Section 3. Distribution System Adjustment

3.1 Importance of the Facility Plan Considered NRW

A reservoir not only controls the volume of water distribution, but also reduces water pressure in water pipes.

At many places, water is distributing through pipelines bypassing a reservoir to transmit water to high altitude or to prevent overflow of the reservoirs. The use of these bypass pipelines has led to the distribution of highly pressurised water, which has been a cause of leakage, in an intended water distribution area.

Water distributed through a pipeline that directly branches off from a transmission pipeline is highly pressurised and the distribution of such water has caused leakages. The review of the distribution block based on the re-development of reservoirs is needed for leakage reduction.

What is most important is to develop the distribution facilities in consideration for minimizing NRW from the beginning of the planning and design stage.

Section 4. Water Leakage Survey and Repair

Reference;

4.1 Visible Leakage Survey (Passive Leakage Control)

Passive leakage control is a procedure whereby water loss is tackled when leakage is visible or when problem is reported from the public.

1) Selection of the Survey Area and Review of Records in the Area

Make a review of all leak repair records of the survey area and their causes to clarify leak pattern and places where the leakage used to take place. Under normal conditions, visible leaks are usually found on the weakest points of pipelines like tees, bends, flanges, unions, valves, inlets and outlets of the structure (ex. meter chambers, tanks, reservoirs, pipe bridges, etc.), where unexpected land subsidence takes place.

2) Customer Survey

In the course of the customer survey undertaken for "Customer Meter Survey/ Customer Survey", visible leaks may be found on the customer connections, especially on stopcocks, meters and unions. When the leaks are found, the team for meter replacement shall gauge how much water are being lost per minute and shall repair them immediately for recording leak amount, their causes, water pressure, location, materials used, time spent for repair, any water losses during repair, etc.

4) Pipeline Survey

The survey team shall carry out pipeline survey by walking on foot along the pipelines located within the survey area. The team shall pay particular attention to those installed in the area of swamps and valleys where the normal routine work by WASAC used to lack full monitoring and maintenance.

5) Repair and Record

When leaks are found, the volume of water lost on that leakage shall be estimated. The team shall repair immediately and record them in a proper format as stated above. Procurement of materials, tools and equipment required for repair shall be under responsibility of the leader.

6) Inflow Measurement to the Area

After completion of the visible leak repair in the survey area, the team shall measure inflow rate to the survey area for continuing several weeks, preferably one month. The total inflow and water consumption by the customers will give NRW rate of the survey area.

7) Report

The leader shall report the outcome of their activities to NRW unit. (refer to Reporting sheet od 5YSP: Leakage Information System)

4.2 Step Test for Leakage Survey

I. Objectives

This step test is a part of process usually applied in advance to initiate NRW reduction in a survey area.

At the survey area divided into several subzones, portable flow meters shall be installed on all inlets and outlets.

Flow volume of each subzone can be obtained approximately by closing boundary valves step by step.

To obtain leakage volume of the subzones, it is appropriate to conduct the test during night time when water consumption falls minimum (minimum night flow: Qmnf).

Thus, the test is a kind of survey that provides information on priority areas for the NRW reduction activity.

At the selected prioritized subzones, the survey team initiate full-scale NRW reduction in terms of physical loss, that is not only invisible but also visible.

II. Preparatory Work

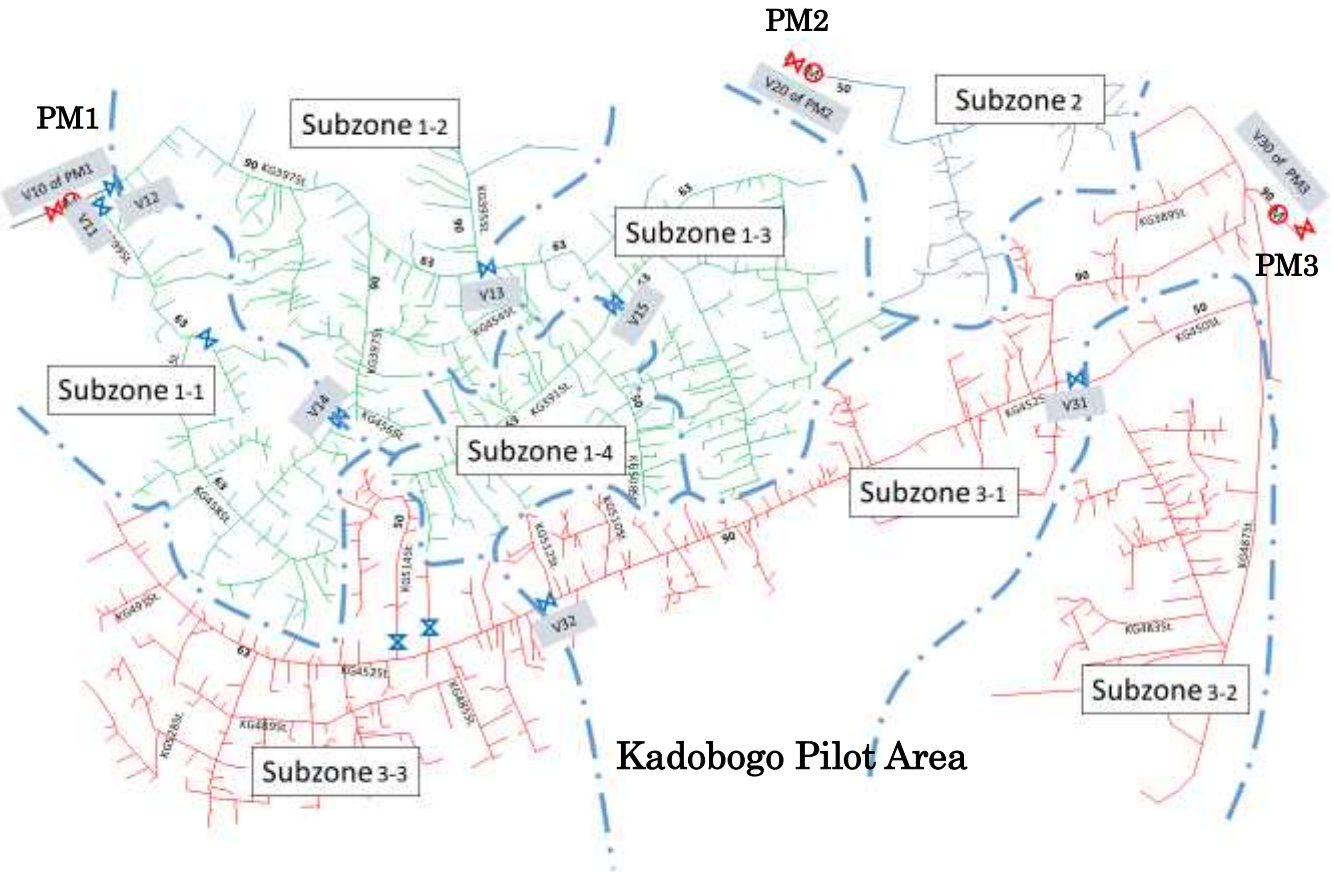
Major preparatory work shall include the following:

1) Review all data and drawings regarding pipeline network and customers (POC) information in the survey area.
2) Confirm location of the subzone boundaries.
3) If considered appropriate, conduct hydraulic isolation to confirm the survey boundaries and the hydraulic independence of the subzones.
4) Check the functional condition of the subzone boundary valves.
5) Provide valve if boundary valve is not existing.
6) Replace the boundary valve if it is in malfunction.
7) If boundary valve is not existing and it will be not provided, prepare the place to install of the ultrasonic flow meter at that place instead of the valve.

III. Survey Procedures

Sample procedures of the step test in Kadobogo are given as below.

1) The survey team will install portable (ultrasonic) flow meters on the inlet.
2) After ten-minutes measurement (or five minutes, depending on the local condition) by the **Step Test**, compute flow rate difference subzone by subzone.
3) Identify subzone with excessive flow rate
4) Conduct flow measurement and leak detection on the existing pipelines in that subzone with excessive flow rate
5) Find leakage of the ground surface on the existing pipelines and service connection
6) Continue the leak detection on the existing pipelines by excavating where required (underground invisible leak) as given on Procedures for **Modified Step Test**
7) Locate the leak point by GPS, measure leakage rate by buckets or measurement, identify causes of leak and take photos, when leak found
8) Repair the leaks, take photos and record quantity of tools, materials and manpower used for repair in the leak repair record sheet



Step test procedures Case 1
Using boundary valves and one ultrasonic flow meter

	Step Test Procedures	Measured Subzone
1	Install an ultrasonic flow meter at inlet flow meter chamber, at PM1 pilot area	
2	Start flow measurement at one minute interval during the following procedures	
3	Close boundary valves, V14 and V15	1-4
4	Close boundary valve V13 after a 10 minutes measurement	1-3
5	Close boundary valve V12 after a 10 minutes measurement	1-2, 1-1
6	Close boundary valve V11 after a 10 minutes r measurement	
7	Confirm no water flow and open all valves	
	Open boundary valve V11	1-1
	Open boundary valve V12 after a 10 minutes measurement	1-2
	Open boundary valve V13 after a 10 minutes measurement	1-3, 1-4
	Open boundary valve V14 and V15 after a 10 minutes measurement	
8	Record all data obtained	
9	Continue step test at PM2 and PM3 pilot areas	

Step test procedures Case 2
Using two ultrasonic flow meters instead of boundary valves

	Step Test Procedures	Measured Subzone
1	Install two ultrasonic flow meters at V15 and at V13 and measure	1-3
3	Replace a flow meter from V15 to V14 and measure	1-4
4	Replace a flow meter from V13 to V12 and measure	1-2
5	Replace a flow meter from V12 to Inlet and measure	1-1
6	Record all data obtained	
7	Continue step test at PM2 and PM3 pilot areas	

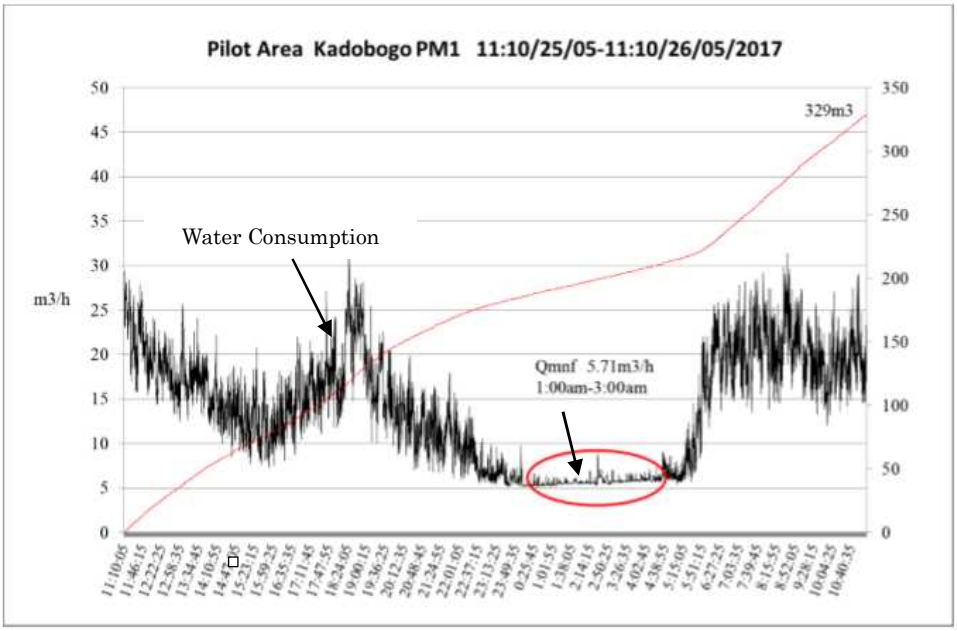
Reference; Minimum Night Flow Survey

The MNF is the lowest inflow in the DMA over 24 hours of the day, which occurs depending on consumption patterns but reportedly, between 00:00 and 04:00 a.m. when most of the customers are probably not consuming and the flow at this time is predominantly leakage.

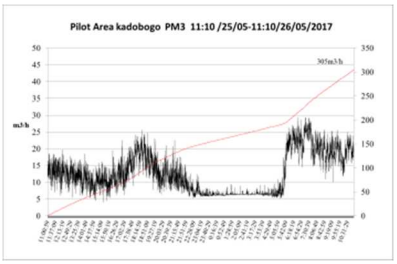
Water losses on any given supply system increase over time due to infrastructure deterioration, meter under-reading/failure, non-authorized consumption etc.

To quantify and understand the level of water loss occurring on a supply network it is necessary to undertake a water balance or minimum night flow test. Daily demand levels on a network increase and decrease depending on the time of day but, generally speaking, levels of demand between the hours of 00:00 & 04:00 am are at a minimum. It is therefore necessary to monitor and record flows during these hours to get a true representation of a network's level of water loss.

The following image is of a typical daily cycle of water consumption:



Flow Chart of Step Test



Setting of Ultrasonic Flow Meter at Intake

Qmnf Step Test Measurement 1

Area 1 High

Area 2 Medium

Area 3 Low

Caution or hold

No action

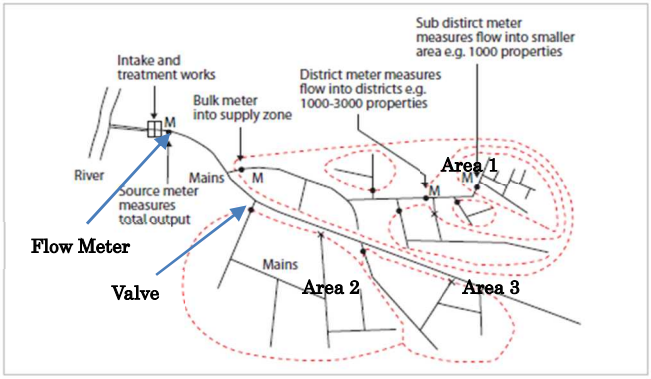
Qmnf Step Test Measurement 2

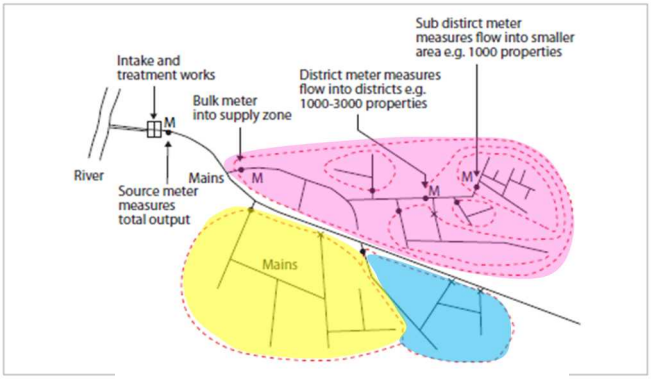
High

Low

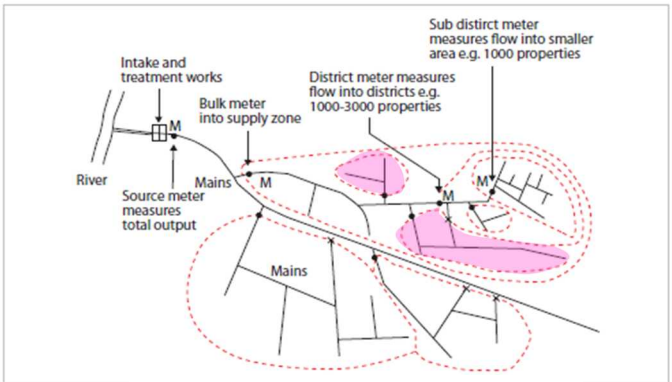
Leak Detection

Correlation,
Headphone leak detection,
Sounding bar leak detection,
Flow Measurement,
etc





Qmnf Step Test Measurement 1



Qmnf Step Test Measurement 2

4.3 Invisible Leakage Survey

I. Objectives

Most water leaks occur in visible places such as underground or hidden place on the ground. It may take a few months before it rises up on the surface for you to see, or it is not rises up to the ground even if it passes at time.

Leaks in underground plumbing can be caused by many different factors, including age or driving over pipe with heavy trucks or equipment, poor initial installation, leaking joints or valves, or high pressure in the distribution water network.

Invisible leakage survey is for locating invisible leakage hardly detectable.

The step test is to determine priority areas for NRW reduction. At survey area divided into several subzones, NRW rate of each subzone can be computed from the water consumption and inflow rate obtained by closing boundary valves step by step.

Priority for NRW reduction can be given to the subzones with a larger NRW rate. At the selected prioritized zones, the survey team conducts more elaborate leakage survey and detection.

As far as visible leakage is concerned, it is easy to locate and repair them. Regarding invisible underground leakage, it is another issue. Leakage detection shall be conducted. And it requires some special technology and experience. Due to geographical condition where leak sounds are less detectable, it is, indeed, hardly possible to locate leak points. To cope with this issue, the step test focuses on pipelines (secondary and tertiary distribution mains), instead of subzones set up.

Portable flow meters, to be properly installed on the pipelines gives precious information on abnormal or excessive flow rate. Based on this information, probable leak points can be located within a short span length of several meters.

II. Preparatory Work

WASAC branch offices shall first select several patches of survey areas to conduct NRW reduction. This selection might be easy when the normal step test precedes the modified. To confirm appropriateness of the area, the staffs concerned shall carry out preparatory work, including the following;

- Collecting and making a review of all customer and pipeline data, diameter, pipe materials, year of installation, leak repair records and pipe rehabilitation in the survey

area, prepare pipeline sketch, a list of customers, POCs, and monthly water consumption

- Allocate average flow rate at each pipeline in advance from the consumption data of each POC
- Prepare work schedule, tools, logistic such as survey vehicles, equipment to be utilized in the survey.
- Organize a survey team which consists of five members

III. Survey Procedures

1) Branch technicians shall confirm customer POCs and pipeline drawings prepared above, by carrying out asset survey (pipe alignment, pipe materials, diameter, earth covering over the pipe, leaks, etc.) by closing inlet valves and/or conducting hydraulic isolation and by visiting all customers
2) Measure distance of the located pipeline from the property of permanent structure (bridge, electric pall, etc.) and update the sketch of the pipeline and customers as shown on Figure - Pipeline Sketch
3) The team shall determine proper spots of flow measurement to carry out the work efficiently, with a view to the pipeline length and location, number of customers, and volume of water flow
4) When considered necessary, inlet valves shall be installed (Note: additional installation of the ultrasonic portable flow meter, in most cases, will offset a lack of gate valves)
5) Make a review of and revise the work schedule based on the survey above
6) The team initiate the work, by installing ultrasonic flow meters on the proposed spots of the inlet and the branched mains
7) After ten-minute measurement, compute flow rate difference, based on flow rate measured
8) Continue flow rate measurement on the existing and the inlet main
9) Identify pipelines with excessive flow rate

10) Continue the flow rate measurement on the other mains and branches by excavation where required (invisible leak)

11) After locating the pipeline with excessive flow rate, excavate the most probable spot and locate leaks

12) Obtain X-Y coordinates of the leak points by GPS, measure leakage rate by buckets, identify causes of leak and take photos/video if found

13) Repair leaks, take photos and record quantity of tools, materials and manpower used for repair in the leak repair record sheet

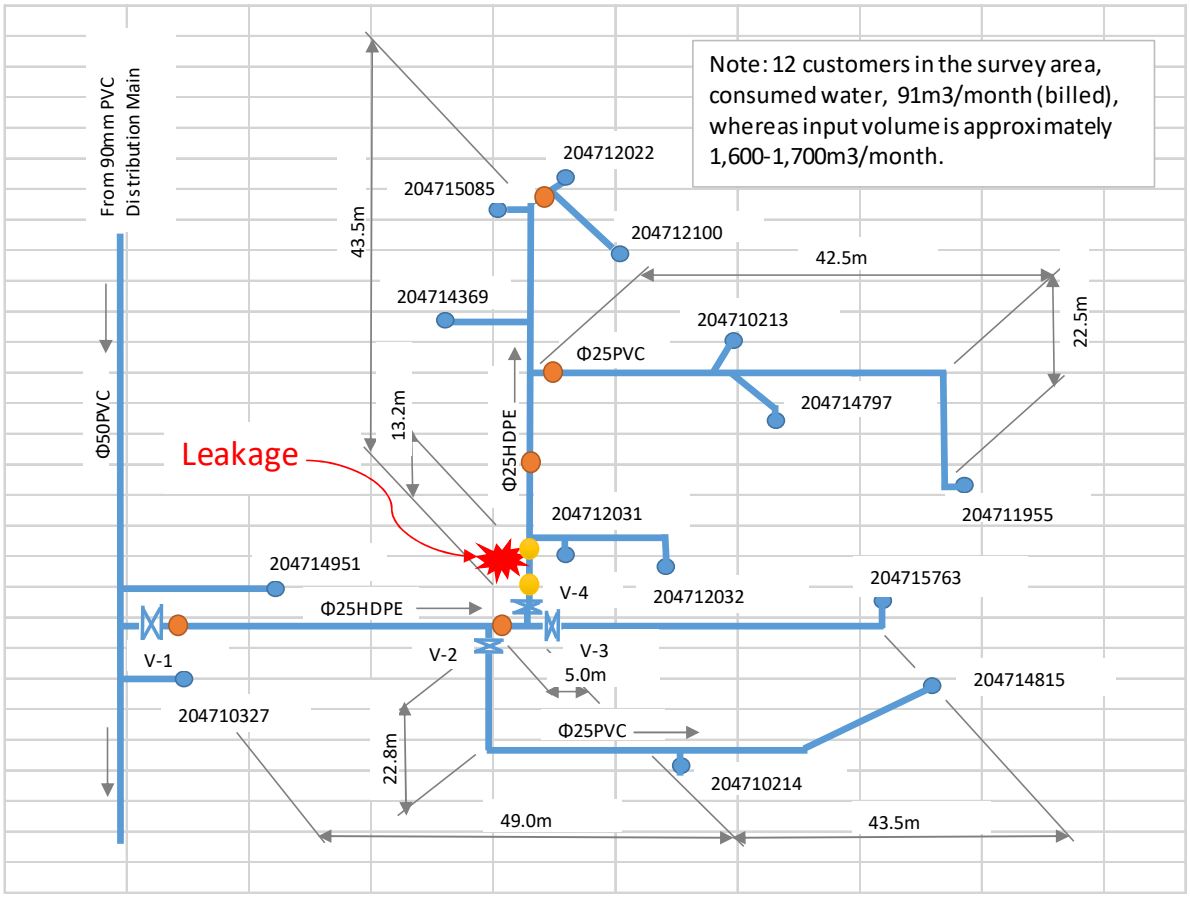


Figure- Pipeline Sketch

Signs of underground leaks include:

- Unusually wet spots in landscaped areas and/or water pooling on the ground surface.
- An area that is green, mouldy, soft, or mossy surrounded by drier conditions.
- A notable drop in water pressure/flow volume.
- Heaving or cracking of paved areas.
- Sink holes or potholes.
- Unexplained sudden increase in water use, consistently high water use.

4.4 Leakage Detection

4.4.1 Acoustic leakage sound detection method

Most appropriate leakage detection methods for WASAC distribution network is "Acoustic Leakage Sound Detection Method". About water pipeline network system in Rwanda, distance between fittings of pipeline is long, therefore "Analysis of sound source method" is difficult to adopted.

Leak sound is propagated to the valve or water meter from the leak point. Accordingly, propagated sound at the fitting is identified as the leak sound by the acoustic survey devices. Leak sound is checked by the listening stick at the meter or valve. It is the loudest which is nearest to the leak point.

"Acoustic Bar" and "Electric Acoustic Bar" are used for point survey such as survey at valves, fire hydrants, and meters.

(1) Point Survey

Many leakages occur at service connections. Point survey can detect service pipe line and distribution line. Necessary procedure is as follows:

- Visit customer's house and inform the customer the purpose of leakage survey and get permission to get in the property and check meter and stop valve.
- Hear leak noise at customer's meter or stop valve using an acoustic bar or an electric acoustic bar.
- Shut a valve and hear the noise again when the leak noise is detected, if leak noise stops, leakage occurs after stop valve. If the leak noise continues, leak occurs before stop valve.
- At same time, to observe around the meter and confirm existence of illegal connection.
- When leakage is found, measure leakage volume using measuring devices and repair the leak.

(2) Line survey:

It is necessary to survey on the road for detecting leaks on distribution pipeline survey using a head phone type leak detector (ground microphone). Necessary procedure is as follows:

- Hear leak noise on the road using a leak detector.
- Walk along pipeline, stop and touch ground microphone on the surface of the ground

about 5 seconds and hear the noise at every step.

- When leak noise is detected, mark the point on the ground and write report about the place.
- After checking leaks by confirmation survey, measure leakage volume and repair leaks.

(3) Equipment

1) Acoustic Bar

An acoustic bar is the basic device used for the leak detection survey. An acoustic bar is a very simple device without electronic parts and maintenance for a long time. It is the most basic device for leak detection.

Listening stick consists of acoustic bar which is made of stainless steel or steel and head part which has a room and a vibration plate.

When listening stick is contacted to fittings, leak sound is propagated to the bar and amplified the sound by the vibration plate in the head part. There is no sound if there is no leak.

When a leak generates on the fitting, it has sounds like a “SHEE” or “HUEE”. Surveyor should check the sound at all fittings, and if a strange sound is heard, mark it on the survey map. It is identified as a leak point by the confirmation survey.

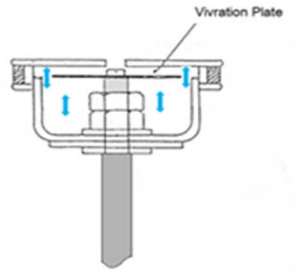


Fig. 1 Structure of Acoustic Bar

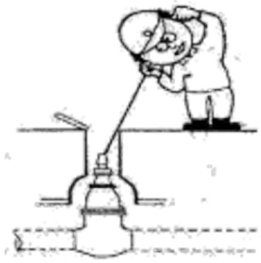


Fig. 2 Image of Hearing Noise

- Boring method

Even when leakage is found but it is difficult to pinpoint the place of the leakage. Boring method will identify exact place of leakage and improve burden of repairing work.

Fig. 3 Boring Method

2) Electric Acoustic Bar

Leak noise on non-metallic pipe is small with low frequency. It is difficult to distinguish for small sound. An Electric Acoustic Bar can amplify such a small sound and easy to distinguish through the head phone or sound level meter.

Acoustic survey using electric acoustic bar is to make contact to the valve or meter and check the sound and level meter. Fig. 5-19 shows nearest point from which leak a largest sound with 75other points further from the leak point has, the sound becomes smaller.

Leak surveyor can identify the rough leak point by the sound level.

Fig. 4 Electric Acoustic Bar

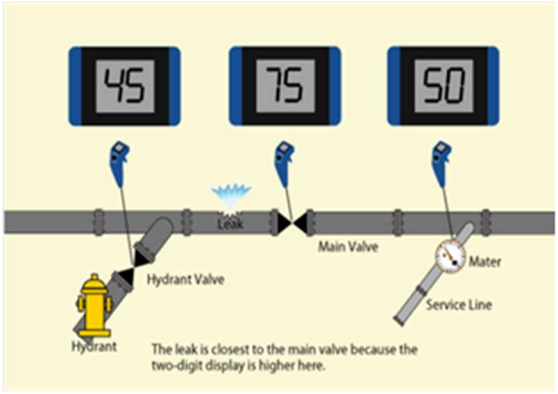


Fig. 5 Image of Sound Level Check

3) Headphone type Leak Detector (Ground Microphone)

Water leak detector is the representative device for the pinpoint method. It has a long history and has been used on the leak detection survey.

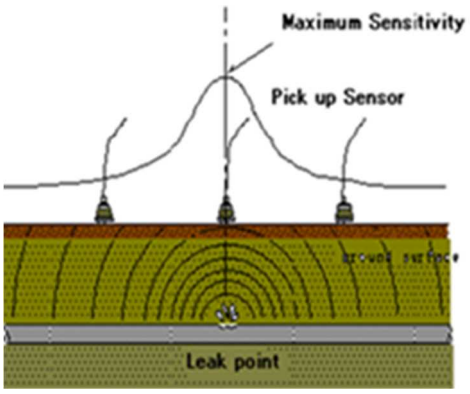


Fig.6 Peak Point

Fig. 6 shows the detection of the peak point on the ground surface by the sensor of water leak detector. Generally, the leak point has loud sound, and headphone type leak detector can identify the peak point.

Water leak survey team should consist of at least two staff and separate each other. One staff walk along the main pipe and detect leakage, the other staff detect the leak on the service pipe. They keep a distance to avoid foot noise of each other. If a strange sound is heard, mark the place on the survey map.

Fig. 7 Headphone Type Leak Detector

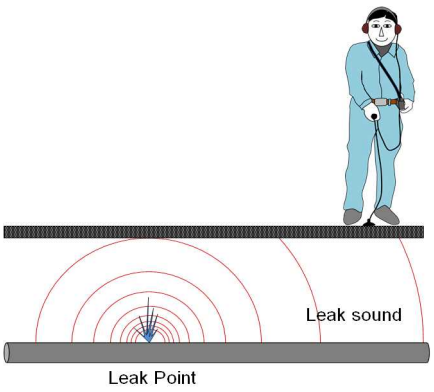
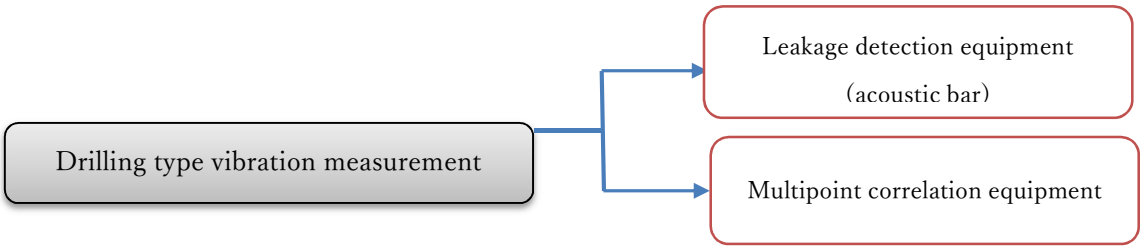


Fig. 8 Image of Listening Leak Sound

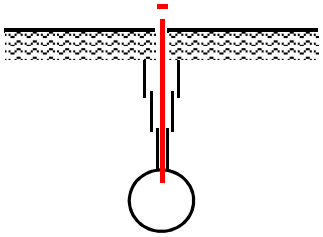
(4) Drilling type vibration measurement method

This specification to be used for acoustic (sound) investigation is to drill seismometrics bar into the top of large size pipe and acquire leakage sound (dummy leakage sound) which transmit through pipe. This is called as drilling type vibration measurement method because seismometric bar is drilled into pipe.

The following system and equipment are used for drilling type vibration measurement method.



As shown in the figure below, different size of drilling holes was made every 1 m pitch. Then carefully contact the seismometric bar with pipe not to damage pipe and investigate existence of leakage by using leakage detection equipment.

		
Drilling hole	Seismometric bar and leakage detection equipment	Drilling holes

4.4.2 Analysis of sound source method

Correlated leak detection method

Install two detectors (extension) at both side of pipe and observe/evaluate waveform shape difference.

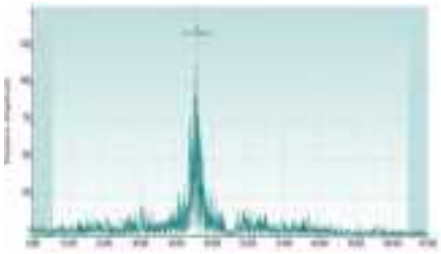
To confirm whether interrelated waveform available or not. And input data of number of model pipeline, length (actual length), sound wave velocity, pipe material and diameter of pipe. Based on data, calculation will start. From leakage points, distance will show in the screen.

Sound-level meter

Install censer roger at fire hydrants, gate valves and water meters and record (memorize) the sound level in the measuring time. Analyze the data in three dimensions by special software. Based on the three-dimension figure, Judge whether abnormal sound is found or any leakage from pipe line.

Multipoint correlation method

Logger type correlation leakage detector with non-wireless type.



4.5 Leakage Data Analysis

Whenever leak repair was conducted the related data shall be reported. Using those data, we can identify the main cause of the leakage and take countermeasures.

1) Necessary data for leak point should be:

- Date
- Pipe diameter
- Pipe material
- Pipe category
- Leak point (for example: joint, fittings…..etc)
- Cause of leak
- Location (geographical coordinate: x and y)
- Administrative location (Cellule and village)
- Reported time
- Closed time
- Volume of lost water
- Materials used for repair

Example of leakage information format of 5YSP

[The format of leakage information]

WASAC

Leakage Information System

Branch KACYIRU

Period April 2018

No.	Date	DN(mm) /inch	Pipe Material	Pipe category	Leakage point	Cause of the leak	Location (geographic coordinates)		Location Admin (Cell and Village)	Reported time		Closing time		Duration of leakage		Reopening time		Response time	Lost water		Material used	Repaired by	Comment if any
							X	Y		H	M	H	M	H	M	H	M		Volume(m3)	Way used			

2) Analysis of Leakage

Analyzing leakage information data through (Example: GIS, excel Pivot table) we can identify the flowing issues:

- Identify the location of leakage point on the Map.
- Assist to determine priority area to be taken reduction measures of NRW by knowing the frequent occurrence position of leakage.
- Which pipe material has the biggest problem
- Which part of the network has leakage?
- What is the main causes of leakage?
- etc.

Result of the analysis of leakage data can be utilized for following activities to make more surely:

- Pressure control by installation of PRV or Construct BPT
- Network rehabilitation (replacement of pipeline)
- Project evaluation

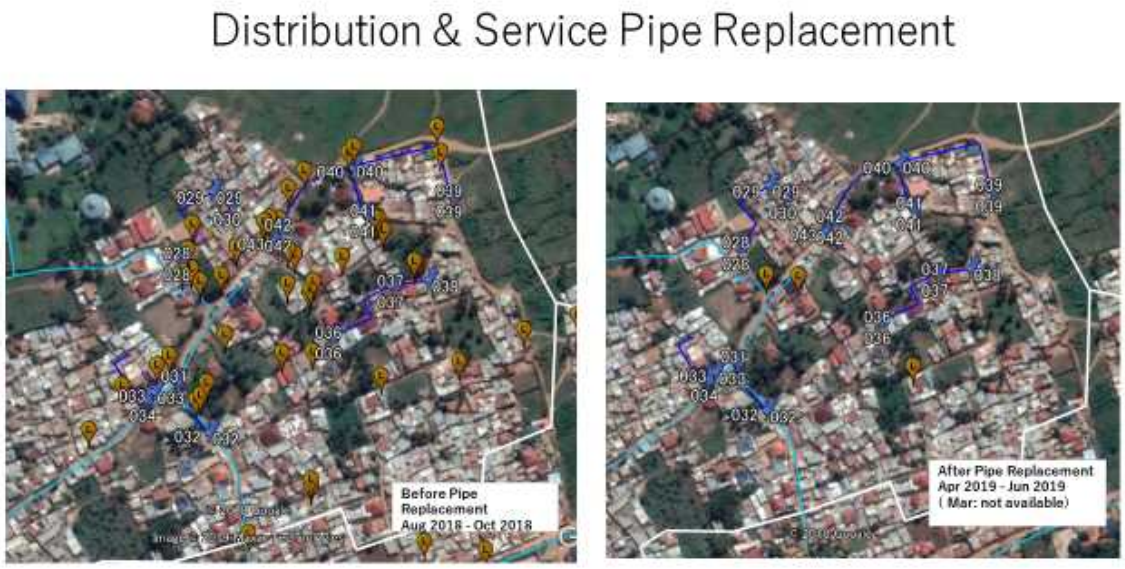
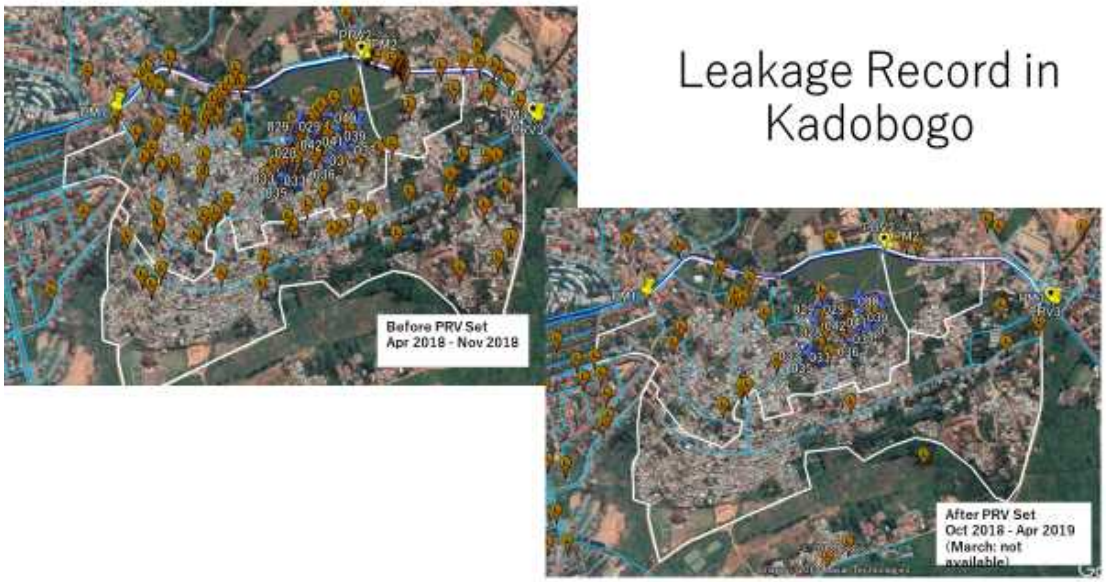


Fig. 1 Plotting of the Leakage Repair Point

Trend in number of Leakage Repair

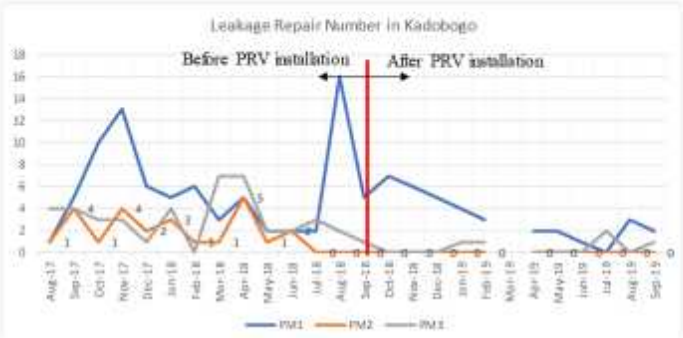


Kadobogo Pilot Area

Leakage Repair Number

Month	PM1	PM2	PM3	Total
Aug-17	1	1	4	6
Sep-17	5	4	4	13
Oct-17	10	1	3	14
Nov-17	13	4	3	20
Dec-17	6	2	1	9
Jan-18	5	3	4	12
Feb-18	6	1	0	7
Mar-18	3	1	7	11
Apr-18	5	5	7	17
May-18	2	1	2	5
Jun-18	2	2	2	6
Jul-18	2	0	3	5
Aug-18	16	0	2	18
Sep-18	5	0	1	6
Oct-18	7	0	0	7
Nov-18	6	0	0	6
Dec-18	5	0	0	5
Jan-19	4	0	1	5
Feb-19	3	0	1	4
Mar-19	No data	No data	No data	0
Apr-19	2	0	0	2
May-19	2	0	0	2
Jun-19	1	0	0	1
Jul-19	0	0	2	2
Aug-19	3	0	0	3
Sep-19	2	0	1	3
Total	116	25	48	189
Average	4.5	1.0	1.8	7.3

PRV installation (PM2,PM3)



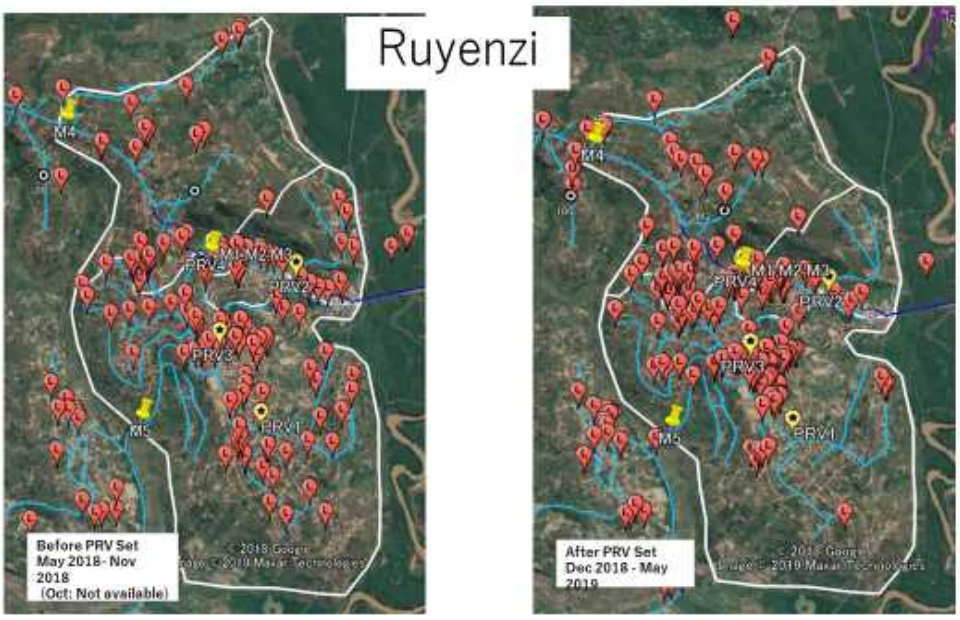
Leakage Repair Number (10 months)

Term	PM1	PM2	PM3	
Jan-18～Oct-18	53	13	28	Before PRV installation
Nov-18～Sep-19	28	0	5	After PRV installation

Leakage Repair Number per Month

Year	PM1	PM2	PM3	Total
2017	7.0	2.4	3.0	12.4
2018	5.3	1.1	2.3	8.8
2019	2.1	0.0	0.6	2.8

Fig. 2 Plotting of the Leakage Repair Point

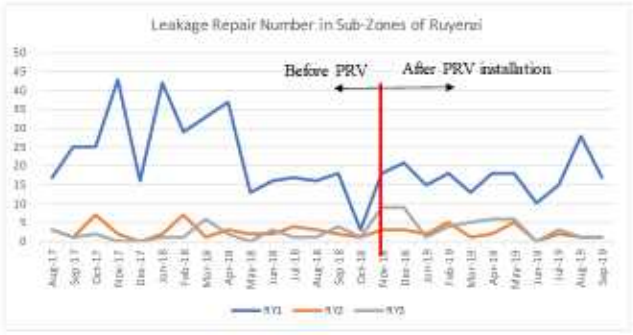


Ruyenzi Pilot Area

Leakage Repair Number

Month	RY1	RY2	RY3	Total
Jul-17	4	0	1	28
Aug-17	17	3	3	23
Sep-17	25	1	1	27
Oct-17	25	7	2	34
Nov-17	43	2	0	45
Dec-17	16	0	0	16
Jan-18	42	2	1	45
Feb-18	29	7	1	37
Mar-18	33	1	6	40
Apr-18	37	3	2	42
May-18	13	2	0	15
Jun-18	16	2	3	21
Jul-18	17	4	1	22
Aug-18	16	3	1	20
Sep-18	18	2	4	24
Oct-18	3	1	1	5
Nov-18	18	3	9	50
Dec-18	21	3	9	33
Jan-19	15	2	1	18
Feb-19	18	5	4	27
Mar-19	13	1	5	19
Apr-19	18	2	6	26
May-19	18	5	6	29
Jun-19	10	0	0	10
Jul-19	15	2	3	20
Aug-19	28	1	1	30
Sep-19	17	1	1	19
Total	545	65	72	705
Average	20.2	2.4	2.7	26.1

PRV installation (PRV1,2,3)



Leakage Repair Number (10 months)

Tarm	RY1	RY2	RY3	
Feb-18～Nov-18	200	28	28	Before PRV installation
Dec-18～Sep-19	173	22	36	After PRV installation

Leakage Repair Number per Month

Year	RY1	RY2	RY3	Total
2017	21.7	2.2	1.2	28.8
2018	21.9	2.8	3.2	27.8
2019	16.9	2.1	3.0	22.0

Fig. 3 Plotting of the Leakage Repair Point

Leakage Data Number Year: 2017

DNmm	January	February	March	April	May	June	July
25	1,358	1,212	1,241	1,178	1,265	1,257	1,172
32	363	373	487	437	417	410	429
40	125	114	145	123	150	127	131
50	115	124	125	130	134	98	119
63	181	224	179	188	171	155	163
75	43	42	37	54	33	59	37
90	109	119	86	91	120	90	77
110	57	76	68	64	57	60	58
125	19	18	19	21	18	7	18
140	5	4	1	2	17	1	1
160	18	13	11	15	13	11	11
200	13	10	17	8	14	11	17
225	0	3	0	2	0	1	0
250	0	2	0	2	6	4	0
280	0	1	0	2	2	2	0
315	3	2	0	0	1	1	0
400	0	0	0	0	1	0	0
500	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0
Total Places	2,409	2,337	2,416	2,317	2,419	2,294	2,233
Loss	167134.6138	215,021	156,415	161,685	228187.2069	194,192	144745.403
Rate m3/Plac	69	92	65	70	94	85	65

Leakage Data m3/place

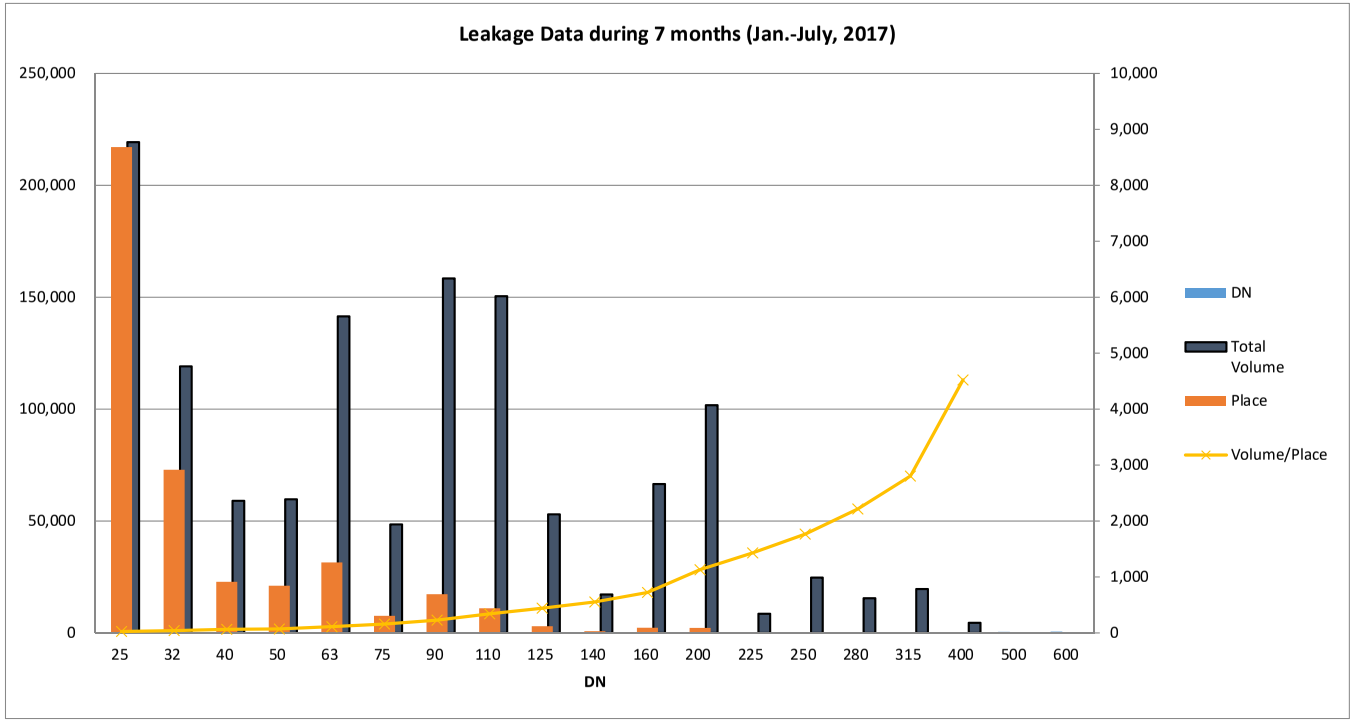
DN	Total Volume	Place	Volume/Place
25	219,315	8,683	25
32	119,110	2,916	41
40	59,052	915	65
50	59,699	845	71
63	141,439	1,261	112
75	48,484	305	159
90	158,403	692	229
110	150,456	440	342
125	52,988	120	442
140	17,171	31	554
160	66,558	92	723
200	101,736	90	1,130
225	8,584	6	1,431
250	24,728	14	1,766
280	15,509	7	2,216
315	19,629	7	2,804
400	4,522	1	4,522
500	0	0	0
600	0	0	0
Total Places	1,267,381	16,425	77
Loss		1,267,381	
Rate m3/Place		77	

Leakage Data Volume m3

DN mm	January	February	March	April	May	June	July	TOTAL
25	23,986	42,814	21,919	20,806	44,686	44,404	20,700	219,315
32	10,505	21,588	14,093	12,646	24,134	23,729	12,415	119,110
40	5,652	10,309	6,556	5,562	13,565	11,485	5,923	59,052
50	8,125	8,761	8,831	9,185	9,467	6,924	8,407	59,699
63	20,302	25,125	20,077	21,087	19,180	17,385	18,283	141,439
75	6,835	6,676	5,882	8,584	5,246	9,379	5,882	48,484
90	24,951	27,240	19,686	20,830	27,469	20,602	17,626	158,403
110	19,491	25,988	23,252	21,885	19,491	20,517	19,833	150,456
125	8,390	7,948	8,390	9,273	7,948	3,091	7,948	52,988
140	2,769	2,216	554	1,108	9,416	554	554	17,171
160	13,022	9,405	7,958	10,852	9,405	7,958	7,958	66,558
200	14,695	11,304	19,217	9,043	15,826	12,434	19,217	101,736
225	0	4,292	0	2,861	0	1,431	0	8,584
250	0	3,533	0	3,533	10,598	7,065	0	24,728
280	0	2,216	0	4,431	4,431	4,431	0	15,509
315	8,412	5,608	0	0	2,804	2,804	0	19,629
400	0	0	0	0	4,522	0	0	4,522
500	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0
Total Loss	167,135	215,021	156,415	161,685	228,187	194,192	144,745	1,267,381
Supply	3647942	3,265,264	3,582,770	3,560,437		3,260,627		
Loss%	4.6%	6.6%	4.4%	4.5%	#DIV/0!	6.0%	#DIV/0!	#DIV/0!

6.6626875

Flow rate : 2m/sec
Time from leak occurrence to repair completion: 5 hours
Water unit price: 565Rwf/m3
Leakage volume = Area X Verosity (2m/s) X 5 hours
Cost = leakage volume X 565 Rwf



Reference 4.1 Flow Measurement

Handling and attention to use Ultrasonic Flow Meter and Electromagnetic Flow Meter

(1) Principle of Ultrasonic Flow Meter measurement

Ultrasonic flow meter comprises of time difference of the transmit method, time difference by inverse number method, sing-around measurement method and Doppler method.

Each method has its own characteristics. In this chapter, the project explains the most popular method of time difference by inverse number method (frequency difference method).

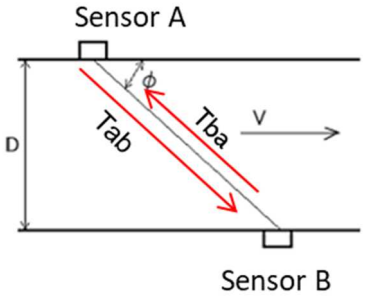


Fig -1 Principle of Measurement

Transducer (ultrasonic censor) should be installed at a certain location of pipe and receive ultrasonic wave. When there is no flow, time to take from upstream A to downstream, "Tab" will be equal to time from downstream B to upstream A, "Tba". When there is flow, ultrasonic wave flow from A to B will be forward direction with follow wind. Thus, speed of transmit of ultrasonic wave will be faster comparing with there is no flow. On the contrary, speed of transmit from B to A will become slower than speed no water flowing against that water is flowing.

(2) Method of installation of Sensors (V, Z, W, others)

1) V method

This method is also called reflect mode. It is advisable to install by this mode method because installation of transducer is easy.

And when a transducer cannot be installed at opposite side, a transducer can be easily installed at same side to another one.

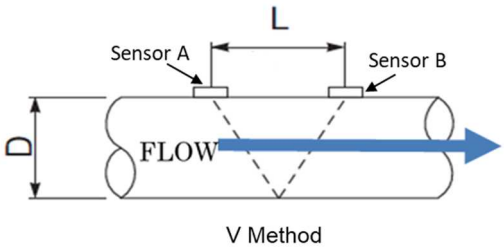


Fig-2 Setting by V Method

2) Z method

This method is also called direct mode. Route of ultrasonic wave can be shortened and used for transmitting of wave is not good for pipe and /or fluid to measure flows.

When material of pipe is plastic, transmit of wave will be attenuated. In this case, it is advisable to use direct method to measure flow.

In addition to this, reflect mode needs two times of pipe length comparing with direct mode. When straight pipe is not enough, direct mode method is recommended to be installed.

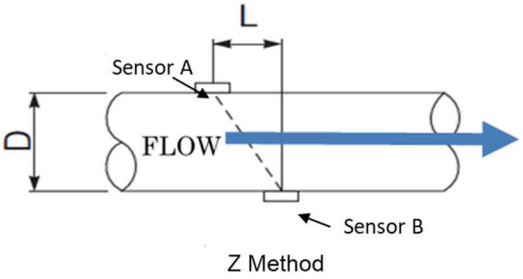


Fig-3 Setting by Z Method

3) W method

There are some flow meters which V method is superimposed to measure flow. This is called W method.

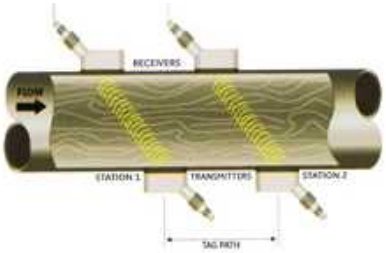


Fig-4 Setting by W Method

4) Inside welding method

Accuracy to measure only flow inside of pipe will be increased outstandingly. Censor is installed inside of pipe from the beginning to apply the welding method for large size transmission and distribution pipes.

(3) Characteristics of ultrasonic flow meter

1) There is no obstacles inside of pipe

There are no materials to disturb flow inside pipe. Therefore, the following strong points will be available.

- Head loss will be zero, but head loss will be occurred for small size pipe due to bindings.
- Structure is simple, and trouble is seldom developed.

2) Pipe inside is clean

When transmitter/receiver are installed at outside of pipe, flow measuring pipe inside is completely contactless with any devices.

3) No influence by density and viscosity of flow

Signal of flow will be proportional to volume of the flow but not influenced by density and viscosity of the fluid in principle.

4) Wide range of measuring flow

Full scale flow of the ultrasonic flow meter can be adjusted freely at the converter side. Signal of the flow will be appeared at nearly zero pint and wide range of flow can be measured by one ultrasonic flow meter. Wide range of ultrasonic flow meters have been made for diameter of several meters in large size and 4 mm in small size.

5) High accuracy

It is said that accuracy of the wetted type ultrasonic flow meter is 1 to 2 % for full scale meter but now accuracy is 0.5 % of the indicated value due to the technological development.

6) Quick response

Ultrasonic flow meter can be adjusted against variation of flow quickly because mass and thermal capacity are not involved. It is also able to adjust pulsatile flow.

7) Possible to measure for opposite direction flow

Structure of upstream and downstream is symmetrical and can be measured for the opposite flow.

8) Others

- Cost is constant for large size meter.
- Contactless completely with fluid
- Repairing work can be made without interrupting flow.

However, error factor to estimate thickness of pipe and refraction of ultrasonic wave will increase. Thus, accuracy of the measurement at full scale will be 2 to 3 %.

(4) Attention points to measure by ultrasonic flowmeter

Position of installation of sensor will be greatly influenced to accuracy of measuring. The following conditions must be kept to measure.

1) Need straight pipe

Ultrasonic flow meter needs straight pipe at the upstream 10 times of diameter and downstream 5 times of diameter pipe. Longer straight pipe will be necessary under some pipe line conditions (when lateral line is increased, straight pipe length be decreased but cost will increase).

2) Air bubble

Air bubble in the fluid will block the flow of ultrasonic wave. Only small amount of air bubble will stop operation of ultrasonic flowmeter and this is the most outstanding week point. However, recently new ultrasonic flowmeter is made by devising signal processing against air bubble which is less influenced to measure the flow.

3) Outer diameter of serial pipes to be measured

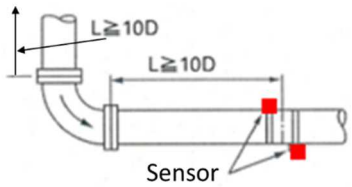
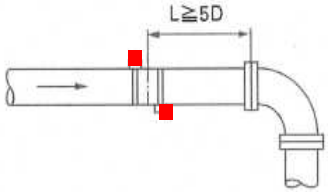
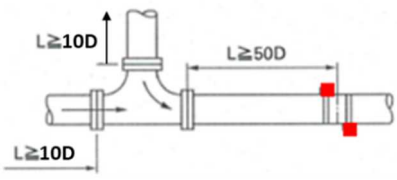
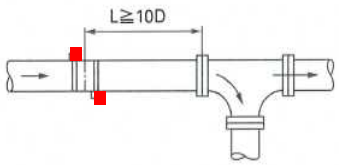
Outer diameter of pipe is same even different pressure-resistance pipe such as 16bar and 10bar. Thickness of pipe wall is different. For example, PVC DN160mm 16bar is 12.94mm and 10bar is 9.03mm.

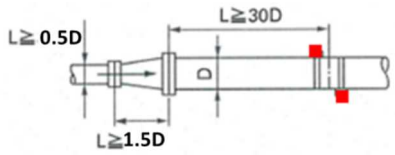
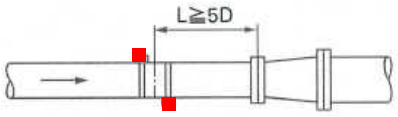
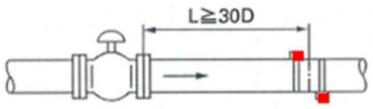
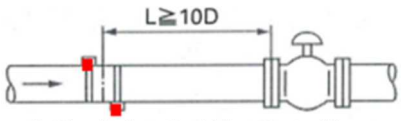
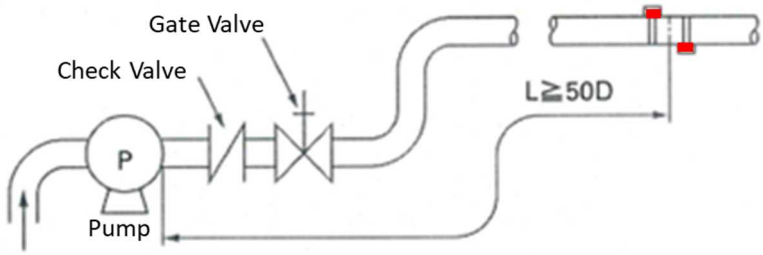
Sometimes, different pressure-resistance pipes are installed on a same pipeline. Without measurement of pipe wall thickness, if setting parameter are same, measurement result becomes error. Because sound speed on PVC and water are much different.

For example, measured value on DN160mm PVC 16bar pipe is around 80m3. Measured value on DN160mm PVC 10bar pipe same parameter of 16bar becomes around 70m3. Lesson learned above experience are as follows:

- Sometimes different thickness of pipes is used on same pipeline.
- Measure pipe wall thickness every time.
- Think outside the box.

Table-1 Attention Point for Setting of Ultrasonic Flow Meter

Position	Install at downstream of fittings	Install at upstream of fittings
90°bend		
T-shaped pipe		

Reducer		
Controlling Valve	 Setting after the Valve Controlling Water Volume	 Setting before the Valve Controlling Water Volume
Before/After Pump		

Avoid pipeline which fluid will not be full flow

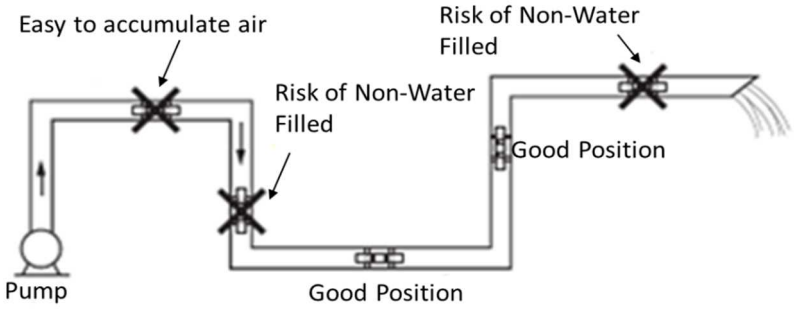


Fig-5 Possible Non-Water Filled Point

- Install Sensors in ± 45°of horizontal line to avoid accumulated air and sediments

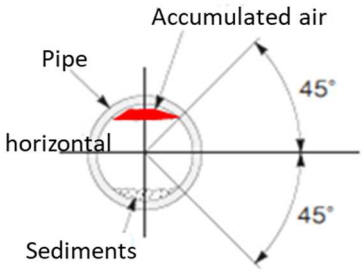


Fig-6 Setting Position of Sensors

- Avoid welded part and joint

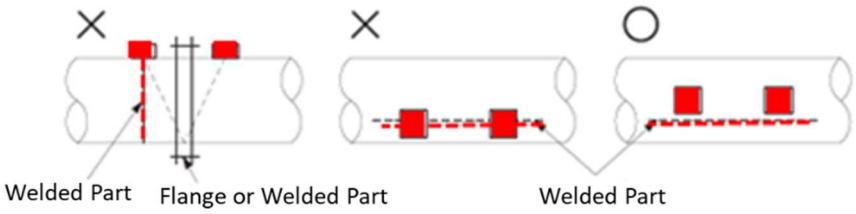


Fig-7 Setting Position of Sensors avoid Welded Part

(5) Installation points of Electromagnetic Flow Meter

- **No water filled**

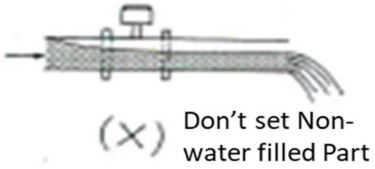


Fig-8 Non-Water filed Part

- **Not approved appearance dead air space**

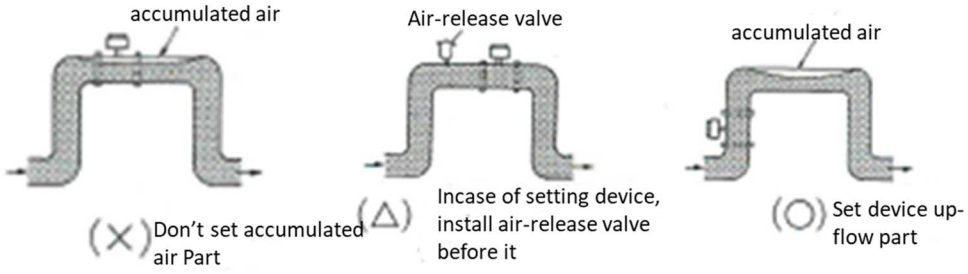


Fig-9 Dead Air Space

- **Pay attention to install near water tank**

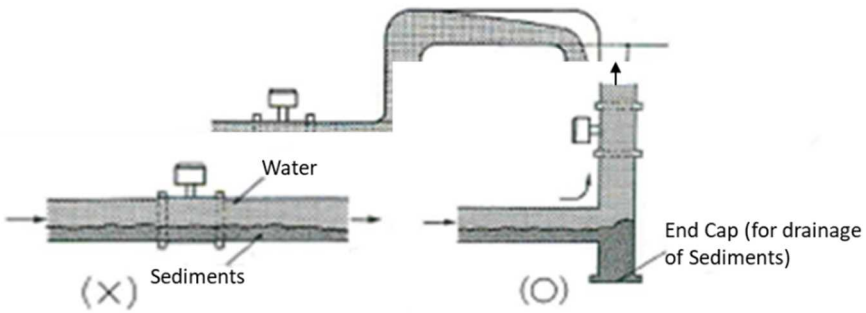


Fig-11 Sediments in the Pipe

- **Sediments in the pipe**

- **Installation Position to Valves**

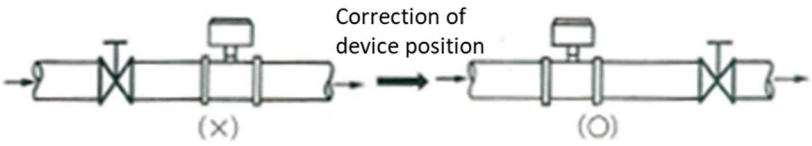


Fig-12 Correction of Installation Position

- **Necessary Distance to Valves**

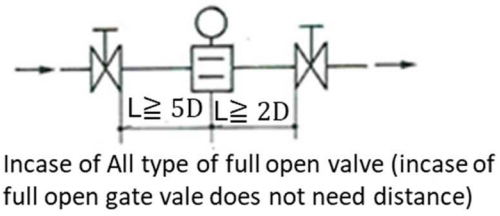


Fig-13 Necessary Distance

- Approve close related use of sluice valve

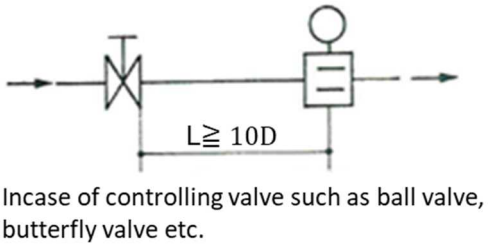


Fig-14 Necessary Distance to Controlling Valve

- **Necessary Distance to Bend and Joint Flow**

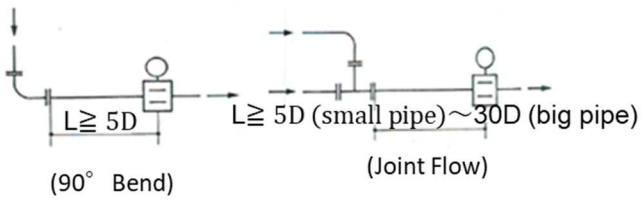
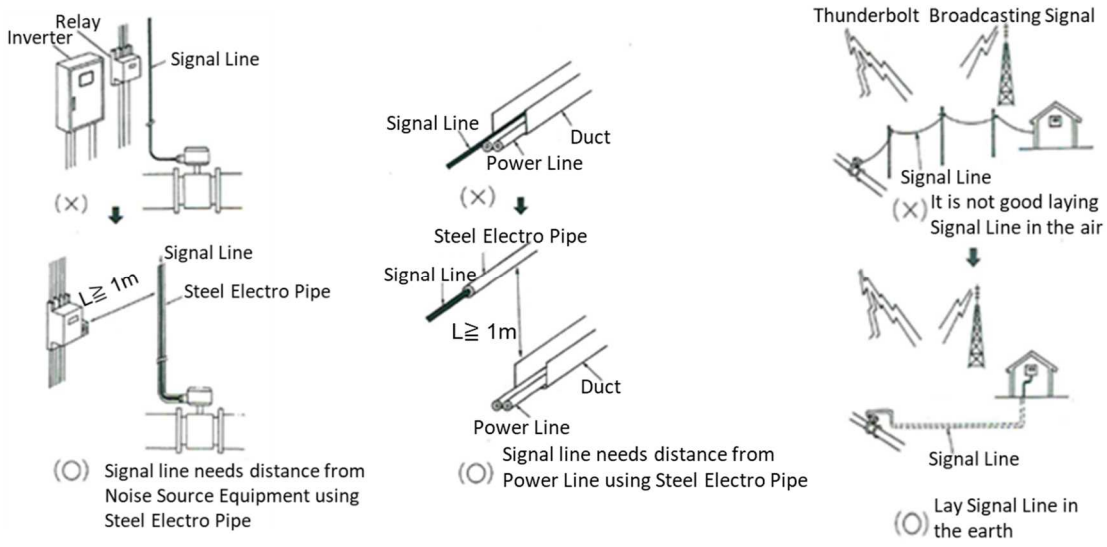


Fig-15 Bend and Joint Flow

- **Avoid Electric Magnetic Noise**



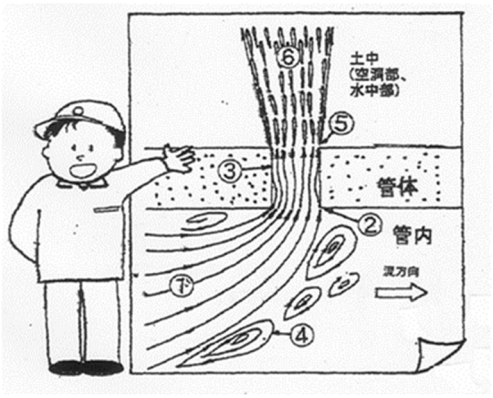
Fi -16 Electric Magnetic Noise

Reference 4.2 Leakage Sound

(1) Occurrence of leakage sound

Leakage sound will find out when pipeline is damaged and sound will occur from a hole where pressured water leaked outside and make noise.

Characteristic of leakage sound is distributed ranging from low (below 0.1 kHz) to high sound (above 1.0 kHz). It is within the range of 0.5 kHz to 2.0 kHz which human being can easily hear.



(2) Variation of leakage sound with environment

1) There is no same leakage sound

The different leakage sound will occur due to different size/dimension of damaged part, different pipe material/quality, different installation conditions, and different pressure conditions.

2) Change of leakage sound due to time passing

Leakage sound will be changed by water pressure change when customer use water. It will change with time passing. The low pressure makes low sound and the high pressure makes the sound louder.

3) Change of leakage sound due to velocity of spouted water

The faster velocity makes the higher sound, and the slower velocity make the lower sound. Where size of damaged part is small, high leakage sound will occur. On the other hand, where size of damaged part is large, low leakage sound will occur.

4) Leakage sound will change according to condition of surroundings

Leakage sound will change according to the depth of pipe laying and earth pressure against pipe will affect volume of spouted water. And sound of spherical shaped wave near the damaged part and sound of plane shaped wave distant from damaged part will transmit.

(3) Transmitting leakage sound

1) Location of transmitting leakage sound

Leakage sound will transmit at rate of speed around「approximately 1,400m/sec」in the soil ,「approximately 250～700 m/sec」in the sandy soil and 「approximately1,000m/sec～2,000 m/sec」in the loamy layer.

Speed of transmitting will vary according to pipe material and diameter and transmitting leakage sound will also vary depending on pipe material and diameter.

2) Leakage sound transmitting for composite pipe, metal and nonmetal pipes

Transmitting speed will vary according to the junctions of pipe material and diameter. It is because elastic modulus will change depending on pipe material and diameter.

Transmitting speed of leakage sound for nonmetal pipe is slower than that of metal pipe and distance is also shorter due to different elastic modulus.

Note:

Elastic modulus is explained that when stress is added to the uniform elastic body, proportionally distortion will occur. Proportional constant in the formula is called elastic modulus and nonmetal pipe's elastic modulus is bigger than that of metal pipe.

3) Frequency wave and attenuation of leakage sound

When scale layer sticking inside of pipe, transmitting speed will vary according to formation of scale layer. And the more the scale layer formed, the slower the speed.

Leakage sound will vary the place where we hear the sound and distance from source of sound. Various leakage sounds such as high sound (low frequency wave), middle sound and low sound (high frequency wave) will occur at the leakage point.

Only low sound will be heard where high sound will be attenuated at the higher place than leakage location.

When leakage sound travels long distance, high sound of leakage will be attenuated and disappear in the middle of distance.

On the contrary, rate of attenuated for low sound is rather little and travel up to far place. When we hear low leakage sound, location of leakage place is rather far from the place where hearing sound in general, even though. It is defined as echo of leakage sound as imaging technical terms.

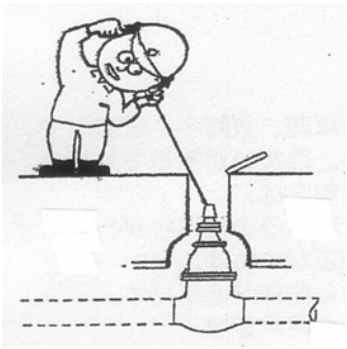
Table Factor of Leakage Sound

Leakage Sound	Low sound (Low frequency zone)	High sound (High frequency zone)
Diameter	Small	Large
Material	Ductile iron pipe, Steel pipe, Asbestos cement pipe, Lead pipe, Stainless pipe	Polyethylene pipe, Vinyl pipe
Aged year	New pipe (no scale layer and corrosion)	Old pipe (many scale layer and corrosion)
Joint	Welding, Lead joint	Rubber joint
Transmitting distance	Far	Short

(4) Acoustic sound listening method and other leakage detection method

Leakage detection method by audible sound listening method

1） Leakage detection method by audible listening is to estimate leakage availability, condition and location which will occur from the damaged pipe and listening at exposed meters, appurtenances and listening at the surface of road and detecting leakage.



2) Outline of leakage and tone quality

Audible range of frequency zone of leakage sound detected by leakage detection equipment at present is classified as three categories of「0.2～5kHz」,「less than Hz 」and「low sound（below 0.5KHz）」as shown in Outline of leakage and the table below.

Item	High sound	Middle sound	Low sound
Frequency zone	Above1.0kHz	0.5～1.0kHz	Under 0.5kHz
Size of leakage	Small	big	Very big
Dimension of leakage hole	Complicated	Simple	Simple
Flow in leakage hole	Very fast	Slow	Very slow
Diameter of pipe	Small diameter	Middle diameter	Large diameter
Material of pipe	Steel pipe and stainless pipe	Ductile iron pipe, asbestos cement pipe, polyethylene pipe and vinyl pipe	
Distance	Near	Far	Very far
Water pressure	High	Low	Very low

WASAC Water & Sanitation Corporation
'Dignifying Life'

Leakage Information System

S7

Branch KACYIRU

Period NOVEMBE DECEM 2019

N	Date	DN	e Mate	Pipe Category	Leakage point	Cause of the leak	Location (GPS)	Location admin.(cell & village)	Reported time	Closed time	Volume of lost water in cm	terials used	Technici	Comment if any
1	**2019/1/12**	25mm	HDPE	Service	Pipe	high pressure	-1.930642/30.073144	Kibaza	8h00	8h30	0.1	union	placide	
2		25mm	HDPE	Service	Pipe	subsndard of fittings	-1.898930/30.076835	Kagarama	10h00	10h45	0.2	union,niple	placide	
3		3/4"	GS	Service	Junction	corrosion	-1.948427/30.090703	Kibaza	15h00	15h10	0.10.5	,-	placide	
4	**2019/2/12**	63mm	PVC	Sub-main	Pipe	high pressure	-1.924767/30.069867	Musezero	9h00	9h35	0.6	1m pipe 63	Kamana	
5		110mm	PVC	Distribution	Clump	subsndard of fittings	-1.941407/30.090839	Kamatamu	10h00	10h15	0.1	clump dn 11	Patrick	
6	**2019/3/12**	63mm	PVC	Sub-distribution	Pipe	high pressure	-1.932024/30.053269	Budurira	8h20	8h45	0.4	1m pipe 63	Kamana	
7		90mm	PVC	Distribution	Clump	subsndard of fittings	-1.923250/30.079704	Gauriro	13h40	14h15	0.8	screwed clu	Kamana	
8		90mm	PVC	Sub-distribution	Pipe	corrosion	-1.958605/30.095299	Rugando	14h00	14h15	1.5	pipe dn 90,socket dn 90	Patrick	
9	2019/4/12	25mm	HDPE	Service	Pipe	substandard of pipe	-1.920008/30.101741	Karuvusha	7h50	8h30	0.2	union dn 3/4	Kamana	
10	**2019/5/12**	2"	GS	Sub-distribution	Junction	aged pipe	1-1.95182/30.092137	Kamukina	14h00	14h15	0.4	valve 2"	Patrick	
11	**2019/6/12**	90mm	PVC	Distribution	Junction	aged pipe	-1.941199/30.077479	Kacyiru	8h15	8h30	0.4	pipe dn 90,socket dn 90	Patrick	
12		2"	GS	Sub-distribution	Pipe	aged pipe	-1.931975/30.073485	Kacyiru	13h40	14h00	0.1	union 2",clu	Patrick	
13		63mm	PVC	Sub-distribution	Pipe	corrosion	-1.917345/30.081701	Kadobogo	8h00	8h20	0.2	1m pipe 63	Kamana	
14		50mm	PVC	Sub-distribution	Clump	subsndard of fittings	-1.909910/30.060288	Nyakariba	12h25	12h50	2	screwed clu	Kamana	
15		3/4"	LDPE	Service	Pipe	corrosion	-1.914577/30.093835	Gacuriro	14h35	15h00	1.3	union	Kamana	
16	2019/7/12	3/4"	HDPE	Sub-distribution	Pipe	high pressure	-1.899611/30.069872	Giheka	8h02	8h25	0.1	union,niple,	Claire	
17		3/4"	PPR	Sub-distribution	Pipe	aged pipe	-1.930411/30.068107	Kacyiru	10h10	10h30	0.3	valve, teflor	Claire	
18		90mm	PVC	Distribution	Junction	subsndard of fittings	-1.915620/30.083791	Kabuhunde	14h40	14h50	0.9	screwed clu	Claire	
19	**2019/8/12**	25mm	HDPE	Service	Pipe	substandard of pipe	-1.923201/30.079727	Gacuriro	8h00	8h30	0.2	union	Kamana	
20		50mm	PVC	Sub-distribution	Pipe	high pressure	1.920462/30.067345	Musezero	11h30	12h30	1.1	screwed clu	Kamana	
21	2019/9/12	32mm	HDPE	Sub-main	Pipe	road construction	-1.958483/30.094176	Rugando	6h15	7h00	2	pipe hdpe dn 32,2unon 2",5teflon	patrick	
22		25mm	HDPE	Service	Pipe	substandard of pipe	-1.910449/30.080431	Gicikiza	7h50	8h25	0.5	union 3/4"	Kamana	
23		200mm	PVC	Distribution	Clump	road construction	-1.907469/30.079115	Batsinda	10h10	10h30	0.8	screwed clu	Kamana	
24	2019/10/12	1/2"	GS	Service	Pipe	aged pipe	-1.949191/30.081129	Kimihurura	10h15	10h30	0.4	pipe 1/2",un	Patrick	
25		63mm	PVC	Sub-distribution	Pipe	high pressure	-1.920419/30.071421	Gasave	8h57	9h15	0.9	1.5m of pip	Kamana	
26		3/4"	LDPE	Service	Junction	corrosion	-1.918606/30.079520	Kadobogo	13h30	14h00	0.3	union 3/4"	Kamana	

R4-12

Inspection of leak repair

S8

Branch #REF!

Period DECEMBER 2019

No.	Date	Coordinates (X,Y)	Pipe information		Reported date	Repaired date	Quality of repair	Quality of materials	Quality of works	Observation	Reference No.
			size	material							
1	28/12/2019	-1.904097/30.080007	63mm	secrewed clumb Dn63	28/12/2019	28/12/2019	Excellent	Good	Good	done	
2	2019/4/12	-1.941407/30.090839	110mm	secrewed clump dn 110*1"	2019/2/12	2019/2/12	Good	Good	Good	done	
3	15/12/2019	-1.959724/30.091599	25mm	union 3/4"	13/12/2019	13/12/2019	Excellent	Excellent	Excellent	done	

Prepared by (Water Distribution Officer)

Approved by (Branch Manager)

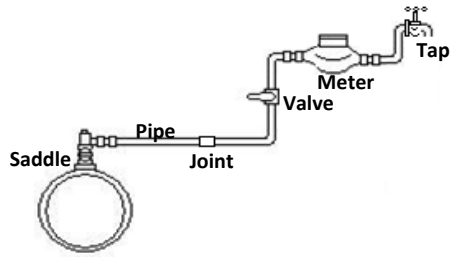
KN 5RD, WASAC Ltd. HQ, Rukiri I, Gasabo District, Kigali City, Rwanda
Email: wasac@wasac.rw, Website: www.wasac.rw , P.O Box 2331 Kigali-Rwanda

Leakage Repair Record Sheet

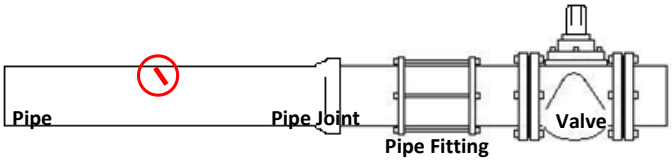
Leak No. 4-13

Date of Survey:	2012, Oct. 13	Street Name	Fairfield Road
Address (Area Name)	Katahena-4	House or Plot No.	201/12
Pipe Material (Main Pipe)	1. CIP, 2. DIP, 3.PVC, 4. GP, 5. Others	Leak Part	1. Pipe, 2. Pipe Joint, 3. Saddle, 4. Pipe Fitting 5. Valve, 6. Meter, 7. Tap, 8. Reservoir Tank, 9. Others
Pipe Diameter	100 mm	Leak Condition	1. Hole, 2. Crack, 3. Breakage, 4. Gasket, 5. Loosening Joint, 6. Over Flow, 7. Unknown, 8. Others
Pipe Material (Service Pipe)	1. PEP, 2. PVC, 3. GP, 4. Others ( )	Cause	1. Corrosion, 2. Deterioration (Aging), 3. Traffic Load, 4. Poor Construction Work, 5. Less Adhesive, 6. Water Hammer, 7. Defective Valve, 8. Vandalization 9. Another Company's Construction Work, 10. Unknown, 11. Others ( )
Diameter	mm		
Depth	90 cm	Surface Condition	1. Asphalt, 2.Concrete, 3.Gravel, 4.Grass, 5.Soil, 6.Others
Leakage Size	1. Large, 2. Medium, 3. Small, 4.Water Drops Measured (150 L/Min.) by flow meter	Detected Method	1. Patrol, 2. Customer Informing, 3. Point Survey (Acoustic Bar), 4. Line Survey (Ground Microphone)

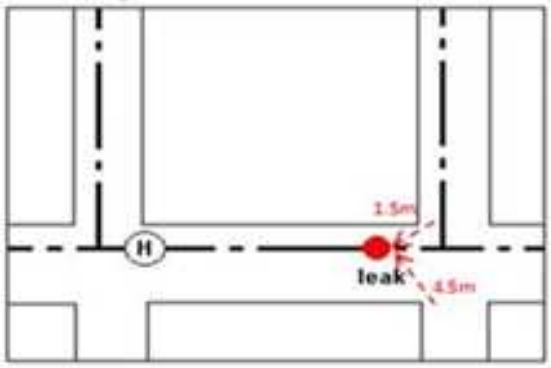
Leak Point



Hole/Crack Size:(5 cm)



Location Map



Photo

Remarks:

Leakage water flow into the sewage pipe

Information of leak repair (Used Materials and Repair Cost)

Excavation size: 1.5 m X 1.0 m X 1.2 m = (1.8 m^3)

	Unit price	Hour	Volume	Sub total
Worker		2.0	3	
Plumber		2.0	2	
Supervisor		2.0	1	
Engineer		1.0	1	
Backhoe		2.0	1	
Generator		1.0	1	
Drainage Pump		1.0	1	
Lighting equipment				
Sand			0.3	
Gravel			0.2	
Asphalt			1.5	
Total				

Used Material

	Size/Type	Unit price	Volume	Sub total
Pipe-1	DN 100 PVC		2.0 m	
Pipe-2				
Pipe-3				
Joint-1	DN 100 Coupling		2	
Joint-2				
Joint-3				
Joint-4				
Joint-5				
Meter				
Gasket				
Saddle				
Total				

Section 5. Replacement of Pipe Network

Reference;

Section 5. Replacement of Pipe Network

5.1 Necessity of Pipe Network Replacement

It is recognized that real cause of leakage is pipe network itself, when much leakage is still existing after high water pressure was controlled and partial leak repairs were repeated. In such a case it is required that whole distribution pipe network including service pipes in the identified area having leakage problem is replaced.

5.2 Procedure of the replacement work

Work procedure is as follows;

1) Preparation of general work schedule

- Selection of the problem area
- Survey of the existing pipe network condition
- Design for proposed pipe network
- Procurement of the equipment and materials
- Installation work of the equipment and materials
- Effect evaluation of replacement work

2) Selection of the problem area

- Selection of the specific area which has serious leakage problem in the distribution network, based on the information such as result of Qmnf measurement, leakage repair record, plotting map of leakage history and knowledge of the branch office staffs.
- Identify the lines which have repetition of the leaks and has substandard materials.

3) Survey of the existing pipe network condition

- Clarify existing pipeline route (XY Coordinate), length, material, class, diameter
- Confirm the location of existing valves and its functional condition
- Clarify the number of connections to be replaced
- Making customer list supplied by pipe line (POC list)
- Approval of the customers
- Proposal on additional equipment such as stop valve

4) Design for proposed pipe network

- Design of new piping diagram (location, material, class, diameter, length) in line with Pipe Standard of WASAC
- Propose additional valve installation
- Protection at the road crossing
- Concrete thrust block
- Bill of Quantity of the pipe to be replaced (Pipes, Fittings, Accessories, Valve) and replacement work
- Cost estimation of the Material and the Construction (Removal, Installation)

5) Procurement of the equipment and materials

- Procurement schedule and replacement schedule
- Implementation of the procurement work

6) Installation work and effect evaluation

- Preparation of detail work schedule
- Qmnf measurement before replacement work
- Installation of pipes and additional equipment such as stop valve
- Supervisory work of the installation on Quality, Progress and Safety Management
- Finished dimension measurement, Pressure Test
- Photo record
- Qmnf measurement after replacement work

7) Reporting

- Preparation of As-build Drawing
- Preparation of Work Report (Contents of the Work, Test result, Photo)
- Updating GIS Data

5.3 Example of the Pipe Network Replacement in Kadobogo

As an example of pipe replacement work, the case which was conducted in Kadobogo is shown next page.

WASAC
Water & Sanitation Corporation

"Dignifying Life"

Kigali,

N° 11.07.024/.....211...../18/DUWSS -WASAC/jb

Ms. Izumi SHOJI
Leader
JICA Monitoring Mission Team
Japan

Dear Madam,

RE: SUBMISSION OF THE PLAN TO REPLACE THE SERVICE PIPES IN KADOBOGO

Reference made to the Minutes of Meeting between JICA monitoring mission team and CEO, WASAC signed on 28th Aug. 2018.
According to 3-3. Eliminate Obstacle Factors in the Minutes of Meeting, we are pleased to submit the plan to replace the service pipes in kadobogo as attached.

I thank you for your usual cooperation

Yours sincerely,

WATER AND SANITATION CORPORATION WASAC

Mr. Méthode RUTAGUNGIRA
Project Director &
Director of UWSS, WASAC
The Republic of Rwanda

Cc: JICA Rwanda

KN4 Av 8, CENTENARY HOUSE, Nyarugenge District, Kigali City, PO Box 537, Rwanda. e-mail: wasac@wasac.rw, www.wasac.rw

WASAC
Water & Sanitation Corporation

"Dignifying Life"

BILL OF QUANTITY FOR SERVICE PIPE REPLACEMENT IN KADOBOGO .

Part I. PM1 (Sub-zone 1-3)

N°	DESCRIPTION	UNIT	Qty	Unit price	Total price(Rwf)
I	**SUPPLY AND LAYING OF PIPES**				
1	**The following prices include :**				
2	**Earthwork by excavation and backfilling**				
3	Excavation and backfilling in loose ground up to 0.60m depth average , including all accruals.	lm	152.00	1,000	152,000
	SUBTOTAL I				**152,000**
II	**Supply pipes of;**				
1	PVC (Ganga type) pipes ND32 NP 16	Pcs	14.00	18,000	252,000
2	PVC (Ganga type) pipes ND25 NP 16	Pcs	19	12,000	228,000
	Sub -Total				**480,000**
V	**ACCESSORIES AND FITTINGS**				
1	Screwed clamp for pvc 63*1" NP 16 (type DI)	Pcs	3	18,600	55,800
2	Nipple 1" galvanized NP 16	Pcs	6	1,750	10,500
3	Nipple 3/4" galvanized NP 16	Pcs	16	1,500	24,000
4	Union 1" galvanized NP 16	Pcs	9	2,500	22,500
5	Union 3/4" galvanized NP 16	Pcs	6	1,800	10,800
6	Galvanized reducer 1" * 3/4"	Pcs	4	1,500	6,000
7	ball valve 1" NP 16	Pcs	6	12,000	72,000
8	ball valve 3/4" NP 16	Pcs	8	10,000	80,000
9	Galvanized Tee 1" NP 16	Pcs	3	1,500	4,500
10	Galvanized Tee 3/4" NP 16	Pcs	2	1,200	2,400
11	Galvanized elbow (90°) 1" NP 16	Pcs	4	1,500	6,000
12	Galvanized elbow (90°) 3/4" NP 16	Pcs	7	1,200	8,400
13	Galvanized Socket 1" NP 16	Pcs	16	1,500	24,000
14	Galvanized Socket 3/4" NP 16	Pcs	15	1,200	18,000
15	Teflon	Pcs	25	450	11,250
	Sub -Total				**356,150**
	Grand Total				**988,150**

WASAC
Water & Sanitation Corporation

"Dignifying Life"

BILL OF QUANTITY FOR SERVICE PIPE REPLACEMENT IN KADOBOGO.

