Republic of the Philippines

Metropolitan Cebu Water District
(MCWD)

Technical Assistance on
Water Supply Operation and Management
for Metropolitan Cebu Water District

Final Report

March 2013

Japan International Cooperation Agency (JICA)

Yokohama Water Co., Ltd.

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Abbreviation (Alphabetical order)

C/P: Counter Part

CS: Customer Service, Customer Satisfaction

DBS: Distribution Block System

DIP: Ductile Iron Pipe

DMA: District Metered Area

EDP: Environmental Development Project

EISCP2: Environmental Infrastructure Support Credit Program – Phase II

ES: Employee Satisfaction

GIS: Geographic Information System

GP: Galvanized Iron Pipe

GPS: Global Positioning System

HIVP: High impact polyvinyl chloride pipe

IBNET: The International Benchmarking Network for Water and Sanitation Utilities

ISO: International Organization for Standardization

JICA: Japan International Cooperation Agency

JWWA: Japan Water Works Association

LCC: Life Cycle Cost

LWUA: Local Water Utilities Administration

MCWD: Metropolitan Cebu Water District

NRW: Non-Revenue Water

NTU: Nephelometric Turbidity Unit (Approximate value of Degree = 0.7 × NTU)

PAC: Polyaluminum Chloride

PDCA: Plan – Do – Check – Act

PEP: Polyethylene Pipe

pH: potential Hydrogen

PI: Performance Indicator

PR: Public Relation

PSI: Pound per Square Inch

PVC: Polyvinyl Chloride

SCADA: Supervisory Control And Data Acquisition

SEAWUN: Southeast Asian Water Utilities Network

WD: Water District

WSP: Water Safety Plan

YWC: Yokohama Water Company

YWWB: Yokohama Waterworks Bureau

Technical Terms (Alphabetical order)

Aluminum sulfate: This chemical is widely used as a flocculating agent and comes in both solid and liquid form. In recent years, it has been more widely used in liquid form than in solid form due to its ease of handling. Aluminum oxide typically makes up 8.0~8.2% of liquid aluminum sulfate, but crystals tend to separate if the concentration exceeds this level.

DMA: This stands for "District Metered Area", and refers to water supply areas divided off to measure and manage water supply volume using a water service meter. The area is divided with a slice valve, and water flows in from one or multiple spots and is consumed within the area. By subtracting the sum total of water use as recorded on the meters installed at each house (revenue water) from the water volume from the parent meter on the inflow side (water supply volume), the NRW within the area (= water supply volume – revenue water volume) can be calculated.

Flash mixer: This is a mixing device that rapidly mixes the water after injecting the flocculating agent so that it can be dispersed evenly throughout the raw water. The hydration reaction in which the flocculating agent neutralizes the electric charge of the suspended particles as it reacts to the raw water is completed in a short time, so the holding time in the mixing basin can also be short, but during this time a large amount of mixing energy must be applied. The mixing methods include a mechanical mixing method using a flash mixer, or a water flow method in which the water flow is agitated so that the head loss is changed into mixing energy. The mechanical method in which the mixing intensity can be freely changed with little head loss is often adopted.

Floc: The injection of a flocculating agent neutralizes the load voltage on suspended particles in raw water that causes them to lose their repellent force; Wan der Waal's force causes them to adhere together, creating a substance called micro-floc. Chain-like macromolecules such as aluminum hydroxide resulting from the hydration of the flocculating agent bring together the microflocs, creating large particles several millimeters in diameter. They are called "floc" because they contain large amount of water and are fluffy like down. Floc has much better sedimentation properties than suspended matter itself, so flocs are formed as preparation for sedimentation.

Flocculating agent: Flocculating agents are metallic hydroxides with positive charges that neutralize the negative charge of minute particles in the water (suspended particles) and bridge between the particles so that the suspended solids form large aggregates (flocs).

Aluminum Sulphate, often called Sulphuric acid band in water services, and Polyaluminum Chloride (PAC) are used as flocculating agents. pH conditioning agents and coagulation aids are sometimes used in conjunction in order to enhance the flocculating effect.

Head loss: The energy lost as a result of friction with the rough inner walls of pipes, influx and outflow, expansion and contraction of the pipe cross-section, and bifurcation and confluence of pipes is expressed as the head (indicated in terms of water pressure). In the case of head loss in a filtration basin, the decrease in hydrostatic pressure in the sand layer as a result of the closure of the channels between the filter particles and the increase in flow resistance as the suspended solids are captured in the space between the replenished filtration material is expressed as the head.

Jar test: This is a test performed using a testing device called a Jar tester, which has mixing blades that can control the number of revolutions, to determine the optimum dosage requirements for the flocculating agent. The test is repeated in the same way with different flocculating agent injection ratios.

Mixing intensity and GT value: This is an indicator for mixing conditions in flocculation. If the mixing intensity (G value) is too low, floc growth is slow, but if it is too high, the floc is destroyed by shearing force. Experience indicates that a G value of 10~75 (1/s) is appropriate. The product of the mixing intensity (G value) and mixing time (T) is expressed as the GT value. Data indicates that GT of 23,000~210,000 is the right condition for good flocculation.

Polyaluminum Chloride (PAC): This inorganic polymer is a flocculating agent developed in Japan in the 1960s. Aluminum is hydrolytically polymerized, and compares favorably to Aluminum Sulfate in terms of the appropriate condensation pH scope, tolerance for injection ratio, flocculating effect in high and low turbidity, alkali consumption, and floc sedimentation rate. Some Aluminum remains in water treated with coagulate sedimentation and filtration, but appropriate injection processing reduces the remaining Aluminum to minimal amounts.

Rapid filtration: After using chemicals to treat the raw water through coagulate sedimentation and removing as much suspended matter as possible in the sedimentation basin, the water is filtered at a rate of 120~150m/day in a rapid filtration basin, and is then disinfected with chlorine. Since the physical filtration effect plays the central treatment function in the rapid filtration basin, the suspended matter can be effectively removed, but some bacteria pass through and dissolution materials such as ammoniac nitrogen and manganese can barely be removed. As a result, chemical treatment such as pre-Chlorination must be used.

Slow filtration: This process is best suited for raw water that is relatively clean. Typically, after the suspended matter in the raw water is removed through spontaneous sedimentation, the water is filtered at a filtration rate of 4~5m/day in a slow filtration basin, and is then treated with chlorine. The slow filtration basin treats the water using viscid biological slime made up of organisms such as the algae and bacteria that breed on the surface of the sand layer and within the sand layer, and provides clean, safe water.

Turbidity: Turbidity is a measure of the murkiness of water; a turbidity level of 1 (1mg/L) is equivalent to the turbidity when adding 1mg of standard kaolin to 1 liter of purified water. The turbidity of raw water has a major impact on water treatment, and is the most important indicator in clean water management. Moreover, the turbidity of tap water is important as an indicator of abnormalities in the water supply facilities and pipes.

Water supply block system: This system divides the water supply area, centered on the water supply basin and water supply pump, into several water supply areas, which were then further divided; water volume and water pressure is managed for each block. In setting the water supply area, the form of demand, geographical conditions and topographical conditions are taken into account;

when the vertical drop is particularly pronounced, the area is divided into the pumping water supply area and gravity flow water supply area. The main water supply pipe in the water supply area should form a pipe network. The water supply block should be divided into areas of appropriate width, taking geography and topography into account, and water should be supplied to individual users through the water supply branch pipe network, but booster pumps and decompression valves can be installed as necessary. Moreover, in order to minimize the extent of the impact on water supply in the event of abnormalities, reciprocal accommodation between adjacent water supply areas and water supply blocks should also be possible.

Unit Conversion Table

Pressure	MPa (N/mm^2)	bar ($Mdyn/cm^2$)	PSI (lbf/in^2)	atm (Standard Atmosphere)
MPa (N/mm^2)	1	10	145.04	9.869
bar ($Mdyn/cm^2$)	0.1	1	14.504	0.9869
PSI (lbf/in^2)	0.006895	0.06895	1	0.06805
atm (Standard Atmosphere)	0.101325	1.01325	14.696	1

Exchange Rate Conversions

1 PHP (Philippine Peso) = 2.260 JPY (Japanese Yen)
1 USD (US Dollar) = 91.84 JPY (Japanese Yen)
(March 2013)

0. Summary

0.1 Project Purpose and Target

In the Environmental Infrastructure Support Credit Program-Phase II (EISCP2) and the Environmental Development Project (EDP) which are subsidiary projects to this project, medium and long-term financial resources are provided via Development Bank of Philippine (DBP) for capital investment in the environmental field for the purpose of contributing to environment conservation in the Philippines.

The Metropolitan Cebu Water District: MCWD, a district subject to EISCP2 loan, requested use of Japanese water works advanced operation/management know-how to improve MCWD's water supply services focusing on measures for non-revenue water and performance enhancement of the existing water treatment plants. Therefore, it was decided that this project be implemented for the purpose of increasing the effectiveness of the Yen-loan-financed projects of the past by providing technical assistance related to water utility business operation/management, water quality control, and measures for Non-Revenue Water (NRW).

The Japanese water utility business operation/management is mainly conducted by municipal governments or companies established by municipal governments, and the above technical assistance could be provided by municipal governments using their vast experience in solving similar problems with similar situations. It was decided that studies of utilizing the rich know-how of the Japanese municipal governments would be conducted from various aspects in this project. Also, potential need for utilization of the water utility business operation/management know-how in districts other than MCWD are strong. The model case of using Japanese water works operation/management know-how in assisting MCWD is expected to be extended to other water districts that will borrow funds from EDP in the future. These activities will contribute to the realization of a "New Growth Strategy" of the Japanese government.

Improving the living environment and expanding basic social services in Metropolitan Cebu are priorities. The project target is to develop an EISCP2 effect through water supply service expansion by improving MCWD's water supply operation/management as well as to promote effective EDP implementation through improvements in water service.

0.2 Work Schedule

Yokohama Water Company (YWC) accepted this project on trust and conducted Field Operation and provided training in Japan based on the schedule below.

The 1st Field Operation	Sunday, March 11	to	Saturday, March 24, 2012	(14 days)
The 2nd Field Operation	Tuesday, June 12	to	Saturday, June 30, 2012	(19 days)
Training in Japan	Monday, July 23	to	Friday, August 3, 2012	(2 weeks)

The 3rd Field Operation	Sunday, October 14	to	Thursday, November 1, 2012	(19 days)
The 4th Field Operation	Sunday, February 3	to	Saturday, February 23, 2013	(21 days)

0.3 Content of Reports

The project team made the Inception Report on March 2012 and the Interim Report on September 2012. Those Reports were submitted to Japan International Cooperation Agency (JICA) and MCWD. In the 4th Field Operation on February 2013, the project results were reported to MCWD. The project team and MCWD discussed about issues requiring MCWD's continued improvement. This Final Report was made including the project results and discussions with MCWD.

0.4 Content and Results of Activities

Through the Field Operations and Domestic Works, the project team examined the issues that MCWD was facing regarding MCWD's water business management and general management as well as water distribution development, groundwater quality improvement, and performance improvement of the existing Water Treatment Plant (WTP) so as to achieve NRW rate reduction and 24-hour water supply. The project team made proposals for solving various problems.

Also, during the Field Operation, the training for MCWD working-level personnel was provided in Japan (for 2 weeks).

(1) Improvement of Rapid and Slow Mixing of the Sedimentation Basin and Flow Uniforming Facility at the Existing Water Treatment Plant

Sedimentation treatment water flows from the cross flow type sedimentation basin to both the rapid and slow sand filter basins at the Tisa WTP of MCWD. In normal water treatment, coagulant injected raw water is fully mixed and agitated, floc forms by low mixing, and floc is effectively deposited and removed. However, at the Tisa WTP, appropriate coagulant injection and mixing were not fully performed, and floc did not form. Water was sent to the filtration basin without sedimentation treatment in the sedimentation basin. As the result, all turbidity needed to be removed during the filtration treatment, and the sludge layer on the filtration sand surface could not be removed even though it was periodically backwashed.

To perform sound filtration, turbidity is removed and adequate floc is formed in the sedimentation basin. In this project, we examined (a) how to decide appropriate coagulation injection rate, (b) introduction of slow mixing device for floc formation, and (c) rapid filtration basin rehabilitation construction, and we their implementation.

As for the mixing method, we installed the vertical baffled mixing unit that did not use electricity before the sedimentation basin taking the circumstances on site into consideration. This was a mixing unit made of waste materials, which could be made at considerably low cost. Three fourths of the unit was made during this project period, but turbidity in sedimentation treatment reduced by 57% in comparison with the case without the device.

Appropriate coagulant injection was needed for mixing. We instructed to perform a Jar test on site, and they came to be able to perform the test manually without a mechanical Jar tester. By switching the Jar test method from "rapid mixing + sedimentation" to "rapid mixing + slow mixing + sedimentation", they learned that effective coagulant injection rates could be obtained. We discovered that maintenance had not been performed on the rapid filtration basin for 28 years since its establishment, and we instructed them on how to perform a series of filtration rehabilitation work that are commonly implemented in Japan. Special machines for the work were not available there, so each work was implemented manually by MCWD personnel based on their original ideas.

(2) Improvement of Highly Concentrated Nitrate, Iron, and Manganese

There were a group of wells with high concentrations of Nitrate in the Southeast area of the Tisa WTP, and the concentration partially exceeded the standard. Nitrate concentration of treated water from the Tisa WTP was low, so we made a pipeline network development plan, which was to reduce the Nitrate concentration by mixing (diluting) flow out water from the Tisa with water from the deep wells.

For two deep wells with high concentration of Iron and Manganese, a verification plant using oxidization filtration was built after our proposal during the Confirmatory Investigation in 2011, and the plant was improved in this project.

After discussions in this project, the water quality inspection system was reviewed, and the number of water supply pipe inspection points for Residual Chlorine and Nitrate increased. Through this project, MCWD's awareness of importance on supplying safe water to citizens increased.

(3) Preparation for Non-Revenue Water Rate Reduction and Distribution Development for 24-Hour Water Supply

As the model DMA, 3 areas were selected each from the DMA at high NRW rate and the DMA that did not achieve24-hour water supply.

In the MCWD pipeline network, many resin pipes are used. The conventional leak detector worked effectively for leaky iron pipes as the leaking sound could be detected by the inspector due to the high water pressure. However, it was difficult to detect water leaks in resin pipes at low water pressures. In this project, we took a rental leak detector that is good for leak detection of resin pipes to the Philippines to implement leak detection research in the model DMA. NRW rates, 58.8%, 39.8%, and 34.0%, in the model DMA decreased to 47.5%, 7.8%, and 21.3% respectively after leak detection investigation and water leak repairs in 6 months until January 2013 (Average: -19 points). NRW rate for the entire MCWD in 2012 is 25.2%.

In this project, we made improvement proposals for MCWD's existing leak detection investigation plan and the pipeline rehabilitation work plan. MCWD selected leak detection areas (polygon mesh) based on the DMA in the past, we decided to introduce a new leak detection investigation mesh (500m * 500m) that is used by YWWB. It was also decided to plot leaking points in this leak protection investigation mesh, select routes where leaks are concentrated among leaking points in the mesh, and to reflect the selection in the plan to evaluate priorities of the pipeline rehabilitation work plan.

MCWD made a significant decision, which was to replace PVC pipes with Ductile Iron Pipe (DIP) in the major routes where rehabilitation works have been implemented starting 2012. In the training for the top officials of MCWD implemented in Japan in 2011, they were strongly interested in DIP which is expensive but highly durable with the low incidence of water leakage. After discussions in this project and the training in Japan, they decided to use DIP. It is expected that measures for reducing NRW rate will make steady advances and they will reach the target, NRW rate 15% in 2020, set by the MCWD 2020PLAN.

MCWD's average water supply hours are 23.15 hours. 24-hour water supply is conducted in many areas, but it is not implemented in upland areas in the DMA. In this project, we discussed about reasons why a 24-hour water supply was not implemented in those areas and examined how measure would be taken for solving the problems in 2 DMAs.
MCWD aims for expanding water supply areas, so we discussed how to make waterworks plans/distribution plans by prioritizing a 24-hour water supply.

(4) Forming Basic Concept for Pipeline Training Facility, Simple Design

The pipeline training facility was a high-priority request from MCWD. MCWD had a site for building the facility, so feasibility of the facility construction was high. Discussions related to this matter at MCWD went smoothly.
The training in Japan for MCWD executives was implemented in Japan in 2011. YWWB's pipeline training facility was used for the training. In this project, working level officials experienced training at the pipeline facility in Japan and deeply understood the functions and structure of the facility. After they returned to the Philippines, they made a simple designs followed by detailed designs and construction estimates. They had discussions of the site for construction based on the detailed designs, and many improvement proposals were made. Area for this facility is approximately 2,000m^2. The facility consists of a leak detection area, water pipe connection area, distribution pipe connection (leak repair) area, a lecture facility and a warehouse.

As for the water detection facility among the pipeline facilities, constructing it is more difficult than designing it. Reproducing leaking sounds is very difficult. Training of detecting leaking sounds should be performed in this facility. We expect that MCWD will deal with construction of the facility in a trial-and-error method until they can reproduce simple leaking sounds and even leaking sounds which would be difficult to detect by skilled personnel.

(5) Assessing Issues Related to General Water Business Management

We assessed the actual conditions and issues of general water business management of MCWD and water bill collection. Based on them, we made proposals.

In this project, we examined measures for improving customer services and customer satisfaction of household water users and private water companies as well as plans for improving management and financial strength. We also studied how to enhance Public Relations to promote citizens' correct understanding of the water supply services.

During these examination and assessment of issues, we made various proposals based on YWWB's experience. It cannot be said that all YWWB's experience is effective because our history and regional characteristics differ from those of the Philippines. However, MCWD were interested in many points we offered and worked on improvement.

(6) Examination of Introducing Performance Indicators (PIs)

We believe that daily work conducted by individual personnel should be made into documentation, manuals, or reports in MCWD so as to be shared between personnel, which will help in better understanding all work thereby creating a natural check system within the organization. If any questions arise from it, they will work to improve problems. It will link to improvement of the entire organization.

In order to actually perform it, the conditions need to be understood using numerical figures based on Performance Indicators (PIs). By doing so, the direction where the organization should proceed for can be diagnosed. Therefore, we examined evaluation based on PI for the improvement. The PI is to evaluate not only facilities or equipment but also the individual personnel or the entire organization. Low PI indicates negligence. Searching old data seemed to be difficult, but we proposed this as a tool for evaluating MCWD and other water companies for the purpose of strengthening the organization.

1) Documentation Rate (%): Ratio of plans and projects in documentation against the entire plans and projects
2) Manual Rate (%): Ratio of work with complete manuals against the entire work
3) Personnel Rotation Rate (%): Rate of personnel who were transferred to other sections among all personnel during the evaluation period
4) The Number of Personnel Rotations (times/people): The total number of personnel who were transferred

5) Personnel Proposal Rate (number/people): The total number of proposals submitted by personnel during the evaluation period

0.5 Issues, Ideas, and Lessons in the Project

In this project, the project team discussed problems in the MCWD water business and the future tasks with MCWD personnel from the same side and from the same points of view as compared to the YWWB water business.

Some matters of operation and maintenance which should be implemented in Japan are not implemented by MCWD. Referring to the problem gives them a clue to recognizing the situation. It is important for them to understand the background that they experienced in Japan and recognize the necessity of introduce our proposals. It is not certain whether or not all things implemented in Japan are effective in the Philippines due to the differences in laws, customs, and climate. However, if MCWD personnel have learned, seen, or heard possible solutions to solve problems, it is worth giving advice to them.

Water suppliers outsource many maintenance and operation tasks to external companies on commission. In the beginning, personnel of water suppliers worked manually. Later on, such work was outsourced, and the specialized private companies established know-how for efficient work by saving manual work and mechanizing work. The project team can introduce the basic know-how to them, but there are many works where we rely on specialized private companies. In the future, technologies that fit local conditions will be introduced through the cooperation of private companies.

0.6 Achieving Priorities

Maturity of water supply business starts with maintaining an adequate water supply volume, and once 24-hour water supply is achieved, an interest in water quality grows. Water quality should be maintained in accordance with the water quality standards in the country and must not exceed those standards. Good water sources are desired for maintaining safe water quality. Then development of sewage systems is enhanced so that the water supply not to be polluted by sewage water.

Water service starts with maintaining an adequate water supply volume. Full realization of a 24-hour water supply is an absolute requirement. Safe water quality cannot be expected with an intermittent water supply. Without a constant monitoring of water quality (water volume, water pressure) by SCADA, it cannot be confidently said that safe water is being supplied.

Cebu is the second largest city in the Philippines and a tourist city where many tourists visit from all over the world. We strongly expect that the "Water Safety Declaration" will be announced and the water environment with safe water quality will be established in Cebu.

We also expect that our activities in this project will give Water Districts besides MCWD a hint for improvement of their water business and link to improvement of the water environment in the countries of Southeast Asia.

1. Outline of Project

1.1 Project Background / Development

In the Philippines, the Water Districts established in each region and the municipal governments provide the water supply and sewerage services based on Executive Order 198, but there are various issues such as the delayed water supply and sewerage development, unstable water supply, bad water quality, high water leak ratio, fragile business/financial conditions, etc. In the Environmental Infrastructure Support Credit Program – Phase II (EISCP2) (accepted in 1999) and the Environmental Development Project (EDP) (accepted in 2008) which are subsidiary projects to this Yen-loan-financed project (hereinafter referred to as "this Project"), medium and long-term financial resources are provided via Development Bank of Philippine (DBP) for capital investment in the environmental field for the purpose of contributing to environment conservation in the Philippines.

One of districts subject to EISCP2 loan, the Metropolitan Cebu Water District: MCWD, is a relatively good Water District (WD) considering financial aspects. According to the Confirmatory Investigation ("Confirmatory investigation on operation & management state of the MCWD", March 2011), although the project of laying water service pipes have been implemented, issues, such as high non-revenue water rate, bad water quality, insufficient water supply service (regions with 24-hour water supply are limited), necessity for developing an alternative water source to underground water, and performance issues of existing Water Treatment Plant (WTP) whose water source is surface water, remain. Under those circumstances, during the above Confirmatory Investigation and the training in Japan ("Training Program for operation & management of the MCWD") which took place in July 2011, MCWD requested use of Japanese water works advanced operation/management know-how to improve MCWD’s water supply services focusing on measures for Non-Revenue Water (NRW) and performance enhancement of the existing WTP.

Due to the above-mentioned background, it was decided that this project would be implemented for the purpose of increasing effectiveness of the Yen-loan-financed projects in the past by providing technical assistance related to water utility business operation/management, water quality control, and measures for NRW.
The Japanese water utility business operation/management is mainly conducted by municipal governments or companies established by municipal governments (hereinafter referred to as "Municipal Government"), and the above technical assistance can be provided by Municipal Governments using on their vast experience in solving similar problems with similar situations. It was decided that studies of utilizing the rich know-how of the Japanese Municipal Governments would be conducted from various aspects in this project. Also, potential needs for utilization of the water utility business operation/management know-how in districts other than MCWD are strong. The model case of using Japanese waterworks operation/management know-how in assisting MCWD is expected to be

extended to other WDs that will borrow funds from EDP in the future. These activities will contribute to the realization of a "New Growth Strategy" of the Japanese Government.

1.2 Project Target

Improving the living environment and expanding basic social services in Metropolitan Cebu are priorities. The project target is to develop an EISCP2 effect through water supply service expansion by improving MCWD's water supply operation/management as well as to promote effective EDP implementation through improvements in water service.

1.3 Project Policy

As project policy, we analyzed the actual conditions and issues of the MCWD water business management, distribution system, leakage prevention, water treatment, and water quality by using our experience, technologies, and know-how of the Japanese water business management. Based on the analysis, we made proposal of solutions for providing technical assistance which will lead to future improvement of MCWD's water business management. We also conducted training for MCWD personnel in Japan in order to effectively transfer technology. Each work item is described below, and the work execution flow is shown in Figure 1-3-1.

1.3.1 Water Business Management / General Management (including Water Utility Business Operation)

(1) Ascertaining Current Situation and Issues of Business and Financial Structure

(2) Ascertaining Current Situation and Issues of Customer Service and Customer Satisfaction Level

(3) Review of Current PR Situation and Measures for Strengthening PR

(4) Ascertaining Current Situation and Issues of Organizational Operations and Employee Awareness

(5) Measures for Improvement through Application of Japanese Water Utility Operation Know-how and Deliberations on Implementation of Performance Indicators (PIs)

1.3.2 Establishing Distribution Block System (DBS) to Reduce Non-Revenue Water (NRW) Rate and Ensure 24-hour Water Supply (Water Distribution System / Water Leakage Prevention)

(1) Selecting Model Block to Develop the Distribution Block System (DBS) from the Existing DMA

(2) Developing a Pipeline Network and Incidental Equipment (Gate valve, Fire hydrant, etc.) and Providing Training for Leakage Volume Measurement and Leakage Detection

(3) Studying Establishment of the Most Suitable Distribution Pipeline Network Based on Distribution Network Calculations in order to Form a Block Consisting of the Neighboring DMA Collective Entities and Distribution Reservoir (Elevated tank, etc.)

