Study of Asset Attributes & Classification

Nizam-ud-Din

GIS Manager, The Urban Unit

Outline

- Study of Asset's Attribute Data
- Displaying Asset Data in terms of (Diameter, Condition, Risk, Years of Construction, Pipe Type, Material, etc.)
- Asset Categorizing in Labelling Asset's Attribute
- Demonstration
- Practice

Study of Asset's Attribute Data

Definition-Attribute (Non-Spatial Data)

Attribute Data- the information which is associated with the asset's spatial features is called attribute data of assets. The example of attribute data are; name, diameter, condition, age, material, etc.

Existing_WS

Shape *	Street_Nam	Sub_Divisi	Town	Materia	Age	Cond	Repl_Di	Repl	Ris
Polyline ZM	Zubair Road	Krishan Nagar	Gunj Bakhsh To	AC	1985	C	4"x6"	3	L
Polyline ZM	Zaman Park to Nich	Shimla Hill	Gulberg Town	AC	1990	B	12"	15	H
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	6"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zatoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L

(0 out of 35865 Selected)

GIS Asset Data Used

The following asset GIS data is used for data browsing and study;

- ✓ *The SubDiv_Boundary City of Lahore*
- ✓ *All Valves in the SubDiv_Boundary*
- ✓ *Existing_WS (used in this lecture)*
- ✓ *Existing _TW*
- ✓ *Existing _OHR*

Tasks

- Asset's Attribute data browsing & study in an attribute table.
- Adding field/column to a table.
- Calculation of length of existing water supply lines.
- Identification of water supply of maximum length
- Calculation of statistics.

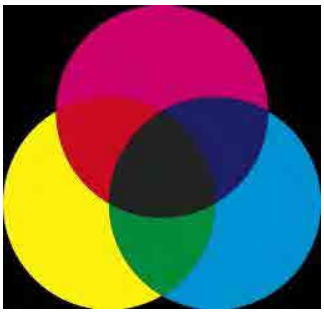
Displaying Asset's Data

Questions to Ask

- Who is your intended audience?
- What is the message or story you are portraying? Determine the purpose
- Is the data available? Data Collection
- What is the scale of final product?
- What is the final product? Map Construction

Cartography

Cartography is the science that deals with the construction, use and principles behind maps.



Symbolizing

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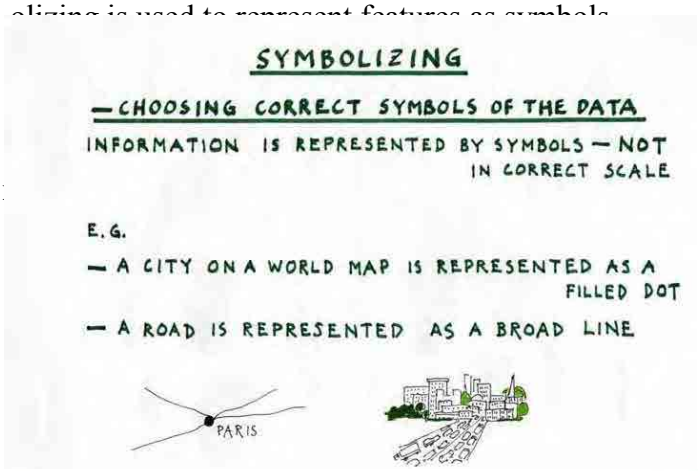
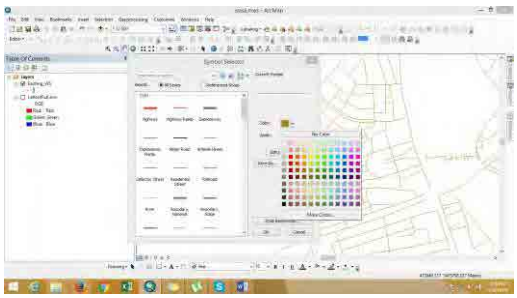
- For



Outline

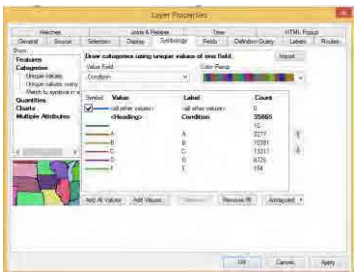
- Symbology Setting of feature class
- Setting of symbol color
- Setting of size
- Demonstration
- Practice



Asset's Categorizing in Labelling Assets Attribute

Outline

- Symbology Setting by using categories
- Asset's attribute labelling
- Demonstration
- Practice



Demonstration

Practice

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Course Title: Asset Management-M 4131
Lecture-03
Module 6: Use of GIS Application in Asset Management

Editing and Updating Asset Network Data According to as Build Drawings & Preparation of Block Map

Nizam-ud-Din

GIS Manager, The Urban Unit

Outline

- Editing the Assets Data
- Making Shapefiles
- Digitization
- Preparation of Layouts/Block Maps
- Demonstration
- Practice
- Assignment – Preparation of Block Map

Editing Assets Data

GIS Asset Data Used

The following asset GIS data is used for data browsing and study;

- ✓ *The SubDiv_Boundary City of Lahore*
- ✓ *All Valves in the SubDiv_Boundary*
- ✓ *Existing_WS (used in this lecture)*
- ✓ *Existing _TW*
- ✓ *Existing _OHR*

Tasks

- Editing Attribute Information
- Creation of New Pipelines
- Adding of Attribute Information against created New Pipelines

Making Shapefile

Tasks

- Concept of Shapefile
- Preparation of Shapefile in ArcCatalog
- Setting/Importing of Projection to New created Shapefile

Concept of Shapefile

- Shapefiles are the simplest, non-topological format and most commonly used format to store the geometric location and attribute information of geographic features.
- It is a one of the spatial data formats that we work with and edit in ArcGIS.

Necessary files for Shapefiles

- .shp - The main file that stores the feature geometry. Required
- .shx - The index file that stores the index of the feature geometry. Required
- .dbf - The dBASE table that stores the attribute information of features. Required
- .sbn and .sbx - The files that store the spatial index of the features.
- .prj - The file that stores the coordinate system information. Used by ArcGIS.
- .cpg - An optional file that can be used to specify the codepage for identifying the characterset to be

Digitization

Outline

- Concept of Digitization
- Adding/Importing of created Shapefile in ArcMap
- Creation of New Spatial Feature by using Created Shapefile.
- Adding of Attribute information

Digitization

- Digitizing is the process where features on a map or image are converted into digital format in GIS.
- Points, lines & polygons are converted into digital form.

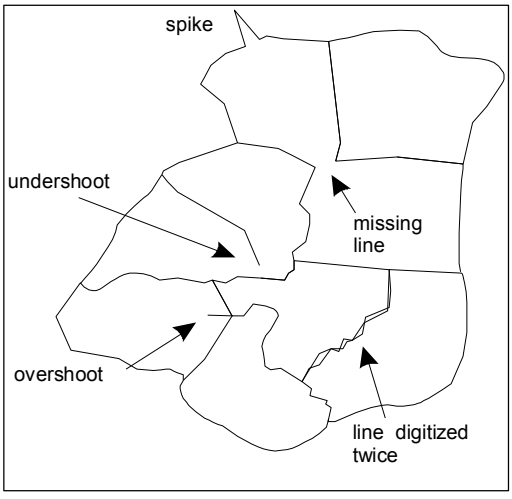
Remember!

Garbage In ⟷ **Garbage Out**

Process – Feature Digitizing

- Start Editing
- On Snapping tool
- Use Zoom for tracing
- Verify Progress and save option
- Add Attribute during digitization or during post-digitizing editing
- Check for Error free
- Finalize the data

Common Line Errors



Preparation of Layouts/Block Maps

Outline

- Concept of Block Mapping
- Preparation of Block/Grid Boundary
- Setting of Page and Print Setup
- Setting of Map Template
- Setting the Map Symbology
- Inserting of Map essentials elements
- Selection of Suitable data for block mapping
- Export map with suitable format

Grid Map

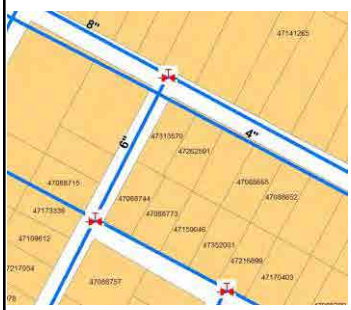
Sabzazar Sub-Division

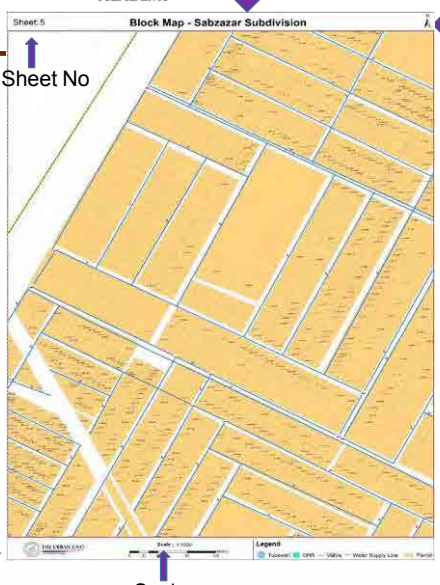
- Indexing is required to divide larger area into smaller zones to make efficient survey process.
- Field handling problem
- Survey management

Block Map

1:1000

Paper size: A1





Title

Sheet No

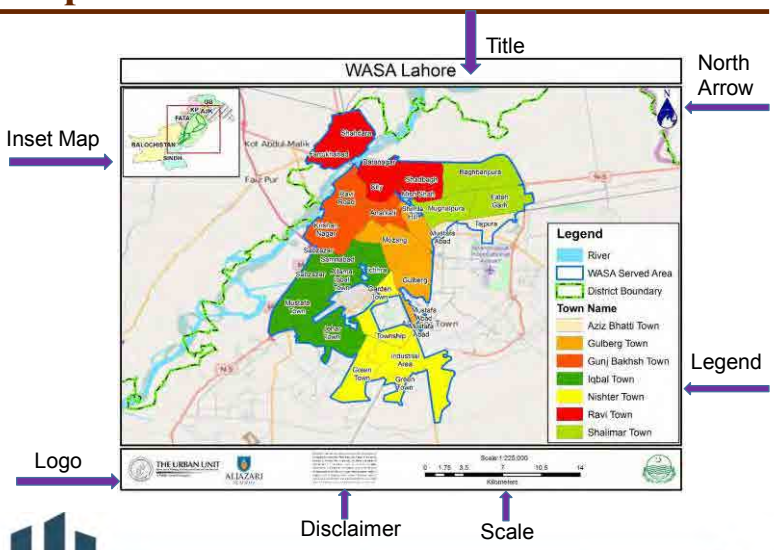
North Arrow

Logo

Legend

Scale

Map Elements



Demonstration

Practice

Assignment

Preparation of Block Map

Assignment

Course participants will prepare a block map of water supply in Sabzazar Sub-Division, choosing paper size A1 with scale 1:1000.

Pipe Replacement Planning

Nizam-ud-Din

GIS Manager, The Urban Unit

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Outline

- Applying Query Functions
- Query the pipelines of your interest
- Calculating Length
- Demonstration
- Practice
- Assignment – Query and Length Calculation

GIS Asset Data Used

The following asset GIS data is used for data browsing and study;

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- ✓ *Existing _OHR*

Applying Query Functions

Query

- Query is the filtering of information from the existing features class in ArcGIS.
- Query is applied to know the answers of questions in GIS.
- Query is applied on the assets attributes information associated with spatial features.

What does query do?

- Performs a basic arithmetic operation on selected data.
- Selects a subset of data that matches specified criteria.
- Finds an answer in a help document.
- Formalizes a question for spatial analysis.
- Places a request in a que.

Query the Pipeline of Your Interest

Tasks

- Concept of Query
- Applying query by using selection tab in ArcMap
- Example -1: Selection of pipelines with diameter 6
- Example -2: Selection of pipelines with diameter 6 with condition C
- Discussion

Calculation of Length

Tasks

- Asset's Attribute data browsing & study in an attribute table
- Adding field/column to a table
- Calculation of length of existing water supply lines
- Calculation of statistics

Demonstration

Practice

Query and Length Calculation

Assignment

Course Participants will query the lines of water supply in Gulberg sub-division which should be replaced in year 1, and also calculate length in meters.

Preparation of Water and Sewerage Network maps with Scale 1:500 & 1:1000

Nizam-ud-Din

GIS Manager, The Urban Unit

ALJAZARI

Outline

- Question to Ask
- Preparation of Water Network Map
- Preparation of Sewerage Network Map
- Demonstration
- Practice

Questions to Ask

- Who is your intended audience?
- What is the message or story you are portraying? Determine the purpose
- Is the data available? Data Collection
- What is the scale of final product?
- What is the final product? Map Construction

GIS Asset Data Used

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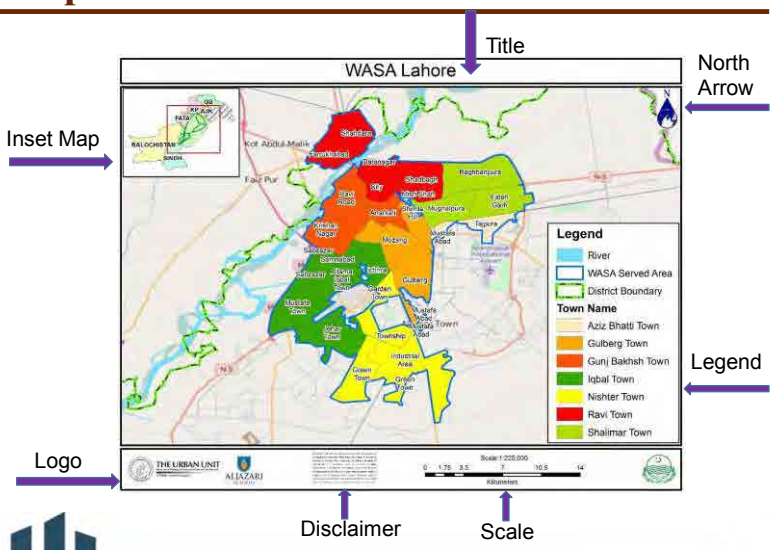
- ✓ *Existing _OHR*

Tasks

- Layout Setting
- Adding Map Essentials
- Selection of Data
- Scale Setting
- Setting of Map Sybmology
- Exporting Map
- Printing

Map Essentials



Preparation of Water Network Map

Demonstration

Preparation of Sewerage Network Map

Demonstration

Practice

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Course Title: Asset Management-M 4131
Lecture-06
Module 6: Use of GIS Application in Asset Management

Field Verification Survey

Nizam-ud-Din

GIS Manager, The Urban Unit

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Outline

- Introduction to Global Positioning System (GPS)
- Use of GPS Device (Training)
- Asset Data Collection with GPS
- Synchronization of GPS data with ArcGIS
- Map Making
- Demonstration
- Practice

Introduction to GPS

GPS - Definition

A system of geostationary satellites, ground receivers, and associated software that provides an electronically instrumented means of determining position on the earth.

GPS

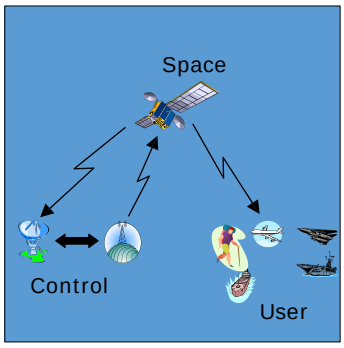
- GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use.
- GPS works in any weather conditions, anywhere in the world, 24 hours a day.
- There are no subscription fees or setup charges to use GPS.

GPS in Asset Management

- GPS is a device which is used as data source in GIS.
- It is used for data collection of WASA assets from the field to ascertain the positional accuracy of the ground features.
- It is also used for the verification of the assets data.

GPS Components

- **Space Segment**
  24 operational NAVSTAR satellites that orbit the earth every 12 hours at an altitude of approximately 20,200 km.
- **Control Segment**
  One Master Control Station and 5 Monitoring Stations
- **User Segment**
  Civilian
  Military



What GPS Measures?

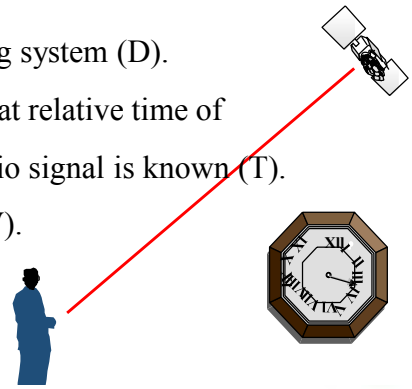
- Latitude
- Longitude
- Altitude
- Time

GPS Principle – How to compute position?

The distance can be computed as:

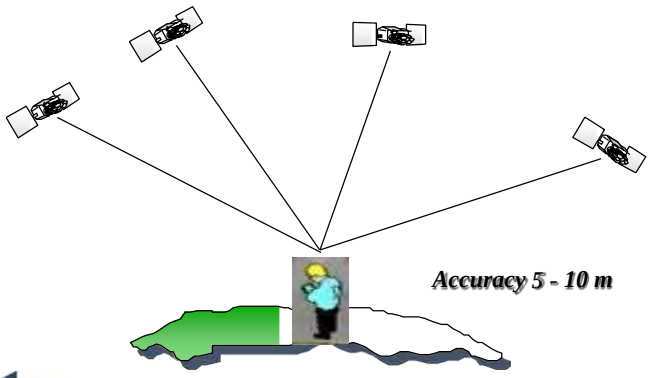
$$D = V \times T$$

- GPS is a distance (range) measuring system (D).
- Clock offset can be computed so that relative time of transmission and reception of a radio signal is known (T).
- Velocity of radio wave is known (V).



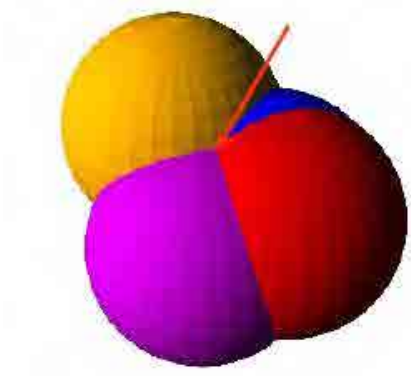
GPS Principle – How to compute position?

At least 4 satellites to compute one position solution due to 4 parameters: X, Y, Z and Time offset



Satellite Location

GPS measures the satellite location by intersection of 4 spheres (1 point).



Limitations of Standard GPS

- The GPS signal may bounce off nearby objects causing problem called multi-path interference.
- Can not perform complex processing on signals.
- Positional accuracy varies from 5-10 m

GPS data into GIS Environment

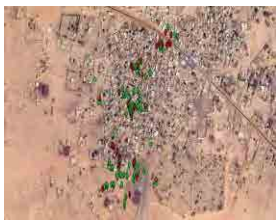
Survey

GPS software

Coordinates

Longitude	Latitude
22.462727	-8.4268467
22.46279	-8.4304833
22.46279	-8.4304833

Data in GIS environment



GPS Applications

- Asset Management
- Ship Navigation
- Police
- Emergency Services
- Special Child
- Animal Movement
- Mapping
- Tracking Software
- Disaster
- Much more

Thought of the Day

GIS, GPS and Remote Sensing bring sense to censuses!

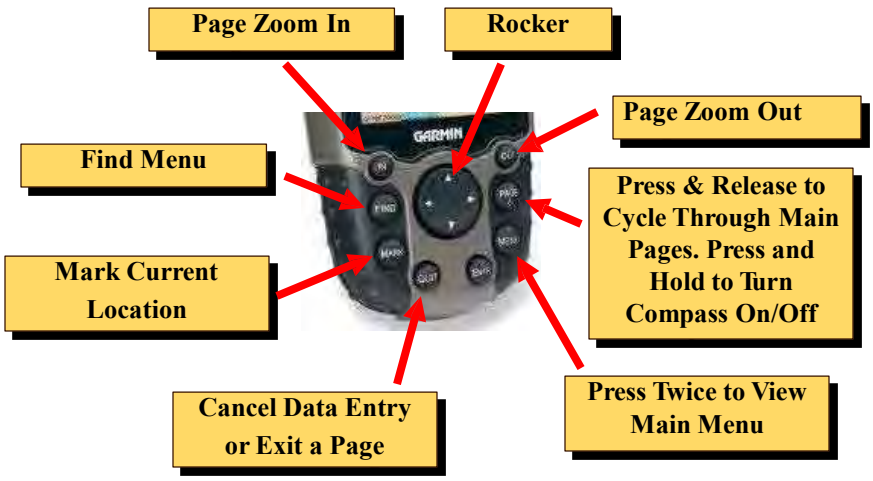
Use of GPS Device

GPS Device

Garmin GPS 60 is used for the field verification survey

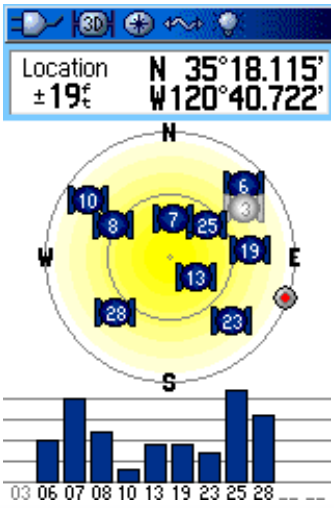
Installation of GPS

Keys Overview



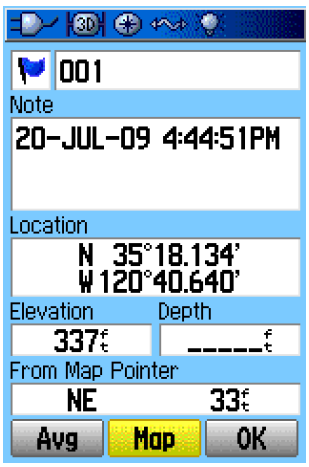
Accessing of Menu Window

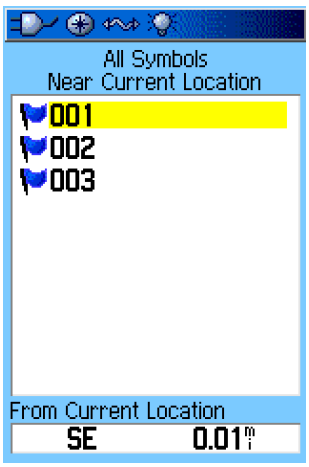
Satellite Signals Strength



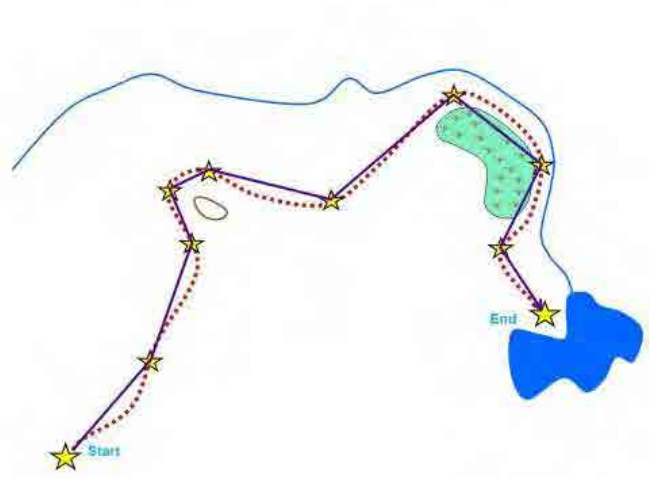
Marking Waypoints

Saving Way Points





GPS Survey Points

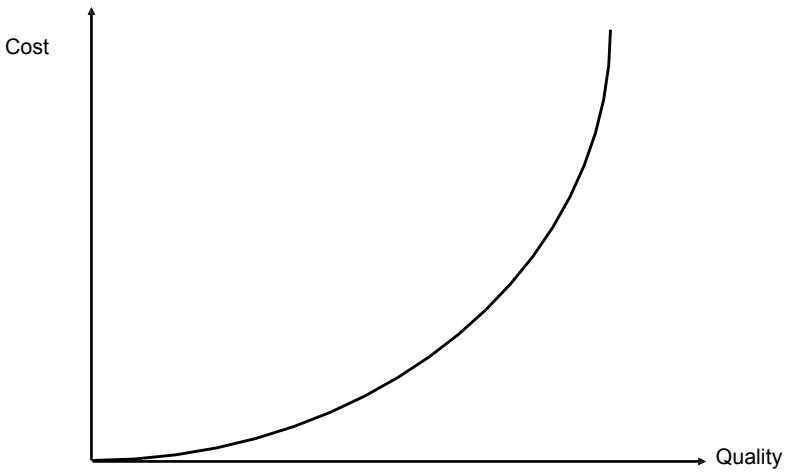


Keep Record on Notebook or Survey Form

GPS Point No.	Longitude (X)	Latitude (y)	Height	Name	Location	Remarks
1	842481.849	3210719.887	184.493	TW	Green Town	
2	842498.439	3210783.267	185.229	TW	Green Town	
4	842521.743	3210771.998	183.222	Sewerage	Ali Road	Start Point
5	842525.175	3210780.722	183.111	Sewerage	Ali Road	End Point
6	842505.661	3210773.781	184.39	Main Hole	Ali Road	1
7	842510.808	3210781.604	184.356	Main Hole	Ali Road	2
8	842486.379	3210776.207	185.309	Main Hole	Ali Road	3
9	842487.924	3210785.244	185.323	Main Hole	Ali Road	4
10	842499.839	3210756.193	186.935	Main Hole	Ali Road	5
11	842497.972	3210756.457	186.936	Main Hole	Ali Road	6
12	842494.307	3210741.019	186.886	Main Hole	Ali Road	7
13	842495.894	3210739.968	186.888	Main Hole	Ali Road	8
14	842488.719	3210717.607	186.833	Main Hole	Ali Road	9
15	842490.499	3210716.952	186.854	Main Hole	Ali Road	10

Asset Data Collection with GPS

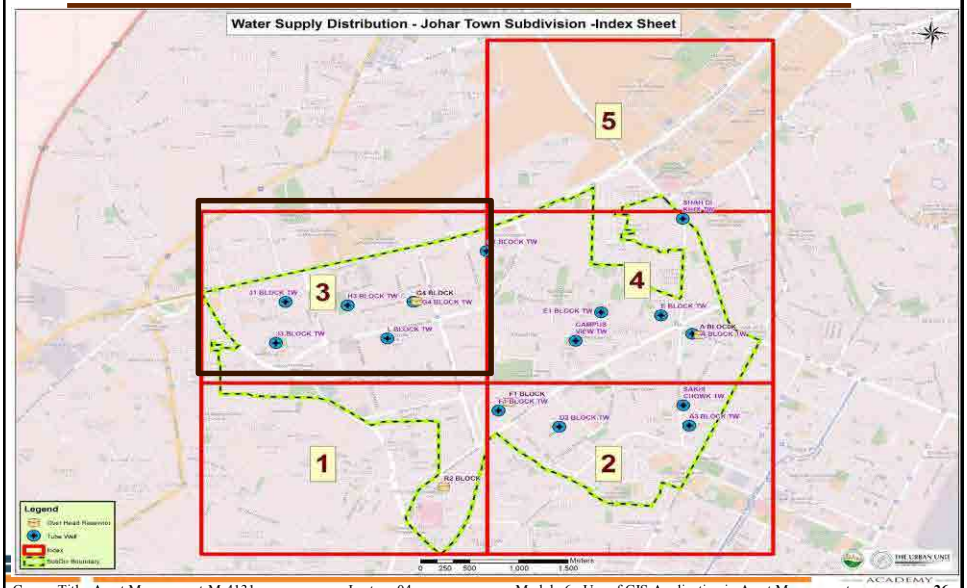
Data Quality



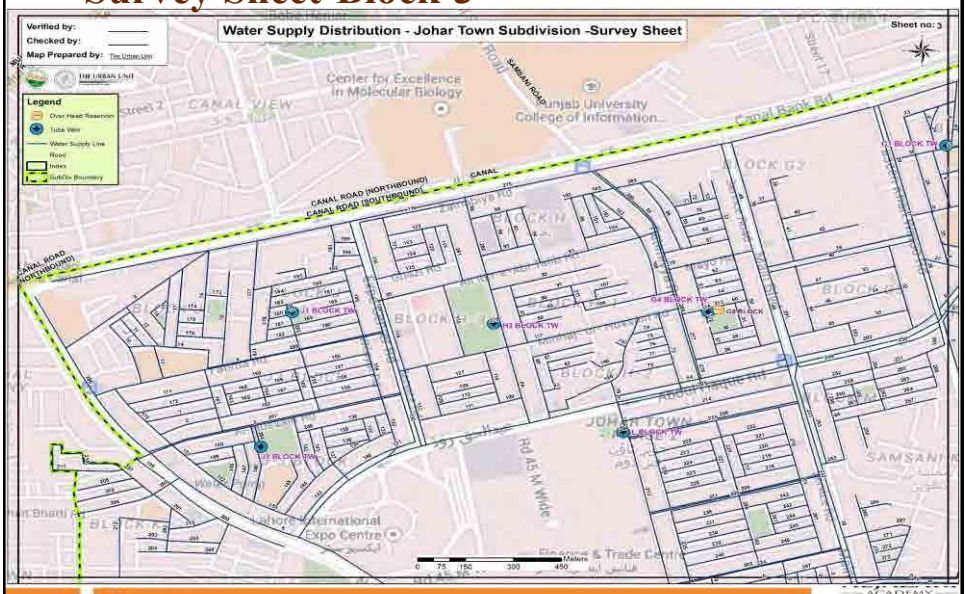
Tasks

- Collection of GPS points Sewerage Mainholes
- Collection of GPS points of Tube well
- Collection of Water supply new line
- Confirmation of exiting line attributes
- Take Photographs of each survey points if necessary

Survey Sheet-Index Map



Survey Sheet-Block-3



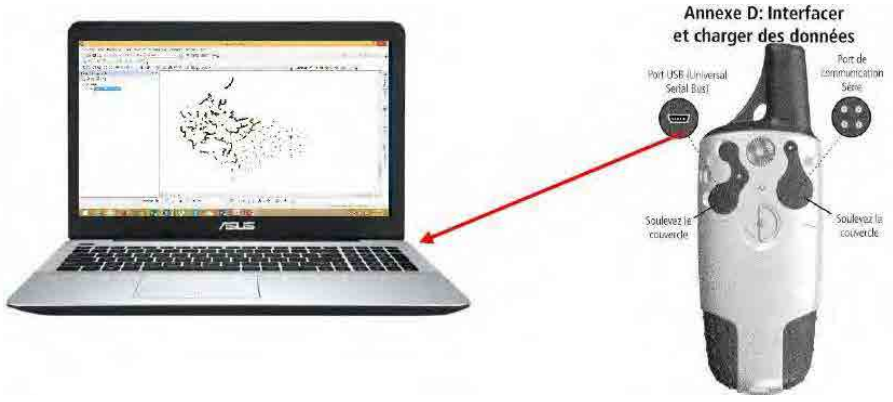
Survey Sheet-Block-3 (Attributes)

Iqbal Town-Johar Town Sub Division-Water Supply Network-Sheet No. 3										
Sr_No	Material	Age	Condition	Replace Dia	Level	Risk	Length (m)	Diameter	Replace Year	Unique_Id
1	AC	1992	C	4"	T	L	222.83	4"	15	1
2	AC	1992	C	4"	T	L	193.17	4"	15	2
3	AC	1992	C	12"	S	M	937.05	12"	15	3
4	AC	1992	C	10"	S	M	928.63	8"	15	4
5	AC	1992	C	10"	S	M	1384.62	8"	15	5
6	AC	1992	C	4"	T	L	214.54	4"	15	6
7	AC	1992	C	4"	T	L	125.04	4"	15	7
8	AC	1992	C	4"	T	L	92.71	4"	15	8
9	AC	1992	C	4"	T	L	573.48	4"	15	9
10	AC	1992	C	4"	T	L	319.14	4"	15	10
11	AC	1992	C	4"	T	L	124.47	4"	15	11
12	AC	1992	C	4"	T	L	175.41	4"	15	12
13	AC	1992	C	4"	T	L	122.92	4"	15	13
14	AC	1992	C	4"	T	L	320.92	4"	15	14
15	AC	1992	C	4"	T	L	255.88	4"	15	15
16	AC	1992	C	4"	T	L	149.68	4"	15	16
17	AC	1992	C	4"	T	L	290.85	4"	15	17
18	AC	1992	C	4"	T	L	346.26	4"	15	18
19	AC	1992	C	4"	T	L	388.38	4"	15	19
20	AC	1992	C	10"	S	M	591.99	8"	15	20
21	AC	1992	C	12"	P	H	3319.41	12"	15	21
22	AC	2006	B	10"	P	H	634.01	10"	15	22
23	AC	1992	C	4"	T	L	312.53	4"	15	23
24	AC	1992	C	4"	T	L	149.04	4"	15	24

Synchronization of GPS Data

Tasks

- GPS data is converted into shapefile in ArcMap
- Existing Asset sewerage data is corrected with respect to surveyed data.


Annexe D: Interfacer
et charger des données
Port USB (Universal Serial Bus)
Port de communication Série
Soulevez le couvercle
Soulevez le couvercle

Map Making

Demonstration

Practice

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Asset Management

Course Code: M4131

Introduction of Asset Management
Module 1

Lecture Notes

2016

Introduction to the Asset Management Course:

This course introduces key concepts related to asset management specifically for water utilities. The examples are generic enough that they can be applied to other manufacturing environments, but the governance concerns are obviously linked to public service asset management. As such, the course focuses on identifying and measuring assets, asset attributes, condition based assessments, risk profiles, asset life cycles, monitoring programs (i.e. reliability and preventative maintenance based), accounting practices, asset valuation and preparing asset replacement plans. This course is especially beneficial for officers of grade 17 and 18 who are directly or indirectly involved in planning and the routine management of assets.

In order to effectively supervise asset maintenance practices to frontline staff, while communicating and reporting asset management to senior management, course participants will be versed in a few key areas of asset knowledge. Course Participants (CPs) will develop knowledge and skills about asset identification, inventory creation, maintenance documentation life cycle assessment and asset condition based measurement. They will be taught to develop, maintain and report out on an asset data base for asset replacement planning. This course will also help the CPs in understanding application of the concepts related to Asset Replacement Plans, Asset Operational Plans (Standard Operating Procedures) and Condition Based Monitoring. The CPs will also be introduced through OJT, to the Asset Management Information System, GIS and other tools.

Why do Asset Management?

Early developments in Computerized Maintenance Management Systems (CMMS) led to the adoption of work management systems for service request generation, work order completion and activity based management and costing. Advances in automation have arguably led to reductions in risk and cost overruns as pertaining to labour allocations and resource management. In other words, the more automation, the less people requiring management. Let us leave contract management of third parties out of the picture for a moment, as their productivity is mixed across utilities. Nevertheless, attention related to CMMS has increasingly turned to asset management. We in the utility sector are faced with costs (energy, consumables and maintenance/replacement services) which are directly linked to assets. Upon the completion of this course the CPs will be in a better position to apply their learning in their routine jobs and prepare an Integrated Development & Asset Management Plan (IDAMP) to provide better water supply and sewerage services to their consumers.

Introduction of Asset Management Module 1:

This module contains four lectures and twelve hours of totaling to three (3) days of class room teaching. Major topics in this module are;

I. Assets and Asset Attributes
II. Condition Based Assessment of different asset types and asset classes
III. Risk assessment of different assets
IV. Application of asset attributes
V. Asset lifecycle
VI. and Asset Management Plan

Lecture 1

1. Lecture Information

Topics: 1) Assets 2) Asset Attributes
Lecture Duration: 4 Hours

2. Introduction of Topic

2.1 Brainstorming

Knowledge testing: What is an Asset?

Current knowledge of course participants related broadly to “Asset and Asset Management” will be assessed through a brainstorming period. The following question will be posed to the class: 'What is an asset?' Probing questions may be asked which speak to 'What can asset information used for?', 'How do we know when to replace equipment/assets?' The expected responses are presented below:

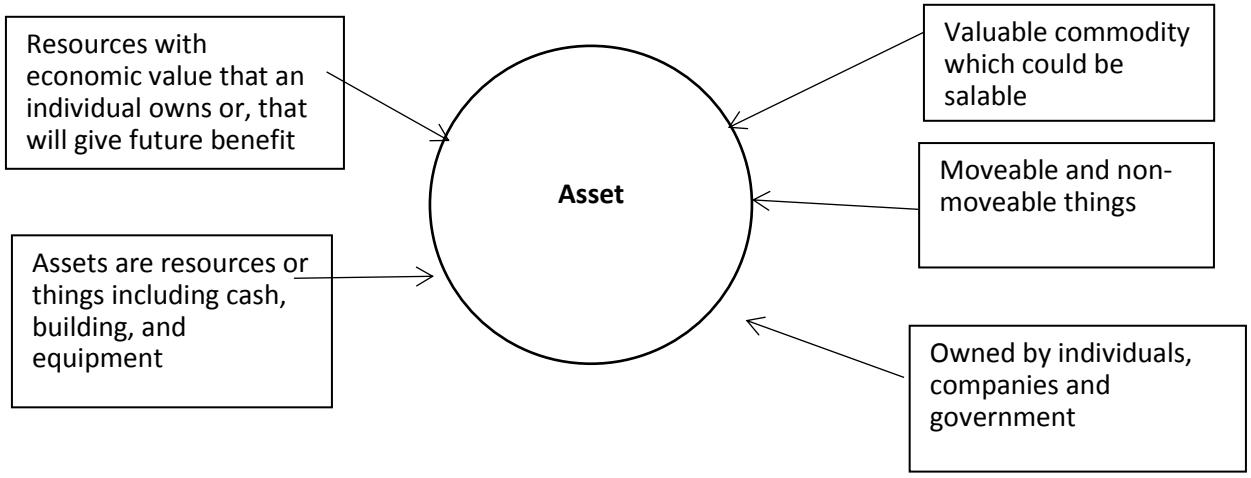


Figure 1: Expected responses to the question “what is an asset?”

2.2. Definition of Asset (10 Minutes)

An asset is anything with value. Assets can be categorized into physical assets, financial assets, human resource asset etc. Rest of the reading will focus on physical assets. There are two types of physical assets which is Current Asset and Fixed Asset.

The authentic definition of an asset is as:

"Anything of value such as an area of land, or a building, or an item of plant or equipment or infrastructure that provides service potential or future economic benefits over a period longer than one year and has a cost which is not "immaterial" (typically defined as more than, say, Rs. 100,000). Assets are typically classified as either "financial" (cash, stocks, debt instruments), "intangible" (intellectual property, goodwill) or "physical". Unless otherwise specified, the term "asset" as used in is assumed to be a physical asset or more specifically fixed assets."

Asset(s) are the physical resources of a business, such as plants, facilities, fleets or their parts and components (Campbell and Reyes-Picknell, 2006)

Asset List is a register of items usually with information on manufacturer, vendor, specifications, classification, costs, warranty and tax status (Campbell and Reyes-Picknell, 2006)

Asset Management is the systematic planning and control of a physical resource throughout its economic life (Campbell and Reyes-Picknell, 2006)

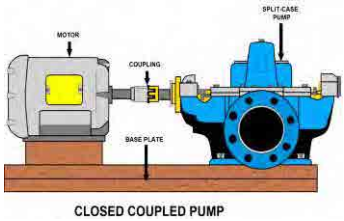
The introductory activity must end by summarizing course participants' responses, appreciating and encouraging them and clarifying their misconceptions if any. If the lecturer is organized, they should tabulate the definitions on the board (or on white paper) by utility (what assets are used for) and by discipline (an engineering definition, operator definition, management definition, financial definition). This can then be used later to show the CPs what their original thoughts on an asset were and how they have changed after taking the course.

Exercise # 1: (20 minutes)

Please list and present a number of critical aboveground and belowground assets of WASAs. Divide them into the following services;

1. Water supply services
2. Sewerage (wastewater) services
3. Drainage (storm water) services

Examples and Pictures of 'Assets in WASAs'



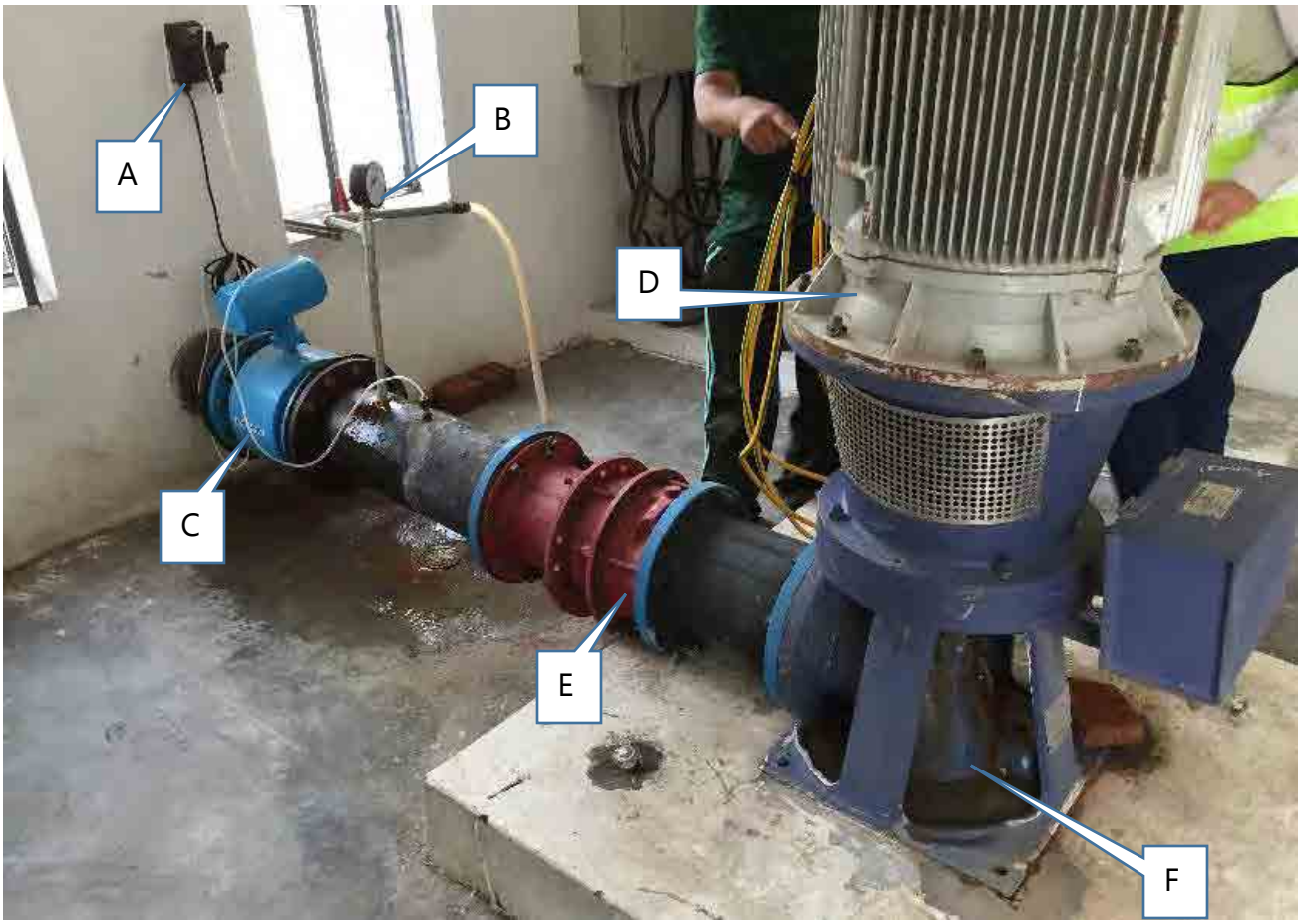
CLOSED COUPLED PUMP

The list of assets includes;

1) Water Supply pipelines
2) Sewerage Pipelines
3) Tube wells
4) Disposal Stations
5) Vehicles
6) Transformers
7) Electrical & Mechanical Works
8) Buildings

Exercise # 2: **(20 minutes)**

Exercise 2-1. Please select the equipment name described below to fill in the blanks from A to F.



Pump, Motor, Flow meter, Non return valve, Pressure gauge, Chlorine dosing pump

Also indicate how you label the asset as part of your standard operating procedures, maintenance manuals, daily logs, inspections and reports to senior management

Answers may include: Process area, by equipment type, by numerical tag, by year of commissioning, etc. Lecturer should ask the CP if the label and asset tagging standard is consistent across the organization.

As a reference, Toronto Water uses the following asset tagging method:

A. Coding System:

- The code consists of up to eighteen (18) characters and each section may be of an alpha-numeric combination.
- Dashes are included, as shown in the examples below, for GE RPUs' and are replaced by underscore "_".
- The basic code shall be:

AAA-	CCC-	AAAA-	NNNN	A
(1)	**(2)**	**(3)**	**(4)**	**(5)**

Where: A Denotes Alphabetic character (letter)

N Denotes Numeric character (number)

C Denotes generic Character (either alphabetic or numeric)

The different groups of characters are split into various fragments which have specific functions meanings. These fragments or groups of characters are denoted by the numbers 1 to 5 and have the following functions:

Fragment 1 is a three-digit character representing the facility or location (site). (See section 3.01)

Fragment 2 is a two or three character code representing a process/sub-process performed within the facility or site. Water mains, reservoirs and pumping stations are classified as processes in the tag name. (See section 3.02)

Fragment 3 is a one to four-character code representing the type of equipment (section 3.03), instrument (section 3.04) or signal (section 4.07) codes.

Fragment 4 is a four-character alpha / numeric code (alpha is only to be used for electrical equipment to represent existing numbering conversions that are difficult to change due to both health and safety and operational reasons) that identifies the equipment number **(this may contain loop number intelligence for process equipment that is associated to other equipment – see section 3.05).** Where loop numbers are not used (for standalone equipment), leading zeroes are used to fill the code for numbers with less than four characters. For water mains, the Equipment number is the chamber number.

Fragment 5 is a one character alpha code to differentiate between otherwise duplicate equipment items (see the example in section B below. FCL-FLT-LIT-0012A

Fragment 5 is an extension of fragment 4 used only when needed for duplicate equipment)

B. Example Equipment and Loop Coding

The following is an example of an equipment and loop names.

THR-PRM-V-0551

(1)	(2)	(3)	(4)	(5)
THR-	**PRM-**	**V-**	**0551**	
Humber Treatment Plant	Primary Treatment Process	Valve	No. 551	No Duplicate

FHA-TRW-P-0100 (including associated equipment in the loop)

(1)	(2)	(3)	(4)	(5)
FHA-	**TRW-**	**P-**	**0100**	
Harris Filtration Plant	Treated Water Process	Pump	No. 1	No Duplicate
FHA-	**TRW-**	**V-**	**0101**	
Harris Filtration Plant	Treated Water Process	Valve (Suction)	1st Valve in loop	No Duplicate
FHA-	**TRW-**	**V-**	**0102**	
Harris Filtration Plant	Treated Water Process	Valve (Check)	2nd Valve in loop	No Duplicate
FHA-	**TRW-**	**SWG-**	**0101**	

Harris Filtration Plant	Treated Water Process	**Switch Gear**	**Switch Gear** for Pump No. 1	No Duplicate

TAB-STR-PAL-2332

(1)	**(2)**	**(3)**	**(4)**	**(5)**
TAB-	**STR-**	**PSL-**	**2332**	
Ashbridges Bay Treatment Plant	Secondary Treatment	Pressure Switch Low	No. 2332	No Duplicate

FCL-FLT-LIT-0012A

(1)	**(2)**	**(3)**	**(4)**	**(5)**
FCL-	**FLT-**	**LIT-**	**0012**	**A**
Clark Filtration Plant	Filtration Process	Level Indicating Transmitter	No. 12	First Duplicate

WTR-PEG-FIT-0324

(1)	**(2)**	**(3)**	**(4)**	**(5)**
WTR-	**PEG-**	**FIT-**	**0324**	
Water Transmission	Eglinton Pumping Station	Flow Indicating Transmitter	Loop 3 FIT 24	No Duplicate

WTR-103-FIT-0012

(1)	**(2)**	**(3)**	**(4)**	**(5)**
WTR-	**103-**	**FIT-**	**0012**	

Water Transmission	Water Main 103	Flow Indicating Transmitter	Chamber 12	No Duplicate

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

Exercise 2-2: Please write each function as well as the relationship to the assets upstream and downstream of this particular process area (in other words, if this asset does not work well, how does it impact the rest of the system? This will get CPs thinking about a larger system perspective.

A (function: _____)

B (function: _____)

C (function:_____)

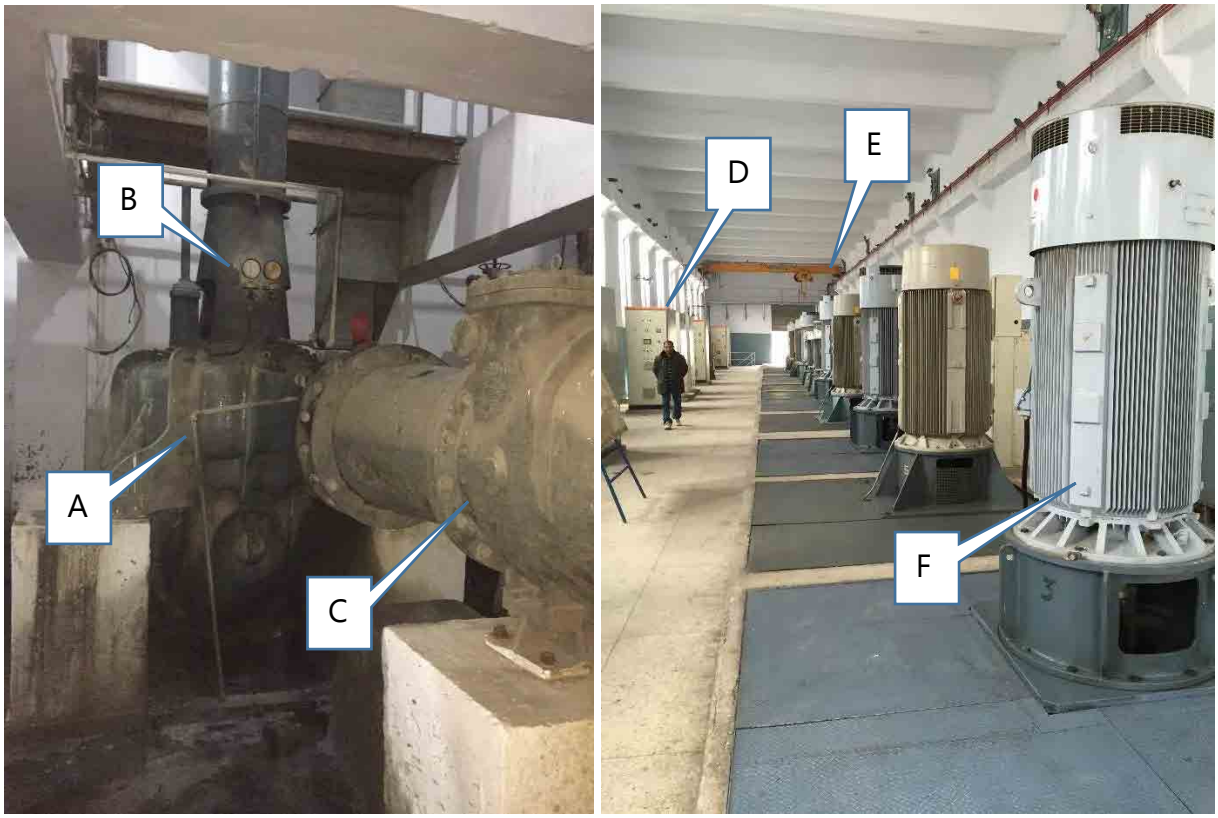
D (function:_____)

E (function:_____)

F (function:_____)

Exercise # 3: (20 minutes)

Exercise 3-1: Please select the equipment name described below to fill in the blanks from A to F.



Control panel, Motor, Non return valve, Pump, Crane, Pressure gauge

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

Exercise 3-2: Please write each function.

A (function: _____)

B (function: _____)

C (function: _____)

D (function: _____)

E (function: _____)

F (function: _____)

Exercise 3-3: Please select the equipment name described below to fill in the blanks from A to D.

A:_____ B:_____ C:_____ D:

Water level censer, Penstock valve, Exhaust duct, Screen facility

Exercise 3-4: Please write each function.

A (function: _____)

B (function: _____)

C (function: _____)

D (function: _____)

2.3. Asset Attributes: (40 Minutes)

Asset attributes

Every asset has a certain set of attributes like historical cost, book value, condition, risk, capacity, residual life, efficiency etc. Other attributes include:

- Physical attributes including size, material, installation date, manufacturer, model, date deployed, spare parts and numbers, etc.
- Asset condition, performance and probability of failure data.
- Procedures to secure AM related data security and archive records required for legal or knowledge preservation purposes

Scale to determine conditions of different assets - handouts

The condition scales of different assets are as under:

Water & Wastewater Networks Condition Rating			
Rank	**Rating**	**Condition**	**Description**
A	Excellent	Very Good Condition	Only normal maintenance required. No failures. Complies with engineering standards.
B	Good	Minor Defects Only	Minor maintenance required (5%). Few failures. Few areas not complying with engineering standards.
C	Fair	Maintenance Required to Return to	Significant maintenance required (10-20%). Failures beginning to occur.

		Accepted Level of Service	Significant areas not complying with engineering standards.
D	Poor	Requires Renewal	Significant renewal / upgrade required (20-40%). Regular failures occurring and significant corrosion. Increased operating costs as a result. Many parts must be replaced.
E	Critical	Asset Unserviceable	Over 50% of asset requires replacement. Significant failures and should be substantially reconstructed.

Water Supply and Wastewater Condition Grading Standards: Civil Structures		
Grade	**Condition**	**Description**
0	Non-existent	Asset abandoned or no longer exists.
1	Excellent	Sound physical condition: Asset likely to perform adequately without major work for 25 years or more.
2	Good	Acceptable physical condition: Minimal short-term failure risk but potential for deterioration in long-term (10 years plus). Only minor work required (if any).
3	Fair	Significant deterioration evident: Failure unlikely within next 2 years but further deterioration likely and major replacement likely within next 10 years. Minor components or isolated sections of the asset need replacement or repair now but asset still functions safely at adequate level of service. Work required but asset is still serviceable.
4	Poor	Failure likely in short-term. Likely need to replace most or all of asset within 2 years. No immediate risk to health or safety but works required within 2 years to ensure asset remains safe. Substantial work is required in short-term, asset barely serviceable.
5	Critical	Failed or failure imminent. Immediate need to replace most or all of asset. Health and safety hazards exist which present a possible risk to public safety or asset cannot be serviced / operated without risk to personnel. Major work or replacement required urgently.

Condition Grading System for Building Assets					
	CONDITION GRADE				
	1	2	3	4	5
Element	Excellent	Good Condition	Moderate Condition	Poor Condition	Critical
Estimated Proportion of Life Consumed	Up to 45%	Between 45% to 90%			90% to 100%
Structure	Sound structure.	Functionally sound structure.	Adequate structure, some evidence of foundation movement, minor cracking	Structure functioning but with problems due to foundation movement. Some significant cracking.	Structure has serious problems and concern is held for the integrity of the structure.
External	Fabric constructed with sound materials, true to line and level. No evidence of deterioration or discolouration.	Showing minor wear and tear and minor deterioration of surfaces.	Appearance affected by minor cracking, staining, or minor leakage. Indications of breaches of weatherproofing. Minor damage to coatings.	Fabric damaged, weakened or displaced. Appearance affected by cracking, staining, overflows, or breakages. Breaches of weatherproofing evident. Coatings in need of heavy maintenance or renewal.	Fabric is badly damaged or weakened. Appearance affected by cracking, staining, overflows, leakage, or damage. Breaches of waterproofing. Coatings badly damaged or non-existent.
Internal			Appearance affected by minor cracking, staining, or minor leakage, some dampness or mildew. Minor	Fabric damaged, weakened or displaced. Appearance affected by cracking, staining,	Fabric is badly damaged or weakened. Appearance affected by cracking, staining,

			damage to wall / ceiling finishes.	dampness, leakage, or breakages. Breaches of waterproofing evident. Finishes of poor quality and in need of replacement.	leakage, or wilful damage. Breaches of waterproofing . Finishes badly damaged, marked and in need of replacement.

Water Supply and Wastewater Condition Grading Standards: Mechanical and Electrical Assets		
Grade	**Condition**	**Description**
0	Non-existent	Asset abandoned or no longer exists.
1	Excellent	Plant in sound physical condition designed to meet the current standards. Operable and well-maintained. Asset likely to perform adequately within routine maintenance for 10 years or more. **No work**.
2	Good	Acceptable physical condition but not designed to current standards, or showing minor wear. Deterioration has minimal impact on asset performance. Minimal short-term failure risk but potential for deterioration or reduced performance in medium term (5-10 years). **Only minor work required (if any).**
3	Fair	Functionally sound plant and components, but showing some wear with minor failures and some diminished efficiency. Minor components or isolated sections of the asset need replacement or repair but asset still functions safely at adequate level of service. For example, bearing and gland wear becoming evident and some corrosion present. Deterioration beginning to be reflected in performance and higher attendance for maintenance. Failure unlikely within 2 years but further deterioration likely and major replacement required within next 5 years. **Work required but asset still serviceable**.
4	Poor	Plant and components function but require a high level of maintenance to remain operational. Likely to cause a marked deterioration in performance in short-term. Likely need to replace most or all of assets within 2 years. No immediate risk to health or safety but work required within 2 years to ensure asset remains safe. **Substantial work required in short-term, asset barely serviceable**.
5	Critical	Failed or failure imminent. Plant and component effective life exceeded and excessive maintenance costs incurred. A high risk of breakdown with a serious impact on performance. No life expectancy. Health and safety

		hazards exist which present a possible risk to public safety, or the asset cannot be serviced / operated without risk to personnel. **Major work or replacement required urgently.**

Case Study Calgary Rating Scale by Condition Category

CONDITION CATEGORY DESCRIPTION RATING SCALE

Physical refers to the physical deterioration of the asset.

- Very good – Sound or "as new" condition
- Good – Acceptable physical condition. Asset shows only minor deterioration.
- Fair – Tolerable physical condition. Moderate deterioration evident.
- Poor – Major deterioration evident.
- Critical – Asset deteriorated to such an extent that it is generally inoperable or unsafe.

Demand refers to the asset's capacity to deal with long-term demand or usage.

- Excellent – The asset has capacity to comfortably deal with long-term demand, loading or usage requirements.
- Good – The asset has capacity to comfortably deal with medium-term demand, loading or usage requirements, but may have minor long-term shortcomings.
- Moderate – The asset's design and function are generally aligned with its current purpose although there may be some minor shortcomings.
- Borderline – The asset is operating near the limits of its design parameters and only has capacity to deal with short-term demands, loading or usage requirements.
- Fail – The asset is already operating at the limits of/or in excess of its design parameters and/or is incapable of meeting any short-term demands, loading or usage requirements.

Functional the level of alignment with the asset's current purpose.

- Excellent - The asset's design and function are fully aligned with its current purpose.
- Good – The asset's design and function are well aligned with its current purpose.
- Moderate – The asset's design and function are generally aligned with its current purpose although there may be some minor shortcomings.
- Borderline – The asset's design and function are only partially aligned with its current purpose and there are significant shortcomings.
- Fail – The asset's design and function are substantially misaligned with its current purpose.

2.4. Asset Conditions Assessment: (40 minutes)

How to determine the condition of assets using asset attributes like physical appearance, performance efficiency, and failure history?

Asset physical condition reflects the physical state of the asset which may or may not affect its performance. It is imperative for an organization to have a clear picture of the physical condition

of their assets and their current level of service. All management decisions regarding maintenance, rehabilitation and renewal revolve around these two aspects. Oblivion to the current asset condition may lead to the premature failure. Asset physical condition analysis is used to determine the need and timing of some preventative or remedial maintenance to ensure desired Level of Service and prevent service breakdown.

Following factors contribute to the overall condition of an asset:

- Its age
- Its operating environment (what weather etc. it is exposed to)
- Its apparent wear and tear
- How well it is treated by the community
- How much use it gets

According to USEPA GHD; Asset condition can be analyzed by using the following methodology. A score from 5-1 shall be awarded by the O&M department for each factor. Asset condition can be specified using the following scales:

1. Physical Condition

Physical Condition	New/ Excellent Condition	Minor Defects Only	Moderate Deterioration	Significant Deterioration	Unserviceable
Score	*1*	*2*	*3*	*4*	*5*

2. Asset Performance ()

Performance ()	Meets Performance Targets	Minor Performance Deficiencies	Considerable Performance Deficiencies	Major Performance Deficiencies	Doesn't Meet Performance Targets
Score	*1*	*2*	*3*	*4*	*5*

3. Asset reliability

Reliability	As Specified by Manufacturer	Random Breakdown	Occasional Breakdown	Periodic Breakdown	Continuous Breakdown
Score	*1*	*2*	*3*	*4*	*5*

Asset Condition Rating

An average score shall then be calculated by the O&M department and final score shall be awarded on the basis of average score of all the factors.

Average Score	*1*	*2*	*3*	*4*	*5*
Asset Condition	Excellent	Good	Fair	Poor	Failing
Category	*A*	*B*	*C*	*D*	*F*

Average figures may be rounded off to the nearest whole number for convenience

Action on the basis of Condition Assessment

Category	Asset Condition	Actions Required
A	Excellent	Only Normal Maintenance Required
B	Good	Minor Maintenance And Rehabilitation Required
C	Fair	Significant Maintenance And Minor Rehabilitation Required
D	Poor	Significant Renewal/ Upgrade Required
F	Critical	Major Renewal/Replacement Required

Exercise # 4:

Please determine the condition of Tubewell using following information and justify your answer in light of the preceding parameters and criteria:

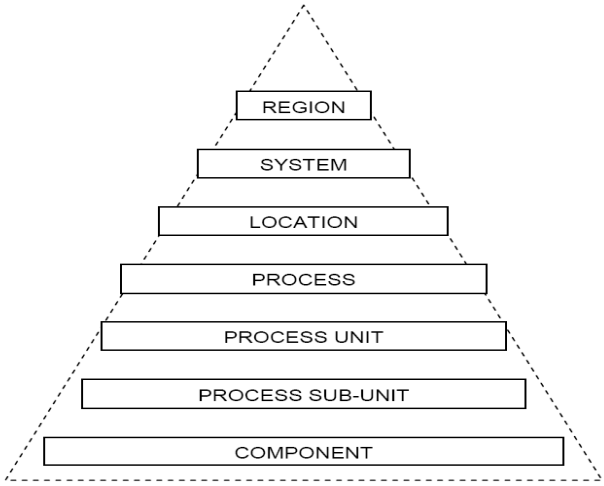
(An actual case study of WASA will be used.)

Group work

1. **Asset management system in each wasa and strength and weakness – Lab work**
2. **Asset condition exercise – class work**

Asset Code

Coding of Asset



WASA Lahore example of Asset Register by JICA

Table 10.4 Information to Be Input in Ledger (Example)

Facilities	Data to be input
Pipe line	Diameter, Length, Invert level, Flow direction, Material, Installation year, Construction cost
Well, Pumping station	Construction year, Construction cost, Specifications of Equipment, Equipment installation year, Equipment procurement cost
Water/Wastewater treatment plant	Treatment capacity, Treatment method, Construction year, Construction cost, Specifications of Equipment, Equipment installation year, Equipment procurement cost

Level	Description	Description	AMIS
I	District	Lahore	180
		Faisalabad	090
		Rawalpindi	020
		Gujranwala	120
		Multan	260
II	City	Lahore	1850
		Faisalabad	1490
		Rawalpindi	1100
		Gujranwala	1630
		Multan	2120
III	Town (WASA Lahore)	Allama Iqbal	106
		Gunj Buksh	109
		Ravi	101
IV	Union Council	Gulberg	097
		Mozang	079

Lecture 2

1. Lecture Information

Topic:	1) Measuring Risk as pertaining to Assets 2) Application of Asset Attributes for decision making
Lecture Duration:	4 Hours

2. Introduction to Topic

2.1. Setting the Basics: (10 Minutes)

Knowledge Testing: what is a Risk?

"Risk can be defined as a situation involving exposure to danger or possibility of loss. The risk related to physical assets is called Asset Failure risk. Simply put, it means that assets have inherent risks or the potential for failure."

Risk is often defined as a measure of the probability and severity of adverse effects [Lowrance 1976]. In an era of austerity and increasing pressure on operating and capital costs, asset managers are spending more resources in building their understanding of risks as related to assets and decision making regarding asset management.

In assessing risk to assets, managers often consider a few questions: What can go wrong with an asset? What is the likelihood that it would go wrong? And, what are the consequences of this asset failing? Answers to these questions help asset managers identify, measure, quantify, and evaluate risks and their consequences and impacts to assets.

(Adapted from University of Virginia, Centre for Risk Management of Engineering Systems http://bart.sys.virginia.edu/risk/riskdefined.html)

The following scale is used worldwide to determine risk of an asset;

a) Significant
b) High
c) Medium
d) Low

2.2. Asset Risk Assessment (90 minutes)

The risks must be clearly understood and managed to assure cost-effective service delivery.

ISO 55002 states that "*the organization should determine the actions that are necessary for addressing risks when planning for its asset management system. The overall purpose is to understand the cause, effect and likelihood of adverse events occurring, to manage such risks to an acceptable level, and to provide an audit trail for the management of risks. The intent is for the organization to ensure that the asset management system achieves its objectives, prevents or reduces undesired effects, identifies opportunities, and achieves continual improvement.*

Addressing risks in the asset management system, the organization should determine the risk assessment criteria (e.g. likelihood and consequence, and risk attitude). A risk matrix may be used as part of this process."

For every risk there are some conditions or vulnerabilities that give rise to such risk. These vulnerabilities are called the risk factors/ contributing factors. The greatest risk associated with Asset Management is "*Asset Failure Risk*". There are two basic factors that determine the **magnitude** of Asset Failure Risk.

- Probability (likelihood) of Asset Failure
- Impact of Asset Failure

a) Probability of Asset Failure

The Probability of asset breakdown can be defined as the likelihood that the asset will fail. Asset breakdown does not necessarily means that an asset is faulty and has stopped working; it can also mean that the asset is not contributing to the service delivery as it should.

Following factors can be analyzed to predict the probability of Asset Failure:

- Asset Condition
- Asset Effective Age
- Past Failure history

Asset probability of failure can be calculated according to the following scales:

Condition	A	B	C	D	F
Probability of Failure Rating	*1*	*2*	*3*	*4*	*5*

b) Impact of Asset Failure

Impact of the asset failure means the gravity of damage failure of said asset would do to service delivery. The larger service delivery is, the more impact it has. Thus, assets can be categorized into two broader categories in respect of the impact, namely:

- Critical Assets
- Non critical assets

Critical assets are those assets which are essential for the service delivery and their failure may have severe impact on the business. Failure of a critical asset will adversely affect delivery of service if not bring it to a halt. It should be kept in mind that critical assets are those that have adverse consequences of failure but not necessarily a high probability of failure. It is important to identify critical assets, to target and refine maintenance plans, capital expenditure plans, and investigative activities at the critical areas.

Potential consequences of asset failure are assessed against 4 key strategy elements:

- Environment - damage to the environment
- Customer - disruption of the customer/community
- Efficiency- costs associated with the failure
- Culture – potential for injury or damage when repairing a failed asset

Based on the aforementioned potential impacts/ consequences associated with the failure of asset, Impact of an asset to the service delivery can be assigned using the following scale.

Impact	Total System Failure	Facility/ Sub-Division Failure	Asset Failure	Major Component Failure	Minor Component Failure
Scale Value	*5*	*4*	*3*	*2*	*1*

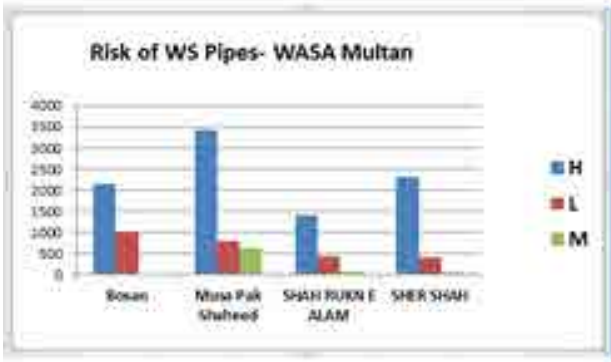
Risk Rating

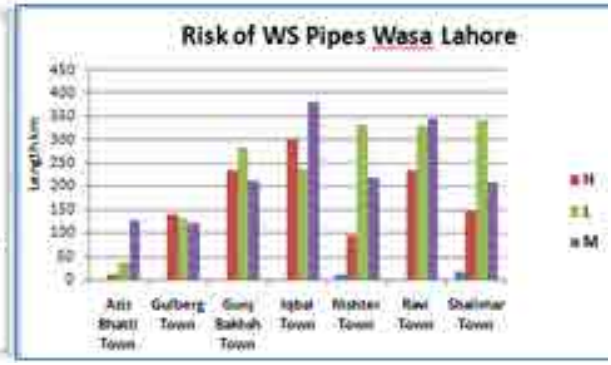
The overall risk depends on both the probability and consequence of the event. As mentioned above, the overall asset failure risk depends upon the Probability of asset failure and Impact of Asset Failure (Asset Criticality)

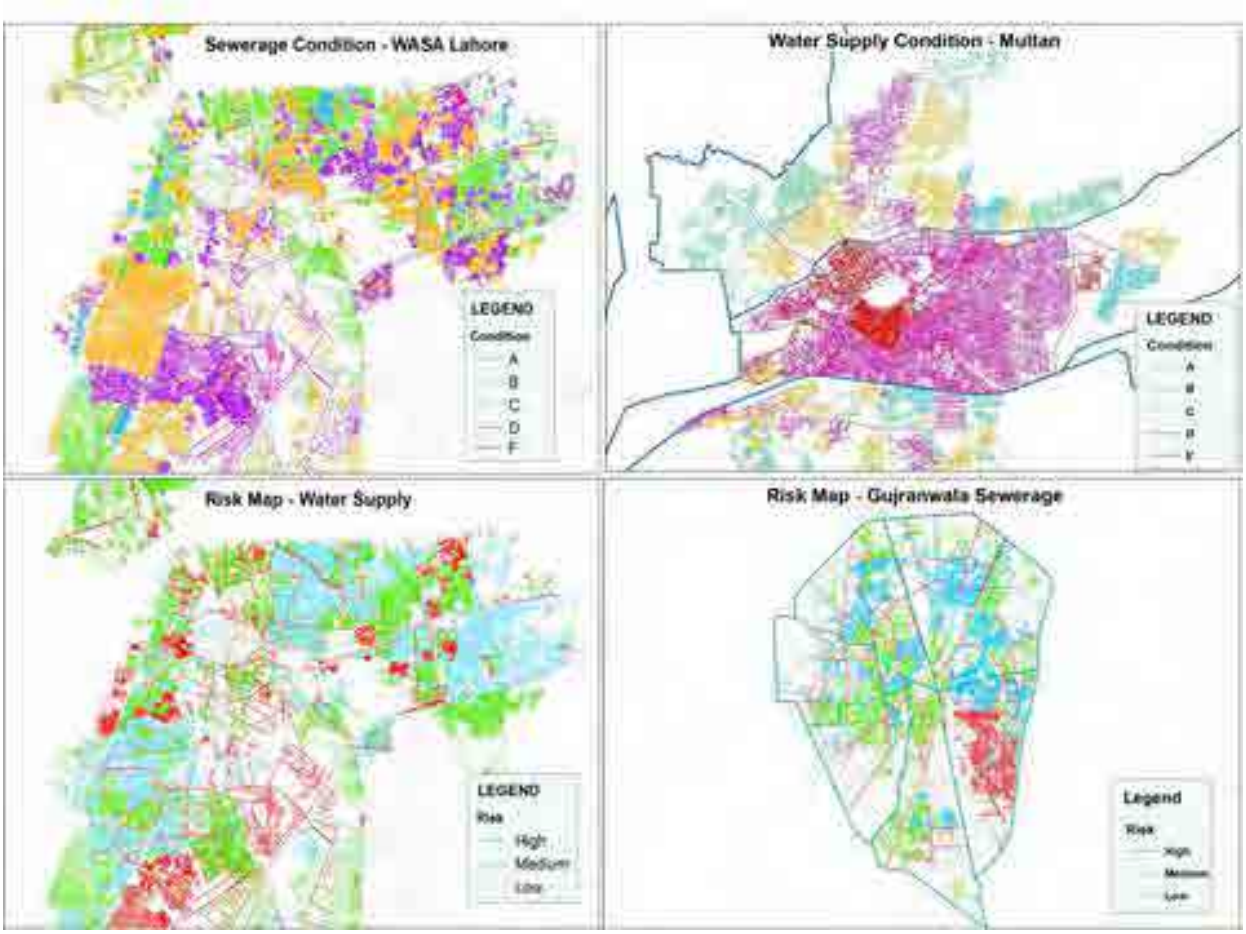
Thus asset failure risk is the product of Probability rating and the impact rating. Calculation steps are shown in the following table:

Probability	**Impact (criticality assessment)**				
	1	***2***	***3***	***4***	***5***

A	Low Risk	Low Risk	Low Risk	Moderate Risk	High Risk
B	Low Risk	Low Risk	Moderate Risk	High Risk	High Risk
C	Low Risk	Moderate Risk	High Risk	High Risk	Significant Risk
D	Moderate Risk	High Risk	High Risk	Significant Risk	Significant Risk
F	High Risk	High Risk	Significant Risk	Significant Risk	Significant Risk







The following industry best practices are employed when developing a risk management framework (RMF)

B.1 Establish a Risk Context

Effective risk management programs are characterized by clear objectives that an organization is trying to meet. Setting the context of a risk assessment serves to scope the risk assessment process. Industry leading practice suggests this is done best by aligning strategic objectives and goals to asset-specific customer and technical levels of service. Risks to assets against these service levels and metrics are then used to form the basis for identification of critical assets with a particular service area (e.g. water, wastewater, storm water).

B.2 Identification of Risk

This step focuses on the identification of applicable risk scenarios for assets. Risk scenarios should consider threats related to natural disasters, third party damage, proximity to dangerous sites, operational process / methods, physical breaks and design and construction.

B.3 Risk Evaluation

Risk is typically expressed as the product of Probability of Failure x Consequence of Failure. More sophisticated measures of risk evaluation include vulnerability analysis. Each is discussed further below.

- **Probability of Failure Analysis:** Probability of failure (PoF) measures the "probability" or "likelihood" that an asset will fail to meet is desired level of service objectives. Many industry leaders have developed 5 point rating scales to evaluate PoF that reflect the percent (%) chance of failure occurring or a temporal measure (e.g. number of years) for estimated failure. PoF is best measured through formal condition assessment of an asset. In the absence of condition data, deterioration modelling, asset age relative to maximum potential life (MPL), historical records, staff knowledge, industry trends, fundamental risk, site experience and data, expert judgement and applicable regulatory requirements.
- **Consequence of Failure Analysis:** Consequence of Failure (CoF) provides a measure for the consequence of an asset failure. From an organizational perspective, consequence of failure encompasses failure to meet established customer and technical levels of service related to capacity, health and safety, financial and asset integrity considerations. The impacts of CoF in these areas should be measured against triple bottom line impacts - Social, Environmental and Financial.
- **Vulnerability Analysis:** Vulnerability analysis recognizes the extent to which an asset can withstand a risk event. Vulnerability criteria are typically associated with asset attributes, design parameters, operating conditions and site data. This criterion is used to supplement the PoF evaluation of a watermain segment being able to withstand a risk event.

$$\textbf{Risk} = |\textbf{Probability (PoF) x Vulnerability (V)}| \times |\textbf{Consequence (CoF)}|$$

B.4 Mitigation Plans

Industry leaders in risk management have adopted an approach to mitigation planning that is based on a cost–benefit–risk analysis to identify mitigation strategies that provide the greatest overall risk reduction for the lowest cost. This is typically done through cost benefit analysis (CBA) or net present value (NPV) economic analysis of potential mitigating options. The outcome of the phase in the risk management process consists of program-level mitigation strategies based on like strategies and organized around short, medium and long term delivery times and geographic areas (e.g. pressure zones).

B.5 Implementation

Implementation of risk assessment and evaluation processes are primarily undertaken by geographic or pressure zone boundaries. Mitigation planning is done similarly but further organized into program level initiatives (e.g. Program to replace metallic pipe to reduce the risk of physical pipe failure from corrosion).

B.6 Monitoring and Review

Monitoring and review programs are characterized by updating risk profiles on an annual basis and updating residual risk scores following implementation of mitigation strategies.

Exercise # 4: Please determine the Risk of Tubewell and disposal station (extending the previous case):

(The case will be developed based on actual information)

Group Exercise – all wasa / KSB/NSUSC

Data on tube well with its condition

Exercise

Data on tube well with its condition

Exercise

Your managing director has asked you to prepare a risk report of tube wells data based on the consultant report as attached.

You will use the risk table to determine the risk and its impacts

Use condition table

Impact table

Write a report to MD - 3 paragraph recommendation what to do with asset along with table of condition and impact marks

2.3. Combining Condition, Risk and Residual life to plan (20 minutes)

The course participants will be asked to list down the possible uses of condition, risk and residual life in future planning of assets. The possible answers are;

a) Replace the assets with poor condition.
b) Rehabilitate the assets which have high risk
c) Replace the assets which have completed the useful life.

In order to plan asset management in light of the ***Physical Condition*** and assessed ***Asset Failure Risks*** the following matrix may be used to identify action plan for asset management.

Condition	Failure Risk State			
	Low	***Moderate***	***High***	***Significant***
A	Regular Maintenance	Regular Maintenance	Preventive Maintenance	Priority Maintenance
B	Regular Maintenance	Preventive Maintenance	Priority Maintenance	Priority Rehabilitation

Condition	Failure Risk State			
	Low	*Moderate*	*High*	*Significant*
C	Preventive Maintenance	Priority Maintenance	Priority Rehabilitation	Immediate Rehabilitation
D	Priority Maintenance	Priority Rehabilitation	Immediate Rehabilitation	Immediate Replacement
F	Priority Maintenance	Immediate Rehabilitation	Immediate Replacement	Immediate Replacement

Use the table …..for group work

- Assets that require “immediate Replacement/ Rehabilitation” should be top priority
- Assets that require “ Priority Rehabilitation” should be accommodated if resources allow
- Assets that require “Preventive/ Priority maintenance” should be carefully monitored to prevent the need for their replacement

Assets that require regular maintenance does not pose a risk and can be operated with regular maintenance schedule.

Exercise # 5: Application of Risk, Condition and other attributes to make decision:

Lecture 3

1. Lecture Information

Topics: 1) Asset Life Cycle 2) Preventive Maintenance of Assets 3) Asset Management Plan
Lecture Duration: 5 Hours

2. Introduction of Topic

2.1. Definition of Asset Life Cycle (15 Minutes)

The asset life cycle includes following four stages;

1) Planning
2) Acquisition
3) Operation &Maintenance
4) Disposal

Asset Life Cycle Management is a process designed based on best practices from multiple industries on how to best manage the performance/activities of an asset over its entire life span. This is of course, challenging without adequate information and records (think of how you would service your car proactively in order of frequency – wiper fluid, tire pressure, oil, coolant, brakes, transmission, etc.). If we adopt this approach, the asset has the following phases during its life span:

0) Planning
   A Identified need to provide a product / service
1) Acquisition
   A Concept and specification
   B Design development
   C Fabrication / Build
   D Install / Commissioning
2) Utilization
   A Operations and Maintenance (requires the most cost)
3) Disposal

Please comment on life cycle costing and identify which phase require maximum cost?

2.2. Asset Management: (105 Minutes)

Asset Management is organizing, planning and controlling the acquisition, use, care, refurbishment and/or disposal of physical assets to:

- Optimize their service delivery potential

- Minimize related risks and costs over their entire life through development and application of intangible assets such as business processes and decision supporting systems

In order to avoid failures in the operations and maintenance phase, where most of the costs are incurred, a reliability approach needs to be taken which considers the following:

Are designs reviewed before asset(s) are built from the perspective of maintainability – reliability, sustainability and safety?

• Did M&R professionals &/or designer review design to ensure:
– Easy access to repair
– Easy to lift, provision for lifting
– Easy to align
– No or minimum special tools required
– Use of Standardized components, modular design, etc.
– Built in health monitoring (Predictive maintenance technologies) including diagnostics
– Use of energy efficient components
– Performed preliminary FMEA, SSHA, Reliability modeling etc.

• Were O&M or designers involved during build phase to ensure
– Was everything done with high quality - welds, testing done as required etc..

• Did O&M or designers perform reliability check during commissioning process to:
– Ensure cables / hoses have right size loops to avoid rubbing or tightness
– Proper labeling of cables, piping, etc...
– Components such as motors, bearings, oils have been properly sized and right for the environment to be used

Then the Lecturer will bring the attention of course participants toward the preventive maintenance during the cycle of the assets. The lecturer will give a brief concept of international best practices regarding frequencies of preventive maintenance for different assets of WASA. A few of the frequencies are;

Mechanical & Electrical parts of tube wells, disposal stations

A full set of maintenance routines should be provided to cover all work on all equipment.

Table 1: Instrumentation Maintenance Frequencies

Asset type	Monthly	3 monthly	6monthly	Annual
Control panel meters			•	
Level sensors/transmitters	•			
SCADA control panels				•
Soft starters		•		

Bearing sensors			•	
Chemical dosing	•			
Bulk Flow meters				•
pH Calibration (RO) Plants	• weekly			

The monitoring of pump efficiency as an annual check should be carried out. The intention should be to evaluate whether there is a cost savings or operational improvements as a result of overhauling pumps with poor performance.

Table 2: M&E Maintenance Frequencies

Asset Type	Monthly	3 Monthly	6 Monthly	Annual	Two yearly	Overhaul Period (yrs)
Pumps (dw/ww)	•			•		•5
Motors		•	•		•	•5
Sub pumps			•			•5
Gear boxes	•		•			•5
Transformers		•	•	•		
Control panels	•					
Control valves	•					
Bulk meters	•					
Compressors	•		•			•3
Generators	•	•		•		•5
Chlorinators	•			•		•3
A/sc blowers	•	•				•3
Bk/w pumps	•		•			•5
Lime handling	•	•				•2-3
Chemical handling	•	•				•3

Tank stirrers			•			•5
Cooling fans	•	•		•		•3
RO plants	•	•				
Lifting equip				•		
Site security	•					
Safety inspections				•		

The on-line pumping stations should be incorporated into the Maintenance Management System. Guideline frequencies for mechanical and electrical maintenance are given below:

Table 3: Pumping Station M&E Maintenance Frequencies

Asset Type	Monthly	3 Monthly	6 Monthly	Annual	Two Yearly	Overhaul Period (years)
Pumps (dw/ww)	•			•		•5
Motors		•	•		•	•5
Sub pumps			•			•5
Gear boxes	•		•			•5
Transformers		•	•	•		
Control panels	•					
Control valves	•					
Generators	•	•		•		•5
Lifting equip				•		
Security	•					
Safety inspections				•		

Typical target instrumentation fréquences are also given below:

Table 4: Pumping Station Instrumentation Maintenance Frequencies

Asset type	Monthly	3 Monthly	6 Monthly	Annual
Control panel meters			•	
Level sensors/transmitters	•			
SCADA control panels				•
Soft starters		•		
Bearing sensors			•	
Chemical dosing	•			
pH Meters (RO) Plants	• weekly			

3 Asset Management Plan (100 minutes)

Exercise # 6: Please prepare daily, monthly, quarterly and annually checklist of asset management plan and also workout asset lifecycle costing.

3. Conclusion: (20 minutes)

Questions?

Evaluation of Instructor?

Asset Management Plan- Template
For Tube well (District Lahore:180 , Lahore City:1850 , Gulberg Town:104, UC:000, WASA Organization :20 , Asset auto generated code by AMIS:110)

Name of Asset	Asset code	Condition	Maintenance Frequency /Checking	Remaining Life	Improvement required to extend life of asset	budget
Pump	1					
Motor	2					
Electrical	3					
Chlorinator	4					
Meter	5					
Transformer	6					

ALJAZARI
ACADEMY

Asset Management

Course Code: M4131

Asset Management Information System

Module 2

Lecture Notes

2016

Introduction of the Asset Management Course:

This course introduces key concepts related to asset management specifically for water utilities. The examples are generic enough that they can be applied to other manufacturing environments, but the governance concerns are obviously linked to public service asset management. As such, the course focuses on identifying and measuring assets, asset attributes, condition based assessments, risk profiles, asset life cycles, monitoring programs (i.e. reliability and preventative maintenance based), accounting practices, asset valuation and preparing asset replacement plans. This course is especially beneficial for officers of grade 17 and 18 who are directly or indirectly involved in planning and the routine management of assets.

In order to effectively supervise asset maintenance practices to frontline staff, while communicating and reporting asset management to senior management, course participants will be versed in a few key areas of asset knowledge. Course Participants (CPs) will develop knowledge and skills about asset identification, inventory creation, maintenance documentation life cycle assessment and asset condition based measurement. They will be taught to develop, maintain and report out on an asset data base for asset replacement planning. This course will also help the CPs in understanding application of the concepts related to Asset Replacement Plans, Asset Operational Plans (Standard Operating Procedures) and Condition Based Monitoring. The CPs will also be introduced through OJT, to the Asset Management Information System, GIS and other tools.

Why do Asset Management?

Early developments in Computerized Maintenance Management Systems (CMMS) led to the adoption of work management systems for service request generation, work order completion and activity based management and costing. Advances in automation have arguably led to reductions in risk and cost overruns as pertaining to labour allocations and resource management. In other words, the more automation, the less people requiring management. Let us leave contract management of third parties out of the picture for a moment, as their productivity is mixed across utilities. Nevertheless, attention related to CMMS has increasingly turned to asset management. We in the utility sector are faced with costs (energy, consumables and maintenance/replacement services) which are directly linked to assets. Upon the completion of this course the CPs will be in a better position to apply their learning in their routine jobs and prepare an Integrated Development & Asset Management Plan (IDAMP) to provide better water supply and sewerage services to their consumers.

Introduction of AMIS Module:

An Asset Management Information System take the inventory based view envisioned by financial management of assets, and frames assets geo spatially. This module provides an overview of how GIS systems can enable and enhance asset management functionality. This course uses proprietary software and introduces CPs to the solution. CPs are encouraged to see their login and account creation as a progression of their public service to WASAs and the Punjab Water Operators

Network. As with the homework provided, the more engaged and the more CPs leverage their own WASA asset inventories, the more networked they will be to the analysis offered by the AJA team.

Lecture 1

1. **Lecture Information**

Topics: 1) Recording & Reporting of Assets in books of accounts. 2) Asset Depreciation & Application of depreciation information. 3) Fixed Asset Register.
Lecture Duration: 2 Hours

2. **Introduction of Topic**

2.1 Introduction of Accounting Regimes (20 minutes)

The following two accounting manners are applied all over the world;

Cash Basis of Accounting

Accrual Basis of Accounting

Cash Basis of Accounting

The modified basis of accounting records transactions on a cash basis but also takes into account:

Accounting for certain assets and liabilities. At period end, disclosure of all material assets and Liabilities shall be made in the Annual Financial Statements.

Physical assets are recorded into asset Fixed Asset Register and memorandum/ supplementary record.

Thus, an additional step in this process is the memorandum recording of certain assets and liabilities.

Accrual Basis of Accounting

Accrual basis means a basis of accounting under which transactions and other events are recognized when they occur (and not only when cash or its equivalent is received or paid).

Therefore, the transactions and events are recorded in the accounting records and recognized in the financial statements of the periods to which they relate. The elements recognized under accrual accounting are assets, liabilities, net assets/equity, revenue, and expenses.

2.2 Reporting of asset under different accounting methods

1. IPSAS for Cash Basis of Accounting
2. IFRS & IAS for Accrual Basis of Accounting

Discussion Question on what method is being followed in Government of the Punjab & WASAs?

2.3. Treatment of Assets in WASAs (20 minutes)

Please explain the Accounting system in your respective WASA?

The following Matrix will be filled

WASA Lahore	
WASA Faisalabad	
WASA Gujranwala	
WASA Rawalpindi	
WASA Multan	

2.4. Treatment of assets in Financial Management Manual-Cash Basis

I. Introduction

Asset management function deals with the optimal management of Fixed assets and their life cycles. Fixed Assets Management process aims to ensure that:

i. Fixed Assets are appropriately disclosed in financial statements in accordance with WASA's policies and the applicable financial reporting standards;
ii. Only authorized employees have access to the asset records;
iii. Fixed assets acquisitions, receipt, recording and disposal duties are segregated;
iv. Fixed asset acquisition, transfers, disposals are approved and recorded in accordance with WASA's policies and in light of the IPSASs;
v. Fixed assets are properly safeguarded in accordance with WASA's policy.

II. Policies

A. Accounting for Fixed Assets:

1. All the items of property, plant and equipment (physical assets), freehold land and capital work in progress shall be expensed out on cash basis at the time of payment made to the vendor/ contractor.
2. In addition to expensing out all the physical assets in the relevant accounts as per prescribed in Chart of Account, Finance Directorate shall maintain a supplementary record for the Fixed assets management as per following provision:

CWIP Ledger

i. Fixed Assets through construction shall be recorded in the supplementary 'capital work in progress (CWIP) Ledger'.

ii. Capital Work in Progress shall be recorded at costs including overhead cost and related expenses incurred thereon.

iii. The assets in CWIP shall be transferred from capital work in progress (CWIP) Ledger to the 'Fixed Assets Register' upon completion of work and completion certificate obtained by relevant directorate

Fixed Assets Register

i. Finance Directorate shall maintain a "Fixed Assets Register" to record the all the categories of assets whether acquired through construction or purchase. The categories of assets shall include the following:

- Land & building
- Machinery and Equipment
- Pipelines
- Tube wells
- Vehicles
- Computer equipment
- Furniture & fitting
- Office equipment

ii. Each Fixed asset purchased or improvement/extension made above Rs 100,000 shall be recorded in the Fixed Assets Register. This threshold should be subsequently adjusted in the light of experience and better defined management information requirements.

iii. The record of each item shall also include references to the relevant files, plans and deeds, source of acquisition, and give other relevant details such as rents payable or receivable, and restrictive covenants.

iv. Every change affecting the ownership, occupation or change in location of the asset shall be the subject of an entry in the register

v. The Finance directorate shall ensure that the Fixed Assets Register kept is properly maintained and is up-to-date.

vi. The Fixed Assets Register will be maintained by the Senior Account Book keeping section who should take appropriate precautions to safeguard the accuracy and integrity of the record.

vii. No item will be removed from the register except under proper authority. When an item is removed the record should be noted to show the date and reasons for removal and the reference of the relevant written authority.

B. Disposal of Fixed Assets

1. Assets shall be disposed by the relevant directorate as per disposal policies/ guidelines/rules framed by the WASA.
2. Receipts from the sale of Fixed assets shall be credited to the capital receipts as per chart of Account.
3. Sale receipts shall be accounted for as an income in the on a gross basis. Sale expenses will not be netted off the sale proceeds but shall be separately accounted for as an expenditure item.

C. Insurance of Fixed Assets

1. WASAs shall OPTIONALLY opt to insure the Fixed assets.
2. All the assets of WASA pertaining to the following categories having cost above 1,000,000 may be insured:
    - Plant and Machinery
    - Building
    - Pipelines
    - Tube wells
    - Vehicles
    - Computer equipment
3. Insurance premium shall be recognized as expense on cash basis

Amount recovered from insurance claim shall be recognized as other income on cash basis.

2.5. Treatment of assets in Financial Management Manual- Accrual Basis

FIXED ASSET ACCOUNTING POLICIES

- All the items of property, plant and equipment (fixed assets) except freehold land and capital work-in- progress shall be stated at cost less accumulated depreciation. Freehold land and capital work-in-progress shall be stated at cost.
- Major renewals and improvements resulting in increase of useful life of fixed assets shall be capitalized whereas minor renewals, replacements, maintenance and repair shall be charged to surplus or deficit as and when incurred
- Gain or loss on disposal of fixed assets, if any, shall be charged to income and expenditure account in the year of disposal
- Items of property, plant and equipment (fixed assets) which cost below 10,000 shall not be capitalized and booked as expense in the relevant period

- The residual value and the useful life of an asset shall be reviewed at least at each financial year-end and, if expectations differ from previous estimates, the change(s) shall be accounted for prospectively
- Depreciation of an asset shall begin when it is available for use
- Depreciation for an asset shall not be charged when the asset is derecognized.
- Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item shall be depreciated separately.
- Depreciation on additions to fixed assets is charged when the asset is available for use until the asset is held for use and up till the asset is disposed-off.
- The depreciation charge for each period shall be recognized in income and expenditure account unless it is included in the carrying amount of another asset
- Capital Work in Progress shall be shown at costs incurred thereon up to the date of balance sheet including overhead cost and related expenses
- The assets shall be transferred from capital work in progress (CWIP) account to the Fixed Assets account upon completion of work and completion certificate obtained by relevant directorate
- Capital Work in Progress shall be classified as non-current asset and no depreciation shall be charged on CWIP
- The carrying amount of assets shall be reviewed at each balance sheet date to determine whether there is any indication of impairment. If any such indication exists then the assets recoverable amount shall be estimated. The recoverable amount is the greater of its value in use and fair value less cost to sell.
- Impairment loss shall be recognized if the carrying amount exceeds its estimated recoverable amount.
- The impairment loss shall be charged to the income and expenditure account for the period. The depreciation of an impaired asset shall be adjusted in future periods and shall be charged on the impaired value of asset.
- When conditions which led to the recognition of impairment loss cease to exist, the impairment loss may be reversed only if the recoverable amount of asset exceeds its carrying amount. However, the increased carrying amount due to reversal should not be more than the depreciated historical cost had the impairment not been recognized.
- Reversal of an impairment loss shall be recognized as income in the income and expenditure account

- All the assets of WASA pertaining to the following categories having cost above 50,000 shall be insured:
    - Plant and Machinery
    - Building
    - Vehicles
    - Computer equipment
    - Finished goods inventory
    - Cash in hand
- Insurance policy shall be reviewed and signed by DMD-Finance and Managing Director
- Insurance premium shall be recognized as expense on accrual basis

Amount recovered from insurance claim shall be recognized as other income

The recording of assets into the books of accounts has huge implications in terms of presentation in financial accounts of an organization. The assets are reported on the balance sheet of accounting statements and create smoothing effect. Companies usually have a policy to record assets with a view that assets must have life of more than one (1) year and material value. The recording of assets is called Capitalization.

