MANUAL OF REHABILITATION WORKS FOR WUSC IN SEMI-URBAN TOWNS

< version 2 >

WASMIP

For providing safe and quality drinking water to people

Revision History

Version	Date	Remarks
1	19th February, 2021	Prepared as version 1.
2	31st May, 2021	Revised the title and contents to clarify the objective and target of this manual.

Table of Contents

I. Overview and Introduction

"There are many challenges in water and sanitation sector, at one end, functionality/ sustainability with efficient O&M, upgrading the service level, and rehabilitations of completed water supply schemes, at another end, providing water and sanitation services with systematic water supply and sanitation facilities to the un-served people. While facing such challenges, we should think about the indicators like available quantity, quality, accessibility and reliability. Since "National Drinking Water Quality Standards, 2062 (hereafter the Standards)" and its implementation directive are in effect, we must be concerned with quality of drinking water." [Water Safety Plan Handbook Nepal, 2013]

In this manual, "Rehabilitation Works" is defined as providing WUSCs in semi-urban towns with essential equipment, materials and instruments such as chlorination unit, water meter, valve and pressure gauge, in order to recover and ensure the proper function of water supply system.

II. Sustainable Water Supply to Consumers

Sustainable water supply to consumers is defined as follows.

To supply sufficient water volume

To provide safe water

To extend lifetime of facility and equipment

a) To supply sufficient water volume

How much water do you supply? WUSC must answer this question. This is very simple, but fundamental question.

To measure/grasp the supplied water amount, bulk/flow meters are required in water supply system.

b) To provide safe water

Do you care about safe water compared with water volume? What is safe water? Do you know the Standards ?

Water quality test shall be performed to check whether the quality meets the Standards.

WUSC has obligation to provide safe water and to disclose the water quality information to consumers.

c) To extend lifetime of facility and equipment

Do you periodically maintain your water supply facility and equipment? Your facility/equipment always requires periodical maintenance to extend its lifetime. Without proper maintenance to the facility, its performance to supply sufficient and safe water might be gradually deteriorating, and finally its function suspends. In this case, water supply is stopped and it is costly to recover the original performance. (Refer to **ANNEX-1**, Preventive Maintenance)

III. Sound Operation and Maintenance

Firstly, to grasp the supplied water volume and to ensure adequate production and supply water to consumers, flow meters shall be installed. Valves and pressure gauge are also required in a water supply system to maintain the pipelines with adequate pressure and control the water flow according to the demand.

Secondly, to provide safe water without any pathogenic bacteria and/or virus, chlorination unit shall be installed within the water supply system/network.

To operate and maintain water supply system effectively, aforementioned items shall be operated and maintained properly with keeping necessary record. Proper operation and maintenance (O&M) including record keeping and analyzing data is the next step after installation of essential items.

A concept of sound O&M with essential equipment is shown below.

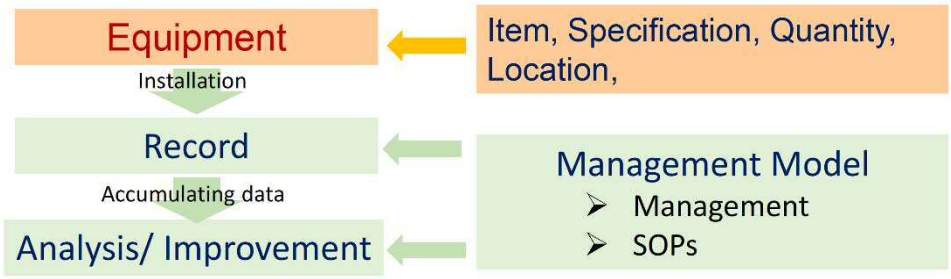


Figure 1. Concept of Sound Operation and Maintenance (O&M)

- **First step: [Installation of Essential Equipment (flow meter, chlorination unit, valve etc.)]**
  1) Verify the necessity of installation of equipment by conducting a survey.
  2) Identify the installation location and quantity of equipment by preparing a schematic flow diagram.
  3) Determine the specifications for the required equipment.
  4) Procure/install the equipment.

- **Second step: [Record Keeping]**
  1) Keep updating the O&M record (supplied water volume, water quality, maintenance, repair etc.) in accordance with the Standard Operating Procedures (SOPs).
  2) Collect the required data to calculate Key Performance Indicators (KPIs).

- **Third step: [Analysis and Improvement]**
  1) Summarize/analyze the data and results of O&M activity.
  2) Detect potential errors such as abnormal condition of equipment (before malfunction), increasing non-revenue water value, exceeding the water quality value compared to the Standards etc.
  3) Calculate/evaluate the KPIs.
  4) Make/conduct an improvement plan of O&M activities.

IV. Water Supply System

Water supply system is an essential link between water source and consumers. Water supply system consists of several facilities such as intake facility, raw water transmission pipeline, water treatment plant, transmission pipeline, service reservoir, distribution pipeline and household connection with domestic water meter.

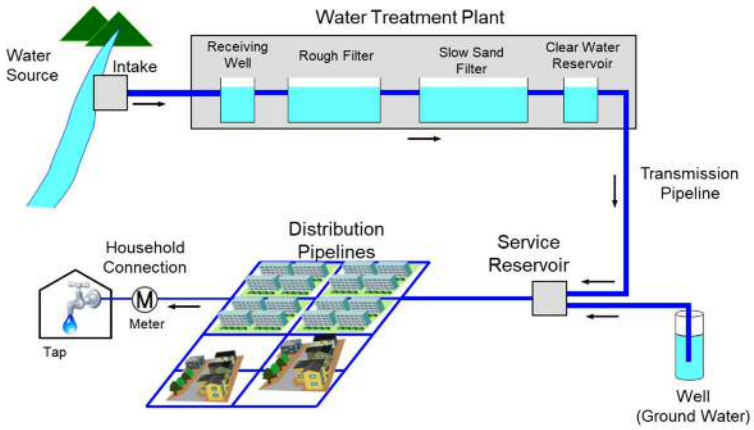


Figure 2. Water Supply Facilities

- **Intake Facility**
  Intake facility is defined as the facilities and equipment which extract raw water from sources such as surface water or groundwater from the designated intake point.

- **Raw Water Transmission Pipeline**
  Raw water transmission pipeline is defined as the pipeline and ancillary equipment which convey the raw water from an intake point to the water treatment plant and/or service reservoir.