(4) Support in Establishing New Plan Based on Existing Leak Detection Plan

(5) Leak Detection in Model Blocks in New Leak Detection Plan

(6) Consideration of Back-up Between Blocks and DMA for Emergencies (Accidents)

(7) Assisting in Making an Aged Pipeline Renewal Plan

(8) Assessing Feasibility of Changing from the Existing Geographic Information System (GIS) to the Comprehensive Mapping System

(9) Studying Establishment of Basic Concepts for Introducing a Pipeline Training Facility and a Simplified Design

1.3.3 Water Quality Improvement of Water Distribution and Supply from Groundwater Supplies and Capacity Building of the Existing Water Treatment Plant (WTP) (Water Purification Management / Water Quality Management)

(1) Studying Improvement of Rapid and Slow Mixing of the Sedimentation Basin and Flow Uniforming Facility at the Existing Water Treatment Plant (WTP)

(2) Studying How to Improve the Existing Rapid Filter Basins

(3) Analyzing Hydraulic Calculations and Development Plan of the Outlet Flow System at the Existing WTP

(4) Developing Measures for Deferrization and Demagnetization of Groundwater Containing Excesses of Iron and Manganese that Exceed Water Quality Standard

(5) Assessing the Actual Conditions and Issues of Groundwater Quality and On-going Water Quality Improvement Measures

(6) Assessing the Actual Condition and Issues of Water Quality and Coagulant Injection Rate Settings and Studying Improvement Measures

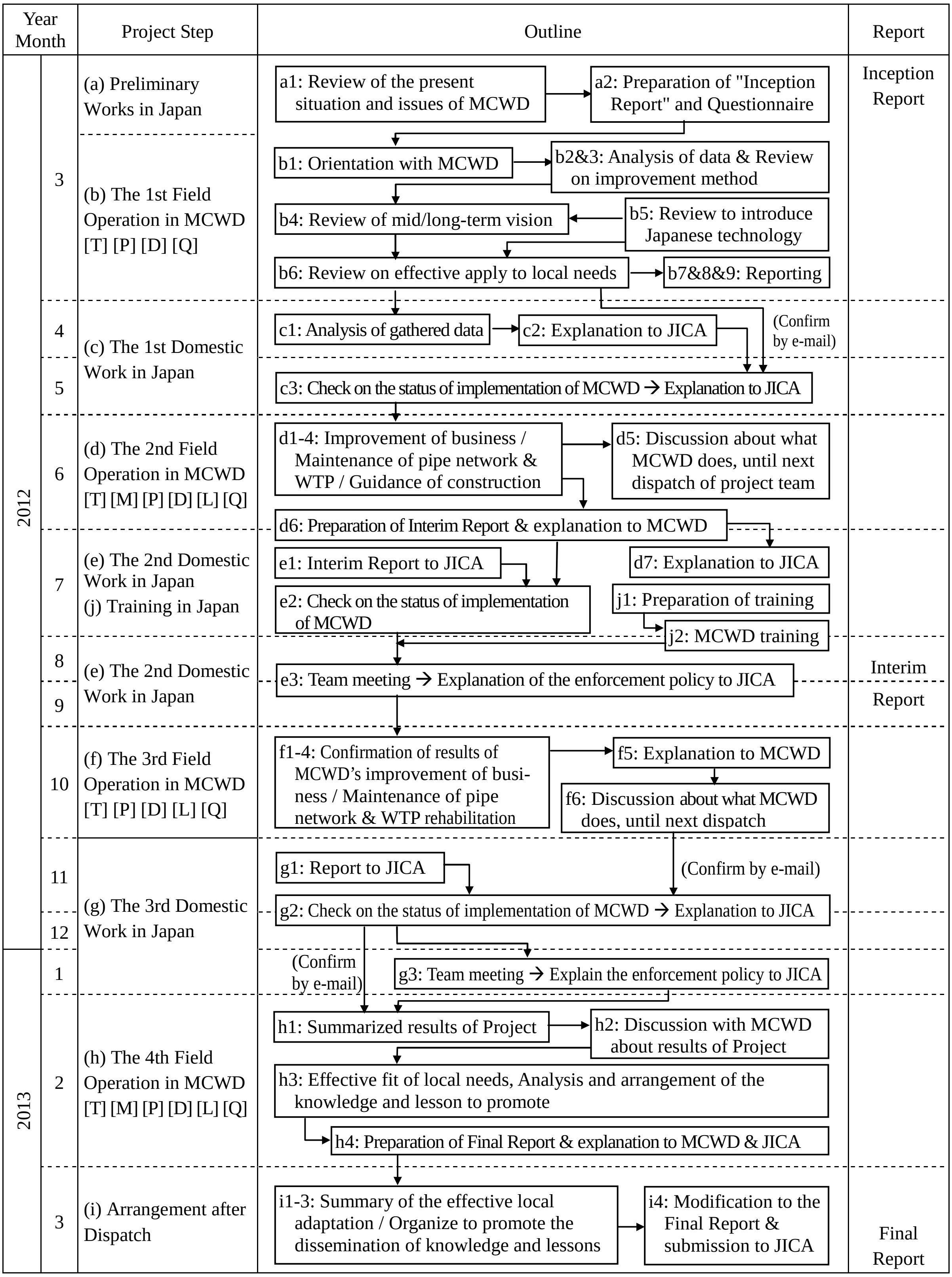


Figure 1-3-1 Project Work Execution Flow

1.4 Regions Subject to Project

This project was implemented in 4 Cities and 4 Municipalities in the MCWD located in Visayas, the midland of the Philippines, which are Cebu City, Mandaue City, Lapu-lapu City, Talisay City, Compostela Municipality, Lilo-an Municipality, Consolacion Municipality, and Cordova Municipality in Cebu State (colored in green on the right side of Figure 1-4-1).

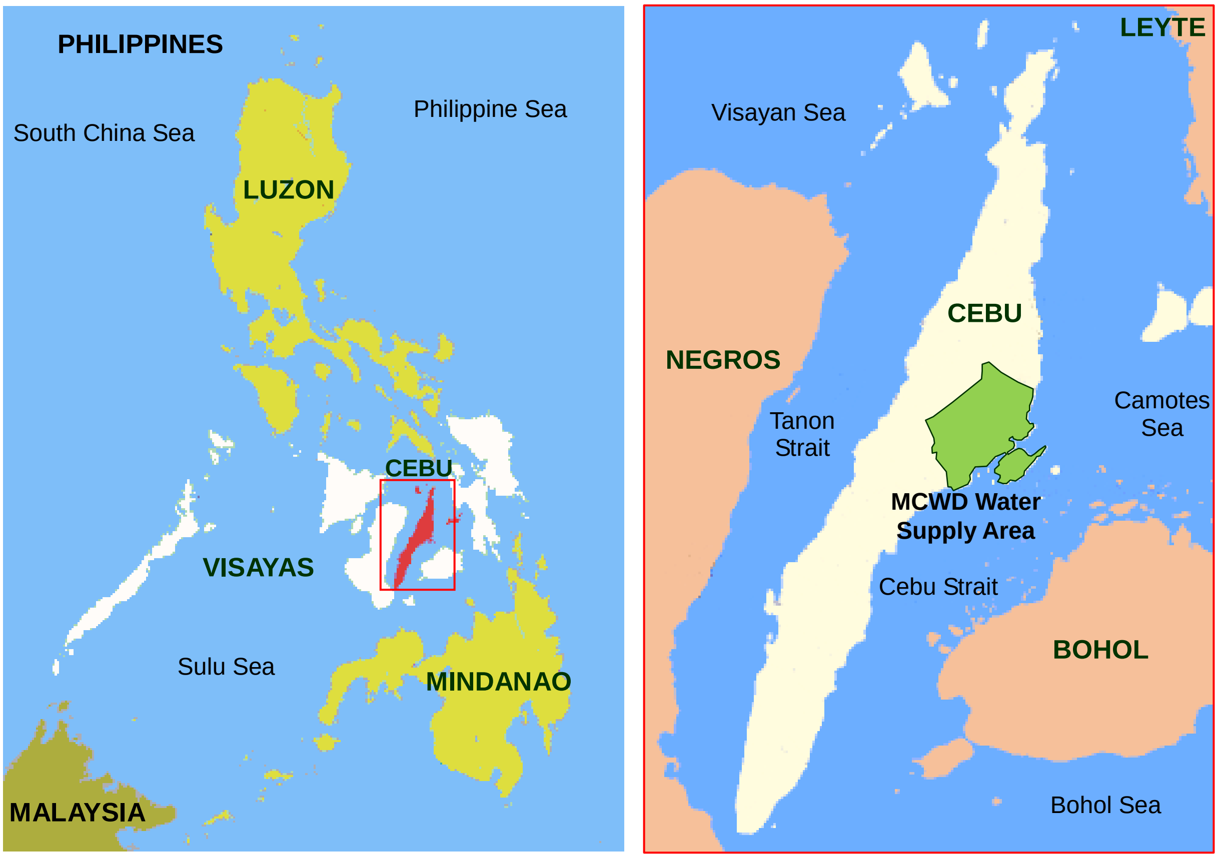


Figure 1-4-1 Locations Subject to Project (within green section of the figure on the right side)

1.5 Field Operation Schedule and Training in Japan

The 1st Field Operation in MCWD

Sunday, March 11 to Saturday, March 24, 2012 (14 days)

Team Leader [T] / Water Purification System [P] / Water Distribution System [D] / Water Quality Management [Q] (4 personnel)

The 2nd Field Operation in MCWD

Tuesday, June 12 to Saturday, June 30, 2012 (19 days)

Team Leader [T] / Business Management [M] / Water Purification System [P] / Water Distribution System [D] / Water Leakage Prevention [L] / Water Quality Management [Q] (6 personnel)

The 3rd Field Operation in MCWD

Sunday, October 14 to Thursday, November 1, 2012 (19 days)

Team Leader [T] / Water Purification System [P] / Water Distribution System [D] / Water Leakage

Prevention [L] / Water Quality Management [Q] (5 personnel)

The 4th Field Operation in MCWD

Sunday, February 3 to Saturday, February 23, 2013 (21 days)

Team Leader [T] / Business Management [M] / Water Purification System [P] / Water Distribution System [D] / Water Leakage Prevention [L] / Water Quality Management [Q] (6 personnel)

Training in Japan

Monday, July 23 to Friday, August 3, 2012 (2 weeks)

Water Distribution Course / Water Quality Course (10 trainees accepted)

2. Details of Activities

This project aims to apply Japan's experience, technology and know-how relating to water utility operation to the water business operation, water distribution systems, leak countermeasures, treatment processes and water quality control performed by MCWD. In addition to analyzing the current situation and issues in the operation of MCWD's water utility operation, the project team offers suggestions for solutions and provides technical support for future improvement of MCWD's water utility operation. It has also been a policy to train MCWD employees and promote transportation of technology.
Details of the project are described below in "2.1 Water Business Management / General Management (including Water Utility Business Operation)", "2.2 Installation of a Distribution Block System to Reduce Non-Revenue Water Rate and Provide a 24-Hour Water Supply", "2.3 Improvement of Quality of Water Supply and Distribution from Groundwater Sources and Increase of Treatment Performance of Existing Water Treatment Plant" and "2.4 Training in Japan".

2.1 Water Business Management / General Management (including Water Utility Business Operation)

The current situation and issues in the overall operation of MCWD's water supplies were ascertained and improvement measures were discussed and proposed. Areas of particular attention are detailed in "2.1.1 Business and Financial Structure", "2.1.2 Customer Service and Customer Satisfaction Level", "2.1.3 Public Relations", "2.1.4 Organizational Operations and Employee Awareness" and "2.1.5 Improvement Measures for Overall Water Utility Operation". The data from the "Annual Plan" and "Corporate Plan 2013" is not included here. Please see the appendix at the end of this report.

2.1.1 Ascertaining Current Situation and Issues of Business and Financial Structure

(1) Business Plan

MCWD devises a year-long "Annual Plan" every year including various financial tables. During the project, the "2020PLAN" was devised as a longer-term business plan up to 2020, and there are plans to disclose this in the near future (early 2013).
This business plan details efforts that MCWD will take between now and 2020 to achieve goals such as improving the water supply coverage, providing 24-hour water supplies and reducing the leakage rate, and the benchmarks for these efforts. A "Corporate Plan" breaking the targets of the plan down into yearly targets was also devised, and posters and notices were made to ensure thorough awareness in each department of MCWD.
Main points have been decided for a medium-term business plan, which had been an issue. The targets of the plan have been broken down into annual business plans, and progress of the plan is promoted through measures such as ascertaining progress at times such as budgeting and settling time. The medium-term plan needs to be disclosed to promote thorough sharing between employees

and make customers aware of the business situation.

Below are the main points of the "2020PLAN".

(a) Coverage Rate*1 Target

2011: 39.28% → 2020: 66%

(b) Targets for Expanding Commercial Share

Coverage Rate*1:	(Household)	2011: 32% → 2020: 60%
	(Commercial)	2011: 42% → 2020: 80%
Ratio of Tariff Income:	(Household)	2011: 99.5% → 2020: 70%
	(Commercial)	2011: 0.5% → 2020: 30%

*1 Coverage Rate = daily water supply volume / daily water demand volume * 100

The annual business plan, "Corporate Plan 2013" (the business year is from January to December), details annual targets in order to meet the targets set in the "2020PLAN". Targets such as tariff income and number of households with a water supply are broken down into monthly targets.

Disclosure of the medium-term plan was proposed to promote thorough information sharing between employees and make customers aware of the business situation, but after confirming related efforts with MCWD, it was decided that strengthening employees' mindsets was a more pressing goal for 2013 than disclosure to citizens. "Corporate Plan 2013" includes content on the mindset required for meeting the targets, stating that "Meeting the 2020PLAN requires effort not only from the leaders but from each and every employee". To encourage all employees to work together to meet the targets, seminars are held to share MCWD's vision for the future and set strategies for meeting targets, and efforts are being made to raise every employee's awareness of their responsibility and contribution to meeting the targets.

MCWD is working to ascertain the current situation of other business aspects using a Performance Indicator (PI). Target figures had been set through previously conducted investigations (customer awareness investigations), the databook and the "2020PLAN", but PIs were determined for other indicators considered to be useful through PI reviews throughout every department of MCWD (details are included in 2.1.5).

Direct management and outsourcing have also been reviewed to slim down business operations, as shown in Tables 2-1-1 and 2-1-2.

Table 2-1-1 Review of Direct Management and Outsourcing

	Direct Management	Outsourcing
Facility designing, Planning, Construction	Less than 50,000,000 PHP	50,000,000 PHP or more
O&M of Tisa WTP	Carrying out, currently	Planning in future.

Maintenance of water pipes	Carrying out, currently	Planning in future.
Distribution of payment voucher	Carrying out, currently	Replacement of retirees is not replenished. Outsourcing in stages.
Cleaning services	Carrying out, currently	Replacement of retirees is not replenished. Outsourcing in stages.
Water meter reading	Carrying out	No plan
Water tariff collection	Carrying out, mainly	Water charge payment window that is located in the banks and supermarket has already been commissioned.

Table 2-1-2 Work/Operation Considered for Outsourcing

Business	Work/Operation that is planning to outsourcing
Install and Sustain the Infrastructure	- Land Acquisition - Survey & Design
Operate and Maintenance	- Road Restoration - Fabrication of fittings - Septage & Sewerage management
Service Customers	- Call Center - Installation - Reconnection - Disconnection
Business Support	- Buildings, grounds & facilities Maintenance - Carpentry works - Transportation & Equipment Maintenance - Dental & Medical Examination - Psychological Testing for applicants - Equip/material testing - IT hardware maintenance - IT Systems Development

Source: Corporate Plan 2013

(2) Water Tariff

A water tariff is an important resource for water utility operation. MCWD's was investigated during the 2nd Field Operation. Information on notable points is included below.

- ◆The method for setting tariffs was determined after conducting investigations of the country's lowest incomes and holding public hearings to devise possible methods. These were then discussed by MCWD's board of directors and a method was decided by the Local Water Utilities Administration (LWUA). Tariffs were increased 10% from 2004 to 2005 and by another 10% from 2005 to 2006, but have not been increased since then.
- ◆LWUA restricts tariff increases of 60% or more, but no such increases have been made in the past.
- ◆In 2011, a law was passed entitling residents aged 60 or over to a 5% discount on services such as transport, hospitals and medicine. As a result, water users aged 60 or over are given a 5%

discount on their tariff, but the water suppliers do not receive a subsidy for this from the government. In fact, water suppliers do not receive any subsidies from the government at all.

- ◆There is no tariff for water use by other government organizations. For example, there is no tariff for firefighting water or water used for firefighting training. Additionally, MCWD will receive no assistance in its plans to build dams to secure an alternative water source to subsoil water. MCWD have made several efforts to convince the government to change this but have so far been unable to gain the government's understanding.

As was ascertained in the Confirmatory Investigation, while MCWD receives no money for firefighting water or the installation and maintenance management of fire hydrants, the government asks MCWD to provide a discount (subsidy) for residents aged 60 and over.
It is currently difficult to increase the water tariff, so in order to maintain sustainable water utility operation, discussions on requesting subsidies from the government or the other government organizations are an issue that needs to be considered on an ongoing basis. Measures such as creating a united front with LWUA in discussions need to be taken.

(3) Situation of Competing Private Water Suppliers

MCWD's water coverage rate (population to whom water is supplied / entire population of the water supply area * 100) is approximately 56% of the water user population base. Ascertaining the water supply situation of the other 44% is an issue. According to people in charge at MCWD, the most common water source in areas not covered by MCWD is household wells, followed by private water suppliers, water delivered by truck, and direct collection from sources such as rivers, streams and springs.

To ascertain the situation of private water suppliers, an interview was conducted with a water supplier (the Vice-President of PWRI) operating in areas not covered by MCWD. The main points are as follows.

- ◆PWRI is one of three major private water suppliers operating in MCWD's supply area.
- ◆Users of PWRI's water supply include SM Mall (a major supermarket), Coca Cola and hotels.
- ◆PWRI's water tariff is lower than MCWD's (35PHP/m^3 for usage of over 31m^3 in a month, compared to 48PHP/m^3 at MCWD).
- ◆They are digging wells and supplying water at the request of a small settlement (5~6 groups) in an area not covered by MCWD, but water tariff payments from the customers has been poor.
- ◆The settlement is far away from MCWD's distribution pipes, so if MCWD was to supply water from its distribution pipes, the cost of building a branch pipe to the settlement would be considerably high compared to the tariff that would be received.
- ◆Even the three largest private water suppliers have a share and water supply volume only a few percent of MCWD's (PWRI accounts for approximately 2~3%). They cannot be considered

rivals for MCWD's customer base.

In particular, MCWD is actually recognized as a customer of Mactan Rock, which provides a bulk water supply to MCWD to treat its RO membranes for seawater desalination (2,000m^3/d supplied to MCWD in the Banawa region and 5,000m^3/d in the Mactan region).

◆PWRI recognized MCWD as "achieving a high level of water quality and supply volume stability".

Competing private water suppliers have lower water tariffs than MCWD. Although they hold only a few percent of the share that MCWD holds, "2020PLAN" includes plans to acquire large commercial facilities as customers and expand into commercial water supply, and this factor gives the private water suppliers an edge over MCWD in this area.

Strengthening MCWD's financial structure will also be a direct deciding factor in whether MCWD succeeds in expanding into the commercial domain. In addition to reviewing tariff setting for commercial customers and working to improve satisfaction with aspects such as the convenience of the payment system, MCWD needs to set itself apart from its competitors by appealing to customers with the good water quality, steady supply volume and high level of customer service that are its strengths.

In terms of household water supply, however, private suppliers can be considered not competitors but rather supporting companies that cover the areas that MCWD does not. In this area, it may be possible to form close alliances with the private water suppliers to provide a more effective water service to the four Cities and four Municipalities of Cebu Province.

MCWD therefore needs to continue investigating the water supply situation in areas outside MCWD's coverage area and gathering information to ascertain the situation of private water suppliers.

2.1.2 Ascertaining Current Situation and Issues of Customer Service and Customer Satisfaction Level

(1) Awareness of Commercial Customers

As stated in the "2020PLAN", MCWD interviewed companies and residential facilities that are currently major customers of MCWD [(a) a major supermarket (ShopWise), (b) a high-scale condominium complex (Persimmon Residence) and (c) a real-estate company (Megaworld)] to ascertain the needs of the commercial customers who are the target of MCWD's future share expansion.

◆As a company handling food products, the supermarket places a high trust in the quality of MCWD water, which was why they chose MCWD despite its tariffs being somewhat more expensive than those of private water suppliers. The supermarket saves costs by using rainwater collected in a tank within its grounds for its toilet and cleaning water.

- They feel that MCWD eliminates the inconvenience of water suspensions by announcing them in advance by TV and radio, which gives customers time to take measures.
- All three companies were satisfied with MCWD's service level for factors such as the speed with which the water service is commenced after application, the speed of MCWD's response to problems, and the quality of the water.
- There were requests for payment methods such as bank transfers to increase convenience.
- Some of the customers were worried about what would happen to the water supply in events such as disasters. We suggested discussing measures such as water supply training.

The interviews with the commercial customers showed a high regard for MCWD. MCWD appeared to be achieving a consistent level of customer satisfaction.

However, there were also a large number of requests relating to matters such as the tariffs being somewhat more expensive than those of private water suppliers, convenient payment methods such as bank transfers, and disaster prevention training for times when water is suspended. In addition to providing MCWD with feedback about these items, we suggested the possible need for future efforts to ensure a steady influx of new commercial customers, such as investigating the awareness of commercial users and reflecting the needs learned in that investigation in MCWD's business.

Strengthening MCWD's financial structure will also be a direct deciding factor in whether MCWD succeeds in expanding into the commercial domain. MCWD's Corporate Planning Department (CPD) is actively marketing MCWD to commercial customers as part of MCWD's efforts to set itself apart from its competitors by appealing to customers with the good water quality, steady supply volume and high level of customer service that are its strengths.

"Corporate Plan 2013" includes reviews for reorganization of the departments in order to actively expand the business. The Public Affairs Department (PAD) and Service Connection & Installation Department (SCID) are also currently planning reorganizations as they perform market research and business.

The plan also includes a review of tariff setting, with plans for measures such as increasing the unit price of the lowest bracket of $30m^3$ per month and lowering the increase rate to attract more large-pipe-diameter customers.

(2) Water Meter Reading

Water meter reading is performed directly by MCWD, with 18 meter readers currently employed. There are currently around 135,000 water meters installed. Each meter is read monthly, and meter reading is possible on an average of 22 days each month, meaning that each reader reads around 340 water meters per day (around 250~400 water meters per reader per day are read in Japan.) Handheld terminals have been used for meter reading since 2004.

MCWD's water supply method is called Stub-Out (extraction from concentrated service pipes). A number of water meters from a few to twenty or so are placed in a row at each service pipe extraction point, allowing fast meter reading. Measures such as entering the reading codes in the order that the water meters are arranged allow each water meter to be checked in 5 to 6 seconds, a fairly high reading speed. If a leak is discovered or the water volume has increased or decreased, a report is submitted to the Action Center on the first floor of the main MCWD building and MCWD responds to it.

All meter readers wear ID and matching uniform (jacket only) when reading meters. They are courteous when reading meters, calling out to customers politely before entering the premises. They create resources such as meter layout maps of their areas to allow a smooth transition when they are replaced by a new reader.

Teams of two readers were often seen reading the large pipe diameter water meters used by commercial customers, as these have a double layer steel lid that cannot be opened by one person (see photo on the right.) The structure of the water meter box and lid needs to be reviewed soon so that meter reading can be done more efficiently.

(3) Tariff Collection and Water Suspension

MCWD collects tariffs monthly in line with its monthly meter reading. YWWB generally reads meters and collects tariffs every two months, with monthly meter reading and tariff collection done only in exceptional cases, such as when customers such as commercial users request this due to a high monthly usage. This is because the billing that accompanies meter reading comes with costs such as labor costs and postage fees. Water meters are therefore read every two months to reduce these costs. On the other hand, MCWD chooses to read water meters and collect tariffs every month because poverty is widespread and they fear that many customers would be unable to pay two months' worth of tariffs at once.

Tariff payment forms are delivered to each connection by a contracted delivery company. The forms contain a barcode by which information can be read, and details on warnings given before water is suspended are written on the back.

MCWD has an incentive system for paying water tariffs on time that YWWB does not have. A 5% discount is given when the water tariff is paid by the due date, with a 2% penalty added every 15 days after the due date for late payments. The 5% discount and 2% penalty make a big difference, and customers even leave their workplaces to come and pay their tariffs.

Tariffs are paid at the Tariff Payment Center on the first floor of the main MCWD building. The reception hours are 7:30am to 4:00pm, with up to 6,000 people coming in one day. The Center is considerably crowded on days close to the due date.

There are 9 reception windows, and each customer takes a numbered ticket and waits to be called like in a bank. There are plenty of seats for waiting, and each transaction is completed within one minute, but the waiting time is inevitably long when a backlog of people occurs. Payment windows can be found in 4 branch buildings in addition to the Tariff Payment Center on the first floor of the main MCWD building. All of these are directly managed by MCWD. In addition to the tariff payment windows directly managed by MCWD (top photo), there are tariff payment windows at contracted banks in 17 locations and at 22 other locations such as shopping malls and large supermarkets (bottom photo: shopping mall). There are plans to expand both of these in the future.

There are plans to discuss future implementation of methods such as bank withdrawals, internet banking and credit card payments to make the tariff collection process more convenient for customers and more efficient for MCWD.

Crowding at the windows is unavoidable with the current system in which payment can only be made using the payment form. MCWD are appreciably working to increase the number of tariff payment windows with this in mind. In addition to alleviating crowding at directly managed payment windows in the near future, a shift to outsourcing is also expected to decrease the number of directly managed payment windows in the future.

The need for and efficiency of methods such as automatic bank withdrawals and credit card payments has also been recognized, and MCWD are working to expand these systems. There is a particularly high demand for this among commercial customers, a sector in which MCWD plans to increase its share in the future. A large number of companies are already hoping for these payment methods, with many requests to implement them. It is therefore desirable for MCWD to expand these systems soon.

MCWD's process for suspending the water supply of non-paying customers is much stricter than that in Japan. YWWB suspends a customer's water only if a payment is not made after three two-month meter reading cycles, or six months. MCWD suspends a customer's water one week after the second one-month meter reading cycle, or after two months. Whereas a 5% discount is given for payments before the due date, a 2% penalty is charged for every 15 days by which a payment is late. If payment is still not made after the customer's water is suspended, the Tariff Department sends an overdue payment notice, and if the customer still fails to pay, the Legal Department sends a final warning and then takes legal action. While YWWB does not charge a penalty for late payments, this system is worth learning from, as suspending water generates labor costs. Around 5% of customers do not pay their water tariffs and an average of around 300 customers' water is suspended each month.

The reason the period before water suspension is so short is because customers receive sufficient explanation of MCWD's obligations as a water supplier and the customer's obligations to pay their tariffs at the orientation seminar for new customers mentioned later in this section. New customers sign a water supply contract with MCWD after sufficiently understanding the procedures for water suspension in the event of non-payment.