Activity **(10 Minutes)**

Assume a utility has a policy to record assets if its acquisition cost is more than 100,000/- and expected life of more than one (1) year. Please identify the following transactions may or may not be recorded into assets:

Purchase of a table in Rs. 120,000/- (Yes / No)

Purchase of UPS in Rs. 80,000/- (Yes / No)

Purchase of stationery of Rs. 110,000/- (Yes / No)

2.6 Different methods of Depreciation **(20 minutes)**

- Straight Line Method
- Declining Balance Method
- Average Balance Method

Depreciation Policy of WASAs:

- Depreciation on fixed assets shall be provided on the straight line method so as to write off the historical cost of the assets over its estimated useful life.

- Fixed assets will be depreciated using the following rates:

Description	Depreciation %age	Tax Depreciation (@ WDV)
Freehold land	0%	0
Building	2%	10
Plant and Machinery		
• Tube-wells and water supply	7%	10
• Sewerage and disposal station	7%	10
Pipelines		
• Water supply	3%	10
• Sewerage	3%	10
Office equipment	10%	30
Furniture and fixture	10%	10
Vehicles	20%	20
Computer equipment	20%	30

2.7 Application of Depreciation in Planning

Average Age = Accumulated depreciation/annual depreciation expense

Average depreciable Life = ending gross investment/ annual depreciation expense

Remaining useful life = ending net investment/annual depreciation expense.

2.8 Fixed Asset Register (30 Minutes)

Fixed asset register is a compulsory accounting record. Accounting Policies and Procedural Manual (APPM) requires to record following attributes into the Fixed Asset Register at minimum (Section 13.4)

a) Description
b) Classification of asset
c) Year of Purchase or completion
d) Original Cost in PKR
e) Cost in foreign currency (if applicable)
f) Asset Identification Number
g) Current Location
h) Ownership / Responsibility of Asset

International Accounting standard requires following additional information into the Fixed Asset Register (TS 6):

a) Addition / Deletion of assets
b) Depreciation
c) Accumulated Depreciation
d) Revaluation
e) Date of Revaluation

Assignment: Prepare a Fixed Asset Register.

Suppose you are an Asset Manager of XYZ Subdivision of WASA-A. The fixed asset register for Financial Year 2014-15 is attached at annexure-A. In July 2015, you extended services in liberty area and installed water supply pipelines in 50 million and a Tubewell in Rs. 13 million. Please do the following;

1. Prepare Fixed Asset Register for FY 2015-16.

Conclusion (20 Minutes)

Questions?

Lecture 2

1. Lecture Information

Topics: 1) Introduction of AMIS 2) Registration Users into AMIS 3) Addition of Assets into AMIS
Lecture Duration: 2 Hours

2. Introduction of Topic

2.1 Introduction and Basic Functions of AMIS: (20 minutes)

The trainer will provide an overview of the GIS based asset management system along with basic functions of the system. Given the number of assets (including subcomponents), asset attributes and decision making processes which fall under the umbrella of utility responsibilities; an overarching information system is required for effective asset management. As such, it is critical to have as much of the needed information captured within one comprehensive system to serve the needs for a range of users. The Geographic Information System (GIS) based Asset Management System (AMS) is an integrated web based system developed for CDGs and WASAs of five (5) large districts of the Punjab. The scope of the system's use by AJA, UU and other Punjab Government offices will be outlined. Some of the best practices of such systems, in terms of functionality will also be provided, based on leading practices from utilities around the world.

2.2 Objectives

- To enter an inventory of major assets of CDGs and WASAs into the AMIS.
- To educate CPs on how to automate the asset management processes using the AMIS
- To educate CPs on how to use the AMIS to make appropriate decisions and create and effective support systems.

2.3 Basic Functions of Asset Management Information System (AMIS)

2.3.1 Create Asset

Users can create/add an asset by filling a form designed for each type of asset. Each form has a form number and basic attributes of the assets. The form is filled and sent for approval of the authorized personnel. Upon the approval the asset becomes a part of the GIS based asset inventory. A unique asset identifier should also be assigned to this particular asset once it has been created. See the previous course outline for more details on possible information and identifier fields for the development of a unique tag.

2.3.2 Asset revaluation

AMIS enables the users in asset revaluation and planning for decommissioning and replacement. Asset revaluation removes any anomalies in the valuation of the assets in the public infrastructure, it is particularly important in times of high inflation where realizable values have risen sharply over the years and a revaluation would bring the asset valuation in line with the market values. It is also critical for long term asset planning as capital investment comes under increasing pressure. This is critical in developing countries

2.3.3 Asset depreciation

This module also allows the users in calculation and inclusion of asset depreciation through gradual dilapidation and ageing. The depreciation shall be charged against the cost of the asset reflected in the GIS based Asset Inventory. This module allows for assets to be gradually depreciated so that managers and project planners can take measures to extend critical asset lifecycles in order to avoid the convergence of too many assets in need of replacement. Multiple assets, back-up systems and process redundancy are typically justified in order to guard against critical assets and their depreciation.

2.3.4 Asset disposal

Asset Disposal covers the disposals of assets to remove a particular asset from the GIS based Asset Inventory. This can be particularly useful in case an asset has completed its useful life, is dilapidated beyond maintenance and the decision makers have decided to replace the asset entirely.

2.3.5 Asset maintenance

The maintenance function allows the users to record the repair on a particular asset. This information could be useful to develop reporting mechanisms to aid in the budgeting and forecasting in the medium to long term. It can also be used to manage assets which will be extended in their life cycles and will experience substantial maintenance, vs. those which are simply being driven to failure. A continuum of critical assets (experiencing more maintenance) and non-critical assets (and processes, ostensibly) should be created and understood by process area in order to clearly delineate between assets of different financial and engineering value. Labour resource utilization should in turn, be aligned with such a system, using a work management system (also computerized) or some similar system.

2.3.6 GIS based Asset Inventory

The GIS based asset inventory covers the asset listing of all the assets and integrates the above mentioned modules to provide the asset name, ownership, department, location, cost and the satellite imagery of the particular asset. The inventory integrates the essential attribute data put in the system through

the above mentioned modules, and feed the data into the reporting module. The GIS asset base is typically used for measuring the health of the linear system, which is linked to customer service connections, residential and ICI. This system should be linked as closely as possible to customer service efforts as well as field support.

2.3.7 Decision Support System

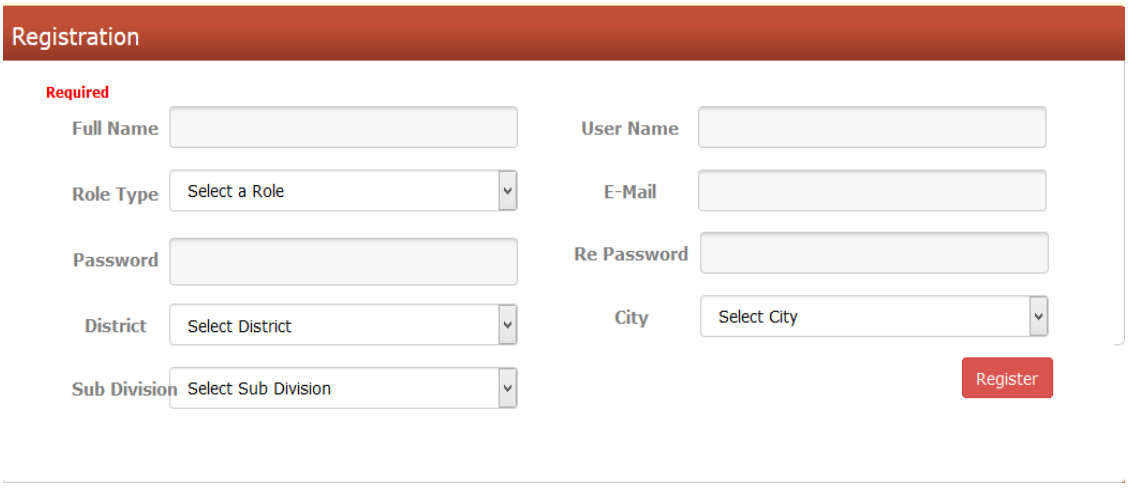
The system also produces consolidated reports based on the attribute data put into the GIS based asset inventory. The reports will help to make decisions regarding replacement of assets, their timely repair and maintenance and will provide a better control and monitoring mechanism. This support system should link engineers, planners and field support staff to middle management. Once aligned, then data and reports can be fed up to senior management to prioritize asset replacement programs and investments to balance customer service standards with capital project plans.

3. User Registration in AMIS (20 minutes)

Then the trainer will teach the CPs how to get register in the software.

To get register with the AMS follow the following steps

- Open web browser
- Type the following URL address http://202.166.168.184:99/Home/login
- Click on the registration link
- Fill the following form



- Username will be used for login into the AMS software

4. **Addition of Information related to Assets into AMIS (80 minutes)**

4.1 User Login

The trainer will teach how to login into the system.

- Open web browser
- Go to the login page by typing the following URL address
  http://202.166.168.184:99/Home/login
  It will take you to the following screen

- Enter your username and password
- Click Login button
- After authentication you will be redirected to your dashboard

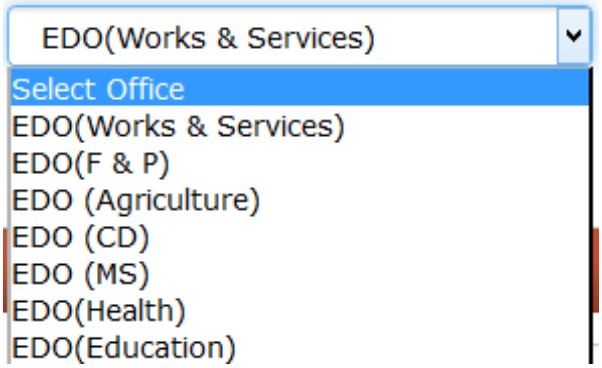
The trainer will tell how to add information into the system;

- To add an asset go to the Asset Acquisition Menu

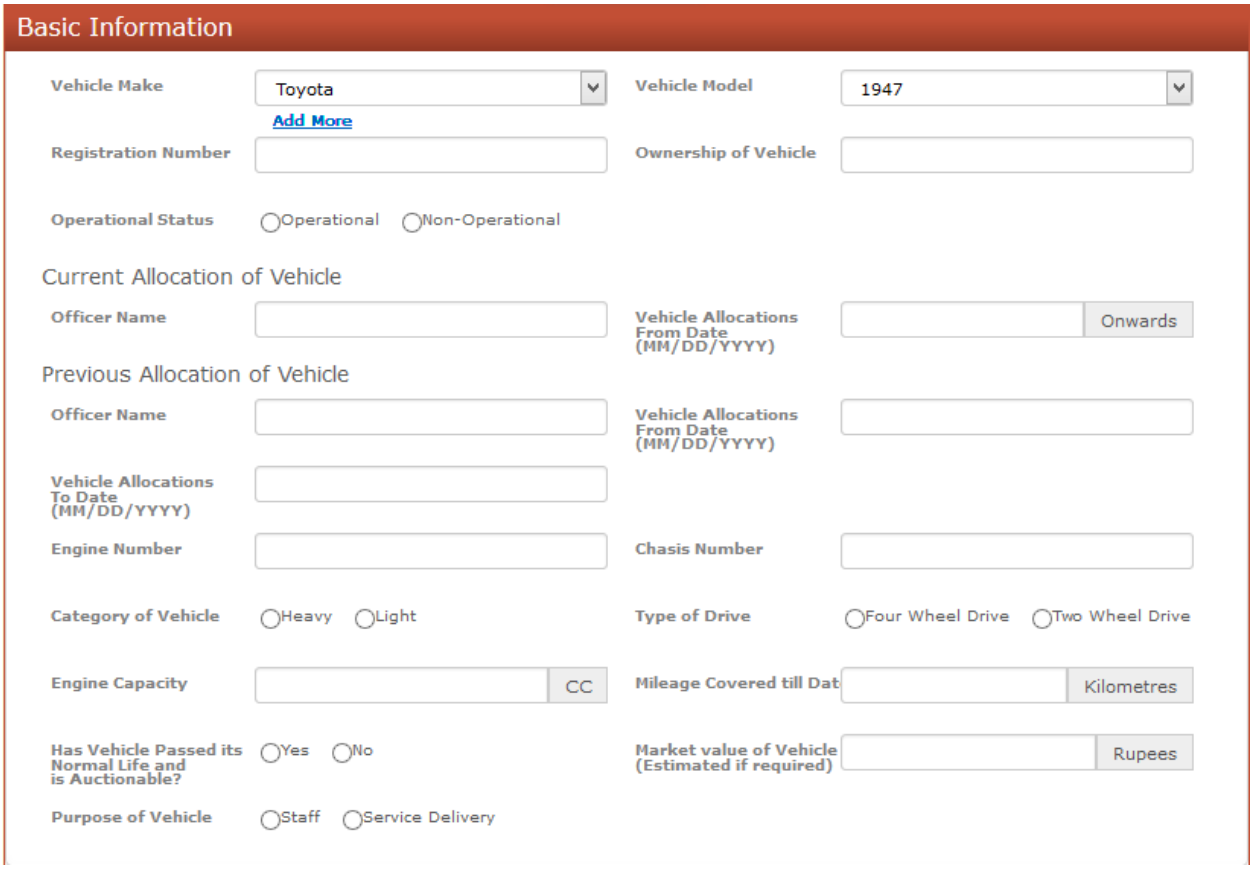
- Click on the asset name
- For example if you click on vehicle, a form will be open with following information on the top

- Fill the form number
- Select the Organization as CDG or WASA
- Select the Department/Office pertaining to selected organization

For instance, In case of organization as in CDG-LHR the following options are available



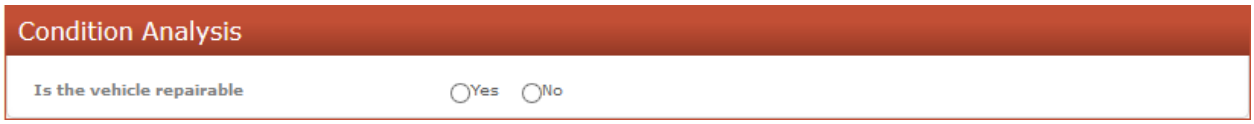
- Then select the sub office/department up to the 3rd level, but 2nd and 3rd levels are optional
- Then fill the basic information of asset, In case of vehicle following form will be opened



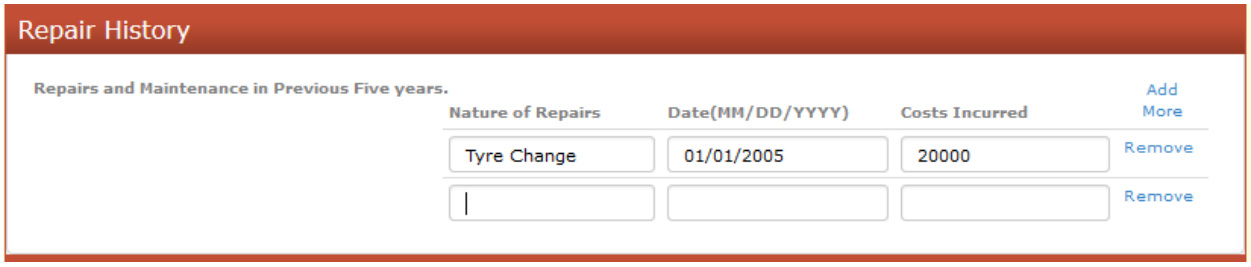
- Select the Manufacturer of vehicle from "Vehicle Make" drop down option

- If targeted manufacturer is not in the list, you may add it by clicking the "Add More" option
- By doing so, you will be presented with the following form for entry

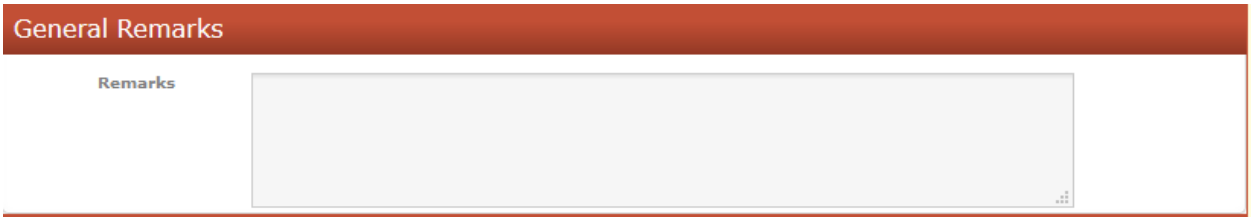
- Enter a targeted manufacturer name in the textbox under the "Value" label
- It becomes a part of the asset entry form & you can select this new manufacturer from Add Vehicle form
- Then select the vehicle model year from drop down list
- Fill all the basic information of vehicle as given in the form which is mostly self-explanatory
- Then specify the condition of the asset by select radio button



- Then fill in the repair history of the asset by specifying the date, cost & nature of repair

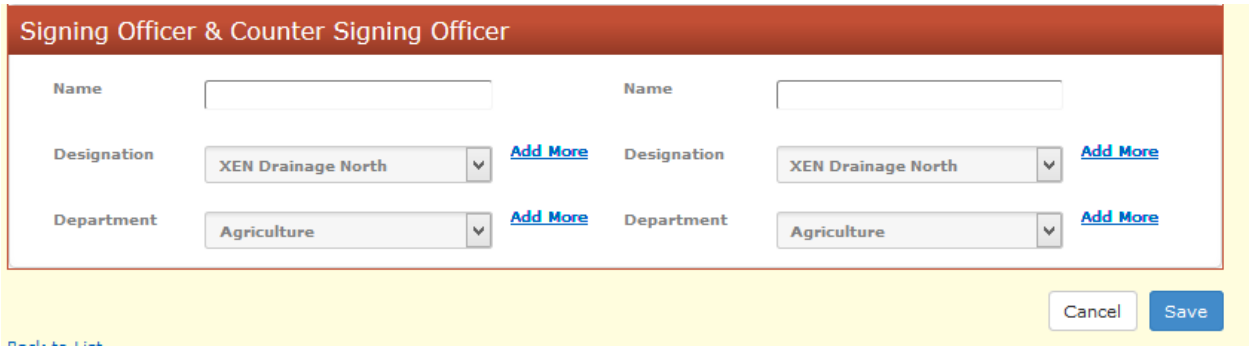


- You can add multiple repairs by clicking "Add More"
- Then fill in the general remarks of vehicle



It can be hundreds of characters

- In the end, specify the verifiers of this asset information with their designation & departments



- After it you can save all the provided information by clicking “Save”
- If you wish to discard all the information entered on this Add Asset Page, you can do so by clicking the “Cancel“ button

Exercise 2: Login to the AMIS and add a tube well having all the information mentioned in the form.

Lecture 3

1. Lecture Information

Topics: 1) Searching and Editing of Assets into AMIS
Lecture Duration: 2 Hours

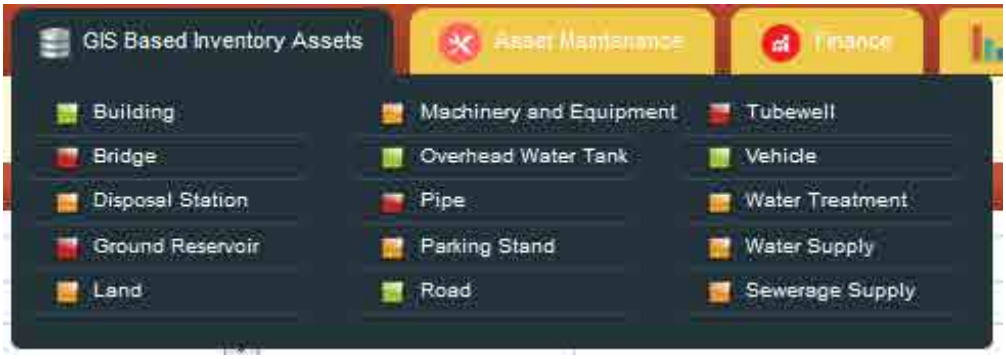
2. Introduction of Topic

Searching and Editing **(90 minutes)**

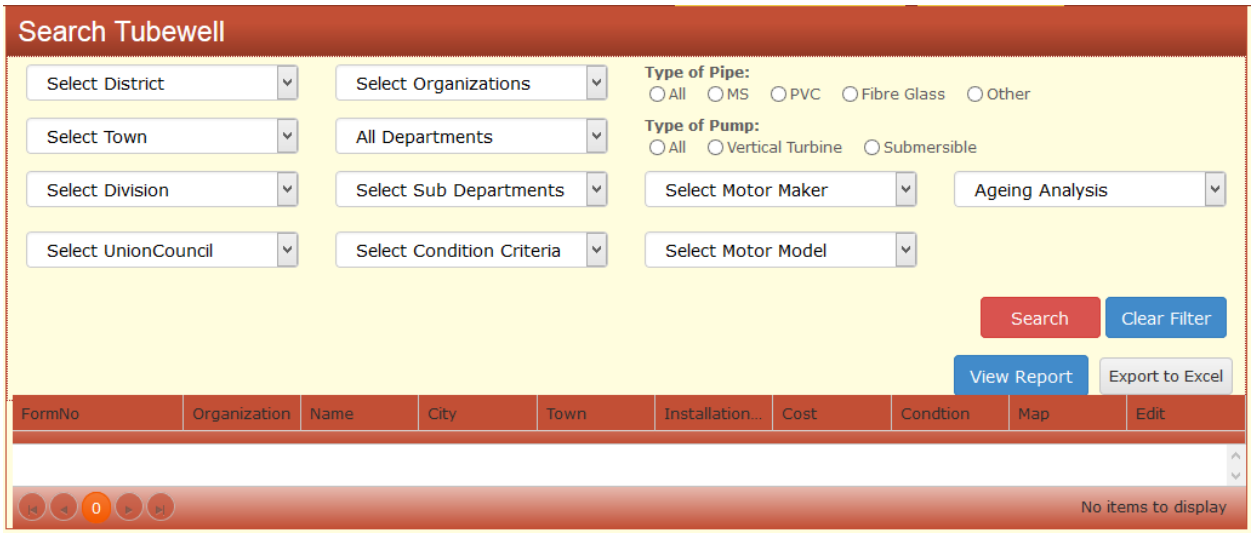
2.1. Asset Searching:

The instructor will guide the course participants regarding searching and editing of assets in AMIS. To search and view information of any asset in your scope, follow these steps

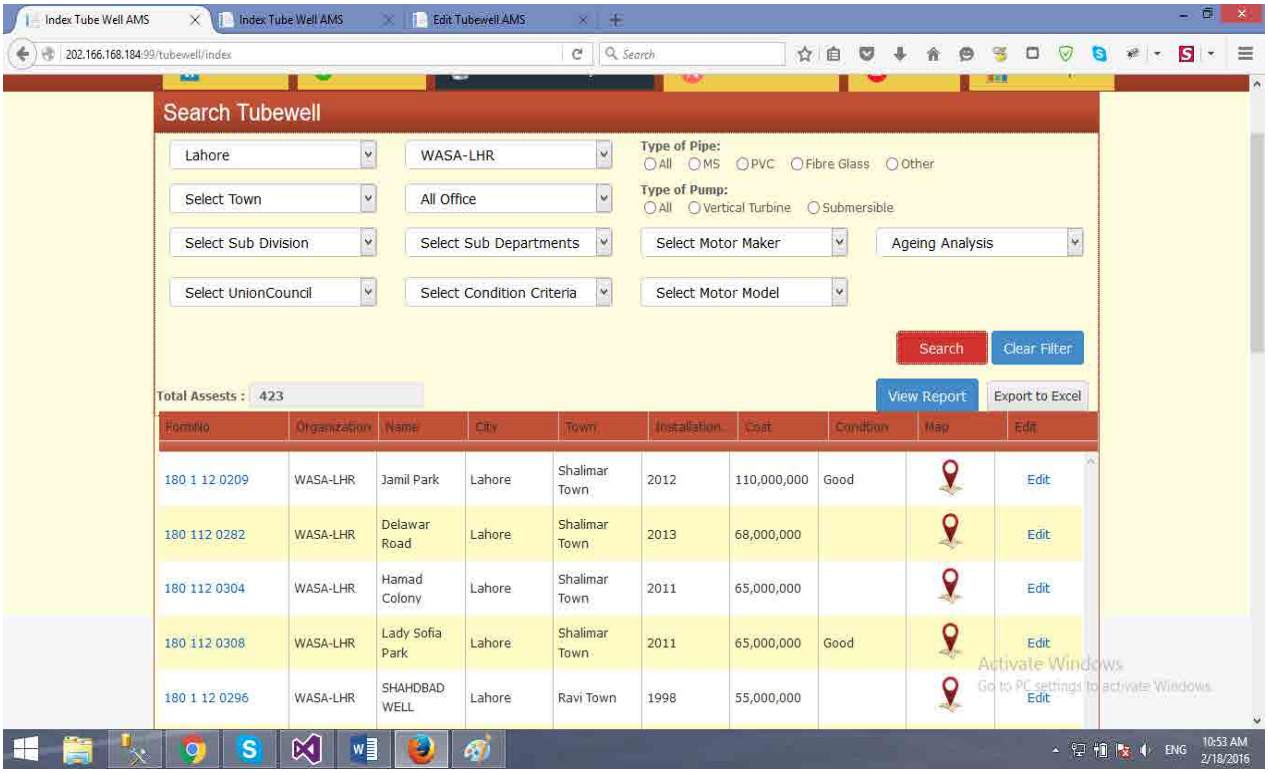
- Click on the 3rd Menu Option "GIS Based Inventory Assets" and click the type of asset you are wondering for, as in the following screenshot



- In case of **Tubewell** you will be redirected to the following search page



- Here you can search any **Tubewell** by selecting relevant dropdowns and clicking search button
- For instance if you wish to search for all of the Tube Wells in Lahore your criteria specification in dropdown will look like the following



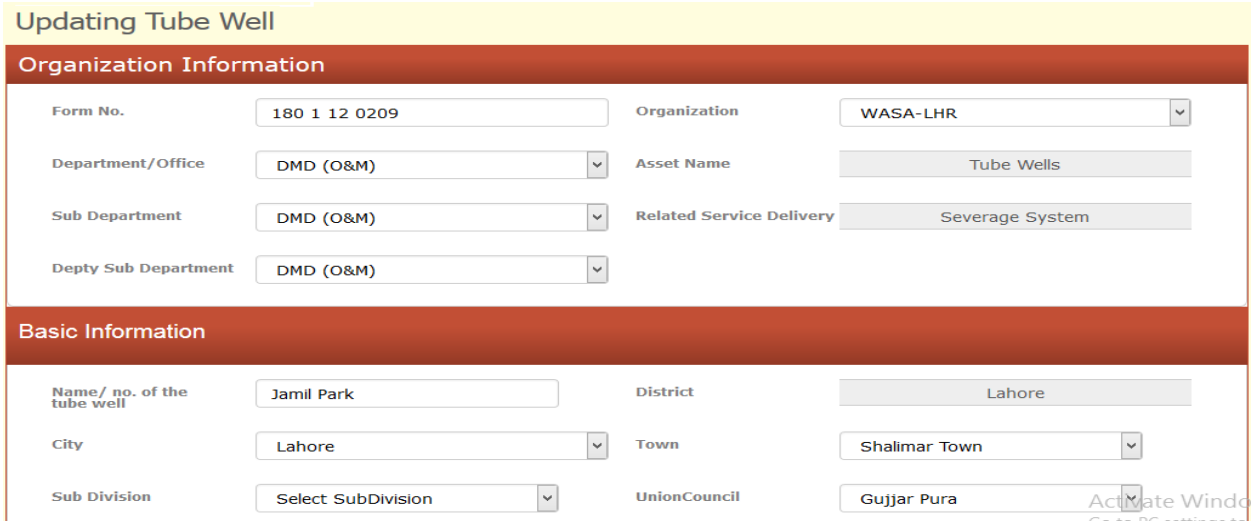
- You can export the results of table in excel sheet by clicking “Export to Excel” button
- “Total Assets” label shows the number of assets meeting this search criteria

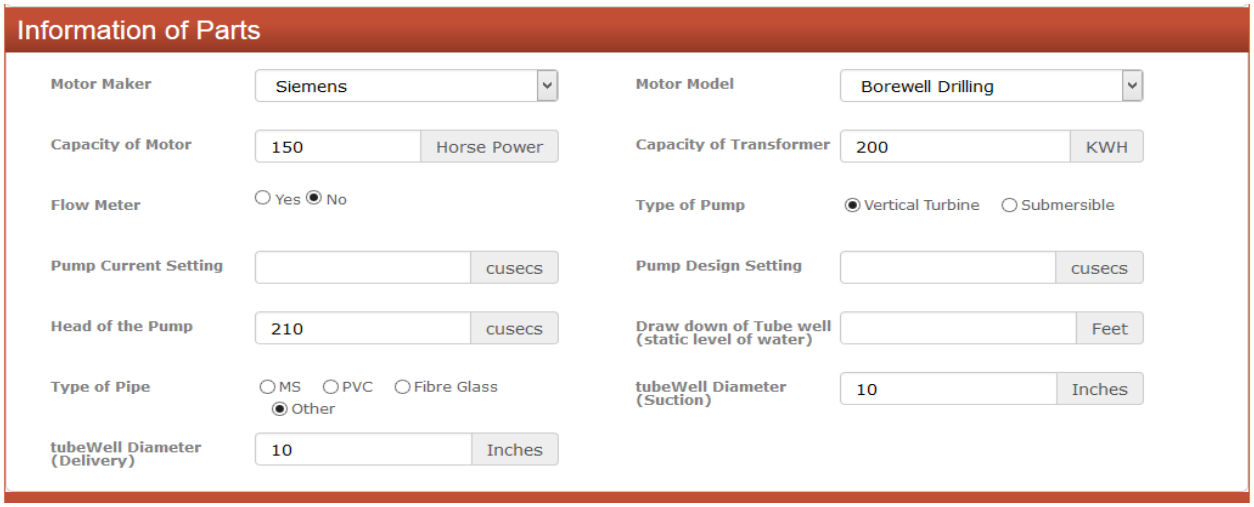
- You can clear the filter and search for all the assets (In this case TubeWell) by clicking clear filter and then search button
- From the list you can edit the already entered information of assets by clicking the "Edit Button"
- By clicking on map icon, it will take you to the GIS site of the asset where you can view all TubeWells geographically on map

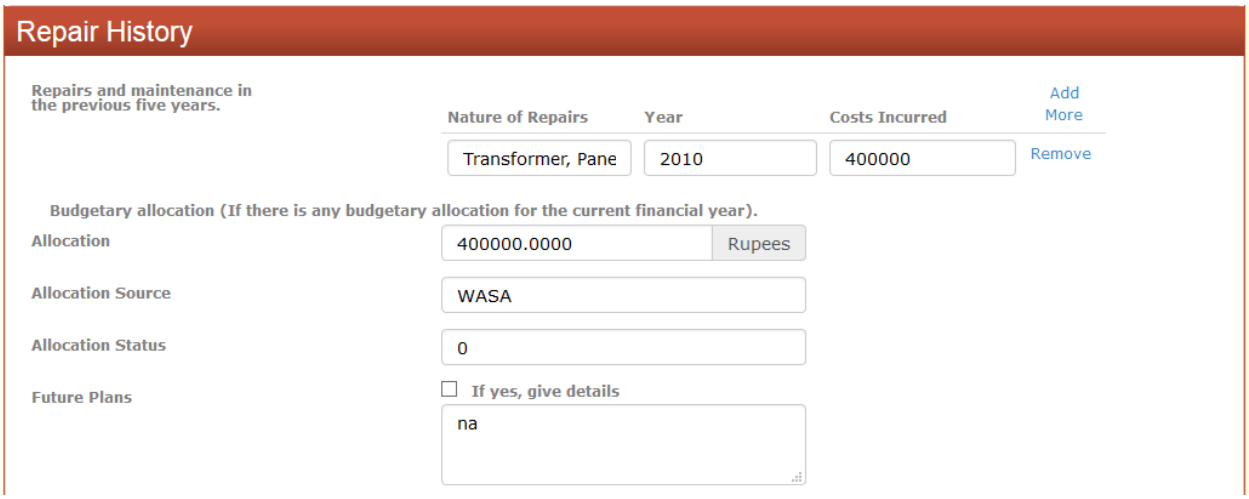
- For detailed list of asset, click on "View Report" button

2.2. Edit Asset

- To edit information of any asset, search the required asset by following the above steps
- Click on the Edit button in the grid which will take you to the following form







- You can modify the required information on page as per need
- You can also modify basic information, condition analysis, repair history, remarks & verification detail
- After modification click on the save button to persist all the changes
- Otherwise clicking on the “Cancel” button will take you to the asset list

Exercise 3: Search any tube well and edit information

3. Conclusion **(20 Minutes)**

The lecturer will invite questions from course participants for further clarification related to addition of asset, searching and editing the asset attributes.

The lecturer will distribute lecture feedback forms among participants for feedback and reflection.

Assignment: Add one Asset of each category and give a presentation highlighting the attributes you feel are missing.

Lecture 4

1. Lecture Information

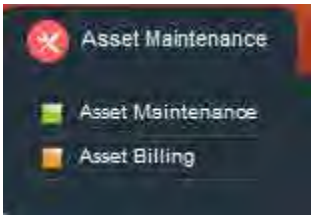
Topics: 1) Operation & Maintenance expenses of Assets 2) Reports
Lecture Duration: 2 Hours

2. Introduction to Topic

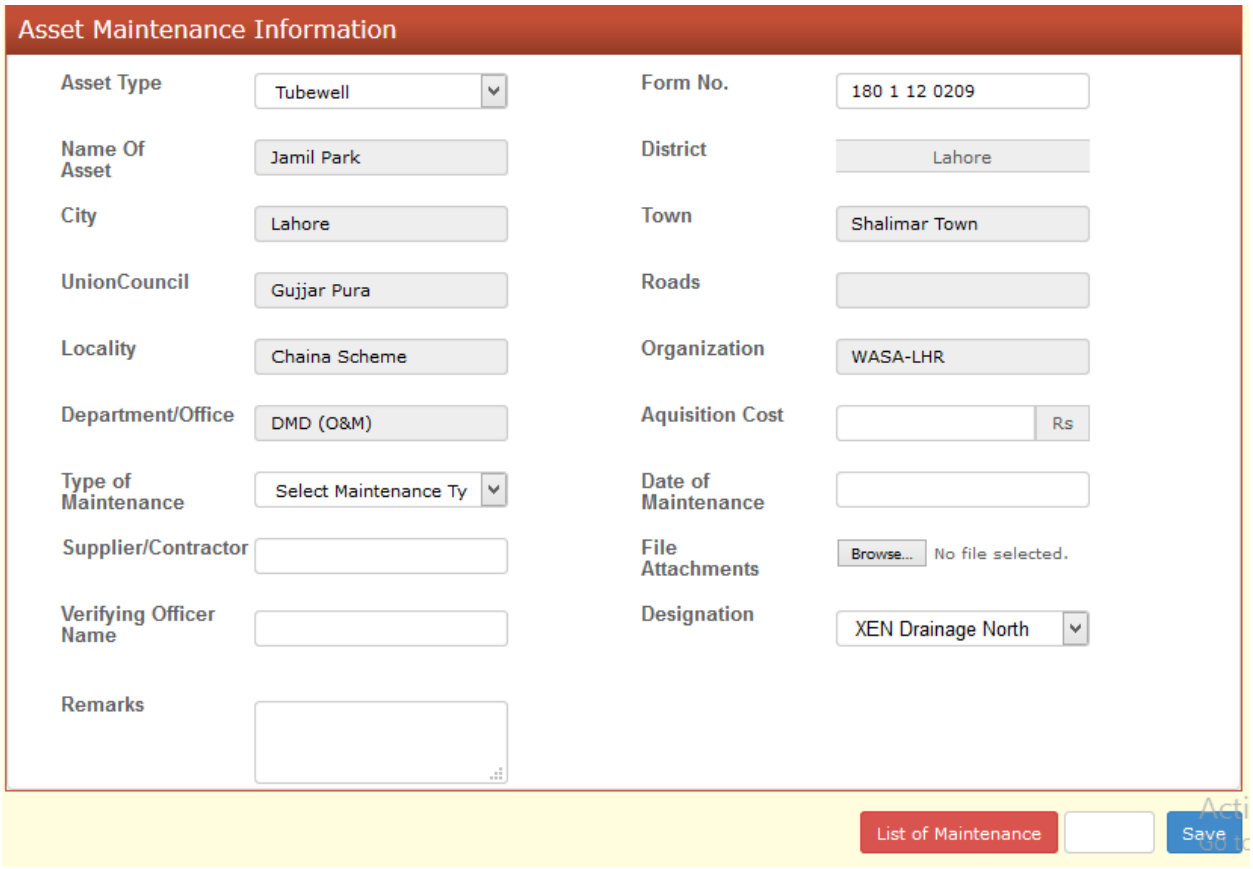
2.1 Operation & Maintenance expenses of Assets: (90 minutes)

The instructor will teach the methods of adding information related to asset maintenance. The steps include;

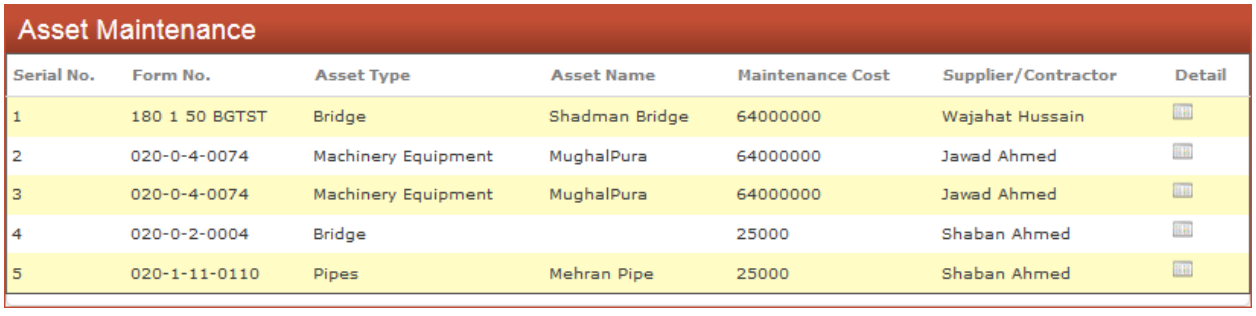
- Hover on the Asset Maintenance Menu & Click on the First Option



- You will be presented with the following form



- Select the Required Asset Type for which you want to enter maintenance information
- Enter Form number and hit enter key
- The grey labels will automatically show up as depicted in above screenshot
- Then enter the maintenance related information of this particular asset
- Click save to persist your changes
- To view already entered maintenances click “List of Maintenance” button
- It will take you to the following screen



Serial No.	Form No.	Asset Type	Asset Name	Maintenance Cost	Supplier/Contractor	Detail
1	180 1 50 BGTST	Bridge	Shadman Bridge	64000000	Wajahat Hussain	
2	020-0-4-0074	Machinery Equipment	MughalPura	64000000	Jawad Ahmed	
3	020-0-4-0074	Machinery Equipment	MughalPura	64000000	Jawad Ahmed	
4	020-0-2-0004	Bridge		25000	Shaban Ahmed	
5	020-1-11-0110	Pipes	Mehran Pipe	25000	Shaban Ahmed	

- You can view maintenance detail by clicking on the detail button, it will look like following screen

Repair & Maintenance Details

Form No. 180 1 50 BGTST Asset Type: Bridge

Print

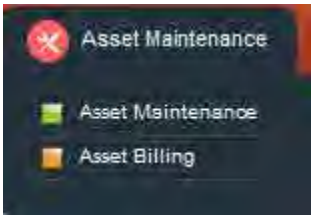
Location		Organization Information	
District	Lahore	Name of Organization	CDG-LHR
City	Lahore	Name of Department/Office	EDO(F & P)
Town	Samanabad Town		
Union Council	Gulshan Ravi		
Road /Street	Fawerra Raod		
Locality	Assembly Hall to Shimla		

Basic Information	
Name of Particular Asset	Shadman Bridge
Aquisition Cost of Asset	64,000,000 (RS)
Type of Maintenance	----
Date of Maintenance	
Supplier/Contractor Name	Wajahat Hussain
Remarks	Nobi

Signing Officer	
Name	---
Designation	

2.2 Asset Billing

- Hover on the Asset Maintenance Menu & Click on the 2nd Option



- You will be presented with the list of billing as depicted below

ReferenceNo	Name	Feeder Name	Tariff	City	Town	Cost
24112459005700	H-2 Block	SABAZA ZAR COLON	46	Lahore	Iqbal Town	15118136
24111349010000	Bagh Munshi Ladha	DATA DARBAR	12	Lahore	Datta Ganj Baksh Town	14225507
24113529003701	B-I Block Gujarpura	CHINA SCHEEM	46	Lahore	Shalimar Town	13513084
24115159005402	G-Block Gulberg-II	RABI CENTER	10	Lahore	Gulberg Town	10669323

- Like the other lists it can be exported to excel
- Like the other lists it can be filtered based on criteria selection from dropdowns

2.3 Asset Depreciation

- Hover on the Finance Menu & Click on the 1st Option

- Here you can make selection of asset type and enter form number
- After it hitting enter key, asset information will automatically show up in grey labels
- Then you can select deprecation year, method from dropdown list
- After it specify rate of depreciation
- Then you can save the specified depreciation for the asset by clicking save button
- To view old depreciations click on list button
- You will be presented with the list of depreciations as depicted below

Asset Depreciation

Serial No.	Form No.	Asset Name	Year of Acquisition	Acquisition Cost	Depreciation Rate	Current Year Depreciation	Detail
1	120050008	Parking Stand	2005	810000	0.255	53999	
2	BR-7241	Bridge	1998	2100000	25000	138333	
3	1200950003	Parking Stand	2005	1820000	211	7136	
4	020-0-6-0610	Land		150000	25000	8333	
5	0200-0-7-0012	Building	1978	12000000	0.255	22018	

- Like the other lists it can be exported to excel
- Like the other lists it can be filtered based on criteria selection from dropdowns

2.4 Asset Auction

- Hover on the Finance Menu & Click on the 3rd Option

- Here you can make selection of asset type and enter form number
- After it hitting enter key, asset information will be auto populated in grey labels
- Then you can specify net book value, auction value & date

- After it you can upload any attachment
- Then you can save the specified depreciation for the asset by clicking save button
- To view accumulated depreciation click on list button
- You will be presented with the list of depreciations as depicted below

Asset Auction

Serial No.	Form No.	Asset Type	Netbook Value	Auction Value	Profit/Loss	Detail
1	180 1 50 BGTST	Bridge	6000000	6500000	500000	
2	180 002 21TST	Parking Stand	25000000	2500000	-22500000	
3	120072036	Building	10000000	1200222	-8799778	

- Like the other lists it can be exported to excel
- Like the other lists it can be filtered based on criteria selection from dropdowns

2.5 Energy Audit

- Hover on the Finance Menu & Click on the 4th Option

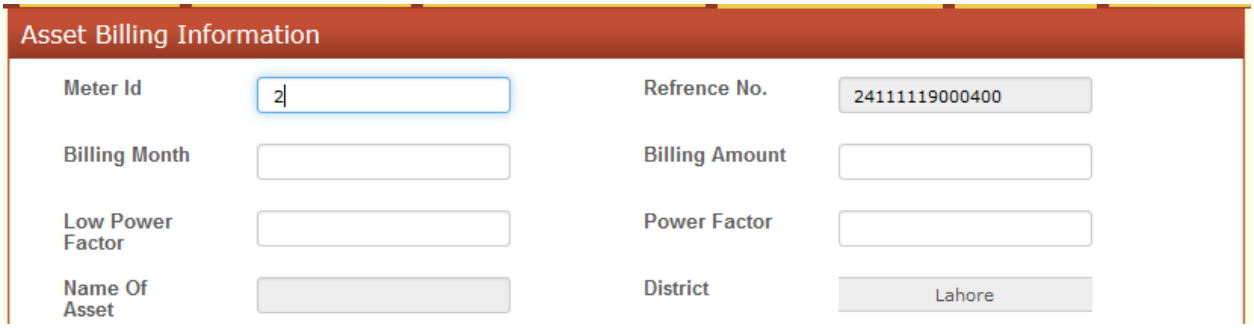
- You will be presented with the list of meters/connections as depicted below

New Meter

Meters/Connections

Meter No	Reference No	Tariff	Sancationed Load	Feeder Name	
2	24111119000400	46	135	SANT NAGAR	Associate Assets | Details | Add Bill
4	24111119000900	46	61	SANDA	Associate Assets | Details | Add Bill
5	24111119001000	46	61	SIR SYED	Associate Assets | Details | Add Bill
6	24111119001600	46	116	SIR SYED	Associate Assets | Details | Add Bill

- You can view detail of connection by clicking on “Details” link
- This detail page also enlist previous bills and its trend graphically
- You can add bill by clicking on “Add Bill” link in meters listing
- The add bill screen looks like the following screenshot



- Here you can add Billing amount along with the month & power factors
- You can also upload any attachment relating to this bill

Exercise 4: Insert information related to Operations and maintenance of a disposal station

3. Reports (20 minutes)

Currently there are three types of asset reports available

3.1 Asset Condition

- Hover on the Asset Reports Menu & Click on the 1st Option

- You will be presented with the list of assets condition wise as in the following figure

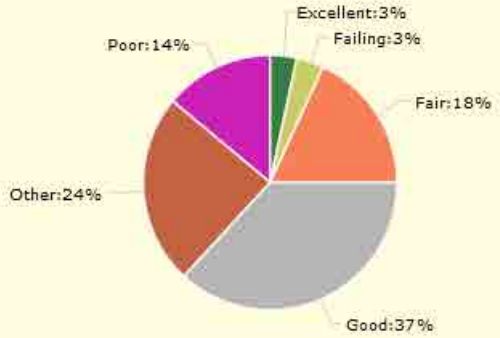
Asset Condition

Asset	Poor	Fair	Good	Excellent	Total
Building	1749	424	1749	2274	6196
Tubewell	392	79	410	0	881
Disposal Station	11	116	29	0	156
Total	**2152**	**619**	**2188**	**2274**	**7233**

- There is also a graphical representation of asset condition wise & its depicted below

Building Assets Condition

Type	Condition
Excellent	424
Failing	435
Fair	2274
Good	4620
Other	3030
Poor	1749
Total	**12532**



3.2 Asset IDAMP

- Hover on the Asset Reports Menu & Click on the 2nd Option

- From here, you can view IDAMP graphically

3.3 Long List of Assets

- Hover on the Asset Reports Menu & Click on the 3rd Option

- It will take you to the page of long list of assets
- Its screenshot is given below

Asset Code	Category	Sub Categ	Condition	Risk	Residual	Classification	Condition	Residual	Long List	Type of	Estimated	SSE(30%)	Feasibility(1	Environment	Service	PP(10%)	Total Grade
1801850104000200 20-11	Building	--	Fair		5	A		5	No		--						
1801850104000200 20-41	Building	--	Good		21	A		21	No		--						

- It can be exported to excel by clicking on “Export” button

3.4 Logout

You can sign out of the AMS System by clicking on the logout button at the top bar

- It will clear your session & take you to the login page

Lecture 5

1. Lecture Information

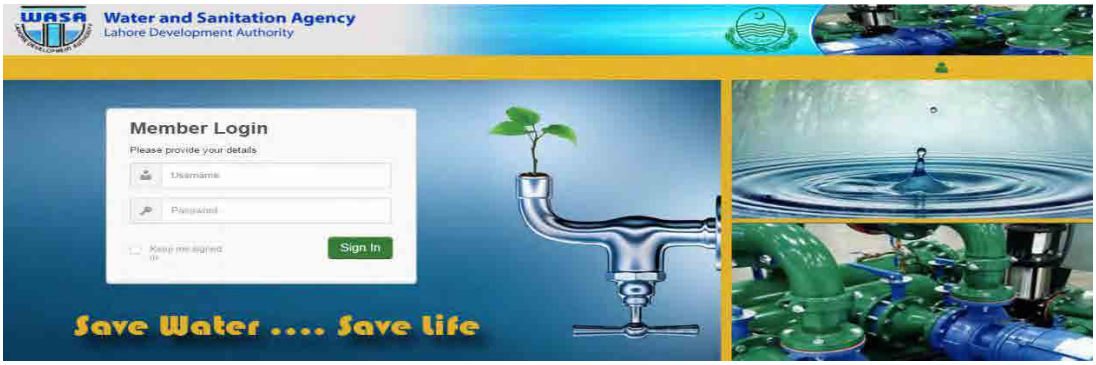
Topics: 1) Addition of Underground pipelines and plan the replacement 2) Reports
Lecture Duration: 2 Hours

2. Introduction to Topic

2.1. **Addition of Underground Pipelines and plan the replacement: (100 minutes)**

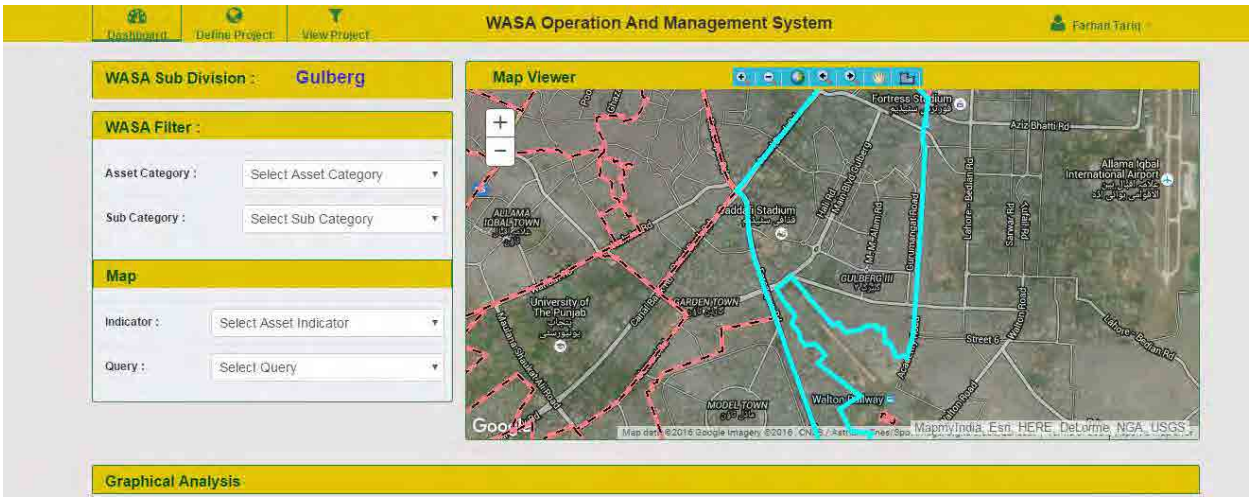
The trainer will tell the CPs about the login information of underground GIS based software. To login into the system follow following steps;

- Open web browser
- Go to the login page by typing the following URL address
  http://202.166.167.126/wasa_asset/login.php
  It will take you to the following screen



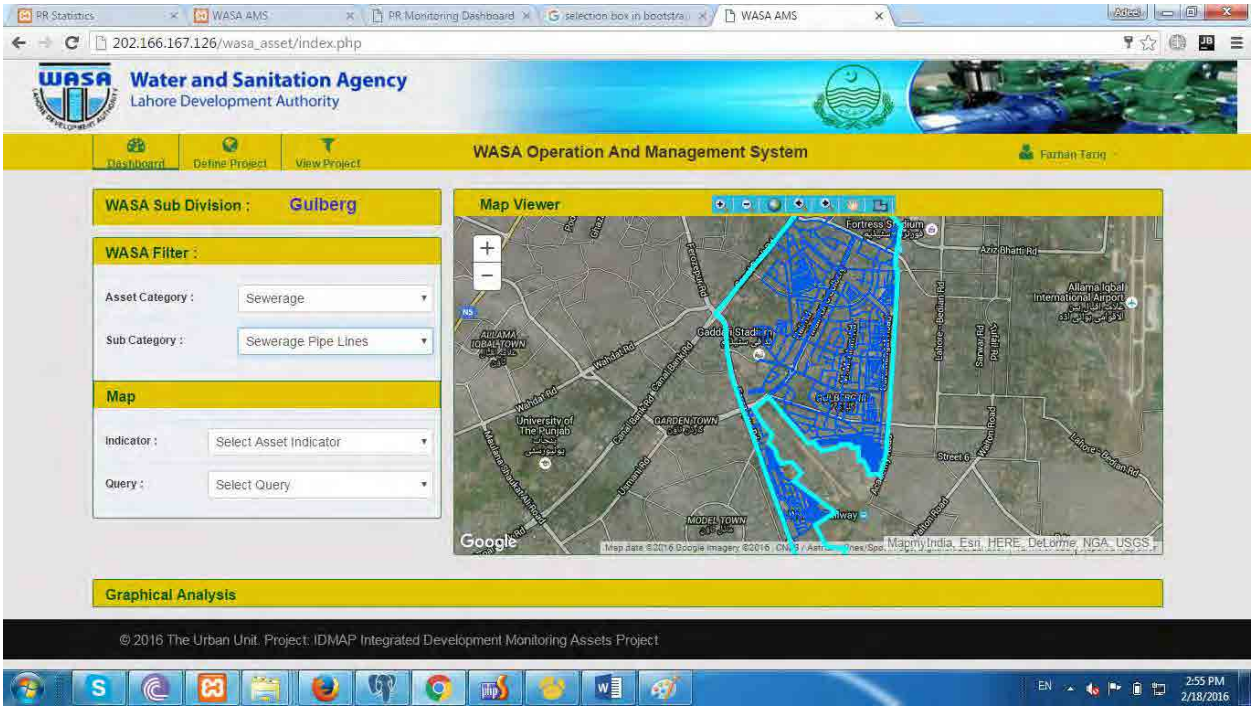
- Enter your username and password
- Click Login button
- After authentication you will be redirected to your dashboard

At present, all the underground assets have been included into the software and Subdivision Officer is required to plan the replacement and extension of these water supply and sewerage pipelines. The SDO Dashboard looks like;



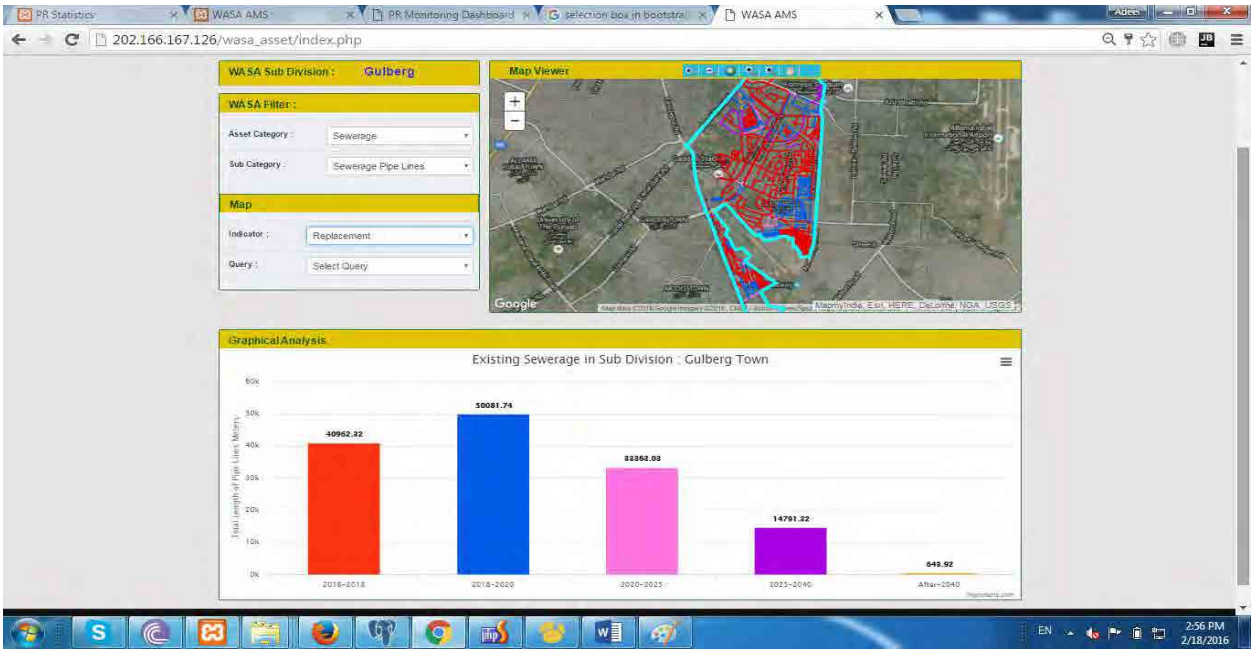
Then the trainer will tell how to see the sewerage lines of a subdivision. In order to see the sewerage lines, the following steps are to be followed;

- Select the sewerage from the asset category
- Select the sewerage pipelines from the sub category. Then the dashboard will look like;

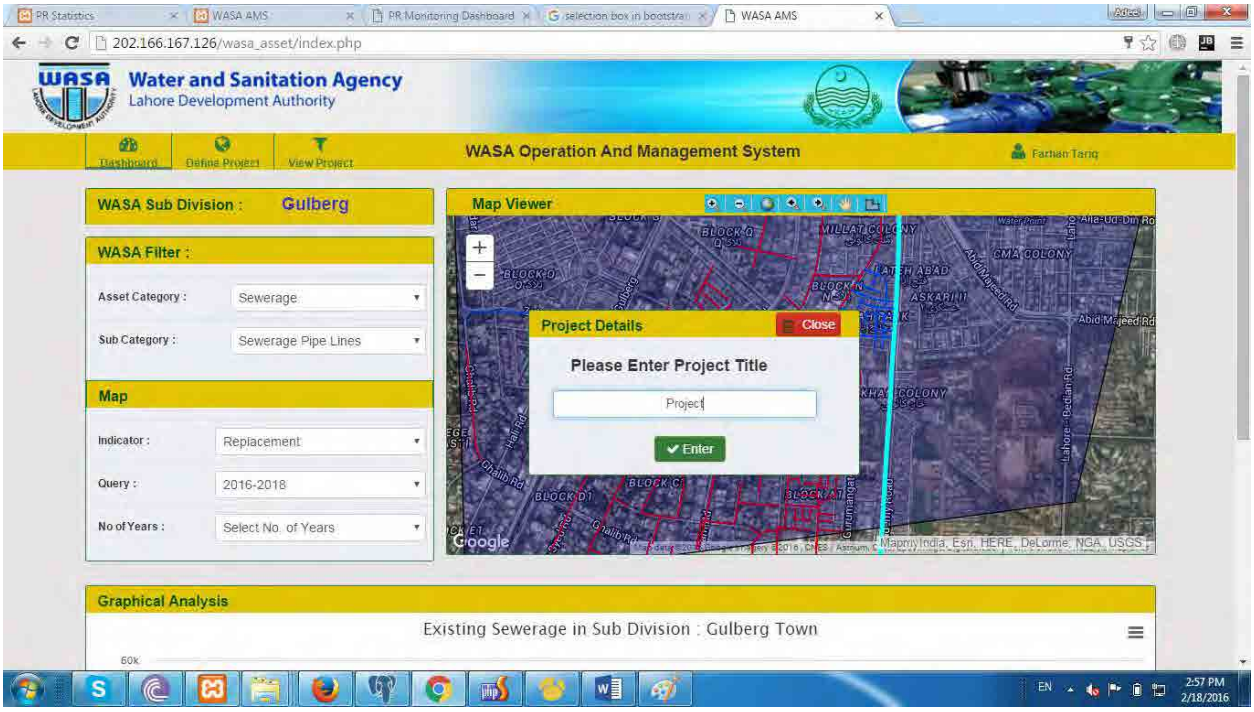


The lecturer will explain how to see the replacement planning of any subdivision. In order to see that follow the steps;

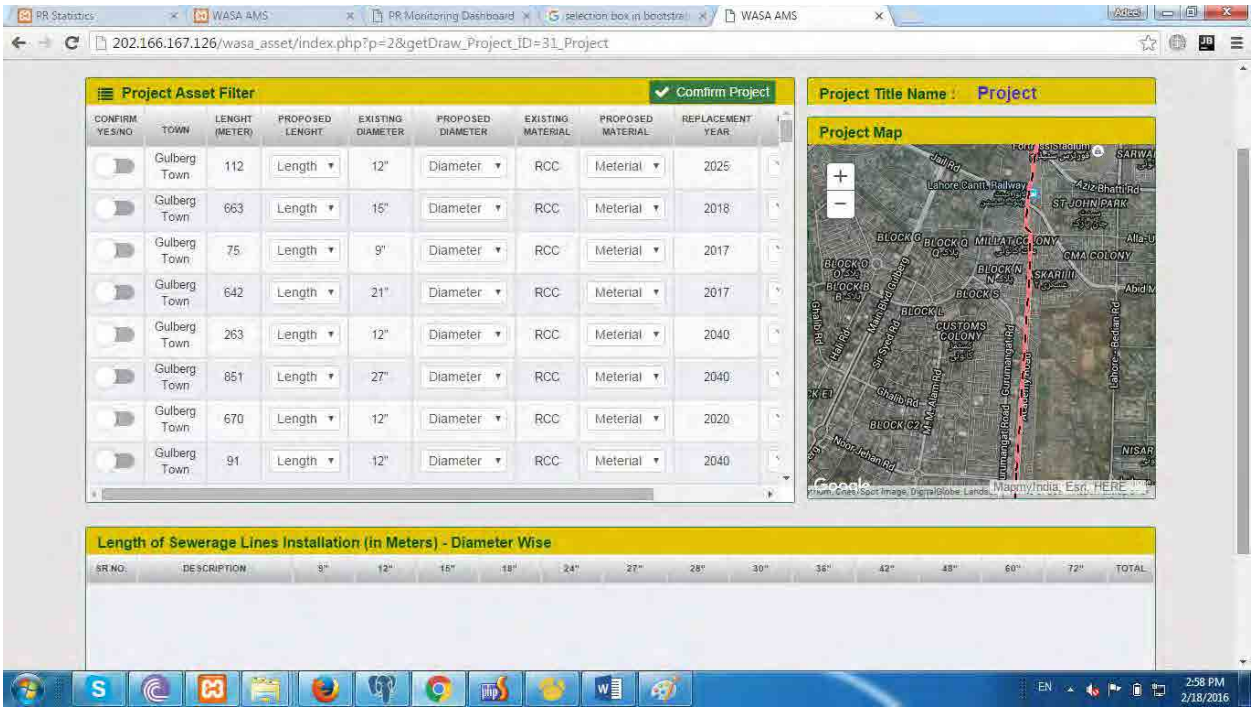
- Select replacement from indicator. The window looks like;

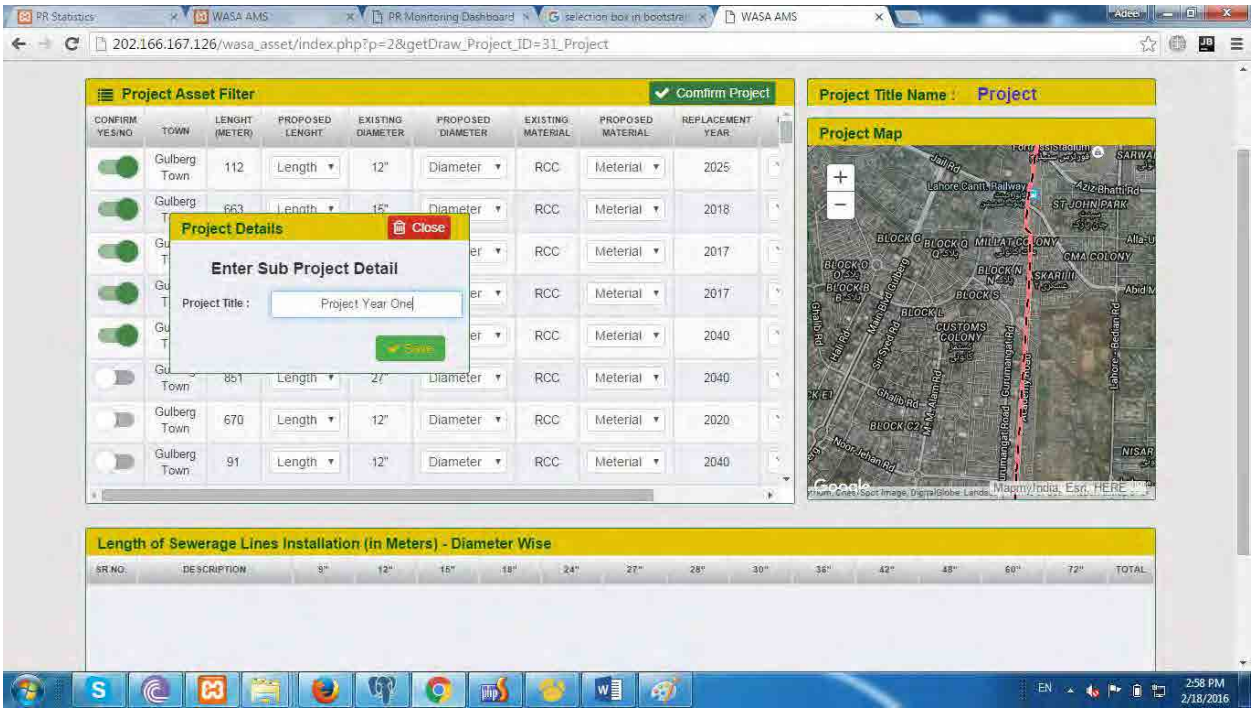


The lecturer will explain how to create projects, sub-projects, view the aspects and prioritize the projects from the replacement planning. In the process the following windows will appear;

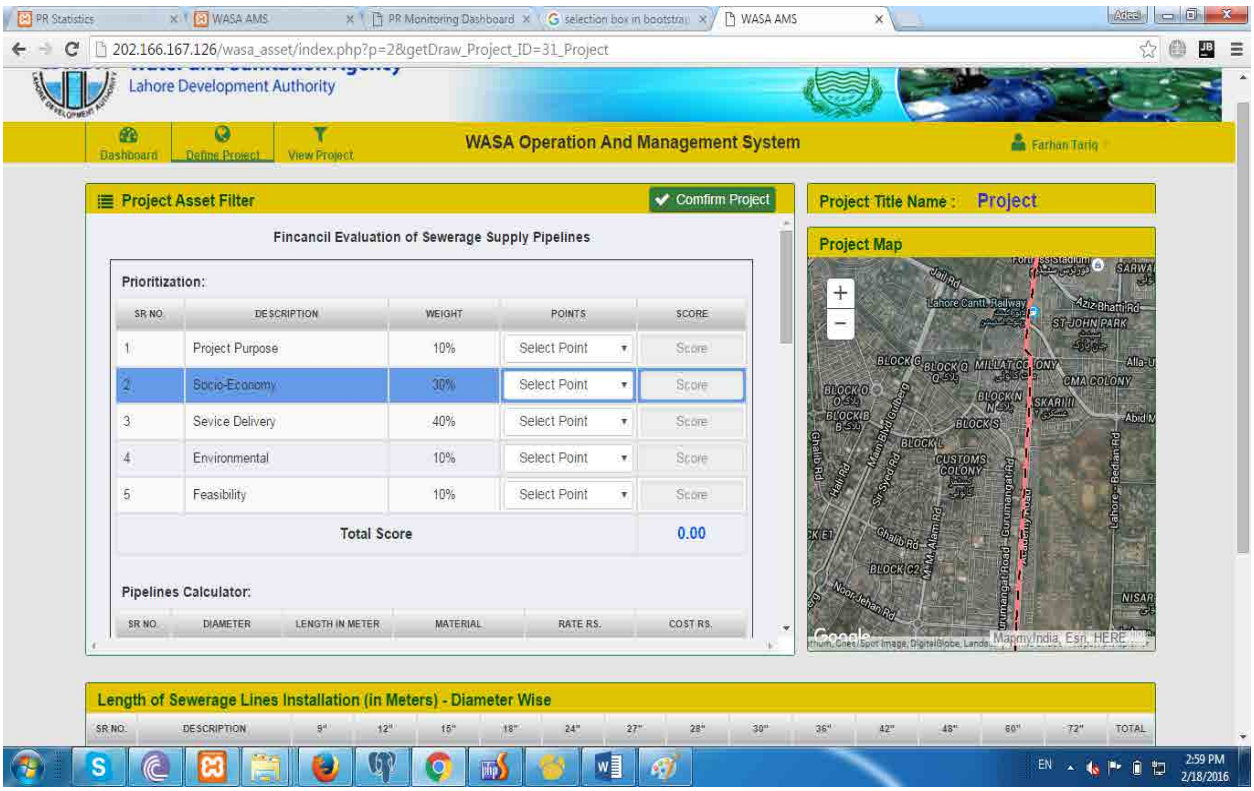


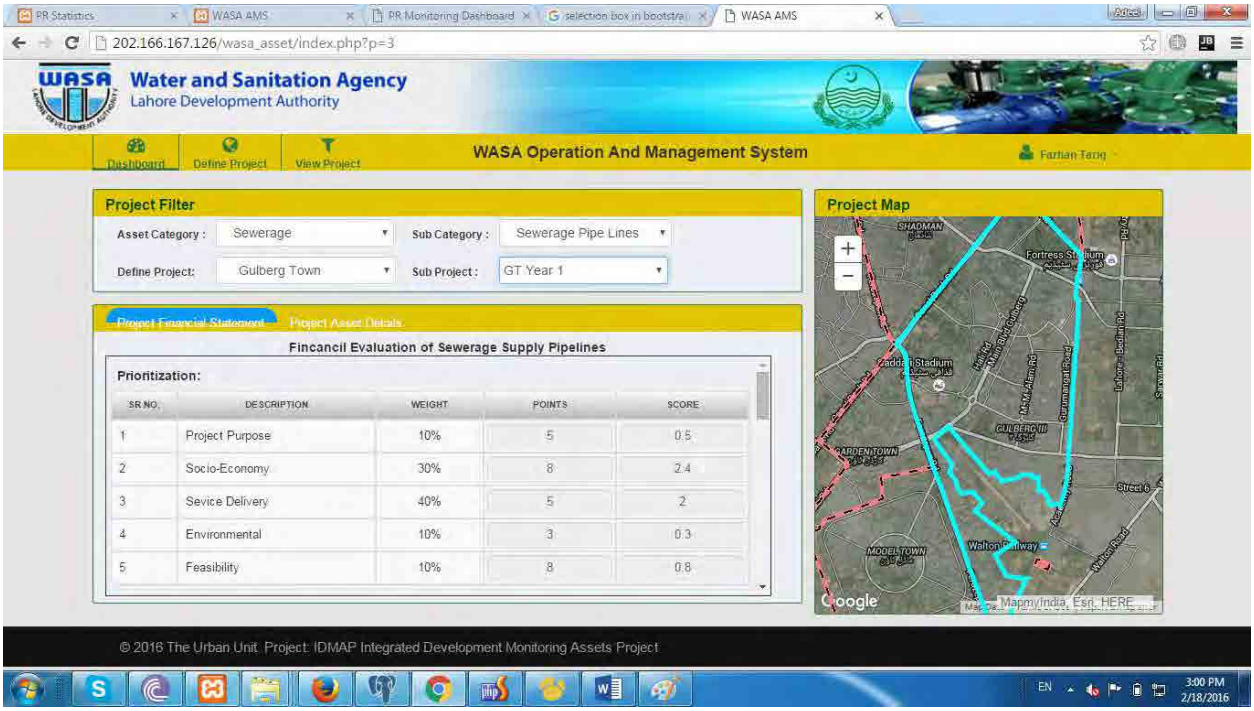
Creation of sub-projects:





Filling of Project Digest Form:





Exercise 5: Create project, sub-project and fill the financial evaluation form for water supply pipelines

3. Conclusion (20 Minutes)

The lecturer will invite questions from course participants for further clarification related to addition of underground water supply pipelines, Sewerage Pipelines, creation of projects and evaluation.

The lecturer will distribute lecture feedback forms among participants for feedback and reflection.

Asset Management

Course Code: M4131

Asset Database Analysis
Module 3

Lecture Notes

2016

1. Lecture Information

Course Title: Asset Management	**Course Code**:
Module Title: Asset Database Analysis	**Module No**: 3
Lecture Topic : Asset Condition Analysis, Diameter base Analysis	**Lecture Duration:**4 Hours

2. Data Description

The terms used in the datasets are listed and defined below, for reference by the tutor as well as the CPs.

Asset condition

Asset condition explains the state of the asset in term of its physical, functional and performance based ranking. For example:

Rank	Condition	Description
A	Excellent	No noticeable defects. Some aging or wear may be visible.
B	Good	Only minor deterioration or defects are evident.
C	Fair	Some deterioration or defects are evident, but function is not significantly affected.
D	Poor	Serious deterioration in at least some portion of the structure. Function is inadequate.
F	Failed	No longer functional. General failure or complete failure of a major structural component.

Asset Risk

Risk is the probability of failure of the asset and is defined in term of High, Medium and Low:

H → High, M → Medium, L → low

Level

Level is classified in three classes; Primary level, secondary level and tertiary level. In the attribute table they will be shown as:

P → Primary, S → Secondary, T →Tertiary

Replacement Year

Replacement year indicates the remaining life of an asset and provide information on when an asset should be replaced. This is usually determined by the manufacturer and lead engineer, based in part on the service life and run time.

Replacement diameter

Replacement diameter means when a pipe has to be replaced, what should be its future diameter and also diameter reveals the information that whether it should be changed or should remain same.

3. Inventory of WASA Lahore Assets

Summary of WASA assets with help of pivot tables.

	Lahore	Gujranwala	Faisalabad	Multan	Rawalpindi
Tube wells	519	53	85	104	400
Water Pipelines (km)	4500	507	1436	1290	714
Disposal stations	99	22	22	20	-
Sewerage Pipeline (km)	3957	808	1760	1382	134

4. What is Pivot Table

Pivot tables are one of Excel's most powerful features.

A pivot table allows you to extract, summarize and explore data interactively from detailed data set. Building a pivot table is the process of answering questions you have about the data e.g.:

- ✓ What is total length of Pipes by Subdivision?
- ✓ What is the length of pipelines with 6” diameter?
- ✓ Once you create a pivot table, you can quickly transform huge numbers of rows and columns into a meaningful, nicely formatted report.

Different type of analysis related to assets can be performed using pivot tables. The following exercises will explain its functionality and benefits. First we’ll perform analysis regarding assets condition.

Exercise 1: Condition Analysis

The following table shows Water supply pipes of Lahore. Please conduct your database analysis in a table and graph, using Pivot Table in the Excel.

	Street_Name	Sub_Division	Town	Diameter	Material	Intallation	Conditi	placement_Dia	eplacement_Y	Level	Risk	hape_Length	)
2	main pecco road	Township	Nishter Town	10"	AC	2000	B	10"	11	P	M	1896.653919	
3	Main pecco road	Township	Nishter Town	10"	AC	2011	B	10"	25	P	L	1915.949432	
5		Township	Nishter Town	8"	AC	2000	B	8"	12	S	L	600.8450439	
7		Township	Nishter Town	10"	AC	2010	B	10"	20	S	L	213.4052574	
9	model town link road	Township	Nishter Town	8"	AC	2009	B	8"	20	S	L	444.5776576	
10	R Block Model town	Township	Nishter Town	4"	AC	1994	B	4"	12	S	L	97.24220231	
11	Karma_wala Bazar	Township	Nishter Town	6"	AC	1986	B	6"	15	T	L	329.7944242	
15		Township	Nishter Town	12"	AC	1987	B	12"	15	T	L	478.8977818	
16		Township	Nishter Town	8"	AC	1987	B	8"	15	P	L	1943.078345	
17	extention	Township	Nishter Town	12"	AC	1987	B	12"	15	S	L	139.3136498	
19	Extention	Township	Nishter Town	8"	AC	2000	B	8"	20	T	L	253.9458667	
20	Extention	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	123.0487501	
21	KHADAM PARK	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	110.4098695	
22	R Block Model Town Extention	Township	Nishter Town	4"	PVC	1992	B	4"	12	T	L	199.2874524	
23	R Block Model Town Extention	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	282.9811107	
24	R Block Model Town Extention	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	105.9039282	
25	R Block Model Town Extention	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	66.6975641	
26	R Block Model Town Extention	Township	Nishter Town	4"	PVC	1992	B	4"	12	T	L	107.4636598	
27	Khadam Park near Itefaq Cricket Ground	Township	Nishter Town	8"	AC	2000	B	8"	16	P	L	277.9007928	
28	R Block Model Town Extention	Township	Nishter Town	4"	AC	1992	B	4"	12	T	L	73.52308128	
31	Q Block Model Colony	Township	Nishter Town	4"	AC	1987	B	4"	20	T	L	245.8719307	
32	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	102.1487785	
33	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	213.0720068	
34	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	240.9920837	
35	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	116.8837562	
36	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	210.3503903	
37	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	210.8930082	
38	Q Block Model Colony	Township	Nishter Town	4"	AC	1974	B	4"	20	T	L	71.49516675	

Figure 1: Water supply pipes data of Lahore

For Creating pivot tables do the following steps:

1. Select the data you want to analyze,
2. Then go to Insert and click on “Pivot Table”
3. Choose “New Work Sheet” for the Pivot table to be placed

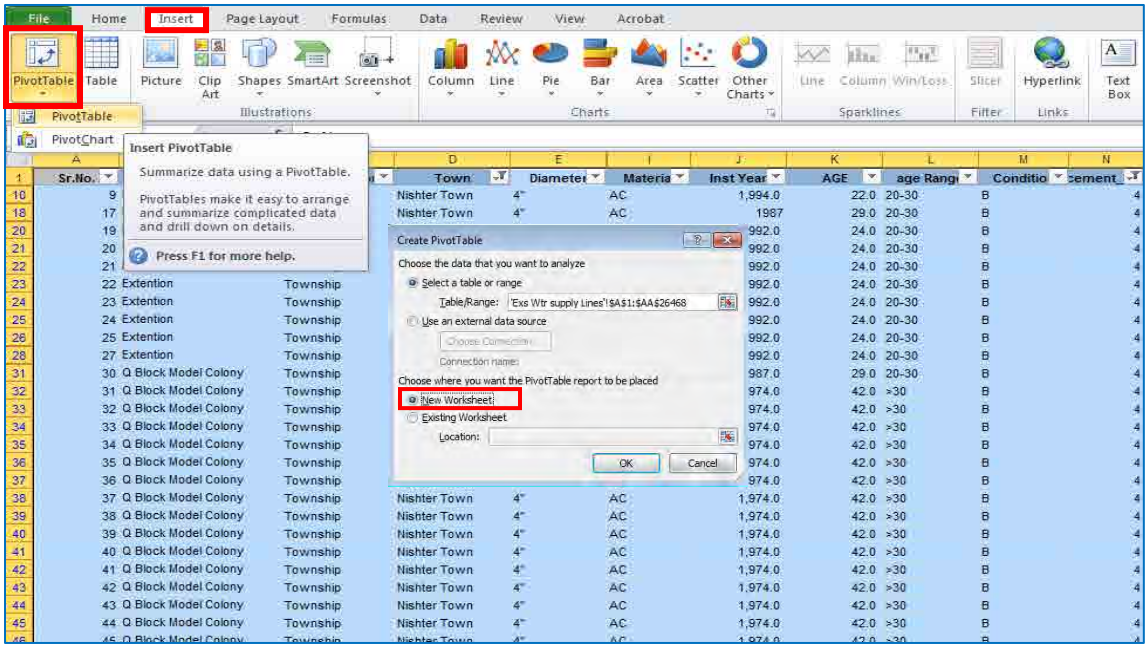
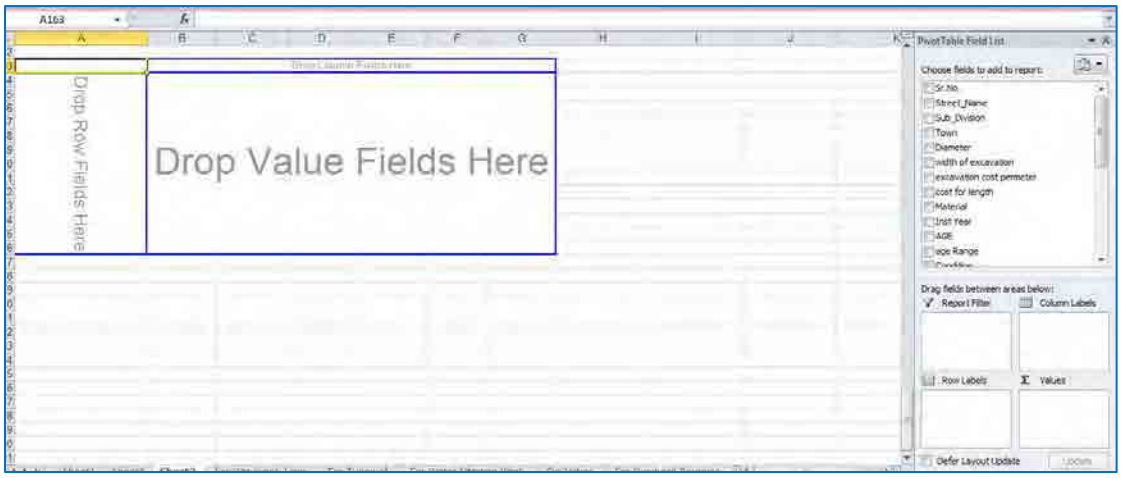


Figure 2: Creating Pivot Table



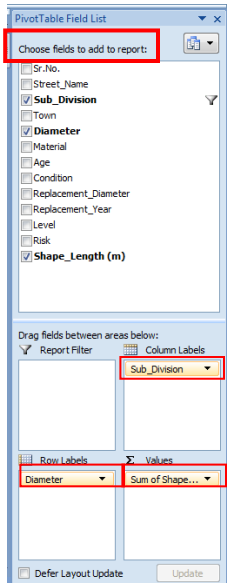
Exercise1-1: Condition of Pipelines (m) on town level

For creating the condition of pipeline table on town level follows the steps in "Pivot table Filed List"

1. Drag the Sub_division field and drop to "**Column labels**"
2. Drag the diameter field and drop to "**Row Labels**"
3. Drag and drop the length field to **"∑ Values"**

Town	A	B	C	D	F	Grand Total
Aziz Bhatti Town	28063	4601	50987	90828	190	174669
Gulberg Town	19464	142638	190013	38620	3113	394237
Gunj Bakhsh Town	50247	176774	322865	180271	22	730178
Iqbal Town	44302	88379	501957	277390	2828	914856
Nishter Town	30690	350795	169589	104291	2415	657779
Ravi Town	157818	250400	299473	201094	2637	911422
Shalimar Town	137574	265308	150241	133932	15492	718371
Grand Total	468158	1278895	1685124	1026427	26696	4501514

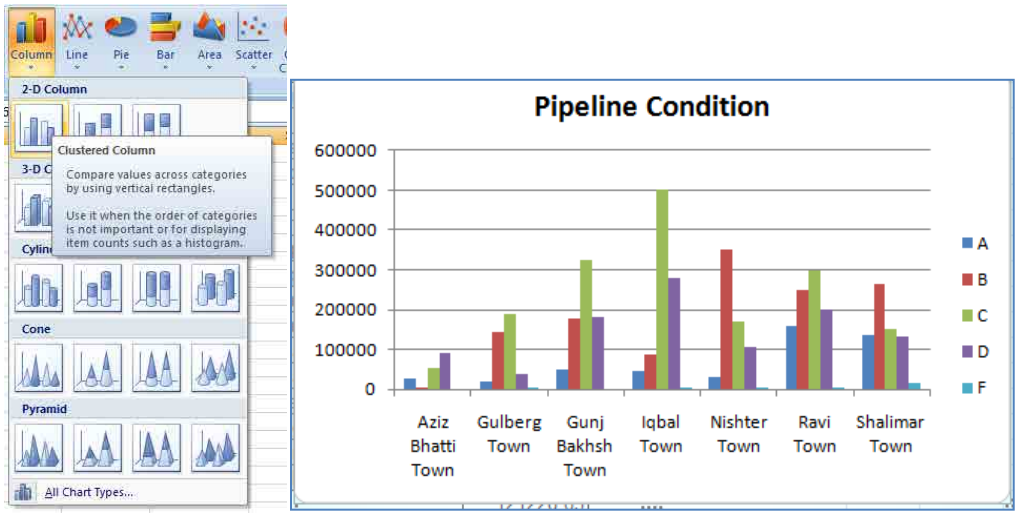
Figure 3: Pipes Condition on Town level



For making graph from the table:

1. Select the table created
2. Go to **Insert** and Click on **"Column"**

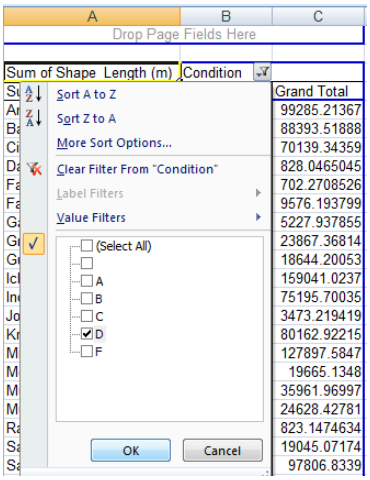
You will get the following graph

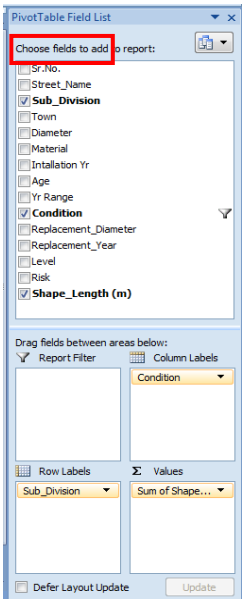


Exercise 1-2: Comparison of Poor pipes on Subdivision level

If you want to find out which subdivision has more poor condition pipeline,follow the steps:

1. Drag the Sub_division field and drop to "**Row Lables**"
2. Drag the Condition field and drop to "**Column Labels**"
3. Drag and drop the length field to "∑ **Values**"
4. Filter the Condition column for D (poor) condition, "Check D" only





You will get the following graph

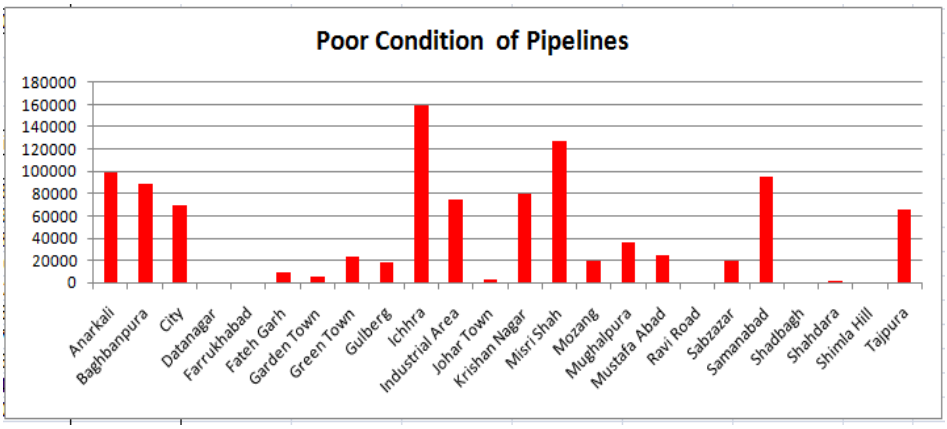


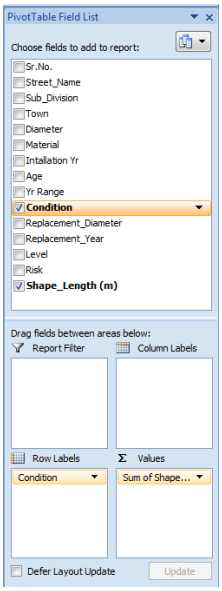
Figure 4: Poor Condition of Pipes

The Graph shows that water supply pipes of Ichra subdivision are in poor condition.

Exercise: 1-3 Percentages of pipeline lengths in terms of condition

Filter garden town subdivision and assess the percentage of pipeline lengths in terms of condition.

1. Drag and drop the Condition Column to "**Row Lables**"
2. Drag and drop the length field to "∑ **Values**
3. Use the function **"**=B118*100/B124" (**"**=Length*100/Total Length") to get value sin %age. You will get 0.36 % for 1st row.
4. Then Drag this 1st cell upto rest of the rows



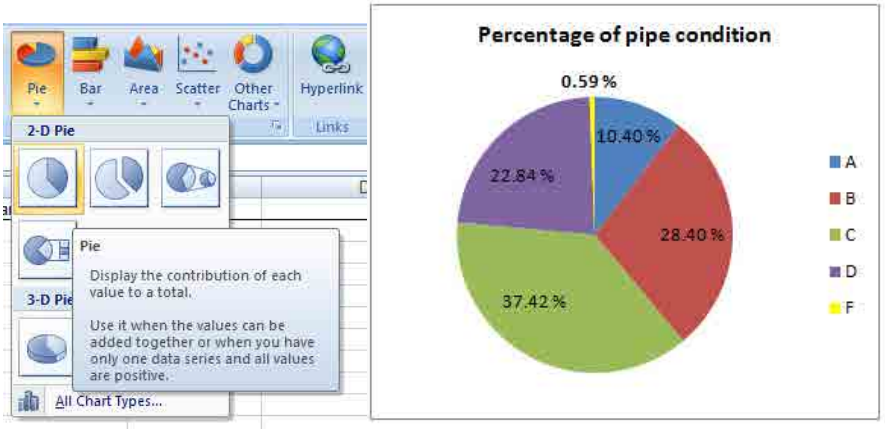
Condition	Length (m)	% Length
	16213.50	0.36
A	468157.53	10.40
B	1278894.94	28.40
C	1685124.37	37.42
D	1028403.21	22.84
F	26696.20	0.59
Grand Total	4503489.75	100.00

Figure 5: Percentages of pipeline lengths in terms of condition

Pie Chart of the above table will help in better understanding.

To make a pie chart from the table:

1. Select the "Condition" and "% Length" Column
2. Go to Inset and click on "Pie"



The following table shows tube wells in Lahore. Please conduct your database analysis in a table and graph, using Pivot Table in the Excel.

Sr. No.	Name	Installation Year	Status	Town	Generator	Design Capacity	Actual Capacity	Condition	Replaceme	Motor_Size	Sub_Divisi
1	Chenab Block	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	8	150 HP	Allama Iqbal Town
2	Pak Block	1986	Functional	Iqbal Town	YES	4 CFS	1.75 CFS	D	4	150 HP	Allama Iqbal Town
3	Asif Block	2014	Functional	Iqbal Town	NILL	4 CFS	4 CFS	A	14	150 HP	Allama Iqbal Town
4	Clifton Colony	2014	Functional	Iqbal Town	NILL	4 CFS	4 CFS	A	14	150 HP	Allama Iqbal Town
5	Neelum Block	2008	Functional	Iqbal Town	NILL	4 CFS	2 CFS	D	5	150 HP	Allama Iqbal Town
6	Hunza Block	2008	Functional	Iqbal Town	YES	2 CFS	2 CFS	C	7	80 HP	Allama Iqbal Town
7	College Block	1993	Functional	Iqbal Town	NILL	4 CFS	2 CFS	C	7	150 HP	Allama Iqbal Town
8	Raza Block	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	9	150 HP	Allama Iqbal Town
9	Kareem Block	1996	Functional	Iqbal Town	NILL	4 CFS	1.75 CFS	D	4	150 HP	Allama Iqbal Town
10	Kareem Block Graveyard	2004	Functional	Iqbal Town	YES	2 CFS	2 CFS	C	8	80 HP	Allama Iqbal Town
11	Nishter Block	2009	Functional	Iqbal Town	NILL	2 CFS	1.90 CFS	D	6	80 HP	Allama Iqbal Town
12	F&V Market 2 Wadhat Road Multan Chungi	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	B	8	150 HP	Allama Iqbal Town
13	F&V Market 1 Main Multan Road	2010	Functional	Iqbal Town	NILL	4 CFS	3.75 CFS	C	10	150 HP	Allama Iqbal Town
14	Ravi Block	2011	Functional	Iqbal Town	NILL	4 CFS	3.90 CFS	C	12	150 HP	Allama Iqbal Town
15	Nargis Block	2008	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	7	150 HP	Allama Iqbal Town
16	Huma Block	1999	Functional	Iqbal Town	NILL	4 CFS	3.25 CFS	C	8	150 HP	Allama Iqbal Town
17	Jahanzaib Block	1986	Functional	Iqbal Town	NILL	4 CFS	2 CFS	D	2	150 HP	Allama Iqbal Town
18	Kmaran Block	2010	Functional	Iqbal Town	NILL	4 CFS	3.75 CFS	C	10	150 HP	Allama Iqbal Town

Figure 6: Tube Wells data -WASA Lahore

You are required to conduct the database analysis with Pivot tables in excel.