Part I. PM1 (Sub-zone 1-4)

N°	DESCRIPTION	UNIT	Qty	Unit price	Total price(Rwf)
I	**SUPPLY AND LAYING OF PIPES**				
1	**The following prices include :**				
2	**Earthwork by excavation and backfilling**				
3	Excavation and backfilling in loose ground up to 0.60m depth average , including all accruals.	lm	512.00	1,000	512,000
	SUBTOTAL I				**512,000**
II	**Supply pipes of;**				
1	PVC (Ganga type) pipes ND32 NP 16	Pcs	65.00	18,000	1,170,000
2	PVC (Ganga type) pipes ND25 NP 16	Pcs	41	12,000	492,000
	Sub -Total				**1,662,000**
V	**ACCESSORIES AND FITTINGS**				
1	Screwed clamp for pvc 63*1" NP 16 (type DI)	Pcs	6	18,600	111,600
2	Screwed clamp for pvc 63*3/4" NP 16 (type DI)	Pcs	4	14,700	58,800
3	Nipple 1" galvanized NP 16	Pcs	21	2,000	42,000
4	Nipple 3/4" galvanized NP 16	Pcs	42	1,500	63,000
5	Union 1" galvanized NP 16	Pcs	25	2,500	62,500
6	Union 3/4" galvanized NP 16	Pcs	29	1,800	52,200
7	Galvanized reducer 1" * 3/4"	Pcs	25	1,500	37,500
8	Galvanized end cup 3/4" NP 16	Pcs	8	1,500	12,000
9	ball valve 1" NP 16	Pcs	9	12,000	108,000
10	ball valve 3/4" NP 16	Pcs	32	10,000	320,000
11	Galvanized Tee 1" NP 16	Pcs	23	1,500	34,500
12	Galvanized Tee 3/4" NP 16	Pcs	2	1,200	2,400
13	Galvanized elbow (90°) 1" NP 16	Pcs	2	1,500	3,000
14	Galvanized elbow (90°) 3/4" NP 16	Pcs	12	1,200	14,400
15	Galvanized Socket 1" NP 16	Pcs	67	1,500	100,500
16	Galvanized Socket 3/4" NP 16	Pcs	35	1,200	42,000
17	Teflon	Pcs	80	450	36,000
	Sub -Total				**1,100,400**
	Grand Total				**3,274,400**

N°	DESCRIPTION	UNIT	Qty	Unit price	Total price(Rwf)
V	**CIVIL WORKS**				
1	Demolition of cement pavement, parking area paved and hardcore pavement (road)	Lump Sum	1		-
	MATERIAL NEEDED FOR REPAIRING THOSE DIFFERENTS AREAS				
1	Fine sand	Truck	1	80,000	80,000
2	Gravel sand	Truck	1	70,000	70,000
3	Cement	Bag	12	15,000	180,000
4	Water	Lump Sum	1	20,000	20,000
	LABOR				
8	Masons	Num	6/day		
9	Manpower	Num	12/day		
	Sub -Total				
	Total				**350,000**
	GRAND TOTAL(1-3 +1-4 + Civil Works)				**4,612,550**

Total Amount: Four millions Six Hundreds Twelve, Five Hundreds and Fifty Rwandan Francs

Done at Kigali on 24th Sept 2018

Prepared by:

MUGABO J.M.V
Leak Detection and Pressure Management Operator

Cheched by:

NTAMUTURANO DESIRE
Head of LD&PM

BAHIGE Jean Berckmans
NRW Manager

Approuved By

Methode RUTAGUNGIRA
DUWSS

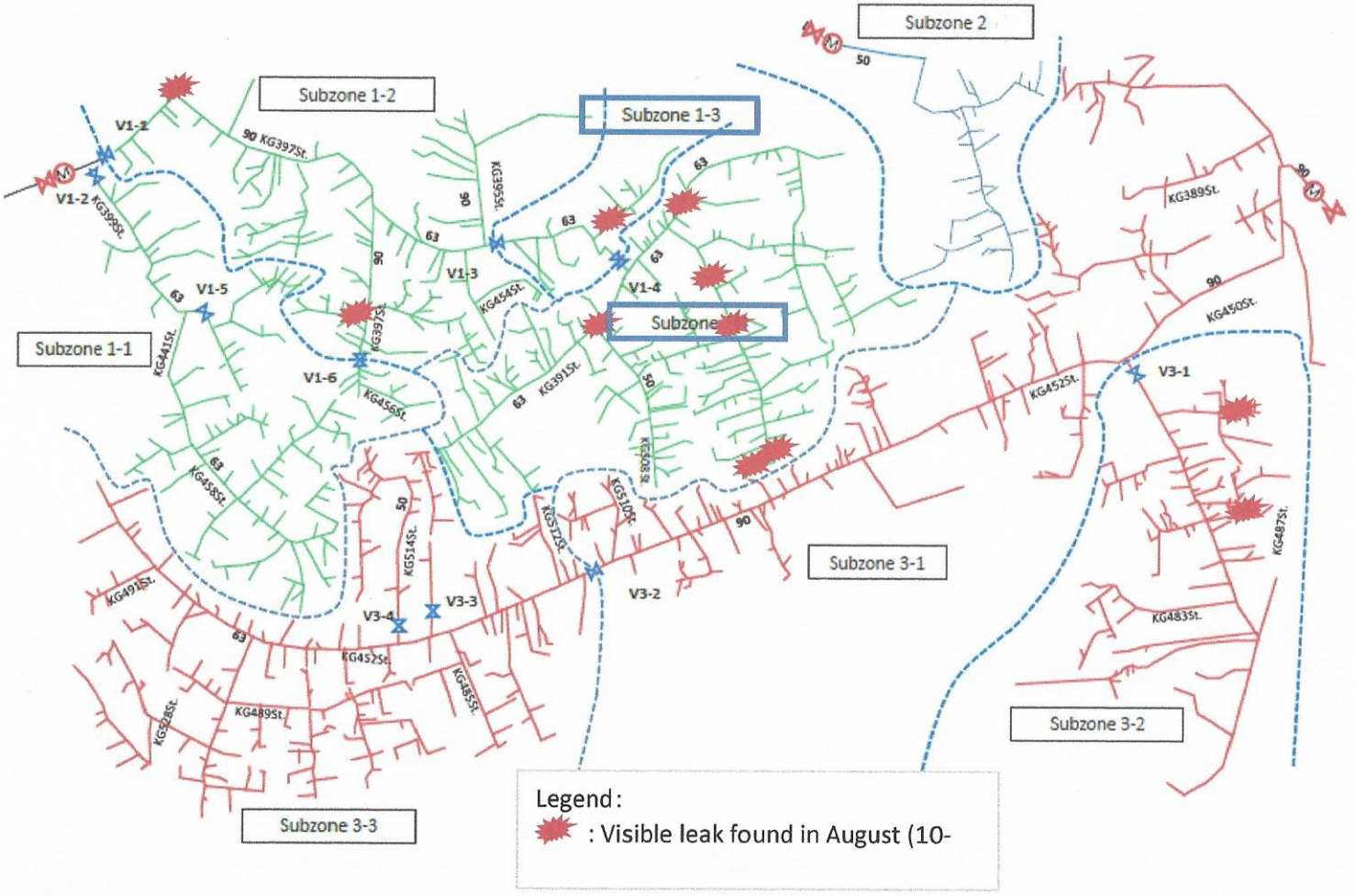
The Project for Strengthening NRW Water Management in Kigali City Water Network

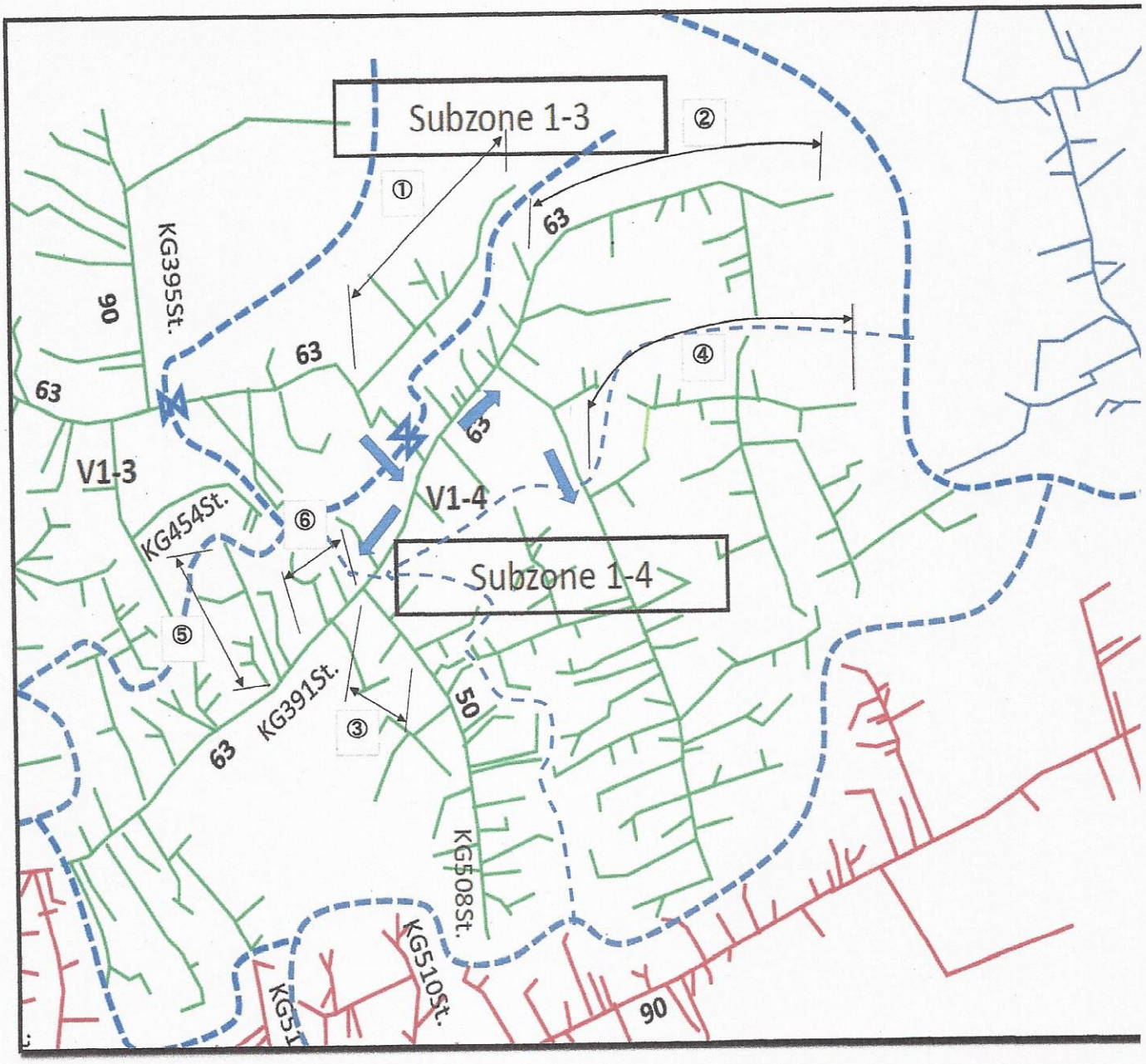
Schedule of Implementation for

the Service Pipe Replacement in Kadobogo Pilot Area 1 (PM1)

No	Work Item	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
1	Proposal of actual plan to replace the service pipes							
2	JICA Evaluation and Approval							
3	Budget allocation							
4	Preparation of Procurement of the materials							
5	Procurement of the materials							
6	Measurement of water loss /NRW rate							
7	Preparation of replacement implementation plan							
8	Installation of the materials (Replacement work)							
9	Measurement of water loss/ NRW rate (Evaluation of the effect)							

Kadobogo Subzone Map

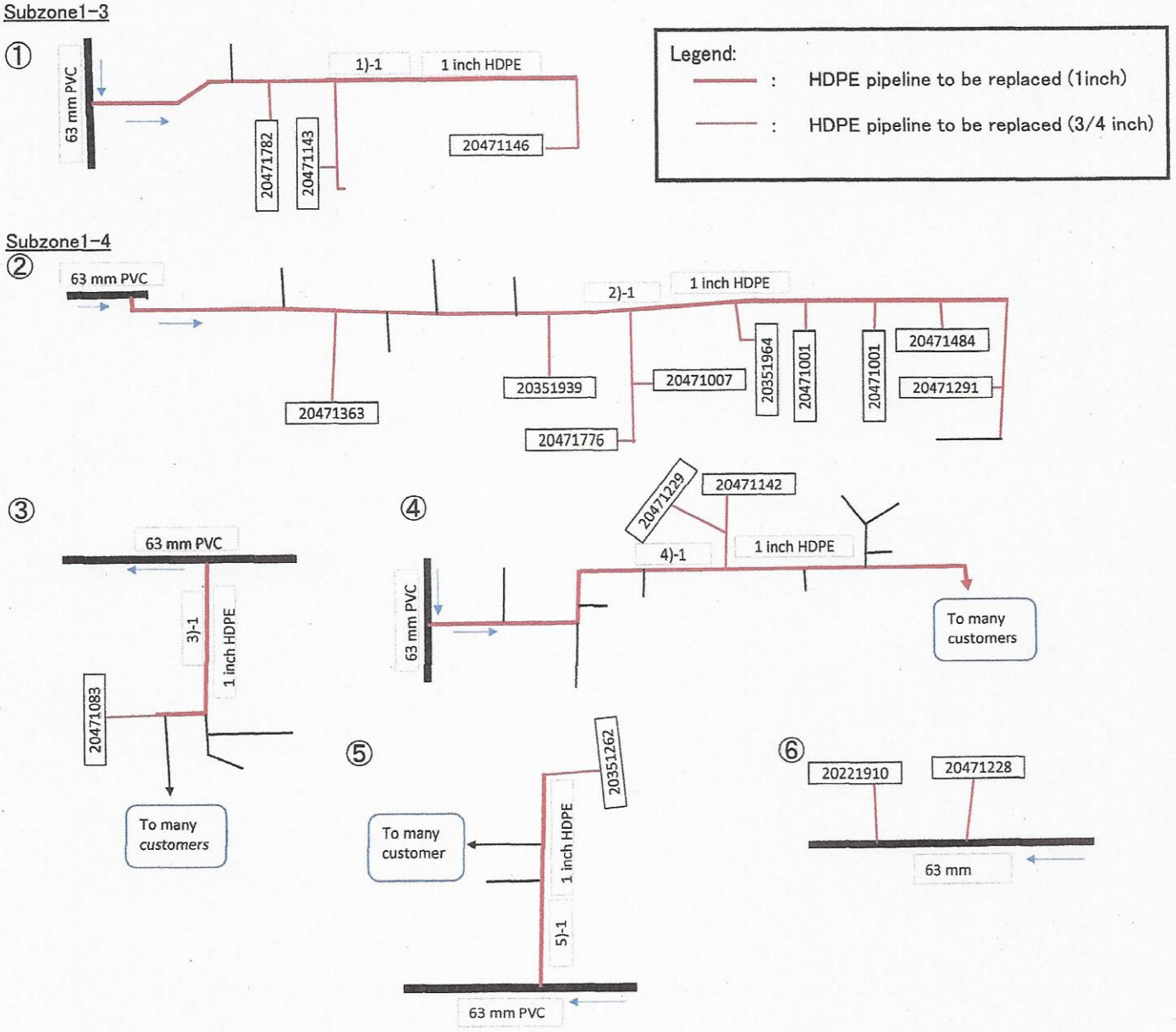




Figure– Pipeline to be Replaced in S

Details of Pipeline Replacement

Subzone1-3



zones 1-3 & 1-4, PM1Area, Kadobogo

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
Subzone 1-3					
1	203519484	-1.913818	30.081224	3/4"	Domestic Use
2	204711464	-1.914030	30.080926	3/4"	Domestic Use
3	203519308	-1.913934	30.080884	3/4"	Domestic Use
4	204713516	-1.913749	30.081082	3/4"	Domestic Use
5	203519109	-1.913822	30.080739	3/4"	Domestic Use
6	203519235	-1.914299	30.080100	3/4"	Domestic Use
7	204710097	-1.914014	30.080647	3/4"	Domestic Use
8	203519908	-1.914236	30.080974	3/4"	Domestic Use
9	204712302	-1.914799	30.080359	3/4"	Domestic Use
10	203512623	-1.914710	30.079926	3/4"	Domestic Use
11	203512621	-1.914689	30.080530	3/4"	Domestic Use
12	203512615	-1.914504	30.080171	3/4"	Domestic Use
13	203512622	-1.914330	30.080231	3/4"	Domestic Use
14	204713984	-1.914364	30.080473	3/4"	Domestic Use
15	203512626	-1.914555	30.080618	3/4"	Domestic Use
16	204713353	-1.914649	30.080573	3/4"	Domestic Use
17	203512785	-1.914946	30.080050	3/4"	Domestic Use
18	203519910	-1.914162	30.080882	3/4"	Domestic Use
19	203519976	-1.914110	30.081028	3/4"	Domestic Use
20	203519461	-1.913825	30.081058	3/4"	Domestic Use
21	204711433	-1.913996	30.080873	3/4"	Domestic Use
22	204713746	-1.914931	30.079971	3/4"	Domestic Use
23	204711315	-1.914439	30.080408	3/4"	Domestic Use
24	204715143	-1.915035	30.080135	3/4"	Domestic Use
25	204715126	-1.914685	30.080405	3/4"	Domestic Use
Subzone 1-4					
1	204712824	-1.915377	30.080824	3/4"	Domestic Use
2	202217730	-1.916548	30.081495	3/4"	Domestic Use
3	204710551	-1.915004	30.080785	3/4"	Domestic Use
4	202219000	-1.916433	30.079428	3/4"	Domestic Use
5	204710828	-1.915617	30.080047	3/4"	Domestic Use
6	203514752	-1.915730	30.079172	3/4"	Domestic Use
7	202219013	-1.916455	30.079102	3/4"	Domestic Use
8	203514749	-1.916374	30.078901	3/4"	Domestic Use
9	202219319	-1.916739	30.079569	3/4"	Domestic Use
10	203511082	-1.916813	30.079589	3/4"	Domestic Use
11	204711201	-1.917056	30.079634	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
12	202219018	-1.916641	30.079462	3/4"	Domestic Use
13	202219436	-1.916918	30.079247	3/4"	Domestic Use
14	203514503	-1.917248	30.078856	3/4"	Domestic Use
15	204711523	-1.916151	30.079467	3/4"	Domestic Use
16	202219736	-1.915886	30.079318	3/4"	Domestic Use
17	203519478	-1.916017	30.079401	3/4"	Domestic Use
18	204710096	-1.915989	30.079177	3/4"	Domestic Use
19	204715022	-1.916267	30.079093	3/4"	Domestic Use
20	204710148	-1.916529	30.079034	3/4"	Domestic Use
21	204714032	-1.916502	30.079000	3/4"	Domestic Use
22	203519644	-1.917200	30.079380	3/4"	Domestic Use
23	203511905	-1.917293	30.079147	3/4"	Domestic Use
24	203511650	-1.917118	30.078984	3/4"	Domestic Use
25	204710326	-1.917042	30.078975	3/4"	Domestic Use
26	203514411	-1.916958	30.079137	3/4"	Domestic Use
27	204712388	-1.916884	30.079084	3/4"	Domestic Use
28	202219046	-1.916699	30.078940	3/4"	Domestic Use
29	202219066	-1.916734	30.078744	3/4"	Domestic Use
30	203519579	-1.916889	30.078741	3/4"	Domestic Use
31	202216900	-1.917083	30.078822	3/4"	Domestic Use
32	203514410	-1.917393	30.078864	3/4"	Domestic Use
33	202219572	-1.917480	30.079023	3/4"	Domestic Use
34	202219105	-1.915443	30.080323	3/4"	Domestic Use
35	204710999	-1.915243	30.080358	3/4"	Domestic Use
36	204713877	-1.915173	30.080530	3/4"	Domestic Use
37	203512625	-1.914865	30.080749	3/4"	Domestic Use
38	204710480	-1.916841	30.081171	3/4"	Domestic Use
39	204713198	-1.915397	30.080002	3/4"	Domestic Use
40	204710461	-1.915399	30.079685	3/4"	Domestic Use
41	204713241	-1.916019	30.081207	3/4"	Domestic Use
42	204711832	-1.915881	30.080510	3/4"	Domestic Use
43	203515019	-1.915673	30.080658	3/4"	Domestic Use
44	204711279	-1.915795	30.080525	3/4"	Domestic Use
45	202219024	-1.915990	30.080055	3/4"	Domestic Use
46	204710000	-1.916529	30.081295	3/4"	Domestic Use
47	204711126	-1.916601	30.081138	3/4"	Domestic Use
48	203519617	-1.916368	30.081196	3/4"	Domestic Use
49	204780044	-1.916764	30.081421	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
50	202217421	-1.915602	30.079871	3/4"	Domestic Use
51	204712865	-1.915435	30.080310	3/4"	Domestic Use
52	204712926	-1.915155	30.079808	3/4"	Domestic Use
53	203519604	-1.915632	30.079649	3/4"	Domestic Use
54	204710499	-1.915814	30.079533	3/4"	Domestic Use
55	204710498	-1.915847	30.079464	3/4"	Domestic Use
56	203519356	-1.915333	30.079849	3/4"	Domestic Use
57	203519499	-1.916683	30.081266	3/4"	Domestic Use
58	204710766	-1.916391	30.081007	3/4"	Domestic Use
59	204710426	-1.915735	30.080956	3/4"	Domestic Use
60	204712166	-1.915677	30.080843	3/4"	Domestic Use
61	204710965	-1.916311	30.080823	3/4"	Domestic Use
62	204712370	-1.916803	30.080815	3/4"	Domestic Use
63	204713681	-1.916658	30.080897	3/4"	Domestic Use
64	204714386	-1.916833	30.080917	3/4"	Domestic Use
65	204715032	-1.916966	30.079980	3/4"	Domestic Use
66	204713175	-1.915258	30.080156	3/4"	Domestic Use
67	203519629	-1.915670	30.080046	3/4"	Domestic Use
68	204711209	-1.915587	30.079929	3/4"	Domestic Use
69	203514845	-1.915503	30.080054	3/4"	Domestic Use
70	204710523	-1.915618	30.080218	3/4"	Domestic Use
71	204711397	-1.915855	30.079780	3/4"	Domestic Use
72	202219031	-1.916119	30.079585	3/4"	Domestic Use
73	203511267	-1.916701	30.078566	3/4"	Domestic Use
74	202219051	-1.916642	30.078552	3/4"	Domestic Use
75	203519631	-1.916223	30.081283	3/4"	Domestic Use
76	204711632	-1.916433	30.081261	3/4"	Domestic Use
77	204711229	-1.915992	30.081060	3/4"	Domestic Use
78	204711467	-1.916598	30.079141	3/4"	Domestic Use
79	203515428	-1.915605	30.079179	3/4"	Domestic Use
80	204711548	-1.916400	30.079038	3/4"	Domestic Use
81	202219295	-1.917113	30.079222	3/4"	Domestic Use
82	203511534	-1.917258	30.079535	3/4"	Domestic Use
83	203511535	-1.917141	30.079681	3/4"	Domestic Use
84	204710458	-1.916362	30.081307	3/4"	Domestic Use
85	203516272	-1.915977	30.080719	3/4"	Domestic Use
86	204711196	-1.916189	30.081424	3/4"	Domestic Use
87	204710374	-1.916526	30.081394	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
88	204711123	-1.915979	30.079770	3/4"	Domestic Use
89	203519230	-1.915778	30.079720	3/4"	Domestic Use
90	204712719	-1.916230	30.080952	3/4"	Domestic Use
91	203511743	-1.915581	30.080132	3/4"	Domestic Use
92	203512624	-1.915060	30.080405	3/4"	Domestic Use
93	204712954	-1.915182	30.080177	3/4"	Domestic Use
94	202219107	-1.916470	30.079610	3/4"	Domestic Use
95	203512304	-1.916390	30.080938	3/4"	Domestic Use
96	203514753	-1.915668	30.079057	3/4"	Domestic Use
97	204710080	-1.916777	30.079962	3/4"	Domestic Use
98	204713586	-1.915802	30.079968	3/4"	Domestic Use
99	204713332	-1.915443	30.080545	3/4"	Domestic Use
100	203514704	-1.915364	30.080236	3/4"	Domestic Use
101	204711489	-1.915705	30.079929	3/4"	Domestic Use
102	204713388	-1.915985	30.081295	3/4"	Domestic Use
103	204711349	-1.915980	30.081433	3/4"	Domestic Use
104	204711700	-1.916594	30.079044	3/4"	Domestic Use
105	204715485	-1.916415	30.079228	3/4"	Domestic Use
106	204715439	-1.915677	30.079028	3/4"	Domestic Use
107	204715376	-1.917157	30.079187	3/4"	Domestic Use
108	204811324	-1.916890	30.078837	3/4"	Domestic Use
109	204710700	-1.916879	30.081281	3/4"	Domestic Use
110	204710754	-1.916669	30.080755	3/4"	Domestic Use
111	204714285	-1.915923	30.081229	3/4"	Domestic Use
112	204715304	-1.916208	30.081308	3/4"	Domestic Use
113	203514727	-1.916037	30.080612	3/4"	Domestic Use
114	204710028	-1.916238	30.080367	3/4"	Domestic Use
115	204710832	-1.915757	30.080727	3/4"	Domestic Use
116	203514980	-1.915335	30.080424	3/4"	Domestic Use
117	204712825	-1.916341	30.081364	3/4"	Domestic Use
118	204715358	-1.916040	30.081118	3/4"	Domestic Use
119	204715451	-1.916109	30.079627	3/4"	Domestic Use
120	204710428	-1.915500	30.081142	3/4"	Domestic Use
121	204715165	-1.915774	30.080904	3/4"	Domestic Use
122	204715517	-1.915690	30.080966	3/4"	Domestic Use
123	203519424	-1.916227	30.080462	3/4"	Domestic Use
124	203519482	-1.915766	30.081705	3/4"	Domestic Use
125	204713502	-1.915804	30.081558	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
126	204710781	-1.916120	30.081765	3/4"	Domestic Use
127	204711103	-1.916489	30.081904	3/4"	Domestic Use
128	204711244	-1.915149	30.081516	3/4"	Domestic Use
129	204710184	-1.916146	30.081609	3/4"	Domestic Use
130	204710854	-1.915963	30.081802	3/4"	Domestic Use
131	204712632	-1.915842	30.081702	3/4"	Domestic Use
132	204714129	-1.916497	30.081629	3/4"	Domestic Use
133	204714724	-1.916416	30.081749	3/4"	Domestic Use
134	204712880	-1.916250	30.082678	3/4"	Domestic Use
135	204713165	-1.916265	30.082202	3/4"	Domestic Use
136	203519659	-1.916261	30.082353	3/4"	Domestic Use
137	204713813	-1.915783	30.082676	3/4"	Domestic Use
138	204712110	-1.916080	30.082432	3/4"	Domestic Use
139	203515726	-1.915964	30.082594	3/4"	Domestic Use
140	204710002	-1.915551	30.082168	3/4"	Domestic Use
141	203512619	-1.915831	30.082108	3/4"	Domestic Use
142	203519245	-1.916141	30.082276	3/4"	Domestic Use
143	203519085	-1.915941	30.081986	3/4"	Domestic Use
144	204710205	-1.916568	30.081648	3/4"	Domestic Use
145	203512630	-1.916173	30.081943	3/4"	Domestic Use
146	202217800	-1.916901	30.082017	3/4"	Domestic Use
147	204710235	-1.916713	30.081908	3/4"	Domestic Use
148	203514274	-1.916852	30.081897	3/4"	Domestic Use
149	204713289	-1.915756	30.081058	3/4"	Domestic Use
150	204713820	-1.915623	30.081140	3/4"	Domestic Use
151	204711469	-1.915673	30.081102	3/4"	Domestic Use
152	204713779	-1.915720	30.081071	3/4"	Domestic Use
153	204713942	-1.915764	30.081045	3/4"	Domestic Use
154	204712008	-1.915060	30.081373	3/4"	Domestic Use
155	204711228	-1.915844	30.081277	3/4"	Domestic Use
156	204710427	-1.916063	30.081599	3/4"	Domestic Use
157	203519531	-1.916115	30.082348	3/4"	Domestic Use
158	204714097	-1.915956	30.082716	3/4"	Domestic Use
159	204713551	-1.916203	30.082583	3/4"	Domestic Use
160	204715076	-1.916467	30.082414	3/4"	Domestic Use
161	202218107	-1.916902	30.082058	3/4"	Domestic Use
162	204713846	-1.916111	30.082048	3/4"	Domestic Use
163	204711683	-1.915856	30.081444	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
164	204715017	-1.916724	30.081853	3/4"	Domestic Use
165	203519618	-1.915488	30.081396	3/4"	Domestic Use
166	204712511	-1.916716	30.081833	3/4"	Domestic Use
167	204714391	-1.915758	30.081604	3/4"	Domestic Use
168	204711076	-1.916234	30.081555	3/4"	Domestic Use
169	203519084	-1.915940	30.082089	3/4"	Domestic Use
170	204710377	-1.916065	30.081746	3/4"	Domestic Use
171	204710378	-1.915832	30.081627	3/4"	Domestic Use
172	204711074	-1.916202	30.081524	3/4"	Domestic Use
173	204712281	-1.915330	30.082088	3/4"	Domestic Use
174	204715155	-1.915828	30.082838	3/4"	Domestic Use
175	204715213	-1.915319	30.081638	3/4"	Domestic Use
176	204715299	-1.916539	30.082058	3/4"	Domestic Use
177	204715331	-1.916626	30.082004	3/4"	Domestic Use
178	204715046	-1.915660	30.082249	3/4"	Domestic Use
179	204714777	-1.915717	30.082427	3/4"	Domestic Use
180	204710178	-1.915972	30.082497	3/4"	Domestic Use
181	204711269	-1.915921	30.082274	3/4"	Domestic Use
182	203512860	-1.914847	30.081034	3/4"	Domestic Use
183	203519691	-1.914635	30.081541	3/4"	Domestic Use
184	203516393	-1.915061	30.081680	3/4"	Domestic Use
185	204713943	-1.914938	30.083554	3/4"	Domestic Use
186	204713976	-1.915152	30.083724	3/4"	Domestic Use
187	204712482	-1.915433	30.083122	3/4"	Domestic Use
188	204714232	-1.915522	30.082871	3/4"	Domestic Use
189	204714070	-1.915554	30.082835	3/4"	Domestic Use
190	204711062	-1.915319	30.082757	3/4"	Domestic Use
191	204712098	-1.914582	30.082706	3/4"	Domestic Use
192	204712422	-1.914459	30.082600	3/4"	Domestic Use
193	204710702	-1.914982	30.083140	3/4"	Domestic Use
194	204711022	-1.914517	30.081039	3/4"	Domestic Use
195	203512616	-1.914504	30.080924	3/4"	Domestic Use
196	204712153	-1.914345	30.081192	3/4"	Domestic Use
197	204711375	-1.914321	30.081081	3/4"	Domestic Use
198	204712148	-1.914258	30.081216	3/4"	Commercial
199	204714953	-1.913860	30.081367	3/4"	Domestic Use
200	204712729	-1.915182	30.082953	3/4"	Domestic Use
201	204712731	-1.915349	30.082987	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
202	204712964	-1.915377	30.083063	3/4"	Domestic Use
203	204712474	-1.914098	30.082477	3/4"	Domestic Use
204	204712916	-1.913863	30.082422	3/4"	Domestic Use
205	204714231	-1.914975	30.081719	3/4"	Domestic Use
206	203516021	-1.915226	30.082362	3/4"	Domestic Use
207	204712564	-1.913995	30.082430	3/4"	Domestic Use
208	204711163	-1.914215	30.081745	3/4"	Domestic Use
209	203512761	-1.914401	30.081363	3/4"	Domestic Use
210	203514313	-1.914218	30.081496	3/4"	Domestic Use
211	203519396	-1.913797	30.081756	3/4"	Domestic Use
212	203519611	-1.913786	30.081908	3/4"	Domestic Use
213	204710012	-1.913724	30.082103	3/4"	Domestic Use
214	204710013	-1.913729	30.082254	3/4"	Domestic Use
215	204710308	-1.914058	30.082559	3/4"	Domestic Use
216	203512769	-1.914383	30.081463	3/4"	Domestic Use
217	204711124	-1.914466	30.081771	3/4"	Domestic Use
218	204714735	-1.914940	30.082226	3/4"	Domestic Use
219	203519880	-1.914672	30.082333	3/4"	Domestic Use
220	203519876	-1.914666	30.082395	3/4"	Domestic Use
221	204710393	-1.915008	30.082442	3/4"	Domestic Use
222	204710254	-1.915267	30.082573	3/4"	Domestic Use
223	204712483	-1.914478	30.081200	3/4"	Commercial
224	204713699	-1.914504	30.082072	3/4"	Domestic Use
225	204711428	-1.914463	30.082108	3/4"	Domestic Use
226	204713857	-1.915035	30.083610	3/4"	Domestic Use
227	204780043	-1.915508	30.083103	3/4"	Domestic Use
228	204710369	-1.915038	30.081959	3/4"	Domestic Use
229	204714842	-1.913702	30.082357	3/4"	Domestic Use
230	204710386	-1.914119	30.081296	3/4"	Domestic Use
231	204712889	-1.914980	30.081213	3/4"	Domestic Use
232	203512762	-1.914275	30.081457	3/4"	Domestic Use
233	204710699	-1.914570	30.081782	3/4"	Domestic Use
234	204711358	-1.914819	30.082044	3/4"	Domestic Use
235	204713153	-1.914434	30.081739	3/4"	Domestic Use
236	204713635	-1.914263	30.081463	3/4"	Domestic Use
237	203519390	-1.913825	30.081768	3/4"	Domestic Use
238	204710072	-1.914117	30.082151	3/4"	Domestic Use
239	204712291	-1.914524	30.081895	3/4"	Domestic Use

Table - List of POC

No.	point_of_c	X	Y	Diameter	User Category
240	204712293	-1.914534	30.082207	3/4"	Domestic Use
241	204713380	-1.915460	30.083110	3/4"	Domestic Use
242	204713733	-1.915391	30.082898	3/4"	Domestic Use
243	204715180	-1.915018	30.082988	3/4"	Domestic Use
244	204715205	-1.914101	30.082590	3/4"	Domestic Use
245	204715253	-1.913896	30.082322	3/4"	Domestic Use
246	204710912	-1.913901	30.082388	3/4"	Domestic Use
247	204713520	-1.914877	30.083120	3/4"	Domestic Use

POCs with service connections of substandard quality materials

No.	point_of_c	X	Y	Dimeter	User Category
Subzone 1-3					
1	204711464	-1.914030	30.080926	3/4"	Domestic Use
2	204711433	-1.913996	30.080873	3/4"	Domestic Use
3	204717822	-	-	3/4"	Domestic Use
Subzone 1-4					
1	204710832	-1.915757	30.080727	3/4"	Domestic Use
2	203512624	-1.915060	30.080405	3/4"	Domestic Use
3	204712291	-1.914524	30.081895	3/4"	Domestic Use
4	202219105	-1.915443	30.080323	3/4"	Domestic Use
5	204712288	-	-	3/4"	Domestic Use
6	204711428	-1.914463	30.082108	3/4"	Domestic Use
7	204717762	-	-	3/4"	Domestic Use
8	203519641	-	-	3/4"	Domestic Use
9	204710012	-1.913724	30.082103	3/4"	Domestic Use
10	204714842	-1.913702	30.082357	3/4"	Domestic Use
11	204710013	-1.913729	30.082254	3/4"	Domestic Use
12	204712916	-1.913863	30.082422	3/4"	Domestic Use
13	204710072	-1.914117	30.082151	3/4"	Domestic Use
14	203519390	-1.913825	30.081768	3/4"	Domestic Use
15	204713635	-1.914263	30.081463	3/4"	Domestic Use

Pipe Replacement in Kadobogo Pilot Project Area 1

February, 2019

ITEM OF PRESENTATION

1. INTRODUCTION
2. SCHEDULE OF PIPE REPLACEMENT
3. TEAM FOR PIPE REPLACEMENT
4. OBSERVATIONS
5. TRENCH PREPARATION AND CONTROL
6. LAYING CONDITIONS
7. PRESSURE TEST PROCEDURES
8. PRESSURE RESULTS
9. RECOMMANDATIONS

Baseline data by Qmnf Survey

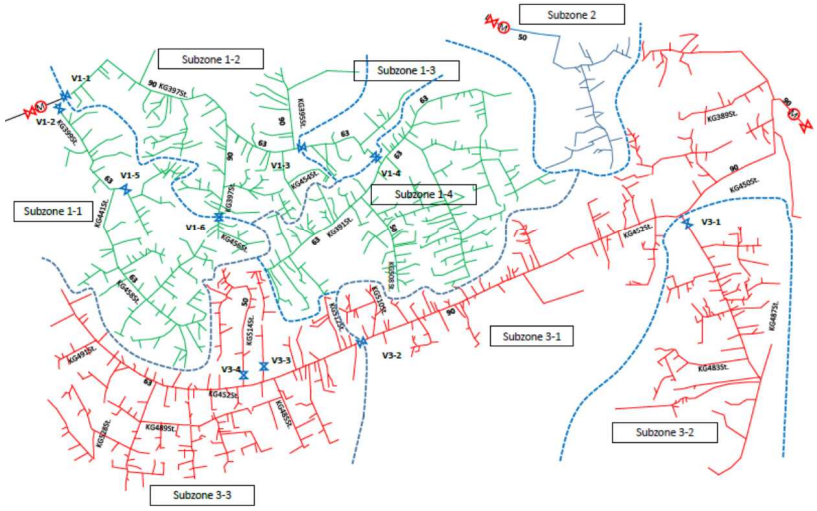
INTRODUCTION

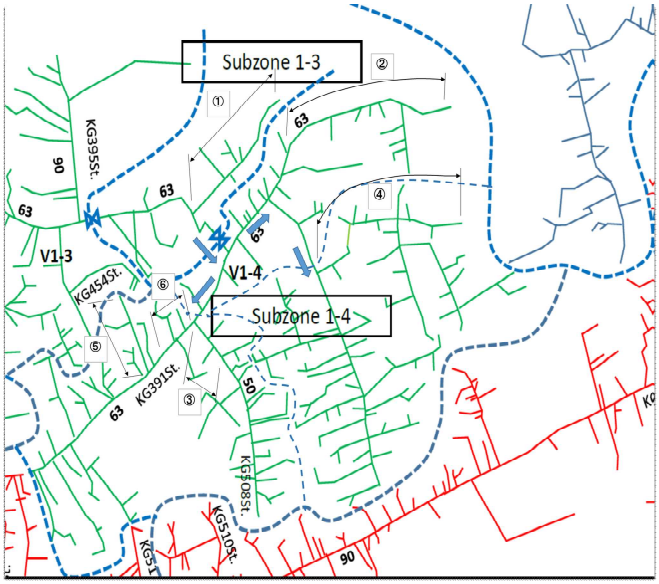
The replacement of the existing pipes in Kadobogo was made on the area presenting the repetition of the leaks.

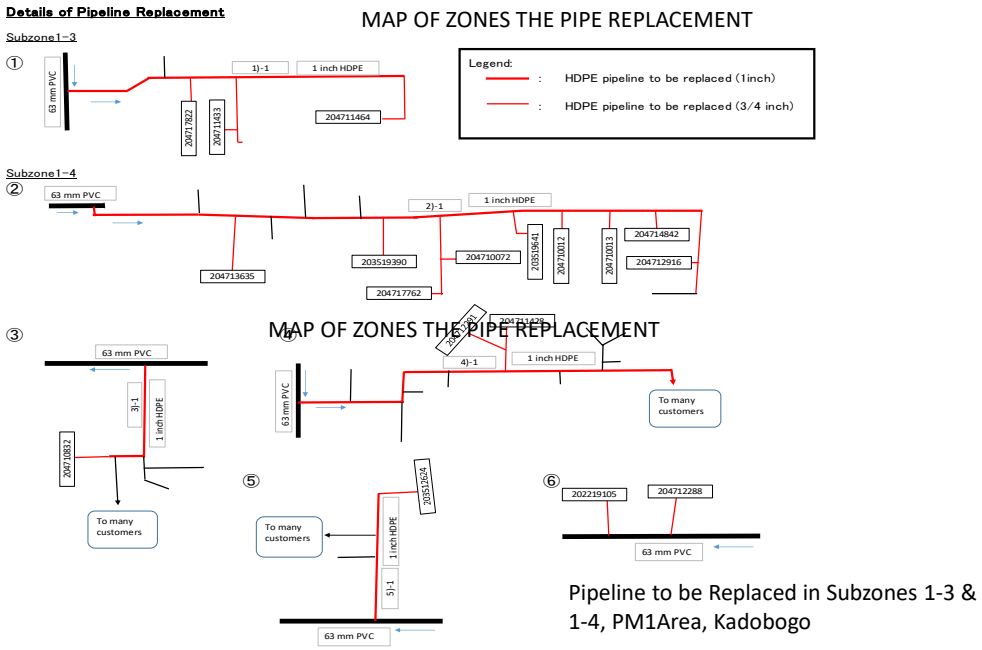
During the activities of reduction of water loss in the pilot, we found that the repetitions of the leaks were caused by the substandard pipe of type HDPE. The solution was to elaborate all frequent leak pipes to replace them.

These part of network which are pipes of distributions and services in the Subzone 3 and 4 of PM 1, totaling in 1000 meters for 6 Zones.

Kadobogo Subzone Map







Material and work preparation

JICA RESPONSIBILITY

N0	DESCRIPTIONS	COMMENTS
1	Procurement of the pipes and accessories	Done, on December 2018
2	Excavations of trench and Back-filling work	Done, from 4/2/2019
3	Procure all material needed for protection, preparation soil	Done
4	Assistance work	Done

WASAC RESPONSIBILITY

N0	DESCRIPTIONS	COMMENTS
1	Team (Technicians & Plumbers) for installation new pipes	Available, from Kacyiru branch
2	Team (Masons & assistant masons) for repairing the civil work	Not available
3	Procure the material needed for repairing civil work (sand, cement, gravel)	Not done
4	Supervision of work	Done

SCHEDULE AND PROGRESS

SCHEDULE OF PIPE REPLACEMENT IN KADOBOGO PILOT AREA

Feb-19

PILOT ZONE	WEEK 1 (Days)							WEEK 2 (Days)							WEEK 3 (Days)							WEEK 4 (Days)			
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Excavation work, Backfilling work, New connection and Civil work																									
Subzone 1-3 & Code number	1		100% Finished																						
Excavation work, Backfilling work, New connection and Civil work																									
Subzone 1-4 & Code number			3					4	5						2							2		6	
			100% Finished												50% done										

SUPERVISION TEAM

Team

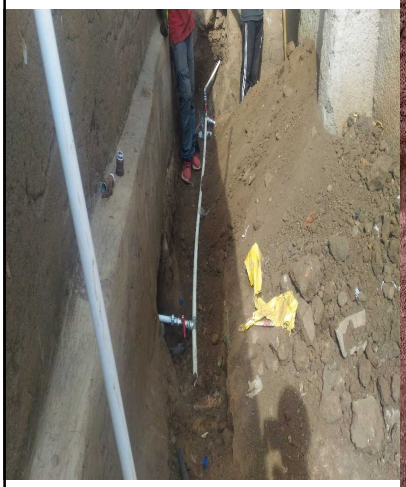
N0	Description	Nbre	Responsible	In charge	Observations
1	Man powers	10	JICA	Vedaste	Recrutment local team
2	Plumbers	2	Kacyiru branch	Patrick & Claire	Kacyiru branch plumbers
3	Masons	2	DUWSS	Desire	Recrutement local macon
4	Supervision 1	2	Kacyiru	Patrick & Claire	Kacyiru technicians
5	Supervision 2	1	NRW Team	Desire	Mugabo LD&PM
6	Supervision 3	1	JICA Team	Vedaste & Otani	Vedaste

OBSERVATIONS DONE

- The pipeline situation on map not matching with the situation on field
- The many repairing was done to sub standard pipe show us the repetition leaks
- The WASAC standard for new connection should cause the weakness of pipe (For example, 3 to 5 saddles for connection in 1m of main pipe) Each customer has owner saddle, which causes many holes to the main pipe.

- The current situation on the ground will not correspond with the BOQ elaborated during the calculation of the necessary materials. During the replacement, we found that the drawings used to calculate the materials are totally different with the situations of the pipes to be replaced.
- Also during the installation of the new pipes, we are obliged to put the new valves and the other accessories accompanied for all the branches (connections) of the customers. In the estimation of materials, some branches are not considered at that time of preparation of BOQ, because the MAP and current situation on site different.
- Consequently, the materials especially the accessories are insufficient, the extra-materials will be procured for complete all the replacement.

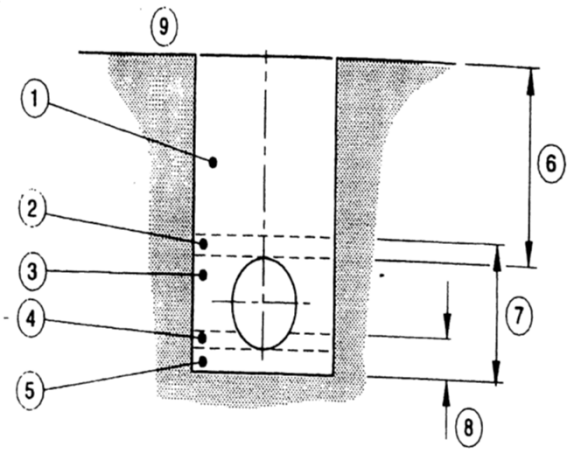
Photos



TRENCH CONTROL AND PREPARATION

- Before laying, the technician should make verification measurement of the trench (depth, width, straight alignment or curves size) by usin g the tape measurement, form work, cable,…
- We must prepare the bottom of the trench, by the soil sifted before l aying the pipe and also after the installation of the pipe, the soil shou ld be sifted for protection reasons pipe. (10 to 20 centimeters botto m and top)

Standard work



Key components:

1. Mail backfill including road construction, if any
2. Initial backfill : Sifted soil
3. Side fill : Sifted soil
4. Upper bedding : Sifted soil
5. Lower bedding : Sifted soil
6. Depth of cover
7. Embedment
8. Seeding
9. Ground surface

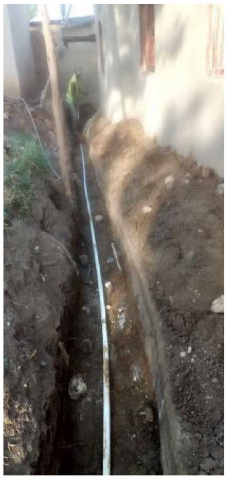
PHOTOS



LAYING CONDITION

- The pipe must be laid in the middle of the slice, it must not have the zig zag
- Avoid direct curves, the correct curve of a pipe must be done regularly without broken the pipe. Radius of the curve must be at least large and more open.
- The application of Teflon must be the number limited between 5 to 7 times if thickness of Teflon is 1mm. To much Teflon can cause also mal connection.
- The pipe must have a good number treads and also the accessory must be well fixed to ensure the good connection to the pipe

PHOTOS





PHOTOS



PHOTOS

PRESSURE TEST

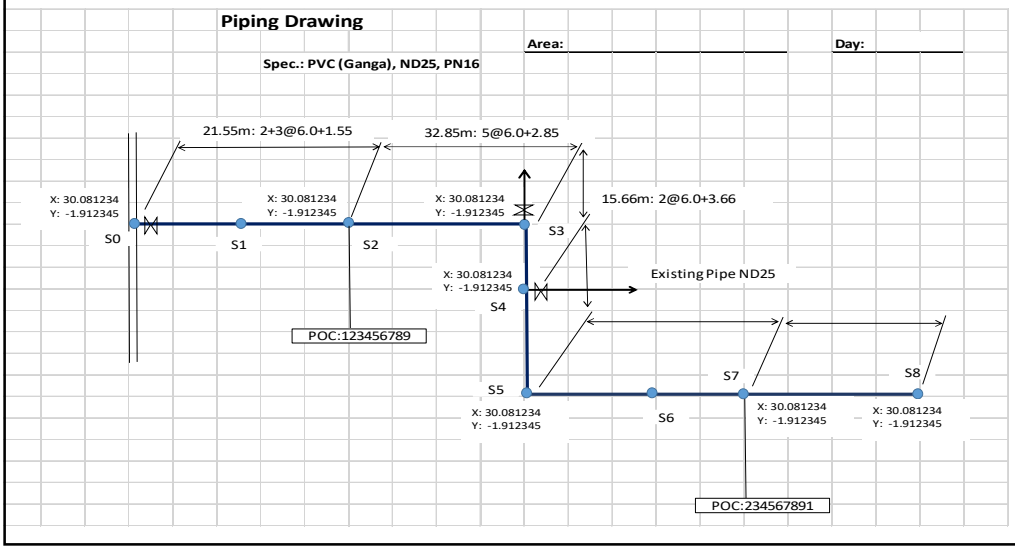
- Testing the pressures after the pipe is also important to check all points of the connections (valves, plugs, unions, ..) are well connected to ensure goo d resistance to pressure available.
- In Kadobogo case, the pressure available change between 9 to 11 bars, but the test done, we have extended 5 bars more, because it is important to predict that the water source can change and can cause the pressure change in the area, directly to the pipes. So the test done was 16 bars.
- The good test should resist between 5 to 10 minutes with the result of the same bar or reduced to 5% only. The result after should the 16 bars or 15.2 bars.
- If the result change under 5% of reduction, There is leakage, the test shoul d be repeated until the correct result, after finding the leak and repairing it.

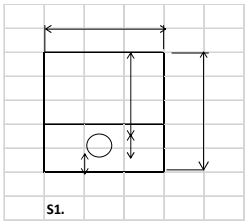
Pressure Test result

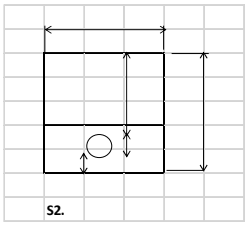
Result after 10 minutes Sub zone 1-3

ZONE TESTED	DATE	RESULTS AFTER 10 MUNITES	COMMENTS
Sub zone 1-3, N0 1	22/2/2019	16 Bars	Good result
Sub zone 1-3, N0 2	25/2/2019	16 Bars	Good result
Sub zone 1-3, N0 3	26/2/2019	16 Bars	Good result
Sub zone 1-3, N0 4	26/2/2019	15.8 Bars	Good result
Sub zone 1-3, N0 5	27/2/2019	16 Bars	Good result
Sub zone 1-3, N0 6	----------	No test (No big change pipe)	Good result
Sub zone 1-3, N0 7	28/2/2019	15.5 Bars	Good result
Sub zone 1-3, N0 8	28/2/2019	16 Bars	Good result

AS BUILT DRAWING AND RECORD







RECOMMANDATIONS

1. It is recommended that the new connections can be made from other pipes of near by customers, for to reduce the saddles creating holes on the main pipe, because they increase the risk of causing the number of leaks, the weakness of a main pipe through too close holes and so this solution decreases the expense by the length of the pipes used, by the supreme saddles, ----

2. It is recommended that the pipes and accessories used during the new connections should have and with the required pressure. for this moment, the pipe resist the 20 bars are available on market, in this case all the change of the pressures will not cause the leak.

3. It is also recommended that the technicians must consider a reception trench and control the size, good supervision during installation (pipe laying, Teflon using, fitting connection, back-filling conditions, ----)

4. The as-built drawing, coordinates location, and all important information, change done during installation should be presented and reported to GIS section for update the document.

5.4 Improvement of the Present Pipe Installation Work

Note: Refer to attached sheet of Power Point with video phot

5.4.1 Causes of Leakage

The causes of the leakage in pipe network itself are aging, substandard materials and inappropriate installation work. In this section, problems on “Pipe Materials”, “Procurement Procedure of Materials” and “Pipe Laying and Jointing Methods” are described.

1) Pipe Materials

There are many substandard pipe materials are sold in the market Kigali. Even the pipe printed “PE 100 (ISO/TR9080)”, they sometimes crack by high water pressure as Fig. 1. PE 100 is described as “By increasing the high molecular part and increasing the number of tie molecules that connect the crystal structure, cracks between crystal parts are less likely to occur, improving long-term hydrostatic pressure strength and environmental stress cracking resistance. By optimizing the low molecular part, it improves impact resistance and secures moderate flexibility.” So, PE 100 is not easy to be cracked. Cracked and burst HDPE is substandard one. And their pipe thickness is not uniform, the cross-section of pipe is not double circle. The inside of circle is eccentric. So, thinnest wall is week against high water pressure.

Fig. 1 Leaked PEP

Fig. 2 Cross-section of PEP

2) Procurement Procedure of Materials

For house connection, customers procure pipe materials.
Customers don’t pay attention to leakage of upstream of customer meter, because it is not measured by customer meter. Usually, customers want to save money to buy materials. They have tendency to buy cheap pipe materials even if that is substandard quality.

3) Pipe Laying and Jointing Methods

- Pipe Laying

When pipes are laid in the earth, backfilling of pipe laying ditches is soils dug at the site. The soils usually contain stones and rocks. They damage to laying plastic pipes. It causes leakage.

- Jointing Methods

For small size pipes, screw jointing is usually adopted, even pipe materials are plastics. Screwed part of plastic pipes become thin and weak.

- Service Pipe Connection

When service pipe is connected to distribution pipeline, the hole on the pipeline is usually bored by heated iron bar. It is not clear circle and smooth. It causes some friction at the connection point.

5.4.2 Proposed Proper Measures

Now, it is required to make a higher specific standard. When it is easy to get good quality polyethylene pipe in the market, polyethylene pipe should be used for small size pipes. Because, polyethylene pipe (PE 100) is not easy to be cracked as described above.

(1) Pipe Materials

- Pipe Materials

At present in case of small size pipe, PVC GANGA (U.P.V.C) is the most reliable pipe materials in the market Kigali. During substandard pipe materials are popular in the market, it is better to use PVC GANGA.

Polypropylene (PPR) & PE100 should be used with standard. Confirm materials by pressure test. List the name of product company which pipes are passed by the pressure test.

- Design Water Pressure

Design water pressure should be 16 bar. Even under pressure control, 16 bar is recommendable to use.

Fig.3 HDPE Pipe

Fig.4 PVC Pipe

Fig.5 uPVC Pipe

(2) Procurement Procedure of Materials

WASAC should order customers to buy good quality pipe materials produced by the listed company by WASAC. Otherwise, WASAC provides customers pipe materials produced by listed company.

It is very important to check pipe surface condition whether there is some scratch or damages or not. If there is some scratch or damages on the surface. It will be a cause of leakage.

(3) Pipe Laying

1) Connection Method

a. Screw joint with seal tape

For small size PVC pipe, screwing joint method is adopted. In this case, the wind seal tape keeps the water-tightness of the screw. Wind seal tape (Teflon tape) about 6 to 7 rounds remaining one thread of screw as Fig.6. When winding tape is finished, fit the seal tape with your fingers as Fig.7. It becomes familiar if you try to press it with nails and fingers.

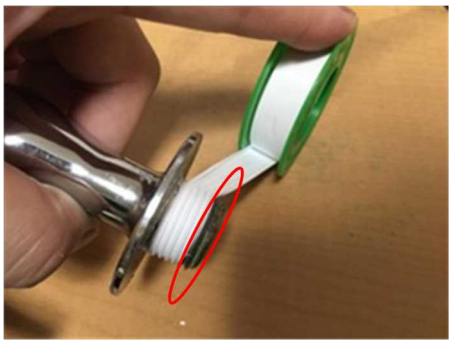


Fig.6 Rapping Taping

Fig.7 Fit Tape

b. Mechanical compression fitting

Fig.8 Repairing HDPE

Fig.9 Screwing of uPVC

Fig.10 Coupling (screw)

Screwing of plastic pipe such as HDPE and uPVC is not recommendable, because screwed part of plastic pipe becomes week against pulling out.

For repairing of plastic pipe it's better to use mechanical compression joint such as following figures:

Fig.11 Mechanical compression joint (MCJ)

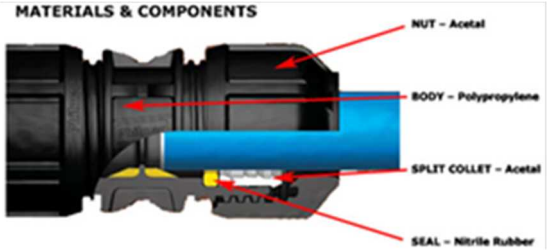


Fig.12 Structure of MCJ

Compression couplings are another form of non-permanent jointing for HDPE pipes. As indicated below, the general components of a compression fitting or coupling are a body, a threaded compression nut, an elastomer seal ring or O-ring, a stiffener and a grip ring.

Compression fittings are popular because they do not require soldering, so they are comparatively quick and easy to use and require no special tools or skills to operate. Because compression fittings are not permanent, they are especially useful in installations that may require occasional disassembly or partial removal for maintenance.

c. Rubber ring joint

Rubber ring should be set correct position, if not it will be a cause of leakage. Procedure of joint method is as followings:

Fig.13 Setting a rubber ring

Fig.14 Leaks caused by incorrect positioned rubber ring

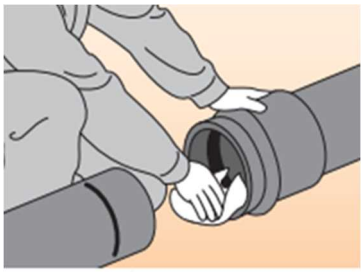


Fig.15 Step1

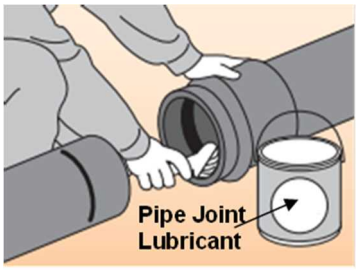


Fig.16 Step 2

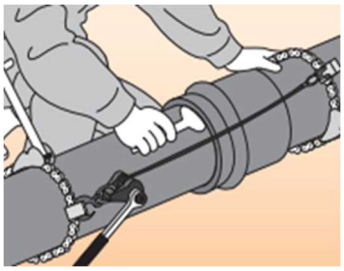


Fig.17 Step 3

Step 1:

Check scraped pipe edge, mark and rubber ring setting situation. Remove sand and mud with the waste clothing on the inner face of the socket and the surface of the insertion pipe end.

Step 2:

Apply pipe joint lubricant uniformly to the surface of the rubber ring and the insertion pipe end (scraped pipe edge). Absolutely, use dedicated pipe joint lubricant.

Step 3:

Align the pipe axis and insert it to the mark position. Inspect the position of the rubber ring over the entire circumference using a check gauge.

Note:

- If there is a problem such as twisting in the rubber ring, remove it with an inserter etc. to pull out the rubber ring. Check that the rubber ring has no abnormality and the condition of the rubber ring and apply the pipe joint lubricant and insert it again.
- If the pipe joint lubricant enters the back side of the rubber ring, it will cause pulling out of the rubber ring so wash the inner surface of the pipe socket and the rubber ring, remove the pipe joint lubricant and reinstall the rubber ring.

d. Socket fusion welding

For small size (up to DN50mm) polyethylene pipe, socket fusion welding method should be adopted. Socket fusion welding is a widely used technique for assembling plastics piping systems using injection moulded fittings. Socket fusion device is shown in Fig.18. Procedure of welding is as follows:

Fig.18 Socket Fusion Device

a. Assemble the male and female bushings on the cold plate and connect the welder to the power network. Wait for the sound or light signal (see the user's manual of the welder) that informs that the actual temperature is reached.

b. Cut the tube perpendicularly to its axis using the suitable pipe cutter.

c. Find a sheet that shows the welding parameters (diameter, pipe insertion depth, heating time, fusion time and time prior to testing) as Table 1.

d. Mark the insertion depth on the pipe.

e. Make a longitudinal mark as a reference on the external surfaces of the pipe and fitting to avoid turning the components to be welded while performing the welding procedure (do not cut the surface of the pipe and fitting).

f. Place the ends to be welded close to each other to be able to begin the heating process of the components simultaneously.

Table.1 Welding Parameter (Sample)

diameter	Heat Up Time (seconds) SDR 11 SDR 7.3	Heat Up Time (seconds) SDR 17	Max Change-over (seconds)	Cool Down Time Clamped (seconds)	Cool Down Time Total (minutes)
1/2" (20mm)	5	NA	4	6	2
3/4" (25mm)	7	NA	4	10	2
1" (32mm)	8	NA	6	10	4
1-1/4" (40mm)	12	NA	6	20	4
1-1/2" (50mm)	18	NA	6	20	4
2" (63mm)	24	10	8	30	6
2-1/2" (75mm)	30	15	8	30	6
3" (90mm)	40	22	8	40	6
4" (110mm)	50	30	10	50	8
5" (125mm)	60	35	10	60	8

g. After checking the surface temperature of both bushings, insert the pipe into the female bushing without rotating it and the fitting over the male bushing up to the depth previously marked. This position should be maintained for the heating time t1 as shown in Table1. Do not heat up the parts to be welded twice.

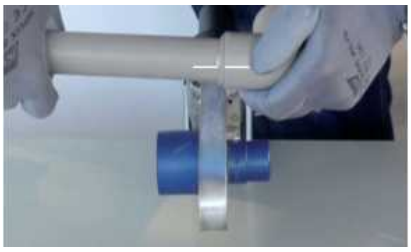


Fig.19 Inserting Socket

h. After the heating time, quickly remove the elements from the bushings and insert them one inside the other, within time t2, until you reach the insertion depth previously marked. Be careful not to rotate the pipe into the fitting and carefully align the reference longitudinal signs.

2) Drilling for Service Pipe Connection

Use a drilling device as Fig.22 for making a hole on distribution pipe to connect a service pipe instead of using a heated iron bar. Heated iron bar is not suitable because it cannot make a clear hole on distribution pipeline.

Fig. 20 Heated iron bar

Fig. 21 Drilling by heated iron bar

Fig. 22 Drilling Device

3) Important point of backfilling

For backfilling, use soils without stones and rocks especially surroundings of pipeline to avoid damage to them. Remove stones and rocks from backfilling soils.

For backfilling, use sands surroundings of pipeline to avoid damage to them as Fig.23. Sands are used 30 cm upper and under the pipe. Back fill by soils at the site removed stones and rocks upper the sand bed.

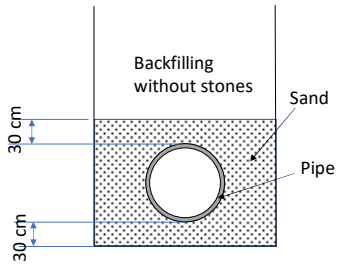


Fig. 23 Sand Bed

Fig.24 Digging

Fig.25 Pipe laying condition

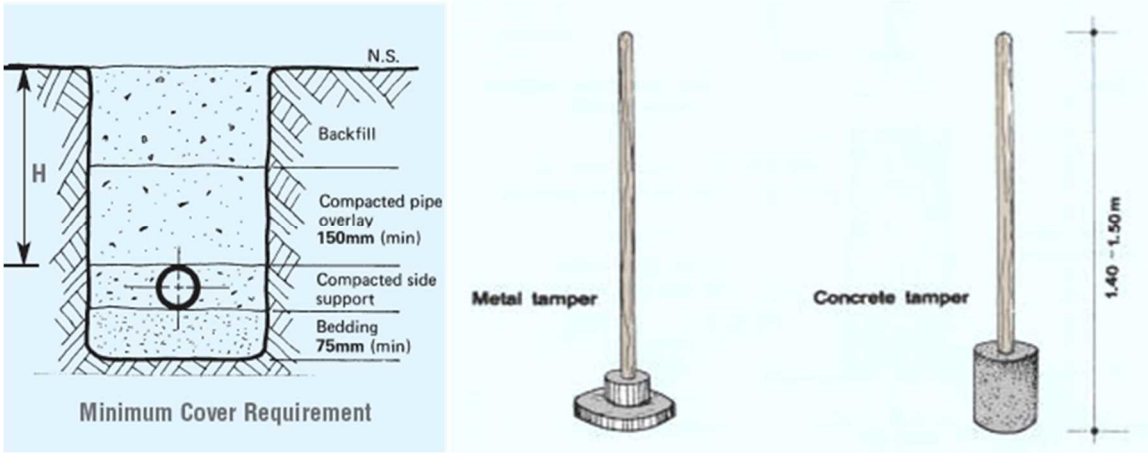


Fig.26 Standard backfilling and tamper

- The bottom of the ditch should flatten well and be tamped. After that, sand is spread

75mm (minimum), and flattened.

- Compact the sides of the pipe well.
- Compact pipe overlay 150mm (minimum) with sand or good quality soil.
- For soil compaction, use a tamper.

(4) Tools of Piping Work

1) Maintenance of tools

When using a die to thread the pipe, use oil as a lubricant so that thread (screw) becomes clear and damage of the die becomes less. Check tools whether they are good condition or not. If tools are not good condition, the result of work becomes bad as Fig.28.

Fig.27 condition of screwing pipe

Fig.28 Screwed pipe by bad condition die

2) Recommendable tools and fittings stored at branch offices

At every branch office, following tools and fittings as Table 2 should be stored and they should be maintained and replenished at regular intervals.

Table 2 Tools necessary for joining plastic pipes

Tool Name	Purpose	photo
Permanent Marker	Marking for cutting position	

Pipe Cutter 2types	Cutting pipes	
File	Deburring of cut surface	
Convex Rule	Measure cutting position	
Waste (Soft cloths)	Wipe off dirt	
Lubricant (for PVC Pipe)	For push-on joint (insertion)	
Check Gage (for PVC Pipe)	Confirmation of insertion condition of rubber ring	

Plumbers Wide Jaw Adjustable Wrench	Tightening of bolt and nut and others	
Pipe Wrench	Connecting of pipes and others	
Pipe Threader	Cut thread on pipes	
Pipe Drilling Devices	To tap for service connection	
Mechanical Compression Fittings	Connection in the case of pipe repair	
Grease	Lubricant for threading pipes	

Present Pipe Material
Hole Making by Heated Iron Bar
Screw Joint with Seal Tape
Cutting Pipe

1. Pipe replacement planning





Topic 5: How to make the plan of Replacement for NRW Reduction.
- Identification of areas ~~with~~ having many leakages
- Analysis to know the cause of those leakages (Pressure, old network / poor quality of pipe)
- If the cause is old network or poor quality, Replacement plan should be made.

1-3. Selection and Maintain of Material

2. Present way of drilling for service pipe connection

1. Drilling for service pipe connection by heated iron bar






5. Install the good equipment in branch and enhance the technician ability.



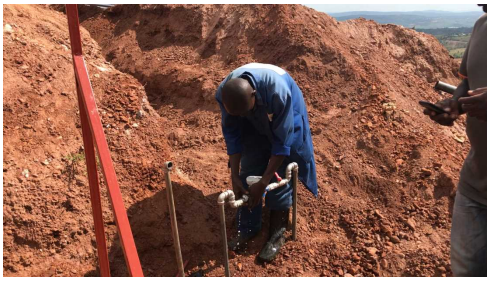




5. Install the good equipment in branch
and enhance the technician ability.




1-4. Pipe Cleaning





5.5 Service Pipe Connection

Recommended procedure for service pipe connection is as shown below.

Note: Refer to attached sheet of Power Point with video phot

1. Pipe Drilling Procedure

   ① Dig enough space to set the drilling tool and saddle.
   ② Clean the main pipe.
   ③ Clean the rubber of saddle.
   ④ Set the saddle and fix bolts.
   ⑤ Fit the drilling tool to the gate valve by the nipple and confirm the position of spindle.
   ⑥ Locate the ratchet onto the drill spindle and work the ratchet in a clockwise direction to the main.
   ⑦ Open the relief valve to remove pipe pieces when you feel the main cut perfectly.
   ⑧ The drill spindle moves to your side when you pull the drill spindle slightly.
   ⑨ Close the gate valve and remove the drilling tool.

2. Measurement of water pressure

   ① Set pressure gage after drilling.
   ② Measure the water pressure after relief the air from relief valve.
   ※ Record the range of water pressure if the water pressure would move sharply.

3. Measurement of chlorine

   ① Pour water test tube until 70%
   ② Put a pack of DPD into water
   ③ Confirm Chorine figure within 30 seconds
   ④ Clean up test tube after measuring

4. Confirm pipe position

   ① Confirm the distribution pipe position including depth
   ② Cheek service pipe depth

5. Screw threading

① Using oil

6. Pipe cutting and connection

① Use Oil when you make the screw of steel pipe.
② Round of Teflon is around 15 times with good fitness.

7. Reporting

① Recording site position, pipe position, water pressure, chorine figure.
② Schematic drawing.

Training on Service Pipe Connection

1. Recommended Pipe Drilling procedure

①Dig enough space

③Clean the rubber of Saddle

②Clean the main Pipe

④Set the Saddle and fix the bolt

1. Pipe Drilling procedure

⑤Fit the Drilling machine

⑦Open the relief valve

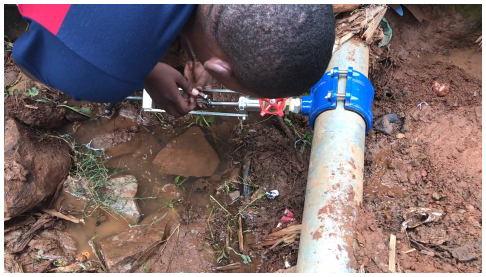
⑥Work the Ratchet in clockwise direction to the main

1. Pipe Drilling procedure

⑧The Drill spindle moves to your side

⑨Close the gate valve and remove drilling

※Case of the steel pipe



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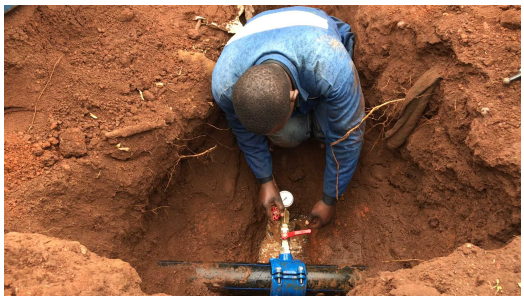
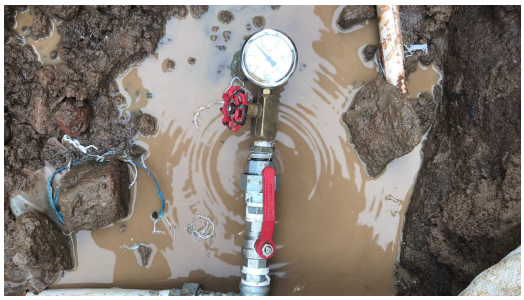
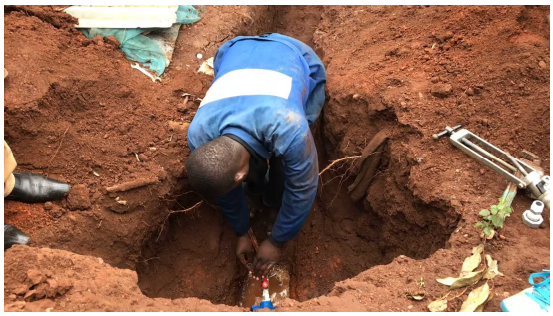
2. Measurement of water pressure

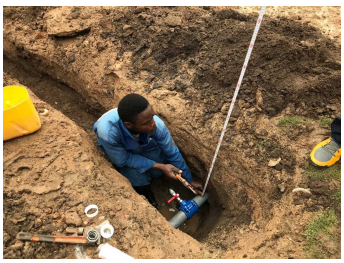




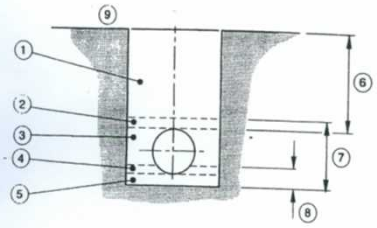
3. Measurement of water Chlorine



4. Confirm the Pipe position and depth



System layout

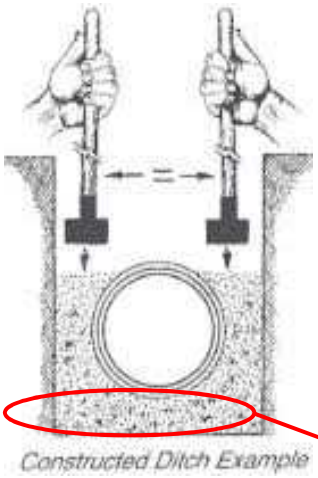


S/N	Components of layout system	Pipe diameter 20 – 50 mm	Pipe diameter 63 – 110 mm	Pipe diameter 125 – 200 mm	Pipe diameter 225 – 400 mm
1	Main backfill including (including upper bedding)	Min 40 cm	Min 60 cm	Min 70 cm	Min 100 cm
2	Initial backfill	10 – 20 cm	10 – 20 cm	10 – 20 cm	10 – 20 cm
3	Side fill	Min 20 cm	Min 25 cm	Min 30 cm	Min 35 cm
4	Upper bedding	10 – 20 cm	10 – 20 cm	10 – 20 cm	10 – 20 cm
5	Lower bedding	Min 20 cm	Min 20 cm	Min 20 cm	Min 20 cm
6	Depth of cover	Min 40 cm	Min 60 cm	Min 70 cm	Min100 cm
7	Embedment	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe
8	Seeding	Min 30 cm	Min 30 cm	Min 30 cm	Min 30 cm
9	**Ground surface**	**Min 70 cm**	**Min 90 cm**	**Min 110 cm**	**Min 130 cm**

5. Compaction of backfilling soil

Remove stone!

Compaction!

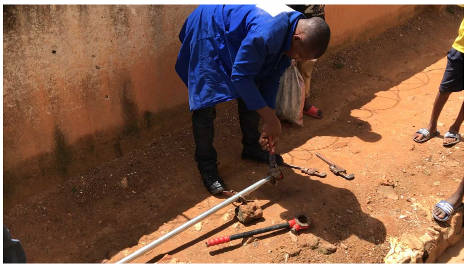


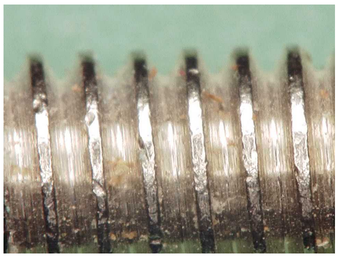
This parts is most important for carefully back filling and compaction.

6. Screw threading by use oil

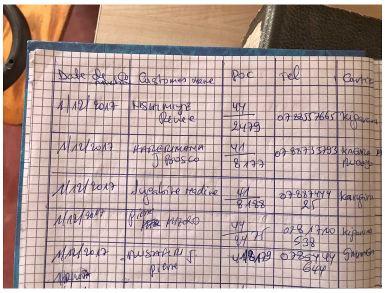
Make the screw thread by water !?

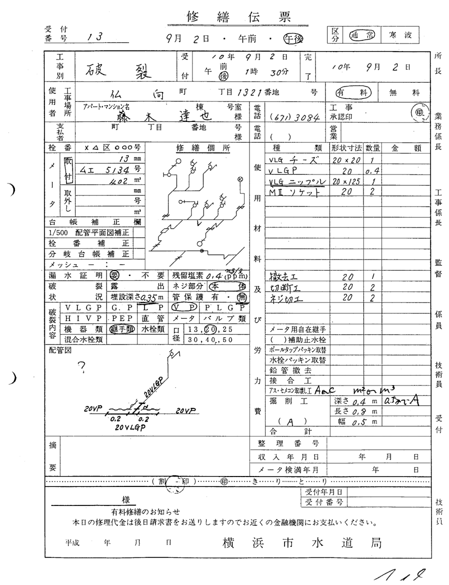
Make the screw thread by oil.





7. Reporting





修 繕 伝 票

受付番号 13　9月 2日 ・ 午前 ・ 午後　区分 通常 寒波

工事別: 破裂　受付: 10年 9月 2日 午前 後 1時 30分　完了: 10年 9月 2日

使用者 工事場所: 仏向 町 丁目 1321 番地 号　有料 無料

アパート・マンション名 棟 号室 様: 藤木 達也　電話 (671) 3084　工事承認印

支払者: 町 丁目 番地 号 様　電話 ( )　営業

栓番: ×△区 ○○○号　修繕個所

メーター 取付: 13 mm / ムエ 5134 号 / 402 m³　取外し: mm / 号 / m³

台帳補正欄: 1/500 配管平面図補正 / 栓番補正 / 分岐台帳補正 / メッシュ ー : ー

漏水証明 要 ・ 不要　残留塩素 0.4 mg/l (ppm)

破裂状況: 露出　ネジ部分 本体　埋設深さ 0.35 m　管保護 有 ・ 無

破裂内容: VLGP　G.P　LP　VP　PLGP / HIVP　PEP　直管　メータ　バルブ類 / 機器類　継手類　水栓類 / 混合水栓類　口径 13, 20, 25 / 30, 40, 50

配管図: 20VP　20VLGP　0.2　0.2　20VP　20VLGP

使用材料及び労力費

種類	形状寸法	数量	金額
VLG チーズ	20×20	1	
VLGP	20	0.4	
VLG ニップル	20×125	1	
MⅡ ソケット	20	2	
撤去工	20	1	
切断工	20	2	
ネジ切工	20	2	
メータ用自在継手			
( )補助止水栓			
ボールタップパッキン取替			
水栓パッキン取替			
鉛管撤去			
接合工			
アス・セメコン取壊し工 AaC m² or m³			
掘削工 (A)	深さ 0.4 m / 長さ 0.8 m / 幅 0.5 m		
合計			

摘要　整理番号　収入年月日 年 月 日　メータ検満年月 年 日

(割 印) 印 きりとり　受付年月日　受付番号

様

有料修繕のお知らせ

本日の修理代金は後日請求書をお送りしますのでお近くの金融機関にお支払いください。

平成 年 月 日　横 浜 市 水 道 局

所長　業務係長　工事係長　監督　係員　技術員　受付　技術員

Reference-1 Standardization of Piping Work

1. Standard of materials and works

1.1 Standard of piping works

(1) Transmission Pipes

Pipelines or conduits which carry water from one point to another without intermediate service connection

A water pipe is designed to transport treated drinking water to Distribution reservoir

a. Pipe Material

In transmission, the pipe material in minimum shall be made up of High-Density Poly Ethylene (HDPE), Ductile Iron (DI) and PVC material.

The selection of pipe material depends upon several factors. Some of the major factors are listed below:

i. Diameter of the pipe and internal pressure.
ii. Quality of water i.e. some sources of water may be corrosive in nature.
iii. Type of soil where the pipelines is to be laid i.e. hard, soft, saline soil etc.
iv. Atmospheric temperature where the pipeline is to be laid.
v. Distance between the source and the terminal point i.e. pipe laying and maintenance involvement.
vi. Expected backfilling on the pipe.

b. Pipe sizes

For the transmission main, the diameter of pipes shall be ranging from 160 mm and above depending on the design. (This size can change according to availability of water quantity)

c. Design Water Pressure

The rating pressure for each pipe size will depend on working condition and design but should not be rated below 16 bars.

(2) Distribution pipeline

Distribution main usually conveys large amounts of water over long distances from a storage tank within the distribution system. Distribution mains are typically smaller in diameter than the transmission mains and generally follow the city streets.

A water pipe is designed to transport treated drinking water to consumers. The varieties include large diameter main pipes which supply entire towns, smaller lines that supply a street or group of buildings.

a. Pipe Material

In distribution, the pipe material in minimum shall be made up of High-Density Poly Ethylene (HDPE) and PVC material.

b. Pipe sizes

For the distribution main, the diameter of pipes shall be ranging from 75 mm and above depending on the design.

c. Design Water Pressure

The rating pressure for each pipe size will depend on working condition and design but should not be rated below 16 bars.

(3) Services pipe and meter connection

The water service supply line delivers potable water to your home from the distribution water main. the clamp saddle should be made of Ductile iron with blue epoxy coating

1) Pipe sizes

The water service line for a residential home are small diameter pipes located within individual buildings. Typically, are ¾" pipe that can be seen entering your building near the water meter.

2) Pipe material

The pipe material in minimum shall be made up of GANGA, High-Density Poly Ethylene (HDPE) or polypropylene (PPR). At present in case of small size pipe, PVC GANGA is the most reliable pipe materials in the Kigali market.

3) Design Water Pressure

Design water pressure should be 16 bar, but under pressure control, 10 bar is also used.

4) Meter Installation

a. Customer meter installation

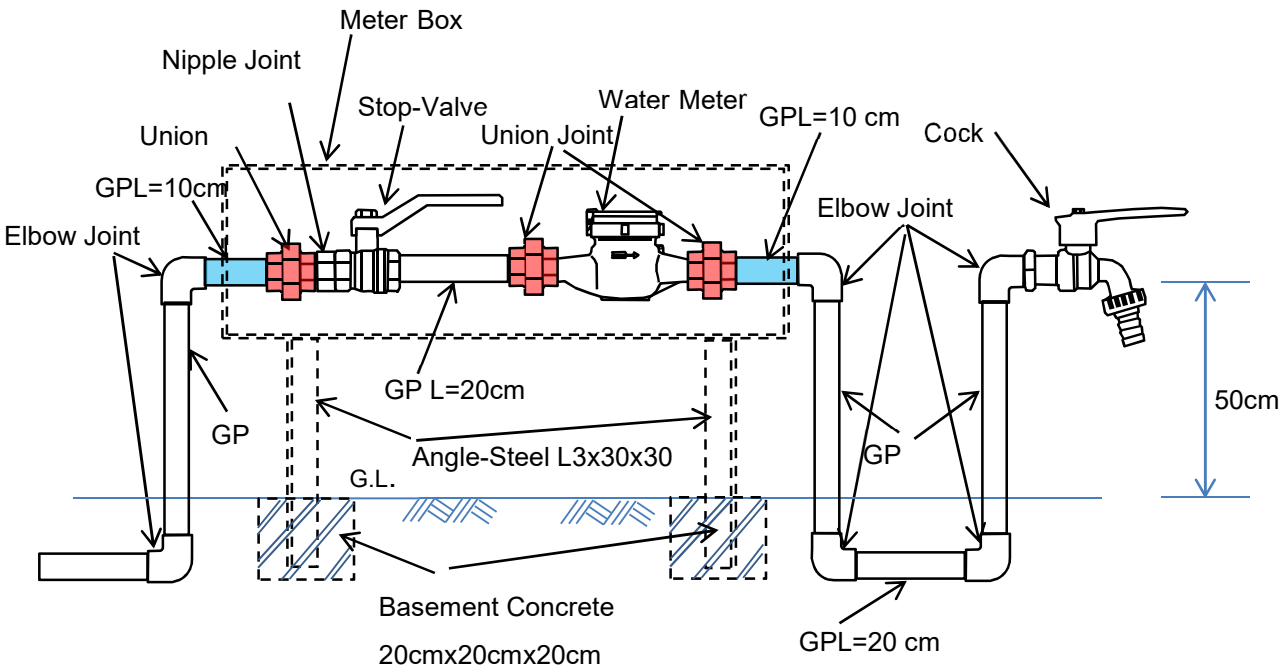


Fig.1 Standard Meter Installation with Meter Box

Meter Installation Standard with Meter Box

When a customer wants to install a meter box, the water meter and the stop valve should be able to be changed easily in the box. Therefore, short length pipes; two 10cm pipes are installed to make a space for replacement of them in the box and one union joint should be installed both sides of water meter and before a stop-valve shown as Fig 1.

Handling of Key for Meter Box

If a customer locks the meter box, WASAC must keep spare key with POC number so that the field officer can open when staff of WASAC reads meter index and change the meter or stop valve.

Other considerations

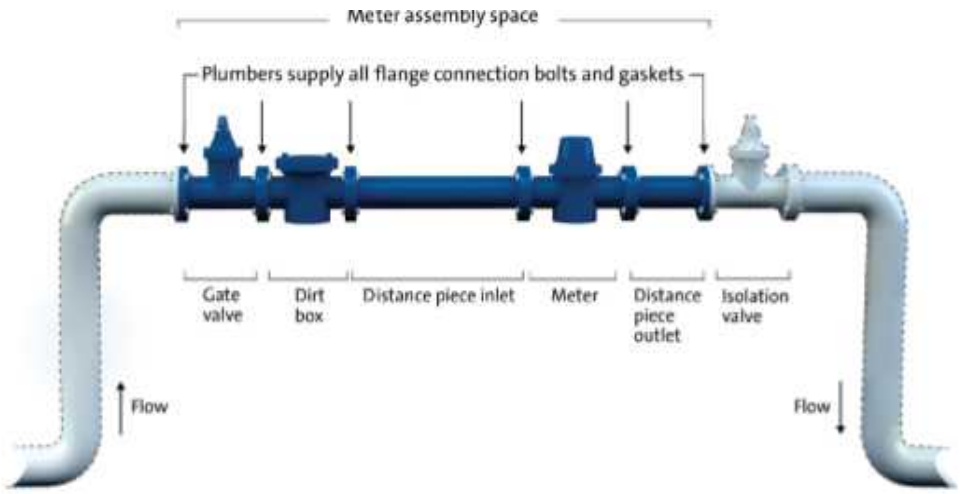
- Distance from domestic distribution pipe to water meter should be 90 m maximum in urban areas and 200 m in rural areas.
- Distance from the main entrance to the meter should be between 1 and 2m at accessible place.

b. Bulk meter installation

Guidelines for Bulk water meter installation

- Water meter should be installed horizontally inside the concrete waterproof chamber in the same level as mainline or raised to ground level according to site condition to avoid ground water flooding inside the chamber.
- Should not be installed in basement, pump room, upper floors or roof of a building under any circumstances.
- Bulk meter should not be allowed to fall or to receive impact damage during installation
- Meter should be installed according to the arrows shown on the body of the meter
- Meter register shall be arranged so that the meter will be read easily from outside the chamber
- Pipes, valves or other fittings used to connect the meter must be high quality, no corrosive metal, non- toxic, heavy duty etc.
- Installation of T or bend immediately before or after should be avoided
- The meter should be always full of water to avoid air flow through the meter
- Proper concrete support must be provided on valve, strainer, pipes or other fittings to avoid any displacement of the meter and associated fittings.
- All connections must be thoroughly checked for leak after meter installation

- A non-return valve shall be installed after the meter if the supply is coming from two directions to avoid reverse flow through the meter, as per the site conditions.
- Valves shall be fitted downstream and upstream to isolate the meter for maintenance
- Consumer shall install a separate valve outside the meter chamber on the pipeline to isolate water supply for any maintenance works.



Meter size DN	Gate valve PN16	Dirt box	Distance piece inlet	Meter	Distance piece outlet	Meter assembly space
50 mm heavy	175 mm	208 mm	372 mm	311 mm	150 mm	1,216 mm
80 mm	203 mm	252 mm	396 mm	413 mm	240 mm	1,504 mm
100 mm	229 mm	260 mm	476 mm	483 mm	300 mm	1,748 mm
150 mm	267 mm	406 mm	762 mm	500 mm	450 mm	2,385 mm
200 mm	292 mm	428 mm	1,000 mm	520 mm	600 mm	2,840 mm
250 mm	330 mm	522 mm	1,250 mm	450 mm	750 mm	3,302 mm
300 mm	356 mm	580 mm	1,500 mm	500 mm	900 mm	3,836 mm

c. Accessories and fittings

Water material other than pipes are called accessories or fittings. When installed and operated under condition by which they were designed, accessories and fitting must maintain their functional characteristics over their operating life due to the constant material properties

The standards sizes of fittings in mm are the following:

Steel and DI: 40,50,60,65,80,100,125,150,200,250,300, etc.