- **Water Treatment Plant**
  Water Treatment Plant (hereafter WTP) is defined as the plant consists of facility and equipment which purify raw water and produce clean water that meets with the Standards. Water treatment processes in a semi-urban area are basically classified into the five patterns as shown in **Figure 3**.

- **Service Reservoir**
  Service reservoir is defined as the storage facility to meet the requirements for 1) absorption of water demand fluctuation, 2) water storage for firefighting, 3) water storage for emergency.

- **Water Distribution Pipelines**
  Water distribution pipeline is defined as the pipeline and ancillary equipment which distribute the clear water (purified and disinfected water) from service reservoirs to the respective water supply service areas.

- **Household Connection and Domestic Water Meter**
  Household connection is defined as a facility which extract clean water from distribution pipe into a household. A water meter is equipped on a household connection pipe to measure water consumption of users.

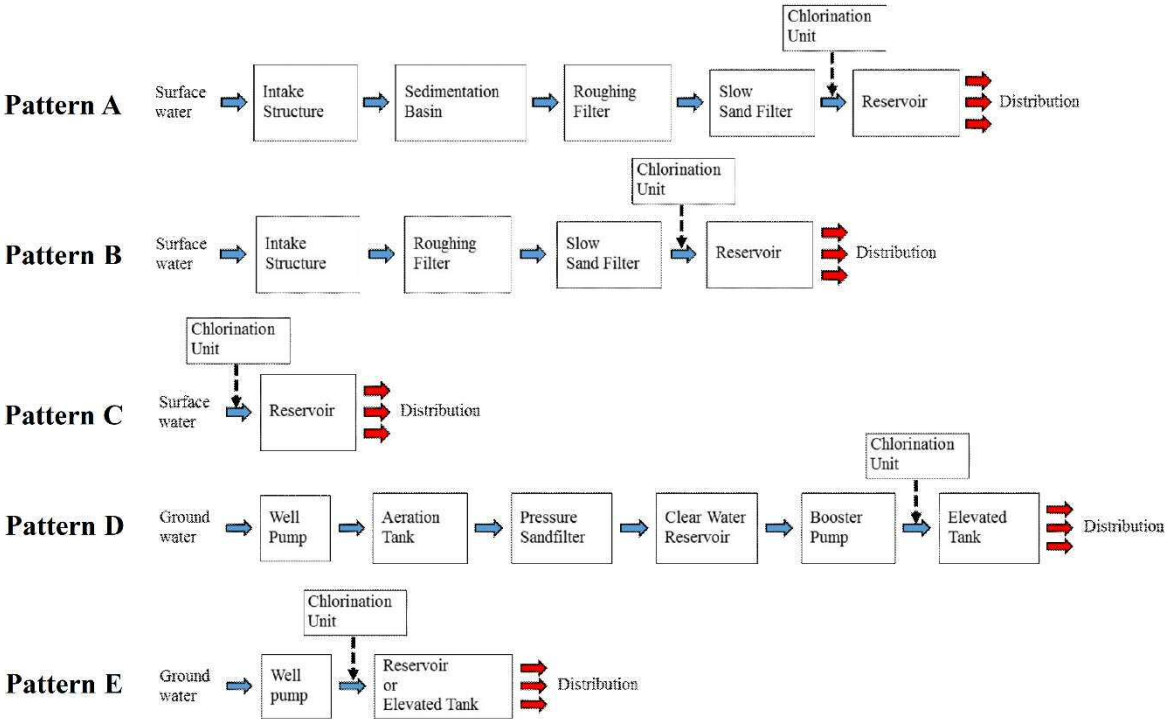


Figure 3. Five Patterns of Treatment Processes

V. How to Use This Manual

The targets of this manual are **engineer of FWSSMP** and **manager/engineer of WUSC**. The objective of this manual is **to understand the procedure of rehabilitation works (planning, designing, procuring and installing the essential equipment/material/instrument) for WUSCs in semi-urban towns**. This manual mainly instructs the following seven processes.

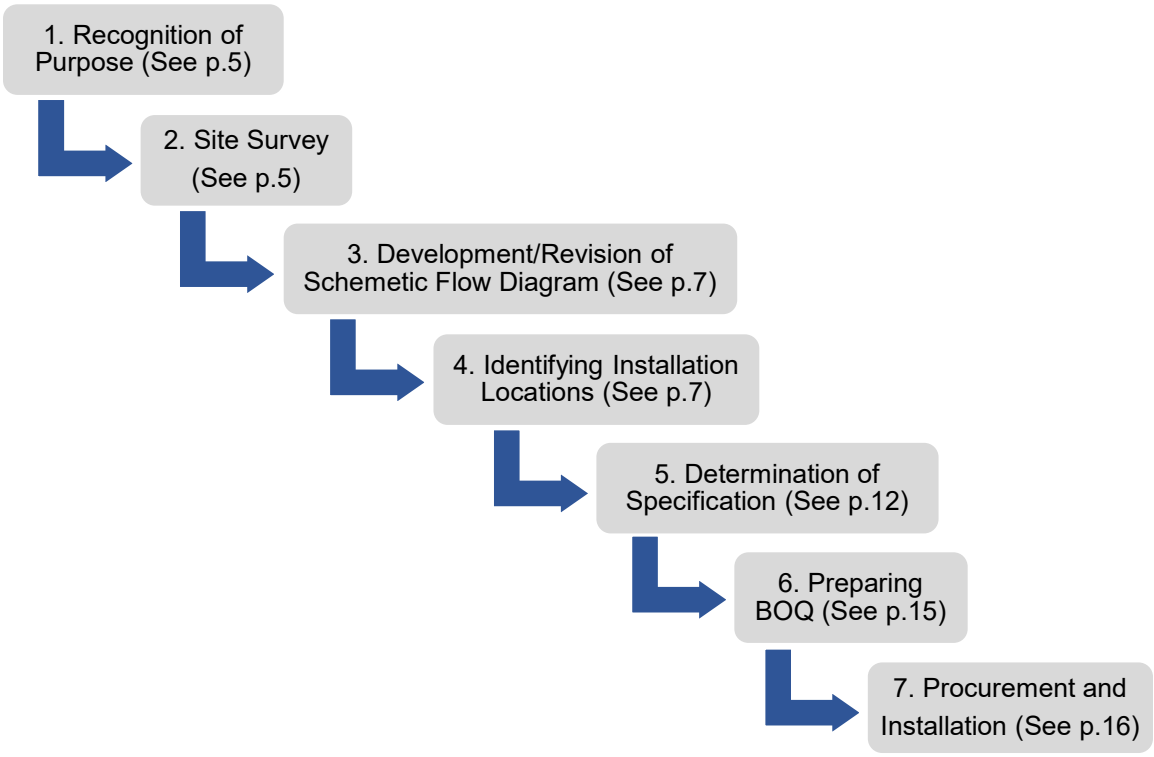


Figure 4. Procedure of Rehabilitation Works

1. Recognition of Purpose

An effective water supply system has the following essential equipment, material and instrument.