Exercise 1-4: Status of Tube wells

If you want to find out status of tube wells follow the steps below:

1. Drag the status field and drop to "**Axis field**"
2. Drag and drop the Name field to "∑ **Values**"

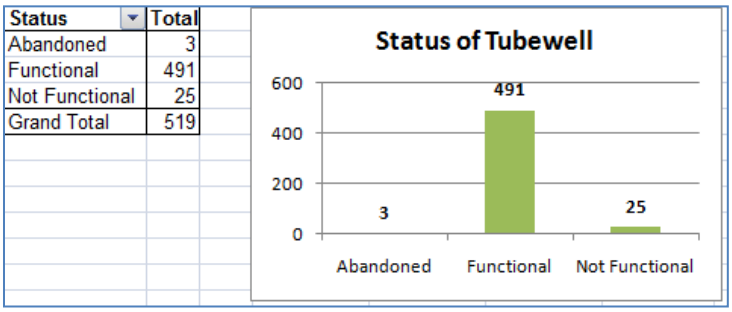
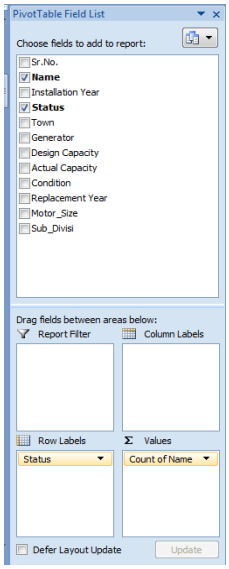


Figure 7: Tube well Status table and graph



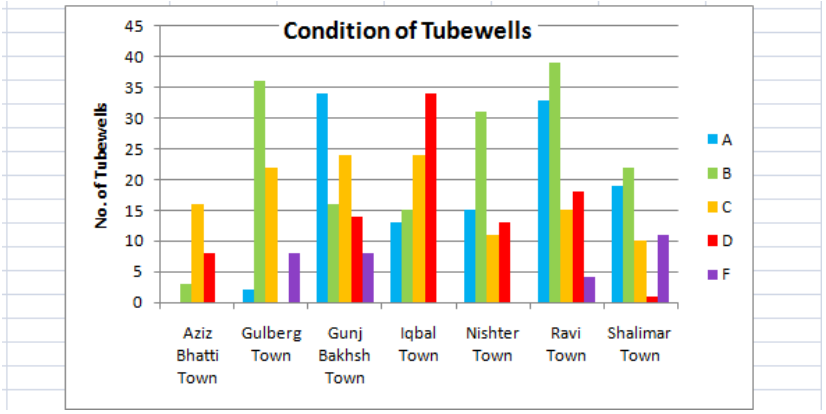
Exercise 1-5: Condition of Tube wells on town level

On town level tube wells with different conditions can be assessed. You will follow the steps described below;

1. Drag and drop the Town field to **"Row Labels**"
2. Drag and drop the Condition Column to **"Column Labels"**
3. Drag and drop the Name field to **"∑ Values".**

It will sum up the no. of tube well according to condition

Count of Name	Condition					
Town	A	B	C	D	F	Grand Total
Aziz Bhatti Town		3	16	8		27
Gulberg Town	2	36	22		8	68
Gunj Bakhsh Town	34	16	24	14	8	96
Iqbal Town	13	15	24	34		86
Nishter Town	15	31	11	13		70
Ravi Town	33	39	15	18	4	109
Shalimar Town	19	22	10	1	11	63
Grand Total	116	162	122	88	31	519



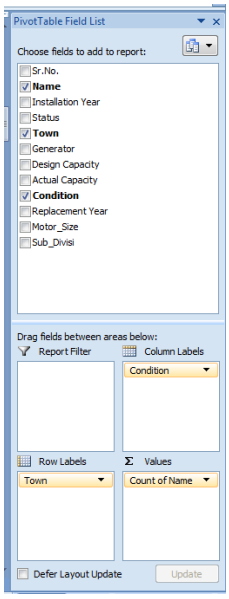


Figure 8: Condition of Tube wells on town level

The above graph shows that in Iqbal town there is maximum no. of poor (D) condition tube wells. And most of the tube wells in Ravi town are in A(Excellent) or B(Good) condition.

Similarly various analysis based on pipe diameter can also be carried out. Examples of these analysis are shown in the following exercises.

Exercise 2: Diameter based Analysis

Exercise 2-1: Diameter wise Length (m) of pipeline (Township)

1. Drag and drop the Diameter field to "**Row Labels**"
2. Drag and drop the Sub_Division field to **"Report Filter"** and filter the township subdivision
3. Drag and drop the Length field to "∑ **Values.**

Diameter	Length (m)
10"	7989.93
12"	1118.21
3"	3466.31
4"	70528.08
5"	297.04
6"	8824.87
8"	8418.66
Grand Total	100643.10

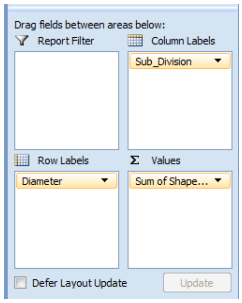
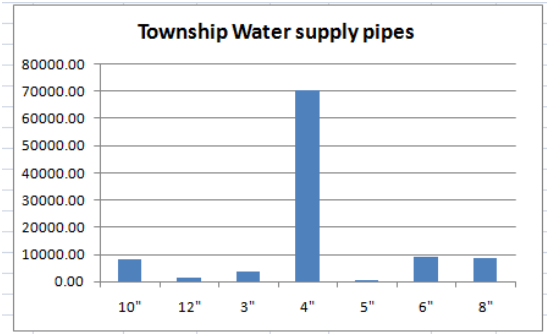


Figure 9: Diameter wise Length (m) of pipeline



The Y axis of the graph can also be changed into km units by right clicking on the axis and then click on "Format Axis". From here you can change the Display Units to thousands to show the length in kilometers.

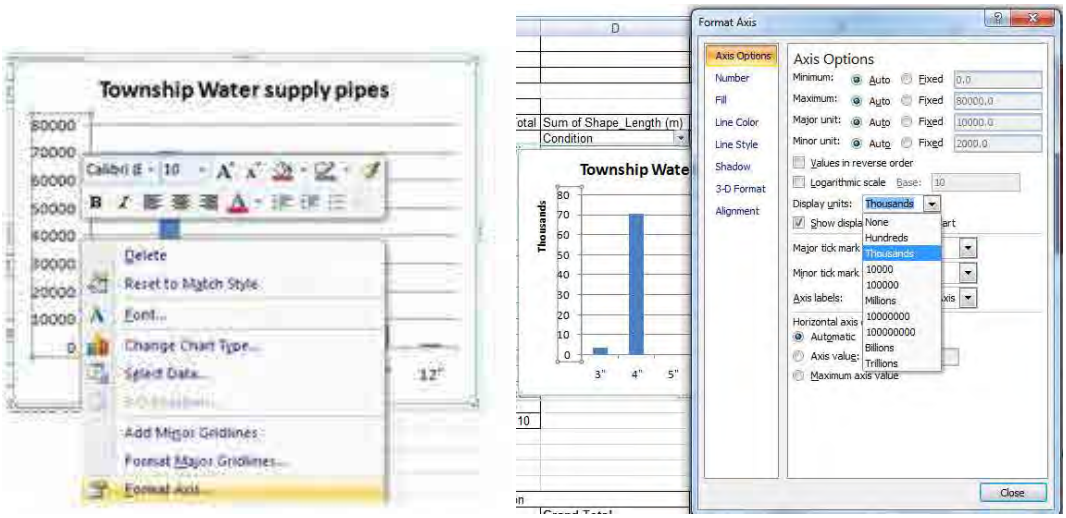


Figure 10: Changing Length in Kilometers

You can rearrange or sort the diameter column by taking the cursor to the row and drag it down or up as per requirement.

14	Sum of Shape	Sub_Division	
15	Diameter	Length	Grand Total
16	10"	7989.93	7989.93
17	12"	1118.21	1118.21
18	3"	3466.31	3466.31
19	4"	70528.08	70528.08
20	5"	297.04	297.04
21	6"	8824.87	8824.87
22	8"	8418.66	8418.66
23	Grand Total	100643.10	100643.10

A16:C16

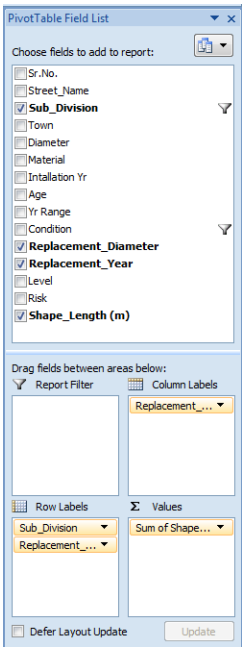
Sum of Shape_Length (r	Sub_Division
Diameter	Length
3"	3466.31
4"	70528.08
5"	297.04
6"	8824.87
8"	8418.66
10"	7989.93
12"	1118.21
Grand Total	100643.10

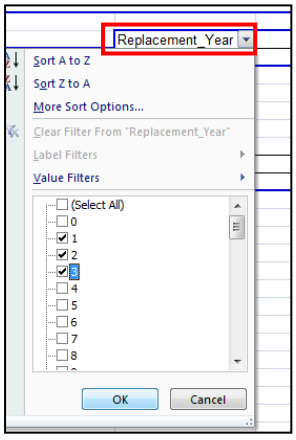
Figure 11: Rearranging the Rows

Above graphs depict that in township most of water supply pipes are of 4inch diameter

Exercise 2-2: Diameter, Replacement Year and Replacement Length

1. Drag and drop the Sub_division and Replacement_Dia field to to "**Row lables**"
2. Drag and drop the Replacment_Year field to "**Column Labels**"
3. Drag and drop Length Field to **"∑Values"**
4. Filter the replacement_year to only for Year 1,2 and 3, uncheck the rest of the years





You will get the following table and graph.

Sum_Length (m)		Replaceme			
Sub_Division	Rep_Dia	1	2	3	Grand Total
Township	4		2615	3942	6557
	6	2573	3254	4738	10565
	8	2425	426		2852
	10		43	588	631
	12			267	267
Township Total		4998	6338	9535	20871
Grand Total		4998	6338	9535	20871

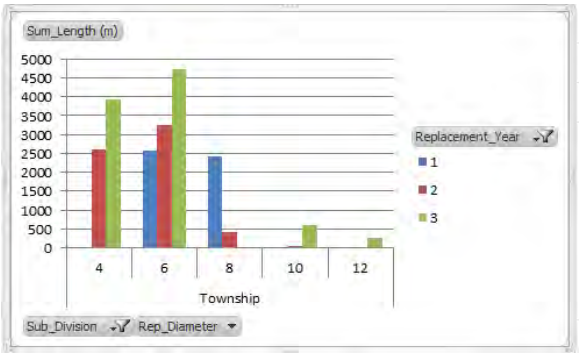


Figure 12: Pipes Lengths with Replacement Year

You can also have the figure in percentage.

1. Select the table
2. go to show values as and
3. then click on "% of Grand Total"

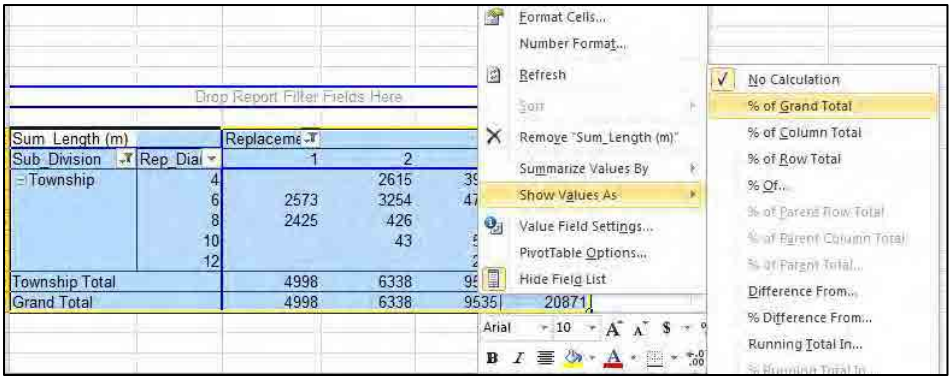


Figure 13: Changing the Numbers into Percentages

You will get the following table and graph.

Sum_Length (m)		Replacer			
Sub_Division	Rep_Dia	1	2	3	Grand Total
Township	4	0.00%	12.53%	18.89%	31.42%
	6	12.33%	15.59%	22.70%	50.62%
	8	11.62%	2.04%	0.00%	13.66%
	10	0.00%	0.20%	2.82%	3.02%
	12	0.00%	0.00%	1.28%	1.28%
Township Total		23.95%	30.37%	45.68%	100.00%
Grand Total		23.95%	30.37%	45.68%	100.00%

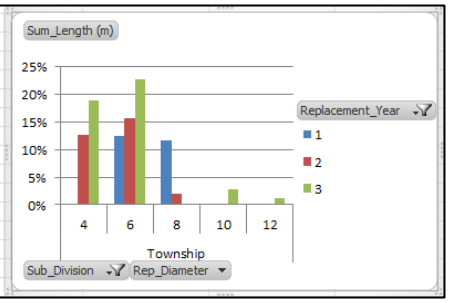


Figure 14: %age of Pipe Lengths with Replacement Year

This shows that 6" and 8" pipes are about 24% of the total pipes that need attention in year 1.

Exercise 2-3: Pipeline Replacement Plan – Township

Pipelines which need replacements in year 1 and so on upto year 25 can be categorized as follows:

1. Drag and drop the Sub_Division field to **"Report Filter**" and filter the township subdivision
2. Drag and drop the Rep_Year field to "**Row Labels**"
3. Drag and drop the Diameter field to "**Column Labels**"
4. Drag and drop the Length field to "∑ **Values.**

Rep_Year	10"	12"	3"	4"	6"	8"	Grand Total
1			1996.89	2276.56	2294.26	2128.37	8696.07
2	42.63			4156.05	2125.56		6324.23
3	588.11	266.73		7591.10	1233.59		9679.53
4				335.24	1031.56		1366.80
5			226.86	16208.62	1106.41	820.05	18361.94
6					860.51		860.51
8	124.67			719.39			844.06
9	9.68						9.68
10	2490.45		2235.22	12602.05	748.75	464.16	18540.63
11	1896.65						1896.65
12	74.19		1497.61	4489.01	197.15	936.62	7194.58
13				2138.86			2138.86
15	177.09	618.21	20.07	4255.30	967.48	2419.43	8457.58
16				172.10		682.50	854.60
17		233.27	158.85	1814.43			2206.55
20	2030.65			16173.56		1251.56	19455.76
22	5.28					4.58	9.85
25	1915.95			579.90			2495.85
Grand Total	9355.34	1118.21	6135.50	73512.17	10565.27	8707.26	109393.74

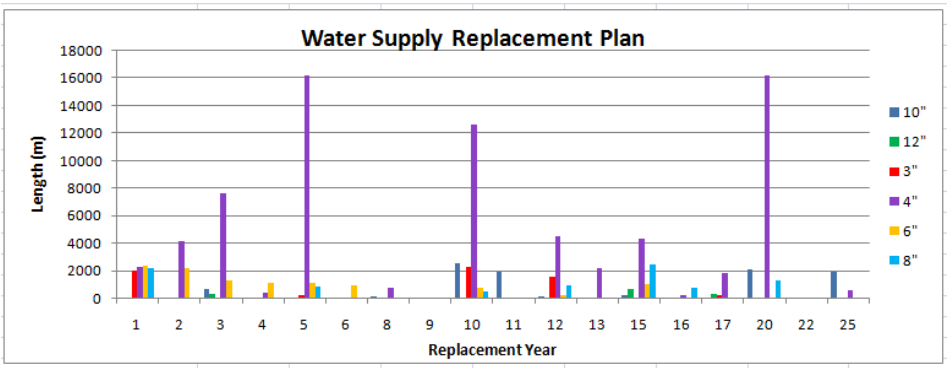


Figure 15: Pipeline Replacement Plan - Township

1. Lecture Information

Course Title: Asset Management	**Course Code**:
Module Title: Asset Database Analysis	**Module No**: 3
Lecture Topic : Asset Age Analysis, Cost Calculation for Replacement	**Lecture Duration:**4 Hours

Other important parameters of the assets can be analyzed which include assets age profiling, asset replacement cost calculation and prioritization of assets for replacement planning. Exercises for asset age analysis are described below.

Exercise 1: Asset Age Analysis

For doing these analysis we need to calculate the age of the asset from its Installation Year. So insert new column by right clicking on the "installation year" go to "insert", then click on "Insert column to Right". Name it as "Age". Now add Age information in this column with the help of year of installation e.g. how old an asset is. For this please input a formula "=2016- installation year" to get how many years from installation.

Then If you can input "=IF(D2>39,">40",IF(D2>29,"30-40",IF(D2>19,"20-30",IF(D2>9,"10-20","0-9")))) "to get a range of years (Age).

=IF(D2>39,">40",IF(D2>29,"30-40",IF(D2>19,"20-30",IF(D2>9,"10-20","0-9"))))

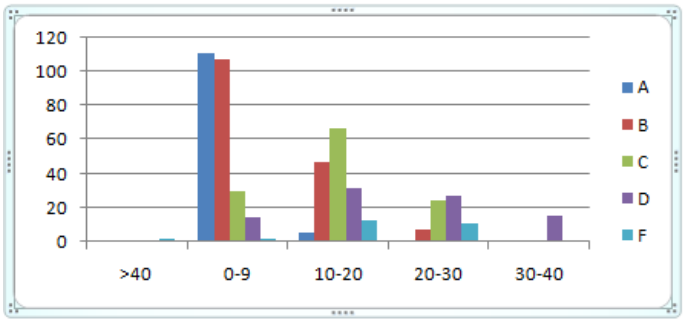
Sr.No.	Name	Installation Year	Age	Age Range	Status	Town	Generato
1	Chenab Block	2009	7	0-9	Functional	Iqbal Town	NILL
2	Pak Block	1986	30	30-40	Functional	Iqbal Town	YES
3	Asif Block	2014	2	0-9	Functional	Iqbal Town	NILL
4	Clifton Colony	2014	2	0-9	Functional	Iqbal Town	NILL
5	Neelum Block	2008	8	0-9	Functional	Iqbal Town	NILL
6	Hunza Block	2008	8	0-9	Functional	Iqbal Town	YES
7	College Block	1993	23	20-30	Functional	Iqbal Town	NILL
8	Raza Block	2009	7	0-9	Functional	Iqbal Town	NILL
9	Kareem Block	1996	20	20-30	Functional	Iqbal Town	NILL
10	Kareem Block Graveyard	2004	12	10-20	Functional	Iqbal Town	YES
11	Nishter Block	2009	7	0-9	Functional	Iqbal Town	NILL
12	F&V Market 2 Wadhat Road Multan Chungi	2009	7	0-9	Functional	Iqbal Town	NILL
13	F&V Market 1 Main Multan Road	2010	6	0-9	Functional	Iqbal Town	NILL
14	Ravi Block	2011	5	0-9	Functional	Iqbal Town	NILL
15	Nargis Block	2008	8	0-9	Functional	Iqbal Town	NILL
16	Huma Block	1999	17	10-20	Functional	Iqbal Town	NILL
17	Jahanzaib Block	1986	30	30-40	Functional	Iqbal Town	NILL
18	Kmaran Block	2010	6	0-9	Functional	Iqbal Town	NILL
19	Usmania Colony	2009	7	0-9	Functional	Gunj Bakhsh Town	NILL
20	Mela Ram Park	1990	26	20-30	Functional	Gunj Bakhsh Town	200 KVA
21	Mozang Road	2015	1	0-9	Functional	Gunj Bakhsh Town	NILL
22	Nisar Scheme	1995	21	20-30	Functional	Gunj Bakhsh Town	NILL
23	Mohallah Gawalian	1993	23	20-30	Functional	Gunj Bakhsh Town	NILL
24	Nasir Bagh	1985	31	30-40	Functional	Gunj Bakhsh Town	NILL
25	Patial Ground	2015	1	0-9	Not Functional	Gunj Bakhsh Town	NILL
26	Shimla Hill	2015	1	0-9	Not Functional	Gunj Bakhsh Town	NILL
27	Dhobi mandi	1970	46	>40	Not Functional	Gunj Bakhsh Town	NILL
28	Cattle Park	2010	6	0-9	Functional	Gunj Bakhsh Town	NILL
29	Lady Mclegon	2009	7	0-9	Functional	Gunj Bakhsh Town	NILL

Figure 16: Calculating Pipe line Age from Installation Year

Exercise1-1: Age Range, Condition and No. of Tube wells

1. Drag and drop the Age Range field to "**Row Labels**"
2. Drag and drop the Condition field to "**Column Labels**"
3. Drag and drop the Name field to "∑ **Values.**

Count of Name	Condition					
Age Range	A	B	C	D	F	Grand Total
>40					2	2
0-9	111	107	30	14	2	264
10-20	5	47	67	32	13	164
20-30		7	24	27	11	69
30-40		1	1	15	1	18
Grand Total	116	162	122	88	29	517



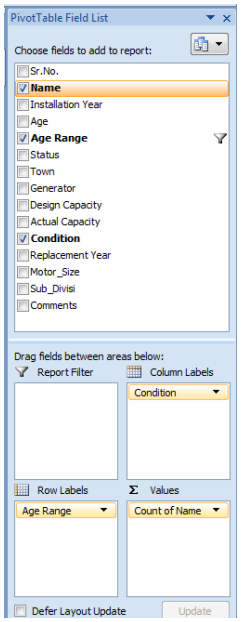
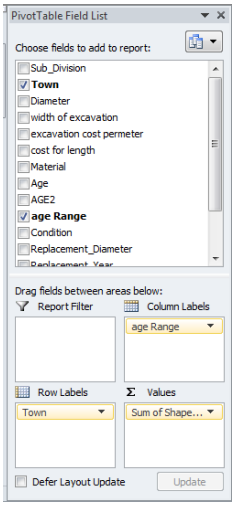


Figure 17: Tube wells Age and Condition

Exercise 1-3: Pipeline age range in each town of Lahore (table)

Do the same age profile analysis on pipes data using pivot table and making graph

1. Drag and drop the Age Range field to "**Column Labels**"
2. Drag and drop the Town field to "**Row Labels**"
3. Drag and drop the Length field to "∑ **Values.**



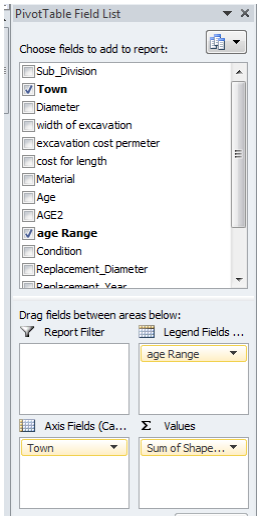
Sum of Shape_Length (m)	age Range				
Town	0-9	10-20	20-30	>30	Grand Total
Aziz Bhatti Town	35061	32167	37646	69796	174669
Gulberg Town	38252	75959	93183	186843	394237
Gunj Bakhsh Town	42559	111796	308083	267741	730178
Iqbal Town	98422	116945	393923	307542	916832
Nishter Town	59666	152896	413136	32081	657779
Ravi Town	160020	223999	304603	222800	911422
Shalimar Town	184900	249459	165867	118146	718371
Grand Total	618880	963221	1716440	1204949	4503490

Figure 18: Age Profile of Pipelines

Exercise 1-4: Pipeline age range in each town of (graph)

For making the graph

1. Drag and drop the Age Range field to **"Legend Fields"**
2. Drag and drop the Town field to "**Axis Field**"
3. Drag and drop the Length field to "∑ **Values.**



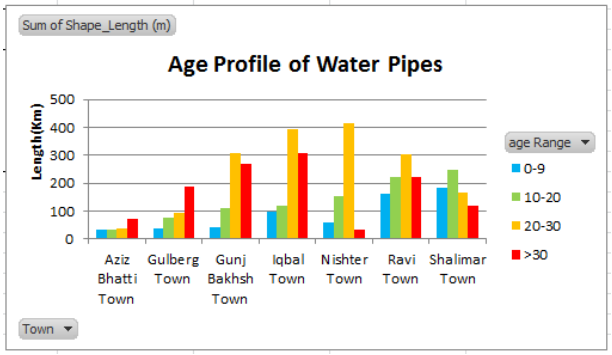


Figure 19: Age Profile of Pipelines (Graph)

Exercise 2: Replacement Cost Calculation

Cost for replacing a pipeline can be calculated using length of the pipes and standard MRS rates.Inser a column for entering unit cost. Enter the unit cost of pipe according to diameter one by one.By applying filter for each diamter you can enter the unit cost at once. For example from filter check diameter 4. The records for 4" diameter pipeline will be shown only. Now one can enter its rate which is 351.64 according to MRS rates for district Lahore, and drag it to all records. Similarly enter the unit cost of other diameters of pipes.

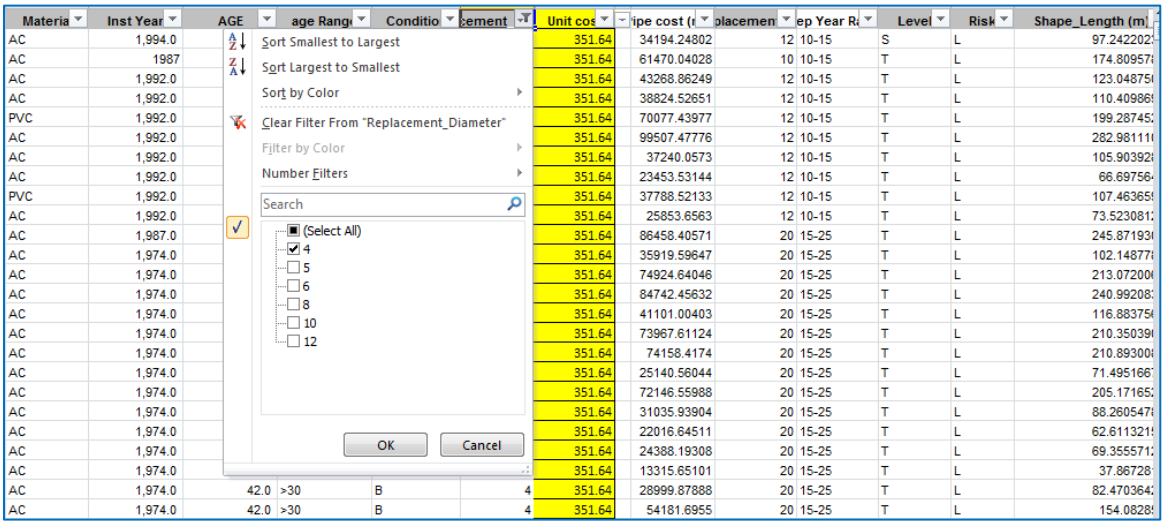


Figure 20: Entering Unit Cost

Now add a column for rep year range. Then If you can input "=IF(W2>24,">25",IF(W2>14,"15-25",IF(W2>9,"10-15",IF(W2>4,"5-10","1-5"))))".

X1 | Rep Year Range

Materia	Inst Year	AGE	age Rang	Conditio	cement_	Unit cos	ipe cost (r	placemen	ep Year R	Level	Risk	Shape_Length (m)
AC	2,000.0	16.0	10-20	B	10	1057.8	# 2006280.515	11	10-15	P	M	1896.653919
AC	2,011.0	5.0	0-9	B	10	1057.8	2026691.309	25	>25	P	L	1915.949432
AC	2000	16.0	10-20	C	8	703.28	407517.4585	1	1-5	T	H	579.4526483
AC	2,000.0	16.0	10-20	B	8	703.28	422562.3025	12	10-15	S	L	600.8450439
AC	1994	22.0	20-30	C	8	703.28	299800.7457	2	1-5	S	M	426.2893096
AC	2,010.0	6.0	0-9	B	10	1057.8	225740.0812	20	15-25	S	L	213.4052574
AC	1995	21.0	20-30	B	8	703.28	645813.891	1	1-5	S	L	918.2884357
AC	2,009.0	7.0	0-9	B	8	703.28	312662.5751	20	15-25	S	L	444.5776576
AC	1,994.0	22.0	20-30	B	4	351.64	34194.24802	12	10-15	S	L	97.24220231
AC	1,986.0	30.0	>30	B	6	485.04	159963.4875	15	15-25	T	L	329.7944242
AC	1994	22.0	20-30	B	10	1057.8	953804.0657	10	10-15	T	M	901.6865813
AC	1994	22.0	20-30	B	10	1057.8	1080537.158	10	10-15	T	M	1021.494761
AC	2000	16.0	10-20	B	10	1057.8	685183.5878	5	5-10	P	M	647.7439854
AC	1,987.0	29.0	20-30	B	12	1701.1	814653.0167	15	15-25	T	L	478.8977818
AC	1,987.0	29.0	20-30	B	8	703.28	1366528.138	15	15-25	P	L	1943.078345
AC	1,987.0	29.0	20-30	B	12	1701.1	236986.4497	15	15-25	S	L	139.3136498
AC	1987	29.0	20-30	B	4	351.64	61470.04028	10	10-15	T	L	174.8095788
AC	2,000.0	16.0	10-20	B	8	703.28	178595.0491	20	15-25	T	L	253.9458667
AC	1,992.0	24.0	20-30	B	4	351.64	43268.86249	12	10-15	T	L	123.0487501
AC	1,992.0	24.0	20-30	B	4	351.64	38824.52651	12	10-15	T	L	110.4098695
PVC	1,992.0	24.0	20-30	B	4	351.64	70077.43977	12	10-15	T	L	199.2874524
AC	1,992.0	24.0	20-30	B	4	351.64	99507.47776	12	10-15	T	L	282.9811107
AC	1,992.0	24.0	20-30	B	4	351.64	37240.0573	12	10-15	T	L	105.9039282
AC	1,992.0	24.0	20-30	B	4	351.64	23453.53144	12	10-15	T	L	66.6975641

Figure 21: Making Replacement Year Range

You will get a range of replacement years.

Now if you multiply the length with unit cost (T*AA) you will get an estimate of pipe cost.

Inst Year	AGE	age Rang	Conditio	cement_	Unit cos	ipe cost (r	placemen	ep Year R	Level	Risk	Length (r
1,994.0	22.0	20-30	B	4	351.64	34194.24802	12	10-15	S	L	97.24220231
1987	29.0	20-30	B	4	351.64	61470.04028	10	10-15	T	L	174.8095788
1,992.0	24.0	20-30	B	4	351.64	43268.86249	12	10-15	T	L	123.0487501
1,992.0	24.0	20-30	B	4	351.64	38824.52651	12	10-15	T	L	110.4098695
1,992.0	24.0	20-30	B	4	351.64	70077.43977	12	10-15	T	L	199.2874524
1,992.0	24.0	20-30	B	4	351.64	99507.47776	12	10-15	T	L	282.9811107
1,992.0	24.0	20-30	B	4	351.64	37240.0573	12	10-15	T	L	105.9039282
1,992.0	24.0	20-30	B	4	351.64	23453.53144	12	10-15	T	L	66.6975641
1,992.0	24.0	20-30	B	4	351.64	37788.52133	12	10-15	T	L	107.4636598
1,992.0	24.0	20-30	B	4	351.64	25853.6563	12	10-15	T	L	73.52308128
1,987.0	29.0	20-30	B	4	351.64	86458.40571	20	15-25	T	L	245.8719307
1,974.0	42.0	>30	B	4	351.64	35919.59647	20	15-25	T	L	102.1487785
1,974.0	42.0	>30	B	4	351.64	74924.64046	20	15-25	T	L	213.0720068
1,974.0	42.0	>30	B	4	351.64	84742.45632	20	15-25	T	L	240.9920837
1,974.0	42.0	>30	B	4	351.64	41101.00403	20	15-25	T	L	116.8837562
1,974.0	42.0	>30	B	4	351.64	73967.61124	20	15-25	T	L	210.3503903
1,974.0	42.0	>30	B	4	351.64	74158.4174	20	15-25	T	L	210.8930082
1,974.0	42.0	>30	B	4	351.64	25140.56044	20	15-25	T	L	71.49516675
1,974.0	42.0	>30	B	4	351.64	72146.55988	20	15-25	T	L	205.1716525
1,974.0	42.0	>30	B	4	351.64	31035.93904	20	15-25	T	L	88.26054783
1,974.0	42.0	>30	B	4	351.64	22016.64511	20	15-25	T	L	62.61132155
1,974.0	42.0	>30	B	4	351.64	24388.19308	20	15-25	T	L	69.35557126
1,974.0	42.0	>30	B	4	351.64	13315.65101	20	15-25	T	L	37.8672819
1,974.0	42.0	>30	B	4	351.64	28999.87888	20	15-25	T	L	82.47036424
1,974.0	42.0	>30	B	4	351.64	54181.6955	20	15-25	T	L	154.082856
1,974.0	42.0	>30	B	4	351.64	31867.65818	20	15-25	T	L	90.62580532
1,986.0	30.0	>30	B	4	351.64	50926.96208	15	15-25	T	L	144.8269881
2,010.0	6.0	0-9	B	4	351.64	131209.5183	20	15-25	T	L	373.1359296
2,010.0	6.0	0-9	B	4	351.64	100985.6016	20	15-25	T	L	287.1846252

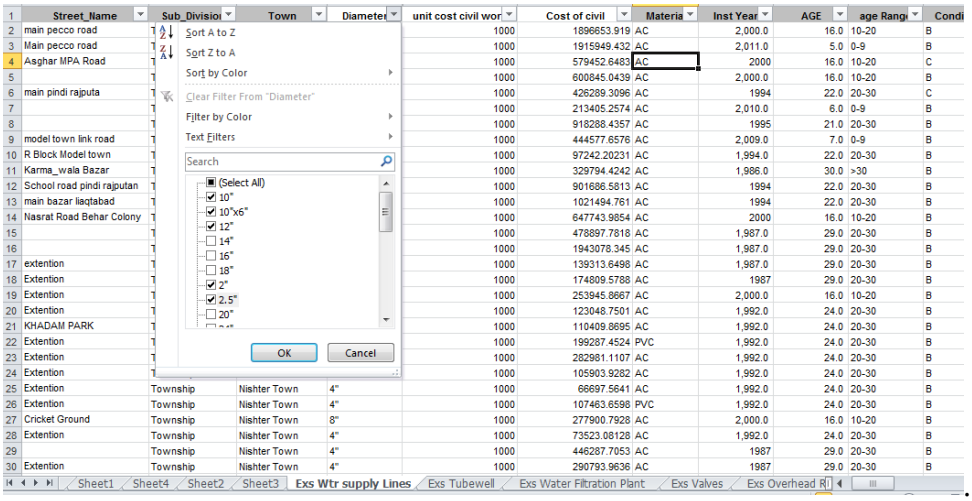
Figure 22: Pipe Cost Calculation

The tabe shows the cost of each pipe to be replaced.

For calculating civil work cost, insert new coulum as “Civil work cost”. CW Cost depends on pipe diameter and excavation width. Assumed unit cost for civil works according to diameter is described in below table:

Diameter	Excavation width	Unit cost Civil Work
<12	7 ft	1000
12-24	8 ft	2000
24-36	9 ft	3000

Click on filter of diameter coulum and check diameters upto 12” diameter and type 1000 in unit cost of civil works and drag it,simlarly enter diameter for 12-24 inch diameters and for 24-36 inch diameter and type 2000 and 3000 unit cost for civil works respectively



Now add a coulum “Civil work cost” multiply unit cost of civil work with length (=I2*AC2). You will get Cost of Civil Works.

	Sub_Divisio	Town	Diameter	unit cost civil wor	Cost of civil Work	Total cost	Materia	Inst Year	AGE	age Rang	Conditio
2	Township	Nishter Town	10"	1000	1896653.919	3902934.434	AC	2,000.0	16.0	10-20	B
3	Township	Nishter Town	10"	1000	1915949.432	3942640.742	AC	2,011.0	5.0	0-9	B
4	Township	Nishter Town	8"	1000	579452.6483	986970.1068	AC	2000	16.0	10-20	C
5	Township	Nishter Town	8"	1000	600845.0439	1023407.346	AC	2,000.0	16.0	10-20	B
6	Township	Nishter Town	6"	1000	426289.3096	726090.0553	AC	1994	22.0	20-30	C
7	Township	Nishter Town	10"	1000	213405.2574	439145.3386	AC	2,010.0	6.0	0-9	B
8	Township	Nishter Town	8"	1000	918288.4357	1564102.327	AC	1995	21.0	20-30	B
9	Township	Nishter Town	8"	1000	444577.6576	757240.2327	AC	2,009.0	7.0	0-9	B
10	Township	Nishter Town	4"	1000	97242.20231	131436.4503	AC	1,994.0	22.0	20-30	B
11	Township	Nishter Town	6"	1000	329794.4242	489757.9118	AC	1,986.0	30.0	>30	B
12	Township	Nishter Town	10"	1000	901686.5813	1855490.647	AC	1994	22.0	20-30	B
13	Township	Nishter Town	10"	1000	1021494.761	2102031.92	AC	1994	22.0	20-30	B
14	Township	Nishter Town	8"	1000	647743.9854	1332927.573	AC	2000	16.0	10-20	B
15	Township	Nishter Town	12"	1000	478897.7818	1293550.799	AC	1,987.0	29.0	20-30	B
16	Township	Nishter Town	8"	1000	1943078.345	3309606.483	AC	1,987.0	29.0	20-30	B
17	Township	Nishter Town	12"	1000	139313.6498	376300.0995	AC	1,987.0	29.0	20-30	B
18	Township	Nishter Town	4"	1000	174809.5788	236279.6191	AC	1987	29.0	20-30	B
19	Township	Nishter Town	8"	1000	253945.8667	432540.9158	AC	2,000.0	16.0	10-20	B
20	Township	Nishter Town	4"	1000	123048.7501	166317.6126	AC	1,992.0	24.0	20-30	B
21	Township	Nishter Town	4"	1000	110409.8695	149234.396	AC	1,992.0	24.0	20-30	B
22	Township	Nishter Town	4"	1000	199287.4524	269364.8922	PVC	1,992.0	24.0	20-30	B
23	Township	Nishter Town	4"	1000	282981.1107	382488.5885	AC	1,992.0	24.0	20-30	B
24	Township	Nishter Town	4"	1000	105903.9282	143143.9855	AC	1,992.0	24.0	20-30	B
25	Township	Nishter Town	4"	1000	66697.5641	90151.09554	AC	1,992.0	24.0	20-30	B
26	Township	Nishter Town	4"	1000	107463.6598	145252.1811	PVC	1,992.0	24.0	20-30	B
27	Township	Nishter Town	8"	1000	277900.7928	473342.8624	AC	2,000.0	16.0	10-20	B
28	Township	Nishter Town	4"	1000	73523.08128	99376.73758	AC	1,992.0	24.0	20-30	B
29	Township	Nishter Town	4"	1000	446287.7053	662755.0939	AC	1987	29.0	20-30	B
30	Township	Nishter Town	4"	1000	290793.9636	431840.6677	AC	1987	29.0	20-30	B

Sheet1 Sheet4 Sheet2 Sheet3 **Exs Wtr supply Lines** Exs Tubewell Exs Water Filtration Plant Exs Valves Exs Overhead Resorvoir Pro Wtr Supply Line

Figure 23: Civil Work Cost

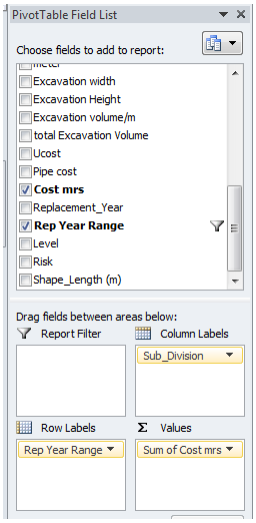
Total cost of replacement can be estimated by summing up the pipe cost and civil work cost. Inset new column as total cost and type =J2+Y2.

=J2+Y2

	C	D	E	I	J	K	L	M	N	O	
1	Sub_Divisio	Town	Diameter	unit cost civil wor	Cost of civil	Total cost	Materia	Inst Year	AGE	age Rang	
2	Township	Nishter Town	10"	1000	1896653.919	3902934.434	AC	2,000.0	16.0	10-20	B
3	Township	Nishter Town	10"	1000	1915949.432	3942640.742	AC	2,011.0	5.0	0-9	B
4	Township	Nishter Town	8"	1000	579452.6483	986970.1068	AC	2000	16.0	10-20	C
5	Township	Nishter Town	8"	1000	600845.0439	1023407.346	AC	2,000.0	16.0	10-20	B
6	Township	Nishter Town	6"	1000	426289.3096	726090.0553	AC	1994	22.0	20-30	C
7	Township	Nishter Town	10"	1000	213405.2574	439145.3386	AC	2,010.0	6.0	0-9	B
8	Township	Nishter Town	8"	1000	918288.4357	1564102.327	AC	1995	21.0	20-30	B
9	Township	Nishter Town	8"	1000	444577.6576	757240.2327	AC	2,009.0	7.0	0-9	B
10	Township	Nishter Town	4"	1000	97242.20231	131436.4503	AC	1,994.0	22.0	20-30	B
11	Township	Nishter Town	6"	1000	329794.4242	489757.9118	AC	1,986.0	30.0	>30	B
12	Township	Nishter Town	10"	1000	901686.5813	1855490.647	AC	1994	22.0	20-30	B
13	Township	Nishter Town	10"	1000	1021494.761	2102031.92	AC	1994	22.0	20-30	B
14	Township	Nishter Town	8"	1000	647743.9854	1332927.573	AC	2000	16.0	10-20	B
15	Township	Nishter Town	12"	1000	478897.7818	1293550.799	AC	1,987.0	29.0	20-30	B
16	Township	Nishter Town	8"	1000	1943078.345	3309606.483	AC	1,987.0	29.0	20-30	B
17	Township	Nishter Town	12"	1000	139313.6498	376300.0995	AC	1,987.0	29.0	20-30	B
18	Township	Nishter Town	4"	1000	174809.5788	236279.6191	AC	1987	29.0	20-30	B
19	Township	Nishter Town	8"	1000	253945.8667	432540.9158	AC	2,000.0	16.0	10-20	B
20	Township	Nishter Town	4"	1000	123048.7501	166317.6126	AC	1,992.0	24.0	20-30	B
21	Township	Nishter Town	4"	1000	110409.8695	149234.396	AC	1,992.0	24.0	20-30	B
22	Township	Nishter Town	4"	1000	199287.4524	269364.8922	PVC	1,992.0	24.0	20-30	B
23	Township	Nishter Town	4"	1000	282981.1107	382488.5885	AC	1,992.0	24.0	20-30	B
24	Township	Nishter Town	4"	1000	105903.9282	143143.9855	AC	1,992.0	24.0	20-30	B
25	Township	Nishter Town	4"	1000	66697.5641	90151.09554	AC	1,992.0	24.0	20-30	B
26	Township	Nishter Town	4"	1000	107463.6598	145252.1811	PVC	1,992.0	24.0	20-30	B
27	Township	Nishter Town	8"	1000	277900.7928	473342.8624	AC	2,000.0	16.0	10-20	B
28	Township	Nishter Town	4"	1000	73523.08128	99376.73758	AC	1,992.0	24.0	20-30	B
29	Township	Nishter Town	4"	1000	446287.7053	662755.0939	AC	1987	29.0	20-30	B
30	Township	Nishter Town	4"	1000	290793.9636	431840.6677	AC	1987	29.0	20-30	B

Sheet1 Sheet4 Sheet2 Sheet3 **Exs Wtr supply Lines** Exs Tubewell Exs Water Filtration Plant Exs Valves Exs Overhead R

Figure 24: Total Replacement Cost



Exercise 1-1 : Replacement Cost Calculation in Phased Manner

Using the replacemet cost and replacement year range you can plot a pivot table and its graph for town level plan

1. Drag and drop the "Rep Year Range" field to "**Row Labels**"
2. Drag and drop the Sun_Division field to "**Column Labels**"
3. Drag and drop the Length field to "∑ **Values.**

Sum of Cost mrs	Sub_Division				
Rep Year Range	Garden Town	Green Town	Industrial Area	Township	Grand Total
1-5	50709038.77	22533360.11	38139473.14	11219600.64	122601472.7
5-10	12622665.59	53649928.82	54503321.69	7178572.269	127954488.4
10-15	1562415.118	18499568.93	8065076.187	14098030.55	42225090.79
15-25	7524965.225	8574681.541	8362222.573	13545621.72	38007491.06
>25	761970.9141	2874168.377	2574367.624	3022497.682	9233004.597
Grand Total	73181055.61	106131707.8	111644461.2	49064322.85	340021547.5

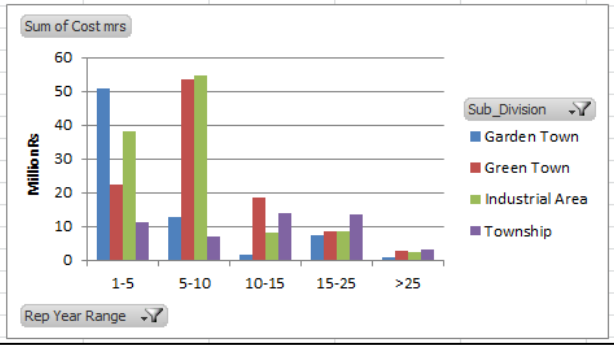


Figure 25: Replacement Cost calculation in phased manner

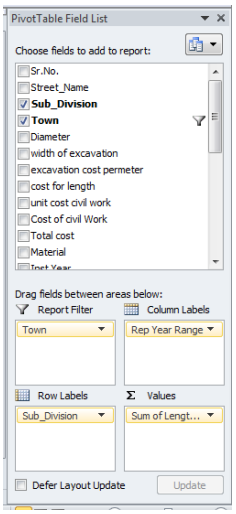
The above example is on the replacement plan of Nishter town subdivisions. From the chart it is evident that in first phase (1-5 year) most of the cost is involved in industrial area subdivision.

Exercise 3: Prioritization for Replacement planning

Successful asset management enables a drinking water or wastewater system to maintain a desired level of service in the most cost-effective manner. Generally, this allows utility managers to proactively rehabilitate or replace system components on a continual basis rather than disruptive to system operations.

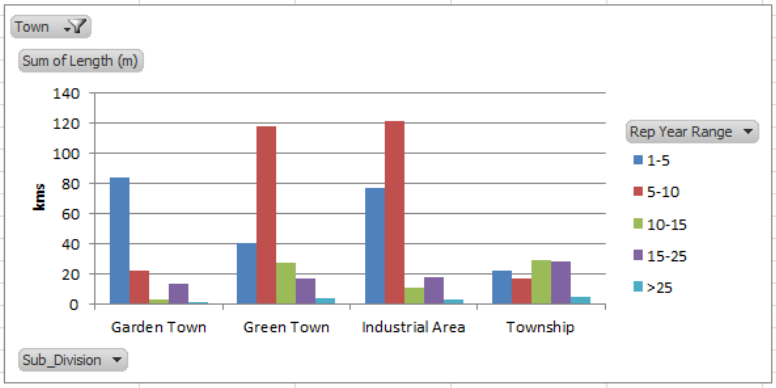
Therefore for replacing assets (e.g. pipelines) utility managers have to prioritize their assets based on useful remaining life. Prioritization here means ranking system's assets for replacement. Following exercises will demonstrate how pivot table can help in prioritizing the pipelines for replacement in Lahore.

Exercise 3: Replacement Year, for Nishter Town subdivisions



1. Drag and drop the "Town" field to "**Report Filters**"
2. Drag and drop the **Sub_Division** field to **Row Lables**""
3. Drag and drop the "Rep Year Range**"** to Coulum Labels.
4. Drag and drop Length to ""∑ **Values.**

Town	Nishter Town					
Sum of Length (m)	Rep Year Range					
Sub_Division	1-5	5-10	10-15	15-25	>25	Grand Total
Garden Town	83776	21635	2696	13248	1196	122551
Green Town	40116	118082	27314	16349	3787	205648
Industrial Area	77124	121078	10263	17646	2434	228544
Township	22238	16698	28841	28512	4748	101036
Grand Total	223254	277493	69114	75755	12164	657779



Exercise3-1: Replacement Cost, Age Range for Nishter Town

1. Drag and drop the "Town" field to "**Row Labels**"
2. Drag and drop the Age Range field to "**Column Labels**"
3. Drag and drop the Cost field to "∑ **Values.**

Sum of Cost mrs	age Range				
Town	0-9	10-20	20-30	>30	Grand Total
Nishter Town	34488780.2	73010265.52	217687464.5	14835037.27	340021547.5
Grand Total	34488780.2	73010265.52	217687464.5	14835037.27	340021547.5

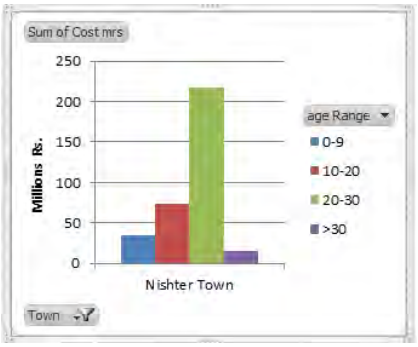


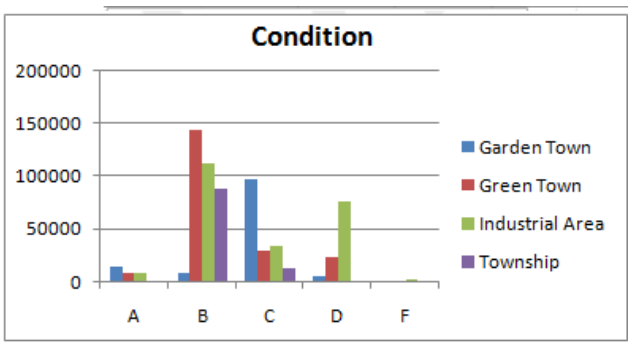
Figure 26: Pipe Replacement Cost and Age Profile - Nishter Town

Exercise 3-2: Pipes Condition of Nishter Town

First we will analyze which subdivision needs more attention. For this pipeline condition table of Nishter Town will be prepared to see which subdivision is in poor condition

1. Drag and drop the "Condition" field to "**Row Labels**"
2. Drag and drop the Sub_Division field to "**Column Labels**"
3. Drag and drop the Length field to "∑ **Values.**

Sum of Shape	Sub_Divisic				
Condition	Garden Town	Green Town	Industrial Area	Township	Grand Total
A	13829.53366	8817.264938	7611.581447	431.76921	30690.149
B	7855.905457	143415.3926	111487.9577	88035.357	350794.61
C	95637.89295	28792.70571	32588.87072	12569.187	169588.66
D	5227.937855	23867.36814	75195.70035		104291.01
F		755.0804177	1659.743127		2414.8235
Grand Total	122551.2699	205647.8118	228543.8534	101036.31	657779.25



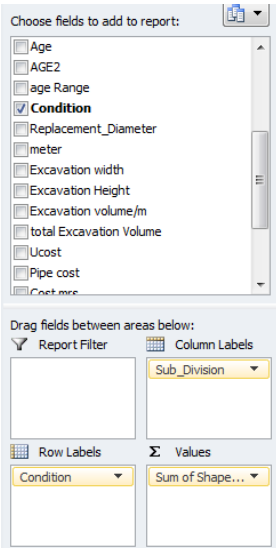


Figure 27: Pipes Condition -Nishter Town

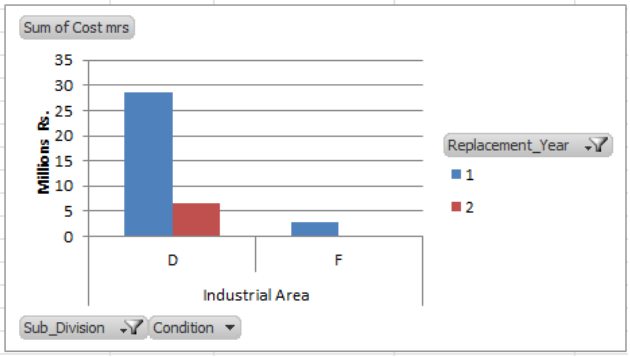
It is clear from the chart that Industrial area has more D and F condition Pipes.

Exercise 3-3 : Condition, Replacemet Year, Replacement Cost of Industrial area

Pipes can be priortized further on the basis of condition

1. Drag and drop the Sub_Division field to "**Report Filter**"
2. Drag and drop the "Condition" field to "**Row Labels**"
3. Drag and drop the "Replacement_Year" field to "**Column Labels**"
4. Drag and drop the Cost field to "∑ **Values.**

Sum of Cost mrs	Replacement_Year		
Condition	1	2	Grand Total
D	28711411	6474433	35185843
F	2823389		2823389
Grand Total	31534800	6474433	38009232



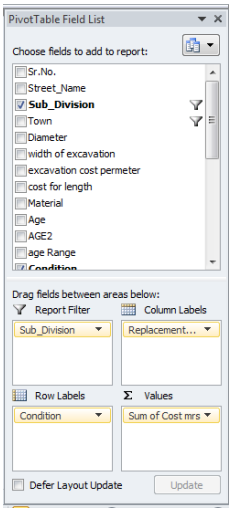


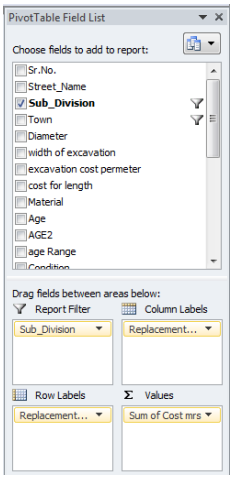
Figure 28: Cost for Replacing Poor Condition Pipes

The graph shows the cost involved for replacing poor condition pipes in first and second year.

Exercise3-4: Replacement diameter, Replacement year, Cost

You can priortize the asset for replacement based on diameter and cost

1. Drag and drop the Sub_Division field to "**Report Filter**"
2. Drag and drop the "Replacement_Year" field to "**Column Labels**"
3. Drag and drop the "Replacement_Diameter" field to "**Row Labels**"
4. Drag and drop the Cost field to "∑ **Values.**



Sub_Division	Industrial Area		
Sum of Cost mrs	Replacement_Year		
Replacement_Diameter	1	2	Grand Total
4	13753492.66	6316527.94	20070020.6
6	3613461.476	157904.7682	3771366.245
8	837179.4923		837179.4923
10	8329165.427		8329165.427
12	5001500.719		5001500.719
Grand Total	31534799.77	6474432.708	38009232.48

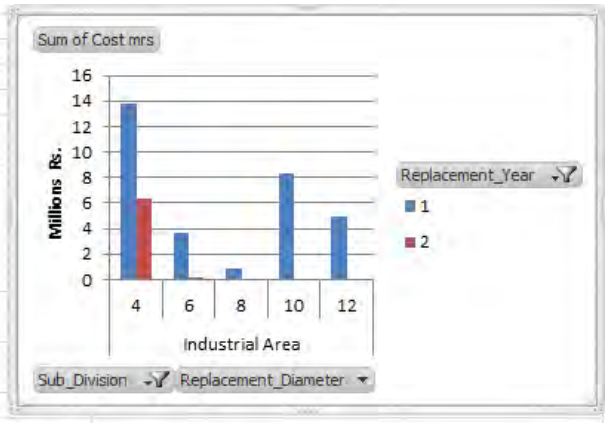


Figure 29: Prioritizing Pipes for Replacement – Industrial Area

The above chart you may take up pipes with 10 and 12 inch diameter first, then 6 and 8 inch, then 4 inch pipe for replacement purpose according to available budget**.**

This is one of the approaches of prioritizing the assets.

ALJAZARI
ACADEMY

Asset Management

Course Code: M4131

Asset Replacement Plan
Module 4

Lecture Notes

2016

Introduction of the Asset Management Course:

This course is about asset management related to water utilities. It focuses on assets, its attributes, determining their condition, risk, life cycle of an asset, monitoring of existing assets, accounting treatment of assets and preparing asset replacement plan. This course is especially beneficial for officers of grade 17 and 18 who are directly or indirectly involved in planning and routine management of assets.

Course Participants (CPs) will develop knowledge and skills about asset, its life cycle and carry out asset condition survey. They will be able to develop and use asset data base for asset replacement planning. This course will also help the CPs in understanding application of the concepts related to Asset Replacement Plan, Asset Operational Plan and its monitoring. The CPs will learn through OJT, how to use the Asset Management Information System, GIS and other tools.

Upon the completion of this course the CPs will be in a better position to apply their learning in their routine jobs and prepare an Integrated Development & Asset Management Plan (IDAMP) to provide better water supply and sewerage services to their consumers.

Asset Replacement Module:

The module includes key concepts related to current asset monitoring, repair, and replacement practices at WASAs. The module also outlines cost comparison of repair and replacement of assets. Finally, it also provides guidance on preparing short / medium/ long term replacement plans.

Lecture 1

1. Lecture Information

Topics: 1) Current Asset monitoring and Procurement at WASA Lahore 2) Repair or Replacement based on monitoring results 3) Inspection and payment to suppliers
Lecture Duration: 2 Hours

Day 1

Introduction of Topic

Prior Knowledge/Brainstorming **(20 Minutes)**

Lecturer will evaluate course participants' prior knowledge related to "current practices of monitoring" through brainstorming. The Lecturer will put a question to class: What are current practices of monitoring of existing WASA assets ? The expected responses are presented below:

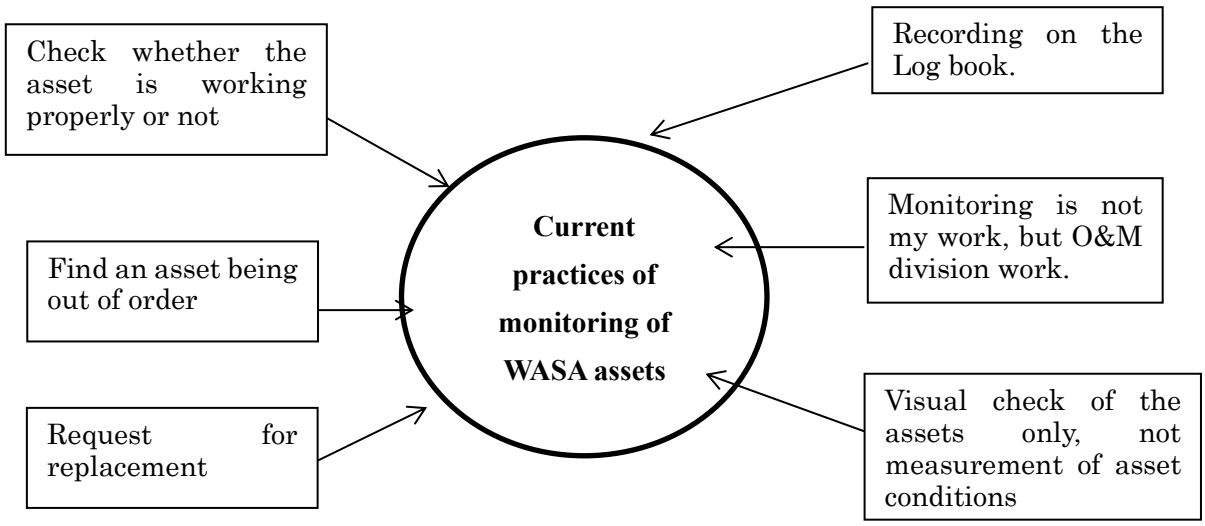


Figure 1: Expected responses to the question "what is monitoring?"

The lecturer will conclude the brainstorming through discussion and clarifications of "monitoring" and will emphasize an importance of preventive maintenance and short/ medium/ long term asset replacement planning.

Motivation Activity **(20 Minutes)**

The lecturer will first emphasize an importance of asset replacement with an example of a prestigious shrine, Ise shrine in Japan. The Ise shrine has conducted replacement of a main building every twenty (20) years for more than one (1) thousand years. The replacement needs three requirements: first **human resources** who are able to plan and rebuild a wholly building with high skills, second **good materials**, wood for the building which are grown in the shrine forest and third **a fund** for the construction work. The asset replacement in WASAs needs staffs with high expertise, materials/ equipment/ facility of good quality and budget to proceed with asset replacement and preventive maintenance.

Lecture 1 Case study: Current Asset monitoring and Procurement at WASA Lahore

(40 Minutes)

Relevance of case study

The lecturer will explain current monitoring practices at Lahore WASA to share relevant experiences with participants. Because Lahore WASA has substantial assets and its management practices would be a good reference for the other WASAs. In addition, GIS unit there collects/ inputs asset data, having expertise in digital manner of asset management.

Overview of Lahore WASA assets

Water production: 435 million gallons per day
Tube wells: 519
Pipelines: 4,500 kilometers
Water purification plants: 150

Valves: 8,500
Overhead reservoirs: 50
Water connections: 636,338
Disposal stations: 12 (2,299cfs)
Lift stations: 93 (826cfs)
Drainage network: 461km
Drainage stations: 4 (663cfs)
Offices
Land

The lecture will contain following topics:

1. 1. Monitoring of the existing assets (60 minutes)

Logbooks of machinery/ equipment maintenance recording are maintained by mechanical engineers, sub engineers, pipe fitters, mechanical helpers, mechanical supervisors, electricians, operators of the Operation and Maintenance department (O & M) on daily basis: date, timing, operating time, meter reading, operating load, electricity shutdown, diesel consumption and others.

When they find a failure or insufficient function, reporting is done to Executive engineers to be immediately repaired by a maker or contractor. In case of replacement, the O & M would request for Procurement & Store Department (P&S) to purchase a new one.

Table1: Current monitoring and repair/ replacement process at Lahore WASA

	Monitoring of the existing assets	Keeping records of the monitoring results	if they find a breakdown	Repair/ replacement	Request for replacement
Departments in charge	O &M department implements a everyday monitoring of the assets (according to SOP).	O &M department keeps records of the monitoring results in their log books.	O &M department staffs report to their executive engineers.	O &M department makes a decision: repair/ replacement	(repair) O &M department requests for suppliers to repair. (replacement) O &M department requests for Procurement and Store Dep. (P&S) to procure a new one.
Staff in charge	mechanical engineers, sub engineers, pipe fitters, mechanical helpers, mechanical supervisors, electricians, operators			executive engineers	

1.2. Demarcation of departments requesting for procurement and those in charge of procurement

Procurement process in WASA is done by PEPRA rules prepared by government. The Procurement & Store Department (P&S) is in charge of routine and non-routine purchase requested by other departments and prepares estimates. Non-development-budget is prepared by them as well.

On the other hand, the Planning and Design division (P&D) is in charge of on-site survey, design, cost estimation, scheduling and procurement in their PC1s to formulate the development budget. Due to staff shortage, however, those works are actually handled by Construction 1, 2 and Waste Water Treatment (WWT) Departments. Only procurement of machine is implemented by P & S.

The P&S/ P&D could, thus, reduce unit purchasing cost with consolidation of many purchase requests. In addition, the WASA could proceed with competition among suppliers, transparency of procurement, as well as avoid corruption.

1.3. Repair/ replacement based on monitoring results

The P&S/ P&D would estimate the procurement costs to obtain an approval from DMD. If the estimation cost is less than Rs.100,000, P&S/ P&D would obtain cost offers from more than three (3) suppliers, then placing an order to the supplier which offers the best one. The suppliers would deliver the products within one (1) week from the award if they have a stock. It would take three (3) to four (4) weeks from the date of procurement request for P&S/ P&D to the delivery.

At the estimation cost of Rs.100,000- 2 million, P&S/ P&D make a bid announcement on PPRA web site, thereby conducting a tender. At more than Rs. 2 million, P&S/ P&D make a bid announcement on newspaper as well as on PPRA web site. Then, P&S/ P&D obtain quotations from more than three (3) suppliers. Those suppliers put their offers in the "Quotation Box". P&S/ P&D, Finance department, departments requesting for the procurement would jointly formulate an "Appraisal Committee", to evaluate those quotations, thereby placing an order to a bidder offering the best one.

It would take 45- 60 days from the date of procurement request for the P&S to the product delivery, including the bid announcement period on newspaper.

Table 2: Procurement and its finance source (budget) at Lahore WAS

Departments in charge	Actual works	Finance source (budget)	Actual expenditures	Process of procurement
Procurement and Store division (P&S) is in charge of routine/ non-routine purchases requested by various departments.	Cost estimation, tender, selection of bidders, awarding, inspection upon delivery, request for payment to Finance Division.	"Repair & maintenance", non-development budget (formulated by P&S, every year May 15- June 15)	Repair & maintenance (Million Rs.) (year 2012-13) 785 (year 2013-14) 615 (year 2014-15) 1,146	(estimation costs: less than Rs. 100,000) Obtaining offers more than three (3) companies (estimation costs: Rs. 100,000- 2 million) Bid announcement on PPRA website
Planning and Design division (P&D)	on-site survey, design, cost estimation, scheduling and procurement	development budget (formulated by P&D, every year May 15- June 15)	Annual dev. program (year 2012-13) 701 (year 2013-14) 1,745 (year 2014-15) 6,918	(estimation costs: more than Rs. 2 million) Bid announcement on PPRA website and newspaper The estimations shall be authorized upon DMD

Note: Procurement process in WASA shall be done by PEPRA rules prepared by government.

1.4. Inspection and payment to suppliers

P&S/ P&D conduct an inspection upon delivery, examining whether the product quality meets the requirement. Upon acceptance of the product, Departments in charge would request for the Finance department for payment of the contract amount. The Finance department would issue a check which would be converted into cash in a bank by the supplier.

Table 3: Procurement process at Lahore WASA

Cost estimation	Selection of bidders	Order placement	Inspection upon delivery	Payment to suppliers
P&S/ P&D The cost estimations shall be authorized upon DMD approval	**Appraisal committee including Finance department**	**P&S/ P&D**	**P&S/ P&D**	**Finance department upon request by the P&S/ P&D**

Summing up the previous discussion, the whole process of monitoring and procurement would be described in the following graph.

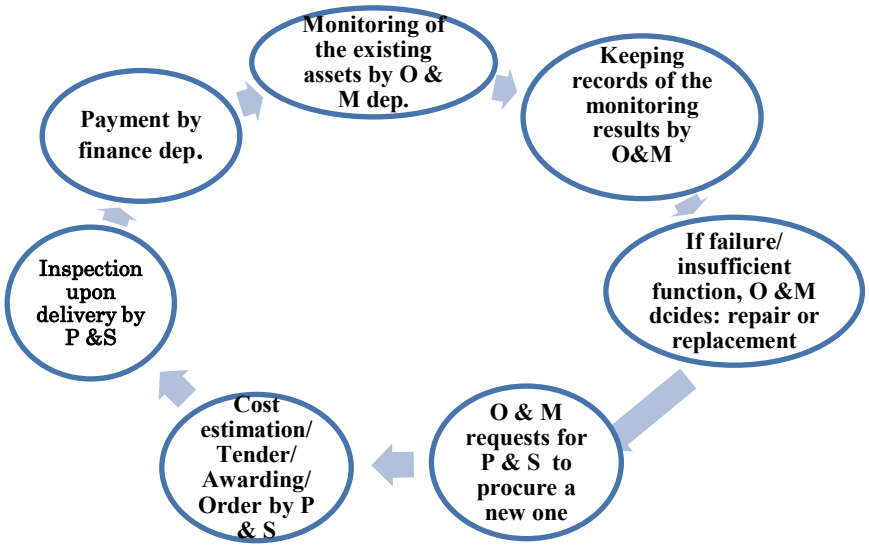


Figure 2: Whole process of monitoring and procurement at Lahore WASA

Lecture 2

1. Lecture Information

Topics: 1) Financial Report and budget formulation
Lecture Duration: 80 Minutes

2. Introduction of Topic

1.1. Financial report and Budget formulation (20 minutes)

Lecture 2 will be related to values of fixed assets, budgeting, and GIS at Lahore and other WASAs.

1.2. Values of fixed assets and budgeting

The lecture will highlight that it is difficult to know current asset values of Lahore or other WASAs.

On the other hand, P&S/ P&D formulate a new fiscal year budget of procurement from May 15 to June 15.

1.3. Fixed asset list

The WASAs have prepared fixed asset lists with support of the Urban Unit, however, current use of the lists is limited. The Asset management course will assist WASAs to more efficiently take advantage of those lists.

1.4. GIS

The GIS unit was established in 2013 and has currently three (3) assistant directors and one (1) CAD operator. They conduct a data input of tube wells, disposal stations, water supply/ sewerage pipe line network in GIS. The unit has completed those works in five (5) sub divisions of Lahore WASA. The work in remaining 27 sub divisions is on-going.

If other information is required to be input, it is necessary for the Unit to obtain a DGPS (Differential Global Position System) and others. The Unit recommended that Lahore WASA establish a MIS (Management Information System) section in charge of programing for data input and reporting with information from various departments, for example:

1) Fixed asset location and its values including tube wells, pipelines and others

2) Consumer address, tariff, payment situation, illegal connections

3) Water production and distribution

Group Discussion and Presentation **(60 Minutes)**

Group 1/2 will discuss 1) when the assets should be inspected, 2) how inspection should be conducted, 3) how asset condition should be measured, and 4) what actions should be taken based on the inspection. 4) Who would input data of new assets in the asset list.

They will present their findings/ suggestions to the whole class.

Group 3/4 will discuss: how to share the asset monitoring results with GIS department.

Lecture 3

1. Lecture Information

Topics: 1) Cost comparison of repair/ replacement
Lecture Duration: 1 Hours

2. Introduction of Topic

2.1. Cost comparison of repair/ replacement (30 minutes)

When failure or insufficient function is found in an asset, managers at the O & M department would make a decision: repair or replacement. The repair would reduce an initial cost of the recovery while maintenance costs afterward might be increasing. By contrast, the initial purchasing cost of a substitute one would be much higher than that of repair, while maintenance costs afterward might be less than those of the repair. The quantitative manner of cost comparison in described below might help the managers to appraise the options.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total costs
Repair	130	40	40	40	40	40	330
replacement	250	10	10	10	10	10	300

Conclusion (20 Minutes)

The lecturer will conclude day 1 by reviewing current monitoring practices and will invite questions from course participants for further clarifications. Lastly it will be highlighted that WASA staff could prepare replacement plans to incorporate these plans in an annual non-development/ development budgets, as well as recognize the importance of daily monitoring and its recording.

Review Questions

1) If you find a generator out of order, which do you recommend, repair or replacement?
2) How do you judge?

3) If you have a budget limitation in your replacement plan, which do you give a priority to, business area or school area?

Lecture 4

1. Lecture Information

Topics: 1) Pipeline replacement of Yokohama Water 2) asset database analysis and presentation by the participants
Lecture Duration: 4 Hours

2. Introduction of Topic

Review of day 1 **(10 minutes)**

The lecturer reviews the day 1 sessions: current asset monitoring/ replacement practices, emphasizing an importance of checklist preparation. The lecturer suggests a quantitative manner of evaluation would be necessary to procure a new asset.

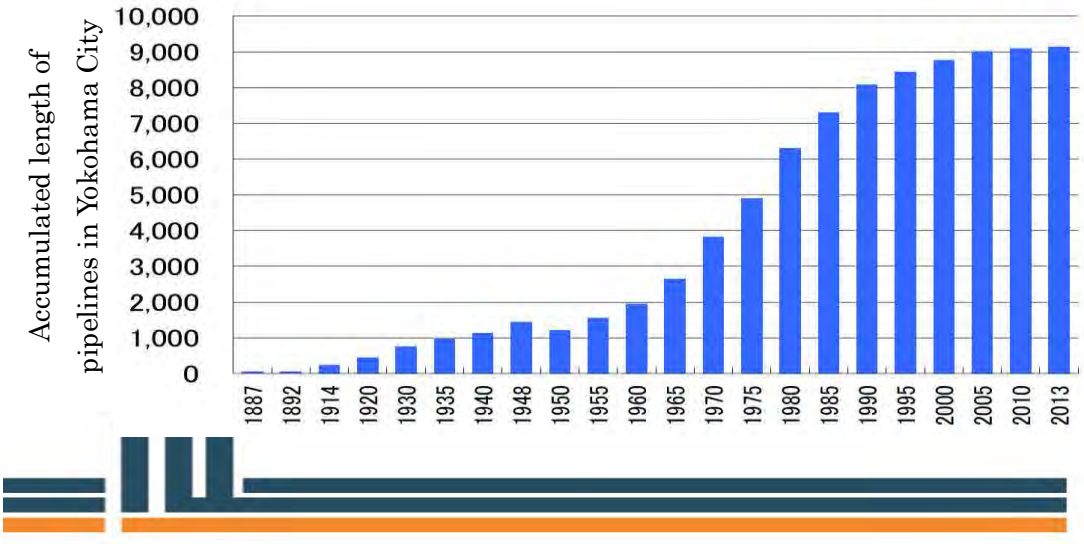
Reflection of day 1 **(10 minutes)**

The lecturer promotes each participant to present what he/ she learned in day 1.

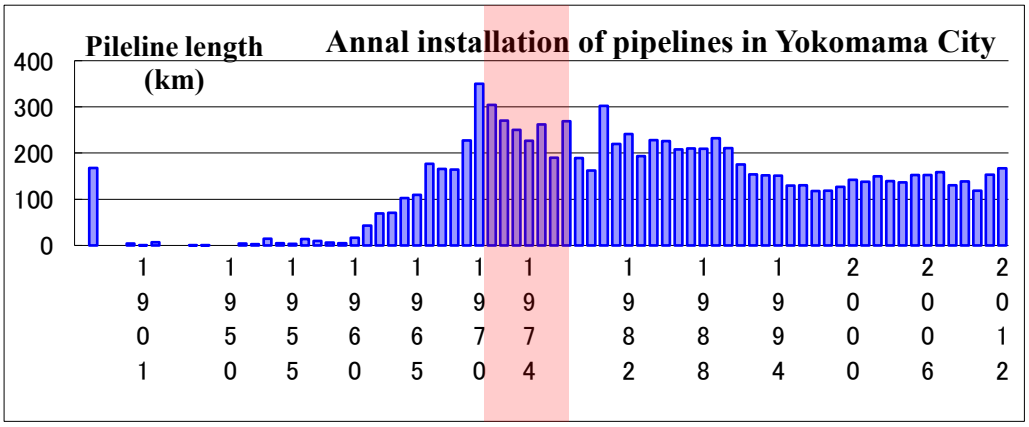
Lecture 1 (case study): Pipeline replacement of Yokohama Water **(20 minutes)**

In recent one (1) hundred years, Government of Japan has implemented a huge investment to increase water resources, water purification plants, pipelines to cope with growing demand. The policy is: supply enough (quantity) and safe (quality) water at reasonably lower prices. Yokohama city government is one of such typical local governments, as described below.

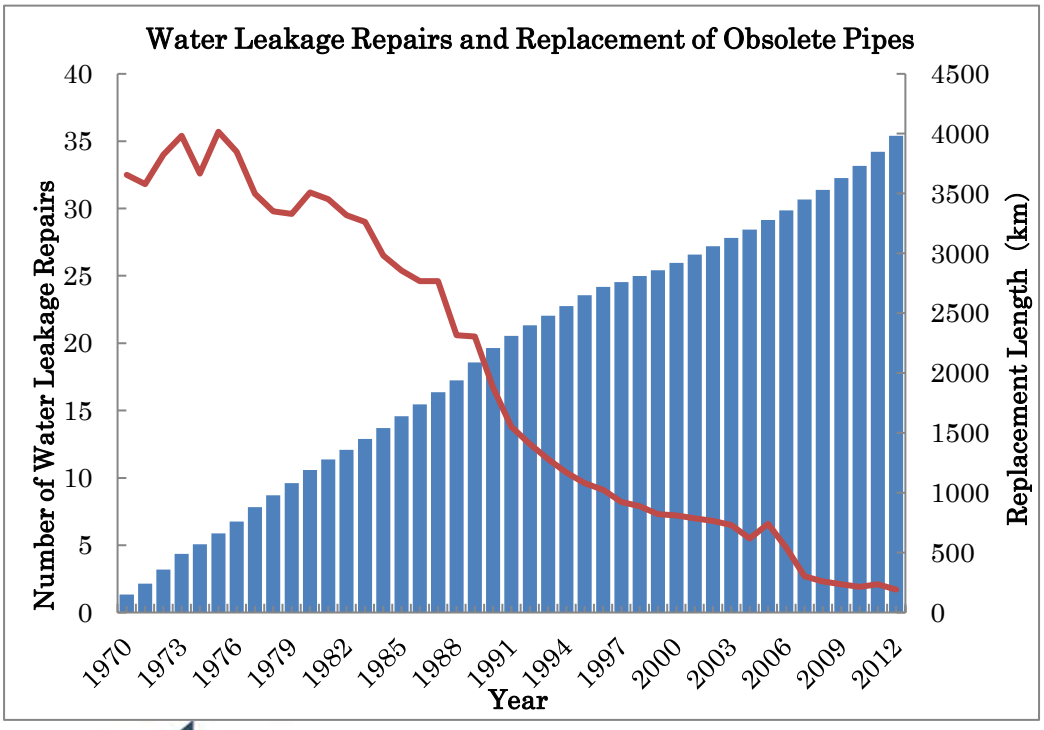
Yokohama Water Works was established in the year 1887. The Yokohama city population then was 140 thousand, and increased to 1 million in 1942, 2 million in 1968, 3 million in 1985, and 3.7 million now. Yokohama water works was merged in Yokohama city government to become "Yokohama Water Works Bureau (YWWB)". The YWWB has implemented a new pipeline installation every year to meet the increasing demand. Current length of the pipeline has reached to 9,100 km.



The following graph shows annual installation of new pipelines in Yokohama City. In Japan, life span of pipelines stipulated by law is forty (40) years. Japan used to achieve a rapid economic growth in 1960's and early 1970's until 1972, so called "Nixon shock". Annual installation then was 350 km, accumulating to 2,400 km. in this era, 1/4 of the total length, 9100 km.



Many water leakages were found in old pipes installed in early era of Yokohama Water Works. The City has, thus, implemented a replacement of old pipes since the year 1970, reaching to 3,900 km. The replacement has reduced numbers of leakage, from 30,000 in 1970 to 2,000 in 2011 and ratio of leakage from 20% to 5 %.



Group discussion **(20 minutes)**

YWWB has achieved 24-hour water supply, daily water quality analysis to meet consumers' demand. On the other hand, Lahore WASA carries out limited time of water supply. It might not meet growing demand of Lahore residents, as well as might generate a contamination of water. Participants will talk about what good practices of YWWB could be implemented in their WASA and how?

Asset database analysis exercise 1: **(40minutes)**

The following table shows tube wells in Iqbal Town of Lahore. Please conduct your database analysis in a table and graph, using Pivot Table in the Excel.

Some WASA staffs might conduct the database analysis with Pivot tables in excel.

Sr. No.	Name	Installation Year	Status	Town	Generator	Design Capacity	Actual Capacity	Condition	Replaceme	Motor_Size	Sub_Divisi
1	Chenab Block	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	8	150 HP	Allama Iqbal Town
2	Pak Block	1986	Functional	Iqbal Town	YES	4 CFS	1.75 CFS	D	4	150 HP	Allama Iqbal Town
3	Asif Block	2014	Functional	Iqbal Town	NILL	4 CFS	4 CFS	A	14	150 HP	Allama Iqbal Town
4	Clifton Colony	2014	Functional	Iqbal Town	NILL	4 CFS	4 CFS	A	14	150 HP	Allama Iqbal Town
5	Neelum Block	2008	Functional	Iqbal Town	NILL	4 CFS	2 CFS	D	5	150 HP	Allama Iqbal Town
6	Hunza Block	2008	Functional	Iqbal Town	YES	2 CFS	2 CFS	C	7	80 HP	Allama Iqbal Town
7	College Block	1993	Functional	Iqbal Town	NILL	4 CFS	2 CFS	C	7	150 HP	Allama Iqbal Town
8	Raza Block	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	9	150 HP	Allama Iqbal Town
9	Kareem Block	1996	Functional	Iqbal Town	NILL	4 CFS	1.75 CFS	D	4	150 HP	Allama Iqbal Town
10	Kareem Block Graveyard	2004	Functional	Iqbal Town	YES	2 CFS	2 CFS	C	8	80 HP	Allama Iqbal Town
11	Nishter Block	2009	Functional	Iqbal Town	NILL	2 CFS	1.90 CFS	D	6	80 HP	Allama Iqbal Town
12	F&V Market 2 Wadhat Road Multan Chungi	2009	Functional	Iqbal Town	NILL	4 CFS	4 CFS	B	8	150 HP	Allama Iqbal Town
13	F&V Market 1 Main Multan Road	2010	Functional	Iqbal Town	NILL	4 CFS	3.75 CFS	C	10	150 HP	Allama Iqbal Town
14	Ravi Block	2011	Functional	Iqbal Town	NILL	4 CFS	3.90 CFS	C	12	150 HP	Allama Iqbal Town
15	Nargis Block	2008	Functional	Iqbal Town	NILL	4 CFS	4 CFS	C	7	150 HP	Allama Iqbal Town
16	Huma Block	1999	Functional	Iqbal Town	NILL	4 CFS	3.25 CFS	C	8	150 HP	Allama Iqbal Town
17	Jahanzaib Block	1986	Functional	Iqbal Town	NILL	4 CFS	2 CFS	D	2	150 HP	Allama Iqbal Town
18	Kmaran Block	2010	Functional	Iqbal Town	NILL	4 CFS	3.75 CFS	C	10	150 HP	Allama Iqbal Town

Example 1-1: Installation year and actual capacity of tube wells

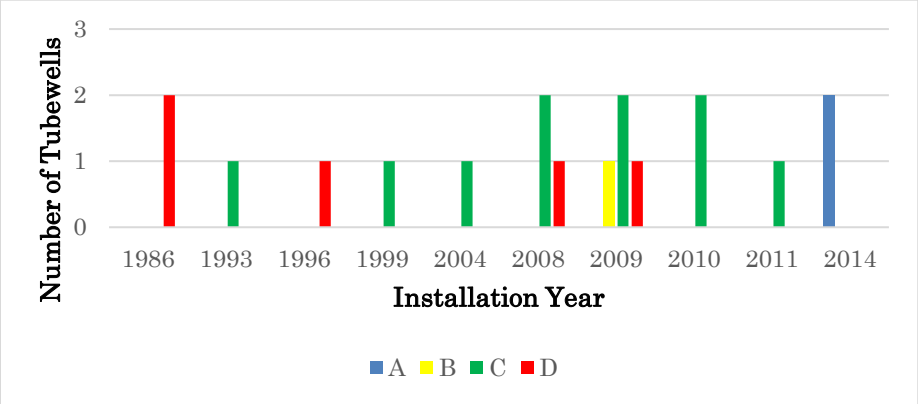
Installation Y	1.75 CFS	1.90 CFS	2 CFS	3.25 CFS	3.75 CFS	3.90 CFS	4 CFS	Total
1986	1		1					2
1993			1					1
1996	1							1
1999				1				1
2004			1					1
2008			2				1	3
2009		1					3	4
2010					2			2
2011						1		1
2014							2	2
Total	2	1	5	1	2	1	6	18

Example 1-2: Installation year and conditions (A, B, C, D) of tube wells (table)

Installation Y	A	B	C	D	Total
1986				2	2
1993			1		1
1996				1	1
1999			1		1
2004			1		1
2008			2	1	3
2009		1	2	1	4
2010			2		2
2011			1		1
2014	2				2
Total	2	1	10	5	18

The above table shows half of the tube wells in Iqbal Town are in C condition. The following graph might help visual understanding.

Example 1-3: Installation year and conditions (A, B, C, D) of tube wells (graph)



Even tube wells installed in the year 2009/ 2010 are now in C condition. It is important to clarify the reasons to implement countermeasures.

Presentation of asset database analysis by participants (40 minutes)

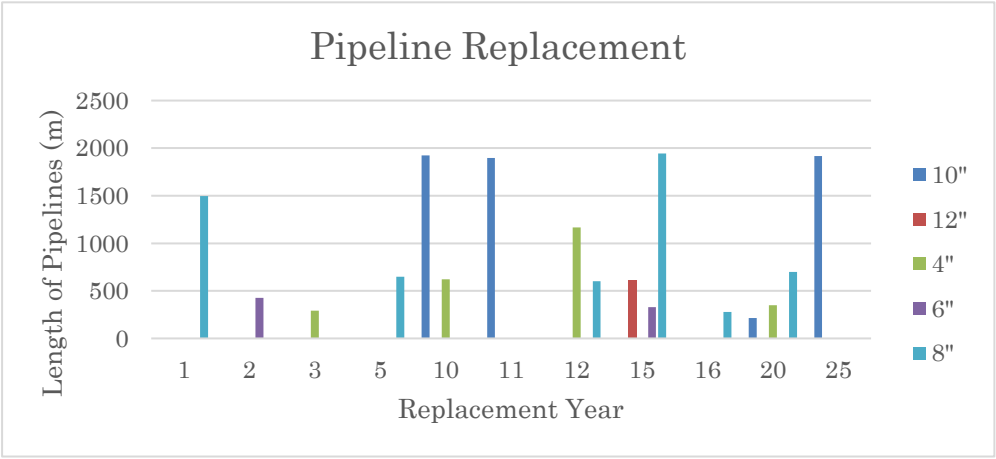
Each participant will present his/ her own database analysis results in the class, explaining observations with tables/ graphs. Some might say a large difference is found between design and actual capacity of many tube wells. Others might insist AC pipes should be replaced because many water leakages have been found in these pipes in Lahore.

Exercises 2 **(40 minutes)**

The following table shows a part of pipelines in Lahore. Please conduct your database analysis in a table and graph, using Pivot Table in the Excel.

Sr.No.	Street_Name	Sub_Division	Town	Diameter	Material	Installation year	Condition	Replacement_Diameter	Replacement_Year	Level	Risk	Shape_Length (m)
1	main pecco road	Township	Nishter Town	10"	AC	2,000.0	B	10"	11	P	M	1897
2	Main pecco road	Township	Nishter Town	10"	AC	2,011.0	B	10"	25	P	L	1916
3	Asghar MPA Road	Township	Nishter Town	8"	AC	2000	C	8"	1	T	H	579
4		Township	Nishter Town	8"	AC	2,000.0	B	8"	12	S	L	601
5	main pindi rajputa	Township	Nishter Town	6"	AC	1994	C	8"	2	S	M	426
6		Township	Nishter Town	10"	AC	2,010.0	B	10"	20	S	L	213
7		Township	Nishter Town	8"	AC	1995	B	8"	1	S	L	918
8	model town link road	Township	Nishter Town	8"	AC	2,009.0	B	8"	20	S	L	445
9	R Block Model town	Township	Nishter Town	4"	AC	1,994.0	B	4"	12	S	L	97
10	Karma_wala Bazar	Township	Nishter Town	6"	AC	1,986.0	B	6"	15	T	L	330
11	School road pindi rajputan	Township	Nishter Town	10"	AC	1994	B	10"	10	T	M	902
12	main bazar liaqtabad	Township	Nishter Town	10"	AC	1994	B	10"	10	T	M	1021
13	Nasrat Road Behar Colony	Township	Nishter Town	8"	AC	2000	B	10"	5	P	M	648
14		Township	Nishter Town	12"	AC	1,987.0	B	12"	15	T	L	479
15		Township	Nishter Town	8"	AC	1,987.0	B	8"	15	P	L	1943
16	extention	Township	Nishter Town	12"	AC	1,987.0	B	12"	15	S	L	139
17	Extention	Township	Nishter Town	4"	AC	1987	B	4"	10	T	L	175
18	Extention	Township	Nishter Town	8"	AC	2,000.0	B	8"	20	T	L	254
19	Extention	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	123
20	KHADAM PARK	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	110
21	R Block Model Town Extention	Township	Nishter Town	4"	PVC	1,992.0	B	4"	12	T	L	199
22	R Block Model Town Extention	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	283
23	R Block Model Town Extention	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	106
24	R Block Model Town Extention	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	67
25	Khadam Park near Itefaq Extention	Township	Nishter Town	4"	PVC	1,992.0	B	4"	12	T	L	107
26	Cricket Ground	Township	Nishter Town	8"	AC	2,000.0	B	8"	16	P	L	278
27	R Block Model Town Extention	Township	Nishter Town	4"	AC	1,992.0	B	4"	12	T	L	74
28		Township	Nishter Town	4"	AC	1987	B	6"	10	S	M	446
29	Q Block Model Town Extention	Township	Nishter Town	4"	AC	1987	B	6"	3	T	L	291
30	Q Block Model Colony	Township	Nishter Town	4"	AC	1,987.0	B	4"	20	T	L	246
31	Q Block Model Colony	Township	Nishter Town	4"	AC	1,974.0	B	4"	20	T	L	102

Example 2-1: Diameter (inch), length (meter) and replacement year of pipelines



Presentation of asset database analysis by participants **(40 minutes)**

Course participants will present their own database analysis results in the class. Some participants might show a graph with replacement year and pipe diameters/ lengths.

Conclusion **(20 minutes)**

The lecturer will conclude day 2 by reviewing an example of actual and prospective pipeline replacement in Yokohama and database analysis manners with actual data of tube wells and pipelines in Lahore. The lecturer will invite questions from course participants for further clarifications. Lastly it will be emphasized that both the daily practices described in Day 1 and replacement planning are important and co-related each other.

Review Questions

1) Many leakages have been found in AC pipes. Do you hear many customer complaints in AC pipe areas?
2) Would AC pipe replacement reduce customer complaints?
3) Would AC pipe replacement increase collection rates of water/ sewerage charges?

Lecture 5

1. Lecture Information

Topics: 1) Presentation of replacement plans by participants 2) Replacement cost
Lecture Duration: 4 Hours

2. Introduction of Topic

Review of day 2 **(10 minutes)**

The lecturer reviews the day 2 sessions: actual and prospective pipeline replacement in Yokohama and database analysis manners.

Reflection of day 2 **(10 minutes)**

The lecturer promotes each participant to present what he/ she learned in day 1/2 and how they would disseminate it to co-staffs.

Brain storming **(10 minutes)**

The lecturer asks participants what difficult exercises in Day2 are, thereby promoting them to help and teach each other.

Exercise 1 **(40 minutes)**

Let us add some information, e.g. how many years from installation. First please input a formula "=2016- installation year" to get how many years from installation. Then, for example, if you input

=IF(K3<6,"0-5",IF(K3<11,"6-10",IF(K3<16,"11-15",">15")))

Or

=IF(K5<=5,"0-5",IF(K5<=10,"6-10",IF(K5<=15,"11-15",IF(K5>15,">15"))))

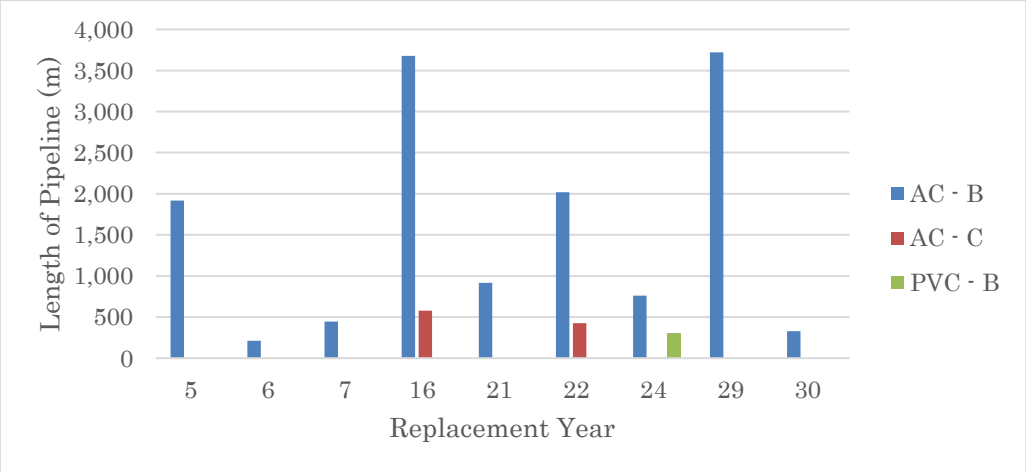
you can get a range of years from the installation.

Sr.No.	Street_Name	Sub_Division	Town	Diameter	Material	Installation Year	age	Condition	ment_Dia meter	Replacement_ Year	Replacement yr range	Level	Risk	Length of pipe (m)
1	main pecco road	Township	Nishter Town	10"	AC	2000	16	B	10"	11	11-15	P	M	1897
2	Main pecco road	Township	Nishter Town	10"	AC	2011	5	B	10"	25	>15	P	L	1916
3	Asghar MPA Road	Township	Nishter Town	8"	AC	2000	16	C	8"	1	0-5	T	H	579
4		Township	Nishter Town	8"	AC	2000	16	B	8"	12	11-15	S	L	601
5	main pindi rajputa	Township	Nishter Town	6"	AC	1994	22	C	8"	2	0-5	S	M	426
6		Township	Nishter Town	10"	AC	2010	6	B	10"	20	>15	S	L	213
7		Township	Nishter Town	8"	AC	1995	21	B	8"	1	0-5	S	L	918
8	model town link road	Township	Nishter Town	8"	AC	2009	7	B	8"	20	>15	S	L	445
9	R Block Model town	Township	Nishter Town	4"	AC	1994	22	B	4"	12	11-15	S	L	97
10	Karma_wala Bazar	Township	Nishter Town	6"	AC	1986	30	B	6"	15	11-15	T	L	330
11	School road pindi rajputan	Township	Nishter Town	10"	AC	1994	22	B	10"	10	6-10	T	M	902
12	main bazar liaqtabad	Township	Nishter Town	10"	AC	1994	22	B	10"	10	6-10	T	M	1021
13	Nasrat Road Behar Colony	Township	Nishter Town	8"	AC	2000	16	B	10"	5	0-5	P	M	648
14		Township	Nishter Town	12"	AC	1987	29	B	12"	15	11-15	T	L	479
15	Q block model town	Township	Nishter Town	8"	AC	1987	29	B	8"	15	11-15	P	L	1943
16	extention Q Block Model Town	Township	Nishter Town	12"	AC	1987	29	B	12"	15	11-15	S	L	139
17	Extention R Block Model Town	Township	Nishter Town	4"	AC	1987	29	B	4"	10	6-10	T	L	175
18	Extention R Block Model Town	Township	Nishter Town	8"	AC	2000	16	B	8"	20	>15	T	L	254
19	Extention	Township	Nishter Town	4"	AC	1992	24	B	4"	12	11-15	T	L	123

Example 1-1: Age, condition, materials (AC/ PVC) and length of pipelines (table)

Shape_Length (m)	Material	Condition				
	AC		AC Total	PVC	PVC Total	Ttoal
How many years from installation	B	C		B		
5	1,916		1,916			1,916
6	213		213			213
7	445		445			445
16	3,677	579	4,257			4,257
21	918		918			918
22	2,020	426	2,447			2,447
24	763		763	307	307	1,069
29	3,719		3,719			3,719
30	330		330			330
(空白)	102		102			102
Ttoal	14,103	1,006	15,109	307	307	15,416

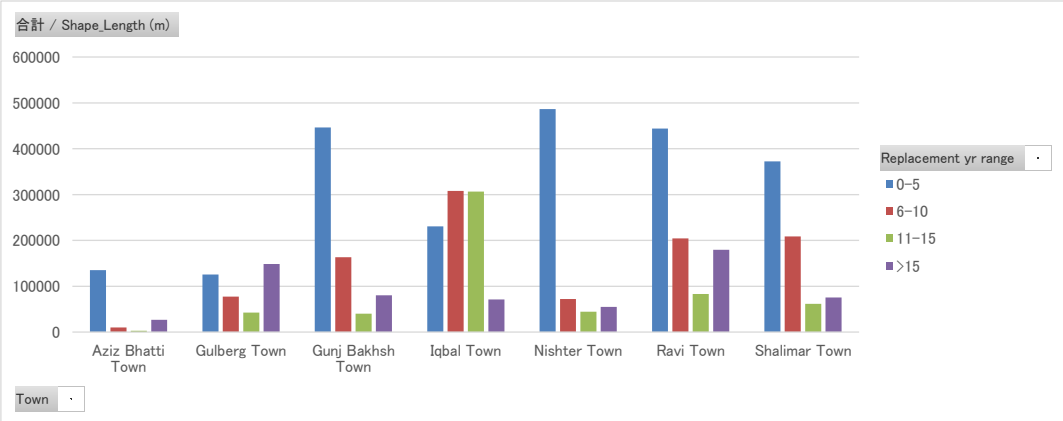
Example 1-2: Age, condition, materials (AC/ PVC) and length of pipelines (graph)



Example 1-3: Pipeline Replacement in each town of Lahore (table) unit: meter

Town	0-5	6-10	11-15	>15	Total
Aziz Bhatti Town	135324	10072	2717	26556	174669
Gulberg Town	125692	77557	42284	148704	394237
Gunj Bakhsh Town	446671	163515	39951	80041	730178
Iqbal Town	230795	308241	306631	71165	916832
Nishter Town	486552	72078	44200	54950	657779
Ravi Town	443878	204613	83309	179622	911422
Shalimar Town	372534	208761	61809	75268	718371
Total	2241445	1044837	580901	636306	4503490

Example 1-4: Pipeline Replacement in each town of Lahore (graph)



Presentation of replacement plans by participants (40 minutes)

Some participants might show their short/ medium/ long term replacement plans, using the "replacement year" in the database. It is, however, found in the above Example 1-2 that the replacement demand varies with the year. Annual budget would not fluctuate by as much as double or triple. It is important to make an effort to equalize distribution of replacement budget, by e.g. making those assets life spans longer with careful monitoring and preventive maintenance.