Plastic: 50,63,75,90,110,125,140,160,180,200, 225,280,315, etc.

Fittings and accessories must be free from defects and surface imperfection which can impair their compliance with requirement.

Material

The material in which accessories and fitting are made up is selected as per design pressure and operation conditions (e.g.: Ductile iron for PN 16 bars, cast iron or Stainless steel for 25 bars and above, for rated pressure less than 16 bars Plastic accessories and fitting are also allowable)

Flanged joint

Flanged joint must be designed to facilitate attachment to flanges whose dimensions and tolerance comply with ISO 7005-2 or EN 1092-2, this ensure interconnection between all flanged components.

Rubber Gasket

The design of rubber gasket must be conforming to appropriate international standard. Its material must be conforming to the requirement of ISO 4633 for water application.

1.2 Standard of works

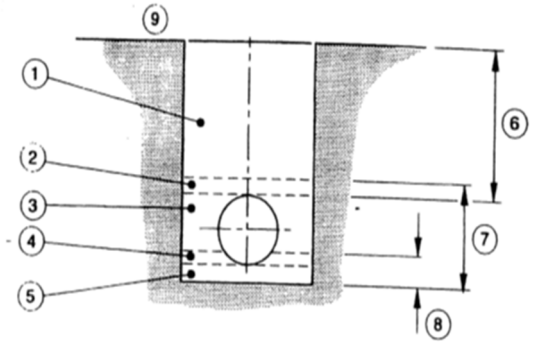
When customers purchase pipes, they have tendency to buy cheap one, in consequence they are substandard quality. Otherwise, WASAC purchase and provide good quality pipe materials instead of customers. When materials have to be purchased by customers WASAC is in obligation of checking and testing before they will be used.

It is very important to check pipe surface condition whether there is some scratch or damages or not. If there is some scratch or damages on the surface. It will be a cause of leakage.

Before laying the pipes, the technician should make sure that trench is meeting standard (depth, width, straight alignment or curves size) by using the tape measurement, form work, cable, etc.

Once the trench excavation is completed, you must prepare the pipe bed, using fine sand or sifted soil before the installation of the pipe,

a. Pipe installation



1. Mail backfill including road construction, if any
2. Initial backfill
3. Side fill
4. Upper bedding
5. Lower bedding
6. Depth of cover
7. Embedment
8. Seeding
9. Ground surface

Table:

S/N	Components of layout system	Pipe diameter 20 – 50 mm	Pipe diameter 63 – 110 mm	Pipe diameter 125 – 200 mm	Pipe diameter 225 – 400 mm
1	Mail backfill including (including upper bedding)	Min 40 cm	Min 60 cm	Min 70 cm	Min 100 cm
2	Initial backfill	10 – 20 cm	10 – 20 cm	10 – 20 cm	10 – 20 cm
3	Side fill	Min 20 cm	Min 25 cm	Min 30 cm	Min 35 cm
4	Upper bedding	10 – 20 cm	10 – 20 cm	10 – 20 cm	10 – 20 cm
5	Lower bedding	Min 20 cm	Min 20 cm	Min 20 cm	Min 20 cm
6	Depth of cover	Min 40 cm	Min 60 cm	Min 70 cm	Min100 cm
7	Embedment	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe	Min 30 cm +ø of pipe
8	Seeding	Min 30 cm	Min 30 cm	Min 30 cm	Min 30 cm
9	**Trench Bottom to Ground surface**	**Min 70 cm**	**Min 90 cm**	**Min 110 cm**	**Min 130 cm**

b. Pressure Test

Objective

Hydrostatic pressure tests are performed to ensure the safety, reliability, and leak tightness of piping systems. A pressure test is required for a new system before use or an existing system after repair, alteration and replacement.

Pressure test machine

Procedure

Pressure tests must always be performed under controlled conditions, following an approved test plan, and documented in a test record. A single approved test plan may be used for several similar tests, but a separate test record is required for each.

The procedure follows three major steps:

Step 1: planning

The engineer in charge must establish a pressure test plan to be approved by the supervisor

Step 2: Performing

The engineer in charge must prepare necessary material and equipment prior to start pressure test then follows the following:

- ✓ Ensures the pressure gauges used have current calibration stickers
- ✓ Removes all persons not involved with the test from the immediate test area
- ✓ Installs the calibrated test gauge so it is always visible
- ✓ Fills and vents system as necessary to remove as much air as practical
- ✓ Ensures that water used for the test is at not less than ambient temperature,
- ✓ Pressurizes the system, raising the pressure in the system gradually until the designated test pressure is achieved

- ✓ Maintains this test pressure for 10 minutes before inspection. Then, if test is above maximum allowable working pressure (MAWP), reduces to MAWP while making a full through inspection for leaks.
- ✓ If there is leakage in the system, performs the following as appropriate: Ensure repairs is performed and continue the process
- ✓ When the test is completed, vents the test pressure to atmosphere and returns the devices to normal configuration

Step3: Record

The result of pressure test must be recorded and submit copy to the supervisor.

Reference-2 Guideline of Pipe Laying

1. Distribution and Service Pipeline Layout

1.1. Distribution pipeline layout

In this chapter, distribution pipeline means secondary and tertiary pipelines.

a. It is advisable that distribution pipelines layout is a network shape and do not become a dead end.
b. When pipeline becomes dead end, install a vale for flushing sands in the pipeline.
c. It is better to interconnect distribution pipelines laid in a boundary of adjacent different supply areas.
d. Install valves at every branch so that a suspended water supply area becomes smallest.

1.2. Service pipeline Layout

In this chapter, service pipeline means the pipeline from distribution pipe line to a customer's meter diameter from 3/4inch to one inch. The standard layout of service pipeline is as Fig 1.2.1.

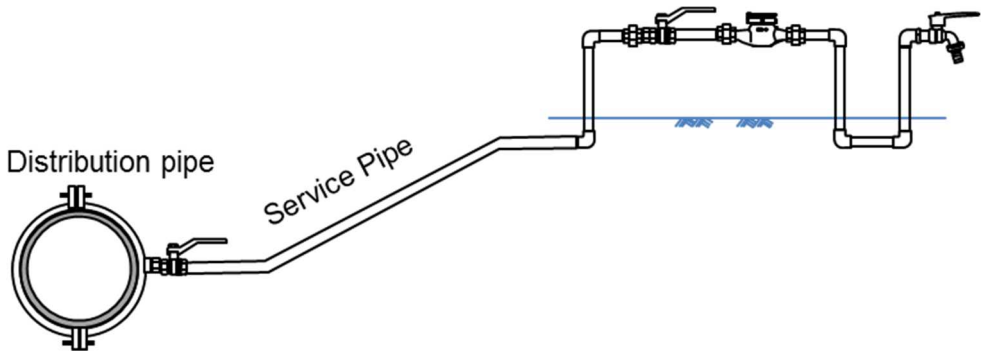


Fig 1.2.1 Example layout of service pipeline

Explanation 1

Where a distribution main and a secondary distribution pipeline are laid in parallel, it is the principle to connect a service pipe to secondary pipeline. Therefore, it is advisable that a secondary distribution pipeline will be planned lying on the road where many service connections are expected.

If a service pipeline is connected to a distribution main, it is inconvenient to suspend water supply on distribution main, when a service pipe connection construction, a pipe repair or maintenance is done.

Explanation 2

Water accumulates in the dead end pipeline, as a result of it the water quality becomes bad or water pressure does not be equalized. Therefore, it is necessary to install a valve at the end of pipeline for drain water.

Even some accident occurs or shut valves both sides of construction point on the pipeline, the water suspended area becomes smaller if pipelines are interconnected as a network.

Explanation 3

It is principle to lay service pipeline as a rising gradient.

If the service pipeline is laid as a rising gradient, the air accumulated in the pipeline can be released so that it is possible to prevent to become water flow area narrow. In addition, it is possible to prevent dirty water is not supplied to customer when the dirty water is produced by an accident or a construction work.

2. Transportation and Storage

2.1. Transportation

2.1.1. Transportation of Polyethylene Pipes

a. There are no special tools or treatment for their loading and unloading, but it is considered not to be thrown and dragged, because polyethylene is easy to be fragile.

b. It is necessary to use cushioning to protect polyethylene pipe for fear of bumping against edge of truck bed.

c. It is necessary to fix pipes tightly by bands for fear of making scratches by shaking while transportation.

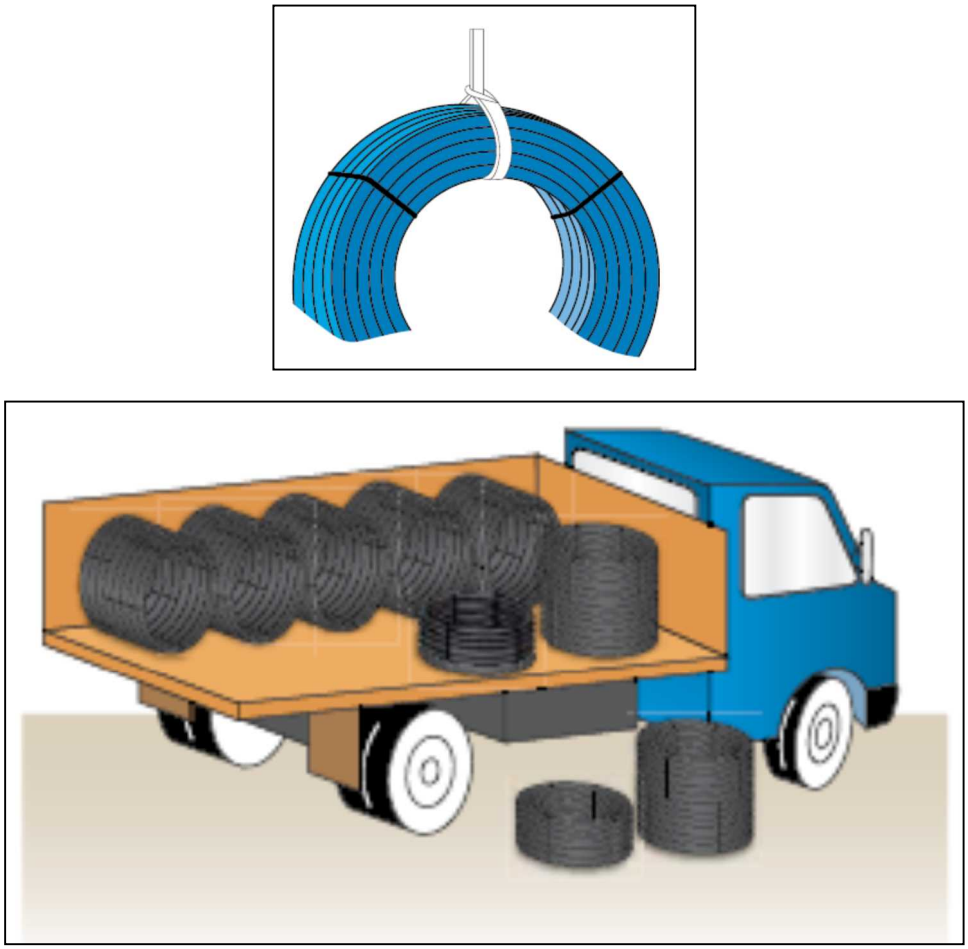


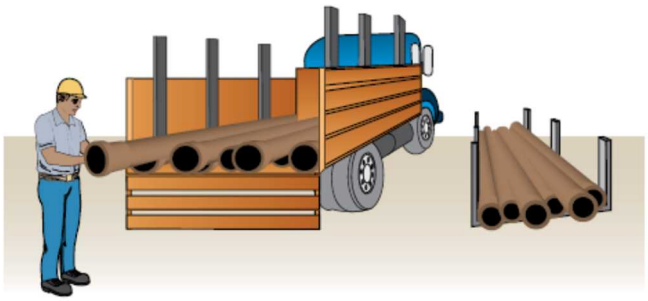
Fig.2.1.1 Loading Way of Polyethylene Pipes

2.1.2 Transportation of PVC Pipes

a. There are no special tools or treatment for their loading and unloading, but it is considered not to make an impact to pipes using a rope.

b. It is necessary to insert cushioning between pipes and a truck bed and a rope to protect pipe for fear of deformation and bumping into each other.

c. It is necessary not to be thrown and dragged, because surface fragile becomes a cause of weakness of pipes same as polyethylene pipe.



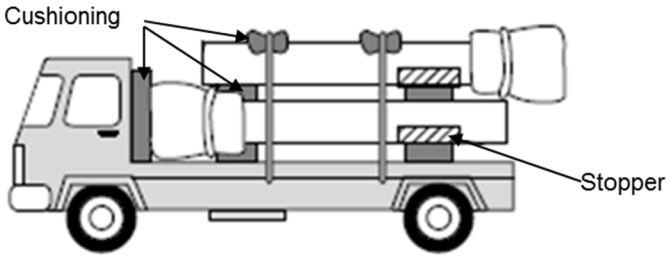


Fig 2.1.2 Example of Transportation of PVC Pipes

2.2. Storage

2.2.1 Storage of Polyethylene Pipes

a. It is to be desired to pile pipes horizontal up to 1.5m height.

b. It is necessary to avoid leaving pipes outside for prevention of dirtiness and disappearing of expression on the pipe surface.

c. Fittings must be stored in the room by packaging and arrangement.

d. A material of pipe edge might become depleted by direct sunlight. If a pipe edge was not protected properly, it is recommendable to cut pipe edge about 10cm and use it.

Explanation 1

If polyethylene pipe is exposed to sunlight for a long time, deterioration progresses due to the influence of ultraviolet rays.

Explanation 2

In the case of vertical stacking, load collapse tends to occur and the lower pipe is easy to deform, so lay it as horizontally as possible. Since all stacked pipe weights are pushed to the lowest pipes, they must be kept in a flat place.

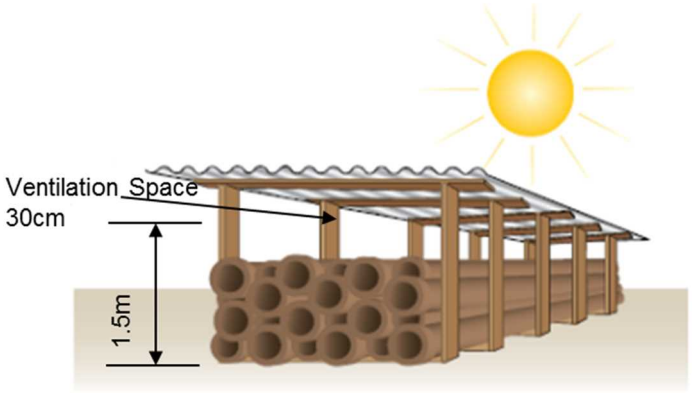
Explanation 3

Since the lower pipe is flattened when stacking in many stages, it is preferable to set the stacking height within 1.5 m.

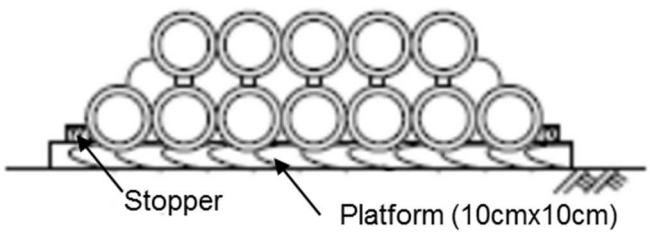
2.2.2 Storage of PVC Pipe

Like polyethylene pipe, PVC is also a plastic material, so it will deform due to high temperature by direct sunlight or deteriorate due to ultraviolet rays.

When it is inevitable to keep PVC pipes outdoors, a place with a roof is desirable, but it should be covered with a sheet to shield from direct sunlight and improve breathability so that heat does not stay.



【Staggered Arrangement】



【Parallel Cross Arrangement】

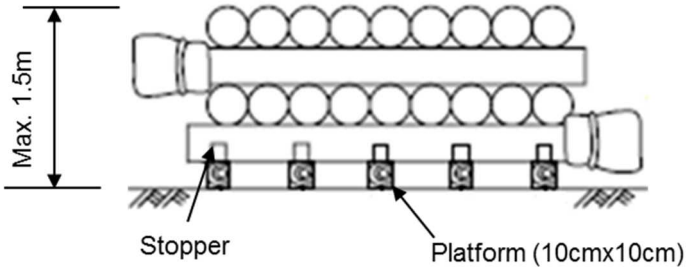


Fig 2.2.1 Example of storage of PVC Pipes

3. Joining

3.1. Tools

The tools used for joining plastic tubes are as follows.

Table 3.1.1 Tools necessary for joining plastic pipes

Use	Tool Name	Purpose
Cutting	Permanent Marker	Marking for cutting position
	Pipe Cutter	Cutting pipes
	Scraper	Deburring of cut surface
	Convex Rule	Measure cutting position
Joining	Waste (Soft cloths)	Wipe off dirt
	Lubricant (for PVC Pipe)	For push-on joint (insertion)
	Check Gage (for PVC Pipe)	Confirmation of insertion condition of rubber ring
	Adjustable Wrench	Tightening of bolt and nut
	Torque Wrench	Tightening force management
	Crowbar	Push on pipe


Permanent Marker

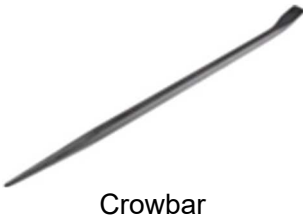

Pipe Cutter


Adjustable Wrench

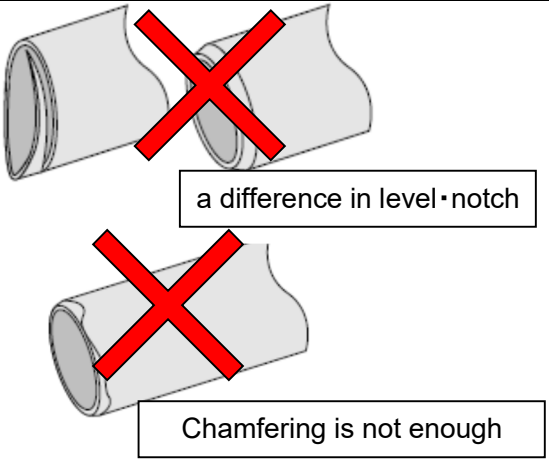

Torque Wrench

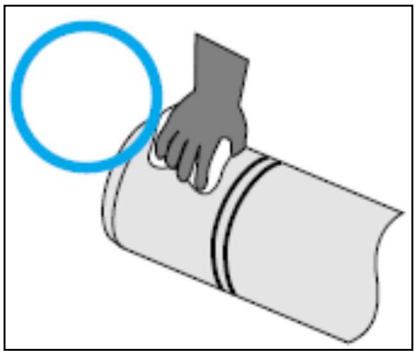

Scraper


Waste


Crowbar

3.2. Cutting

	Work Instruction	Photos
1	1) When cutting a pipe with a diameter of 50 mm or more, draw a marker line with a marker at the cutting position. 2) Cut in a direction perpendicular to the tube axis along the marked line with a pipe cutter. 3) It is better to avoid cutting with a saw. ※ There are two kinds of blades of pipe cutter, for polyethylene and PVC pipes. ※ Be sure to replace with a blade suitable for the type of pipe to be cut.	 
2	4) Remove burrs on the cut surface with a scraper or a metal file.	 
3	5) If burrs remain on the cut surface of pipe end, it will hurt the rubber ring of the fitting.	

	Work Instruction	Photos
4	6) Wipe off cut surface and surroundings of pipe so that mud and sand do not stick	

Explanation 1

When determining the length of cutting pipe, check the depth of the pipe socket and draw a marker line at the cutting location. If the diameter is 30 mm or more, wind the tape in a direction perpendicular to the tube axis and draw a straight line along the tape.

Explanation 2

Touch the blade on the marked line and tightens lightly and cuts the pipe with rotating.

Explanation 3

If there are scratches on the pipe, cut it again so that there are no scratches on the jointing part

3.3. Joining Procedure

3.3.1. Joining of Polyethylene Pipes (Union coupling)

	Work Instruction	Photos
1	1) Before inserting the pipe, draw a line with a marker 8 cm and 9 cm from the end of the pipe. (In the case of DN = 50 mm) 2) It is easily to check whether both pipes are neatly in the vicinity of the center by this line. 3) The depth of insertion depends on the pipe diameter.	
2	4) Insert the union coupling joint in following order: ①clamping ring, ②inner ring, ③union body to the one pipe. 5) At this time, wipe off the sand and dust attached to the surface of the pipe clean with a cloth.	
3	6) When the end of the union body is inserted to a marked line, tighten the clamping ring slowly. 7) The initial tightening is done by hand, and tightening of the finish is done with a dedicated tool.	

3.3.2. Joining of PVC Pipes

There are two types of PVC pipes, one using a rubber ring and the other using an adhesive. Here, the joining with a rubber ring will be described.

In PVC pipe of rubber ring joint, one end is a socket and the other is a pipe-end.

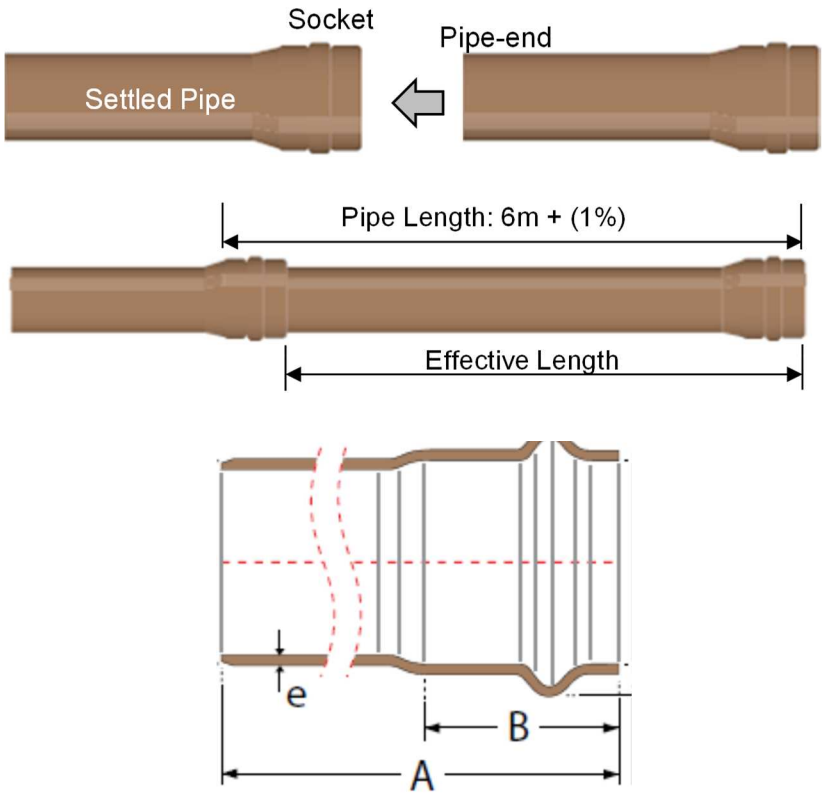
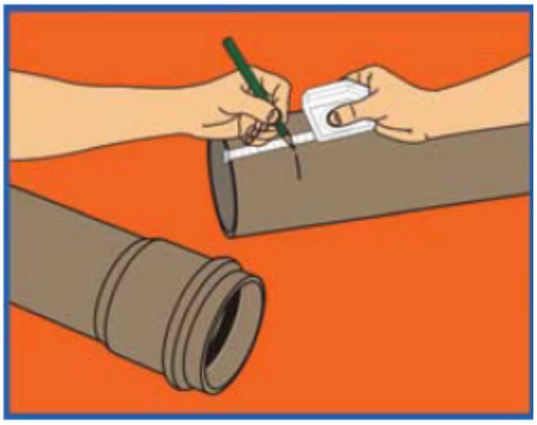
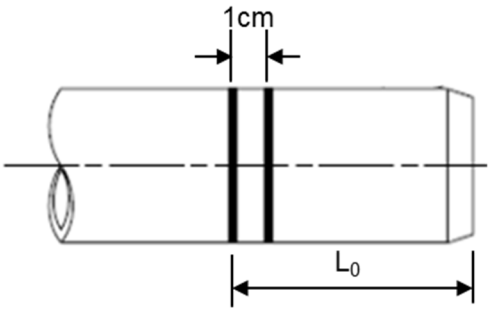
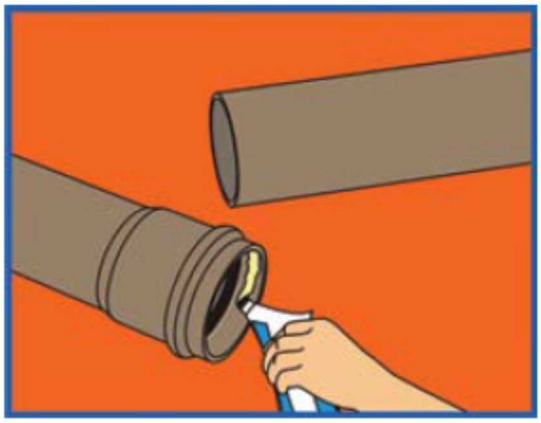


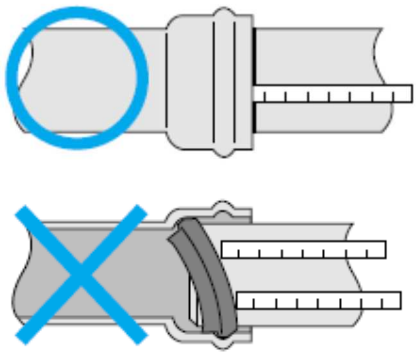
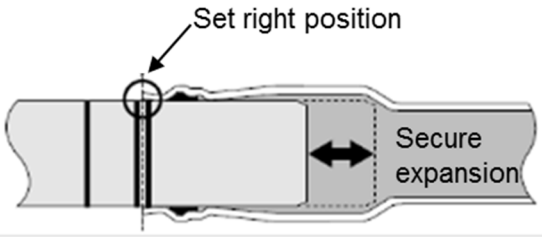
Fig 3.3.1. Joining of PVC Pipes

The total length of one PVC pipe is 6.0m, but the effective length (EL) excluding the socket is as follows.

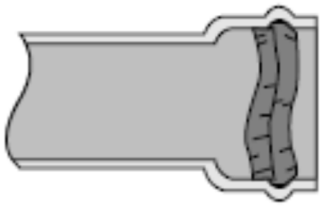
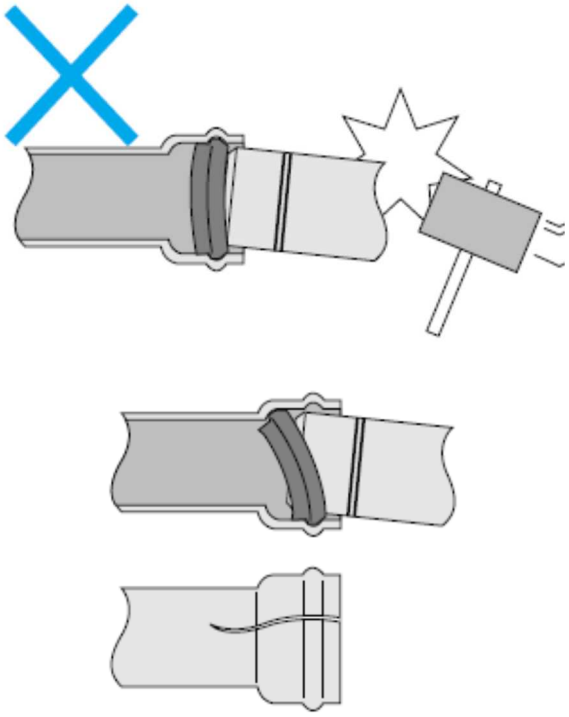
Table3.3.1. Effective Length of PVC Pipe

Nominal Diameter (DN)	External Diameter (DE)	Socket Length (B)	Effective Length	
			(EL)	Minimum in standard NBR
50	60 mm	77 mm	5,923 m	5,88 m
75	80 mm	107 mm	5,893 m	5,85 m
100	110 mm	128 mm	5,872 m	5,83 m

	Work Instruction	Photos
1	1) The depth of the socket is as shown in Table3.3.1, but before inserting the pipe, confirm the depth of the socket. 2) Drow a line with a marker at a position of a predetermined depth from the pipe end of the socket. 3) With this line, it is easy to check whether the pipe is inserted to correct position.	
	4) It is recomended to write two marks at intervals of 1 cm as shown on the right. 5) "L_0" is the depth of the socket and the other line is written 1cm inside it. 6) When inserting, insert so that the pipe end of the socket will come to the middle of these lines. 7) If insert the pipe to the end of socket, the pipe may be damaged when the pipe moves due to water pressure.	
2	8) Lubricate evenly in the circumferential direction of the inner rubber portion of the socket and then the outer surface of the pipe-end. 9) In the case of a pipe-end, lubricate the entire circumference from end to line.	

	Work Instruction	Photos
3	10) Align the pipe, and then push it in the socket and join. ※ If there is no dedicated tool, push the pipe with the force of the lever by the crowbar. ※ In this case, be sure to use wood as a cushoning. ※ After aligning the pipes, it is easy to insert the pipe by pushing the bar at a stretch.	
4	11) After insertion, use a check gauge to check whether the pipe is evenly in the socket.	
	※ If pipe is correctly inserted, the value of the gauge is the same regardless of where the circumference is measured. ※ When the value of the gauge is different, there is a possibility that the rubber is displaced inside the socket.	
5	※ Make sure that the end of the socket is between the marking lines.	

【Case of Trouble】

	Trouble	Photo
1	1) Forced insertion without pipe chamfering. ※ Rubber ring caught and it got detached, leakage occurred.	
2	2) Dedicated lubricant was not used. ※ Because of using soap, grease, oil, etc., the rubber ring deteriorated, leakage occurred.	
3	3) Forced insertion with a hammer or the like. ※ Water leakage occurred due to separation of the rubber rings or cracks in the pipe.	

3.4. Notes on Joining

a. For the joint, select a place where there is no scratch on the pipe as much as possible.

Polyethylene pipes tend to scratch the surface, so if there are scratches, the durability against external forces falls. Therefore, when a scratch is found at the time of cutting, select a part without scratches and cut it again.

b. Cut polyethylene pipe perpendicular to the pipe axis. When determining the dimensions, confirm the length from the socket of the fitting joint, draw a line with a marker beforehand in the cutting place.

c. If mud adheres to the pipe surface of the joint part, it scratches the rubber ling of the joint part and the pipe surface. Since this scratch leads to future leakage, be sure to wipe the surface of the connection part with waste.

d. When joining with steel pipes, meters, valves etc., join the joint them first. If the polyethylene pipe and the joint are first joined, the polyethylene pipe will be twisted when screwed into the joint and the steel pipe.

e. Since the internal parts (color, rubber ring) of the union coupling for the polyethylene pipe used for construction once cannot be reused, it must be replaced with new parts.

4. Laying Method

4.1 Laying method of polyethylene pipe

a. For backfilling around the polyethylene pipe, you must use sand or screened good quality soil. In particular, it is necessary to exclude stones, concrete pieces, brick pieces and other stiff substances having a size of 2mm or more.

b. The excavation width of the ditch ensures the outer diameter of the pipe plus 30 to 70cm; the work can be carried out efficiently.

c. The burial depth is preferably 120cm in the case of a roadway. However, it must be adjusted according to the existing pipe laying conditions. Since it is necessary to lay sand on the bottom of the pipe, the excavation depth should be "earth cover plus tube outside diameter plus 10 to 15cm".

d. The bottom of the ditch should flatten well and be solidified. After that, sand and good quality soil is spread 10 to 15cm, and flattened.

e. Be sure to make a flat floor with sand or soil before laying down the polyethylene pipe.

   When sand is dumped after laying polyethylene pipe, sand does not sufficiently reach the bottom of the pipe, and compaction cannot be sufficiently compacted.

f. It is desirable that the polyethylene pipe is buried as tortuous as possible in the ditch.

g. Fill back 10-15cm each time with sand or good quality soil; tamp it firmly on the pipe and thrust. When the upper part of the pipe is covered with sand or high quality soil by 10cm or more fill it with excavated soil in 10 to 15cm each and fill it back.

h. When using a vibrating compactor, use it after the soil covering depth at the top of the pipe becomes 50cm or more. Using a compactor in a shallow cover of the pipe may damage pipes and fittings.

Explanation 1

When the surface of the buried polyethylene pipe is hit by pieces of stone, concrete, wood chips, etc., a very large force locally acts. As a result, a crack of the pipe occurs, causing water leakage.

Of particular importance is the material used for back filling around the pipe. It is important to use sand that does not contain stone or brick fragments larger than 2mm in size, or that is well screened.

Explanation 2

①Excavation Section

For the width of the excavation ditch, the pipe diameter plus 30 to 70cm is standard. When joining work in the ditch, when replacing the pipe, it is necessary to secure the necessary width and length.

②Finish of ditch bottom

Remove the stone from the groove bottom and the side and flatten it. If irregularities cannot be avoided by rocks, etc., fill up sand or good quality soil and make it flat.

③Sand bed

Finish the ditch floor by sand or well-screened good quality soil on a leveled ditch bottom with a thickness of 10 to 15cm. Failure to do this work is troublesome, because a local external force acts on a part of the polyethylene pipe, leading to breakage of the pipe.

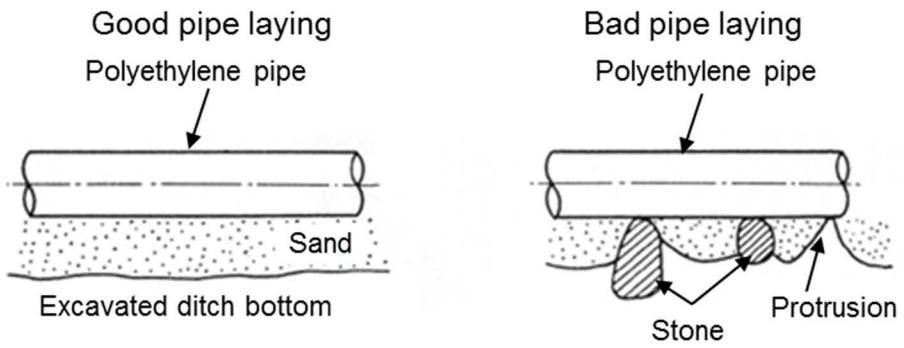


Fig4.4.1 Protection of pipe bottom

Explanation 3

④Pipe laying

When pulling the polyethylene pipe in the groove, do it by hand as much as possible.

If the ditch is deep, a person stands inside and outside the ditch and hands down.

In the case of a long and coiled tube, place it in a ditch so that straiten its curls and meanders it.

Do not drag when carrying the pipe.

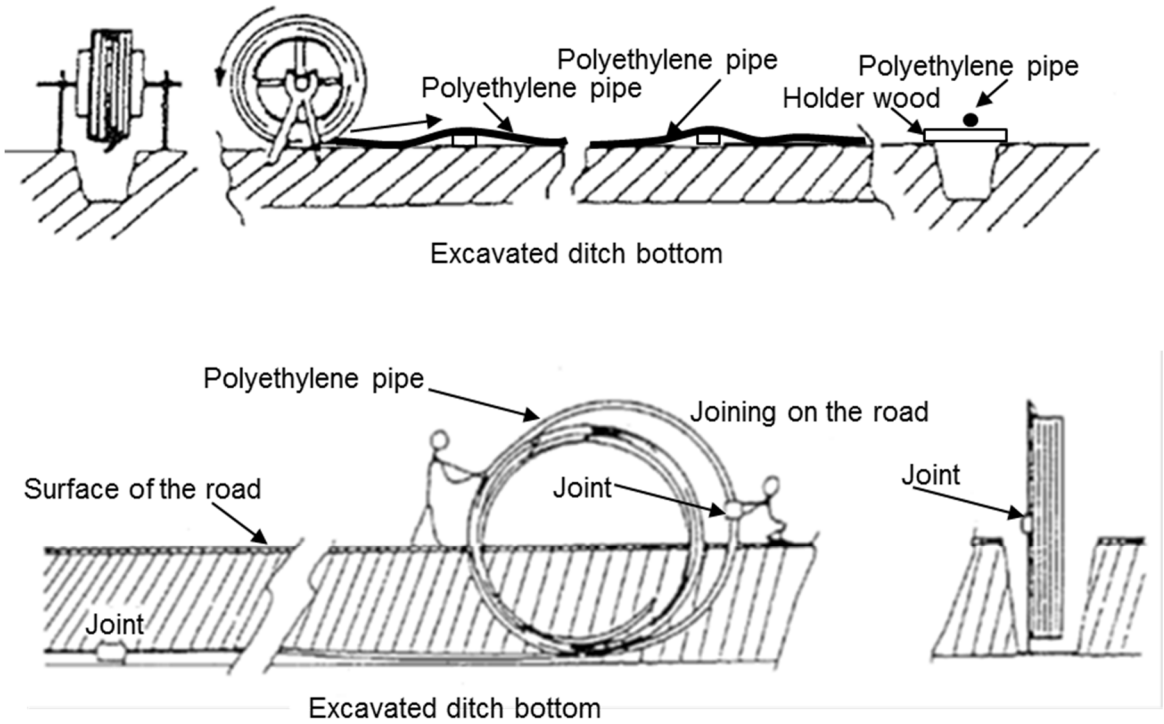


Fig4.1.2. How to handle rolled polyethylene pipe

Explanation 4

⑤Backfilling of pipe

For backfilling, use sand or good quality soil.

Use soil that has been screened so that stones and brick fragments larger than 2mm in size do not get mixed in.

Clayed soil that was excavated once, the soil particles are disturbed and cannot be compacted enough, so it should not be used for the road part.

For backfilling, set the depth to about 10 to 15cm every time, tamp it well and move to the next layer backfill.

The first tamping is particularly important for backfilling. If the surrounding and the bottom of the pipe are not sufficiently filled back, the pipe breaks again as time passes.

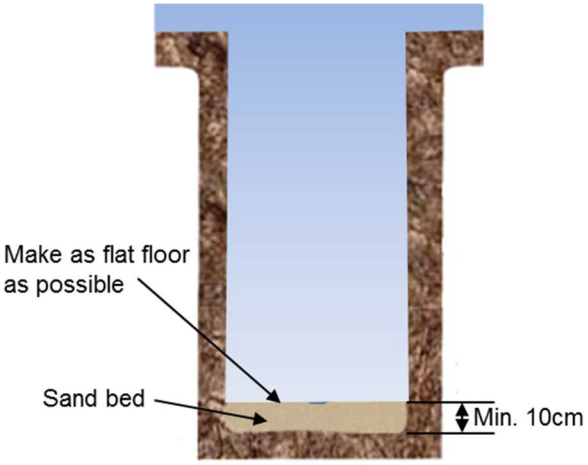
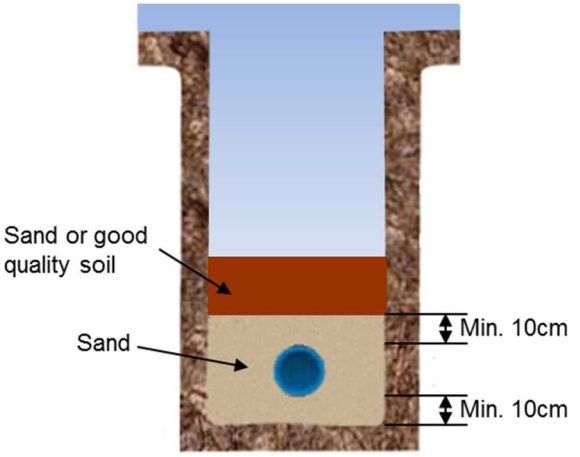
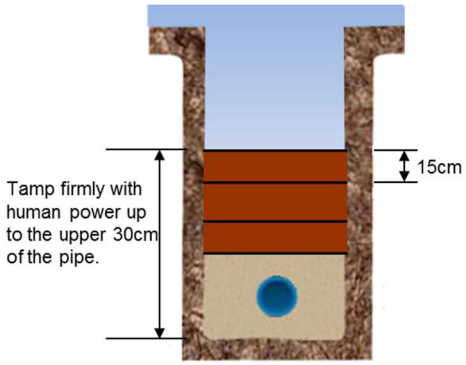
For adjustment of the height difference, do not bite stones or wooden pieces at the bottom of the pipe.

To adjust the difference in elevation, use materials that come into contact with the pipe on a large surface such as a thick plate, square material, etc. Remove it promptly after adjustment and pack the sand sufficiently.

Before reaching the upper 30 cm of the pipe, fill with human power using sand or good quality soil. In doing so, be careful not to scratch the surface of the pipe.

Outside the road part, from the soil covering 30 cm to the surface of the earth, the soil generated at the site may be used, but solids such as stones and rocks of 10 cm or more must be removed.

If soil can cover 60cm or more of the pipe, it can be compacted by the compactor

	Work Instruction	Photos
1	1) The bottom of the ditch should flatten well and be tamped. After that, sand is spread 10 to 15cm, and flattened. ※ Be sure to make a flat floor with sand or soil before laying down the polyethylene pipe. ※ When sand or soil is backfilled after laying polyethylene pipe, sand or soil does not sufficiently reach the lower part of the pipe and tamping cannot be sufficient.	
2	2) Tamp tightly with sand up to 10cm above the top of the pipe. ※ The first tamping is particularly important for backfilling. If the surrounding and the bottom of the pipe are not sufficiently filled back, the pipe breaks again as time passes. 3) After that, fill it with sand or good quality soil with 10 to 15cm tall and backfill. However, do not use soil containing stones, rocks, concrete blocks, etc.	
3	4) Be sure to backfill with human power until you reach the top 30 cm of the pipe. 5) Afterwards it is able to tamp with tamping mahine.	

Explanation 5

⑥Protection of pipe

In the case of being installed in parallel with or crossing the existing pipe, it is desirable to take a space of 30cm or more.

If it is not able to avoid distance of 30cm or more, protect the polyethylene pipe with a sheath tube.

A sheath tube is a PVC pipe or a steel pipe having a large diameter enough to cover the outside of the pipe to be protected, and it is a thing that put outside and protects a pipe.

The length of the sheath tube should be more than 30cm each at both ends more than other buried objects.

Place a polyethylene pipe of the same diameter on both ends of the sheath tube so that it does not come into direct contact with the sheath tube and the pipe to be protected.

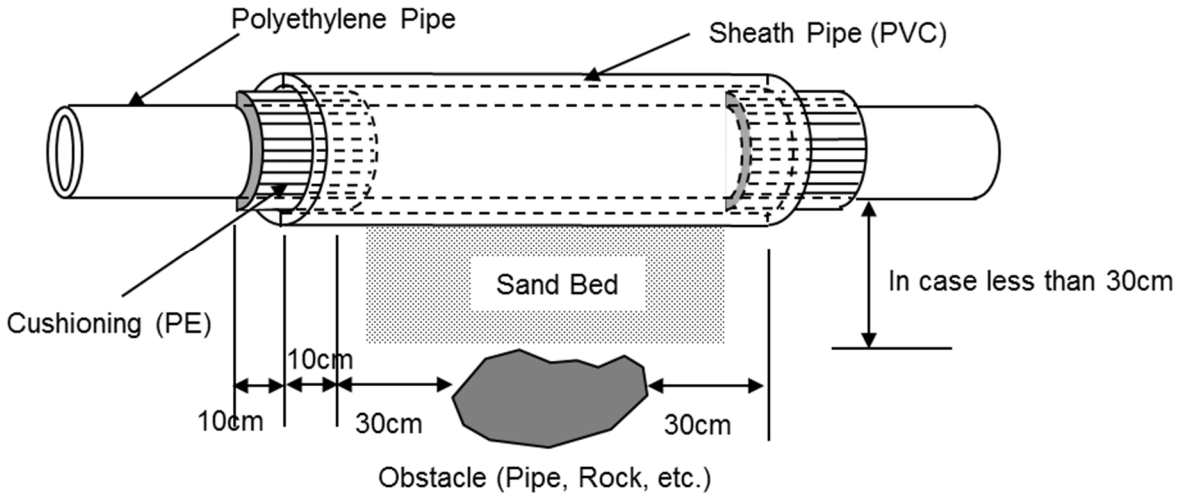


Fig4.1.3. Protection method ofthe pipe near obstacle

Table4.1.1. Relation between PE Pipe and Sheath Tube (PVC)

Polyrthylene Pipe (PE)	Sheath Tube (PVC)	
Outer Diameter (mm)	Nominal Diameter	Inside Diameter (mm)
40	50	54.6
50	75	77.2
63	100	100.5
110	-	-

4.2 Laying method of PVC pipe

The method of laying pipes is the same as that of polyethylene pipes, and careful laying must be done so as not to receive shocks.

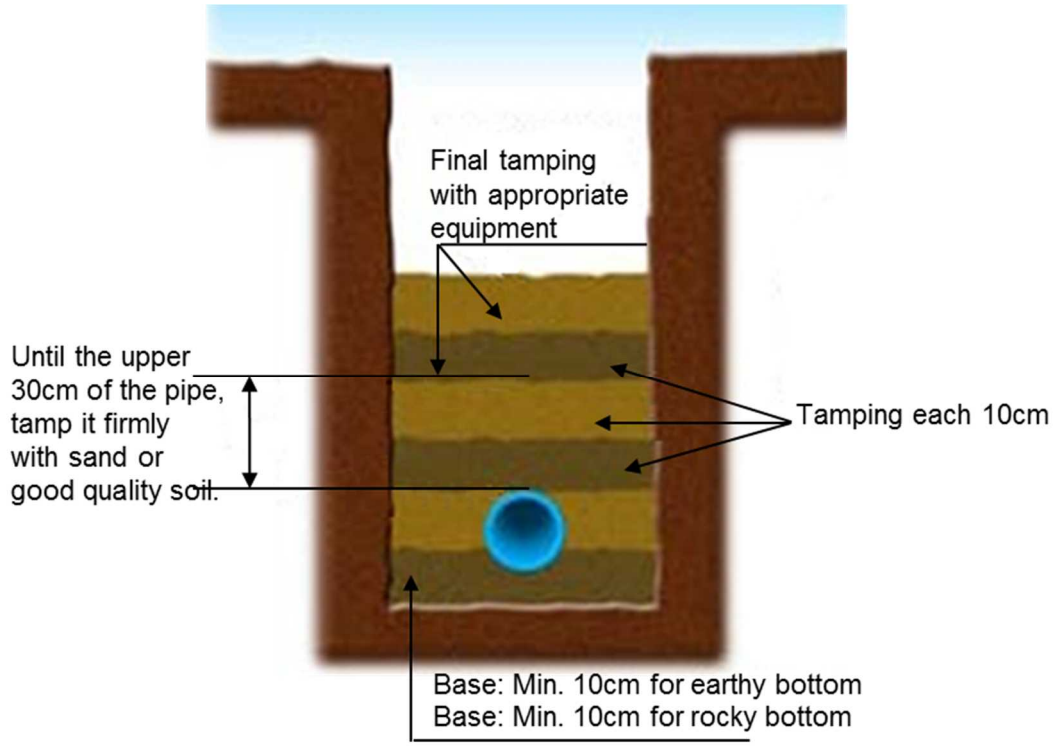


Fig4.2.1. Section of PVC pipe laying

In the case of laying the pipe in the road, if the laying depth is less than 80cm, the circumference of the pipe shall be protected in a special way.

Option 1: Surround the pipe with sand and solidify it around by reinforced concrete.

Option 2: Surround the pipe with sand and lay a reinforced concrete plate on top of it.

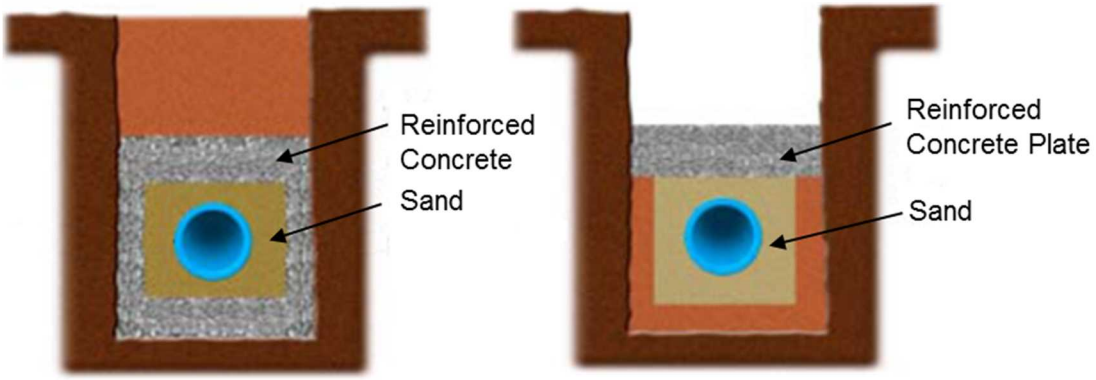


Fig4.2.2. Protetion methods of PVC pipe

4.3 Protection of PVC pipe fittings

In the socket type joint using the rubber ring, when the internal water pressure increases, a force tending to deviate in the axial direction of the pipe occurs. This force is called "thrust load", which increases in proportion to the size of the tube external sectional area.

Therefore, it is necessary to protect by the concrete block at the joint part, the pipe end part, the branch part, the bent part, the part where the bore changes, in order to prevent the movement due to the thrust load.

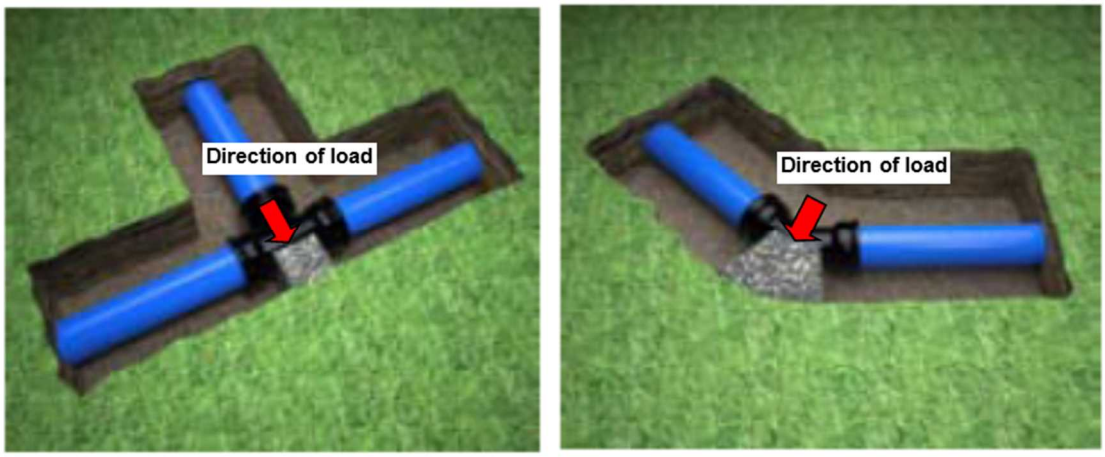


Fig4.4.1. Direction of load

5. Inverted Siphon

a. When polyethylene pipe is to be passed under the river, take as far as possible as far as possible from each other, and lay it by protecting with a sheath tube.

b. The piping slope before and after the inverted siphon is set to 45° or less, and it is constructed so that the polyethylene pipe is bent and raised. Since the bent portion is easily damaged, the foundation and protection must be adequately provided

Explanation 1

The use of a polyethylene pipe in an inverted siphon is safe because there is no joint and no fear of pulling -off.

Because the external force is easy to act on the rising part, it is necessary to apply the foundation and protection sufficiently, it is desirable to apply it with a gentle slope of 45 ° or less.

6. Pipe bending

6.1. Bending of polyethylene pipe

a. Since polyethylene pipes are made very flexible, they can be bent unless they have excessive radius of curvature. For example, in the case of PN 16 DN63 mm pipe, if the amount of displacement is L = 180 to 200cm per 5 m straight pipe, the pipe body will not be affected.

Table6.1.1. Allowable angle of bending by 5m long

Diameter	50mm	75mm	100mm	150mm	200mm
Angle(θ)	55°	40°	30°	20°	15°
Distance(L)	220cm	170cm	125cm	90cm	60cm

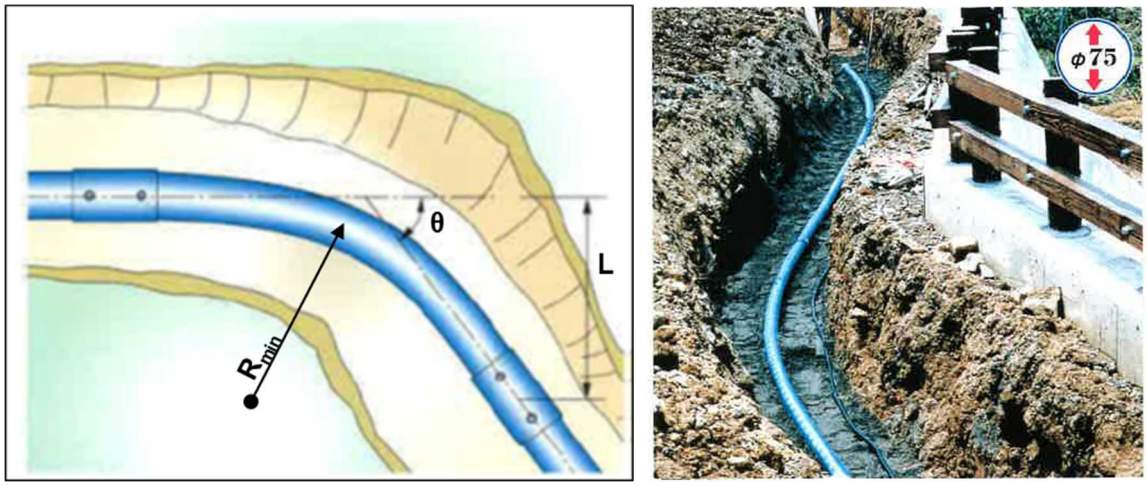


Fig6.1.1 Allowable bending

This allowable displacement can also be indicated by the bending radius, which is roughly 20 times the outer diameter.

In this case, the standard minimum bending radius (Rmin) is as follows:

Table 6.1.2. Minimum bending radius

Diameter	13mm	20mm	25mm	30mm	40mm	50mm
Minimum Bending Radius (R_{min})	45cm	55cm	70cm	85cm	100cm	120cm

b. When laying the bent part, sufficiently tamp the surround of the pipe with backfilling sand or soil so that the pipe is fixed in the center of the ditch.

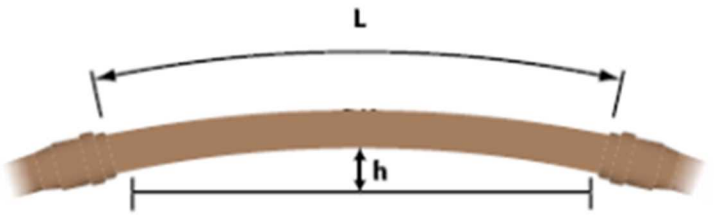
Explanation 1

The polyethylene pipe has very high flexibility, so it can be laid while bending. However, if it is bent beyond the limit, the pipe becomes flattened, not only the flow rate decreases, but also the life of the pipe decreases.

It is absolutely to avoid bending by directly applying a flame using a burner or the like.

6.2. Bending of PVC pipe

Although bending of PVC pipes is not allowed in principle, some bending pipe can be performed depending on the construction conditions of the site. In this case, the allowable bending distance is as follows.



DN	h (cm)
50	16
75	13
100	10

Fig6.2.1. Allowable radius of bend

7. Branch from existing pipe

At branching of the service pipe, a branch is made by using a branch saddle. Also, dedicated tool should be used for tapping. Note that the branch tapping saddle shown in the figure below is easy to tap because it has a built-in blade for tapping.

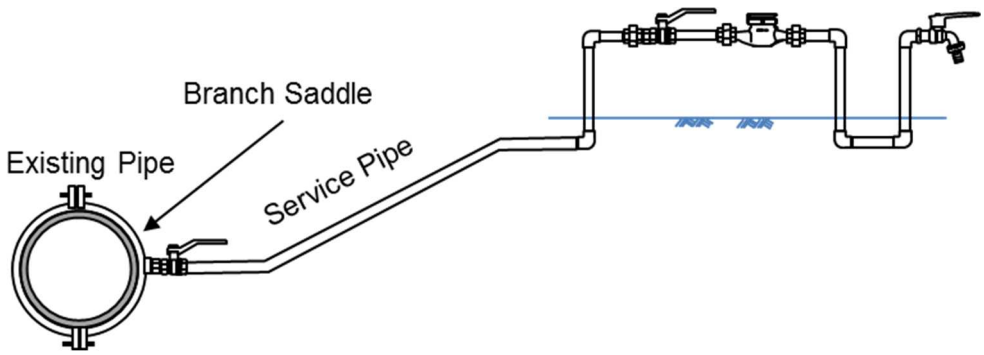


Fig 7.1.1 Example layout of branch

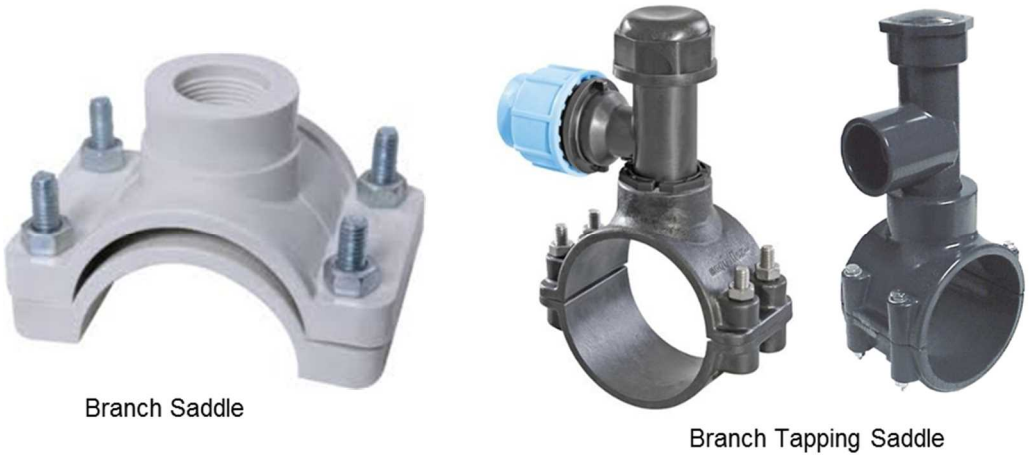


Fig 7.1.2 Branch saddle

8. Repair of existing polyethylene pipe

8.1. When the scratch is small and shallow

In this case, protect the scratched part with a repair band.

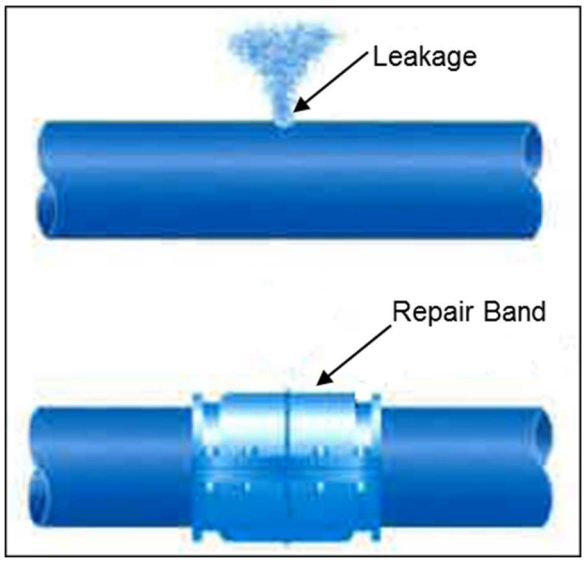


Fig8.1.1 Method for repairing minor leakage

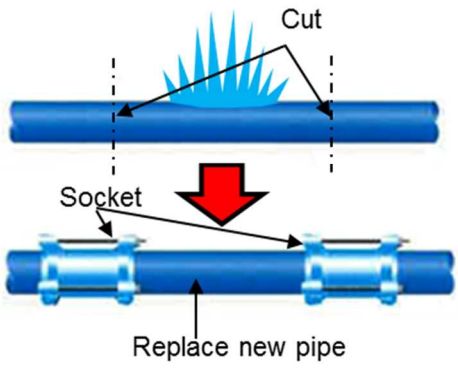
Table8.1.1. Criteria for repair method

Extent of scratch	Extent of judgment	Repair method
Small, shallow	1/4 or less of the circumference or Axial scratches are less than diameter length	Repair band
Big, deep	1/4 or more of circumference or Axial scratches are larger than diameter length	Exchange for new pipe

Fig8.1.2 Plastic repair ban

8.2. When the scratch is relatively deep

In the case where the scratch is deep or wide, the stress from the inside is locally generated by the water pressure from the inside, and it may burst. Cut the pipe with a length of 20cm or more including the scratch part, replace with a new pipe using 2 sockets.



Before inserting the pipe, draw a line with magic at 8 cm from the end of the tube and 9 cm. (In the case of DN = 50 mm) With these lines, it is easy to check whether both pipes are neatly in the vicinity of the center.

9. Squeeze off method

9.1. About squeeze off method

This method is an urgent procedure for water leakage and extension of pipeline, etc., when there is no valve for stopping water in the polyethylene pipeline and flowing water can not be stopped.

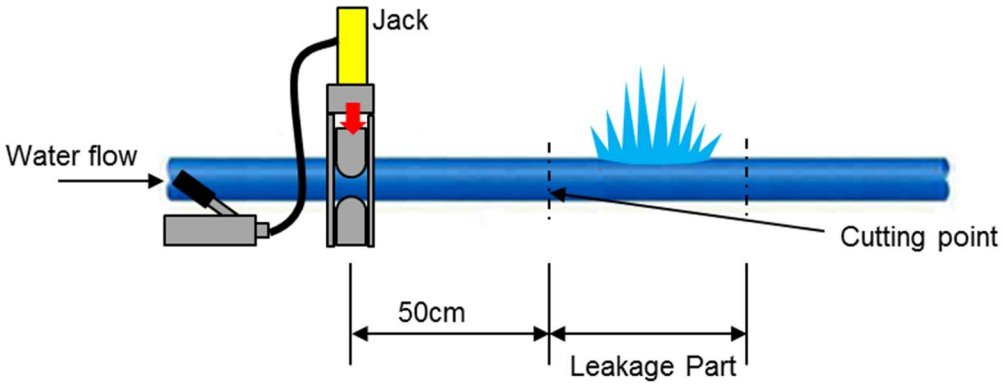


Fig9.1.1. Outline of squeeze-off construction method

In order to clamp the polyethylene pipe, the following designate compressor is used.

Fig9.1.2. Designate compressor for squeeze method

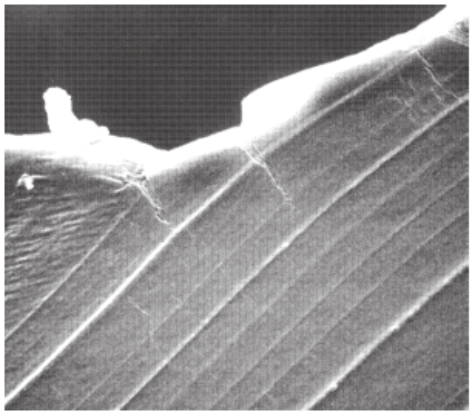
9.2. Post-compression treatment

The pipe after release of compression gradually returns to its original shape due to internal pressure, but it is desirable to correct it so that it is close to a circle if possible by the following equipment.

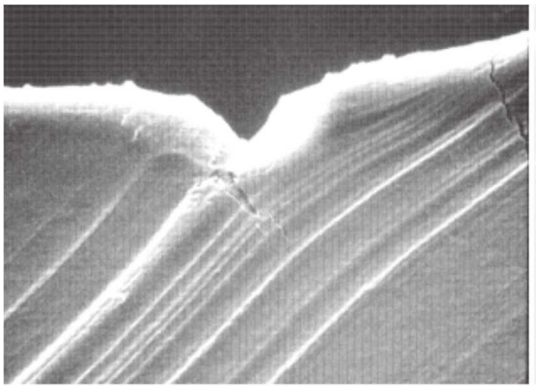
Even if the pipe is compressed as slowly as possible, a very small invisible crack is generated in the compressed part, and if it is used for a long period of time, there is a fear that the tube will be damaged.

The pictures of the most compressed parts viewed under a microscope are as follows. Very small cracks are generated on the inner surface side of the pipe. This crack appears only on the inner surface side of the pipe, and water leakage does not occur even through water in this state.

Section of the compression part 1



Section of the compression part 2



Reinforcement with repair band

Start compression

Condition after compression

Enlarged view of the compression part

Reforming of flattened part

Reference-3 Safety Management

1. Prior consultation with concerned authorities

Fig.1 MINFR

Fig.2 RTDA

Fig.3 REG

Fig.4 National Police

Before start the construction work, it is necessary to consult with concerned authorities such as MNINFR, RTDA, REG, and Traffic Police etc. about sharing information, planning, collaboration and supporting.

2. Public announcement (Customer satisfaction)

Fig.5 RTV

Fig.6 SNS

Fig.7 Radio broadcasting

When the construction work is planning, it is necessary to announce the working schedule, working outline and water suspension schedule using mass media (in case of big construction work), SNS and WASAC web site, and also it is necessary announcement by meter readers for local area.

Public announcement at a branch office

Fig.8 Emergency communication system at Remera branch office

Fig.8 shows the emergency communication system noted at Remera branch office. It is very important the notice and it is recommendable at every branch office.

3. Confirmation of the obstacle matters

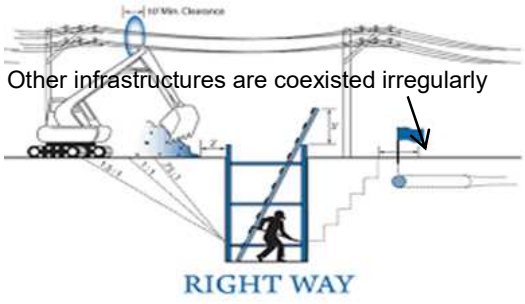


Fig.9 Important point 1

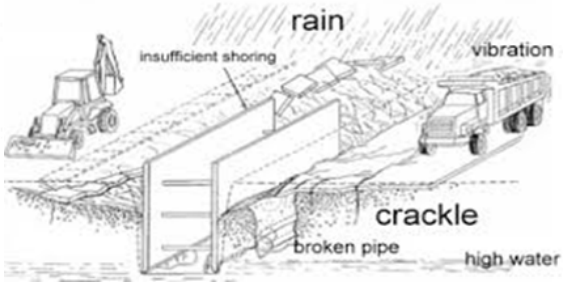


Fig.10 Important point 2

It is very important to take attention to obstacle matters such as power cables, telecommunication cables and so on. It is necessary to confirm working duration, protection methods, and emergency organization with related authorities.

4. Identify the working area

It is very important to avoid disasters of all party concerned with the work and third party, so it is necessary to identify the working area and to protect the working area from third party by net, tape and sign boards for restriction to enter (e.g. “No Entry”, “Keep Out” etc.).

5. Protect workers and third party against accidents

Fig.11 Sign Board

Fig.12 Attention Tape

Fig.13 Sign

Fig.14 Protection Net

Protect workers and third party against accidents using net, tapes, and sign board etc.

It is very useful to take a Tool-Box Meeting as a safety meeting.

Tool-Box Meeting (TBM):

TBM is a task that talks about the content of the day's work, methods, setups and problems in a short time, and instructs instruction, centering on the employee's head. The TBM is done not only before starting work but also during work and workplace meeting according to progress of work.

Fig.15 Scenery of TBM

Fig.16 Samples of sign

6. Soil Handling

6.1 Soil Wall Collapse

Fig.17 Soil wall collapse

Trenching and excavation procedures are performed through the piping work, it should be taken care about injurer in trenching accidents.

6.2 Protection against Wall Collapse

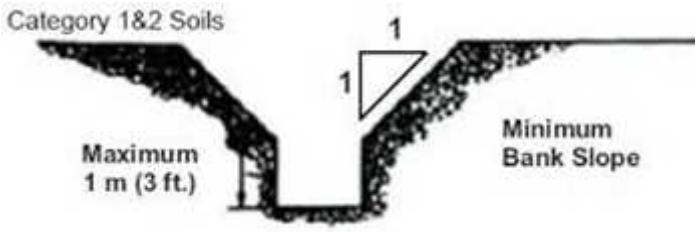


Fig.18 Shape of Open Cut Trench

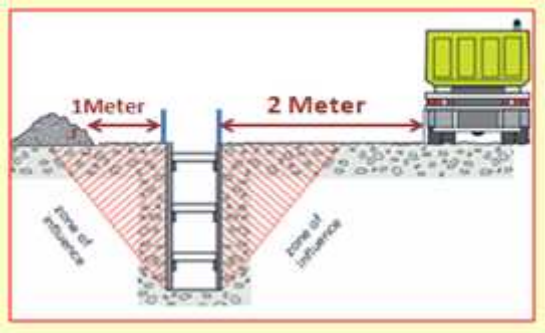


Fig.19 Avoid Heaving (cohesive soil)

Open Cut Trench: (source http://www.hsewebsite.com/excavation/)

Category 1 – Cohesive soils of firm to stiff consistency that are fissured (Category 1b) or unfissured (Category 1a). These soils are generally of medium to high plasticity but may also include glacial clay tills of low to medium plasticity. These

soils usually have low moisture content and most often occur above the water table.

Category 2 – Cohesive soils of soft consistency and non cohesive silt soils. The cohesive soils can be of medium to high plasticity while the silt soils are of non to low plasticity. These soils typically have high moisture contents and will tend to fill voids left between the excavation walls and shoring.

When excavate the open cut trench in low to medium plasticity soil, the shape of trench should be followed as Fig.18.

Heaving: (source https://serveforsafety.com/excavation-safety/)

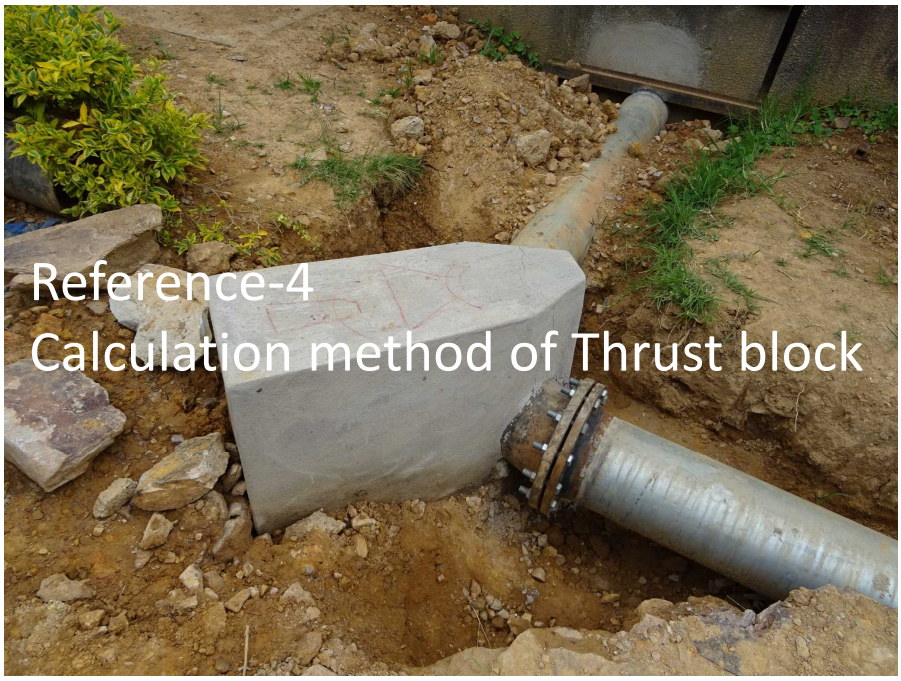
When excavate a trench in cohesive soil, following matters should be done to avoid heaving.

- Dump excavated earth/Soil min. 1 M away from the lip of trench/excavation.
- Don't allow vehicle movement at least 2 M from the edge of excavation/trench.

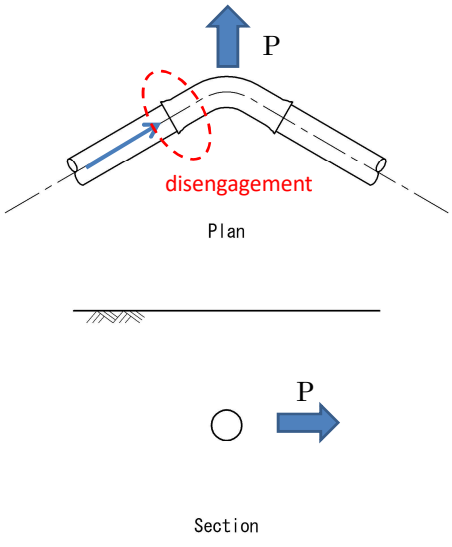
Fig.20 Soil Retaining Wall 1

Fig.21 Soil Retaining Wall 2

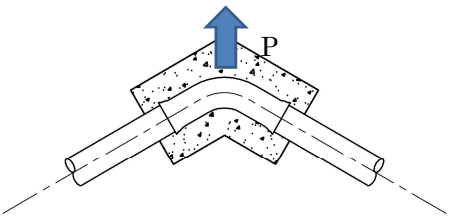
Cross-trench bracing is used in utility trench excavations for prevention of soil wall collapse. It is available to use wooden piles and timber plates.



Reference-4
Calculation method of Thrust block



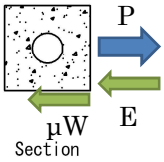
P: Thrust Force of Bending Point
(force of outside direction)



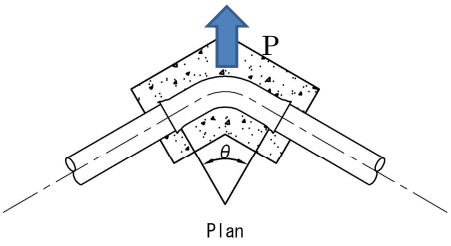
P: Thrust Force of Bending Point (force of outside direction)

E: Passive Earth Resistance Force of Back of Concrete

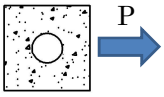
μW: Friction Resistance Force within Bottom of Soil

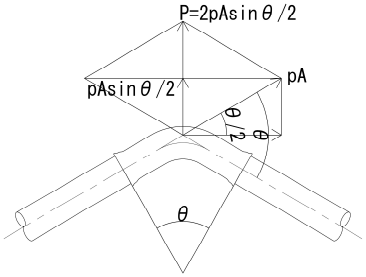


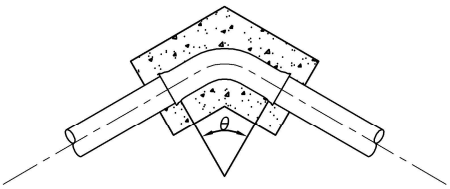
$$P < \mu W + E$$



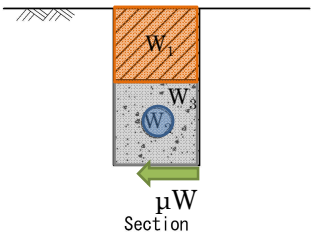
$$P = 2pA \times \sin\theta/2$$







Plan



Section

$$\mu W=\mu(W_1+W_2+W_3)$$

W:Total Wight against Bottom of Concrete

W_1:Load from Soil

W_2:Load from Water and Pipe

W_3:Load from Concrete

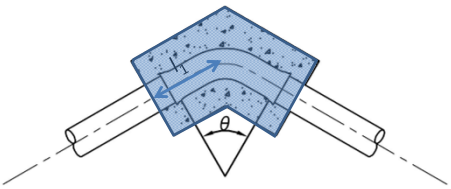
μ:Coefficient of Frictional Resistance within Concrete and Soil

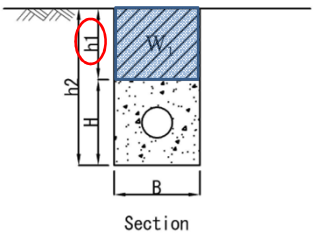
μ:Coefficient of Frictional Resistance within Concrete and Soil

Coefficient of Frictional Resistance within Concrete and Soil

Type of the soil	Coefficient of Frictional	Type of the soil	Coefficient of Frictional
Compaction	0.50	Gravel	0.60
Soil of muddy	0.33	Clay	0.20～0.50
Small Cobble stone	0.60	Dry sand	0.50
Cobble stone	0.50	Norumal sand or wet sand	0.20～0.33

【Reference:The Design Criteria for Water Supply Facilities 2012 P509 Table-7.7.1】





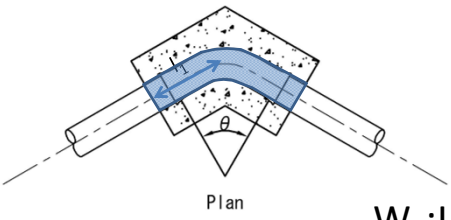
W_1:Load from Soil

$$W_1 = 2 \times l_1 \times B \times h_1 \times \gamma s$$

γs: Unit Weight of Soil

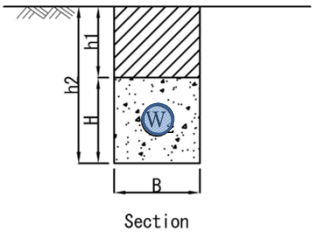
Unit Weight of Soil

Type	Condition	Unit weight
Norumal sand	Dry	14.0
	Including the water	16.0
Sand	Dry	16.0
	Including the water	18.0
Clay mingling sand	Dry	20.0
	Including the water	15.0
	saturated with water	19.0
Clay	Dry	16.0
	Including the water	20.0
	saturated with water	-
Silt		17.0



Plan

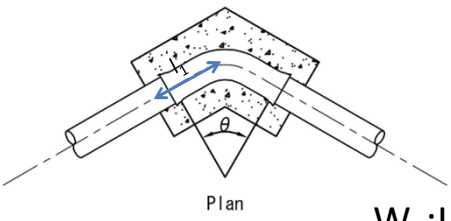
W_2:Load from Water and Pipe



Section

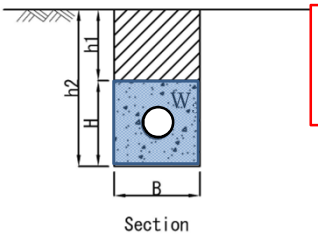
$$W_2 = Wp + \pi/4 \times D^2 \times 2 \times l_1 \times \gamma w$$

Wp:Weight of Pipe
γw: Unit weight of Water



Plan

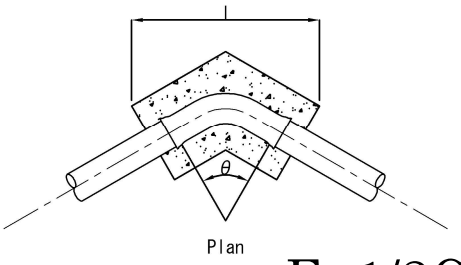
W_3:Load from Concrete



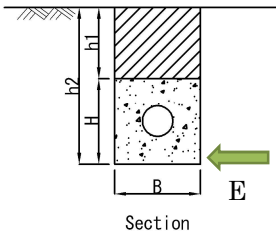
Section

$$W_3 = \{2 \times l_1 (B \times H - \pi/4 \times D_2^2)\} \times \gamma c$$

D_2:External Diameter
γc: Unit weight of Concrete



$$E=1/2Ce\times r\times(h_2^2-h_1^2)\times l$$

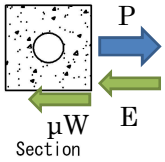


Ce:Coefficient of Passive Earth Resistance Force
r:Unit Weight of Soil(kN/m^3)
l:Length of Projection of back of Concrete (m)

Ce=tan2(45° +Φ/2)
Φ: Internal Friction Angle of Soil(°)

Internal Friction Angle

Type	Condition	Internal friction
Norumal sand	Dry	30～40
	Including the water	45
Sand	Dry	30～35
	Including the water	40
Clay mingling sand	Dry	20～25
	Including the water	40～45
	saturated with water	20～25
Clay	Dry	40～45
	Including the water	20～25
	saturated with water	14～20
Silt		10～20

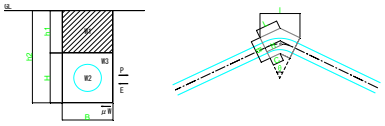


R:Total Resistance Force of Thrust Block

R=μW+E

Sr=R/P＞1.5 (JAPAN STANDARD)

Sr:Safety Rate



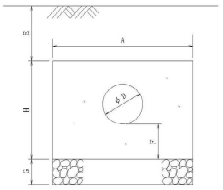
	Unit	PN40				
Bent:θ	°	90.00	45.00	22.50	11.25	2.50
Nominal Diameter :D	m	0.600	0.600	0.600	0.600	0.600
External Diameter:D2	m	0.635	0.635	0.635	0.635	0.635
Dpath of Pipe Head from ground	m	1.00	1.00	1.00	1.00	1.00
Internal Pressure:p	kN/m2	4000	4000	4000	4000	4000
Coefficient of Frictional Resistance within Concrete and Soil:μ		0.50	0.50	0.50	0.50	0.50
Unit Weight of Soil:γs	kN/m3	16.00	16.00	16.00	16.00	16.00
Internal Friction Angle of Soil:φ	°	30.00	30.00	30.00	30.00	30.00
Unit weight of Water:γw	kN/m3	9.80	9.80	9.80	9.80	9.80
Unit Weight of Pipe	kN/m	1.67	1.67	1.67	1.67	1.67
Unit Weight of Concrete:γc	kN/m3	23.00	23.00	23.00	23.00	23.00
B	m	2.70	2.70	1.20	1.20	1.20
H	m	3.50	2.30	2.00	1.20	1.20
H1	m	2.20	2.20	2.40	1.90	0.50
L	m	3.55	2.76	2.52	1.96	0.51
h1	m	0.80	0.80	0.32	0.72	0.72
h2	m	4.30	3.10	2.32	1.92	1.92
C	m	0.85	1.64	2.28	1.84	0.49
Friction Resistance Force within Bottom of Pipe and Soil μW=μ*W		547.94	383.99	140.39	83.78	22.05
Passive Earth Resistance Force of Back of Concrete E=1/2*C*γs*tan^(θ/2+π/4)*h1^2*θ1		2150.76	1097.57	626.23	296.47	78.00
Thrust Force of Bending Point (force of outside direction) P=2*π*A*SIN(θ/2)	kN	1791.48	969.54	494.27	248.33	55.27
Cross Section Area of Pipe A=D2^2*π/4	m2	0.32	0.32	0.32	0.32	0.32
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	1095.88	767.99	280.79	167.57	44.10
Load from Soil W1=2*11*B*γs*h1	kN	152.06	152.06	29.49	52.53	13.82
Load from Water and Pipe W2=(Ww+π/4*D^2*2*l)*γw)	kN	19.52	19.52	21.30	16.86	4.44
Load from Concrete W3=2*11*B*H-π/4*D^2)*γc	kN	924.29	596.40	230.00	98.18	25.84
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	5.02	5.10	4.94	3.90	1.03
Coefficient of Passive Earth Resistance Force C=TAN(45+θ/2)^2		3.00	3.00	3.00	3.00	3.00
Unit Weight of Pipe Ww=Unit Weight of Pipe*11*2	t	7.33	7.33	8.00	6.33	1.67
Total Resistance Force of Thrust Block R=μW+E	kN	2698.70	1481.56	766.63	380.26	100.05
Safety Rate Sf=R/P		1.51	1.53	1.55	1.53	1.81
More than Safty Tate x 1.5 is OK		OK	OK	OK	OK	OK
Bearing Force of Ground for Supporting Thrust block σ=W/B*11	kN/m2	92.25	64.65	48.75	36.75	36.75
Volume of Thrust Block	m3	41.58	27.32	11.52	5.47	1.44
Volume of Pipe (deduction)	m3	1.39	1.39	1.52	1.20	0.32
Volume of Concrete	m3	40.19	25.93	10.00	4.27	1.12
Aggregate (t=20cm)	m3	2.38	2.38	1.15	0.91	0.24
Formwork	m2	49.07	32.03	23.37	11.37	4.65

参　考　図

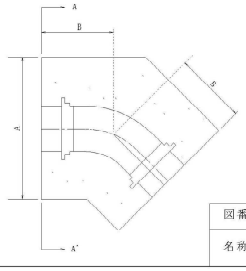
材　料　及　び　寸　法　表

呼び径 D mm	管頂土被り m	設計水圧 MPa	A m	B m	H m	E m	F m	G m	一体化拘束長 m	Co打設量 m²	型枠面積 m²	砕石 m²
300	0.80	1.30	0.85	1.40	0.70	0.61	0.19	0.15		1.44	5.11	0.36
			0.85	0.40	0.70	0.61	0.19		6.00	0.41	2.31	0.10
400	1.50		0.95	0.40	1.90	1.00	0.97			1.33	6.65	0.11
500			1.05	0.60	2.00	1.00	0.97			2.26	9.00	0.19
600			1.15	0.80	2.15	1.00	1.02			3.46	11.83	0.28
			1.15	0.20	1.05	1.29	0.21		6.00	0.36	3.26	0.07
700			1.30	1.05	2.25	1.00	1.02			5.26	15.30	0.41
			1.10	0.30	1.20	1.27	0.23		6.00	0.54	4.08	0.10
300	0.80	1.00	0.85	0.65	1.05	0.50	0.43	0.15		1.05	4.52	0.17
400	1.50		0.95	0.40	1.55	1.00	0.62			1.06	5.43	0.11
500			1.05	0.60	1.70	1.00	0.67			1.88	7.65	0.19
600			1.15	0.80	1.80	1.00	0.67			2.81	9.90	0.28
700			1.30	1.05	1.85	1.00	0.62			4.16	12.58	0.41

A-A'　断面図



平　面　図



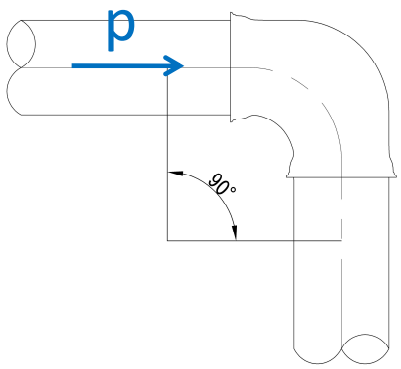
図番	2－3	平成	18
名称	曲管防護コンクリート工図（45° HB）		

Exercise of Calculatio

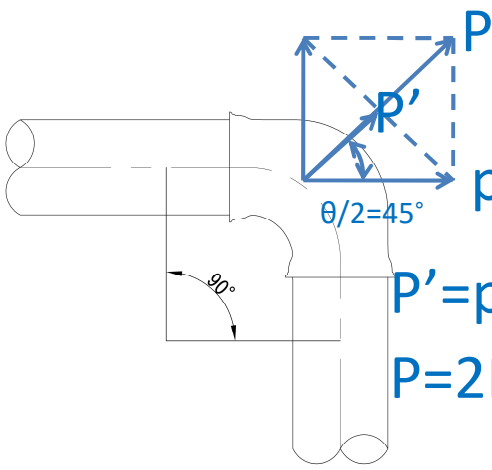
Thrust Block

Exercise(Thrust Force)

How does thrust power occur?



Answer (Thrust Force)



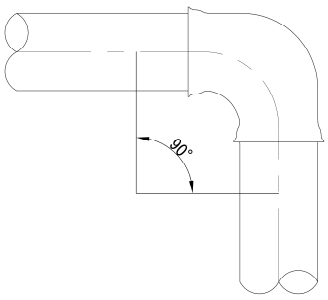
$P' = pA\sin\theta/2$

$P = 2P' = 2pA\sin\theta/2$

Exercise (Calculaition)

Basic data

Pipe Material: DIP
Pipe Nominal Diameter: 600mm
Pipe External Diameter: 630.8mm
Pipe Weight of pipe: 1.23
Bent: 90˚
Internal Pressure: PN16 (1,600 kN/m^2)
Depth of Pipe Head from ground: 1.2m
Type of the soil: Compaction, Normal sand Dry



Exercise (Calculaition)

Which type is suitable?