In addition to the suggestions made during this project, MCWD have already been working to expand their tariff payment windows and improve convenience of payment, with some efforts made already. In December 2012, MCWD implemented a system where payments could be confirmed and tariff payment forms could be printed via the MCWD website. Customers can access this system by entering their customer number and name or their customer number and water meter number. This system has been widely publicized in media such as newspapers.

The system has only just been implemented, its effects will need to be reviewed in the future, and there is the issue of a double standard between this system and the tariff payment forms that have been sent up to now, but deliberations are underway to eventually connect this to a system such as internet banking on the website, allowing automatic payment. It will take time to put this into practice, but this will be a major step toward greater convenience.

MCWD also plans to continue expanding its windows so that customers who cannot use mobile phones and computers can pay directly at a window. As many convenience stores have been opened in recent years, there are deliberations about including these in the expansion.

(4) Shared Handling of Customer Feedback

MCWD is centralizing its customer service by combining the departments handling water tariff collection and water suspension with the department issuing tariff payment forms and the department in charge of Public Relations and public information. This reorganization includes a centralization of how customer feedback is handled. Customer requests and items requiring response are collected at the Action Center, allowing quick supply of information to the departments concerned.

We suggested that customer response could be improved by gathering information on action taken by each department in addition to providing information on the feedback itself.

(5) Orientation Seminar

MCWD holds an orientation seminar for customers wishing to start using its water supply, in an

effort to build a relationship between the water supplier and customer before the customer signs the water supply contract. This is held every Wednesday and Saturday at MCWD's main building and branch buildings. The top photo shows a Wednesday seminar held in the main MCWD building during the 2nd Field Operation.

The three-hour seminar is a talk given to customers wishing to start a new water contract (to install a water meter) with the aim of providing all of the important information they need to know at the beginning, from the importance of water sources and water suppliers to water saving tips and payment rules. Resources are handed out to the attendees. As the bottom photo shows, the talk includes an explanation of how the water meter works. The seminar is given by employees with excellent presentation skills, who provide easy-to-understand explanations in simple language that can be understood by customers with little knowledge of waterworks.

Along with explaining the company's obligations in the water supply contract, MCWD makes sure the customers understand that their right to receive water comes with obligations such as maintaining the water meter and paying their tariffs on time. An attendance certificate is given to attendees along with their application form before their application is processed and they are allowed to receive a water supply. Customers cannot receive a water supply without attending the seminar and agreeing to the terms about breaches of their obligations. MCWD also provides a service in which employees go to newly built subdivisions and give the seminar there if a large number of residents request it.

There is currently a need for YWWB to find ways to give their customers an understanding of how a water business operates and communicate with them about risks. We were interested to discover that MCWD has already taken measures to deepen mutual understanding between themselves and their customers.

MCWD appear to be reviewing methods for holding their seminars in anticipation of new customers in the future, but, at any rate, undertaking this kind of effort at such an early stage – one might say the very beginning – will have significant future benefits. It will probably be difficult for YWWB to hold such seminars, but it provides a point of reference for our own efforts to foster communication with our customers.

(6) Use of Customer Surveys

MCWD surveys customers visiting the main building around once every two years. There were 5,665 responses in 2009 and 2,015 in 2010. The main topics include (a) Water quality in local water supply are, (b) Water tariff, (c) Convenience of water tariff payment methods, (d) Handling of requests and complaints, and (e) Attitude of MCWD employees.

Each question item is rated on a five-point scale. MCWD received high scores for all question items in both 2009 and 2010, with an average score of 4.23 in 2010. While there is a good balance between questions on "hard" and "soft" aspects of the water supply, only visitors to the main building are surveyed, creating a bias. The survey also does not ask for information on attributes such as area of residence, age and amount of water used.

To make surveys more useful for creating business plans and increasing Customer Satisfaction in future, surveys need to be conducted throughout a wider area, including areas outside MCWD's coverage area, and need to include information on attributes. Commercial users also need to be surveyed.

2.1.3 Review of Current PR Situation and Measures for Strengthening PR

(1) PR Plan and Strategies

MCWD conducts various PR activities and events throughout the year. Various PR goods and media are also issued with carefully tailored content. Here are a few examples.

- ◆MCWD has created its own calendar with photographs and comments about something they would like to promote each month, such as photographs of MCWD's water supply facilities, or pictures of the previous year's event for months when there is an event. This has been done continuously for around 30 years, with around 135,000 free calendars being printed and distributed to customers.
- ◆Events are held once or twice a month, including day-long free drinking events in which water from MCWD supply is provided to promote the safety of MCWD water.
- ◆An annual report is created as a business report for government organizations. This is not distributed to the general public.

While a large number of efforts such as these are being conducted, there is insufficient annual planning of the purpose or targets of these public relations activities and events. It was confirmed, however, that the annual schedule and cost-benefit relationship have been taken into account in PR planning, and these plans are included as "active PR strategies" in "Corporate Plan 2013" (Table 2-1-3). The plans mention use of various media such as TV, radio, newspapers and wall advertising in the MCWD buildings, along with PR to schools. The company's PR strategies are stated in the business plan, and all employees appear to work together in these efforts.

There is a need for MCWD to strengthen its PR about the safety of its water, and there is a particular need to create an annual schedule that clearly states such efforts and create a PR plan after a cost-benefit analysis. Examples include reduction of printing expenses that generate advertising costs instead of printing other companies' advertisements, and holding joint events with other organizations instead of alone.

Table 2-1-3 Main PR Efforts in 2012

Date		Contents
January		- Free drinking station in Sinulog (2 days)
February	1st 13th	- MCWD Anniversary, Free breakfast for consumer - Buhisan Dam 100th Anniversary - City hall shower and Free drink
March	22nd	- UN (United Nation) World Water Day promotion
December	25th	- St. day Free drink - Distribute the MCWD original Calendar to all customers - Distribute the MCWD original Tumbler to the customer who installed DN50mm meter

One PR effort for a specific audience is a Parent-Child water treatment classroom run by MCWD for elementary school students. Events based on this will be held on a trial basis from June 2013. The Filipino school system consists of seven years of elementary school from the age of seven, followed by three years of junior high school and two years of senior high school. MCWD would like to target all of these levels. In addition to raising understanding of the importance of water sources and the role of MCWD, MCWD plans to include hands-on experiences done by YWWB, such as water tasting and filter experiments.
Opinions on this plan were exchanged during the 4th Field Operation, and it was confirmed that the targeted grade levels would need to be narrowed down (such as to grades whose curricula include water-related topics) if such activities were to be carried out.

MCWD has also expressed interest in creating a mascot as part of its PR strategies to foster a greater familiarity among the public, with the use of a mascot mentioned as part of MCWD's plan to build a new company image in "Corporate Plan 2013". As MCWD plans to hold an event to celebrate its 40th anniversary in 2015, there are plans to hold a mascot design contest for citizens in the lead-up to this event and unveil the new mascot at the event.

Other efforts to create a new company image are also underway, including continuous improvement of everyday services, updating the uniforms and holding joint events with companies and other organizations. A TV commercial was also created in September 2012 to improve MCWD's company image and increase the public's trust. There are plans for this to air in the future.

(2) Signature Advertising Media

As a large proportion of individuals in the Philippines have Facebook® accounts, MCWD has created a Facebook® page. The page has around 770 followers as of February 2013.

MCWD also uses TV, radio and newspapers not only for PR activities but to provide urgent information on situations such as water suspensions.

In order to ascertain effective advertising media and strengthen related efforts in the future, MCWD needs to include items in its customer surveys about whether respondents have seen their advertising and form PR strategies based on their responses.

2.1.4 Ascertaining Current Situation and Issues of Organizational Operations and Employee Awareness

MCWD is carrying out some extremely interesting efforts relating to organizational operations and employee motivation. Here is a report on these efforts.

(1) Personnel Relations

MCWD's hiring is basically done through separate staff recruitment for each department (Accounting, PR, etc.). Each department hires employees with specialist knowledge; for example, a former newspaper reporter was hired as a PR supervisor. Hired employees therefore perform their duties as experts in their fields. The expertly hired employees exercise their full potential and are extremely valuable human resources. While there is a need for employees with specialist skills and knowledge, our discussions with many employees throughout this project revealed several cases in which knowledge and techniques were not shared between technical departments due to a lack of interdepartmental experience. As mentioned in 2.1.1 and 2.1.2, MCWD is planning a shift toward outsourcing of work, along with a reorganization. Considering the future need for a small staff with high skills, it can be considered an important strategy to train employees not only as experts in one specialist area but as multi-skilled employees with a wide range of waterworks knowledge and technical skills.

The Personnel Department conducts training to improve employees' skills. Employees are surveyed to determine what kind of training they would like, and these needs are reflected in the training.

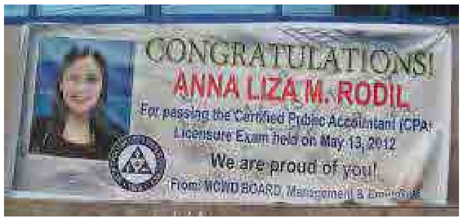
However, there is also a need to improve the skill level of the organization as a whole. Employee transfers are an effective way to do this and to prevent the harmful effects of vertical division in an organization. In YWWB, employees are generally transferred every 2~6 years. This allows them to experience multiple departments in several years, making the experience they acquire as they become veteran employees even more valuable. MCWD employees are currently able to request transfers and some move to other departments when they are promoted, but we suggested that YWWB's transfer system would be worth considering as an organizational strategy.

(2) Working Environment

The offices of each department in the main MCWD building have a comfortable working environment, with each employee given a large desk with partitions to facilitate individual work. Efforts are also taken to make employees feel at home, with music playing at a suitable level, employees creating posters for workplace parties such as the Christmas party and photographs of employees together displayed as large posters (see top photo).

The meeting room, meanwhile, is designed to enhance concentration on meetings, with maps and data of the department's latest work displayed on the walls and relevant materials organized.

An employee who received government-accredited public accountant certification was honored in a large poster containing the employee's photograph by the entrance and exit of the main MWCD building (see bottom photo). The working environment is designed to motivate employees and inspire them to improve their skills.



(3) Welfare

MCWD holds employee sports events every Saturday throughout the year, attended by employees throughout the company. From June to October, they hold basketball tournaments, the most popular sport in the Philippines. Employees from throughout MCWD form 10 teams of around 10~15 employees apiece, with each team containing employees from various departments. We saw new employees playing together with executives, everybody working hard but having fun. It looked like a very significant bonding experience. The tournament starts with an opening ceremony planned by the employees, with various events for the enjoyment of the spectators.

(4) Awareness of Management and Employees

MCWD's supervisors often approach employees, and were often seen talking to employees in the corridor. While authoritative relationships are in place, there is minimal distance between supervisors and employees, with mutual acknowledgement between the two as they engage in their work. We had many discussions with executives throughout this project, and while they took their instruction and training of their employees seriously, it was clear that there was a love of their employees in their seriousness. It was clear that the executives were good people and highly skilled leaders.

The charismatic leadership of MCWD General Manager has significant effects. The General Manager strongly encourage managers to obtain a management qualification before becoming executives, whether their field is administrative or technical. The initiative taken by managers surely leads to improvements throughout MCWD as a whole.

There is an extremely high awareness among the management, with management fully aware of situations in both the administrative and technical areas. However, when we conducted interviews and discussions with general employees, the figures and data we received often differed greatly from one employee to another. This is because little information relating to plans and operations is documented and employees are not aware of documentation that does exist.

We suggested a future need to organize data and documentation so that all employees can have the same objective awareness of the operation of the company that the executives have, and to encourage site employees to find and improve on issues. This will raise the level of the organization as a whole.

2.1.5 Measures for Improvement through Application of Japanese Water Utility Operation Know-how and Deliberations on Implementation of Performance Indicators (PIs)

(1) Ascertaining Current Situation

Our technical work for this project included application of the know-how and technology used in Japanese water utility operations, including water distribution systems, leak control, treatment processes and quality control. We deliberated on how to introduce these. The current state of MCWD included items that were insufficient or missing compared to Japanese water utility operations. Improving on these provided a fertile ground for implementation of Japanese water utility operation know-how. Examples of cases identified so far are detailed below, with deliberations on the potential for improvement.

1) Management of Diagrams and Organization of Manuals

We were initially told that there was no floor plan of the Tisa WTP; however, one was found and submitted during the final stage of the 2nd Field Operation. However, there were no detailed structural drawings of facilities such as sedimentation basins and filtration basins as yet. We therefore showed the MCWD employees how to measure the facilities and create drawings during the project.

There is no manual for operational management of WTP, with operational management left to the site operators. It was not clear which departments would manage changes and improvements to the operational management of treatment processes and who was responsible for these, and there seemed to be little focus on this. Furthermore, the water quality laboratories of the WTP were not aware of the details of water quality sampling points, meaning that sampling had continually been done at unsuitable points.

After discussing the state of organizational management with MCWD's general employees and executives during this project, water quality laboratory employees became involved in improving water treatment processes for the first time.

2) Awareness of Entire Water Treatment and Distribution System

When discussing nitrate dilution methods to improve the water quality, it was revealed that information on operation, transmission and distribution systems of Tisa WTP, wells of subsoil water sources and Jaclupan Subsoil Water (subsoil river water) was not being shared. Only a few employees had an accurate understanding of these systems, with other employees unaware that diagrams existed.

The way MCWD was being run made it unsurprising that while employees were aware ofthe details of the specialist departments they belonged to, they were unaware of what was going on in the departments around theirs. A waterworks system is like a relay, with each drop of water being passed from one process to the next. Waterworks processes cannot be performed satisfactorily without each department also understanding how the water is passed to them and then on to the next department. Employees involved in water treatment and distribution need to understand the whole process from treatment to distribution.

3) Sharing Historical Background

When verifying leak detection plans, there was no common awareness between employees of the history and background of leak detection at MCWD. Only a few group leaders and employees who had been there a long time understood these things. This is because there was no documentation that could be shared. This Field Operation therefore included the creation and mutual confirmation of basic documentation on the history of and future plan for leak detection.

As with leak detection, employees were asked about specification and equipment lists for the mapping system during interviews. Clear answers were not received during the 2nd Field Operation, but documentation was submitted during the 3rd Field Operation. The lack of awareness of shared documentation means that it is probably not often used in MCWD's actual operations. As there was no documentation on the implementation details of the mapping system, these were documented during the 3rd Field Operation and shared throughout MCWD after mutual confirmation.

4) Data Sharing and Cooperation with Other Government Organizations

GIS data is the foundation of mapping. We proposed a new revision of MCWD GIS data, as it is old and often inconsistent with the actual state. We requested an investigation of existing data at Cebu City government organizations other than MCWD but it was not until the 3rd Field Operation that we were able to confirm the existence of GIS data and obtain this data from the Cebu City Urban Planning Department.

Meanwhile, valve chambers installed on water pipes in the city have been overlaid in paving work by the Road Administration Department, meaning that the valves cannot be operated. In fact, the locations of the valves and pipes are not even clearly known. These issues could be dramatically improved through more proactive cooperation with other government organizations on a day-to-day basis.

As a result of this project, MCWD employees are aware that these are issues and have been making sure that issues needing to be resolved are discussed with other government organizations.

5) Documentation

One excellent area of MCWD is that they have obtained ISO9001 and have created a Water Safety Plan (WSP) (completion of each cycle is not yet verified). It is rare for a water supplier to have already worked on and completed both of these.

However, a major factor in both of these is sharing of documentation, and this was often not being done, meaning that there is probably little functioning of operational and PDCA cycles.

Documentation and manual creation was urged for both ISO9001 and theWSP, and a format was set for documentation such as inspection reports. Steady implementation of these measures will improve this issue, and it is therefore expected that ISO9001 and the WSP will be reviewed soon.

(2) Implementation of a PI for Improvement

The analysis of the current situation in (1) shows that sharing information on employees' day-to-day work and operations with the whole of MCWD via documentation, manuals and reports and giving employees an understanding of each other's work and operations will lead to every member of the organization checking on each other as a matter of course. Employees will then take improvement measures to resolve any doubts that arise, resulting in improvement of the organization.

Quantifying situations with a PI makes it possible to determine the directions that the organization is taking in order to put these measures into practice.

PIs for performance evaluations by each department are gathered and evaluated as part of "2020PLAN". The plan was explained to the MCWD board of directors during the 3rd Field Operation, with a detailed audit of the PIs gathered by MCWD before and after this. Titles of all 61 PIs have been decided, but there were issues with some basic conditions of the PIs; namely, that they are data that can be easily collected and that the same figures will be obtained no matter who collected the data. Some of the data could not be easily collected, while other data would be difficult to evaluate over a long period of time. These were discussed and revised.

The five basic principles to be checked when creating PIs are as follows.

- ◆Data collection and calculation method must be easy
- ◆Must be easy to explain
- ◆Results must be easy to explain to customers
- ◆Must be possible to review results at end of year or evaluation period
- ◆Must be possible to evaluate over a long period of time and set targets

The following revisions were made to the PIs submitted by each department for "2020PLAN".

- ◆All PIs are given a four-digit number for a short name and easy identification.
- ◆Past data is used to make tables and graphs of the situation up to the present.
- ◆Reasons are given for high and low PI scores and for the specific score of each item.
- ◆Poor PI scores are analyzed to determine the reason and specific areas of underperformance.
- ◆Results of analysis are reflected in the next facility rehabilitation or amendment of policies.
- ◆PI data is disclosed to other water districts and comparative data is collected.
- ◆A link is made between this PI data and existing PI data such as that for SEAWUN, IBNET and ISO24510.

A goal of this project is to create PIs for new evaluations. With our analysis of the current situation in mind, we suggested a documentation preparation rate, personnel transfer rate and staff suggestion rate.

Each PI is given an identification number for use in discussions. We stated that there is no need for these numbers to have any relation to the Japan Water Works Association (JWWA) Q100 PI numbers.

1) Documentation Rate

During the interviews and discussions that the project team has conducted with MCWD general employees so far, figures and data provided have often differed greatly from one employee to another. This is because there has been little documentation on plans and operations and there have been cases in which employees are unaware of documentation that does exist.

- ◆Information on the existing leak detection plan is not documented, with only group leaders aware of the plan and employees simply following their group leader's directions on a day to day basis.
- ◆In terms of pipeline rehabilitation plans, the Planning Department has a table of rehabilitation targets for each year, but this is not shared. Additionally, as there is no documentation of definitions, purposes, annual goals and ultimate goals for pipeline rehabilitation, interpretation of the table is inconsistent, with different employees making different judgments.
- ◆In terms of the mapping system, system diagrams and manuals that were unknown during the 2nd Field Operation have been found to exist.

Management of documentation is extremely significant to the operation of an organization. Evaluating these PIs makes it possible to determine the basic potential of employees, who are the driving force of the organization. A 100% score is desirable, and efforts therefore need to be undertaken to document information if the score is less than this. This needs to be done on an ongoing basis: the denominator increases each time a new project or plan is started, and the score therefore decreases if the project or plan is not accompanied by documentation.

1011 Documentation Preparation Rate (%)

$$= \frac{\text{Fully documented}^{*1}\text{ plans and projects (number)}}{\text{All plans and projects (number)}} * 100\ (\%)$$

*1: In order for a plan or project to be considered fully documented, there must not only be diagrams and tables but documentation such as information on the background, purpose and details of the plan or project, reference materials and a revision history.

1012 Manual Preparation Rate (%)

$$= \frac{\text{Operations for which a full manual}^{*2}\text{ has been prepared (number)}}{\text{All operations (number)}} * 100\ (\%)$$

*2: To be considered a full manual, the manual must contain information such as inspection items, inspection cycles, operation procedures and inspection reports (the actual form and an example of how to fill it out) for the applicable maintenance management operations.

2) Personnel Transfer Rate

Like in other Asian companies, MCWD employees work in the same job for years and become an expert in that one job, with few employees transferring from, for example, the water treatment department to the distribution department. This is an issue in Japan too, and creates a high risk of vertical division. As mentioned in the section on personnel relations in 2.1.4, a water supply organization includes a large number of different jobs, and the organization performs better when a large number of employees possess knowledge and technical skill in a wide range of waterworking areas.

When we discussed nitrate reduction measures with both the water treatment and water quality department and the distribution department, we noticed that the employees who were familiar with both departments were able to participate actively in the discussions, while those who only had experience with one department were more reserved and less able to participate in the discussions. At YWWB, employees are generally transferred every 2~6 years. This allows them to experience multiple departments in several years, making the experience they acquire as they become veteran employees even more valuable. Although employee transfers are not a familiar concept to MCWD, this was set as a PI to raise the performance level of the organization. It was planned that a benchmark would be set for each year and the number would be compared over time in order to achieve the skill transfer that is present in Japan.

1021 Personnel Transfer Rate (%)

$$= \frac{\text{Number of employees transferred to different department during year (people)}}{\text{Total number of employees (people)}} * 100\ (\%)$$

1022 Personnel Transfer Times (times/people)

$$= \frac{\text{Total number of transfers for all employees (times)}}{\text{Total number of employees (people)}}$$

3) Staff Suggestion Rate

At Tisa WTP, installation of a vertical baffled mixing unit was discussed as the mixing function of the standard sedimentation basin, after which the employees built and installed the unit themselves. Maintenance management of the rapid filtration basin has also been done through regeneration of the filter media and suitable management of the filter layer (depth of water above the sand). Each job was done manually instead of automatically, making the work extremely strenuous, but the MCWD employees appeared to feel a deep sense of accomplishment. In order to perform this work, somebody needs to make a plan and suggestion, after which an organization-wide policy is decided and the work is carried out. With so many projects and suggestions made at MCWD, evaluating these is expected to lead to the creation of a sustainable water supplier through the capabilities of the employees, as well as an increase in motivation. Creating a PI for suggestions and conducting an evaluation based on this is expected to enliven the organization.

1031 Staff Suggestion Rate (number/people)

$$= \frac{\text{Total number of suggestions submitted by employees during year (number)}}{\text{Total number of employees (people)}}$$

MCWD's current state regarding these PIs is shown in Table 2-1-4.

Table 2-1-4 Current State of MCWD for Proposed PIs

Number	Name of proposed PI	PI value			Numerator
		2010	2011	2012	Denominator
1011	Documentation preparation rate (%)			57.7	30 (number) / 52 (number)
1012	Procedure manual preparation rate (%)		92.1	88.9	56 (number) / 63 (number)
1021	Personnel transfer rate (%)	4.92	6.35	4.99	43 (people) / 861 (people)
1022	Personnel transfer times (times/people)	0.0320	0.0242	0.0314	27 (times) / 861 (people)
1031	Staff suggestion rate (number/people)	0.0206	0.0219	0.0290	25 (number) / 861 (people)

These PIs do not only evaluate the implementation of "hard" items such as facilities and equipment but also the performance of both individual employees and the organization as a whole. Neglect of duties leads to a lower evaluation score. While it is expected to be difficult to search old data, this was suggested during this project as a tool to evaluate MCWD and other water suppliers in order to strengthen the organization in the future.

2.2 Establishing Distribution Block System (DBS) to lower Non-Revenue Water (NRW) Rate and ensure 24-hour Water Supply (Water Distribution System / Water Leakage Prevention)

2.2.1 Selecting Model Block to Develop the Distribution Block System (DBS) from the Existing DMA

(1) Current conditions at MCWD

MCWD has adopted the District Metered Area (DMA) as its water supply method. DMA refers to a demarcated area in which the water supply quantity is managed using water meters. The flow volume of the tap water from a single site or multiple sites is measured using flow meters, and the total water used at all connections as indicated by the water meter installed in each house within the demarcated area is then deducted to calculate the flow loss in the DMA within a given time period (Water loss [m^3] = flow meter reading [m^3] – Σ water meter reading at each connection [m^3]). This enables the Non-Revenue Water (NRW) rate to be measured within the DMA (NRW rate [%] = flow loss [m^3] / flow meter reading [m^3] * 100%).

The flow volume on each house's meter is measured when the meter reading is taken (approximately 330 homes on average per day), which means that the flow cannot be measures at the same time at all of the houses' meters in the DMA area. Accordingly, there is a slight time lag between the water volume data from the flow meter and the water volume data from each home's meter, making it impossible to accurately calculate the NRW rate, but the data is adequate in assessing trends in the NRW rate.

The NRW rate within the DMA could be accurately measured using the minimum night flow approach. In this method, the minimum flow at the point in time when none of the homes are using water (sampling interval is about 2 seconds) is ascertained by installing recording flow meters capable of measuring a low flow volume when water usage is minimal at night. Conducting such measurements for not just one night, but more than a week, could likely enable better measurements of the minimum flow, so normal water use should be measured during the day using the installed flow meter, and bypass and switchover flow meters should be installed so that a recording flow meter can take measures of the low night time flow.

The ground elevation must be considered when the DMA are demarcated. Since water pressure declines in places on a high elevation and water pressure increases in areas with low elevation, terrain with extreme differences in elevation should divide the DMA. MCWD uses DMA for its water distribution system, and currently has 62 DMAs, with an average of about 2,400 connections within the DMA. Water is pumped from deep wells in 102 sites for a direct water supply, while water is also stored at 10 distribution reservoirs for supply. Dam surface water is treated at the Tisa WTP and supplied to adjacent DMA using gravity flow.

