x9)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Counted by: 1. ____________________. For Physical Count 1: ____________ Calculated by: __________ Approved By:__________

Name and Sig.2. ____________________ Storekeeper 2.________________ Checked By: __________________

Annex E: Fixed Asset Registry Card Form-3

Description: ____

Identification No.__________________ Serial No.__________

Plate No.__________ Engine No._________ Chassis No.________

Supplier's Name:____

Date of Purchase: __________________ Accounts Ref: __________

Goods received note No.______________ Date: ________________

Store Issue Voucher No.______________ Date: ________________

Purchase Cost Birr: __________ No. of Unit ____ Unit Cost Birr_________

Location: __________ Depreciation Rate:______________

Depreciation Schedule										Remarks
Year	No. of Unit	Cost		Depreciation for the year		Accumulated Depreciation		Book Value		
		Birr	ct	Birr	ct	Birr	ct	Birr	ct	

Tools, Equipment and Vehicle

S. No.	Description	Part Number	Quantity	Purchase Year	Cost

Annex F: Repair and Replacement Schedule Example

Year	Item	Description	Estimated Cost (Birr)	Method of Estimation	One time or recurring	Time Period of Recurrence

Annex G: Capital Improvement Plan

Year Desired	Project Name	Project Description	Project Need	Date Flexible (Y or N)	Estimate Of Project Cost	Method of Estimation	Potential Funding Source	Changes in Operations	Impact of Project on LOS

Annex H: Long-term Funding Strategy

The objective in preparing long-term financial forecasts is to outline the organization's future financial requirements based on all information relating to asset creation, maintenance, renewal/rehabilitation and disposals.

Three questions must be answered when preparing the strategy:

- What funds are needed to acquire, operate, maintain and renew the asset?
- When will the funds be required?
- How do these types of funds affect the utilities rates?

There are five types of expenditures that a WSS/utility needs to plan for. Each type of expenditure has a typical funding source associated with it as well.

Expenditures and Funding

Expenditure Type	Description	Funding Source
Operational	Activities which have no effect on asset condition but are necessary to keep the asset utilized appropriately (i.e. labor cost, power costs, overhead costs, etc.).	Annual Budget, Rates, Revenue
Maintenance	The ongoing day-to-day work required to keep assets operating at required service levels (i.e. repairs, minor replacements).	Annual Budget, Rates, Revenue
Renewal	Significant work that restores or replaces an existing asset towards its original size, condition or capacity.	Annual Budget, Rates, Revenue, Grants, Loans
One WASH Program, Capital Projects	Works to create a new asset, or to upgrade or improve an existing asset beyond its original capacity or performance, in response to changes in usage, customer expectations, or anticipated future need.	Annual Budget, Rates, Revenue, Grants, Loans
Disposal	Any costs associated with the disposal of a decommissioned asset.	Annual Budget, Rates, Revenue

Annex I: Example of Asset Management Reviews Checklist

Name of the Water Supply System: Robe-Melliyu Rural Piped System

Component of Asset Management	Specific Item	Completed Y or N	Method of Completion	Comments
Asset Inventory	List of Assets	Y	Handwritten	
	Map of Assets	Y	Auto CAD Map With drawn assets	
	Asset Condition Assessment		Ranked from 0 to 5	Many assets ranked as 1, may underestimate condition
	Remaining Useful Life of the Assets	Y	Provided years of life left	
	Asset Value (Optional)	N		
Level of Service	Level of Service Agreement		Agreement provided to customers	
Critical Assets	Criticality Analysis	N		
Life Cycle Costing	Operation and Maintenance Program	Y	Notebook of each piece of equipment and maintenance required	Very thorough program
	Repair Replacement Schedule	N		
	Capital Improvement Plan (CIP)	Y	5 Year CIP	
Long-Term Funding Strategy	5 Year Financial Plan	N		
	Rate Structure	Y	Used Computer program to set rates	Rates cover expenses
	Funding Strategy for Repair and Replacement Schedule	N		
	Funding Strategy for CIP	Y	Table indicating potential funding sources for each CIP element	

Overall Assessment: This is a RPS. Their asset management strategy contains most of the required elements. For the size system, they did a good job gathering information and completing the required items.