Exercise 2 (50 minutes)

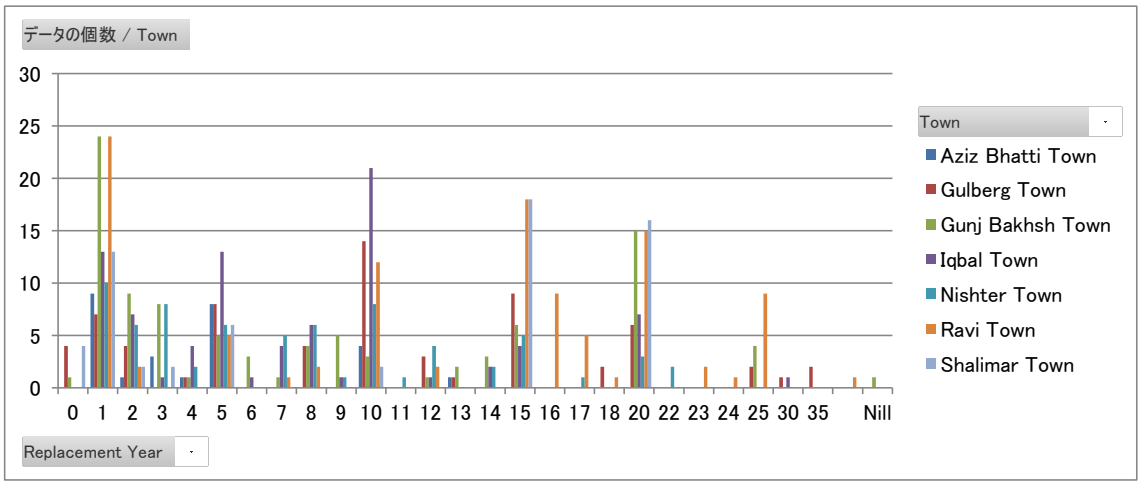
Please make your short/ medium/ long term replacement plans, using Pivot Table in the Excel.

The following table and graph shows a data analysis of all tube wells in Lahore.

Example 2-1 Tube well replacement from the year 2016 in each town of Lahore (table)

Town	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	23	24	25	30	35	Nill	Total
Aziz Bhatti Town		9	1	3	1	8					4			1														27
Gulberg Town	4	7	4		1	8			4		14		3	1		9			2	6				2	1	2		68
Gunj Bakhsh Town	1	24	9	8	1	5	3	1	4	5	3		1	2	3	6				15				4			1	96
Iqbal Town		13	7	1	4	13	1	4	6	1	21		1		2	4				7					1			86
Nishter Town		10	6	8	2	6		5	6	1	8	1	4		2	5		1		3	2							70
Ravi Town		24	2			5		1	2		12		2			18	9	5	1	15		2	1	9			1	109
Shalimar Town	4	13	2	2		6					2					18				16								63
Total	9	100	31	22	9	51	4	11	22	7	64	1	11	4	7	60	9	6	3	62	2	2	1	15	2	2	1	519

Example 2-2 Tube well replacement from the year 2016 in each town of Lahore (graph)



Replacement cost **(50 minutes)**

The following table shows a replacement cost of old water supply pipes. The old pipes should be replaced by HDPE. The following table shows the material and construction cost;

	A	B	C	D	E	F	G	H
1	Diameter		Material	Cost of Different Pressure Rated Pipes/m				Construction Cost/ m
2	(mm)	(Inch)		PN 8	PN 10	PN 12.5	PN 16	
3	50	2"	HDPE	97	120	148	181	244
4	110	4"	HDPE	473	582	713	864	529
5	160	6"	HDPE	1000	1220	1512	1835	1001
6	200	8"	HDPE	1560	1910	2355	2860	1539
7	250	10"	HDPE	2310	2836	3475	4461	2385
8	315	12"	HDPE	4095	4916	6161	7455	3321
9				*The cost is in Pak Rupee.*				

We'll need to add fields in "Existing Wtr supply lines" sheet as follows;

1. material cost per meter
2. Total Material cost
3. Construction cost per meter
4. Total Construction cost
5. Total Material and Construction Cost

Now it should look like below;

	R	S	T	U	V	W
1						
2	Cummulative Length	Material Cost/m	Total Material Cost	Const. Cost /m	Total Const. Cost	Total material & Const.
3	226.2397776					
4	630.9364019					
5	1179.331479					
6	1933.648482					
7	2375.146592					
8	2786.024012					
9	1896.653919					
10	3812.603351					
11	4026.008609					
12	4927.69519					
13	5949.189951					
14	6596.933937					
15	7152.397213					
16	7190.042472					
17	7194.756608					
18	7235.08102					
19	7415.415614					
20	8780.826129					
21	8790.551909					

Sub Divisions | Pivot Table | **Exs Wtr supply Lines** | Costing Table | Exs Tubewell | Exs Water Filtration Plant | Exs Valves

Now look if the following columns represent the mentioned fields in "Exs Wtr supply lines" sheet;

L= Replacement Diameter

Q= Length of Pipe

Now look in the costing table if these columns represent the mentioned fields;

B= Diameter (inch)

D= PN8 Cost/m

H= Construction Cost/m

Now in "Exs Wtr Supply line" sheet, select 'S3' cell to get the cost per meter for corresponding diameter in row # 3.

Input the following formula;

```
=IF(L3='Costing Table'!B$3,'Costing Table'!D$3,IF(L3='Costing Table'!B$4,'Costing Table'!D$4,IF(L3='Costing Table'!B$5,'Costing Table'!D$5,IF(L3='Costing Table'!B$6,'Costing Table'!D$6,IF(L3='Costing Table'!B$7,'Costing Table'!D$7,IF(L3='Costing Table'!B$8,'Costing
```

Table'!D$8))))))

Or simply do the following;

1. Type "=IF(L3="
2. Then go to "costing table" sheet and select 'B3'
3. Type comma, and then select "D3" and type a comma. The formula should look like this;

   =IF(L3='Costing Table'!B3,'Costing Table'!D3,
4. Now continue the formula, type "=IF(L3="
5. Then stay in "costing table" sheet and select 'B4'
6. Type comma, and then select "D4" and type a comma. The formula should look like this;

   =IF(L3='Costing Table'!B3,'Costing Table'!D3,IF(L3='Costing Table'!B4,'Costing Table'!D4,

You will continue this till "B8" and "D8" and at the insert))))). Also The formula should look like this

=IF(L3='Costing Table'!B3,'Costing Table'!D3,IF(L3='Costing Table'!B4,'Costing Table'!D4,IF(L3='Costing Table'!B5,'Costing Table'!D5,IF(L3='Costing Table'!B6,'Costing Table'!D6,IF(L3='Costing Table'!B7,'Costing Table'!D7,IF(L3='Costing Table'!B8,'Costing Table'!D8))))))

Now put the '$' sign between 'B' and 'D' values to fix the cells.

=IF(L3='Costing Table'!B$3,'Costing Table'!D$3,IF(L3='Costing Table'!B$4,'Costing Table'!D$4,IF(L3='Costing Table'!B$5,'Costing Table'!D$5,IF(L3='Costing Table'!B$6,'Costing Table'!D$6,IF(L3='Costing Table'!B$7,'Costing Table'!D$7,IF(L3='Costing Table'!B$8,'Costing Table'!D$8))))))

Now press enter, you will get "2310" if you have done it correctly.

R	S	T	U	V	
mulative I	Material Cost/m	Total Material Cost	Const. Cost /m	Total Const. Cost	Total mate
226.2397776	2310				
630.9364019					
1179.331479					
1933.648482					
2375.146592					
2786.024012					

If you double click on the bottom right corner, it will expand and apply the same formula till the

last row.

Now in the "Total Material cost" go to 'T3' and type the following formula to get the Total material cost.

```
=Q3*S3
```

You will get the total material cost. Expand it by double clicking on bottom right corner of 'T3' cell and the formula will be applied till the last row.

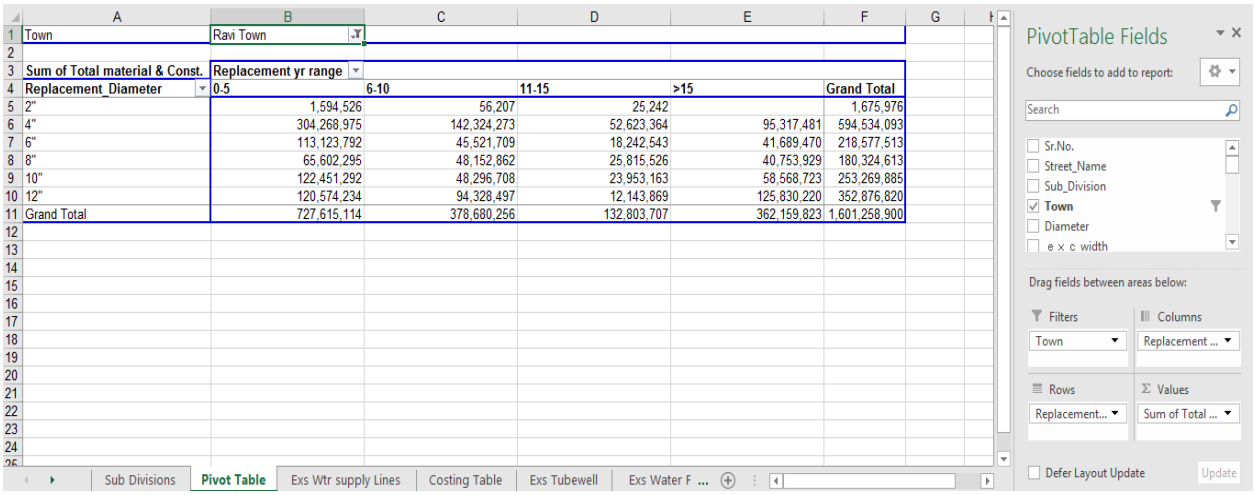
Now calculate the construction cost/m and total construction using the procedure you just learnt. You can get the total material and construction cost by adding the two already calculated material and construction costs.

The sheet will look like below.

P	Q	R	S	T	U	V	W
Risk	Length of pipe (m)	mulative l	Material Cost/m	Total Material Cost	Const. Cost /m	Total Const. Cost	Total material & Const.
M	226.2397776	226.2397776	2310	522614	2385	539581.8697	1062196
M	404.6966243	630.9364019	2310	934849	2385	965201.4489	1900051
M	548.3950768	1179.331479	2310	1266793	2385	1307922.258	2574715
M	754.3170036	1933.648482	2310	1742472	2385	1799046.054	3541518
M	441.4981101	2375.146592	2310	1019861	2385	1052972.992	2072834
M	410.8774195	2786.024012	2310	949127	2385	979942.6455	1929069
M	1896.653919	1896.653919	2310	4381271	2385	4523519.597	8904790
L	1915.949432	3812.603351	2310	4425843	2385	4569539.396	8995383
L	213.4052574	4026.008609	2310	492966	2385	508971.5388	1001938
M	901.6865813	4927.69519	2310	2082896	2385	2150522.496	4233418
M	1021.494761	5949.189951	2310	2359653	2385	2436265.006	4795918
M	647.7439854	6596.933937	2310	1496289	2385	1544869.405	3041158
M	555.4632768	7152.397213	2310	1283120	2385	1324779.915	2607900
L	37.64525845	7190.042472	2310	86961	2385	89783.9414	176744
L	4.714136618	7194.756608	2310	10890	2385	11243.21583	22133
L	40.32441192	7235.08102	2310	93149	2385	96173.72242	189323
M	180.3345934	7415.415614	2310	416573	2385	430098.0053	846671
M	1365.410515	8780.826129	2310	3154098	2385	3256504.079	6410602
M	9.725779647	8790.551909	2310	22467	2385	23195.98446	45663

Table | Exs Wtr supply Lines | Costing Table | Exs Tubewell | Exs Water Filtration Plant | Exs Valves | ... | 100%

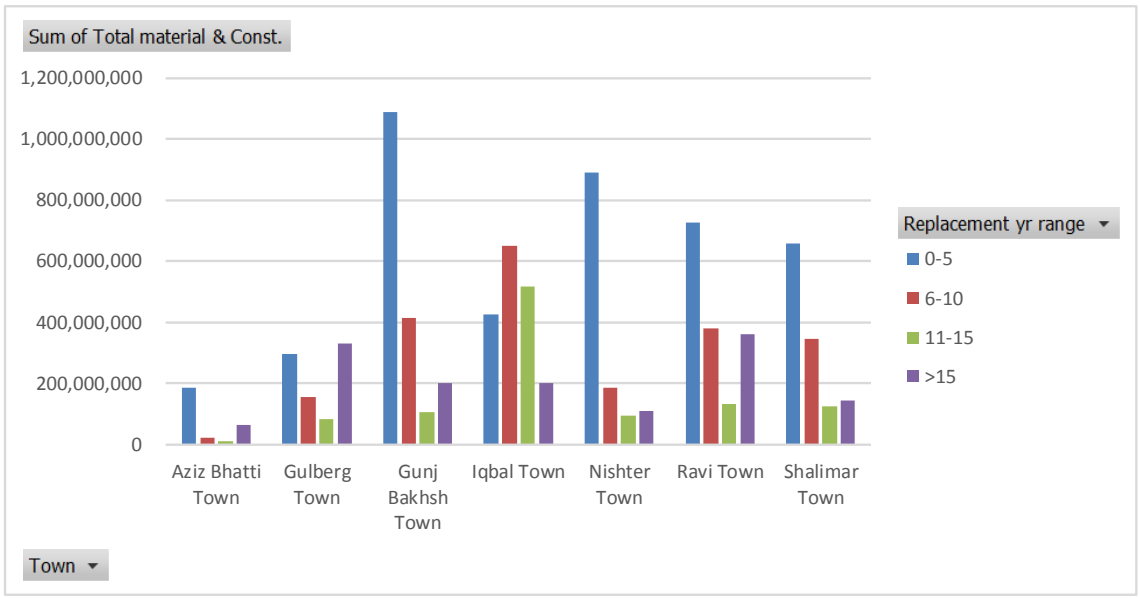
Now select the whole data and insert a pivot table to get the desired analysis. In this exercise , we have used the pivot table to generate the replacement cost of Ravi Town water supply pipes over a range of years as shown below.



Town	Ravi Town					
Sum of Total material & Const.	Replacement yr range					
Replacement_Diameter	0-5	6-10	11-15	>15	Grand Total	
2"	1,594,526	56,207	25,242		1,675,976	
4"	304,268,975	142,324,273	52,623,364	95,317,481	594,534,093	
6"	113,123,792	45,521,709	18,242,543	41,689,470	218,577,513	
8"	65,602,295	48,152,862	25,815,526	40,753,929	180,324,613	
10"	122,451,292	48,296,708	23,953,163	58,568,723	253,269,885	
12"	120,574,234	94,328,497	12,143,869	125,830,220	352,876,820	
Grand Total	727,615,114	378,680,256	132,803,707	362,159,823	1,601,258,900	

Then let's calculate the replacement cost of all water supply lines in Lahore over range of years.

Sum of Total mater	Replacement yr range				
Town	0-5	6-10	11-15	>15	Grand Total
Aziz Bhatti Town	185,403,496	19,756,561	9,588,960	63,813,814	278,562,832
Gulberg Town	297,436,638	155,803,822	83,009,541	331,050,800	867,300,802
Gunj Bakhsh Town	1,086,468,286	415,525,725	103,628,531	202,211,284	1,807,833,826
Iqbal Town	425,919,353	648,808,775	517,205,448	200,829,247	1,792,762,822
Nishter Town	888,594,127	183,652,234	92,780,167	108,259,202	1,273,285,729
Ravi Town	727,615,114	378,680,256	132,803,707	362,159,823	1,601,258,900
Shalimar Town	656,215,937	344,278,292	125,817,497	143,879,672	1,270,191,397
Grand Total	4,267,652,951	2,146,505,665	1,064,833,851	1,412,203,841	8,891,196,308



If you don't get the diameters or year range in proper order, then you can manually drag the rows or columns to desired position.

For the desired number format, you can just select the values and right click to go to "Number Format".

Presentation of replacement plans by participants (60 minutes)

Many participants would show their own short/ medium/ long term plans. If annual replacement budget is limited, we have to give a priority to allocate the budget. The following criteria, e.g. pipelines, might help allocate the budget.

- Pipelines with much leakages
- Pipelines providing water/ sewerage for wider area
- Pipe lines near schools or hospitals
- Pipelines near pumps
- AC pipelines
- Pipelines supplying areas with higher rates of water/ sewerage charge collection
- Pipelines without substitute lines (no backup)
- Leakage of the pipelines might lead another accident

It is, thus, more realistic to prepare replacement plans given a priority, e.g.

This year: priority 1, priority 2, priority 3

Next year: priority 4, priority 5, priority 6

If the priority 3 has not been implemented by the end of this year, priority 3 would be the first target for the next year.

Conclusion (20 minutes)

The lecturer will conclude day 3 by reviewing short/ medium/ long term replacement plans with actual data in Lahore. The lecturer will invite questions from course participants for further clarifications. Lastly the lecturer will emphasize implementation of what they learned from the course, and promoting them to:

1) Carry out a daily monitoring of assets with check sheets

2) Evaluate repair or replacement of the existing assets, especially those with values of more than two (2) million Rs.

3) Formulate of an annual “repair and maintenance” budget in non-development/ development, every year, May 15- June 15

Review Questions

1) What would be urgent replacement work for consumers?

2) Why do you give priority to the work?

3) How do you prepare necessary human resources/ good materials and fund (budget)?

Definition of Terms

Asset management

Asset management is to ensure that assets are on booked on the utility's register when placed in service, depreciated appropriately on an annual basis, and removed from the register when retired.

Asset replacement

Asset replacement is substitution of an entire asset with a new or equivalent asset without enhancement of capability. Replacement of assets is done when it is insufficient to keep the asset serviceable or when it is more cost effective to replace.

Replacement plan

Replacement plan outlines replacement or rehabilitation approaches to maximize the performance and minimize costs of the assets. It also describes what capital investments are needed in short/ medium/ long term.

Cost comparison

Cost comparison is a quantitative manner of selective judgment among more than two (2) cases by estimation of cash requirements and cumulative costs over asset life

Monitoring

Condition assessment to check deterioration or eventual failure of the existing assets

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1. Progress Report for Year II, March 2014, Punjab Cities Governance Improvement Project
2. Mechanism of Integrated Development & Asset Management Plan (IDAMP), 2015, Planning and Development Department, Government of Punjab
3. Uniform Financial Management Manual, Volume II Uniform FM Procedures Manual, Water and Sanitation Agencies (WASAs)
4. The Urban Unit, Standard Operating Procedures, Second Edition, Punjab Procurement Rules 2014

ALJAZARI
ACADEMY

LECTURE NOTES

Asset Management

Asset Condition Survey

Module No: 5

2016

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Introduction of the Asset Management Course:

This course is about asset management related to water utilities. It focuses on assets, its attributes, determining their condition, risk, life cycle of an asset, monitoring of existing assets, accounting treatment of assets and preparing asset replacement plan. This course is especially beneficial for officers of grade 17 and 18 who are directly or indirectly involved in planning and routine management of assets.

Course Participants (CPs) will develop knowledge and skills about asset, its life cycle and carry out asset condition survey. They will be able to develop and use asset data base for asset replacement planning. This course will also help the CPs in understanding application of the concepts related to Asset Replacement Plan, Asset Operational Plan and its monitoring. The CPs will learn through OJT, how to use the Asset Management Information System, GIS and other tools.

Upon the completion of this course the CPs will be in a better position to apply their learning in their routine jobs and prepare an Integrated Development & Asset Management Plan (IDAMP) to provide better water supply and sewerage services to their consumers.

Introduction of OJT-1 Asset Conditioning:

Asset conditioning OJT is the most important part of Asset Management Course. It is the practical through which the condition of the asset is determined by doing the physical inspection and some performance parameters most importantly discharge, pressure and electrical are measured by instruments in the field. Based on asset condition survey, interventions to improve the condition of asset is usually carried out. These interventions become the part of asset management planning to maintain the service delivery at good level and further contribute to long term sustainability of the water & sewerage supply.

Course Participants will be able to rate the asset based on their condition and performance after this OJT. They will be able to make a plan to improve the condition of the assets as these assets are responsible for service delivery of water utilities towards their consumers.

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Lecture 1

1. Lecture Information

Topics: 1) WASA Asset Type 2) Water Supply Assets 3) Disposal Station Asset
Lecture Duration: 40 Minutes

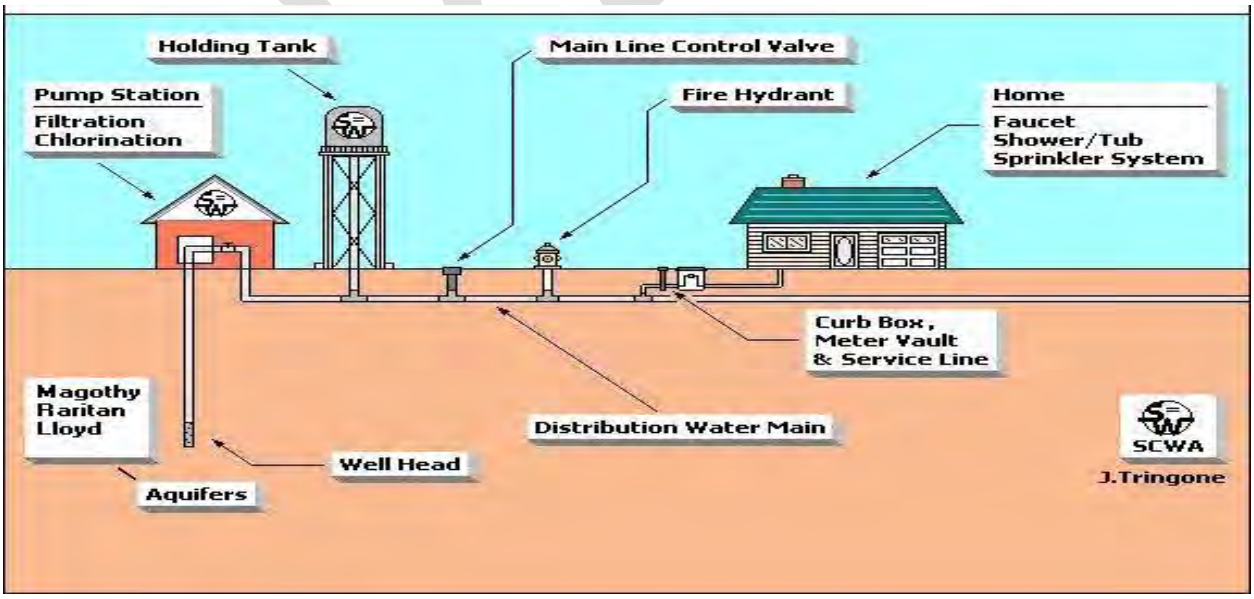
2. WASAs Asset Types (10 Minutes)

In WASA there are different type of assets through which WASA perform the service delivery. Main Asset types are given below;

- Water Supply Assets
- Disposal Station Assets
- Vehicle, Mechanical Machinery & Other Assets

2.1 Water Supply Assets (10 Minutes)

In water supply, WASA has many assets that starts from the tube well station to the water consumer. The following diagram is showing the basic assets of the water supply system.



In water Supply system main assets are listed below;

- Tube well Station
- Transformer

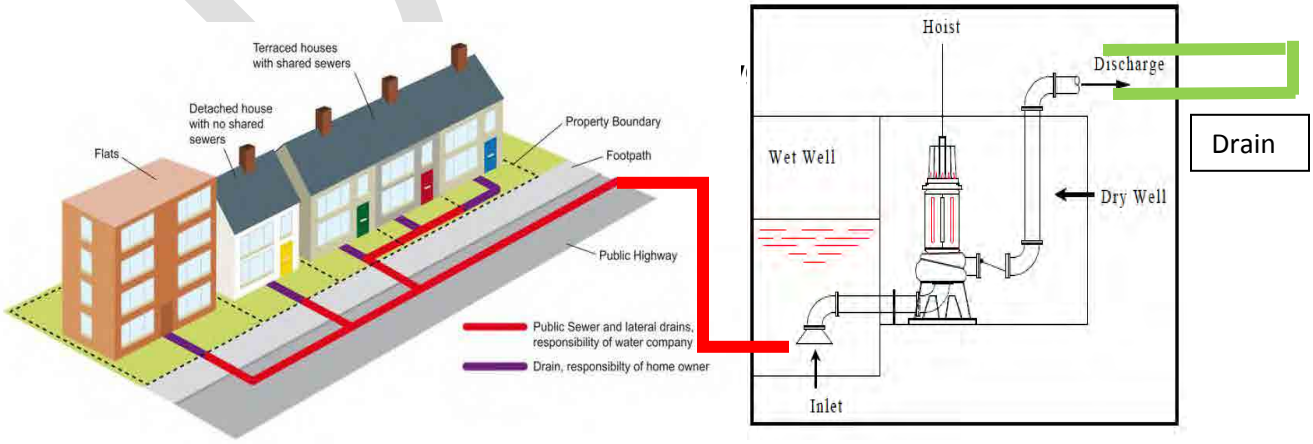
- Energy Meter
- Generator
- Water Supply Lines (Primary, Secondary and Tertiary)
- Control Valves
- Over Head Reservoir
- Water Tankers
- Consumer Meter

Assets which are within the tube well station are listed below;

- Main Breaker
- Motor Control Units
- Electric Motor
- Pump
- PFI Plant
- Non- Return Valve
- Gate Valve
- Air Release Valve
- Bulk Flow Meter
- Pressure Gauges
- Chlorinator
- Priming Box
- Lighting
- Exhaust Fan
- Tube Well Room

2.2 Sewerage System Asset **(20 minutes)**

In Sewerage, WASA has many assets that starts from the house hold to the disposal station and from disposal station to the drain. The following diagram is showing the basic sewer system of the sewerage system.



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Assets which come under the sewerage system are listed below;

- Tertiary Sewer Line (Connects Household sewer to Secondary Sewer Line)
- Secondary Sewer Line (Connects tertiary sewer lines to Primary Sewer line)
- Primary Sewer Line (Connects Secondary Sewer lines to Disposal Station)
- Lifting Station
- Disposal Station
- Drains
- Sucker Jetting Machine
- Tractor
- Trolleys
- De-silting Machines
- Dewatering Set

Assets which are within the disposal station are listed below;

- Wet Wells
- Screens
- Float Switches
- Motor
- Pumps
- Motor Control Units
- Main Breaker
- PFI Plant
- Energy Meter
- Transformers
- Generators
- Lifting Machines
- Lights
- Disposal House
- Non-Return Valve
- Gate Valves
- Log Books
- Plantation

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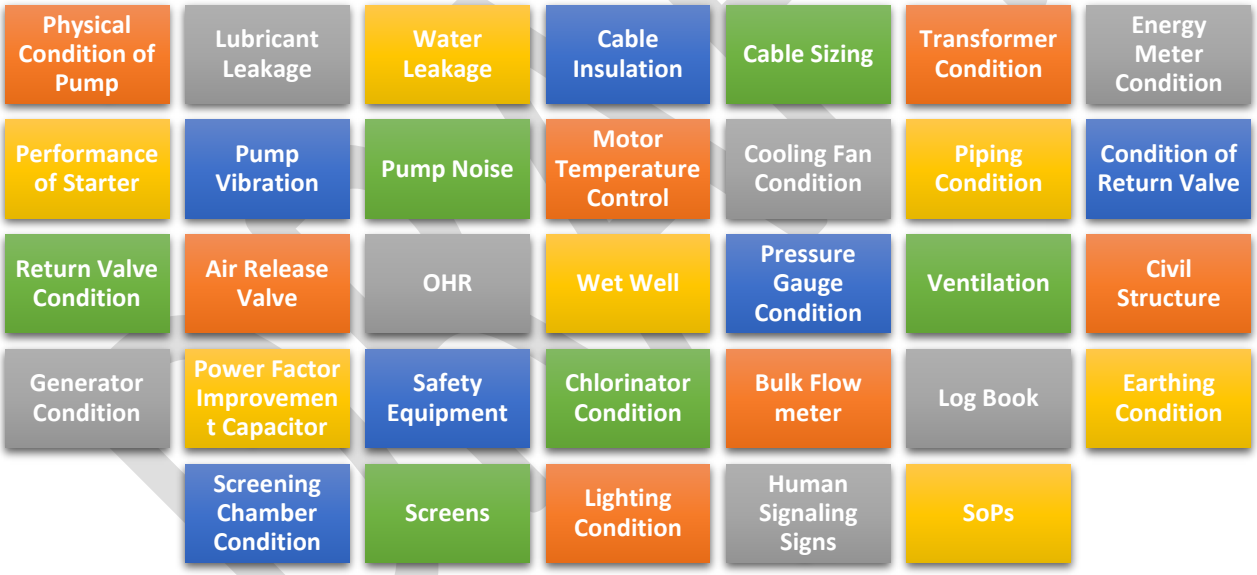
Lecture 2

1. Lecture Information

Topic:	1) Asset Conditioning 2) Asset rating
Lecture Duration:	80 Minutes

2. Asset Conditioning (40 Minutes)

All of the assets contribute in the WASA service delivery. Each asset contribute in the service delivery based on its performance and condition. Performance and condition of the asset is primarily important to know and should be evaluated after certain time. It is also important for the asset management planning and asset replacement plan. There are different asset condition parameters based on that condition of the asset is usually evaluated through physical and measurement inspection of the assets. A survey is usually carried out to know the condition of the asset which is called condition survey. Indicators of physical condition survey are given below in the fig;



2.1 Measurement Parameters of the condition Survey

There are parameters which are measured during the condition survey. These parameters are used to evaluate the performance of the asset. These parameters are listed below;

- Pressure Measurement at Tube well station, Disposal station and water & waste water network (This can be checked from the log book of the operator)
- Flow Measurement at tube well station, disposal station and Water & Waste Water Network (This can be checked from the log book of the operator)

- Power factor measurement at the tube well station & Disposal Station (This can be checked from the log book of the operator)
- Residual Chlorine testing in the network

2.2 Measurement Tools

In order to measure pressure, head, flow (Discharge) power factor and other electrical parameter in the measurement condition survey following tools are used.

1. Pressure Gauge
2. Ultrasonic Flow Meter
3. Power Analyzer

2.2.1 Pressure Gauge

Pressure is the primary factor to measure the suction and discharge head in the water supply and on disposal pumps. Pressure gauge is installed vertically on the suction and delivery side of the pump to know the pressure. Pressure is then converted in to feet that constitute the suction and delivery head of the pump. This is important parameter in calculating the efficiency of the pump. Following is the formula to convert the pressure (bar) in to feet.

$$h = p * \frac{1}{0.0981 * SG}$$

H= head (m)

P= Pressure (bar)

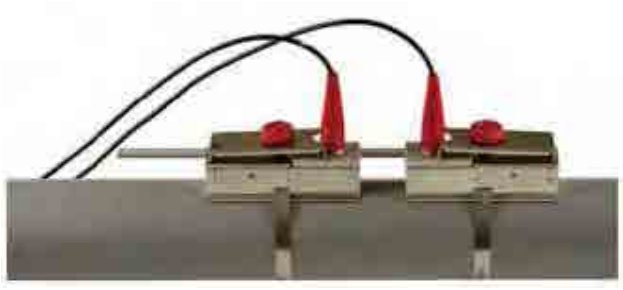
SG= Specific Gravity

2.2.2 Ultrasonic Flow Meter

Discharge of the fluid is measured with the ultrasonic flow meter. This instrument has two sensors upstream and downstream. There are two main methods (V and Z) of mounting sensors on the pipe but we prefer V method to measure the discharge and discharge velocity in the pipe. Following figure shows V method for measuring the flow in the pipe.

Following parameters are to be feed in the flow meter before installation;

1. Perimeter of the pipe (mm)
2. Pipe Thickness (mm)
3. Type of Fluid (water, gas and etc.)
4. Method of installation (V or Z)



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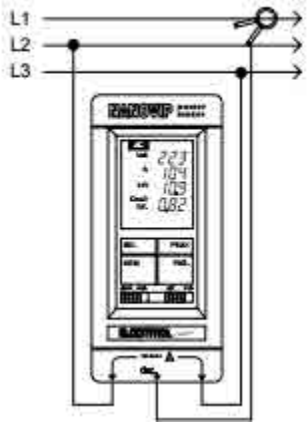
Flow meter calculates mounting distance between two sensors on the pipe. Sensors should be installed at the distance given by the flow meter in straight direction. If the signal strength is greater than 50 then flow meter main screen will show the discharge in the pipe otherwise make the direction of sensor correct, rub the pipe surface or add ultrasound gel on the sensor to get better signal for discharge reading. Flow meter manual is attached as Annex-1

2.2.3 Power Analyzer

Power analyzer is the electrical instrument that is used to measure all six parameters of the Power both for single and three phase electric supply like kilowatts, KVARS, KVA, Voltages, Amperes, Power factor and frequency of the electric supply. Following figure shows power analyzer and the installation procedure to measure electrical parameters. Power Analyzer manual is attached as Annex-2



2.3 Asset Condition Rating (40 Minutes)

Asset is rated in to different grades between A-F during the condition survey. These grades translate different actual conditions, findings and observations during the physical inspection of the condition survey. Description or meaning of the grades is given below;

A = No noticeable defects. Some aging or wear may be visible.

B = only minor deterioration or defects are evident.

C = some deterioration or defects are evident, but function is not significantly affected.

D = Serious deterioration in at least some portion of the structure. Function is inadequate.

F = No longer functional. General failure or complete failure of a major structural component.

These grades can to translated into different other ratings like Score and position indicators are given in the table below;

Average Score	*1*	*2*	*3*	*4*	*5*
Asset Condition	Excellent	Good	Fair	Poor	Failing
Category	*A*	*B*	*C*	*D*	*F*

Example Rating of the Asset:

The following picture showing the motor terminal box
Where the cable are bear and housekeeping of the cable is
Very poor and cable insulation is seriously deterioration. So
The condition of the insulation is rated as **"D"** and same in
The case of the priming box.

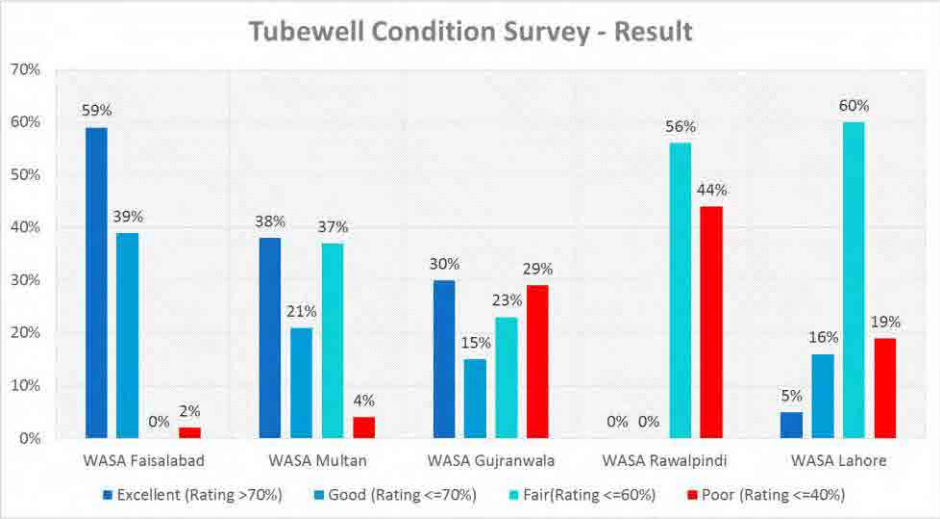
Figure 1: Poor Priming Box and Poor Cable Insulation

Condition of the motor terminal box is rated as **"Excellent"** as there is no noticeable defects in it.

Figure 2 : Excellent Condition of Priming Box and Insulation of cable of Motor Terminal Box

2.4 Generating Reports based on the Asset Condition

Based on condition survey of assets a report is generated in the form of pie graphs or bar graphs. For example in WASAs of Punjab condition survey was conducted and based on the condition survey parameters and following bar graph was generated to visualize overall condition of assets in WASAs. No of interventions were derived to improve existing condition from Fair/Poor to Excellent/Good. These interventions become the part of asset management planning.



Exercises

Activity: 1) Condition Survey of Tube Well Station (Day 1) 2) Condition Survey of the Disposal Station (Day 2) 3) Condition Survey of the Water Supply & Waste Water Lines (Day 3) 4) Condition Survey of Filtration Plant (Day 3)
Activity Duration: 3 Hours

1. **Conduct the condition survey of the tube well station of C-1 Block Gulberg Subdivision Lahore**

Condition Survey of Tube well						
1. Asset Location Information						
Sub Division Name						
Tube well Name						
Tube well Station Address						
2. Asset Technical Information						
Operational Status (YES/No)						
Year Of Installation						
Type of Pump (Turbine/Submersible/Centrifugal)						
Operational Hours (Avg)						
Pump Make						
Pump Design Discharge (Cusec)						
Pump Design Head (ft.)						
Motor Make						
Motor Rating (HP)						
Attached to Over Head Reservoir	Yes	No	Year of Construction			
Operational Status of OHR	Operational		Non- Operational	Capacity (G)		
Attached to Filtration Plant	Yes	No	Year of Construction			
Operational Status of Filtration Plant	Operational		Non- Operational	Capacity (L/H)		
Filtration Type (RO/UV/Multimedia						

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3. Asset Condition Rating						
Physical Condition of Pump	A	B	C	D	F	Attach Pic
Physical Condition of Motor	A	B	C	D	F	Attach Pic
Lubricant Leakages Condition	A	B	C	D	F	Attach Pic
Water Leakages	A	B	C	D	F	
Electric Cable insulation	A	B	C	D	F	
Electric Cable Sizing	A	B	C	D	F	
Transformer Condition	A	B	C	D	F	Attach Pic
Generator Condition	A	B	C	D	F	Attach Pic
Energy Meter Condition	A	B	C	D	F	
Condition of Performance of Starter / Motor Control Unit	A	B	C	D	F	Attach Pic
Power factor Improvement Capacitors	A	B	C	D	F	
Pump Vibration Status	A	B	C	D	F	
Pump Noise Level	A	B	C	D	F	
Motor Temperature Control	A	B	C	D	F	
Cooling Fan Condition						

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	A	B	C	D	F	
Piping Condition	A	B	C	D	F	Attach Pic
Bulk Meter Condition	A	B	C	D	F	
Condition of Return Valve	A	B	C	D	F	Attach Pic
Condition of Gate Valve	A	B	C	D	F	Attach Pic
Condition of Air Release Valve	A	B	C	D	F	Attach Pic
Pressure Gauges Condition	A	B	C	D	F	Attach Pic
chlorinator Condition	A	B	C	D	F	Attach Pic
Civil Structure Condition of Assets	A	B	C	D	F	Attach Pic
OHR Condition	A	B	C	D	F	Attach Pic
Pipe Line Condition (Tube well to OHR)	A	B	C	D	F	
Safety Equipment	A	B	C	D	F	
Ventilation Condition	A	B	C	D	F	
Log Book	A	B	C	D	F	
Discharge (Cusecs) =_____	A	B	C	D	F	
Power Factor =_____	A	B	C	D	F	
Pressure Head (Ft) =_____	A	B	C	D	F	

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A = Excellent: No noticeable defects. Some aging or wear may be visible.
B = Good: Only minor deterioration or defects are evident.
C = Fair: Some deterioration or defects are evident, but function is not significantly affected.
D = Poor: Serious deterioration in at least some portion of the structure. Function is inadequate.
F = Failed: No longer functional. General failure or complete failure of a major structural component.

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DAY 2

Review of Day -1 **(100 Minutes)**

The lecturer reviews the day 1 activity about the condition assessment of the tube well station. The lecturer suggests a list of improvement steps that are to be done to improve the condition of the tube well based on the day-1 survey. Lecturer will analyze the data of the condition survey and will prepare asset management plan for the tube well.

Reflection of Day-1 **(20 Minutes)**

The lecturer promotes each participant to present what he /she learned in day -1

Activity No. 2 **(3 Hours)**

Conduct condition survey of the Out Fall Road disposal station.

Disposal Station Condition Survey	
1. Asset Location Information	
Subdivision	
Disposal Station Name	
Disposal Station Address	
2. Asset Technical Information	
Operational Status (YES/No)	
Total No. of Pumps	
Year Of Installation	
Type of Pump (Turbine/Submersible/Centrifugal)	
Operational Hours (Avg)	
Pump Make	
Pump Design Discharge (Cusec)	
Pump Design Head (ft.)	
Motor Make	
Motor Rating (HP)	
No. of Wet Well	

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Year of Construction of Wet Well						
3. Asset Condition Rating						
Physical Condition of Pump	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Physical Condition of Motor	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Lubricant Leakages Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Water Leakages	☐ A	☐ B	☐ C	☐ D	☐ F	
Electric Cable insulation	☐ A	☐ B	☐ C	☐ D	☐ F	
Electric Cable Sizing	☐ A	☐ B	☐ C	☐ D	☐ F	
Transformer Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Generator Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Energy Meter Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Condition of Performance of Starter / Motor Control Unit	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Power factor Improvement Capacitors	☐ A	☐ B	☐ C	☐ D	☐ F	
Pump Vibration Status	☐ A	☐ B	☐ C	☐ D	☐ F	

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Pump Noise Level	☐ A	☐ B	☐ C	☐ D	☐ F	
Motor Temperature Control	☐ A	☐ B	☐ C	☐ D	☐ F	
Cooling Fan Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Piping Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Return Valve	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Gate Valve	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Pressure Gauges Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Wet Well Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Civil Structure Condition of Assets	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Screen Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Earthing Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Desilting Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
HSE Sign Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Plantation Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Safety Equipment	☐ A	☐ B	☐ C	☐ D	☐ F	

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Ventilation Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Log Book	☐ A	☐ B	☐ C	☐ D	☐ F	
Discharge (Cusecs) =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
Power Factor =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
Pressure Head (Ft) =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
A = Excellent: No noticeable defects. Some aging or wear may be visible.						
B = Good: Only minor deterioration or defects are evident.						
C = Fair: Some deterioration or defects are evident, but function is not significantly affected.						
D = Poor: Serious deterioration in at least some portion of the structure. Function is inadequate.						
F = Failed: No longer functional. General failure or complete failure of a major structural component.						

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DAY 3

Review of Day -2 **(100 Minutes)**

The lecturer reviews the day 1 activity about the condition assessment of the disposal station. The lecturer suggests a list of improvement steps that are to be done to improve the condition of the disposal station based on the day-1 survey. Lecturer will analyze the data of the condition survey and will prepare asset management plan for the disposal station.

Reflection of Day-2 **(20 Minutes)**

The lecturer promotes each participant to present what he /she learned in day -1

Activity No. 3 **(140 Minutes)**

Conduct the condition survey of the filtration plant.

Filtration Plant Condition Survey	
1. Asset Location Information	
Subdivision	
Filtration Plant Name	
Filtration Plant Address	
2. Asset Technical Information	
Operational Status (YES/No)	
Filtration Type (RO/UV/Multimedia	
Year Of Installation	
No. of Pumps	
Type of Pump (Turbine/Submersible/Centrifugal)	
Operational Hours (Avg)	
Pump Make	
Pump Design Discharge (LPM)	

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Pump Design Head (ft.)						
Motor Make						
Motor Rating (HP)						
Source of Raw Water	Ground Water		Canal		OHR	
Attached to Over Head Reservoir	Yes	No	Year of Construction			
Operational Status of OHR	Operational		Non- Operational		Capacity (G)	

4. Asset Condition Rating

Physical Condition of Pump	A	B	C	D	F	Attach Pic
Physical Condition of Motor	A	B	C	D	F	Attach Pic
Lubricant Leakages Condition	A	B	C	D	F	Attach Pic
Water Leakages	A	B	C	D	F	
Electric Cable insulation	A	B	C	D	F	
Electric Cable Sizing	A	B	C	D	F	
Transformer Condition	A	B	C	D	F	Attach Pic
Generator Condition	A	B	C	D	F	Attach Pic
Energy Meter Condition						

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	A	B	C	D	F	
Condition of Performance of Starter / Motor Control Unit	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Power factor Improvement Capacitors	☐ A	☐ B	☐ C	☐ D	☐ F	
Pump Vibration Status	☐ A	☐ B	☐ C	☐ D	☐ F	
Pump Noise Level	☐ A	☐ B	☐ C	☐ D	☐ F	
Motor Temperature Control	☐ A	☐ B	☐ C	☐ D	☐ F	
Cooling Fan Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Piping Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Water Meter Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Flow Meter Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Condition of Return Valve	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Gate Valve	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Two Way Valve	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic

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Condition of the Butterfly Valve	☐ A	☐ B	☐ C	☐ D	☐ F	
Pressure Gauges Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
chlorinator Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of the UV filter	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Multimedia Filter	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Coconut Filter	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of the Membrane	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Raw Water Tank	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of the Treated Storage Tank	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of the control System	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Civil Structure Condition of Assets	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
OHR Condition	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Pipe Line Condition (Tube well to OHR)	☐ A	☐ B	☐ C	☐ D	☐ F	

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Safety Equipment	☐ A	☐ B	☐ C	☐ D	☐ F	
Ventilation Condition	☐ A	☐ B	☐ C	☐ D	☐ F	
Log Book	☐ A	☐ B	☐ C	☐ D	☐ F	
Discharge (Cusecs) =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
Power Factor =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
Pressure Head (Ft) =_____	☐ A	☐ B	☐ C	☐ D	☐ F	
A = Excellent: No noticeable defects. Some aging or wear may be visible.						
B = Good: Only minor deterioration or defects are evident.						
C = Fair: Some deterioration or defects are evident, but function is not significantly affected.						
D = Poor: Serious deterioration in at least some portion of the structure. Function is inadequate.						
F = Failed: No longer functional. General failure or complete failure of a major structural component.						

Activity No. 4 **(40 Minutes)**

Conduct the condition survey of the water Supply / Sewerage Line

Condition Survey of Water Supply /Sewer Line						
1. Asset Location Information						
Subdivision						
Tehsil/Town						
2. Asset Technical Information						
Type of Line	Water Supply		Sewer		Drains	
Operational Status	Yes/ No					
Length of Line (ft.)	Primary		Secondary		Tertiary	
Year of Installation	Primary		Secondary		Tertiary	
Existing Diameter (In)	Primary		Secondary		Tertiary	
Material of Pipe (PVC/RCC/PCC/HDPE)	Primary		Secondary		Tertiary	

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No of Line Failure (Annual)	Primary		Secondary		Tertiary	
No of Line Repairs (Annual)	Primary		Secondary		Tertiary	
No of Valves on the Lines	Primary		Secondary		Tertiary	
Undersized Remarks	Primary	Yes/No	Secondary	Yes/No	Tertiary	Yes/No
Replacement Dia (In)	Primary		Secondary		Tertiary	
Contamination	Primary	Yes/No	Secondary	Yes/No	Tertiary	Yes/No
3. Asset Condition Rating						
Condition of Primary	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Secondary	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic
Condition of Tertiary	☐ A	☐ B	☐ C	☐ D	☐ F	Attach Pic

A = Excellent: No noticeable defects. Some aging or wear may be visible.

C = Fair: Some deterioration or defects are evident, but function is not significantly affected.

D = Poor: Serious deterioration in at least some portion of the structure. Function is inadequate.

F = Failed: No longer functional. General failure or complete failure of a major structural component.

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Participant Notes

Course Code: M 4131

Use of GIS Application in Asset Management

Module 6

2016

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Lecture No. 1

1. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Introduction to GIS and Its applications in Assets Mapping • Introduction to GIS • GIS Data Types • Referencing System • Map Scale • GIS applications in context to AMIS & WASA	Lecture Duration: Two Hours

1.2. Introduction to GIS and Its applications in Assets Mapping

Lecture 1: introduction to GIS and its application in assets mapping covers the sub-topics; introduction to GIS, data types, reference system, map scales and GIS applications especially explained about the assets management information system related to WASA under module 6 "use of GIS applications in assets management". This course is designed for WASA assets mapping so here we discuss case studies related to 5 WASA's (Rawalpindi, Faisalabad, Lahore, Multan and Gujranwala), water supply & sewage network for Madurai Region-India and concept paper-mapping for water supply and sanitation (WSS) in Ethiopia and water supply GIS-Yokuhama water-Japan. The IRIS demonstration related to WASA is also covered in this lecture.

Lecture 1 is formulated in strengthening the concept of course participants regarding GIS and its applications in assets mapping. After completion of lecture 1; the course participant will be familiar about the concept of GIS and its applications regarding the assets management.

The explanation of the sub-topics are given as;

1.2.1. Introduction to GIS

Introduction to GIS covers, GIS overview, GIS components, GIS functions, GIS capabilities, and data sources. The questions like; "What is GIS?" & why GIS is necessary in Assets mapping? is also explained.

The acronym GIS stands for *geographic information system* to collet, store, retrieve, analyze and display the geographic data related to WAS. It helps in maintaining the assets data related to WASA about geographic space and provides answers to questions, from assets data resource. Use of GIS technology, WASA decision makers can perform decision easily.

- ✓ *Geographic* -- 80% of government data collected is associated with some location in space.
- ✓ *Information* -- attributes, or the characteristics (data), can be used to symbolize and provide further insight into a given location.
- ✓ *System* – a seamless operation linking the information to the geography – which requires hardware, networks, software, data, and operational procedures.

In relation to decision making by the decision maker in governance, the quality of governance is directly dependent upon the quality of decision making by the Government.

Good Governance = Good Decision making

So the quality of decision making is directly dependent upon the quality of Information available with the decision Maker.

GIS is, a key element of the information used by utilities is its location relative to other geographic features and objects. GIS technology that offers the combined power of both geography and information systems is an ideal solution for effective management of water industry infrastructure. Geo-technology and geospatial technology are alias names of GIS technology.

GIS is necessary for assets mapping as well as other applications, because GIS gives the following answers;

- ✓ Location: Where specific asset (pipelines, tube well etc.) is?
- ✓ Condition: Status of assets (pipelines, tube well etc.)?
- ✓ Trends: What has changed since...?
- ✓ Patterns: What spatial patterns exist?
- ✓ Modeling: What if…?

For GIS mapping of assets, the basics GIS elements; people, data, software, hardware, procedures/methods, are necessary.

1.2.2. GIS Data Types

A logical data type model is how data are organized for use by the GIS. GIS have traditionally used either raster or vector data for maps.

There are two major types of GIS data; spatial data (vector data & raster data) & non-spatial (Attribute/tabular) data.

- **Vector Data-** In the vector data model features on the earth are represented as point, line and polygon as shown in figure 1.1.

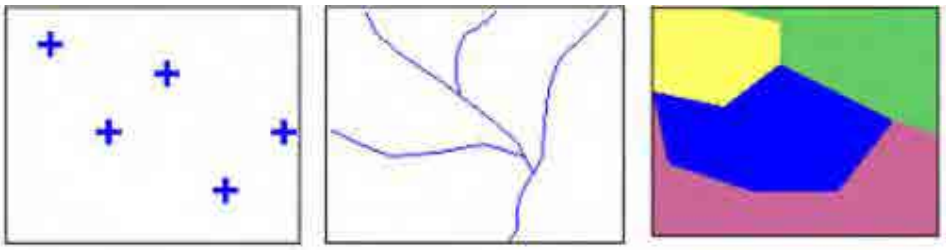


Figure 1.1. Vector Data Model

  - **Point Data-** A point is a combination of two numbers (X, Y), and some time in three (x, Y, Z), z represents hieght value. The examples are; disposal station, filteration plant, mainhole, OHR, etc.
  - **Line/polyline Data-** A line is the shortest distance between two points. It consists of begining and an ending point. The examples are; sewerge line, water supply line, road, stream, etc.
  - **Polygon Data-** A polygon is a set of points connected by line segments that close back to the first vertex. The examples are; WASA town boundary, sub-division boundary, etc.

- **Raster Data-** Raster data is comprised of discrete pixels with a value. The example of raster data are cell based/pixel based data such as satellite image with spatial resolution 0.6 meter, which is used for the demarcation of pipeline and above ground assets as shown in figure 1.2.

Figure 1.2. Raster Data

- **Attribute Data**- the information which is associated with the assets spatial features is called attribute data of assets. The example of attribute data are; name, diameter, condition, age, material of asset as shown in the figure 1.3.

Existing_WS

Shape *	Street_Nam	Sub_Divisi	Town	Materia	Age	Cond	Repl_Di	Repl	Ris
Polyline ZM	Zubair Road	Krishan Nagar	Gunj Bakhsh To	AC	1985	C	4"x6"	3	L
Polyline ZM	Zaman Park to Nich	Shimla Hill	Gulberg Town	AC	1990	B	12"	15	H
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	8"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L
Polyline ZM	Zaitoon colony	Fateh Garh	Shalimar Town	AC	2000	B	4"	5	L

0 (0 out of 35865 Selected)

Figure 1.3. Attribute data

1.2.3. GIS applications in context to AMIS & WASA

There are many applications but here we discuss applications related to WASA assets mapping. The asset management information system (AMIS) of 5 WASA is also discussed.

- **Suitable Site for Disposal Station**

Disposal sites for the waste water can be selected by using GIS technology.

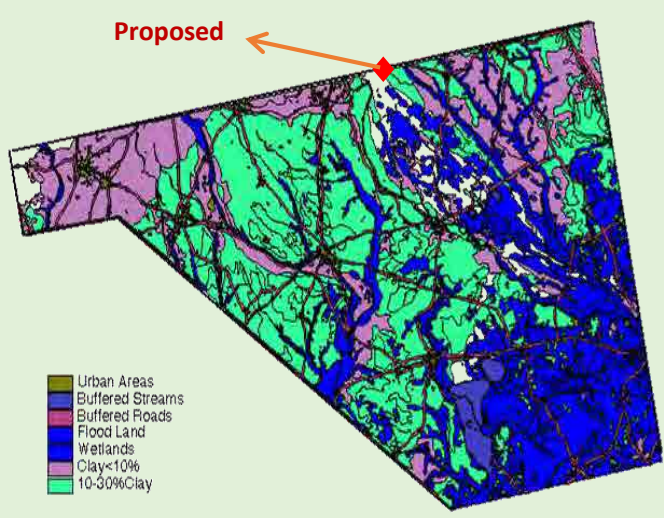


Figure 1.4. Proposed Disposal Site

- **Utility Management**

Due to the urban growth in the city, water and sewerage are crucial to the growth and survival of any city. GIS is used as tool in utility management to enhance the effectiveness and efficiency of the facilities of an area. The water supply and sewerage distribution replacement plan of Allama Iqbal Town subdivision, Lahore is shown in figure 1.5 and 1.6.

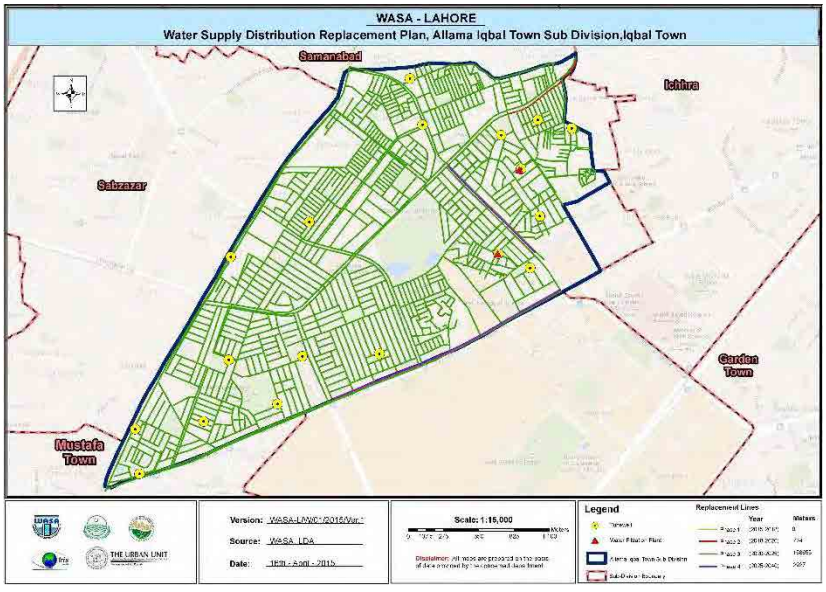


Figure 1.5.Water Supply Distribution Replacement Plan

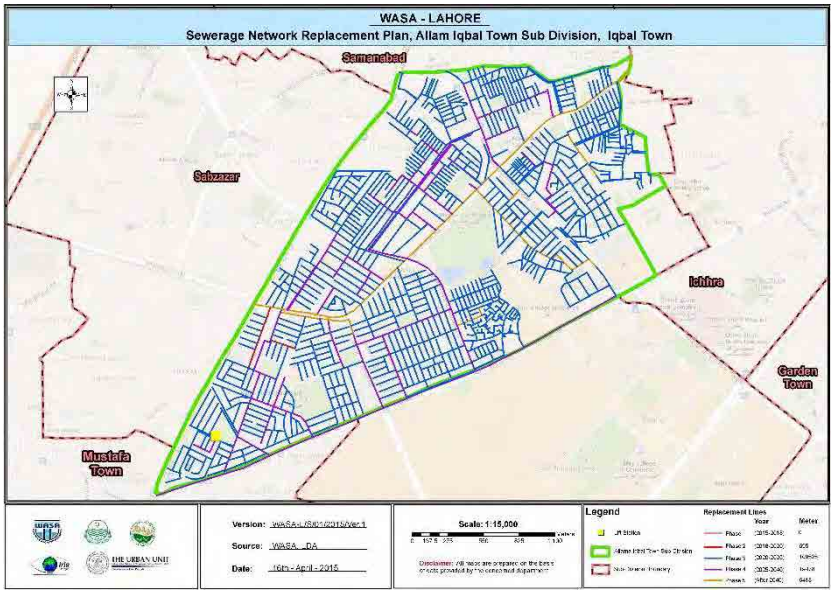


Figure 1.6. Sewerage Distribution Replacement Plan

- **Water and Sewerage Network of Sialkot City**

The Iris GIS web interface of water supply and sewerage network of Sahiwal city under PICIIP project is developed and can be seen by using URL; http://www.irispunjab.gov.pk/IntermediateCities.aspx, is shown in figure 1.7.

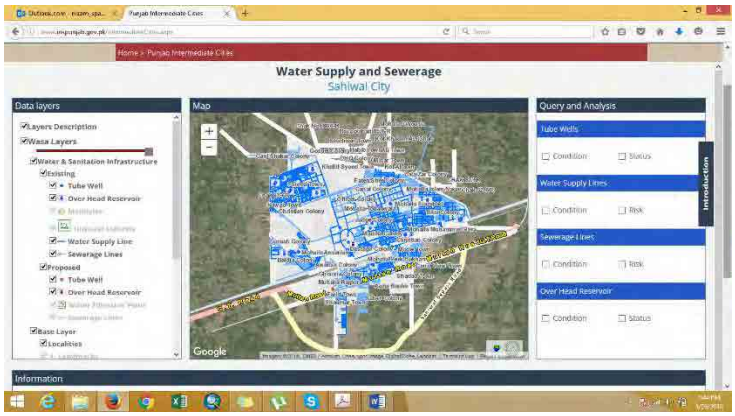


Figure 1.7.Water Supply Sewerage-Sahiwal City

When we select water supply pipelines with condition C and risk medium (m) and condition of tube well B with status functional, the result is shown in figure 1.8 & 1.9.

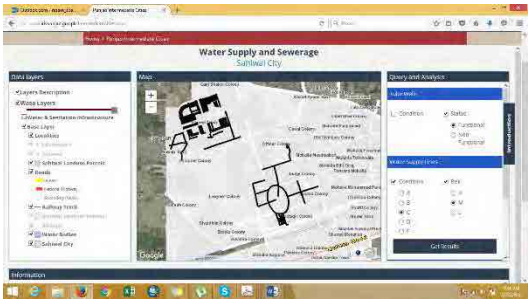


Figure 1.8.Water Pipelines

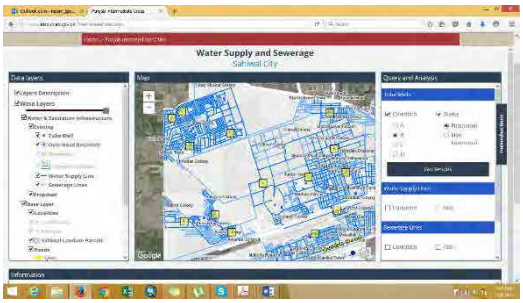


Figure 1.9.Tube Wells

When we select sewerage pipelines with condition C and risk high (h) and condition of OHR B with status functional, the result is shown in figure 1.10 & 1.11.

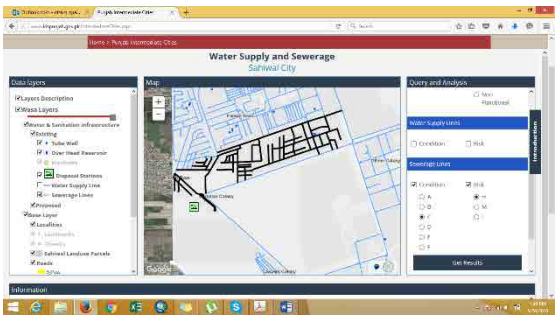


Figure 1.10.Sewerage Pipelines

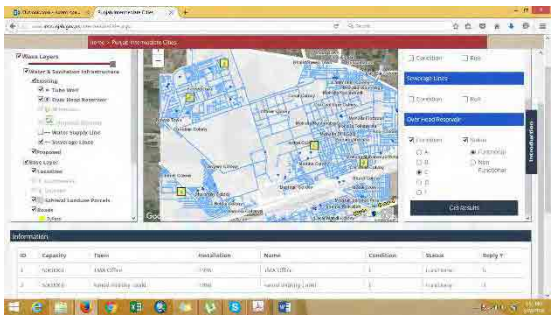


Figure 1.11.Over Head Reservoir

- **Asset management Information System for 5 WASA's**

The detail water supply network and sewerage network with necessary attribute information of Rawalpindi, Faisalabad, Gujranwala, Multan and Lahore has been developed by the Urban Unit and perform different analysis. Asset management information system for 5 WASA's also developed by the Urban Unit and can be seen by using the following URL; http://202.166.168.184:99/Common/Superadmin.

The WASA number of assets information, category wise number of assets, daily progress with pie chart, GIS based number of assets, finance information and assets maintenance is available on this AMIS. The dashboard information of WASA assets of 5 cities is shown in figure 1.12 and bills of tube wells of Gulberg sub-divion Lahore under asset maintenance is shown in figure 1.13.

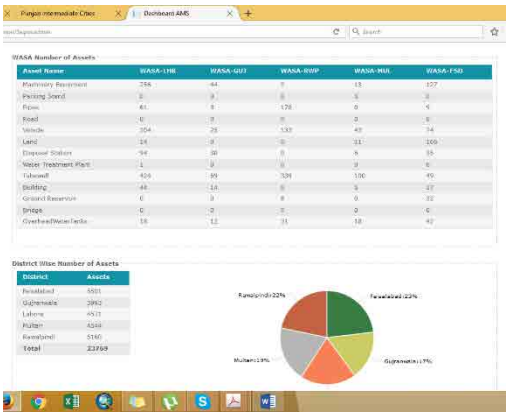


Figure 1.12.WASA Assets

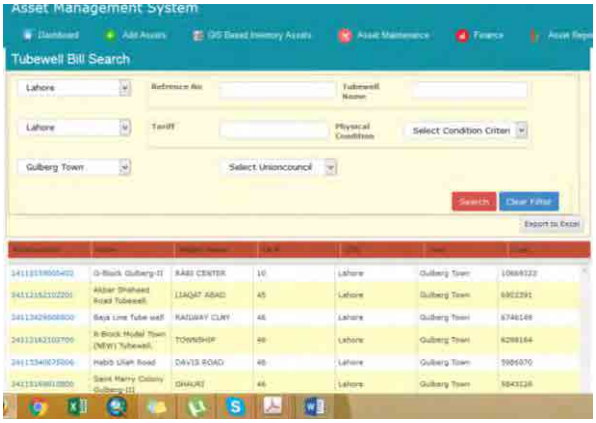


Figure 1.13.Tube Wells Bills

- **Case Study**

The case studies related to assets mapping; water supply & sewage network for Madurai Region-India and concept paper- mapping for water supply and sanitation (WSS) in Ethiopia and water supply GIS-Yokuhama water-Japan are given as;

- **Water Supply & Sewage Network for Madurai Region-India**

The study has focused on the utility of Remote Sensing and GIS in the identification of existing system. The present scenario situation of sewage and water network of Madurai City as shown in figure 1.14 & 1.15. Present population and expected rate of growth are critical factors in design of Water Distribution and Sewage Network in Madurai City.

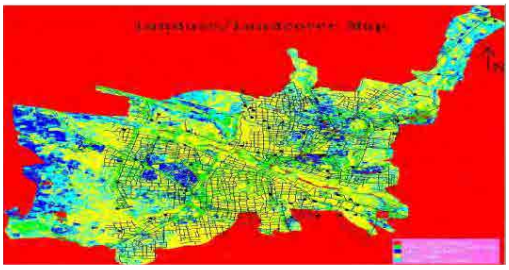


Figure 1.14.Water Network Map

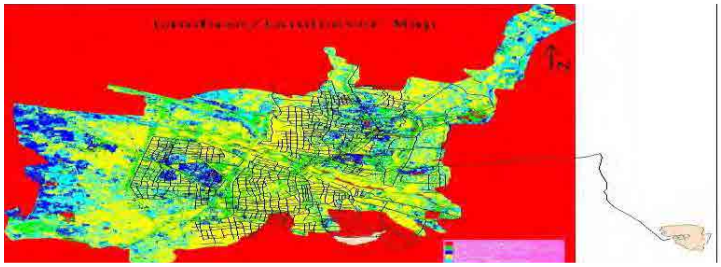


Figure 1.15.Sewerage Network Map

- **Mapping of Water Supply and Sanitation (WSS) in Ethiopia- Concept Paper**

Mapping has many benefits for WASH, and can play a crucial role in helping WASH services be more effective. Mapping framework highlights the important role that maps have in turning raw data into information and knowledge the challenges of undertaking mapping effectively in Ethiopia highlights the need for careful planning of mapping activities.

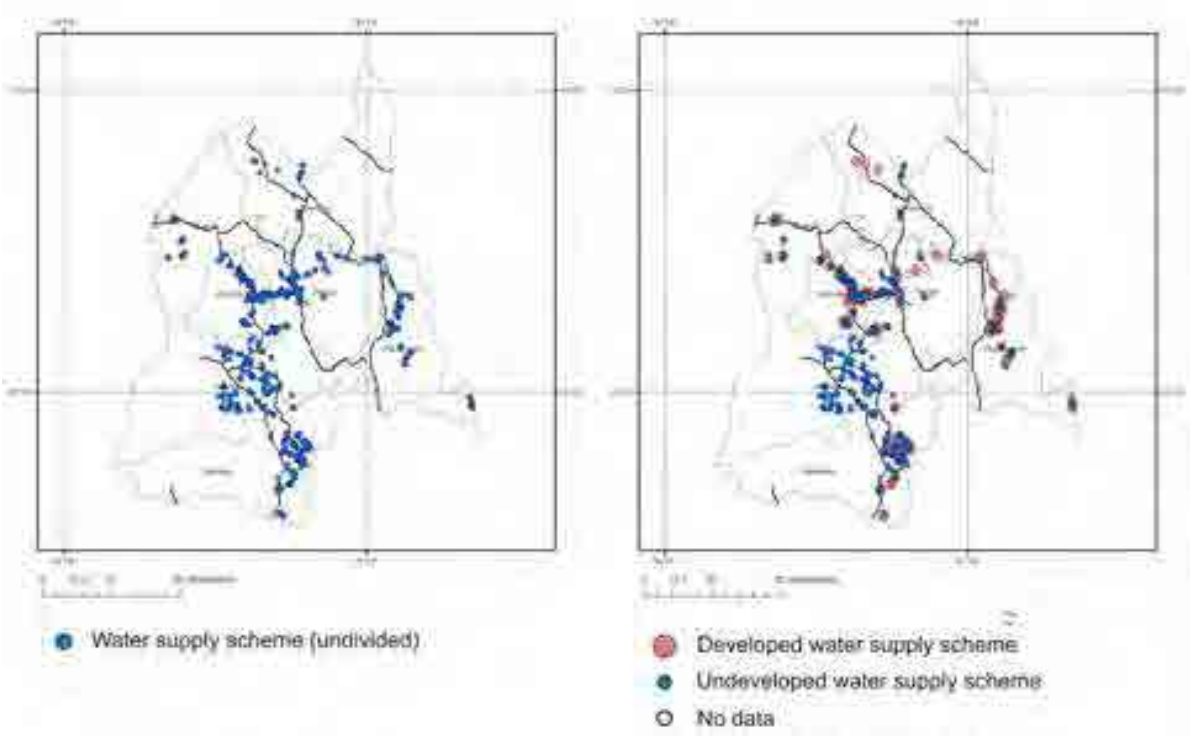


Figure 1.16.Sewerage Network Map

On the left are the water schemes as mapped by a GIS consultancy. On the right, the water schemes are differentiated into developed schemes and unprotected, undeveloped schemes.

- **Water supply GIS-Yokuhama water-Japan**

Pipeline Mapping Information System constructed the network with the lease line of YOKOHAMA City, and are operated in Headquarter bureau and in the office in 30 places such as the water service maintenance sections. An individual information for water service facilities used under the strict management system. It works on the leakage prevention of information.

Figure 1.17. Retrieval & Indication

Figure 1.18.Support for Water Stoppage

The process which involves for the preparation of final map for leakage prevention is shown below;

Figure 1.19.Construction Map

Figure 1.20.Tracing

Figure 1.21.Overlay

Figure 1.22.Digital Tracing

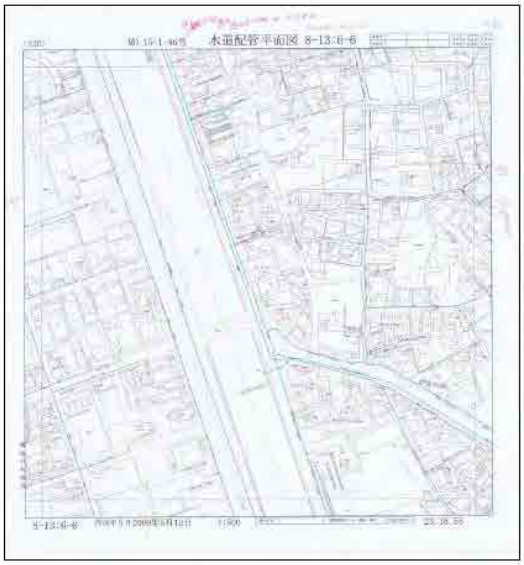


Figure 1.23.Final Map

Lecture No. 2

2. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6

Lecture Topics:
Asset data browsing and study
• ArcGIS & its components.
  ○ ArcCatalog
  ○ ArcMap
  ○ ArcToolbox
• Browsing the Asset GIS Database
	Lecture Duration: Four Hours

2.1. Asset data Browsing and Study

Lecture 2: asset data browsing and study, covers the sub-topics; ArcCatalog, ArcMap and ArcToolbox and browsing the assets GIS database related to WASA under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices regarding components of ArcGIS is covered in strengthening the practical skills of course participants. The existing GIS data related to assets is browsed and explored in the lab activity.

Lecture 2 is formulated in strengthening the practical skills of ArcGIS and its components to course participants regarding GIS and its applications. After completion of lecture 2; the course participant will be familiar about practical skills of ArcGIS software & its components, and they can explored and browsed the assets data in ArcGIS.

The explanation of the sub-topics are given as;

2.1.1. ArcGIS & its Components

ArcGIS & its components covers, over view of ArcGIS component's ArcCatalog, ArcMap and ArcToolbox and browsing the assets GIS database in the GIS lab. The detail function of these three components is covered.

Here we start from GIS software ArcGIS which is the ESRI producti.

❖ **ArcGIS:**

It is an operating system which is used in for mapping of WASA assets in GIS.

➢ **How to Access ArcGIS?**

In-order to access the ArcGIS 10.2, it must be installed in your workstation/computer. For installation of ArcGIS on your workstation/computer must be at high efficiency to run the ArcGIS. Otherwise it will not run in a smooth way and you will feel problem during working in ArcGIS.

The ArcGIS has been installed on the workstations in the GIS lab and you can access as;

➢ ***Start>>program>>ArcGIS***

The snap shot is given as;

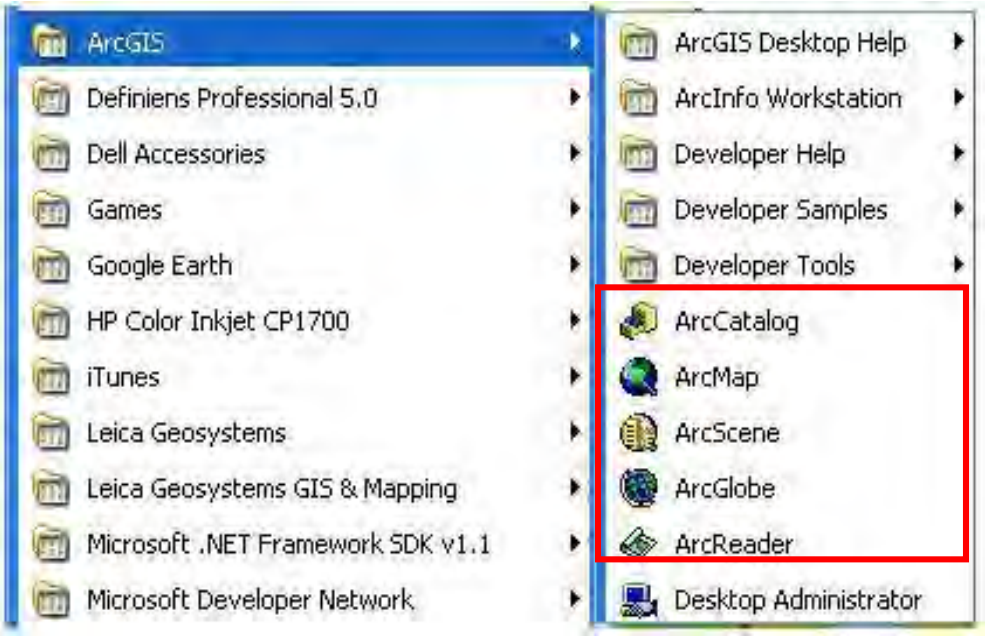


Figure 2.1. Accessing of ArcGIS

➢ **ArcCatalog:**

ArcCatalog is an application within ESRI's ArcGIS suite, whose primary role is to maintain geospatial data and the corresponding metadata. Data management, processing and symbolization are the main tasks of ArcCatalog. In order to develop GIS data, shapefile is developed in ArcCatalog for spatial data storage, you will prepare shapefile in future.

- **Launch of ArcCatalog**
  - Go to Start>>program>>ArcGIS
  - Open ArcCatalog
  - Click connect to folder icon in the menu bar.
  - Navigate to the folder where the data for this exercise are saved (e.g., C:\GIS Training in the Connect to Folder dialog Click OK.
  - The C:\GIS Training folder now appears in the Catalog tree.

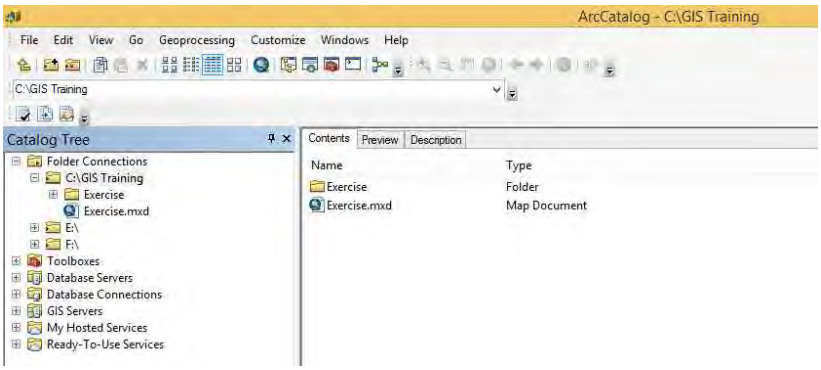


Figure 22. ArcCatalog

The geography preview, content and description about data is seen in ArcCatalog.

➢ **ArcMap:**

ArcMap is the main component of Esri's ArcGIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data. ArcMap allows the user to explore data within a data set, symbolize features accordingly, and create maps for decision makers. ArcMap is used for preparation, management and processing of spatial vector data and prepared layout.

- **Launch of ArcMap**
  - Go to Start>>program>>ArcGIS
  - Start ArcMap, "ArcMap – Getting Started" dialog box is opened.
  - Pick an existing map or choose to create a new map.
  -

Here new maps is selected for the creation of new map document.

  - Select new maps in dialog box and click on blank map.

- Click OK.
- A new map document is opened.
- Click on file button and click on Save as option and save the document in the folder path C:\GIS Training\Exercise.mxd. This document is saved and can be used in future for further working.

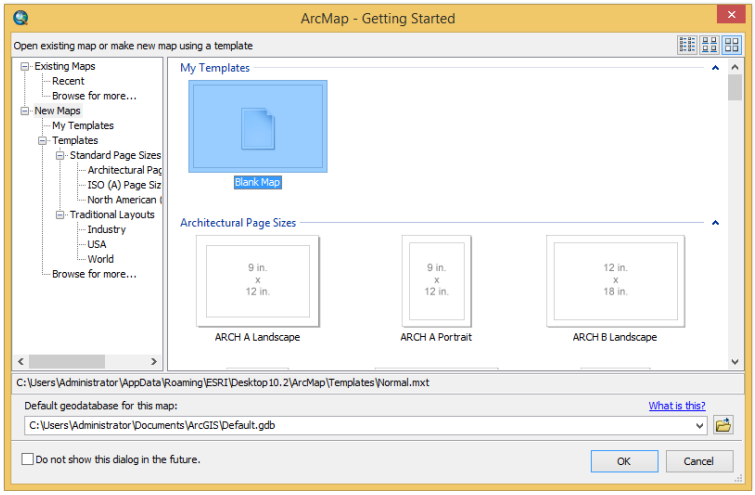


Figure 2.3. Content Tab

ArcMap is also opened from ArcCatalog.

2.1.2. Browsing the Asset Database

In this section GIS data related to WASA asset is browsed and explored in the ArcMap. In-order to access the GIS exercise data;

- Click the Add Data button which opens a window similar to start-up splash window.

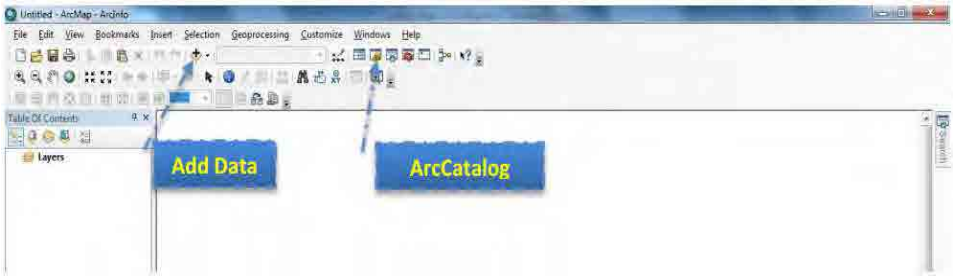


Figure 2.4. Data add

- Make a folder connection to add the data. To browse to the file you want to work with, you can link to the folder containing all these files by clicking the Connect to Folder button shown in figure, then browse to add the folder that contains your related files and click OK.

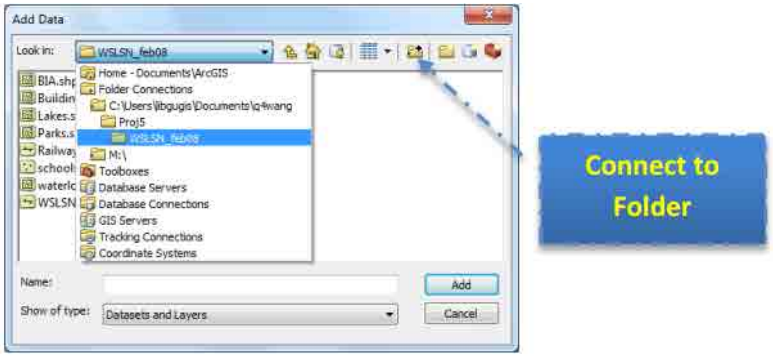


Figure 2.5. Folder Connection

- Locate the required vector files from the list of personel database and add them all at once by holding the Ctrl or Shift button while clicking on each selection. Here we add the following data by using the Lahore WASA personel database "WASA-Lhr.mdb";

  - ✓ *The SubDiv_Boundary City of Lahore*
  - ✓ *All Valves in the SubDiv_Boundary*
  - ✓ *Existing_WS*
  - ✓ *Existing _TW*
  - ✓ *Existing _OHR*

- When the data is loaded, all files will be listed in the left pane, called the table of Contents. The geographic features (contents) are displayed in the main data frame window.

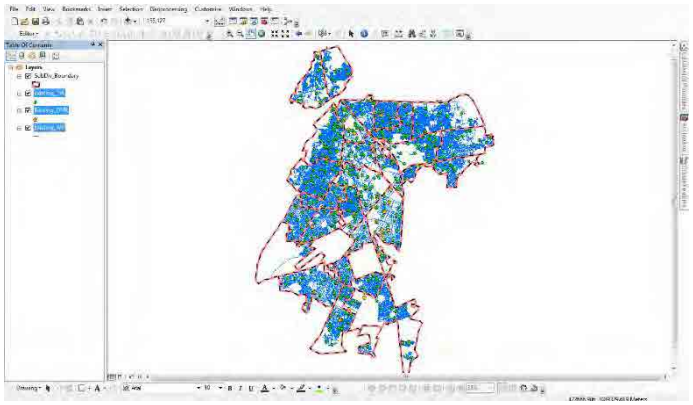


Figure 2.6. ArcMap Data View

- Now the data has been uploaded in the data view window of ArcMap.

Study the data and think about what further this data can be used?

Lecture No. 3

3. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Study of asset attributes and Classification • Study of Asset Attributes data • Displaying Asset Data in terms of: o Diameter o Condition, o Risk, o Year of construction o Pipe type o Material o etc • Asset Categorizing in Labeling asset's attributes	Lecture Duration: Three Hours

3.1. Study of Asset attributes and Classification

Lecture 3 study of asset attribute and classification, covers the sub-topics; ; study of asset attribute data, displaying asset data in term of asset characteristics and asset categorizing in labeling asset's attribute related to WASA under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices regarding study of asset attributes and classification by using ArcGIS is covered in strengthening the practical skills of course participants. The existing GIS data related to assets is studied and classified on the basis of their attributes of spatial features in the lab activity.

Lecture 3 is formulated in strengthening the practical skills to categorize and label the attribute data by using ArcGIS to course participants. After completion of lecture 3; the course participant will be familiar about practical skills regarding the study of asset's attribute data, categorizing and labelling of spatial features on the basis of attributes in ArcGIS software.

The explanation of the sub-topics are given as;

3.1.1. Study of Asset Attribute data

ArcGIS 10.2 version is used for the study of asset's attribute data. In a GIS, a spatial feature on a map may be associated with a great deal of information-more than can be displayed at any given time. This information is stored in an attribute table. A spatial layer's attribute table contains a row (or record) for every feature in the layer and a column (or field) for every attribute or category of information.

You have learned about the exploring and browsing of GIS asset data in the previous lecture.

So add the following data in ArcMap by using the Lahore WASA personel database "*WASA-Lhr.mdb*";

- ✓ *The SubDiv_Boundary City of Lahore*
- ✓ *All Valves in the SubDiv_Boundary*
- ✓ *Existing_WS*
- ✓ *Existing _TW*
- ✓ *Existing _OHR*

➢ **Open Attribute Table**

- Right-click on the spatial layer "Existing_WS" in table of content in ArcMap and click "open attribute table" as shown in the figure 3.1.

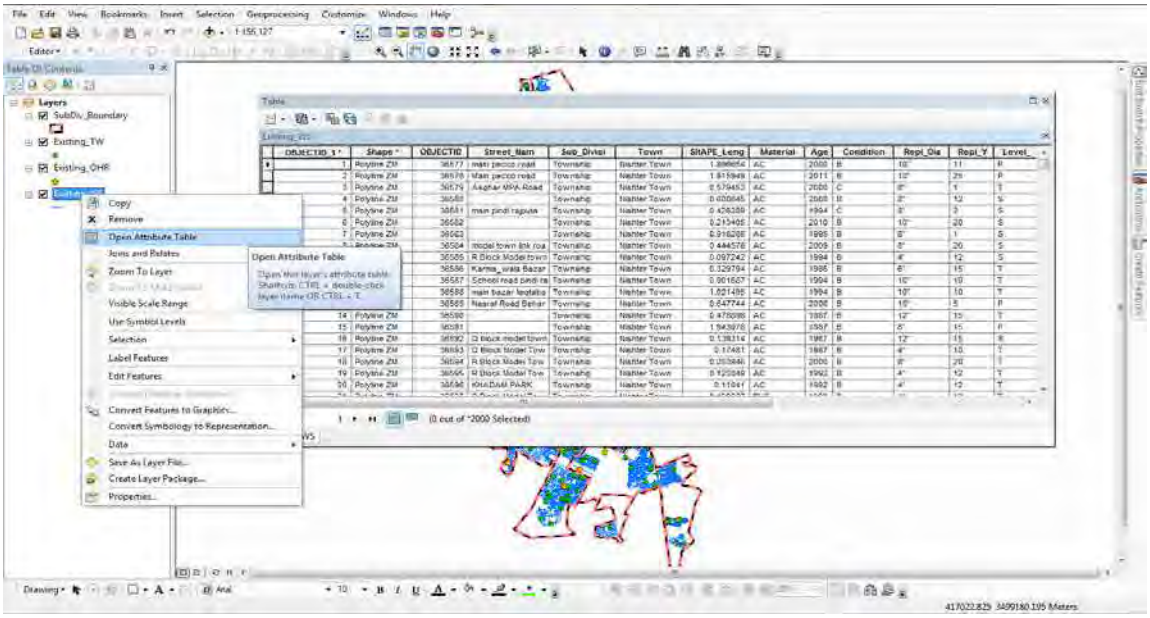


Figure 3.2. Open Attribute Table in ArcMap

- Scroll down through the attribute table, number of attribute records (OBJECTID, Shape, Street_Nam, Sub_Divisi, Town, SHAPE_Leng, material, age, condition, repl_dia, repl_y, Level_, length, diameter, etc.) against each spatial feature of existing water supply pipelines is present in that attribute table.

- There are 12 fields with different names of columns are present in the attribute table. The OBJECTID field is the default field of spatial feature class and contains a unique identification number for every record.

- The Shape field is also the default field and describes the geometry of spatial feature. In this existing water supply feature class, the geometry is mentioned as "Polyline ZM" in default Shape field.

➢ **Turn off field**

- In-order to view only the fields/column if the data fields are in massive then turn of fields which are not necessary at time of processing the data for your interest. For this go to layer properties by right click on spatial feature layer in table of contents of ArcMap as shown in figure 2.

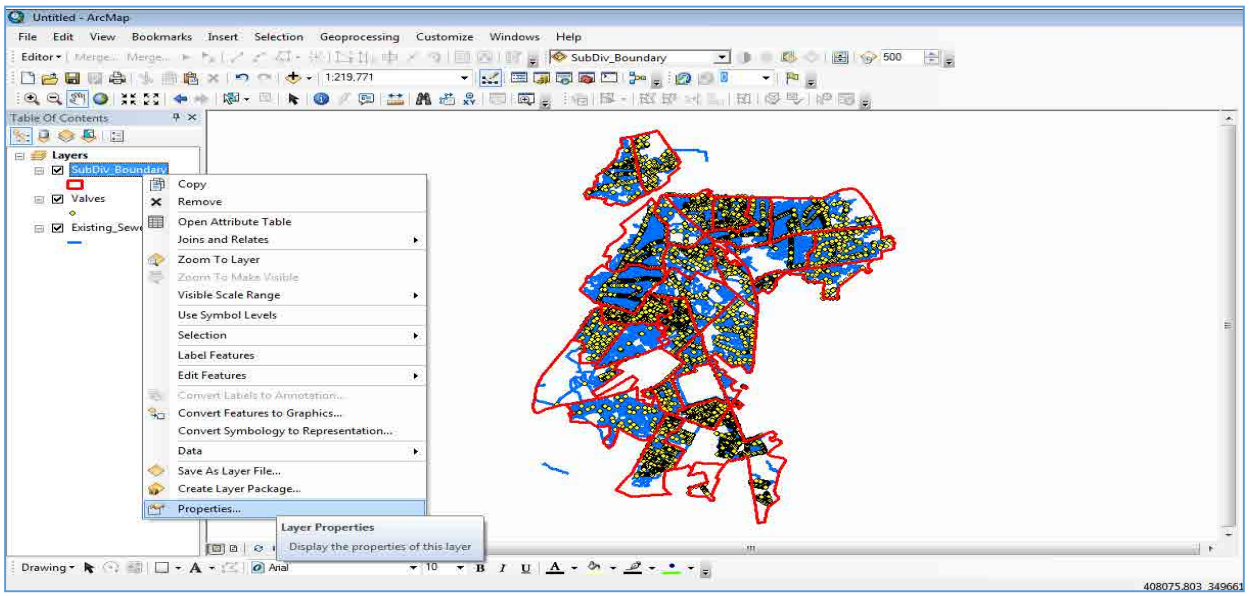


Figure 3.2. Accessing of Properties of Spatial feature

- Select the tab of fields and turn of the fields as shown in figure 3.3.

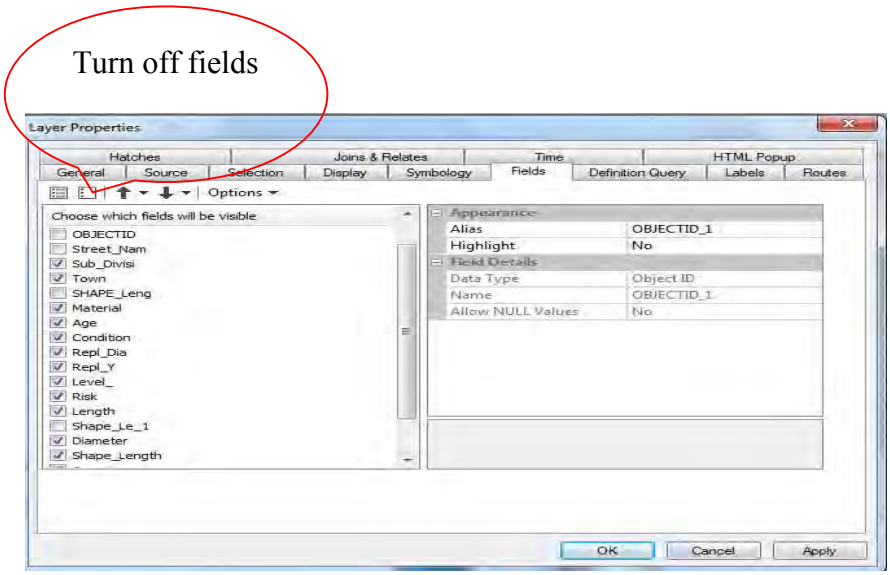


Figure 3.3. Layer Properties

- Un-Check fields/columns which you want to turn off. All the fields is turned off by pressing tab "turn all field off" as shown in figure 3.3.

➢ **Adding field/column to a table-Calculate Length**

- In-order to add the attribute data in a new field/column, add a new field to attribute table of Existing_WS feature class.

- Open the attribute table and click on the pull down button in the top left of the table, then click 'add field' as shown in figure 3.4.

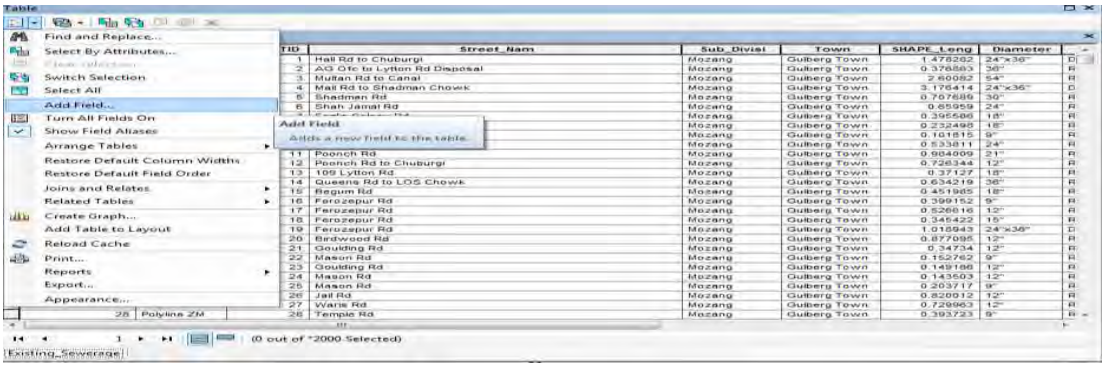


Figure 3.4.Add Field in attribute table

- "Add Field" dialog box is opened as shown in figure 5.
- Add the name of the field/column as 'length' and select 'double' from drown down list of type and click ok as shown in figure 3.5. There are many different data field types and carefully add that type which is most appropriate for your data. Here field type double is selected, because the length contains decimal values for more precision.