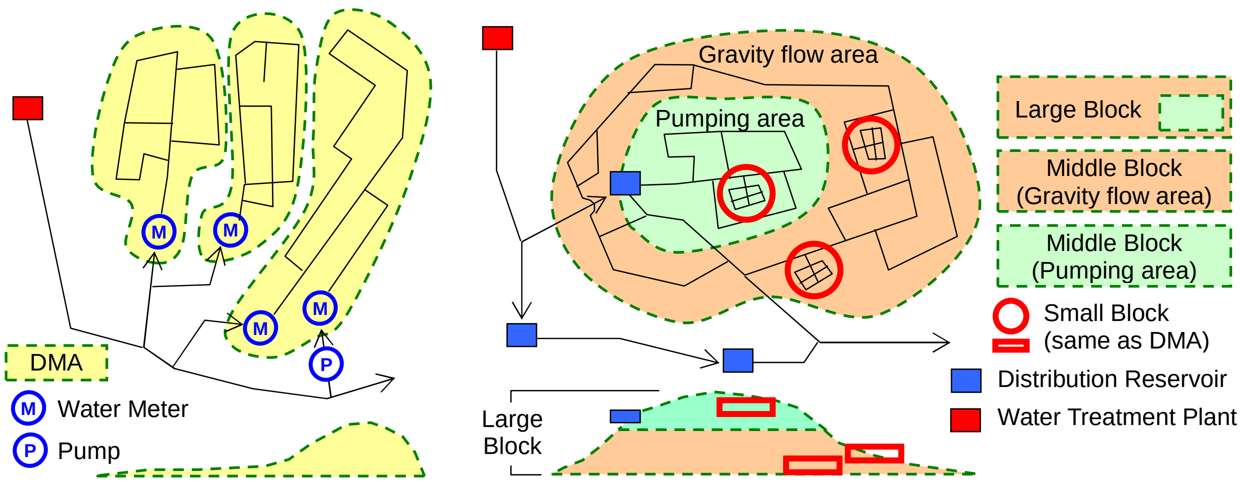


Figure 2-2-1 Diagram of DMA System (left) and Distribution Block System (DBS) (right)

The Distribution Block System (DBS) was adopted by YWWB in 1971. This water distribution system aims to adjust water pressure primarily at the respective distribution reservoirs. The blocks are divided into large, medium and small blocks. Large blocks form a single block in which the entire area is supplied from one distribution reservoir. The pump areas to which water is supplied via pump from the distribution reservoir and the gravity flow areas to which water is directly supplied from the distribution reservoir are the medium blocks. These blocks might be broken down into the smallest blocks, given the ground elevation and number of homes supplied with water, in order to maintain water pressure within a certain range and keep the water supply population within the block at manageable levels. In terms of scale, these small blocks are equivalent to DMA in MCWD, but some DMA should be reviewed in terms of the balance with the water supply capacity, as determined by the ground level and the population size. Moreover, laying down pipes that can communicate between blocks in the event of an accident or other incident makes backup on a reciprocal basis possible (although there are cases in which only one-way backup is possible, depending on the terrain and the pump head) and minimizes the impact of pipeline constructions and accidents (water suspension area and water suspension time), thus making stable 24-hour water supply possible and enabling the utility to provide high quality water services.

Since Yokohama city has many hills and valleys (small rivers) with an undulating terrain, YWWB led the rest of the country in introducing DBS suited to water pressure management. As a result, the city is able to supply water consistently for 24-hours a day, despite its complex terrain.

(2) Consideration of MCWD's adoption of DBS

During the training in Japan for MCWD managers held in 2011, YWWB gave a lecture on DBS. A manager who took note of its effectiveness took up the question of whether MCWD could run a water distribution system that incorporates elements of DBS into the current DMA. This issue came up as a question for review in the Terms of Reference (TOR), and in the 1st and 2nd Field Operations, the effect of adopting DBS and the burdens were discussed in talks about DBS.

MCWD supplies water directly from deep wells to a significant extent and has few distribution reservoirs, so in light of the difficult in forming blocks and the fact that MCWD incurred considerable expense in laying the piping network when it built DMA, which is currently nearly complete, it was determined that at present no attempt would be made to shift the existing DMA to DBS. Instead, introducing the strong points of DBS (backup, sustainability of a 24-hour water supply) to the existing DMA, using a model DMA, would be considered.

Table 2-2-1 Overview of Selected Model DMA

Section	Model DMA	Priority	Remarks
(a) High NRW rate area, Frequency leakage occurrence pipeline	25A	1	Rehabilitation pipeline construction
	11A	2	Commercial area / Densely populated area
	9C	3	Densely populated area
(b) Less than 24-hour water supply and low water pressure area	16	1	High elevation area
	17	2	High elevation area
	19&20	3	High elevation area

The model DMA selected one DMA site that was most in need of improvements and then selected two additional candidates, primarily from among DMA in (a) areas with a high leakage rate and frequent leakage pipelines and (b) areas that do not yet have 24-hour water supply. We facilitated the examination based on the progress made. Table 2-2-1 shows the model DMA selected in light of (a) and (b) in this section, while Table 2-2-2 depicts the relationship with the MCWD water supply area overall.

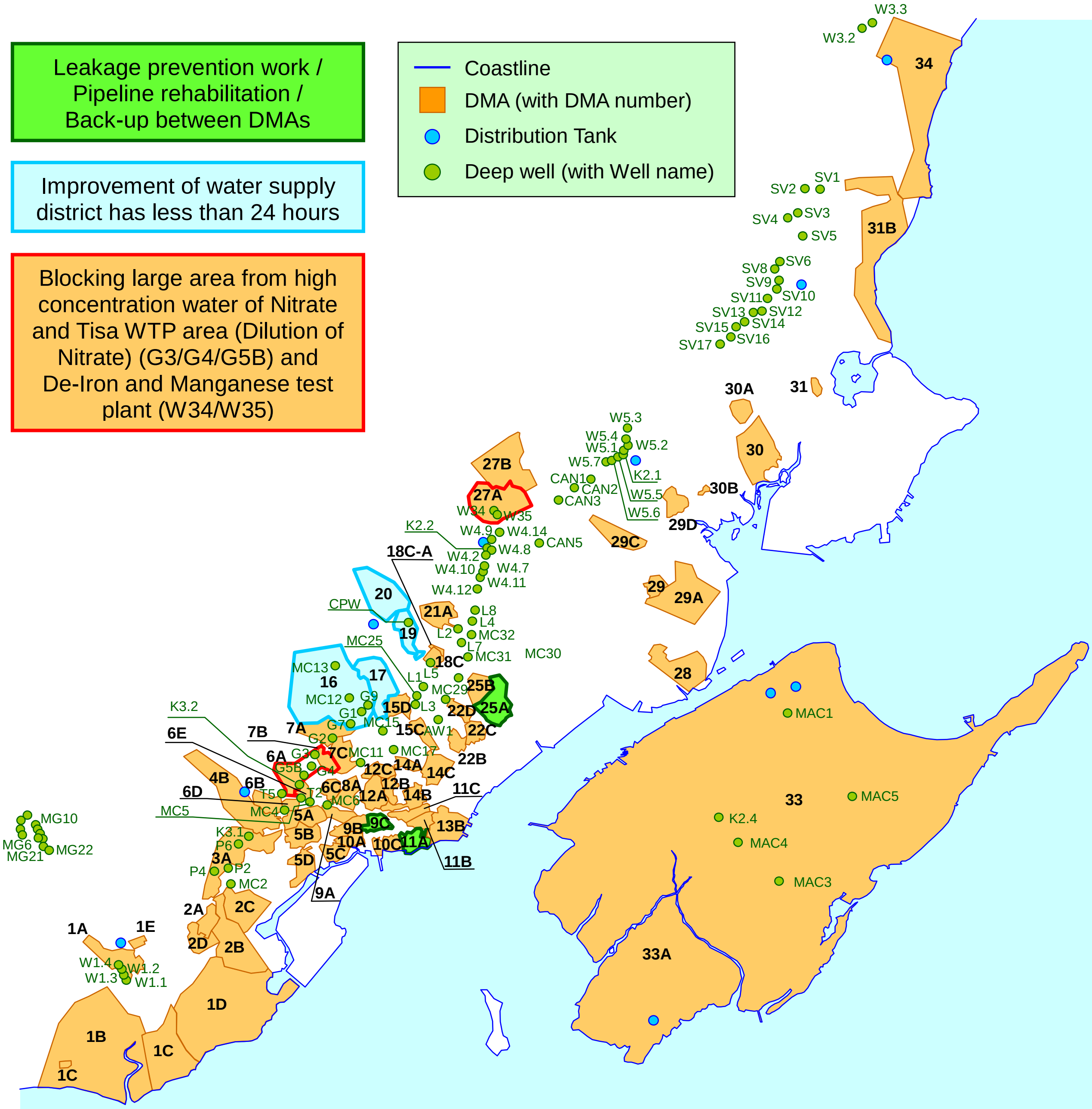


Table 2-2-2 MCWD Water Supply Area DMA Map and Model DMA under Consideration

2.2.2 Developing a Pipeline Network and Incidental Equipment (Gate valve, Fire hydrant, etc.) and Providing Training for Leakage Volume Measurement and Leakage Detection

(1) Current Status of Leak Detection at MCWD

MCWD's leak detection operations are divided into the Northern area (including Mactan Island) and the Southern area. The water distribution offices (Northern and Southern) each form three teams made up of five people each. A monthly leak detection schedule is prepared, and a weekly rotation put together for daytime surveys, nighttime surveys and minimum flow meter surveys.

Existing leak detection equipment includes five acoustic rods, 12 leak detectors, and 3 leak detection correlators, but some of the equipment is broken, and there is not enough surveying equipment relative to the number of technicians. This means that leak detection is not being effectively carried out.

(2) Introduction of Leak Detection Equipment

The equipment introduced in this project was rented in Japan for a limited time period and installed at the local site for the 2nd Field Operation. The equipment selected was three D305 Goodman Company products that integrate a resin pipe location finding device with a leakage detection device and one Portaflow-C, an ultrasonic water flow meter made by Fuji Tecom Inc. to measure flow. The leakage detection device initially was to be a logger-type zone detection device able to carry out planar surveys, but the majority of the pipe lines in the model DMA pipe lines are resin pipe (PVC pipes and Polyethylene pipes), and the 1st Domestic Work revealed that the logger-type zone detection device could not function adequately in a resin pipe distribution work. Accordingly, the D305, which was developed for use with resin pipes, was introduced instead.
As with the leak detector typically used, one surveyor uses one D305 detector, which means that the efficient planar surveys carried out initially by multiple sensor loggers cannot be conducted. Accordingly, three D305 were introduced, reaching the budgetary ceiling, and multiple surveyors are now able to carry out more leakage investigations.

In the 2nd Field Operation, the three teams at MCWD's leak detection department invited employees to explain how the equipment is used. They also detected leaks in the model DMA.
DMA25A in the leak detection area had a NRW rate of 52.2% as of December 2011, which is an extremely high rate relative to the average for MCWD at that time of about 28%. The distribution pipes laid underground in this area were PVC pipes; the service pipe branches a Galvanized Iron Pipe (GP) with a DN50mm pipe off of the distribution pipe so that it is exposed on the surface, with many water meters installed (in some places, about 25 water meters are installed). Below the meter (downstream), open piping supplies water to the surface (or below ground) through GP with a DN13~25mm.

The leak detection device introduced in this project was a multifunction machine combining a resin pipe leakage detection with resin pipe detection, newly developed by Goodman Compny. (a small- to medium-sized Japanese company), in Yokohama. This product is a surveying device suited to leak detection in resin pipes such as PVC pipes and PE pipes.
The survey is conducted by attaching electrodes to the metal parts, such as the gate valve and fire hydrant ancillary to the resin pipe, or the water meter, and then pulling out the grounding wire from the soil in the area where leaks are being detected. By transmitting electromagnetic waves from the main body, the water in the pipe from the metal part is used as the medium and the electromagnetic wave is passed to the inside of the pipe. As a result, the electromagnetic waves diffuse the leak in the

earth at the site of the leak, and the device picks up on the corresponding sudden drop in the the intensity of the electromagnetic waves at the site of the leak. This enables the surveyor to identify the site of the leak. At the same time, this device carries out two functions since the transmission of electromagnetic waves through the pipes confirms the location of the pipes laid underground.
Detecting leaks in resin pipes with the leak detection equipment generally used requires mature listening skills and sound leak detection to discover the site of the leak since it is difficult for the leak detector's sensor to pick up the leakage sound. With typical leak detection, it takes considerable experience to improve one's listening skills since the amplified sound of the leak is picked up on headphones. Typical leak detectors are not suited to leak detection on roads that have a high volume of traffic with significant vibration and noise since this static noise obstructs the sound of the leak. However, this product can easily discern leaks from changes in the electromagnetic wave readings on the monitor display, so surveys can easily be carried out even on roads with a high volume of traffic.

An ultrasonic water flow meter made by Fuji Tecom (a Japanese company) was also introduced for flow measurements. A sensor is installed at intervals along the length of the pipe at two points (point A and B) in a vertical direction; an ultrasonic wave is transmitted at a set speed from point A and picks up the speed of the water flow in the distribution pipe as it moves toward point B so that it arrives slightly sooner than would otherwise be expected. This difference in speed is converted and calculated to determine the speed (flow speed) of the water flow between points A and B. By multiplying the area within the pipe by the flow speed, the flow volume per unit of time can be calculated. Installing an electromagnetic flow meter in the distribution pipe is more exact, but the accuracy drops slightly because the water flow in the existing pipes is easily measured using ultrasonic waves from outside without requiring any construction.

(3) Implementation and Evaluation of Leak Detection and Flow Volume Surveys

In the 2nd Field Operation, work to detect leaks and confirm the location of underground resin pipes was carried out. Over the two-day survey, both large and small leaks were detected in seven spots and repairs were made promptly. MCWD employees discovered for themselves that the D305 is suited for leak detection in resin pipes such as the PVC pipes and PE pipes used as distribution pipes in Southeast Asia, which has few earthquakes. During the project period, this survey equipment was used by MCWD employees to conduct many surveys, even after the project team returned home.

These surveys confirmed the effectiveness of this equipment in detecting leaks in resin pipes. In collaboration with MCWD, this equipment was used to conduct surveys from July to September 2012 in the model DMA that particularly urgently needed to lower their leakage rates. As shown in Tables 2-2-2~4, the NRW rate at the end of May 2012 was 58.5%, 39.8% and 34.0%, respectively, for DMA9C, 11A and 25A, but from the 2nd Field Operation, leak detection was carried out to lower the NRW rate to target rates of 40%, 30% and 25%, respectively, by the end of September. As a result, the NRW rate reached 52% (estimate due to maintenance on the flow mater, 12 points above target), 31.9% (2 points above target) and 30.0% (5 points above target). Ultimately, the NRW rate for DMA9C, 11A and 25A reached 47.5% (11 points below the maximum NRW rate), 7.8% (32 points below), and 21.3% (13 points below) in December 2012 and January 2013.

Table 2-2-2 Water Supply Volume, Flow Meter Count, and NRW Rate in DMA9C

9C	Connection	Inlet Vol. (m^3)	Meter Count (m^3)	NRW rate (%)
Jan., 2012	763	46,056	19,837	56.9
Mar., 2012	759	45,764	19,175	58.1
Apr., 2012	760	45,390	18,088	60.2
May, 2012	758	45,952	18,941	58.8
Jun., 2012	758	44,784	20,366	54.5
Jul., 2012	757	44,897	19,068	57.5
Dec., 2012	755	34,033	17,995	47.1
Jan., 2013	755	34,795	18,280	47.5

The inflow meter accurately measured the volume in DMA9C, but during the 2nd Field Operation, the newly introduced ultrasonic water flow meter was used to measure the volume. Since the water volume as measured by the inflow meter differed considerably from the flow volume measured by the ultrasonic water flow meter, flow meter measurements began to be taken in December after flow volume was inspected, the meter was disassembled for inspection in the meter testing room and instrumental errors were corrected beginning in August as part of maintenance procedures. When carrying out this kind of maintenance, care must be taken to prepare a backup meter and ensure that there is no missing data from the flow meter when measuring data.

This DMA is detecting leaks and identifying and repairing leaks, and the NRW rate is on the decline, but the distribution pipe laid in the DMA is aged pipeline more than 20 years of age and the leaks are expected to return, so leak detection work must be carried out once every fourth months in this priority area.

Table 2-2-3 Water Supply Volume, Flow Meter Count, and NRW Rate in DMA11A

11A	Connection	Inlet Vol. (m^3)	Meter Count (m^3)	NRW rate (%)
Jan., 2012	1,120	69,242	43,514	37.2
Feb., 2012	1,122	64,783	39,312	39.3
Mar., 2012	1,123	73,950	44,429	39.9
Apr., 2012	1,123	70,023	40,735	41.8
May, 2012	1,127	66,976	40,293	39.8
Jun., 2012	1,127	65,414	39,080	40.3
Jul., 2012	1,140	57,538	40,236	30.1
Sep., 2012	1,131	55,452	37,752	31.9

11A	Connection	Inlet Vol. (m^3)	Meter Count (m^3)	NRW rate (%)
Oct., 2012	1,132	48,858	36,314	25.7
Nov., 2012	1,127	41,406	38,046	8.1
Dec., 2012	1,126	42,978	39,644	7.8

The shaded section of the table indicates the extreme drop in the NRW rate due to construction work from October to remove unused pipes that had experienced frequent leaks. Essentially, the pipes should be plugged with the end of an operational pipe as soon as it becomes unusable. MCWD does not have the habit of removing residual pipes and it was abandoned for a long period, but was finally removed after consultation with the project team.

This DMA carefully carries out leak detection work and reliably detects leaks and identifies and repairs them, so the NRW rate was reduced. This was the result of efforts to improve employees' leak detection technique and reinforce the leak repair system.

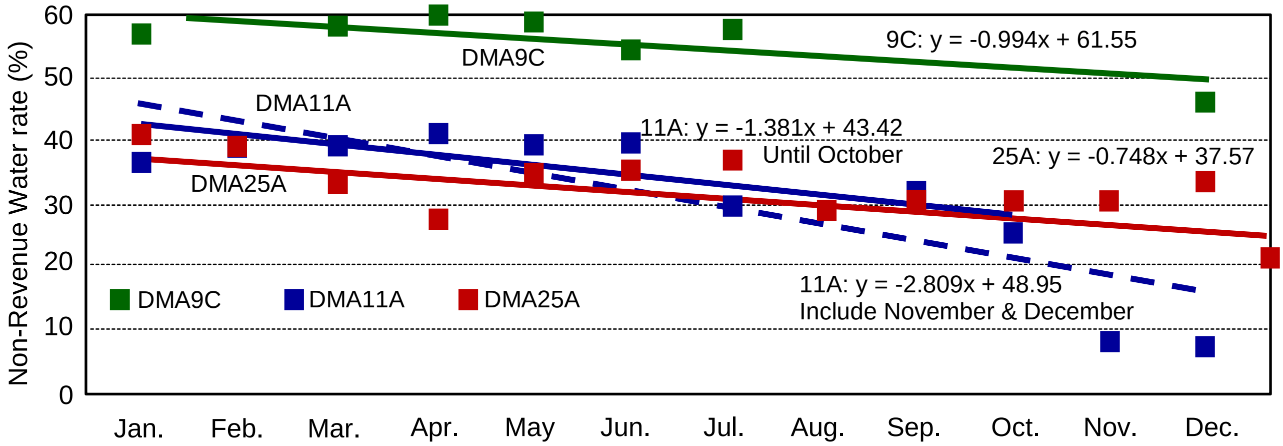
Table 2-2-4 Water Supply Volume, Flow Meter Count, and NRW Rate in DMA25A

25A	Connection	Inlet Vol. (m^3)	Meter Count (m^3)	NRW rate (%)
Jan., 2012	1,206	60,440	36,035	40.4
Feb., 2012	1,212	55,392	34,559	37.6
Mar., 2012	1,213	55,628	37,342	32.9
Apr., 2012	1,217	50,249	36,612	27.1
May, 2012	1,217	60,378	39,837	34.0
Jun., 2012	1,217	60,825	39,650	34.8
Jul., 2012	1,220	59,455	38,254	35.7
Aug., 2012	1,222	55,174	39,095	29.1
Sep., 2012	1,222	53,856	37,683	30.0
Oct., 2012	1,222	57,536	39,481	31.4
Nov., 2012	1,222	57,384	39.246	31.6
Dec., 2012	1,222	63,413	41,530	34.5
Jan., 2013	1,222	51,973	40,912	21.3

As a result of leak detection and repairs, the NRW rate fell steadily, but rose sharply in December and then plummeted in January. This was because Christmas falls in December, when water usage is high, and the meter readers finished reading water meters early, so the typical number of days of use in the month fell compared to typical levels, while the inflow meters were calculated using the typical number of days. As a result, the NRW rate was high in December. The following month, the number of days of use in the month was high, so the NRW rate was markedly low in January. The approximate straight line in Figure 2-2-3 shows the long-term trend.

As with DMA11A, this DMA carries out thorough surveys, which helps to steadily reduce NRW. The pipeline rehabilitation construction work carried out in this project to lay down new pipes is expected to lead to further reductions in the NRW rate.

Figure 2-2-3 shows the trends in the aforementioned NRW rate results in graph form. Trends in each DMA are plugged into approximate straight lines (primary) to identify fluctuations.



9C	56.9	ND	58.1	60.1	58.8	54.5	57.5	Inflow Meter Maintenance				47.1
11A	37.1	39.3	39.9	41.8	39.8	40.2	30.0	ND	31.9	25.7	(8.1)	(7.8)
25A	40.3	37.6	32.8	27.1	34.0	34.8	35.6	29.1	30.0	31.4	31.6	34.5

Figure 2-2-3 Effect of Changes in Leak Detection Equipment in Reducing the NRW Rate

The 2nd Field Operation held in June 2012 succeeded in lowering the NRW rate in the DMA11A and 25A areas as a result of leak detection and leak repairs, and the outcomes of MCWD's steady efforts thus far and the D305 leak detection device introduced are functioning effectively. At the same time, DMA9C, in the center of Cebu City, carried out similar surveys, but the NRW rate did not fall. This was because the aged pipelines were not adequately rehabilitated, there were many illegal connections, and the accuracy of the flow meter on the inflow side had not been confirmed. Even if there was not time to lay the piping network, simple steps can be taken to address the illegal connections and the installation of a flow meter on the inflow side, so it was decided to conduct another survey, together with DMA11A and 25A, after countermeasures are taken in October to December 2012.

In the 4th Field Operation, the inflow flow meters and outflow flow meters installed in model DMA9C, which had a high NRW rate and no sign of a decline, were surveyed for accuracy at night, when water usage is low, using an ultrasonic water flow meter to take flow measurements. Moreover, some of the service pipes within the DMA had illegal connections, so ongoing work will be needed to identify the illegal connections.

(4) Selection of Lines for Pipeline Rehabilitation Construction Based on Leak Detection Results

The main reason that the NRW rate (which, in this case, refers to the rate of leakage) in Southeast Asian countries is high, even though leak detection is carried out, is that water pipes with low durability are used for a long period. Even if leakage is detected in this kind of pipe and the site is repaired, there is a good chance that water will, similarly, leak from other weak points. However, if the leak is not discovered, the pipe will simply continue to leak water.

Ongoing pipeline rehabilitation construction is the best way to reduce NRW, and indeed, without taking this step, it is impossible to reduce the NRW rate. Moreover, there are many cases in which leaks are repaired after they are detected, but there is no record of this repair being made. Keeping records means that data can be entered onto a map and diagrammed, which gives a visual understanding of the factors causing leaks, such as trends in vulnerable pipelines, the soil's impact, and the impact of the main roads (traffic volume). By correlating this with pipeline data (the year in which pipes were laid, the pipe materials, depth at which they were laid, etc.), priorities in rehabilitating pipelines can be clearly decided, which leads to effective use of budgets.

In the case of transmission and distribution pipes such as YWWB that are about 9,100km in length, the distribution pipeline database can be used to calculate the priority by reckoning conditions, at which point the pipeline with the greatest priority can be selected by taking into account conditions at the site. The extent to which results can be achieved with a limited budget is important for management. This concept is learned in lectures during training in Japan, and is understood by MCWD trainees as well, who are expected to carry it out going forward.

In the 2nd Field Operation, leak detection equipment was introduced, and leaks were detected in model DMA (DMA25A). This DMA had a NRW rate of about 35%, about 10% higher than the average for MCWD. When leak detection work was carried out in this region, leaks were discovered primarily along a particular line. This line consists of PVC pipes that are DN100mm and were laid in January 1995, 18 years ago. There are factories along this line, and since it is a transportation hub, large trucks pass along here both day and night. The pipes' soil covering was shallow (underground depth), which meant that the vehicles' weight was not distributed by the earth's pressure but instead applied weight directly to the pipes, which continued to stress the pipes. In addition to leak detection, an assessment (survey) of nearby buildings and traffic conditions are important steps in preventing leaks.

By entering the points at which leaks were detected in this leak detection work and analyzing the leakage points, the pipes with frequent leaks were listed and their lines were given priority for rehabilitation. This is the process for devising a pipeline rehabilitation plan. This is expected to provide MCWD with a model case for formulating future pipeline rehabilitation plans.

Figure 2-2-4 plots all of the distribution pipelines (red line) in DMA25A and the leak points detected (blue stars). Figure 2-2-5 shows the construction sites selected, in consultation with MCWD, for pipeline rehabilitation construction from among the lines in the region where leaks were most frequently detected (blue line).

The construction work involves the laying of approximately 530m in PVC pipes (DN100mm) on W. Cabalse Street and Holyname Street, Brangay Mabolo, Cebu City. This construction work does not consist simply of relaying the pipes, but is also intended to loop branched pipes at two points. At one point, a pipe that is DN75mm is connected to the distributing main, while the other is connected at both ends of the DMA. The former could be easily connected in the construction project, but the latter pipe was on a main road and the connection could not be completed during the project period because of traffic regulations and difficulties in obtaining authorization for the road excavation, although discussions are underway with the road administrators.

At this point, the project calculated the distribution network again, and considered a scenario in which the DN75mm pipes are connected to the distributing main and looped, while the second pipe is not connected. Since a private well is being used at the plant at present, there is little water demand in the area, and it was confirmed that the feed-water pressure would not be changed much if the pipe was not looped. However, if water demand increases in the near future, connecting the two ends would be more effective in terms of water management. Accordingly, it was decided to continue negotiations with the road administrators.