- **Flow Meter**: To Measure supplied and distributed water amount.
- **Chlorination Unit**: To provide safe water by disinfection.
- **Valves/Pressure Gauge**: To perform proper O&M activities.

If the above items are not installed or installed at improper location, WUSC cannot supply sufficient amount of water and provide safe water to consumers. In this case, a rehabilitation work to install the above items at proper locations shall be conducted.

2. Site Survey

The schematic flow diagram shows the current situation of water supply system, existence/absence and installation location of the essential items. Therefore, the diagram shall be developed for each WUSC

and revised it if required. The procedure to conduct a site survey for developing the diagram is shown as follows;

1) Contact a chairperson or manager of WUSC, discuss/decide a schedule of site survey and ask to dispatch a staff who knows the location of the water supply facility/equipment including pipe.

2) Prepare/bring camera, measuring tape, check list as shown in Table 1, notebook and pen for recording data at the site.

3) Start the survey from the water source. If it is difficult, start from the intake.

4) Identify the water source/intake facility and note their type and quantity with taking pictures.

5) Identify the transmission pipelines from the intake to WTP and/or reservoirs.

- Check and note the pipe diameter and material. In case that carved seal/marking is invisible, the diameter shall be checked by using measuring tape and the material shall be checked by visual inspection.
- If the pipe is inaccessible/invisible, verify it by excavating.
- Identify the locations of reservoir, flow meter, valve (including chamber) and washout (including chamber).
- In case that reservoir exists, its type, quantity and capacity shall be checked and noted.
- Take pictures of the above facility/equipment and note their location.
- Draw a rough flow diagram based on the acquired information.

6) Identify pipeline and water supply facility/equipment within WTP.

- Check and note the pipe diameter and material.
- Identify the location of T-junction, bypass line, valves, washout, dosing point of chlorine and flow meter.
- Check and note the results in accordance with Table 1 and operating condition of facilities/equipment such as Sedimentation Tank, Roughing Filter, Slow Sand Filter, Aeration Tank, Pressure Filter, Lifting Pump, Chlorination Unit etc. in WTP.
- Take pictures of the above facility/equipment and note their location.
- Draw a rough flow diagram based on the acquired information.

7) Identify the transmission pipelines from WTP to reservoirs.

- Same as 5) above.

8) Identify the transmission pipelines from reservoir to service area.

- Same as 5) above.

- Check and note the quantity of service areas.

9) Develop the schematic flow diagram from the intake to reservoir.

3. Development/Revision of Schematic Flow Diagram

3.1. Necessary Information

The following basic information of water supply facilities is required for the schematic flow diagram.

- Water Sources (stream, spring, surface, groundwater)
- Intake Facility (type, quantity, location, capacity (in case of well pump))
- Transmission Pipeline (pipe material, diameter)
- Water Treatment Plant (treatment process, information of facility/equipment; name, type, quantity, capacity, location)
- Reservoir (type, capacity, location)
- Chlorination Unit (type, quantity, capacity, location)
- Flow Meter (type, quantity, diameter, location)
- Valve, Pressure Gauge and other materials/instruments (type, quantity, diameter, location)
- Water Service Areas (number of wards)

Use the check list as shown in **ANNEX-2** to identify the necessary information of Water Supply System

3.2. Procedure to Develop/Revise Schematic Flow Diagram

1) The diagram must include intake (type), intake facility, pipe diameter and material, main facility/equipment in WTP, reservoirs (type, capacity), flow meter (if existing), chlorination unit/dosing point (if existing), valves etc.
2) The direction of flow should be denoted by an arrow and note survey date.
3) The unit of the pipe diameter should be same throughout the drawing (either mm or inch).
4) WUSC's name along with location, plotter's name and date of preparation should be written in lower right corner of the drawing.
5) Legends shall be shown in upper right or left corner of the drawing.
6) In case that any equipment, material and/or instrument is installed newly, reinstalled to another location or removed, revise/update the diagram.

4. Identifying Installation Locations

4.1. Flow meter

(1) Installation Location

1) Flow meter should be installed at easily accessible location for reading, installation and maintenance.

2) The meter should be installed on the pipe. Proper installation location is where relatively close to the ground. If the meter is installed under the ground, a chamber should be constructed to protect it.

3) Priority of installation location should be given to the location where total volume of supplied water from WTP can be measured. Desirable location is the outlet of Clear Water Reservoir within WTP area.

(2) Minimizing the Quantity

Considering the burden of WUSC staffs, the quantity of flow meter shall be minimized so that WUSC staff can perform reading and O&M work of the meter properly within the jurisdiction.

4.2. Chlorination Unit

(1) Installation Location

Chlorination Unit shall be installed at the location where the following conditions are satisfied.

1) O&M works such as preparation of chlorine solution can be performed easily and safely. (Roof, ventilation, electrical power supply and clear water supply shall be considered.)

2) The prepared chlorine solution can be injected properly with required amount and pressure.

(2) Dosing Point

1) Dosing point of chlorine should be selected/decided to disinfect all the supplied water.

2) Recommended dosing point of chlorine is upstream of reservoirs as shown in **Exapmple-1 to 3**.