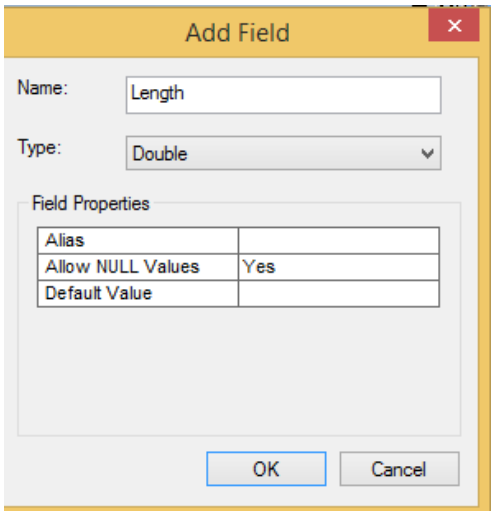


Figure 3.5.Add Field

- The new field is highlighted in the attribute table which contains "Null" values.
- Right click on that length field and click on calculate geometry as shown in figure 6.

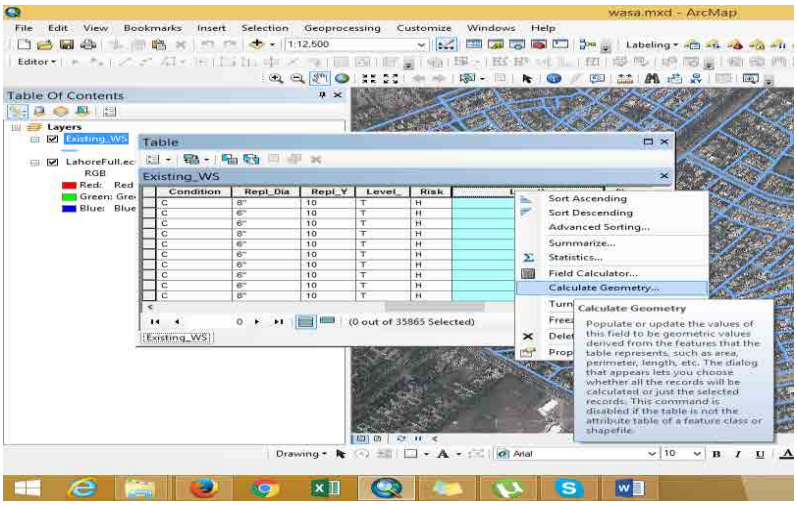


Figure 3.6.Calculate Geometry tab

- Calculate Geometry window is opened as shown in figure 3.7.

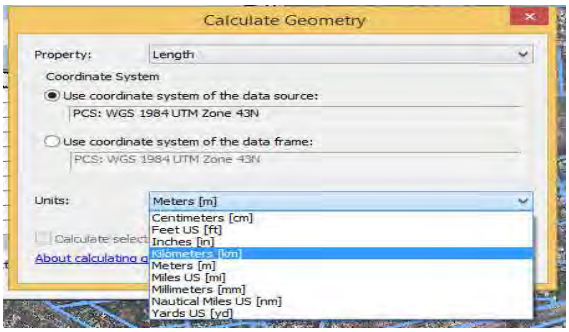
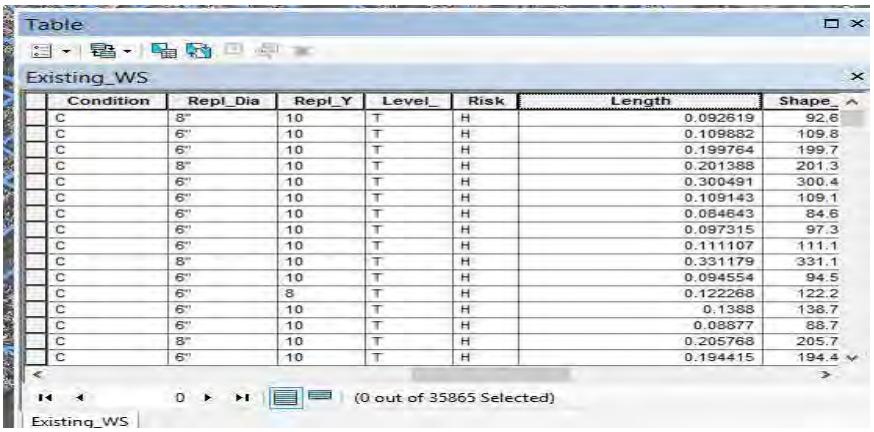


Figure 3.7. Calculate Geometry Window

- Select kilometer (m) from the drop down list of Units and click ok. It takes a few time and the length of water supply is calculated as shown in figure 3.8.



Condition	Repl_Dia	Repl_Y	Level_	Risk	Length	Shape_
C	8"	10	T	H	0.092619	92.6
C	6"	10	T	H	0.109882	109.8
C	6"	10	T	H	0.199764	199.7
C	8"	10	T	H	0.201388	201.3
C	6"	10	T	H	0.300491	300.4
C	6"	10	T	H	0.109143	109.1
C	6"	10	T	H	0.084643	84.6
C	6"	10	T	H	0.097315	97.3
C	6"	10	T	H	0.111107	111.1
C	8"	10	T	H	0.331179	331.1
C	6"	10	T	H	0.094554	94.5
C	6"	8	T	H	0.122268	122.2
C	6"	10	T	H	0.1388	138.7
C	6"	10	T	H	0.08877	88.7
C	8"	10	T	H	0.205768	205.7
C	6"	10	T	H	0.194415	194.4

Figure 3.8. After Length Calculation

Note that in order to calculate length or area, the feature class must have projected coordinate system.

➢ **To locate the Water Supply of maximum length**

- In order to locate the water supply of maximum length, go to length field in attribute table of existing water supply feature class and click on "sort descending order" as shown in figure 9.

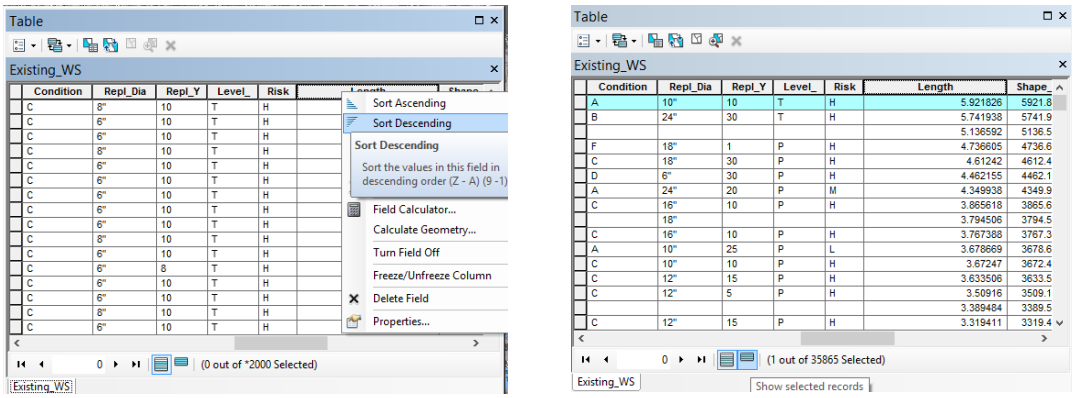


Figure 3.9. Maximum Length

- The maximum length of water supply pipeline is 5.921826 kilometer is highlighed in figure 9.

➢ Calculation of Statistics

Statistics calculate only integer values and not calculate the text values. So be careful about the field entries of spatial feature class. In-order to calculate the statistics right-click the field "length" in attribute table of spatial feature class and click the tab "statistics" as shown in figure 3.10.

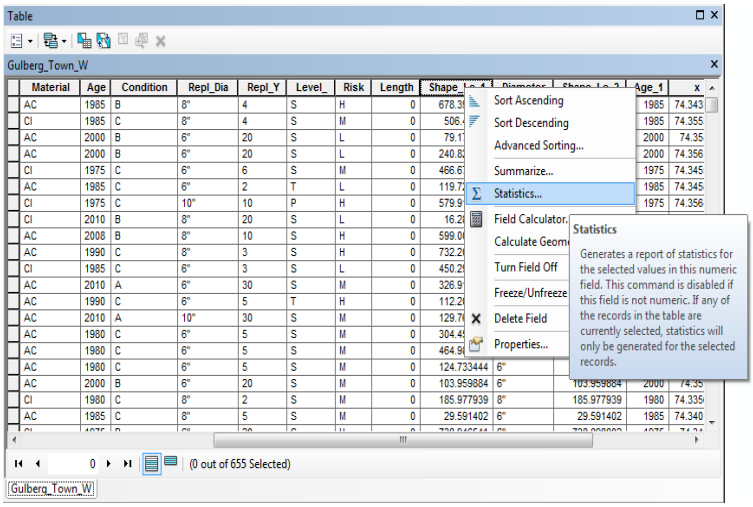


Figure 3.10.Accessing of Statistics tab

- The statistics of water supply Length of Gulberg sub-division is shown in figure 3.11.

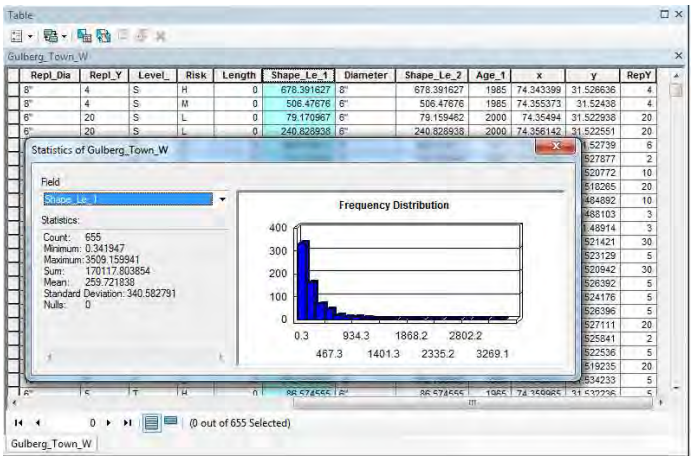


Figure 3.11. Statistics Window

- The statistics window shows the following information;

  Selected Field: Shape_Le_1
  Minimum: 0.341947
  Maximum: 3509.159941
  Sum: 630027.577585
  Mean: 277.789937
  Standard Deviation: 290.156913
  Nulls: 0

- The frequency distribution bar chart represents the distribution of values graphically is shown in figure 11.
- The statistics of other filed can also be calculated by choosing field directly in the statistics window.

3.1.2. Displaying Asset Data

The displaying of data is the function of GIS. For displaying of assets data, cartography regarding in symbology setting must be strong. Symbols are graphic elements that are used in map displays in ArcMap.

➢ Defining Symbols

- Start ArcMap document which you have saved in the previous exercise or open new ArcMap and add the data of existing water supply as shown in figure 3.12.

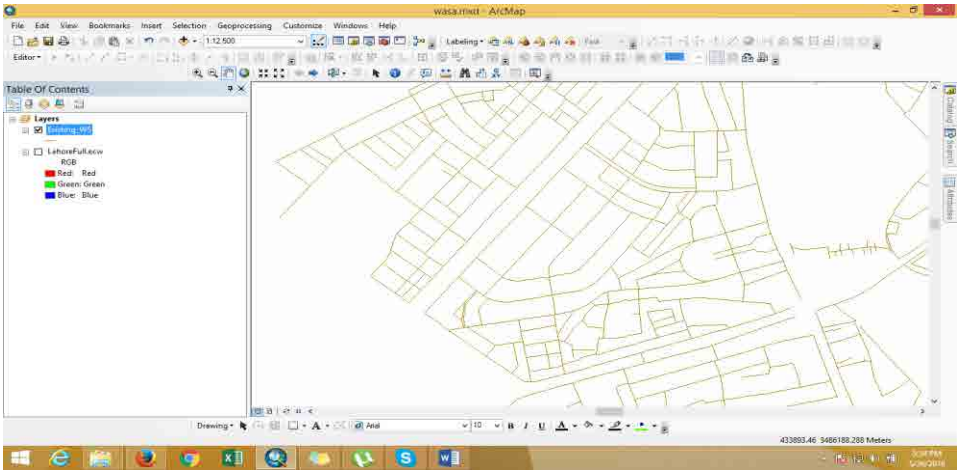


Figure 3.12. Statistics Window

- In the table of contents, click on color symbol below the name of existing water supply. Then symbol selector window is opened and select color “Cretan Blue” and select width 2 as shown in figure 3.13.

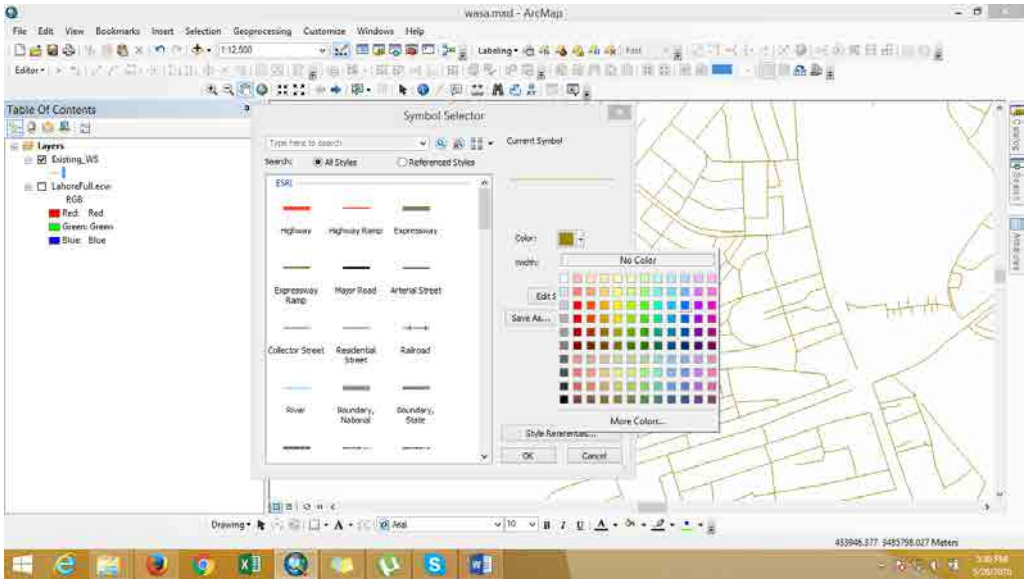


Figure 3.13. Statistics Window

- Then click ok, and also click ok in symbol selector window. The result after symbollogy setting is given as;

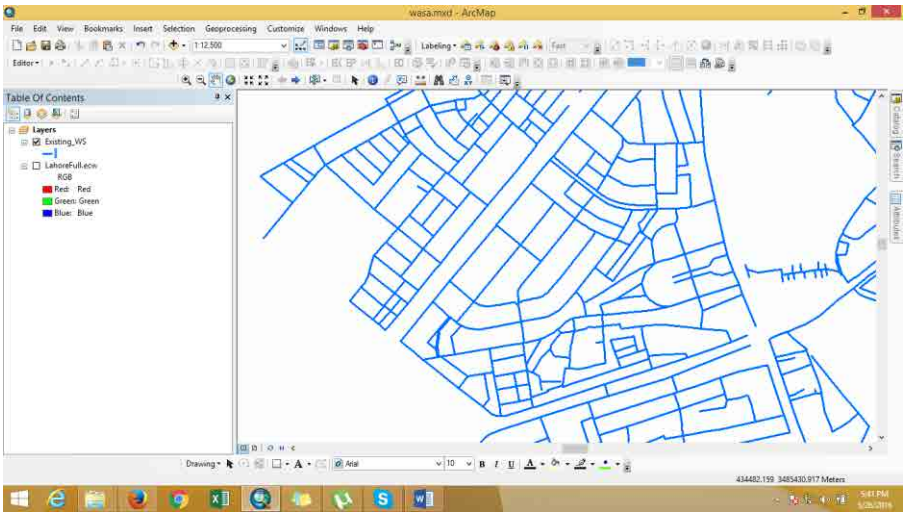


Figure 3.14. After Symbollogy Setting

3.1.3. Asset Categorizing in labeling asset's attributes

The asset data is categorized and labeled on the basis of attribute information which is associated with the vector feature class to display the asset information in better way for the decision maker.

- **Labeling Features**

  Labels are text strings that are used to label features within map layers in ArcMap. Properties define the attribute column used as the source of the text string.

  In ArcGIS, labeling refers specifically to the process of automatically generating and placing descriptive text for map features in ArcMap. Labelling information is based on attribute values associated with vector feature class. So for labelling, existing water supply must have the attribute information of diameter in the attribute table.

  - Right Click on Water Supply layer and select properties. A layer properties dialog is opened
  - Click on the labels tab and select "Diameter" from labels field as shown figure 15.
  - Check the box "label feature in the layer"

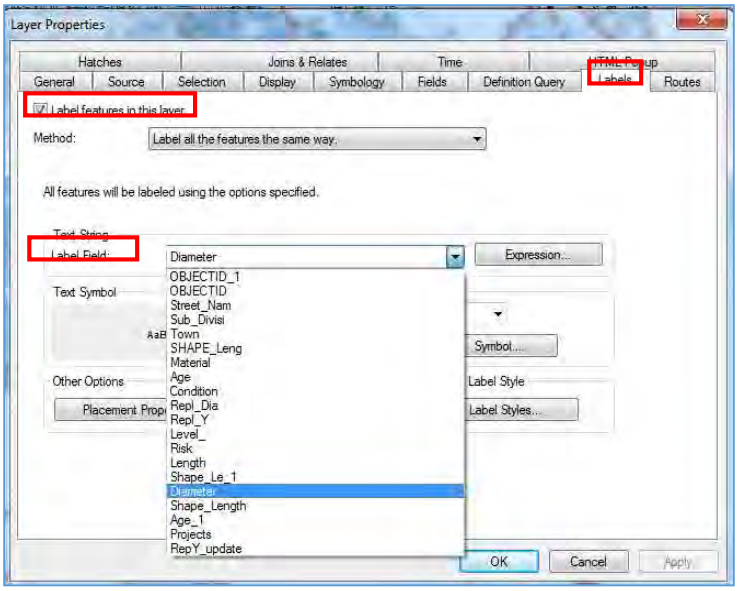


Figure 3.15. Labelling window

- Select symbol option as shown in figure 3.16.

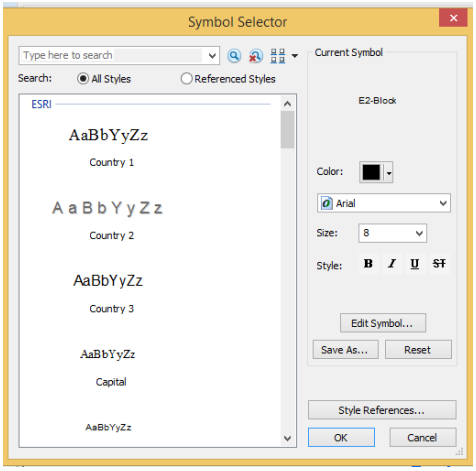


Figure 3.16. Labelling symbol selector

- Select color “Black”, font type “Arial”, size ” 10” , style “B” for bold and then click ok in symbol selector as well as in layer properties.
- The result is shown in figure 3.17.

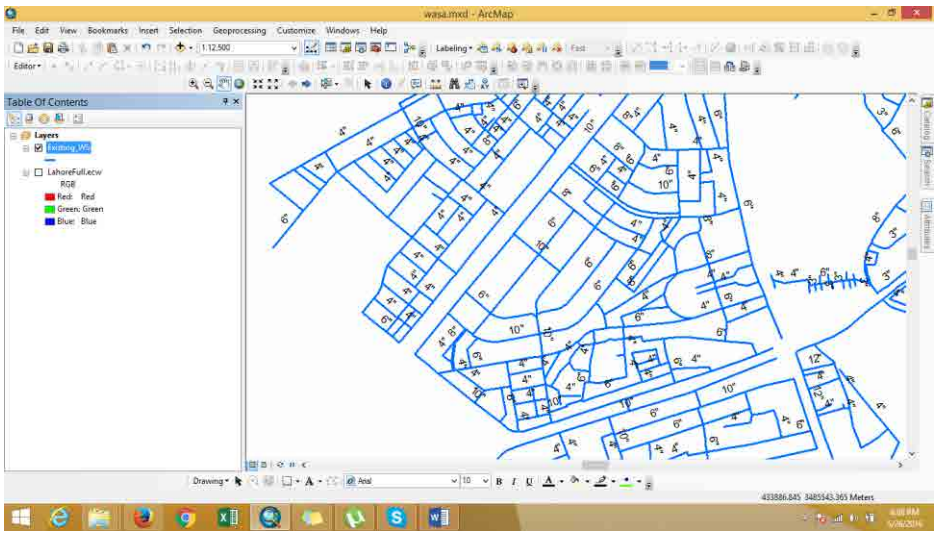


Figure 3.17. After labelling

- **Categorizing the Assets**

  Categorizing of assets is based on the attribute information which is associated in the feature class. Categorizing is the function of symbology setting of feature class having different attribute information in the fields to display the information in different category of symbology.

  Here we set the categorization on the basis of condition of water supply pipelines.

  - Right click the existing water supply feature class in table of content of ArcMap and click on properties.
  - Click the symbology tab in layer properties and select unique values after clicking on categories in “Show” window and select condition field from “Value field” as shown in figure.

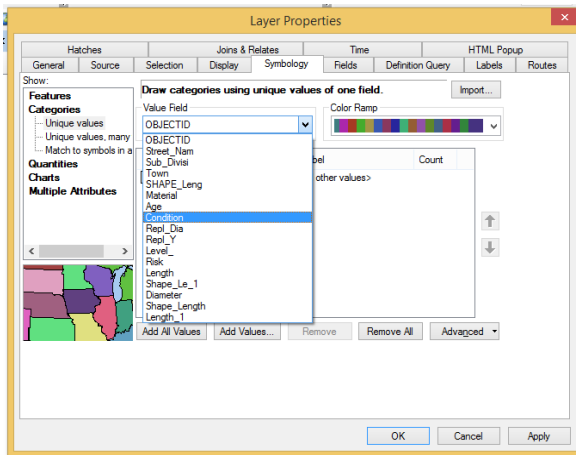


Figure 3.18.Symbology setting for categories

- Then click “add all values tab”, set the symbol color & size and click ok as shown in figure 3.19.

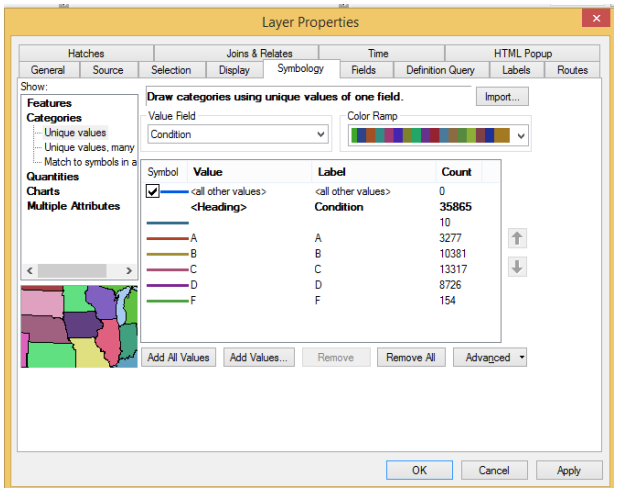


Figure 3.19. After Categorizing

- The final output after categorizing of water supply feature class in ArcMap is shown in figure 3.20.

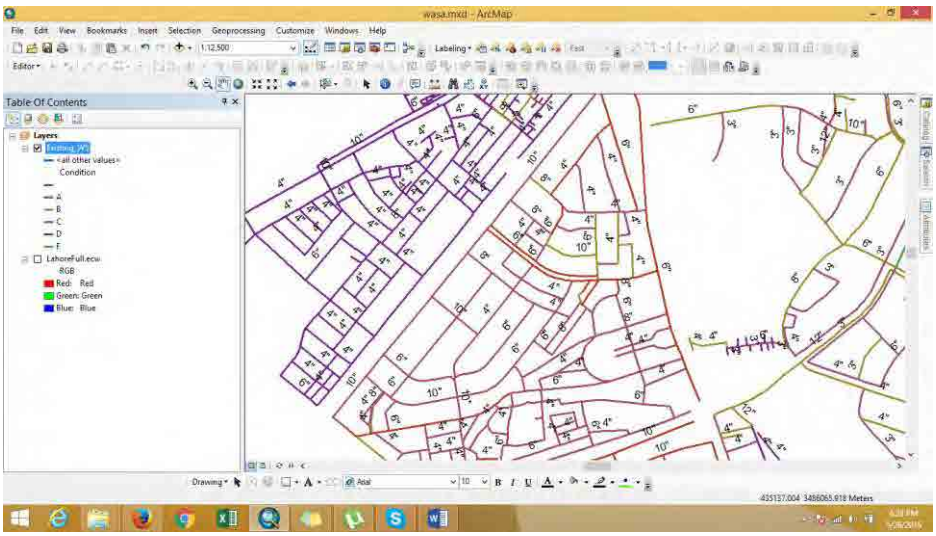


Figure 3.20.Display after Categorizing

The conditon categorizing and labelling of diameter of water supply pipelines is seen in table of contents as well as in data view window of ArcMap

Lecture No. 4

4. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Editing and updating assets network data according to as build drawings & preparation of Block Maps. • Editing the assets • Making Shapfiles • Digitization • Preparation of Layouts/Block Maps	Lecture Duration: Three Hours

4.1. Editing and updating assets network data according to as build drawings & preparation of Block Maps.

Lecture 4 Editing and updating assets network data according to as build drawings & preparation of Block Maps, covers the sub-topics; editing the assets data, making shapefiles, digitization, preparation of layouts/block maps related to WASA under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices regarding editing and updating assets network data according to as build drawings & preparation of block maps is covered in the lab activity. The existing GIS data related to assets is edited according the requirement, digitized new pipelines and block maps will be prepared.

Lecture 4 is formulated in strengthening the practical skills to assets data editing and updation, preparation of shapefile for assets data storage in GIS environment and preparation of block level maps of assets for decision making by using ArcGIS to course participants. After completion of lecture 4; the course participant will be familiar about practical skills regarding the assets data editing and updation, preparation of shapefile for assets data storage in GIS environment and preparation of block level maps of assets.

The explanation of the sub-topics are given as;

4.1.1. Editing the assets

ArcGIS 10.2 version is used for the editing the assets vector and attribute data. Editing of assets vector data is required on demand. Editing is done in the existing vector feature class of assets. Creation of new spatial feature, re-editing of existing pipelines and edition of attribute information associated with the spatial feature are done.

➢ **Editing of Attribute Information**

- Right Click on the Menu Bar and select the Editor Toolbar. The editor toolbar will be added to the ArcMap as shown in figure.

Figure 4.3. Accessing of Editor Toolbar

- Click on the Editor Button on editor toolbar, a drop down menu will be open.

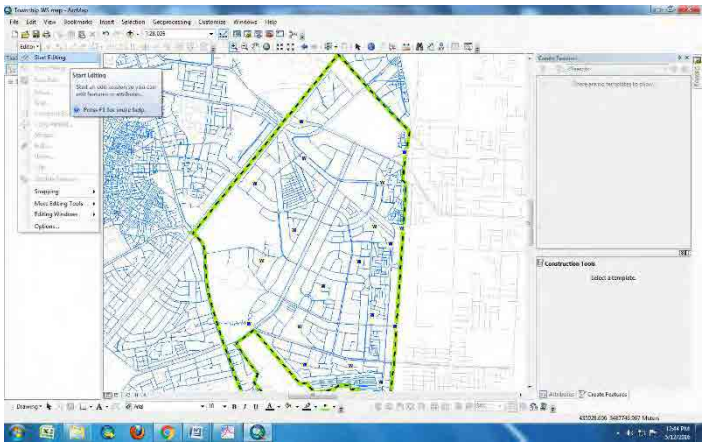


Figure 4.2. Opening of Editor Toolbar

- Select Start Editing and click on the Existing _WS and click Ok.

Figure 4.3. Opening Start Editing window

Note that if you have only one feature class in the table of content of ArcMap then software choose the editing target layer automatically, otherwise you have to choose the target feature class in which you want to edit.

- Now select any pipeline by using selection tool and click on Attribute table icon in editing toolbar.
- From attribute table one can edit or modify the information regarding the specific pipeline.

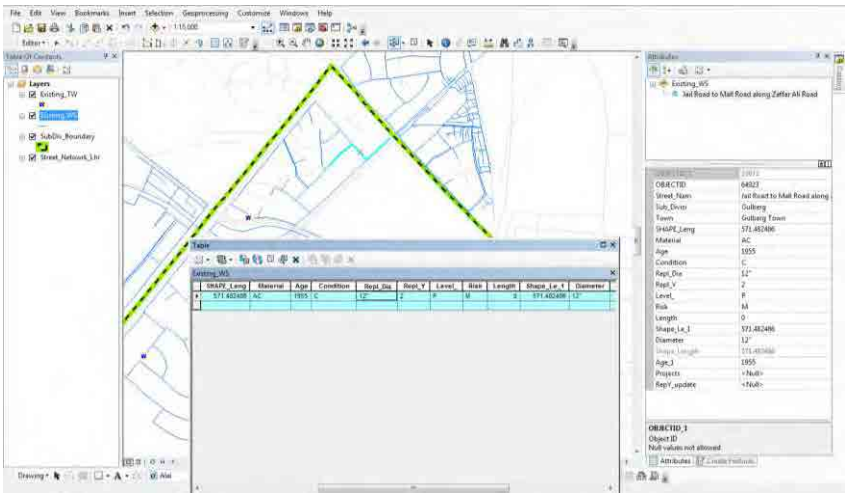


Figure 4.4. Selection of feature

- Click on “Editor” Tab and select “Save Edits” and click “Stop Editing”.

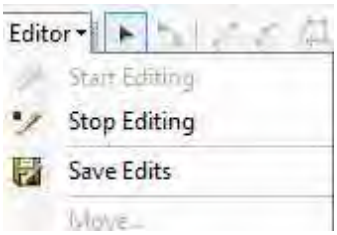


Figure 4.5. Save Editing and stop Editing

If you did not save the edits, you all work done will be discarded and not saved.

- **Creation of New Pipeline**

  In-order to create a new pipeline in the water supply feature class perform the following steps;

  - Right Click on the Menu Bar and select the Editor Toolbar. The editor toolbar will be added to the ArcMap.
  - Click on the Editor Button on editor toolbar, a drop down menu will be open.
  - Select line from construction tools and trace the pipeline which you want to create, and perform double click by using mouse on where you want to finish the pipeline. The new pipe line will be highlighted as shown in figure.

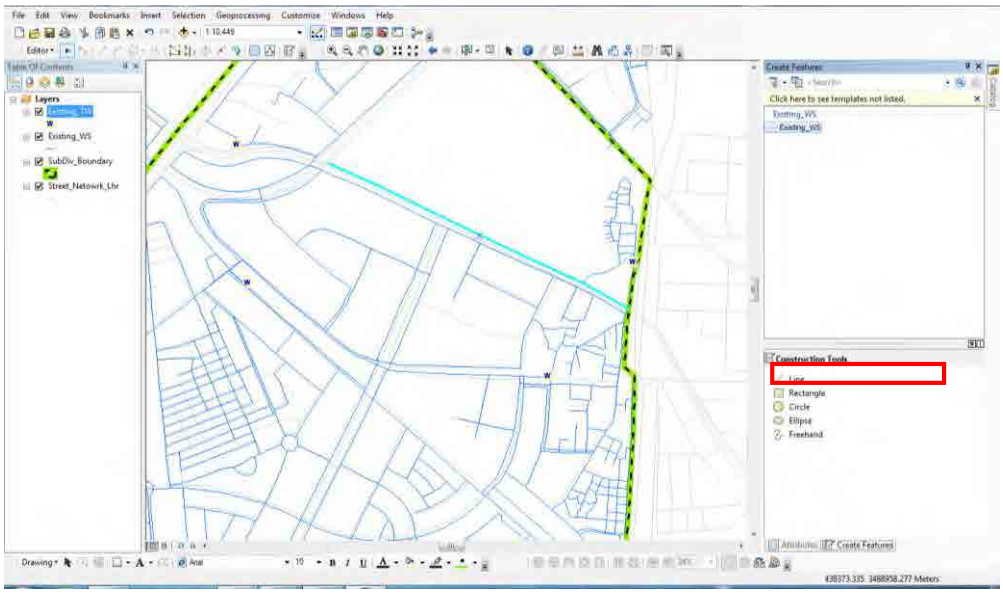


Figure 4.6. ArcMap Window for Editing

  - Add the attribute information of new created feature.

- Click on “Editor” Tab and select “Save Edits” and click “Stop Editing”.

4.1.2. Making Shapefile

Shapefile is the dataset of storing of spatial information of assets. ArcMap 10.2 is used for the preparation of shapefile. The ArcCatalog is used for the preparation of shapefile.

In-order to make the shapefile perform the following steps;

- Go to Start>>program>>ArcGIS.
- Open ArcCatalog.
- Navigate to the folder or path where you want make the shapefile.
- Use C:\GIS Training\Make Shapefile path in table of content in ArcCatalog.
- Right click, select new and then select new shapefile as shown in figure.

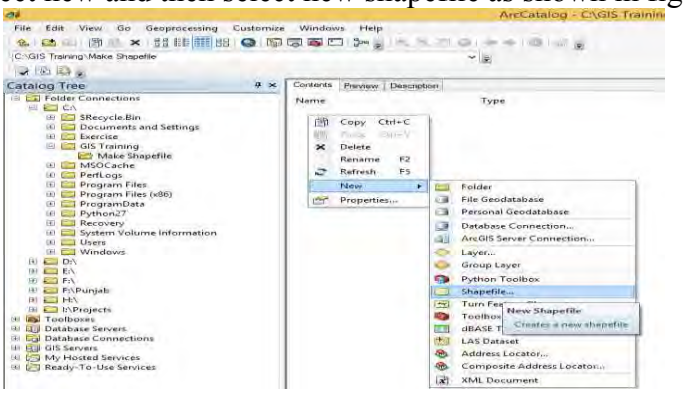


Figure 4.7: Shapefile Tab in ArcCatalog

- Create new shapefile window is opened, type name “Sewerage”, select feature type “Polyline” as shown below.

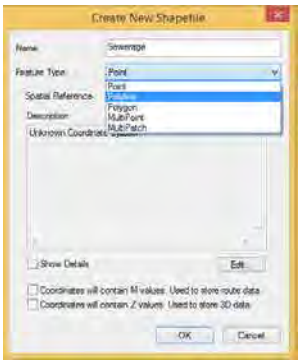


Figure 4.8. Create New Shapefile window

- Give the spatial references by click edit tab and select import.

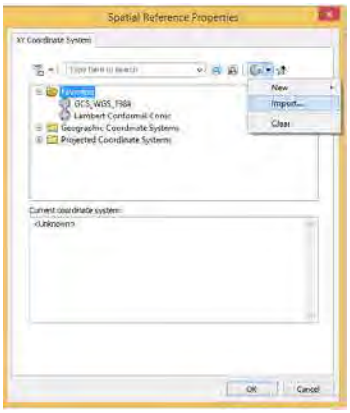


Figure 4.9. Spatial reference properties window

- Select Exiting_WS for the spatial reference and click add button.

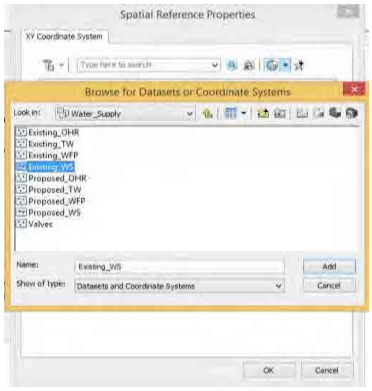


Figure 4.10. Importing of Spatial reference properties

- Spatial reference properties window is appeared which shows the highlighted spatial reference system and click ok.

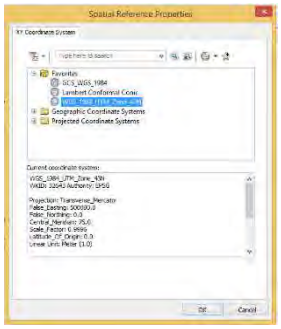


Figure 4.11. After importing Spatial Reference

- That spatial reference information is also appeared in Create New Shapefile window.

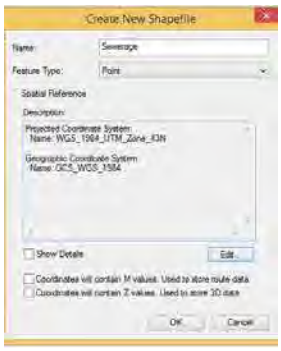


Figure 4.12. After setting of spatial reference

- Then click on in create new shapefile window, the new shapefile window is prepared and is ready for digitization.

Figure 4.13. New Shapefile prepared in ArcCatalog

The shapefile is ready for the storage of spatial features of sewerage pipelines. Digitize the sewerage information by using ArcMap.

4.1.3. Preparation of Layouts/Block Maps

After the preparation of spatial data related to WASA assets, block level map of water supply replacement plan of Allama Iqbal Town subdivision, Lahore is prepared.

The following methodology is used for the block level mapping.

- Prepare the block boundary/index boundary. So here we use the sub-division boundary as block boundary.

- To open the ArcMap software, click on the "Start" button in "Window Task Bar" then navigate to the ArcMap shortcut.
- Click on "Add Data" button. In the open dialog, navigate to the folder "C\:GIS Training\Exercise" to add the asset GIS data.
- Locate the required vector files from the list of personal database and add them all at once by holding the Ctrl or Shift button while clicking on each selection. Here we add the following data by using the Lahore WASA personel database "WASA-Lhr.mdb";

    - ✓ *The SubDiv_Boundary City of Lahore*
    - ✓ *All Valves in the SubDiv_Boundary*
    - ✓ *Existing_WS*
    - ✓ *Existing _TW*
    - ✓ *Existing _OHR*

- When the data is loaded, all files will be listed in the left pane, called the table of Contents. The geographic features (contents) are displayed in the main data frame window.

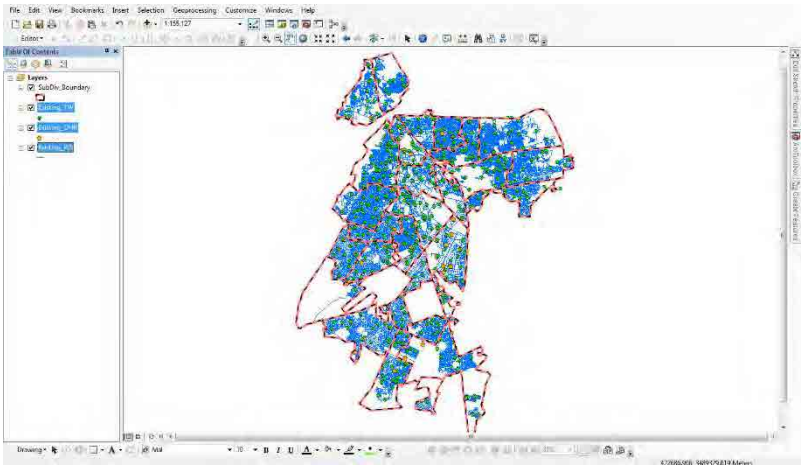


Figure 4.15. After Data added in ArcMap

- In-order to selection of data only Allama Iqbal Town Subdivision, go to layer properties of sub-division boundary and select definition query tab and select write "[Name] = 'Allama Iqbal Town'" in query window.

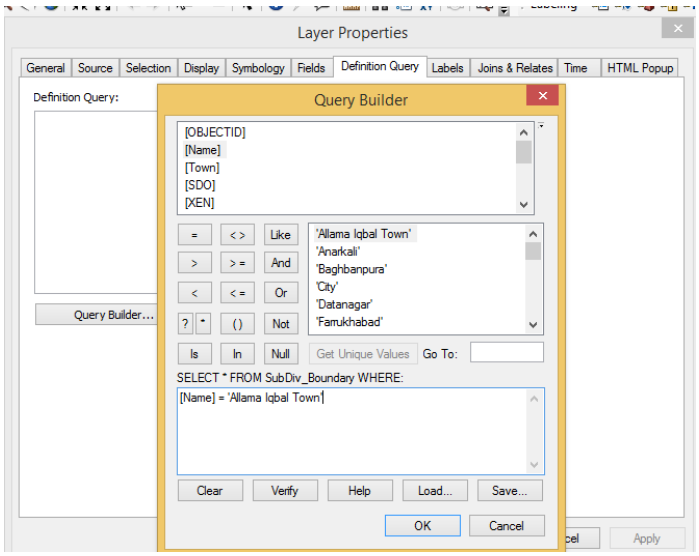


Figure 4.16. Definition Query

- To define the size of map, Click "File" on ArcMap and Click Page and Print setup.

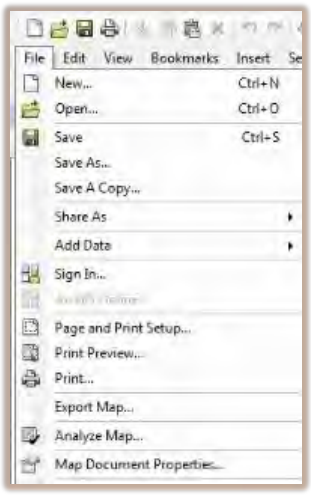


Figure 4.17. Print and page setup

- A page and print setup window is opened and select size A3.
- Click "View" tab on ArcMap and select layout View.

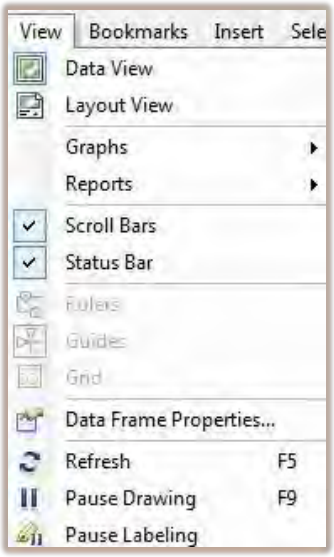


Figure 4.18. Setting Layout View

- Set the map template.
- Set color, size and labeling style of the all the layers and categorize the symbology.

- Click “Insert” option and enter title, North Arrow, Logo, Scale and Legend for map.

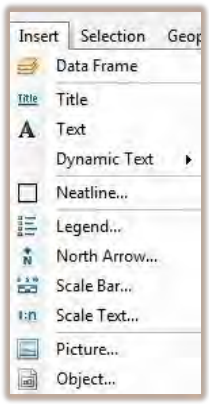


Figure 4.19. Insert Option

- Go to file and select export map.

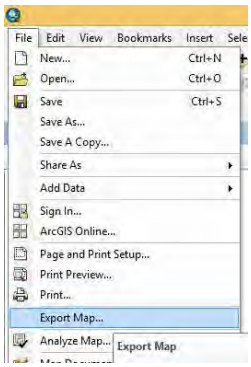


Figure 4.20. Export Map

- Export map window is opened, select path, file name, resolution and format as JPG and then save it.

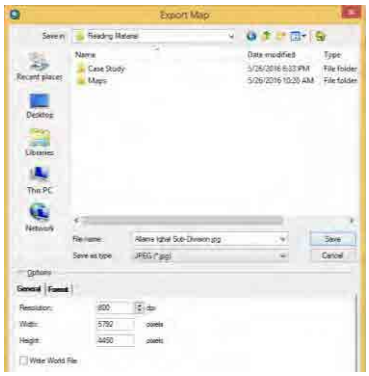


Figure 4.21. Export map window

- The block map of water supply of Allama Iqbal sub-division is ready as shown in figure.

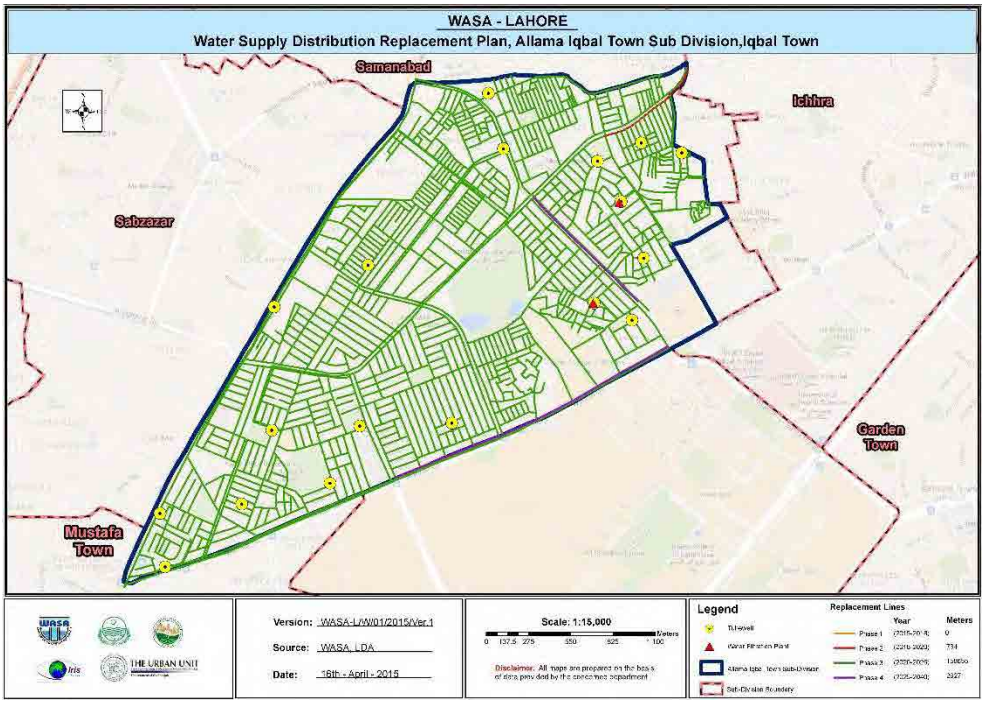


Figure 4.22. Water Supply distribution Block Map

Lecture No. 5

5. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Pipe Replacement planning • Applying Query Functions • Query the pipelines of your interest (e.g.,with 6 inch diameter) • Calculating Lengths of Pipeline	Lecture Duration: Three Hours

5.1. Pipe Replacement Planning

Lecture 5, pipe replacement planning covers the sub-topics; applying query functions, query the pipelines of your interest and calculating the length of pipelines related to WASA under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices pipe replacement planning is covered in the lab activity. The existing GIS data related to assets is access after applying query functions and calculate the length of pipelines.

Lecture 5 is formulated in strengthening the practical skills to asset data is accessed after applying query functions and calculated the length of pipelines. by using ArcGIS to course participants. After completion of lecture 5; the course participant will be familiar about practical skills regarding the query functions, query of pipelines of interest and calculation of length.

The explanation of the sub-topics are given as;

5.1.1. Applying Query Functions

ArcGIS 10.2 version is used for query functions on attribute data associated with spatial feature class of pipelines and calculated length of pipelines.

➢ Applying Query Functions

Query is the filtering of information from the exiting spatial feature class in ArcGIS. Query is applied on the assets attribute information associated with the spatial feature class.

❖ Example-1:

In-order to select pipelines of your interest on the basis of assets attribute information associated with spatial feature class, query function is applied. Here we want to select "all the pipelines with Diameter 6" following steps is followed.

- Go to Start>>program>>ArcGIS.
- Select ArcMap.
- Locate the required vector files from the list of personal database and add them all at once by holding the Ctrl or Shift button while clicking on each selection. Here we add the following data by using the Lahore WASA personel database "WASA-Lhr.mdb";

    - ✓ *The SubDiv_Boundary City of Lahore*
    - ✓ *All Valves in the SubDiv_Boundary*
    - ✓ *Existing_WS*
    - ✓ *Existing _TW*
    - ✓ *Existing _OHR*

- When the data is loaded, all files will be listed in the left pane, called the table of Contents. The geographic features (contents) are displayed in the main data frame window.

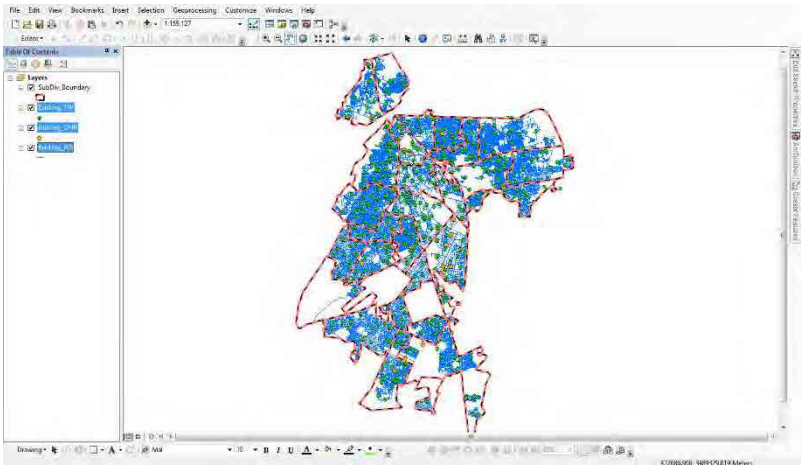


Figure 5.1. After Data added in ArcMap

- Click on Selection Tab and Select by Attribute from the drop down list.

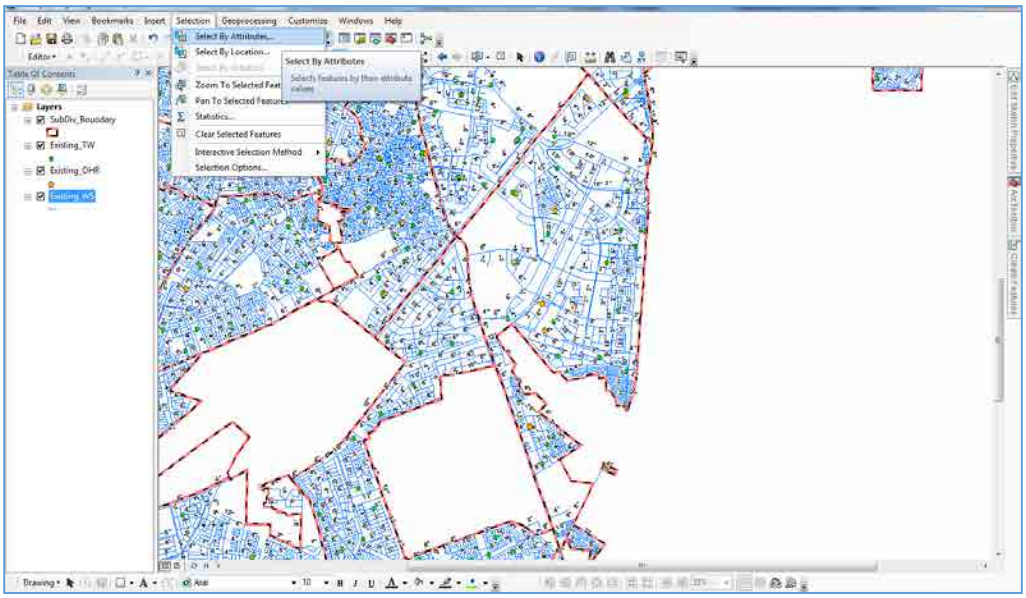


Figure 5.2. Accessing of Select by Attributes in ArcMap

- Select by attributes window is opened.
- Select the “Existing _WS” layer from layer drop down list.
- Select “Diameter” tab after “selection of create new selection” in method dropdown list.
- Select equal “=” sign.
- Click on “Get Unique values” and select <6”>.
- The Query will become as: [Diameter] = '6"‘and visible in Select * from Existing_WS where window.

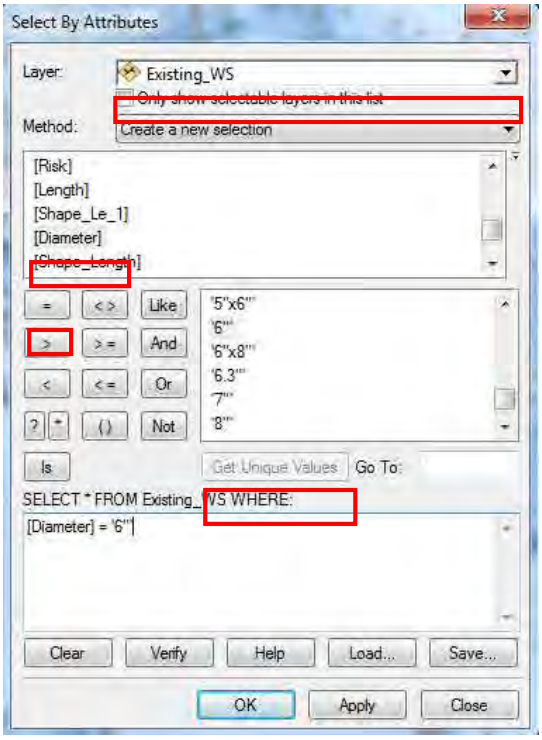


Figure 5.3. Select by Attributes window

- Water supply pipelines of six inches (6”) diameter are selected.
- Open the attribute table to see the selected record.
- The selected records of pipelines with diameter 6 inches is showed in figure.

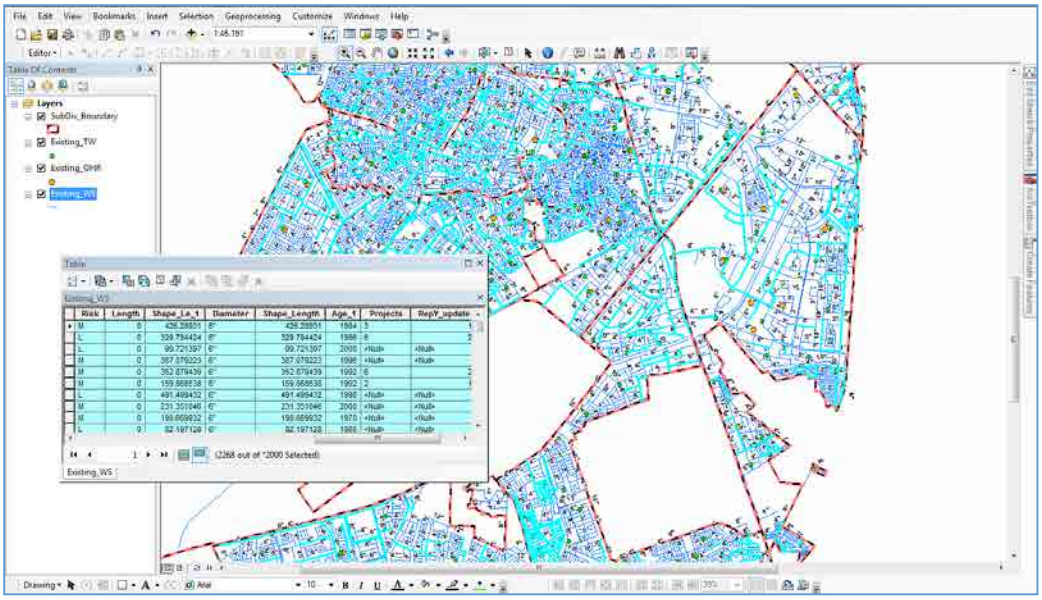


Figure 5.4. Highlighted Water Pipelines with Diameter 6'

❖ **Example-2:**

- In-order to select pipelines in Gulberg subdivision with diameter 6 with condition C on the basis of assets attribute information associated with spatial feature class, following query function is applied.

  [Sub_Divisi] = 'Gulberg' AND [Diameter] = '6"' AND [Condition] = 'C'.

- The result of above query is shown below.

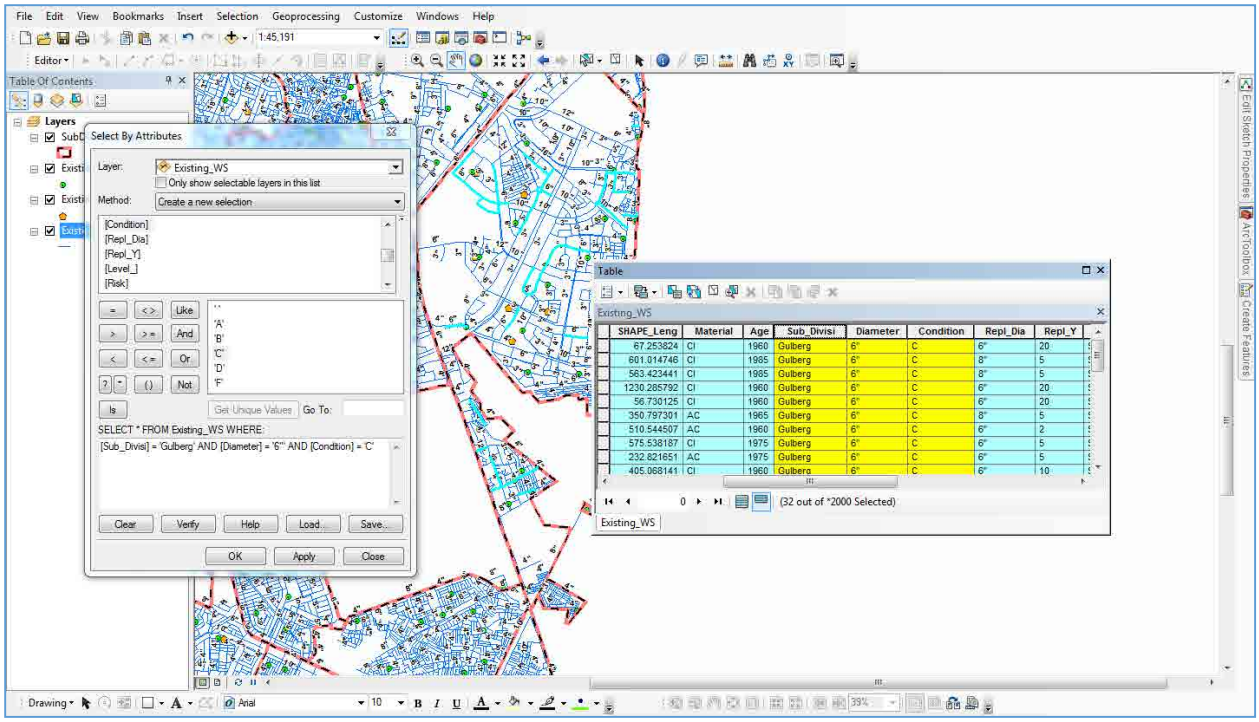


Figure 5.5. Highlighted Pipelines with diameter 6 with condition C in Gulberg Sub-Division

5.1.2. Calculating Lengths of Pipelines

For the calculation of length a new field "length" is required in order to calculate the length of selected pipelines with diameter 6 inches in the attribute information.

- In-order to add the attribute data in a new field/column, add a new field to attribute table of Existing_WS feature class.
- Open the attribute table and click on the pull down button in the top left of the table, then click 'add field' as shown in figure.

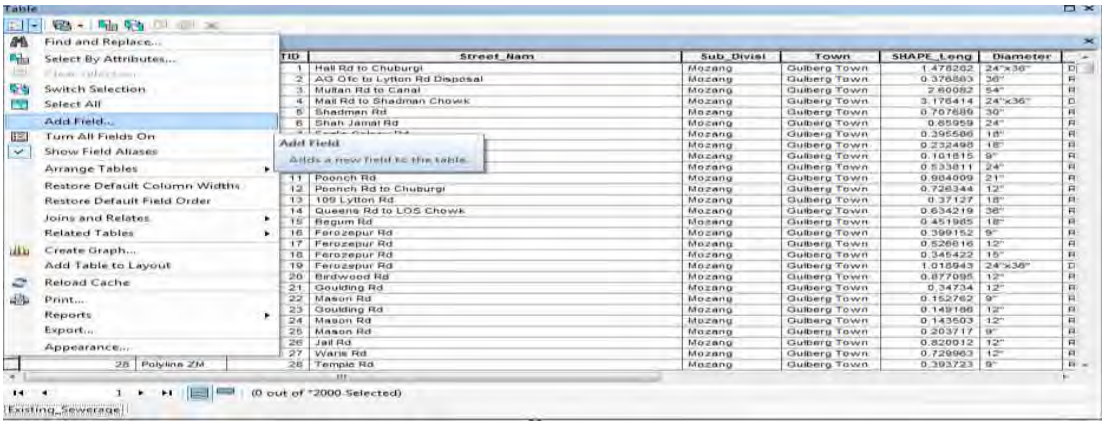


Figure 5.6.Add Field in attribute table

- "Add Field" dialog box is opened as shown in figure 5.6.
- Add the name of the field/column as 'length' and select 'double' from drown down list of type and click ok as shown in figure 5.7. There are many different data field types and carefully add that type which is most appropriate for your data. Here field type double is selected, because the length contains decimal values for more precision.

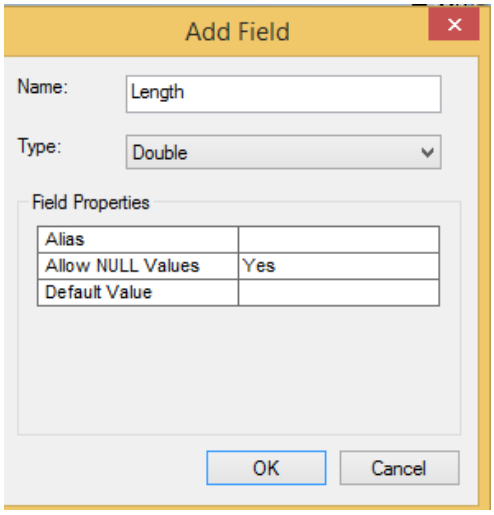


Figure 5.7.Add Field

- The new field is highlighted in the attribute table which contains "Null" values.
- Right click on that length field and click on calculate geometry as shown in figure 5.8.

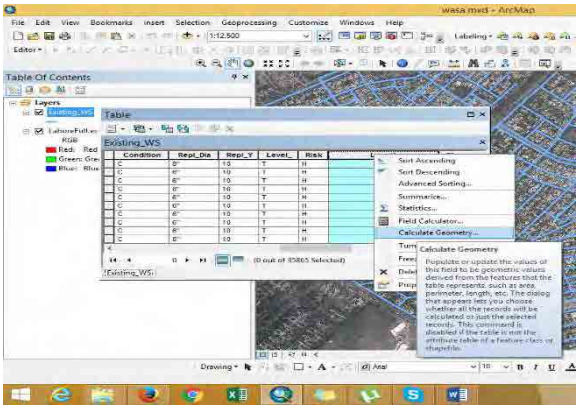


Figure 5.8.Calculate Geometry tab

- Calculate Geometry window is opened as shown in figure 5.9.

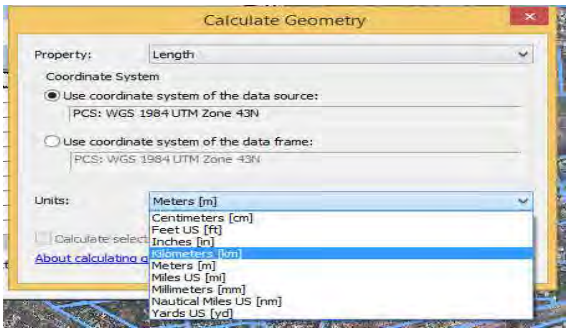


Figure 5.9. Calculate Geometry Window

- Select kilometer (m) from the drop down list of Units and click ok. It takes a few time and the length of water supply is calculated as shown in figure 5.10.

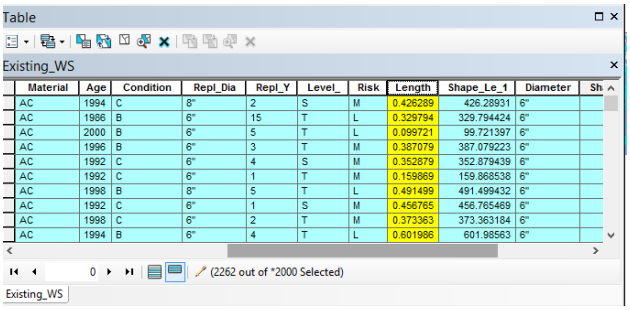


Figure 5.10. After Length Calculation

Note that in order to calculate length or area, the feature class must have projected coordinate system.

Statistics calculate only integer values and not calculate the text values. So be careful about the field entries of spatial feature class. In-order to calculate the statistics right-click the field “length” in attribute table of spatial feature class and click the tab “statistics” as shown in figure 5.11.

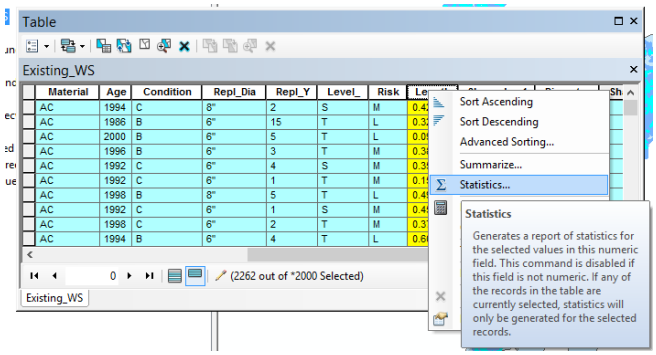


Figure 5.11.Accessing of Statistics tab

- The statistics of water supply Length of Gulberg sub-division is shown in figure 5.12.

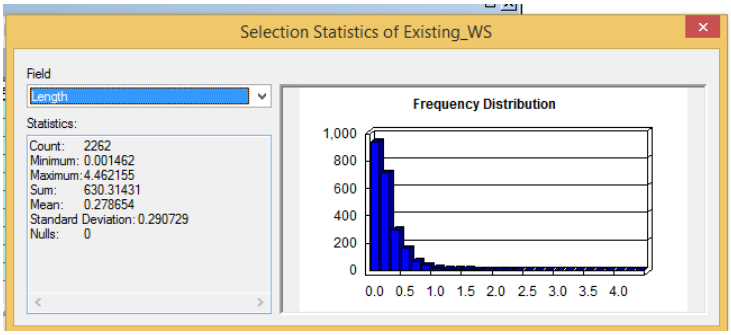


Figure 5.12. Statistics Window

- The statistics window shows the following information;

Selected Field: Length
Count: 2262
Minimum: 0.001462
Maximum: 4.462155
Sum: 630.31431
Mean: 0.278654
Standard Deviation: 0.290729
Nulls: 0

- The frequency distribution bar chart represents the distribution of values graphically is shown in figure 5.12.
- The statistics of other filed can also be calculated by choosing field directly in the statistics window.

Lecture No. 6

6. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Preparation of water and sewerage network maps with scale 1:500 & 1:1000 • Layout setting • Adding Map essentials • Creating map of water supply system e.g., Gulberg Subdivision • Scale setting • Exporting map • Printing	Lecture Duration: Three Hours

6.1. Preparation of Water and Sewerage Maps with Scale 1:500 & 1:1000

Lecture 6, Preparation of water and sewerage network maps with scale 1:500 & 1:1000 of assets covers the sub-topics; layout setting, adding map essentials, creating map of water supply system, scale setting, exporting map and printing related to WASA under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices regarding preparation of water and sewerage network maps with scale 1:500 & 1:1000 are made in the lab activity. The existing GIS data related to assets is used for this activity.

Lecture 6 is formulated in strengthening the practical skills in preparation of water & sewerage maps with different scales by using ArcGIS to course participants. After completion of lecture 6; the course participant will be familiar about practical skills regarding the map preparation of assets with different scales.

Map is the important element of GIS and is the key type of GIS functions. So the decision make use this map and perform decision making. So in-order to map preparation, the audience who will use this map and what should be the information in that map is very important.

The explanation of the sub-topics are given as;

6.1.1. Layout Setting

ArcGIS 10.2 version is used for layout setting regarding map preparation in ArcMap. A page layout (often referred to as a layout) in ArcMap is a collection of map elements organized on a virtual page, designed for map printing. Common map elements that are arranged in the layout include one or more data frames (each containing an ordered set of map layers), a scale bar, north arrow, map title, descriptive text, and a symbol legend.

- To open the ArcMap software, click on the "Start" button in "Window Task Bar" then navigate to the ArcMap shortcut.
- Click on "Add Data" button. In the open dialog, navigate to the folder "C\:GIS Training\Exercise" to add the asset GIS data.
- Locate the required vector files from the list of personal database and add them all at once by holding the Ctrl or Shift button while clicking on each selection. Here we add the following data by using the Lahore WASA personel database "WASA-Lhr.mdb";

    - ✓ *The SubDiv_Boundary City of Lahore*
    - ✓ *All Valves in the SubDiv_Boundary*
    - ✓ *Existing_WS*
    - ✓ *Existing _TW*
    - ✓ *Existing _OHR*

- When the data is loaded, all files will be listed in the left pane, called the table of Contents. The geographic features (contents) are displayed in the main data frame window.

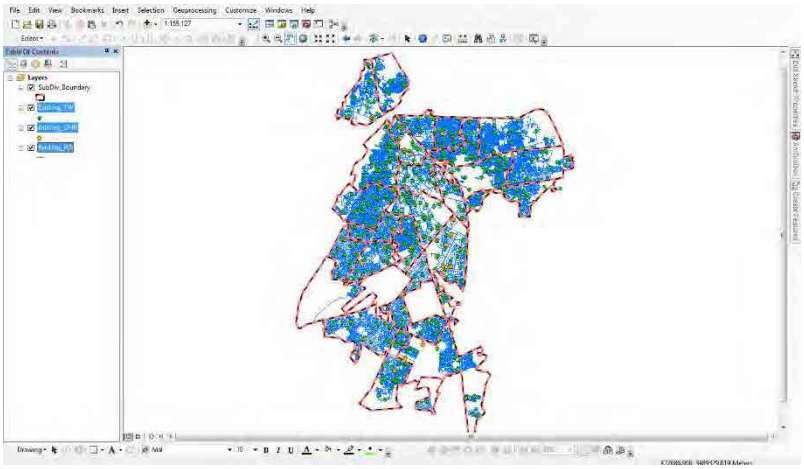


Figure 6.1. After Data added in ArcMap

- In-order to selection of data only Gulberg Subdivision, Lahore, go to layer properties of sub-division boundary and select definition query tab and select write [Name] = 'Gulberg'" in query window.

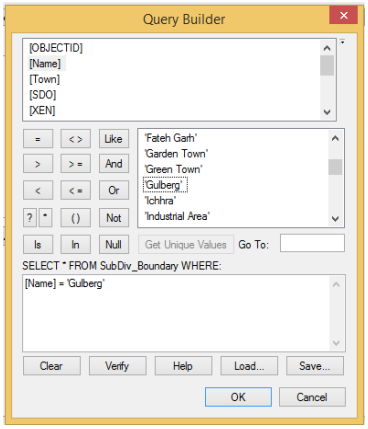


Figure 6.2. Definition Query

- To define the size and scale of map, Click "File" on ArcMap and Click Page and Print setup.

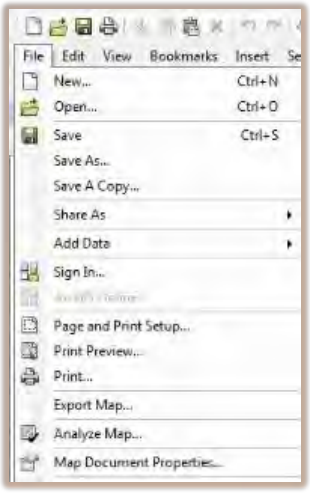


Figure 6.3. Print and page setup

- A page and print setup window is opened and select size A3.
- A land scape layout with printer setting is added to the layout view.
- Click "View" tab on ArcMap and select layout View.

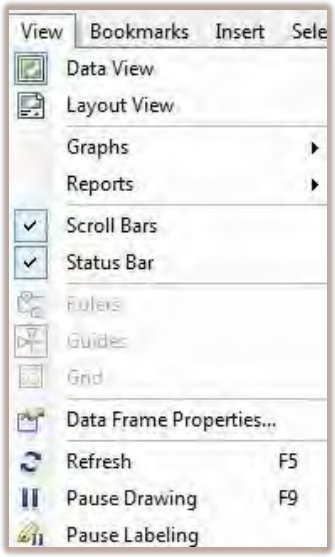


Figure 6.4. Setting Layout View

- Set the map template.

- Set color symbology after categorizing the symbols of assets vector layers and set also size and labeling style of the all the layers.

6.1.2. Adding Map essentials

- Click Insert option and insert map elements (Title, North Arrow, Logo, Scale, Legend, etc.).

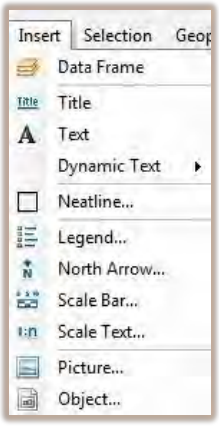


Figure 6.5. Insert Option for map elements

- Double click on the title string.
- Click "Insert" option and enter title after double click on title string.
- A title properties window is opened and write name as Water Supply System Gulberg Subdivision and click ok.

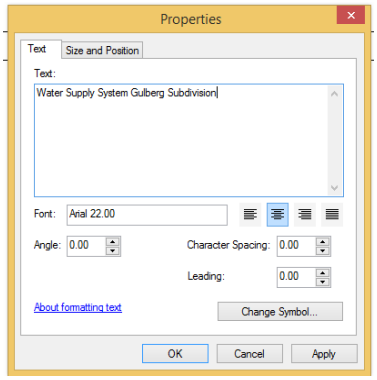


Figure 6.6. Title properties

- Click "Insert" option and select north arrow from "north arrow selector" window.

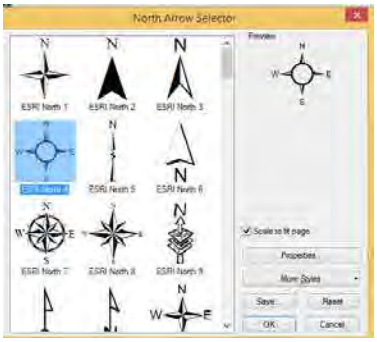


Figure 6.7. North Arrow Selector

6.1.3. Scale Setting

- Click “Insert” option and select scale bar.
- The scale bar is selected from “scale bar selector” window.

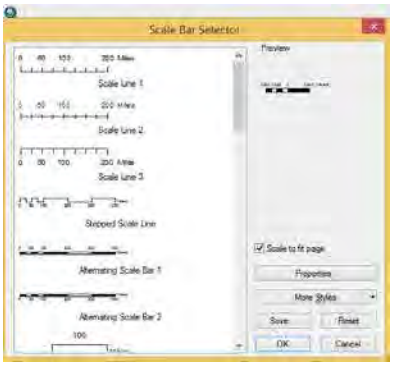


Figure 6.8. Scale Bar Selector

- Click “Insert” option and select scale text from “scale text selector” window. For the preparation of map 1:1000 map a scale is adjusted in scale window in ArcMap.

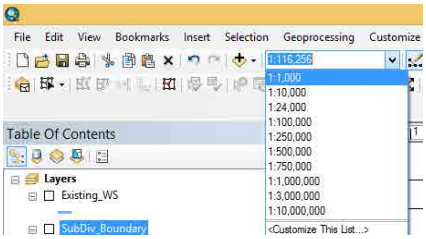


Figure 6.9. Scale Setting

- Zoom in, zoom out and pan tools in layout view tool is also used for adjustment of map elements and scale.

Figure 6.10. Layout Tools

6.1.4. Creating and exporting map of water supply system e.g., Gulberg Subdivision

- Go to file and select export map.

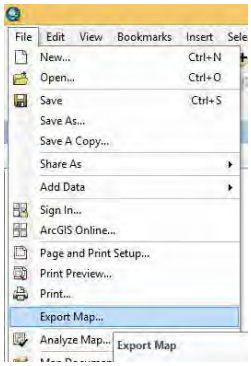


Figure 6.11. Export Map

- Export map window is opened, select path, file name, resolution and format as JPG and then save it.

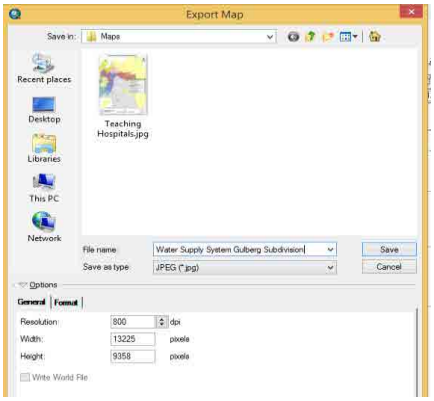


Figure 6.12. Export map windo

- The water supply system Gulberg Subdivision is ready as shown in figure.

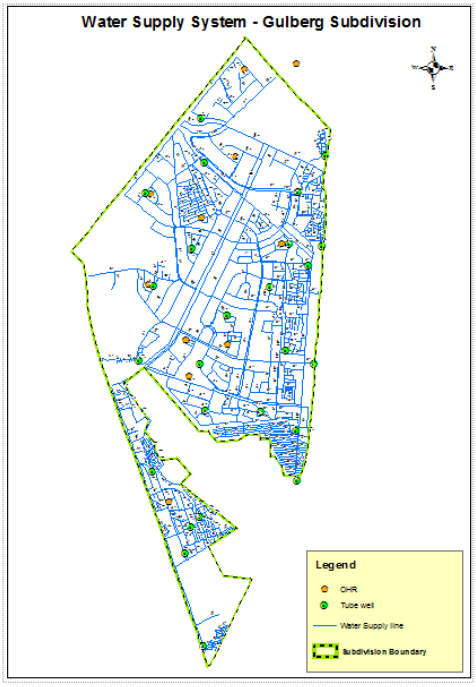


Figure 6.13. Water Supply System Gulberg Subdivision

6.1.5. Printing

The water supply system of Gulberg subdivision is ready for printing and decision maker can use for decison making.

Lecture No. 7

7. Topic Information

Course Title: Asset Management	Course Code: M 4131
Module Title: Use of GIS Application in Asset Management	Module No: 6
Lecture Topics: Field Verification Survey • Introduction to Global Positioning System (GPS) • Use of GPS Device • Assets data collection with GPS • Tracking Pipeline • Synchronization of GPS data with ArcGIS • Map Making	Lecture Duration: Six Hours

7.1. Field Verification Survey

Lecture 7 study of field verification survey, covers the sub-topics; ; introduction to GPS, use of GPS device, assets data collection with GPS, tracking pipelines, synchronization of GPS data with ArcGIS 10.2 and map making related to WASA assets under module 6 "use of GIS applications in assets management". This lecture consists of practical work and practical assignment. The demonstration and practices regarding field verification by using GPS device and ArcGIS is covered in strengthening the practical skills of course participants. The surveyed data is used for the upgradation of existing GIS data of assets, classified on the basis of their attributes associated with spatial features and prepared a map in the lab activity.

Lecture 7 is formulated in strengthening the practical skills regarding GPS usage, data collection from field survey, synchronization of GPS data with ArcGIS feature classes and map preparation using ArcGIS and GPS receiver to course participants. After completion of lecture 7; the course participant will be familiar about practical skills regarding the field verification survey and modification of existing GIS data of assets.

The explanation of the sub-topics are given as;

7.1.1. Introduction to GPS

GPS is the device which is used as data sources in GIS. It is used for data collection of WASA assets from the field to ascertain the positional accuracy of the ground features and also used for the verification of the assets data.

- Garmin GPS 60 is used for the field verification survey of Gulberg Subdivision as shown in figure 1.

Figure 7.4.GPS Receiver

7.1.2. Use of GPS Device

The survey teams are formulated on the basis of that each team consists of two members. GPSs are issued with batteries to all survey teams and areas of interest (AOI) for field survey is allotted to each team.

After the training of survey teams regarding the use of GPS receiver, the teams will be deputed for the data collection of assets in Gulberg subdivision of Lahore.

Use following steps during the field survey;

- Installed the batteries in the GPS and turn on the GPS by pressing turn on button.

Figure 7.2. Turning on GPS and Installation of Batteries

- After pressing the menu button, the main window of GPS is given as.

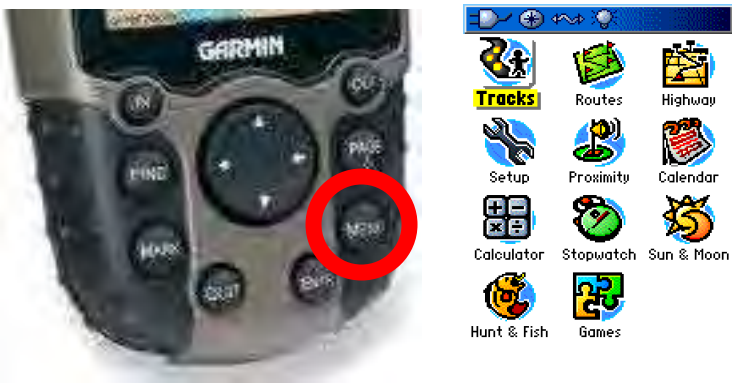


Figure 7.3. Accessing of Menu on GPS

- Set the GPS units as WGS84 by using setup on main window.
- In-order to mark the location of assets check the satellite signal strength for accuracy and mark points when the maximum 4 signal strength is required.

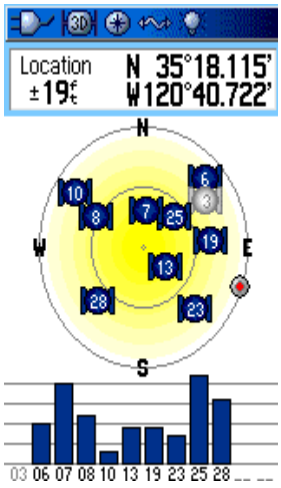


Figure 7.4. GPS Satellites

- Mark Current location of assets by press and hold mark and select mark way points.

Figure 7.5.Marking waypoints

- Note GPS location on the notebook also, because during the field GPS may be damage so your note book will be beneficial in that case.
- Save the location by writing the GPS point name and click ok.

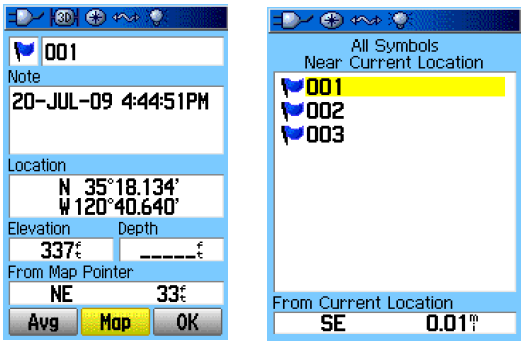


Figure 7.6.Saving of GPS Location

- The GPS saved locations/waypoints can be deleted or edited.
- In order to view saved points go to list where the waypoints saved and go to map window.

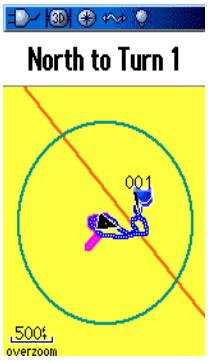


Figure 7.8.Map Viewer on GPS

- GPS has the facility to keep track record on GPS during the field survey. So on the GPS track during the field.

7.1.3. Assets data collection with GPS

Survey teams record the location of main holes and sewerage pipe line (start & end location). The survey team also identify the sewerage problems during field survey and highlighted that information on the provided map.

Take at least 10 to 20 GPS locations from the field.

7.1.4. Synchronization of GPS data with ArcGIS

After the field survey the GPS data is downloaded on work station and synchronized the data with existing GIS data of assets.

- GPS is connected with the computer via GPS cable.

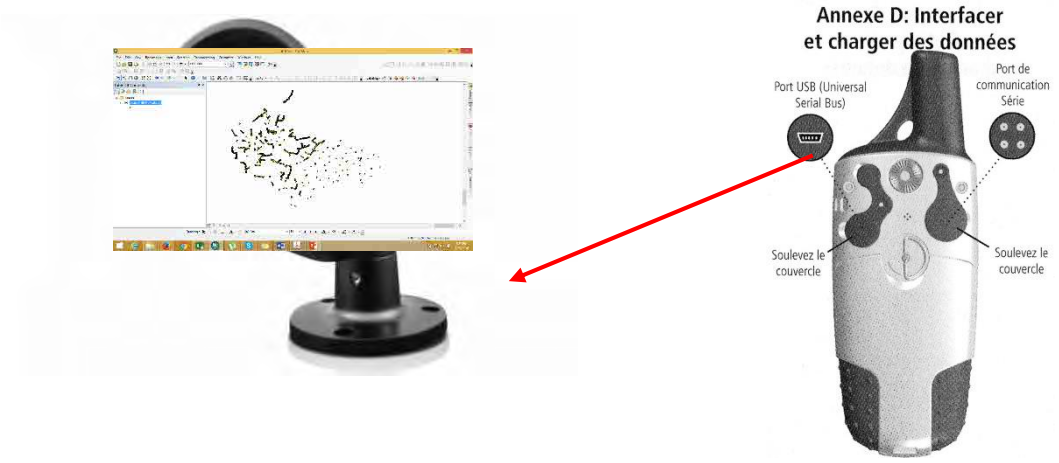


Figure 7.9. GPS connection with Laptop

- Turn on your GPS.
- Start new ArcMap and click ArcToolbox.

Figure 7.10. Accessing of ArcToolbox

- Go to conversion tools in ArcToolbox, select from GPS and click on GPx to features.

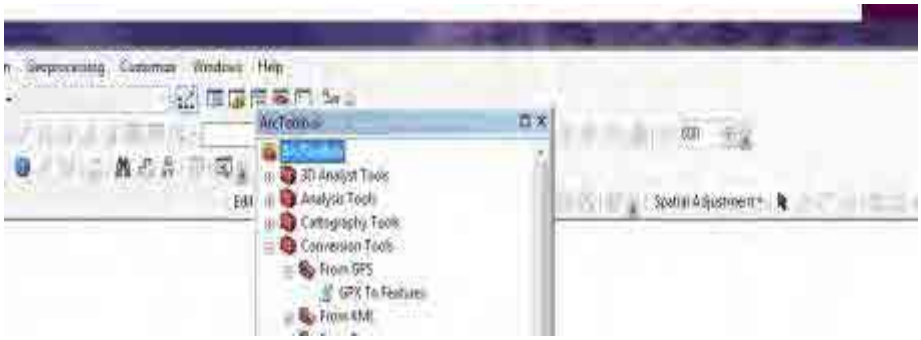


Figure 7.11. Assessing of GPX to features tool

- GPx to features window is opened and GPX file is given in input GPX file and set the path of output fearutes class.

Figure 7.12. GPx to features window

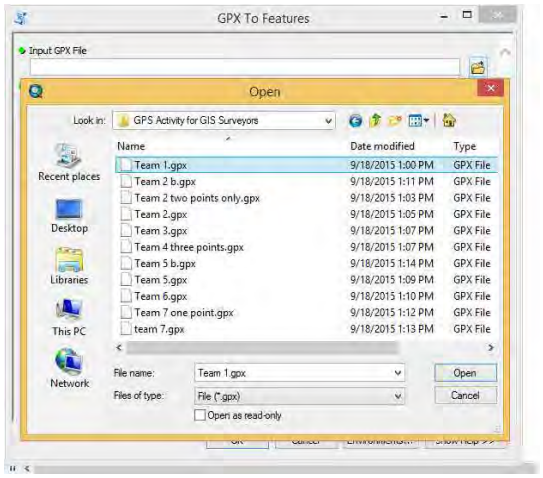


Figure 7.13. Accessing of GPx file

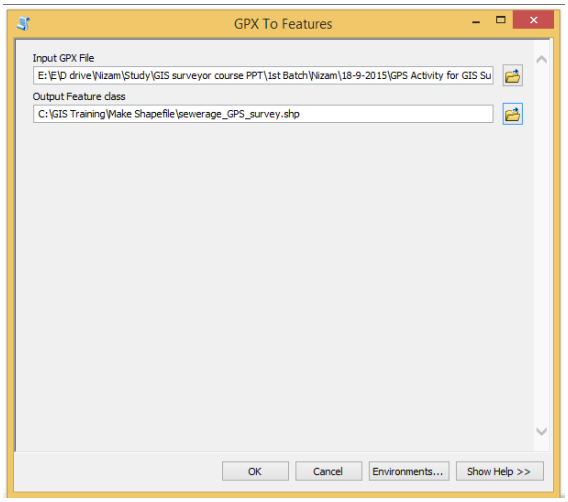


Figure 7.14. Saving the path of feature class

- After few seconds the process runs in ArcMap and convert that GPx file into point feature class.
- Then open that converted feature class in ArcMap esiting document.

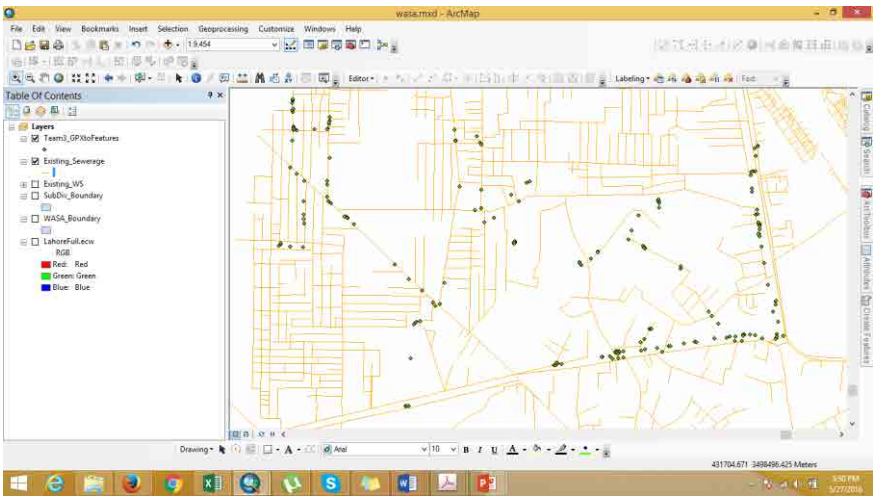


Figure 7.15. Opening of GPS converted data

- Edit the sewerage data as per surveyed data and save the edits.

7.1.5. Map Making

Now the asset data is updated in ArcMap after the field verification and the final map of sewerage system Gulberg subdivision is prepared after adding the map essentials.