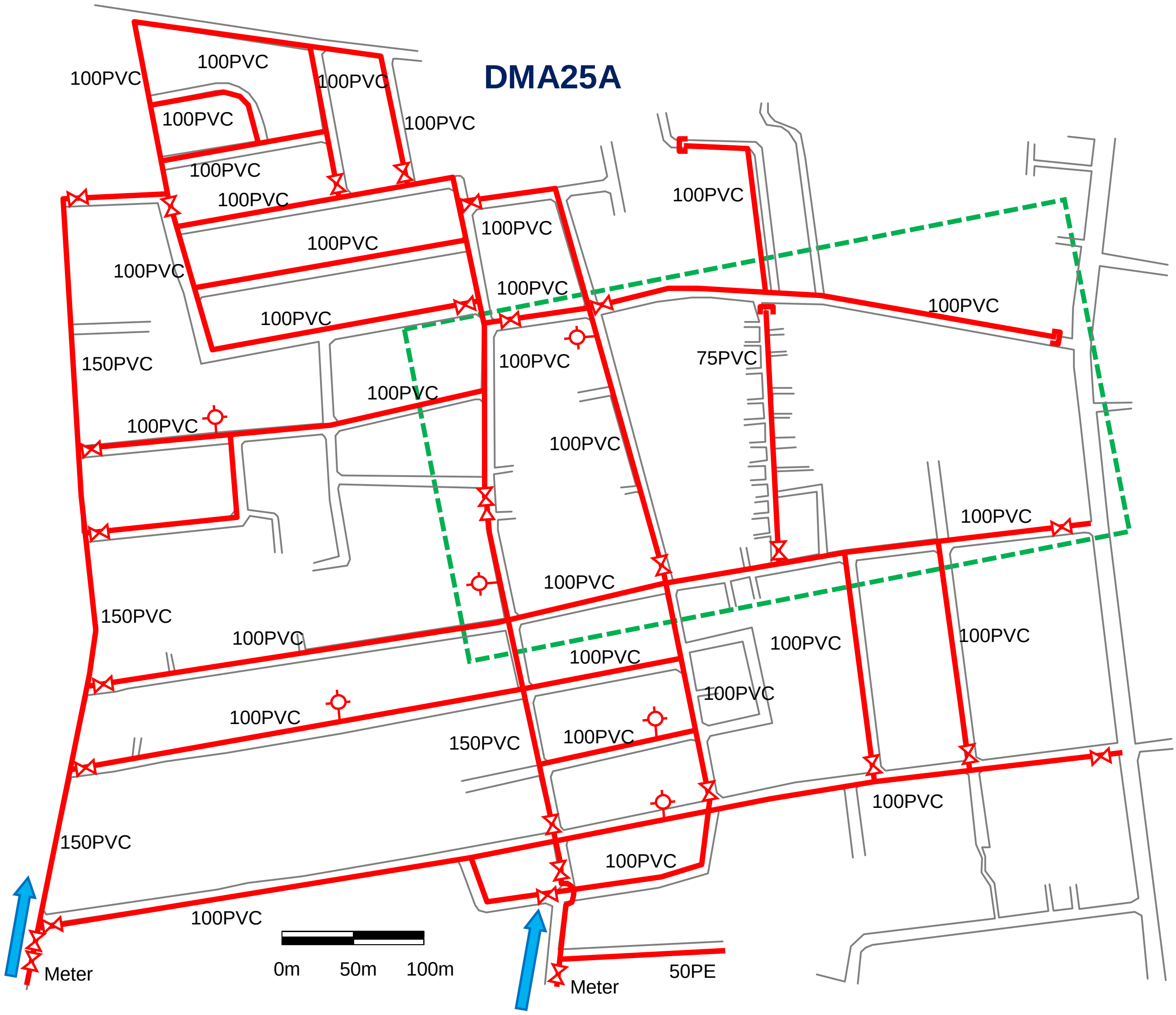


Figure 2-2-4 DMA (DMA25A) Targeted for Pipeline Rehabilitation Construction; the area within the green dotted lines indicates areas in which leaks are frequent (refer to Figure 2-2-5)

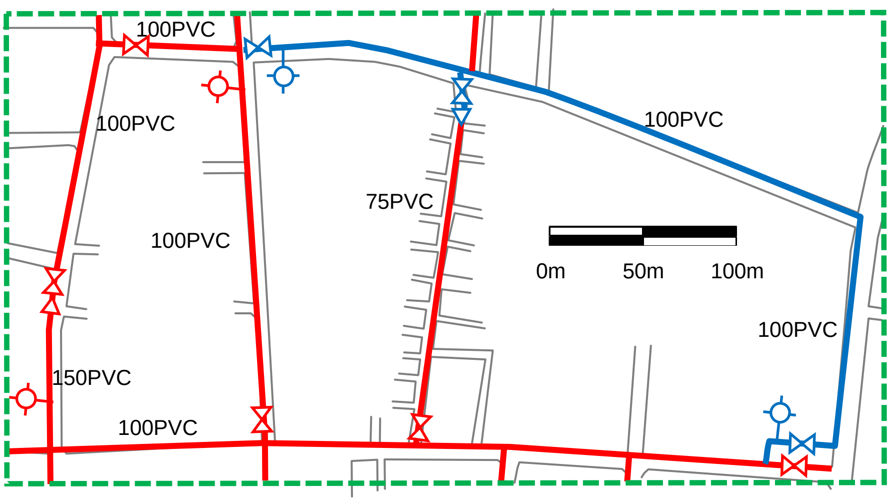


Figure 2-2-5 Pipeline Rehabilitation Construction (Blue line route: about 530m)

2.2.3 Studying Establishment of the Most Suitable Distribution Pipe Network Based on Distribution Network Calculations in order to Form a Block Consisting of the Neighboring DMA Collective Entities and Distribution Reservoir (Elevated tank, etc.)

The development of an optimal distribution network was also considered with the model DMA. Since MCWD is already making steady progress in establishing DMA, it had been decided that a shift to DBS would not be made in this project, but in order to resolve the failure to provide a 24-hour water supply in the model DMA region, it was felt that a scheme incorporating the strong points of block management in DBS was essential. This idea was duly considered.

(1) Factors Behind Failure to Provide 24-hour Water Supply in Area

In general, a 24-hour water supply is not provided in the area for several reasons.

(a) Insufficient pump head
(b) Inadequate distribution pipe diameter
(c) Excessive water supplied population within DMA
(d) Excessively low hourly factor
(e) Water supply point is located on a high elevation
(f) Back-up and looping not completed
(g) Lack of elevated tanks
(h) Water suspension and interruption in power supply due to accidents on main pipe

Above (a) and (b) can be resolved by reinforcing the facility's capacity when it is upgraded. MCWD is currently working on pump facility rehabilitation plans and distribution pipe rehabilitation plans that, at considerable expense, will give the facility a high pump capacity and lay pipes with increased pipe diameter. The rehabilitation cycle is shorter for the PVC pipes often used by MCWD compared to iron pipes, but the rehabilitation costs are lower than for iron pipes, so the plan to take the lead in replacing pipe lines will be revised to conform with the priority rehabilitation target pipes with frequent leaks underway separately.

In the case of (c), the water supplied population within the area was appropriate when the DMA was initially set, but the DMA was not revised to address the rising influx in population from outside of this area. This resulted in excessive water use relative to the appropriate volume of water, and the water supply was inadequate in certain time periods at the water supply area's terminal points so that water service was suspended. In calculating the distribution network when (a) and (b) are rehabilitated, the future population within the area must be projected. In addition, (d) the hourly factor must be set for each DMA (water distribution block) and (e) the maximum water supply per hour must be simulated, taking into account the maximum water level. In order to make it possible to provide a 24-hour water supply, clearly setting the hourly factor makes it possible to secure servise water pressure not only during normal service hours, but also during maximum water supply times.

Even if the above countermeasures are taken, external factors such as (h) water suspension resulting from accidents and power outages can impede a 24-hour water supply. Despite this, however, a water supply network premised on a response to accidents such as (f) and (g) must be developed.

(2) Resolving Issue of Water Supply Areas in MCWD Unable to Provide 24-hour Water Supply

This project discussed what problems were preventing a 24-hour water supply from being offered in MCWD model DMA, and how they could be resolved. These issues were introduced in seminars given in the 2nd Field Operation as well as the short seminars given during discussions, and it was confirmed that the following perspectives would be focused on in MCWD.

(a) Low water pressure → When upgrading, replace with a pump with a high pump head
(b) Small pipe diameter → When upgrading, replace with a distribution pipe with larger pipe
(c) High water demand → Divide DMA / if low demand, make adjustments such as consolidation
(d) Frequent power outages → Set up storage tanks such as distribution reservoirs and elevated tanks, and supply water using gravity flow thereafter
(e) Water suspension during construction → Set up back-up piping and loop piping between DMA

It was also confirmed that, in addition to measures to resolve current issues, the following steps would have to be taken from a medium- to long-term perspective.

(A) Set water-supplied populations for water supply area for target year
(high, medium and low population forecasts)
(B) Set water usage per person and per day up to target year (set a water supply unit)
(C) Method for detecting leaks
(D) Set load rate

These measures require that piping networks and pump equipment be set up and distribution reservoirs and elevated tanks be built, which requires that infrastructure be built. This technical cooperation project does not provide infrastructure, but instead provides expertise in identifying issues and resolving problems.

(3) Results of Review

In the 3rd Field Operation, MCWD and the project team discussed and considered ways of resolving problems in the 3 regions – DMA16 (Guadalupe), DMA17 (Capital: Oppra) and DMA 19 & 20 (Nivel) – with conditions that made it extremely difficult to provide a 24-hour water supply as they are on high ground along the mountain.

These 3 regions located within Cebu are sited on a slope extending from flat terrain along the coast to the mountainous region. The vertical drop is immense for a single DMA, which currently makes it extremely difficult to manage. YWWB's water supply system uses DBS, but there are large blocks with major differences in elevation. By breaking up the large block into medium-sized blocks and dividing the minimum unit in the water supply area into small blocks, the differences in elevation can also be separated to a moderate degree, making it easier to manage. However, since these DMA corresponding to YWWB's small block have major differences in elevation, MCWD cannot manage the water supply pressure, and as a result, it is impossible to provide a 24-hour water supply on high ground.

When calculating the distribution network, rather than using the average water used per hour, this figure is converted to the hourly factor in order that the water service can be planned and designed so that water can be supplied for the maximum time. However, MCWD does not does not use the value calculated from water volume data, but rather uses the hourly factor "2.0" as an empirical value. A short seminar was held to raise understanding of the hourly factor, and MCWD was encouraged to calculate the hourly factor.

The aforementioned (a) through (e) are all factors that impede the 24-hour water supply in this case, with (a) through (c) particularly applicable. The difference in elevation within the small blocks in YWWB are less than about 30m, but the vertical drop in these regions is 40~60m, making it difficult to manage in a single DMA and requiring that the DMA be split up. The pump functionality is satisfactory, if not adequate, to supply water for about 21 hours a day, including late at night and during the day and even at high ground, but the distribution pipe was laid a long time ago and some distribution pipe dates to the years before 1975 (about 40 years ago) and has already exceeded the renewal period. The population has increased significantly since the pipes were laid, and the diameter of the existing distribution pipe is too small, so that some lines impede water distribution. It was decided that the distribution network calculations and leak detection results would be reflected in the pipe line rehabilitation plan and that MCWD would consider splitting up the DMA.

Figure 2-2-6 identifies the distribution pipe excluding the service pipes within the DMA being reviewed (including the distribution branch pipe). YWWB's planning department only calculates distribution networks for distribution mains with pipe diameters exceeding DN400mm (in some cases, less than DN300mm are also considered), but MCWD's calculations extend to distribution branch pipes (DN50mm). In this review, calculations were made excluding distribution branch pipes with small pipe diameters with little influence on calculations of water pressure. It was proposed that the points with inadequate water pressure be identified and those pipelines be given a high priority in rehabilitation plans, with this section being the result.

As a condition for rehabilitation, methods to ensure that the water pressure could be brought to more than 14PSI (about 1.0kgf/cm^2) in areas with extremely low water pressure of less than 7PSI (about 0.5kgf/cm^2) were considered. The results are shown in Table 2-2-5. The Point column in the table corresponds to the numbers in Figure 2-2-6.

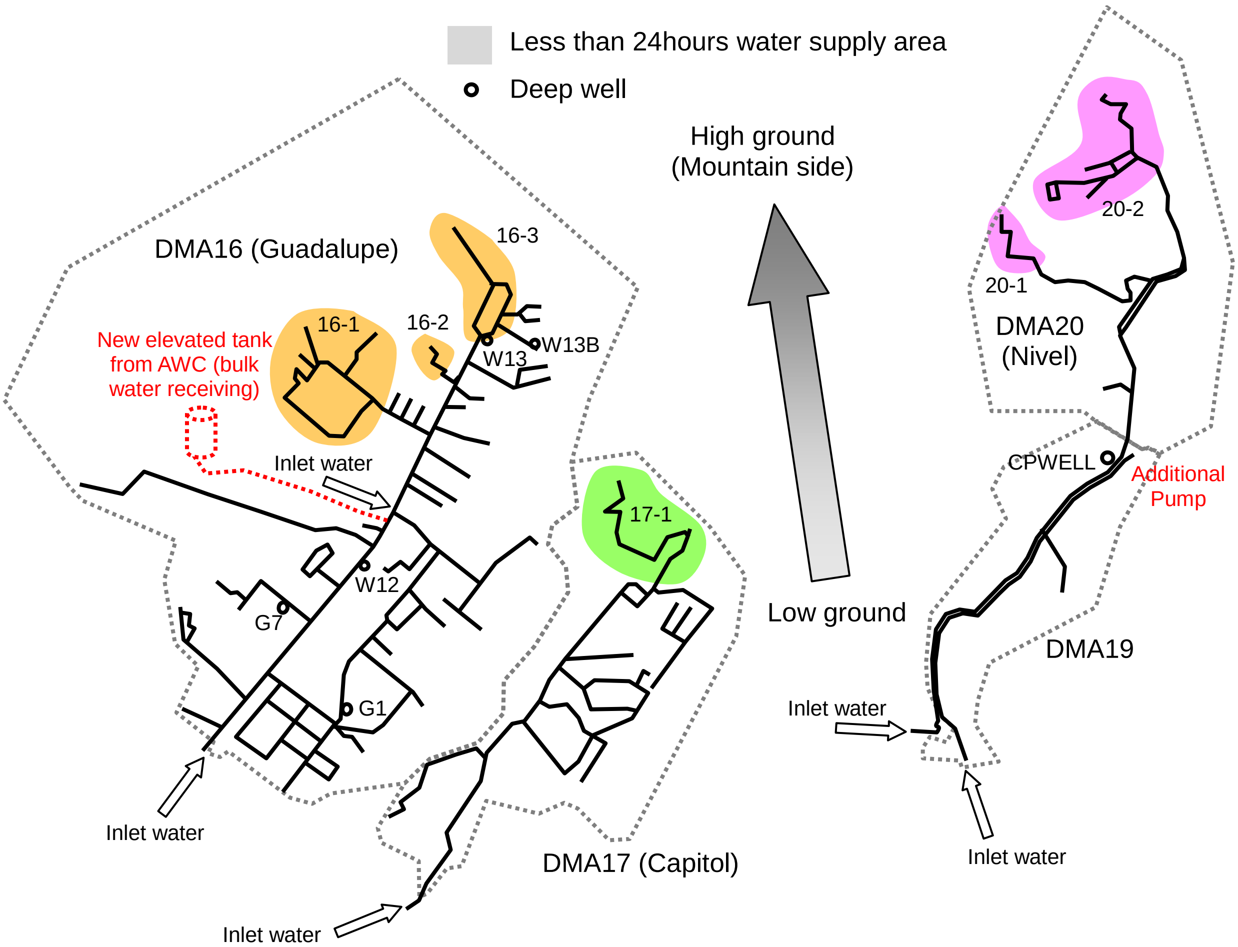


Figure 2-2-6 Distribution Pipe Networks Identified in Areas without 24-hour Water Supply

Table 2-2-5 Targets for Rehabilitation and Resolutions

DMA	Point	Characteristics of object area	Rehabilitation plan
16	16-1	High elevation area	Need introduction of booster pump (more than 15m) between J73 and J84 on P36
	16-2, 3	Less W13 & W13B pump capacity	Pump capacity upgrade (more than 15m). But MCWD will disuse these pumps, because Nitrate concentration becomes high level.
	16-1~3	Total solution for high elevation	Install new high elevated tank (Bulk water receiving from AWC: ABEJO Water Company) and supply to area of 16-1~3.
17	17-1	High elevation area	Need introduction of booster pump (more than 15m) between J43 and J32 on P27 (200m on this side of J32) Or introduction of elevated tank where higher than J32
19&20	20-1, 2	High elevation area	Install additional pump (same performance as existing pump) in the pumping station. (→ Double capability)

In most cases, it was decided to widen the pipe diameter when the pipeline is rehabilitated as the length of pipeline slated for rehabilitation is long given the extensive area in which 24-hour water supply is not available; more recently, it was decided to replace the booster pump.

In November 2012, after the 3rd Field Operation, MCWD set up additional pumps at DMA 19 & 20's pump station and resolved the low water pressure at Points 20-1&2 as part of the aforementioned recent measures. However, the intensified pressure actually resulted in high water pressure in some low-lying areas, which required that water pressure be adjusted by introducing a pressure reducing valve and a gate valve.

2.2.4 Support in Establishing New Plan Based on Existing Leak Detection Plan

2.2.5 Leak Detection in Model Blocks in New Leak Detection Plan

(1) Current Status of Leak Detection Plan

The leak detection plan is the plan that MCWD prioritizes the most. At the 3rd Field Operation, the current plan was reviewed with a view to reflect (a) demarcating the survey area using a leak detection mesh and (b) reflecting the leak detection results in the aged pipeline rehabilitation plan, both of which had been proposed in lectures and practice sessions on leak detection during the July 2012 training in Japan. Prior to this, MCWD had been asked to submit its current leak detection plan, but it was found in interviews that there was no document that could be shared in discussions.

Interviews revealed the following concerning leak detection planning. The heads of the three leak detection teams at the Northern and Southern branches meet together to discuss leak detection. The team heads divide up the region to be covered by the teams, and the survey area is determined based on conditions that day (weather, traffic regulations, etc.). There are daily work plans, but MCWD acknowledged that it lacks long-term planning.

In this project, leak detection mesh was introduced so that the points at which leaks are detected can be plotted on the mesh, and the number of points can be divided by rank and colored according to the mesh unit. This enables trends in water leaks to be identified within the water supply area. As a result, the locations of aged pipelines and trends in road conditions such as heavy vehicle traffic can be visually ascertained. In addition, overlaying a soil property distribution map over the mesh reveals the conditions of the piping. This can be reflected in future countermeasures and plans.

In YWWB, the marine clay deposits (soil with corrosive properties) rapidly corrode distribution pipes so that they degrade quickly, and this corrosion leads to frequent leaks. In some cases, polyethylene sleeves were wound around the distribution pipe in an attempt to prevent corrosion. There were also situations in which highly flexible earthquake-resistant pipes were quickly introduced in regions with soft ground.

Since the distribution pipes in MCWD are covered only with a shallow (less than 50cm in some places) earth covering (depth to top of pipe is typically 120cm in YWWB), the pressure of the vehicle impact when heavy vehicles cross above is not completely dissipated by a layer of soil, the distribution pipes are easily broken. The affected lines are color coded using mesh (sub-mesh) so that in the future, the pipes can be laid at deeper depths.

(2) Introduction of Leak Detection in Mesh Units and Evaluation

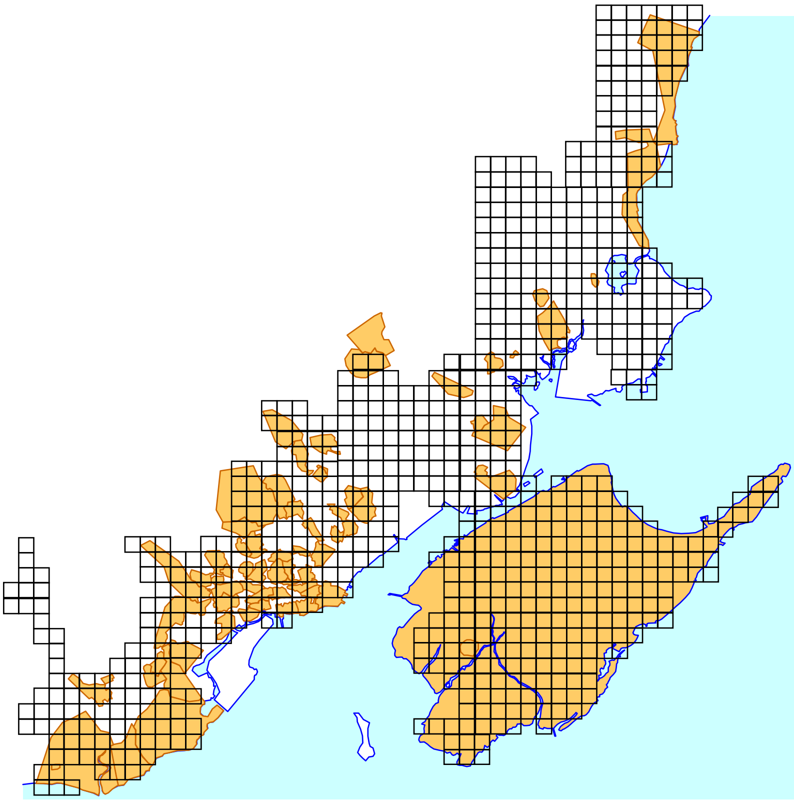
In the 3rd Field Operation, installing mesh (500m West-East * 500m North-South) in MCWD water supply area was discussed and advice provided. Based on this, mesh was installed in MCWD during the 3rd Domestic Work period. In the pilot area (DMA9C, 11A and 25A), the size of the mesh was considered, taking into account the amount of leak detection work on a daily and weekly basis. The leak detection plan in the model DMA from November 2012 is shown in Table 2-2-6. As a reference point, Table 2-2-6 shows the survey process thus far.

Table 2-2-6 Leak Detection Process

	2012							2013		
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
DMA9C				■■			■■		■■	
DMA11A			■■			■■			■■	
DMA25A	■■		■■			■■			■■	

The survey was conducted based on the aforementioned plan. After waiting for the survey in the model DMA mesh to be complete, the points at which leaks were discovered in the mesh were plotted and color-coded. Since the leak detection results can be plotted on top of the pipeline map overlaid with the mesh, a map of the leaks in MCWD overall, and not just the model DMA, can be plotted on the mesh, and color coded based on the number of leaks detected so that trends in leaks can be ascertained (Figure 2-2-7). Color coding on the mesh enables the areas with frequent leaks and the soundness of the distribution pipe lines to be identified. On lines with frequent leaks, the work of identifying and repairing leaks should be repeated, and given priority in the aged pipeline rehabilitation plans. These aged pipelines, which will likely continue to experience leaks, should be promptly added to the construction list. In order to assess aging, consistent diagnostic values should continue to be used for color-coded diagnostic values (identified by color corresponding to the number of leak points). Currently, MCWD's NRW rate is about 25%, which is quite high. This is because there are relatively many points at which leaks have occurred, but as a result of work to prevent leaks, the NRW rate will be reduced and leaks will be identified in fewer places. The 2020PLAN devised by MCWD targets a NRW rate of 15% by 2020. The same identification range will be used up to a 15~25% NRW rate by 2020, and once the NRW rate reaches 15%, the color identification range will be reset, at which point work to prevent leaks will have to be undertaken under new targets.

The objective of this section is achieved through discussions on the above new leak detection plan and pipeline rehabilitation plan and MCWD's subsequent preparation and sharing of documentation on the plan.



Example of Mesh Coloring

Number of leak	Color	Number of Mesh
16 –	**Red**	
9 – 15	**Yellow**	
4 – 8	**Green**	
1 – 3	**Light Blue**	
0	**Dark Blue**	
Non pipe	**White**	

This number of leak was proposed by the Project Team. After that, MCWD needs to decide it by detail investigation.

Figure 2-2-7 Leak Detection Mesh (500m X 500m mesh) and Color-coded Identification Range

Year	Stage	NRW (%)
2009	Jan. to Mar.	30.4
	Apr. to Jun.	28.8
	Jul. to Sep.	30.5
	Oct. to Dec.	31.4
2010	Jan. to Mar.	30.0
	Apr. to Jun.	28.0
	Jul. to Sep.	27.0
	Oct. to Dec.	29.6
2011	Jan. to Mar.	29.8
	Apr. to Jun.	28.1
	Jul. to Sep.	27.5
	Oct. to Dec.	27.6
2012	Jan. to Mar.	27.4
	Apr. to Jun.	26.2
	Jul. to Sep.	25.5
	Oct. to Dec.	25.2

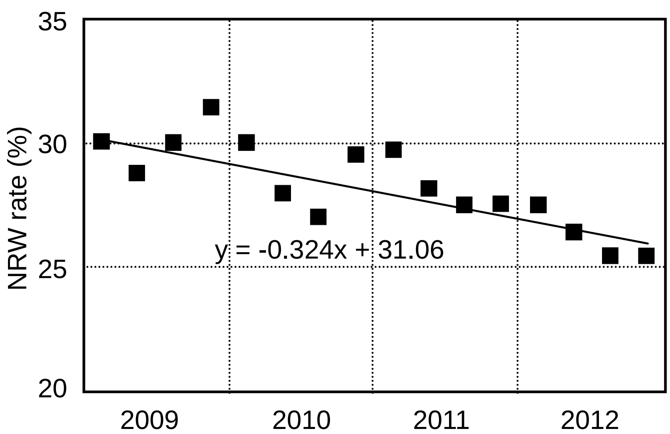


Figure 2-2-8 NRW Rate Data by Quarter (MCWD's overall average)

In discussions, the current leak detection plan was reviewed and a leak detection plan (draft) was compiled to cover the period from 2013 to 2020. This plan divides MCWD's water supply area into four areas, with four teams each consisting of six people (three teams as of 2012) that enables the area to be covered in four months with daily work covering 2.6km. The leak detection plan is very effective, involving color coding of the mesh as described above so that the color-coded mesh can be used to set priorities for the leak detection areas and determine contrasts while gradually making improvements. The NRW rate from 2009 to 2012 is shown in Figure 2-2-8.

(3) Future Issues

When carrying out this leak detection plan (draft), the following issues were discussed. Going forward, MCWD will discuss these issues in greater depth and decide on the direction to take.

(a) In order to reduce the NRW rate, the Life Cycle Cost (LCC) will be examined when rehabilitating aged pipelines, and tough DIP, which have a long service life, will be used.