4.3. Examples of Schematic Flow Diagram

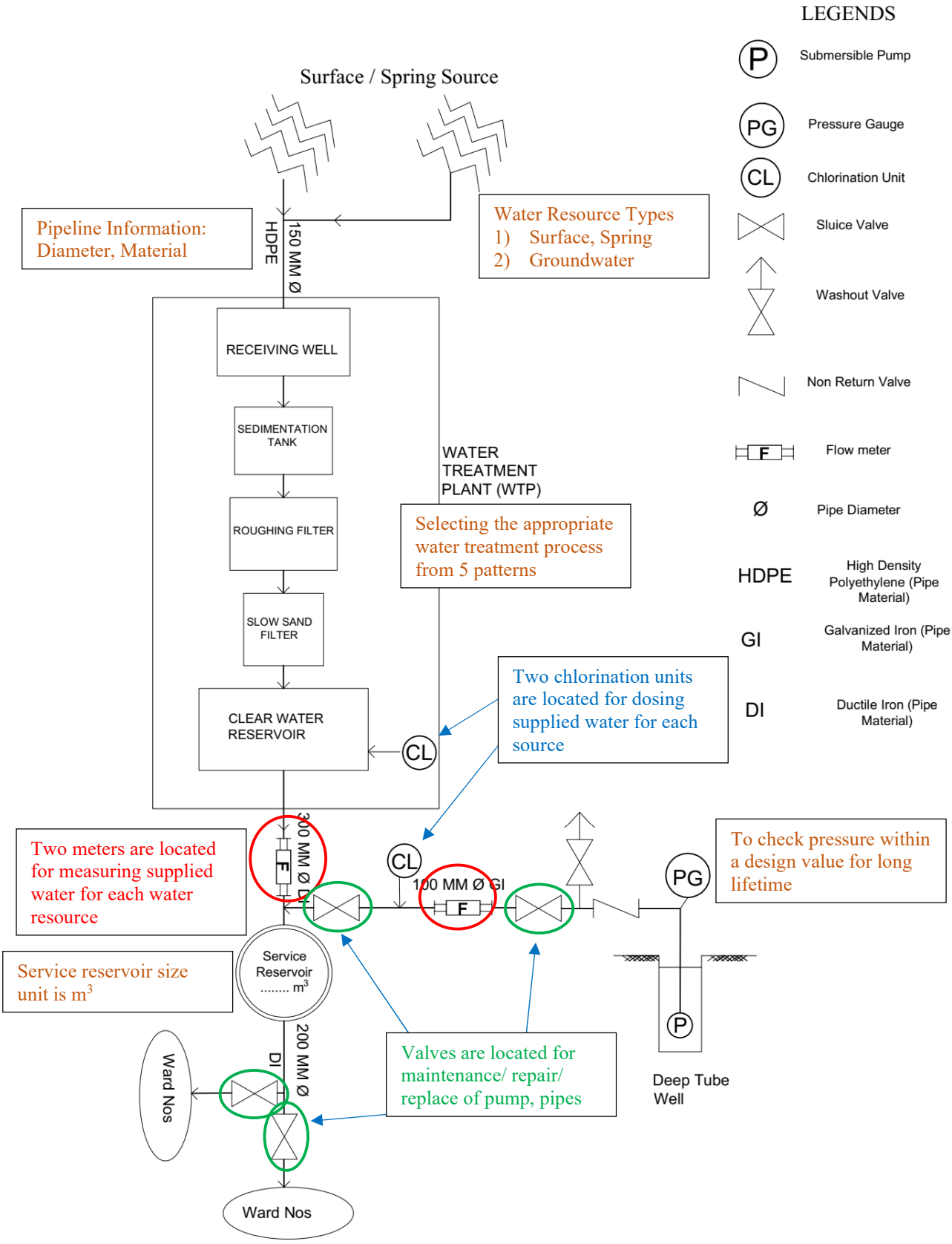
Three examples of the schematic flow diagrams are shown in page 9 to 10.

Example-1: Multiple Water Sources (combination of surface water and groundwater)