Type A	
B	1.50
H	1.50
l1	1.50
L	2.25
h1	0.75
h2	2.25

Type B	
B	2.50
H	2.00
l1	1.80
L	3.05
h1	0.50
h2	2.50

Type C	
B	3.00
H	2.50
l1	2.50
L	4.00
h1	0.30
h2	2.80

Answer

Type A	
B	1.50
H	1.50
l1	1.50
L	2.25
h1	0.75
h2	2.25

Type B	
B	2.50
H	2.00
l1	1.80
L	3.05
h1	0.50
h2	2.50

Type C	
B	3.00
H	2.50
l1	2.50
L	4.00
h1	0.30
h2	2.80

Answer

Type A	
B	1.50
H	1.50
l1	1.50
L	2.25
h1	0.75
h2	2.25

Friction Resistance Force within Bottom of Soil μW=μ*W		96.47
Passive Earth Resistance Force of Back of Concrete E=1/2*Ce*γs*(h2^2-h1^2)*l		460.78
Thrust Force of Bending Point (force of outside direction) P=2*p*A*SIN(θ/2)	kN	701.45
Cross Section Area of Pipe A=D2^2*π/4	m2	0.31
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	192.94
Load from Soil W1=2*l1*B*γs*h1	kN	47.25
Load from Water and Pipe W2=(Wp+π/4*D^2*2*l1*γw)	kN	12.00
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	133.69
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	3.18
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		4.60
Unit Weight of Pipe Wp=Unit Weight of Pipe*l1*2	kN	3.69
Total Resistance Force of Thrust Block R=μW+E	kN	557.25
Safety Rate Sf=R/P		0.79
More than Safty Tate x 1.5 is OK		NG

Answer

Type B	
B	2.50
H	2.00
l1	1.80
L	3.05
h1	0.50
h2	2.50

Friction Resistance Force within Bottom of Soil μW=μ*W		232.77
Passive Earth Resistance Force of Back of Concrete E=1/2*Ce*γs*(h2^2-h1^2)*l		832.69
Thrust Force of Bending Point (force of outside direction) P=2*p*A*SIN(θ/2)	kN	701.45
Cross Section Area of Pipe A=D2^2*π/4	m2	0.31
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	465.53
Load from Soil W1=2*l1*B*γs*h1	kN	63.00
Load from Water and Pipe W2=(Wp+π/4*D^2*2*l1*γw)	kN	14.41
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	388.12
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	4.31
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		4.60
Unit Weight of Pipe Wp=Unit Weight of Pipe*l1*2	kN	4.43
Total Resistance Force of Thrust Block R=μW+E	kN	1065.46
Safety Rate Sf=R/P		1.52
More than Safty Tate x 1.5 is OK		OK

Answer

Type C	
B	3.00
H	2.50
l1	2.50
L	4.00
h1	0.30
h2	2.80

Friction Resistance Force within Bottom of Soil μW=μ*W		454.78
Passive Earth Resistance Force of Back of Concrete E=1/2*Ce*γs*(h2^2-h1^2)*l		1412.45
Thrust Force of Bending Point (force of outside direction) P=2*p*A*SIN(θ/2)	kN	701.45
Cross Section Area of Pipe A=D2^2*π/4	m2	0.31
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	909.56
Load from Soil W1=2*l1*B*γs*h1	kN	63.00
Load from Water and Pipe W2=(Wp+π/4*D^2*2*l1*γw)	kN	20.00
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	826.56
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	5.66
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		4.60
Unit Weight of Pipe Wp=Unit Weight of Pipe*l1*2	kN	6.15
Total Resistance Force of Thrust Block R=μW+E	kN	1867.23
Safety Rate Sf=R/P		2.66
More than Safty Tate x 1.5 is OK		OK

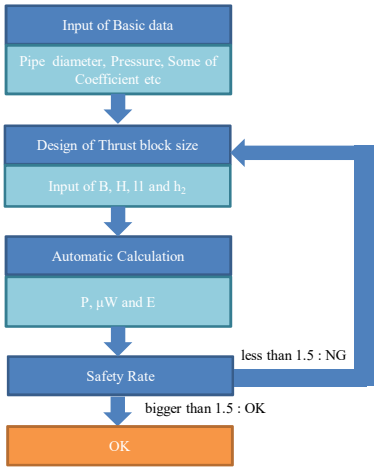
Answer

Type B	
B	2.50
H	2.00
l1	1.80
L	3.05
h1	0.50
h2	2.50

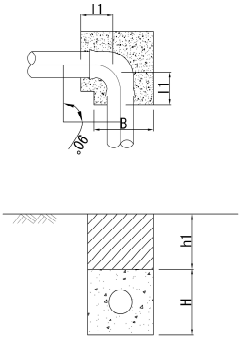
Type C	
B	3.00
H	2.50
l1	2.50
L	4.00
h1	0.30
h2	2.80

Type	Safety Rate	Volume of Concrete
B	1.52	16.87m^3
C	2.66	35.94m^3

How to use Excel for calculaiton



	Unit	PN
Bent : θ	°	
Nominal Diameter : D	m	
External Diameter : D2	m	
Depth of Pipe Head from ground	m	
Internal Pressure : p	kN/m2	
Coefficient of Frictional Resistance within Concrete and Soil : μ		
Unit Weight of Soil : γs	kN/m3	
Internal Friction Angle of Soil : φ	°	
Unit weight of Water : γw	kN/m3	
Unit Weight of Pipe	kN/m	
Unit Weight of Concrete : γc	kN/m3	
B	m	
H	m	
l1	m	
L	m	
h1	m	
h2	m	
C	m	
Friction Resistance Force within Bottom of Soil μW=μ*W		
Passive Earth Resistance Force of Back of Concrete E=1/2*Ce*γs*(h2^2-h1^2)*l		
Thrust Force of Bending Point (force of outside direction) P=2*p*A*SIN(θ/2)	kN	
Cross Section Area of Pipe A=D2^2*π/4	m2	
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	
Load from Soil W1=2*l1*B*γs*h1	kN	
Load from Water and Pipe W2=(W_P+π/4*D^2*2*l1*γw)	kN	
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		
Unit Weight of Pipe W_P=Unit Weight of Pipe*l1*2	kN	
Total Resistance Force of Thrust Block R=μW+E	kN	
Safety Rate Sf=R/P		
More than Safty Tate x 1.5 is OK		



PN			DN					
			100	200	300	400	500	600
40	B	m	0.70	1.30	1.60	2.50	3.00	3.00
	H	m	0.70	1.30	1.70	2.00	2.00	2.00
	l1	m	0.70	1.10	2.00	2.40	3.30	5.30
	h1	m	0.90	0.65	0.50	0.40	0.55	0.50
25	B	m	0.60	1.00	1.40	1.90	2.50	3.00
	H	m	0.60	1.00	1.40	2.00	2.00	2.00
	l1	m	0.45	1.00	1.40	1.50	2.00	3.00
	h1	m	0.95	0.80	0.65	0.40	0.55	0.50
16	B	m	0.40	0.90	1.20	1.50	2.00	2.50
	H	m	0.50	0.80	1.20	1.50	2.00	2.00
	l1	m	0.40	0.80	1.00	1.40	1.20	1.80
	h1	m	1.00	0.85	0.75	0.65	0.55	0.50
10	B	m	0.40	0.70	1.00	1.20	1.50	1.80
	H	m	0.40	0.70	1.00	1.20	1.50	1.80
	l1	m	0.30	0.55	0.75	1.10	1.40	1.40
	h1	m	1.05	0.95	1.85	0.80	0.60	0.60

KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN

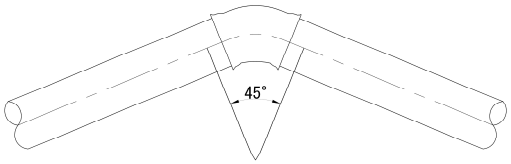
WASAC Water & Sanitation Corporation – WASAC

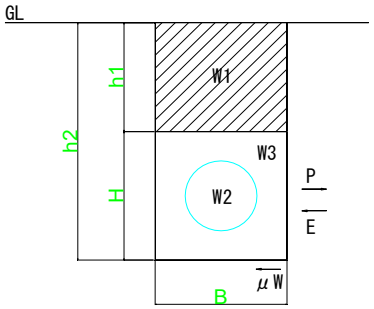
Thrust Block (90°)

DESIGN | DRAWN | CHECKED | DATE | SCALE

THE PROJECT FOR
STRENGTHENING NON-REVENUE WATER CONTROL IN
KIGALI CITY WATER NETWORK

Pipe model

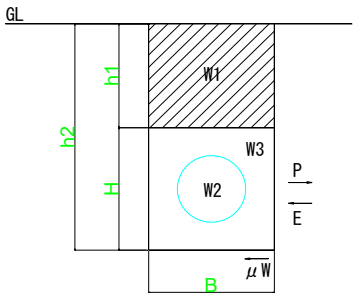


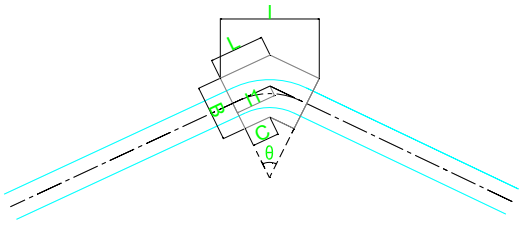


Basic data
Pipe Material: DIP
PiPe Nominal Diameter: 200mm
PiPe Extemal Diameter: 220mm
Bent: 45°
Internal Pressure: PN16
Depth of Pipe Head from ground: 1.2m
Type of the soil: Compaction, Norumal sand, Dry

	Unit	PN16
Bent:θ	°	45.00
Nominal Diameter :D	m	0.200
External Diameter:D2	m	0.220
Depth of Pipe Head from ground	m	1.20
Internal Pressure:p	kN/m2	1600
Coefficient of Frictional Resistance within Concrete and Soil:μ		0.50
Unit Weight of Soil:γs	kN/m3	14.00
Internal Friction Angle of Soil:φ	°	30.00
Unit weight of Water:γw	kN/m3	9.80
Unit Weight of Pipe	kN/m	1.23
Unit Weight of Concrete:γc	kN/m3	23.00
B	m	1.00
H	m	1.00
l1	m	0.60
L	m	0.81
h1	m	0.60
h2	m	1.60
C	m	0.39
Friction Resistance Force within Bottom of Soil μW=μ*W		19.24
~~Passive Earth Resistance Force of Back of Concrete~~ E=1/2*Ce*γs*(h2^2-h1^2)*l		68.90
~~Thrust Force of Bending Point (force of outside direction)~~ P=2*p*A*SIN(θ/2)	kN	46.55
Cross Section Area of Pipe A=D2^2*π/4	m2	0.04
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	38.48
Load from Soil W1=2*l1*B*γs*h1	kN	10.08
Load from Water and Pipe W2=(Wp+π/4*D^2*2*l1*γw)	kN	1.85
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	26.55
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	1.49
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		3.00
Unit Weight of Pipe Wp=Unit Weight of Pipe*l1*2	kN	1.48
Total Resistance Force of Thrust Block R=μW+E	kN	88.14
Safety Rate Sf=R/P		1.89
More than Safty Tate x 1.5 is OK		OK
Bearing Force of Ground for Supporting Thrust block σ=W/B*l1	kN/m2	32.06
Volume of Thrust Block	m3	1.20
Volume of Pipe (deduction)	m3	0.05
Volume of Concrete	m3	1.15
Aggregate (t=20cm)	m3	0.24
Formwork	m2	4.32

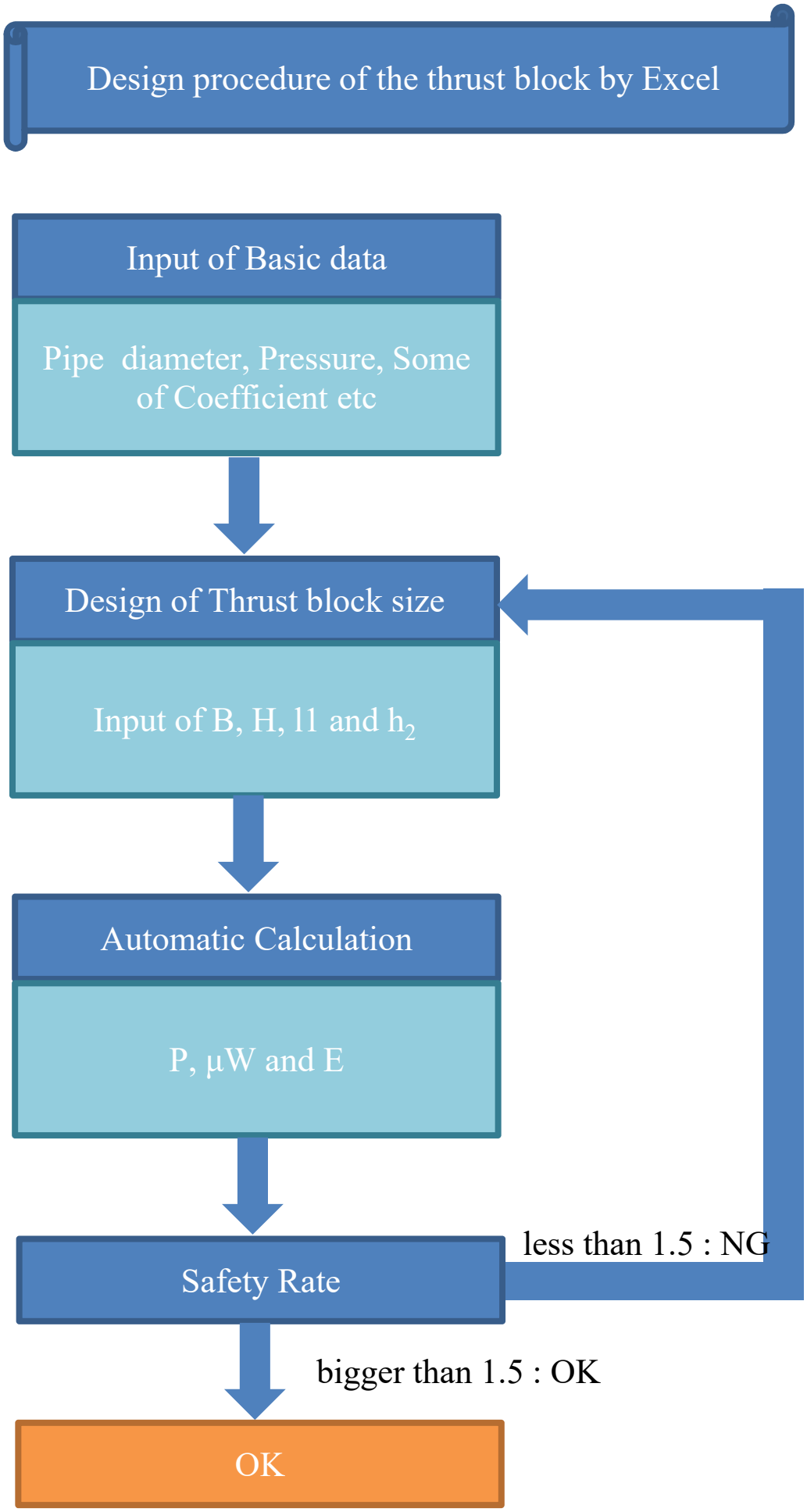
:fill in numerical value
:A safety factor can be included by adjusting numerical value becoming OK





	Unit	PN40				
Bent:θ	°	90.00	45.00	22.50	11.25	2.50
Nominal Diameter :D	m	0.600	0.600	0.600	0.600	0.600
External Diameter:D2	m	0.635	0.635	0.635	0.635	0.635
Depth of Pipe Head from ground	m	1.00	1.00	1.00	1.00	1.00
Internal Pressure:p	kN/m2	4000	4000	4000	4000	4000
Coefficient of Frictional Resistance within Concrete and Soil:μ		0.50	0.50	0.50	0.50	0.50
Unit Weight of Soil:γs	kN/m3	16.00	16.00	16.00	16.00	16.00
Internal Friction Angle of Soil:φ	°	30.00	30.00	30.00	30.00	30.00
Unit weight of Water:γw	kN/m3	9.80	9.80	9.80	9.80	9.80
Unit Weight of Pipe	kN/m	1.67	1.67	1.67	1.67	1.67
Unit Weight of Concrete:γc	kN/m3	23.00	23.00	23.00	23.00	23.00
B	m	2.70	2.70	1.20	1.20	1.20
H	m	3.50	2.30	2.00	1.20	1.20
l1	m	2.20	2.20	2.40	1.90	0.50
L	m	3.55	2.76	2.52	1.96	0.51
h1	m	0.80	0.80	0.32	0.72	0.72
h2	m	4.30	3.10	2.32	1.92	1.92
C	m	0.85	1.64	2.28	1.84	0.49
Friction Resistance Force within Bottom of Soil μW=μ*W		547.94	383.99	140.39	83.78	22.05
Passive Earth Resistance Force of Back of Concrete E=1/2*Ce*γs*(h2^2-h1^2)*l1		2150.76	1097.57	626.23	296.47	78.00
Thrust Force of Bending Point (force of outside direction) P=2*p*A*SIN(θ/2)	kN	1791.48	969.54	494.27	248.33	55.27
Cross Section Area of Pipe A=D2^2*π/4	m2	0.32	0.32	0.32	0.32	0.32
Total Wight against Bottom of Concrete W=W1+W2+W3	kN	1095.88	767.99	280.79	167.57	44.10
Load from Soil W1=2*l1*B*γs*h1	kN	152.06	152.06	29.49	52.53	13.82
Load from Water and Pipe W2=(Wp+π/4*D^2*2*l1*γw)	kN	19.52	19.52	21.30	16.86	4.44
Load from Concrete W3=2*l1*(B*H-π/4*D2^2)*γc	kN	924.29	596.40	230.00	98.18	25.84
Length of Projection of back of Concrete l=2*L*COS(θ/2)	m	5.02	5.10	4.94	3.90	1.03
Coefficient of Passive Earth Resistance Force Ce=TAN(45+Φ/2)^2		3.00	3.00	3.00	3.00	3.00
Unit Weight of Pipe Wp=Unit Weight of Pipe*l1*2	t	7.33	7.33	8.00	6.33	1.67
Total Resistance Force of Thrust Block R=μW+E	kN	2698.70	1481.56	766.63	380.26	100.05
Safety Rate Sf=R/P		1.51	1.53	1.55	1.53	1.81
More than Safty Tate x 1.5 is OK		OK	OK	OK	OK	OK
Bearing Force of Ground for Supporting Thrust block σ=W/B*l1	kN/m2	92.25	64.65	48.75	36.75	36.75
Volume of Thrust Block	m3	41.58	27.32	11.52	5.47	1.44
Volume of Pipe (deduction)	m3	1.39	1.39	1.52	1.20	0.32
Volume of Concrete	m3	40.19	25.93	10.00	4.27	1.12
Aggregate (t=20cm)	m3	2.38	2.38	1.15	0.91	0.24
Formwork	m2	49.07	32.03	23.37	11.37	4.65
Excavation amount	m3	51.084	36.828	13.3632	8.7552	2.304

:fill in numerical value
:A safety factor can be included by adjusting numerical value becoming OK


Design procedure of the thrust block by Excel
Input of Basic data
Pipe diameter, Pressure, Some of Coefficient etc
Design of Thrust block size
Input of B, H, l1 and h2
Automatic Calculation
P, μW and E
Safety Rate
less than 1.5 : NG
bigger than 1.5 : OK
OK

OPERATING INSTRUCTIONS FOR

J1 Drilling Machine

1. **Machine to be operated by trained personnel.**
2. **Instructions to be read before use.**

Hy-Ram Mansfield
Pelham Street
Mansfield
Nottinghamshire
NG18 2EY

Tel: 01623 422982
Fax: 01623 661022

Hy-Ram Bury
9 Portland
Industrial Estate
Portland Street
Bury
Lancashire
BL9 6EY

Tel: 0161 7641721
Fax: 0161 7620577

Hy-Ram Enfield
Unit 2, Riverwalk
Business Park
Riverwalk Road
Enfield
EN3 7QN

Tel: 0208 805 8010
Fax: 0208 805 6010

Hy-Ram Livingston
18 Napier Square
Houstoun Road
Trading Estate
Livingston
West Lothian
EH54 5DG

TEL: 01506 440233
Fax: 01506 440266

Hy-Ram Junior J1

AC Cutters PVC Cutters Holesaw Cutter

J1 Drilling Machine & Accessories

Facilitates underpressure drilling on service type fittings, especially useful where service connections are made through saddle straps, clamps and welded nipples where inserting directly into the main is not possible.

Description	Application	Cutter Sizes	Body Adaptors
Hy-Ram J1-1 Underpressure Drilling Machine	Drilling through Saddle Straps, Saddle Clamps, Ferrule Straps and Welded Nipples.	19mm & 24mm ¾" & 1" AC ¾" & 1" PVC	¾" & 1" BSP

Ref	Product code	Description	
	130-000165	Junior J1-1 Drilling Machine Kit	
Kit Includes			
A		Junior J1-1 Drilling Machine	
B	661-000035	J1 Holesaw Spindle	
C	300-000004	10.5mm Plug Inserter	
D	300-000005	8.00mm Plug Inserter	
E	711-000007	Ratchet Spanner	
F	300-000001	1" Ferrule Adaptor	
G	300-000002	¾" Ferrule Adaptor	
H	363-000003	1 ¼" BSP Gate Valve (c/w 2 x 1" bushes)	
I	045-000057	Black Carrying Case 20" Auto Latch	

Cutters & Accessories

Product code	Description
130-000169	¾" AC Cutter
130-000168	1" AC Cutter
130-000166	¾" PVC Cutter
130-000167	1" PVC Cutter

Product code	Description
117-000058	Holesaw Cutter 19mm (½" BSP)
117-000020	Holesaw Cutter 24mm (¾" BSP)
640-000055	J1 Drill Body Spacer (for use with EBCO Gunmetal Self Tapping Ferrule Straps)

Hyram recommend that a pressure test is completed prior to the use of the J1 Drilling Machine. The following test pumps are available for hire and purchase.

Hydrostatic Test Pumps

Rothenberger RP50 Pump

Pressure testing pump for carrying out hydrostatic pressure tests on water pipework systems.

Maximum Pressure: 60 bar.
Tank capacity: 12 litres
Connection: ½" BSPT

Product code	Description	
652-000015	RP50 Pressure Test Pump	
161-000161	Replacement Gauge	

Virax 262030 Pump

Pressure testing pump for carrying out hydrostatic pressure tests on water pipework systems.

Maximum Pressure: 50 bar.
Tank capacity: 5 litres
Connection: ½" BSPT

Product code	Description	
652-000033	Virax Pressure Test Pump	
161-000129	Replacement Gauge	

This unit is design and manufactured by Hyram Engineering Co Ltd.
Hy-Ram Engineering Co Ltd has a policy of continuous improvement in product quality and design. Hy-Ram Engineering Co Ltd therefore reserves the right to change the specification of its models at any time, without prior notice.

Important!

This manual forms a part of the product to which it relates. It should be kept for the life of the product. Any amendments issued by Hy-Ram Engineering Co Ltd should be incorporated in the text. The manual should be passed to any subsequent holder or user of this product.

Safety Information

The Hy-Ram J1 Drilling Machine should only be used by trained and competent operators. As an operator, always ensure that you fully understand how the equipment functions and that you are fully aware of the dangers. Always wear the necessary protective clothing including adequate eye protection, hard hat, gloves, overalls, protective boots etc.

Prior to commencing work, always ensure that the drill kit is complete and fully serviceable. If in doubt replace.

Product Information

The J1 Drilling machine will drill through the centre of ¾" BSP (British Standard Pipe) & 1" BSP Ferrules and nipples.

The Machine operation:

1. Fit the ferrule to the pipe using a wrap around gun metal strap or a repair clamp with a threaded outlet.
2. Remove the plug from the centre of the ferrule.
3. Fit the appropriate adaptor onto the ferrule along with the gate valve.
4. Fit the drill on to the gate valve with the appropriate cutter fitted.
5. Ensure the gate valve is fully open.
6. Connect Hydrostatic Test Pump to port on Drilling Machine. Bleed air back through pump. After bleeding, pressure test to approx. 1 1/2 times mains pressure. Check for leakage.
7. Disconnect Hydrostatic Test Pump.
8. Locate the ratchet onto the drill spindle and work the ratchet under load in a clockwise direction to drill the main.

DO NOT APPLY EXCESSIVE PRESSURE, LET THE CUTTER DO THE WORK! 95% OF FAILED DRILLINGS ARE DUE TO OPERATOR ERROR. EXCESSIVE PRESSURE (RESULTING IN HOLESAW DAMAGE) IS THE MOST COMMON PROBLEM.

9. Once the hole has been drilled retract the cutter and shut off the gate valve.
10. Use the relief valve on the side of the drill to remove any pressurized water.
11. Remove the drill and fit the plug inserter spindle with the ferrule plug fitted on the end.
12. Open gate valve and re-fit the plug to isolate the water.
13. Use the relief valve on the side of the drill to remove any pressurized water.
14. Remove the drill, valve and adaptors and the drilling is now complete.

Thread on the drill body = 1" BSP
Ferrule adaptor sizes =3/4" BSP & 1" BSP

Please note gate valves should be 1 ¼" BSP bushed down either side to 1" BSP to allow sufficient clearance for the cutters to travel thorough the valve internal bore.

To drill through a nipple

1. Insert the nipple into the pipe clamp.
2. Fit a gate valve to the nipple (Would need to be a 1 ¼" BSP gate valve bushed down to the same size as the nipple on one side and bushed down to 1" BSP on the drill side).
3. Fit the drill on to the gate valve with the appropriate cutter fitted.
4. Ensure the gate valve is fully open.
5. Connect Hydrostatic Test Pump to port on Drilling Machine. Bleed air back through pump. After bleeding, pressure test to approx. 1 1/2 times mains pressure. Check for leakage.
6. Disconnect Hydrostatic Test Pump.
7. Locate the ratchet onto the drill spindle and work the ratchet under load in a clockwise direction to drill the main.

   DO NOT APPLY EXCESSIVE PRESSURE, LET THE CUTTER DO THE WORK! 95% OF FAILED DRILLINGS ARE DUE TO OPERATOR ERROR. EXCESSIVE PRESSURE (RESULTING IN HOLESAW DAMAGE) IS THE MOST COMMON PROBLEM.

8. Once the hole has been drilled retract the cutter and shut off the gate valve.
9. With the gate valve closed open the relief valve on the side of the drill to remove any pressurized water.
10. Remove the drill and the pipe is now live up to the gate valve.
11. Connect whatever pipe work you desire to the 1" BSP side of the gate valve.

Certificate of Calibration.

- This product has been inspected and tested in accordance with the ISO9001 quality control systems and procedures in place at Hyram Engineering Co Ltd.

- This product has no calibration period, periodic, safety inspections should be carried out by the operator if in any doubt please contact the manufacturer for further information

Decommissioning & Disposal Instructions

These give the instructions for decommissioning and disposal of the equipment and confirm how it is to be taken out of service safely, in respect of the Essential Health and Safety Requirements.

- If a Hyram tool has reached the end of its useful working life and cannot be refurbished it must be disposed of through a licensed scrap or waste disposal facility. Alternatively, a reverse engineering company could be used to strip the equipment for recycling purposes.
- Disposal is the responsibility of the Customer this can also be achieved by returning the product back to the manufacturer.

CE

Warranty Information.

1. Extent of Warranty.

(a) Hy-Ram Engineering Co Ltd warrants to the end-user customer that its products will be free from defects in materials and workmanship, for six months after the date of purchase by the end-user customer, subject to providing proof of purchase.

(b) If Hy-Ram Engineering Co Ltd receives, during the warranty period, notice of a defect in product which is covered by this warranty, Hy-Ram Engineering Co Ltd shall either repair or replace the product, at its option. Any replacement product may be either new or like-new, provided that it has functionality at least equal to that of the product being replaced.

(c) All warranty work will be carried out by Hy-Ram Engineering Co Ltd unless otherwise agreed. On-site warranty and repair or replacement services are available from authorised Hy-Ram Engineering Co Ltd service facilities world-wide.

(d) Customers shall prepay shipping charges for products returned to Hy-Ram Engineering Co Ltd for warranty service, and Hy-Ram Engineering Co Ltd will charge for return of the products back to the customer.

(e) This warranty statement gives the customer specific legal rights. The customer may also have other rights which vary from country to country in the world.

Pre-conditions for Warranty Application.

Hy-Ram Engineering Co Ltd' warranty covers only those defects which arise as a result of normal use of the product, and this warranty shall only apply in the following circumstances:

(a) All the instructions contained in the operating manual have been complied with
(b) And none of the following apply:

(i) Improper or inadequate maintenance;
(ii) Physical abuse;
(iii) Unauthorised modification, misuse or any use not in accordance with the operating manual and good industry practice;
(iv) Operation outside the products specifications;
(v) Improper site preparation or maintenance; and
(vi) Faulty pipe or fittings.

Limitations of Warranty.

(a) Hy-Ram Engineering Co Ltd does not warrant the operation of any product to be uninterrupted or error free.
(b) Hy-Ram Engineering Co Ltd makes no other warranty of any kind, whether express or implied, with respect to its products. Hy-Ram Engineering Co Ltd specifically disclaims the implied warranties of satisfactory quality and fitness for a particular purpose.
(c) To the extent that this warranty statement is inconsistent with the law of the locality where the customer uses the product, this warranty statement shall be deemed modified by the minimum necessary to be consistent with such local law.
(d) To the extent allowed by local law, the remedies provided in this warranty statement are the customer's sole and exclusive remedies.
(e) This tool has been designed for the range of fittings available at the time of its design and development. Hy-Ram Engineering Co Ltd can accept NO liability for the unit's ability or otherwise to work with new or different fittings that subsequently appear in the market place.

Section 6. Water Distribution Reservoir Management

Reference:

6.1 Necessity of the Reservoir Management

(1) Role of the Reservoir

The reservoir is a basin to store treated water for the purposes of receiving water transmitted from the water treatment plant and distribute water to the service area according to its demand (daily demand especially peak demand) in regulating the hourly fluctuation of water demand.

The reservoir is built in the vicinity of the service area and it is situated at the elevated place for the distribution network so that distribution by gravity flow can be made.

The reservoir has a function to reduce the excessive pressure of the transmission line by storing water in the free water surface.

Operator shall check the amount of water (water level) in the reservoir at appointed times of the day. The maximum water level to be maintained in the reservoir at each early morning should be known to ensure that the system demand is met for the day and the water level should be recorded. Check of water levels at other times of the day will enable to determine if any unusual consumption conditions have occurred.

In case of intermittent supply (rationing), timings for supply of water in the distribution areas are fixed in advance. The water shall be supplied to sub-areas during particular fixed hours by operation of the necessary valves. Routine valve operations are normally done at the reservoirs.

(2) Problem of the Reservoir

1) Use of Bypass Pipe

When the reservoir cannot be used due to its repair and so forth, it is needed for water to directly be distributed bypassing the reservoir. Therefore, a bypass pipe connecting from the inlet line to the outlet line for drawing water is provided.

It becomes the problem that this bypass pipe is used to supply water for the service area of the high altitude than a reservoir which has additionally incorporated after the construction of the reservoir. Pressure from of the transmission pipe directly

Because the pressure of the transmission line acts to the service area directly, the water pressure in the service area becomes higher, and leaks of water in the area increase.

2) No setting or Malfunction of Float Valve

Water level control to prevent overflow of the reservoir is one of the most important management to reduce physical loss. In many cases of existing reservoirs in WASAC water distribution networks, float valves are not installed or not in functioning condition.

There is a case overflow cannot be stopped because the inflow valve is not working well. In addition, there is also a case operator for operating valves is not always assigned.

When there is not the setting of float valve, following action are being taken now to prevent overflow;

- Inflow valve is frequently operated at every low and high water level
- Inflow pipe is disconnected from transmission pipe (abandonment of the function as the reservoir)
- Bypass is used daylong or night-time (abandonment of the function as the reservoir)
- Inflow valve is closed in night-time (abandonment of the function as the reservoir)

Because even these are not performed properly, overflow occurs frequently.

6.2 Standard

1) WASAC Standard (Water Supply and Sewerage Systems Procedure Manual)

   No description about the figure of volume of the reservoir

2) Japanese Standard (The Design Criteria for Water Supply Facilities: Ministry of Health, Labor and Welfare)

   The standard effective capacity of the service reservoir is set at 12 hours equivalent of the maximum daily supply of the service area.

6.3 Function Survey of Reservoir

It is necessary to perform the function survey for the management of the reservoir. Required items to be survey are as follows;

- Service area of reservoir in the distribution network GIS map
- Inflow condition (source, water pressure at inlet, frequency and time)
- Water level fluctuation (continuous measuring for 24 hours by data logger)

- Outflow condition (supply area, time)
- Overflow condition (frequency, time)
- Float valve condition
- Valve working condition (inlet, outlet, inlet check valve)
- Use situation of the bypass pipe (frequency, time)
- Operator duty system (number, shift)
- Flow meter situation

The hearing information from an operator and neighbouring inhabitants is very important, and it is necessary to measure a water level change with water level measuring device with a data logger.

Refer to Reservoir survey sheet, Photo Sheet and Schematic drawing attached hereto.

6.4 Setting Plan of FV

Following setting plan of FV shall be performed.

- Preparation of BoQ of the equipment and materials
- Procurement of the equipment and materials
- Installation of FV
- FV Effect Measurement (Water level measurement of the reservoir)

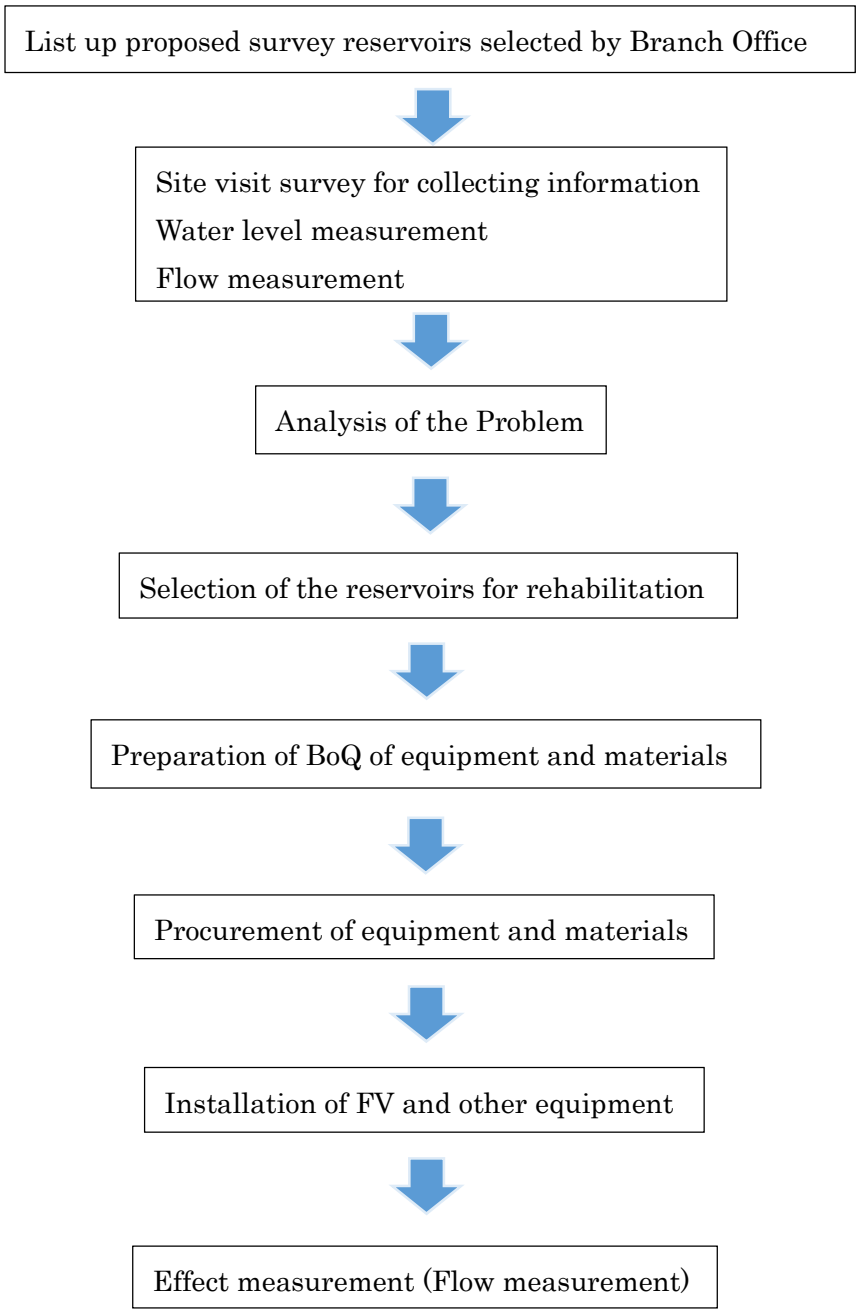
Note the following about the setting of the float valve;

- ✓ Gate Valve should be installed to allow to maintenance operation.
- ✓ Observe the overflow level and make sure that the outlet flange is always above it, this is to avoid backflow.
- ✓ In case of excessive pressure drop (Dp) across the float valve, to avoid cavitation and possible damages to the float valve, a direct acting pressure reducing valve (PRV) should be installed before the water reach to the reservoir

Specification (reference);

- ✓ Function: Automatically controls the rate of filling, and will shut off when a predetermined water level is reached.
- ✓ Type: an equilibrium, single seat upstream pressure balanced float valve
- ✓ Installation body pattern: angle pattern.
- ✓ Pressure: PN16 bars
- ✓ Max. allowable pressure drop (Dp) across the valve: more than 8 bar (to avoid cavitation)
- ✓ Structure: Ductile Iron body, epoxy coating, stainless steel float

Procedure for the Survey and Rehabilitation Work of Reservoirs



Reservoir Survey Sheet

Date: 9th April, 2020

No.	Item	Details
A: General		
1	Number of Reservoir	
2	Name of Reservoir	
3	ID Code	
4	Ward	Sector: , District: , Cell: , Village:
5	Branch Office	Nyarugenge, Nyamirambo, Kacyiru, Gikondo, Remera, Kanombe
6	Location	Latitude: , Altitude: , Altitude
7	Function of Reservoir	Storage, Kiosk Reservoir, BPT
8	Age of Reservoir	year
9	Storage Capacity	m3
10	Service area of the Reservoir	
B: Operational Condition		
1	Operational Condition	Operational, Not Operational, Abandoned
2	Operator Assignment	No operator, 1 person, 2 shift in a day, 2 shift in a week,
	Action against to overflow	
3	Wall Leakage	Flowing , Oozed, Nothing
4	Overflow observation	_____ times/month, _____times/week
	Phenomenon	
	Reason of overflow	
5	Bypass-flow operation	Always/ Nothing, Timing: _____,
	Reason of bypass operation	
6	Inflow Condition	Source:
		Water pressure at inlet:
		Frequency and time:
7	Water level movement	Proper movement, always low level, always no water
8	Issue on Functional Condition	
C:Structure		
1	Form of Reservoir	Circular, Rectangular, Hexagon, Dimension:
2	Foundation	Underground, Semi-ground, Ground, Elevated
3	Structure Material	Concrete, Stones, Steel, Plastic, Other( )
4	Inside Dimension	D: / L: × B: , H:
5	Remarks/ Issue	

No.	Item	Details
D: Equipment		
1	Floater Valve	Function, Malfunction No installation, DN:
2	Water Level Gauge	Function/ Malfunction/ No installation
3	Flow Meter	Mechanical, EMFM, UFM, DN: _____ , PN(bar): _____,
		Function, Malfunction, No installation
		Location: Inlet Pipe, Outlet Pipe
4	Inlet pipe No.1	SP/ DIP/ PVC/ Others ( ), DN: , Roof/ Top/ Bottom
	Inlet pipe No.2	SP/ DIP/ PVC/ Others ( ), DN: , Roof/ Top/ Bottom
5	Inlet valve No.1	DN: , Function:
	Inlet valve No.2	DN: , Function:
6	Outlet pipe No.1	SP/ DIP/ PVC/ Others ( ), DN:
	Outlet pipe No.2	SP/ DIP/ PVC/ Others ( ), DN:
	Outlet pipe No.3	SP/ DIP/ PVC/ Others ( ), DN:
7	Outlet valve No.1	DN: , Function:
	Outlet valve No.2	DN: , Function:
	Outlet valve No.3	DN: , Function:
8	Overflow Pipe	SP/ DIP/ PVC/ Others ( ), DN:
9	Drain Pipe	SP/ DIP/ PVC/ Others ( ), DN:
10	Remarks/ Issue	

Other Information:

Photo Sheet

Reservoir Name: No:

Whole View

Reservoir

Inlet Pipe with Valve

Outlet Pipe with Valve

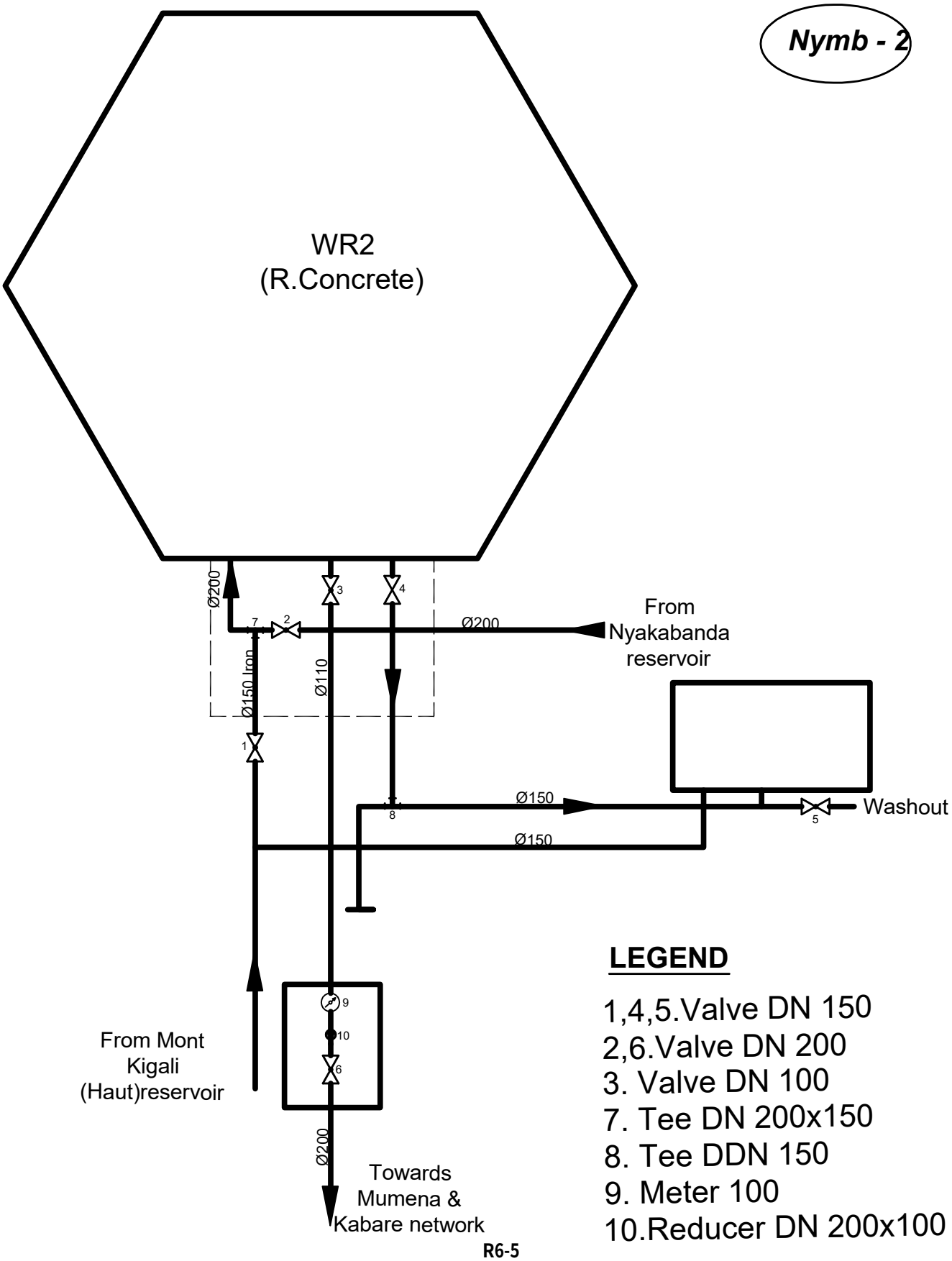
Float Valve

Meter

Photo Sheet

Reservoir Name: **No:**

MONT KIGALI (Bas)
RESERVOIR(300CUM)



LEGEND

1,4,5.Valve DN 150
2,6.Valve DN 200
3. Valve DN 100
7. Tee DN 200x150
8. Tee DDN 150
9. Meter 100
10.Reducer DN 200x100

1. Case of Present Operation Status of the Existing Reservoir

Case	Reservoir	Present Way of Operation
1	Gacuriro(24,25) Primaire(32)	Overflow frequently because of inflow valve trouble and no float valve setting
2	Ayabaraya(26)	Inflow pipe is disconnected from a main distribution pipe for prevention of overflow (abandonment of the function as the reservoir)
3	Kigali Bas(113）	For prevention of overflow, inflow valve is frequently operated at every low and high water level.
4	Muendo(72) Nyarurama(118) Chez lando(15)	For prevention of overflow in the night, all inflow valve are closed (Because of much water distribution in daytime, tank is not filled with water) (No water distribution in nighttime)
5	Kibagabaga(71) Nyarutarama(121)	Bypass is used by night for prevention of overflow
6	Fawe	Bypass is used daylong for prevention of overflow (abandonment of the function as the reservoir)

2. Conditions of the Reservoir for Needs of Floater Valve

- Inflow rate is enough to fill the Tank.
- Water fills the full capacity of the tank. Water level rises up to high water level.
- Floater valve is not installed, or it does not function.
- Bypass is always used to prevent overflow.
- Bypass is used at nighttime to prevent overflow.
- Inflow valve is always closed to prevent overflow.
- Inflow valve is closed when water level rises up to high water level.
- Operator is not fulltime-stay at the reservoir site. Especially nighttime.

Result of Reservoir Survey for Argent Task

Date	Branch Name	Reservoir Name	No	Supply Condition				Operational Condition				Measures to be taken	Remarks	Priority
				Water Level	Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operator Shift	By-pass			
Sept 2 (Mon)	Nyamirambo	Mont Kigali Bas (Golf Mike-Nyakabanda) Resp: Branch	113	High	From Mt. Kigali haut EL1792. The inflow valve is closed at night and any time when operator found overflow. The impulse of in-flow is very strong (EL1792-Kigali Bas EL1683=109m).	Supplied to Nyakabanda Reservoir Supplied net work: -Kivugiza, -Rwarutabura, -Nyakabanda	24 h except power cut or leakage on pipeline	No float Valve DN200 x 1 No flunge at the end of in-flow pipe. Flange volt number 12.	Over flowing can be in one or two houres and many times a month. Day time and night time. Over flow pipe DN110	two shift a day (12 hours x 2)	None	Float valve DN200 is needed urgently as it overflowing any time. Over flow pipe shall be rize up about 300mm. Additional one sluse valve shloud be set to the existing one in order to decrease cavitation impact.	Capacity of the tank is too small to the distribution discharge. In-flow rate is too big and high pressure. At every one or two houres, operator has to close and open the in-flow valve to prevent overflow and to fill the water in the tank. Function of this tank is just BPT not Reservoir. Cavitation is occured at operation of in-flow valve when close it because of too high pressure.	H
Sept 3 (Tue)	Nyamirambo	Mwendo-Rwesero, Resp: Branch	72	Low	Dn 110 from Mt. Kigali haut. In flow valve is closed night time (18:00-6:00) due to lack of Float Valve. Mt. Kigali haut EL1792. Mwendo 72 EL1583 Diffe. 209m	Out flow is working only day time .	12 hours	No float Valve DN80 x 1	Over flowing in night time when inflow valve is not closed	One operator working day time and moving into the whole network.	None	Float Valve ND90 is needed to help night supply Pressure reduction on the inflow pipeline (EL 1690?): DN100 (PRV should be installed)	Inlet valve is closed night to prevent overflow Leakage at AirValve and on inflow pipe line.	H
Sept 3 (Tue)	Gikondo	EP GIKONDO (Primaire), Resp: Branch	32	Low	From Rebero and Mburabutura PS,Upper and Down. Water pressure from Rebero was low. Each inflow pipes are connected. From Mubrabutura inlet is bottom of the tank. Two inlet valves are not well function.	Supplying a big part of Gikondo Area.	24 haurs	No float valve DN110 x 1	5 times a month at night	One Operator 24h seven days,	By pass pipes connecting two inlets	Float Valve needed: DN 100 In let Valve dn 80 mm is not working, always open (Needs urgent replacement),	In flow valve is not function, over flow always. Tow infow valves are needed for both inlet.	H
Sept 3 (Tue)	Gikondo	NYARURAMA, Resp: Branch	118	Low	From Rebero	DN 110 to Kabare Area	5-7 Haurs	No float valve DN110	2 times in a months	One operator 24 hours,	No bypass	Float Valve 100 needed. Over flow pipe is lower than inlet needs some modification before Float installation.	Inlet valve is closed night to prevent overflow	H
Sept 2 (Mon)	Kacyiru	Gacuriro (Kadobogo PM3)	24, 25	High	Inflow Valves can not be closed. Inflow impuls is ordinaly.	- Taxtail area '- Other network	24 houres	Existing x 1, DN200, No function No existing x 1, DN200	Very often at night	One Operator 1x24x7x12	Bypass is used for UTEX Rwanda because there is high area on the middle point to Utex.	*Needed float valve DN200 x 2* *Inflow Valves should replaced DN200 x 2*	In flow valve is not function, over flow always.. Daytime high consumption, so the overflow not occure in daytime. All inflow and outflow valves are not function so that these shoud be replaced (Number: **).	H
Sept 2 (Mon)	Remera	Kibagabaga (Hospital)	71	Low (Main Pipe Probrem)	Ntora, Rationing 2day /week	Kiibagabaga Zone	24 Haurs depending of Rationning program.	Exist, No function, DN200	Yes	1 x daytime Network maintenance	Nighttime bypass due to overflow	*Need Float Valve Urgently*	Bypass is used night to prevent overflow	H
Sept 2 (Mon)	Remera	Nyarutarama (Near Stadium)	121	Low (Main Pipe Probrem)	Ntora- Nyarutarama-	Nyarutarama, Nyabisindu zones	24 Haurs	No exist, DN110	Lot	1x24x7x12 Network mintenance	Nighttime bypass due to overflow	*Need Float Valve Urgently*	Bypass is used night to prevent overflow	H
Sept 2 (Mon)	Remera	Chez lando	15	Low (Main Pipe Probrem)	From Ntora-Gishushu Inflow valve closed nighttime.	Urwego Village	24 Haurs	Exist, No function, DN150	Daytime high consumption, but nighttime over flow is occure, so inflow valve is closed night time.	1x24x7x12	No bypass	*Need Float Valve Urgently*	Inlet valve is closed night to prevent overflow	H
Sept 3 (Tue)	Kanombe	Ayabaraya (Gako)	26	No water because inflow pipe disconnected	Inflow pipe DN80 branched from main of Karenge I DN300 Public tap high pressure	To Gako /Ayabaraya zones	NA	No Exist. DN80	No	One looking nearest network	Main pipe to Network (Required pressure controle) Branched off inflow pipe to the reservoir.	Needs piping rehabilitation at Inlet and Outlet and Float Valve Dn 80.	In flow pipe is disconnected to prevent overflow. PRV shall be installed on the main pipe to distribution network. Distribution area of Reservoir shall be cralified.	H

Reservoir Survey Desire 190821

Nyamirambo Branch

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity (m3)	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operator Shift	By-pass		
25.07.2019	9:15	Mont Kigali Bas (Golf Mike-Nyakabanda) Resp: Branch	113	Hexa, Concrete	400	200	200	High	Normal, No leakage	From Mt. Kigali haut. The inflow valve is closed at night and any time when operator found overflow.	Supplied areas: -Kivugiza, -Rwarutabura, -Nyakabanda	24 h except power cut or leakage on pipeline	No float Valve DN200 x 1	Over flowing can be in 30 minutes and many times a month.	two shift a day	None	Float valve DN200 is needed urgently as it overflowing any time.	H
25.07.2019	10:21	Mwendo-Rwesero, Resp: Branch	72	Circle, Concrete	50	90	90	Low	Normal, No leakage	Dn 110 from Mt. Kigali haut. In flow valve is closed night time (18:00-6:00) due to lack of Float Valve.	Out flow is working only day time .	12 hours	No float Valve DN80 x 1	Over flowing in night time when inflow valve is not closed	One operator working day time and moving into the whole network.	None	Float Valve ND90 is needed to help night supply	H
25.07.2019	12:22	Mount Kgli haut Resp: Kimisagara	101	Circle, Concrete	400	300	200	Low	Normal, No leakage	Pumping from Karenge station	Supply to Mount Kigali bas	24 hours	No Float Valve DN300 x 1	Not Over flowing	Operator: shift?	None	No need of float valve now but in the future	L
25.07.2019	13:35	Nyakabanda-Golf4 (Ruwezamenyo) Resp: Branch	146, 148	Hexa, Concrete x 2	600 x 2	200 x 2	200	High	Normal, No leakage	from Mount Kigali bas	There is issue of *back flow* on one pipeline	24 haurs	No float valve, DN200 x 2	Overflow: sometime	Operator: shift?, Indicator is there to show operators the level of water in reservoir.	None	need to localize the source or install anti return valve	L
29.07.2019	12:12	Rugarama (Rubona), Resp: Branch	138	Circle, Stone	100	80	90	Low	Normal, No leakage	from Mount Kigali haut, Main pipeline ø 110 mm now has got 4 junctions from it:, 110 Nyakabanda-Kabeza, 110 Muhabura-Mont kgli, 110 Nyakaband Sun city, 110 Kugasoko, NB: All those doesn't have shut off Valve and cant allow water to reach the main reservoir.	Supplied areas: -Rugarama	3-5 haurs	No Float Valve DN80 x 1	None	Some times	None	*need independent pipeline., Float Valve not needed now*	L

Gikondo

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity m3	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operator Shift	By-pass		
30.07.2019	10:15	Murambi, Resp: Branch	104	Circle, Stone	50	110	110	High	Normal, No Leakage	From Nyanza Military camp	Supplying Murambi area	24 haurs	No float Valve, DN100 x 1	Over flow is often happening.	No Operator,	By pass some time	Float Valve: needed	H
30.07.2019	12:27	Rwandatel, Resp: Branch	144	Circle, Concrete	???	400	300	Low	Normal, No Leakage	From Mont Kigali In let Valve is not working.	Supplied areas: -G7 -Kagarama -Muyange , -Kanombe Branch.	24 haurs	No float Valve, DN110 x 1	Reservoir is much over flowing.	One operator 24 hours,	None	Float Valve: not needed now	L
30.07.2019	1:30	G7, Resp: Branch	39, 40	Hexa, Concrete	600 x 2	200 x 2	200 x 2	Low	Normal,No Leakage	From Rwandatel Reservoir, In let valves can't be closed	Kicukiro Area	24 haurs	No Float Valve DN200 x 2	Over flows is often happening but not too much.	Two operators ,	Yes	Float Valve: not needed now	L
31.07.2019	8:54	EP GIKONDO (Primaire), Resp: Branch	32	Circular, Concrete	400	PVC110, DI:80(Bottom)	Out let: 110 & 3'',	Low	Normal,No Leakage	From Rebero and Mburabutura PS,Upper and Down.	Supplying a big part of Gikondo Area.	24 Haurs	No float valve DN110 x 1	5 times a month at night	One Operator 24h seven days,	By pass pipes connecting two inlets	Float Valve needed: 100 In let Valve dn 80 mm is not working, always open (Needs urgent replacement),	H
31.07.2019	9:26	RUJUGIRO (Kuri Petito Prince) Resp: Branch	88	Circular, Concrete	100	80	3''	Middle	Normal, No Leakage Elevation: 1610 m	From Gikondo Carierre	Supplied areas: -RUJUGIRO VILLAGE	24 Haurs	Reservoir has a new float valve in good condition.	None	No need operator.	None	No Need of Float Valve	-
31.07.2019	9:42	Rebero-CARRIERE, Resp: Branch	134	Circular, Stone	50	80	Out let1: EP Gikondo PVC 90, Outlet 2: Kimisange,	Middle	There is a found leakage in out let EP Gikondo manhole.	Supplying res: Rebero	Out let1: EP Gikondo PVC 90, Outlet 2: Kimisange, Outlet 3: Kibelioni	24 Haurs	No float valve DN80*1	None	One operator 24 hours.	None	*Needed float valve 3 ''*.-Float Valve: 3'' bridee Needed.	M
31.07.2019	10:28	REBERO, Resp: Branch	133	Circular, Stone	200	In let1: DI: 4'', In let2: PVC: 200 from Kimisange.,	110 and 3''	Low	Leaking on surface always.	From Mont Kigali and Kimisange. *Water comes from Pumping station .*	Supplied areas: - Carriere Reservoir -Rujugiro Reservoir -BNR , -Nyiragasazi.	24 Haurs	No float valve DN110 x1, DN200 x 1	1 times in 3 months at night	One operator 24 hours.	None	Float Valve: Needed but getting water from pumps.	M
31.07.2019	11:13	NYARURAMA, Resp: Branch	118	Circular, Concrete	125	PVC: 110	110	Low	Normal,No Leakage	From Rebero	DN 110 to Kabare Area	5-7 Haurs	No float valve DN110	2 times in a months	One operator 24 hours,	None	Float Valve 100 needed. Over flow pipe is lower than inlet needs some modification before Float installation.	H

Nyarugenge

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity m3	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operatoe Shift	By-pass		
No Need		Nyabitare MTN Antena		Circle, Stone					Located in RuyenziPilot area, the project will be responsible									
2019/7/31	14:11	Shatton metallique (Plateau)	127, 128, 129	Elevated x 3	250xx3				Reservoir will be replaced? Could not enter	Pumping from Centre Ville			DN150 x 3					L
No Need		All reservoirs in Pumping stations							Not concerned in this mission									

2019/8/7	9:33	Kabizoza	54	Circle, Concrete	250	200		Low	Oil Tank North Consumption bigger than inflow. No storage.	Pumping			No Exist x 1, DN200+Reducer150		1 x 24x7			L

Kacyiru

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity m3	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operatoe Shift	By-pass		
		Utexrwa																
-		Fawe	21	Circular, Concrete						Ntora	No overflow because of bypass use.		No Existing, DN100			Always		-
		Public Library	55															
09.08.2019	9:40	Gacuriro	24, 25	Circular, Concrete	400 x 2	200 x 2		High		Inflow Valves can not be closed.			Existing x 1, DN200, No function No existing x 1, DN200	Very often at night			*Needed float valve DN200 x 2 Inflow Valves should replaced DN200 x 2*	H
-		Rwankuba	145						New reservoir under guarranty time, no need to make visit									

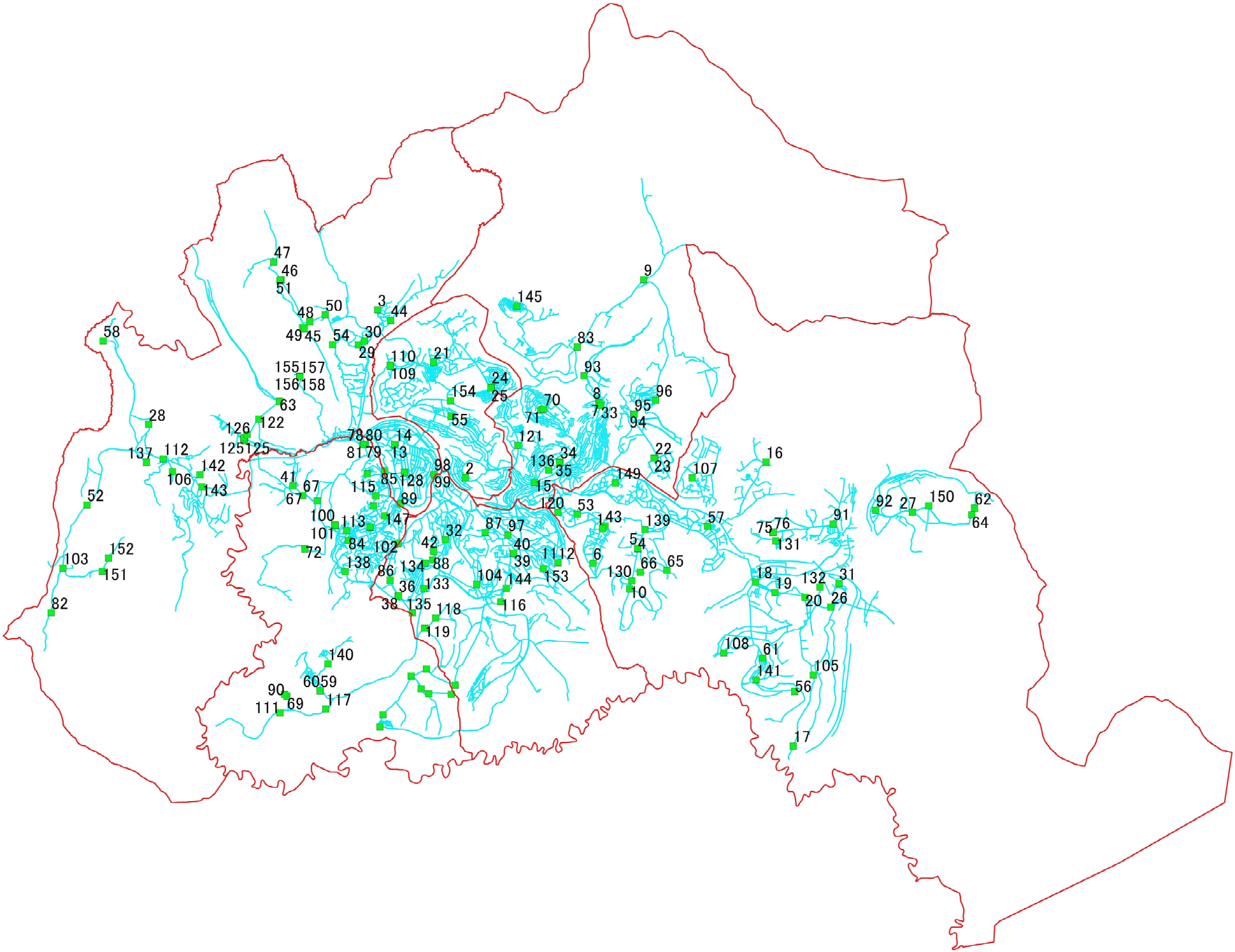
Remera

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity m3	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operator Shift	By-pass		
2019/8/19	Pass	G 10 Kimironko	33	Rect, Concrete	100	90	90	Low	Normal, No Leakage	From Kinyinya Bas	Kimironko zone and BCR Area.	15-18 Haurs	None	No	One Operator 24 Haurs	None	No need of Float Valve now	L
2019/8/19	9:30	Buhoro	7, 8	Rect, Conc/ Circular, Stone	100	200		Low	7: No use, 8:Cercle Consumption bigger than inflow. No storage.	Pumping, Rationing			No exist, DN200		3 for Res. and Pupingstation	bypass		L
2019/8/19	10:00	Masoroho (Haut)(Free zone)	96	Rect, Concrete	1,000	200	200	Low	Normal,No Leakage	Karenge, Masoroho Bas, Rationing Tue, Fry	Economic Zone	24 Haurs depending of Rationning program.	No exist, DN200	No	1x24x7x12	No bypass	No need of Float Valve now	L
2019/8/19	10:22	Kibagabaga	71	Circular, Concrete	200	200	200	Low	Normal,No Leakage	Ntora, Rationing 2day /week	Kiibagabaga Zone	24 Haurs depending of Rationning program.	Exist, No function, DN200	Yes	1daytime	Nighttime bypass due to overflow	*Need Float Valve Urgently*	H
2019/8/19	11:10	Nyarutarama	121	Circular, Concrete	400	110	3''	High	Some Leakages on the Surface.	Ntora- Nyarutarama-	Nyarutarama, Nyabisindu zones	24 Haurs	No exist, DN110	Lot	1x24x7x12	Nighttime bypass due to overflow	*Need Float Valve Urgently*	H
2019/8/19	11:27	Chez lando	15	Circular, Stone	200	150	110	High	Momozono, Leak from wall	From Ntora-Gishushu	Urwego Village	24 Haurs	Exist, No function, DN150	Yes	1x24x7x12	No bypass	*Need Float Valve Urgently*	H
-		Bumbogo	x	-										-				
2019/8/19	11:49	G8 - Remera	34, 35	Hexa, Concrete/ Rect, Concrete	600, 1500	Hexa:200, 250 / Rect;300x2	160, 200, 110	34: Middle 35: Low	Stadium Consumption bigger than inflow. Less storage.	From Karenge and Nzove	Stade, Kabeza and Bibare	24 Haurs	34:No exist. DN200*2, DN250*2	No	2: day & night	None	No need of Float Valve now	L

Kanombe

Date	Time	Reservoir Name	No	Structure				WL at Visit	Storage Condition	Supply Condition			Operational Condition				Measures to be taken	Priority
				Shape	Capacity m3	Inlet (mm)	Outlet(mm)			Inflow	Outflow	Supply Hours	Floater Valve	Over Flow	Operator Shift	By-pass		
2019/8/19	13:38	Ayabaraya (Gako)	26	Circular, Concrete	50	80	90	Low	Not Used	From Karenge I	To Gako /Ayabaraya zones	NA	No Exist. DN80	No	One looking nearest network	Yes	Needs Network Rehabilitation at Inlet and Outlet and Float Valve Dn 80.	H
2019/8/19	14:40	Cyaruzinge (Gasogi?)	16	Circular, Concrete	No more information				Could not enter	Karenge	No more information							?
2019/8/19	15:16	Nezerwa	107	Elevated	No more information				Could not enter	Rationing			DN200	No more information				L

No	No of Reservoir visited	With Float Valve	With Float Valve not functioning	Without Float Valve/	Urgent to be installed	Recommendation
	22	1	3	18	10	.....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List of Reservoirs in Kigali

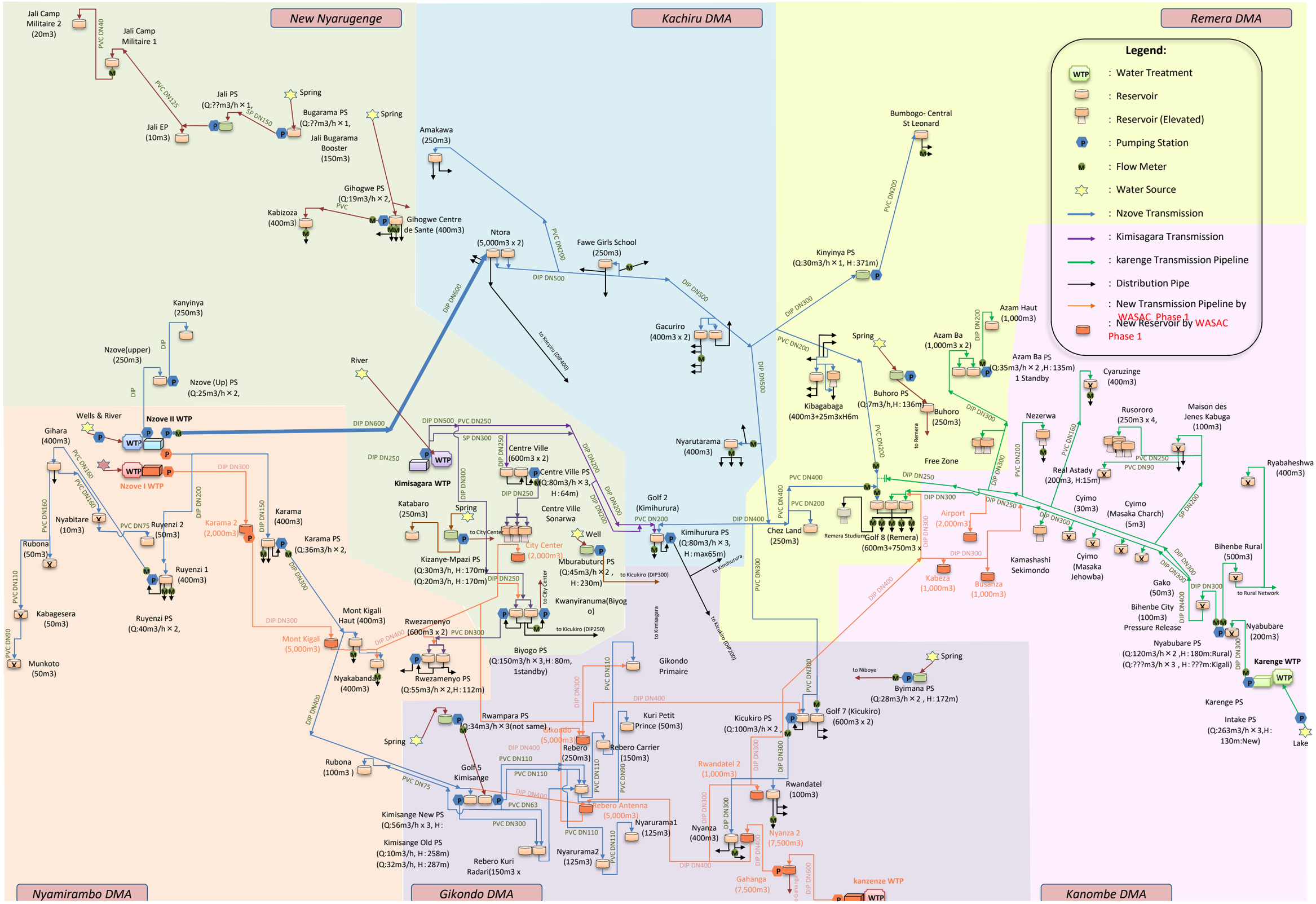
No.	Name of Reservoir	Note	Site Survey Day	ID_code	No	Drawing No	Branch Office	Sector	District	Cell	Function	Capacity (m3)	Capacity	Operational Condition	Operator	Overflow	Bypass	Form	Fundation	Material	Diameter	Height (m)	HWL?	Float Valve	Iinlet pipe/ FV Dia.	Inlet_pipe Location	Flow Meter	Latitude	Longitude	Elevation (m)
1	Abarezi Samuduha			KANM2RE2	84	Knmb-3	Kanombe	Kanombe	Kicukiro	Rubirizi	Kiosk	50	5	Not Ope.				Circular	Ground	Stone	3	3	3	No	1	Top		-1.9761	30.135448	1,476
2	Amajyambere	Golf 2		KACZ5H3RE01	23	Kcyru-5	Kacyiru	Kimihurura	Gasabo	Kimihurura	Storage	1000	1000	Operational				Circular	Ground	Concrete	22	<Null>	6	Yes	200	Top		-1.956961	30.084182	1,465
3	Amakawa			JABI11RE1	1	Nyge-14	Nyarugenge	Jabana	Gasabo	Kabuye	Storage	400	400	Operational				Circular	Semiground	Concrete	11	5	<Null>	No	200	Top		-1.894242	30.051359	1,512
4	Antenna			KANN3RE2	85	Knmb-4	Kanombe	Kanombe	Kicukiro	Busanza	Storage	45	10	Not Ope.				Circular	Ground	Stone	5	2	2	Yes	63	Top		-1.983556	30.148623	1,500
5	Antene			KANN3RE1	85		Kanombe	Kanombe	Kicukiro	Busanza	Storage	50	10	Not Ope.				Circular	Ground	Stone	5	3	3	Yes	63	Top		-1.98346	30.148605	1,501
6	Beninka			KANN2RE1	4	Knmb-16	Kanombe	Kanombe	Kicukiro	Rubirizi	Storage	25	20	Operational				Circular	Ground	Stone	8	2	2	Yes	2	Top		-1.989079	30.131931	1,434
7	Buhoro			KIMQ5RE2	86	Rmra-1	Remera	Kimironko	Gasabo	Kibagabaga	Storage	30	5	Not Ope.				Rectangular	Elevated	Concrete	<Null>	4	0	No	110	Top		-1.929035	30.134208	1,508
8	Buhoro			KIMQ5RE1	86	Rmra-2	Remera	Kimironko	Gasabo	Kibagabaga	Storage	100	5	Not Ope.				Circular	Ground?	Stone	7	4	0	No	200	Top		-1.928964	30.13413	1,508
9	Bumbogo Central st Leonard			BUL6RE1	5	Rmra-6	Remera	Bumbogo	Gasabo	Mvuzo	Storage	400	400	Operational				Circular	Ground	Concrete	12	5	1	No	200	Top		-1.882886	30.150882	1,842
10	Byimana	Busanza		KANO3RE1	7	Knmb-17	Kanombe	Kanombe	Kicukiro	Busanza	Storage	20	5	Operational				Circular	Ground	Stone	5	2	2	No	40	Top		-1.998659	30.145618	1,490
11	Byimana			NIBX16RE1	6		Gikondo	Kagarama	Kicukiro	Kanserege	Storage	150	100	Operational				Circular	Underground	Concrete	7	2	<Null>	No	<Null>	Top		-1.988865	30.118798	1,386
12	Byimana	P.S.		NIBX16RE2	6	Gkdo-1	Gikondo	Kagarama	Kicukiro	Kanserege	Storage	40	50	Operational				Circular	Underground	Concrete	5	2	<Null>	No	<Null>	Bottom		-1.988865	30.118798	1,386
13	Centre ville			KIM&GITO11RE1	9	Nyge-20	Nyarugenge	Nyarugenge	Nyarugenge	Kiyovu	Storage	600	600	Operational				Hexagon	Ground	Concrete	<Null>	4	<Null>	No	250	Bottom		-1.944561	30.057688	1,515
14	Centre ville			KIM&GITO11RE2	9		Nyarugenge	Nyarugenge	Nyarugenge	Kiyovu	Storage	400	600	Operational				Rectangular	Semiground	Concrete	<Null>	4	<Null>	Yes	250	Top		-1.94455	30.057814	1,517
15	Chez Lando		190819	RET3RE1	10	Rmra-12	Remera	Remera	Gasabo	Rukiri Ii	Storage	200	250	Operational				Circular	Ground	Concrete	16	2	<Null>	Provided	**150**	Top		-1.958752	30.110027	1,508
16	Cyaruzinge		190819	NDERJ7RE1	11	Knmb-28	Kanombe	Ndera	Gasabo	Rudashya	Storage	400	400	Operational				**Circular**	Semiground	**Concrete**	14	4	4	Yes	200	Top		-1.95116	30.196644	1,504
17	Cyeru			MASV7RE1			Kanombe				BPT	10						Circular	Semiground	Stone?	2	2	2	Yes	75	Top		-2.05745	30.206806	1,421
18	Cyimo			MASO6RE1	14		Kanombe	Masaka	Kicukiro	Cyimo	Storage	50	30	Operational				Circular	Semiground	Concrete	6	2	2	Yes	90	Top		-1.996025	30.192659	1,416
19	Cyimo	Masaka Jehowba, Down Hill		MASO7RE1	13	Knmb-20	Kanombe	Masaka	Kicukiro	Cyimo	Storage	150	100	Operational				Circular	Semiground	Stone	8	3	3	Yes	90	Top		-1.999979	30.199968	1,473
20	Cyimo	Masaka Charch, Up Hill		MASP8RE2	12	Knmb-21	Kanombe	Masaka	Kicukiro	Cyimo	BPT	50	5	Operational				Circular	Semiground	Concrete	3	2	2	Yes	90	Top		-2.001774	30.211201	1,563
21	Fawe Girls School			KACZ2F2RE01	15	Kcyru-3	Kacyiru	Gisozi	Gasabo	Musezero	Storage	250	100	Operational				Circular ?	Ground	Concrete	11	2.5	<Null>	**No, Bypassed**	100	Top		-1.913842	30.072253	1,471
22	Free zone			NDES7RE1	16		Remera	Ndera	Gasabo	Masoro	Storage	250	500	Operational				Other ?	Elevated	Steel	<Null>	3	0	Yes	150	Top		-1.949635	30.155031	1,469
23	Free zone	New Industrial Park		NDES7RE2	16	Rmra-3	Remera	Ndera	Gasabo	Masoro	Storage	250	500	Operational				Other ?	Elevated	Steel	<Null>	3	2	Yes	150	Top		-1.949778	30.154724	1,469
24	Gacuriro		190809	KACZ3D4RE01	17		Kacyiru	Kinyinya	Gasabo	Gacuriro	Storage	400	200	Operational				Circular	Ground	Concrete	11	4	<Null>	Provided	200	Top		-1.923208	30.093901	1,495
25	Gacuriro		190809	KACZ3D4RE02	17	Kcyru-2	Kacyiru	Kinyinya	Gasabo	Gacuriro	Storage	400	250	Operational				Circular	Ground	Concrete	11	4	<Null>	Provided	200	Top		-1.923486	30.09373	1,495
26	Gako	Ayabaraya	190819	MASP8RE1	18	Knmb-12	Kanombe	Masaka	Kicukiro	Gako	Storage	**50**		Operational				Circular	Ground	Concrete	6	4	4	Provided	90	Top		-2.00546	30.22085	1,475
27	Gatsata			MUYL11RE2			Kanombe				BPT	10						Circular	Ground	Stone?	2	2	2	No	63	Top		-1.969952	30.251363	1,525
28	Gihara			RUNDN4RE1	19	Nyge-1	Nyarugenge	Runda	Kamonyi	Gihara	Storage	400	400	Operational				Circular	Ground	Concrete	13	4	4	No	160	Top		-1.937084	29.965727	1,730
29	Gihogwe			JALJ10RE1	87	Nyge-29	Nyarugenge	Gatsata	Gasabo	Karuruma	Storage	<Null>	100	Not Ope.				Circular	Semiground	Stone	5	<Null>	<Null>	No	90	Bottom		-1.907305	30.044174	1,495
30	Gihogwe	Centre de Sante		JALJ10RE3	20	Nyge-11	Nyarugenge	Jali	Gasabo	Agateko	Storage	<Null>	250	Operational				Circular	Semiground	Concrete	9	2	<Null>	No	140	Top		-1.905917	30.046478	1,462
31	Gihuke			MASO9RE1	21	Knmb-18	Kanombe	Masaka	Kicukiro	Gako	Storage	10	5	Operational				Circular	Ground	Stone	4	4	4	No	0	<Null>		-1.996604	30.223932/ 30.082952	1,403
32	Gikondo primaire		190731	GIKW13RE1	22	Gkdo-5	Gikondo	Gikondo	Kicukiro	Kagunga	Storage	**400**	150	Operational				Circular	Semiground	Concrete	10	3	3	Provided	110	Top		-1.980201	30.076702	1,531
33	Golf 10	Kimironko	190819	KIMQ5RE3			Remera				Storage	50						Rectangular	Underground	Concrete	<Null>	4	3	No	200	Top		-1.92987	30.134825	1,505
34	Golf 8		190819	RET4RE3	24		Remera	Kimironko	Gasabo	Nyagatovu	Storage	600	600	Operational				Hexagom	Ground	Concrete	0	4	0	No	300	Top		-1.951217	30.11953	1,527
35	Golf 8	Rwahama	190819	RET4RE2	24	Rmra-11	Remera	Kimironko	Gasabo	Nyagatovu	Storage	1500	1500	Operational				Rectangular	Ground	Concrete	0	4	1	No	250	Top		-1.951441	30.119361	1,527
36	Golf five			<Null>							<Null>	250						Circular	Semi-ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,628
37	Golf five			KIGY11RE3	27	Gkdo-9	Gikondo	Kigarama	Kicukiro	Nyarurama	Storage	150	50	Operational				Circular	Semiground	Stone	6	2	<Null>	No	<Null>	Top		-2.001327	30.059058	1,628
38	Golf five kimisange	Kimisange P.S		KIGY11RE2	25	Gkdo-9	Gikondo	Kigarama	Kicukiro	Nyarurama	Storage	250	250	Operational				Circular	Underground ?	Concrete	3	2	<Null>	No	<Null>	Top		-2.001327	30.059058	1,628
39	Golf seven		190730	NIBX15RE2	26		Gikondo	Gatenga	Kicukiro	Nyanza	Storage	600	600	Operational				Hexagon	Ground	Concrete	0	4	<Null>	No	200, 250	Top		-1.985352	30.102244	1,510
40	Golf seven	Kikukiro P.S	190730	NIBX15RE1	26	Gkdo-2	Gikondo	Gatenga	Kicukiro	Nyanza	Storage	1500	600	Operational				Rectangular	Ground	Concrete	0	4	<Null>	No	300, 300	Top		-1.985361	30.102098	1,510
41	karama	Karama		KIGAP9RE1	28	Nyge-27	Nyamirambo	Kigali	Nyarugenge	Nyabugogo	Storage	400	400	Operational				Circular	Ground	Concrete	12	8	5	No	<Null>	Top		-1.960132	30.019674	1,519
42	Indatwa village			KIGX12RE2	29	Nyge-30	Gikondo	Kigarama	Kicukiro	Kigarama	Kiosk	5	50	Operational				Circular	Ground	Stone?	2	2	<Null>	No	<Null>	Top		-1.984685	30.072334	1,560
43	Intwari			KANM2RE1	88	Knmb-5	Kanombe	Kanombe	Kicukiro	Rubirizi	Kiosk	50	5	Not Ope.				Circular	Ground	Stone	4	2	2	No	40	Top		-1.975074	30.13642	1,471
44	Jabana			JABI11RE2	30		Nyarugenge	Jabana	Gasabo	Kabuye	Kiosk	8	10	Operational				Circular	Ground	Stone	4	2	<Null>	No	2	Top		-1.898211	30.056244	1,429
45	Jali			<Null>							Storage	125						Circular	Semi-ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,936
46	Jali	Camp Militaire 1		JALH8RE1	32	Nyge-18	Nyarugenge	Jali	Gasabo	Nyamitanga	Storage	400	600	Operational				Circular	Elevated	Concrete	7	<Null>	<Null>	No	125	Top		-1.882975	30.015297	2,071
47	Jali	Camp Militaire 2		JALG8RE1	33	Nyge-26	Nyarugenge	Jali	Gasabo	Muko	Unbalanced?	10	20	Operational				Circular	Semiground	Stone	3	2	<Null>	No	32	Bottom		-1.876315	30.012485	2,014
48	Jali			JALJ9RE1	35	Nyge-17	Nyarugenge	Jali	Gasabo	Nyamitanga	Storage	6	30	Operational				Circular	Underground	Concrete	3	2	<Null>	No	125	Top		-1.89867	30.025981	1,848
49	Jali	EP		JALI9RE2	34	Nyge-13	Nyarugenge	Jali	Gasabo	Nyamitanga	Kiosk	6	10	Operational				Circular	Underground	Stone	2	2	<Null>	No	32	Bottom		-1.900852	30.023305	1,932
50	Jali bugarama	Booster		JALI9RE1	31	Nyge-12	Nyarugenge	Jali	Gasabo	Agateko	Storage	150	150	Operational				Rectangular	Semiground	Concrete	<Null>	5	<Null>	No	125	Top		-1.896104	30.031792	1,608
51	Jali Haut			<Null>							Storage	140						Circular	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	2,065
52	Kabagesera			RUNDQ3RE1	36	Nyge-3	Nyarugenge	Runda	Kamonyi	Kabagesera	Unbalanced?	10	50	Operational				Circular	Ground	Concrete	6	2	2	Yes	110	Top		-1.967177	29.942677	1,674
53	Kabeza			KANL1RE2	89	Knmb-6	Kanombe	Kanombe	Kicukiro	Kabeza	Storage	20	5	Not Ope.				Circular	Ground	Stone	4	4	4	No	1	Top		-1.970691	30.126024	1,470
54	Kabizoza			NYARRE1	37	Nyge-10	Nyarugenge	Jali	Gasabo	Agateko	Storage	250	400	Operational				Circular	Ground	Concrete	12	2	2	No	200x150	Top		-1.907194	30.034529	1,662
55	Kacyiru Public Library			<Null>			Kacyiru				<Null>	150						Circular	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,450
56	Kagese			MASS7RE1	90	Knmb-15	Kanombe	Masaka	Kicukiro	Rusheshe	Kiosk	30	5	Not Ope.				Circular	Ground	Stone	3	2	2	No	0	Top		-2.036988	30.207354	1,374
57	Kamashashi	Sekimondo		NYARUM5RE1	38	Knmb-27	Kanombe	Nyarugunga	Kicukiro	Kamashashi	Storage	100	50	Operational				Rectangular	Elevated	Steel	7	3	3	Yes	75	Top		-1.975249	30.174751	1,421
58	Kamuhoza			NYARRE2			Nyarugenge				Storage	10						Circular	Ground	Concrete	3	3	3	Yes	32	Top		-1.905811	29.948721	1,574
59	Kankuba I			<Null>							Storage	50						Circular	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,567
60	Kankuba II			<Null>							Storage	150						<Null>	Ground	Concrete	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,565
61	Kanyetabi			MASR7RE1	91	Knmb-14	Kanombe	Masaka	Kicukiro	Rusheshe	Kiosk	10	5	Not Ope.				Circular	Ground	Concrete	4	2	1	No	32	Top		-2.024548	30.195401	1,404
62	Kanyinya			MUYL12RE2			Kanombe				BPT	3						Circular	Ground	Stone	3	2	2	No	60	Top		-1.96847	30.274609	1,500
63	Kanyinya			KANM8RE1			Nyarugenge				Storage	250						Circular	Semiground	Concrete	10	3	3	No	150	Top		-1.928457	30.014629	1,827
64	Kanyinya			MUYL12RE1			Kanombe				BPT	10						Circular	Semiground	Stone	3	2	2	No	60	Top		-1.970887	30.273542	1,539
65	Karama			KANN4RE1	92	Knmb-2	Kanombe	Kanombe	Kicukiro	Karama	Storage	10	5	Not Ope.				Circular	Ground	Stone	2	2	2	No	1	Top		-1.991744	30.159549	1,422
66	Karama	Rukundo Vilage		KANO3RE3	73		Kanombe	Kanombe	Kicukiro	Karama	Storage	20	5	Operational				Circular	Ground	Stone	5	2	2	No	0	Top		-1.992376	30.149583	1,470
67	Karama			<Null>							Storage	2000						Rectangular	Underground	Concrete	<Null>	<Null>	<Null>	<Null>	<Null>	Top		-1.963636 -1.963667	30.023316 30.023316	1,562
68	Katabaro			KIM&GITP11RE200	39	Nyge-28	Nyamirambo	Kimisagara	Nyarugenge	Katabaro	Storage	<Null>	250	Operational				Circular	Semiground	Concrete	9	4	3	No	100	Top		-1.955524	30.047485	1,523
69	Kavumu			<Null>							<Null>	100						<Null>	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,532
70	Kibagabaga			KIMQ4RE1	40	Rmra-10	Remera	Kimironko	Gasabo	Kibagabaga	Storage	27	30	**Not Used**				Other	Elevated	Steel?	3	3	1	Yes	110	Top		-1.931302	30.113372	1,496
71	Kibagabaga	Hospital	190819	KIMQ4RE2	40	Rmra-9	Remera	Kimironko	Gasabo	Kibagabaga	Storage	200	200	Operational				Circular	Ground	Concrete	14	4	1	Provided	200	Top		-1.931619	30.112461	1,496
72	Mwendo-Rwesero		190725	NYAMIRE1	41	Nymb-5	Nyamirambo	Kigali	Nyarugenge	Ruriba	Storage	50	50	Operational				Circular	Semiground	Concrete	6	3	<Null>	Provided	90	Top		-1.983639	30.024173	1,614
73	Kigarama	Rusororo		RUSM7RE5	83		Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	250	250	Operational				Rectangular	Elevated	Steel	0	3	3	Yes	200	Top		-1.977384	30.199171	1,463
74	Kigarama	Rusororo		RUSM7RE4	83		Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	250	250	Operational				Rectangular	Elevated	Steel	<Null>	3	3	Yes	200	Top		-1.977397	30.199338	1,464
75	Kigarama	Rusororo		RUSM7RE2	83		Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	250	250	Operational				Rectangular	Elevated	Steel	0	3	3	Yes	200	Top		-1.977485	30.199173	1,463
76	Kigarama	Rusororo		RUSM7RE3	83	Knmb-29	Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	250	250	Operational				Rectangular	Elevated	Steel	0	3	3	Yes	200	Top		-1.977496	30.199338	1,463
77	Kimisagara			KIM&GITO11RE204	42		Nyamirambo	Kimisagara	Nyarugenge	Kimisagara	Storage	600	2400	Operational				Hexagon ?	Semiground	Concrete	<Null>	4	4	No	600	Top		-1.944514	30.046004	1,430
78	Kimisagara			KIM&GITO11RE203	42		Nyamirambo	Kimisagara	Nyarugenge	Kimisagara	Storage	600	600	Operational				Hexagon ?	Semiground	Concrete	<Null>	5	4	No	300	Top		-1.944502	30.046192	1,431
79	Kimisagara			KIM&GITO11RE202	42		Nyamirambo	Kimisagara	Nyarugenge	Kimisagara	Storage	600	600	Operational				Hexagon ?	Semiground	Concrete	<Null>	5	4	No	300	Top		-1.944505	30.046546	1,429
80	Kimisagara			KIM&GITO11RE201	42		Nyamirambo	Kimisagara	Nyarugenge	Kimisagara	Storage	600	600	Operational				Hexagon ?	Semiground	Concrete	<Null>	5	4	No	400	Top		-1.944505	30.046729	1,429
81	Kimisagara			KIM&GITO11RE200	42		Nyamirambo	Kimisagara	Nyarugenge	Kimisagara	Storage	2400	600	Operational				Rectangular ?	Semiground	Concrete	<Null>	4	4	No	300	Bottom		-1.94471	30.046116	1,433
82	Kinyambi			NYARRE7			Nyarugenge				Storage	10						Circular	Ground	Concrete	2	2	2	Yes	32	Top		-2.007556	29.929279	1,657
83	Kinyinya			BUO5RE1	43	Rmra-7	Remera	Kinyinya	Gasabo	Gasharu	Storage	30	30	Operational				Circular	Underground	Concrete	6	4	1	No	150	Top		-1.908096	30.126016	1,485
84	Kivugiza			NYD4RE1	47	Nymb-6	Nyamirambo	Nyamirambo	Nyarugenge	Cyivugiza	Storage	30	30	Operational				Rectangular	Ground	Steel	10	4	3	No	100	Top		-1.980434	30.040344	1,658