→DIP has a service life that is five times longer than that of PVC pipes, so MCWD decided to introduce DIP in light of training in Japan thus far and discussions with the project team. The costs when newly introducing DIP is high compared to PVC pipe, but PVC pipe would have to be replaced more than five times during DIP's service life, incurring the cost of the pipe materials needed for the replacement and the construction costs to repeatedly lay the pipes. Given this, choosing DIP was the more rational choice. Moreover, leaks are more than 37 times less likely to occur with DIP (protected by a polyethylene sleeve) than with PVC pipes (High Impact Polyvinylchloride Pipes [HIVP]), making this a natural choice for MCWD, which wants to lower its NRW rate further.

(b) Currently, unused pipes left as is are being gradually removed.

→Once pipe rehabilitation gets underway in earnest, pipelines should not be left behind. Abandoned pipes can lead to complications when leaks are detected and result in erroneous connections. In particular, empty PVC pipes can result in secondary damage caused by road subsidence and pipe breakage attributable to the future traffic load. Accordingly, although it will depend on future discussions with road managers, removal of pipes to the extent possible is essential in terms of road management, within the scope of reasonable removal costs.

(c) A system to constantly monitor flow volume and water pressure within piping network will be considered.

→With the goal of reducing the NRW rate from 25% to 15%, maintaining this will require early detection and early repair of leaks. This requires that indicators in a normal state be ascertained by constantly monitoring the flow volume and water pressure in DMA, and promptly detecting significant abnormal changes. The SCADA system should be introduced to ascertain conditions in the piping network. MCWD began researching the adoption of SCADA in DMA17~21 as model areas from July 2012.

(d) A pressure reducing valve and regulating value will be installed in some areas with high water pressure.

→Measures have been taken thus far to improve the situation in regions unable to provide 24-hour water service, but while the service water pressure was ensured, the service water pressure increased further in some regions, necessitating that a pressure reducing valve introduced and that pressure be carefully regulated by adjusting the divergence of the existing gate valve. Since measures beyond this cannot be taken when the valve is malfunctioning, appropriate piping networks should be laid when the line is upgraded through further pipe network analysis.

(e) Leak detection mesh shall be adopted in all water-supply areas.

→In the 4th Field Operation, leaks were detected using mesh and the mesh was color coded. Currently, dividing the ranks for the number of leaks detected according to color identification is being considered in order to ensure sound pipeline rehabilitation.

Table 2-2-7 shows the leak detection instrument used to reduce NRW in MCWD, the history of the NRW rate, and future targets. The 2012 NRW rate provided in the shaded part of the table is an estimate based on data through June, the first half of the year (it was actually 25.2%), while the NRW rates for years prior to 2012 are the actual rates and rates from 2013 are the targets.

Table 2-2-7 Leak Detection Instruments, NRW Rate History and Future Targets

Year	Detection staff	Length/Team (Length/day)	NRW rate	Detection instrument	Cycle
1995	10 (1 team)	1.0km/day (1.0km/day)	37.5 %	Leak Detector: 1	3 years
1996			38.1 %		
1997			38.5 %		
1998			38.6 %		3 years
1999			37.9 %		
2000			35.5 %		
2001	6 (1 team)		34.3 %		3 years
2002			33.9 %		
2003			32.1 %	Leak Detector: 3 Pipe Locator: 2 Correlator: 1	
2004			31.9 %		3 years
2005			27.7 %		
2006			29.0 %		
2007			29.6 %		3 years
2008			29.4 %		
2009 (–Jun.)			29.4 %		
2009 (–Dec.)	6 (2 teams)	1.0km/day (2.0km/day)	29.4 %	Leak Detector: 4 Pipe Locator: 2 Correlator: 1	2 years
2010	6 (3 teams)	2.6 km/day (7.8km/day)	28.6 %	Leak Detector x 8 Pipe Locator: 2 Correlator: 1	6 months
2011			28.2 %	Leak Detector: 14 Pipe Locator: 2 Correlator: 1 Acoustic Rod: 7 Leak Noise Correlating Logger: 1 Leak Noise Logger with SMS: 1	
2012			26.4 %		
2013	6 (4 teams)	2.6 km/day (10.4km/day)	26.1 %		4 months
2014			24.7 %		
2015			23.1 %		
2016			21.5 %		
2017			19.9 %		
2018			18.3 %		
2019			16.6 %		
2020			15.0 %		

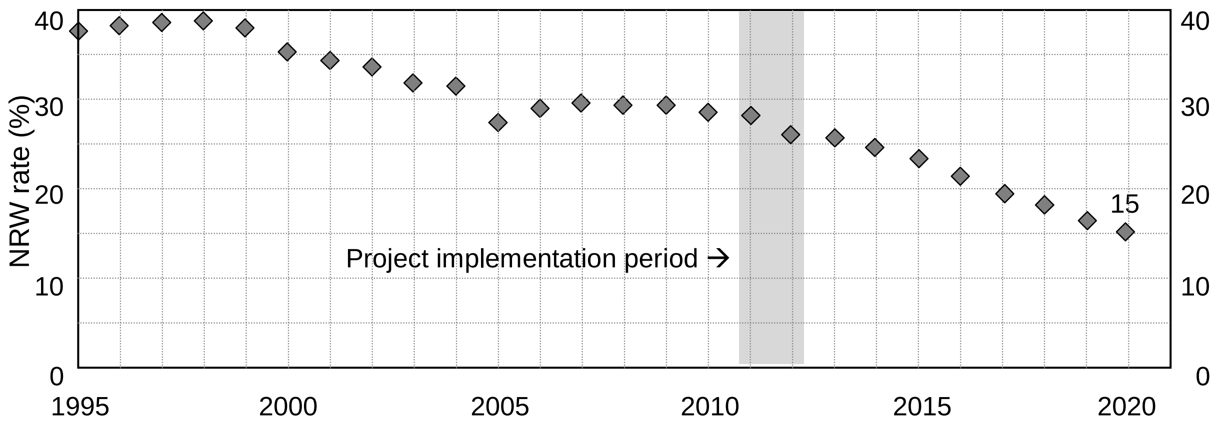


Figure 2-2-9 History of NRW Rate and Future Target

2.2.6 Consideration of Back-up Between Blocks and DMA for Emergencies (Accidents)

Initially, the TOR stated that the project would carry out pipeline rehabilitation construction in the model DMA, as mentioned in 2.2.3 above, and MCWD considered this pipeline rehabilitation construction, but given the procedures for ordering construction materials, the pipe network analysis for the DMA that did not offer a 24-hour water supply were not complete as of the 2nd Field Operation. Moreover, the pipe network analysis for the DMA's future maximum water usage converting the hourly factor had not been started, so it was decided instead to carry out pipeline rehabilitation construction on the lines with frequent leaks that were receiving leak management, as well as looping work on the pipe plug lines.

During the 2nd Domestic Work, MCWD C/P carried out pipe network analysis for the DMA targeted for construction, and MCWD considered whether back-up from a neighboring DMA was necessary. In this pipeline rehabilitation construction on a line with frequent leaks, work was done to extend the resin pipe line system and loop it, as shown in Figures 2-2-4 and 2-2-5. By looping the pipes, the water pressure can be equalized, residual chlorine stagnation is relieved, and the scope of the impact of water suspension can be reduced, so looping should be promoted within MCWD.

The work schedule for this pipeline rehabilitation construction will not result in insufficient water pressure nearby, and also enables the new pipes to be installed next to the existing pipes while continuing the water supply from the existing pipes. As a result, water service is suspended only during the short time it takes to change over from the existing pipes to new pipes (including the time needed to clean the pipes). As a result, it was determined that the water supply could be maintained even without back-up from a neighboring DMA.

In Japan, (YWWB), when, due to the narrow road conditions, water pipes are laid when existing pipes are upgraded, (1) temporary pipes are laid, (2) the connection is changed over to the temporary pipes, (3) the existing pipes are removed, (4), new pipes are laid, (5) the connection is changed over to the new pipes, (6) the temporary pipes are removed and the new pipes are laid in the same place as the existing pipes. This is one kind of back-up measure in water supply construction. In Japan, the road managers direct the removal of existing pipes, but MCWD does not remove the existing pipes but just leaves them in place. Accordingly, the construction work consists only of (1') laying new pipes and (2') changing the connection over to the new pipes.

There are some cases at YWWB in which removal is difficult and the pipes must be left in place in areas used by the water system but privately owned, but in this case backfilling is inserted into the remaining pipes and steps taken to prevent road subsidence when the pipes are damaged. When other lifelines (drainage and sewage, rainwater drainage, telecommunications, electricity, etc.) are laid below the streets with exclusive use, MCWD will find it difficult to leave the pipes behind as they have done thus far.

MCWD is not currently considering any work providing a back-up between DMA, but this is worth considering in the future.

When YWWB's water administration was introduced in a lecture on water administration during manager training in 2011, the importance of back-up between blocks in DBS was expressed, and subsequently there was a discussion on how a back-up concept could be introduced in MCWD and in what form. In project interviews, there were requests to include another lecture on water administration during the July 2012 training in Japan, and this was reflected in the training.

Going forward, MCWD will carry out high-quality water supply services, but is required to avoid suspension of customers' water services to the extent possible. Just as it is impossible to predict where an accident will happen, it is impossible to predict where water suspensions will occur. However, in the event of water suspension, operating gate values and changing the water supply system prolongs the water suspension period, and the water suspension state (when the pipes are empty) encourages the influx of dirty water. When condensing work is carried out (work to once again fill the pipes with water), not only must the dirty water be washed out, but the scales typically adhering to the inner pipe walls are stimulated by changes in the water flow and flake off. The impurities disperse within the pipes, and cleaning the pipes takes longer than expected. If the air within the pipes is not adequately removed, this air can impede the water flow and prevent the transmission of a sound water supply. Ultimately, the water suspension lasts for longer than expected.

By shortening the water suspension period, it is easier to carrying out the condensing work, so a manual should document normal simulations such as ascertaining the section in which water suspension will take place if an accident occurs in one place, discussing the type of changeover work needed to avoid a water suspension, and considering the work flow.

Currently, MCWD is putting all of its efforts into providing a sound water supply during normal hours within the DMA, but once a 24-hour water supply has been achieved, the next goal will be to research a back-up system that will enable this 24-hour water supply to be sustained to the extent possible even when accidents occur. We hope that the training materials used in training in Japan will be helpful in this.

2.2.7 Assisting in Making an Aged Pipeline Rehabilitation Plan

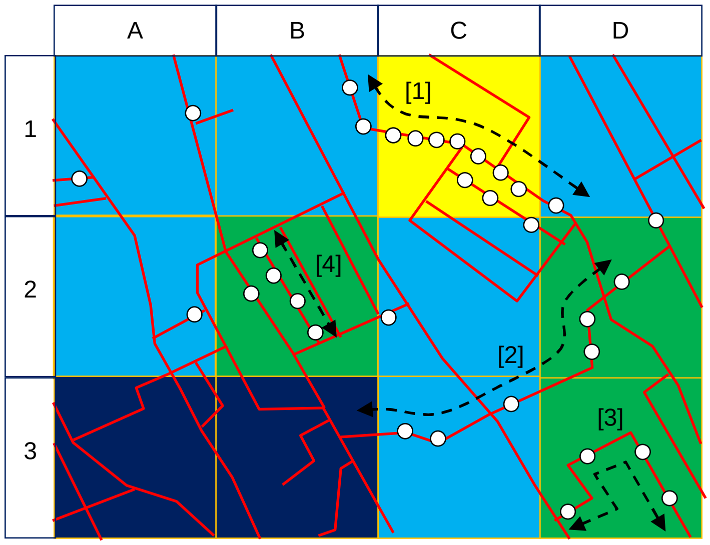
MCWD already has aged pipeline rehabilitation plans, but based on the lecture received during training in Japan, MCWD has decided to revise the definition of its rehabilitation plans together with the C/P.

During the 3rd Field Operation, the history of the leak detection activities discussed in 2.2.4 and 2.2.5 above were summarized. In addition, the formation of leak detection teams, the breakdown of survey equipment, survey cycle and survey extensions through 2020 were documented. It was also decided to adopt leak detection mesh (500m * 500m), identify the condition of leaks on a map overlaid with mesh, and reflect this in pipeline rehabilitation.

There are important connections between leak detection and pipeline rehabilitation, and this section discusses the process after the point at which the locations of the leaks are plotted on leak detection mesh after detection and color-coded based on the number of leaks detected on the mesh.

Selecting some of MCWD's distribution networks, leakage points were plotted on a map of the pipe network that has been overlaid with mesh, and the mesh areas were colored based on a table color-coded by the number of leakage points (Figure 2-2-10). From this point, the mesh coordinates C1, B2, D2 and D3 can be recognized as areas with many leaks. Focusing within C1, we note that leaks are concentrated along the line [1] running from B1 to D1. Leaks are frequent along this line because of (a) Aged pipeline, (2) Frequent passage of heavy vehicles compared to the period in which the pipes were first laid, (c) Shallow depth at which the pipes are buried, and (d) Problems with the construction work. If the pipes are used as is, we can expect ongoing leaks, so pipeline rehabilitation construction would be the best option to reduce the NRW rate. However, the pipe line would not be replaced, but rather countermeasures tailored to the cause must be taken when new pipe lines are laid. As countermeasures for the above example, (b) Pipe material could be changed to DIP with a long service life, and (c) Pipe protection could be adopted to deepen the earth covering, although this would depend on the pipe material. Such steps must be considered in designing new pipe lines. Similarly, there are lines within the mesh area, namely [2] – [4] in the figure, that should be considered for pipeline upgrades. Although not in the case of factor (a) Aged pipeline, other factors such as (b) – (d) are also at work when there are frequent leaks.

The pipeline rehabilitation plan is a plan to rehabilitate aged pipelines, but even if some of the pipes do not fit the definition of an aged pipeline, the pipes to be rehabilitated should be selected from among the candidates based on the surrounding conditions and degree of importance.



Example of Mesh Coloring

Number of leak	Color	Number of Mesh
16 –	**Red**	0
9 – 15	**Yellow**	1
4 – 8	**Green**	3
1 – 3	**Light Blue**	6
0	**Dark Blue**	2
Non pipe	**White**	0

○ Leakage point
— Distribution pipe

Figure 2-2-10 Colored Leakage Points (part of MCWD water supply area)

Currently, when MCWD upgrades distribution pipes beginning with those initially installed, the pipeline rehabilitation is planned in the order of (1) special circumstances, (2) pipelines with extremely high leakage rates, (3) pipelines with somewhat high leakage rates, (4) aged pipelines and asbestos pipes, and (5) proposals based on pipe network analysis. The indicators shown in Table 2-2-8 are used for (2) and (3) above, but this is somewhat complicated. The leakage conditions for every pipeline and the condition of the pipeline is assessed and ranked. YWWB forms review committees and prepares a diagnostic table using mathematical formulas that enable similarly objective assessments of pipeline rehabilitation plans.

The project team proposed that at first the focus should be restricted to the number of leaks in the aforementioned mesh area, after which the condition in the mesh area and the adjacent mesh should be confirmed, and countermeasures (construction) ensuring that the pipeline is in optimal condition should be considered.

Table 2-2-8 Table for Selection of Pipelines for Rehabilitation

Grade	Description
5	More than 5 body leaks per 300 meters in the pipeline for the past 12 months; or more than 7 failures per 300 meters for the last 12 months
4	4-5 body leaks per 300 meters in the pipeline for the past 12 months; or 6-7 failures per 300 meters for the last 12 months
3	2-3 body leaks per 300 meters in the pipeline for the past 12 months; or 4-5failures per 300 meters for the last 12 months
2	1 body leak per 300 meters in the pipeline for the last 12 months; or 2-3 failures per 300 meters for the last 12 months
1	Zero body leak in the pipeline for the last 12 months; 1 failure per 300 meters for the last 12 months

Grade	Structural condition		Risk description
5	Metallic	Pipe breaks on removal from excavation of severe corrosion evident and/or collars or connection materials remaining	leaking pipelines with contamination occurrences; leaking pipeline with entire or portion of length totally submerged in canal/drainage
	Plastic	Old PVC pipes (white colored) with high discoloration	
4	Metallic	Major corrosion, delamination, cracking or pipe loss and/or collars broken or deteriorated rubber rings	Leaking pipeline with maintenance access problems; leaking pipeline with entire or portion of length located inside a drainage but not submerged
	Plastic	Old PVC pipes (white colored) with discoloration, plastic pipes with high discoloration	
3	Metallic	Significant corrosion, determination, cracking or pipe loss and/or collars or joint cracked affected by tree roots	Leaking pipeline with entire or portion of length located near a canal
	Plastic	Old PVC pipes (white colored) without discoloration	
2	Metallic	Minor corrosion or determination evident and/or minor connection deterioration	Leaking pipeline with no possible contamination problem but dilapidated to pipe age
	Plastic	Plastic pipes with slight discoloration	
1	Metallic	No corrosion or determination evident or connection as new	Leaking pipeline with no possible contamination problem
	Plastic	Plastic pipes with no discoloration	

The table above is the pipeline rehabilitation plan given serious consideration thus far at MCWD, making it difficult to suddenly switch to the guidelines proposed by the project team. However, MCWD has decided to introduce the leak mesh proposed by the project team for leak detection and pipeline rehabilitation, and is currently considering ranking the color-coded table.

2.2.8 Assessing Feasibility of Changing from the Existing Geographic Information System (GIS) to the Comprehensive Mapping System

(1) Current Conditions

MCWD obtains its topographic maps from Google Earth® and uses Micro Station® (MST®) to prepare line drawings of roads and buildings. When construction is carried out on the distribution pipe line, detailed surveys of the area around the construction zone are carried out and the detailed road shapes and building location are accurately reflected in the topographic map data. The pipeline network data is managed in layers within MST®, and this pipeline network data is also used in Water GEM® (WGM®), which is used for pipe network analysis. MST®, WGM® and other software are used for the applications to which they are suited, such as preparing topographic maps, managing information on distribution pipelines (facilities), pipe network analysis, and preparing diagrams for business operations.

In the initial phase of the project, managers said that they wanted to consider adopting the comprehensive mapping system that YWWB uses. However, the staffs in charge are sufficiently accustomed to using their current systems according to the appropriate application and accomplish their work without difficulty, so they want to continue using the current system.

(2) Introduction of Mapping System

Below, we have introduced the merits of introducing a comprehensive mapping system.

(a) Space can be conserved in the storage area for paper documents by digitizing paper information.

(b) Operations can be performed more efficiently through central management of construction completion data and books related to construction.

(c) Construction plans and water suspension measures can be devised without depending on the staff's experience and instinct.

(d) Pipe network analysis can be simulated.

(e) Most up-to-date data can be shared among many employees by digitizing data.

(f) Data (paper or digital data) can be provided to outside reconstruction support people in the event of a natural disaster.

The demerits are that, in terms of system stability, systems with many special-order components initially malfunction often compared to commercial, general-purpose systems, so it takes time before the system stabilizes. When a system that is stable from the beginning is wanted, a highly versatile system with a proven track record should be used.

The costs of a mapping system include the initial cost (the cost of purchasing the system, development costs) and maintenance and management costs. Even if the initial costs are low, the maintenance and management costs may be high in some cases, so a manufacturer should be selected by taking into account the maintenance and management costs since long-term optional contracts are often arranged with the system company initially chosen. Although the price of a commercial system includes the development cost, systems with many special-order components will require the payment of separate development costs. In order to keep development costs down, functions should be narrowed down. The objective of the mapping system is not simply to introduce it, but to continue using it over the long term; this requires that data always be updated, which in turn requires maintenance and management costs. The greater the volume of data to be entered in the system, the more work it takes to update the data, which requires considerable personnel costs and work hours. Moreover, if the volume of data increases, enhancing PC functions must also be considered. To this end, in order to curb maintenance and management costs, data volume must be minimized to an amount that can be handled within the scope of operations, without increasing data volume to excessive levels.

(3) Issues Specific to MCWD

During the 2nd Field Operations, the Kokusai Kogyo Company (KKC), a company specializing in reinforced mapping systems, identified problems with switching from the existing GIS and mapping program mentioned above to a comprehensive mapping system.

According to KKC, when confirming basic functions and considering the application functionality that will be needed in the future for a comprehensive mapping system, the functions already available in the current system must be confirmed, and the extent to which the functions are used must also be surveyed. The links between the mapping system and pipe network analysis system must also be considered.

MCWD has (excessive) expectations for GPS measurements, and is setting up a road map measured using GPS in a pilot region 8km in length set up on Mactan Island. Roads are excavated so that GPS measurements can be taken, and then the existing pipes are entered into the newly prepared diagram. This demonstrated the difficulties in terms of time and the cost-effectiveness of using this method for installations in Cebu overall, and it was proposed that a discussion was needed. As a result, MCWD decided that continuing with this method required too much work and that an alternative should be sought.

MCWD uses an aerial photograph taken in 1977 as a road map, which is not consistent with recent water works diagrams (completion drawings), so it was proposed that a new road map be prepared, in conjunction with the aforementioned issues.

Moreover, although the mapping data base and pipe network analysis database are linked, data on completed pipe lines prepared using MST® must be converted to separate pipelines based on nodes used in pipe network calculations for WGM®, and then the link and connection reflecting it back to MST® must be smooth (little time lag).

Table 2-2-9 shows the estimated costs of introducing a new mapping system from updating the topographic data. KKC calculated the amount needed if MCWD were to adopt a comprehensive mapping system using a Japanese water service utility as a reference, adjusted for MCWD's size.

(4) MCWD Internal Considerations

As noted above, KKC told MCWD that its topographic data used in its mapping system is quite old, so it began to consider a proposal from KKC to develop a comprehensive mapping system, as shown in Table 2-2-9 ("cost" column to the left), and in October 2012 MCWD began to consider the possibility of whether this could be done domestically.

Table 2-2-9 Estimated Cost of Introducing New Comprehensive Mapping System ("Cost" column to the left) and updating data using current system ("Cost" column to the right)

Item	Contents	Cost (PHP)	
		Introduction New System	Using Present System
(A) Detail Study / Research	KKC staffs research and study.	1,800,000	0
(B) Creation of Digital Road Map	Aerial Photograph (Scale:1/1000)→ Road Map Creation (0.5 – 1 year)	44,200,000	
	Aerial Photograph (Scale:1/500)→ Road Map Creation (1 – 1.5 years)		5,000,000 (by MCWD staff)
(C) Introduction of PC	Server PC: 1 (400,000 PHP/pcs) Client PC: 20 (80,000 PHP/pcs) Digitizer: 2pcs, Scanner: 2pcs	400,000 1,600,000 400,000	400,000 1,600,000 400,000
(D) Input Pipelines and Facilities	Pipeline 800km (9,000 PHP/km), others	8,900,000	0 (by MCWD staff)
(E) Software new installing	1 Server and 20 Clients	6,600,000	0
Total Amount		63,900,000	7,400,000

The cost of (C) in the table above could be reduced if the PC is bought in the Philippines, given that it doesn't matter whether hardware is bought domestically or internationally as long as the PC functions are satisfactory. (B), the creation of a digital road map, accounts for the majority of the costs, but an aerial survey company in Metro Manila (GEODATA) took an aerial photograph in 2011, and MCWD is currently negotiating its use as an archive. The scale of the photograph is extremely detailed, at 1/500 to 1/300, and even the small roads between houses crowded together in central Cebu are shown in great detail, so MCWD is very interested in using this archive. Currently the terms of use and the price are being negotiated; MCWD wants to use an inexpensive aerial photograph. Converting the photograph into topographic data depends on the quality of the GIS data, but MCWD has expert staff in charge of digitizing topographic data from aerial photographs (the two staff members also carry out pipe network analysis), and also has several employees that digitize data. Although it takes more time than if it were outsourced to specialists, the accuracy of their work is extremely high. Accordingly, if this aerial photograph data can be obtained, (B) can be prepared extremely cheaply. Similarly, entering (D) distribution networks (facilities) can be done using the MST® data currently in use, so there is no need to account for this. However, the map currently used is 35 years old, so in the places in some distribution networks at which pipeline construction has not been carried out (for example, the main transmission pipe and water treatment plant's effluent pipeline), the location of the pipeline is incorrect. If the most up-to-date map is used, consistency must be ensured, and time must be taken to make corrections. (E) software is the based on the program used at YWWB. In the event that MCWD uses the existing MST® and WGM®, the initial investment has already been made, but upgrades will have to be paid for in the future.

2.2.9 Studying Establishment of Basic Concepts for Introducing a Pipeline Training Facility and a Simplified Design

Although not included in the TOR, JICA and MCWD's agreement included support for pipeline training facilities, and the project team considered this issue as described above. This was a high-priority request from MCWD, and the prospects for construction were high since MCWD had obtained the planned construction site in advance. Moreover, related discussions within MCWD moved ahead smoothly. This was likely because the managers had had training at YWWB's pipeline training facilities in Japan the previous year and they had already considered training content suited to the same scale as YWWB's training facilities and the local site, so the purpose, training content and facility scale had been clarified.

During the 1st Field Operation, the project team inspected the site planned for the training facility's construction (empty land owned by MCWD in the Tisa distribution reservoir next to the Tisa WTP), took simple measurements and calculated the site area (about 2,000m^2). In the subsequent training in Japan, the participants learned in the pipeline training facilities, and a workshop was held on the kind of training facility to place on the site, using YWWB's pipeline training facilities as a reference, in order to expand on this plan at MCWD. At the training assessment meeting on the final day of the training, a basic concept was shaped and a simple design (refer to Figure 2-2-11) was prepared for the training facility, and put together as an action plan for the trainees. The training facility to be adopted will consist of three departments: (1) leak detection, (2) distribution pipeline installation and (3) water servicee pipeline connections. A roofed gathering space currently also used as an office will serve as the classroom facility.

During the fourth on-site survey period, adequate space could not be secured for the classroom facility, so it was decided that, instead of using the empty land next to the Tisa water supply area as the site on which to build the training facility, the facility would be constructed on empty land owned by MCWD at the Talamban branch where the water quality testing laboratory, leakage management office, and water meter upgrade department are located since there was more space available. Talamban, where MCWD's main facilities are concentrated, is an extremely good site for a training facility, with the caveat that, although there is more space, the vegetation is overgrown and clearing it away will incur costs. Moreover, the only way to get to Tisa is by walking or using a bike taxi or taxi, but there are safety issues as travel conditions along the way are extremely poor. At the same time, there are good means of transportation to Talamban, and it is far superior to Tisa in that respect. However, the Tisa WTP is adjacent to the Tisa site, so in addition to pipeline training, training in wastewater treatment could also be done in a single place. In discussions with MCWD, it was found that less training on water purification was provided at MCWD than pipeline training, so they wanted to devise a training plan that focused on pipeline training.