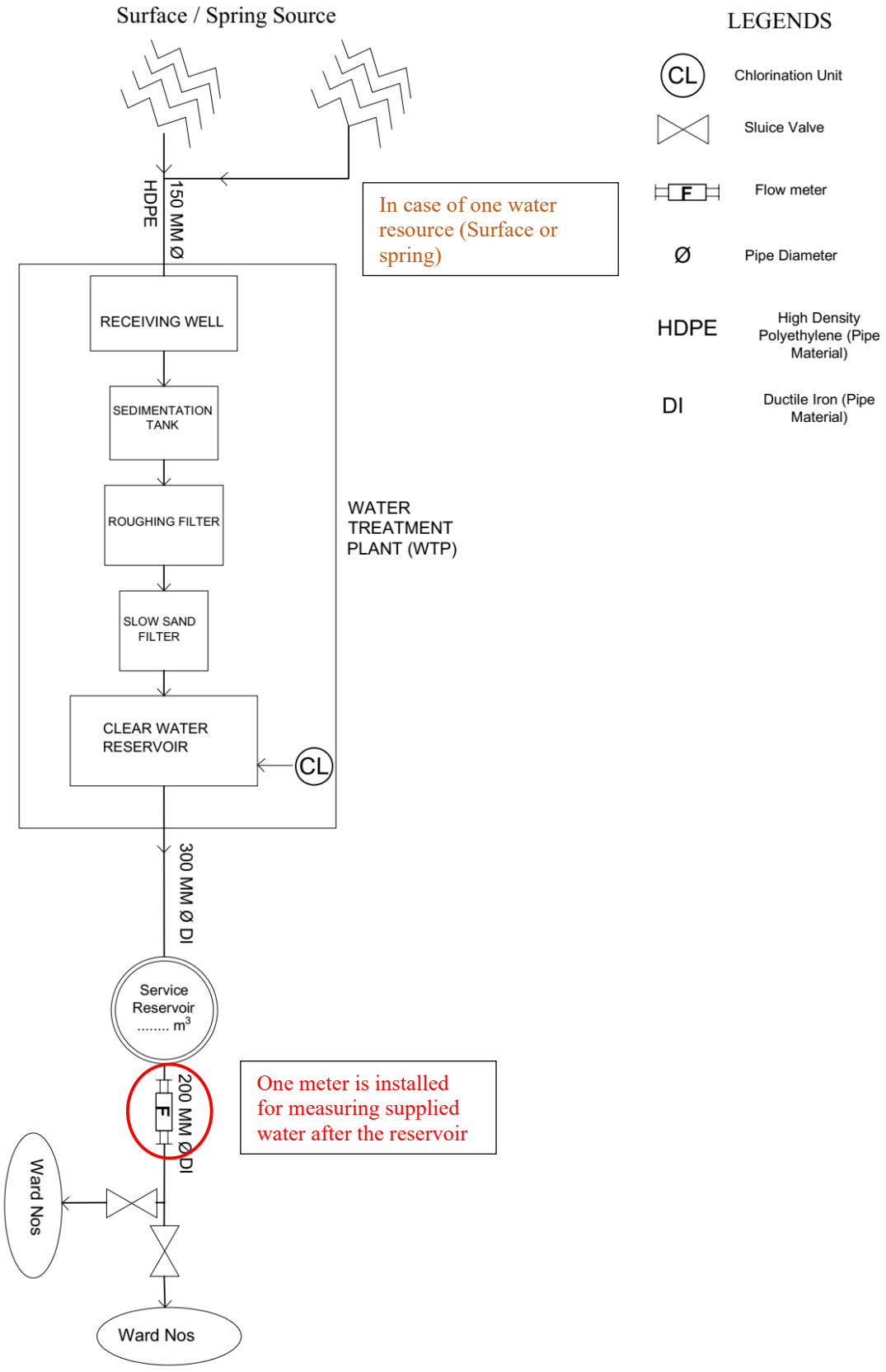
Example-2: Surface Water Source

Example-3: Groundwater Source

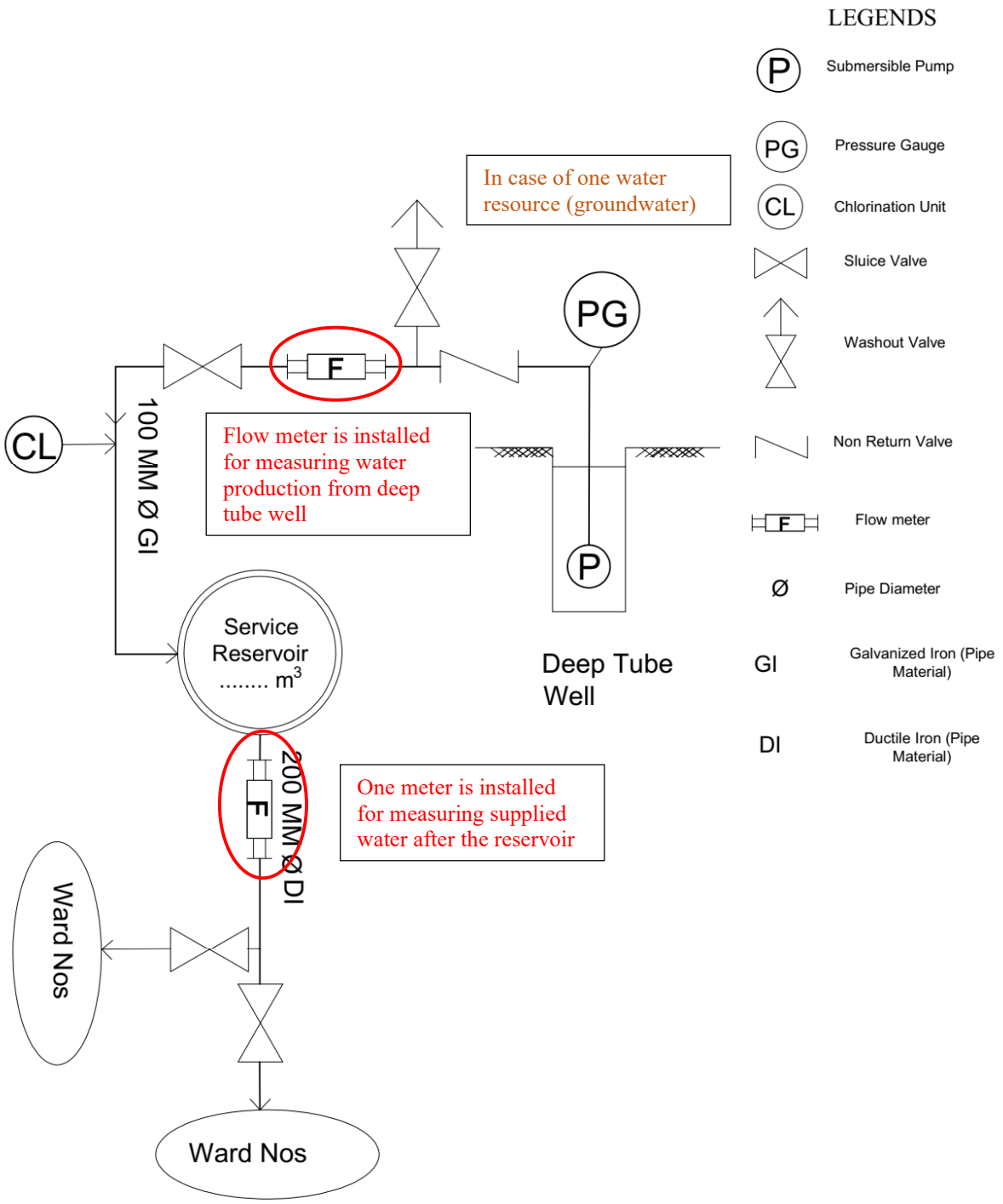
Example-1: Multiple Water Sources (combination of surface water and groundwater)



Example-2: Surface Water Source



Example-3: Groundwater Water Source



5. Determination of Specification

How to determine the specifications of chlorination unit and flow meter to be procured and samples of Bill of Quantity (BOQ) are described below.

5.1. Specification of Chlorination Unit

Generally, a pump type chlorination unit is procured/installed in case that desirable power supply is available. In case of no power supply, a gravity type chlorination unit which injects chlorine solution by gravity flow without using pump is applied.

A pump type chlorination unit consists of the following items:

1) Chemical Storage Tank with Base-frame
2) Propeller Type Mixer
3) Chemical Dosing Pump
4) Other Components; Y-strainer, Relief Valve, Pressure Gauge, Back Pressure Valve, Tube and fittings
5) Electrical Control Panel

A gravity type chlorination unit consists of the following items:

1) Chemical Storage Tank with Base-frame
2) Propeller Type Mixer (operated by solar power or generator)
3) Flow Control Valve with Flow Meter
4) Other Components; Y-strainer, Tube and fittings

The following specifications shall be clarified/determined for procurement of chlorination unit.