No.	Name of Reservoir	Note	Site Survey Day	ID_code	No	Drawing No	Branch Office	Sector	District	Cell	Function	Capacity (m3)	Capacity	Operational Condition	Operator	Overflow	Bypass	Form	Fundation	Material	Diameter	Height (m)	HWL?	Float Valve	Iinlet pipe/ FV Dia.	Inlet_pipe Location	Flow Meter	Latitude	Longitude	Elevation (m)
85	Kizanye mpazi			KIM&GITP11RE2	44	Nyge-25	Nyarugenge	Gitega	Nyarugenge	Akabeza	Storage	300	50	Operational				Rectangular	Underground	Concrete	<Null>	3	<Null>	No	80	Bottom		-1.954563	30.054028	1,424
86	Kmisange			KIGY11RE1	93	Gkdo-2	Gikondo	Kigarama	Kicukiro	Nyarurama	Kiosk	5	5	Not Ope.				Circular	Ground	?	2	2	<Null>	No	<Null>	Top		-1.99534	30.056023	1,544
87	kumunyinya			KICW14RE2	45	Gkdo-13	Gikondo	Gatenga	Kicukiro	Gatenga	Kiosk	5	10	Operational				Circular	Ground	Plastic	2	2	<Null>	No	<Null>	Top		-1.977501	30.091599	1,437
88	Kuri petit prince	Rujugiro	190731	KIGX12RE1	46	Gkdo-6	**Gikondo**	Gikondo	Kicukiro	Kagunga	Storage	100	100	**Operational**				Circular	Ground	Concrete	5	4	<Null>	**Operational**	**80**	**Top**		-1.987856	30.07194	1,616
89	Kwanyiranuma			KIM&GITQ11RE1	49		Nyarugenge	Nyarugenge	Nyarugenge	Biryogo	Storage	1200	600	Operational				Octagon (Two)	Ground	Concrete	<Null>	<Null>	<Null>	No	300	Bottom		-1.966691	30.059912	1,518
90	Mageragera RCS			<Null>							<Null>	<Null>						<Null>	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,509
91	Maison des jeune kabuga			RUSM9RE1	50	Knmb-26	Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	100	100	Operational				Rectangular	Ground	Stone	7	5	5	Yes	100	Top		-1.974363	30.221725	1,468
92	Marembo			MUYL10RE1			Kanombe				BPT	10						Circular	Ground	Stone	2	2	2	Yes	63	Top		-1.969151	30.237658	1,429
93	Masizi			BUP5RE1			Remera				Storage	100						Circular	Underground	Concrete	8	2	<Null>	No	<Null>	Bottom		-1.918954	30.128566	1,417
94	Masoro bas			NDER6RE1	2	Rmra-4	Remera	Bumbogo	Gasabo	Kinyaga	Storage	800	1250	Operational				Rectangular	Ground	Concrete	<Null>	5	1	No	300	Top		-1.933368	30.14714	1,524
95	Masoro bas			NDER6RE2	2		Remera	Bumbogo	Gasabo	Kinyaga	Storage	800	1250	Operational				Rectangular	Ground	Concrete	<Null>	5	1	No	300	Top		-1.933353	30.147336	1,524
96	Masoro free zone phase	Haut	190819	BUQ7RE1	3	Rmra-5	Remera	Bumbogo	Gasabo	Kinyaga	Storage	1000		**Operational**				**Rectangilar**	Ground	**Concrete**	20	6	0	**No**	**200**	Top		-1.928016	30.155336	1,594
97	Master steel			KICW14RE1							Kiosk	3						Circular	Ground	Plastic	2	2	<Null>	No	<Null>	Top		-1.978484	30.100087	1,448
98	Mburabuturo			NYARUP12RE2	51		Nyarugenge	Nyarugenge	Nyarugenge	Kiyovu	Storage	10	10	Operational				Circular?	Underground	Concrete	<Null>	8	<Null>	No	<Null>	Bottom		-1.955717	30.072437	1,392
99	Mburabuturo	P.S.		NYARUP12RE1	51	Nyge-22	Nyarugenge	Nyarugenge	Nyarugenge	Kiyovu	Storage	10	30	Operational				Rectangular	Underground	Concrete	<Null>	5	<Null>	No	100	Bottom		-1.955776	30.07244	1,391
100	Mont Kigali			<Null>							Storage	5000						Rectangular	Underground	Concrete	<Null>	<Null>	<Null>	<Null>	<Null>	Bottom		-1.974646 -1.974686	30.035417 30.035491	1,800
101	Mont Kigali haut		190725	NYAKC4RE1	52	Nymb-3	**Nyamirambo**	Kigali	Nyarugenge	Kigali	Storage	400	400	Operational				Circular	Ground	Concrete	15	8	4	No	300	Top Roof		-1.974988	30.035563	1,790
102	Mumena	Rwampara P.S.		NYD5RE1	76	Nyge-23	Nyarugenge	Nyamirambo	Nyarugenge	Mumena	BPT	200	200	Operational				Other	Underground	Concrete	<Null>	2	2	No	<Null>	Bottom		-1.98159	30.059051	1,439
103	Munkoto			RUGAT2RE1	53	Nyge-4	Nyarugenge	Rugarika	Kamonyi	Sheli	Storage	50	50	Operational				Circular	Ground	Stone	4	4	4	Yes	90	Top		-1.990849	29.93368	1,605
104	Murambi		190730	GATY14RE2	54	Gkdo-4	**Gikondo**	Gatenga	Kicukiro	Nyanza	<Null>	35	30	**Operational**				**Circular**	**Ground**	**Stone**	3	2	<Null>	**No**	110	<Null>		-1.996978	30.088421	1,625
105	Murambi	MTN Antena		MASS8RE1	94	Knmb-30	Kanombe	Masaka	Kicukiro	Gako	BPT	3	5	Not Ope.				Circular	Ground	Stone	4	2	2	Yes	75	Top		-2.030841	30.214312	1,499
106	Musebeya			RUNDP5RE1	95	Nyge-8	Nyarugenge	Runda	Kamonyi	Muganza	Storage	10	10	Not Ope.				Circular	Ground	Concrete?	6	2	2	Yes	90	Top		-1.954798	29.974644	1,550
107	Nezerwa		190819	NDERK5RE1	55	Gkdo-15	Kanombe	Ndera	Gasabo	Kibenga	Storage	150	250	Operational				Rectangular	**Elevated**	Steel	0	3	4	Yes	200	Top		-1.957089	30.169014	1,468
108	Ngarama			MASR5RE1	97	Knmb-11	Kanombe	Masaka	Kicukiro	Mbabe	Kiosk	40	5	Not Ope.				Circular	Ground	Stone	5	3	3	Yes	40	Top		-2.022517	30.180814	1,390
109	Ntora			KACZ2D1RE01	56	Kcyru-4	Kacyiru	Gisozi	Gasabo	Ruhango	Storage	5000		Operational				Rectangular	Ground	Concrete	<Null>	6	6	No	600	Top		-1.915331	30.056157	1,565
110	Ntora			KACZ2C1RE01	56		Kacyiru	Gisozi	Gasabo	Ruhango	Storage	5000		Operational				Rectangular	Ground	Concrete	0	6	6	No	600	Top		-1.915021	30.05606	1,565
111	Ntungamo			<Null>							<Null>	200						<Null>	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	?	1,688
112	Nyabitare			RUNDO5RE1	57	Nyge-9	Nyarugenge	Runda	Kamonyi	Ruyenzi	Storage	10	10	Operational				Circular	Ground	Stone	4	2	2	Yes	150	Top		-1.949965	29.971139	1,614
113	Golf Make - Nyakabanda	Mont Kigali Bas	190725	NYAKC4RE2	58	Nymb-1	**Nyamirambo**	Nyakabanda	Nyarugenge	Nyakabanda Ii	Storage	400	400	Operational				**Hexagon**	Ground	Concrete	12	5	4	Provided	200	Top		-1.976791	30.039748	1,680
114	Nyakabanda			RWB5RE2							Kiosk	10						Circular	Semiground	Steel	1	2	2	No	25	Top		-1.96767	30.049768	1,531
115	Nyakabanda			RWB5RE1							Storage	4						Rectangular	Semiground	Steel	2	1	3	Yes	25	Top		-1.963792	30.050716	1,531
116	Nyanza	Nyanza Up Hill		GAHZ14RE1	59	Gkdo-15	Gikondo	Kagarama	Kicukiro	Rukatsa	Storage	400	400	Operational				Rectangular	Elevated ?	Concrete	0	<Null>	<Null>	Yes	300	<Null>		-2.003365	30.09739	1,700
117	Nyarumanga			<Null>							Storage	250						<Null>	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		<Null>	<Null>	1,711
118	Nyarurama	Nyarurama1	190731	GATZ12RE2	60	Gkdo-10	**Gikondo**	Gatenga	Kicukiro	Nyarurama	Storage	125	125	Operational				**Circular**	Ground	Concrete	6	4	<Null>	**Provided**	110	<Null>		-2.009556	30.073053	1,625
119	Nyarurama ku kigega1	Nyarurama2		GATAA12RE1	61	Gkdo-11	Gikondo	Gatenga	Kicukiro	Nyarurama	<Null>	125	125	Operational				Circular	Elevated	Concrete	8	4	<Null>	Yes	110	Top		-2.013425	30.068927	1,688
120	Nyarurembo	Nyarurembo_Regie		KANL1RE1	98	Knmb-10	Kanombe	Kanombe	Kicukiro	Kabeza	Storage	30	5	Not Ope.				Circular	Ground	Concrete	5	2	3	Yes	1	Top		-1.969933	30.118759	1,430
121	Nyarutarama		190819	RES3RE1	62	Rmra-13	**Remera**	Remera	Gasabo	Nyarutarama	Storage	400	200	Operational				Circular	Ground	Concrete	14	6	6	**Provided**	110	Top		-1.944969	30.103797	1,479
122	Nzove			KANN7RE3	63	Nyge-19	Nyarugenge	Kanyinya	Nyarugenge	Nzove	Storage	250	250	Operational				Rectangular	Ground	Concrete	10	3	63	No	150	Top		-1.935032	30.006932	1,512
123	Nzove			KANN7RE1	63		Nyarugenge	Kanyinya	Nyarugenge	Nzove	Storage	2000	2000	Operational				Rectangular	Semiground	Concrete	<Null>	6	6	No	600	Top		-1.942431	30.001344	1,366
124	Nzove			KANN7RE2	63	Nyge-15	Nyarugenge	Kanyinya	Nyarugenge	Nzove	Storage	36	36	Operational				Rectangular	Semiground	Concrete	<Null>	3	3	No	250	Top		-1.942021	30.00058	1,364
125	Nzove I New			<Null>							<Null>	2000						Rectangular	Ground	?	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>		-1.943141 -1.943120	30.001547 30.001514	1,363
126	Nzove II			<Null>							Storage	1000						Circular	Ground	Steel	<Null>	<Null>	<Null>	<Null>	<Null>	Top		<Null>	<Null>	1,370
127	Plateau	Centre ville Sonarwa		KIM&GITO11RE4	8		**Nyarugenge**	Nyarugenge	Nyarugenge	Kiyovu	Unbalanced?	70	300	Operational				Rectangular	Elevated	Steel	<Null>	3	<Null>	No	150	Top		-1.955095	30.061435	1,559
128	Plateau	Centre ville Sonarwa		KIM&GITO11RE3	8	Nyge-21	**Nyarugenge**	Nyarugenge	Nyarugenge	Kiyovu	Unbalanced?	70	300	Operational				Rectangular	Elevated	Steel	<Null>	3	0	No	150	Top		-1.955134	30.061438	1,559
129	Plateau	Centre ville Sonarwa		KIM&GITO11RE5	8		**Nyarugenge**	Nyarugenge	Nyarugenge	Kiyovu	Unbalanced?	70	300	Operational				Rectangular	Elevated	Steel	<Null>	3	<Null>	No	150	Top		-1.955072	30.061433	1,559
130	Radari			KANO3RE2	65	Knmb-19	Kanombe	Kanombe	Kicukiro	Busanza	Kiosk	20	5	Operational				Circular	Semiground	Stone	5	2	2	No	0	Top		-1.995619	30.146396	1,489
131	Real estate	REAL ASTADY		RUSM7RE1	66	Knmb-25	Kanombe	Rusororo	Gasabo	Nyagahinga	Storage	100	200	Operational				Rectangular	Elevated	Steel	<Null>	2	2	Yes	3	Top		-1.980606	30.200269	1,442
132	Rebero			MASO8RE1	68	Knmb-1	Kanombe	Masaka	Kicukiro	Gako	BPT	15	5	Operational				Circular	Ground	Stone	3	2	2	No	3	Top		-1.997947	30.216776	1,443
133	Rebero	Rebero P.S	190731	KIGY12RE1	67	Gkdo-8	**Gikondo**	Kigarama	Kicukiro	Bwerankori	Storage	**200**		**Operational**				**Circular**	Semiground	**Stone**	12	4	<Null>	**No**	**100x2, 200**	Top		-1.998583	30.068719	1,758
134	Rebero carrier	Gikondo Quary	190731	KIGX12RE3	69	Gkdo-7	**Gikondo**	Kigarama	Kicukiro	Bwerankori	Storage	**50**		**Operational**				**Circular**	Semiground	**Stone**	5	2	<Null>	**No**	**80**	Top		-1.988955	30.06905	1,630
135	Rebero kuri radari	Radar Steel tank 1		GATZ12RE1	64	Gkdo-12	Gikondo	Kigarama	Kicukiro	Bwerankori	Storage	20	250	Operational				Other	Elevated	Concrete	0	3	<Null>	No	0	Top		-2.007727	30.064356	1,810
136	Remera	Remera_Stadium		RET4RE1	70		Remera	Remera	Gasabo	Rukiri Ii	Storage	400	200	Operational				Circular	Ground ?	Steel?	12	4	0	No	160	Top		-1.954136	30.115313	1,520
137	Rubona	Rubona (Runda)		RUNDO4RE1	72	Nymb-4	Nyamirambo	Runda	Kamonyi	Muganza	Storage	50	10	Operational				Circular	Ground	Stone	8	3	3	Yes	90	Top		-1.951292	29.964911	1,690
138	Rubona	Rugarama	190729	NYE4RE1	71	Nyge-2	**Nyamirambo**	Nyamirambo	Nyamirambo	Rugarama	Storage	100		Operational				Circular	Semiground	**Stone**	6	3	2	No	**80**	Top		-1.992128	30.039239	1,623
139	Rugari	Rugari_Regie		KANM3RE1	99	Knmb-9	Kanombe	Nyarugunga	Kicukiro	Nonko	Kiosk	5	5	Not Ope.				Circular	Ground	Stone	3	2	1	No	1	Top		-1.976475	30.151369	1,480
140	Rugendabari			<Null>							Storage	100						Circular	Ground	Concrete	<Null>	<Null>	<Null>	Yes	<Null>	Top		<Null>	<Null>	1,459
141	Rusheshe			MASS6RE1	100	Knmb-8	Kanombe	Masaka	Kicukiro	Rusheshe	Kiosk	10	5	Not Ope.				Circular	Ground	Concrete	4	2	2	No	32	Top		-2.032717	30.192884	1,404
142	Ruyenzi	Ruyenzi 2		RUNDP6RE2	75	Nyge-7	Nyarugenge	Runda	Kamonyi	Ruyenzi	Storage	50	30	Operational				Circular	Ground	Stone	4	3	3	No	75	Top		-1.955911	29.984895	1,576
143	Ruyenzi	Ruyenzi 1		RUNDP6RE1	74	Nyge-6	Nyarugenge	Runda	Kamonyi	Ruyenzi	Storage	400	400	Operational				Circular	Semiground	Concrete	13	4	4	No	250	Top		-1.960488	29.985652	1,508
144	Rwandatel	Nyanza Down Hill	190730	GATY14RE1	77	Gkdo-3	**Gikondo**	Kagarama	Kicukiro	Rukatsa	Storage	75	100	**Operational**				**Circular**	Ground	Conctete	10	2	3	No	100	Top		-1.998404	30.099477	1,650
145	Rwankuba			<Null>			**Kacyiru**				Storage	250						Circular	Ground	Concrete	<Null>	3	<Null>	Yes	160	Bottom		<Null>	<Null>	1,473
146	Rwezamenyo	Golf4-Nyakabanda P.S.	190725	RWC5RE3	78		**Nyamirambo**	Rwezamenyo	Nyarugenge	Kabuguru Ii	Storage	600	600	Operational				**Hexagon**	Ground	Concrete	10	6	6	No	200	Top		-1.975627	30.048531	1,573
147	Rwezamenyo			RWC5RE1			**Nyamirambo**				Kiosk	10						Circular	Ground	Steel/ Plastic?	2	3	3	No	0	Top		-1.971238	30.053939	1,519
148	Rwezamenyo	Golf4-Nyakabanda	190725	RWC5RE2	78		**Nyamirambo**	Rwezamenyo	Nyarugenge	Kabuguru Ii	Storage	600	600	Operational				**Hexagon**	Ground	Concrete	10	6	6	No	200	Top		-1.975459	30.048507	1,572
149	Rwinyange	Rwinyange		NYARUK2RE2	101	Knmb-7	Kanombe	Nyarugunga	Kicukiro	Rwimbogo	Kiosk	10	5	Not Ope.				Circular	Ground	Stone	4	2	2	Yes	40	Top		-1.959012	30.140309	1,456
150	Ryabahesha			MUYL11RE1			Kanombe				Storage	400						Circular	Ground	Concrete	12	7	7	Yes	200	Top		-1.967497	30.25747	1,608
151	Sheli			RUGAT3RE1			Nyarugenge				Unbalanced?	10						Circular	Ground	Concrete	3	3	2	Yes	90	Top		-1.991988	29.948406	1,559
152	Sheli			RUGAS3RE1	79	Nyge-5	Nyarugenge	Rugarika	Kamonyi	Sheli	Storage	2	10	Operational				Rectangular	Ground	Concrete	<Null>	2	2	Yes	63	Top		-1.98708	29.950716	1,468
153	Umudugudu wa bwiza	Muyange		NIBX15RE3	96		Gikondo	Kagarama	Kicukiro	Kanserege	Kiosk	10	50	Not Ope.				Circular	Ground	?	2	2	<Null>	No	<Null>	Top		-1.991049	30.113287	1,469
154	UTEXRWA	Vision 2020		KACZ4E3RE01	80	Kcyru-1	Kacyiru	Kinyinya	Gasabo	Gacuriro	Storage	150	200	Operational ?				Rectangular	Ground	Concrete?	<Null>	6	<Null>	No	<Null>	Top		-1.928194	30.078609	1,385
155	Yanze			NYARRE3			Nyarugenge				Storage	750						Rectangular	Semiground	Concrete	8	8	8	No	600	Bottom		-1.919047	30.022198	1,457
156	Yanze			NYARRE4			Nyarugenge				Storage	750						Rectangular	Semiground	Concrete	<Null>	8	8	No	600	Bottom		-1.919123	30.022227	1,457
157	Yanze			NYARRE5			Nyarugenge				Storage	750						Rectangular	Semiground	Concrete	<Null>	8	8	No	600	Bottom		-1.919224	30.022266	1,457
158	Yanze			NYARRE6			Nyarugenge				Storage	750						Rectangular	Semiground	Concrete	8	8	8	No	600	Bottom		-1.919317	30.022301	1,455

	Biryogo P.S	Kwanyiranuma			49	Nyge-24	Nyarugenge	Nyarugenge	Nyarugenge	Biryogo			600	Operational														-1.966842		1,518
		Radar Steel tank 1(Rebero Kuri Radari)			64		Gikondo	Kigarama	Kicukiro	Bwerankori			250	Operational																1,809
		Bihenbe City			81	Knmb-24		Nyakariro	?	?			100	Operational																1,635
		Nyabubare MTN Antena			82	Knmb-23		Nyakariro	?	?			200	Not Ope.				Circular		Stone				No, Bypassed						1,563

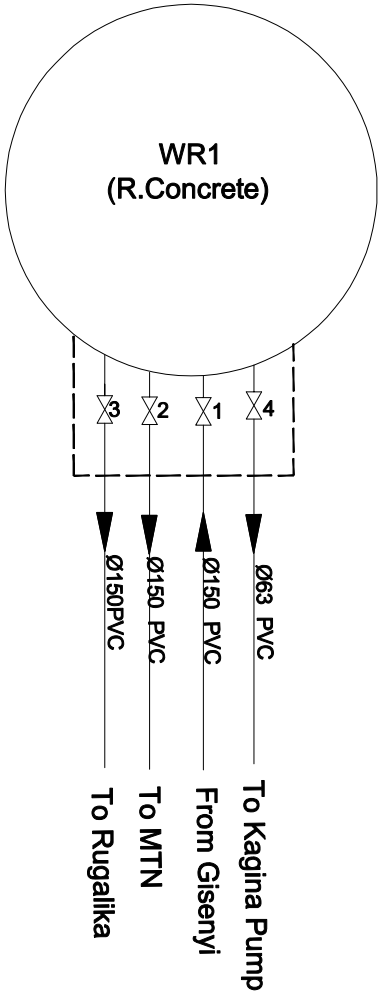
Reservoirs List No.	Qgis		
	Objectid	Location_N	Capacity
125	155	Nzove 1 New	1000
	156	Nzove 1 New	1000
67	157	Karama	1000
	158	Karama	1000
100	159	Mont Kigali	2500
	160	Mont Kigali	2500
124	161	Nzove	1000
126	162	Nzove 1	1000
-	163	Tete	150
-	164	Rushyubi	50
-	165	Burema	50
-	166	Mata	100
-	167	Karembure	25
-	168	Akarambi	10
-	169	Nyarurenzi	100
-	170	Kwamuganga	10
-	171	Skol	100
-	172	NULL	100

不明配水池


New Nyarugenge
Kachiru DMA
Remera DMA
Nyamirambo DMA
Gikondo DMA
Kanombe DMA
Legend:
WTP : Water Treatment
: Reservoir
: Reservoir (Elevated)
P : Pumping Station
M : Flow Meter
: Water Source
: Nzove Transmission
: Kimisagara Transmission
: karenge Transmission Pipeline
: Distribution Pipe
: New Transmission Pipeline by WASAC Phase 1
: New Reservoir by WASAC Phase 1
Jali Camp Militaire 2 (20m3)
Jali Camp Militaire 1
Jali EP (10m3)
Jali PS (Q:??m3/h × 1,
Bugarama PS (Q:??m3/h × 1,
Jali Bugarama Booster (150m3)
Spring
Gihogwe PS (Q:19m3/h × 2,
Gihogwe Centre de Sante (400m3)
Kabizoza (400m3)
Amakawa (250m3)
Ntora (5,000m3 x 2)
Fawe Girls School (250m3)
Gacuriro (400m3 x 2)
Kanyinya (250m3)
Nzove(upper) (250m3)
Nzove (Up) PS (Q:25m3/h × 2,
River
Wells & River
Nzove II WTP
Nzove I WTP
Gihara (400m3)
Nyabitare (10m3)
Ruyenzi 2 (50m3)
Ruyenzi 1 (400m3)
Ruyenzi PS (Q:40m3/h × 2,
Rubona (50m3)
Kabagesera (50m3)
Munkoto (50m3)
Karama 2 (2,000m3)
Karama (400m3)
Karama PS (Q:36m3/h × 2,
Mont Kigali (5,000m3)
Mont Kigali Haut (400m3)
Nyakabanda (400m3)
Kimisagara WTP
Katabaro (250m3)
Kizanye-Mpazi PS (Q:30m3/h, H:170m)
(Q:20m3/h, H:170m)
Centre Ville (600m3 x 2)
Centre Ville PS (Q:80m3/h × 3, H:64m)
Centre Ville Sonarwa
City Center (2,000m3)
Well
Mburabuturo PS (Q:45m3/h × 2 , H:230m)
Kwanyiranuma(Biyogo)
Biyogo PS (Q:150m3/h × 3,H:80m, 1standby)
Rwezamenyo (600m3 x 2)
Rwezamenyo PS (Q:55m3/h × 2,H:112m)
Rwampara PS (Q:34m3/h × 3(not same)
Golf 5 Kimisange
Kimisange New PS (Q:56m3/h x 3, H:
Kimisange Old PS (Q:10m3/h, H:258m)
(Q:32m3/h, H:287m)
Rebero Kuri Radari(150m3 x
Gikondo (5,000m3)
Rebero (250m3)
Rebero Carrier (150m3)
Rebero Antenna (5,000m3)
Nyarurama1 (125m3)
Nyarurama2 (125m3)
Kuri Petit Prince (50m3)
Gikondo Primaire
Golf 2 (Kimihurura)
Kimihurura PS (Q:80m3/h × 3, H:max65m)
Nyarutarama (400m3)
Golf 7 (Kicukiro) (600m3 x 2)
Kicukiro PS (Q:100m3/h × 2 ,
Rwandatel 2 (1,000m3)
Rwandatel (100m3)
Nyanza (400m3)
Nyanza 2 (7,500m3)
Gahanga (7,500m3)
kanzenze WTP
Bumbogo- Central St Leonard
Kinyinya PS (Q:30m3/h × 1, H:371m)
Kibagabaga (400m3+25m3xH6m)
Buhoro PS (Q:7m3/h,H:136m)
Buhoro (250m3)
Free Zone
Azam Haut (1,000m3)
Azam Ba (1,000m3 x 2)
Azam Ba PS (Q:35m3/h × 2 ,H:135m) 1 Standby
Nezerwa
Real Astady (200m3, H:15m)
Cyaruzinge (400m3)
Rusororo (250m3 x 4,
Maison des Jenes Kabuga (100m3)
Ryabaheshwa (400m3)
Cyimo (30m3)
Cyimo (Masaka Charch) (5m3)
Cyimo (Masaka Jehowba)
Kamashashi Sekimondo
Airport (2,000m3)
Kabeza (1,000m3)
Busanza (1,000m3)
Golf 8 (Remera) (600m3+750m3 x
Remera Studium
Chez Land (250m3)
Bihenbe Rural (500m3)
Gako (50m3)
Bihenbe City (100m3) Pressure Release
Nyabubare (200m3)
Nyabubare PS (Q:120m3/h × 2 ,H:180m:Rural)
(Q:???m3/h × 3 , H:???m:Kigali)
Karenge WTP
Karenge PS
Intake PS (Q:263m3/h × 3,H: 130m:New)
Lake
Byimana PS (Q:28m3/h × 2 , H:172m)
to Niboye
to Rural Network
to Remera
to City Center
to Kimihurura
to Kimisagara
to Kicukiro (DIP300)
to Kicukiro (DIP250)
to Kicukiro (DIP200)
to Kicukiro (DIP400)
to Gahanga
PVC DN40
PVC DN125
SP DN150
PVC DN75
PVC DN160
PVC DN110
PVC DN90
PVC DN63
PVC DN200
PVC DN250
PVC DN500
PVC DN400
PVC DN300
PVC DN150
PVC DN100
PVC DN50
DIP DN600
DIP DN500
DIP DN400
DIP DN300
DIP DN250
DIP DN200
DIP DN150
DIP DN110
DIP DN90
SP DN300
SP DN200
DIP

GIHARA RESERVOIR(400 CUM)

Nyge - 1



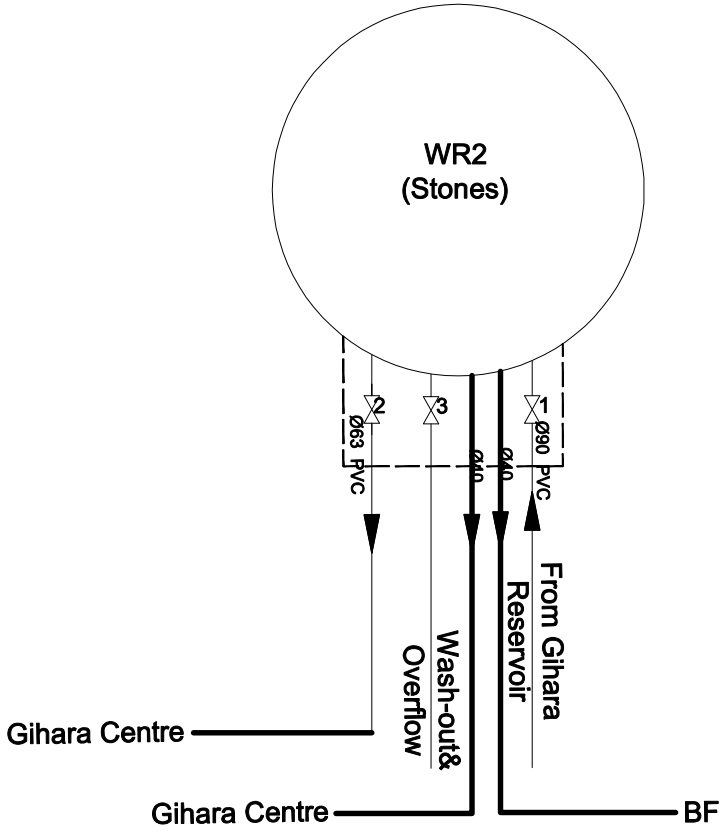
R6-15

LEGEND

1,2,3.Valve DN150
4.Valve DN 63

RUBONA RESERVOIR(50 CUM)

Nyge - 2

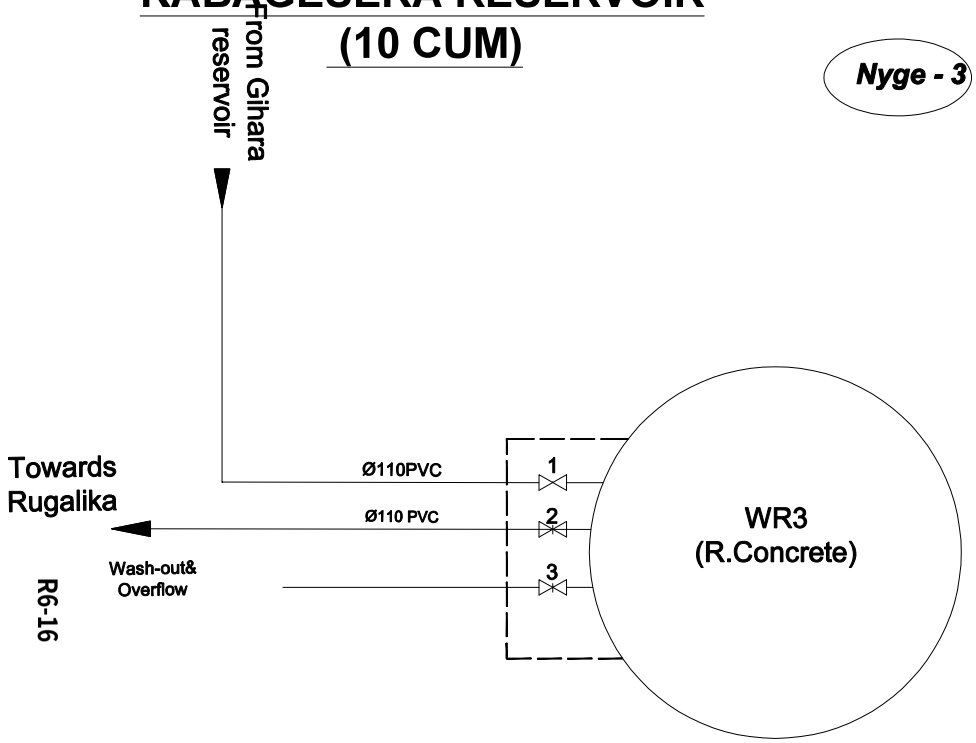


LEGEND

1.Valve DN 90
2.Valve DN 60

KABAGESERA RESERVOIR (10 CUM)

Nyge - 3

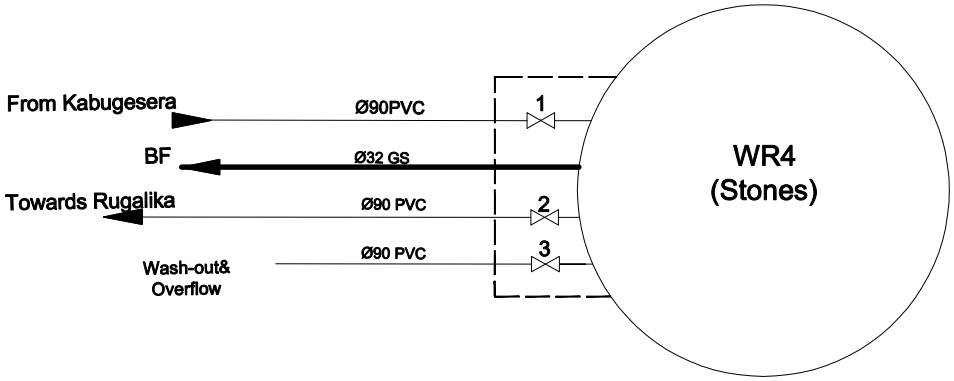


LEGEND

1,2. Vanne DN 100

RUGALIKA/ MUNKOTO RESERVOIR (50 CUM)

Nyge -4

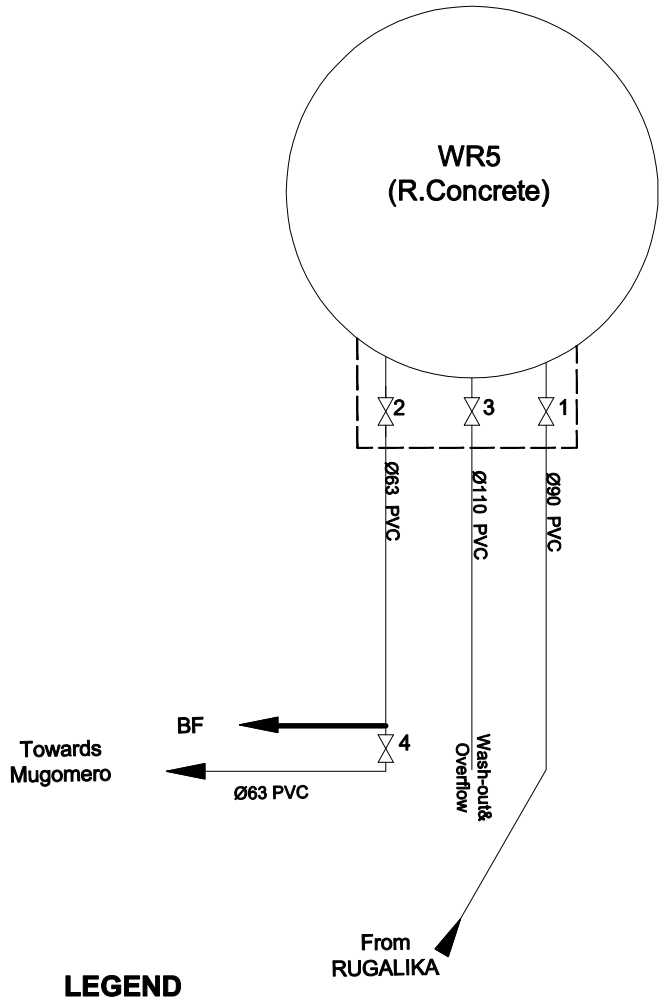


LEGEND

1,2,3. Vanne DN 90

RUGALIKA/SHELI RESERVOIR(10 CUM)

Nyge - 5



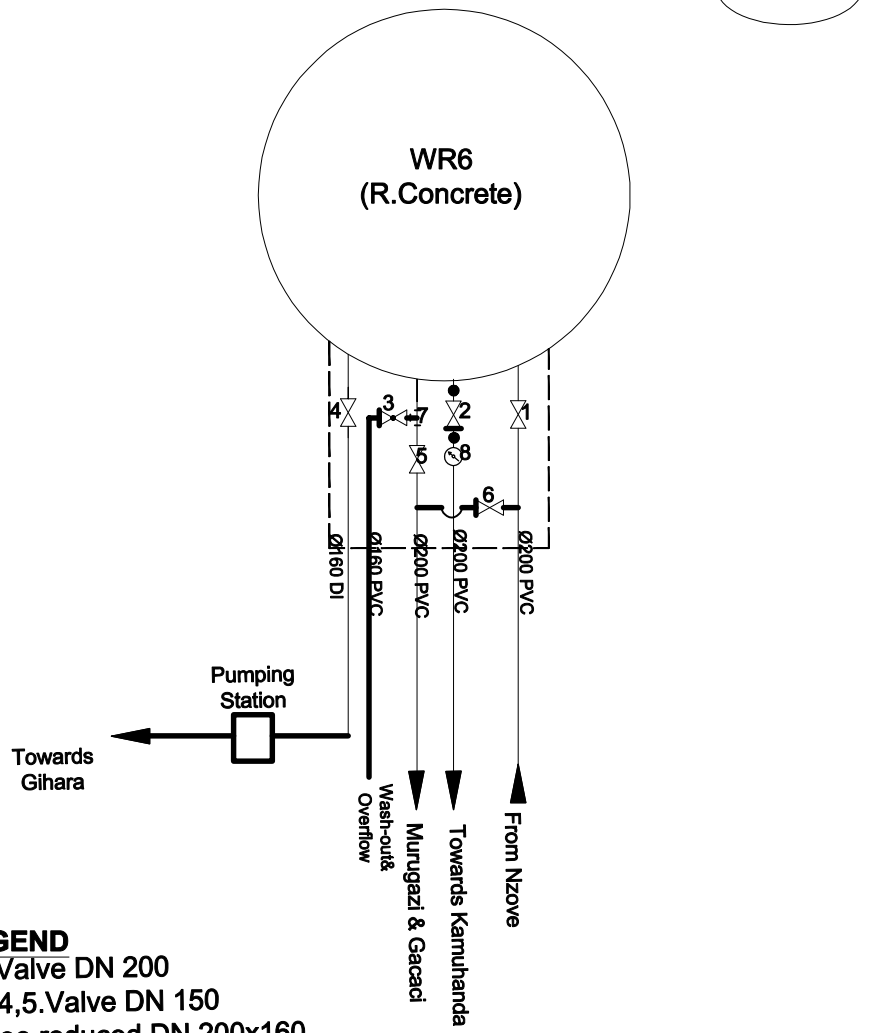
R6-17

LEGEND

1.Valve DN 90
2, 4.Valve DN 60
3. Valve 100

RUYENZI RESERVOIR(400 CUM)

Nyge -6

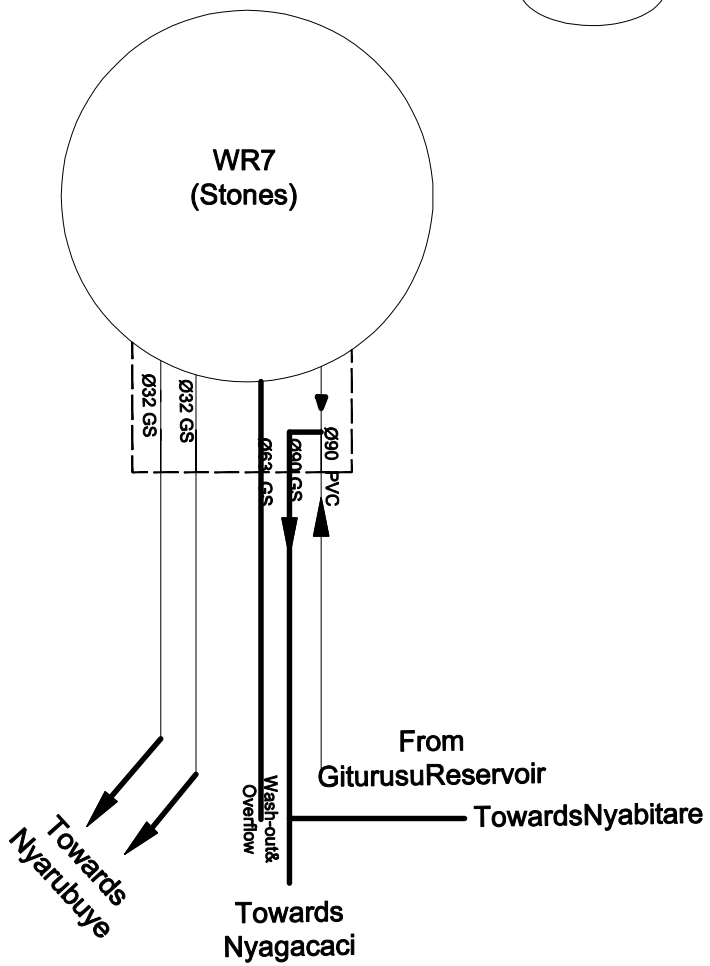


LEGEND

1,6.Valve DN 200
2,3,4,5.Valve DN 150
7. Tee reduced DN 200x160
8. Water meter

RUYENZI/ MTN RESERVOIR(50 CUM)

Nyge - 7



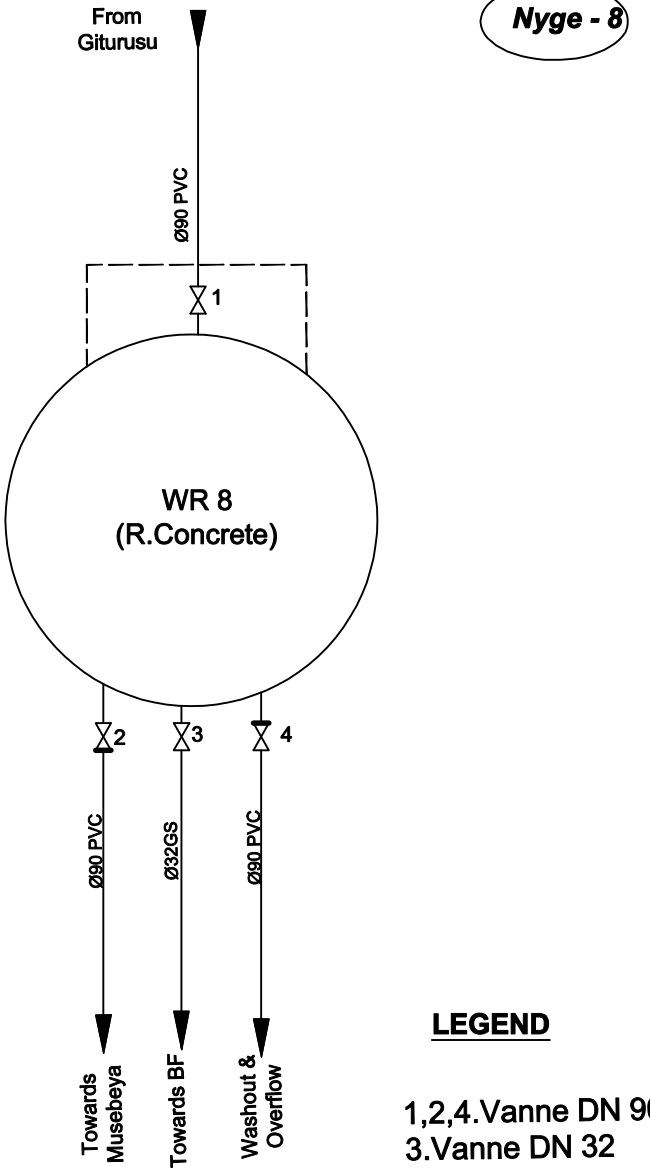
R6-18

LEGEND

1.Valve DN 90
2.Valve DN 60

MUSEBEYA RESERVOIR(10 CUM)

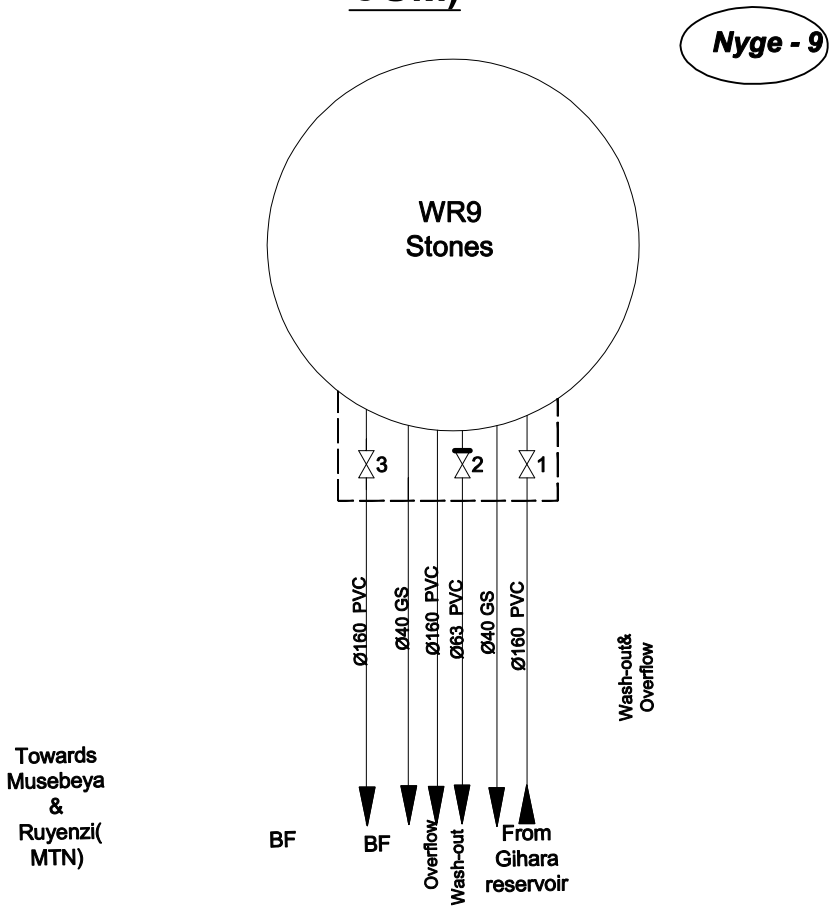
Nyge - 8



LEGEND

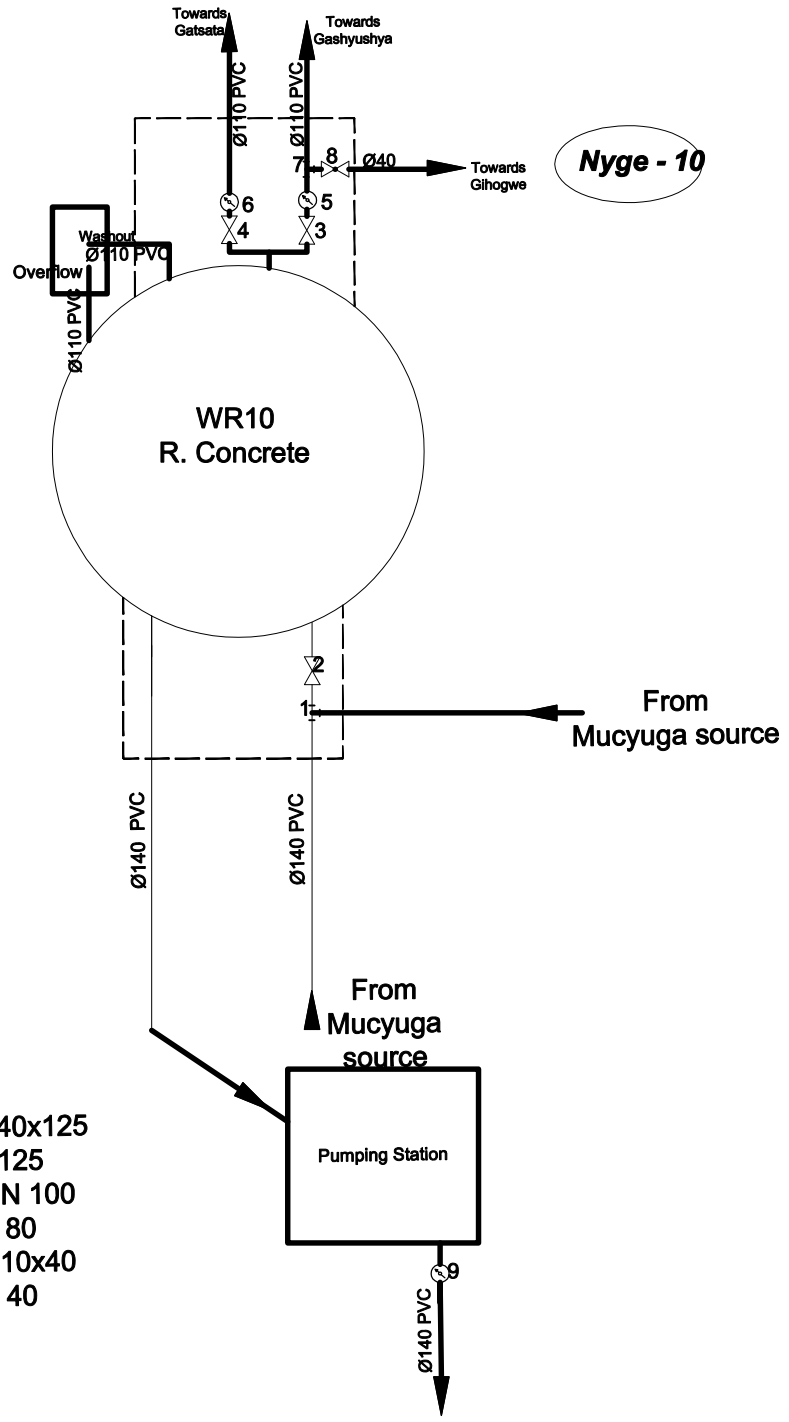
1,2,4.Vanne DN 90
3.Vanne DN 32

GITURUSU RESERVOIR(30 CUM)



R6-19

GIHOGWE I RESERVOIR(330 CUM)

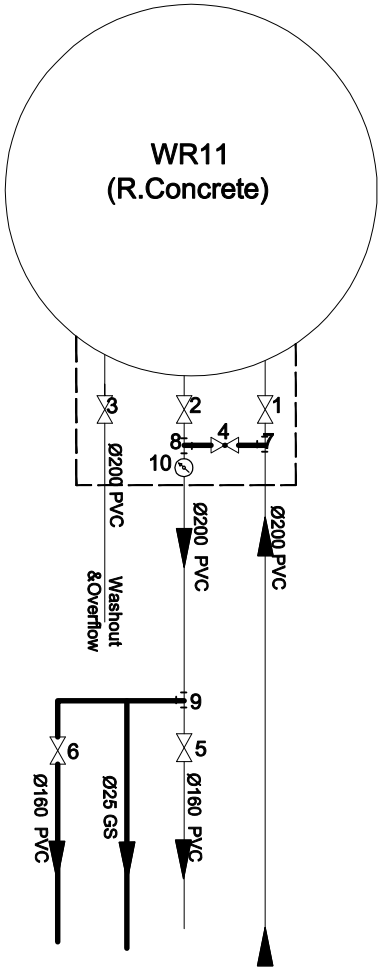


LEGEND

1. Tee DN 140x125
2. Valve DN 125
3,4. Valve DN 100
5,6,9. Meter 80
7. Tee DN 110x40
8. Valve DN 40

GIHOGWE II RESERVOIR(250 CUM)

Nyge - 11



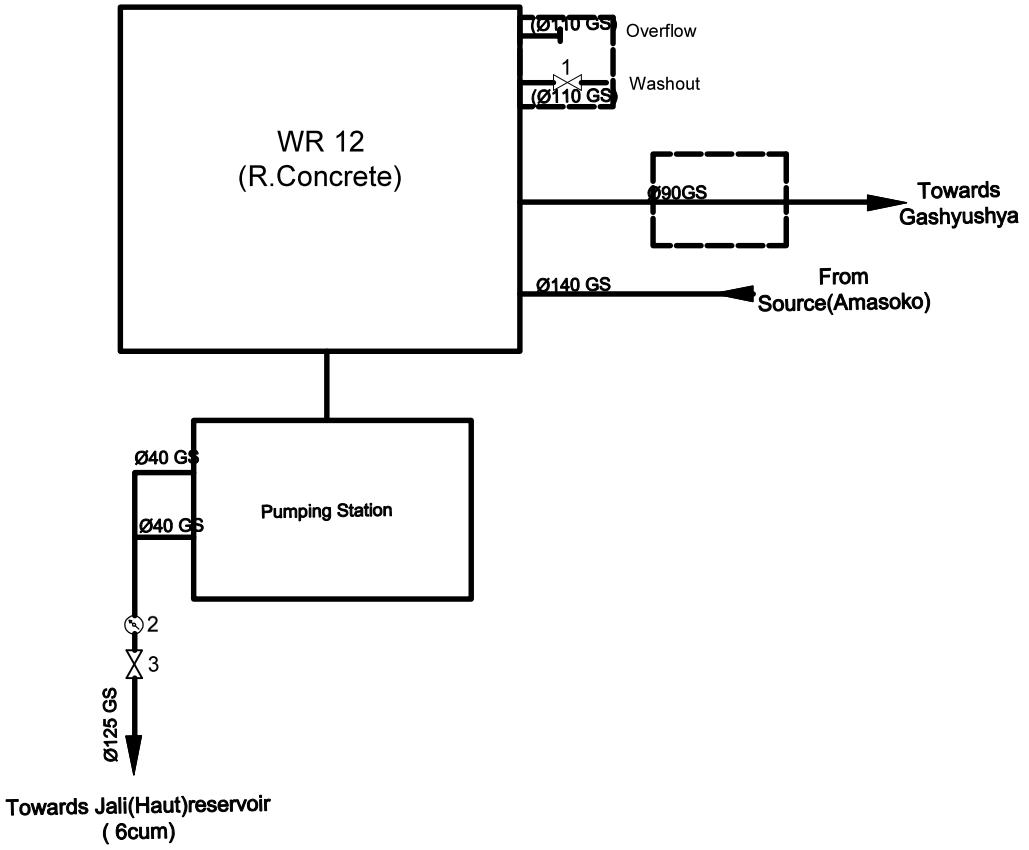
R6-20

LEGEND

1,2,3,4.Valve DN 200
5,6.Valve DN 100
7,8. Tee DN 200
9. Tee 200x160
10. Meter 200

JALI BUGARAMA(Bas) RESERVOIR(200 CUM)

Nyge - 12

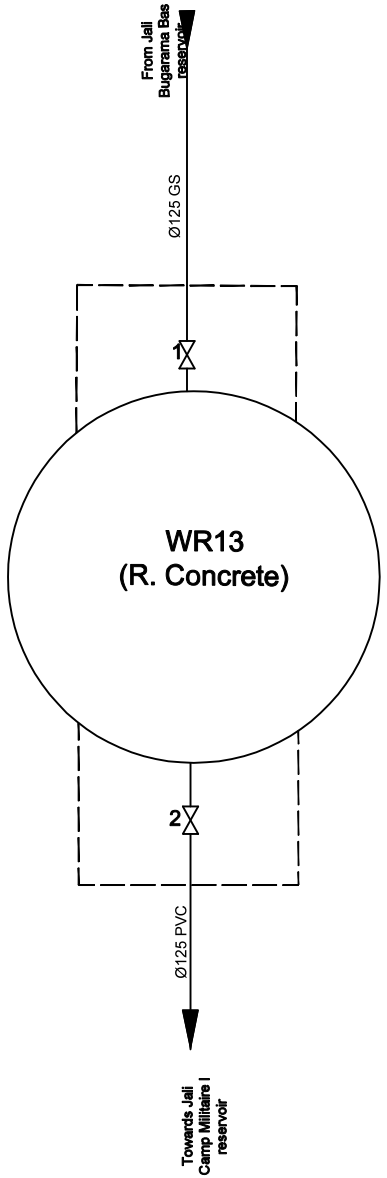


LEGEND

1. Valve DN 100
2. Meter 100
3. Valve DN 125

JALI (Haut) RESERVOIR(6 CUM)

Nyge - 13



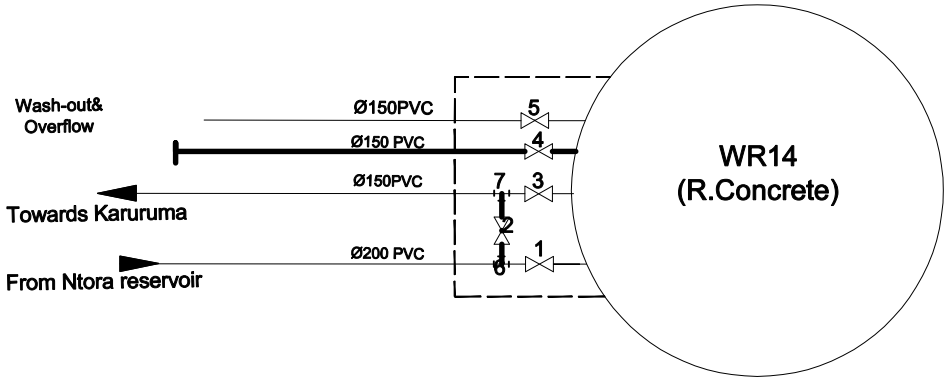
LEGEND

1,2. Valve DN 125

R6-21

AMAKAWA RESERVOIR (250 CUM)

Nyge -14

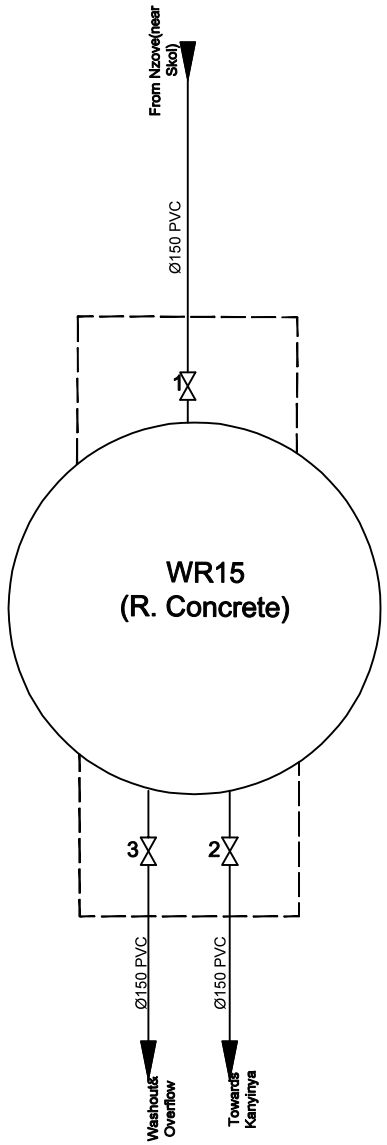


LEGEND

1,2. ValveDN 200
3,4,5. Valve DN 150
6. Tee DN 200
7. Tee DN 200x150

KANYINYA RESERVOIR(250CUM)

Nyge - 15



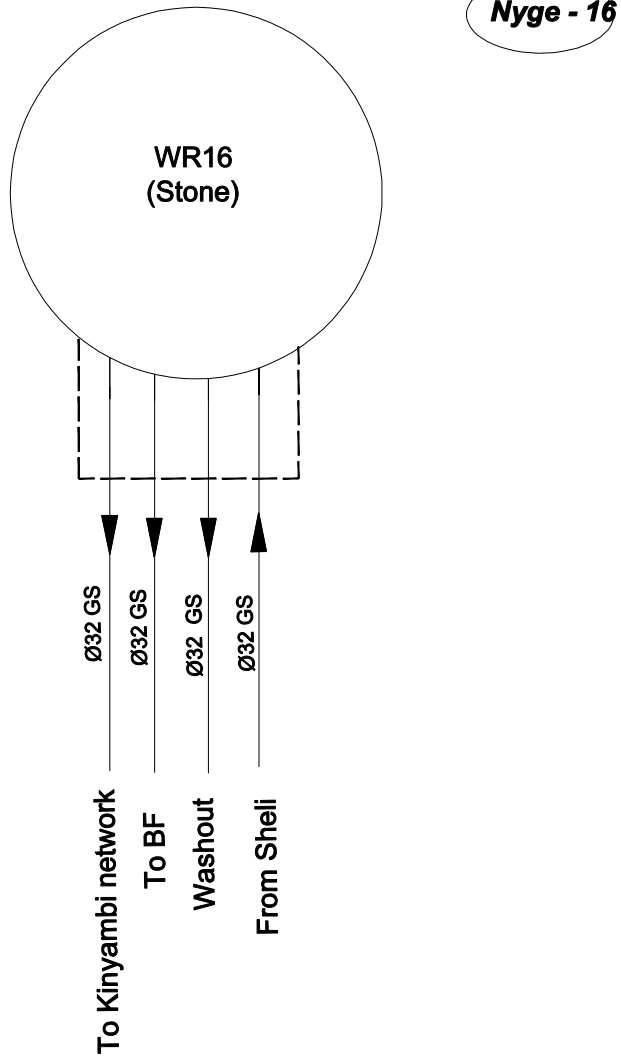
R6-22

LEGEND

1,2,3.Valve DN 150

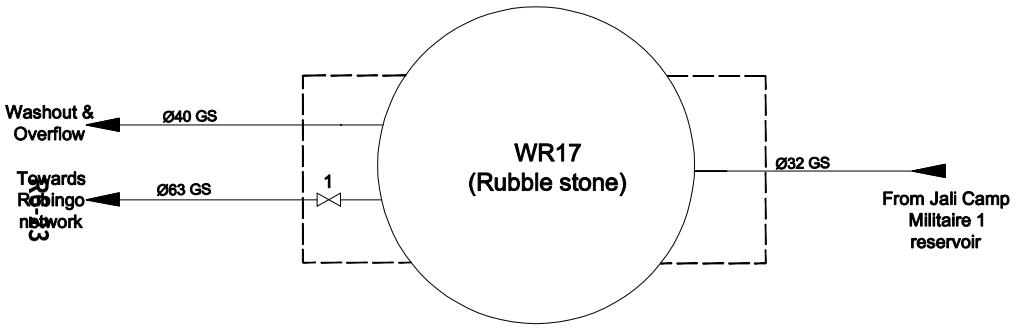
KINYAMBI RESERVOIR(10 CUM)

Nyge - 16



JALI RESERVOIR(32 CUM)

Nyge - 17

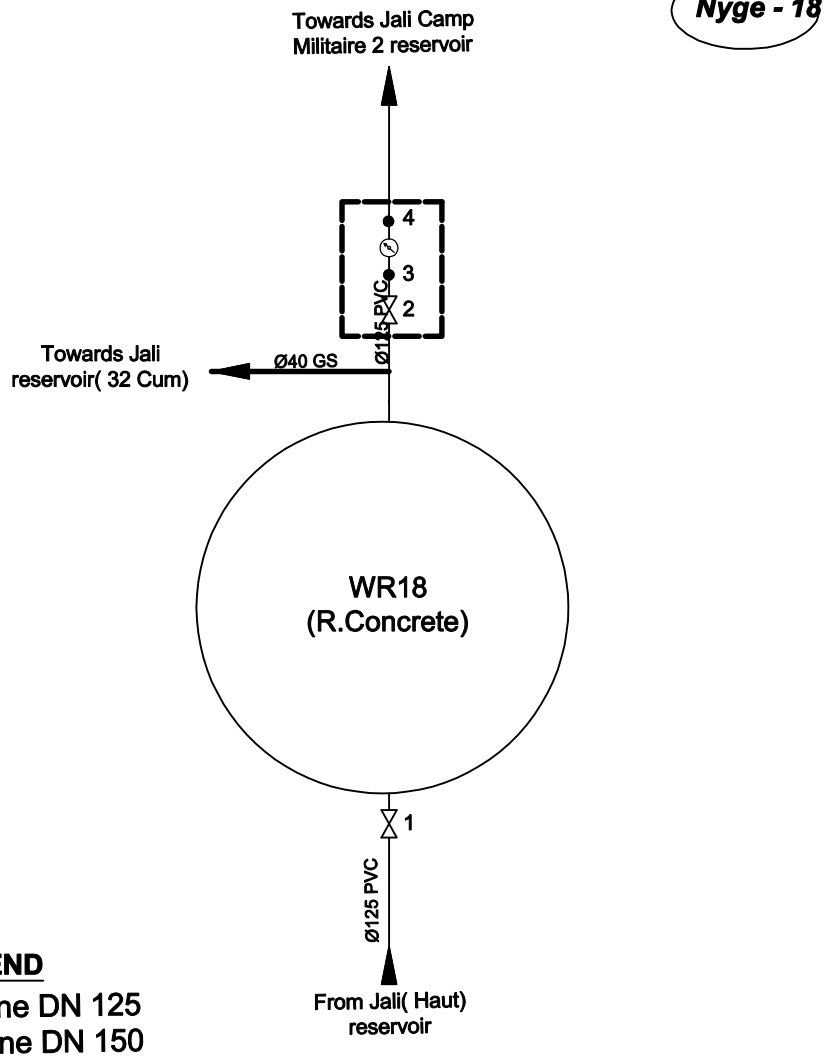


LEGEND

1.Valve DN 63

JALI Camp Militaire 1 reservoir(400 CUM)

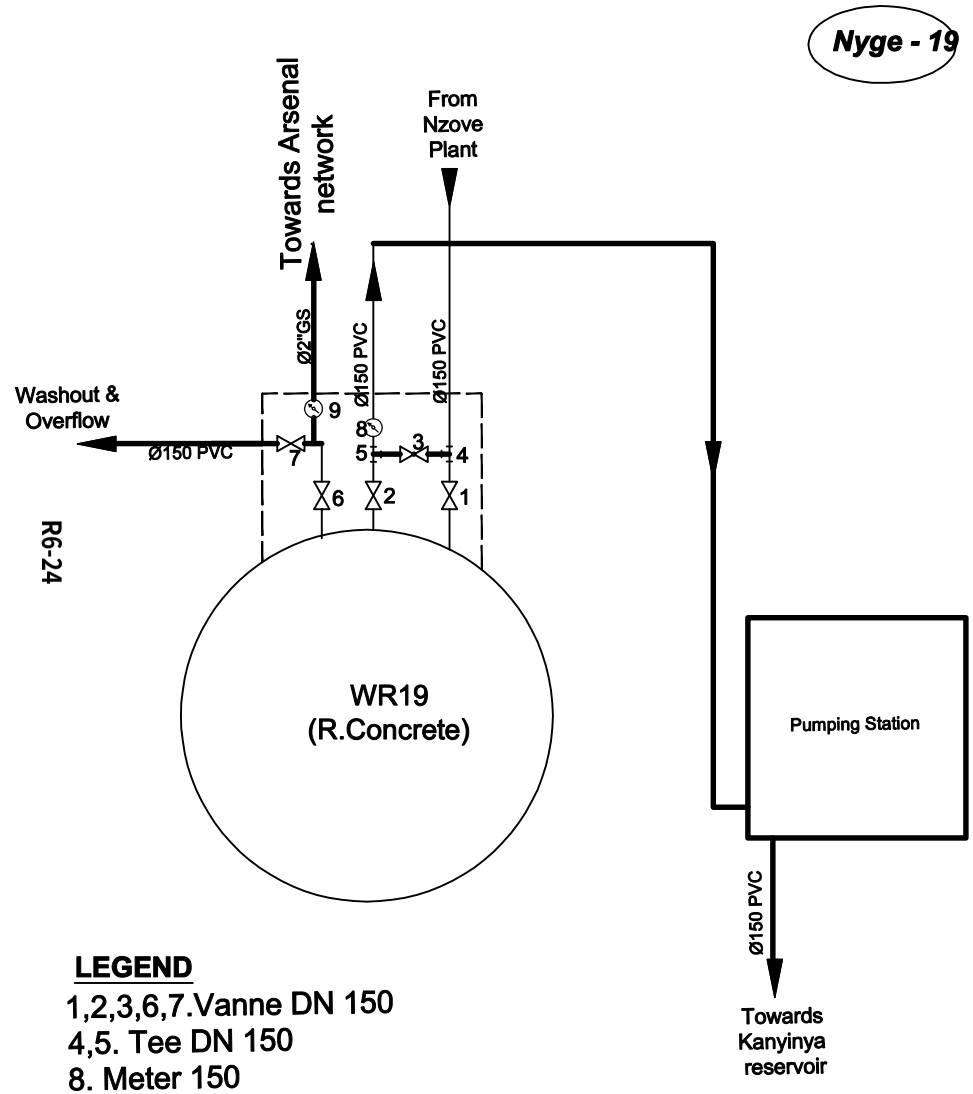
Nyge - 18



LEGEND

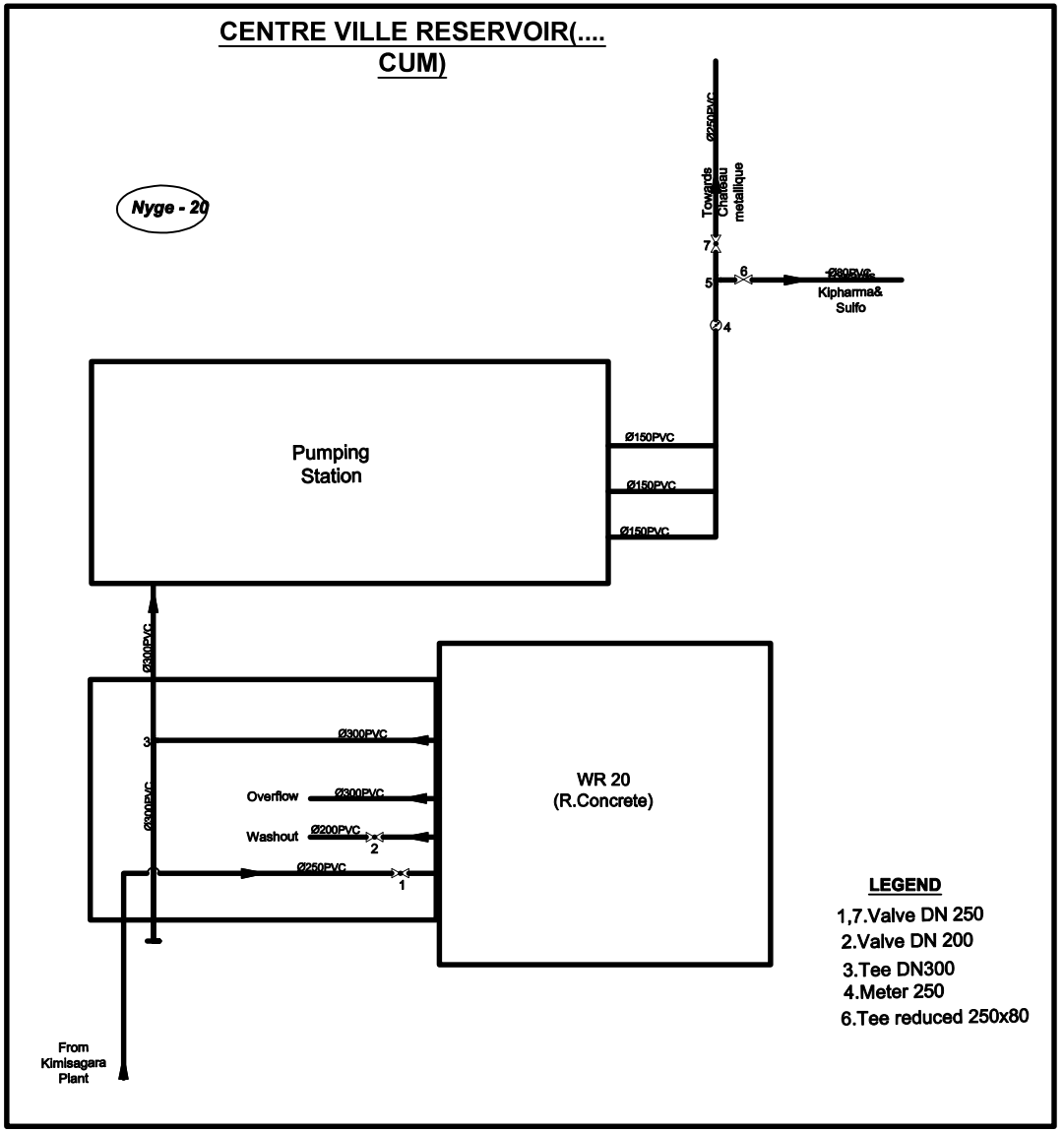
1.Vanne DN 125
2.Vanne DN 150
3,4. Reducer 150x125

NZOVE/ NEAR SKOL RESERVOIR(250 CUM)



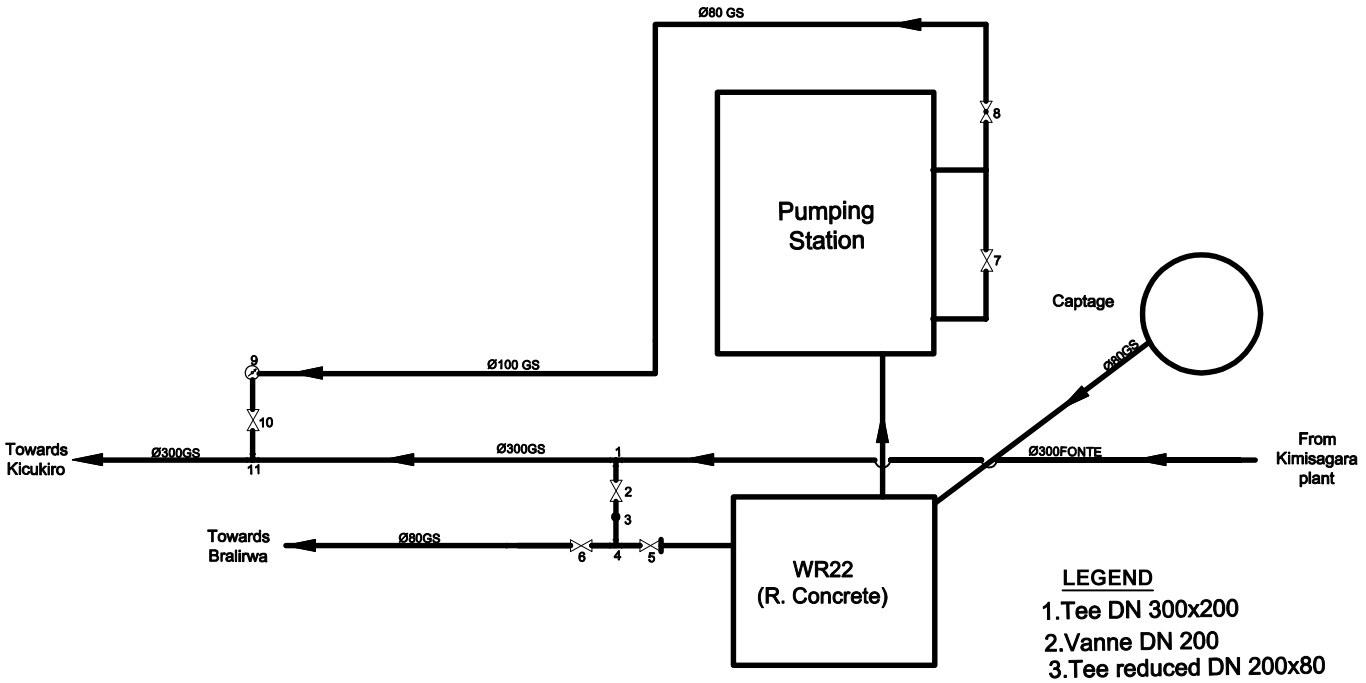
LEGEND

1,2,3,6,7.Vanne DN 150
4,5. Tee DN 150
8. Meter 150
9. Meter 50



MBURABUTURO(near cercle sportif Kigali) RESERVOIR(.... CUM)

Nyge - 22

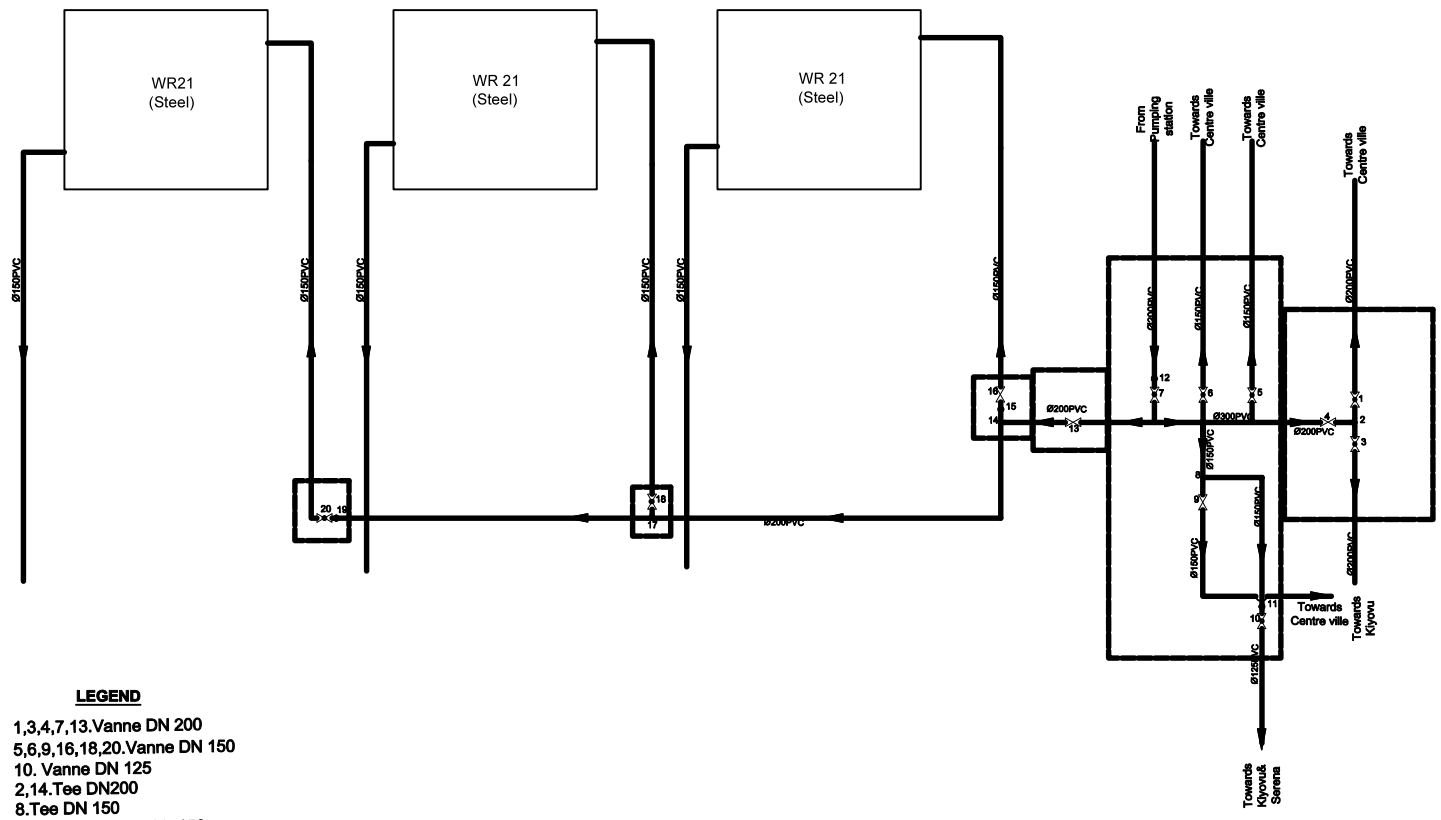


LEGEND

1.Tee DN 300x200
2.Vanne DN 200
3.Tee reduced DN 200x80
4.Tee DN80
5,6,7,8. Vanne DN 80
9. Meter 100
10. Vanne DN 100
11. Tee DN 300x100

CHATEAU METALLIQUE RESERVOIR(.... CUM)

Nyge - 21

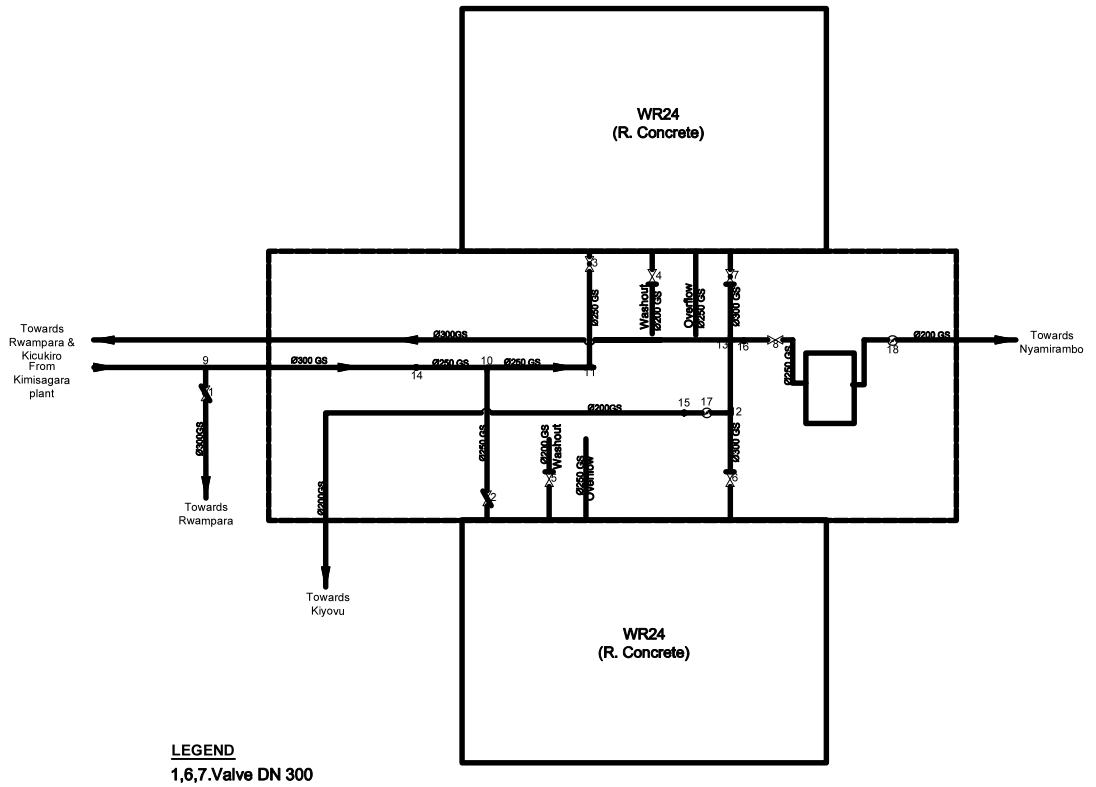


LEGEND

1,3,4,7,13.Vanne DN 200
5,6,9,16,18,20.Vanne DN 150
10. Vanne DN 125
2,14.Tee DN200
8.Tee DN 150
17. Tee reduced 200x150
12,15,19. Reducer 200x150
11. Reducer 150x125

KWA NYIRANUMA RESERVOIR(1200CUM)

Nyge - 24

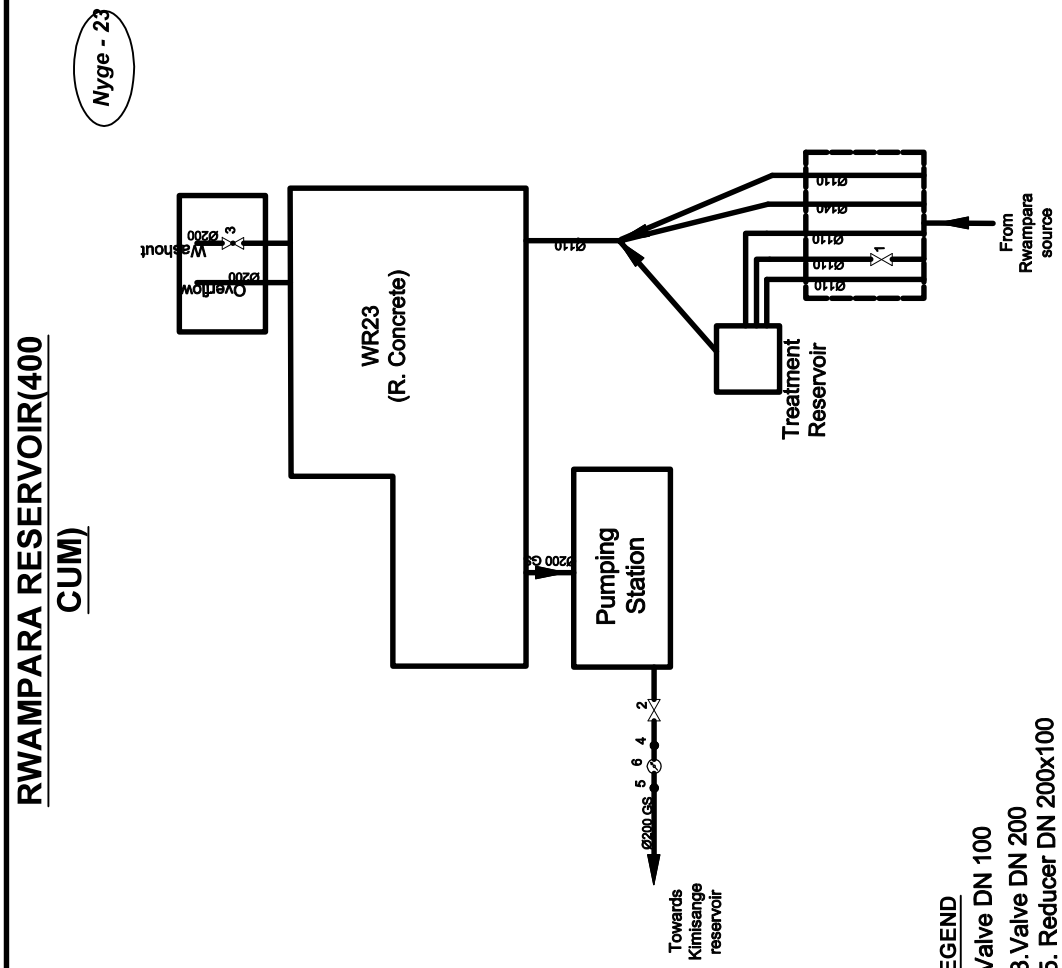


LEGEND

1,6,7.Valve DN 300
2,3,8.Vanne DN 250
4,5. Valve DN 200
9,13.Tee DN300
10,11. Tee DN 250
12. Tee DN 300x150
14,16. Reducer 300x250
15. Reducer 200x150
17. Meter 150
18. Meter 200

RWAMPARA RESERVOIR(400 CUM)

Nyge - 23

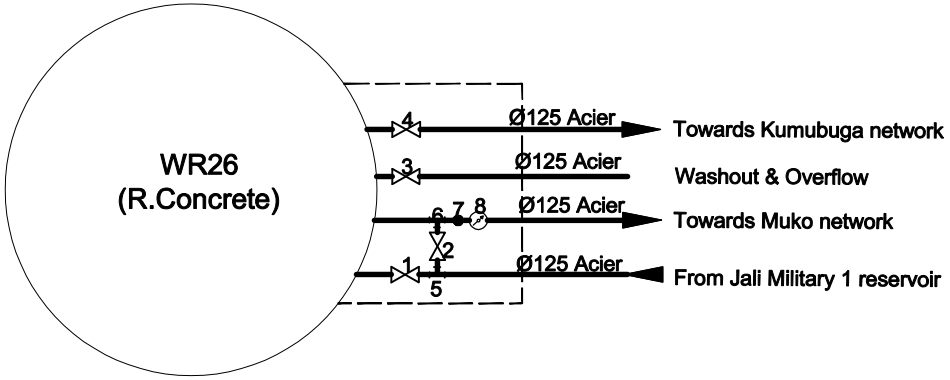


LEGEND

1.Valve DN 100
2,3.Valve DN 200
4,5. Reducer DN 200x100
6. Meter 100

JALI CAMP MILITARY 2 RESERVOIR (125 CUM)