In the future, MCWD will need to review the location of its pipeline training facilities to coordinate with Talamban.

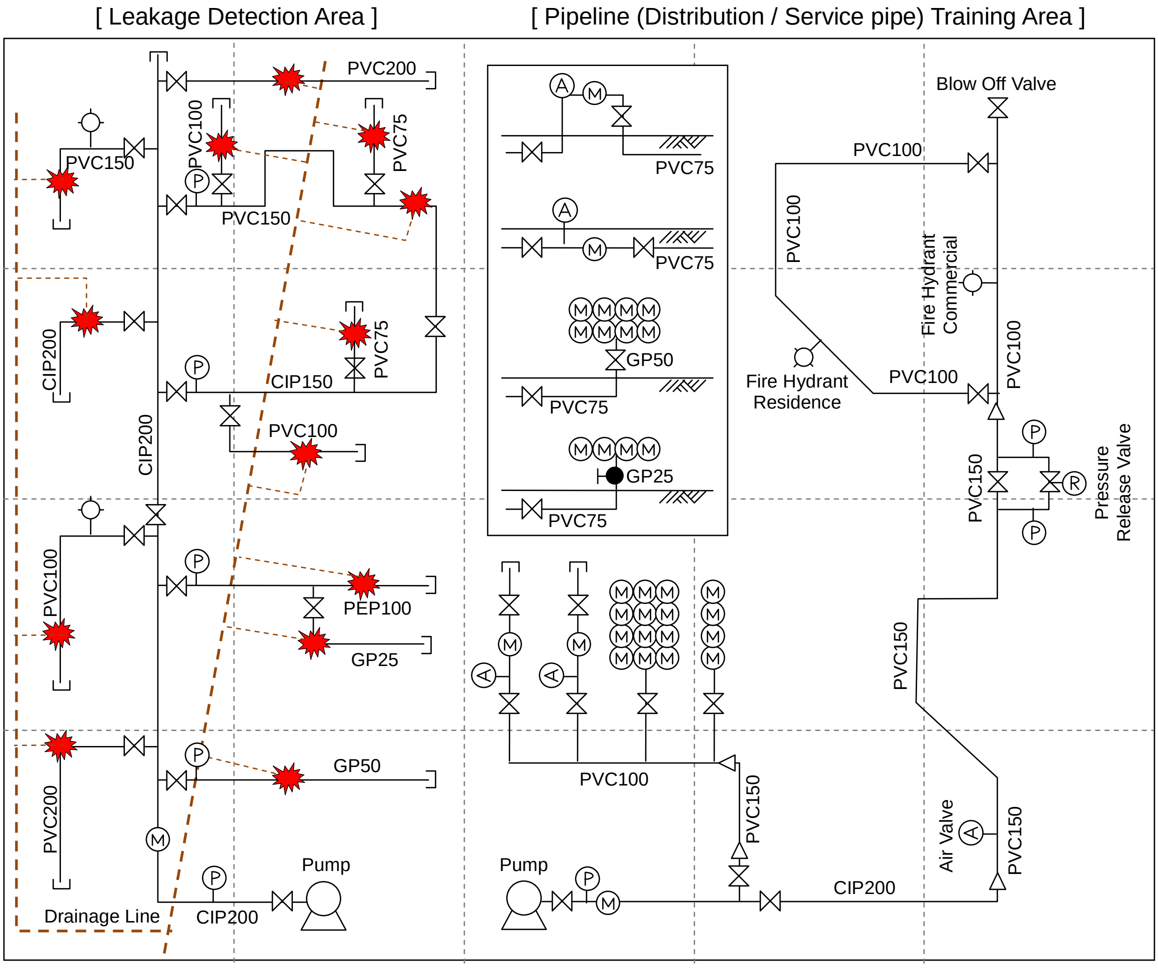


Figure 2-2-11 Simple Design of Pipeline Training Facilities
(Field 50m x 40m: 1 mesh 10m x 10m)

After the training in Japan, the training participants in MCWD's water supply division (leakage, water supply design, mapping) took the lead role in creating a design, based on the above diagram. This design was examined in the 3rd Field Operation. Although it is difficult to recognize the location of the booster pump, the location of the leak and wastewater drainage pit, the stream slope of the leak and wastewater drain, and the slope of the rainwater drainage on the surface pavement from the detailed design prepared here, important points in terms of functionality were made. It was also proposed that in addition to the PVC pipes and new PE pipes (new material) that MCWD usually uses, removed pipes and waste pipe materials be used as examples of aged pipes, and that in the future MCWD should install the DIP that it plans to adopt. In addition, at the planning stage, it is impossible to guarantee that the construction in the leak detection area will take place in accordance with the plan, and MCWD will have to use trial-and-error to figure out how to generate leaking sounds, get rid of the wastewater generated by leaks, and create sounds simulating leaks.

This facility, which will cost a total of about 8.5 million PHP (in the case of Tisa) to build, would not only be used for training within MCWD, but would also accept trainees from other water districts. Currently, the detailed plan and construction budget (funding has been secured) has been completed, and the next step will be the start of construction, but with the change in construction site to Talamban, construction is slated to begin in 2013.

2.3 Water Quality Improvement of Water Distribution and Supply from Groundwater Supplies and Capacity Building of the Existing Water Treatment Plant (WTP) (Water Purification Management / Water Quality Management)

2.3.1 Studying Improvement of Rapid and Slow Mixing of the Sedimentation Basin and Flow Uniforming Facility at the Existing Water Treatment Plant (WTP)

(1) Actual Conditions of Water Treatment Plant (WTP) and Water Purification

The actual conditions of MCWD's Water Treatment Plant (WTP) and water purification are described below. figures in the parenthesis indicate the numbers of facilities in Figure 2-3-1.

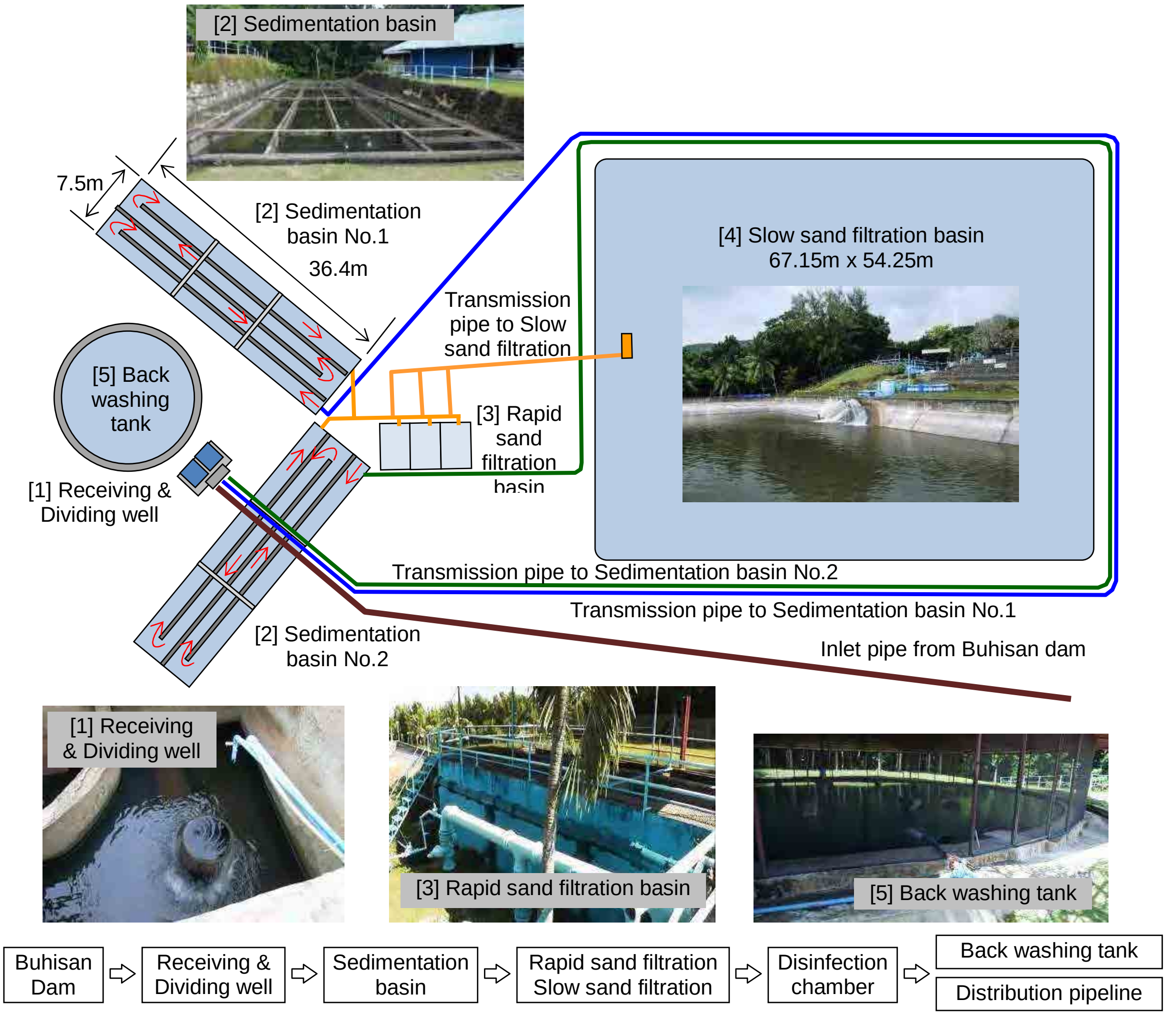


Figure 2-3-1 Plain View of Tisa WTP

Tisa WTP (Figure 2-3-1), established in 1912 with a designed treatment capacity of approximately 10,000m^3/day, is currently in operation in MCWD. Raw water is carried by gravity flow in the conveyance pipe from Buhisan Dam located approximately 2km upstream from the Tisa WTP. As a coagulant, Polyaluminum Chloride (PAC) or Aluminum Sulfate is poured at the outlet section of the

[1] Receiving & Dividing Well. It may not be fully agitated depending on the flow volume from the outlet section, but the water is conveyed to the [2] Sedimentation basin (2 basins) through the transmission pipe (approximately 350m). The sedimentation basin is a cross flow type chemical precipitation basin. The sedimentation basin is divided into M-shaped two-pass channels (4 channels). Water flows approximately 140m in the treatment process from the upstream to the downstream. The supernatant is sent to the adjacent [3] Rapid sand filtration basin (3 basins) and [4] Slow sand filtration basin (1 basin) to filter. Filtration treatment water is also sent to the [5] Backwashing tank with the pump. Chlorine is poured in the filtration treated water, and the water is supplied to citizens by gravity flow through the distribution network.

Buhisan Dam, the water source of Tisa WTP, is a dam facility that is dedicated to water service having an effective impoundment of approximately 200,000m^3, and an embankment 27m high. Its drainage area is about 630ha. The conveyance pipe to Tisa WTP is connected to a place 18.5m away from the edge of the embankment, and the drain pipe / sludge drain pipe used for cleaning is connected to a place 23m away from it.

No houses or plants exist near the dam site, and security personnel work the shift to control entry to the site for 24 hours. Therefore, no management issues were found.

No large communities or plats exist in the drainage basin, so inflow water to the dam is very good, and there are no raw water quality problems at the moment. However, effective impoundment and water catchment area are very small. In the past several years, the dam impoundment rate recorded 0% during the low rainfall period caused by the El Nino effect, which has caused water treatment impossible several times a year depending on the year. Sedimentation has been progressing, and the actual effective impoundment has become less than the above-mentioned figure, approximately 200,000m^3.

Therefore, MCWD is planning to conduct dredging. One of the reasons why sedimentation has progressed is that surface soil is drained by illegal logging in the drainage area. Strict control by government institutions is needed.

MCWD is seeking for a new surface water resource due to progressive quality deterioration (to be described below) of groundwater which accounts for approximately 95% of distribution volume. New dam plans have been made over the years, but a safe and an affluent water resource is needed.

(2) Water Purification Issues

Since the Confirmatory Investigation of water purification was conducted, issues of the coagulant mixing, the sedimentation effect, the filtration performance, and the backwashing performance were pointed out. In this section, improvement in processes of the coagulant mixing to settling in the sedimentation basin is considered, and the verification (experiment) results obtained using the actually made equipment are described.

Coagulant is poured in the water at the receiving well of the Tisa WTP. The design utilizes the slight difference of water dropping height of the dividing well and the slightly generated crosscurrent at the transmission pipe bending section to agitate raw water and coagulant. However, it is clear that the mixing effect is insufficient when comparing the sedimentation treated water with untreated water.
Generally, the proper amount of coagulant is poured in water and sufficient rapid and slow mixing is performed, solid turbidity (floc) should settle in the sedimentation basin. However, it was discovered that sedimentation treatment was not sufficient due to multiple reasons including (a) low coagulant injection rate, (b) insufficient rapid and slow mixing, and (c) incomplete settling due to a high flow rate.
Reasons of these issues are described below.

(a) At Tisa WTP, coagulant injection rate was calculated from the inflow volume chart, so coagulation injection was not performed properly. In the injection rate chart, inflow volume varied, causing fluctuations in turbidity, pH values were not considered and the entire coagulation injection rate was calculated in small amounts. The Jar test can be pointed out as a method to determine coagulation injection rate. In MCWD, a mechanical Jar tester was installed only in water quality testing room. Then, during the 1st Field Operation, we implemented a manual Jar test that can be performed with 2 to 3 people even if there is no mechanical Jar tester on site. Doing so, we could show that slow mixing (floc growth) was performed or not with YWWB method and MCWD method. We could visually present that effective and appropriate coagulation injection could be performed by adopting slow mixing. Also, during the 1st Domestic Work, we videotaped the Jar test conducted by YWWB and showed the video of the Jar test in the seminar during the 2nd Field Operation. The Jar test is described in 2.3.6.

(b) The above appropriate coagulant injection rate is calculated based on the Jar test. In order to obtain the mixing condition to have an optimal coagulation sedimentation, tests were conducted under various conditions using raw water of Tisa WTP, and the combination of rapid mixing + slow mixing (+ still standing) indicated the best sedimentation effect. Therefore, we confirmed that rapid mixing + slow mixing should be introduced to the WTP.
MCWD personnel who participated in the training in Japan presented an idea to build a mixing tank that is similar to the one installed at the 3rd sedimentation basin of Kosuzume WTP and

install an electrically-operated flush mixer in the tank. However, realizing this modification would require a considerable amount of money and considering the space on the site of the plant and the ground height (water level), it was decided to go forward with the idea using a gravity flow type baffled mixing unit at the entrance of sedimentation basin, which we had originally proposed in the Confirmatory Investigation. The baffled mixing unit that we proposed does not use electricity, and we emphasized that it would continue to function during an electric power outage. MCWD personnel seemed to be convinced by our explanation.

(c) The sedimentation basin at Tisa WTP is rectangular and divided into two-pass channels (M-shaped). Flow rate in the basin of treatment volume, 5,000m^3/day at low flow volume and that of the planned treatment volume, 10,000m^3/day look very slow, and water flow cannot be confirmed visually. Flow rate is approximately 45cm/minute and 90cm/minute respectively. According to the Design Criteria for Waterworks Facilities (JWWA), standard of flow rate in the basin is 40cm/minute or less. Compared to the guideline, the flow rate exceeds the standard. This result is obtained by dividing the sedimentation basin into two-pass channels (4 channels) and using the rectangular basin that water flows lengthwise (Left side of Figure 2-3-2). Removing a dividing wall to have water flow in one direction using larger cross-section is one idea to improve the sedimentation function, although it requires large-scale construction (Right side of Figure 2-3-2).

The current sedimentation basin's base plate is flat. Volume of settling substances (floc) gradually decreases right behind the rectifier and becomes very little near the outlet. By creating a slope to the base plate for discharging sludge (right bottom of Figure 2-3-2), settling distance becomes short, and floc easily drops on the base plate.

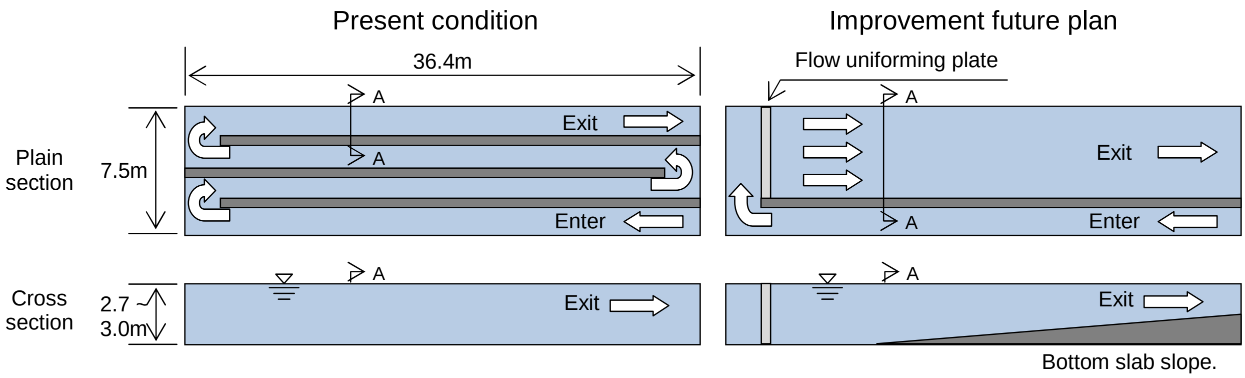


Figure 2-3-2 Plain and Cross-Sectional View of Sedimentation Basin
(Left: The current condition, Right: Improvement plan in the future)

The above facts caused failure in the function of sedimentation treatment as symbolized by the fact that floc formation could not be confirmed visually. Raw water turbidity and sedimentation treated water turbidity, which were calculated based on the record, were 9.9 NTU (6.9 degrees) and 6.7 NTU

(4.7 degrees). When the sedimentation basin functions effectively, it is no exaggeration to say that treated water turbidity should be 1 degree (1.4 NTU) or less at Tisa WTP.

(3) Solving Issues of Water Purification

As a solution of these problems, we discussed with MCWD in the 1st Feild Operation and decided to conduct a comparison experiment by installing a baffled mixing unit to the entrance of sedimentation basin to see if sedimentation treatment functions improve. We implemented a comparison experiment installing the unit at another basin. We also examined the structure (shape, material) of the baffled mixing unit.

In the 2nd Field Operation, we calculated the mixing intensity (GT value) as part of a detailed design and made a proposal to install 11 rectifiers in 20cm interval before the baffled mixing unit and 10 rectifiers in 50cm interval after the baffled mixing unit. Due to the structural reason of the sedimentation basin, mixing intensity is smaller than the guideline value. However, we calculated the maximum number of rectifiers to be installed based on the above conditions, and the result was 8,300 at small flow rate (5,000m^3/day).

Calculation is indicated in Table 2-3-1. Plan and sectional-view of baffled mixing unit is indicated in Figure 2-3-3, and birds-eye view of the baffled mixing unit is indicated in Figure 2-3-4.

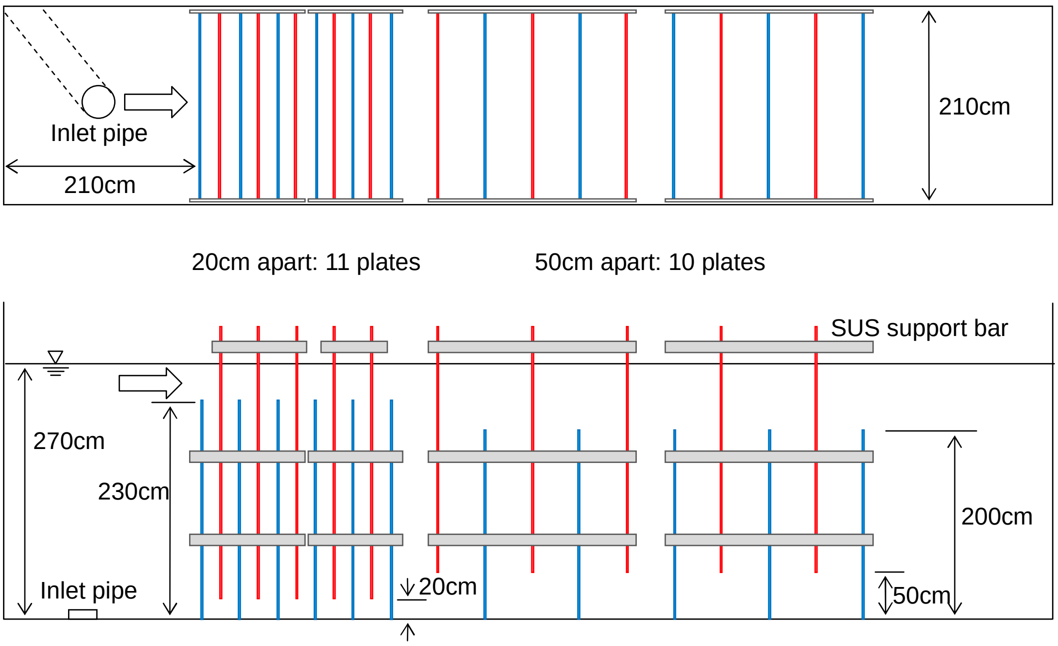


Figure 2-3-3 Baffled Mixing Unit Drawing (Upper: plain view, Lower: sectional view)

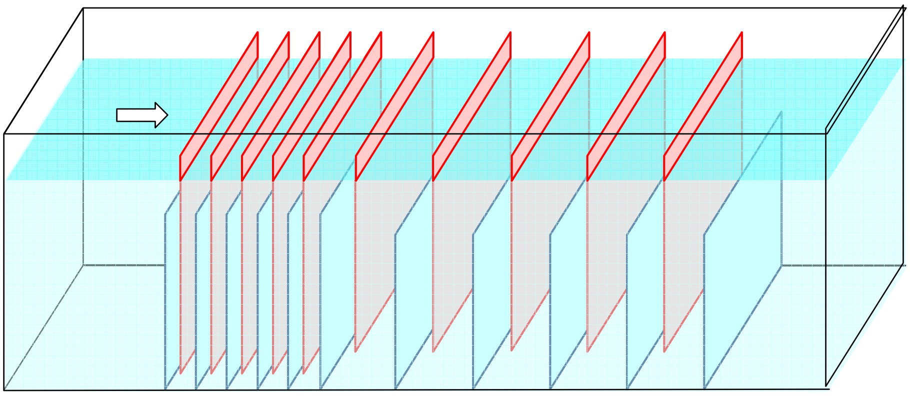


Figure 2-3-4 Birds-Eye View of Baffled Mixing Unit

Table 2-3-1 Proposed Designed Values of Baffled Mixing Unit
(Case of 5,000m^3/day and 10,000m^3/day)

Treatment water volume of Tisa WTP	Residence time (min)	Flow velocity (Front part | Rear part)	Head loss	GT Value (Mixing intensity)
5,000m^3/day	25.8	7cm/sec | 3cm/sec	0.6cm	8,300
10,000m^3/day	12.9	14cm/sec | 6cm/sec	2.5cm	11,800
Design Criteria for Waterworks Facilities	20 – 40	15 – 30cm/sec		23,000 – 210,000

Rectifiers were made using resin material including vinyl chloride and the unit was made including reinforcement for installing plates using PVC pipes and steel in MCWD between the 2nd Domestic Work and the 3rd Field Operation.
Requirements of material selection were materials should be procured at low cost and repairable. We decided that effectively utilization of waste materials would be the best. We expected to produce the device at low cost, but after our investigation, it was discovered that 120,000 to 250,000 PHP would be required only for the plate material because new 180cm by 90cm laminated wood and plastic plate of which thickness was sufficient for maintain strength were sold at 2,000 to 4,000 PHP per plate.

When the project team and MCWD were seeking materials, we found empty coagulation containers; chemical resistance PE chemical drum for 200 liters (photo on the right) made of Polyaluminum Chloride (PAC) that were used at the Tisa WTP. We cut off the head lid and the bottom plate and spread the drum. Approximately 180cm by 85cm polyethylene plate was made out of it. We discovered that materials could be obtained from approximately 60 drums. There was no recycle system provided by the manufacturer and the delivery company, and these empty containers were left in the

WTP until they were disposed of. MCWD always were hard-pressed with disposal of these containers. Using the empty containers that cost free is an effective utilization of waste materials. Empty containers are always supplied, so they are always in stock as repair materials.

We decided to use pipes that were not used for piping construction and removed pipes in MCWD for frames to support rectifiers. We made strong frames by combining PVC pipes (DN50mm) as shown in the photo of Figure 2-3-5. One rectifier can be made by attaching a PE plate to the entire area of the frame. We made 21 rectifiers in total as shown in Figure 2-3-5. Colors of the rectifiers are same as ones set in the unit in Figure 2-3-3 and Figure 2-3-4.