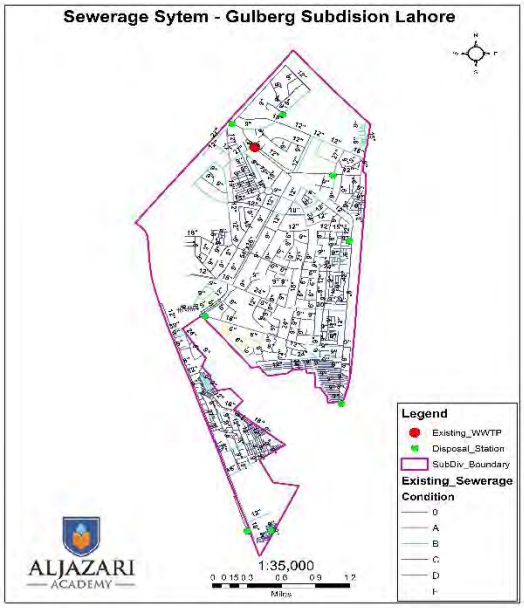


Figure 7.16. Final Map of Sewerage system – Gulberg Subdivision

Annex 3.25
Training Schedule for O&M of Tube Well and Pump Facility
in Spring 2017

ALJAZARI ACADEMY

Operation and Maintenance (O&M) of Tube Well and Pump Facility Course
Training Schedule (March 20 to March 24, 2017)
Course Code: W1221

Sr.No	Day and Date	Themes	Session 1			Tea 11:00-11:15am	Session 2		Lunch 1:15-2:00pm	Session 3
			1st Lecture 9:00-10:00am		2nd Lecture 10:00-11:00am		3rd Lecture 11:15am-12:15 pm	4th Lecture 12:15-1:15pm		Assignment 2:00-4:00pm
1	Monday (March 20, 2017)	·Key Issues in Water Distribution System ·Operation & Maintenance of Water Supply Pipelines & Valves	9:00-9:10 ·Introduction of Course Participants • Training Expectations	9:10-10:00 . Key Issues in Water Distribution System	. Key Issues in Water Distribution System • Components of Water Supply Facility		• Components of Water Supply Facility • Arrangement of Water Distribution System	• Pipe Material • Appurtenances		. Critical Report on Major Issues of Five WASA`s (Group Assignment) . Reflection and Review
2	Tuesday (March 21, 2017)	·Operation & Maintenance of Water Supply Pipelines · Water Safety Plan (WSP)	Review of Previous Lecture	• Water Distribution Operational Plan • Water Distribution Maintenance Plan			• Water Distribution Maintenance Plan • Water Distribution System Mapping . Overhead Reservoirs	. Water Safety Plan Linked with Distribution Pipelines and Reservoirs		. Group Assignment (Preparation of WSP Plan) . Reflection and Review
3	Wednesday (March 22, 2017)	EPANET Analysis for Water Distribution System	Review of Previous Lecture	Pipeline Network Analysis Exercise of Supply Area of One Tube Well						
4	Thursday (March 23, 2017)	National Holiday (Pakistan Resolution Day)								
5	Friday (March 24, 2017)	Operation and Maintenance of Water Distribution System	Review of previous Lecture	OJT at Green Town WASA Sub Division , Lahore . Checking of Valves, Hydrants as per Drawing . Checking of Pressure and Residual Chlorine . Checking of Water Level at Tube well				. Individual Assignment on Preparation of Operational and Maintenance Action Plan		. Individual Assignment on Preparation of Operational and Maintenance Action Plan . Course Evaluation • Training Closure Evaluation

Annex 3.26
Training Schedule for Leakage Detection in Spring 2017

Leakage Detection and Repair

Course Code - W 7231

Training Schedule (20th February to 24th February, 2017)

Sr. No.	Day & Date	Themes	Session 1		Tea 11:00am - 11:15am	Session 2		Lunch 1:15pm-2:00pm	Session 3
			1st Lecture 9:00am - 10:00am	2nd Lecture 10:00am - 11:00am		3rd Lecture 11:15am - 12:15pm	4th Lecture 12:15pm - 1:15pm		2:00pm-4:00pm
1	Monday (February 20, 2017)	• Basic Knowledge of Leakage Detection • Repairing of Leakage and Burst Pipelines	• Introduction of Course Participants & Trainers • Training Expectations from Participants • Current Scenario of Leakage Detection at WASAs	• Countermeasures for Leakage		•Countermeasures for Leakage • Leakage Survey Equipment	• Leakage Survey Equipment • Repairing of Leakage and Burst Pipeline		**Group presentation** . Current practices for leakage prevention and pipe reparing from each Water Utility . Q&As
2	Tuesday (February 21, 2017)	• On Site Leakage Detection	• Review of Previous Lectures • Visit Briefing • Sharing of OJT Plan & Checksheets	**OJT at Green Town Sub Division, Lahore** • Procedure and Use of Acoustic Leak Detector and Acoustic bar • Installation and Operation of Non-Metal Pipe Locator					• Discussion on Site Visit • Site Visit Reflection
3	Wednesday (February 22, 2017)	• On Site Installation and Operation of Leakage Detection Equipment	• Review of Previous Site Visit • Visit Briefing	**OJT at Green Town Sub Division, Lahore** • Installation and Operation of Metal Pipe Locator • Flow Measurement and Pressure Recording by Ultrasonic Flowmeter and Pressure Recorder					• Discussion on Site Visit • Site Visit Reflection
4	Thursday (Febuary 23, 2017)	Visit to Plasco Pipe Industry(Pvt.) Ltd, Gujrat							
5	Friday (Febuary 24, 2017)	• Leakage Prevention Action Plan	• Review of Previous Lecture & Site Visit • Briefing on Leakage Prevention Action Plan	• Preparation of Action Plan of Leakage Prevention by Training Participants		• Preparation of Action Plan for Leakage Prevention by Training Participants . Group Presentation . Training Closure			

Annex 3.27
Training Schedule for O&M of Sewer and Storm Water Drainage in Spring 2017

Operation & Maintenance of Sewer and Storm Water Drainage System including Safety Precautions
Module 01 - Safety Control and Measures for Sewer and Drainage Works (03 Days)
Training Schedule (February 13 - February 15, 2017)

Sr. No.	Day and Date	Themes	Session 1			Tea 11:00 am-11:15am	Session 2			Lunch 1:15 pm-2:00 pm	Session 3		
			1st Lecture 9:00 am-10:00 am		2nd Lecture 10:00 am-11:00 am		3rd Lecture 11:15 am - 12:15 pm		4th Lecture 12:15 am - 1:15 pm		5th Lecture 2:00 pm - 3:00 pm		6th Lecture 3:00 pm -4:00 pm
			09:00 am-9:15 am	9:15 am-10:00 am			11:15 am-11:45 am	11:45 am-12:15 pm			2:00 pm-2:30 pm	2:30 pm-3:00 pm	
1	Monday February 13, 2017	1. Risks & Hazards Associated with O & M of Sewerage & Drainage System	• Welcoming Remarks & Participant Introduction • Course & Modules Overview • Training Expectations	• Hazards & Risks	• Group Discussion on Control Measures related to Hazards & Risks • Briefing on Current Safety Practices in WASA		**Visit-01** **(WASA Training Directorate, Gulshan-e-Ravi)** • Observation of Training Facilities and Infrastructure						• Discussion about Visit • Reflection & Conclusion on Day's Activities
2	Tuesday February 14, 2017	**3.** Use of Safety Gears **4.** SOPs for Sewer & Manhole Operations	• Recap & Review of Previous Day Lectures	• Demonstration on PPE	**Visit-02** **(Field Work - WASA Green Town Sub-Division)** • Testing of Hazardous Gases in Manhole with Portable Gas Monitor & Use of Air Blower • Working in Confined Spaces • Use of Metal Locator (M-130) for Detecting Burried Manhole Cover								• Reflection & Conclusion on Day's Activities
3	Wednesday February 15, 2017	**5.** First Aid in Emergency Situations **6.** Traffic Control Practices during Sewer and Manhole Cleaning Operations	• Recall & Review of Previous Day Lectures	• Demonstration on Arrangements for Medical Treatment	**Visit-03** **(RESUE 1122 Head Quarter, Thokar Niaz Baig)** • Rescue a drowned sanitary worker • Providing first aid against suffocation, head injury and other accidents **Field Work around Academy** • Traffic Routing (Layout / Execution) during O&M Works								• Assignment • Conclusion & Closing of Module-01

Operation & Maintenance of Sewer and Storm Water Drainage System including Safety Precautions

Module 02 - Operation and Maintenance of Storm Water Drainage System (02 Days)

Training Schedule (February 16 - February 17 , 2017)

Sr. No.	Day and Date	Themes	Session 1			Tea 11:00 am-11:15 am	Session 2		Lunch 1:15 pm-2:00 pm	Session 3	
			1st Lecture 9:00 am-10:00 am		2nd Lecture 10:00 am-11:00 am		3rd Lecture 11:15 am-12:15 pm	4th Lecture 12:15 pm-1:15 pm		5th Lecture 2:00 pm-3:00 pm	6th Lecture 3:00 pm-4:00 pm
			9:00 am-9:10 am	9:10 am-10:00 am							
1	Thursday February 16, 2017	**1.** Objectives of Operation and Maintenance of Storm Water Drains **2**. Operation and Maintenance Works for Storm Water Drains	• Module Introduction & Overview • Expected Learning Outcomes	• Need for Operation and Maintenance of Drains • Measurement of Sludge Quantity deposited in Storm Water Drains	• Tools and Equipment for Drain Cleaning Operations • Dredging and De-silting Operations • Maintenance of Storm Water Drains	**Visit-01** **(Field Work at Primary & Secondary Drains around Academy)** • Observing the Machinery for Drain Cleaning Operations (WASA Office, Drainage Division-South) • Estimation of Sludge Quantity in Various Drains (Shaukat Ali Drain) • De-Silting Operations (Sattu Katlah Drain)					• Discussion about Visit • Reflection & Conclusion on Day's Activities
2	Friday February 17, 2017	**3**. Sludge Handling and its Disposal	• Recap & Review of Previous Day Activities • Daywork Overview	• Planning for Sludge Disposal • Disposal Techniques	**Visit-02** **(Drainage Directorate-Cetral, Multan Road)** • Observation of storm water darin mangement model						• Assignment • Conclusion & Closing of Module-02

Operation & Maintenance of Sewerage and Storm Water Drainage System including Safety Precautions
Module 03 - Operation and Maintenance of Sewer System (Duration-04 Days)
Training Schedule (March 7 - March 10, 2017)

Sr. No.	Day and Date	Themes	Session 1			Tea 11:00 am-11:15 am	Session 2			Lunch 2:00 pm-3:00 pm	Session 3
			1st Lecture 9:00 am-10:00 am		2nd Lecture 10:00 am-11:00 am		3rd Lecture 11:15 am-12:15 pm	4th Lecture 12:15 pm-1:15 pm	5th Lecture 1:15 pm-2:00 pm		6th Lecture 3:00 pm-4:00 pm
			9:00 am - 9:15 am	9:15 am-10:00 am							
1	Tuesday March 7, 2017	1. Inspection & Testing of Sewers & Manholes	• Module Introduction & Overview • Expected Learning Outcomes	• Inspection of Manholes & Sewer lines	• Testing Techniques		**Visit-01 (Field Work around Academy)** • Manhole / Sewer Line Inspection			LUNCH	• Reflection & Conclusion on Day's Activities
2	Wednesday March 8, 2017	2. Machinery, Tools & Equipment for Cleaning of Sewer Lines & Manholes	• Recap & Review of Previous Day Activities • Daywork Overview	• Machinery, Tools & Equipment • Cleaning Techniques	**Visit-02 (Field Work at WASA Green Town / Industrial Area Sub Division)** • Introduction & Working of Jetter & Sucker Machine • Hydraulic Method of Sewerline / Manhole Cleaning & Blockage Removal						• Reflection & Conclusion on Day's Activities
3	Thursday March 9, 2017	3. O&M of Disposal Station	• Recap & Review of Previous Day Activities • Daywork Overview	• Disposal Station -Introduction -O&M	**Visit-03 & 04 (Field Work at Disposal Stations)** • Observation of O&M works at: 1. Ameer Chowk Disposal Station 2. Gulshan-e-Ravi Disposal Station						• Reflection & Conclusion on Day's Activities
4	Friday March 10, 2017	4. Maintenance & Rehabilitation of Sewer Lines & Manholes 5. Emergency Response Planning (ERP) for Monsoon	• Recap & Review of Previous Day Activities • Daywork Overview	• Repair & Rehabilitation Techniques	• Introduction of ERP • Briefing on Special Measures taken by WASAs During Monsoon Season		• Action Plan for Module 3				• Conclusion & Closing of Module-03

Annex 3.28
Training Schedule for O&M of Electrical Equipment
in Spring 2017

ALJAZARI ACADEMY

Operations and Maintenance (O&M) of Electrical Equipment
Training Schedule (April 10th - April 14th, 2017)
Course Code: WSD 5231
Module-1, 2 Electrical Control Panels & Generators

Sr. No.	Day and Date	Themes	Session 1		Tea 11:00-11:15am	Session 2		Lunch 1:15-2:00pm	Session 3	
			1st Lecture 9:00-10:00am	2nd Lecture 10:00-11:00am		3rd Lecture 11:15am-12:15 pm	4th Lecture 12:15-1:15pm		5th Lecture 2:00-3:00pm	6th Lecture 3:00-4:00pm
1	Monday (April 10,2017)	**Electrical Control Panel** •Usage of electrical control panel •Control panel assembly	• Introduction of course participants and module expectations •Benefit and purpose of electrical control panels •Electrical units and components	• Introduction to main electrical units, design and its components **Exercise P1**: Wiring diagram of different components of MCU		• Motor Starters • Introduction to Motors • Power factor correction **Exercise P2**: Selection of Motor with respect of Pump size	• Record Keeping • SOP **Exercise P3**: SOP check on demo panel, Modification of Operation Record		**Exercise P4**: Device Inspection on demo panel, Continuity check by Clamp multi-meter ·Day's wrap-up and Review ·Discussion and Queries	
2	Tuesday (April 11, 2017)	**Electrical Control Panel** •Standard operating procedures (SOP) •Problem solving techniques •Preventive maintenance	•Preventative Maintenance •Introduction to testing equipment •Applicable PPE	Demonstration at WASA tube well at Green Town (10:00-12:30) ·PPE Preparation •Record keeping •SOP Checklist ·Device Inspection ·Demostration of Preventive maintenance (·Practice on Insulation resistance tester) Review of results in filled templates at Academy					•5S Implementation **Exercise P5:** 5S activity in house •Label alll essential equipment on control panel •Post standard fault reporting or maintence request procedure •Post emergency contact list (including site operations and maintenance team contacts)	
3	Wednesday (April 12, 2017)	**Generator** •Generator assembly •Standard operating procedures (SOP) •Preventive maintenance •Applicable PPE	• Introduction to Diesel Generator	• Assembly parts of a generators **Exercise G1:** Label exploded diagram of a diesel generator		•SOP •Daily operation and maintenance Record ·Preventive Maintenance	Demonstration on Generator at Academy ·Queries about components and their flow ·Daily operation and maintenance record		Demonstration on Generator at Academy Demonstration of Preventative Maintenance ·Day's wrap-up and Review ·Discussion and Queries	
4	Thursday (April 13, 2017)	**Generator and HSE** •Preventive Maintenance Plan ·Troubleshooting with the manufaturer's manual	• Importance of the Manufacturer's Manual	**Exercise G2**: Develop preventive maintenance plan		Demonstration **Exercise G3:** Refer to operations manual and perform troubleshooting on generator	**Health Safety and Enviroment** Introduction to HSE with respect to Electrical Equipment		**Health Safety and Enviroment** Deomonstration HSE related to electrical equipment operations	
5	Friday (April 14, 2017)	•Output Challenge • Action plan • Course evaluation	**Exercise A1**: ·Output Challenge of Electrical Panel and Generator	·Action plan -List up possible actions -Develop OJT implentation procedure		•Presentation of gained knowledge and action plan (Each WASA) •Course and trainer evaluation				

Annex 3.29
Training Schedule for O&M of Mechanical Equipment
in Spring 2017

ALJAZARI ACADEMY

Operations and Maintenance (O&M) of Mechanical Equipment
Training Schedule (April 24th - April 26th, 2017)
Course Code: WSD 5231
Module-1 Pumps and Valves; Module-2 Filtration and Chlorination Systems

Sr. No.	Day and Date	Themes	Session 1		Tea 11:00-11:15am	Session 2		Lunch 1:15-2:00pm	Session 3	
			1st Lecture 9:00-10:00am	2nd Lecture 10:00-11:00am		3rd Lecture 11:15am-12:15 pm	4th Lecture 12:15-1:15pm		5th Lecture 2:00-3:00pm	6th Lecture 3:00-4:00pm
1	Monday (April 24, 2017)	•Pumps •Valves	•Introduction of course participants •Training expectations •Introduction to pumps and valves	•Assembly components of pumps and valves •Selection criteria for pumps •Preventive maintenance plan		**Exercise1:** •Pump selection criteria •Calculate total head for pumps	**Exercise2:** Find and identify appropriate manual section and develop a monthly maintenance plan		Demonstration visit to Green Town tube well: Observe standard operating procedure of centrifugal pumps •Pressure checks •Leakage inspection •Valve functions •Gland seal replacement procedure •UF plant •Pump lubrication before start	
2	Tuesday (April 25, 2017)	•Preventive maintenance •Common faults and trouble shooting **•Chlorination and Filtration Systems** **(Start of module 2)**	•Record keeping •SOPs	Pumps and Valves: Major faults and root causes		• Introduction to chlorination and filtration system at WASA tube wells	• Introduce OHSAS 18001 • WHO water chlorination guidelines •Chlorination dosage and pump calibration		**Exercise1:** Filtration system components and specific function identification	
3	Wednesday (April 26, 2017)	•Chlorinators **(Start of module 3)** •Introduction to heavy machines (Suction, Jetting and Backhoe)	•Chlorinator pump operating principle •Chlorinator parts and maintenance	•Chlorinator dosage adjustment •Adjustment of chlorinator (pump) for required treatment		**Exercise1:** •Identify various parts and features of the chlorinator pump	•Importance of heavy machines in WASA capacity enhancement (operational efficiency) •Assembly components and operations of Suction and Jetting Machines		•Assembly components and operations of Backhoes	

ALJAZARI ACADEMY

ALJAZARI ACADEMY

Operations and Maintenance (O&M) of Mechanical Equipment
Training Schedule (April 27th - April 28th, 2017)
Course Code: WSD 5231
Module-3 Heavy Machines, HSE & 5S; Module-4 Water Meters

Sr. No.	Day and Date	Themes	Session 1		Tea 11:00-11:15am	Session 2		Lunch 1:15-2:00pm	Session 3	
			1st Lecture 9:00-10:00am	2nd Lecture 10:00-11:00am		3rd Lecture 11:15am-12:15 pm	4th Lecture 12:15-1:15pm		5th Lecture 2:00-3:00pm	6th Lecture 3:00-4:00pm
1	Thursday (April 27, 2017)	•SOPs •Preventive maintenance for heavy machines •HSE •Work place standardization and process optimization (5S)	•SOP of Jetting unit •SOP of Suction unit •SOP of Backhoe	•Preventive maintenance for heavy machines •Demonstration of suction, jetting and backhoe machine operations		•HSE •Work place standardization and process optimization (5S)	•HSE •Work place standardization and process optimization (5S)		Demonstration of HSE and 5S implementation	
2	Friday (April 28, 2017)	•Water meters •Participant reflections and site action plan •Module evaluations	•Importance of water meters •Water meter types	•Common maintenance issues •Water meter accuracy check demonstration		•Participant reflections and site action plan	•Module evaluations			

ALJAZARI ACADEMY

Annex 3.30
Training Schedule for Business Planning in Spring 2017

Training Plan

Business Planning Course

DAY & DATE	MODULE	Session 1		Tea	Session 2		Lunch & Prayer	Session 3	
		9:00-10:00	10:00-11:00	11:00-11:15	11:15-12:30	12:30-2:00	2:00:2:30	2:00pm-3:00pm	3:15pm-4:00pm
6 Feb 2017	Module 1: Business Planning and GAP Anlysis Module Leader: Mr M Kashif	LECTURE & GROUP ACTIVITY Course Introduction, Ice Breaking and Benchmarking			LECTURE & GROUP ACTIVITY Introduction of Business Planning and SWOT Analysis			GROUP ACTIVITY GAP Analysis through SWOT technique for IDAMPs of FIVE WASAs	
		Mr M Kashif, Mr Asif and Mr M Samie			Mr Abid Hussainy, Mr Asif Iqbal, Ms Aneeqa and EY			Mr Abid Hussainy, Mr Kashif, Mr Asif Iqbal, Ms Aneeqa, & Mr Samie	
7 Feb 2017		GROUP ACTIVITY GAP Analysis and Target Setting Energy Management and Non-Revenue Water			GROUP ACTIVITY GAP Analysis and Target Setting Integrated Development and Assets Management Plan			GROUP ACTIVITY GAP Analysis and Target Setting Financial Management	
		Mr Abid Hussainy, Mr Asif Iqbal, Mr Ali, Mr Nizam, Ms Aneeqa			Mr Abid Hussainy, Mr Asif Iqbal, Mr Ali, Mr Nizam, Ms Aneeqa			Mr M Kashif & Mr Samie	
8 Feb 2017		LECTURE Best Practices on Benchmarking in Phnom Penn	LECTURE IDAMP Framework and Project Prioritation		LECTURE & GROUP ACTIVITY Performance Improvement Plan (PIP) Operational Business Plan (OBP) and IDAMP - Water Supply System			LECTURE & GROUP ACTIVITY Performance Improvement Plan (PIP) Operational Business Plan (OBP) and IDAMP - Water Supply System	
		Mr Kuroda	Mr Abid Hussainy and Mr Asif		Mr Abid Hussainy, Mr Asif Iqbal, Mr Ali, Ms Aneeqa and EY			Mr Abid Hussainy, Mr Asif Iqbal, Mr Ali, Ms Aneeqa and EY	

Assistant Director Finance and Revenue

Induction Training Schedule

Training Plan

Business Planning Course

DAY & DATE	MODULE	Session 1		Tea	Session 2		Lunch & Prayer	Session 3	
		9:00-10:00	10:00-11:00	11:00-11:15	11:15-12:30	12:30-2:00	2:00:2:30	2:00pm-3:00pm	3:15pm-4:00pm
9 Feb 2017	Module 2: Strategies for Service Delivery Improvements Module Leader: Mr. Abid Hussainy	LECTURE & GROUP ACTIVITY Performance Improvement Plan (PIP) Operational Business Plan (OBP) and IDAMP - Sewerage and drainage system			LECTURE & GROUP ACTIVITY Performance Improvement Plan (PIP) Operational Business Plan (OBP) and IDAMP - Sewerage and drainage system			ROLE PLAY Project Prioritation Activity Water, Sewerage and drainage system	
		Abid Hussainy, Asif, Ali Rao and Aneeqa Azeem			Abid Hussainy, Asif, Ali Rao and Aneeqa Azeem			Abid Hussainy, Asif, Ali Rao and Aneeqa Azeem	
10 Feb 2017		LECTURE & GROUP ACTIVITY Communication Strategy			LECTURE & GROUP ACTIVITY Communication Strategy			Last day ended at after lunch at 2:30 PM	

Assistant Director Finance and Revenue

Induction Training Schedule

Training Plan

Business Planning Course

DAY & DATE	MODULE	Session 1		Tea	Session 2		Lunch & Prayer	Session 3	
		9:00-10:00	10:00-11:00	11:00-11:15	11:15-12:30	12:30-2:00	2:00:2:30	2:00pm-3:00pm	3:15pm-4:00pm
		Memoona Arslan Bhatti			Memoona Arslan Bhatti				
27 Feb 2017	Module 3: Strategies for Human Resource Development Module Leader: Ms Sadaf Hussainy	LECTURE Human Resource Development	INDIVIDUAL ACTIVITY Job Role Analysis		LECTURE AND INDIVIDUAL ACTIVITY Knowledge Skill Attitude (KSA)	LECTURE AND INDIVIDUAL ACTIVITY Training Prioritization		LECTURE AND INDIVIDUAL ACTIVITY Monitoring & Evaluation	GROUP ACTIVITY (Presentation of training plan by representatives of respective groups)
		Ms Sadaf Hussainy			Ms Sadaf Hussainy			Ms Sadaf Hussainy	
28 Feb 2017		LECTURE Workforce Database Analysis	INDIVIDIAL ACTIVITY Workforce Database Analysis		INDIVIDIAL ACTIVITY Workforce Database Analysis	GROUP DISCUSSION How to motivate staff in preparation and presentation of staff motovation action plans)		GROUP DISCUSSION How to motivate staff in preparation and presentation of staff motovation action plans)	
		Ms Sadaf Hussainy	Mr. Muhammad Samie & Mr. Rehan Khaled		Mr. Muhammad Samie & Mr. Rehan Khaled	Mr. Kuroda		Mr Kuroda	
1 Mar 2017	Module 4: Strategies for Financial Management System Module Leader: Mr Muhammad Kashif	LECTURE AND GROUP ACTIVITY Strategies for Improvement in Financial Management System			GROUP ACTIVITY (Aging of Arrears and Development of Arrears Recovery Strategy)			GROUP ACTIVITY Action Plan - Financial Management	
		Mr Muhammad Kashif and Mr Muhammad Samie			Mr Muhammad Kashif and Mr Muhammad Samie			Mr Muhammad Kashif and Mr Muhammad Samie	

Assistant Director Finance and Revenue

Induction Training Schedule

Training Plan

Business Planning Course

DAY & DATE	MODULE	Session 1		Tea	Session 2		Lunch & Prayer	Session 3	
		9:00-10:00	10:00-11:00	11:00-11:15	11:15-12:30	12:30-2:00	2:00:2:30	2:00pm-3:00pm	3:15pm-4:00pm
2 Mar 2017	Module 5: Business plan formulation and implementation Module Leader: Mr Abid Hussainy	LECTURE AND GROUP EXERCISE Investment Appraisal (Four exercises including a case of bottling company)			GROUP ACTIVITY Finalization of 3 year sub-division wise business plan			GROUP ACTIVITY Finalization of 3 year sub-division wise business plan	
		Mr. Asif Iqbal			Mr Abid Hussainy, Mr M Kashif, Mr Kuroda, Ms. Sadaf, Mr Asif, Mr Ali, Mr Samie, Ms Aneeqa & Mr. Rehan			Mr Abid Hussainy, Mr M Kashif, Mr Kuroda, Ms. Sadaf, Mr Asif, Mr Ali, Mr Samie, Ms Aneeqa & Mr. Rehan	
3 Mar 2017		GROUP PRESENTATION 3 Year Sub-division-wise Business Plan			GROUP PRESENTATION 3 Year Sub-division-wise Business Plan	Closing Ceremony Distribution of Certificates and Group Photo		Last day ended at after lunch at 2:00 PM	
		Mr Abid Hussainy, Mr M Kashif, Mr Kuroda, Ms. Sadaf, Mr Asif, Mr Ali, Mr Samie, Ms Aneeqa & Mr. Rehan			Mr Abid Hussainy, Mr M Kashif, Mr Kuroda, Ms. Sadaf, Mr Asif, Mr Ali, Mr Samie, Ms Aneeqa & Mr. Rehan				

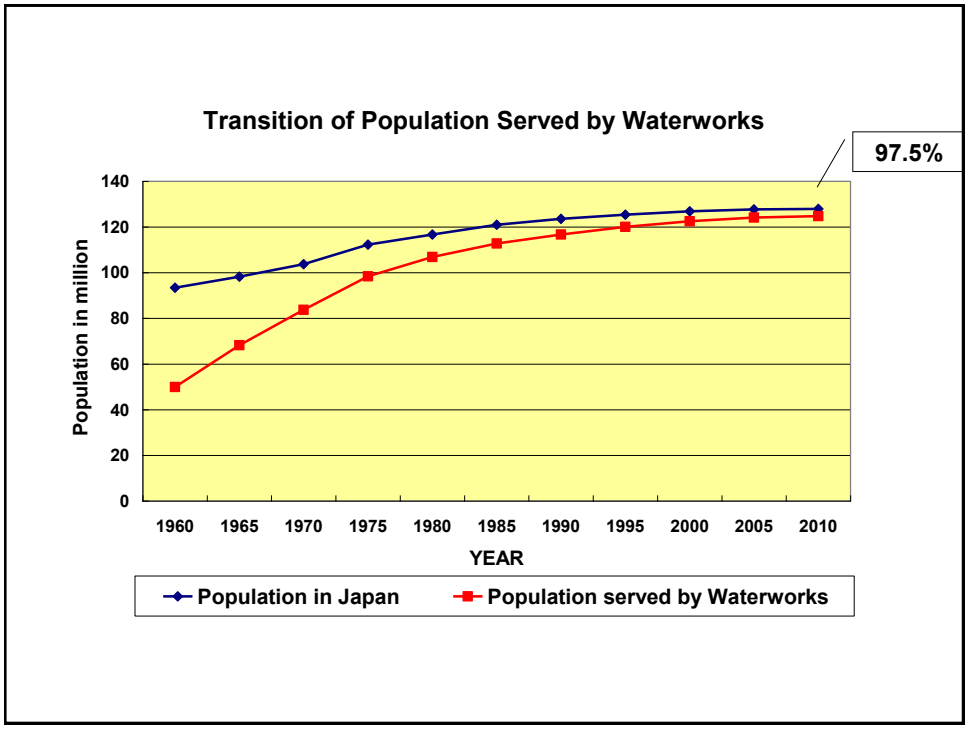
Annex 3.31
Training Material for O&M of Tube Well and Pump Facility in Spring 2017

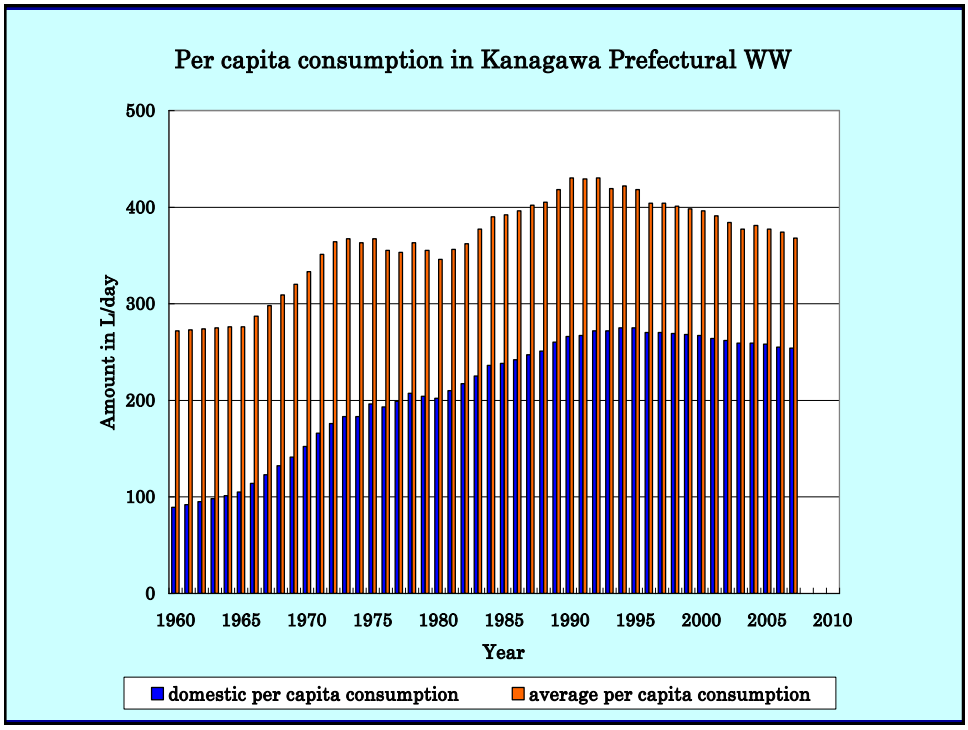
Capacity Building and JWWA's Activities

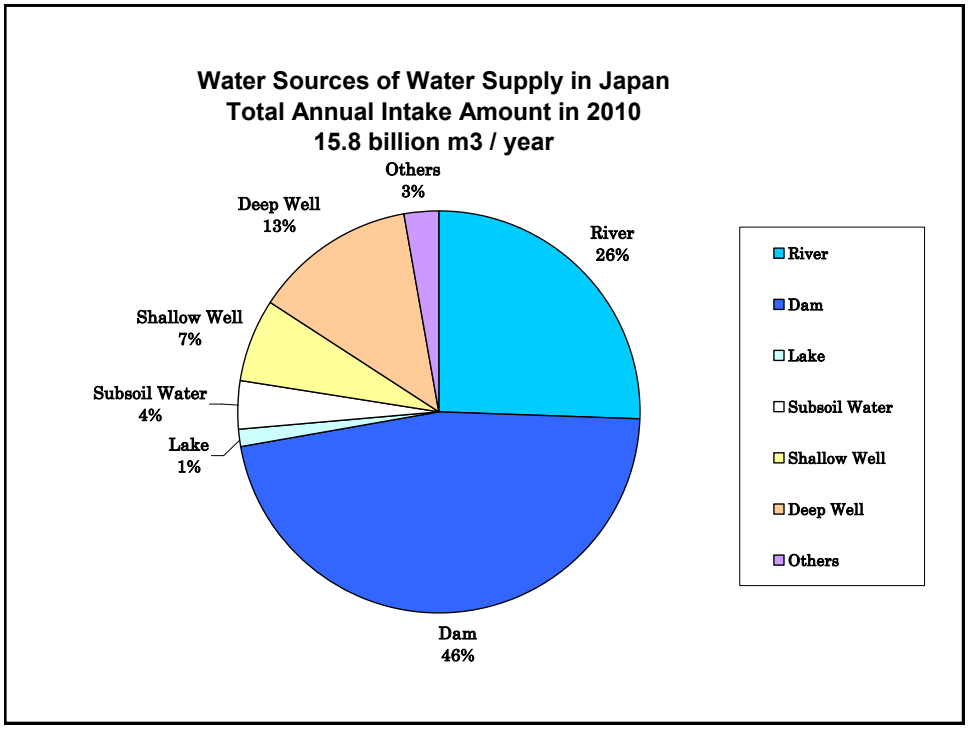
Takuji Okubo
Senior Civil Engineer
Japan Water Works Association

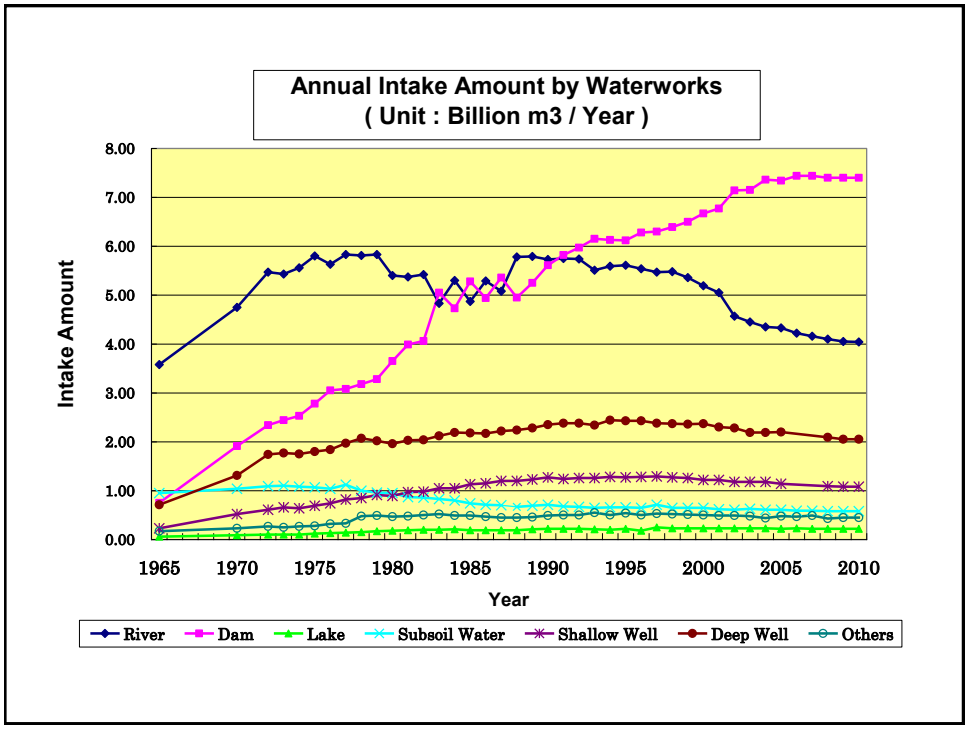
Introduction of JWWA

- **1887** First modern water supply system in Japan established in Yokohama City
- **By 1900** Water Supply System of Hakodate(1889),Nagasaki(1891),Osaka(1895),Tokyo(1898),Hiroshima(1899) and Kobe city(1900) were established.
- **1904** Federation of Water Authority (JWWA's predecessor) established with Seven Cities' WW to create a uniform water quality examination method
- **1932** Japan Water Works Association established

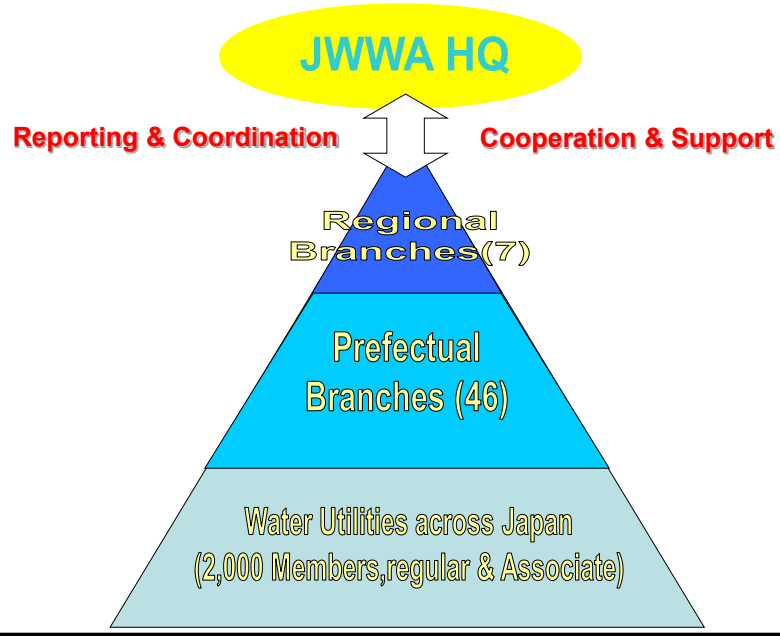

Transition of Population Served by Waterworks
97.5%
Population in million
140
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
YEAR
Population in Japan
Population served by Waterworks


Per capita consumption in Kanagawa Prefectural WW
Amount in L/day
500
400
300
200
100
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
domestic per capita consumption
average per capita consumption

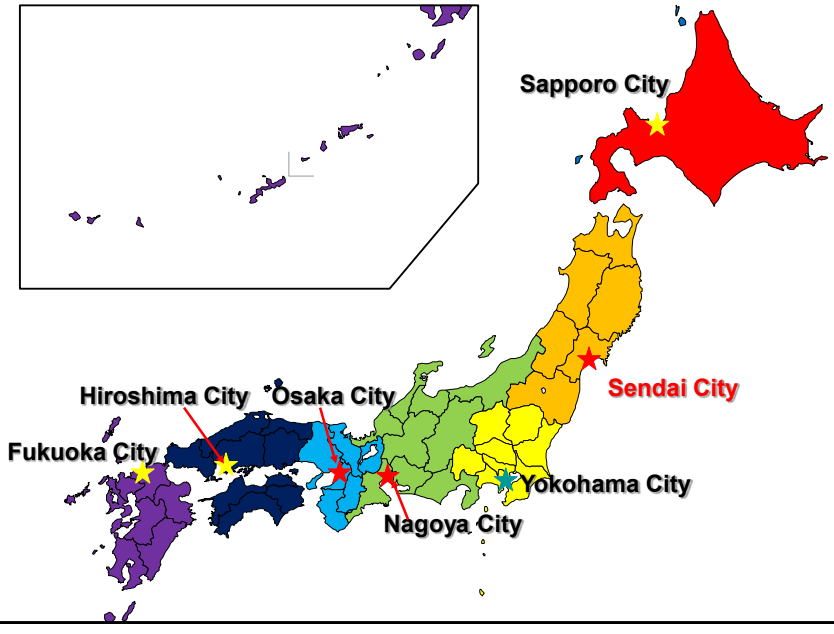

Water Sources of Water Supply in Japan
Total Annual Intake Amount in 2010
15.8 billion m3 / year
Others 3%
Deep Well 13%
River 26%
Shallow Well 7%
Subsoil Water 4%
Lake 1%
Dam 46%
River
Dam
Lake
Subsoil Water
Shallow Well
Deep Well
Others


Annual Intake Amount by Waterworks
(Unit : Billion m3 / Year)
Intake Amount
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
River
Dam
Lake
Subsoil Water
Shallow Well
Deep Well
Others

Overview of Japan Water Works Association (JWWA)



Regional Branches of JWWA



Overview of Japan Water Works Association (JWWA)

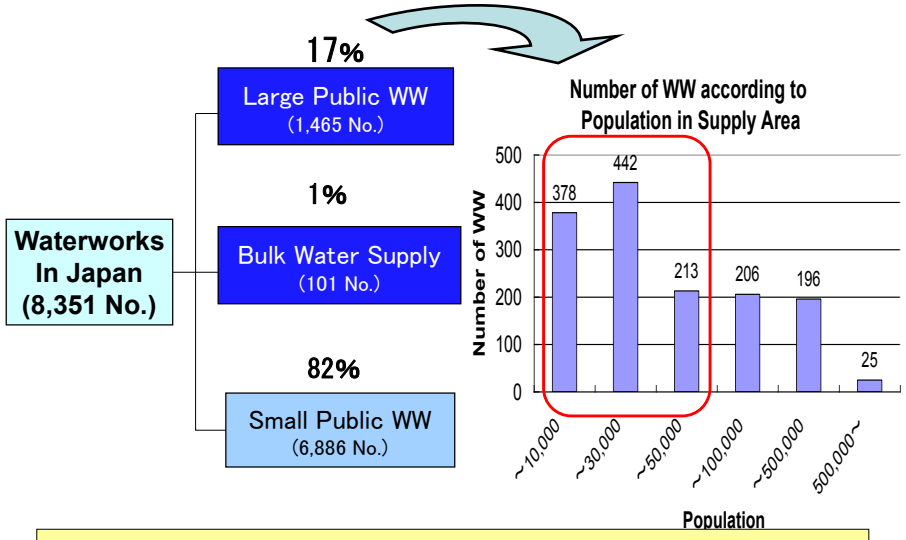
Main Activities

- Research and Study on Management & Technology
- Trainings
- International Cooperation
- Inspection & Certification
- Publication
- Annual Conferences
- Lobbying for Industry Issues
- Disaster Relief & Recovery

Current circumstances of waterworks in Japan

- Recession & Water saving appliances developed
  → decrease in water income
- Old facilities → facing the time for renewal
- The period in which many staff members retire has started since 2007
- Outsourcing of O&M of water supply facilities are increasing
- Unbalanced staff configuration (the young is few).
- Worrying about the succession of technical skills to young generation.

Number of Waterworks in Japan



Rate of small WW less than 50,000 population in supply area is 70%

Purposes of JWWA's Training service

- To develop and improve human resources of water supply utilities
- To develop private sectors' capacity → To motivate cooperation between the public and private sectors

Current JWWA's Training services

18 courses and 173 times of training services are held regularly every year.

Track record of JWWA's Training Services in 2010

Number of sessions : 196

Total number of days : 603

Number of participants : 7,441

Training courses according to rank

Title of Training course	Content	Target	Days	Times
Basic course of WS	Basic information about WS business	New clerical & technical staff	3	3
On clerical affairs for WW	Clerical affairs for WW	Management staff	4 5	2
For executive management staff of WW	Challenges for management of WS	Executive management staff	2	2
For WS engineers in each block	O&M of facilities and water quality	Engineers of WW and private Co.	2	7
For WS engineers	Overall techniques for WS	Young & middle aged engineer	9 10	1 1
For newly appointed Director Generals of WW	Acquired knowledge for Directors	Newly appointed Director Generals	3	1
For Technical Directors of WW	Technical challenges for WS	Technical Directors	2	1

Training courses according to job

Title of Training course	Content	Target	Days	Times
On clerical affairs for WW	Affairs	Management staff	3	1
Practical training seminar on consumption tax	Account of consumption tax	Management staff	2	1
Practical course; countermeasures for cases of water rate non-payment	Countermeasures for cases of water rate non-payment	Management staff	2	4
Specialized course for WS engineers	Water treatment facilities	Engineers	5	1
ditto	Mechanical and electrical installation	Engineers	5	1
ditto	Water service installation	Engineers	5	1
ditto	Water quality management	Engineers	5	1

Continued

Title of training course	Content	Target	Days	Times
Specialized course for WS engineers	Water transmission and distribution facilities	Engineers	5	1
ditto	Advanced water treatment facilities	Engineers	5	1
Practical training course on equipment and technology of water purification plant, etc.	Practice of O&M of Pumping facilities etc.	Engineers	4	7
Water leak prevention course	Techniques against leakage	Engineers	3	3
Pipe laying design	Design, drawing and cost estimate	Engineers	3	9

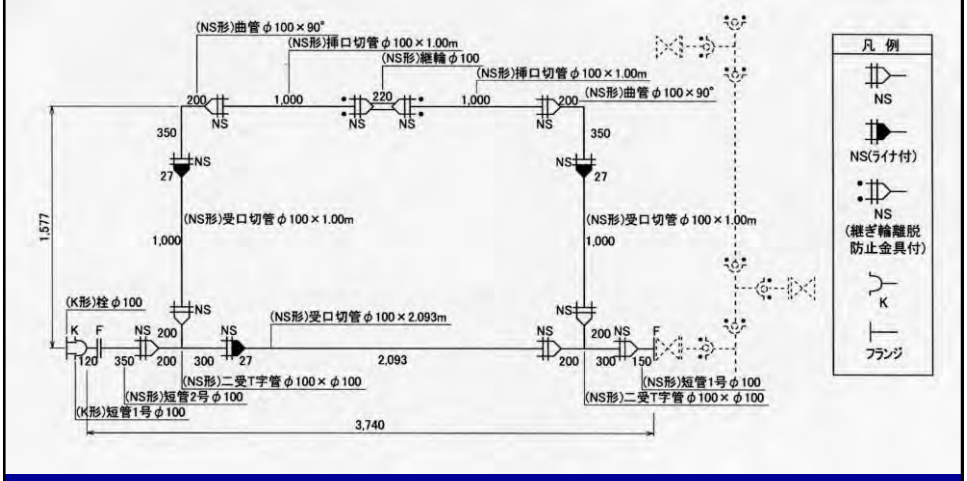
The Kawaguchi Training Center

JWWA's main training facilities constructed in 1993

Training Room at the JWWA Headquarters in Tokyo

Training Facilities for Pipeline Laying Practical Small Diameter Fitting

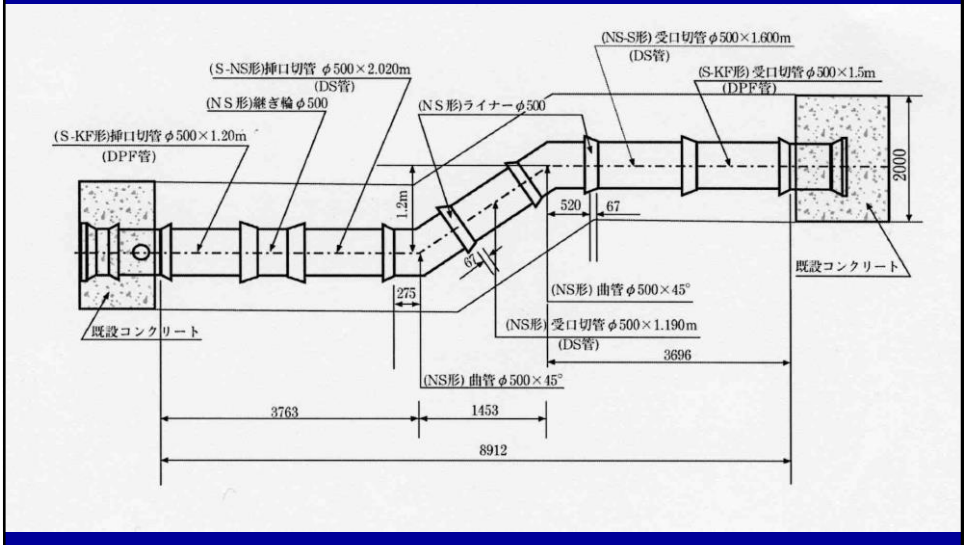
Layout for practical training on distribution pipe laying Small Diameter (φ100 mm)



Training Facilities for Pipeline Laying Practical Large Diameter Fitting

Pipe Laying Practice inside the Trench

Layout for practical training on distribution pipe laying Large Diameter (φ500mm)



Training Facilities for Pumping Equipment

Dismantling and Assembling Practice of Pump

Thank you for your attention

O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module1)

Key Issues in Water Distribution System

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

3

Outline of the Presentation

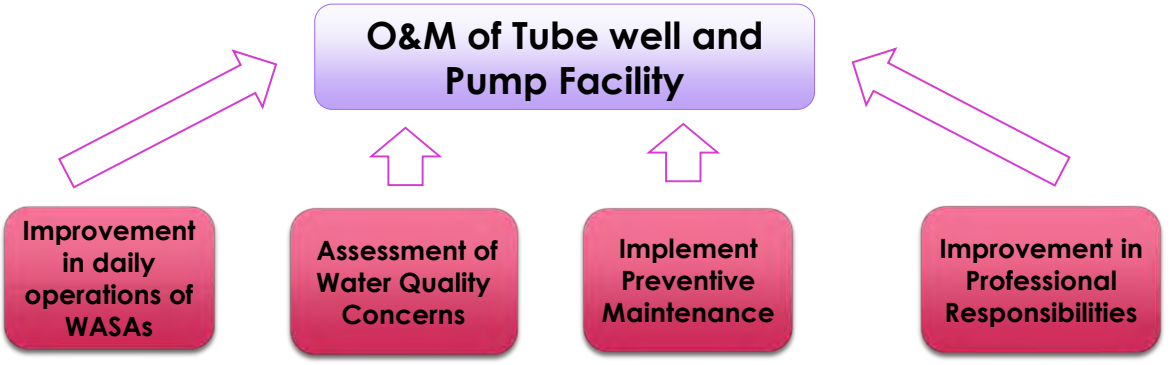
- Trainee's Expectations
- Learning Outcomes
- Existing Water Distribution System in Five WASA`s
- Key Issues in Water Distribution System

4

What are Your Training Expectations??

5

Course Outcomes



6

Existing Water Distribution System in Five WASA`s

WASA Lahore

7

- Water source Groundwater
- Direct Pumping System
- No. of Tube well 550
  (Supply hours 14-18hr/day)
- Total length of water distribution pipelines 5,444km
- No overhead reservoir in operational state except Lange Mandi OHR (capacity 1MG)

WASA Faisalabad

8

- 60% of population provided with piped water supply
- Water source Combination of ground water and surface water
- 15MGD of water being augmented in system by French Project
- Present Water Demand 145MGD
- Supplied Water to Consumers 93.5 MGD

WASA Multan

9

- 65% of population provided with piped water supply
- Water source — Ground water
- Depth of WT — 70-80ft
- No. of Tube wells — 102
- No. of Reservoirs — 18 Nos.
- Water supplied to consumers — 221MGD
- Water supply pipelines — 3" to 24"
  - Main lines — 231 km
  - Distribution lines — 1,049km
- No. of Filtration Plants (Cap. 1000 gallons/hr. Each) — 32

WASA Rawalpindi

10

- 90% of population provided with water supply facility
- Two Surface water sources with treatment plants
  - Rawal Water Treatment Plant — 23MGD
  - Sanjani Water Treatment Plant — 6MGD
- No. of Tube wells (0.25 cusecs capacity each) — 362
  (39 MGD water supplying to consumers)
- Transmission and Distribution pipelines length — 1,250km (3"to 54")

WASA Gujranwala

11

- 40% of population provided with piped water supply
- 10 reservoirs (8 operational & 2 abandoned)
- 67 Tube wells supplying 39MGD of water
- Intermittent supply 10-12 hours in a day
- Distribution length (3" to 24" inches with length of 481km

Salient Features of Water Supply System in Five WASAs (Year 2014-15)

12

Sr. No.	Water Supply Parameters	WASA Lahore	WASA Faisalabad	WASA Multan	WASA Rawalpindi	WASA Gujranwala
1	Water Source	Ground water	Combination of Ground and Surface Water	Ground water	Combination of Ground and Surface Water	Ground water
2	Total Population (Millions)	9.2	7.19	4.22	4.57	4.66
3	Population Served (Millions)	5.89	1.9	1.43	1.65	0.21
4	WASA served water supply area (km^2)	350	225	365.3	276	25.2

Salient Features of Water Supply System in Five WASAs (Year 2014-15)

13

Sr. No.	Water Supply Parameters	WASA Lahore	WASA Faisalabad	WASA Multan	WASA Rawalpindi	WASA Gujranwala
5	Number of Tube wells	528	77	102	362	67
6	Water Coverage (%)	90	60	65	90	40
7	Average amount of water supplied (MGD)	450	93.5	221	68	39
8	Average per capita water supplied GPCD	80	25	50	40	50
9	Supply Hours	14-18	6-7	6	2-4	10-12
10	NRW (% age)	38.4	32.9	22	43	39

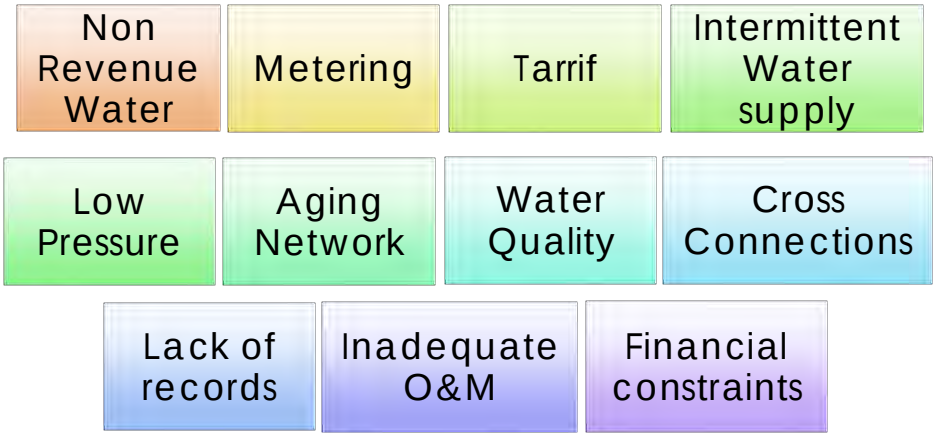
Salient Features of Water Supply System in Five WASAs (Year 2014-15)

14

Sr. No.	Water Supply Parameters	WASA Lahore	WASA Faisalabad	WASA Multan	WASA Rawalpindi	WASA Gujranwala
11	Metering Ratio (%)	5	1	-	-	-
12	Reservoirs (No. and Capacity) Million Gallons	52, 3.16	37, 2.2	18, 2.35	27, 2.77	10, 1.58
13	Total length of Distribution System (km)	5,544	1,218	1,280	1,200	481
14	Total Annual O&M Cost (Rs. Million)	7,354	1,652	1,075	700	643
15	Total water supply connections	636,338	270,451	66,900	114,655	26,091

Key Issues in Water Distribution System

15



Non Revenue Water (NRW)

16

"NRW is the difference in water put into the supply and the amount of water to be billed to consumption"

- NRW Comprises of three components:

1. Unbilled authorized consumption (Water used for Public buildings, parks etc.)
2. Physical losses (leakages from transmission and distribution pipelines)
3. Commercial losses (illegal connections, inaccuracies in meters)

Non Revenue Water (NRW)

17

- Major factors contributing towards NRW include:
  - Old aged pipe Infrastructure
  - illegal Connections
  - Inadequate metering System
  - Invisible leaks

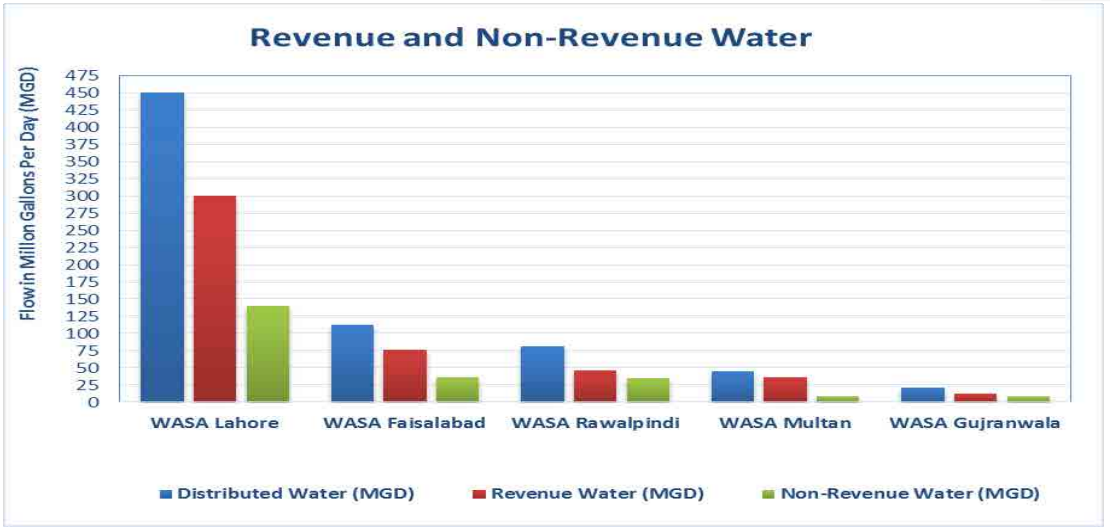
Present Status of Revenue and Non-Revenue Water across Five WASAs (Year 2014-15)

18

Sr. No.	Name of WASA	Distributed Water (MGD)	Revenue Water (MGD)	NRW Water (MGD)
1	WASA Lahore	450	300	140
2	WASA Faisalabad	112	76	36
3	WASA Rawalpindi	81	46	35
4	WASA Multan	45	36	9
5	WASA Gujranwala	21	13	8

NRW Scenario in Five WASAs

19



Metering

20

Metering Ratio in Five WASA`s

Sr. No.	Name of WASA	Metering Ratio
1	WASA Lahore	5 %
2	WASA Faisalabad	1 %
3	WASA Gujranwala	-
4	WASA Multan	-
5	WASA Rawalpindi	-

Metering

- Absence of Metering System except LHR & FSD
- Bill collection on flat rat basis
- Installation of meters at domestic & non domestic connections to ensure actual consumption used by consumers

Tariff

- Present tariff is based on plot sizes (varying from 5 Marla to more than 20 Marla)
- A gradual increase in Tariff is required to improve the financial position of five WASA`s
- The tariff increase needs to address at affordable cost to consumers

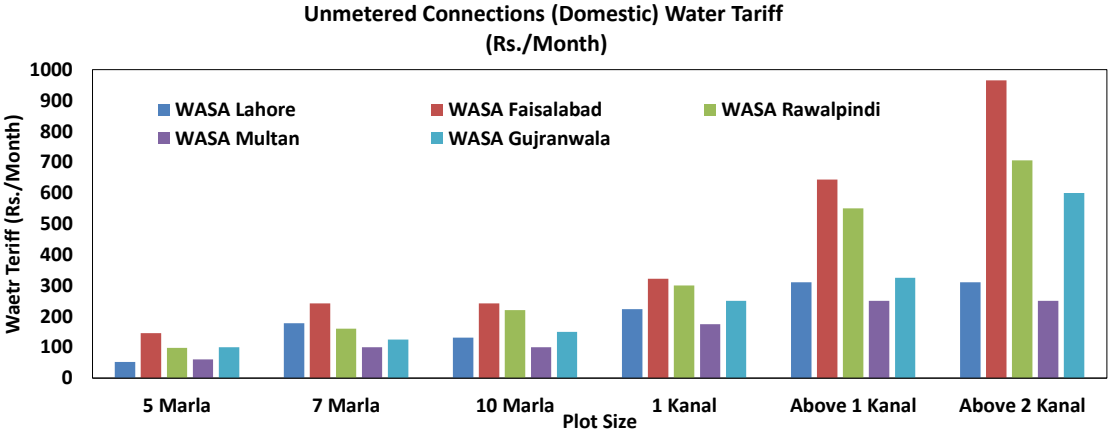
Water Supply Tariff (Rs./Month) in 5 WASAs

23

Sr. No.	Connections	Plot Size	WASA LHR	WASA FSD	WASA RWP	WASA MUL	WASA GRW
1	Unmetered Connections (Domestic)	5 Marla	52	145	98	60	100
		7 Marla	78	242	160	100	125
		10 Marla	131	242	220	100	150
		1 Kanal	223	322	300	175	250
		Above 1 Kanal	311	644	500	250	325
		Above 2 Kanal	311	966	706	250	600

Domestic Tariff on Un Metered Connections

24



Intermittent Water Supply

25

- Intermittent supply system in all WASA`s varying from 2-18 hours
- WASA Lahore 14-18 hours/ day (maximum duration)
- WASA Rawalpindi 2-4 hours / day (minimum duration)
- Supplying water on intermittent basis is major cause of negative pressure which causes contamination of water supply lines

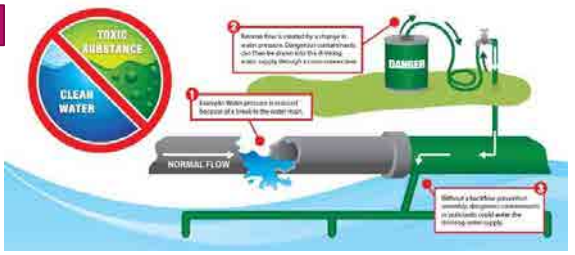
Cross Connections

26

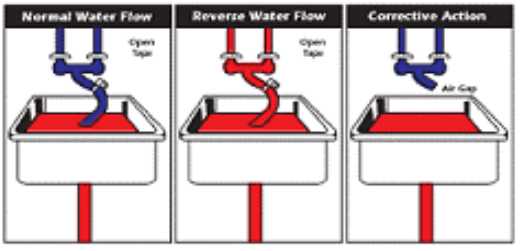
- Any connection between a potable water system and any source of contamination through which contaminated water could enter the potable water system.
- **Backflow** : the flow of any water, foreign liquids, gases, or other substances back into a potable water system.
- **Backpressure** : the foreign substance is forced into a water system under a higher pressure than the system pressure.
- **Backsiphonage** : the water system pressure is less than atmospheric , and the foreign substance is essentially sucked into the potable water system.

Example of Cross Connections

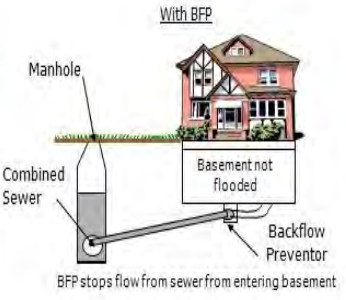
Backsiphonage



Backsiphonage



Backpressure



Low Pressure

- Low pressure frequently encountered in areas distant from Tube wells

Aging Network

29

- Water Supply Pipes used by Five WASAs include:
  - Asbestos Cement (AC)
  - Ductile Iron (DI)
  - Galvanized Iron (GI)
  - Polyvinyl Chloride (PVC)
  - High Density Polyethylene (HDPE)
  - Cast Iron (CI)
  - Mild Steel (MS)

Aging Network…Contd

30

- AC pipes are laid more than 90% in all WASA`s
- Corrosion of pipelines and leakages
- Reduction in carrying capacity and inability to sustain high pressures
- Low pressure at user end due to leakages

Aging Network…Contd

Sr. No.	Pipe Material	Age
1	Ductile Iron (DI)	70 Years
2	Mild Steel (MS)	60 Years
3	Cast Iron (CI)	50 Years
4	Galvanized Iron (GI)	50 Years
5	Poly Vinyl Chloride (PVC)	40 Years
6	Asbestos Cement Pipes	40 Years

Water Quality

- Water quality is main issue confronting all WASA`s
- Sources of water in Multan Gujranwala and Rawalpindi are low in viruses and bacteria
- High levels of arsenic present in water sources of WASA Lahore and Faisalabad
- Water of Faisalabad not fit for drinking due to presence of salts in water

Water Born Diseases in Children

Water Quality Analysis Results of Five WASAs (Year 2016-17)

33

Sr. No.	Water Quality Parameter	WHO Permissible Guideline Value	Water Quality Analysis Results				
			WASA LHR	WASA FSD	WASA GRW	WASA RWP	WASA MUL
1	Appearance	Clear	Clear	Clear	Clear	Clear	Clear
2	Temperature	-	-	-	25 °C	18	NA
3	Turbidity	5 NTU	0.76	0	0.51	2.5	Unobjectionable

Water Quality Analysis Results of Five WASAs (Year 2016-17)

34

Sr. No.	Water Quality Parameter	WHO Permissible Guideline Value	Water Quality Analysis Results				
			LHR	FSD	GRW	RWP	MUL
4	pH	6.5-8.5	8.1	7.55	7.1	7.15	6.52
5	Alkalinity (mg/l)	500	160		50	200	110
6	Hardness asCaCO3 (mg/l)	500	136	182	50	175	140

Water Quality Analysis Results of Five WASAs (Year 2016-17)

35

Sr. No.	Water Quality Parameter	WHO Permissible Guideline Value	Water Quality Analysis Results				
			LHR	FSD	GRW	RWP	MUL
7	Electrical Conductivity (uS/cm)	2000	453	432	204	865	710
8	Calcium (mg/l)	200	37.6	32	32	61	45
9	Total Dissolved Solids (TDS) (mg/l)	1000	285.3	250	143	604	345

Water Quality Analysis Results of Five WASAs (Year 2016-17)

36

Sr. No	Water Quality Parameter	WHO Permissible Guideline Value	Water Quality Analysis Results				
			LHR	FSD	GRW	RWP	MUL
10	Chlorides (mg/l)	200	37	10	52	10	130
11	Fluoride (mg/l)	< 1.5	NA	NA	0.06	NA	NA
12	Arsenic (mg/l)	0.05	49.2	6.34	0.01	-	Nil
13	Fecal Coliform	Nil/100 ml	Nil	Nil	Nil	Nil	Nil

Lack of Records

37

- Almost all WASA`s field offices lack in record keeping related to operational and maintenance data , Updation of Distribution Maps
- Good record keeping is vital to operate the system efficiently

Inadequate Operation and Maintenance

38

- Adequate O&M is necessary to run the system efficiently
- Need of Routine as well as Preventive maintenance are tools for successful O&M
- Training of WASA staff
- Need of best O&M practices

Financial Constraints

- Financial Constraints being faced by all WASA`s
  - Expenditures are more than the collected revenue per annum
  - More spendings on power cost (about 70% in all WASAs) due to pumping of water through tube wells
  - Increase in tariff is required as per actual consumption, however, on an affordability cost of consumers

Contact

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Water Specialist

O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

Components of Water Supply System

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Components of Water Distribution System

Introduction

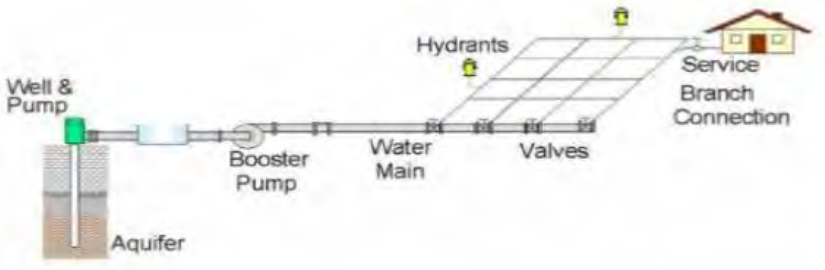
"Water supply system is used to supply water from source to the consumers through different components."

Purpose

- To deliver water to consumer with adequate quantity and quality

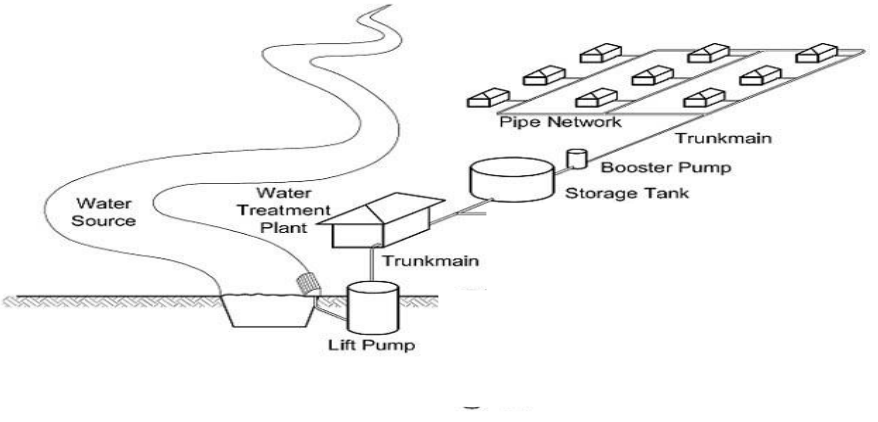
Introduction…contd.

Water Supply System Using a Ground Water Source (Direct Pumping)



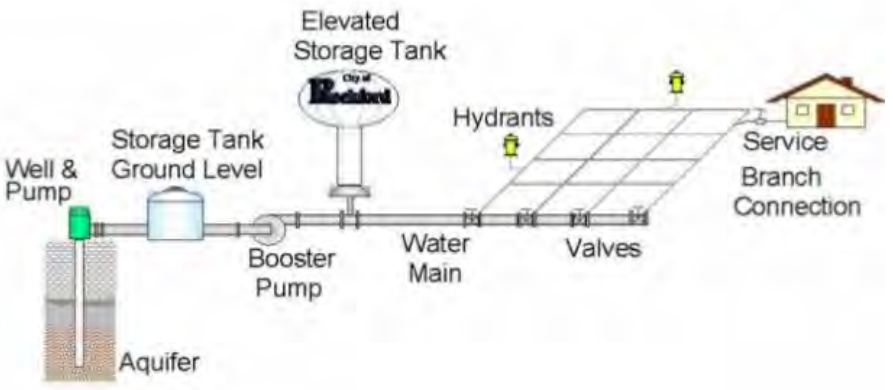
Introduction…contd.

Water Supply System Using a Surface Water Source

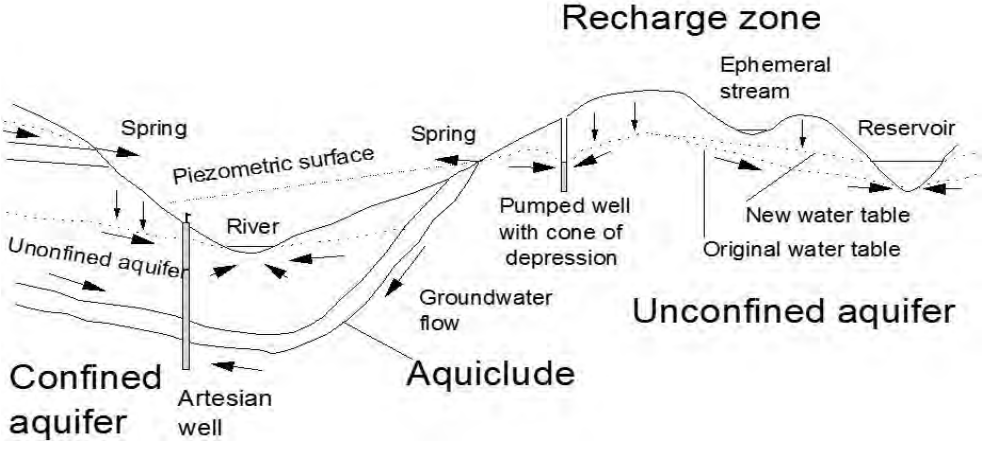


Introduction…contd.

Water Supply System Using a Ground Water Source and Over Head Reservoir



Groundwater Movement



Components of Water Supply System

Major components of Water Supply System are as under:

- Water Source (River/ Tube wells)
- Intake Facilities
- Water Purification Plant
- Water Supply Pipelines
- Control Valves (Gate/Sluice valves, Air valves, Drain valves etc)
- Over Head Reservoirs
- Fire Hydrants

Water Sources

Surface Water

- Streams
- Lakes
- Rivers
- Impoundments

Ground Water

- Tube wells

Tube Well

A water well used to draw groundwater to supply onward to consumers

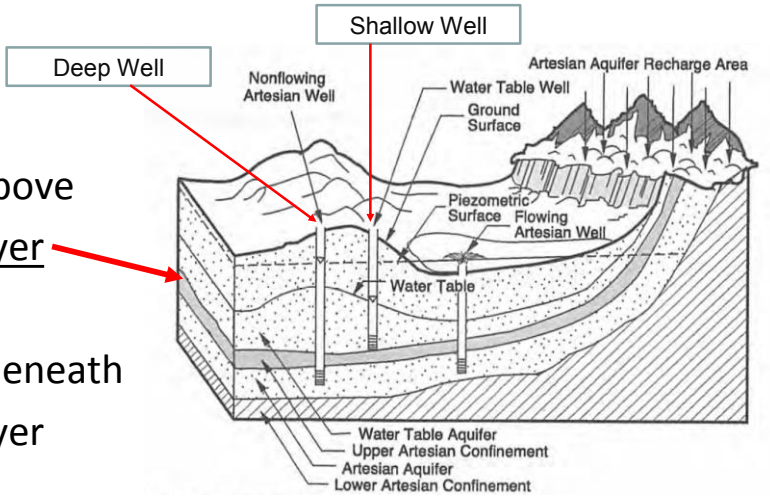
Types of Well

- **Shallow Well**

  Pumping up water above the Impermeable Layer

- **Deep Well**

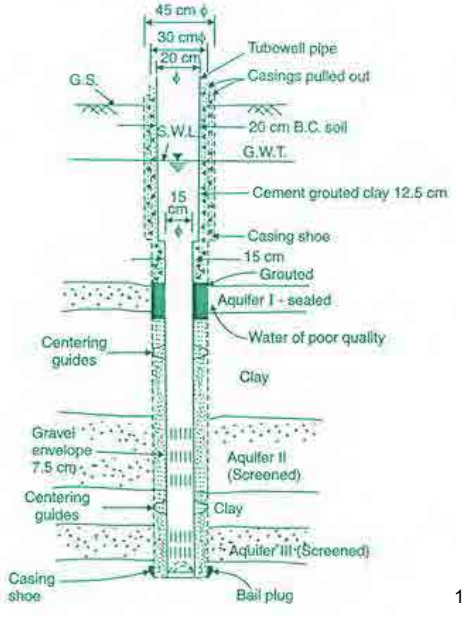
  Pumping up water Beneath the Impermeable Layer



Tube Well….Contd.

Components of Tube well include:

- Housing Pipe/Casing Pipe
- Strainer/Screen Pipe
- Blind Pipe
- Bail Plug
- Vertical Turbine Pump



Tube Well….Contd.

Housing Pipe

Housing Pipe is used to maintain an open access in the earth and to prevent any entrance of surrounding formations

Strainer/Screen Pipe

Strainer is used to keep sand and gravel out of well while allowing groundwater and water from formations to enter into the well

Strainer / Screen Pipe

Tube Well….Contd.

Blind Pipe

Blind pipe is a Plain pipe with no slots which is fixed against an impervious strata

Bail Plug

Bail Plug is provided at the bottom of pipe and strainer assembly

Tube Well….Contd.

Gravel Pack

Gravel is placed around the outside of the screen to prevent sand from entering into the well and to stabilize the well assembly

Vertical Turbine Pump

Vertical turbine pump comprises a shaft rotated by a motor on the surface. The shaft turns the impellers within the pump housing while the water moves up the column

Water Supply Pipelines

Transmission mains

- convey water from the source after treatment to the storage reservoir for onward transmission to distribution system
- larger in diameters

Distribution mains

- deliver water to individual consumer service lines and provide water for fire protection through fire hydrants, if applicable

Water Supply Pipelines

- Pipes used in Water Supply
  - Asbestos Cement (AC)
  - Ductile Iron (DI)
  - Cast Iron (CI)
  - Galvanized Iron (GI)
  - Polyvinyl Chloride (PVC)
  - Unplasticized Poly Vinyl Chloride (UPVC)
  - High Density Poly Ethylene (HDPE)

Water Supply Pipelines

- Selection Criteria
  Soil type , Roughness coefficient, Ability to resist corrosion, Installation & maintenance cost, Ability to withstand desired pressure etc.)

- Pipe Maintenance (repairing leaks and breaks, flushing, disinfecting and relining)

Valves

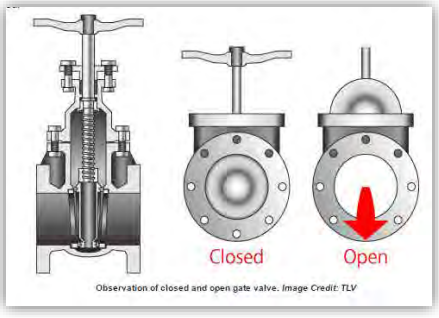
Valves are used to:

- ✓ To shut off or turn on water supply
- ✓ To regulate the flow & pressure
- ✓ To prevent backflow
- ✓ To provide air relief
- ✓ To drain out the sediments accumulated from mains

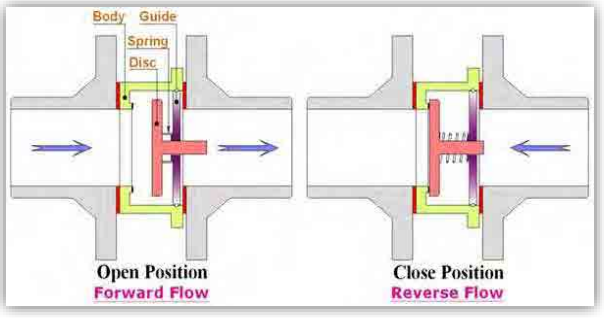
Valves

- Type of Valves (Gate/sluice Valves, Air relief valves, butterfly Valves, shut off valves , altitude valves, Non Return Valve etc.)
- Valve Maintenance (Inspecting valves stem and nut, checking valve condition)

Valves

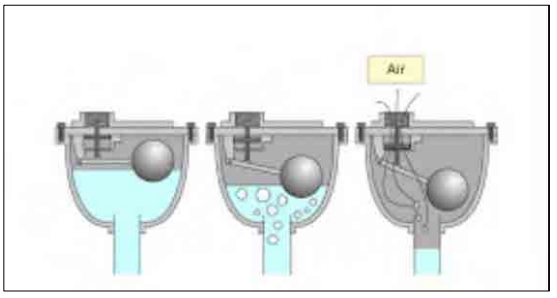


Gate Valve

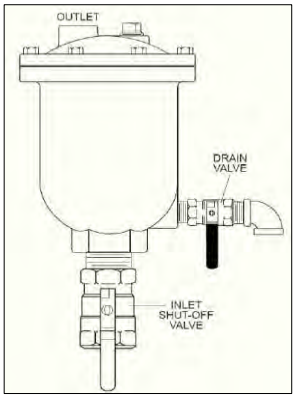


Non Return Valve

Valves



Air Release Valve



Drain/ Scour Valve

Fire Hydrants

Fire Hydrants are used for fire fighting purpose and are provided on distribution main or sub main to tap water for its use during fire

Types Of Fire Hydrants

- Post Type Fire Hydrants
- Flush Fire Hydrants

Overhead Reservoirs

Overhead reservoirs are used for the following purposes:

- To balance supply and demand
- To supply water during emergencies (such as during fires)
- to help in absorbing the hourly fluctuations in the normal water demand

Overhead Reservoirs

Components of Overhead Reservoirs include:

- Inlet pipe (for entry of water in the reservoir)
- Outlet pipe (connected to the distribution mains)
- Overflow Pipes (discharging extra water into drain gutters)
- Air Vents (for fresh air circulation)
- Manholes (for providing entry into the overhead tank for inspection purposes)
- Ladder (to reach bottom of the reservoir)

Contact

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Arrangement of Water Distribution System

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March 2017

Outline of the Presentation

- Types of Water Supply Facilities Arrangement
- Surface Water Treatment Alternative
- Types of Distribution Networks
- Valves and Fire hydrants
- Water Pressure Requirement

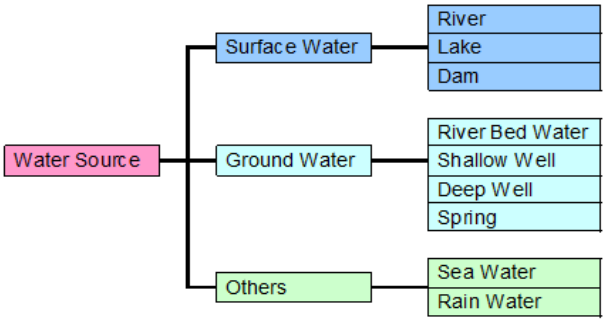
Types of Water Supply Facilities Arrangement

Planning and Design of a water supply system depends on the following:

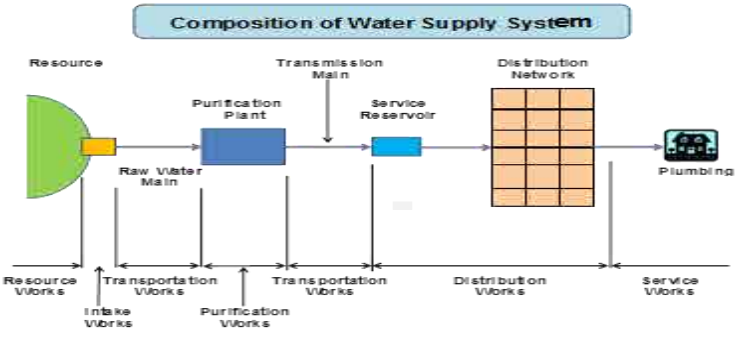
- Source of water
- Transmission of water to overhead Reservoir
- Distribution through distribution pipelines

Types of Water Supply Facilities Arrangement ….Contd.

- Detail of sources of water are as under:

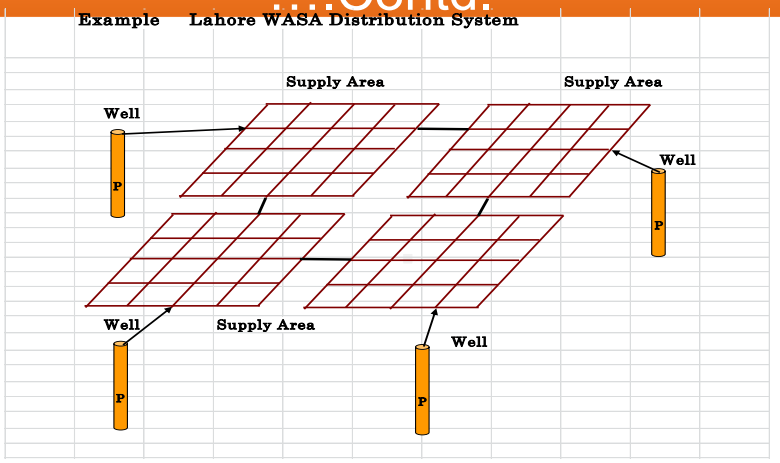


Types of Water Supply Facilities Arrangement ….Contd.



(Layout of Water Distribution System based on Surface Water Source)

Types of Water Supply Facilities Arrangement ….Contd.



(Layout of Water Distribution System based on Groundwater)

Surface Water Treatment Alternative

- Decline of Ground Water on increased levels across all Five WASAs to meet future demand of population
- More water quality concerns in Five WASAs leading to surface water treatment alternative
- Improvement in service delivery by utility service providers

Types of Distribution Network

"Networks are a system of pipes and valves providing the appropriate quality and quantity of water to a community."

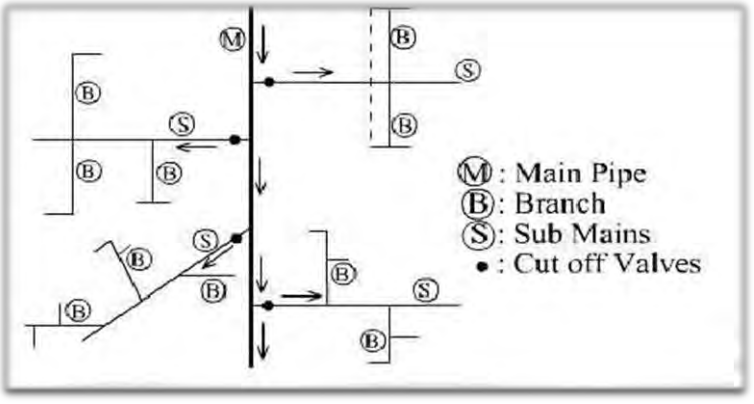
Three ways in which distribution systems are laid include:

- Dead End or Tree System
- Grid System
- Radial System

Selection Criteria for a Distribution Network

- Water quality should be maintained throughout the network
- System capability to supply water to all intended places with sufficient pressure head
- No consumer should be without water supply, during the repair of any section of the system
- Watertight to keep losses to a minimum (e.g. due to leakages)

Dead End or Tree System



one main pipeline runs through the center of the populated area and sub-mains branch off from both sides

Dead End or Tree System

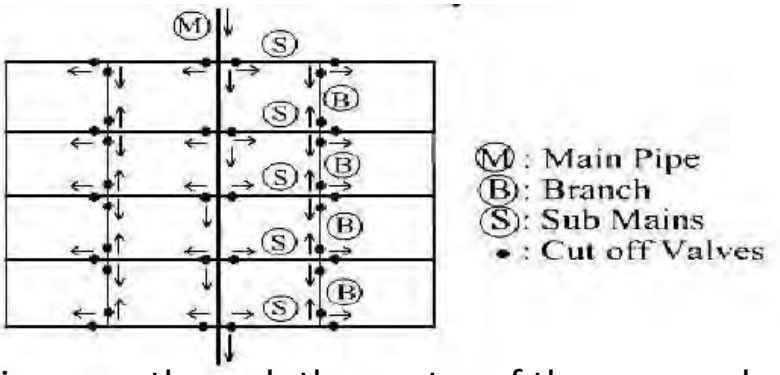
Advantages:

- ✓ Simple pipe laying
- ✓ Less cut off valves are required
- ✓ Low O&M cost

Disadvantages:

- ✓ Low pressure in remote points
- ✓ Interruption of supply in case of main failure
- ✓ Sedimentation and bacterial growth at dead ends
- ✓ Scour valves required at dead ends

Grid Iron System



Main supply line runs through the center of the area and sub mains branch off in perpendicular directions

All of the pipes are interconnected and there are no dead ends

Grid Iron System

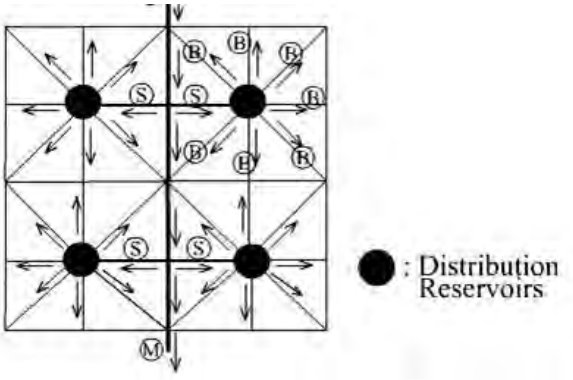
Advantages:

- ✓ Minimal chance of stagnation
- ✓ No sedimentation
- ✓ Repairs require small area to be interrupted

Disadvantages:

- ✓ Greater cost of pipe laying
- ✓ Large number of cutoff valves required
- ✓ Longer pipe lengths with larger diameter

Radial System



Area is divided into distribution districts

Each District has a centrally located distribution *reservoir* (elevated)

Valves and Hydrants

- Provision of shut off valves at frequent intervals in water distribution system
- Provision of Fire Hydrant at frequent intervals to meet emergencies due to fire

Water Pressure Requirement

- Minimum Residual Pressure required in Water Distribution System 14m
- Development of pressure zones in areas with varying elevations

Contact

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O&M of Water Distribution System (Module 1)

Pipe Materials

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March 2017

2

Outline of the Presentation

- Selection Criteria for Pipes
- Types of Pipes used in Water Supply System
- Factors affecting installation cost

Selection Criteria for Pipes

1. Corrosion Resistance
   - External & internal Corrosion
2. Roughness Coefficient
   - Smoothness of internal pipe surface
3. Soil Condition
   - Loss of support (bedding)
4. Overall Cost
   - Capital Cost
   - O&M cost

Types of Pipes Used in Water Supply

- Cast Iron (CI) Pipes
- Ductile Iron (DI)Pipes
- Asbestos Cement (AC) Pipes
- Steel Pipes
- Galvanized Iron (GI) Pipes
- Reinforced Cement Concrete (RCC) Pipes
- PVC (Polyvinyl Chloride) Pipes
- UPVC (Unplasticized Polyvinyl Chloride) Pipes
- HDPE (High Density Polyethylene) Pipes

Cast Iron Pipes

Advantages

- Withstand high pressures
- Inexpensive
- Durable
- Leak detection straightforward
- Easy to install

Disadvantages

- Heavy & brittle
- Difficult to transport
- Corrodes in soft water
- Metallic taste due to iron leaching

Ductile Iron Pipes

Advantages

- High strength for supporting earth loads
- Lighter than Cast iron
- Less Brittle than CI
- Easy jointing

Disadvantages

- May require wrapping or cathodic protection in corrosive soils or water
- Thrust blocks needed

Asbestos Cement Pipes

Advantages

- Rigid
- High tensile strength
- Easily tapped, cut
- Low friction to water flow
- Corrosion resistant to most soils and water

Disadvantages

- Can release asbestos fibers under corrosive conditions
- Easy breakage when bent
- Difficult to locate

Steel Pipes

Advantages
- High strength for supporting earth loads
- High in cost
- Easy handling & transport

Disadvantages
- Poor corrosion resistance

Galvanized Iron Pipes

Advantages
- Low initial cost
- Toughness
- Long life
- Easy inspection
- Fast assembly

Disadvantages
- Contain lead and Corrode easily
- Deposits buildup causing blockages

Reinforced Concrete Pipes

Advantages
- Durable
- Easy installation

Disadvantages
- Gravity flow pipe

Polyvinyl Chloride (PVC) Pipes

Advantages
- Inert and Resists corrosion
- Doesn't support combustion
- Cheap
- Easy to install
- Smooth interior surface
- Very low frictional losses

Disadvantages
- Very brittle (break or crack easily)
- Less flame resistant
- At higher temperature their strength reduces

Unplasticized Polyvinyl Chloride (UPVC) Pipes

Advantages

- Good corrosion resistance
- Light weight
- Ease of jointing
- Low cost
- Smooth internal surface

Disadvantages

- Susceptible to impact damage
- Degradation by certain organic compounds
- Susceptible to poor installation practice

HDPE Pipes

Advantages

- Flexible
- Easily transported because can be rolled
- Used in trenchless installations
- Lightweight
- Resistant to cracking

Disadvantages

- Difficult to locate
- Fusion jointing require skilled installer & special equipment
- Not suitable for large diameters

Factors Affecting Installation Costs

- ✓ Weight of the pipe:
  A pipe that is lightweight can be handled easier and faster
- ✓ Ease of assembling:
  Push-on joints can be assembled much faster than bolted joints
- ✓ Pipe strength:
  If one type of pipe requires special bedding to withstand external pressures while another pipe does not, the choice can impact installation costs significantly

Contact

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O&M of Water Distribution System (Module 1)

Valves in Water Supply System

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Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Valves in Water Supply System
- Types of Valves
- Maintenance of Valves

Valves in Water Supply System

Valves are used to:

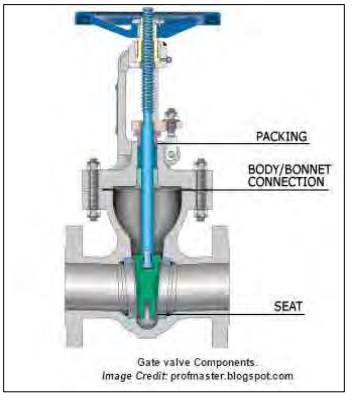
✓ To isolate flow
✓ To regulate the flow & pressure
✓ To prevent backflow
✓ To drain out the sediments accumulated from mains

Types of Valves

- Gate Valve/Butterfly Valve
- Air Release Valves
- Drain Valve/ Wash Outs
- Altitude Valves
- Pressure Relief Valves
- Check Valves/ Non return valve

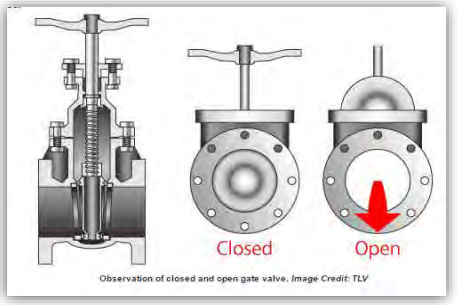
Gate Valve /Butterfly Valve

- Gate valves are used to isolate sections of the distribution system to permit emergency repairs without interrupting service to large numbers of customers
- Components of gate valves include:
  - Body
  - Bonnet
  - Trim



Gate valve Components.
Image Credit: profmaster.blogspot.com

Gate Valve/Butterfly Valve



Observation of closed and open gate valve. *Image Credit: TLV*

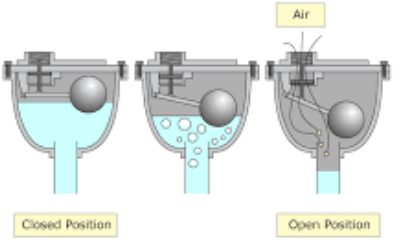
- A sliding flat metal disc is moved at right angles to the direction of flow by a screw operated stem
- Provides very little resistance to flow when it is opened

Butterfly Valves

- Mainly installed in lines 300mm and above in diameter
- Used for isolating the water supply lines for repair purpose

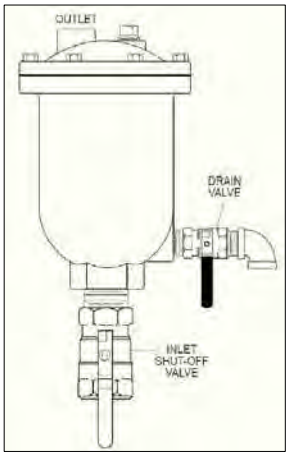
Air Release Valves

- Air valves are used to remove air accumulated in pipe
- Provided at summit points
- Float drops off and air is released



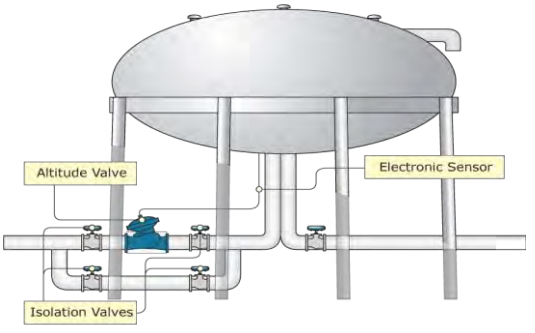
Drain Valves/ Washouts

- Allow sediment to be flushed out and to enable the pipeline to be drained for maintenance and repair work



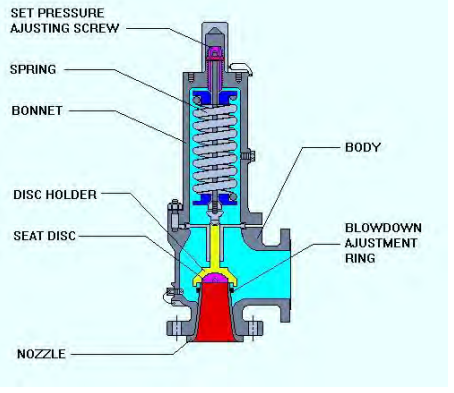
Altitude Valves

- Normally installed at rising mains
- To prevent overflow of overhead reservoirs
- closes at a preset maximum water level to prevent overflow of reservoir and opens to refill when the water level in the tank or reservoir lowers



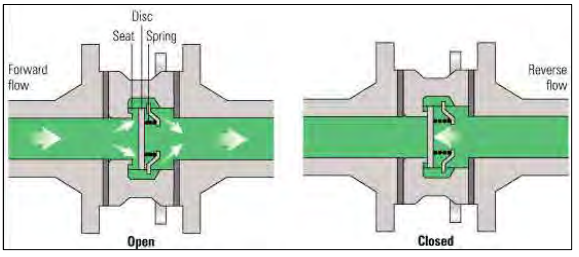
Pressure Relief Valve

- Also known as safety valves
- Used to release high pressures in system to prevent damage



Check Valve/ Non-return valve

- Used for unidirectional flow



Maintenance of Valves

Components of a Valve Maintenance Program:

- ✓ An updated system map
- ✓ Documentation for each valve
- ✓ Record of maintenance work
- ✓ Sample Valve Operation Worksheet
- ✓ A schedule for routine maintenance

Maintenance of Valves

Components of a Routine Valve Inspection:

- Verify accuracy of location of valve boxes on map
- Updation of map when necessary
- Remove valve box cover
- Inspect stem and nut for damage or obvious leakage
- Close the valve fully

Maintenance of Valves

- Record condition of valve (any maintenance required)
- Replace a valve if it does not completely open or close
- Clean the valve box cover seat
- Place the valve in its operating position (open or closed) when inspection is complete.

Valve Exercising

Valve exercising must be done for flushing dead end lines at least quarterly

Following information must be collected:

1	Unique Valve identification number
2	Visibility and proper elevation
3	Accessibility
4	Location and GPS coordinates
5	Manufacturer
6.	Size and Style of Valve
7.	Number or turns and direction for opening
8.	Check for leakage with detection equipment
9.	Condition of valve
10	Age of valve in system

Valve Operation Worksheet

Date	Valve No.	Location	Size	# of Turns	Direction of Closing	Remarks/ Maintenance/ Deficiencies

Contact

Zia Mustafa
Water Specialist

Assignment 1

Critical Report on Major Issues of Five WASA`s

Guidelines for Preparing Assignment

- List down main issues faced by the water utility (Respective WASA).
- Prioritize the issues
- What are the factors that are contributing towards these issues
- How to rectify or improve the current WASA`s Situation in your opinion

O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

Operational Action Plan for Water Supply System

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Operation of Water Supply System
- Why Operational Action Plan Needed?
- Features of Water Supply Operational Action Plan
- Operational Action Plan for Water Supply System

Operation of Water Supply System

Operation of Water Supply System refers to daily operations of various components of Water Supply System such as Pipelines, Valves, Overhead Reservoirs, Fire Hydrants, Equipment etc. to deliver reliable and safe Supply of Water to Consumers with adequate Pressure

Why Operational Action Plan Needed?