Nyge -26



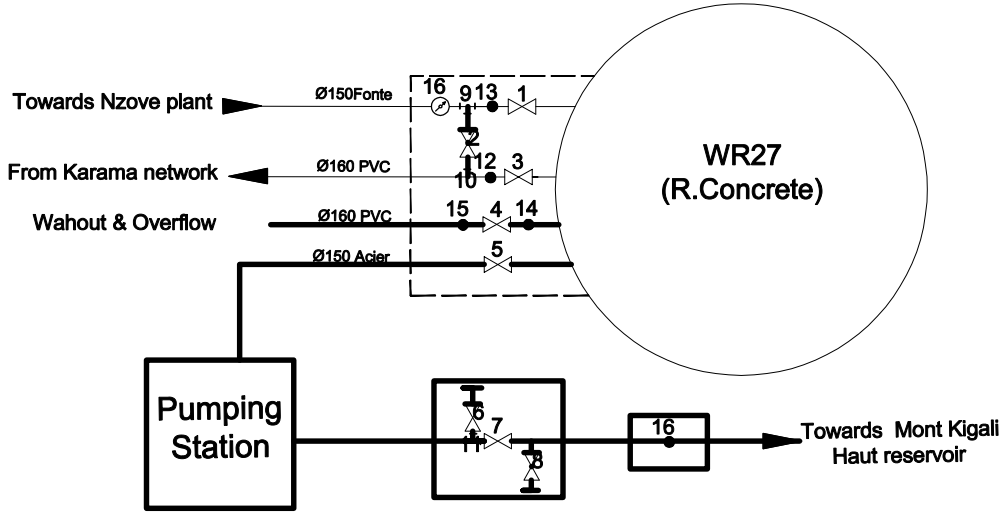
R6-27

LEGEND

1,2,3,4. Valve DN 100
5,6. Tee DN125
7. Reducer DN 125x100
8. Water meter DN 100

KARAMA RESERVOIR (400 CUM)

Nyge -27

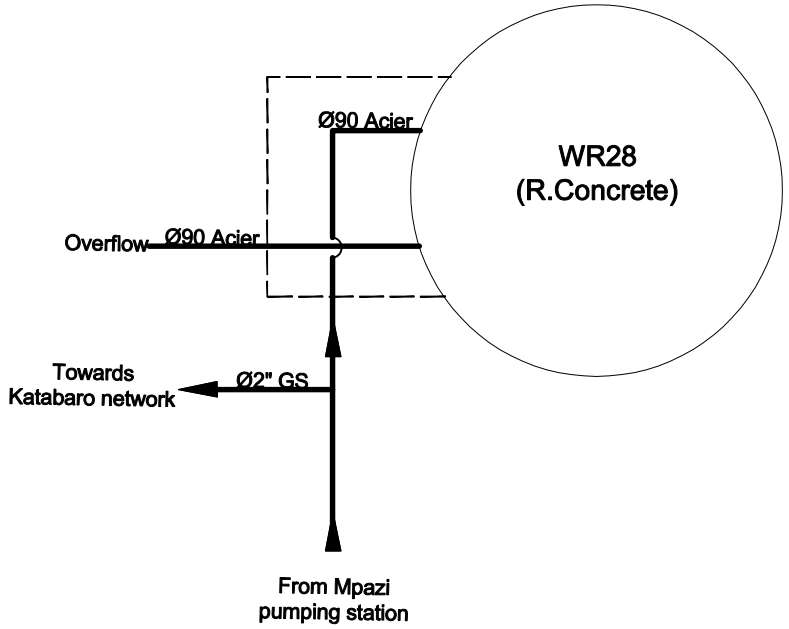


LEGEND

1,3,4. Valve DN 200
2,5,6,7,8. Valve DN 150
9,11. Tee DN 150
10. Tee DN 160x150
12,13. Reducer DN 200x150
14,15. Reducer DN 200x160
16. Reducer DN 150x300

KATABARO RESERVOIR
(... CUM)

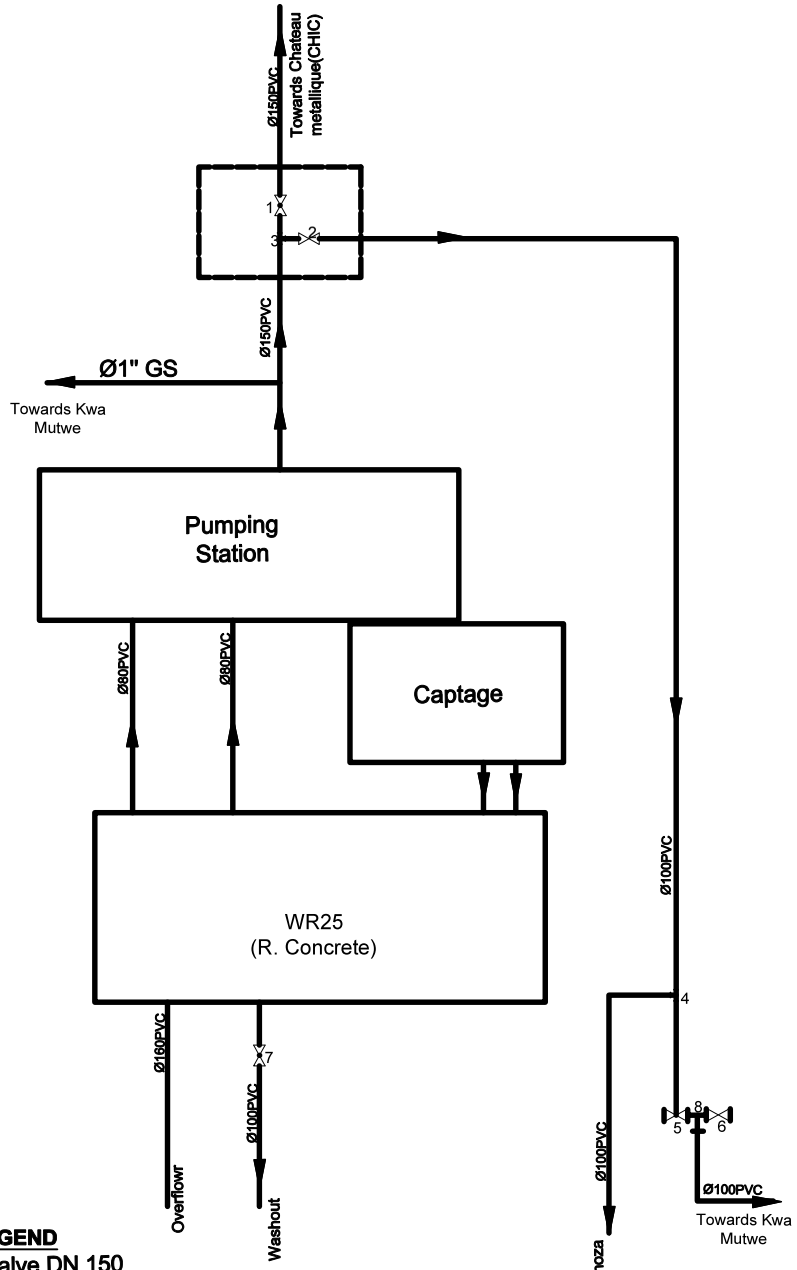
Nyge -28



R6-28

KIZANYE MPAZI
RESERVOIR(.... CUM)

Nyge - 25



LEGEND

1.Valve DN 150

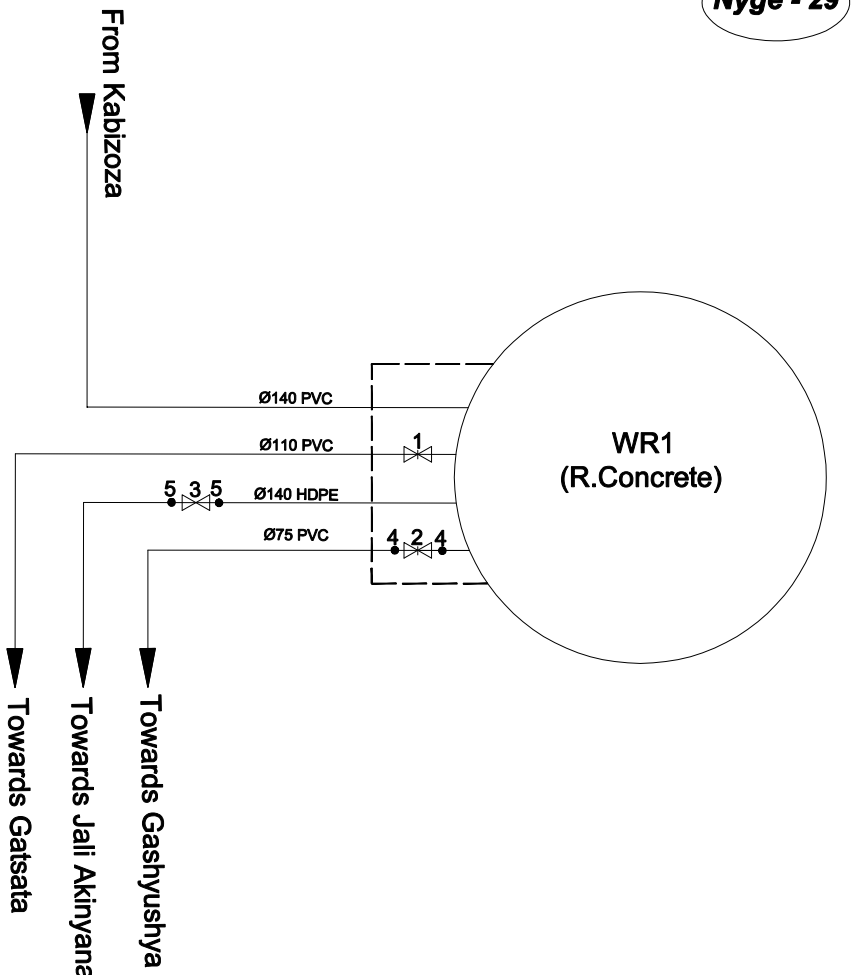
2,5,6,7.Valve DN 100

3.Tee reduced DN 150x100

4,6. Tee DN100

GIHOGWE RESERVOIR (.... CUM)

Nyge - 29



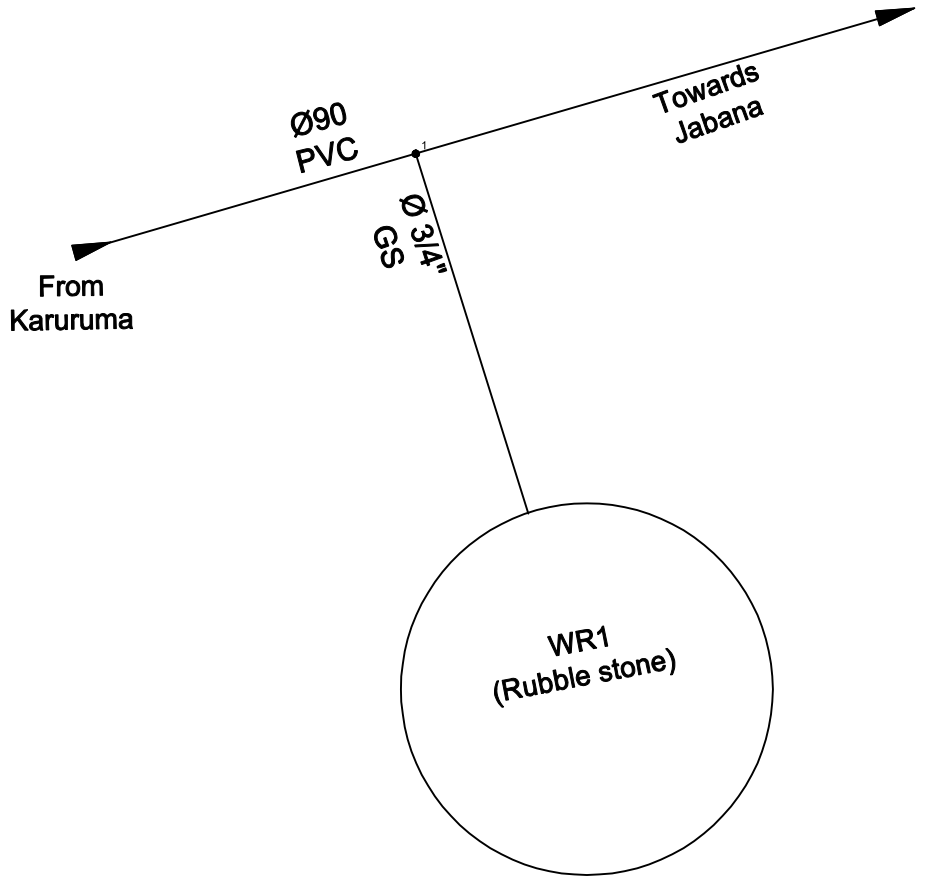
R6-29

LEGEND

1.Vanne DN 100
2. Vanne DN 125
3.Vanne DN 100
4.Reducer DN 100x75
5.Reducer DN140x100

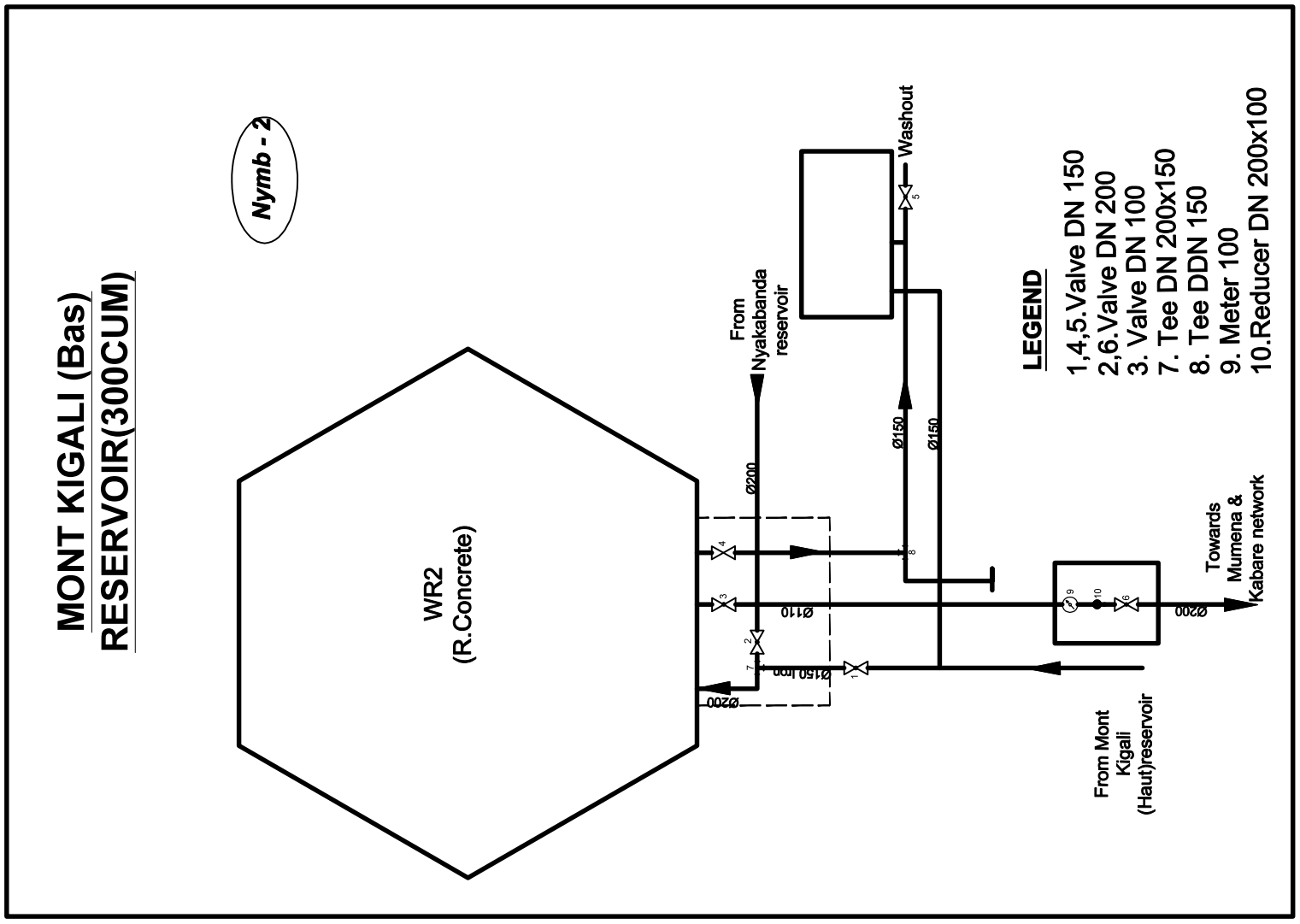
INDATWA VILLAGE RESERVOIR(5 CUM)

Nyge-30

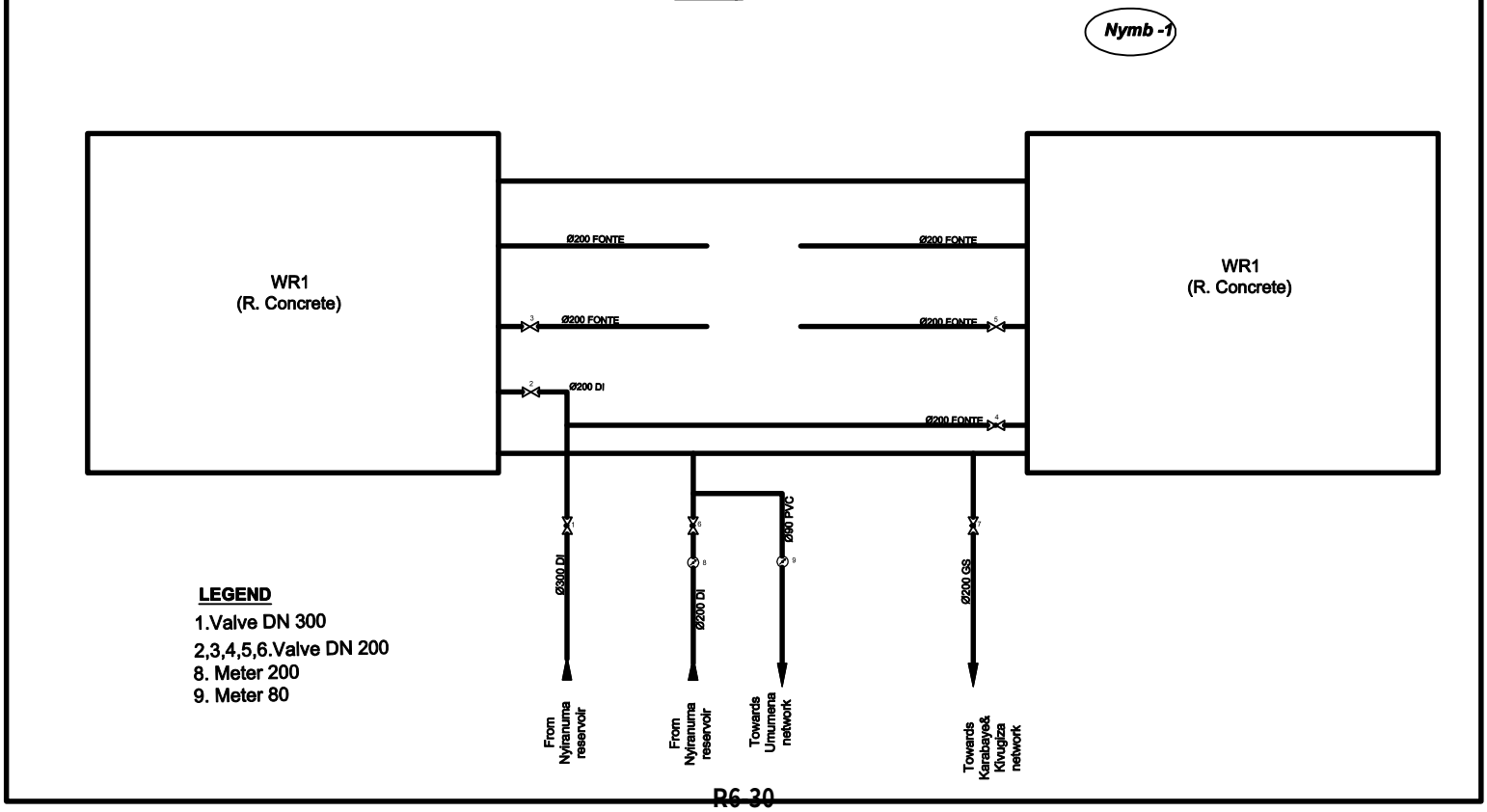


LEGEND

1.Clamp DN90x3/4"

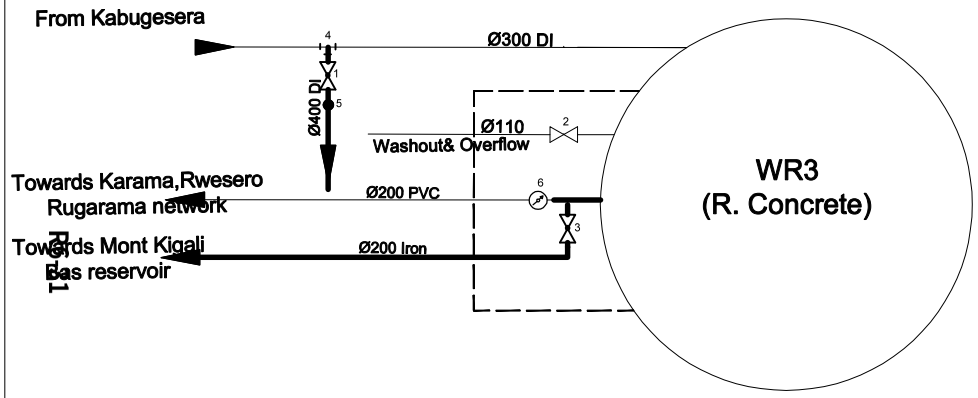


NYAKABANDA RESERVOIR(1200 CUM)



MONT KIGALI (Haut)RESERVOIR (400CUM)

Nymb - 3

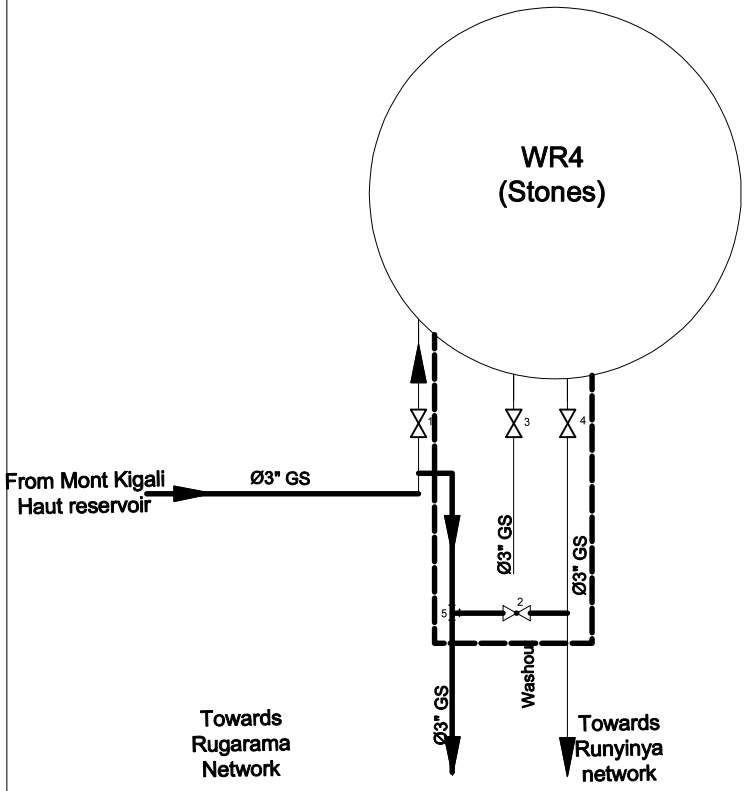


LEGEND

1. Valve DN 150
2. Valve DN 100
3. Valve DN 200
4. Tee DN 300x150
5. Reducer DN 400x150
6. Meter 200

RUGARAMA/RUBONA RESERVOIR (10 CUM)

Nymb - 4

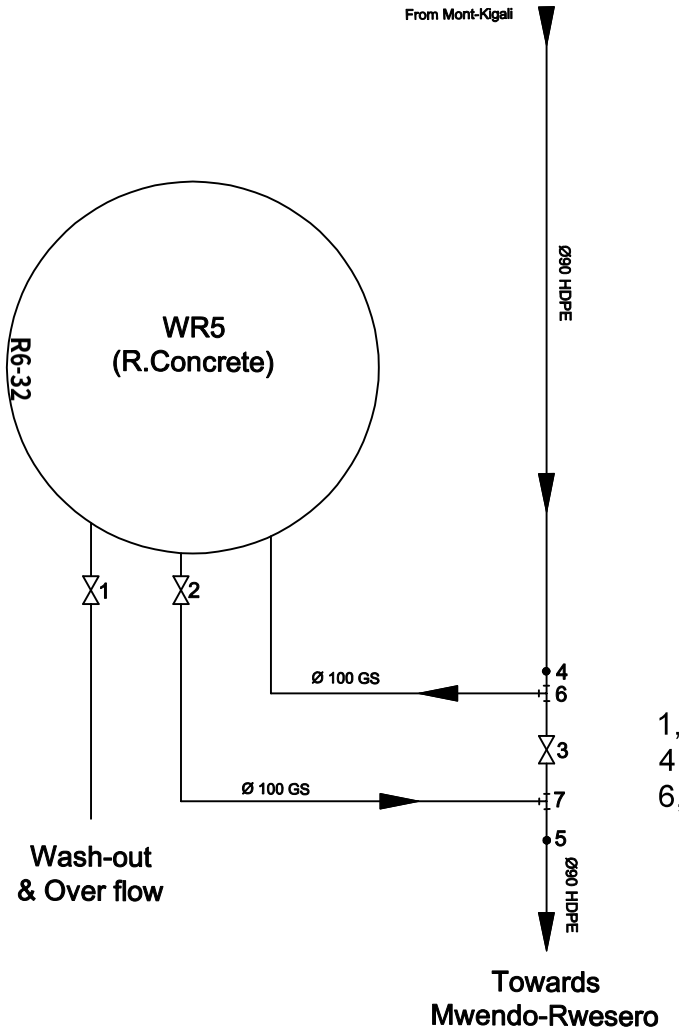


LEGEND

1,2,3,4. Valve DN 80
5. Tee DN 90

KIGALI RESERVOIR
(50 CUM)

Nymb - 5

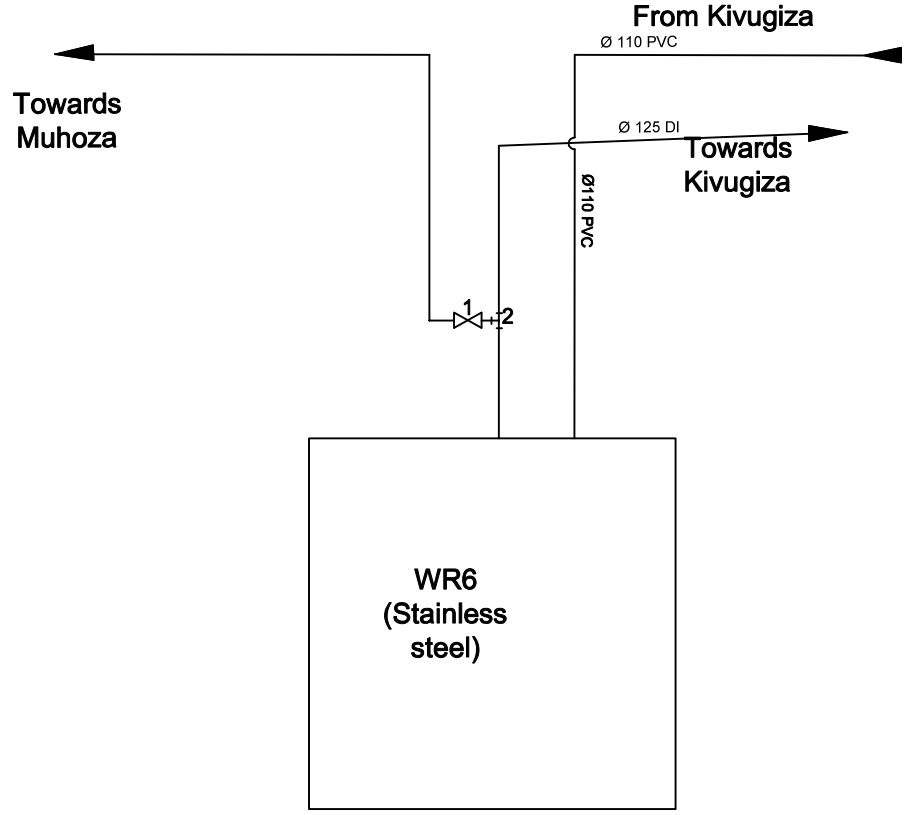


LEGEND

1,2,3.Vanne DN 100
4,5. Reducer DN 100x80
6,7.Tee DN 100

KIVUGIZA RESERVOIR
(30 CUM)

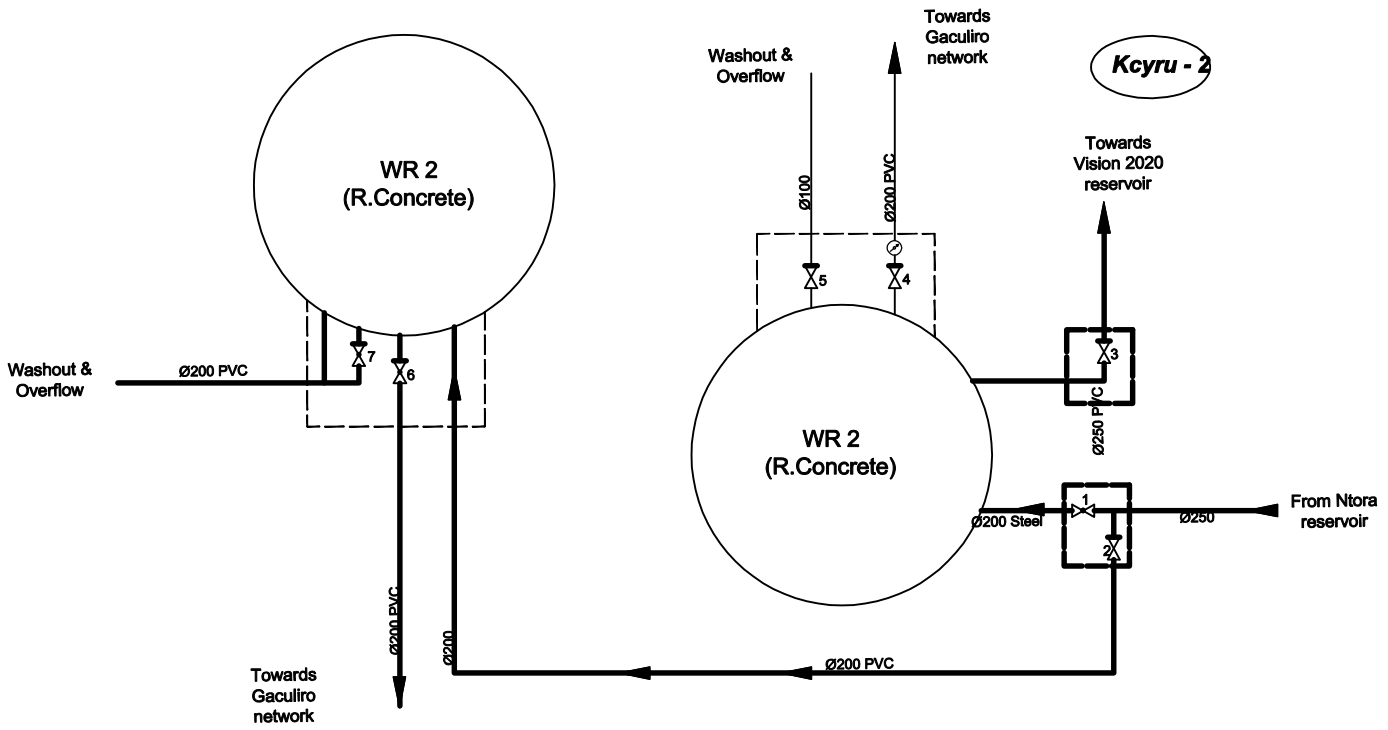
Nymb - 6



LEGEND

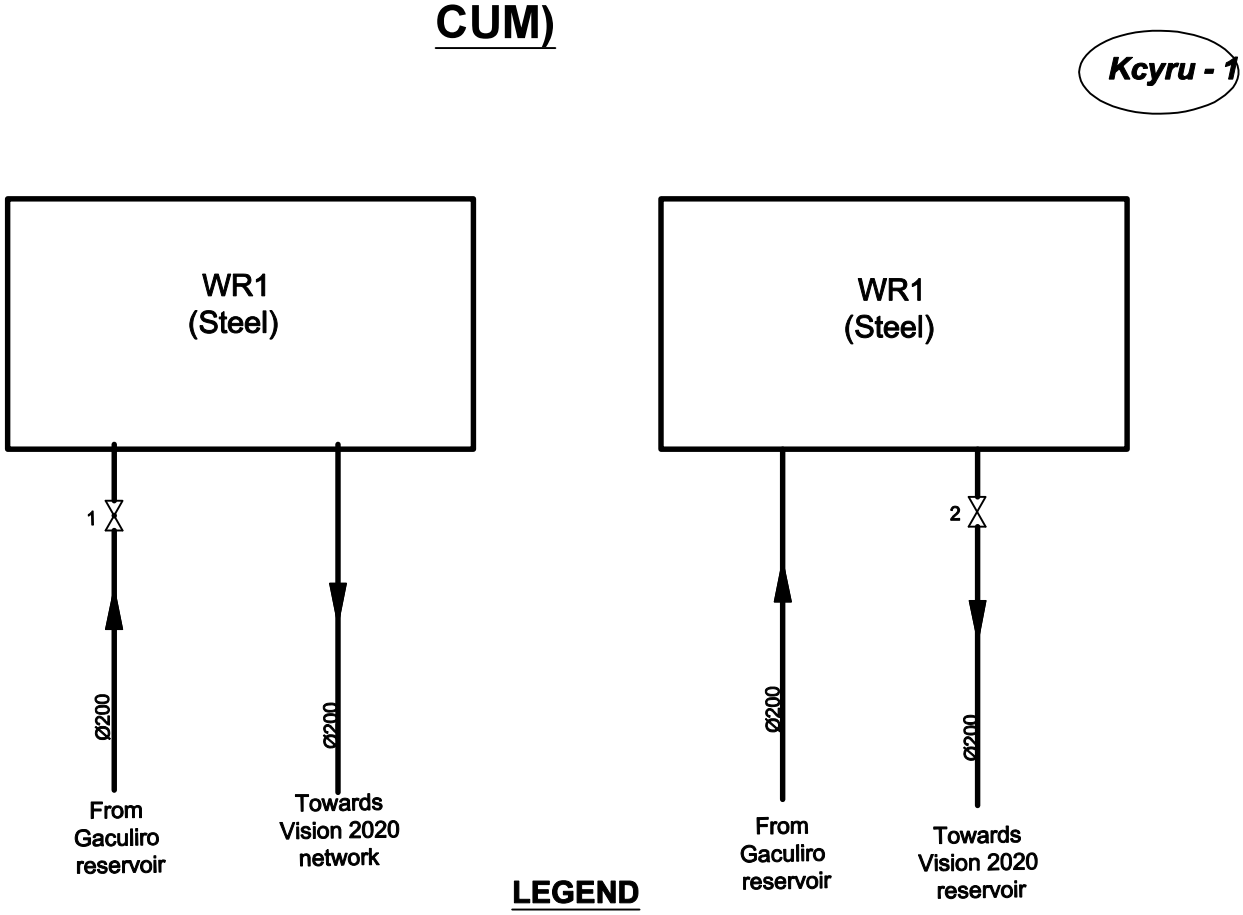
1.Vanne DN 100
2.Tee DN 100

GACULIRO RESERVOIR(... CUM)



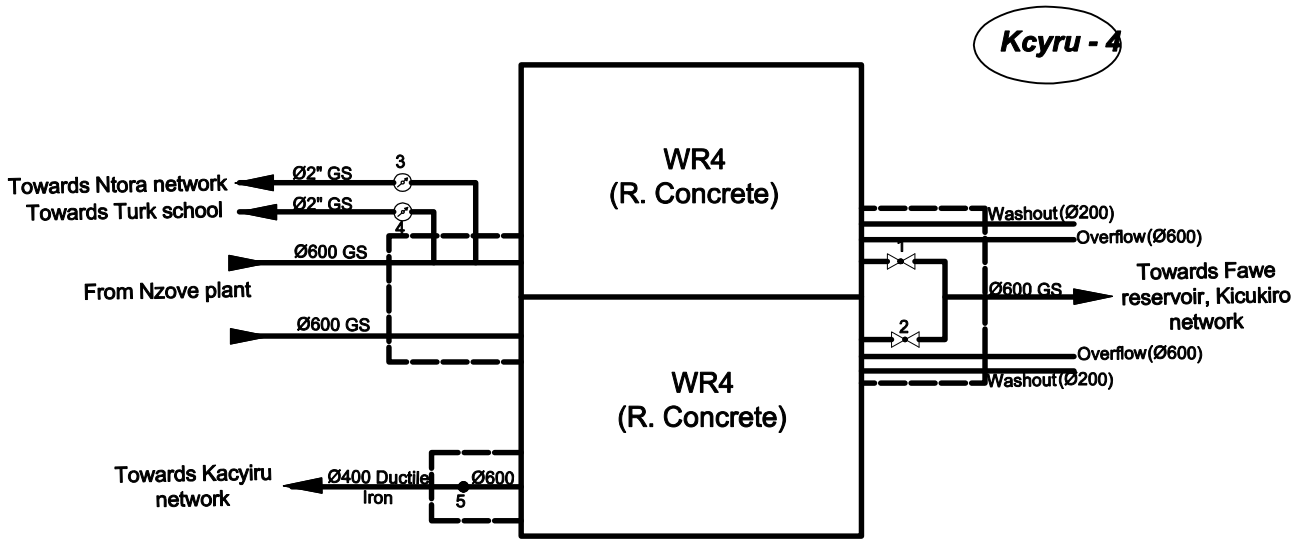
LEGEND
1,2,4,6,7.Valve DN 200
3.Valve DN 250
5. Valve DN 100

VISION 2020 RESERVOIR(... CUM)



LEGEND
1,2.Valve DN 200

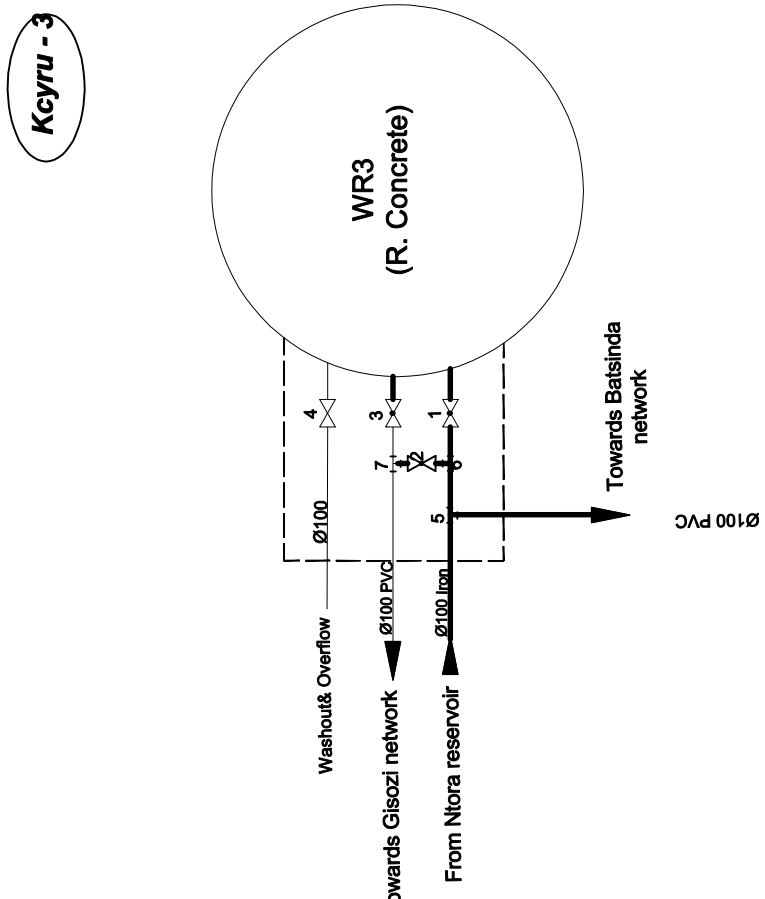
NTORA RESERVOIR
(10000CUM)



LEGEND

1,2. Valve DN 600
3. Meter 75
4. Meter 50
5. Reducer 600x400

FAWE GIRLS SCHOOL RESERVOIR
(5000CUM)

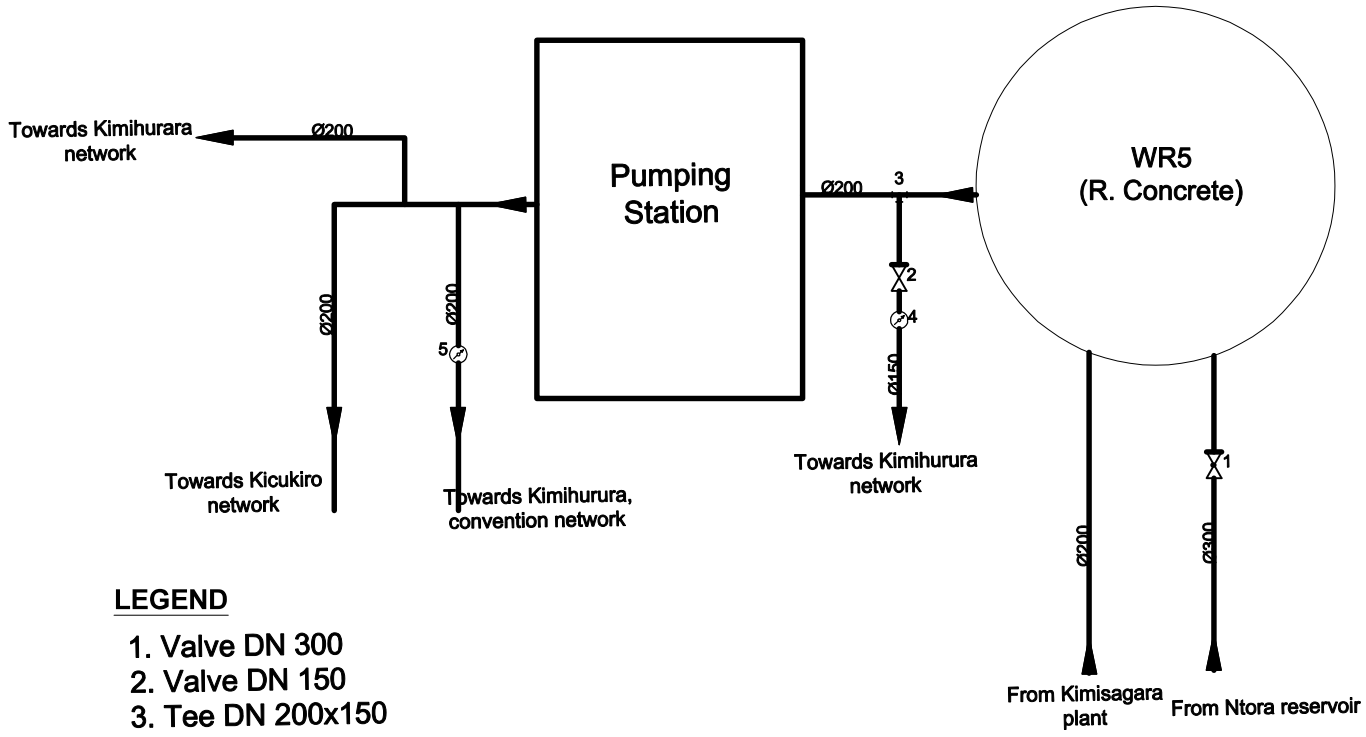


LEGEND

1,2,3,4. Valve DN 100
5,6,7. Tee DN 100

KIMIHURURA RESERVOIR
(...CUM)

Kcyru - 5

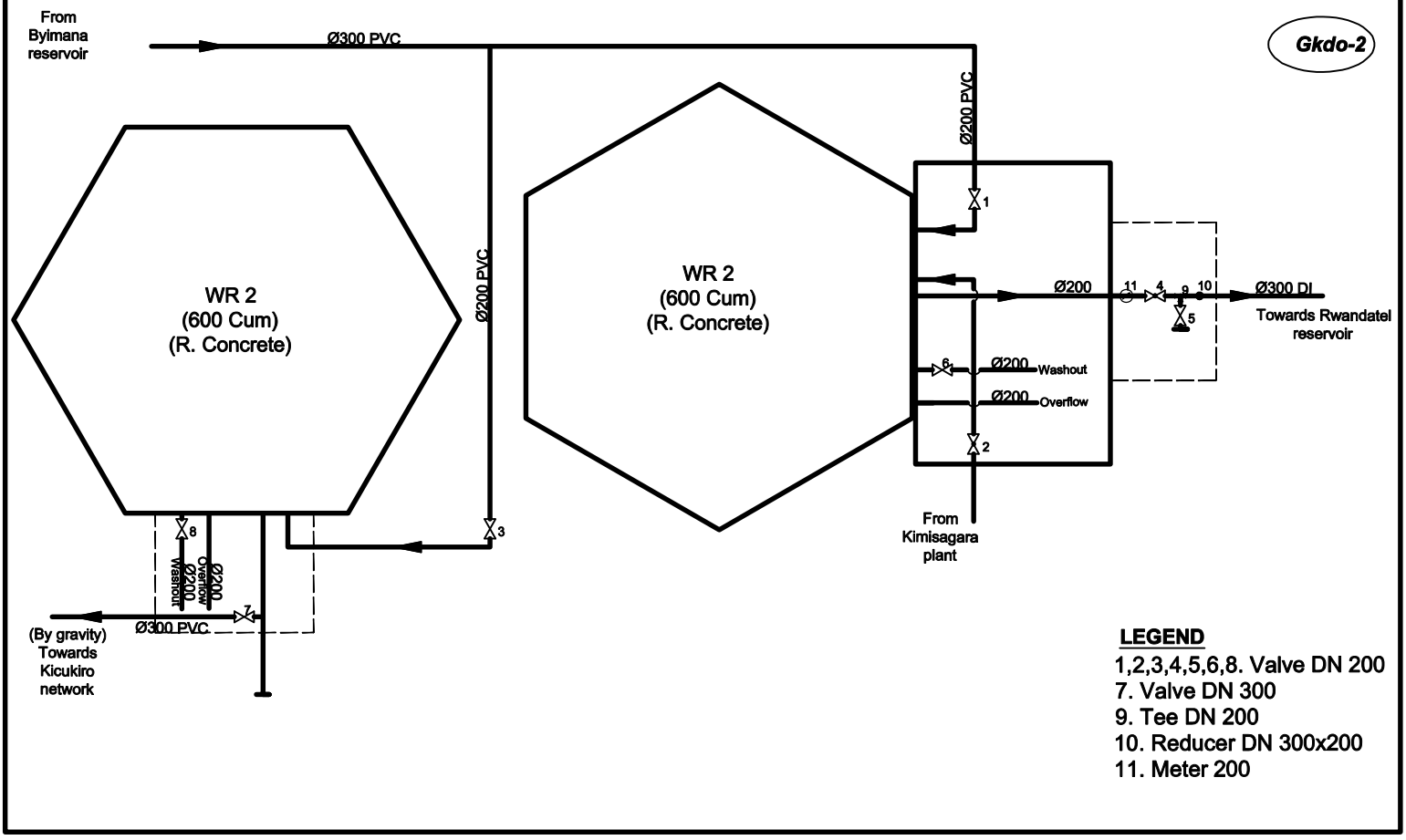


LEGEND

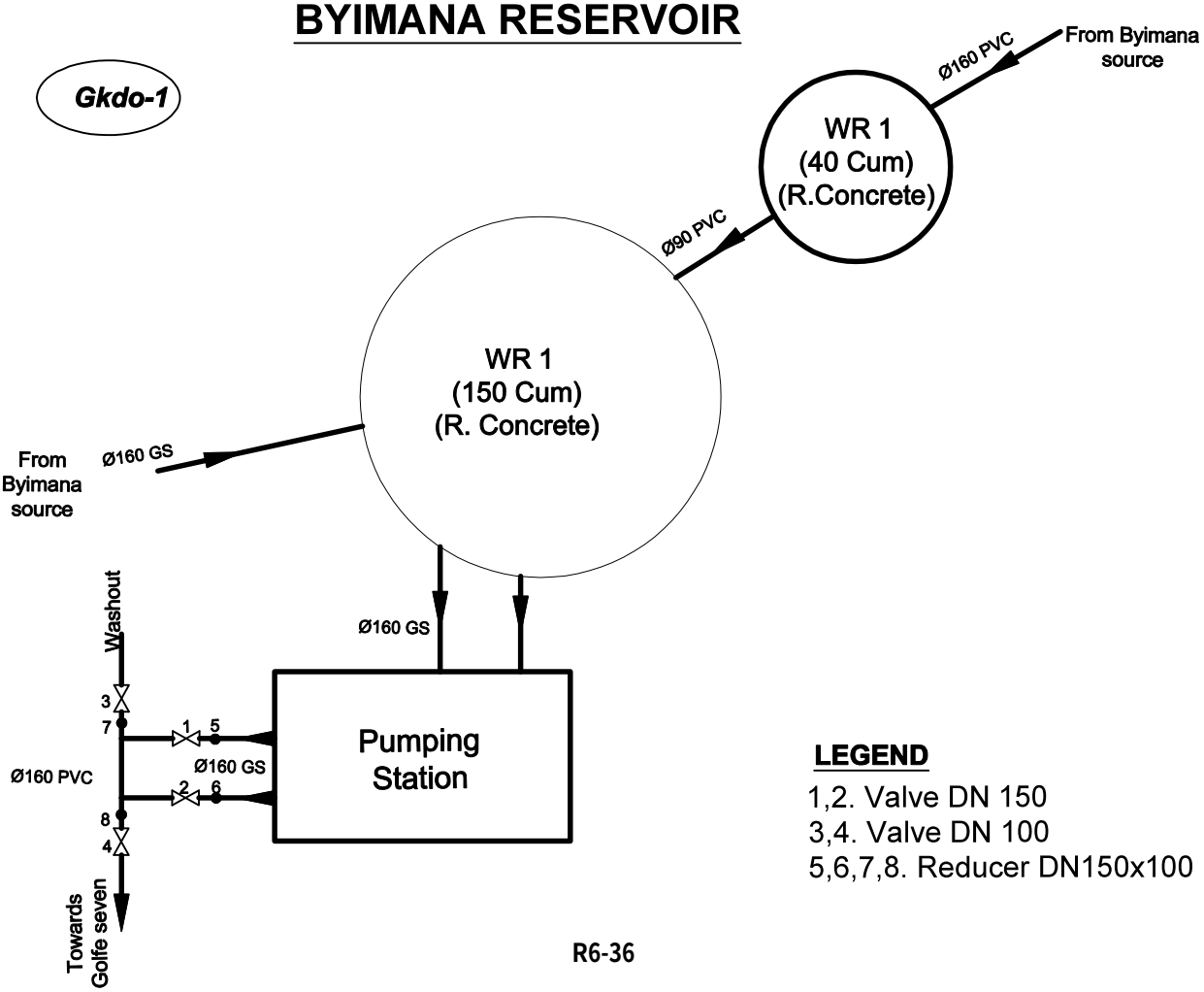
1. Valve DN 300
2. Valve DN 150
3. Tee DN 200x150
4. Meter 150
5. Meter 200

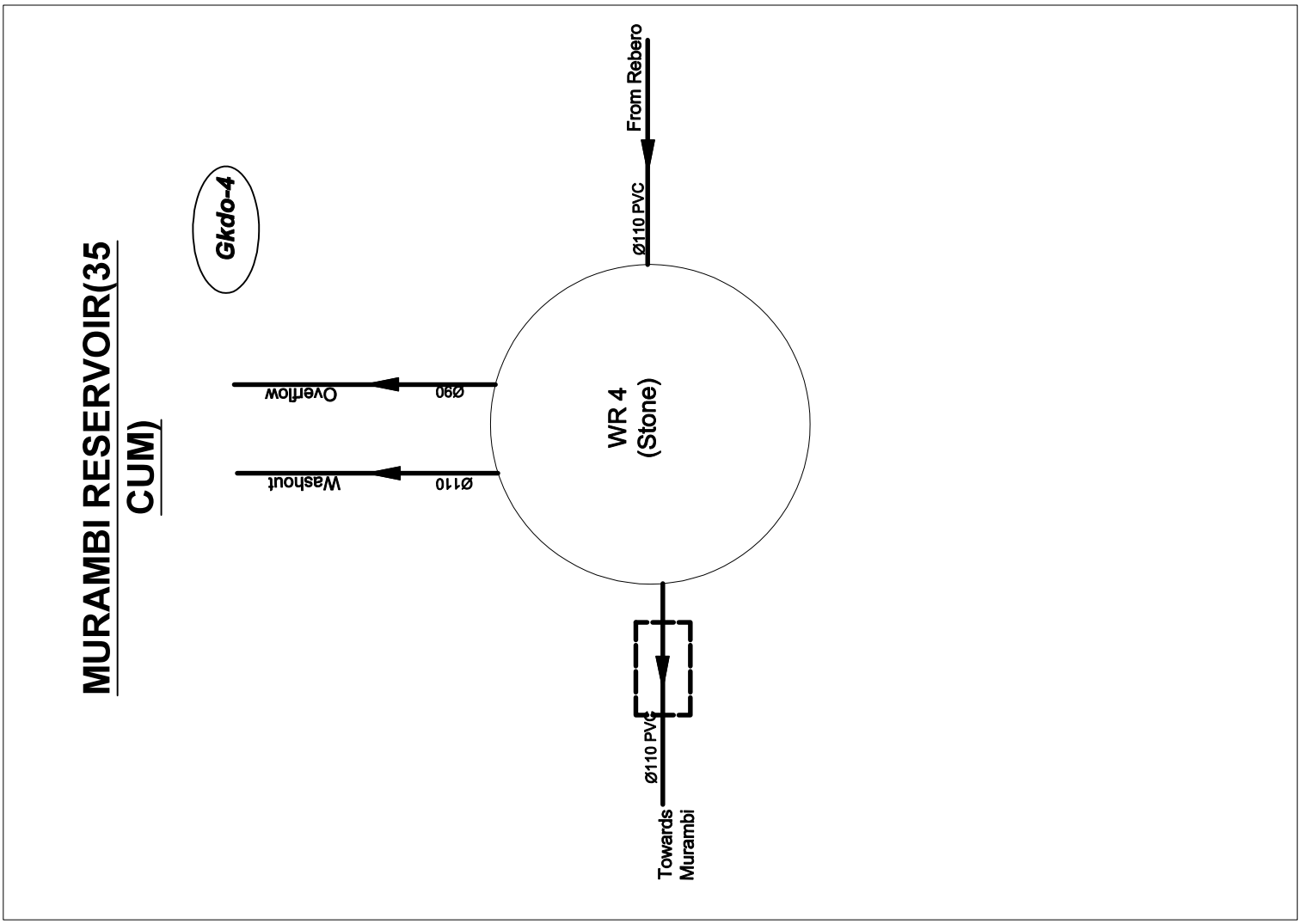
R6-35

GOLFE SEVEN RESERVOIR

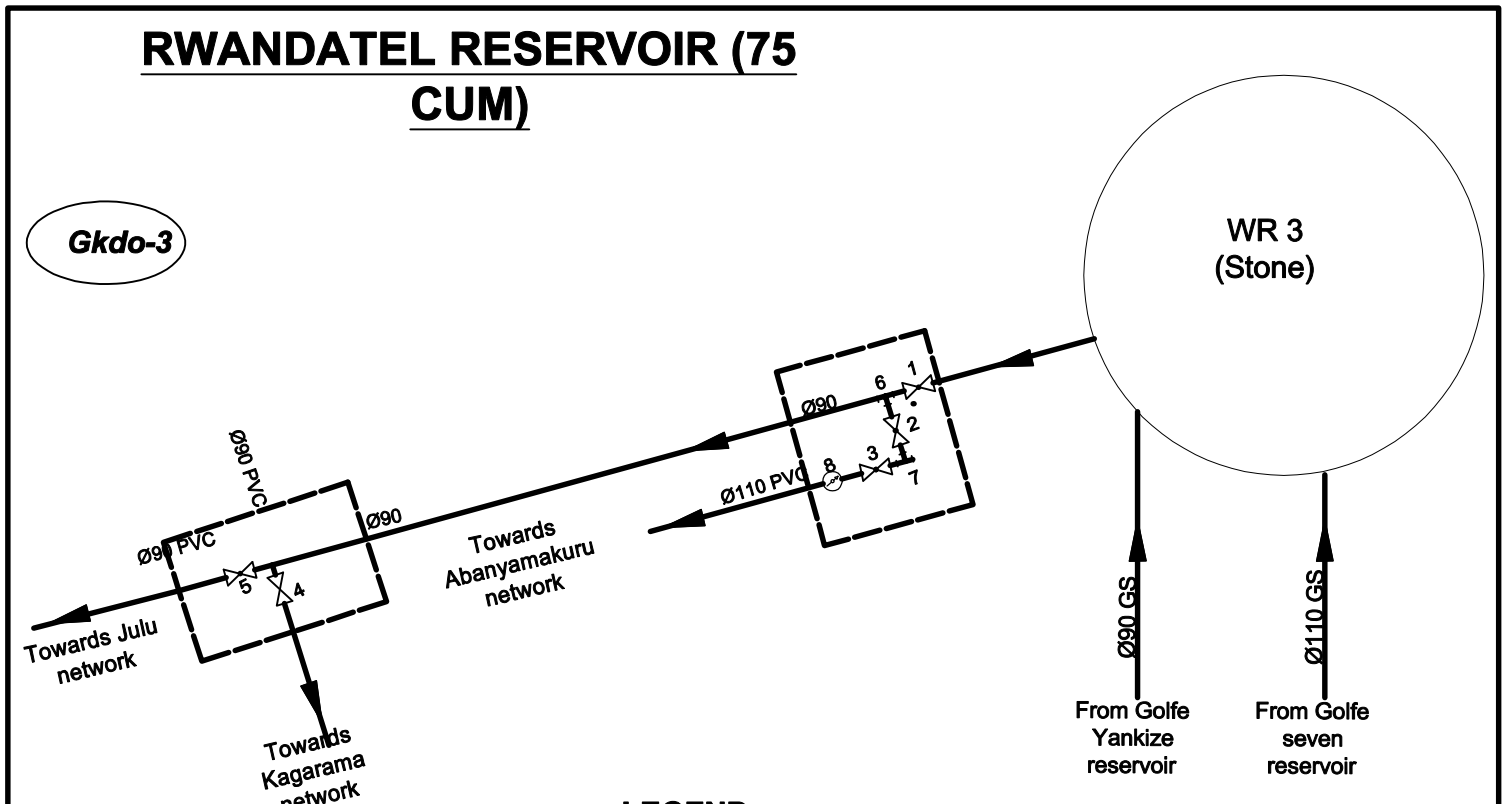


BYIMANA RESERVOIR





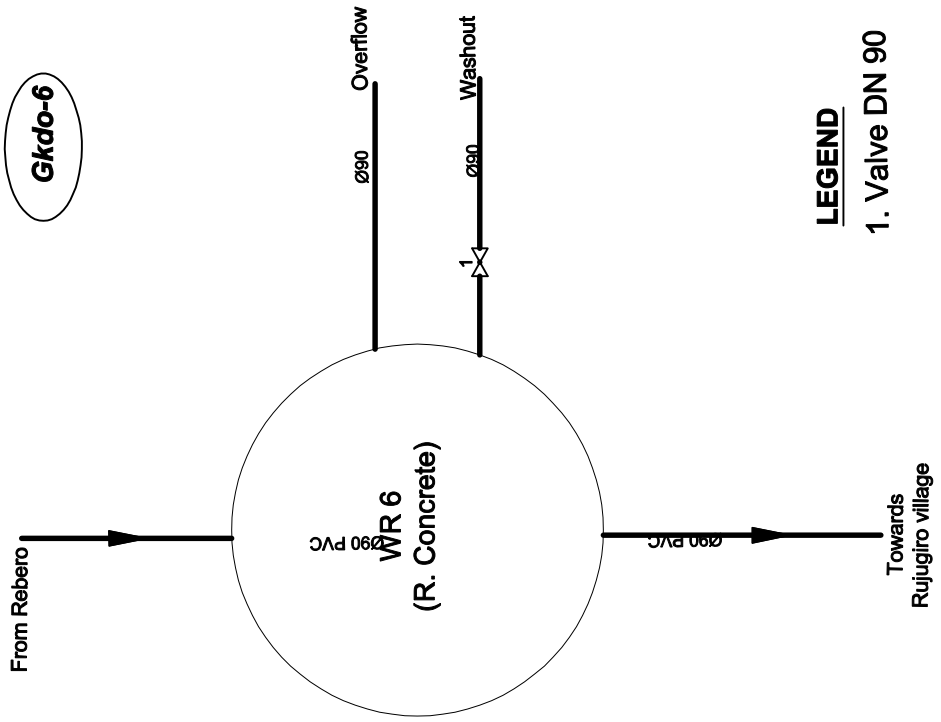
RWANDATEL RESERVOIR (75 CUM)



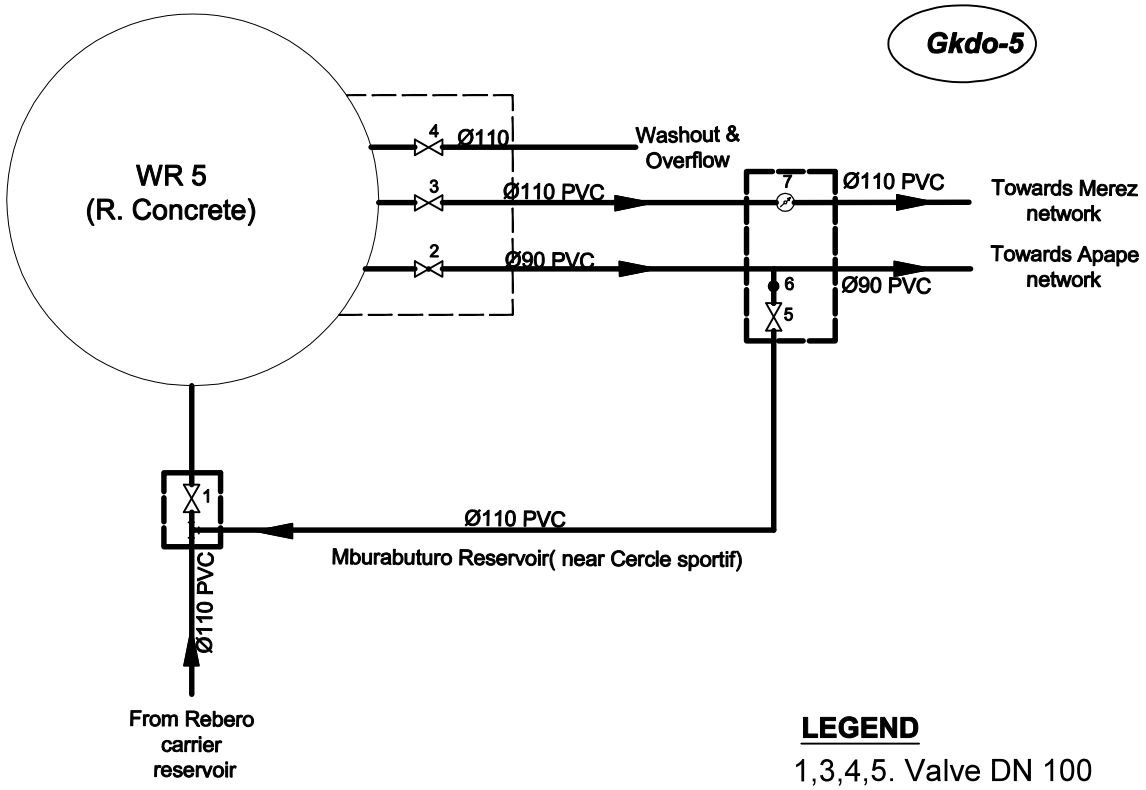
LEGEND

1,2,4,5. Valve DN 80
3. Valve DN 100
6. Tee DN 90
7. Tee DN 100x90
8. Meter 100

PETIT PRINCE RESERVOIR(... CUM)



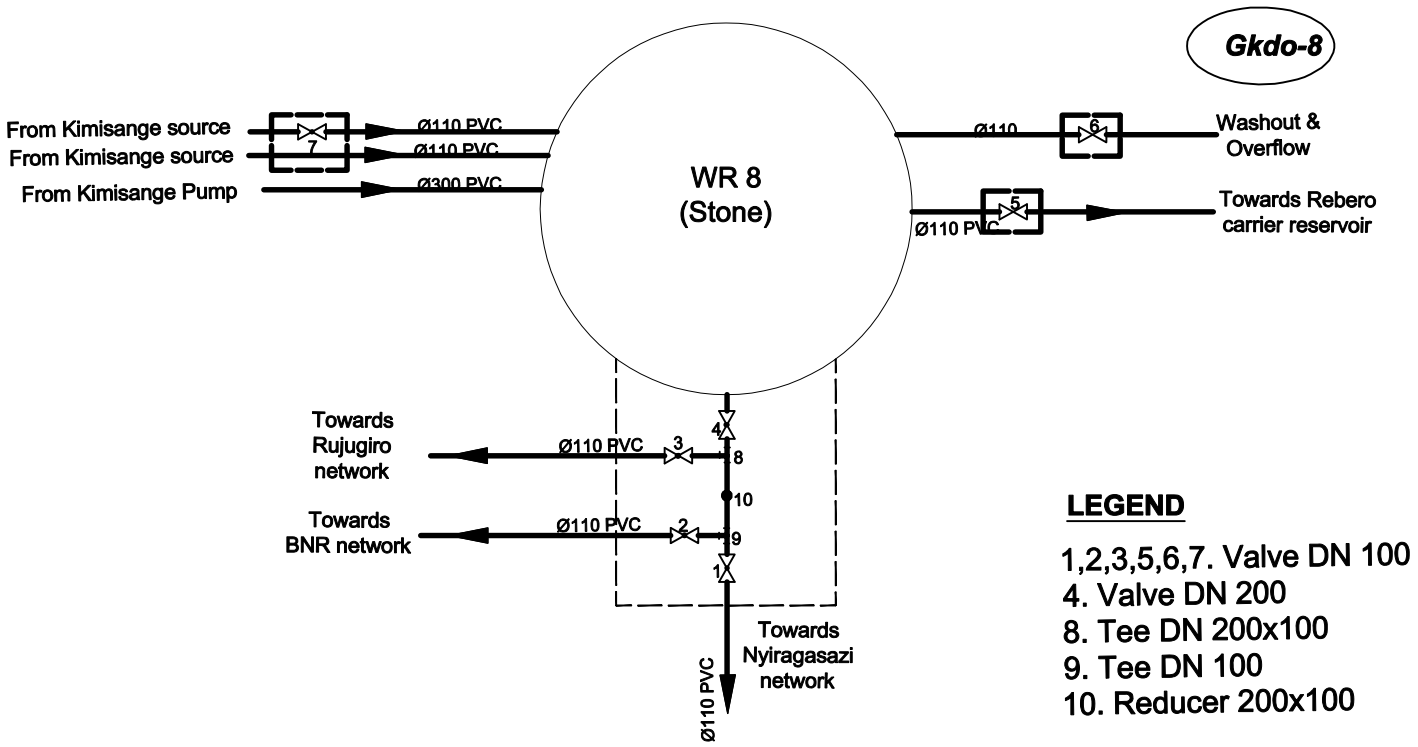
GIKONDO PRIMAIRE RESERVOIR (400 CUM)



LEGEND

1,3,4,5. Valve DN 100
2. Valve DN 80
6. Reducer DN 100x90
7. Meter 80

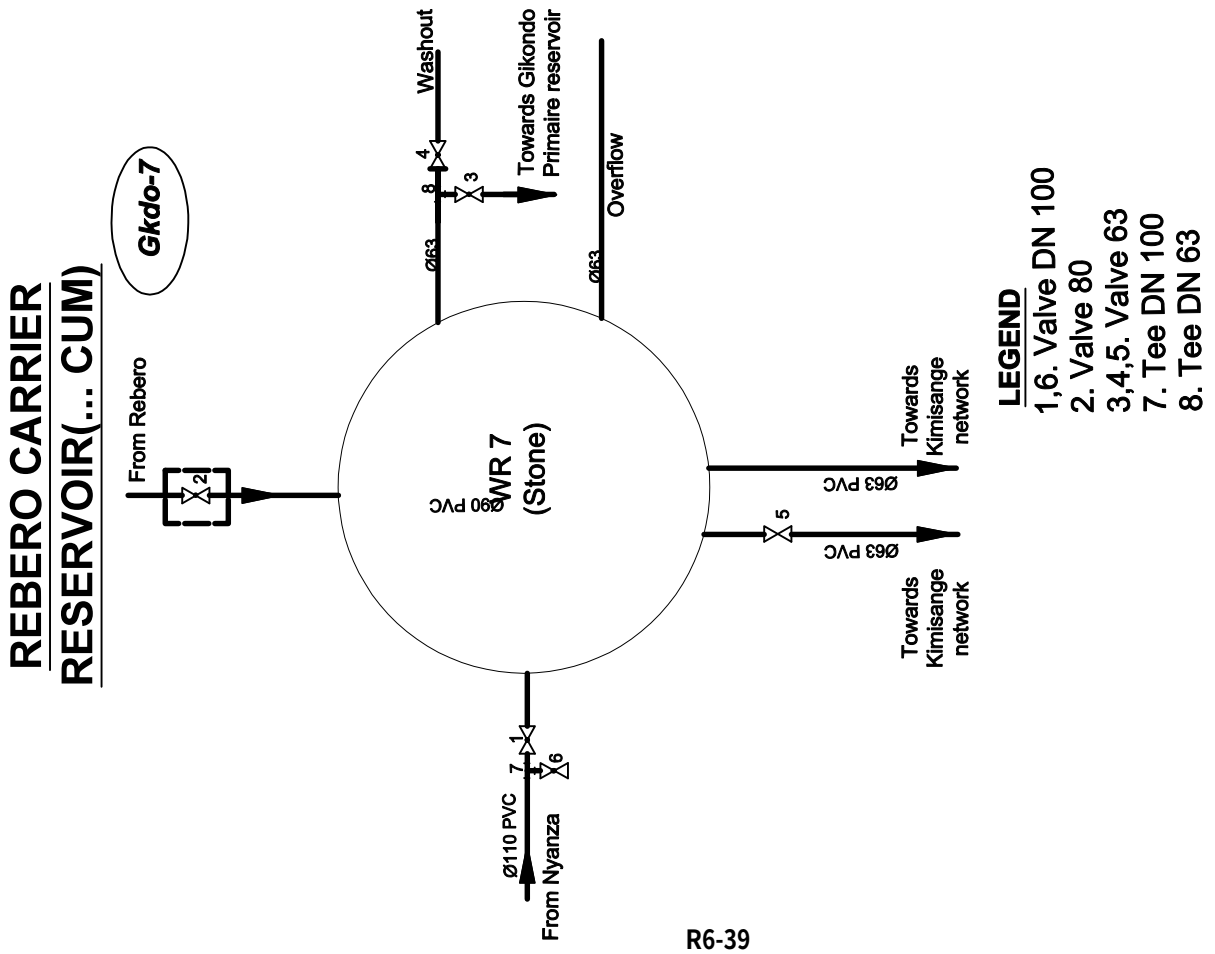
REBERO RESERVOIR(... CUM)



LEGEND

1,2,3,5,6,7. Valve DN 100
4. Valve DN 200
8. Tee DN 200x100
9. Tee DN 100
10. Reducer 200x100

REBERO CARRIER RESERVOIR(... CUM)

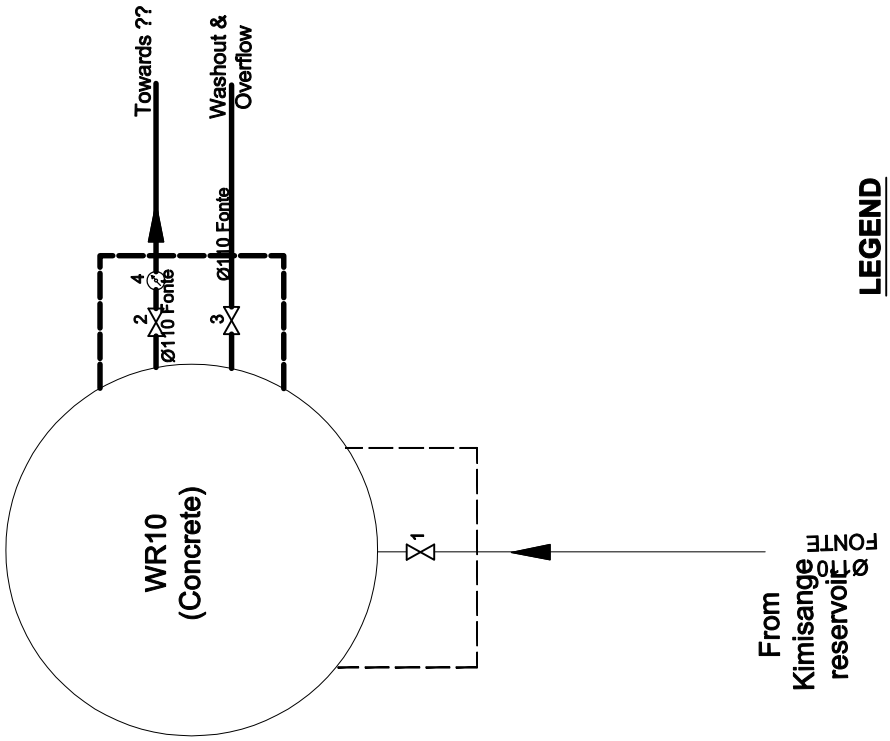


LEGEND

1,6. Valve DN 100
2. Valve 80
3,4,5. Valve 63
7. Tee DN 100
8. Tee DN 63

NYARURAMA I
RESERVOIR(125CUM)

Gkdo-10

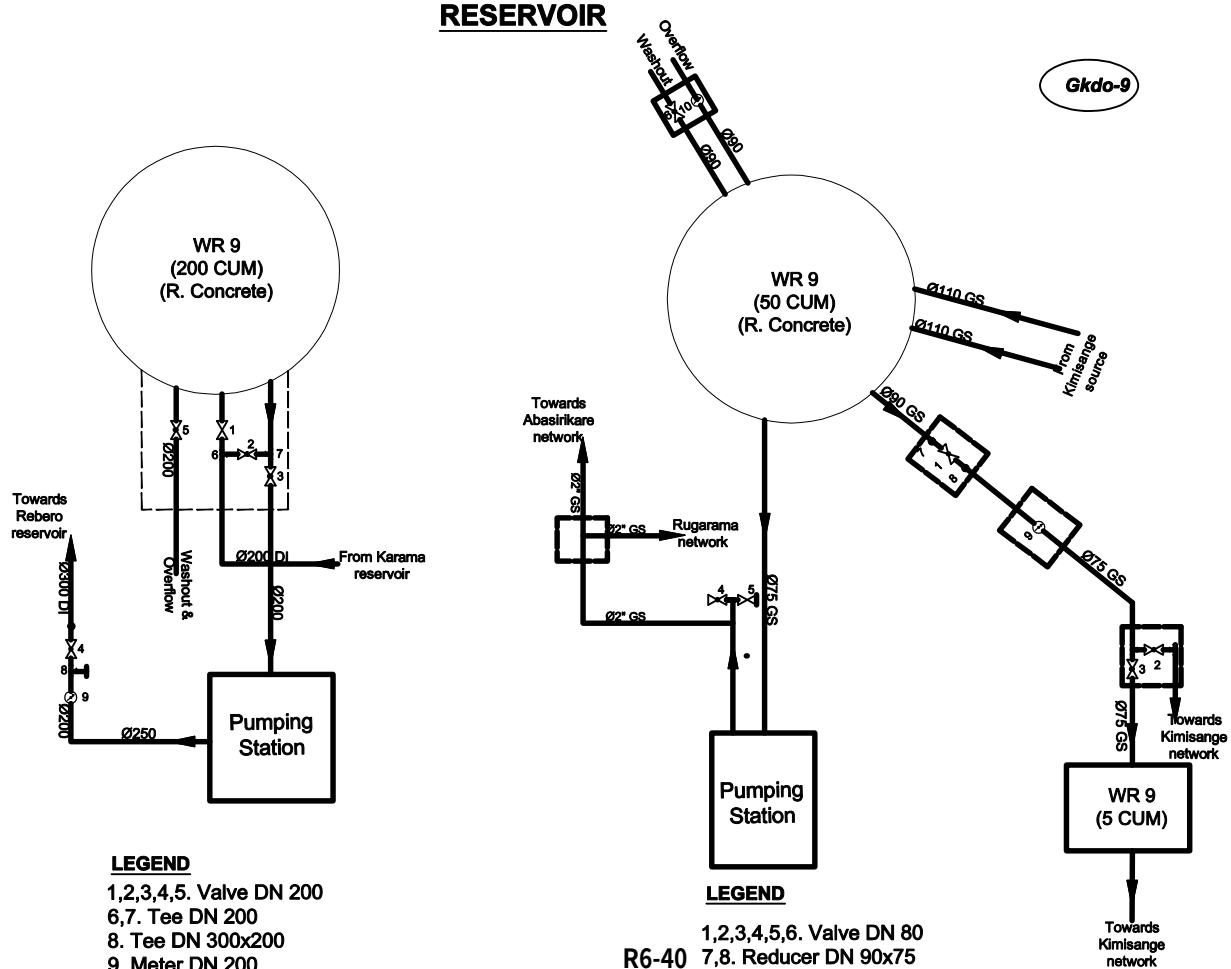


LEGEND

1,2,3. Valve DN 100
4. Water meter DN 100

GOLFE FIVE/KIMISANGE RESERVOIR

Gkdo-9



LEGEND

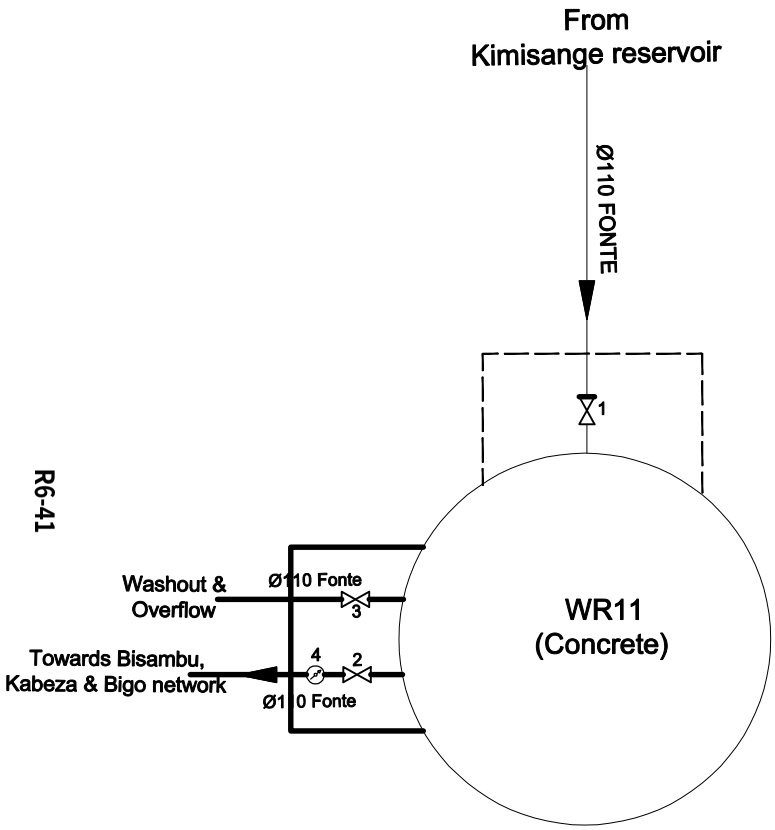
1,2,3,4,5. Valve DN 200
6,7. Tee DN 200
8. Tee DN 300x200
9. Meter DN 200

LEGEND

1,2,3,4,5,6. Valve DN 80
7,8. Reducer DN 90x75
9,10. Meter DN 80

NYARURAMA RESERVOIR(125CUM)

Gkdo-11

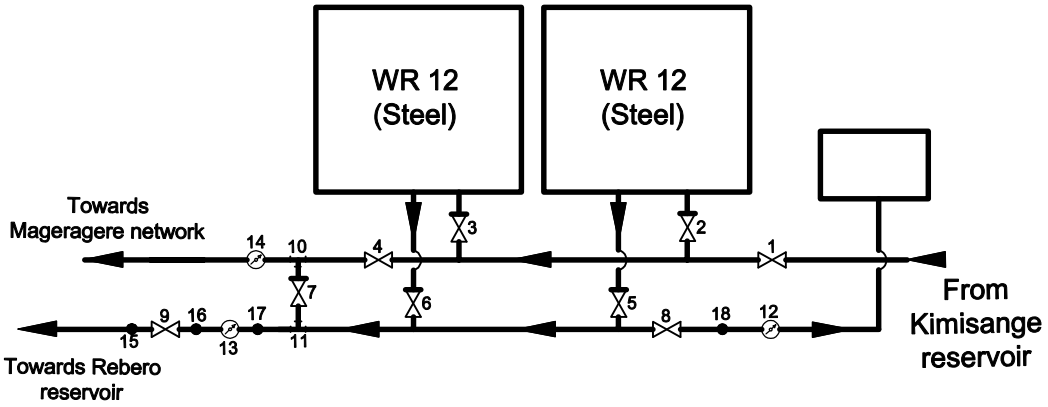


LEGEND

1,2,3. Valve DN 100
4. Water meter DN 100

REBERO RADAR RESERVOIR(250CUM)

Gkdo-12

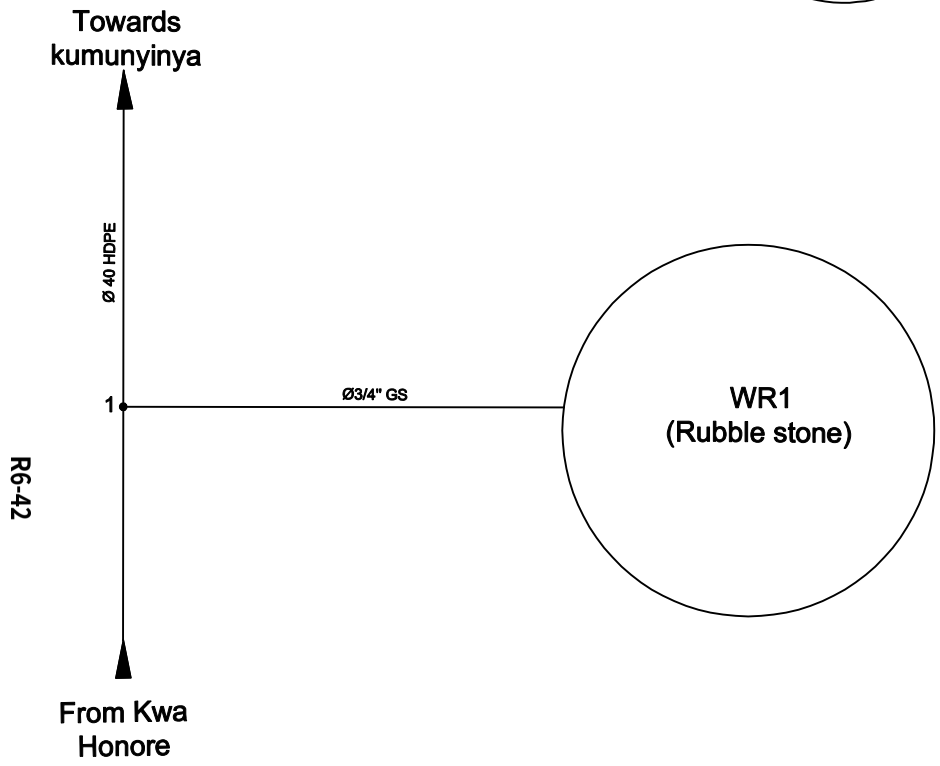


LEGEND

1,2,3,4,5,6,7,8. Valve DN 200
9. Valve DN 150
10,11. Tee DN 200
12,13. Water meter DN 100
14. Water meter DN 200
15. Reducer DN 150x200
16. Reducer DN 100x150
17,18. Reducer DN 200x100

GATENGA/KUMUNYINYA RESERVOIR (5 CUM)

Gkdo-13

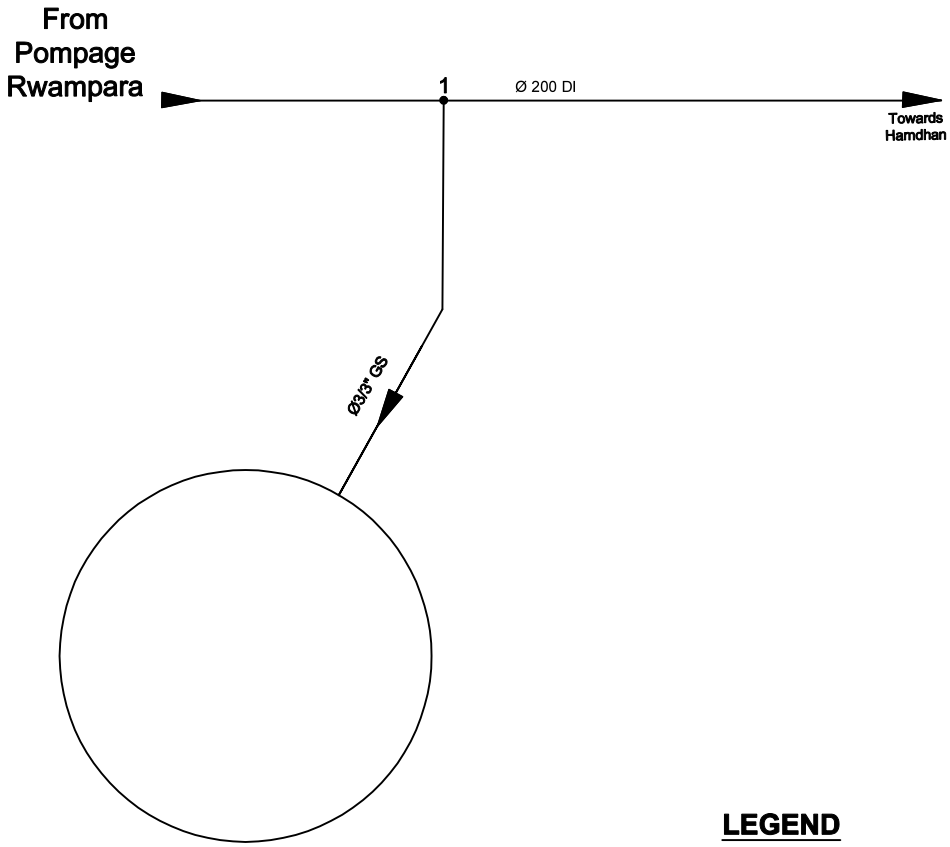


LEGEND

1.Clamp DN 40x3/4"

KIMISANGE RESERVOIR (5 CUM)