(1) Chemical Storage Tank with Base-frame

- The material of a tank shall be chemical resistant plastic against 1 % of chlorine solution such as Polyethylene (PE).
- The size of a tank shall be determined based on dosing volume and frequency of chlorine solution preparation in accordance with the calculation procedure as shown in **ANNEX-3**. Generally, 200L or 500L is required for a water supply system of semi- urban towns in Nepal.
- Base-frame must have sufficient strength to withstand a load of tank and inside chlorine solution. The material of base-frame shall be iron with proper coating such as galvanizing or epoxy coating to prevent from corrosion.
- A drain valve with proper size shall be installed to wash out the sediments at the bottom of tank.
- A level gauge shall be installed to confirm the inside solution level.

(2) Propeller Type Mixer

- The material of shaft and impeller shall be metal which have not only tolerance of 1 % of chlorine solution such as Stainless Steel (SS) or Resin Coating Metal, but also enough strength for mixing.
- The capacity of motor shall be determined based on the tank volume to prepare a homogeneous chlorine solution within 30 minutes.

- The power supply of motor shall be considered/determined depending on the site condition.

(3) Chemical Dosing Pump

- The recommended type of chemical dosing pump is diaphragm pump.
- The capacity of pump shall be determined based on the dosing amount calculated by the procedure as shown in **ANNEX-3**.
- The material of a diaphragm shall be chemical resistant resin against 1 % of chlorine solution.
- Relief Valve shall be installed to protect pump from overpressure due to blockages or closed valves.
- Back Pressure Valve shall be installed to prevent from backflow and excessive dosing.
- Y-strainer shall be installed to protect pump from debris and/or sediments coming from the storage tank.

(4) Flow Control Valve with Flow Meter

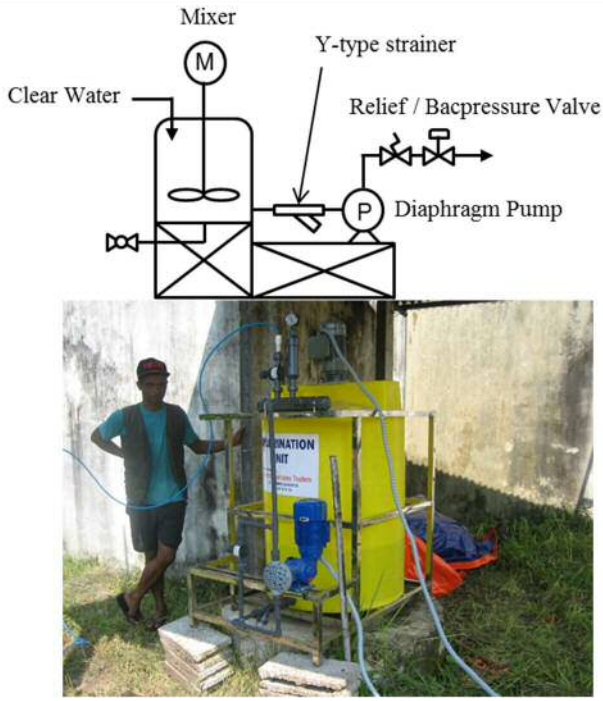
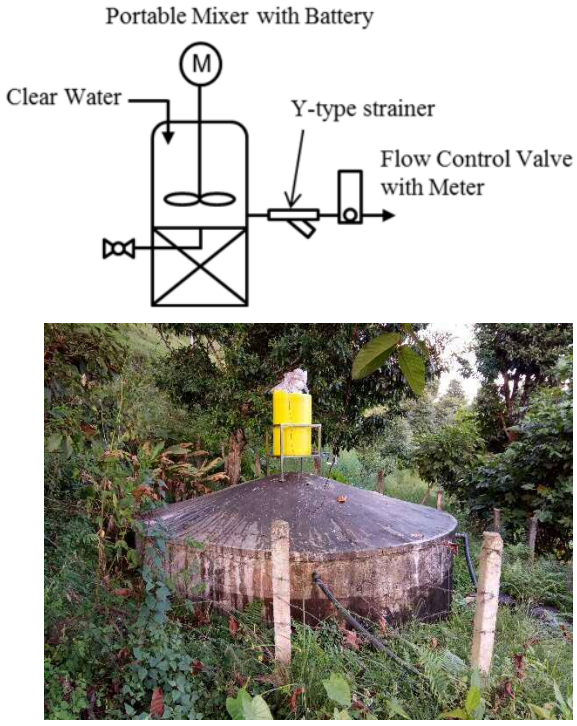
- The recommended type of flow control valve is needle valve or diaphragm valve to control small dosing volume, and flow meter shall be equipped.
- The control range of valve shall be determined based on the dosing amount calculated by the procedure as shown in **ANNEX-3**.
- The material of inside valve shall be chemical resistant resin against 1 % of chlorine solution.
- Y-strainer shall be installed to prevent from clogging by debris and/or sediments coming from the storage tank.

(5) Electrical Control Panel

A typical specification of electrical control panel is shown as follows.

- Three Phase, 400 V, 600mm L x 500mm W x 300mm D (for reference) with key lock for front door
- Equipped with Analog voltage and ampere meter with three phase selector switches.
- Equipped with Main Molded Case Circuit Breaker (MCCB) 30A (for reference).
- Equipped with under/over voltage relay.
- Equipped with respective feeder for the chemical dosing pump and mixer with on/off push button switches.
- Equipped with on/off indication, fault indication lamps.
- Equipped with Earth Leakage Circuit Breaker (ELCB), Magnetic Contactor (MC), and overload relay, a spare feeder and socket, wire connection terminal at bottom with a plastic cover.
- All other internal wires and ducts to be functionally completed.
- Equipped with 20m length of power cable with conduits and fittings for incoming line and the respective load.

The types of chlorination unit are summarized in the following table:

Type	Outline
Pump Type	
Gravity Type	

5.2. Specification of Flow Meter (Bulk Meter)

The following specifications shall be clarified/determined for procurement of flow meter.

- The type of flow meter shall be impeller type integrating flow meter.
- The diameter shall be clarified based on the diameter of target pipe.
- The maximum pressure shall be clarified based on the actual water pressure of target pipe. Generally, 1.0 MPa is applied.
- The type of connection shall be determined based on the condition of target pipe. Generally, flange connection type is applied for easy replacement work.