- To deliver adequate Supply of Water to Consumers without interruption
- To ensure Safe Water requirement without any contamination to Consumers
- To know about System Component Failure (Pumps, Chlorinators, Valves, Meters etc.)
- To find causes of main breaks in Water Distribution System

Features of a Water Supply Operational Plan

Generally, Water Supply Operational Action Plan Comprises of the following:

- Prevailing operational issues in the system
- Possible causes
- Control measures in the form of Checklists
- Key Responsibilities

Operational Action Plan for Water Supply System

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
1	Non availability of updated Water Supply Maps	• Lack of GIS Mapping	• Update water supply Maps with - Clear description of pipe diameter - Location of valves • Ensure availability of updated Maps at respective WASA sub division offices	Sub Divisional Officer (SDO), Supervisor
2	Taste and Odor in water	• High Chlorine Residual • Presence of salts in water	• Lower Chlorine Dose • Apply routine flushing of supply lines or appropriate treatment method	Sub Divisional Officer (SDO), Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
3	Turbidity	• Due to presence of Silt or Clay in water (suspended solids)	• Apply flushing of pipelines and appropriate treatment Method	Sub Divisional Officer (SDO), Supervisor
4	Presence of Coliforms or Bacteria	• Water contaminated due to inadequate chlorine • Ingress of contamination transmitted from sewer line in vicinity of water supply line due to cross connections	• Increase chlorine dose as per requirement of WHO Guidelines	Sub Divisional Officer (SDO), Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
5	Loss of Residual Chlorine	• Inadequate quantity of Chlorine Solution (Sodium Hypochlorite) injected • Some operational problems linked with chlorine feed pump to supply chlorine in main line at tube well	• Inspect Chlorine solution tanks on regular basis at tube well • Check condition of chlorine feed pump to deliver required amount of chlorine solution tank	Supervisor and Operator
6	Cross Connection	• Ingress of contamination from sewer line to water supply lines due to cracks in pipelines during periods of no supply	• Proper horizontal and Vertical Clearance between water supply and sewer/drain pipe need to be provided	Sub Divisional Officer (SDO), Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
7	Pipeline Leakages	• Corrosion, old aged pipes • Absence of leak detection equipment for buried pipe line leakages	• Repair Pipelines leakages • Ensure Gradual replacement of old aged pipes in the network • Conduct Water Audit on regular basis	Supervisor and Operator
8	Leakages from Valves	• Corrosion of Valves • Worn packing material • Improper closure of valves	• Ensure Periodic Inspection of valve chambers • Lubricate gland bolts • Replace cover/bonnet gasket after certain duration • Ensure periodic cleaning of Valve Chambers	Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
9	Leakages through Reservoirs	• Leakage from cracks in reservoirs • Internal corrosion of connected piping (inlet, outlet, overflow, bypass pipe) • Improper closure of valves	• Inspect the reservoir on regular intervals from inside and outside • Inspection of connecting pipes and valves on regular basis • Monitor water levels in Reservoirs on regular basis	Supervisor and Operator
10	House Connection Leakages	• Corroded and sub standard material used for plumbing • Poor plumbing practices	• Ensure Polyethylene Pipe for House Connection • Ensure provision of meters at consumer end • Ensure standard pipe material for House connection	Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
			• Replace Mild Steel Clamps in the Consumer Connections by Polyethylene or PPR saddles and use S/S bolts instead of ordinary MS bolts	
11	Water loss	• Old and deteriorating pipe network • Illegal connections	• All connections (domestic and commercial) need to be metered	SDO, Supervisor and Operator
12	Defective Meters	• Repair Problems • Rotation of meters due to pressurized air and starting of supply on intermittent basis	• Replace defective meters with new meters	SDO, Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
13	Improper Metering	• Majority connections are unmetered • Faulty Meters	• Ensure metering system at consumers end • Ensure routine repair of meters	Executive Engineer, SDO, Supervisor and Operator
14	Low Pressure	• Under Capacity pipes present in the system, distant from tube well • Corrosion of pipelines	• Control buried pipeline leakages • Replace under capacity pipes with increased sizes as per water demand of the area	SDO, Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
		• leakages in supply lines • Valve in system partially closed	• Replace gradually old aged pipes in the network • Inspect the valve chamber condition in service areas to identify leakages	
15	Lack of recording Water abstraction at source and consumption by community	• Absence or presence of faulty bulk flow meters at source (tube well) • Absence of consumer meters	• Provide Bulk Flow meters at sources for recording the flow • Ensure hundred percent consumers metering in the system	SDO, Supervisor and Operator

Operational Action Plan for Water Supply System …Contd.

Sr. No	Problem	Possible Cause	Mitigation Measure	Key Responsibility
16	Lack of Monitoring of Pressure at source and in distribution system	• Absence of pressure gauges at various tube wells • Faulty Pressure gauges	• Ensure presence of pressure gauges at all WASA tube wells • Make repair of faulty pressure gauges on priority basis	SDO, Supervisor and Operator

Contact

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O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

Maintenance Action Plan for Water Supply System

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Types of Maintenance
- Requirements for Preventive Maintenance
- Required Preventive Maintenance Activities in Five WASA`s
- Repair Action Plan For Water Supply System
- Availability of tools

Introduction

"Maintenance refers to contain all the system components (supply pipes, valves, equipment etc.) in a good optimum working order by repair and maintenance"

Types of Maintenance

- Routine Maintenance
- Preventive Maintenance

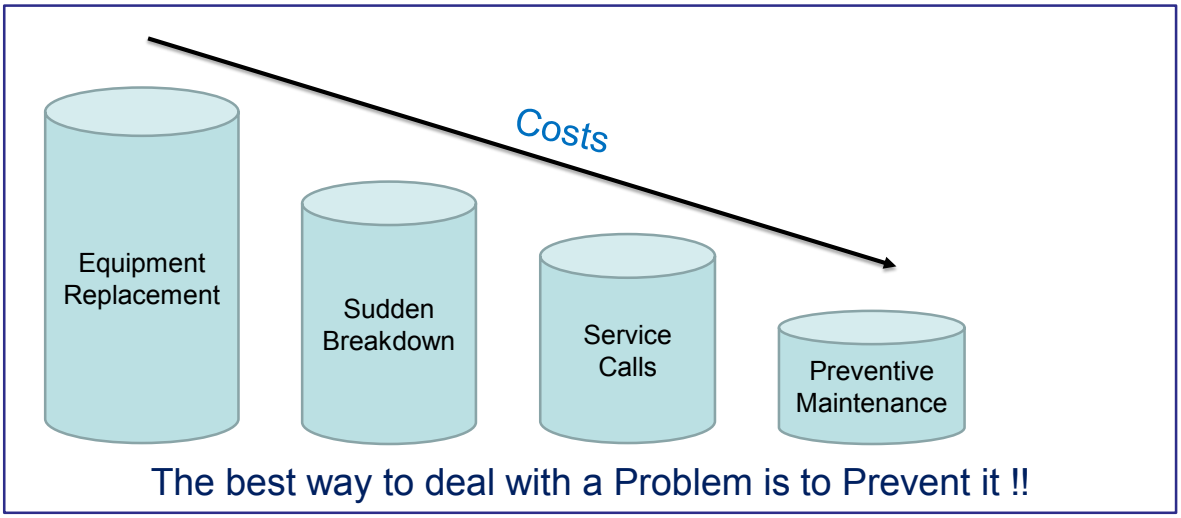
Routine Maintenance

- Routine Maintenance refers to accomplish repair and replacement of parts of the system (Pipes, Valves, Fittings etc.) when damaged or leakages becomes evident from them
- Required to run the system efficiently

Preventive Maintenance

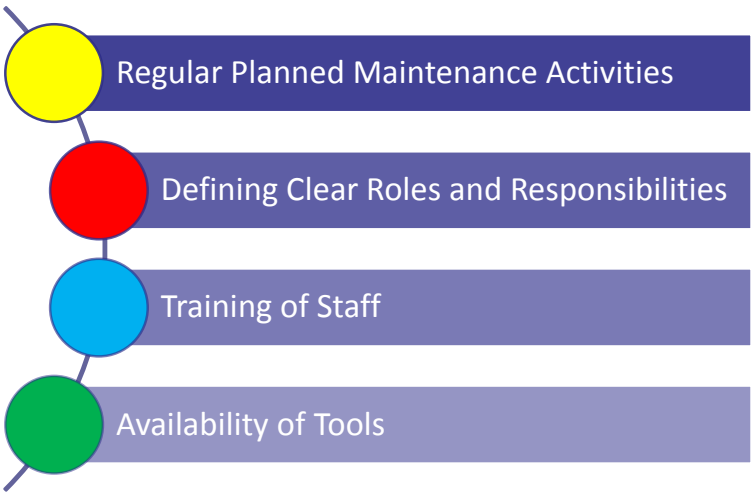
Preventive Maintenance Includes planned activities for maintenance of the system (Pumps, Valves, Flushing of Pipelines etc.) to Prevent their failure at much earlier stage of their design life

Preventive Maintenance



The best way to deal with a Problem is to Prevent it !!

Requirements of Preventive Maintenance Plan



Required Preventive Maintenance Activities in Five WASAs

Sr. No.	Activity	Frequency of Duration	Key Responsibility
1	Flushing of Pipe Lines	Fortnightly	Supervisor and Operator
2	Patrolling of Water Supply Network (To over view Leakages)	Every Month	Supervisor and Operator
3	Water Quality Analysis	Fortnightly	Laboratory Incharge and WASA Sub Division Staff
4	Checking of Pressure in Supply Lines	Daily	Supervisor and Operator
5	Inspection of Bulk Flow Meters	Every Month	Supervisor and Operator
6	Inspection of Consumer Meters	Every Month	Supervisor and Operator
7	Reservoir Cleaning	After every 6 Months	Operators
8	Inspection of Valve Chamber	Every Month	Supervisor and Operator

Repair Action Plan

Sr. No.	Problem	Possible Causes	Mitigation Measures	Key Personnel Responsibility
1	Corrosion of Pipe Line	• Due to completion of service life of pipe • Excess dosage of chlorine in pipeline adversely affecting material of pipe	• Ensure replacement of corroded pipe portion with new pipe • Painting of pipelines if present on ground (especially walled city) • Ensure chlorine dosage as per requirement	Supervisor and Operator

Repair Action Plan

Sr. No.	Problem	Possible Causes	Mitigation Measures	Key Personnel Responsibility
2	Leakages through Pipelines	• External or Internal Pipe Metal Loss due to developed cracks • Faulty and corroded Joints • Aging Pipe Network	• Ensure Replacement of damaged pipe portion with new one • Undertake Regular maintenance audit in service areas	Supervisor and Operator

Repair Action Plan

Sr. No.	Problem	Possible Causes	Mitigation Measures	Key Personnel Responsibility
3	Leakages of Valves (at seat, at cover/ bonnet, at gland packing)	• Corrosion of seat • Settling of Gasket as a result of temperature variations • Worn packing material • Poor maintenance	• Ensure reseating of valve disc • Retighten the bolts at bonnet • Retight the gland packing at nuts • Check opening and closing of valve • Ensure periodic inspection of valve chambers	Supervisor and Operator

Repair Action Plan

Sr. No.	Problem	Possible Causes	Mitigation Measures	Key Personnel Responsibility
4	Valves hard to operate	• Damaged Seat • Valve not fully lubricated	• Provide valves with proper lubrication	Supervisor and Operator
5	Ineffective inventory control system for spare parts and supplies	• Poor Inventory System, based on recording listing of spare parts in registers	• Ensure computerized system at stock yards • Provide adequate inventory of maintenance items	Supervisor and Operator

Availability of Tools

A list of spares required for maintenance shall be prepared and the spares shall be procured and kept for use.

- ✓ Spare check nuts and spindle rods and assorted bolt
- ✓ Nuts and washers for the flanged joints
- ✓ Gaskets for flanged joints for all sizes of sluice valves installed in the transmission system
- ✓ Spare manhole covers
- ✓ Consumables like the gland rope, grease, cotton waste

Contact

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O&M of Water Distribution System (Module 1)

Updation of Water Supply Maps

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Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Importance of Mapping
- Features of updated Water Supply Map
- Example of updated Map
- Procedure for Preparation and Updating of Maps

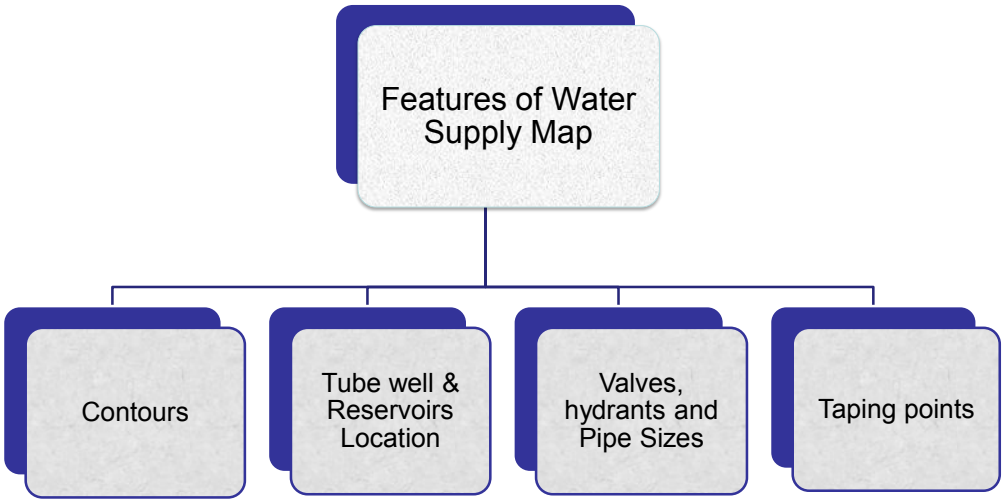
Introduction

- Updated Distribution Maps is pivotal factor for improved operations of utility service providers
- Required to contain updated water distribution system information

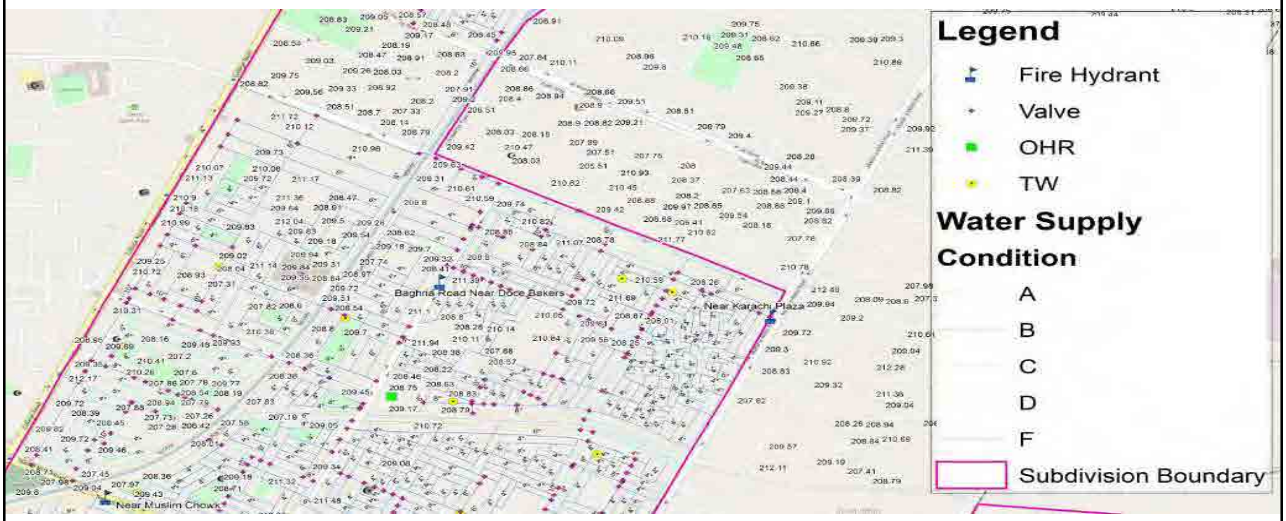
Importance of Mapping

- ✓ Provides a comprehensive knowledge about water distribution network
- ✓ To identify location of buried mains for repair purposes (pipe leakages, bursts)
- ✓ To locate position of valves and hydrants
- ✓ Existing maps can be used to identify areas where future installation can be made

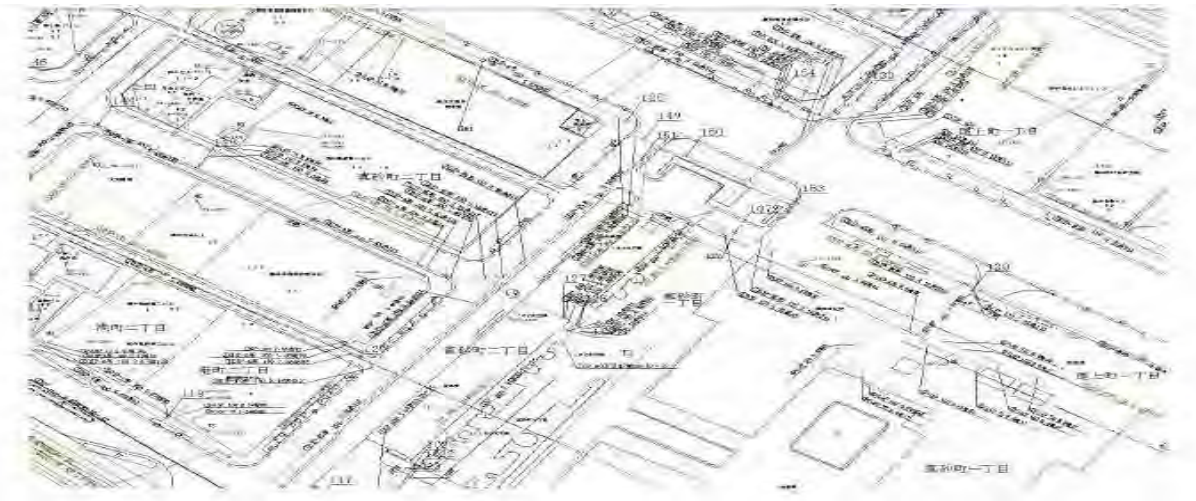
Features of Updated Water Supply Map



Example of Updated Map



Example of Updated Map



Procedure for Preparation and Updation of Maps

GIS Maps

Geographic Information System (GIS) is a computer program that combines mapping with detailed information on physical structures with geographic area

Procedure for Preparation and Updation of Maps

GIS Mapping	Compatible with AutoCAD Design Systems
	Layers of information on a single map such as water Lines, Sewers, power Cables etc.
	Number of valve chambers/manholes, pipe lengths , diameters, reservoir locations, pumping stations are indicated in the form of attributes
	Helps the maintenance crew to locate place of work

Contact

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O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

Overhead Reservoirs

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Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Present Situation of Five WASA`s in Context of Overhead Reservoir
- Shapes of Overhead Reservoirs
- Components of Overhead Reservoir
- Maintenance of Overhead Reservoir
- O&M Plan of Overhead Reservoir

Introduction

Purpose of Overhead Reservoir:

- To equalize the demand during peak hours
- To equalize operating pressure
- To provide storage for emergencies (In case of source failure)
- Maintain desired pressure

Introduction

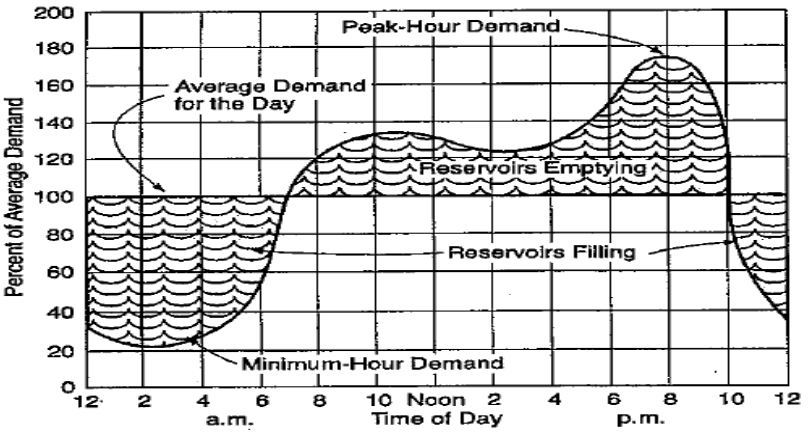
Equalizing Supply and Demand

- Designed for 4-6 hour supply at average demand
- During periods of low demand, OHR are refilled

Advantages of Overhead Reservoirs

- Absorb the hourly variations in demand
- Maintain constant pressure in the distribution mains
- Water stored can be supplied during emergencies
- To facilitate carrying out repairs without interruption to the supply of water

Demand Fluctuation in a Day

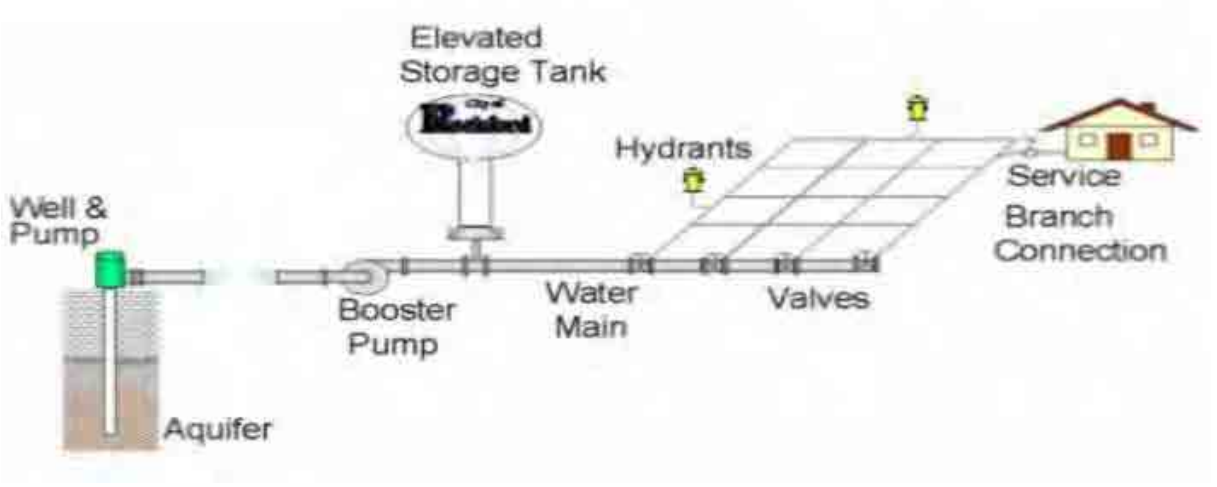


(Function of distribution reservoirs with respect to demand fluctuations)

Present Situation of Five WASA`s in Context of Overhead Reservoir

Sr. No	Water Supply Parameter	WASA LHR	WASA FSD	WASA MUL	WASA RWP	WASA GRW
1	Total Reservoirs	52	37	18	27	10
2	Total Capacity MG	3.16	2.2	2.35	2.77	1.58
3	In Use	1	17	-	25	8
4	Abandoned	51	20	-	2	2

Overhead Reservoir and Gravity Storage System



Shapes of Overhead Reservoirs

Intze Type

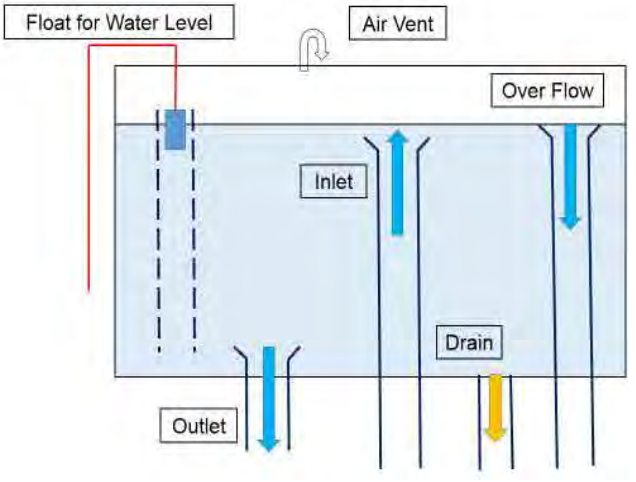
Circular Type

Rectangular Type

Spherical Type

Components of Overhead Reservoir

- Inlet pipe
- Outlet pipe
- Overflow Pipes
- Float for Water Level
- Air Vents
- Manhole for entry
- Ladder
- Valves



Components of Overhead Reservoir

Ladder or Stairs

Inlet Pipe

Bottom of Reservoir

Float Gauge for water level

Maintenance of Overhead Reservoirs

Following are the main maintenance activities:

- Repairing of cracks & leaks
- Proper Screening of air vents & overflow pipes
- Inspection of manhole covers
- Cleaning & inspection of internal structure
- Preventing littoral growth
- Painting of internal surface
- Replacing corroded pipes
- Inspection of valves

Cleaning of Overhead Reservoirs

- Empty the Tank
- Clean the tank with Detergent using steel wire brush
- Fill the Reservoir with water and drain the water
- Fill again the Reservoir for supplying water to consumers
- Add chlorine doze as per requirement in the Reservoir
- Reservoir Cleaning After every 6 Month

Maintenance of Reservoirs

Safety Precautions while cleaning of OHR

- Use of PPE (Gum boots, Hand Gloves, Respirators)
- Proper ventilation by opening air vents
- Guard rails provided at the top roof and around ladder
- Trained personnel

O&M Plan of Overhead Reservoir

Sr. No.	Problem	Cause	Control Measure
1	Structural failure	• Poor engineering design • Poor maintenance • Use of poor quality material	• Improved engineering design • Apply preventive maintenance measures
2	Leakages	• Structural Cracks in reservoir	• Monitoring of Water Level and pressure of water in storage reservoir • Relining • Inspection of Pressure gauges, flow meters and flow level indicator

O&M Plan of Overhead Reservoir…Contd.

Sr. No	Problem	Cause	Control Measure
		• Poor lining material used for water proofing	• Storage tank internal cleaning and lining
		• Aging of piping material	• Replacing older pipe materials
		• Internal corrosion of connected piping (inlet, outlet, overflow, bypass pipe)	• Replacing older pipe materials
		• Improper closure of valves	• Lubrication of valves

O&M Plan of Overhead Reservoir…Contd.

Sr. No	Problem	Cause	Control Measure
		• Corroded entry cover in the reservoir	• Inspection of vents and hatches • Replacing corroded covers
3	Taste and odor complaints	• Long detention time	• Proper opening/closing of outlet valve
		• Contaminant entry	• Check seals on hatches and screens on vents • Install bird wires and fences if necessary
		• Leaching from Internal coatings or new concrete tank	• Check chlorine level • Improve influent water quality • Flush distribution system • Clean and disinfect storage tank

O&M Plan of Overhead Reservoir…Contd.

Sr. No	Problem	Cause	Control Measure
		• Long detention time	• Proper opening/closing of outlet valve
		• Contaminant entry	• Check seals on hatches and screens on vents • Install bird wires and fences if necessary
		• Leaching from Internal coatings or new concrete tank	• Check chlorine level • Improve influent water quality • Flush distribution system • Clean and disinfect storage tank

Contact

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O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

Water Safety Plan linked with Distribution Pipelines & Reservoir

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Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Developing Water Safety Plan
- Water Safety Plan for Water Distribution System

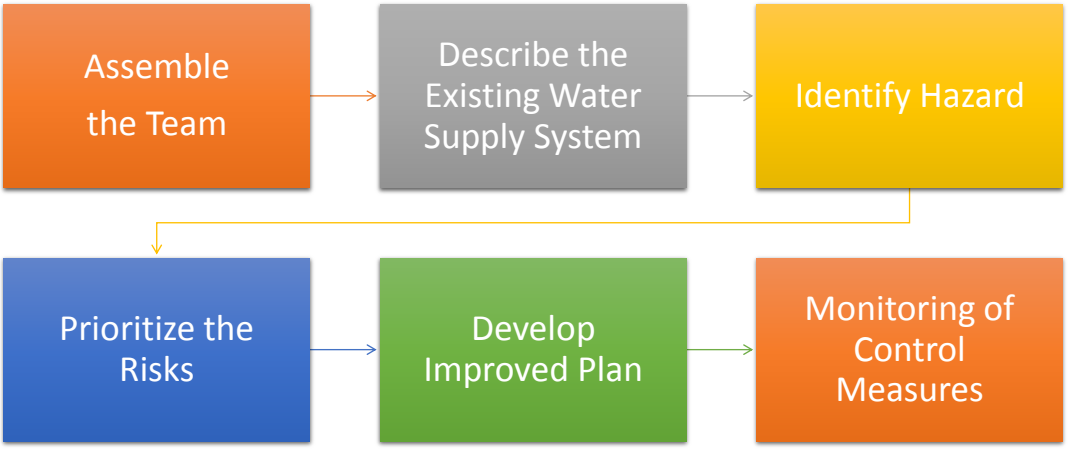
Introduction

"Water Safety Plan is a tool to address the water quality concerns from source to tap in distribution system incorporating possible expected hazards, their possible associated risk setting (risk levels) and finally control measures to address those hazards"

Introduction…..Contd.

Health Impacts of Poor Water Quality

Developing Water Safety Plan



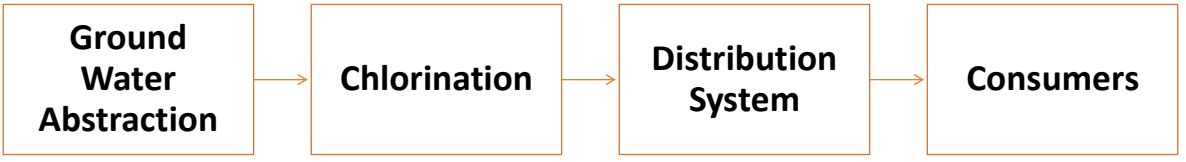
Assembling the Team

- ✓Assemble of team with adequate operational experience
- ✓Major role of team is to identify possible hazards linked with poor water quality in water distribution system and apply control measures in turn

System Assessment

- ✓ Assessment of existing water supply system
- ✓ Developing system flow diagrams from source up to consumers

System Assessment…contd.



System Flow Diagram based on Groundwater Source

System Assessment…contd.

System Flow Diagram based on Surface Water Source

Hazard Identification and Setting Risk Level

- ✓Identification of possible potential hazards
- ✓Prioritizing risks associated with hazards
- ✓Risk level determining

Risk Level = Frequency x Severity

Hazard Analysis and Setting Setting Risk Level

Hazard Analysis **Risk level matrix**

				Severity of damage				
				Almost no	Requires consideration	Slightly significant	Important	Worst
				No effects observed	unsatisfactory , but not serious enough for people to turn to other drinking water	Serious enough to turn to other drinking water	May affect health	May result in fatalities
				1	2	3	4	5
Frequency of hazard	Frequently	Every month	5	5	10	15	20	25
	Often	Once every few months	4	4	8	12	16	20
	Occasion-ally	Once every 1 to 3 years	3	3	6	9	12	15
	Rarely	Once every 3 to 10 years	2	2	4	6	8	10
	Almost never	Once every10 years or less frequently	1	1	2	3	4	5

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
	Water Source			
1	Microbial and chemical Hazards	• Deterioration of water quality	• Good practices of source protection through installation of filtration plant • Implementation of Industrial Effluent Standards and Volume Controls	SDO, Supervisor, Operator

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
	Transmission Mains			
1	Microbial Hazard	• Poor water quality due to source contamination • Deposits of sediments • Disinfection failure due to high loads of organic contents in water from source	• Stop the flow of water by closing valves of problem area • Provide a temporary bypass or alternative supply line, if possible • Water sampling and its testing	SDO, Supervisor, Sub Engineer

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
2	Structural Hazard	• Contamination due to poor jointing • Deterioration of pipe materials • Ingress of contaminated water from leaking valves	• Apply periodic Inspection of supply lines • Gradual replacement of old aged pipe infrastructure • Exercising of valves	SDO, Supervisor, Sub Engineer

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
	Reservoir			
1	Microbial hazard	• Poor water quality due to inadequate disinfection method	• Minimizing ingress of contamination to system • Fitting alarms triggered by low disinfectant level • Ensure inspection covers and ventilator covers remain in place	SDO, Supervisor, Sub Engineer

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
2	Structural failure hazard	• leakage through reservoir • leakage from partially open valves • taste in water due to internal corrosion of pipelines • deterioration of internal lining	• Regular reservoir inspections • Proper opening/closing of valves • Proper pipe material as per specifications should be used • Relining/painting of internal surface • Routine inspection to see any failure in piping and lining	SDO, Supervisor, Sub Engineer

Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
Distribution Supply lines				
1	Microbial and Chemical Hazards	• Low chlorine residual in distribution system • Ingress of contamination due to pressure fluctuations	• Maintain chlorine residual in the system as per requirement • Pressure Management • Apply flushing of pipelines	SDO, Supervisor, Sub Engineer

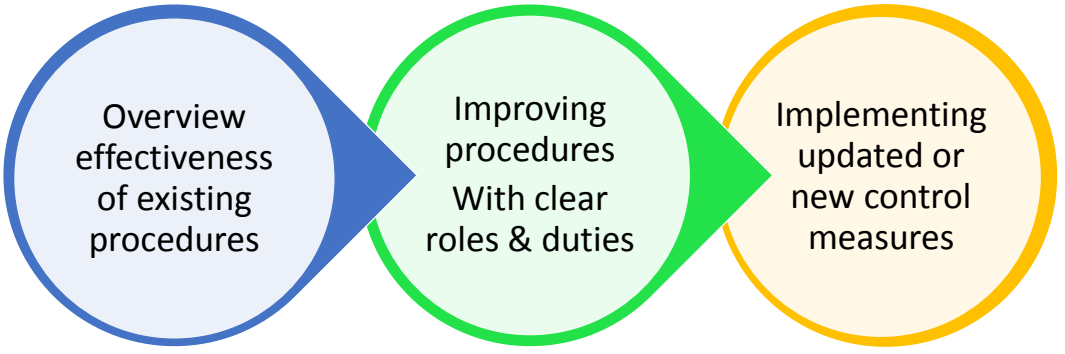
Water Safety Plan(WSP) For Water Distribution System

Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
		• Contamination during water main repair due to debris, soil or groundwater remaining in the main after repairs	• Disinfection prior to commissioning of water main • Follow design specifications for water supply system	SDO, Supervisor, Sub Engineer

Water Safety Plan For Water Distribution System

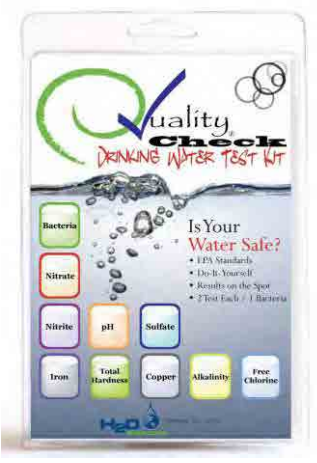
Sr. No.	Hazard Type	Problems with associated hazard	Control Measures	Key Responsibility
		• Cross connection between water system and another system carrying non-potable water		
2	Structural failure hazard	• Ingress of contamination due to main burst • Ingress of contamination due to cracks in pipelines • Ingress of contamination due to improper closure of valves	• Maintenance of pipelines and valves • Use of approved pipeline types	SDO, Supervisor, Sub Engineer

Developing, Implementing & Maintaining an Improved/Upgrade Plan



Monitoring of Control Measures

- ✓ Important for reviewing effectiveness of water safety plan
- ✓ Measuring residual chlorine, pH, turbidity, pressure changes in service area and periodic inspection of infrastructure



Contact

Zia Mustafa
Water Specialist

Assignment 2

Preparation of Water Safety Plan (WSP)

Guidelines for Preparing Assignment

Sr. No. Hazards in Distribution System Type Control Measures

O&M of Tube Well and Pump Facility (W1221)

O&M of Water Distribution System (Module 1)

EPA Net Analysis Exercise

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Introduction
- Purpose of Exercise
- Target Area for Exercise
- Steps in Using EPANET
- Example Network
- Exercise at Supply Area in Green Town

3

Introduction

- A network analysis computer program developed by the U.S. Environmental Protection Agency that analyzes Water Distribution Network
- A tool to determine pressure, velocity in different pipes in a Network

4

Purpose of Exercise

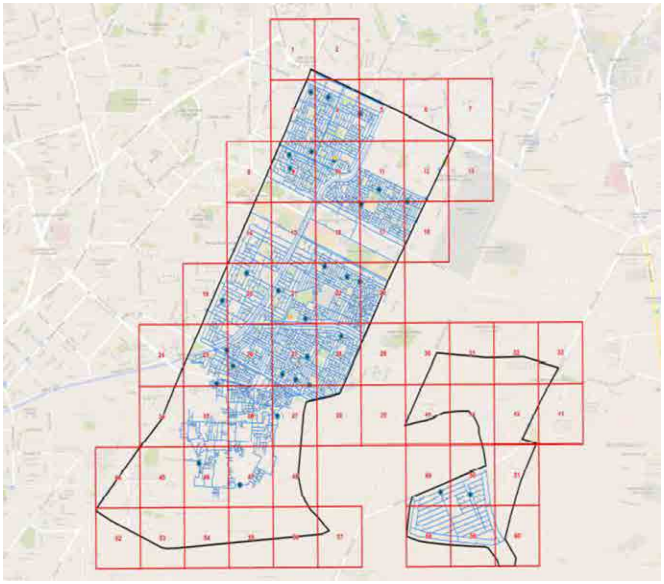
For checking and confirming that sufficient water is supplied to customers within supply area with appropriate pressure or not

- How water pressure within the supply area is changing
- Diameter of pipe is appropriate or not
- Capacity of pump is appropriate or not
- Possibilities of improving

5

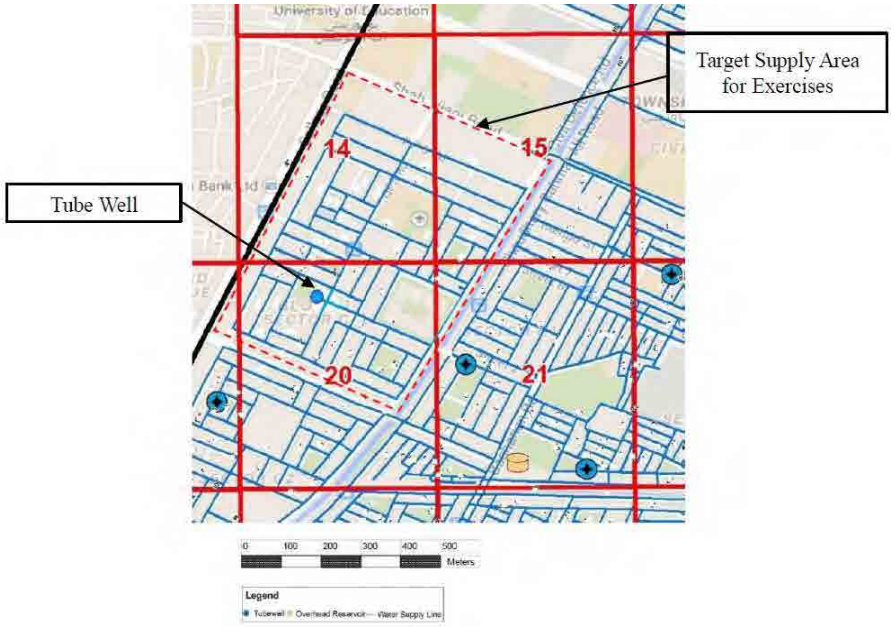
Target Area for the Exercise

Grid Map of Green Town



6

Target Area for the Exercise



7

Steps in Using EPANET

Steps to model a Water Distribution System using EPANET:

1. Draw a network representation of your distribution system or import a basic description of the network placed in a text file
2. Edit the properties of the objects that make up the system
3. Describe how the system is operated
4. Select a set of analysis options
5. Run a hydraulic analysis
6. View the results of the analysis

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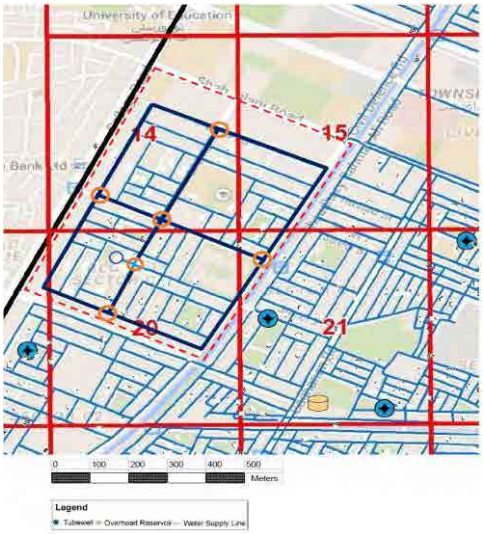
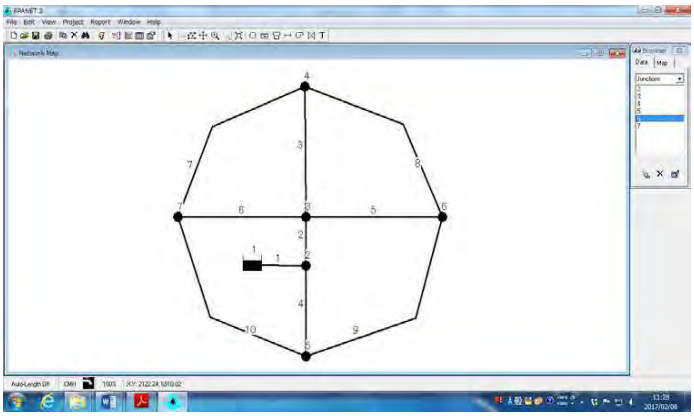
Example Network



Main Distribution Network Example for Analysis



Network Model on the EPANET

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Example Network

Network Node Properties

Node	Elevation(m)	Demand(m3/H)
1	GL+30	(406.8)
2	GL	68.0
3	GL	68.0
4	GL	68.0
5	GL	68.0
6	GL	68.0
7	GL	66.8

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Example Network

Network Pipe Properties

Pipe	Start Node	End Node	Length(m)	Diameter(mm)	C-Factor
1	1	2	100	200	100
2	2	3	100	200	100
3	3	4	300	100	100
4	2	5	200	200	100
5	3	6	300	100	100
6	3	7	200	100	100
7	7	4	500	100	100
8	6	4	600	100	100
9	5	6	600	100	100
10	5	7	500	100	100

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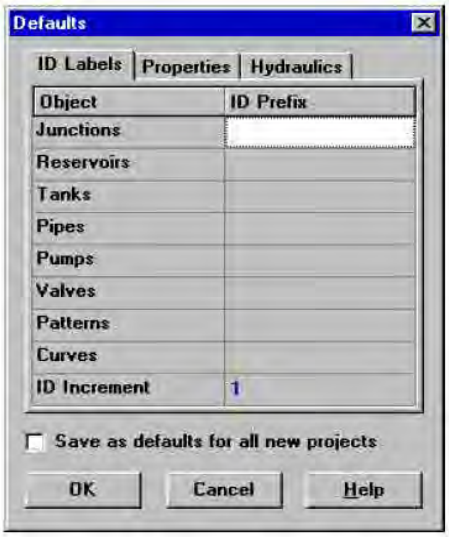
Example Network

Project Setup

- Launch EPANET
- Create a new project
- Select Project >> Defaults to open the dialog form shown in Figure



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Example Network

- On the ID Labels page of the dialog, clear all of the ID Prefix fields and set the ID Increment to 1
- Select the Hydraulics page of the dialog and set the choice of Flow Units to GPM (gallons per minute)

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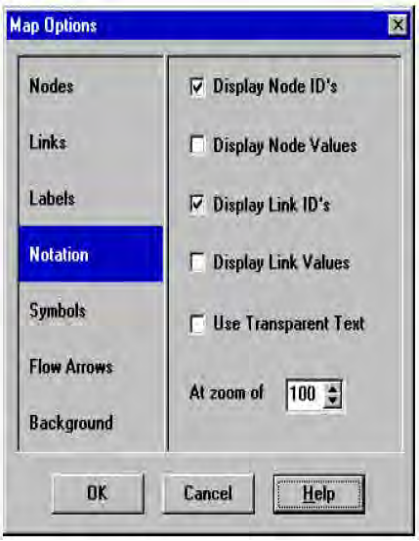
Example Network

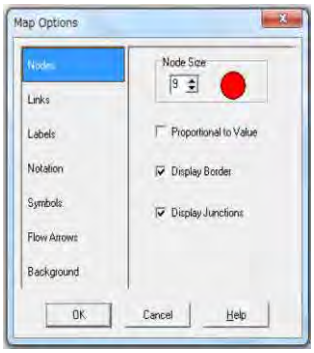
- Select **View >> Options** to bring up the Map Options dialog form
- Select the Notation page on this form and check the settings
- Then switch to the Symbols page and check all of the boxes
- Click the **OK** button to accept these choices and close the dialog

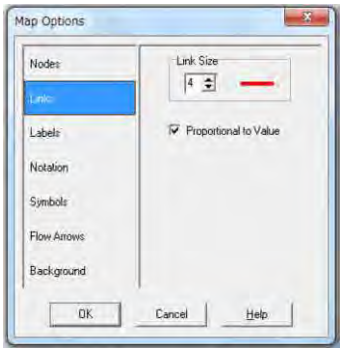


14

Example Network

- Select **View >> Dimensions** to bring up the Map Dimensions dialog
- Note the default dimensions assigned for a new project. click the **OK** button





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Example Network

Drawing the Network

- Select View >> Toolbars >> Map

- Click the Reservoir button
- Then click the mouse on the map at the location of the reservoir

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Example Network

- Click the Junction button and click on the map at the locations of nodes 2 through 7
- Click the Pipe button . (Note how an outline of the pipe is drawn as you move the mouse from node 2 to 3). Repeat this procedure for pipes 2 through 8.

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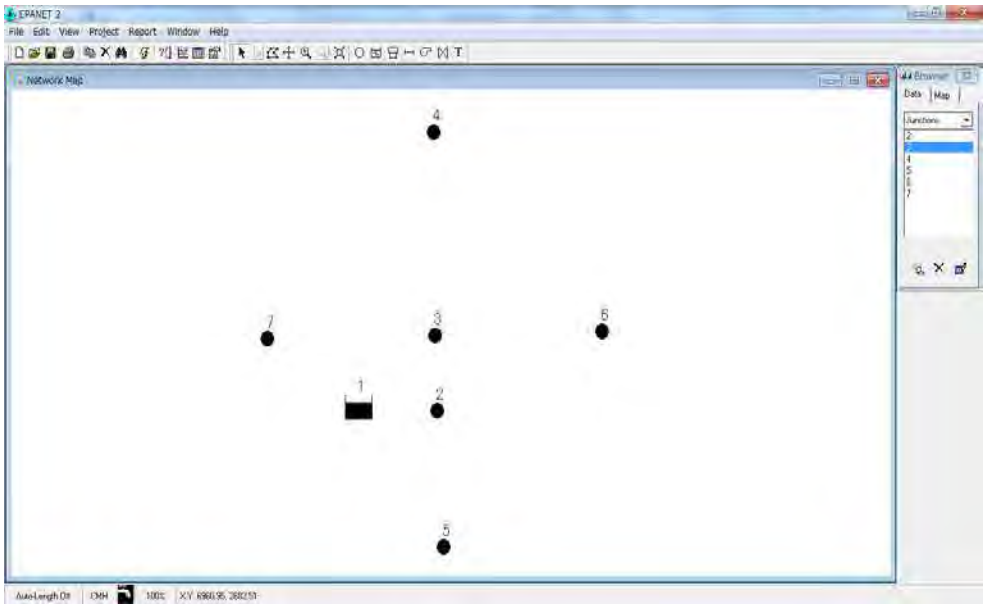
Example Network



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Example Network

- Label the reservoir by selecting

on the Map Toolbar. Edit Box will appear. Type here SOURCE and then
hit the ENTER key

- Click the selection button to put the map on the Objection Selection Mode

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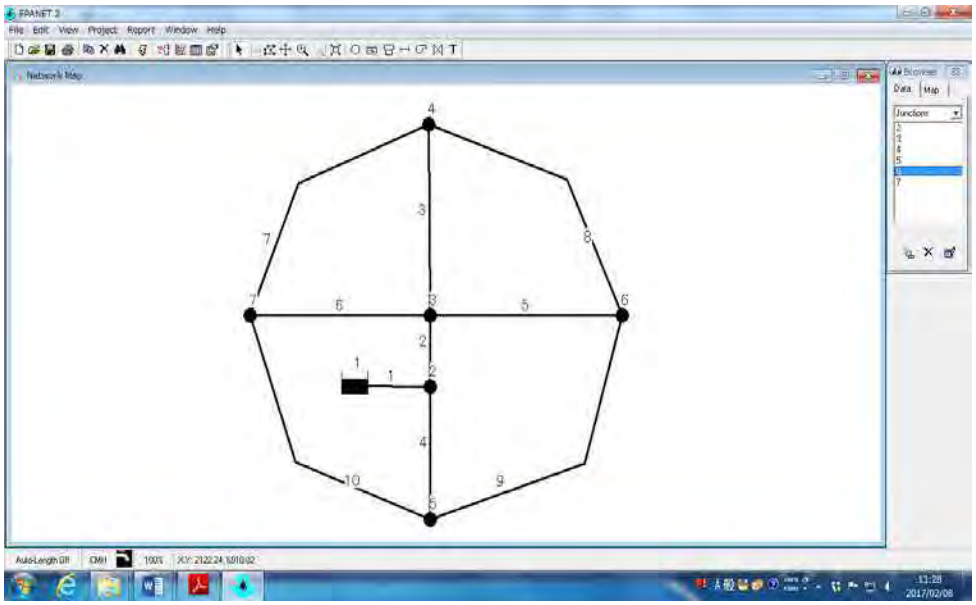
Example Network



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Example Network

Setting Object Properties

- Double-click the object on the map
- Right-click on the object and select Properties from the pop-up menu that appears
- Select the object from the Data page of the Browser window and then click the Browser's Edit button
- Add Elevation and Base Demand (Node 2)
- Click on link to add length, diameter and roughness (c factor) for links

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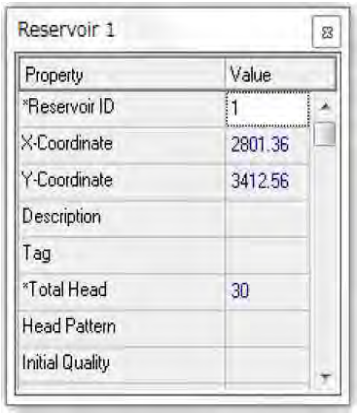
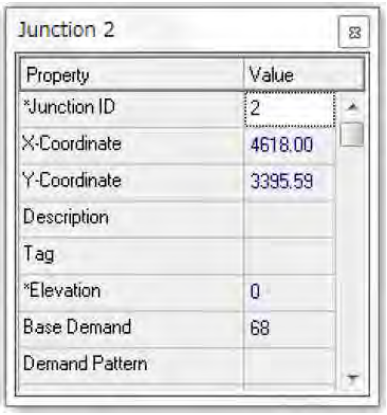
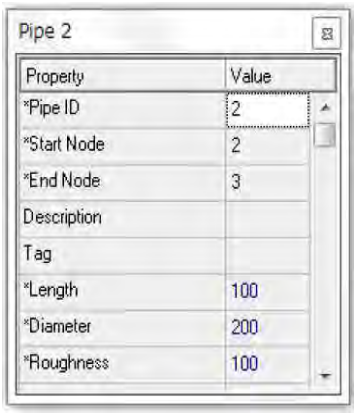
Example Network







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Example Network

Saving and Opening Projects

- From the File menu select the Save As option.
- In the Save As dialog that appears, select a folder and file name under which to save this project.
- Click OK to save the project to file.

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Example Network

Saving and Opening Projects

- The project data is saved to the file in a special binary format. If you wanted to save the network data to file as readable text, use the **File >> Export >> Network** command instead.
- To open project at some later time, select the **Open** command from the **File** menu.

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Example Network

Running A Single Period Analysis

- Select Project >> Run Analysis or click the Run button . (If the toolbar is not visible select View >> Toolbars >> Standard from the menu bar).
- Select Node Pressure from the Browser's Map page and observe how pressure values at the nodes become color-coded.
- To view the legend for the color-coding, select **View >> Legends >> Node** (or right click on an empty portion of the map and select Node Legend from the popup menu).

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Example Network

Running A Single Period Analysis

- To change the legend intervals and colors, right click on the legend to make the Legend Editor appear
- Bring up the Property Editor (double-click on any node or link) and note how the computed results are displayed at the end of the property list
- Create a tabular listing of results by selecting **Report >> Table** (or by clicking the Table button)

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Example Network

The Link Result

Network Table - Links

Link ID	Length m	Diameter mm	Roughness	Flow CMH	Velocity m/s	Unit Headloss m/km	Friction Factor	Reaction Rate mg/L/d	Quality	Status
Pipe 1	100	200	100	406.80	3.60	94.41	0.029	0.00	0.00	Open
Pipe 2	100	200	100	208.49	1.84	27.38	0.032	0.00	0.00	Open
Pipe 3	300	100	100	45.88	1.62	48.54	0.036	0.00	0.00	Open
Pipe 4	200	200	100	130.31	1.15	11.46	0.034	0.00	0.00	Open
Pipe 5	300	100	100	44.25	1.56	45.39	0.036	0.00	0.00	Open
Pipe 6	200	100	100	50.36	1.78	57.69	0.036	0.00	0.00	Open
Pipe 7	500	100	100	14.91	0.53	6.05	0.043	0.00	0.00	Open
Pipe 8	600	100	100	7.21	0.26	1.58	0.048	0.00	0.00	Open
Pipe 9	600	100	100	30.97	1.10	23.44	0.038	0.00	0.00	Open
Pipe 10	500	100	100	31.34	1.11	23.97	0.038	0.00	0.00	Open

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Example Network

The Nodes Result

Network Table - Nodes

Node ID	Elevation m	Base Demand CMH	Demand CMH	Head m	Pressure m
Junc 2	0	68	68.00	20.56	20.56
Junc 3	0	68	68.00	17.82	17.82
Junc 4	0	68	68.00	3.26	3.26
Junc 5	0	68	68.00	18.27	18.27
Junc 6	0	68	68.00	4.20	4.20
Junc 7	0	66.8	66.80	6.28	6.28
Resvr 1	30	#N/A	-406.80	30.00	0.00

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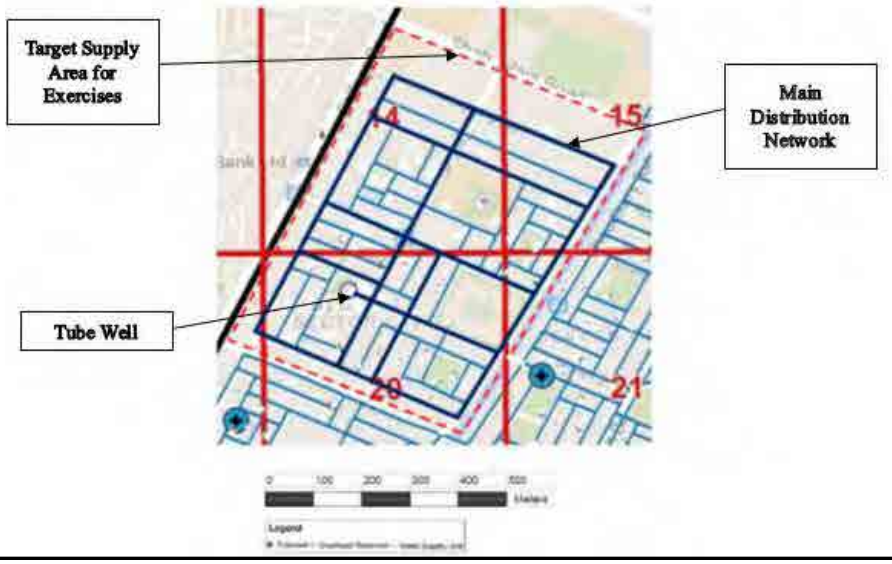
Exercise at Supply Area in Green Town

1. Select and make your main distribution network on your map



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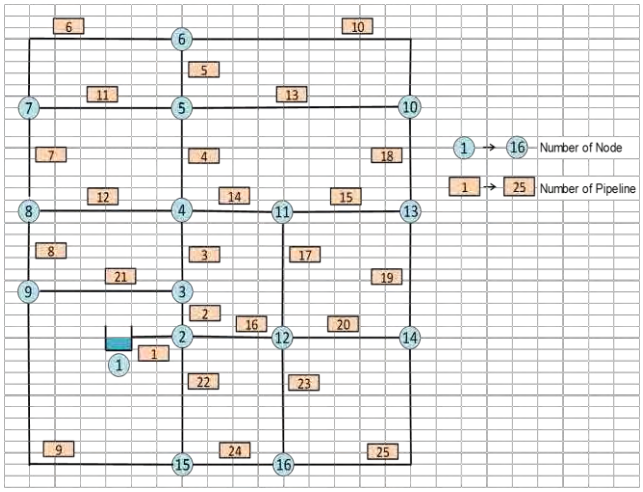
Exercise at Supply Area in Green Town

2. Numbering of Nodes and Pipelines



If number of Nodes is small, you will not be able to get good result from network analysis.
Or if number of Nodes is too big, analysis will be complicated and it will take long hours.

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Exercise at Supply Area in Green Town

3. Data Sheet of Nodes and Pipeline

No.	Elevation	Water Demand or Supply Amount from Node

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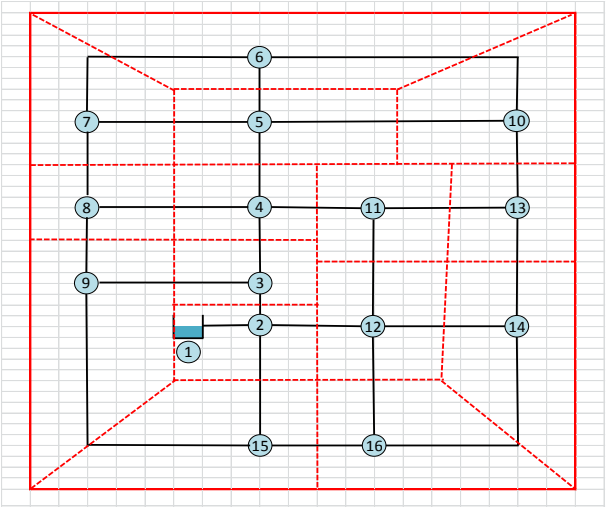
Exercise at Supply Area in Green Town

Supply amount from each node will be calculated according to area, number of customer, population density and types of customers.



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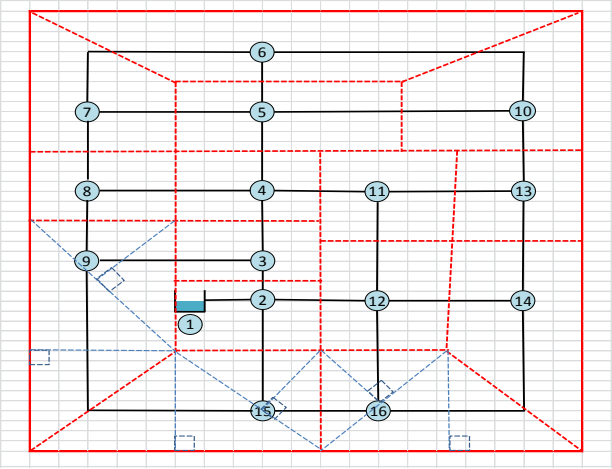
Exercise at Supply Area in Green Town

- Divide each supply area with two right triangle and calculate base times height
- Equal supply amount at each Node (For Exercise Purpose)



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Exercise at Supply Area in Green Town

Supply amount from each Node = Q/(N-1)

Where
Q is Capacity of Tube Well Pump
N is number of Nodes

- Node No.1 is reservoir and we assume water level of the reservoir as lift of Tube Well pump
- Flow amount from reservoir is calculated by Software

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Exercise at Supply Area in Green Town

4. Data Sheet for Pipelines

No.	Start Node	End Node	Length in meter	Diameter in mm	Roughness Coefficient

35

Exercise at Supply Area in Green Town

5. Putting data into EPANET

- Drawing network by making use of mouse and buttons on the Map Toolbar
- First add the reservoir (Lift of Tubewell Pump)
- Add the junction nodes
- Then add the pipes (Begin with pipe 1 connecting node 1 to node 2)
- Put all data of Nodes and Pipelines into EPA Net

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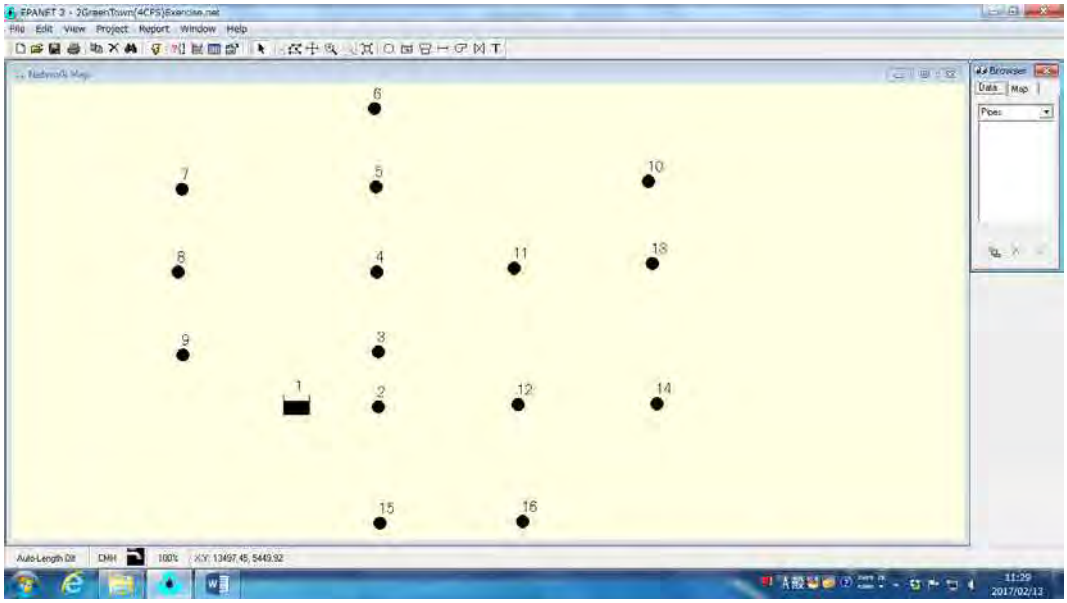
Exercise at Supply Area in Green Town



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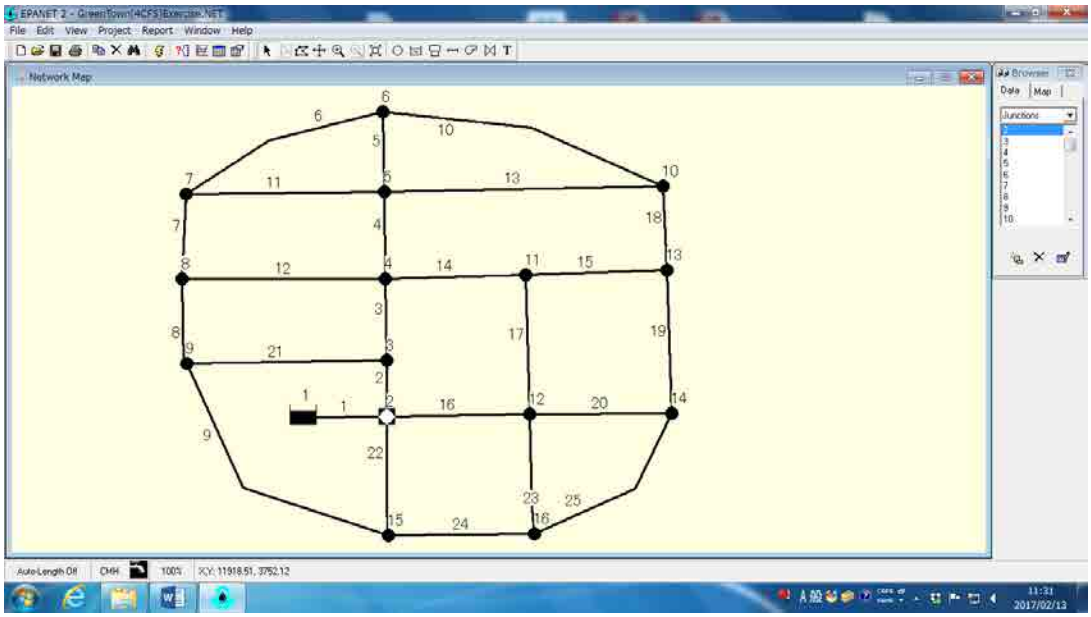
Exercise at Supply Area in Green Town



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Exercise at Supply Area in Green Town

5. Analysis

Run the analysis

6. Evaluation of analysis result

- Water pressure at each node
- Velocity of each pipe

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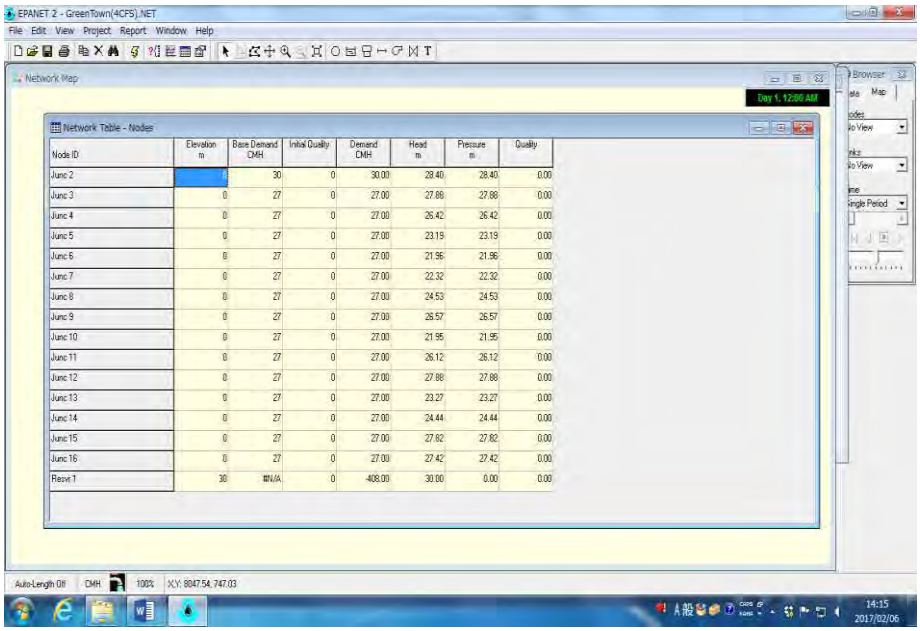
Exercise at Supply Area in Green Town



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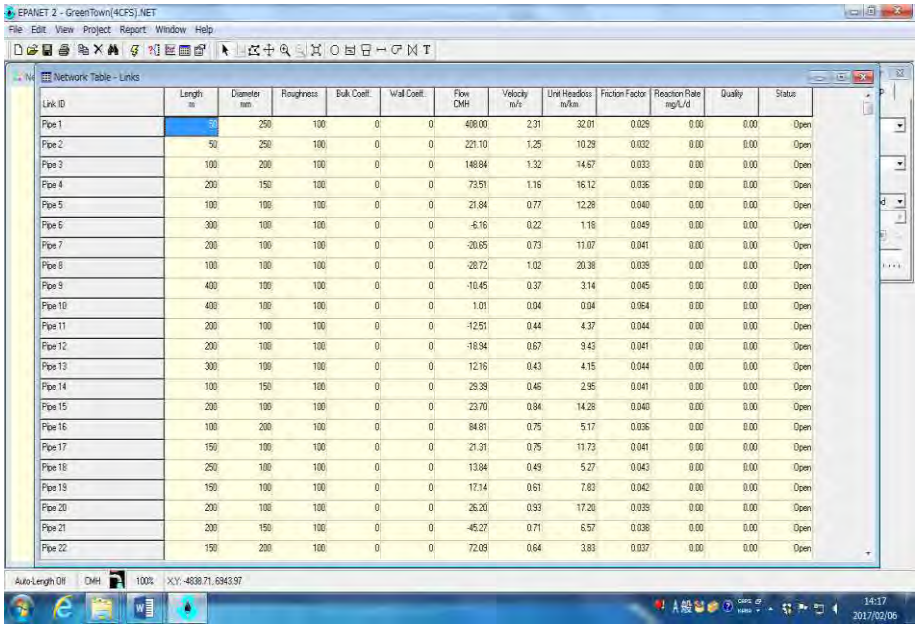
Exercise at Supply Area in Green Town



Link ID	Length m	Diameter mm	Roughness	Bulk Coeff.	Wall Coeff.	Flow CMH	Velocity m/s	Unit Headloss m/km	Friction Factor	Reaction Rate mg/L/d	Quality	Status
Pipe 1	50	250	100	0	0	408.00	2.31	32.01	0.029	0.00	0.00	Open
Pipe 2	50	250	100	0	0	221.10	1.25	10.29	0.032	0.00	0.00	Open
Pipe 3	100	200	100	0	0	148.84	1.32	14.67	0.033	0.00	0.00	Open
Pipe 4	200	150	100	0	0	73.51	1.16	16.12	0.035	0.00	0.00	Open
Pipe 5	100	100	100	0	0	21.84	0.77	12.28	0.040	0.00	0.00	Open
Pipe 6	300	100	100	0	0	-6.16	0.22	1.18	0.049	0.00	0.00	Open
Pipe 7	200	100	100	0	0	-20.65	0.73	11.07	0.041	0.00	0.00	Open
Pipe 8	100	100	100	0	0	-28.72	1.02	20.38	0.039	0.00	0.00	Open
Pipe 9	400	100	100	0	0	-10.45	0.37	3.14	0.045	0.00	0.00	Open
Pipe 10	400	100	100	0	0	1.01	0.04	0.04	0.064	0.00	0.00	Open
Pipe 11	200	100	100	0	0	-12.51	0.44	4.37	0.044	0.00	0.00	Open
Pipe 12	200	100	100	0	0	-18.94	0.67	9.43	0.041	0.00	0.00	Open
Pipe 13	300	100	100	0	0	12.16	0.43	4.15	0.044	0.00	0.00	Open
Pipe 14	100	150	100	0	0	29.39	0.46	2.95	0.041	0.00	0.00	Open
Pipe 15	200	100	100	0	0	23.70	0.84	14.28	0.040	0.00	0.00	Open
Pipe 16	100	200	100	0	0	84.81	0.75	5.17	0.036	0.00	0.00	Open
Pipe 17	150	100	100	0	0	-21.31	0.75	11.73	0.041	0.00	0.00	Open
Pipe 18	250	100	100	0	0	13.84	0.49	5.27	0.043	0.00	0.00	Open
Pipe 19	150	100	100	0	0	17.14	0.61	7.83	0.042	0.00	0.00	Open
Pipe 20	200	100	100	0	0	26.20	0.93	17.20	0.039	0.00	0.00	Open
Pipe 21	200	150	100	0	0	-45.27	0.71	6.57	0.038	0.00	0.00	Open
Pipe 22	150	200	100	0	0	72.09	0.64	3.83	0.037	0.00	0.00	Open

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Contact

Zia Mustafa
Water Specialist

OJT Exercise
Checking of Pressure in Supply Area using Pressure Recorder FJN -501

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Detail of OJT Plan

Date	March 24, 2017
Training Facility	Tube Well located at Green Town WASA Sub Division
Equipment/Machinery	Pressure Recorder FJN -501
Time	2 Hours (10:00AM to 12:00 PM)

2

FJN-501 Pressure Recorder

Water Pressure Recorder is used to measure the pressure of water with the help of graph inside the gauge for specific hours.

Pressure Recorder FJN-501

3

Applications of Water Pressure Recorder

Pressure Recorders are used to:

- Verify low water pressure complaints
- Provide water distribution system modelling data
- Checking for fluctuations in water pressure
- Keeping track of water pressure at night when controlling water leakages by decreasing pressure
- Making a water pressure distribution chart to identify low, high pressure in Supply Area

4

Specifications of Equipment

Model and Type	FJN-501 (A-Type)	FJN-501 (C-Type)
Recording Time	4,12,24,72, 168 hours	15,30,60 Minutes
Maximum Pressure Record	1.0 MPa (10bar)	2.0 MPa (20bar)
Power Check	CPU does not work at voltage less than 2.2 V	
Mode Check	LED indicates by blinking	

Scale: I.0 MPa = 10 Bar

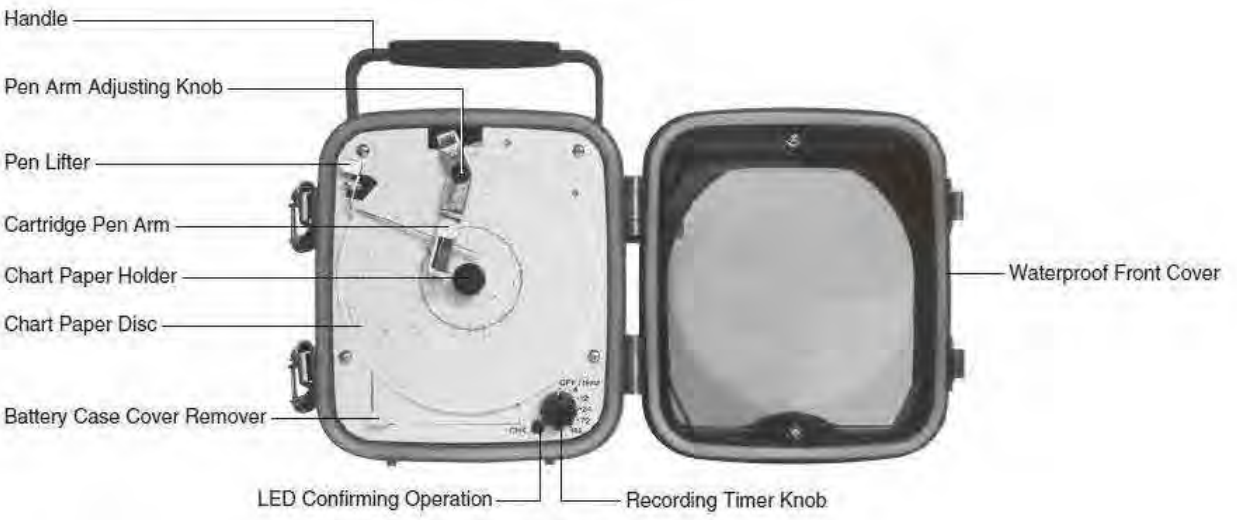
5

Specifications of Equipment

Model and Type	FJN-501 (A-Type)	FJN-501 (C-Type)
Operation Power	3.0 Volts (Minimum 2.2V)	
Weight & Size	1.35kg (Main Unit)	
Gross Weight	3.7kg (with the carrying case)	
Battery Type & Battery Life	AA - Alkaline Battery	
	4 h ..... 80 days 12h ..... 220 days 24h ..... 380 days 72h ..... 720 days 168h ..... 970 days	15 min. ..... 150 days 30 min. ..... 250 days 60 min. ..... 400 days

6

Components of Equipment



7

Components of Equipment

Fuji Coupling

13 mm Dia. Faucet Adaptor

Coupler of Fuji Coupling

Cartridge Pen

Leather Packing

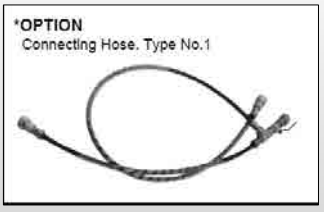
8

Components of Equipment

Alkaline Battery- AA Size

Chart Paper Disc
(100 Sheets per package)

Connecting Hose Type No. 4



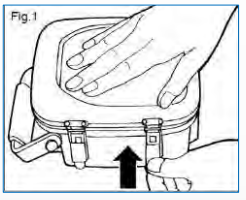
Connecting Hose

Carrying Case

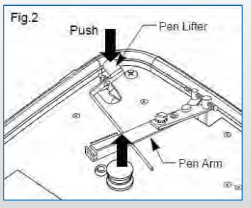
9

Procedure for Measuring Pressure in Water Distribution

1. Unlock the clip and open the front cover



2. Push down the pen lifter to raise the lift arm. Remove chart paper holder by pulling upward and put new chart paper



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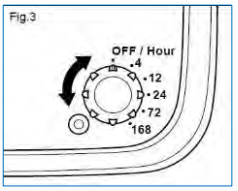
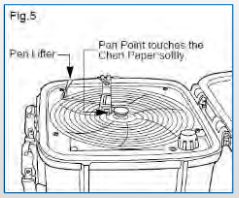
Procedure for Measuring Pressure in Water Distribution

3. Before mounting the chart paper, check battery status (Turn the knob to 4 hour Selector position and confirm blinking of LED for 1 minute, if LED does not light up, change the batteries)



4. Open the cartridge pen and fit it on the pen holder. Release the Pen lifter so that the pen point will touch the chart paper softly



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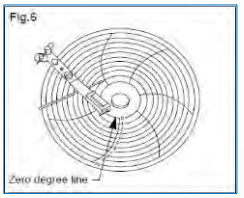
Procedure for Measuring Pressure in Water Distribution

5. Rotate the chart paper Disc so that the pen point will come to the starting point



6. Close the front cover and lock it with catch clips

12

Procedure for Measuring Pressure in Water Distribution

7. Open the Pipeline Valve slowly and drain water to eliminate air trapped in the water supply pipeline
8. Connect the hose pipe with supply line (through FUJI Adapter)
9. Attach the other side of Hose Pipe to the Pressure Recorder
10. Open the valve of Supply Line gradually to its full supply level

13

Procedure for Measuring Pressure in Water Distribution

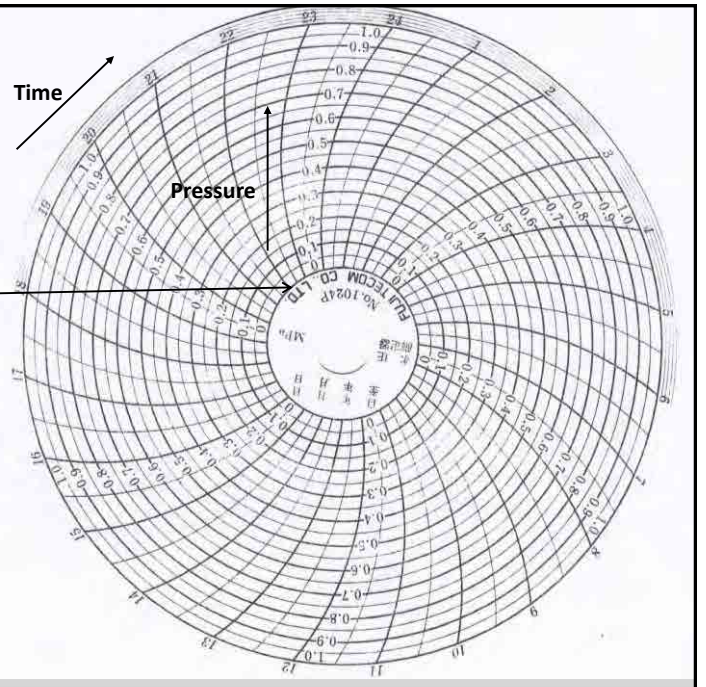
11. Now open the Valve of Pressure Recorder

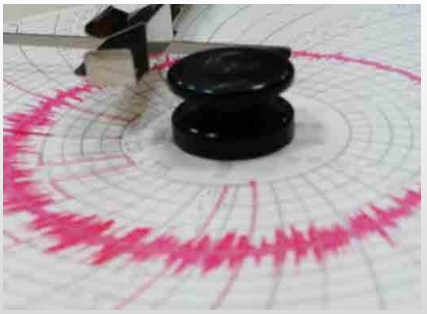
12. Open the Air Bleed knob to confirm that air is removed (continuous drop of water) and then close it

13. Place the Pressure Recorder on Firm Space for recording pressure in supply line

14

Chart Interpretation





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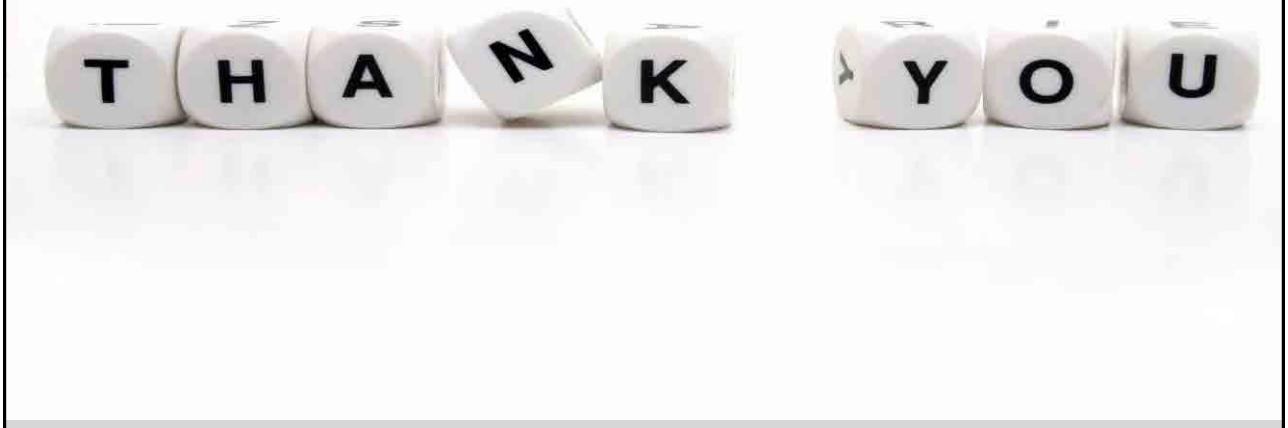
Precautions

- The Pen Point should touch the Zero Line (If it is not on Zero Line adjust it with the help of screw on the pen arm)
- Always turn the knob to OFF, before changing chart paper
- After use, remove the connecting hose after releasing air completely by use of Air bleed knob
- Open the valve of supply line slowly to avoid malfunctions caused by the water pressure changes

16



17

Checking of Residual Chlorine in Supply Area using DPD Reagent

OJT Exercise

Zia Mustafa (Water Specialist)
Ramisha Taseer (Research Associate)

March 2017

Outline of the Presentation

- Objective
- Detail of OJT Schedule
- Specifications of Equipment
- Components of Apparatus
- Applications of Residual Chlorine Measuring Kits
- Procedure

3

Detail of OJT Schedule

Day	March 24, 2017
Place	Green Town WASA Sub Division
Equipment/Machinery	DPD (N,N Diethyl-P-Phenylene diamine Reagent Kit
Time	2 hours (10:00am to 12:00pm

4

Specifications of Apparatus

Range	0 to 2.5 mg/l (ppm) Chlorine
Smallest Increment	0.5 mg/l (ppm) Chlorine
Analysis Method	Colorimetric
Sample Size	5 ml
Number of tests	50 (average)
Shipping Weight	176g (6.6oz.)
Case Dimensions	220*145*55mm

5

Components of Apparatus

Residual Measuring Kit comprises:

- 1 Color Comparator Cube
- Reagent 1 (20mL)
- Reagent 2 (15mL)

6

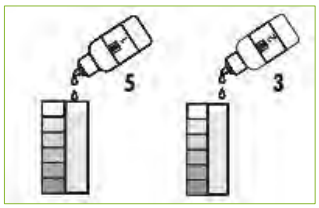
Applications

- To measure Residual Chlorine Levels in Water Supply Pipelines , reservoirs

7

Procedure

- Add 5 drops of Reagent 1 and 3 drops of Reagent 2 to the color comparator cube

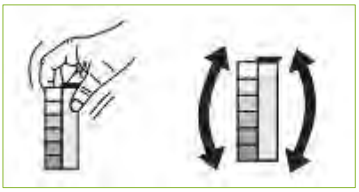


- Fill the color comparator tube with water sample to the 5 mL mark

8

Procedure

- Replace the Cap and mix by carefully swirling the cube in tight circles and inverting it several times



- Determine which color band best matches the solution in the vessel and record the results in mg/L (ppm) free chlorine

9

10

Assignment 2

Preparation of Operational and Repair Action Plan

Guidelines for Preparing Assignment

- What are the prevailing operational issues in the system
- Possible Causes
- Control Measures

Course Code: W1221

O&M of Water Distribution System

Module 1

Participant Lecture Notes

Lecture 1

2017

1. Lecture Information

Course Title: O&M of Tube Well and Pump Facility	**Course Code:** W1221
Module Title: O&M of Water Distribution System	**Module No:** 1
Lecture Topic: Key Issues in Water Distribution System	**Lecture Duration:** 45 Minutes

2. Water Distribution System (WDS)

2.1 Introduction

The utility service providers including WASA Lahore, WASA Faisalabad, WASA Multan, WASA Rawalpindi and WASA Gujranwala are providing water and sanitation services in respective cities, along with Punjab Public Health Engineering Department (PHED) mainly responsible for providing the above services in the urban as well as rural areas remaining other than the Five (5) WASAs jurisdiction in Punjab Province (Before creation of WASAs, all water and sanitation services provision in the Province was mandated by PHED).

The adequate and efficient delivery of providing water supply services to consumers is a pivotal parameter to achieve the Millennium Development Goals (MDGs) which at present is translated into Sustainable Development Goals. The utility service providers in this regard are still lacking beyond the set targets under the above. The current deficiencies in basic utility infrastructure is further inhabiting the economic growth as well as deteriorating the quality of life resulting increased poverty among the communities. Therefore, for improving the service delivery of Five WASAs, it is imperative to firstly analyze the current deficiencies in Five WASAs, key issues in running the system and then bring improvement in the identified gaps in Five WASAs that will not only improve the service delivery of WASAs but also result measureable improvement in health outcome.

The present water distribution system in Five WASAs vary from each other. In case of WASA Lahore, Multan and Gujranwala, major source of water is through groundwater (tube wells) whereas in cities of Faisalabad and Rawalpindi (utility services provided by WASA Faisalabad, WASA Rawalpindi), major source is based on surface water (after treatment supply to consumers) and groundwater through installation of small capacity tube wells. The existing systems are designed to meet the peak hourly demand. In addition, some control valves (gate valves, air valves, drain valves etc.) have also been installed in the system. In some areas of distribution systems (walled city), old Galvanized Iron (GI) pipes of smaller diameters exist which are causing high

head losses and depriving the consumers of reliable water supply. In addition, some areas are also connected to dead ends where water quality concerns are evident. Further, the residents at the remote points are also not getting the desired quantity of water with adequate pressure.

This lecture has been divided into different activities which will be carried out, the detail is as under.

2.2 Group Discussion

The Lecturer will first invite discussions regarding major issues being faced by Five WASAs in operating the water supply system and will summarize the discussions by adding further detail into it. Afterwards, the Lecturer will share the information of water supply system of five WASAs to training participants.

2.3 Existing Water Distribution System in Five WASAs

The water distribution system generally includes tube wells, reservoirs (for storage, equalizing and distribution purpose), pipes, valves, hydrants and appurtenances for conveying water system. The description of water distribution system in each WASA is given in the following paragraphs:

WASA Lahore

In case of WASA Lahore, water distribution system comprises tube wells, pipes, valves, hydrants and overhead reservoirs. Most of the tube wells pump directly into the system, few are connected with overhead reservoirs. The only existing water reservoir in working condition in the city is situated at Lange Mandi (Pani Wala Talab) with a capacity of one million gallons, feeded by four (4) tube wells of 4 cusecs capacity each. This reservoir was constructed in year 1876 under the British Rule and is partially feeding the walled city.

The existing water supply system in the city is based on groundwater and about 528 tube wells are abstracting water from ground to feed directly into the system at supplying water about 14-18 hours in a day. Majority of tube wells are of four (4) cusecs and two (2) cusecs capacity, however, one (1) cusec capacity tube wells also exist at WASA Lahore. The aquifer underlying is unconfined alluvium comprising sand, silt and gravel. The reported thickness of aquifer in Lahore is 1,400 feet. The depth to water table is reported as 125-150 feet and groundwater is declining 6 feet per year due to excessive abstraction of water through tube wells. The total length of water distribution supply lines in WASA Lahore is about 5,444 km.

WASA Faisalabad

At present, about 60% of population in the city is provided with piped water supply facilities. 93.5 MGD of water is being supplied to the consumers. About 15 MGD of water is being augmented in the system through French Project which include 10 MGD of water being supplied through Jhal water treatment plant and about 5 MGD water through installation of 10 tube wells upstream of Rakh Branch Canal. The present water demand to meet the needs of present population is 145 MGD therefore, indicating a deficit of 36.5 MGD in the system. The total water supply connections including domestic, commercial and industrial are 270,451.

Recently, WASA Faisalabad has made different development interventions including enhancement of water resources through French Project with the assistance of JICA, establishment of citizen liaison cell, establishment of water bottling plant etc. The future envisaged Plans also include preparation/Updation of Master Plan, augmentation of water resources by treatment of surface water from Gogera and Jhang Branch Canals, expansion of existing water supply system & rehabilitation of existing machinery, augmentation of Jhal water treatment plant etc.

WASA Multan

At present, about 65% of population in the city is provided with piped water supply facilities. The existing water supply system in Multan is mainly based on groundwater. About 221 MGD (408 cusecs) of water is being supplied to the residential areas from about 102 tube wells with capacity of four (04) cusecs each. The aquifer underlying is unconfined alluvium comprising of sand and clay and is bounded by Chenab River in northwest and the Sutlej River to the southeast. The quality of water is sweet and is fit for drinking purpose. All the tube wells in the city pump directly into distribution system. The depth to water table is reported as 70-80 ft. in Multan. The tube wells are generally installed at depth of 425 ft. at which ground strata available is in good condition. Due to excessive abstraction, the water table is depleting 3.0 ft. per year at different locations.

There also exist reservoirs (18 Nos., 2.35 Million Gallons capacity) in the city, however, these are nonfunctional at the moment. The distribution of water is made through main and distribution pipelines of 3 inches to 24 inches diameter with length of 231 km and 1,049 km respectively. The distribution system is designed for a demand of 50 Gallons Per Capita per Day (GPCD). The supplied water is on intermittent basis and supply is made for duration of 6 hours in a day (2 hrs. in the morning, 2 hrs. in afternoon and 2hrs in the evening).

Further, about thirty two (32) water filtration plants, with capacity of 1,000 gallons/hr. each have been installed in WASA jurisdiction. These plants are further sub divided into twenty (20) arsenic plants and twelve (12) filtration plants to provide treated water to the consumers. These plants are not meant for providing treated water to distribution system, however, the consumers from the adjoining areas come at the plant and fill the bottles for drinking purpose. The feed water for these plants are tube wells. The 1,000 Gallons/hr. capacity water filtration plants comprise sand filter, jumbo filter (5 micron filter media size), activated carbon filter, arsenic removal filter, jumbo filter (1 micron filter media size) and ultrafiltration.

WASA Rawalpindi

At present, about 90% of population in the city is provided with water supply facilities. The major water sources are surface water treatment plants (2 Nos., Rawal Water Treatment Plant and Sanjani Water Treatment Plant) and tube wells (362 Nos., 0.25 cusecs capacity each) in the WASA service area. About 29 MGD of treated water is being supplied in the city through Rawal Water Treatment Plant (23 MGD) and Sanjani Water Treatment Plant (6 MGD) whereas tube wells are contributing about 39 MGD of water to consumers. The groundwater beneath is mixture of confined and unconfined acquirer from where water is abstracted through tube wells. The transmission and distribution of water is made through pipelines of 3 inches to 54 inches diameter with length of 1,250 km. The distribution system is designed for a demand of 40 Gallons Per Capita per Day (GPCD). The supplied water is on intermittent basis and supply is provided for duration of 2-4 hours in a day. In addition, no metering system exists in the city to ensure supplied water to the consumers.

WASA Gujranwala

At present, about 40% of population in the city is provided with piped water supply facilities. About 39 MGD of water from 67 tube wells (4 & 2 cusecs capacity) is being supplied to consumers by WASA through direct pumping for duration of 10-12 hours in a day. There are leakages in the distribution network and hundred percent water connections are unmetered resulting in high wastage of water.

There also exist about ten (10) overhead reservoirs (total capacity 1.58 Million Gallons) in the city of which eight are in working conditions and two (2) are abandoned. The eight working reservoirs include four (04) reservoirs of 300,000 gallons capacity and four (04) of 50,000 gallons capacity respectively. The existing distribution network within WASA service area comprises 481 km of water supply lines with diameter ranging from 3 inches to 24 inches. Asbestos Cement (AC) pipes Polyvinyl Chloride (PVC) Pipes and Galvanized Iron (GI) pipes have been used for distribution

system. The distribution system is designed for a demand of 50 Gallons Per Capita per Day. Water quality is satisfactory in the WASA service area as Gujranwala lies in sweet water zone and water is not contaminated with bacteria and other viruses.

The salient features of water supply system of Five (5) WASAs in Punjab Province is given in Table 1.1

Table 1.1: Salient Features of Water Supply System in Five WASAs (Year 2014-15)

Sr. No.	Water Supply Parameters	WASA Lahore	WASA Faisalabad	WASA Multan	WASA Rawalpindi	WASA Gujranwala
1	Water Source	Ground water	Combination of Ground and Surface Water	Ground water	Combination of Ground and Surface Water	Ground water
2	Total Population (Millions)	9.2	7.19	4.22	4.57	4.66
3	Population Served (Millions)	5.89	1.9	1.43	1.65	0.21
4	WASA served water supply area (km^2)	350	225	365.3	276	25.2
5	Number of Tube wells	528	77	102	362	67
6	Water Coverage	90 %	60 %	65 %	90%	40%
7	Average amount of water supplied (MGD)	450 MGD	93.5 MGD	221 MGD	68 MGD	39 MGD

8	Average per capita water supplied	80 GPCD	25 GPCD	50 GPCD	40 GPCD	50 GPCD
9	Supply Hours	14-18	6-7	6	2-4	10-12
10	NRW (% age)	38.4 %	32.9 %	22 %	43 %	39 %
11	Metering Ratio	5 %	1 %	-	-	-
12	Reservoirs (No. and Capacity)	52, 3.16 Million Gallons	44, 2.2 Million Gallons	18, 2.35 Million Gallons	36, 2.77 Million Gallons	10, 1.58 Million Gallons
13	Total length of Distribution System	5,544 km	1,218 Km	1,280 Km	1,200 Km	481 Km
14	Total Annual O&M Cost (Rs. Million)	7,354	1,652	1,075	700	643
15	Total water supply connections	636,338	270,451	66,900	114,655	26,091

2.4 Key Issues in Water Distribution System

Major key issues encountered in water distribution system after carrying out requisite site visits and discussions with WASA officials are discussed as under:

2.4.1 Nonrevenue Water (NRW)

For every water distribution system, prior to execution, some allowance of unaccounted for water (water losses through leakages in transmission and distribution mains, service connections, illegal connections etc.) is adopted for design of schemes. However, after execution of schemes, water losses in the form of leakages occur more frequently and in more intensity as was the system originally designed to contain it. These losses termed as Non-Revenue Water (NRW) has become an emerging challenge across Five WASAs to improve their existing water distribution systems.

It has been observed that this problem is more pronounced in developing counties as compared to developed countries, which is generally reported as 35 % in developing countries.