Gkdo - 14

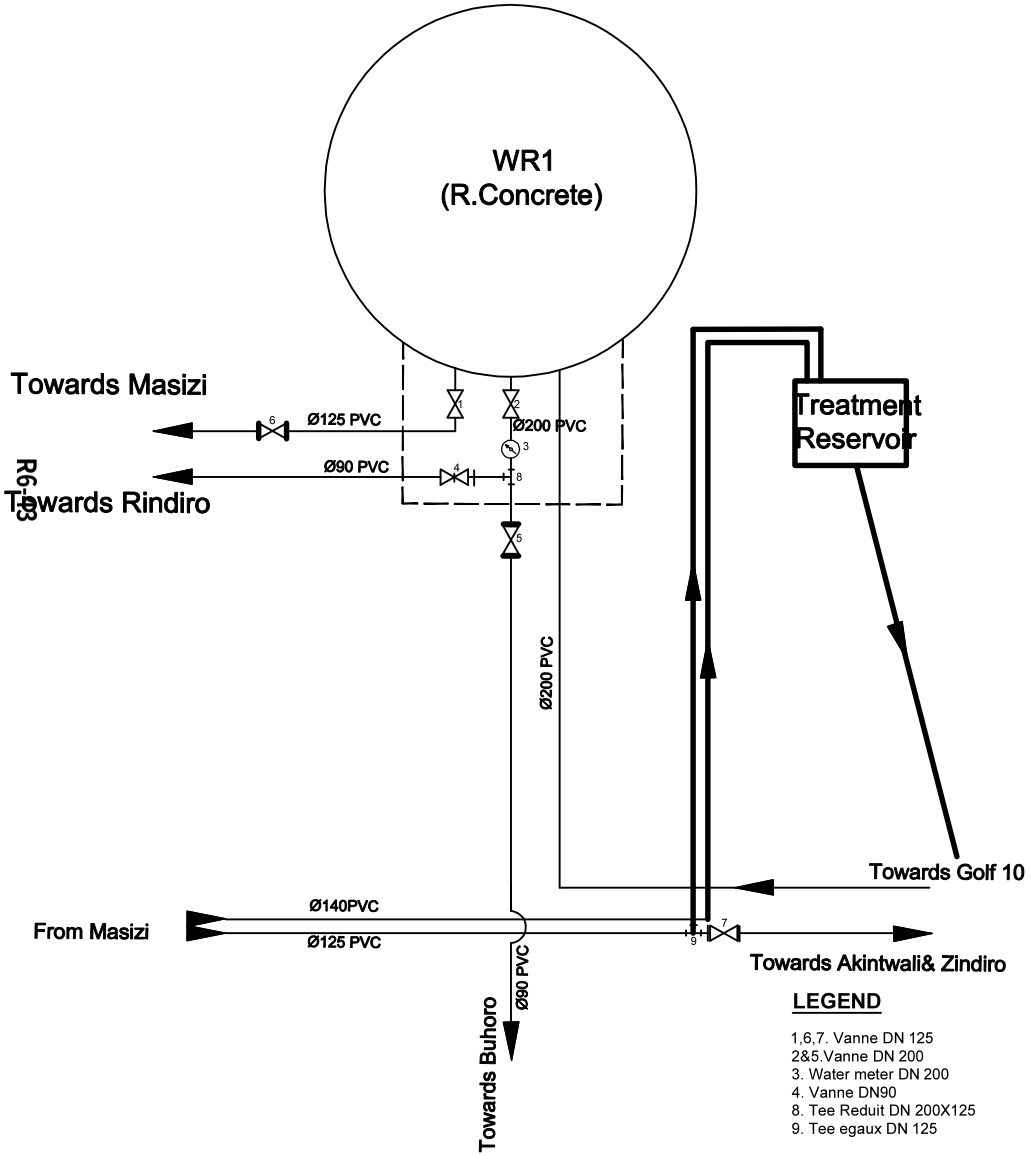


LEGEND

1.Clamp DN 200x3/4"

BUHORO RESERVOIR
(..... CUM)

Rmra- 1

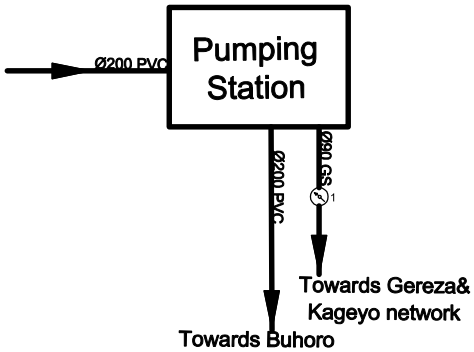


LEGEND

1,6,7. Vanne DN 125
2&5.Vanne DN 200
3. Water meter DN 200
4. Vanne DN90
8. Tee Reduit DN 200X125
9. Tee egaux DN 125

GOLFE 10

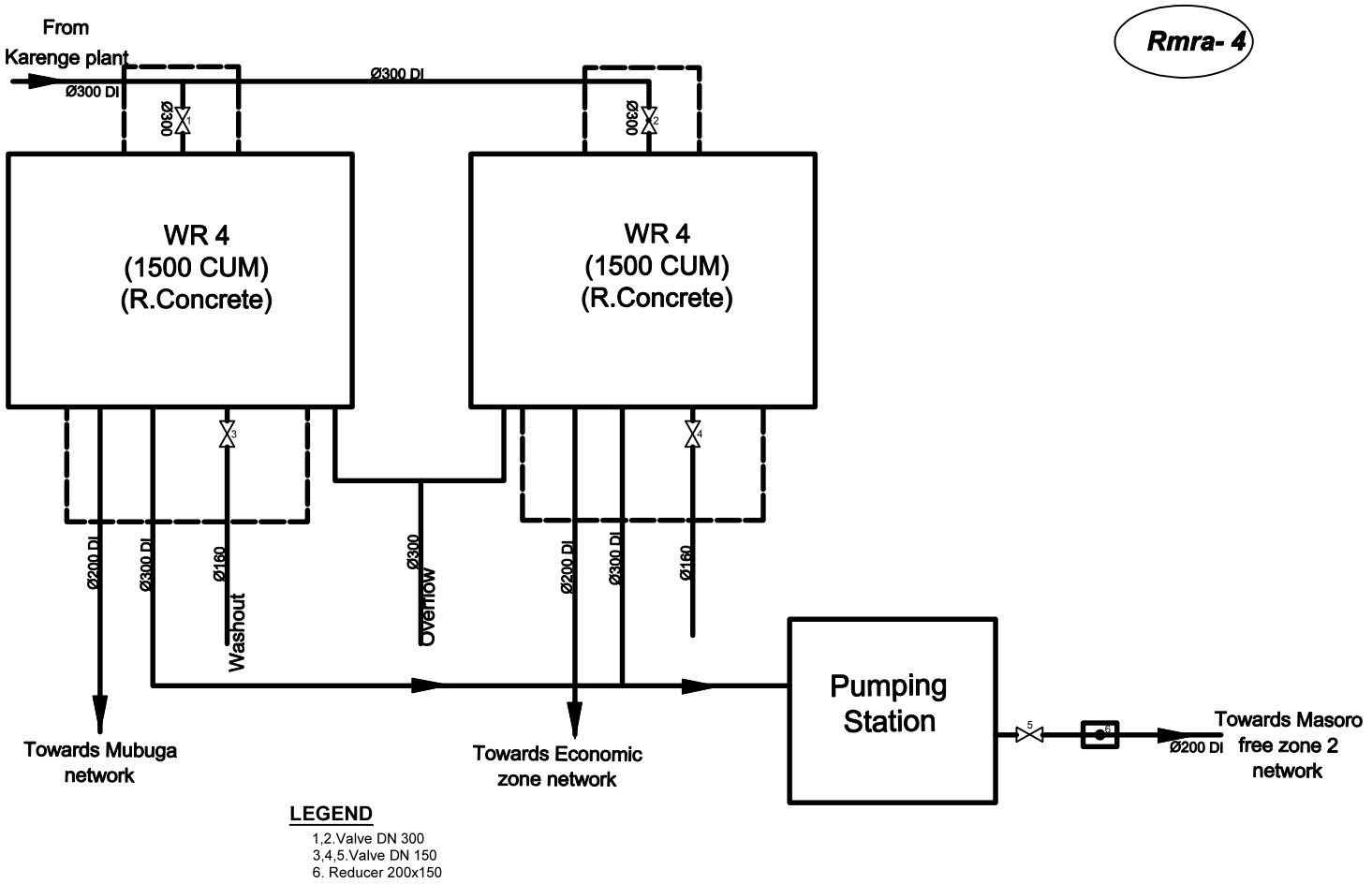
Rmra-2



LEGEND

1. Meter 80

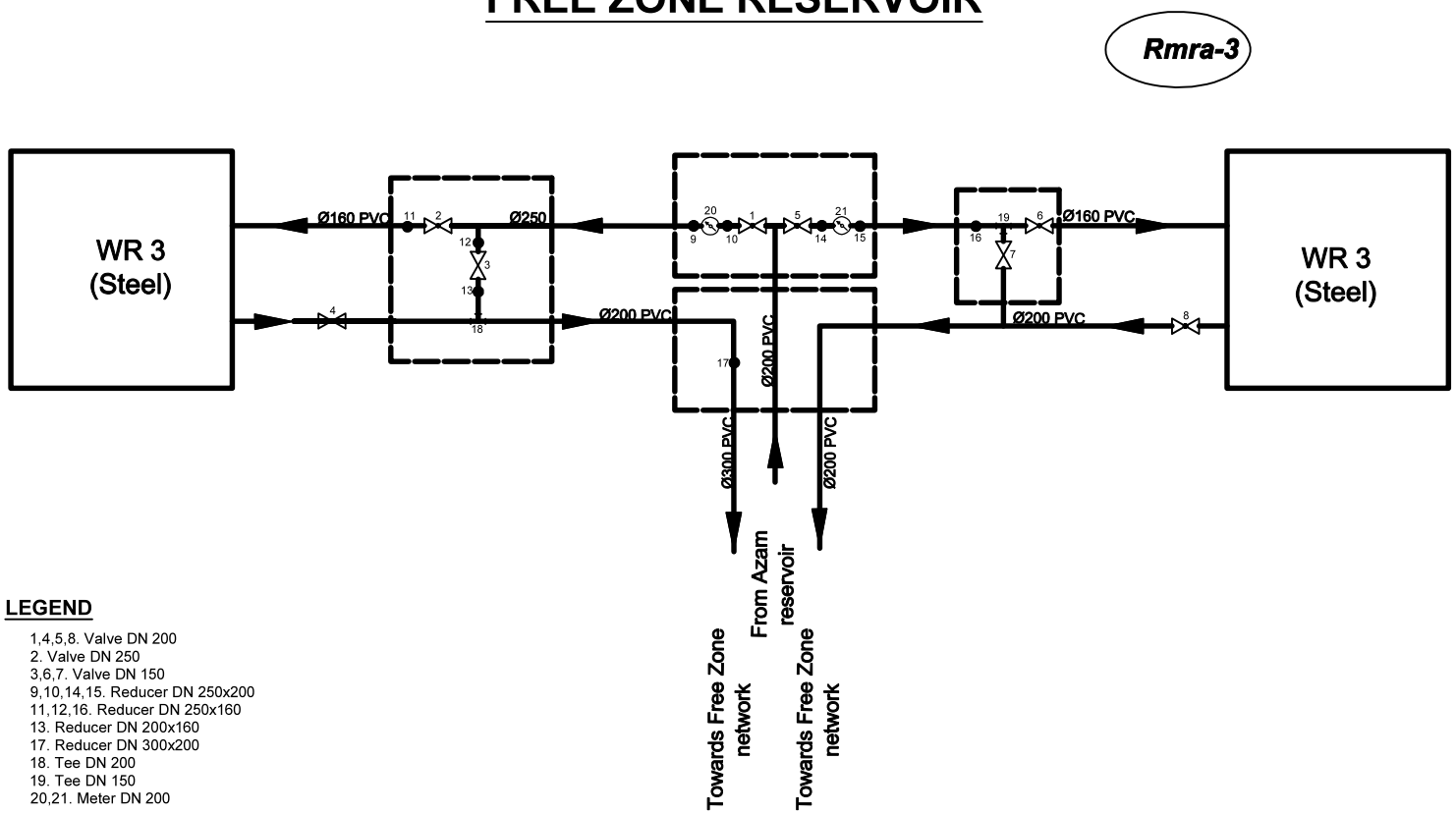
MASORO BAS RESERVOIR



LEGEND

1,2.Valve DN 300
3,4,5.Valve DN 150
6. Reducer 200x150

FREE ZONE RESERVOIR

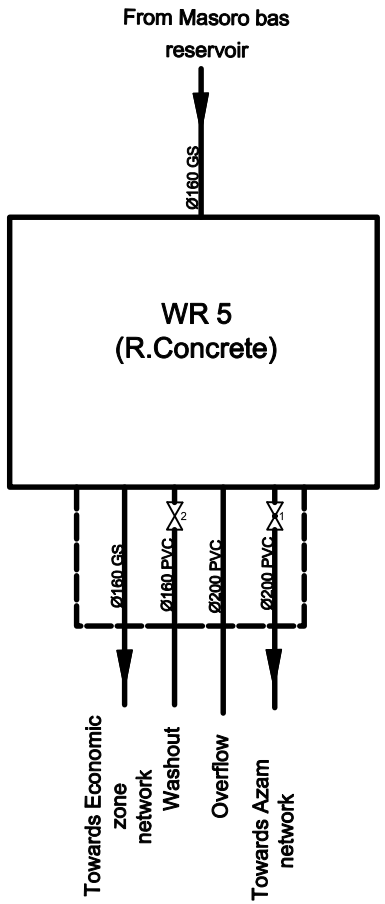


LEGEND

1,4,5,8. Valve DN 200
2. Valve DN 250
3,6,7. Valve DN 150
9,10,14,15. Reducer DN 250x200
11,12,16. Reducer DN 250x160
13. Reducer DN 200x160
17. Reducer DN 300x200
18. Tee DN 200
19. Tee DN 150
20,21. Meter DN 200

MASORO FREE ZONE PHASE 2 RESERVOIR (200 CUM)

Rmra- 5

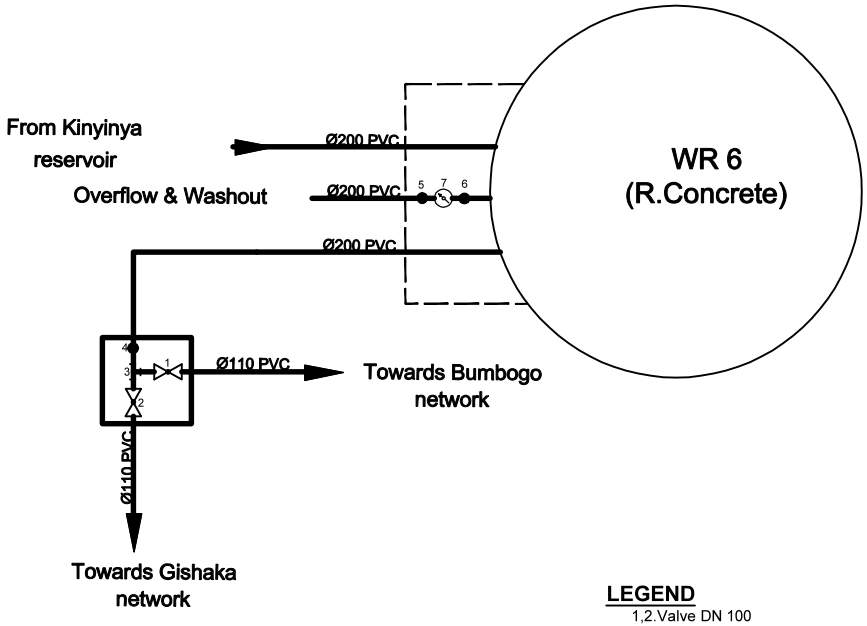


LEGEND

1.Valve DN 200
2.Valve DN 150

BUMBOGO SAINT LEONARD RESERVOIR (400 CUM)

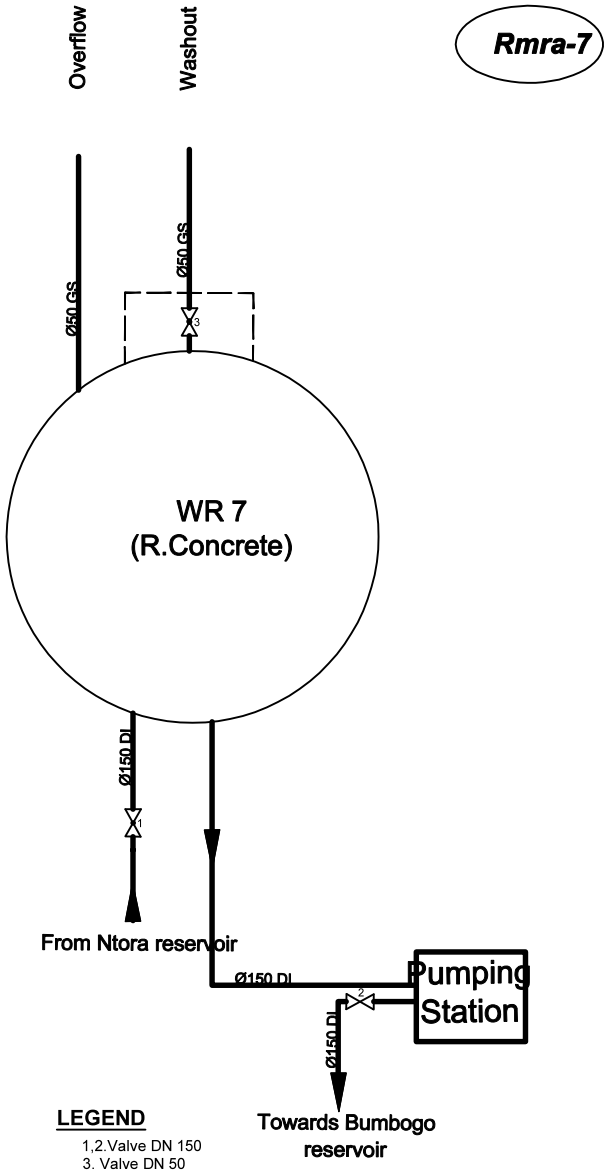
Rmra- 6



LEGEND

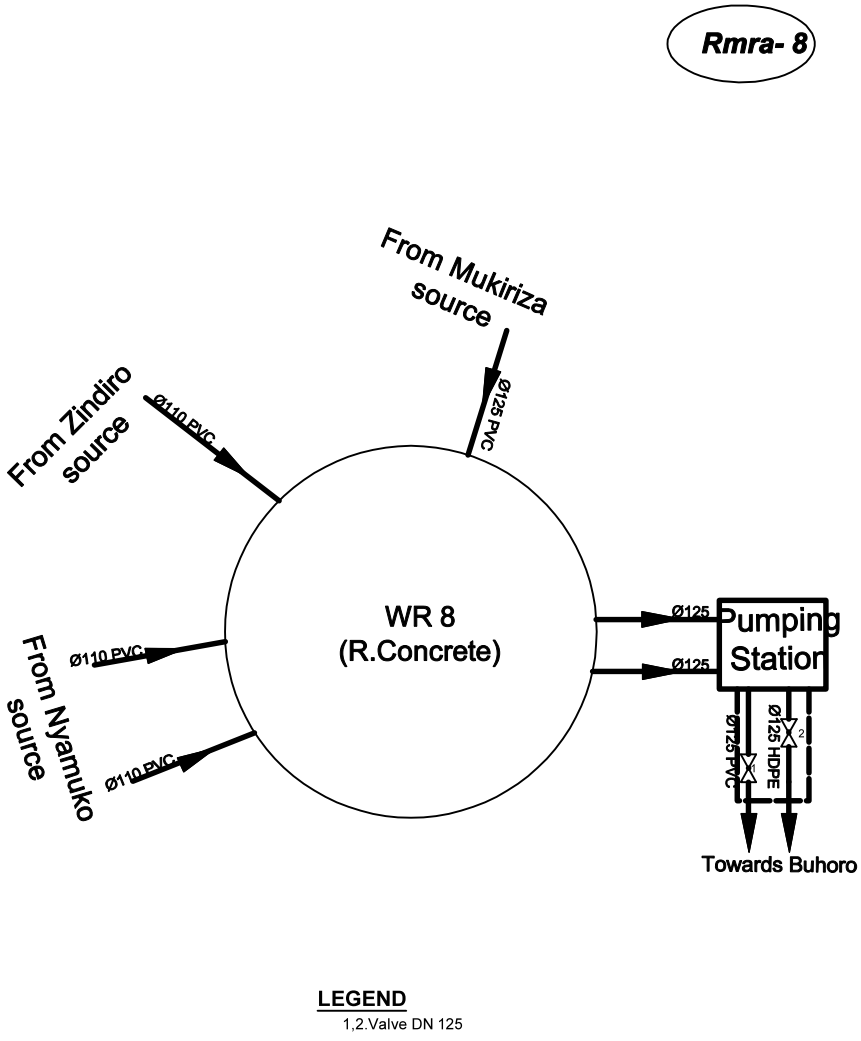
1,2.Valve DN 100
3.Tee DN 100
4. Reducer DN 200x100
5,6. Reducer DN 200x160
7. Meter 160

KINYINYA RESERVOIR(30 CUM)



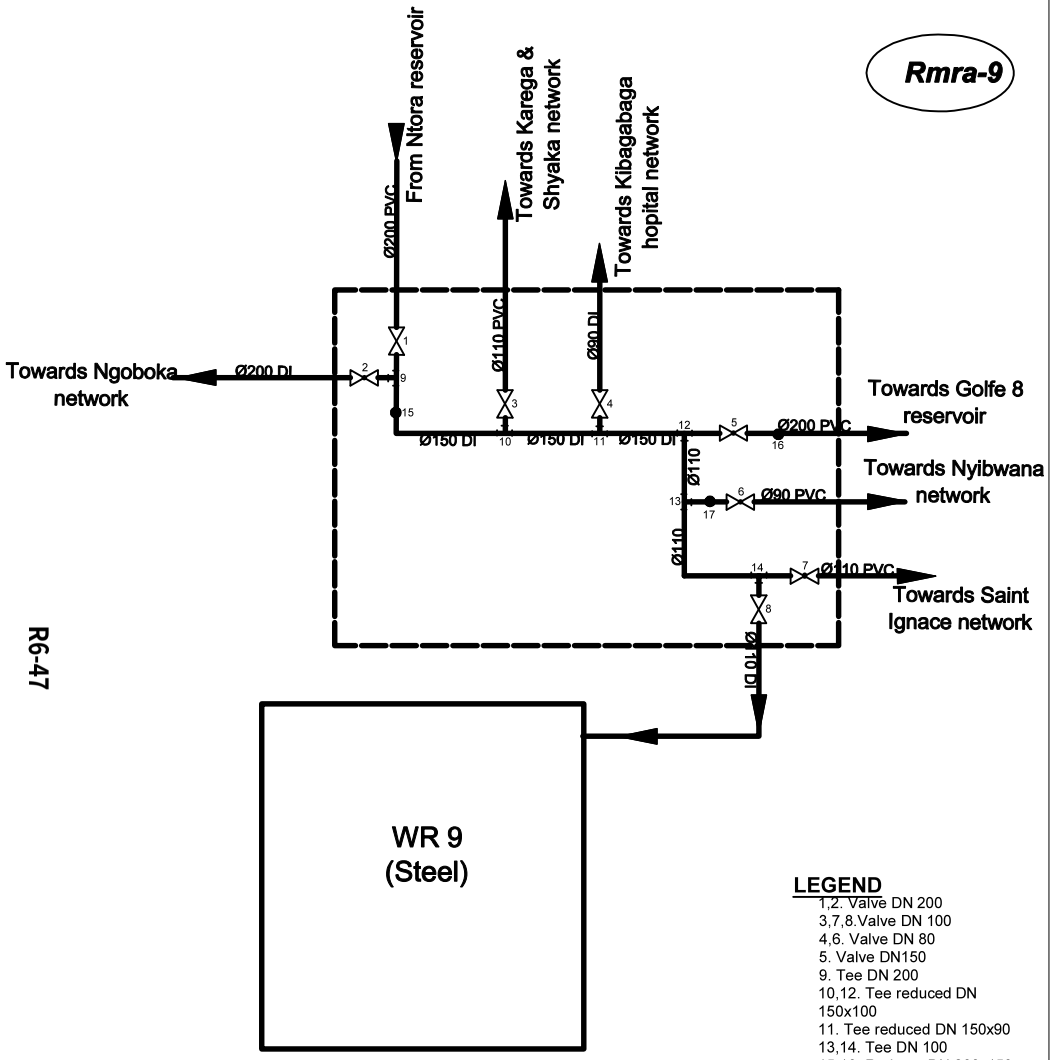
R6-46

MASIZI RESERVOIR(.... CUM)



KIBAGABAGA RESERVOIR (1)

Rmra-9

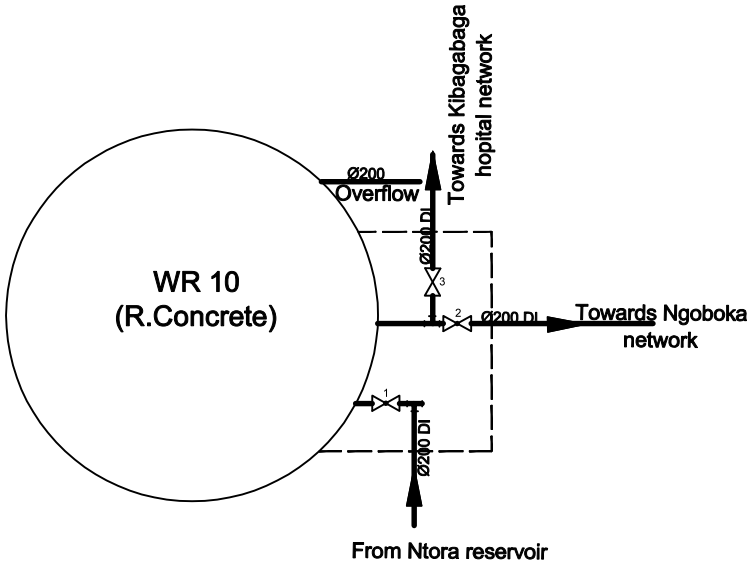


LEGEND

1,2. Valve DN 200
3,7,8.Valve DN 100
4,6. Valve DN 80
5. Valve DN150
9. Tee DN 200
10,12. Tee reduced DN 150x100
11. Tee reduced DN 150x90
13,14. Tee DN 100
15,16. Reducer DN 200x150
17. Reducer DN 100x80

KIBAGABAGA RESERVOIR (200 CUM)

Rmra-10

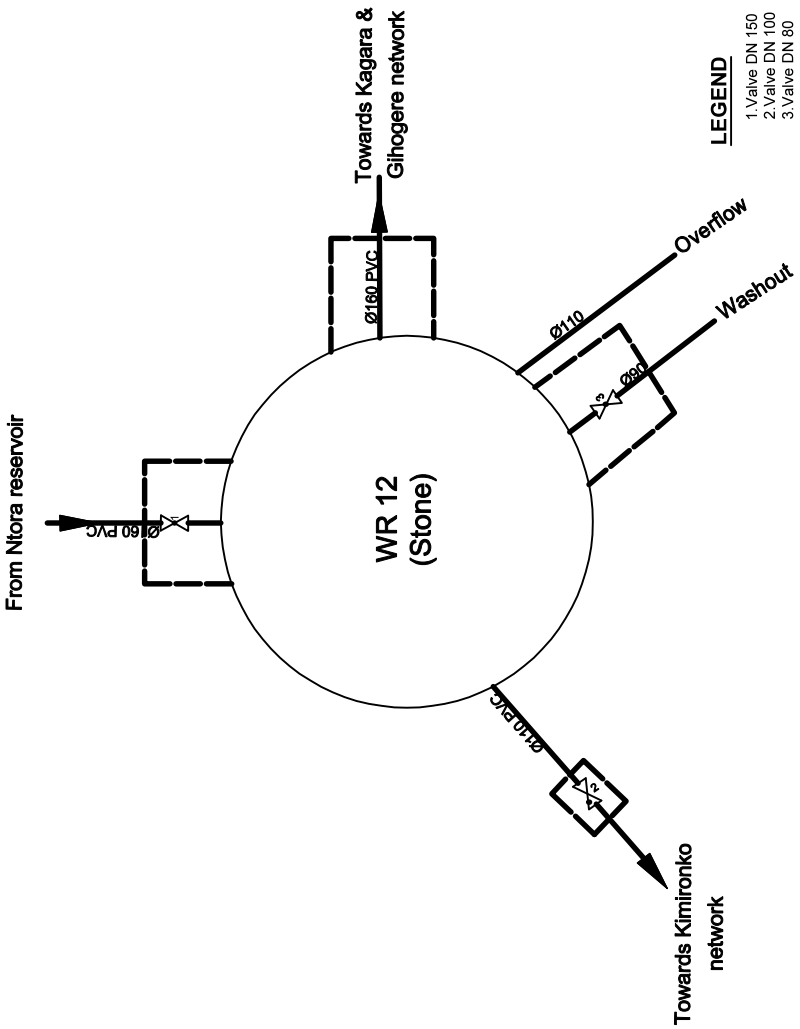


LEGEND

1,2,3. Valve DN 200

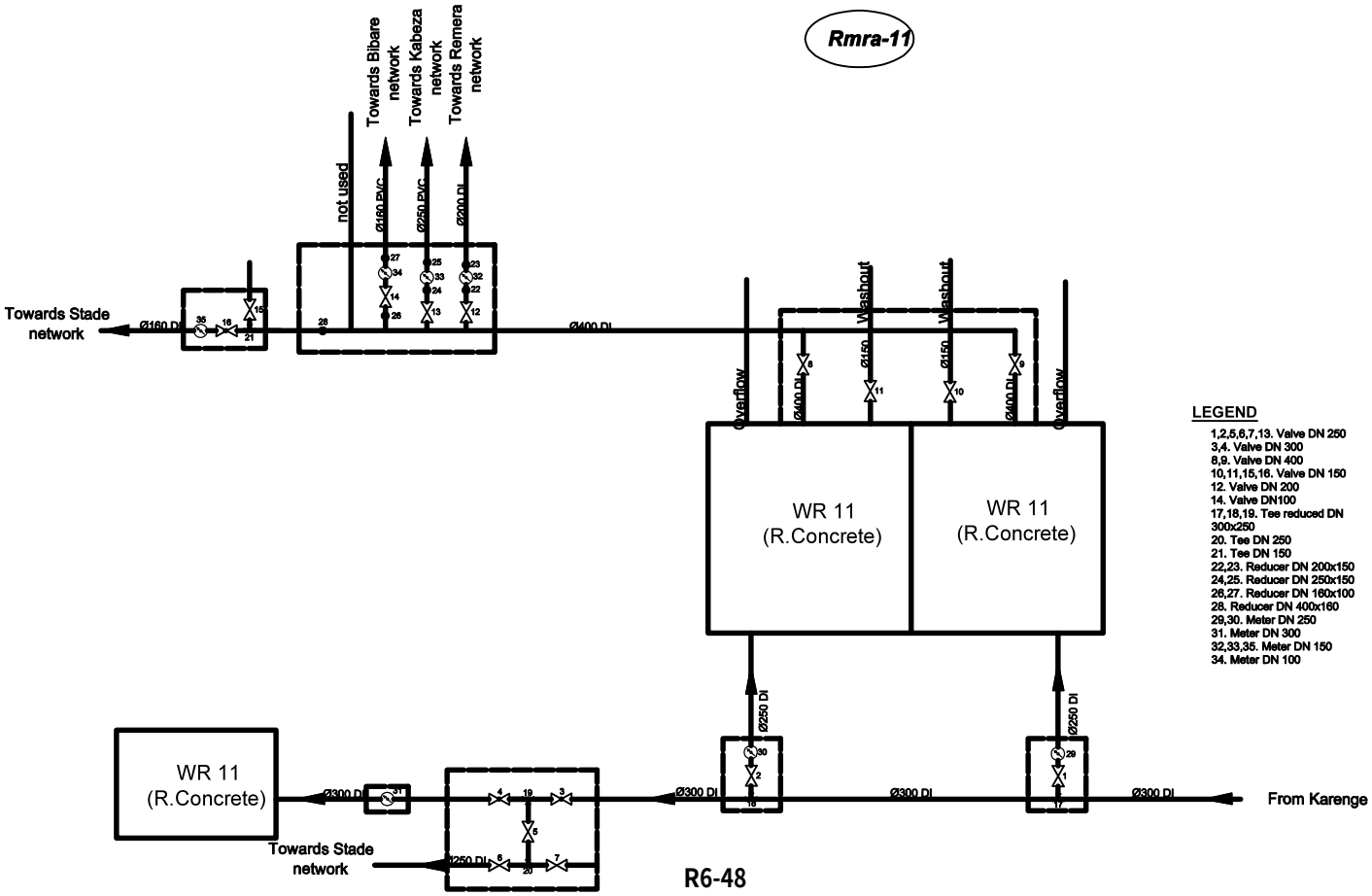
CHEZ LANDO RESERVOIR
(200 CUM)

Rmra- 12



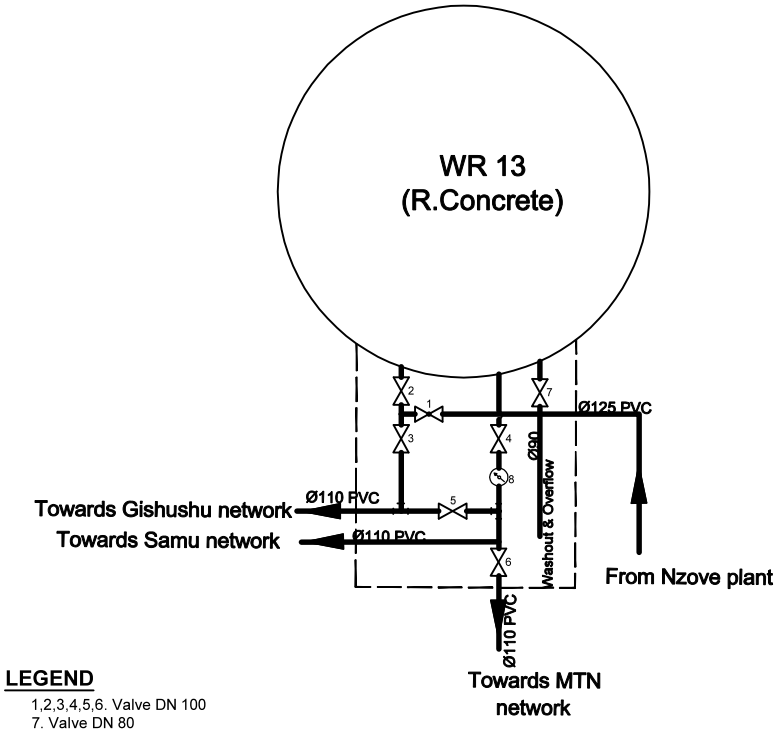
GOLFE 8 RESERVOIR

Rmra-11



NYARUTARAMA RESERVOIR(...CUM)

Rmra-13



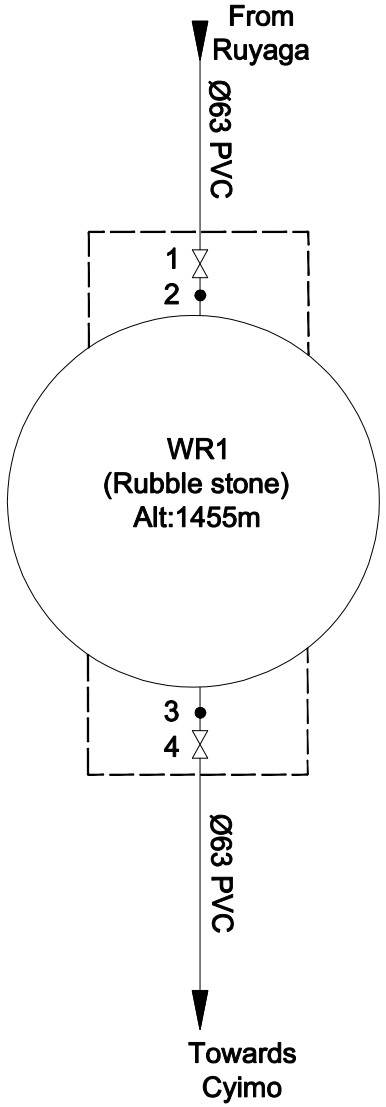
LEGEND

1,2,3,4,5,6. Valve DN 100
7. Valve DN 80
8. Meter DN 100

R6-49

MASAKA-REBERO BREAK PRESSURE(15 CUM)

Knmb - 1



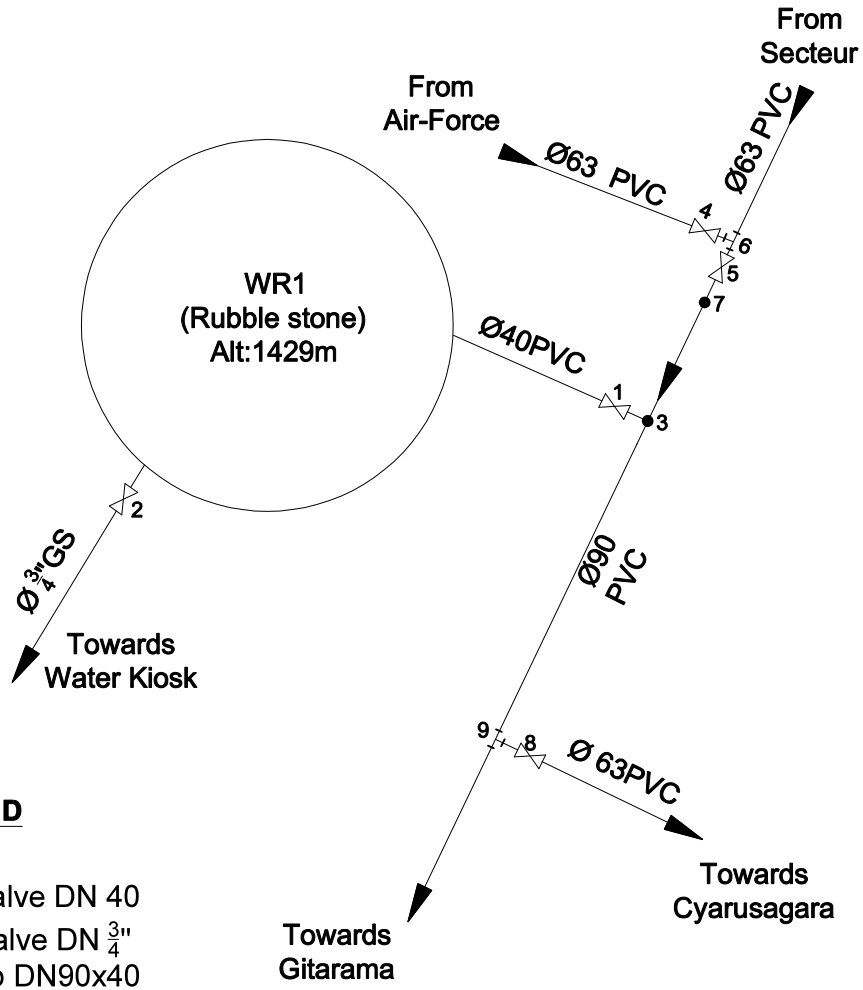
R6-50

LEGEND

1,4.Valve DN 60
2,3.Reducer DN 60x80

KARAMA-Regie (10 CUM)

Knmb - 2

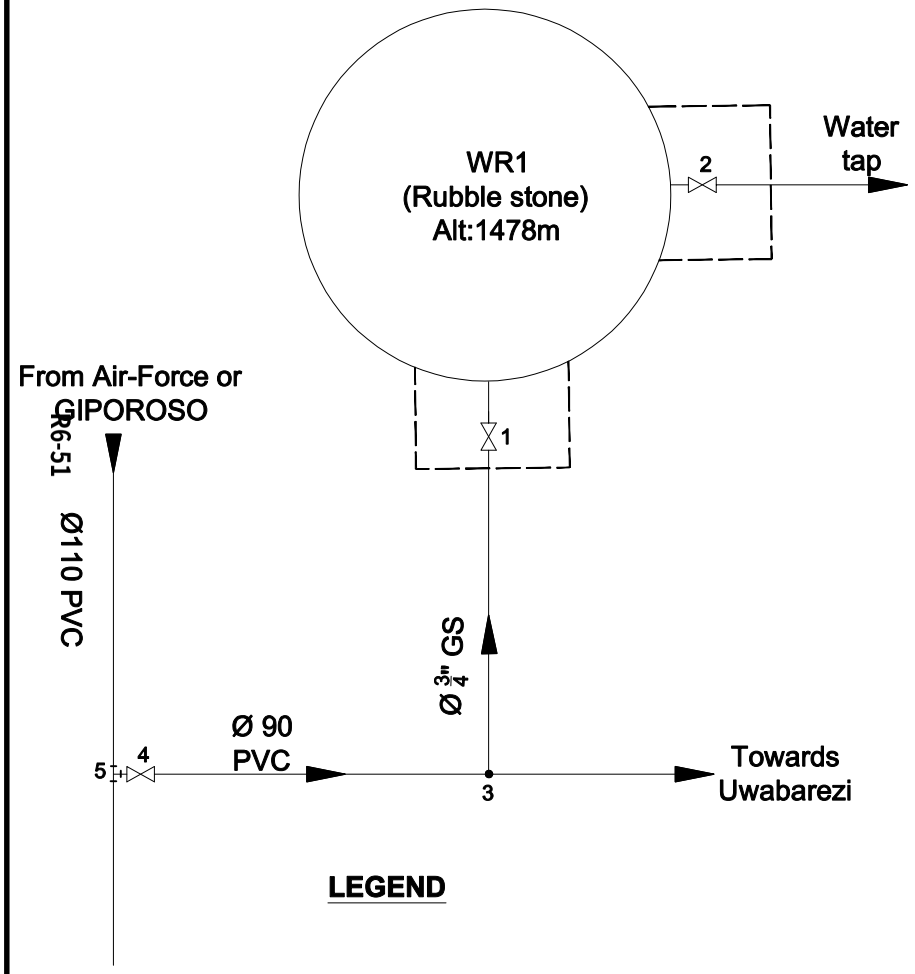


LEGEND

1.Ball valve DN 40
2.Ball valve DN $\frac{3}{4}$"
3.Clamp DN90x40
4,5,8.Vanne DN 60
6.Tee PVC DN 63
7.Reducer DN 90x63
9.Reduced Tee DN 90x60

ABAREZI-SAMUDUHA RESERVOIR(50 CUM)

Knmb - 3

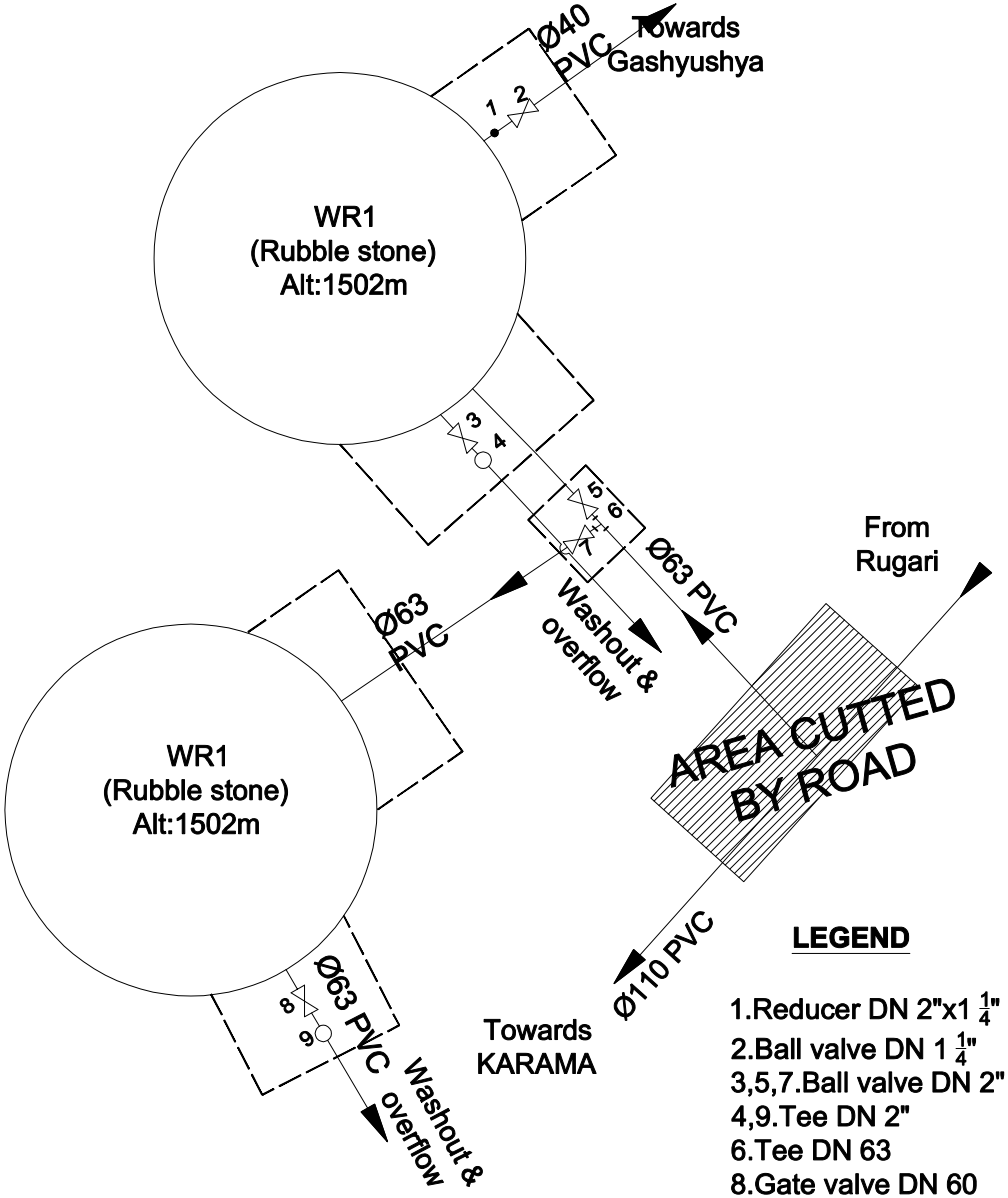


LEGEND

1,2.Ball valve DN $\frac{3}{4}$"
3.Clamp DN90x$\frac{3}{4}$"
4.Valve DN 80
4.Reduced Tee DN 110x90

BUSANZA/ANTENNE RESERVOIR (45 and 50 CUM)

Knmb - 4

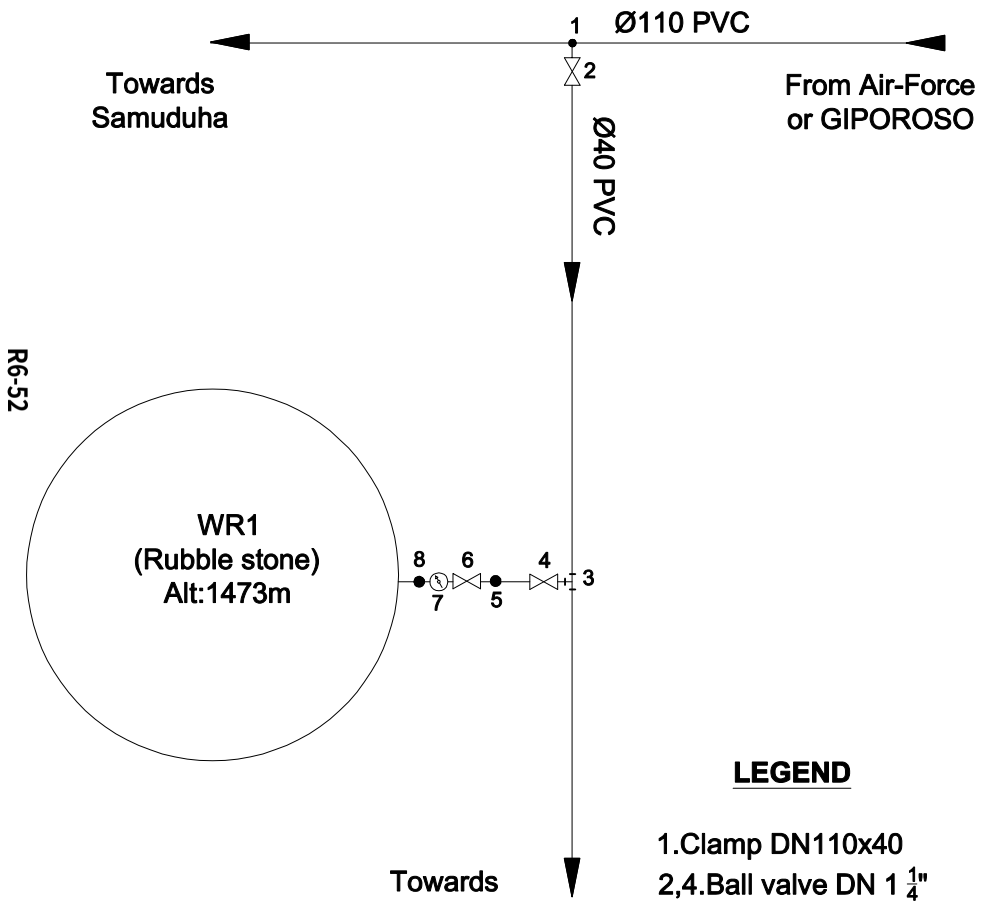


LEGEND

1.Reducer DN 2"x1 $\frac{1}{4}$"
2.Ball valve DN 1 $\frac{1}{4}$"
3,5,7.Ball valve DN 2"
4,9.Tee DN 2"
6.Tee DN 63
8.Gate valve DN 60

INTWARI/KABEZA RESERVOIR(50 CUM)

Knmb - 5

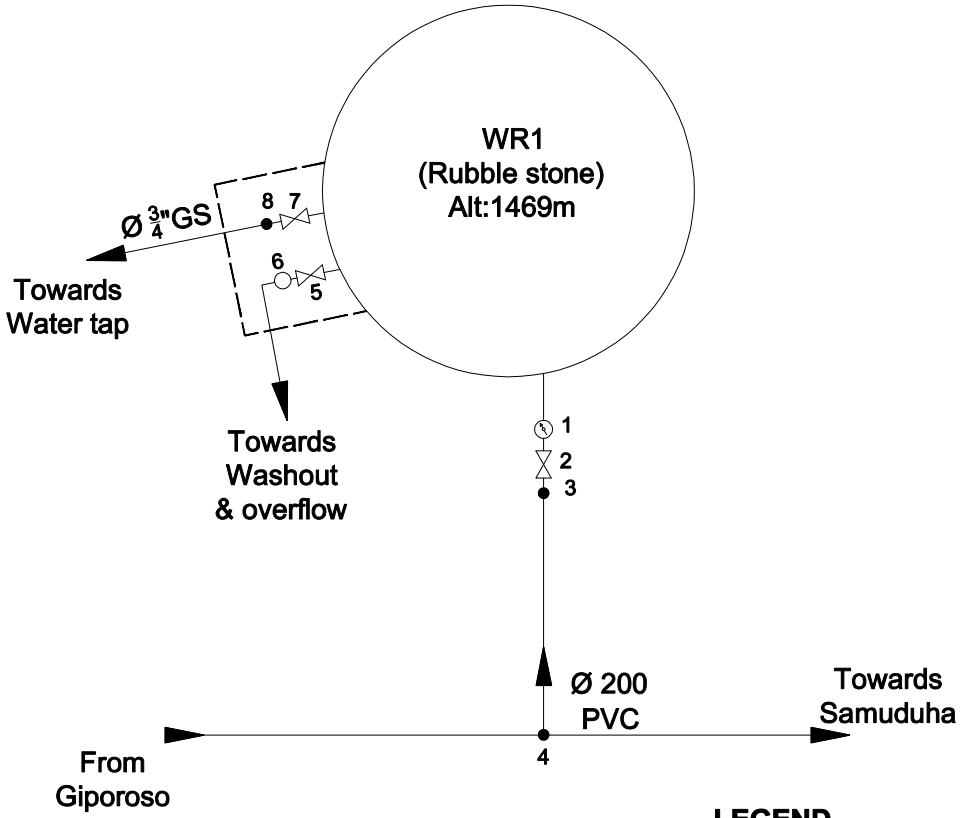


LEGEND

1.Clamp DN110x40
2,4.Ball valve DN 1 $\frac{1}{4}$"
3.Reduced Tee DN 40x32
5.Reducer DN 1 $\frac{1}{4}$"x$\frac{3}{4}$"
6.Ball valve DN $\frac{3}{4}$"
7.Water meter DN $\frac{3}{4}$"
8.Reducer DN2"x$\frac{3}{4}$"

KABEZA/REGIE RESERVOIR (20 CUM)

Knmb - 6

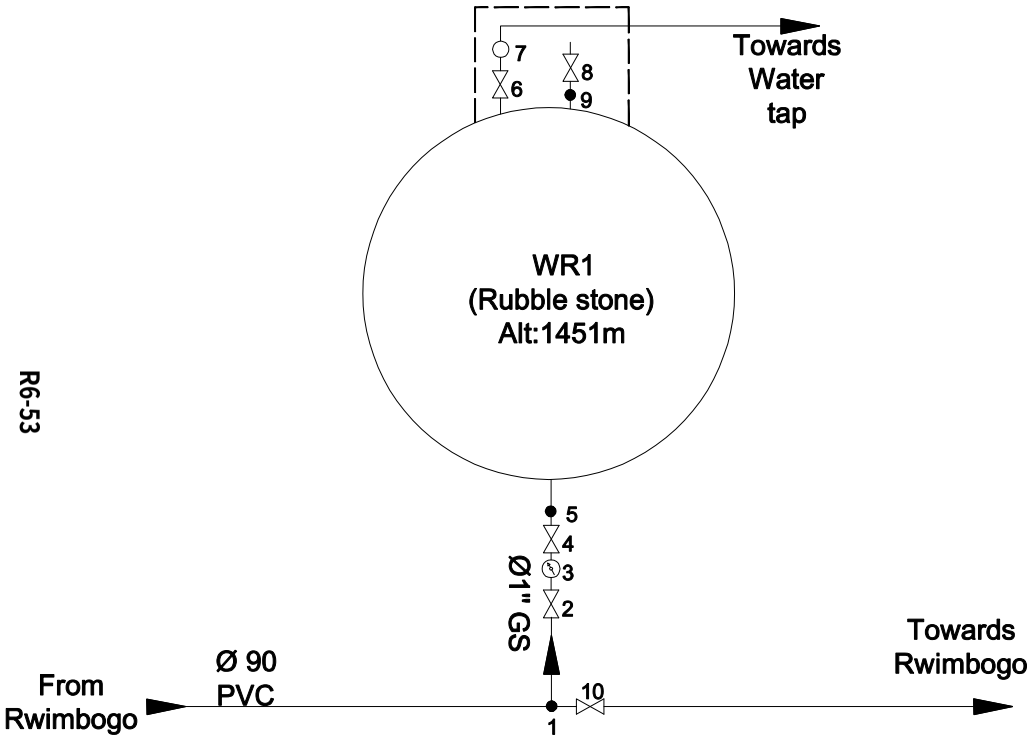


LEGEND

1.Water meter DN $\frac{3}{4}$"
2.Ball valve DN $\frac{3}{4}$"
3,8.Reducer DN 1 $\frac{1}{4}$"x$\frac{3}{4}$"
4.Clamp DN 200x40
5,7.Ball valve DN 1 $\frac{1}{4}$"
5.Tee DN 1 $\frac{1}{4}$"

RWINYANGE RESERVOIR
(10 CUM)

Knmb - 7

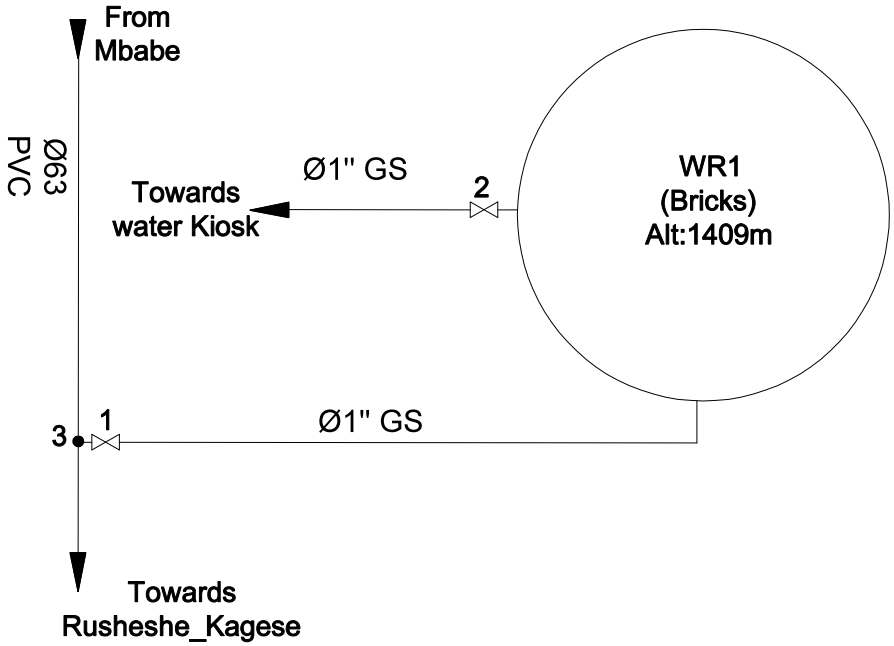


LEGEND

1.Clamp DN 90x1"
2,4,8.Ball valve DN 1"
3.Water meter DN 1"
5,9.Reducer DN 1 $\frac{1}{4}$"x1"
6.Ball valve DN 1 $\frac{1}{4}$"
7.Tee DN 1 $\frac{1}{4}$"

RUSHESHE Kiosk Reservoir
(10 CUM)

Knmb - 8

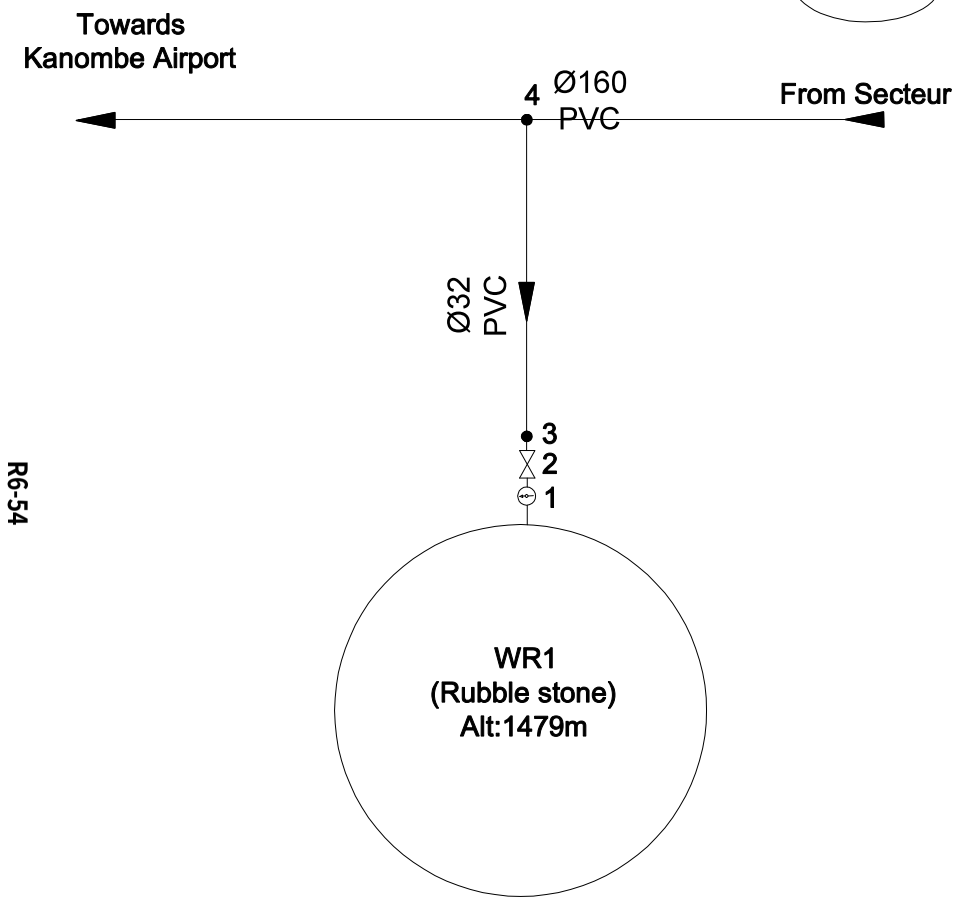


LEGEND

1,2.Vanne a Bille DN 1"
2.Clamp DN 63x1"

RUGALI Kiosk Reservoir (5 CUM)

Knmb - 9



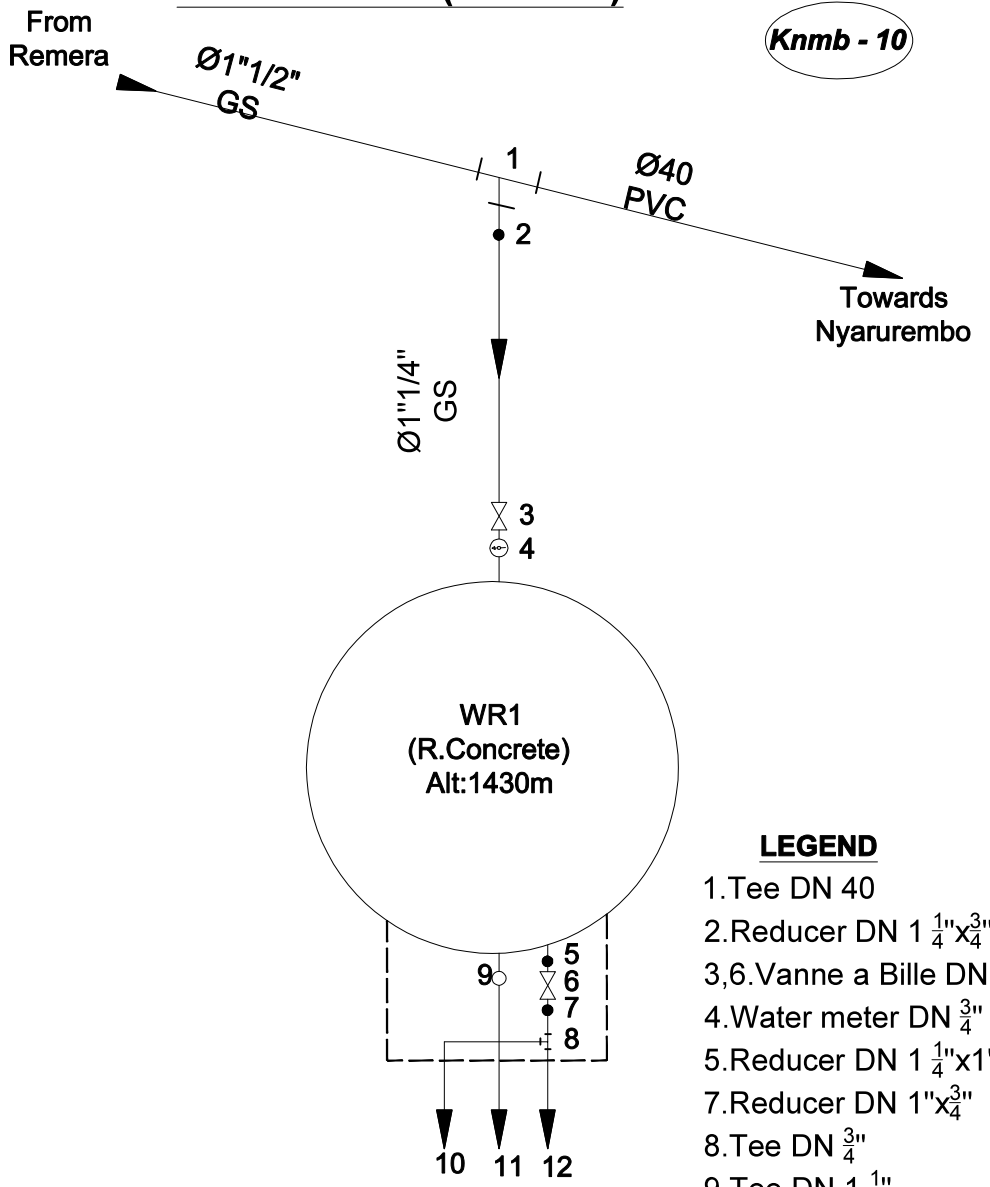
R6-54

LEGEND

1.Water meter DN $\frac{3}{4}$"
2.Vanne a Bille DN $\frac{3}{4}$"
3.Reducer DN 1"x$\frac{3}{4}$"
4.Clamp DN 160x1"

NYARUREMBO/KABEZA RESERVOIR (30 CUM)

Knmb - 10

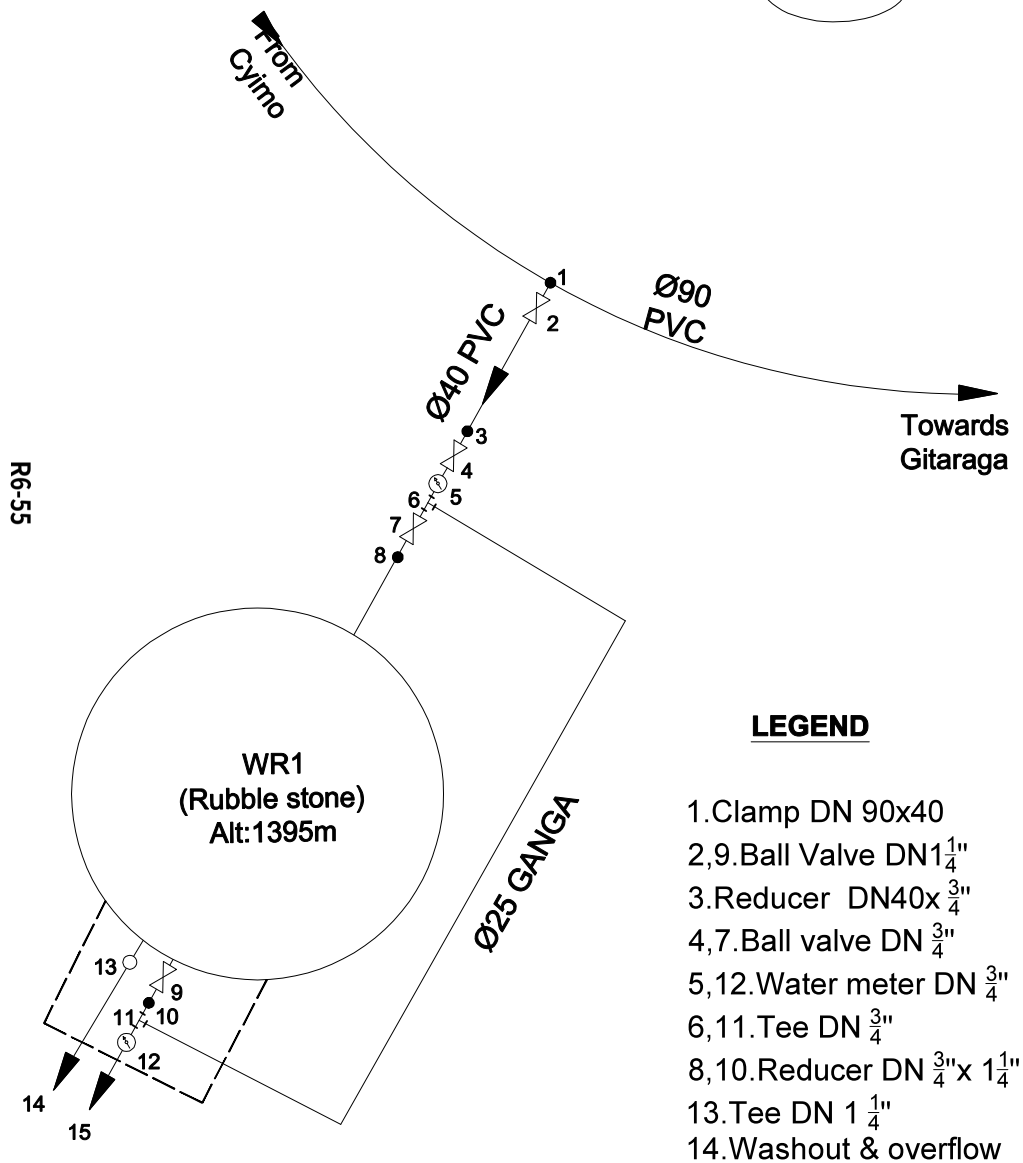


LEGEND

1.Tee DN 40
2.Reducer DN 1 $\frac{1}{4}$"x$\frac{3}{4}$"
3,6.Vanne a Bille DN $\frac{3}{4}$"
4.Water meter DN $\frac{3}{4}$"
5.Reducer DN 1 $\frac{1}{4}$"x1"
7.Reducer DN 1"x$\frac{3}{4}$"
8.Tee DN $\frac{3}{4}$"
9.Tee DN 1 $\frac{1}{4}$"
10,12.Water Tap
11.Washout & overflow

NGARAMA Kiosk Reservoir (40 CUM)

Knmb - 11

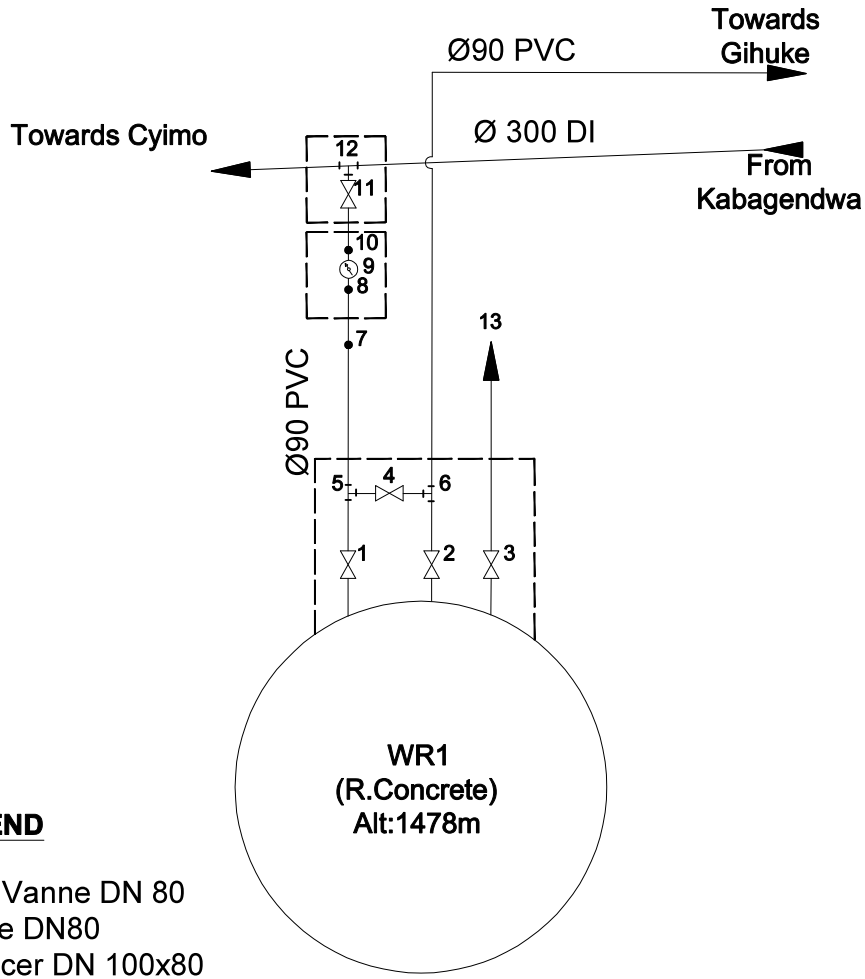


LEGEND

1.Clamp DN 90x40
2,9.Ball Valve DN1$\frac{1}{4}$"
3.Reducer DN40x $\frac{3}{4}$"
4,7.Ball valve DN $\frac{3}{4}$"
5,12.Water meter DN $\frac{3}{4}$"
6,11.Tee DN $\frac{3}{4}$"
8,10.Reducer DN $\frac{3}{4}$"x 1$\frac{1}{4}$"
13.Tee DN 1 $\frac{1}{4}$"
14.Washout & overflow
15.Water Tap

GAKO/MURAMBI RESERVOIR (250 CUM)

Knmb - 12

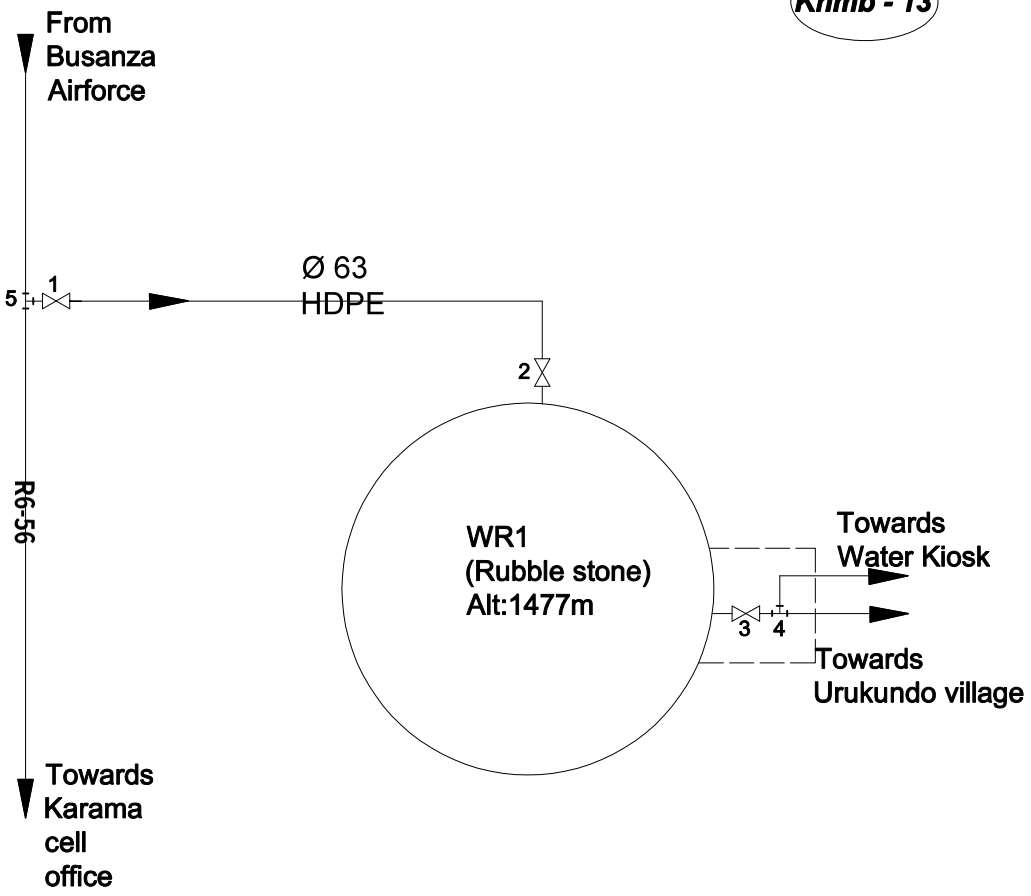


LEGEND

1,2,3,4.Vanne DN 80
5,6. Tee DN80
7.Reducer DN 100x80
8,10.Adaptor DN 100
9.Water meter DN 100
11. Vanne DN 100
12.Reducer Tee DN 300x125
13.Washout & overflow

KARAMA_URUKUNDO VILLAGE RESERVOIR(20 CUM)

Knmb - 13

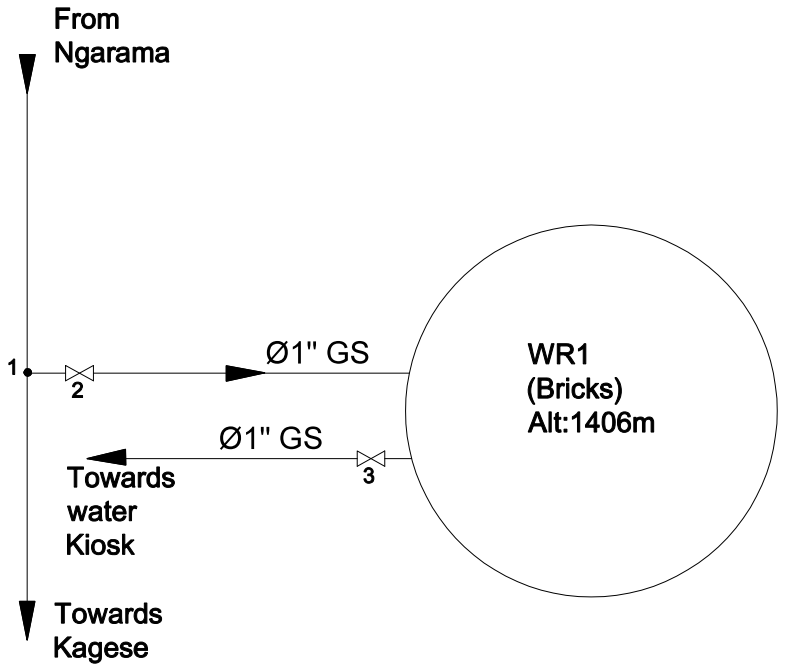


LEGEND

1,2.Ball valve DN 2"
3.Ball valve DN 1 $\frac{1}{4}$"
4.Reduced Tee DN 100x60
5.Reduced Tee DN 1 $\frac{1}{4}$"x1"

KANYETABI Kiosk Reservoir(10 CUM)

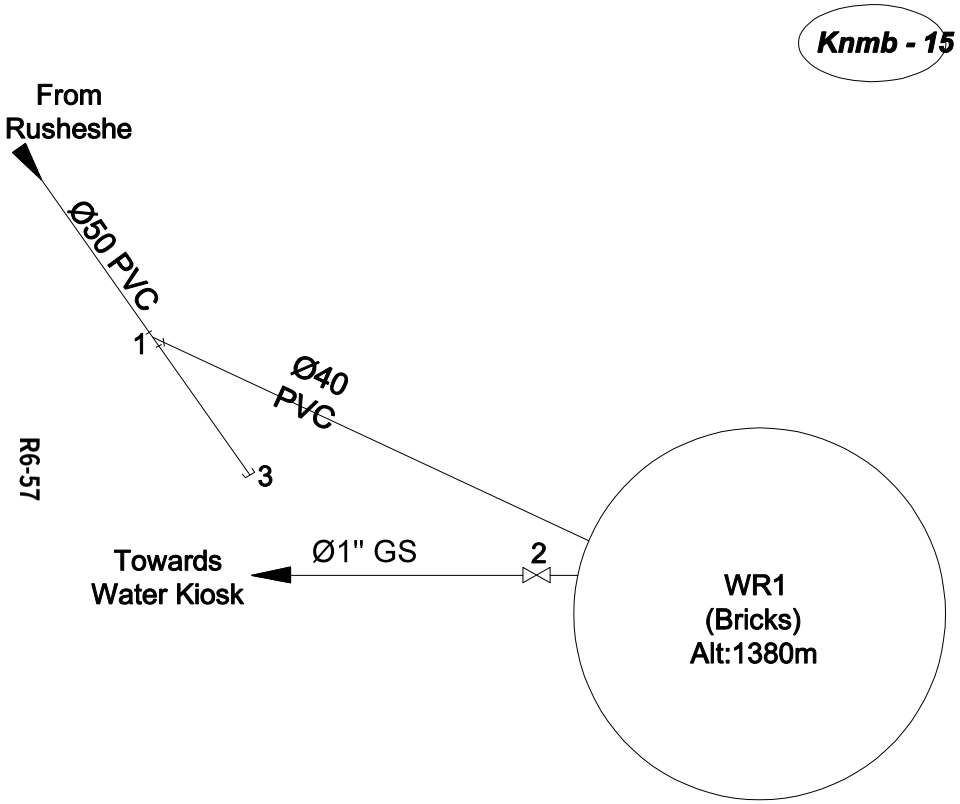
Knmb - 14



LEGEND

1.Clamp DN 63x1"
2,3.Ball valve DN 1"

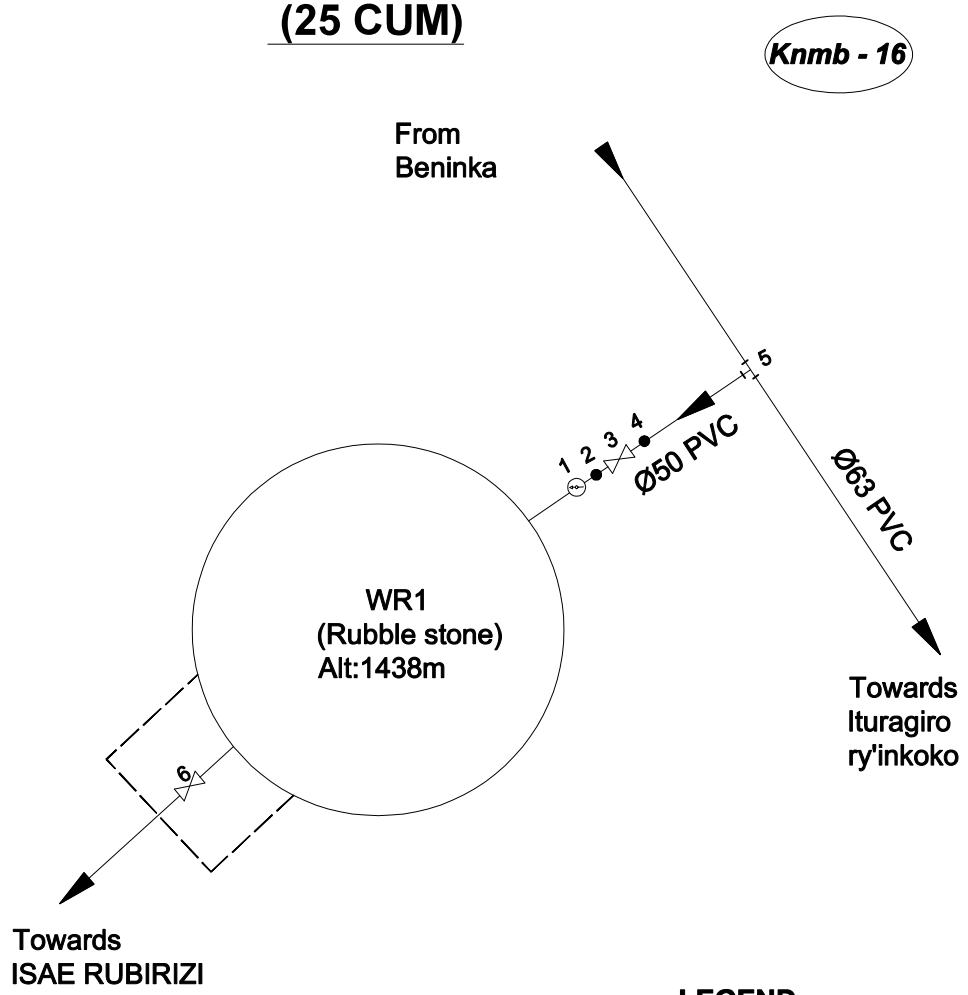
KAGESE Kiosk Reservoir(10 CUM)



LEGEND

1.Reduced Tee DN 50X40
2.Ball valve DN 1"
3.End cup DN 50

BENINKA RESERVOIR
(25 CUM)

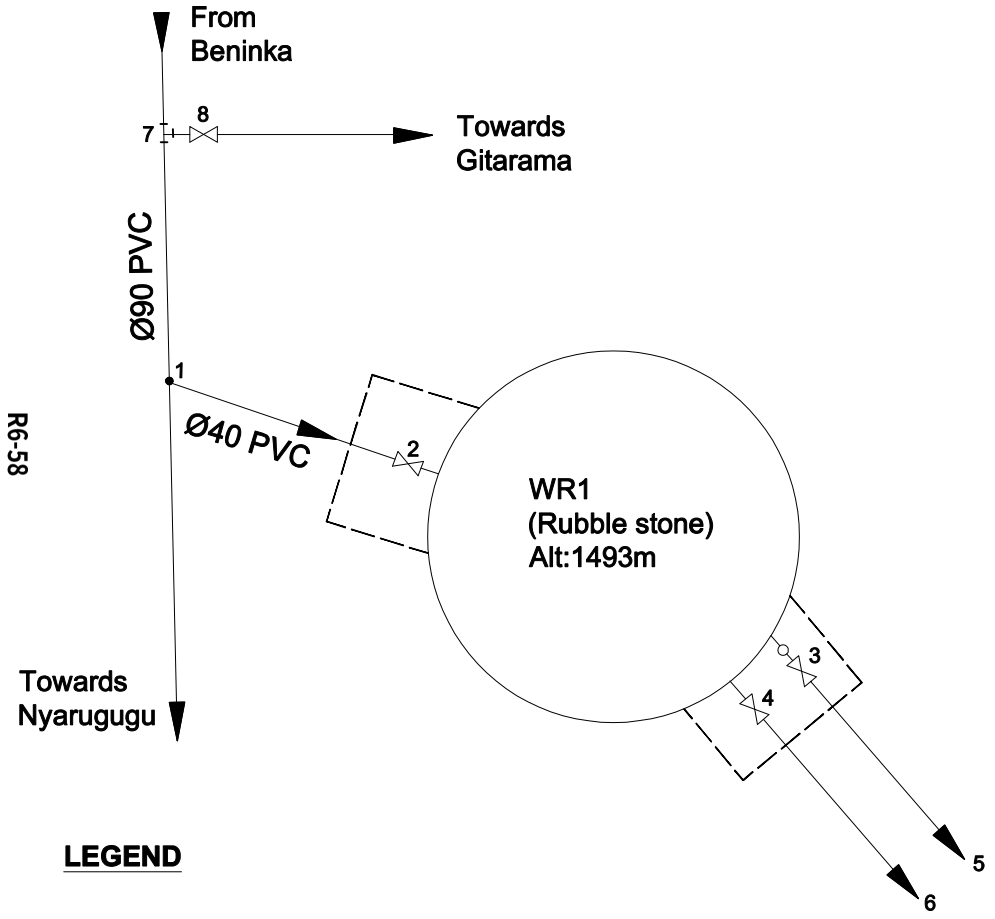


LEGEND

1.Water meter DN 1 $\frac{1}{2}$"
2,4.Reducer DN 1 $\frac{1}{2}$"x2"
3,6.Ball valve DN 2"
5.Reduced Tee DN 63x50

BYIMANA/BUSANZA RESERVOIR (20 CUM)

Knmb - 17

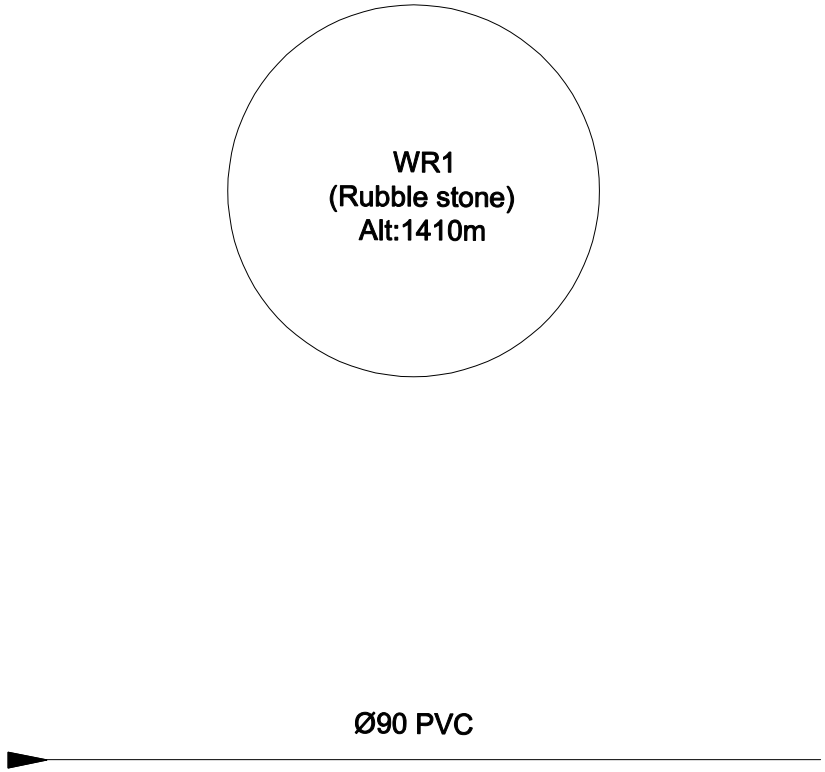


LEGEND

1.Clamp DN90x40
2;3;4.Vanne DN 1 $\frac{1}{4}$"
5.Washout & overflow
6. Water tap
7.Tee DN 90
8.Valve DN 80