6. Preparing Bill of Quantity (BOQ)

Samples of BOQ of chlorination unit and flow meter are shown as below:

Chlorination Unit

[Pump Type]

S.N	Specification	Unit	Quantity
1	Diaphragm Pump; 7-30 L/hr × 1.0MPa × 0.1kW (motor driven) ×2 set (1 set shall be delivered as spare)	pc	2
2	Chemical Tank; PE, 200L with iron base ×1 set	pc	1
3	Mixer; propeller type, SS (SUS304), 0.07 kW ×1 set	pc	1
4	Backpressure Valve; 0.5MPa ×1 set, Relief Valve ×1 set, Y-type Strainer ×1 set, tube & fittings	pc	1
5	Electrical Panel Three Phase, 400 V, 600mm L x 500mm W x 300mm D (reference dimension) with key lock for front door, analog voltage and ampere meter with 3 phase selector switches, main MCCB (Molded Case Circuit Breaker) 30A, under/over voltage relay, respective feeder for the diaphragm pump and mixer with on/off push button switches, on/off indication, fault indication lamps, ELCB (Earth Leakage Circuit Breaker), MC (Magnetic Contactor), and over load relay, a spare feeder and socket, wire connection terminal at bottom with a plastic cover, all other internal wires and ducts to be functionally completed, 20m length power cable with conduits and fittings for incoming line and the respective load.	pc	1

[Gravity Type]

S.N	Specification	Unit	Quantity
1	Flow Control Valve with Flow Meter; 3-14 L/hr× 2set	pc	2
2	Chemical Tank; PE, 200L with iron base ×1set	pc	1
3	Mixer with motor operated by solar power; propeller type, SS (SUS304) ×1set	pc	1
4	Y-type Strainer ×1 set, tube & fittings	pc	1

* xx part shall be clarified/determined based on the actual condition.

6.1. Flow Meter (Bulk Meter)

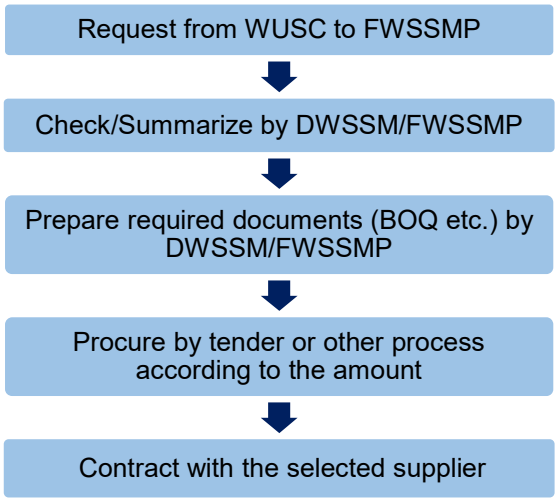
S.N	Specification	Unit	Quantity
1	75mm, 1.0 MPa, Flange connection	pc	1
2	100mm, 1.0 MPa, Flange connection	pc	1
3	200mm, 1.0 MPa, Flange connection	pc	1

* xx part shall be clarified/determined based on the actual condition.

7. Procurement and Installation

7.1. General Rules of Procurement

1) In case of using DWSSM budget for procurement, the following procedure is required generally.



2) In case of using the other budget or fund, it is necessary to confirm the procurement procedure and follow it.

3) Basically, flow meter, valve, pressure gauge and other consumables shall be procured by WUSC.

7.2. General Rules of Installation

1) Basically, installation work, commissioning and O&M training of procured equipment such as chlorination unit shall be conducted by the contractor.

2) The employer (generally FWSSMP or Local Government) and/or responsible person of WUSC shall conduct necessary supervision and inspection for the above works by the contractor, and give necessary instructions as required.

3) As to flow meter, valves etc. which can be installed by WUSC staff, the contractor shall procure and transport them to the designated place in accordance with the contract.

4) Necessary explanation of the warranty/guaranty period shall be provided by the contractor.

5) Necessary documents such as test report and instruction manual shall be provided by the contractor.

7.3. Installation of Chlorination Unit

1) Confirm the installation location of chlorination unit and its dosing point with WUSC staff.

2) Ensure the availability of power supply.

3) A shed shall be prepared by WUSC to protect the dosing unit from rain and direct sunlight.

4) The unit shall be installed horizontally and fixed tightly by using anchor bolt etc. by the contractor.

5) Leakage and/or other abnormality shall be checked and rectified if any by the contractor.

6) Performance curve (calibration curve) shall be provided by the contractor.

7.4. Installation of Flow Meter

1) Confirm the installation location of flow meter.

2) If necessary, flow meter chamber shall be constructed before installation of the meter.

3) The meter shall be installed horizontally with proper flow direction.

4) Leakage and/or other abnormality shall be checked and rectified if any.

5) For further information, refer to SOP (Chapter 3, Section 4, Household Connections and Water Meter).

ANNEX-1. Preventive Maintenance

(1) Maintenance Management

Maintenance management is categorized into the following.

1) Corrective Maintenance
2) Preventive Maintenance

(2) Corrective Maintenance

Corrective Maintenance is repair/ restoration work after malfunction.

(3) Preventive Maintenance

Preventive Maintenance is preliminary maintenance activities such as planned inspection and replacement etc. to prevent any unplanned downtime and expensive costs from unexpected malfunction of equipment.

- To decrease malfunction of equipment.
- To prevent equipment from deterioration by conducting planned inspection and replacement of parts etc.
- To analyze/utilize the obtained data from operational records and inspection results.
- To replace the deteriorated/damaged equipment which exceed its lifetime.

(4) Concept of Preventive Maintenance

The concept of Preventive Maintenance is show in **Figure A1**.

1) The initial performance of facilities is set at the beginning of the operation start.
2) The facility performance has been gradually decreasing according to time passing and operation.
3) Without any maintenance including periodic inspection and repair etc., the facility performance finally reaches zero function that means facility breakage, which means no function and no water supply.
4) However, regular and routine maintenance help to keep equipment in good and sound condition. This maintenance can minimize the repair and replacement costs and can recover the facility performance.
5) Finally, Preventive Maintenance provides longer lifetime to the facility and minimization of Life Cycle Cost.