This NRW can be defined as the difference in water put into the supply and the amount of water to be billed to consumption. It comprises three main components as i) unbilled authorized consumption (water used for public buildings, parks etc.), physical losses (leakages from transmission and distribution mains, valves etc.) and commercial losses (illegal connections, inaccuracies in meters, water theft etc.)

Table 1.2 gives an assessment of Revenue and Non-Revenue water in Five WASAs which shows that about 91 MGD of water is being lost in lieu of NRW against 238 MGD of supplied water at Lahore whereas 8 MGD of water is lost in terms of NRW at Gujranwala against supply of 21 MGD, although this value is minimum among Five WASAs. Figure 1.1 shows graphical presentation of amount of Distributed, Revenue and Non-Revenue water in Five WASAs.

Table 1.2: Present Status of Revenue and Non-Revenue Water across Five WASAs (Year 2014-15)

Sr. No.	Name of WASA	Distributed Water (MGD)	Revenue Water (MGD)	Non-Revenue Water (MGD)
1	WASA Lahore	238	147	91
2	WASA Faisalabad	112	76	36
3	WASA Rawalpindi	81	46	35
4	WASA Multan	45	36	9
5	WASA Gujranwala	21	13	8

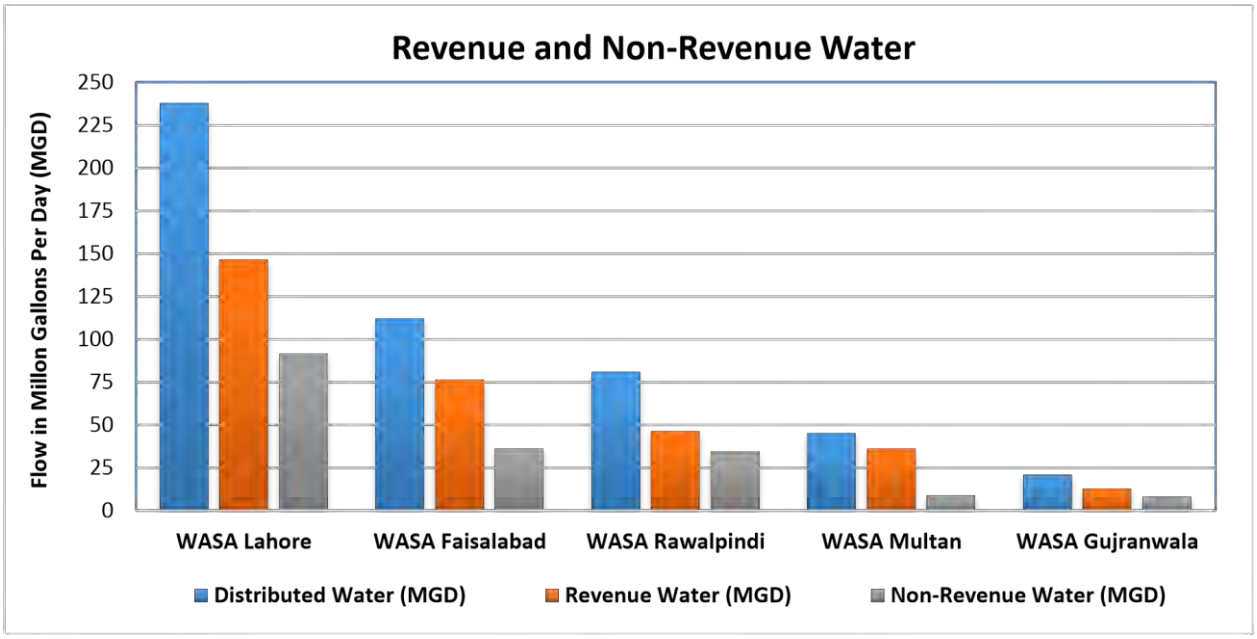


Figure 1.1: NRW Scenario in Five WASAs

From the above figure, it can be realized that NRW is varying on an alarming level and this situation necessitates the need and putting responsibility on five WASAs to develop hundred percent metering system, to account for actually consumed water by the consumers and further replace gradually the old aged pipes in the system. Although among different WASAs, replacement of pipes under Gastro project are being carried out, however, for improving the existing system of each WASA, this should be taken on priority basis. By reducing the leakages in the system will not only improve the water pressure in the system but will also bring improvement in the revenue collection of Five WASAs.

It has been observed after several site visits and discussions with WASA officials that the major contributing factors for NRW among all WASAs include old aged pipe infrastructure, absence of metering system, low pressure in the system, poor maintenance, invisible leaks (due to lack of early detection of buried pipeline leakages) and intermittent water supply. However, the most concerned among above is the presence of old aged pipes in the system. It has also been learnt that old aged pipe lines are contributing about 45 % leakages, inadequate corrosion protection contributing 25% leakages and poorly maintained valves, joints contributing 15 % water losses in the system.

2.4.2 Metering

The metering of water supply within Five WASAs is still in early stage of development. None of WASA has installed meters to ensure supplied water to consumers, except WASA Lahore and WASA Faisalabad, with the share of 30% and 1 % respectively. Out of 30% meters installed, only 5 % are in working conditions (Refer Plate 1). As informed by WASA officials, the major factor responsible for nonfunctioning of meters is the insertion of pressurized air in the installed meters blowing in the vicinity of areas and further rotation of meters, when getting intermittent supply at various intervals in the system.

Due to the absence of meters across Five (5) WASAs, the utility service providers are charging the consumers on flat rate basis, which is not as per actual consumption used by consumers. As a result of it, bills issued are on flat rate basis on the basis of plot size and not on the basis of meters. The Table 1.3 shows metering ratio in Five WASAs.

Table 1.3: Metering Ratio in Five WASAs

Sr. No.	Name of WASA	Metering Ratio
1	WASA Lahore	5 %
2	WASA Faisalabad	1 %
3	WASA Gujranwala	-
4	WASA Multan	-
5	WASA Rawalpindi	-

Plate 1: Domestic Meter at Consumer End

In order to address this problem, installation of extensive meters are required among all WASAs to ensure that consumers pay for their actual consumption. In this context, the domestic as well as non-domestic connections are required to be metered. This will not only check the wastage by consumers but also enable WASA to save revenues on the development of new water sources.

2.4.3 Tariff

At present, all WASAs collect revenues in lieu of providing water and sanitation services through tariff which is imposed on the basis of flat rate, due to absence of meters in the system. The tariff applied in different WASAs are on the basis of plot size varying from 5 Marla to more than 20 Marla for domestic as well as Non domestic connections, although at Rawalpindi and Multan WASAs, commercial connections are not charged on the basis of plot size, rather, it is on actually built assets and on the basis of ferrule size (especially in case of WASA Multan) respectively. Table 1.4 shows comparison of tariff levied on consumers for unmetered domestic connections by Five WASAs in Punjab Province.

Table 1.4: Water Supply Tariff (Rs. / Month) in Five WASAs

Sr. No.	Connections	Plot Size	WASA Lahore	WASA Faisalabad	WASA Rawalpindi	WASA Multan	WASA Gujranwala
1	Unmetered Connections (Domestic)	5 Marla	52	145	98	60	100
		7 Marla	78	242	160	100	125
		10 Marla	131	242	220	100	150
		1 Kanal	223	322	300	175	250
		Above 1 Kanal	311	644	500	250	325
		Above 2 Kanal	311	966	706	250	600

The above table indicates that tariff is lying in the range of Rs. 52 to Rs. 145 per month for five Marla Plot size, with WASA Faisalabad charging maximum tariff of Rs. 145 per month. It is evident from the above table that for 1 Kanal plot size, Tariff is ranging between Rs.31 to Rs. 364, with WASA Faisalabad charging highest tariff of Rs. 644 per month. This situation is also shown graphically in Figure 1.2 which indicates comparison of domestic tariff on unmetered connections in Five WASAs.

It has been observed that the present tariff rates charged by all WASAs for water supply are well below cost price, therefore, a gradual increase of the tariff is necessarily required to ensure equality between cost and tariff. This will not only improve the WASAs financial position but also recover O&M cost from the revenue collection from the consumers in terms of levied tariff on metering system, however, it is suggested that it should be based on an affordable cost to the consumers.

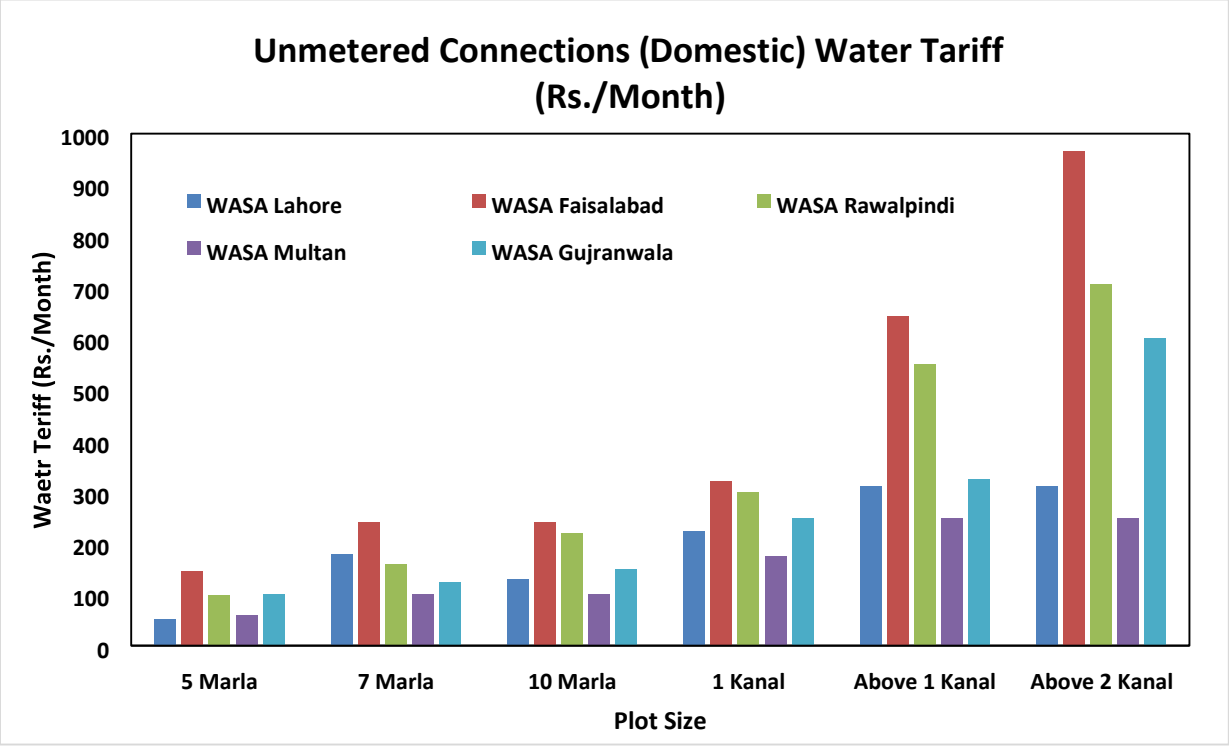


Figure 1.2: Domestic Tariff on Un Metered Connections

2.4.4 Intermittent Water Supply

All the WASAs in Punjab Province are supplying water on intermittent basis for a duration varying from 2 to 18 hours at Lahore, Faisalabad, Gujranwala, Multan and Rawalpindi. The detail of supply hours of different WASAs has already been discussed in previous sub sections. From the existing situation of Five WASAs discussed earlier, it is evident that WASA Lahore is supplying water for maximum duration of 14 to 18 hours among other WASAs and WASA Rawalpindi is supplying water to consumers for minimum duration of 2-4 hours in a day. However, supplying water on intermittent basis is a major contributing factor for inducing contaminated water in the system, especially when consumers (majority of consumers installed their own pumps in all WASAs) suck

water from the water mains during non-supply hours. As a result of this, negative pressure is being developed in the system which introduces contaminated water, particularly in vicinity of sewer/drain.

It is also important to indicate here that the adopted practice of supplying water through direct pumping on intermittent basis by five WASAs is the prevailing feasible option under present energy crisis situation which is further aggravated due to high energy costs involved for running the pumps installed at tube well chambers. However, to combat this situation, it is recommended to fully operationalize the already constructed reservoirs for balancing the water demand which at the moment are nonfunctional and only a small number of these are in working condition and are supplying water to consumers.

2.4.5 Low Pressure

Low pressure in water distribution system is more pronounced in areas distant from tube wells which are lacking in getting water of desired pressure. The areas adjacent to tube wells are having good pressures, however, pressure reduces in outer areas. This situation is more or less the same in all WASAs. The present capacity of surface and groundwater sources among Five WASAs is sufficient to meet the average water demand except at WASA Lahore, however, it becomes reduced during peak hour duration demand.

2.4.6 Aging Network

The pipes used for supplying water to consumers by Five WASAs include Asbestos Cement (AC), Ductile Iron (DI), Galvanized Iron (GI), Poly Vinyl Chloride (PVC), High Density Poly Ethylene Pipe (HDPE), Cast Iron (CI) and Mild Steel (MS) Pipe. The AC pipes have mainly been laid more than ninety (90%) in all WASAs along with small contribution of other pipes. The pipe infrastructure laid in all WASAs are very old, more than fifty years ago and as a result, corrosion, pipe leakages and water contamination problems are evident in the system. The leakages not only are contributing less flow (mostly from faulty joints, corrosive portion of pipes) but also effect the availability of adequate water of desired pressure to consumes. As an impact of aging pipes in the system, the carrying capacity of pipes become reducing and pipes cannot sustain high pressure and there are likely chances of bursting of the pipelines upon high pressure. The useful life of different pipe materials used by WASA are given in Table 1.5.

Table 1.5: Age of Pipe Materials used by WASA

Sr. No.	Pipe Material	Age
1	Asbestos Pipes	40 Years
2	Ductile Iron (DI)	30 Years
3	Poly Vinyl Chloride (PVC)	30 Years
4	Cast Iron (CI)	100 Years
5	Galvanized Iron (GI)	25 Years
6	Mild Steel (MS)	40 Years

Although, the water supply pipes deteriorate with the passage of time, however, gradual replacement of the old aged pipes is the most concerned challenging factor reducing leakages and water quality concerns in all WASAs. The five WASAs in this context are replacing old pipe lines in their system through different programs initiated by Government of the Punjab. However, another aspect in which all WASAs are lacking is the absence of equipment for identification of buried pipeline leakages which is resulting wastage of water without knowing its exact location and volume in the system which needs to be addressed by all WASAs.

2.4.7 Water Quality

The water quality among five WASAs varies from each other. WASA Lahore, WASA Multan and WASA Gujranwala are abstracting water from the ground through tube wells and at WASA Faisalabad and WASA Rawalpindi, water is being supplied to consumers through combination of surface and groundwater. The water quality in Multan, Rawalpindi and Gujranwala Districts is relatively good and water is not contaminated with bacteria and other viruses. However, for WASA Lahore and WASA Faisalabad, water quality is of moderate level with arsenic levels at nearly equal to border line value of permissible WHO Guideline value. The water of Faisalabad is also reported as saline and water is not fit for drinking purpose, although in the analysis, Total Dissolved Solids (TDS) are within range, however, it is varying at different locations in the city. In order to address this problem, WASA Faisalabad is gradually shifting to surface water sources, although 3.5 MGD of water treatment plant (with small contribution to Faisalabad water supply demand) comprising slow sand and rapid sand filters already exist at Jhal Khanuana, still these plants are abandoned due to construction of underpass near the plant site. The water quality analysis results

of tube wells and surface water sources of Five WASAs are given in Table 1.6 and Table 1.7 respectively.

Table 1.6: Water Quality Analysis Results of Five WASAs (Year 2016-17)

Sr. No.	Water Quality Parameter	WHO Permissible Guideline Value	Water Quality Analysis Results				
			WASA Lahore (Ali Park)	WASA Faisalabad (Mansoora Abad)	WASA Gujranwala (Ratta Road Tube well)	WASA Rawalpindi (Zafar ul Haq Road, UC 42)	WASA Multan (Chowk Nawan Shehr)
1	Appearance	Clear	Clear	Clear	Clear	Clear	Clear
2	Temperature	-	-	-	25 ºC	18	NA
3	Turbidity	5 NTU	0.76	0	0.51	2.5	Unobjectionable
4	pH	6.5-8.5	8.1	7.55	7.1	7.15	6.52
5	Alkalinity	500 mg/l	160		50	200	110
6	Hardness as CaCO3	500 mg/l	136	182	50	175	140
7	Electrical Conductivity	2000 uS/cm	453	432	204	865	710
8	Calcium	200 mg/l	37.6	32	32	61	45
9	Total Dissolved Solids (TDS)	1000 mg/l	285.3	250	143	604	345
10	Chlorides	200 mg/l	37	10	52	10	130
11	Fluoride	< 1.5 mg/l	NA	NA	0.06	NA	NA

12	Arsenic	0.05 mg/l, or	49.2	6.34	0.01	-	Nil
13	Fecal Coliform	Nil/100 ml	Nil	Nil	Nil	Nil	Nil

Table 1.7: Surface Water Quality Analysis of WASA Faisalabad and WASA Rawalpindi (Year 2016-17)

Sr. No.	Water Quality Parameter	WHO Permissible Guideline Value	Surface Water Quality Analysis Results	
			WASA Faisalabad (Rakh Branch Canal)	WASA Rawalpindi (Rawal Water Treatment Plant, Treated Water)
1.	Temperature	-	22	15
2	Color	15 True Color	Colorless	Colorless
3	Odor	Odorless	Odorless	Odorless
4	Taste	Un objectionable	-	-
5	pH	6.5-8.5	7.5	7.28
6	Electrical Conductivity	-	206	790
7	Turbidity	< 5 NTU	21	3.48
8	Total Dissolved Solids	1000 mg/l	143	395
9	Total Solids	-	195	-
10	Total Suspended Solids	-	52	-
12	Calcium	75-200 mg/l	143	56
13	Magnesium	50-150 mg/l	54	-
14	Total Hardness	10-500 mg/l	4	164
15	Carbonates	-	Nil	-
16	Bicarbonates	-	116	-
17	Chlorides	250 mg/l	26	12

It is evident from Table 1.7 that treated water quality of Rawal Water Treatment Plant, Islamabad is good, and all the parameters are within prescribed limits of WHO Guideline values. However,

water quality analysis of Rakh Branch Canal near Novelty Pull, Faisalabad indicates that canal water is turbid which shows presence of suspended solids in water, however, all other physical, chemical and bacteriological parameters are within permissible range of WHO Guideline values. Therefore, water at Faisalabad after treatment can be supplied to consumers.

2.4.8 Cross Connections

Cross connection is an important concerning problem common in all WASAs, which is causing contamination of water supply lines in vicinity of sewer/drain. This problem is mainly due to the supplied water on intermittent basis. The old aged pipe infrastructure having structurally week, carrying cracks and corrosion, with leaking joints suck contamination from sewer when pumps are stopped. In order to address this problem, proper horizontal and vertical clearance between water supply pipe and sewer/drain pipe are required to be adopted.

2.4.9 Lack of Records

After carrying out visits to different WASAs, it has been observed that majority of field offices of WASAs lack in maintaining records related to distribution maps, operational and maintenance data, pipe leakages data, water quality analysis results and listing of replacement of goods. Due to the absence of the above data, operational activities some times are affected, although the experienced staff available at field offices handle the problem effectively. However, for a sustainable water supply system, maintaining the operational data is of great significance to operate the system more efficiently.

2.4.10 Inadequate Operation and Maintenance

The pre-requisite for a successful utility provider to operate the system efficiently demands adequate operation and maintenance of the system so that problems at consumers end (less pressure, water quality problem at tap etc.) could be resolved more effectively at much earlier stage. Among all WASAs, after the construction of utility assets, it is handed over to operations department which carry different activities to run the system effectively. However, on the other way around, inadequate O&M results in reduced useful life of the components of the system with outcome of early replacement of components before its due time.

The maintenance in a broader spectrum could be of two types, routine as well as preventive maintenance. Routine maintenance includes replacing the parts of the system components when not in working condition or damaged. However, for preventive maintenance, the activities for maintenance are planned earlier which include visit of networks through road patrolling, cleaning

and greasing of mechanical components, maintaining spare goods in the store to keep utility infrastructure in a good working condition.

It is worth mentioning that government is spending several billions of rupees on the development of infrastructure and schemes and these become fail due to unsustainability owing to poor operation and maintenance practices, therefore, all WASAs which already have had large operational departments should invest on the training of their staff, enhancement of technical knowledge through trainings so that they could be able to operate the utility systems in a more organized manner.

2.4.11 Financial Constraints

After discussions with WASA officials and site visits, it was learnt that all the WASAs are suffering from severe financial constraints, expenditures are more than the collected revenue per annum. The government is also providing subsidy of Rs. 200 Million to every WASA for not increasing tariff levied on consumers. Despite all efforts going on, the financial situation of every WASA is still effecting badly every year. The reason behind is the more spending on power cost (about 70% in all WASAs) due to pumping of water through tube wells. In addition, collection of revenue through tariff is quite below the operating cost.

Therefore, to address the financial constraint, increase in tariff is required as per actual consumption, however, on an affordability cost of consumers.

Course Code: W1221

O&M of Water Distribution System

Module 1

Participant Lecture Notes

Lecture 2

2017

1. Lecture Information

Course Title: O&M of Tube Well and Pump Facility	**Course Code:** W1221
Module Title: O&M of Water Distribution System	**Module No:** 1
Lecture Topic: Operation and Maintenance of Water Supply Pipelines and Valves	**Lecture Duration:** 120 Minutes

2. Operation and Maintenance of Water Supply Pipelines and Valves

2.1 Introduction

For any water supply scheme, after execution on the ground, it is the operation and maintenance of the system which plays pivotal role in delivering the reliable and adequate supply of water to the consumers. Aimed this situation, Five WASAs are operating their water supply systems efficiently, however, still the improved service delivery further requires effective operational management of water supply system which at present is also a requirement of meeting sustainable development goals regarding water sector (Ensuring availability and sustainable management of water for all) under UNO Declaration. Although, the rapid urbanization coupled with population increase has produced increased pressure on utility service providers which at present are facing problems due to number of prevailing issues including wastage of water (NRW), inadequate tariff on flat rate basis, aging pipe infrastructure, lack of human resources, absence of training program for human capital etc. Therefore, it is imperative for Five WASAs to improve their operations through adopting better operational practices that will result improved service delivery to consumers.

Regarding O&M of water supply sector, following are the major components:

i) Water supply pipelines ii) Control Valves (Air valves, Drain valves, Gate/Sluice Valves) iii) Overhead Reservoirs
iv) Fire Hydrants

This lecture has been divided into different activities which will be carried out, the detail is as under:

2.2 Group Discussion

The lecturer will first invite discussions regarding major challenges being faced by five WASAs in running the system and afterwards will summarize the discussion and highlight the importance of

operation and maintenance activities needed to operate the system. In the discussion, pictorial examples of snaps indicating inappropriate O&M will also be shown (Refer Plates 1-2).

Plate 1: An Example of Inappropriate O&M

Plate 2: Improper Storage of Damaged Valves and Pipes in Stock Yard

2.3 Description of Operation and Maintenance (O&M) Activities

2.3.1 Operation

Operation is a terminology which is used to refer daily operations of various components of water supply system such as pipelines, valves, overhead reservoirs, fire hydrants, equipment to deliver reliable and safe supply of water with adequate pressure.

2.3.2 Arrangement of Water Supply System

The planning and Design of a water supply system is dependent on many factors including source of water, transmission of water to overhead Reservoir, then onward distribution through distribution pipelines to community. Generally, two types of sources exist:

A) Surface Water
B) Groundwater

The description of surface and groundwater sources is given in Figure 1.1

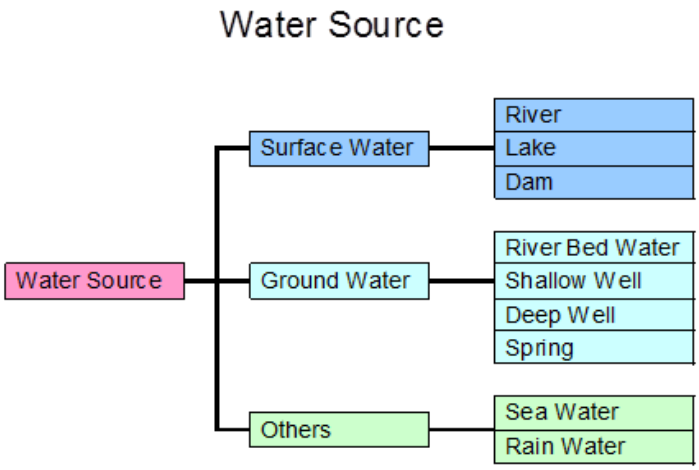


Figure 1.1: Type of Water Sources

In perspective of status of groundwater of five WASAs, it has been observed that groundwater is declining day to day in five utility service areas and it is perassumed that groundwater after 10 years will not be in sufficient quantity to cope the water demand of future population. Therefore, it is

imperative to gradually shift to surface water source. In surface water treatment, water after treatment from water treatment plant can be transmitted to reservoir and then distributed to consumers. Figures 1.2 and 1.3 indicate a general arrangement of supply of water through tube well and on the basis of surface water treatment.

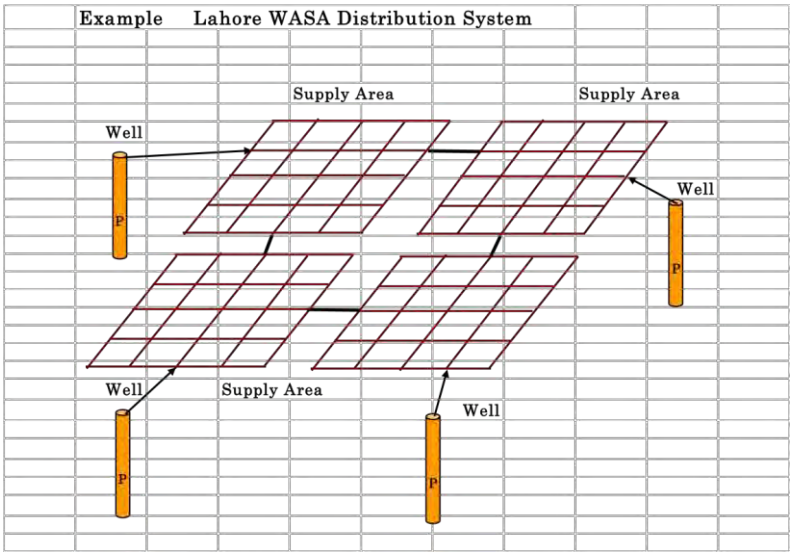


Figure 1.2: Water Supply System based on Groundwater (Tube well)

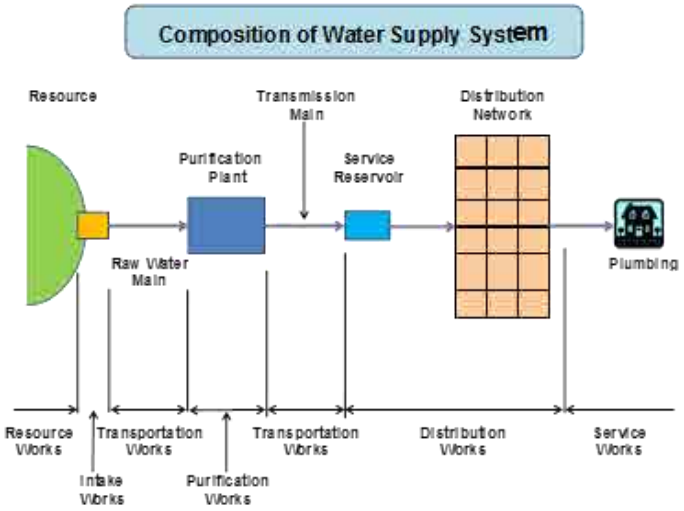


Figure 1.3: Water Supply System based on Surface Water (from intake to Distribution)

In comparison of above two systems, it is obvious that water supply system based on groundwater caters less cost as compared to surface water treatment option. However, due to increase in water

quality concerns in all WASAs, the shifting towards surface water treatment has become a requisite to provide treated water to consumers. In this context, it has been observed that the water quality of surface water treatment plant is generally good which in turn reduces water borne diseases linked with contamination present in water and also builds the confidence of public for improved service delivery by utility service providers.

2.3.2 Components of Water Distribution System

The water distribution system includes water resource development, tube wells, pipes, valves, hydrants and appurtenances, the detail is as under:

2.3.2.1 Water Source Development

For any water supply scheme, a staged approach to water source development is necessary for effective use of resources. Though Punjab's major water supply is dependent on ground water sources, but for broader understanding of resources Table 1.1 gives some assessment of different water sources be used as a checklist of major factors considered when assessing and selecting suitable water sources. If a range of water sources is available and choice has to be made, use the matrix ranking to analyze the options. To decide which sources to exploit consider following questions during your source assessment:

- Estimate the yield of existing sources: Is the yield sufficient to meet the demand of water?
- Carry out sanitary survey (Refer Water Safety Plan Lecture 3 for further details) of the existing sources: What measures are needed to safeguard the quality of the source water?
- Determine the time, materials and equipment needed to protect, improve and further develop the existing sources. Compare the advantage of using the existing sources against the development of new sources

Table 1.1 : A Guide to Water Source Selection

Source	Surface water		Groundwater		
	River, Stream, Lake	Rainfall Collection (Rainwater Harvesting)	Spring	Shallow Well	Deep Well
Yield	May be seasonally variable – assess lowest yields	Unlikely to meet total demand; may be used as supplement	Seasonally variable; wide variation between yields of springs	Seasonally variable; wide variation between yields of wells	Yield fairly constant except in droughts; wide variation in

					yields between boreholes
Collection	Stream diversion or pumped abstraction Control access	Collect from roofs or divert surface runoff to ground tanks	Protect and develop gravity flow to supply	Protect and cover; hand or motor pump to storage	Motor pump to storage;
Notes	Often easily accessible and developed if source is near.	Simple to implement if material and equipment is available	Good source Quick to develop for communities small in size.	Needs good organization. It depends on type of soil to be digged for water.	Expensive, High Skills, Specialized Equipment, and time for all type of soils.

Ground Water

The main source of water source in Punjab in most of the WASAs is ground water, which is discussed as under:

Groundwater is water underground that fills the natural openings in rocks and sediments. Recharge is the process whereby rainwater percolates through the soil, and through fractures and joints in rock, until it reaches the water table and joins the groundwater flow system. Like surface water, water underground flows under the influence of gravity. Consequently, groundwater is likely to be closer to the ground surface in the bottom of the valley than at the top of a hill.

Groundwater movement is slower than the movement of water in streams and rivers under the same topography gradient. This is because of the resistance to flow caused by the interconnected system of pore spaces, fractures or solution cavities in rock. The speed of movement is also dependent on the hydraulic gradient. In some alluvial aquifers and rock fractures, the flow rate may be up to a few meters per day, but in other less permeable aquifers, the flow rate is the order of a few meters per year. A consequence of the slow movement of groundwater is that the water has time to dissolve chemicals from the soils and rock through which it passes. The longer the time spend underground, and the more soluble the rock, the higher will be the level of dissolved solids in the groundwater, indicated by the electric conductivity (EC) . EC

can be measured with a hand-held, battery powered EC meter. If water sampled from a well source has a 'low salinity' (a low EC of say 150µS/cm) then the water may not have had much time to dissolve minerals in the rock. This could mean the water has moved relatively quickly through the aquifer and the any pollution of the upstream groundwater could also move quickly to the well. A slightly saline water (EC of say 1200 -1800µS/cm) may indicate that the groundwater has followed a long travel path. Figure 1.4 and 1.5 show the overview of hydrological cycle and groundwater flow through ground strata.

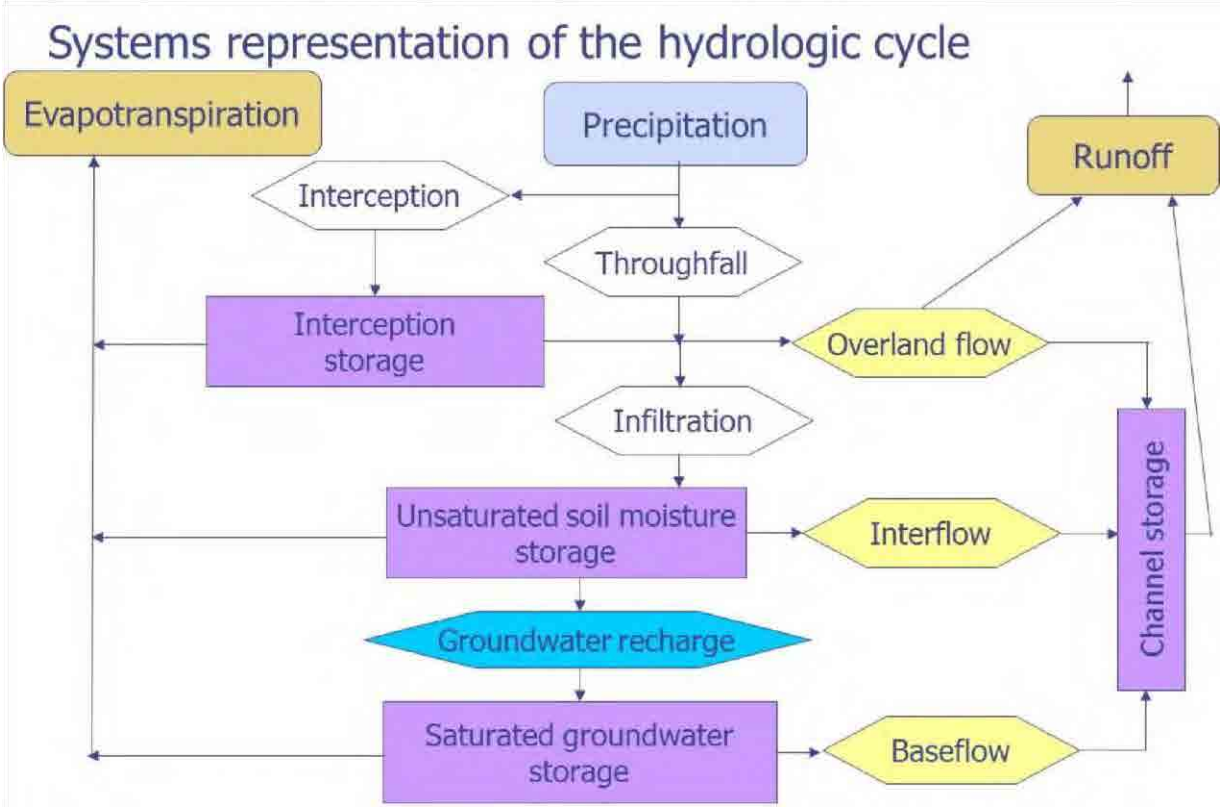
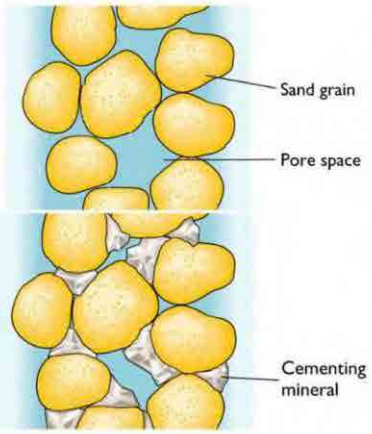
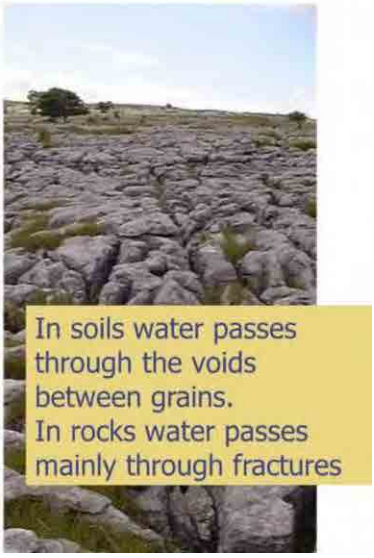
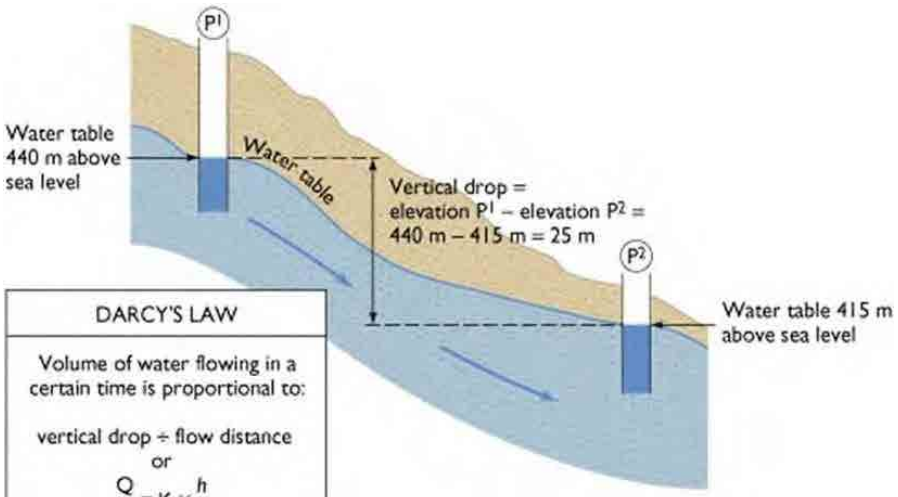


Figure 1.4: Overview of Hydrological Cycle

How Water Flows Through Soil and Rock







DARCY'S LAW

Volume of water flowing in a certain time is proportional to:

vertical drop ÷ flow distance

or

$$\frac{Q}{A} = K \times \frac{h}{\ell}$$

- Q: Volume of water flowing in a given time
- A: Cross-sectional area through which water flows
- K: Hydraulic conductivity (a measure of permeability)
- h: Vertical drop between two points
- ℓ: Distance the flow travels

BOX E - Classification of Geomaterials:

- Aquifer – soil/rock that can store and transmit water (k>1m/d -for a good aquifer k>30m/d) e.g. gravel, sand, chalk, fractured sandstone.
- Aquiclude – soil/rock that can store water but cannot easily transmit it ($k<10^{-5}$m/d) e.g. clay.
- Aquifuge – soil/rock that cannot store or transmit water ($k<10^{-5}$m/d & very low porosity + wide discontinuity spacing) e.g. granite (un-fractured).
- Aquitard – soil/rock that can store and transmit water but their permeability is not sufficient to allow the completion of production wells (eg clays, shales and dense crystalline rocks)

Ground Water Flow :

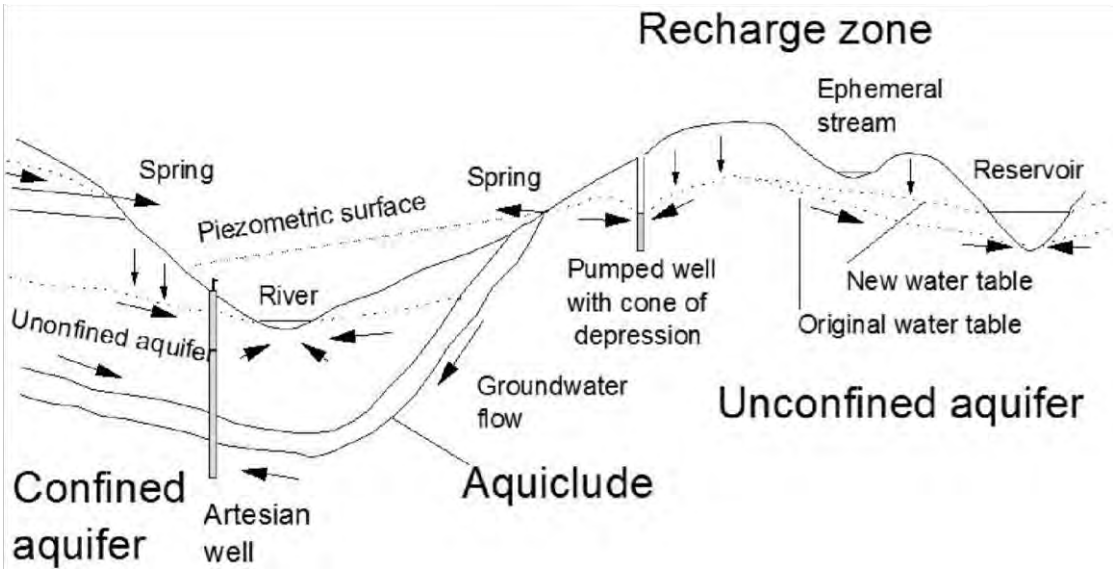


Figure 1.5: Groundwater Flow through Strata

2.3.2.2 Tube well

Tube well is a water well used to draw groundwater to supply onward to consumers. Two types of wells are common given as under:

1. Shallow Wells (Depth of well is less than 30 meters)
2. Deep Wells (Depth of well is more than 30 meters)

The detail of major components of tube well are as under:

a) Housing Pipe/Casing Pipe
b) Strainer/Screen Pipe
c) Blind Pipe
d) Bail Plug
e) Vertical Turbine Pump

Housing Pipe

Housing Pipe is used to maintain an open access in the earth and to prevent any entrance of surrounding formations.

Strainer/Screen Pipe

The strainer is used to keep sand and gravel out of well while allowing groundwater and water from formations to enter into the well.

Blind Pipe

A Plain pipe with no slots which is fixed against an impervious strata.

Bail Plug

Bail Plug is provided at the bottom of pipe and strainer assembly.

Gravel Pack

Gravel is placed around the outside of the screen to prevent sand from entering into the well and to stabilize the well assembly.

Vertical Turbine Pump

Vertical turbine pump is most commonly used in tube well in almost all WASAs, except in WASA Rawalpindi (where submersible pumps have been installed). The vertical turbine pump is driven by a shaft rotated by a motor on the surface. The shaft turns the impellers within the pump housing while the water moves up the column.

2.3.2.3 Service Reservoirs

Service reservoirs are introduced into a water distribution system to provide temporary storage facilities for treated water so that the widely fluctuating daily demand on the system can be met by provision of the minimum pumping capacity and the smallest delivery mains.

As these tank are used for storage of treated water, it is essential that these tanks should be covered and that there should be no leakage in or out that may lead to pollution of the supply.

Common sizes for service reservoirs supply water between ½ to 3 days community supply and they are usually in the form of large rectangular reinforced concrete tanks, with internal columns and concrete roof slab, or in the form of water tower of various shapes.

Obviously the size of the service reservoir required for a particular system will depend on the demand placed on that system.

Functions of Service Reservoir:

Service reservoirs fulfill some or all of the following functions:

- To provide a reserve of treated water that will minimize interruptions of supply due to pump failure or failure of mains,
- To enable a widely fluctuating demand to be satisfied by a constant rate of pumping or treatment and/or by intermittent pumping, and through smaller mains than would otherwise be needed to meet peak rates of demand,
- To act as a break pressure tank where the range of elevation of an area served from a common storage reservoir makes it necessary to sub-divide the distribution system into zones,

- To permit a reduction in the size of distribution mains below that which would be required in the absence of a reservoir, or to act as an alternative to partial duplication of an existing main as the demand increases,
- To provide a reserve of water for fighting in isolated areas.

Secondary Functions:

- May act as a central storage facility for supplies form 2 or 3 sources so that management problems are alleviated, ▪ Water at inlet and outlet to the tank is aerated, resulting in fresher water.

2.3.2.4 Distribution Pipelines

Eight pipe materials are extensively used for transmission and distribution of water in water supply system and include Mild Steel (MS), Ductile Iron (DI), Asbestos Cement (AC), Galvanized Iron (GI), Poly Vinyl Chloride (PVC), Unplasticized Polyvinyl Chloride (uPVC), and High Density Polyethylene Pipe (HDPE). These material are widely available and are manufactured and tested according to very stringent codes and standards. The merits and demerits of the above pipes are given in Table 1.2

Table 1.2: Merits and Demerits of Transmission and Distribution Pipes

Sr. No.	Pipe Material	Advantages	Disadvantages
1	Mild Steel (MS)	- High strength for supporting earth loads -Low in cost -Easily handled and transported - Can withstand up to 65 Bar Pressure	- Poor corrosion resistance -Must be lined and protected on the outside against corrosion
2	Ductile Iron (DI)	- High strength for supporting earth loads, less brittle than CI, lighter than CI - Can withstand up to 25 Bar Pressure	- Heavy weight -May require wrapping or cathodic protection in corrosive soils or water, typically lined to limit corrosion

3	Asbestos Cement (AC)	-Rigid -Light weight in long lengths -High tensile strength -Easily tapped, cut -Low friction to water flow -Corrosion resistant to most soils and water -Flexible joints can be used to allow some deflection	-No longer used in new constructions because under corrosive conditions, it can release asbestos fibers harmful to human health -Easy breakage when bent -Difficult to locate
4	Cast Iron (CI)	-Inexpensive -Durable -Ability to withstand high pressure -Easy to install -Leak location straightforward	-Heavy , Brittle, -Corrodes in soft water, water with high chloride reduces carrying capacity - Leaves a metallic taste in water due to leaching of iron
5	Poly Vinyl Chloride (PVC)	-Inert and stable material -Resists corrosion -Cheap -Easy to install -Smooth interior surface -Very low frictional losses	-Very brittle (break or crack easily) - less flame resistant - at higher temperature their strength reduces
6	Unplasticized Polyvinyl Chloride (uPVC)	-Good corrosion resistance -Light weight -Ease of jointing -Low cost -Smooth internal surface	-Brittle susceptible to impact damage -Degradation by certain organic compounds - Susceptible to poor installation practice
7	Galvanized Iron (GI)	-Low initial cost -Toughness -Long life -Easy inspection -Fast assembly	-Contain lead and Corrode easily -Deposits buildup causing blockages

8	High Density Polyethylene (HDPE)	-Flexible -Easily transported because can be rolled -Used in trenchless installations -Lightweight -Resistant to cracking	-Difficult to locate -Fusion jointing require skilled installer and special equipment -Not suitable for large diameters

2.3.2.4.1 Design of Water Distribution Systems (Basics)

The design of water distribution systems requires a knowledge of :

- Demand – not only the total average demand, but also the pattern of demand variation and the likely simultaneous demand from a number of properties
- Mains capacities
- Pressure to be maintained in parts of the system.
- Storage capacity required.

The lecture notes give a guide to factors that should be taken into account, the requirements for individual applications will be defined via national, regional, and local standards

A number of methods of distribution network analysis exist, although the choice is effectively between computer based method like EPANET, WATERGEMS or manual calculations for a small network. This course focuses on EPANET which can be downloaded from website freely, whereas WaterGEMS is expensive software modeling tool.

Following Box D shows Method of Analysis for Water Distribution Network and basic principal :

Box D Methods of Analysis

Exact Mathematics ----------Network of "n" separate mains (or elements) hence "n" unknown flows and "n" unknown head losses. Giving 2n simultaneous equations to be solved (Linear) (very difficult and impractical)

Trial and Error ----------Network subject to a number of trials which gradually approach a balance (very time consuming and laborious)

Graphical Methods ----------Producing head loss v/s quantity flow graphs for each main may assist a numerical trial.

Analogue Computer ----------Electrical Model h----------voltage

Q--------- current

(can use transistor electronics)

Hardy Cross Relaxation Method----------Assumed flows tried on a circuit >determine flow error

$q = - \sum h / n \sum (h/Q)$

where it is assumed that $h = kQ^n$

Assumed flows are corrected evenly by flow error and a further trial balance made. After several trials q should become insignificantly small (although sometimes individual q values will increase before decreasing with further trials) this method is applicable for small networks.

Digital Computers ----------Basically computer programs use 3 conditions

Q/h relationship

$\Sigma Q = 0$

$\Sigma h = 0$ in any circuit or loop.

No convergence formulae necessary but number of trials is greater. EPANET is free software, other commercially available software are WaterCAD, WaterGEMS and WatNET etc.

2.3.2.5 Valves

Following are the valves used in distribution system.

A) Gate Valve/Butterfly Valves

Gate valves are used to provide complete isolation of any section of pipeline by providing electrically/manually operated gate/butterfly valves at selected intervals depending upon the alignment of the supply line.

All isolation valves are placed in reinforced concrete chamber. Provision is also provided for blind flanged take off branches in all chambers for future extension of water supply to other reroute area, if required. Figure 1.6 shows sketch of a gate valve used in distribution system.

Valves should not be closed suddenly as this will cause an immediate increase in pressure (water hammer) which could damage pipe and fittings. Gate valves avoid sudden closure problems because they can only be screwed down relatively slowly. Overtightening gate valves can damage the mating faces and valve threads.

Gate valves should be inspected for leaking valve stems. The stem seal may be a compression packing or an "O" ring. Packing must be tightened only enough to prevent leakage and no further. Packed glands can be temporarily repaired with natural string or other material which expands when wet.

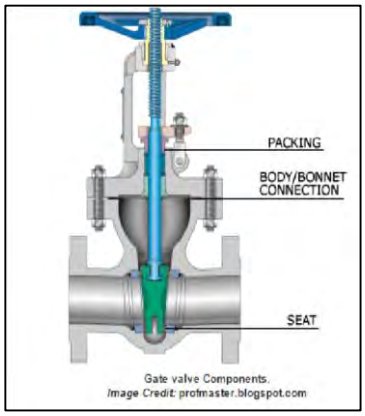


Figure 1.6: Sketch of Gate Valve

B) Air Release Valve

Air Release Valves are used to remove air during pipe filling and to avoid sub atmospheric conditions during transient flows. Air release valves will also be installed at all summit points in the pipelines. Generally, air release valves are double orifice type fitted with isolated gate valves. The air valves will be installed in well ventilated reinforced concrete chamber. Figure 1.7 shows sketch of Air release valve.

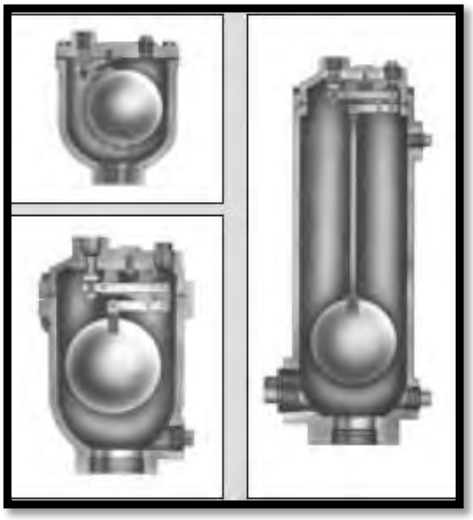


Figure 1.7: Sketch of Air Release Valve

C) Drain Valve/ Wash Outs

At low points in water distribution system, drain valves/wash outs are provided to facilitate the emptying of pipeline for inspection or repair etc. or to drain off the sediments at low points. A tee branch takes off from the pipeline to discharge into a natural ditch through a controlling gate valve. The drain valve is generally installed in a concrete chamber.

D) Altitude Valves

Altitude valves are generally used at Reservoir. An altitude valve is similar in design to a pressure reducing valve and can be adjusted to allow water to fill a reservoir at a controlled rate and is activated by the water pressure from the reservoir to close automatically when the reservoir is full.

E) Pressure Relief Valves

Pressure relief valves are used to reduce pressure in supply lines (mainly transmission lines) caused due to water hammer (A rapid increase in pressure in a water system is called surge or water hammer). Common causes of water hammer include starting or stopping a large pump or opening

or closing a valve quickly. Pressure relief valves can be installed at points on a water system to release some of the high-pressure water created by the water hammer.

F) Check Valves/ Non return/reflux

Check valves are used at generally pumping station to prevent back flow of water. A check valve uses a hinged disc which close flow openings when the flow is reversed. Check valves are often equipped with a weight and spring that assists the valve in closing rapidly under flow reversal.

2.3.2.6 Fire Hydrant

A hydrant is an outlet provided in a water distribution main or sub main to tap water for its use during fire. Purposefully, it can also serve the filling of water tankers, if required. During a fire, nearby hydrant is connected to fire hose and water obtained from hydrant is used for extinguishing the fire.

Generally, the type of fire hydrant used in service areas maintained by utility service providers is post type fire hydrant, which lies 0.9m to 1.2 meter above the ground. The post fire hydrant consists of a barrel of Cast Iron (CI) with connection to water main. There is a valve stem with a leather valve at its lower end. The valve stem at the top is connected to a nut to regulate the flow. For opening the hydrant, the nut is opened so as to raise leather valve up and thereby admitting water into hydrant barrel. The hydrant is provided with two, three or four outlet openings. Plate 3 shows Post Type Fir Hydrant in green town area under WASA Lahore Jurisdiction.

Plate 3: Post Type Fire Hydrant at Green Town, Lahore

2.3.4 Operational Action Plan

For ensuring the supply without any interruption and meeting the safe water requirements without any contamination, an operational action plan has emerged as an important tool to be implemented in field including different operational issues, its causes and mitigation measures in the form of different checks to operate the system sustainably. Further, different operational issues like leakages in supply lines, low pressure, and absence of recording pressure in supply lines through pressure gauges etc. has further emphasized the need of operational plan to be developed for improved O&M practices.

The Lecturer will also share the operational action plan (Refer Table 1.3) with training participants for improved O&M development, to apply different checks for efficient operations.

Table 1.3: Operational Action Plan

Sr. No.	Problem	Possible Cause	Mitigation Measures	Key Responsibility
1	Non availability of updated Water Supply Maps	No GIS Map available at WASA operational offices	- Update water supply Maps with clear description of pipe sizes (diameter), location of valves with updated information of pipes replaced after repair - Ensure availability of updated Maps at respective sub division offices	Sub Divisional Officer (SDO), Supervisor
2	Taste and Odor	- High Chlorine Residual - Presence of salts in water	- Lower Chlorine Doze - Apply routine flushing of supply lines or appropriate treatment method	SDO, Supervisor and Operator
3	Turbidity	Due to presence of Silt or Clay in water (suspended solids)	- Apply flushing of pipelines and appropriate treatment Method	SDO, Supervisor and Operator

4	Coliforms or Bacteria	Water contaminated due to inadequate chlorine or ingress of contamination transmitted from sewer line in vicinity of water supply line (due to corroded old aged water supply pipes)	- Increase chlorine doze as per requirement of WHO Guidelines	SDO, Supervisor and Operator
5	Pipeline Leakages	- Corrosion, - old aged pipe infrastructure, - absence of leak detection equipment for	- Repair the Pipeline leakages with appropriate method and material - Ensure Gradual replacement of old aged	Supervisor and Operator
		identification of buried pipe line leakages	pipe infrastructure in the network - Conduct Water Audit on regular basis	
6	House Connection Leakages	- Corroded and substandard material of pipe used for House Connection - Illegal or unauthorized connections - Poor plumbing practices inside house	- Ensure Polyethylene Pipe for House Connection - Ensure provision of meters at consumer end - Ensure standard pipe material for House connection	Supervisor and Operator

7	Leakages of Valves	- Corrosion of Valves - Presence of contaminants in water - Poor maintenance - Worn packing material	- Ensure Periodic Inspection of valve chambers (Air release, sluice valve chamber, drain valve chamber etc.) - Ensure that stuffing boxes of valve are properly packed to prevent leakages - Ensure replacement of ball of air release valve upon requirement - Ensure the valve chambers completely dry. - Lubricate gland bolts with suitable lubricant - Replace cover/bonnet gasket after certain duration	Supervisor and Operator
8	Low Pressure	-Under Capacity pipes present in the system, distant from tube well - Corrosion of pipelines - leakages in supply lines - Interruption of supply from source - Valve in system partially closed	- Control buried pipeline leakages - Replace under capacity pipes with increased sizes as per water demand of the area - Replace gradually old aged pipes in the network - Inspect the valve chamber condition in service areas to identify leakages	SDO, Supervisor and Operator

9	Lack of recording Water abstraction at source and consumption by community	- Absence or presence of faulty bulk flow meters at source (tube well) - Absence of consumer meters	- Provide Bulk Flow meters at sources for recording the flow and ensure hundred percent consumers metering in the system	Supervisor and Operator
10	Loss of Residual Chlorine	- Inadequate quantity of Chlorine Solution (Sodium Hypochlorite) at tube well chamber - Some operational problems linked with chlorine feed pump to supply chlorine in main line at tube well chamber	- Replace Chlorine solution tanks on regular basis at tube well chambers - Check condition of chlorine feed pump to deliver required amount of chlorine solution tank	Supervisor and Operator
11	Lack of Monitoring of Pressure at source and in distribution system	- Absence of pressure gauges at various tube wells - Faulty Pressure gauges	- Ensure presence of pressure gauges at all tube wells - Make repair of faulty pressure gauges on priority basis	SDO, Supervisor and Operator
12	Water loss	-Old and deteriorating pipe network -illegal connections	All connections (domestic and commercial) need to be metered.	SDO, Supervisor and Operator
13	Cross Connection Control	Ingress of contamination from sewer line to water supply lines due to intermittent supply (mainly due to corroded water supply pipe network and rusted leaking faulty joints)	- Proper horizontal and Vertical Clearance between water supply and sewer/drain pipe need to be provided.	SDO, Supervisor and Operator

14	Defective Meters	- Repair Problems - Rotation of meters due to pressurized air and starting of supply on intermittent basis	- Replace defective meters with new meters	SDO, Supervisor and Operator
15	Improper Metering	-Majority connections are unmetered - Faulty Meters	- Ensure metering system at consumers end - Ensure routine repair of meters	Executive Engineer, SDO, Supervisor and Operator
16	Leakages through Reservoirs	- Structural cracks in reservoirs - Internal corrosion of connected piping (inlet, outlet, overflow, bypass pipe) - Improper closure of valves	- Inspect the reservoir on regular intervals from inside and outside - Inspection of connecting pipes and valves on regular basis - Monitor water levels in Reservoirs on regular basis.	Supervisor and Operator

2.3.5 Maintenance

Maintenance refers to contain all the system components (supply pipes, valves, equipment etc.) in a good optimum working order by repair and maintenance. The maintenance can be divided into different types such as i) Routine Maintenance ii) Preventive Maintenance, the detail is as under:

2.3.5.1 Routine Maintenance

The routine maintenance refers to accomplish repair and replacement of parts of the system (pipes, valves, fittings etc.) when damaged or leakages becomes evident from them. This routine maintenance is necessary for running the water supply system effectively.

In addition to above, some emergency repairs may also occur such as outbreak of pipe lines, break down of some equipment. For that purpose, all utility service providers must have a plan of action to deal with emergencies.

2.3.5.2 Preventive Maintenance

The preventive maintenance includes planned activities for maintenance of the system which include visit of networks through road patrolling, cleaning and lubricating the mechanical parts, flushing of pipelines especially dead end supply lines to avoid contamination, maintenance of valve chambers, maintaining utility service goods in stores, replacement of spares with limited design life. For preventive maintenance, the operator should have adequate knowledge of the system, the availability of tools and spare parts in stores, information about different pipe sizes available in store, valves and jointing material.

In addition to above, the planned maintenance of any distribution system being operated by any of WASA further requires defining the clear roles and responsibilities of the staff, availability of proper tools, proper skills adhered by them to do the job effectively. Table 1.4 shows a preventive schedule of activities to be adopted in Five WASAs.

Table 1.4: Required Preventive Maintenance Activities in Five WASAs

Sr. No.	Activity	Frequency of Duration	Key Responsibility
1	Flushing of Pipe Lines	Fortnightly	Supervisor and Operator
2	Patrolling of Water Supply Network (To over view Leakages)	Every Month	Supervisor and Operator
3	Water Quality Analysis	Fortnightly	Laboratory Incharge and WASA Sub Division Staff
4	Checking of Pressure in Supply Lines	Daily	Supervisor and Operator
5	Inspection of Bulk Flow Meters	Every Month	Supervisor and Operator
6	Inspection of Consumer Meters	Every Month	Supervisor and Operator
7	Reservoir Cleaning	After every 6 Months	Operators
8	Inspection of Valve Chamber	Every Month	Supervisor and Operator

In addition to the activities as per table 1.4, the Lecturer will also share Repair Action Plan (Table 1.5) with training participants for their implementation during field work, required to ensure the system to be operated on sustainable basis.

Table 1.5: Repair Action Plan

Sr. No.	Problem	Possible Causes	Mitigation Measures	Key Personnel Responsibility

1	Corrosion of Pipe Line	- Due to completion of service life of pipe - Excess dosage of chlorine in pipeline, adversely affecting material of pipe	- Ensure replacement of corroded pipe portion with new pipe - Painting of pipelines if present on ground (especially walled city) - Ensure chlorine dosage as per requirement	Supervisor and Operator
2	Leakages through Pipelines	-External or Internal pipe Metal Loss due to developed cracks - Faulty and corroded Joints - Aging Pipe Network	- Ensure Replacement of damaged pipe portion with new one - Undertake Regular maintenance audit in service areas	Supervisor and Operator
3	Leakages of Valves (at seat, at cover/bonnet, at gland packing)	- Corrosion of seat - Settling of Gasket as a result of temperature variations - Worn packing material - Poor maintenance	- Ensure reseating of valve disc - Retighten the bolts at bonnet - Retight the gland packing at nuts - Check opening and closing of valve - Ensure periodic inspection of valve chambers	Supervisor and Operator
4	Valves hard to operate	- Damaged Seat - Valve not fully lubricated	- Provide valves with proper lubrication	Supervisor and Operator
5	Ineffective inventory control system for spare parts and supplies	- Poor Inventory System, based on recording listing of spare parts in registers	- Ensure computerized system at stock yards - Provide adequate inventory of maintenance items	

2.3.6 Updation of Water Distribution System Mapping

One of the major concern regarding improved operations of utility service providers is the presence of updated maps of the water distribution system in respective sub division of WASA. The updated map should include all the system information including location of tube wells, distribution mains (diameters), location of hydrants, location of various controlling valves (gate valve, air release valve, drain valve), reservoirs and different zones of variation of pressures.

The updated maps of the water distribution system will be required to carry out maintenance of the system in more appropriate way thereby leading a major mile stone for sustainable O&M.

OJT Implementation Plan

Lecture Topic: Checking of Residual Chlorine in Supply Area **Date :** October 27, 2016

Academy Trainer(s):- Mr. Tajiku Okubo, Mr. Zia Mustafa **OJT Trainer(s):** Mr. Tajiku Okubo, Mr. Zia Mustafa

Day	Place	Target knowledge & skills	Equipment/ Machinery/ Material	Step by step procedure	Time	Evaluation

March 24, 2017	Green Town WASA Sub Division	- The Participants would be able to measure the Residual Chlorine in supply area - Ability to identify contamination in different segments of the supply area	DPD (N,N Diethyl-PPhenylenediamine)	- Put free available chlorine reagent in sample tube. - Fill sample tube with water - Cap the tube and shake. - The color of violet indicates the amount of free chlorine present. Compare with standard colors to determine the	Whole Day	The Participants will provide Reflection Report after site visit.
				amount of chlorine residual. - Put total chlorine reagent in sample tube and shake - Wait 3 minute then once again compare with standard color to determine amount of total chlorine		

				- Subtract free available chlorine (chlorine residual) from total chlorine to determine combined chlorine.		

OJT Implementation Plan

Lecture Topic: Checking of Pressure in Supply Area **Date :** October 27, 2016

Academy Trainer(s):- Mr. Tajiku Okubo, Mr. Zia Mustafa **OJT Trainer(s):** Mr. Tajiku Okubo, Mr. Zia Mustafa

Day	Place	Target knowledge & skills	Equipment/ Machinery/ Material	Step by step procedure	Time	Evaluation

March 24, 2017	Green Town WASA Sub Division	- The Participants would be able to operate and measure the pressure in supply area - Ability to identify low pressure areas in distribution network to address improvement in water distribution network	Pressure Recorder FJN -501 (through graph inside the gauge for specific hours)	- Unfasten the clip and open the front cover. - Push down the pen lifter to lift up the lift arm, Remove chart paper holder by pulling upward, remove the used one and put new chart. - Before mounting the chart paper, check battery	Whole Day	The Participants will provide Reflection Report after site visit.
				status. Turn the knob to 4 hour position and confirm if the Led light ON and OFF for 1 minute than status is good, if Led does not light up, change the batteries.		

				- Remove the cap of cartridge pen and fit on pen holder, Release the Pen lifter and put down the pen arm so that the pen point will touch the chart paper softly (After use remove the pen from arm and place cap back on it to be avoid from dry of pen tip). - Confirm if the pen point is located on the line of zero, if it is not on zero, adjust it with the help of screw on the arm of pen. - Route the chart paper Disc so that		

				the pen point will come to the starting point, when the recording work is finished then pen point will come to the starting point. - Always turn the knob to OFF, before changing chart paper. - Close the front cover after cleaning the water proof packing. - Connect the hose with meter (valve side) - After use, remove the connecting hose after releasing air completely by use of Air bleed knob.		

				- Pour out some water from valve for removal of dirt as well as air, with whom you want to attach pressure recorder.		

ALJAZARI ACADEMY

Course Code: W1221

O&M of Water Distribution System

Module 1

Participant Lecture Notes

Lecture 3

2017

ALJAZARI ACADEMY

1. Lecture Information

Course Title: O&M of Tube Well and Pump Facility	**Course Code:** W1221
Module Title: O&M of Water Distribution System	**Module No:** 1
Lecture Topic: Water Safety Plan linked with Distribution Pipelines and Reservoir	**Lecture Duration:** 120 Minutes

2. Water Safety Plan linked with Distribution Pipelines and Reservoir

2.1 Introduction

Water quality has emerged as one of the key issues adversely affecting the health of wellbeing, with spread of water borne diseases. Conventionally, water quality is measured at selected points (at various tube wells), however, need for management of water quality from source up to distribution taps still remains important challenge for service delivery providers. In the perspective of five (5) WASAs, it has been observed that some of the WASAs (WASA Lahore, WASA Multan, WASA Gujranwala) are using groundwater for supply to consumers whereas, rest of two WASAs (WASA Rawalpindi, WASA Faisalabad) are using combination of groundwater and surface water. In this regards, water quality of five WASAs also varies from each others. The reported water quality in Multan, Rawalpindi and Gujranwala Districts is relatively good and water is not contaminated with bacteria and other viruses. However, for Lahore and Faisalabad Districts, the reported water quality is of moderate level with arsenic levels at nearly equal to border line value of permissible WHO Guideline value. Therefore, for addressing the concerns of safe drinking water, it is imperative to develop water safety plan incorporating safe water concerns from source to distribution system. The WSP developed would cover probable potential water quality hazards, its major causes and control measures in distribution system. The WSP generally comprises the following components:

a) Assembly of Team for preparing WSP
b) Description of Existing Water Supply System
c) Identification of Hazards
d) Prioritization of the Risks
e) Development and Implementation of an Improved Plan
f) Monitoring of Control Measures

This lecture has been divided into different activities which will be carried out, the detail is as under:

2.2 Current Management Approaches

There is a wide range of both chemical and microbial contaminants that may be found in drinking-water, some of which can have adverse health effects on consumers. These can be derived from a number of sources including, in some instances, the water treatment process. Understanding the nature of sources of contamination and how these may enter the water supply is critical for assuring water safety. For instance, arsenic has become a major international **concern** in groundwater where it occurs from a geological source and it is primarily controlled through source selection.

BOX 1.1

Water supply systems can be considered as a number of steps aimed at assuring the safety of drinkingwater, including:

- preventing pollution of source waters;
- selective water harvesting;
- controlled storage;
- treatment prior to distribution;
- protection during distribution; and
- safe storage within the home and, in some circumstances, treatment at the point of use.

These steps can function as barriers, where activities are designed to minimize the likelihood of contaminants entering the water supply or reduce or eliminate contaminants already present in the supply. With the multiple barrier approach, each barrier provides an incremental reduction in the risk of water becoming unsafe. If there is a failure at one point, the other barriers continue to provide protection

2.3 Framework for Safe Drinking Water and Water Safety Plans.

The Guidelines for Drinking-water Quality WHO outlines, a preventive management framework for safe drinking-water that comprises five components (summarized in Box 1.2), three of which combine to form the water safety plan.

BOX 1.2

Key components:

- Health based targets (based on an evaluation of health concerns).
- System assessment (to determine whether the water supply chain (from source through treatment to the point of consumption) as a whole can deliver water of a quality that meets the health-based targets.
- Operational monitoring of the control measures in the supply chain, which are of particular importance in securing drinking-water safety.

- Manangement plans (documenting the system assessment and monitoring; describing actions to be taken in normal operation and incident conditions – including upgrade and improvement), documentation and communication.
- A system of independent surveillance that verifies that the above are operating properly.

A water safety plan, therefore, comprises system assessment and design, operational monitoring and management plans (including documentation and communication).

The objectives of a water safety plan are to ensure safe drinking-water through good water supply practice, that is:

- to prevent contamination of source waters;
- to treat the water to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets; and
- to prevent re-contamination during storage, distribution and handling of drinking-water.

2.4 Group Discussion

The lecturer will first invite discussions regarding water quality problems being faced by five WASAs, with their remedy adopted by these WASAs and afterwards will summarize the discussion and highlight the importance of development of WSP. In the discussion, pictorial example of snap indicating hand allergic spots due to excessive arsenic concentration in water as a result of poor water quality will also be shown (Refer Plate 1).

Plate 1: Example of Waterborne Diseases in Children

2.5 Description of Water Safety Plan (WSP)

The Lecturer will first share the definition of WSP with training participants, then onward detailed components of WSP would be discussed.

2.5.1 Definition of WSP

Water Safety Plan is a tool to address the water quality concerns from source to tap in distribution system incorporating possible expected hazards, their possible associated risk setting (risk levels) and finally control measures to address those hazards.

2.5.2 Developing Water Safety Plan (WSP)

The Lecturer will discuss major components of WSP in detail with training participants. Figure 1.1 shows detailed framework of water safety plan involving different activities for its development.

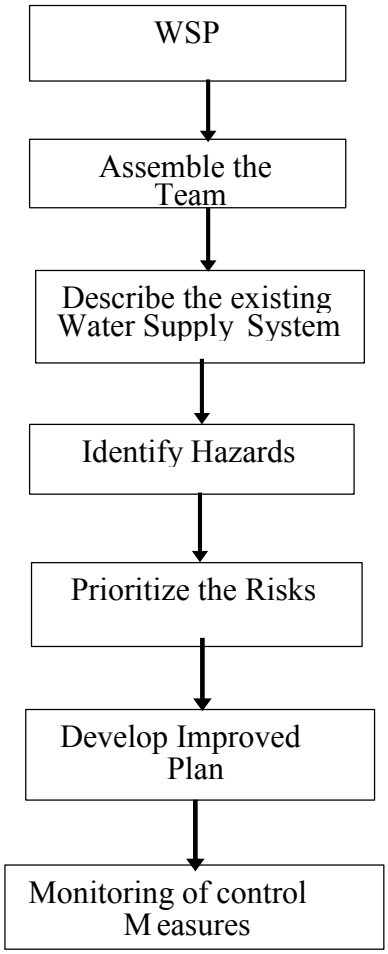


Figure 1.1: Water Safety Plan (WSP) Framework

The detail of various components of WSP is as under:

A) Assemble the Team for WSP

The first step for WSP includes assemble of a dedicated team with adequate operational experience of running the utility, mainly taken from WASAs. The major role of team would be to identify all possible hazards, linked with water quality of distribution system and implementation of control measures in lieu of wsp as a part of their daily routine activities.

B) System Assessment

The second step for WSP is the assessment of existing water supply system, including location of tube wells, their capacity, supply line sizes (diameter), flow rate, location of valves, Fire Hydrants, water quality data in the form of reports at different locations, treatment processes, disinfectant used etc. A system Flow Diagram will also be developed covering detail of all components of water supply system from source up to consumers. In comparison of five (5) WASAs, it has been observed that in case of WASA Rawalpindi and WASA Faisalabad, the source of water is combination of groundwater and surface water whereas for WASA Lahore, WASA Faisalabad and WASA Gujranwala, source of water is groundwater. The system flow diagram based on ground and surface water sources is shown in Figure 1.2 & 1.3

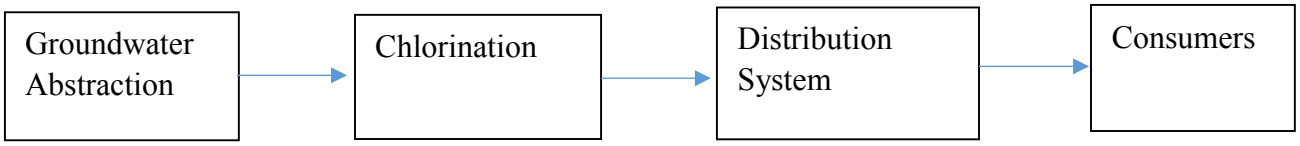


Figure 1.2: System Flow Diagram based on Groundwater Source (WASA Lahore, WASA Multan and WASA Gujranwala)

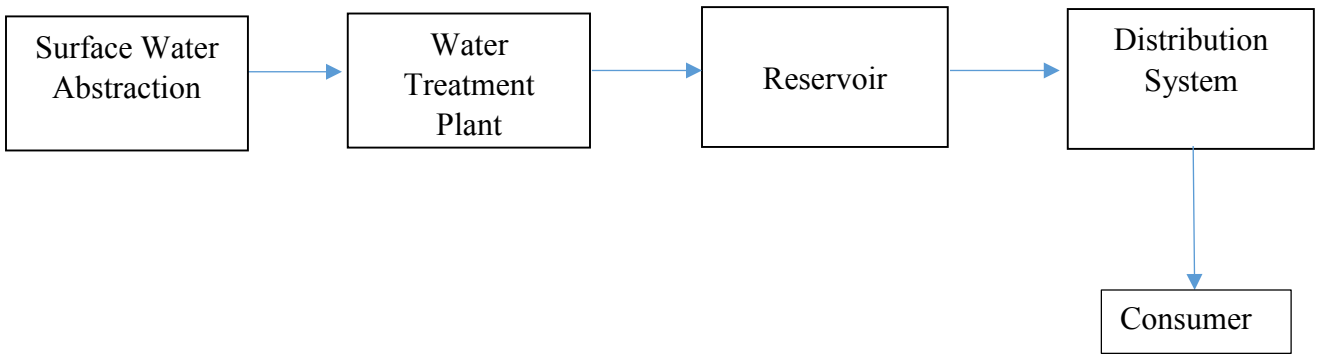


Figure 1.3: System Flow Diagram based on Surface Water (WASA Rawalpindi, WASA Faisalabad)

After developing the conceptual flow diagram of the system, it is essential to confirm the detail of all the components of water supply system (as indicated in system flow diagram) in field as a first step of developing WSP.

C) Hazard Identification and Setting Risk Level

After system Assessment, hazard identification and setting of risk level is required to be determined and in this regard, hazard identification can be defined as the identification of possible potential hazards adversely affecting the quality of water from source to distribution supply lines. Then prioritization of risks associated with different hazards is calculated and risk level is determined. Table 1.1 shows a detail of hazard analysis, associated risk levels with frequency of hazard to be occurred on monthly basis, once in few months, once every 1-3 years, once every 310 years.

Table 1.1: Hazard Analysis and Setting Risk Level

Hazard Analysis **Risk level matrix**

				Severity of damage				
				Almost no	Requires consideration	Slightly significant	Important	Worst
				No effects observed	unsatisfactory , but not serious enough for people to turn to other drinking water	Serious enough to turn to other drinking water	May affect health	May result in fatalities
				1	2	3	4	5
Frequency of hazard	Frequently	Every month	5	5	10	15	20	25
	Often	Once every few months	4	4	8	12	16	20
	Occasion-ally	Once every 1 to 3 years	3	3	6	9	12	15
	Rarely	Once every 3 to 10 years	2	2	4	6	8	10
	Almost never	Once every10 years or less frequently	1	1	2	3	4	5

From the above table, the frequency of hazard level 5 indicates high frequency of occurring and level 1 indicates minimum frequency level. The risk level can be calculated by the following formula.

Risk Level = Frequency x Severity

Further, to elaborate the potential hazards linked with Distribution System including physical hazards (presence of sediments in water), chemical hazards (chemical agents like copper, lead etc.) and biological hazards (bacteria, protozoa etc.) , their risk severity and then control measures to combat the hazard at each stage, a plan would be required to address all these aspects.

The Lecturer will then share the Water Safety Plan (Refer Table 1.2) for water distribution system with training participants to enhance their knowledge regarding safe water supply from source to distribution system.

Table 1.2: Water Safety Plan (WSP) for Water Distribution System

Sr. No.	Hazard type	Problems with associated hazard	Control Measures	Key Responsibility
	Water Sourc e			
1	Microbial and chemical Hazards	-Deterioration of water quality due to Natural Factors (seasonal variations, soil aggressiveness) -Deterioration of water quality due to wastewater discharges (major source of pathogens) -Deterioration of water quality from surface runoff infiltration (pesticides, fertilizers, livestock and agricultural)	-Good practices of source protection through installation of filtration plant -Implementation of Industrial effluent standards and volume controls -Implementation of Codes of practice on agricultural chemical use and slurry spreading	SDO, Supervisor, Operator
	Transmission M ains			
1	Microbial Hazard	- poor water quality due to source contamination - deposits of sediments - disinfection failure due to high loads of organic contents in water from source	- Stop the flow of water by closing valves of problem area - Provide a temporary bypass or alternative supply line, if possible - Water sampling and its testing	SDO, Supervisor, Sub Engineer

2	Structural Hazard	-Contamination due to poor jointing - Deterioration of pipe materials - Ingress of contaminated water from leaking valves	-Apply periodic Inspection of supply lines - Gradual replacement of old aged pipe infrastructure - exercising of valves	SDO, Supervisor, Sub Engineer
	Reservoir			
1	Microbial hazard	-Poor water quality due to inadequate disinfection method - shorter detention times	-Minimizing ingress of contamination to system and lengthening reservoir detention times. -Fitting alarms triggered by low disinfectant level. -Ensure inspection covers and ventilator covers remain in place	SDO, Supervisor, Sub Engineer
2	Structural failure hazard	- leakage of water through reservoir - leakage from partially open valves - taste in water due to internal corrosion of pipelines - deterioration of internal lining of reservoir	-Regular reservoir inspections (external and internal) -Proper opening/closing of valves - proper pipe material as per specifications should be used - relining/ painting of internal surface - routine inspection to see any failure in piping and lining	SDO, Supervisor, Sub Engineer
	Distribution Suppl y lines			

1	Microbial and Chemical Hazards	- Low chlorine residual in distribution system - Ingress of contamination due to pressure fluctuations - Reversed flows due to quick opening or closing of valves -Contamination due to unapproved material use for piping -Contamination by backflow due to unauthorized connections	- Maintain chlorine residual in the system as per requirement - Pressure Management - Apply flushing of pipelines - Disinfection prior to commissioning of water main - Follow design specifications for water supply system	SDO, Supervisor, Sub Engineer
		- contamination during water main repair due to debris, soil or groundwater remaining in the main after repairs -Cross connection between water system and another system carrying non-potable water		
2	Structural failure hazard	-Ingress of contamination due to main burst - ingress of contamination due to cracks in pipelines -ingress of contamination due to improper closure of valves	- repairing and rehabilitation of pipelines - routine preventive maintenance of pipelines and valves - use of approved pipeline types	SDO, Supervisor, Sub Engineer

D) Develop, Implement and Maintain an Improved/Upgrade Plan

Another important step in devising WSP is to overview the effectiveness of existing procedures adopted by utility service providers for water quality concerns and if these procedures are not adequate to address water quality issues, the upgradation of the plan will be needed to be developed through improved procedures to control the potential hazards associated with water supply system. This step would further require putting clear roles and responsibilities of the utility personnel to identify hazards in supply system and then onward implement control measures.

E) Monitoring of Control Measures

The monitoring of control measures is an important concern to review the effectiveness of water safety plan. Various tests that need to be applied in daily operations of WASA regarding water quality include measuring turbidity, pH, chlorine residual, pressure changes in the service area and periodic inspections of infrastructure.

In addition, some activities like active leakage detection and its prevention, treatment of water through multi barrier (in different stages in case of surface water source), pressure management would further ensure the safe water to consumers.

ALJAZARI ACADEMY

Course Code: W1221

O&M of Water Distribution System

Module 1

Participant Lecture Notes - HSE

Lecture 4

2017

ALJAZARI ACADEMY

1. Lecture Information

Course Title: O&M of Tube Well and Pump Facility	**Course Code:** W1221
Module Title: O&M of Water Distribution System	**Module No:** 1
Lecture Topic: Health Safety Environment (HSE) linked with Water Distribution System	**Lecture Duration:** 60 Minutes

2. Health Safety Environment (HSE) linked with Water Distribution System

The Health, Safety, Environment (HSE) has received much attention from economists both in government and industry. Although costs are often considerable, and regulations mandatory, the resulting benefits through a healthier workforce and increased productivity are potentially large enough to more than pay for the costs. Most studies focus on the benefits related to improved health.

Generally, Benefit studies such as cost of illness comprise of three main types - national, company and individual. Most studies were done at the department level. These studies measured a range of benefits in estimating cost-benefit ratios or the costs of illness. A range of benefits of occupational safety and health interventions are presented in Table 1.1. Studies have shown that the benefits included have important implications for conclusions. For example, Fahs et al (1997) argues that econometric models to estimate net social benefits of occupational risk reduction significantly underestimate the net social benefits due to omitting the economic benefits of healthier workers. Conversely, they argue that the models tend to overestimate the social costs of industry regulation, since potential savings in averted health care costs are ignored for worker whose occupational disease is prevented. Another choice for benefit inclusion concerns which occupationally related injuries and diseases to include, since some will account for the majority of costs.

Table 1.1. Health and Non-Health Benefits of Occupational Safety

Benefits related to health effects	Benefits unrelated to health effects
Individuals	Individuals

Health benefits Income losses & fringe benefits averted from reduced illness or injury	Improved job satisfaction Improved working climate
Medical care costs avoided Non-medical rehabilitation costs Unpaid family or community care Reduced home production and leisure time of worker Reduced avertive expenditures due to safer environment	
Departmental	Departmental
Medical care costs avoided Non-medical rehabilitation costs Absenteeism or sick leave (productivity impact) Personnel turnover costs and friction costs Administration costs of sickness absence Reduced liabilities and legal costs Reduced danger money in wages Reduced avertive expenditures due to safer environment Reduced social security disability benefits	Productivity of new machinery Improved quality of products Competitiveness of regulated industry Improved working climate Less damaged equipment Company image effects Impact on non-economic company values
National	
Lost production Morbidity (days spent not producing/earning) Mortality (loss of production) Police and fire services not used	

(Source: Mossink et al, 1998)

Production losses, medical costs and avertive costs saved as a result of improved HSE has been shown to be enormous, even for developed countries that already have strict occupational safety regulations. Mossink et al (1998) emphasise the need to take a societal perspective, as investments at the department level eventually means less expenditure by government on health care and less expenditure by individuals on avertive or corrective behaviour (Aaltonen and Soderqvist, 1988). Non-health benefits have been given little attention, although several studies have recognised increased productivity due to rationalisation associated with HSE interventions, as well as less damaged equipment and buildings through less accidents and fires. For the individual, there may be greater job satisfaction and improved working climate, but no studies have examined these benefits.

With more specific to HSE conditions at work places, it is essential to maintain health, safety, environmental conditions at work places to protect workers workers and general public from potential hazards associated with unsafe work practices, injuries resulting due to accidents at site has emerged as one of the basic requirement under OHSAS 18001 standards for water distribution pipelines and appurtenances for their repair or new installation. In comparison of five WASAs, it has been observed that no HSE practices are adopted while working in field for water distribution system except partially reporting of accidents or injuries. Therefore, this still remains a challenge for five WASAs to opt good safety practices for workers and general public in field to safeguard them from work hazards. Further, as per OHSAS standards 18001 and 18002 for ensuring HSE Management system at sites, it is imperative to firstly assess the potential hazards with reference to health and safety aspects, determine their risk levels and then implement control measures in the form of a Action Plan to curtail these hazards.

This lecture has been divided into different activities which will be carried out, the detail is as under:

2.1 Group Discussion

The lecturer will first invite discussions regarding HSE practices being implemented by five WASAs and afterwards will summarize the discussion and highlight the importance of HSE while working in Field. In the discussion, pictorial example of snaps (Refer Plates 1-2) of unsafe conditions during repair of water supply lines and valves in field will also be shown.

Plates 1-2: Example of Unsafe Working Conditions at Site

2.2 Description of Health, Safety, Environment (HSE)

The Lecturer will first share the definition of HSE with training participants then onward detailed components of HSE would be discussed.

2.3.1 Definition of HSE and its Components

HSE is an important tool regarding maintaining health, safety and environmental considerations (as per requirement of OHSAS 18001 standards) for any operational activity of water distribution system which is necessary to safeguard the workers' health, apply safe practices at work place, reduce injuries due to accidents at sites and maintain general environmental conditions at site.

Health

The absence of disease, for example asbestos creates a health risk because if you inhale asbestos dust you may contract lung cancer. The protection of the bodies and minds of people from illness resulting from the materials, processes or procedures used in the workplace.

Safety

The absence of risk of serious personal injury for example walking under a load suspended from a crane during a lifting operation is not safe because if load falls serious personnel injuries or death could result. Staying out of danger area results safety and protection of people from physical injury. The borderline between health and safety is ill-defined and the two words are normally used together to indicate concern for the physical and mental well-being of the individual at the place of work.

Environment Protection

The environment protection include arrangements to cover those activities in the workplace which affect the environment (in the form of flora, fauna, water, air and soil) and, possibly, the health and safety of employees and others. Such activities include waste and effluent disposal and atmospheric pollution.

Welfare

The provision of facilities to maintain the health and well-being of individuals at the workplace. Welfare facilities include washing and sanitation arrangements, the provision of drinking water, heating, lighting, and accommodation for clothing, seating (when required by the work activity), eating and rest rooms. First aid arrangements are also considered as welfare facilities.

2.3.2 Detail of HSE Activities

The Lecturer will discuss the various activities involved for maintaining HSE at sites which include the following.

A) Hazard Identification
B) Job Safety Analysis (JSA)
C) HSE Training Program
D) Control Measures

A) Hazard Identification

A hazard is the potential of a substance, activity or process to cause harm. Hazards take many forms including, for example, chemicals, electricity and working from a ladder. A hazard can be ranked relativeother hazards or to a possible level of danger. A risk is the likelihood of a substance, activity or process to cause harm. A risk can be reduced and the hazard controlled by good management. It is very important to distinguish between a hazard and a risk – the two terms are often confused and activities such as construction work are called high risk when they are high hazard. Although the hazard will continue to be high, the risks will be reduced as controls are implemented. The level of risk remaining when controls have been adopted is known as the residual risk. There should only be high residual risk where there is poor health and safety management and inadequate control measure.

Hazard Identification is the evaluation of all possible potential hazards where associated system of work (repair/new installation) with distribution system could cause an incident. Identification of hazards is carried out using site inspections. The specifications of pipe materials and valves and standard SOPs are also reviewed.

Following the identification of all possible sources of likely hazards from laying or repair of pipelines, the ranking of risk levels (high, medium or low) needs to be applied to implement mitigation measures for priority risks. There exists three types of hazards generally emanating from water distribution system.

i) Physical Hazards ii) Chemical Hazards
iii) Biological Hazards

i) Physical Hazards

Physical hazards is the exposure to adverse weather conditions causing heat strokes among workers.

ii) Chemical Hazards

Chemical hazards produce injuries due to exposure to disinfectant used in water distribution system. Generally, sodium hypochlorite is used in solution form at tube well chambers for disinfection purpose and it is toxic and causes irritation to eyes and skin.

iii) Biological Hazards

Biological hazard is exposure to pathogenic microorganism (bacteria) due to accidental contact between drinking water and wastewater.

B) Arrangements for Health and Safety

The arrangements section of the health and safety policy gives details of the specific systems and procedures used to assist in the implementation of the policy statement. This will include health and safety rules and procedures and the provision of facilities such as a first aid room and wash rooms. It is common for risk assessments (manual handling and PPE assessments) to be included in the arrangements section particularly for those hazards referred to in the policy statement. It is important that arrangements for fire and other emergencies and for information, instruction, training and supervision are also covered.

The following list covers the more common items normally included in the arrangements section of the health and safety policy:

➤ Employee health and safety code of practice

➤ Accident and illness reporting and investigation procedures

➤ Emergency procedures, first aid

➤ Procedures for undertaking risk assessments

➤ Control of exposure to specific hazards (noise, vibration, radiation, manual handling, hazardous substances etc.)

➤ Machinery safety (including safe systems of work, lifting and pressure equipment)

➤ Electrical equipment (maintenance and testing)

- ➤ Maintenance procedures
- ➤ Permits to work procedures
- ➤ Use of personal protective equipment monitoring procedures including health and safety inspections and audits
- ➤ Procedures for the control and safety of contractors and visitors
- ➤ Provision of welfare facilities
- ➤ Training procedures and arrangements
- ➤ Catering and food hygiene procedures
- ➤ Arrangements for consultation with employees
- ➤ Terms of reference and constitution of the safety committee
- ➤ Procedures and arrangements for waste disposal

B) Job Safety Analysis (JSA)

Job Safety Analysis (JSA) is a tool to determine the possible hazards that could occur from job tasks. It also entails the information to be provided to the workers on possible hazards and its associated risks and measures to curtail those hazards. In this regard, health, safety trainings are imperative steps in reducing accident rates and improved safety performance at sites. These trainings are also important part for effective health and safety management.

C) HSE Training Program

HSE trainings are integral part for reducing frequency of accidents and to ensure implementation of various HSE procedures. Apart from sending some participants to occasional training sessions, HSE is generally a neglected area across five WASAs. There is no formal system of briefing the contract staff of WASA regarding HSE aspects linked with water distribution system.

To combat this situation, procedures should be prepared to ensure that employees working at each relevant function and level are aware of importance of HSE procedures and requirements of OHSAS 18001 standards. In this context, formal HSE trainings and awareness should be imparted to all WASA personnel. The trainings at least should cover the following.

i) Identification of health hazards, their risk assessment and control measures ii) Hazardous Material Management as per Material Safety Data Sheets (MSDS) iii)

Emergency Preparedness and Response iv) Occupational health hazards and safety procedures v) First Aid

It is also suggested to start professional certification courses such as International General Certificate in Occupational Health and Safety organized by NEBOSH UK.

D) Control Measures

i) Personal Protective Equipment (PPE)

The use of Personal Protective Equipment (PPE) during course of work is an important consideration to safeguard the workers from any potential accidents which may cause injury to them. In this regard, the training on the use of PPE is also required mandatory. PPEs generally include, safety helmets, safety shoes, gloves, eye protection etc. Further to address the use of PPE, it is essential to identify the areas requiring specific use of PPEs. System also needs to be developed to enforce to wear safety hats and safety shoes while working in field.

ii) Safety Signage

Adequate safety signage in the form of warning signs, ribbon tape, barriers, traffic cones and person with flag during construction to manage traffic at construction site and access roads need to be placed to warn the traffic regarding work ahead in progress. Plates 3 shows a type of traffic signage to be used during repair or construction of water supply lines.

Plate 3: Example of safety sign during construction of water supply system

iii) HSE Action Plan

An HSE Plan would be required to identify potential hazards, its causes and control measures to implement HSE activities during field work of water distribution system. Table 1.2 shows a detailed HSE Action Plan to be implemented by utility service providers for ensuring safety of workers, health and environment from adverse impacts arising from work places.

Table 1.2: HSE Action Plan for Water Distribution System

Sr. No.	ACTIVITY	Hazards	Impacts of Hazards	Control Measures
1	Delivery and unloading of pipes	Pipes may move/roll or be tampered with by others	Injury to persons generally	-Provide secure stockpile area for pipes and fittings. -Unload and stack pipes strictly in accordance with the manufacturers' recommendations Minimize height of pallets / stockpile. Use PPE
		Pipes and fittings	Lifting injury Swinging load	Correct manual handling techniques. Use mechanical aids where possible. Maintain control of loads when lifting & moving.
2	Secure Site	Public safety	Injury to public	Provide the appropriate fencing and/or barricades as per site risk assessment. Apply appropriate signage and pedestrian control. Devise and implement system for site inspection and security.

		Traffic	Personal injury to public and workers due to	Traffic Control Plan Keep area clean & clear of obstacles.
			vehicle accidents	
		Inadequate Access	Slips, trips and falls, abrasions, strains and sprains; manual handling injuries such as back damage	Conduct site inspection to ensure that access is adequate for the task activities. Use safety shoes, hard hats, Gloves, etc.
3	Locate existing services	Existing underground services	damage service	Check relevant Authority (e.g. power, water, gas, council) records for location of services. If in doubt uses experienced/accredited service locators.
4	Excavation	Work Place	Noise, falling objects Damage to existing surfaces Material spillage	Use appropriate Personal Protective Equipment (PPE) – hardhat, hearing protection etc. Maintain a safety working area around moving plant. Protect surfaces from plant movements. Ensure appropriate plant noise control. Maintain Appropriate spillage control techniques

		Storage of materials	Falling objects	No materials to be placed or stacked near the edge of any excavation.
		Accessing trenches/conduits	Collapse of trench, falling objects	Keeping safe distance from edge of trench Materials not to be placed or stacked near the edge of trench. All trenches to have safety barricades when left open for a period of time.
5	Install pipe and fittings on bed	Accessing trenches/conduits Lifting injury Swinging load	Collapse of trench, falling objects	String only sufficient pipes for day's work. Return all pipes not laid at end of day to secure stockpile areas. Use safety shoes , gloves, goggles , hard hats
6	Dosing of Chlorine	Concentrated solutions handling	Splashes can cause burns and eye damage	Gloves ,protective eye glasses, overalls
7	Cleaning and inspection of storage reservoirs	Climbing on roof top, accidental flooding	Personal injury	Install railing around ladder, wear hard hats, safety shoes

8	Repairing pipelines	Collapse of trenches working on roads	Cuts, bruises, electric shocks, Fractures, Minor and major injuries by vehicle strike	Reduction of allowed vehicle speeds in work zones, Use of high-visibility safety apparel for workers in the vicinity of traffic, For night work, provision of proper illumination for the work space, while controlling glare so as
				not to blind workers and passing motorists Locate all underground utilities before digging Use of hard hats, goggles, safety shoes, overalls
9	Materials Checking	Handling and storage of hazardous materials (chlorine)	Risk of various injuries and illnesses	Handling and storage to be done according to instructions given in Materials Safety Data Sheets (MSDS).
10	Documentation and Data Control	Lack of Proper system for HSE Documentation and Data Control	Retrieval of some vital HSE information is rendered almost impossible	Develop procedures for efficient management of HSE documentation and data control
11	House Keeping	Unsafe Work conditions	Risk to staff and Fire hazard	Apply better housekeeping practices at work places