GIHUKE RESERVOIR (10 CUM)

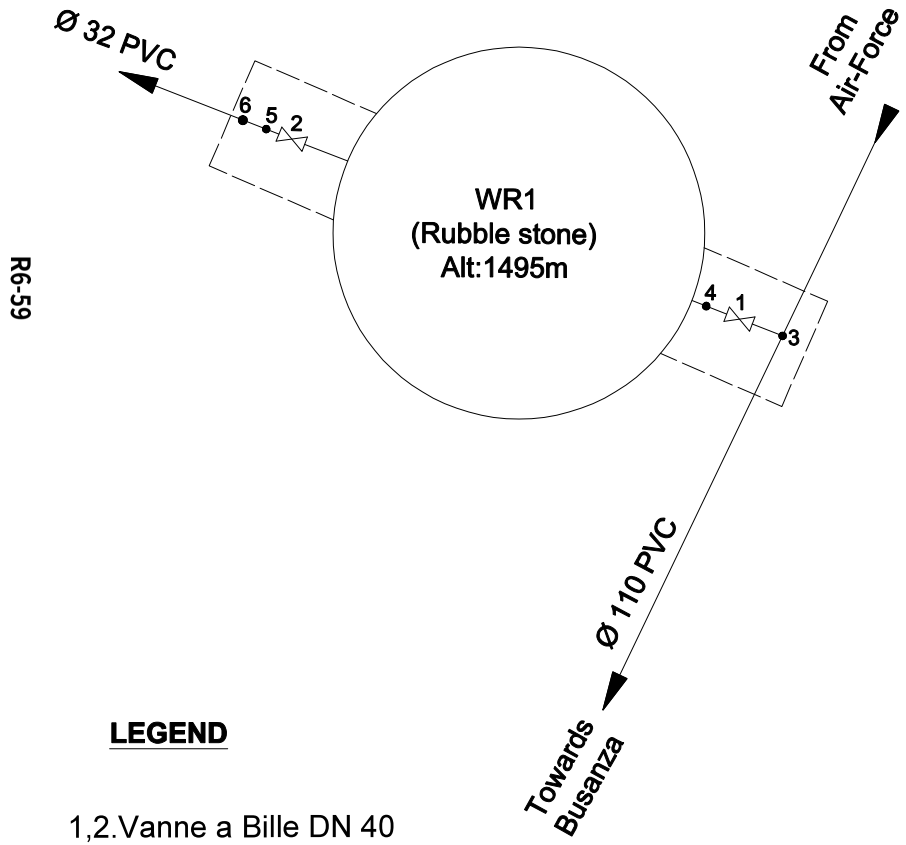
Knmb - 18



LEGEND

RADARI Kiosk Reservoir (20 CUM)

Knmb - 19



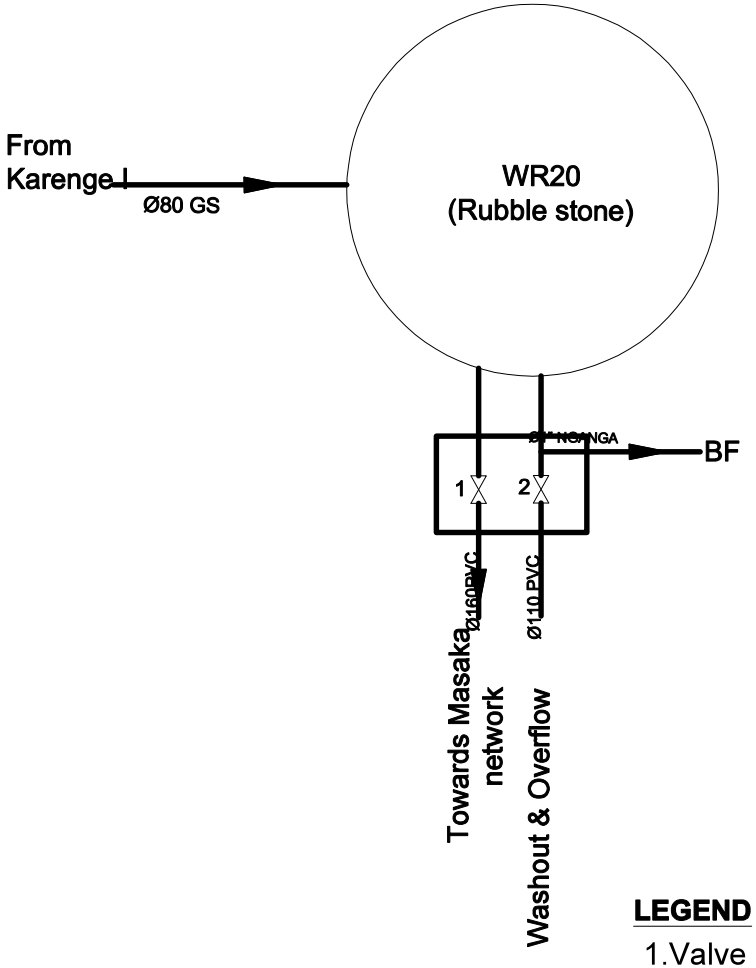
R6-59

LEGEND

1,2.Vanne a Bille DN 40
3.Clamp DN110x40
4,5.Union DN 40
6.Reducer DN 40x32

CYIMO JEHOVAH RESERVOIR
(... CUM)

Knmb - 20

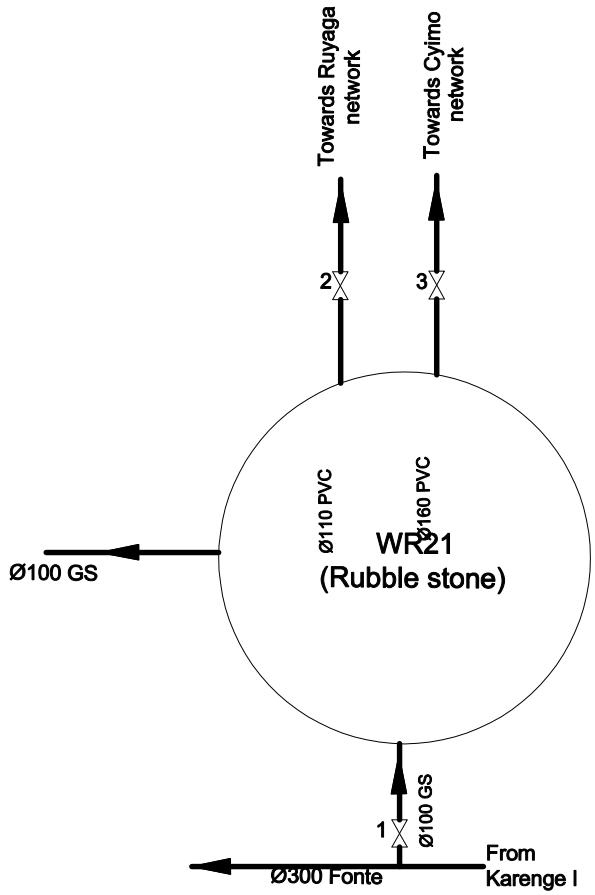


LEGEND

1.Valve DN 150
2.Valve DN 100

CYIMO CHURCH RESERVOIR
(5 CUM)

Knmb - 21



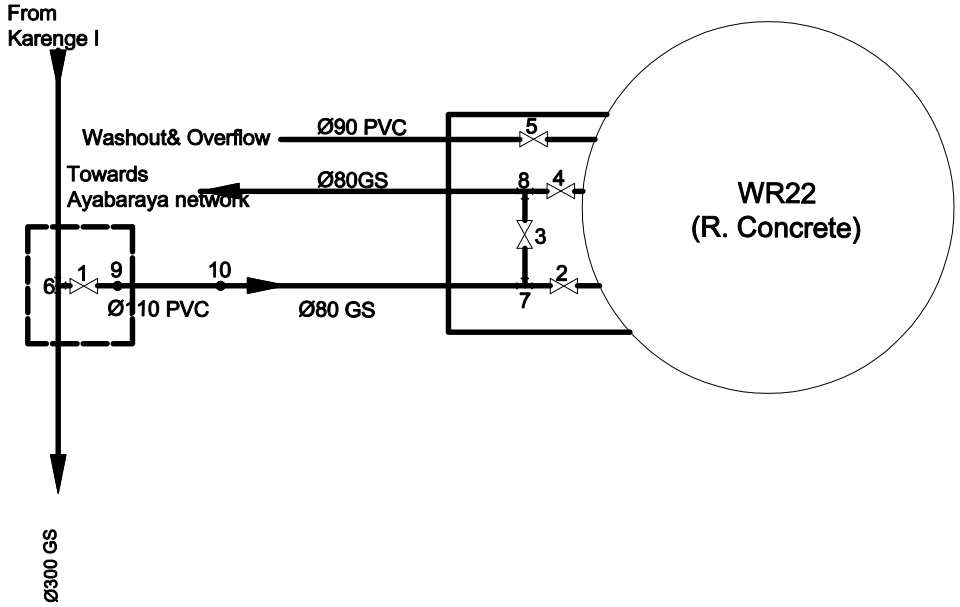
R6-60

LEGEND

1,2.Valve DN 100
3.Valve DN 150

AYABARAYA RESERVOIR
(30 CUM)

Knmb - 22

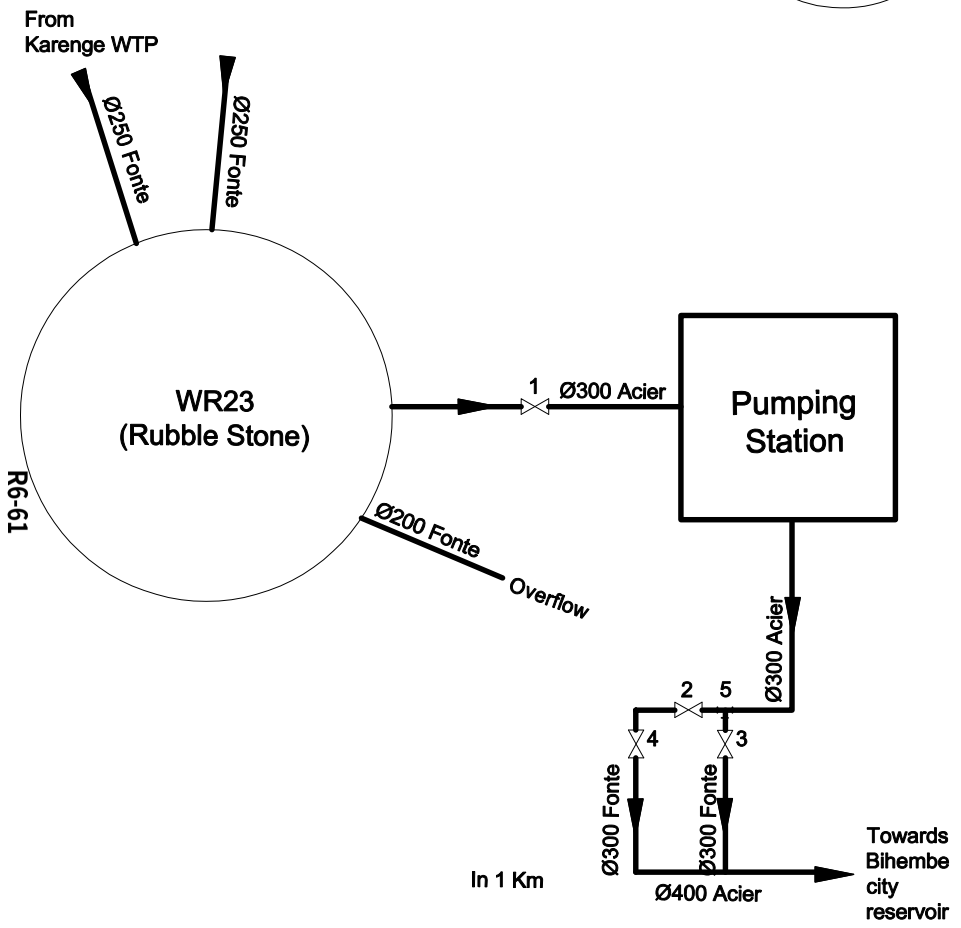


LEGEND

1.Valve DN 150
2,3,4,5.Valve DN 80
6. Tee DN 300x 150
7,8. Tee DN 80
9. Reducer DN 150x110
10. Reducer DN 110x80

NYABUBARE RESERVOIR
(200 CUM)

Knmb - 23

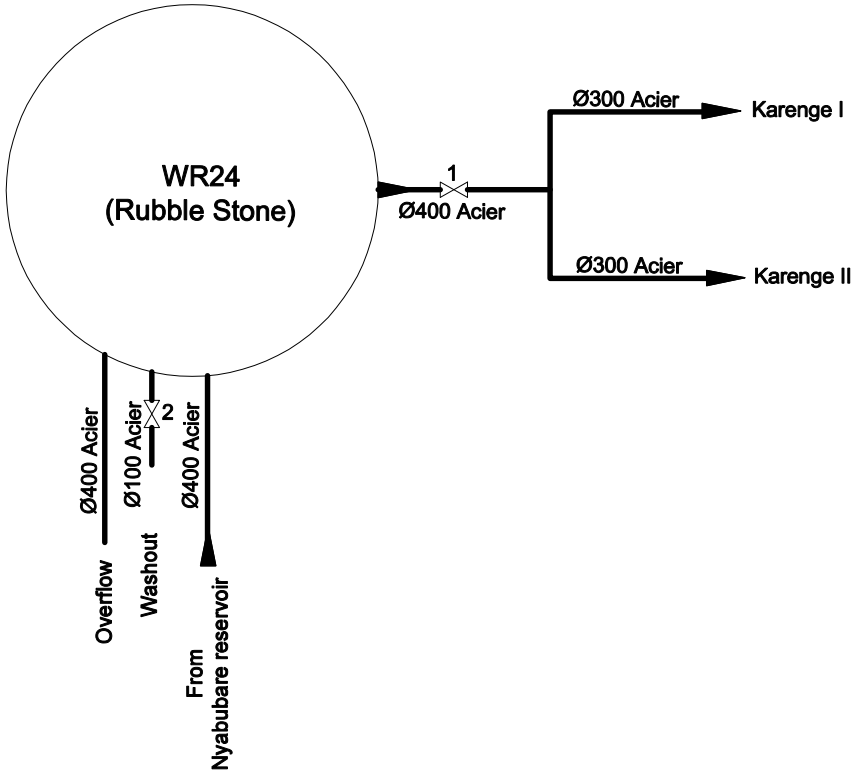


LEGEND

1,2,3,4.Valve DN 300
5. Tee DN 300

BIHEMBE CITY RESERVOIR
(100 CUM)

Knmb - 24

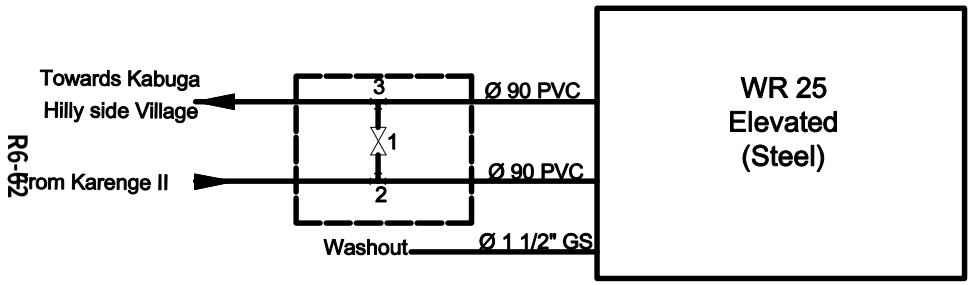


LEGEND

1.Valve DN 400
2.Valve DN 100

REAL ASTADY RESERVOIR
(200 CUM)

Knmb - 25

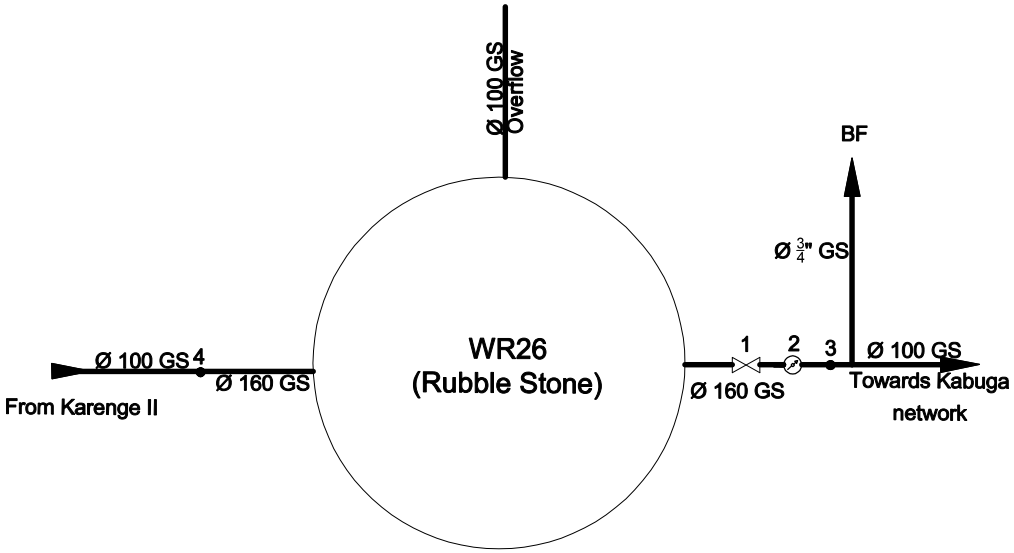


LEGEND

1.Valve DN 80
2,3. Tee DN 90

MAISON DE JEUNES KABUGA
RESERVOIR
(100 CUM)

Knmb - 26

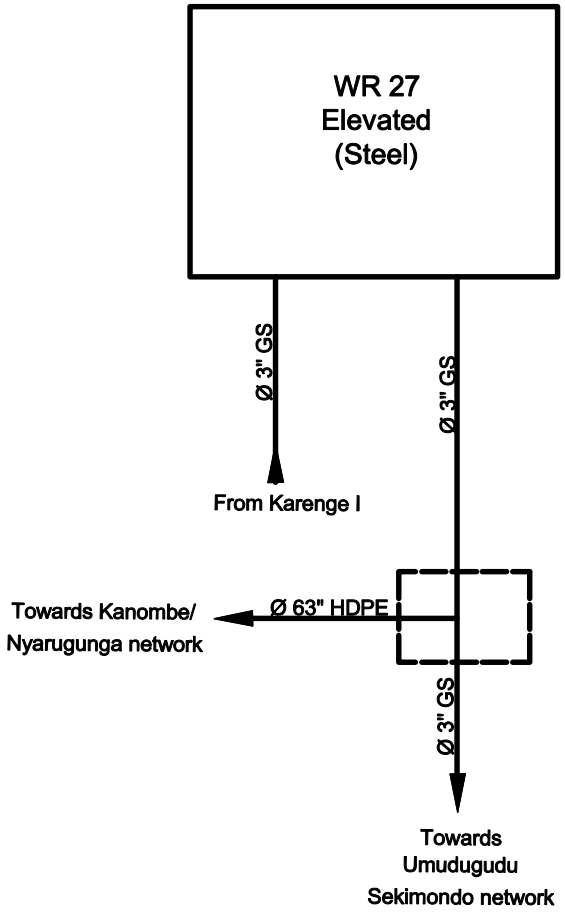


LEGEND

1.Valve DN 150
2. Water Meter DN 150
3. Reducer DN 150x110
4. Reducer DN 100x160

KAMASHASHI RESERVOIR
(250 CUM)

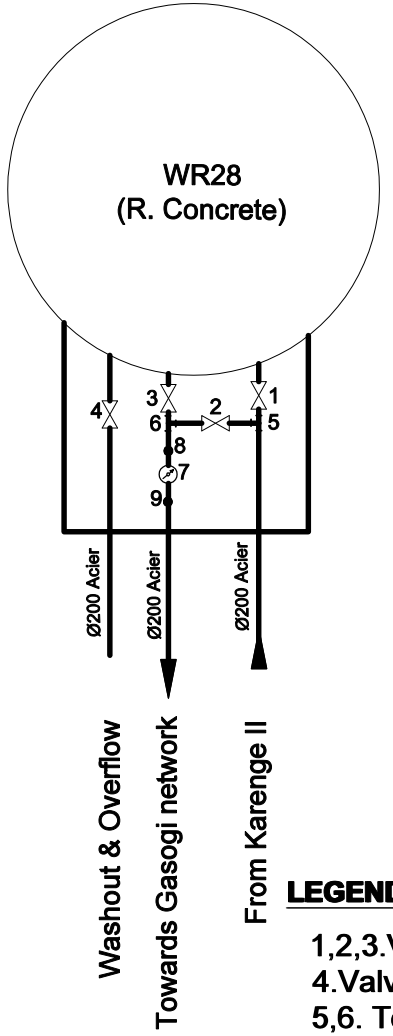
Knmb - 27



R6-63

CYARUZINGE RESERVOIR
(200 CUM)

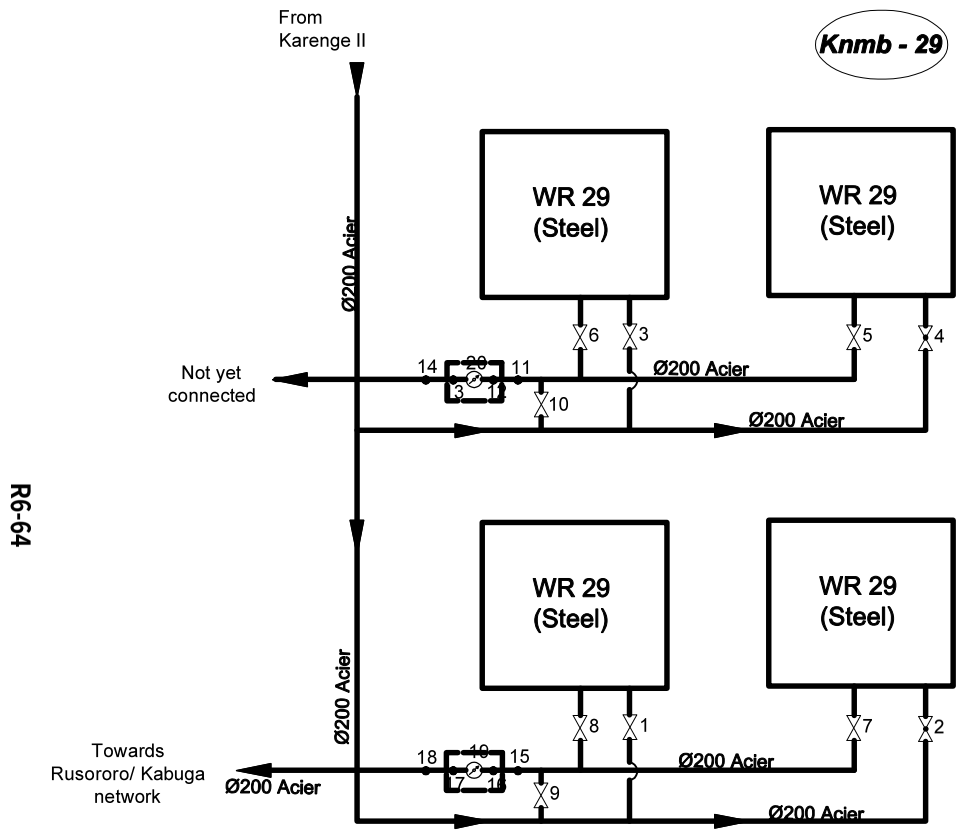
Knmb - 28



LEGEND

1,2,3.Valve DN 200
4.Valve DN 150
5,6. Tee DN 200
7. Water meter DN 150
8,9. Reducer DN 200x150

RUSORORO RESERVOIR
(... CUM)



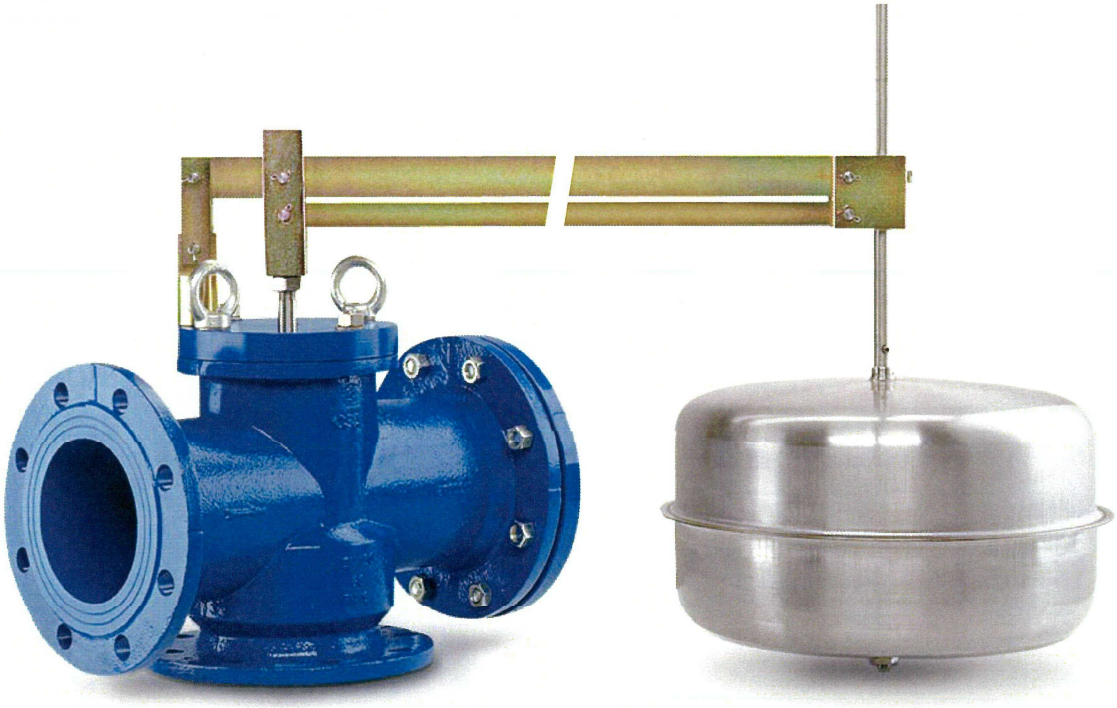
R6-64

LEGEND

1,2,3,4,5,6,7,8,9,10.Valve DN 200
11,14,15,18.Reducer DN 200x150
12,13,16,17. Reducer DN 150x100
19,20. Water meter DN 100

Float valve with balanced single seat Mod. ATHENA

The ATHENA is an equilibrium, single seat upstream pressure balanced float valve, which automatically controls the constant level of a tank or reservoir, regardless of upstream pressure variations, and will shut off when the maximum level is reached. Thanks to its exclusive technology ATHENA brings the concept of reliability and performance to the highest standards.



Technical features and benefits

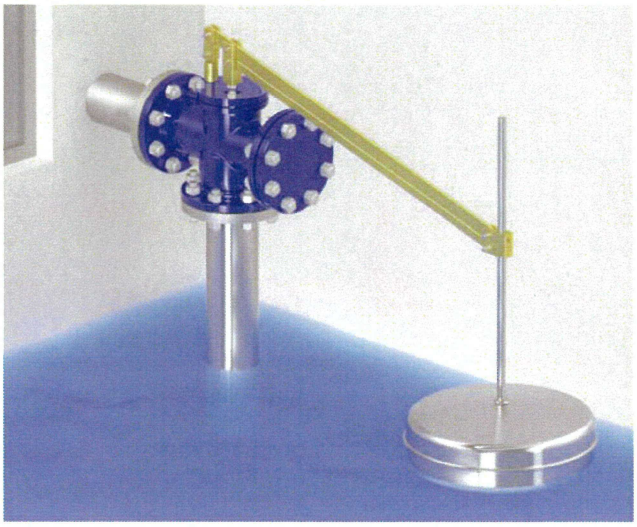
- Body in GJS 500-7 with three ways, allowing the installation both with an angle or a globe pattern, containing an interchangeable sealing seat and piston in stainless steel and a sliding bush in bronze.
- Mobile block composed of the main shaft, obturator, gasket retainer and piston featuring a unique self-cleaning technology (pat. pending) to reduced the accumulation of dirt and maintenance operations.
- The lever mechanism is obtained from a double rod in rolled steel (single rod for DN 40/50/65) which, by means of stainless steel pivots, puts the shaft in communication with the float which imparts the movement allowing the opening or closing of the valve.
- A large float in stainless steel AISI 304 is connected to the above mentioned rods by means of a stainless steel pipe, onto which it exerts a vertical force.
- Thanks to the balanced single seat the valve will perform with high sensitivity, perfect water tightness even with low pressure values.
- The movements of the obturator during opening and closing are not affected by the incoming water pressure, meaning that transient effects are avoided.

Applications

- Water distribution systems.
- Fire protection storage tanks.
- Irrigation systems.
- Whenever the constant level regulation and control function is required.

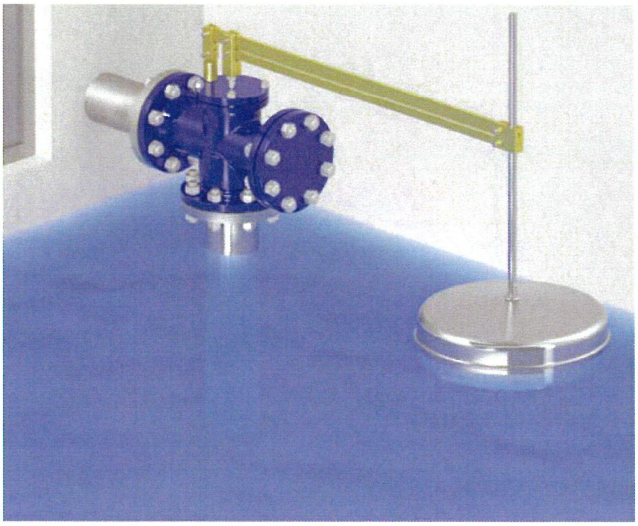
Operating principle

Flanged to the incoming pipe, and driven by a large float in stainless steel, the valve automatically controls the water level inside the tank by cutting off the supply whenever it reaches the maximum level and reopens again as soon as it drops.



Open valve

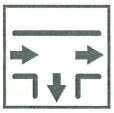
As soon as the water level drops inside the tank the lever, to which the float is connected, will push down the mobile block to the open position allowing the water flow through the valve.



Closed valve

When the water level inside the tanks has reached the maximum level the float, thanks to the lever, will move up the obturator closing the passage through the valve.

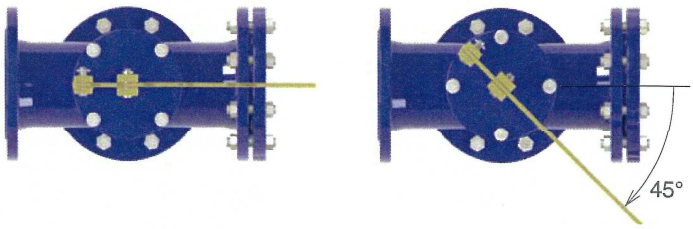
Optional



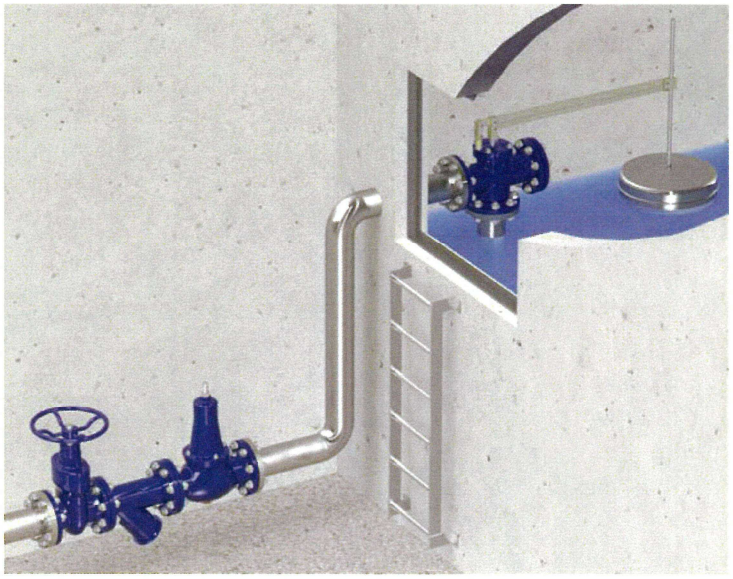
■ **Installation.** Athena has been designed with a three ways body, to allow both the installation as an angle and globe pattern level control valve, simply by placing the blind flange to the desired outlet.

■ **Anti freezing device.** On request the valve is provided with a 3/8"G threaded outlet, which can be used as an anti-freezing device, simply by replacing the tap with a drainage ball valve discharging directly into the tank.
During the winter season, when the temperature drops consistently, the partial opening of the drainage port will create a flow rate inside the valve avoiding frost and possible damages.

■ **Rod rotation.** The rod is normally aligned with the valve axis. It is possible to rotate it on site, with an angle of 45°/90°, to fit the installation requirements.



Technical data



Installation

- Make sure that the supply pipe has the flanges drilled according to the requested PN and that ATHENA is installed in a horizontal position, properly fixed and sustained.
- Gate valves and filters have to be installed to allow for maintenance operations, and to prevent dirt from reaching the internal components of the valve.
- Position the valve in a place which is easy to reach and wide enough for maintenance and control purposes.
- Observe the overflow level and make sure that the outlet flange is always above it, this is to avoid backflow.
- In case of excessive Dp, to avoid cavitation and possible damages to the valve, a direct acting pressure reducing valve CSA VRCD series should be installed.

Working conditions

Max temperature 70°C.
Max pressure PN 16 (please contact us for higher values).
To avoid cavitation the Max Dp across the valve should be limited to 8,5 bar for angle pattern, and 6,5 bar for globe pattern installations.

Standard

Designed in compliance with EN-1074/4.
Flanges according to EN 1092/2.
Epoxy painting applied through fluidized bed technology blue RAL 5005.
Changes and variations on the flanges and painting details available on request.

DN mm	40	50	65	80	100	125	150	200	250	300
Kv (m^3/h)/bar	21,6	21,6	46,8	68,4	108	155	245	360	648	1008

Head loss coefficient for angle pattern

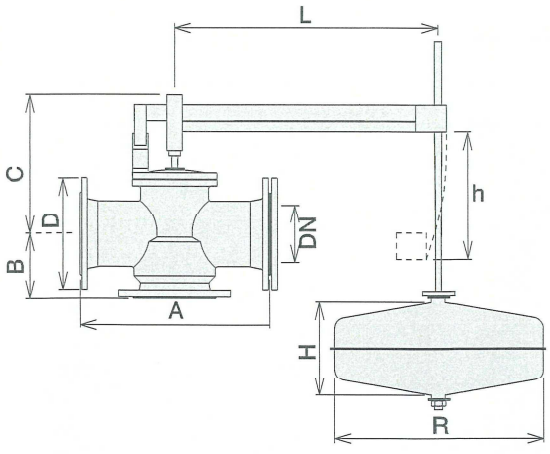
Kv coefficient representing the flow rate flowing through the valve fully open, and producing a head loss of 1 bar.

DN mm	40	50	65	80	100	125	150	200	250	300
Kv (m^3/h)/bar	18,4	18,4	39,6	59,4	90	133	209	313	576	864

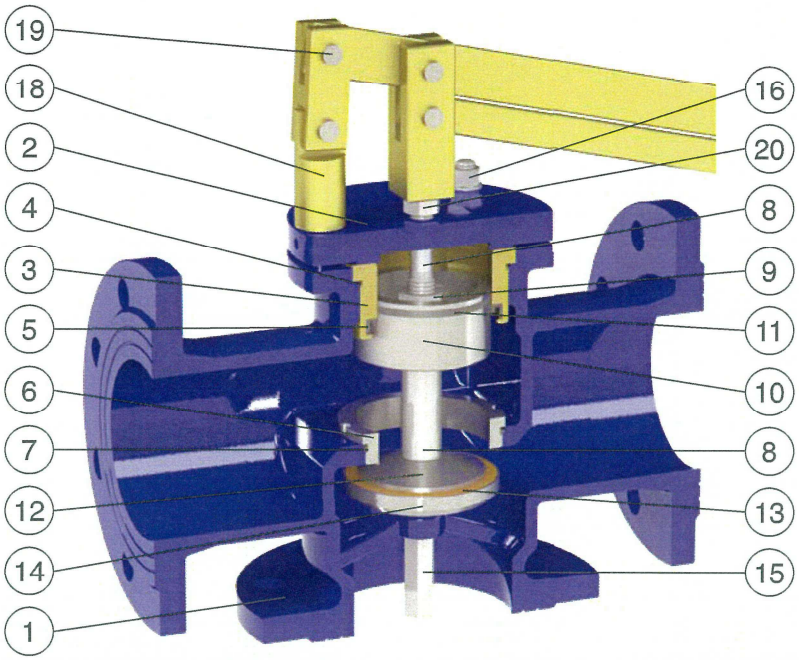
Head loss coefficient for globe pattern

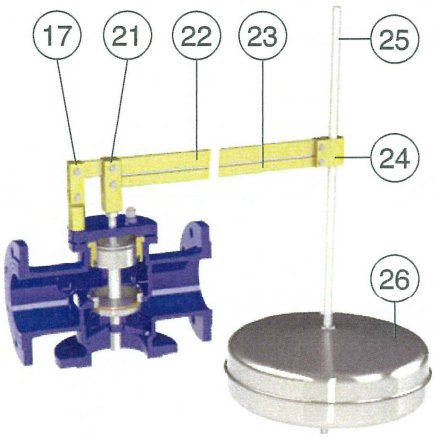
Kv coefficient representing the flow rate flowing through the valve fully open, and producing a head loss of 1 bar.

DN mm	A mm	B mm	C mm	D mm	L mm	H mm	R mm	h mm	Weight Kg
40	230	82,5	173	165	600	Ø220		105	21,0
50	230	82,5	173	165	600	Ø220		105	21,0
65	290	92,5	193	185	600	Ø220		180	25,6
80	310	100	212	200	800	200	300	210	32,6
100	350	125	225	220	800	180	400	267	41,0
125	400	125	230	250	800	180	400	267	49,0
150	480	162	351	285	1000	250	400	400	78,5
200	600	183	380	340	1000	250	400	418	118,0
250	730	270	540	405	1220	300	500	510	162,0
300	850	300	610	460	1400	400	500	610	250,0



Technical details





N.	Component	Standard material	Optional
1	Body	ductile cast iron GJS 500-7	
2	Cap	painted steel Fe 37	
3	Guiding bushing	bronze CuSn5Zn5Pb5 (painted Fe 37 for DN 250-300)	stainless s. AISI 304/316
4	O-ring	NBR	EPDM/Viton
5	Lip gasket	NBR	EPDM/Viton
6	Seat	stainless steel AISI 304	stainless steel AISI 316
7	O-ring	NBR	EPDM/Viton
8	Guiding shaft	stainless steel AISI 303	stainless steel AISI 316
9	Blocking nut	stainless steel AISI 304	stainless steel AISI 316
10	Piston	stainless steel AISI 303	stainless steel AISI 316
11	Guiding ring	PTFE	
12	Counter-seat	stainless s. AISI 303 (painted Fe 37 for DN 250-300)	stainless s. AISI 304/316
13	Plane gasket	NBR	polyurethane
14	Obturator	stainless s. AISI 303 (AISI 304 for DN 200-250-300)	stainless steel AISI 316
15	Tightening nut	stainless steel AISI 303	stainless steel AISI 316
16	Studs, nuts and washers	stainless steel AISI 304	stainless steel AISI 316
17	Upper coupling	zinc-plated steel Fe 37	stainless s. AISI 304/316
18	Lower coupling	zinc-plated steel Fe 37	stainless s. AISI 304/316
19	Pivots	stainless steel AISI 303	
20	Blocking nut	stainless steel AISI 304	stainless steel AISI 316
21	Shaft pivot	zinc-plated steel Fe 37	stainless s. AISI 304/316
22	Upper lever	zinc-plated steel Fe 37	stainless s. AISI 304/316
23	Lower lever	zinc-plated steel Fe 37	stainless s. AISI 304/316
24	Float coupling	zinc-plated steel Fe 37	stainless s. AISI 304/316
25	Float rod	stainless steel AISI 304	stainless steel AISI 316
26	Float	stainless steel AISI 304	stainless steel AISI 316

The list of materials and components is subject to changes without notice.

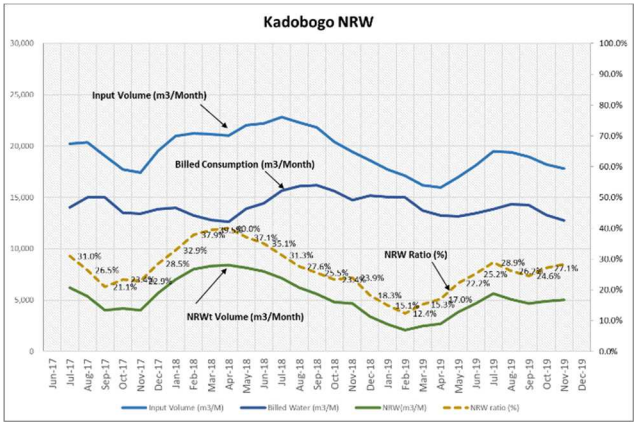
Section7. Water Distribution Volume Management

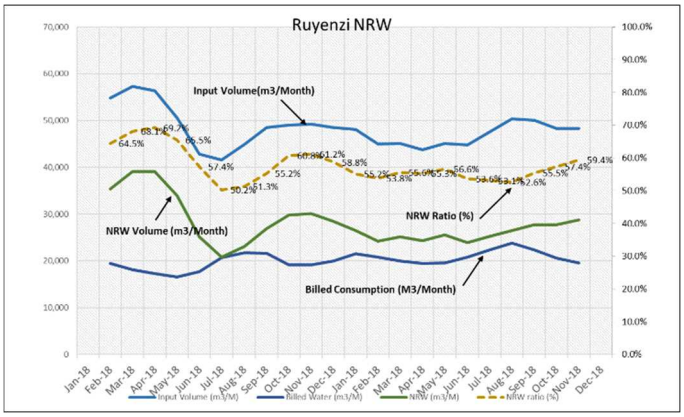
Reference;

7. 1 Necessity of Flow Control

1) Correlation between Input Volume and NRW volume

Following figures show results of NRW survey of Pilot Project in Kadobogo and Ruyenzi. Based on these results, correlations between input volume, billed consumption and NRW volume were estimated as shown in the table below.





Result of Correlation Coefficient of Pilot Project

Pilot Area	Correlation Coefficient (R^2)				Remarks
Kadobogo	Whole	PM1	PM2	PM3	
NRW Rate%	27	22	38	29	
Input-Billed	0.12	0.63	0.23	0.06	Should be correlated. But actually low.
Input-NRW	0.75	0.64	0.96	0.88	High correlation
Billed-NRW	0.04	0.08	0.43	0.01	No correlation
Ruyenzi	Whole	RY1	RY2	RY3	
NRW Rate%	58	58	62	52	
Input-Billed	0.07	0.01	0.17	0.04	Should be correlated. But actually low.
Input-NRW	0.87	0.89	0.98	0.54	High correlation
Billed-NRW	0.34	0.18	0.29	0.27	No correlation

- Correlation between Input volume and NRW volume is high.
- Correlation between Input volume and Billed volume is low
- Correlation between Billed volume and NRW volume is low
- NRW decreases by reducing input volume

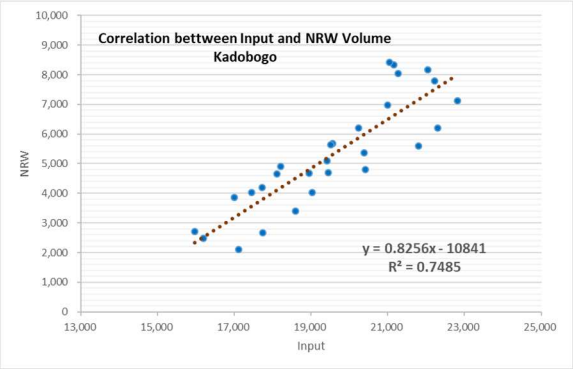
If it is the pipeline of the closed system, there should be a correlation between Input Volume and Billed Consumption. However, correlation is not seen from a result showing in the above table. Correlation is seen only in PM1 of Kadobogo having relatively low NRW rate. Billed Consumption has some changes seasonally, but that is approximately

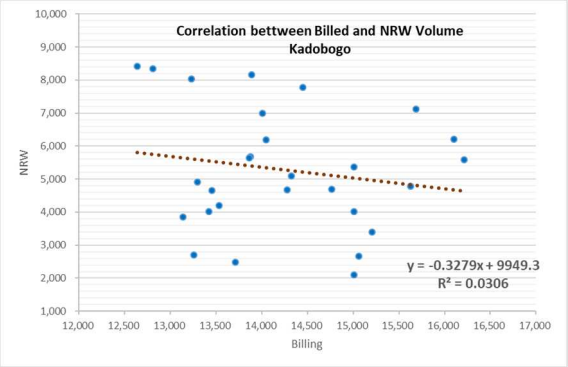
constant generally. On the other hand, strong correlation is seen in Input Volume and NRW Volume.

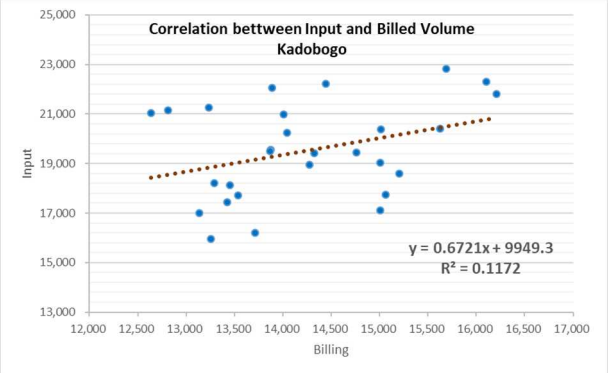
Some quantity of loss might be necessary in order to fulfill the water demand. But above result means that excessive Input Volume drifts as a leakage regardless of Billed Consumption. Thus, this excessive input volume should be removed in flow control at the inlet point.

Continuous flow control is possible by the pressure control of PRV, but some reduction must be possible by existing Inlet Valve when PRV cannot be installed. In other words, Inlet Valve opening should be set in the maximum inflow of the day so that the pressure will meet with minimum required pressure for distribution. And that fixed valve opening should be always maintained in same condition.

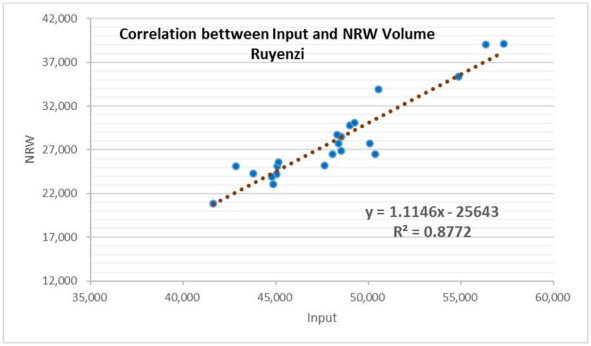
Kadobogo

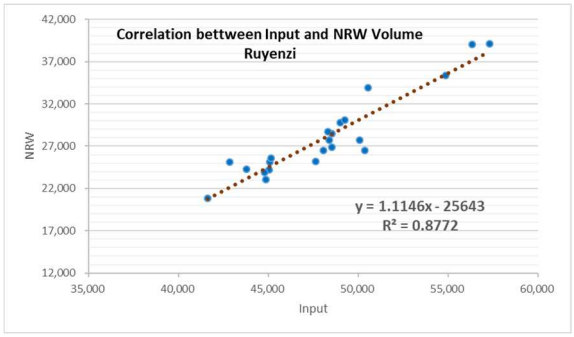


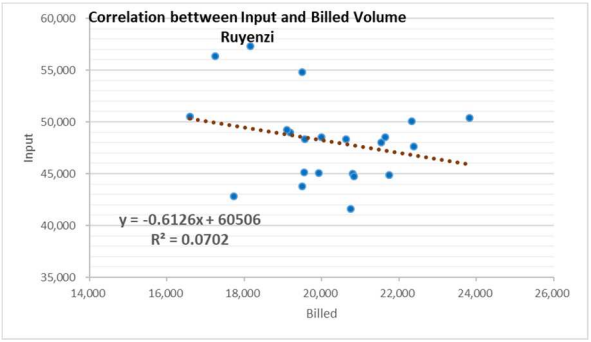




Ruyenzi







Kadobogo Monthly Data

Volume	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18
Input Ave	20,241	20,378	19,032	17,727	17,442	19,556	20,993	21,270	21,148	21,047	22,049	22,227	22,815	22,304
Billed Ave	14,044	15,011	15,006	13,534	13,421	13,877	14,008	13,232	12,810	12,633	13,887	14,446	15,685	16,104
NRW Ave	6,197	5,367	4,026	4,193	4,020	5,679	6,985	8,038	8,338	8,413	8,162	7,781	7,130	6,201
NRW Rate	31%	26%	21%	24%	23%	29%	33%	38%	39%	40%	37%	35%	31%	28%

Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19
21,803	20,421	19,450	18,597	17,736	17,109	16,196	15,964	16,999	18,114	19,505	19,415	18,951	18,200	17,829
16,211	15,628	14,763	15,203	15,061	15,006	13,713	13,253	13,139	13,453	13,864	14,326	14,278	13,293	12,781
5,592	4,793	4,687	3,394	2,675	2,104	2,482	2,711	3,860	4,662	5,641	5,089	4,673	4,908	5,048
26%	23%	24%	18%	15%	12%	15%	17%	23%	26%	29%	26%	25%	27%	28%

Ruyenzi Monthly Data

Volume	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Input Ave	54,836	57,281	56,322	50,530	42,830	41,605	44,847	48,519	48,981	49,235	48,496
Billed Ave	19,500	18,156	17,260	16,604	17,728	20,750	21,758	21,650	19,186	19,106	20,001
NRW Ave	35,336	39,125	39,062	33,926	25,102	20,855	23,089	26,868	29,795	30,128	28,495
NRW Rate	64%	68%	69%	67%	59%	50%	51%	55%	61%	61%	59%

Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19
48,046	45,030	45,073	43,772	45,119	44,762	47,621	50,361	50,055	48,353	48,307
21,543	20,807	19,937	19,493	19,549	20,835	22,393	23,829	22,333	20,636	19,576
26,503	24,223	25,136	24,279	25,570	23,927	25,228	26,532	27,723	27,717	28,731
55%	54%	56%	55%	57%	53%	53%	53%	55%	57%	59%

2) Flow Control

Generally, as for the relational expression between pressure and leak quantity, it is considered that the leak quantity from a hole is expressed in a kind of orifice, and it is expressed as below;

$$Q=A\times V=A\times C\sqrt{2\ g\ h}$$

$$Q = C \times A \times P \hat{} \ (0.5)$$

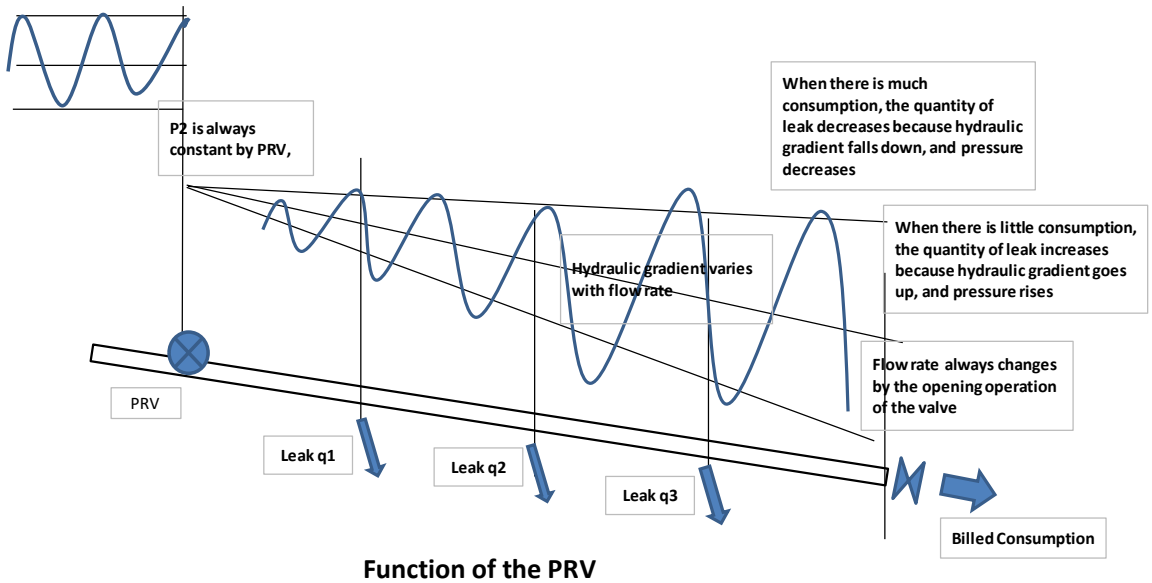
Q：Leak quantity

C：Coefficient by the shape of the leak hole

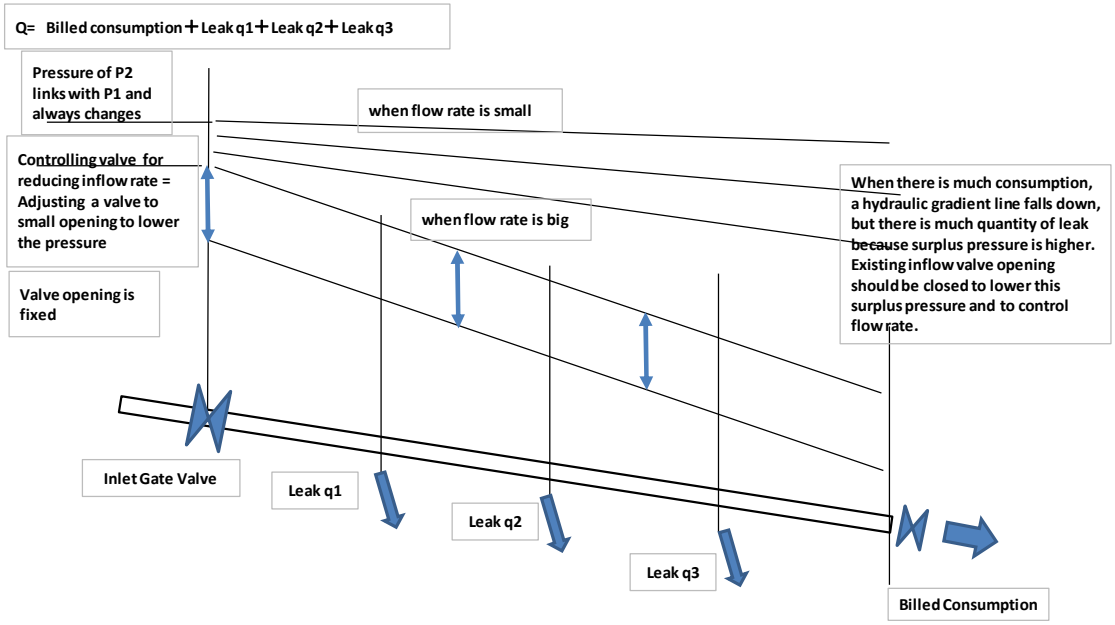
A：Area of the leak hole

P：Pressure

The quantity of leak will be proportional to 1/square of the water pressure, and quantity of leak increases if the water pressure becomes higher.



Function of the PRV



Function of the Gate Valve

7.2 Setting of the Opening of Inlet Valve

Valve opening was set at 16.75 rounds to 4.0 bar P2

Kadobogo M3	PM2, PM3 No Water				Date: January 30, 2020			
Wheel Round	Time	Pressure P1		Index: 5 minutes				
		Start (bar)	End (bar)	Start	End	Volume (m3/5m)	Rate (m3/h)	Rate (%)
0	8:52	4.9	5.0	389.30	391.20	1.90	22.80	100%
1						0.00	0.00	0%
2						0.00	0.00	0%
3						0.00	0.00	0%
4						0.00	0.00	0%
5						0.00	0.00	0%
6						0.00	0.00	0%
7						0.00	0.00	0%
8						0.00	0.00	0%
9						0.00	0.00	0%
10	9:00	5.1	5.2	392.30	394.16	1.86	22.32	98%
11								
12	9:06	5.6	5.0	394.70	396.68	1.98	23.76	104%
13								
14	9:15	5.0	5.1	397.60	399.55	1.95	23.40	103%
15	9:20	5.1	5.5	400.10	402.03	1.93	23.16	102%
15.50	9:27	5.0	5.0	402.60	404.60	2.00	24.00	105%
15.75	9:32	5.0	5.1	405.20	407.05	1.85	22.20	97%
16.00	9:40	5.0	5.0	407.40	409.28	1.88	22.56	99%
16.25	9:45	5.0	4.5	410.00	411.82	1.82	21.84	96%
16.37	9:55	4.5	4.2	412.80	414.85	2.05	24.60	108%
16.37	10:00	3.5	3.6	416.20	417.98	1.78	21.36	94%
16.50	10:10	3.0	3.6	419.00	420.72	1.72	20.64	91%
16.75	Setting		4.0					0%

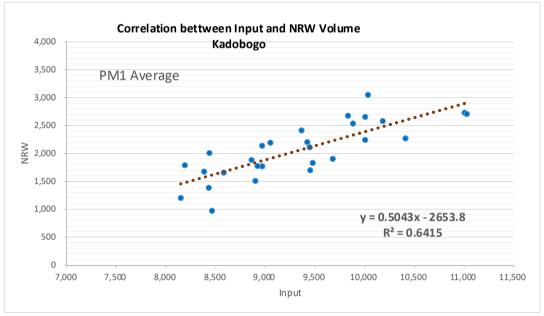
R7-1

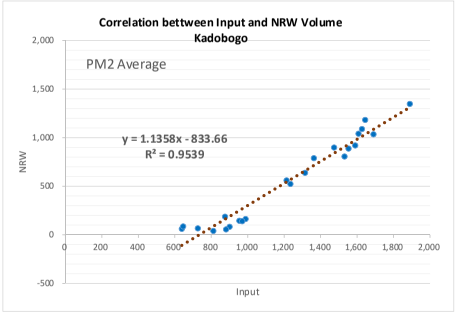
Correlation between Input Volume and NRW Volume

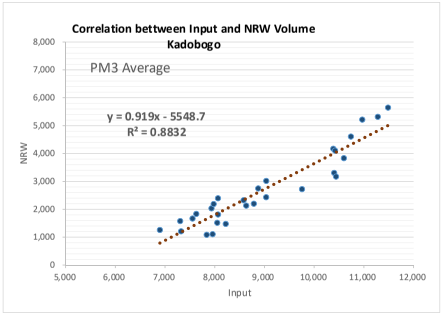
Kadobogo

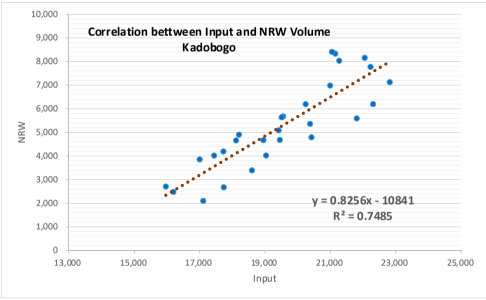
	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Input	19,054	20,389	21,279	19,466	16,350	17,366	18,609	22,694	21,677	19,439	22,328	21,373	22,445	22,862	23,138	20,913	21,358	18,991	18,000	18,800	16,408	16,120	16,059	15,712	19,227	19,404	19,885	18,956	18,012	17,633	17,843
Billed	11,345	13,412	17,374	14,246	13,397	12,959	13,908	14,765	13,351	11,579	13,499	12,822	15,340	15,175	16,541	16,595	15,496	14,792	14,000	16,816	14,367	13,834	12,939	12,986	13,492	13,880	14,221	14,877	13,736	11,265	13,342
NRW	7,709	6,977	3,905	5,220	2,953	4,407	4,701	7,929	8,326	7,860	8,829	8,551	7,105	7,687	6,597	4,318	5,862	4,199	4,000	1,984	2,041	2,286	3,120	2,726	5,735	5,524	5,664	4,079	4,276	6,368	4,501
Input PM1	9,634	10,070	10,309	9,631	8,412	8,537	8,791	9,577	8,391	7,179	8,995	9,134	10,134	11,272	11,607	10,204	9,417	9,410	9,509	9,509	7,676	8,199	8,568	8,521	10,060	9,507	10,527	9,460	9,657	7,782	7,916
Billed PM1	6,057	6,902	9,089	7,286	6,882	6,766	7,122	7,710	6,602	5,808	6,790	6,684	8,182	7,930	8,708	8,326	7,384	7,609	7,011	8,314	6,843	7,308	6,686	7,135	6,747	6,968	7,227	7,268	7,538	5,674	6,203
NRW PM1	3,577	3,168	1,220	2,345	1,530	1,771	1,669	1,867	1,789	1,371	2,205	2,450	1,952	3,342	2,899	1,878	2,033	1,801	2,498	1,195	833	891	1,882	1,386	3,313	2,539	3,300	2,192	2,119	2,108	1,713
Input PM2	1,049	1,281	1,758	1,730	1,105	1,108	1,489	2,061	1,519	1,243	1,659	2,030	1,978	872	789	965	1,108	892	910	899	834	701	644	570	723	1,158	802	892	1,316	1,560	1,066
Billed PM2	379	501	839	666	668	692	768	531	664	503	557	322	742	547	668	849	908	718	863	869	742	701	534	494	647	672	573	776	701	562	669
NRW PM2	670	780	919	1,064	437	416	721	1,530	855	740	1,102	1,708	1,236	325	121	116	200	174	47	30	92	0	110	76	76	486	229	116	615	998	397
Input PM3	8,371	9,038	9,212	8,105	6,833	7,721	8,329	11,056	11,767	11,017	11,674	10,209	10,333	10,718	10,742	9,744	10,833	8,689	7,581	8,392	7,898	7,220	6,847	6,621	8,444	8,739	8,556	8,604	7,039	8,291	8,861
Billed PM3	4,909	6,009	7,446	6,294	5,847	5,501	6,018	6,524	6,085	5,268	6,152	5,816	6,416	6,698	7,165	7,420	7,204	6,465	6,126	7,633	6,782	5,825	5,719	5,357	6,098	6,240	6,421	6,833	5,497	5,029	6,470
NRW PM3	3,462	3,029	1,766	1,811	986	2,220	2,311	4,532	5,682	5,749	5,522	4,393	3,917	4,020	3,577	2,324	3,629	2,224	1,455	759	1,116	1,395	1,128	1,264	2,346	2,499	2,135	1,771	1,542	3,262	2,391

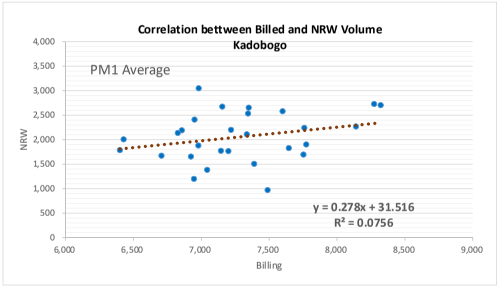
Volume		Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19			
Input Ave		20,241	20,378	19,032	17,727	17,442	19,556	20,993	21,270	21,148	21,047	22,049	22,227	22,815	22,304	21,803	20,421	19,450	18,597	17,736	17,109	16,196	15,964	16,999	18,114	19,505	19,415	18,951	18,200	17,829	19,466	1.17	0.82
Billed Ave		14,044	15,011	15,006	13,534	13,421	13,877	14,008	13,232	12,810	12,633	13,887	14,446	15,685	16,104	16,211	15,628	14,763	15,203	15,061	15,006	13,713	13,253	13,139	13,453	13,864	14,326	14,278	13,293	12,781	14,195	1.14	0.89
NRW Ave		6,197	5,367	4,026	4,193	4,020	5,679	6,985	8,038	8,338	8,413	8,162	7,781	7,130	6,201	5,592	4,793	4,687	3,394	2,675	2,104	2,482	2,711	3,860	4,662	5,641	5,089	4,673	4,908	5,048	5,271	1.60	0.40
NRW Rate		31%	26%	21%	24%	23%	29%	33%	38%	39%	40%	37%	35%	31%	28%	26%	23%	24%	18%	15%	12%	15%	17%	23%	26%	29%	26%	25%	27%	28%	27%	1.51	0.46
Input Ave PM1		10,004	10,003	9,451	8,860	8,580	8,968	8,920	8,382	8,188	8,436	9,421	10,180	11,004	11,028	10,409	9,677	9,445	9,476	8,898	8,461	8,148	8,429	9,050	9,363	10,031	9,831	9,881	8,966	8,452	9,308	1.18	0.88
Billed Ave PM1		7,349	7,759	7,752	6,978	6,923	7,199	7,145	6,707	6,400	6,427	7,219	7,599	8,273	8,321	8,139	7,773	7,335	7,645	7,389	7,488	6,946	7,043	6,856	6,950	6,981	7,154	7,344	6,827	6,472	7,255	1.15	0.88
NRW Ave PM1		2,655	2,244	1,698	1,882	1,657	1,769	1,775	1,676	1,788	2,009	2,202	2,581	2,731	2,706	2,270	1,904	2,111	1,831	1,509	973	1,202	1,386	2,194	2,413	3,051	2,677	2,537	2,140	1,980			
NRW Rate		27%	22%	18%	21%	19%	20%	20%	20%	22%	24%	23%	25%	25%	25%	22%	20%	22%	19%	17%	11%	15%	16%	24%	26%	30%	27%	26%	24%	23%	22%	1.39	0.53
Input Ave PM2		1,363	1,590	1,531	1,314	1,234	1,553	1,690	1,608	1,474	1,644	1,889	1,627	1,213	875	954	988	970	900	881	811	726	638	646	817	894	951	1,003	1,256	1,314	1,185	1.59	0.54
Billed Ave PM2		573	669	724	675	709	664	654	566	575	461	540	537	652	688	808	825	830	817	825	771	659	576	558	604	631	674	683	680	644	665	1.25	0.69
NRW Ave PM2		790	921	807	639	525	889	1,035	1,042	899	1,183	1,349	1,090	561	187	146	163	140	84	56	41	67	62	87	213	264	277	320	576	670			
NRW Rate		58%	58%	53%	49%	43%	57%	61%	65%	61%	72%	71%	67%	46%	21%	15%	17%	14%	9%	6%	5%	9%	10%	14%	26%	29%	29%	32%	46%	51%	38%	1.91	0.13
Input Ave PM3		8,874	8,785	8,050	7,553	7,628	9,035	10,384	11,280	11,486	10,967	10,739	10,420	10,598	10,401	10,440	9,755	9,034	8,221	7,957	7,837	7,322	6,896	7,304	7,935	8,580	8,633	8,066	7,978	8,064	8,973	1.28	0.77
Billed Ave PM3		6,121	6,583	6,529	5,881	5,789	6,014	6,209	5,959	5,835	5,745	6,128	6,310	6,760	7,094	7,263	7,030	6,598	6,741	6,847	6,747	6,109	5,634	5,725	5,898	6,253	6,498	6,250	5,786	5,665	6,276	1.16	0.90
NRW Ave PM3		2,752	2,202	1,521	1,672	1,839	3,021	4,175	5,321	5,651	5,221	4,611	4,110	3,838	3,307	3,177	2,726	2,436	1,479	1,110	1,090	1,213	1,262	1,579	2,036	2,327	2,135	1,816	2,192	2,398			
NRW Rate		31%	25%	19%	22%	24%	33%	40%	47%	49%	48%	43%	39%	36%	32%	30%	28%	27%	18%	14%	14%	17%	18%	22%	26%	27%	25%	23%	27%	30%	29%	1.71	0.48

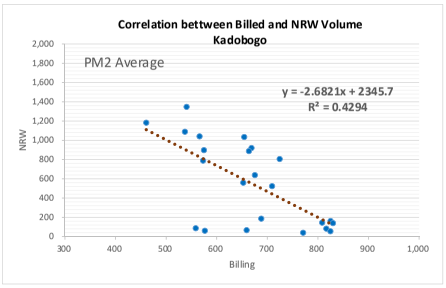


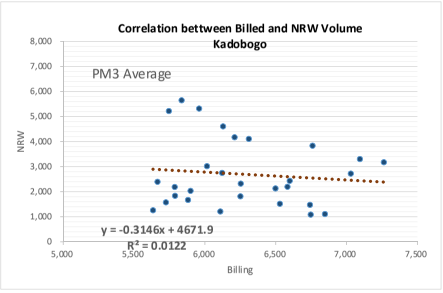


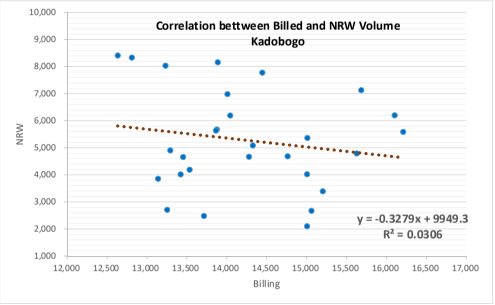


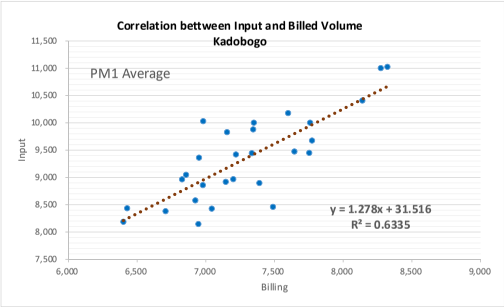


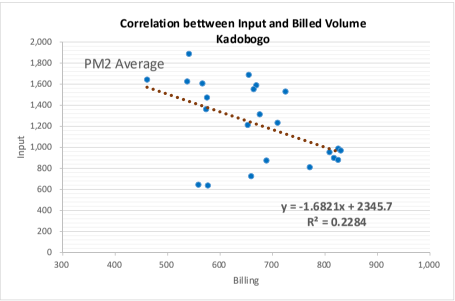


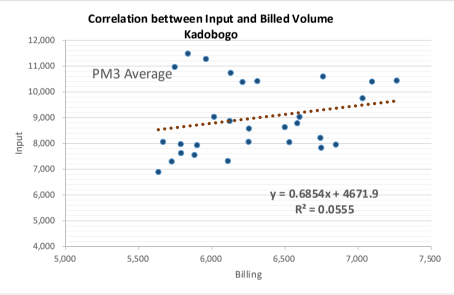


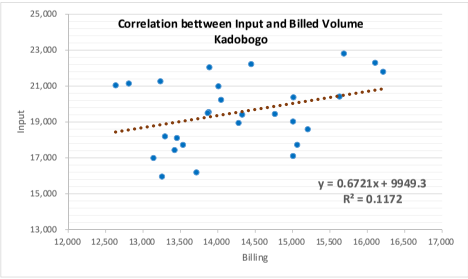


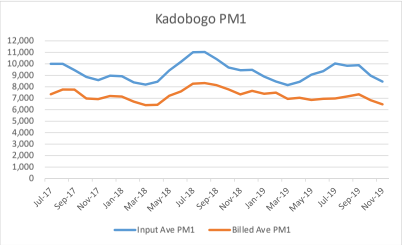




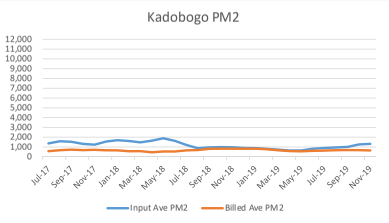




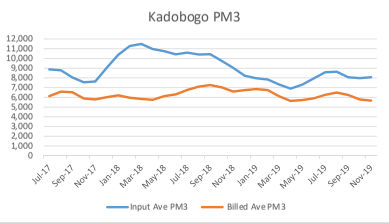




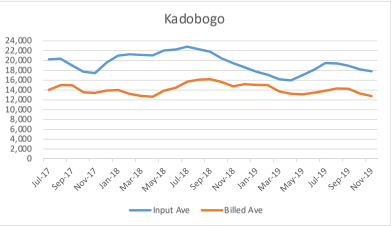
Input and NRW : Relation
Billed and NRW: No relation
Input and Billed: Relation



Input and NRW : High relation
Billed and NRW: No relation
Input and Billed: No lelation



Input and NRW : High Relation
Billed and NRW: No relation
Input and Billed: No lelation



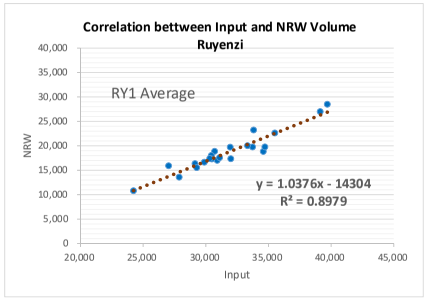
R7-2

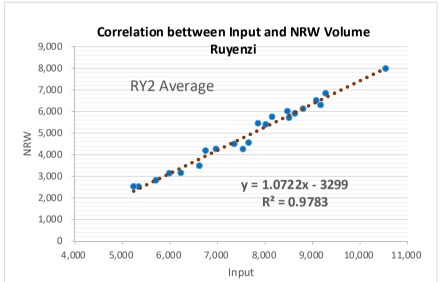
Correlation between Input Volume and NRW Volume

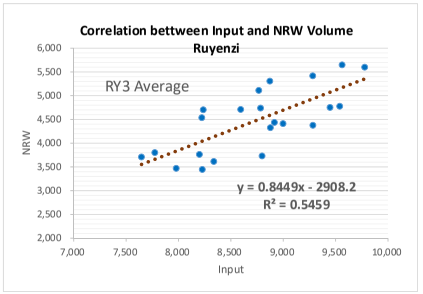
Ruyenzi

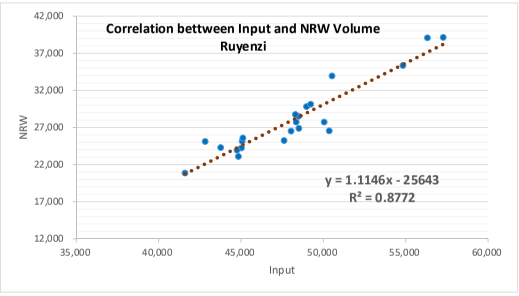
	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Input	55,992	53,704	54,812	63,327	50,826	37,437	40,226	47,153	47,161	51,242	48,539	47,923	49,026	47,189	38,875	49,156	43,285	42,917	48,084	51,863	51,135	47,168	46,755	50,999
Billed	21,574	17,441	19,486	17,540	14,753	17,520	20,910	23,820	20,543	20,588	16,427	20,304	23,271	21,055	18,094	20,662	19,722	18,264	24,518	24,397	22,571	20,030	19,306	19,392
NRW	34,418	36,263	35,326	45,787	36,073	19,917	19,316	23,333	26,618	30,654	32,112	27,619	25,755	26,134	20,781	28,494	23,563	24,653	23,566	27,466	28,564	27,138	27,449	31,607
Input RY1	34,610	33,840	38,085	45,469	35,550	20,439	25,125	27,140	31,371	34,239	30,247	27,636	33,465	32,215	23,971	35,279	28,190	27,490	32,152	36,365	35,270	32,534	33,402	34,065
Billed RY1	14,084	11,762	12,849	11,845	8,909	11,067	13,443	15,821	13,676	12,216	10,819	12,496	14,012	14,098	11,649	13,861	12,910	12,019	16,358	15,639	15,310	13,953	12,711	13,303
NRW RY1	20,526	22,078	25,236	33,624	26,641	9,372	11,682	11,319	17,695	22,023	19,428	15,140	19,453	18,117	12,322	21,418	15,280	15,471	15,794	20,726	19,960	18,581	20,691	20,762
Input RY2	12,580	11,560	7,480	8,790	7,290	9,340	7,420	10,750	7,720	7,940	8,790	10,510	6,220	6,240	6,230	5,500	4,300	5,910	6,910	7,040	8,660	6,360	5,890	8,000
Billed RY2	2,900	2,097	2,666	2,543	1,993	2,848	2,999	2,757	2,404	2,871	1,909	2,920	3,555	2,820	2,843	2,879	2,739	2,494	3,443	3,462	2,923	2,180	3,011	2,502
NRW RY2	9,680	9,463	4,814	6,247	5,297	6,492	4,421	7,993	5,316	5,069	6,881	7,590	2,665	3,420	3,387	2,621	1,561	3,416	3,467	3,578	5,737	4,180	2,879	5,498
Input RY3	8,802	8,304	9,247	9,068	7,986	7,658	7,681	9,263	8,070	9,063	9,502	9,777	9,341	8,734	8,674	8,377	10,795	9,517	9,022	8,458	7,205	8,274	7,463	8,934
Billed RY3	4,590	3,582	3,971	3,152	3,851	3,605	4,468	5,242	4,463	5,501	3,699	4,888	5,704	4,137	3,602	3,922	4,073	3,751	4,717	5,296	4,338	3,897	3,584	3,587
NRW RY3	4,212	4,722	5,276	5,916	4,135	4,053	3,213	4,021	3,607	3,562	5,803	4,889	3,637	4,597	5,072	4,455	6,722	5,766	4,305	3,162	2,867	4,377	3,879	5,347

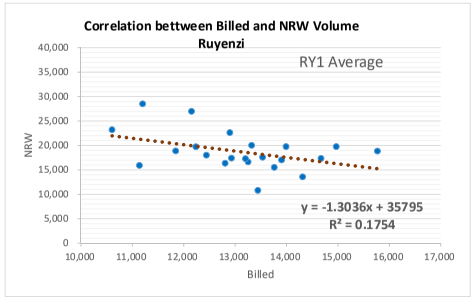
Volume		Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19				
Input Ave		54,836	57,281	56,322	50,530	42,830	41,605	44,847	48,519	48,981	49,235	48,496	48,046	45,030	45,073	43,772	45,119	44,762	47,621	50,361	50,055	48,353	48,307	48,181	1.19	0.86	0.33
Billed Ave		19,500	18,156	17,260	16,604	17,728	20,750	21,758	21,650	19,186	19,106	20,001	21,543	20,807	19,937	19,493	19,549	20,835	22,393	23,829	22,333	20,636	19,576	20,119	1.18	0.83	0.36
NRW Ave		35,336	39,125	39,062	33,926	25,102	20,855	23,089	26,868	29,795	30,128	28,495	26,503	24,223	25,136	24,279	25,570	23,927	25,228	26,532	27,723	27,717	28,731	28,061	1.39	0.74	0.65
NRW Rate		64%	68%	69%	67%	59%	50%	51%	55%	61%	61%	59%	55%	54%	56%	55%	57%	53%	53%	53%	55%	57%	59%	58%			
Input Ave RY1		35,512	39,131	39,701	33,819	27,038	24,235	27,879	30,917	31,952	30,707	30,449	31,105	29,884	30,488	29,147	30,320	29,277	32,002	34,596	34,723	33,735	33,334	31,816	1.25	0.76	0.49
Billed Ave RY1		12,898	12,152	11,201	10,607	11,140	13,444	14,313	13,904	12,237	11,844	12,442	13,535	13,253	13,203	12,807	12,930	13,762	14,672	15,769	14,967	13,991	13,322	13,109	1.20	0.81	0.39
NRW Ave RY1		22,613	26,979	28,500	23,212	15,898	10,791	13,565	17,012	19,715	18,864	18,007	17,570	16,631	17,286	16,340	17,390	15,515	17,330	18,827	19,756	19,744	20,011	18,707	1.52	0.58	0.95
NRE Rate		64%	69%	72%	69%	59%	45%	49%	55%	62%	61%	59%	56%	56%	57%	56%	57%	53%	54%	54%	57%	59%	60%	58%			
Input Ave RY2		10,540	9,277	7,853	8,473	8,017	9,170	8,630	8,803	8,150	9,080	8,507	7,657	6,230	5,990	5,343	5,237	5,707	6,620	7,537	7,353	6,970	6,750	7,632	1.38	0.69	0.69
Billed Ave RY2		2,554	2,435	2,401	2,461	2,613	2,868	2,720	2,677	2,395	2,567	2,795	3,098	3,073	2,847	2,820	2,704	2,892	3,133	3,276	2,855	2,705	2,564	2,748	1.19	0.87	0.32
NRW Ave RY2		7,986	6,841	5,453	6,012	5,403	6,302	5,910	6,126	5,755	6,513	5,712	4,558	3,157	3,143	2,523	2,533	2,815	3,487	4,261	4,498	4,265	4,186	4,884	1.64	0.52	1.12
NRW Rate		76%	74%	69%	71%	67%	69%	68%	70%	71%	72%	67%	60%	51%	52%	47%	48%	49%	53%	57%	61%	61%	62%	62%			
Input Ave RY3		8,784	8,873	8,767	8,237	7,775	8,201	8,338	8,799	8,878	9,447	9,540	9,284	8,916	8,595	9,282	9,563	9,778	8,999	8,228	7,979	7,647	8,224	8,733	1.12	0.88	0.24
Billed Ave RY3		4,048	3,568	3,658	3,536	3,975	4,438	4,724	5,069	4,554	4,696	4,764	4,910	4,481	3,887	3,866	3,915	4,180	4,588	4,784	4,510	3,940	3,689	4,263	1.19	0.83	0.36
NRW AVE RY3		4,737	5,305	5,109	4,701	3,800	3,762	3,614	3,730	4,324	4,751	4,776	4,374	4,435	4,708	5,416	5,648	5,598	4,411	3,445	3,469	3,708	4,534	4,471	1.26	0.77	0.49
NRW Rate		54%	60%	58%	57%	49%	46%	43%	42%	49%	50%	50%	47%	50%	55%	58%	59%	57%	49%	42%	43%	48%	55%	51%			

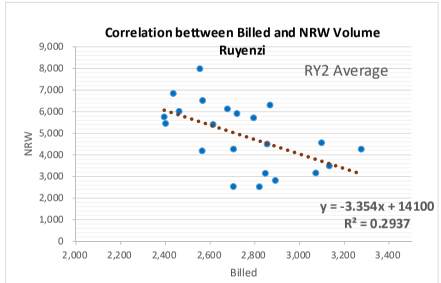


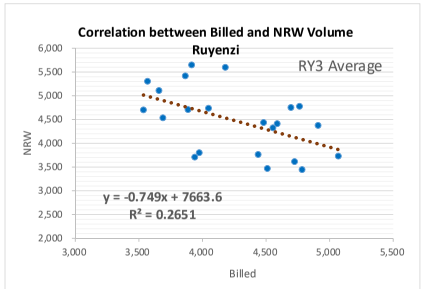


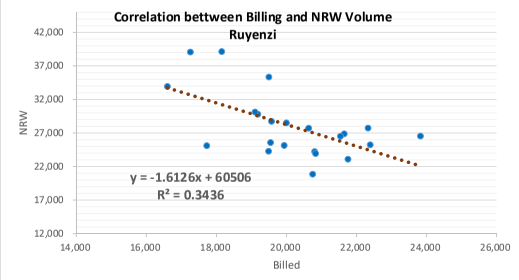




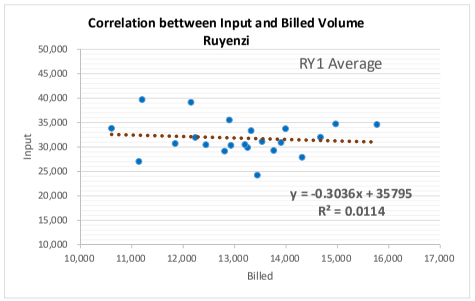




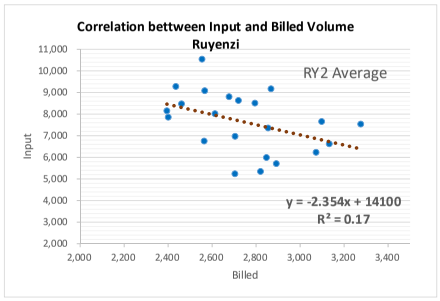




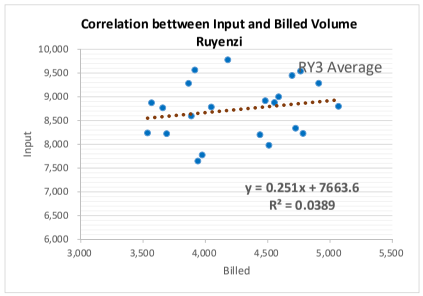
R7-3



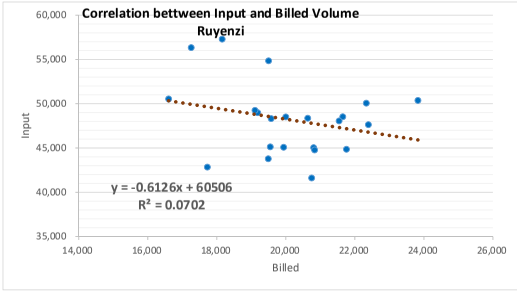
Input and NRW : High relation
Billed and NRW: No relation
Input and Billed: No lelation

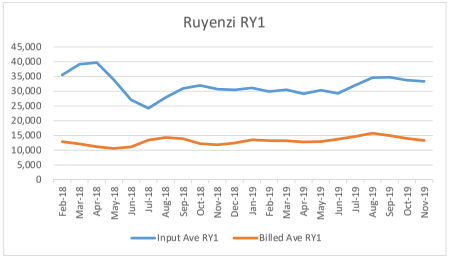


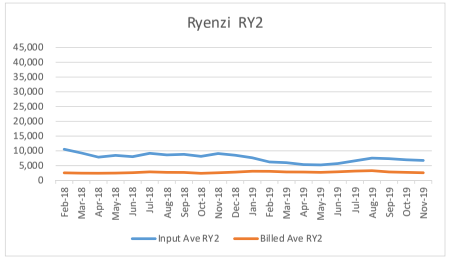
Input and NRW : High relation
Billed and NRW: No relation
Input and Billed: No lelation

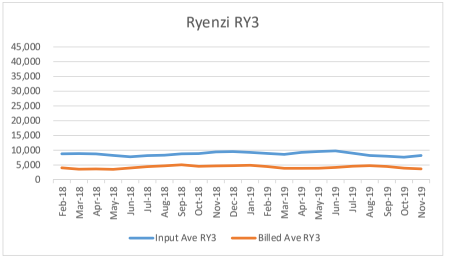


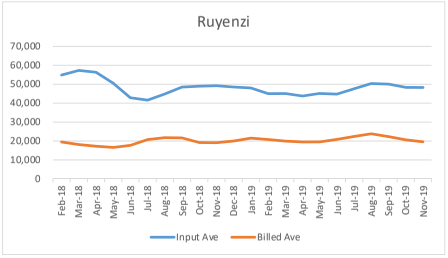
Input and NRW : Relation
Billed and NRW: No relation
Input and Billed: No lelation











R7-4

Kadobogo M3 PM2, PM3 No Water Date: January 30, 2020

Wheel Round	Time	Pressure P1		Index: 5 minutes				
		Start (bar)	End (bar)	Start	End	Volume (m3/5m)	Rate (m3/h)	Rate (%)
0	8:52	4.9	5.0	389.30	391.20	1.90	22.80	100%
1						0.00	0.00	0%
2						0.00	0.00	0%
3						0.00	0.00	0%
4						0.00	0.00	0%
5						0.00	0.00	0%
6						0.00	0.00	0%
7						0.00	0.00	0%
8						0.00	0.00	0%
9						0.00	0.00	0%
10	9:00	5.1	5.2	392.30	394.16	1.86	22.32	98%
11								
12	9:06	5.6	5.0	394.70	396.68	1.98	23.76	104%
13								
14	9:15	5.0	5.1	397.60	399.55	1.95	23.40	103%
15	9:20	5.1	5.5	400.10	402.03	1.93	23.16	102%
15.50	9:27	5.0	5.0	402.60	404.60	2.00	24.00	105%
15.75	9:32	5.0	5.1	405.20	407.05	1.85	22.20	97%
16.00	9:40	5.0	5.0	407.40	409.28	1.88	22.56	99%
16.25	9:45	5.0	4.5	410.00	411.82	1.82	21.84	96%
16.37	9:55	4.5	4.2	412.80	414.85	2.05	24.60	108%
16.37	10:00	3.5	3.6	416.20	417.98	1.78	21.36	94%
16.50	10:10	3.0	3.6	419.00	420.72	1.72	20.64	91%
16.75	Setting		4.0					0%

P1は使用量によって常に変動する。
16.75回転で4.0barに設定した。