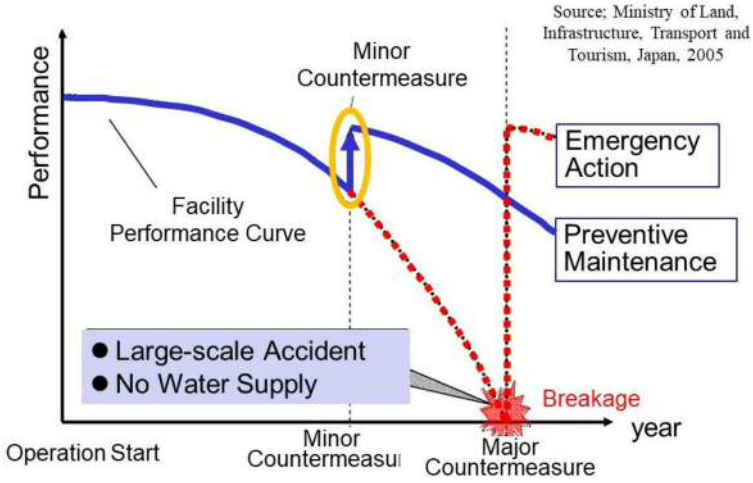


Figure A1. Concept of Preventive Maintenance

ANNEX-2. Check List for Water Supply System

No.	Facility/ Equipment	Check Items	Results	Remarks
1	Intake	Kind of Water Source (surface water, spring, stream, groundwater)		
		Type (collection chamber, well pump etc.)		
		Quantity		
		Location		
		Capacity (in case of well pump)	(L/h)	
			(HP or kW)	
2	Raw Water Transmission Pipeline	Pipe diameter		
		Pipe material (ductile cast iron, GI, HDPE)		
		Bulk meter (type and diameter if installed)		
3	Water Treatment Plant	Treatment process (Pattern A to E or other)		
		Facility/equipment 1	Name:	
			Type:	
			Quantity:	
			Capacity:	
			Location:	
		Facility/equipment 2	Name:	
			Type:	
			Quantity:	
			Capacity:	
			Location:	
		Facility/equipment 3	Name:	
			Type:	
			Quantity:	
			Capacity:	
			Location:	
		Facility/equipment 4	Name:	
			Type:	
			Quantity:	
			Capacity:	
			Location:	

No.	Facility/ Equipment	Check Items	Results	Remarks
4	Service Reservoir	Reservoir-1	Type: elevated or ground	
			Capacity (m^3):	
			Location:	
		Bulk meter (type and diameter if installed)		
		Reservoir-2	Type: elevated or ground	
			Capacity (m^3):	
			Location:	
		Bulk meter (type and diameter if installed)		
5	Chlorination Unit	Unit-1	Type: pump or gravity	
			Tank capacity (L):	
			Pump capacity (L/h):	
			Location:	
		Unit-2	Type: pump or gravity	
			Tank capacity (L):	
			Pump capacity (L/h):	
			Location:	
6	Valve, Pressure gage	Quantity, location, diameter (of valve)	Draw in a rough sketch	
7	Water Service Areas	Number of wards		
8	Water quality test kit	What kind of kit (kit name, if exists)		
9	New project	Is there any new project?	Yes or No	
		Status (planning or under construction)		
		In case of planning, when does it start?		
		In case of construction, when will it complete?		

ANNEX-3. Capacity Calculation of Chlorination Unit

(1) Dosing amount of chlorine solution

The calculation is carried out in accordance with the following formula:

$$W = Q * Rs * 1/(C_1/100) * 1/\rho * 10^{-3}$$

$$= Q * Rs * 0.1$$

W: Dosing amount of chlorine solution (L/hour)
Q: Flow rate of treated water (m^3/hour)
Rs: Dosing rate of chlorine (mg/L) = 0.5(minimum), 1.0(average), 2.0(maximum)
C_1: Concentration of chlorine solution (%) = 1.0
ρ: Specific gravity of 1% chlorine solution (g/mL) = 1.0

<Example>

In case of Rs=0.5 mg/L and Q=10.8 m^3/hour, W_1=0.54 L/hour is obtained by the above formula.

Similarly, in case of Rs=1.0 mg/L and Q=10.8 m^3/hour, W_2=1.08 L/hour.

Similarly, in case of Rs=2.0 mg/L and Q=10.8 m^3/hour, W_3=2.16 L/hour.

Therefore, the required discharge volume of pump is W_1 to W_3, 0.54 to 2.16 L/hour.

(2) Storage Tank Volume

Storage tank volume (V) is calculated by the following formula:

$$V = W_2 * (Supply\ hours\ per\ day)$$

<Example>

In case that supply hour is 24 hours per day, C=1.08*24 = 25.9 L.

Hence, the required tank volume is 30 liters.

(3) Preparation of Chlorine Solution

The calculation is carried out in accordance with the following formula:

$$A = V * \rho * C_1/100 * 1/(C_2/100)$$

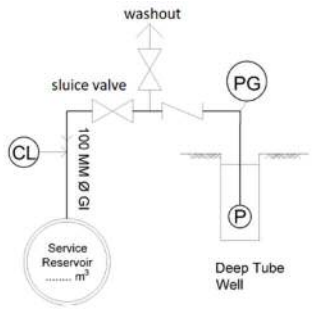
A: Required amount of Bleaching Powder (kg)
V: Storage tank volume (L)
ρ: Specific gravity of 1% chlorine solution (kg/L) = 1.0
C_1: Concentration of chlorine solution (%) = 1.0
C_2: Available chlorine concentration (%) = 34.0

The typical C_2 value of bleaching powder which can be procured in Nepal is 34 %.

In case of V=1,000 L, A=29.4 kg is obtained.

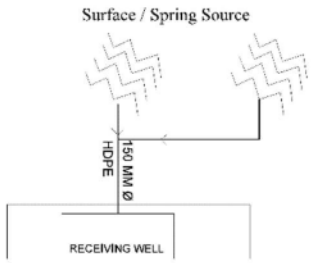
If bulk meter is not installed, Flow rate (Q) should be estimated by the following methods.

Method 1 (for ground water source):



1) Prepare a bucket of known volume (for example 100 liters) and a stopwatch.
2) Close the sluice valve (discharge valve) and open the washout valve.
3) Start operation of the well pump.
4) Collect the water from washout into the bucket and measure the time to fill the bucket using the stopwatch.
5) In case that it takes 10 seconds, Q=100/10=10 L/sec (36 m^3/hour) is obtained.

Method 2 (for surface water source and ground water source):



1) Close all discharge valves (outflow valves) of the reservoir.
2) Measure the inside water level.
3) Measure the inside water level after one hour.
4) In case that the area of the reservoir is 100 m^2 and the increased water level is 1 m/hour, Q=100*1= 100 m^3/hour is obtained.

Method 3 (Measurement by ultrasonic flow meter):

1) Measure the flow rate directly by using ultrasonic flow meter.