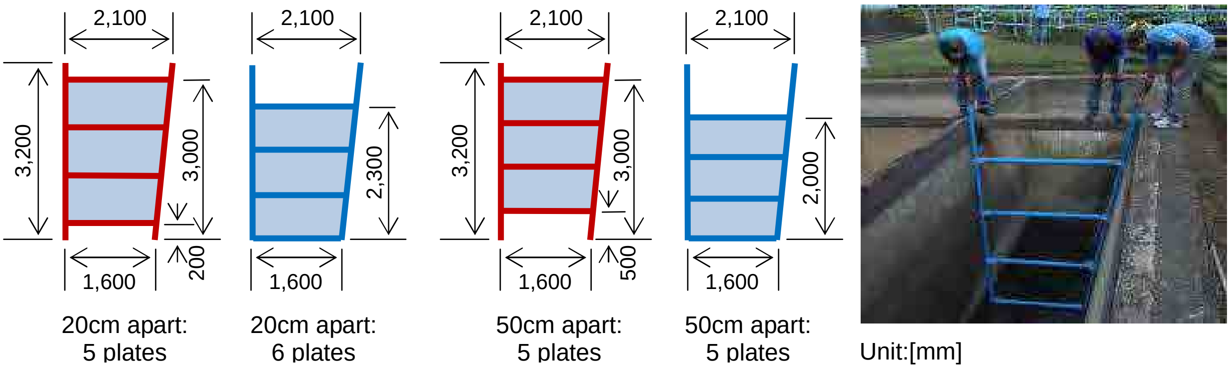
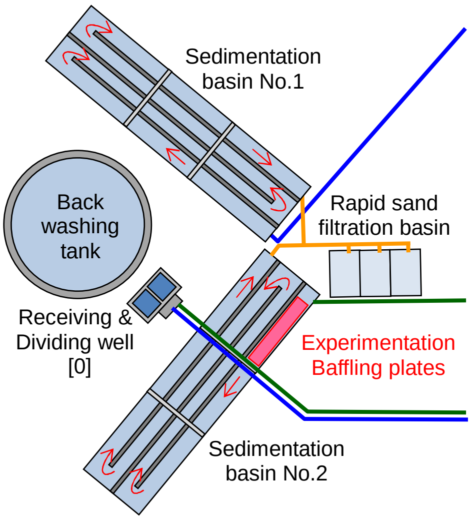
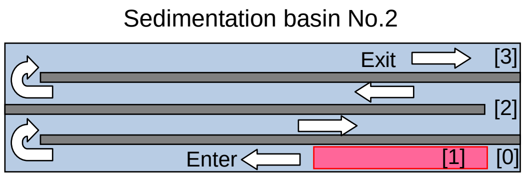


Figure 2-3-5 Plain View of Baffled Mixing Unit Plate

Mixing unit was installed at the sedimentation basin No. 2 in MCWD between the 3rd Domestic Work and the 4th Field Operation. The sedimentation basin No. 1 was a target basin. 4 turbidity measurement points in the plain view of sedimentation basin in Figure 2-3-6 were measured to compare treatment processes. Turbidity measurement points were 4 points, [0] to [3], at the sedimentation basin No. 2, the experiment basin, and 3 points, [1] to [3], at sedimentation basin No. 1, the target basin.





Case \ Turbidity (NTU)	Experimentation basin (No.2)				Object basin (No.1)		
	[0]	[1]	[2]	[3]	[1]	[2]	[3]
Nov., 2012 Q_{max}	15.2	13.9	9.4	6.7	15.3	10.0	7.4
Nov., 2012 Q_{mdl}	12.8	8.5	7.8	7.5	9.4	9.3	8.9
Nov., 2012 Q_{min}	11.9	7.8	7.7	6.4	7.6	8.5	7.3
Average	14.6	10.6	8.3	6.7	11.4	8.2	7.6

Figure 2-3-6 Mixing Unit Effect Measurement
(Turbidity Measurement of Sedimentation Treated Water)

According to the turbidity measurement results in November with 6 rectifiers, turbidity change between the inlet and the outlet is 14.6NTU to 7.6NTU on the average in the existing method (the target basin), and the removal ratio was 48%. By adding a mixing unit, turbidity change between the inlet and the outlet in the experiment basin was 14.6NTU to 6.7UTU, and the removal ratio increased up to 54%.

After that, the turbidity meter was used at places other than the water treatment plant due to repeated typhoon damage. Therefore, turbidity measurement results of December and following months do not exist.

According to the turbidity measurement results of February when 15 rectifiers were completed, turbidity change between the inlet and the outlet was 6.5NTU to 4.7NTU on the average in the existing method (the target basin), and the removal ratio was 28%. By adding a mixing unit, turbidity change between the inlet and the outlet in the experiment basin was 6.5NTU to 3.6NTU, and the removal ratio was 44%.

As a result, sedimentation capacity could be increased by 57% by adding a handmade baffled mixing unit, which realized reduction of turbidity overload to the filtration basin.

The collecting pipe for discharging sedimentation basin treated water is a riser as shown in Figure 2-3-7. It is located under the water, so the settling floc is likely to flow out. Based on this, we proposed to examine surface water intake using a trough for the purpose of reducing weir loading (taken out water volume/total length of weir) to minimize influence on flow rate in the basin as well as of catching supernatant.

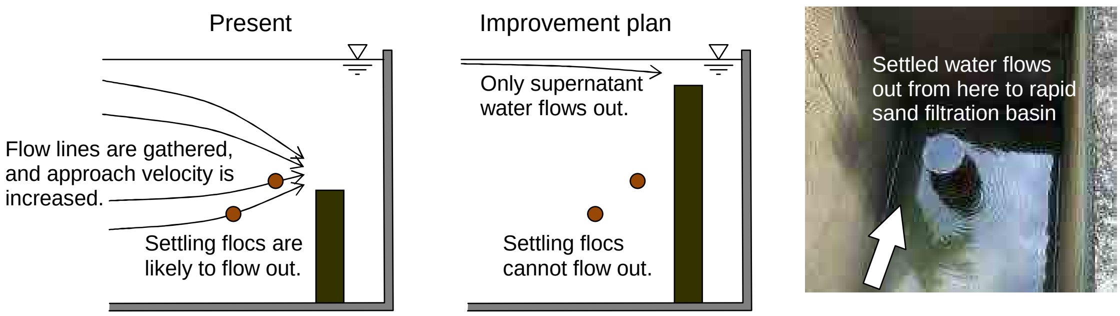


Figure 2-3-7 Improvement of Sedimentation Treated Water Outlet Pipe

2.3.2 Studying How to Improve the Existing Rapid Filter Basins

(1) The Actual Conditions of Filtration Treatment

Buhisan Dam, the only dam in MCWD, was built in 1912 during the American colonial period. In March 2012 when the 1st Field Operation was implemented, the centennial ceremony of Buhisan Dam was held.

The Tisa WTP was built around the same time as the Buhisan Dam. At that time, only slow filtration basin (67.15m * 54.25m, filtration area: 3,643m^2, filtration speed: 2 to 3m/day) was built after the sedimentation basin process. During the Confirmatory Investigation, treatment performance of the slow filtration basin was considered to be better than the rapid filtration basin in MCWD. Periodical maintenance is conducted to the slow filtration basin by scraping away surface sand every 3 months.

Afterwards, MCWD built three rapid filtration basins in a vacant lot in 1985 between the sedimentation basin and the slow filtration basin so that water treatment can be performed during the maintenance of the slow filtration basin. Filtration speed of rapid filtration is approximately 50 times as fast as the slow filtration, 120m to 150m/day in general. Rapid filtration is a method to filter impure substances with filter media when sedimentation treated water passes the filtration layers having sufficient thickness. Gaps of filter media are clogged with impure substances after a period of time, so cleaning (backwash) from the opposite direction to the filtration direction is necessary.

The sedimentation basin has not been modified since the time when the Tisa WTP was built and has served as a sedimentation basin suitable for slow filtration. The rapid filtration basin is also used now, and only the rapid filtration basin is operated when maintenance is performed to the slow filtration basin. We assessed and implemented improvement ideas of processes up to the sedimentation treatment so as to use the sedimentation basin as a filtration basin in the above 2.3.1.

According to the observation of the filtration sand surface in the Confirmatory Investigation in 2011, the surface was covered with silty substances (photo on the right), and the silty substances could not be removed after repeated backwashing. Due to insufficient sedimentation treatment, suspended solids did not flocculate and settle, resulting in a large amount of suspended solids flowing into the filtration basin. Most of the suspended solids stayed of the surface causing an excessive burden to the filtration process. Also, backwash water was gravity flowed from the backwash tank, and the water pressure was small, approximately 0.05MPa. The backwash tank capacity was also small, and washing time was short. Therefore, we determined that sufficient backwash was not performed and drastic changes in backwashing would be required.

Under these circumstances, even though the backwash tank capacity cannot be increased, we assessed proper backwash time and backwash valve travel adjustment and proposed to use a surface wash unit for fracturing the surface silt layer in the proposal and the inception report of this project. This proposal was to adopt technology of the surface washing device (rotary or stationary type) which was used for the rapid filtration basin at YWWB's WTP. This washing method is to fracture the turbidity covering the filtration sand surface and discharge it by backwashing. Originally the stationary type washing device as shown in Figure 2-3-8 was planned to be used for surface washing.

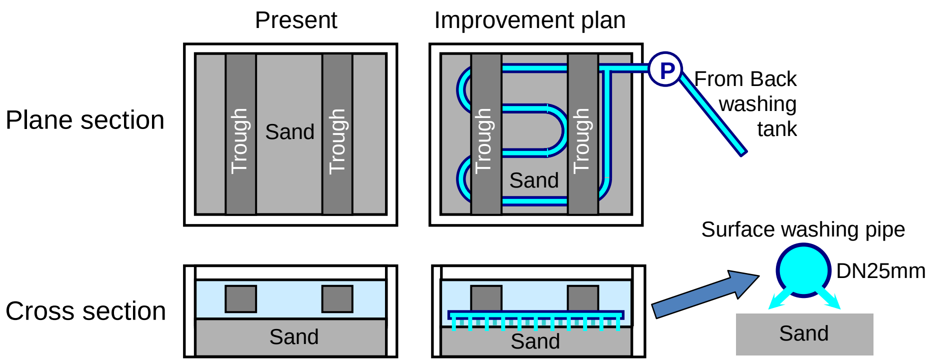


Figure 2-3-8 Surface Washing Device Originally Planned

According to the interview with MCWD personnel about filtration basin operation during the 1st Field Operation, the surface was scraped and sand was refilled every 3 months in the slow filtration basin. Maintenance of the rapid filtration was not performed especially. We heard that the current management staff at the WTP did not have experience in performing rehabilitation (washing) of filtration sand, inspection of the building frame in the tank, inspection and repair of the underside water catchment unit for 28 years since it was built in 1985.

During the 2nd Field Operation, we measured uneven sections (shown in the photo on the right: the filtration sand surface should be even, but it is wavy and uneven) which progressed during the period that the filtration basin rehabilitation construction was not conducted for 28 years after establishment. Sand layer surface of the filtration basin was 150cm maximum below water and 91cm minimum below water. It was confirmed that 59cm vertical interval was created. Clogging of bottom water catchment device and occurrence of water path are possible causes of this problem.

We determined that functions of the filtration basin had been greatly decreased based on the following facts; uneven surface generation connected to existence of water that passed the filtration basin without sufficient filtration during the sedimentation treatment; silty substances that could not be discharged by backwashing built up as mentioned above; the filtration continuance time was set too short, 24 hours (72 hours at YWWB). We recommended that a rehabilitation construction of the filtration basin was required as a drastic maintenance in order to recover the lost functions.

We thought that floc would settle and sedimentation treated water with lower turbidity would be sent to the filtration basin by improving the sedimentation basin and also sufficient filtration treatment would become possible without using the surface washing device by (drastically) improving the rapid filtration basin which will be described below. Therefore, we determined not to install the washing device in this project but to provide MCWD with the concept of installing the washing device. We decided to provide instruction on as many ideas of maintenance for the filtration basin as possible to MCWD.

(2) Improvement in Filtration Treatment

MCWD did not perform maintenance of filter media (sand and gravel) and the underside water catchment unit after the rapid filtration basin was put into operation. We decided to suggest MCWD's current personnel perform sustainable maintenance. We discussed with MCWD about maintenance of which effect could be evaluated within this project, and we decided to execute it.
We pointed out improvement items, 1) washing and screening filter media, 2) cleaning inside the basin and inspection & repair of the underside water catchment unit, 3) taking countermeasures for preventing uneven filtration sand surface and selection of where to refill the filter media, and 4) setting of wash valve travel and washing time for backwashing, to recover functions of the entire rapid filtration basin.

1) Washing and Screening Filter Media

In the past, as maintenance of filter media, MCWD only refilled filtration sand that had been discharged when backwashing. In Japan, many water suppliers perform the filtration basin rehabilitation construction (overhaul) approximately once every 10 years. This is more likely a hospital treatment than a checkup examination of the filtration basin. Checkup examination level is daily inspection or repair performed by the personnel at the WTP, but the rehabilitation construction, which is compared to a hospital treatment above, is an action to remedy bad sections, which exceeds checkup examination level. This action should not be performed so frequently.
Filter media has suspended substances stick (absorb) to itself in the daily process of filtering sedimentation treated water to create purified filtrate. When the filter media becomes dirty, filtration effectiveness decreases (filtration clogging). Performing backwash before exceeding the set conditions (head loss, filtration time) remove clogging between the filter media causing recovery of filtration effectiveness. However, while repeated filtration and backwashing, the filter media gradually becomes dirty, and such dirt becomes difficult to be removed even if backwashing is performed. Therefore, filter media is recovered almost once every 10 years by conducting the filtration basin rehabilitation construction.
In Japan, field personnel of water suppliers performed rehabilitation work in the past. Filter media was carried out of the filtration basin by human power, and the filter media was screened by watering the filter media when sorting out nonstandard filter media size. Screening work by watering filter media enables removal of debris from the surface by friction generated between materials and rinsing off the debris.
During the seminar in the 2nd Field Operation, we introduced the filtration basin rehabilitation work performed by professionals company, which is implemented at YWWB. In Japan, the rehabilitation work is mechanized and administered by professionals. There are no such professionals available in the Philippines, but YWWB originally conducted the rehabilitation work

manually, so we provided MCWD with advice on manual filter media screening and washing.

Figure 2-3-9 shows a figure of filtration sand screening and washing, which was used for a presentation in the seminar and a photo indicating the actual filtration gravel screening work conducted based on the same principle. As shown in the pattern diagram on the right side, filtration sand before washing is screened by the upper 2.0mm mesh shifter, and sand of 2.0mm or larger stays on the shifter, which is sorted out again at filtration gravel. Sand on the lower shifter is screened with 0.3mm mesh shifter. Sand of 0.3mm or smaller passes the mesh and is taken out as a waste material to be used for other purposes. Sand remaining on the lower shift is considered as filtration sand with an appropriate size (0.3 to 2.0mm). The sand rubs each other in the shifter and dirt can be rinsed off by pouring washing water from the top.

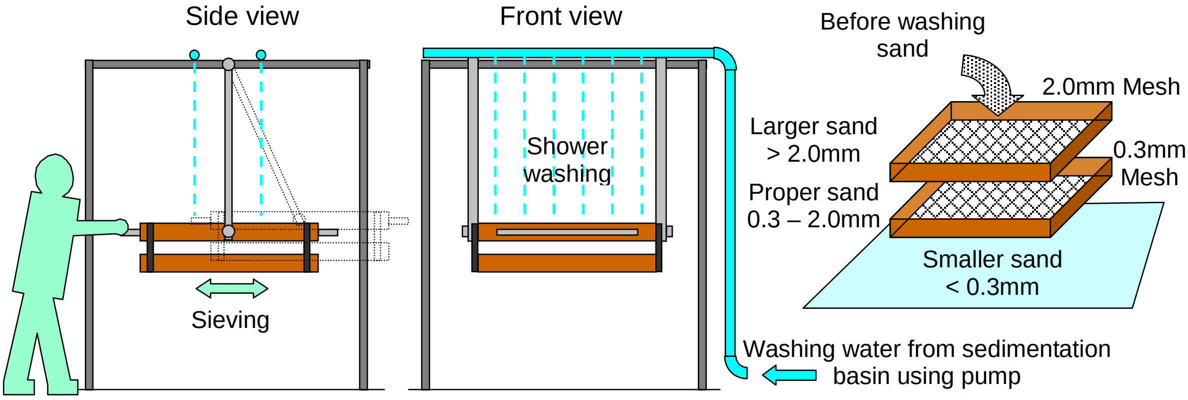


Figure 2-3-9 Filter Media Screening and Washing Device

After screening and washing the filter media using this method, although it depends on the water quality, dark brown wastewater is discharged. In Japan, such wastewater from the WTP cannot be discharged into rivers unless it is within the water quality standards. However, MCWD discharges such wastewater in the mountain on the premise of the WTP. They do so because there are no wastewater treatment facilities, but in the near future, they will need to cope with environment friendliness issues that the developed countries face. Therefore, we expect that personnel in the Philippines to learn knowledge of wastewater treatment during training, etc.

The filtration gravel screening device made by MCWD is shown in the photo on the right side. Gravel is released from the top, and gravel is shifted when gravel is rolling down along the slope while being shaken. With this device, gravel is separated into 4 levels in accordance to size. Due to a short period time for shifting which gravel is rolling down, a lot of gravel tends to remain on the upper shifter. Therefore, gravel remaining on the upper shifter needs to be shifted several times. Cobbled stones are desirable for filtration gravel, but there is gravel similar to crushed stone, which requires screening several times.

2) Cleaning Inside the Basin, Inspection and Repair of the Under Water Collection Device

The current personnel of the WTP management, water treatment, and water quality departments had not seen the structure inside the basin. We determined that no maintenance had been performed in the past.
It was decided that details of the filtration basin would be repaired and MCWD would internally discuss about how to perform future periodical inspections before conducting the filtration basin rehabilitation construction. The photo on the right side shows that the filter media in the filtration basin is taken out and the underside water catchment device that the PVC perforated pipes are connected to the central water catchment main pipe. Water catchment opening is made on the perforated pipes so as to face down. All perforated pipes were removed, damage of the pipes and clogging of the water catchment openings were confirmed, and the perforated pipes were connected to the water catchment main pipe again. We heard that air washing was conducted by mixing air bubbles in the backwash water back when it was built, but only the standpipe for taking air in exists and is not used now. When conducting maintenance of the wall surface, the unnecessary air intake pipe was removed.

3) Taking Countermeasures for Preventing Uneven Filtration Sand Surface and Selection of Where to Refill the Filter Media

In the structure confirmation of the existing filtration basin, it was discovered that both the sand layer and the gravel layer are thicker than the Japanese standard structure as shown in Figure 2-3-10. We made proposals on the layer and gravel layer thickness in the 3rd Field Operation based on the YWWB case. After the discussion, it was decided to recover the layers with the new structure as shown in the figure on the right side.

When the underside water catchment device has perforated pipes, backwash water does not float evenly during the backwashing process and a type of water path occurs, which may cause even filter media washing impossible. In this case, the area where water does not go through hardens. If this is repeated, the surface of each layer of the filter media that was laid flat in layers becomes uneven. This phenomenon has a risk of water passing through filtration basin without being sufficiently filtered. At YWWB, a mesh net is laid between the filtration sand layer and the filtration gravel layer to prevent occurrence of uneven surface. This unevenness occurred in the rapid filtration basin, it was decided to lay a net between layers to prevent occurrence of uneven surfaces at MCWD. Durable stainless mesh nets are expensive, so we decided to use nylon flyscreens or cast nets on a trial basis. Materials of these mesh nets are strong enough to hold the weight of a person. These mesh nets are fixed with stainless bolts to the PVC plates set on the basin wall surface. It is necessary to verify how durable the nets are against friction that will be caused repeatedly by gravel and sand when backwashing.

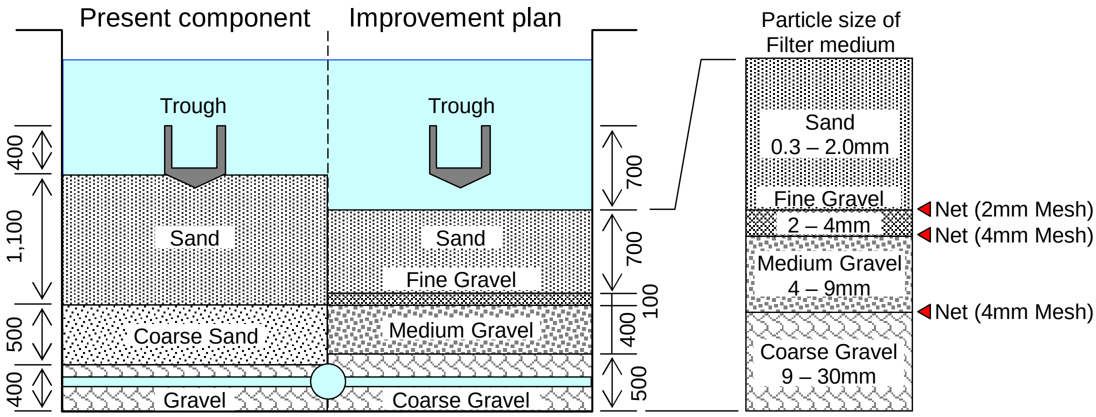


Figure 2-3-10 Rapid Sand Filter Media Structure

Gravel in the bottom layer was not cobbled stones used in Japan but crushed stones for concrete. Cobbled stones are round stones that are often found at river beds. They are expensive to purchase, but we discovered that those stones abundantly existed in the water intake place (owned by MCWD) of Jaclupan Subsoil Water in MCWD. Therefore, it was decided to use 9 to 30mm cobbled stones instead of crushed stones.

When the filter media is carried in the basin, the filter media rubs each other and dirt is discharged. Sufficient backwashing is needed.

We confirmed with MCWD to flow water by discharging air contained in the filter media (air gap) from the backwash pipe when pouring water in the basin prior to operation start. Without sufficient evacuation of air, air gap is compressed creating danger here compressed air may cause the filter media to burst.

4) Setting of Wash Valve Travel and Washing Time for Backwashing

In the 1st Field Operation, we investigated the backwash conditions of the filtration basin based on the actual conditions in (1). It was discovered that washing water did not show low turbidity even after washing for 15 minutes with the backwash valve fully open and the normal backwash time of 8 minutes was inadequate.

When the expansion rate of the sand layer is 20 to 30%, filtration sand friction becomes effective, so backwashing can be performed with the least water volume. With the current backwash flow rate, the sand layer does not expand, so washing is not enough even if washing time is long. Expanding the sand layer means to float the sand, which is to create upward flow velocity almost equivalent to the sand's settling speed. The location of MCWD is tropical. Water temperature is high, and water flow resistance is small. Therefore, the sand settling speed is higher than that of YWWB. As the result, it is necessary to make the backwash flow rate twice as fast as that of

YWWB, but pressure seems to be short with the existing backwashing tank. Building an elevated tank can be a way of increasing backwash pressure, but it is necessary to consider the risk that sand may be discharged by increasing washing pressure. Also, the underside water catchment device has perforated pipes, and clogging was confirmed. Therefore, it can be assumed that washing was not performed uniformly. It was decided to continue operation with the existing backwash facility by adjusting the filter media layer thickness in the filtration basin rehabilitation construction and taking countermeasures for preventing the reoccurrence of an uneven layer surface.

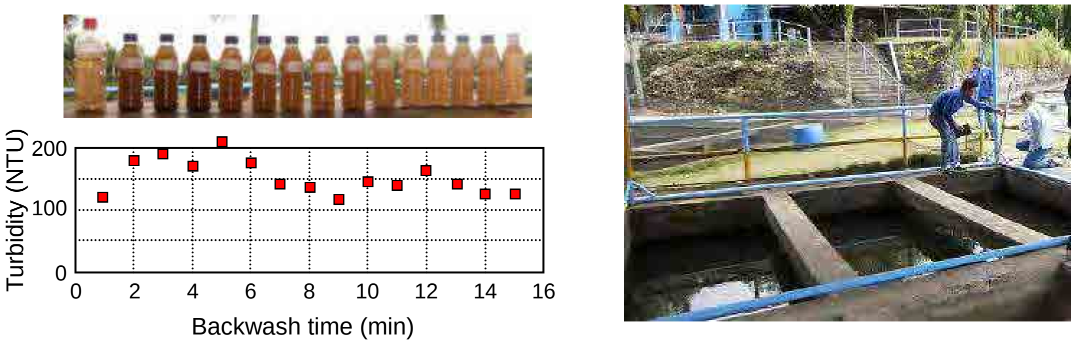


Figure 2-3-11 Backwash Wastewater per Minute of the Current Rapid Filtration Basin

(3) Improvement Priority

Water used for washing the filtration basin come after purification process, which means a part of the water is produced by MCWD. If water volume for backwashing increases, the washing water volume also increases resulting in increased water purification loss. Therefore, it is necessary to recover functions of the entire rapid filtration basin by improvement of 4 items mentioned in (2), but it is desirable to lay weight on reducing the burden to the filtration basin by removing suspended substances in the aforementioned sedimentation basin rather than improvement of the washing device for the filtration basin, which reduces effectiveness due to high temperature water considering MCWD's environmental conditions.

Table 2-3-2: Backwashing Time and Water Volume for the Rapid Filtration Basin

	Backwashing time (min)	Backwashing water volume (m^3)	Backwashing water flow rate ($m^3/min/m^2$)	Rate of water treatment loss (%)
Normal backwashing of MCWD	8	40	0.33	1.2
Investigation of backwash condition (This time)	15	146	0.57	4.3
Design Criteria for Waterworks Facilities	4 – 6	–	0.6 – 0.9	–

2.3.3 Analyzing Hydraulic Calculations and Development Plan of the Outlet Flow System at the Existing WTP

During the Confirmatory Investigation in 2011, we analyzed the actual conditions of the outlet flow system at the WTP and confirmed that there was a group of wells with high Nitrate concentrations Southeast of the Tisa WTP. Nitrate becomes Nitrous acid in the body of newborn babies, which may cause Methemoglobiemia. Therefore, attention is needed when using water containing a high concentration of Nitrate as drinking water for newborn babies.

Chemical treatment processes (electrodialysis process or ion exchange process using electric energy) and physical treatment processes are available for reducing such concentrations. The distribution pipe from the Tisa WTP was comparatively laid close, so the physical treatment process was selected because the cost was far less inexpensive than that for the chemical treatment process.

As an improvement measure, we suggested to study how to reduce the concentrations by diluting with purified water at the Tisa WTP. During the Field Operation, we investigated Nitrate concentration distributions and studied on how to dilute the Nitrate in the water supply district around deep wells, especially G3, G4, G5B and K3.2 in the region with a high concentration of Nitrate in water based on the Nitrate measurement result. In the Philippines, water quality standards concerning Nitrate concentration is set to 50mg/L (3mg/L for standard concerning Nitrous acid concentration). This figure is converted to approximately 11mg/L of Nitrate Nitrogen, which is equivalent to Japanese water quality standards, "Nitrate Nitrogen and Nitrite Nitrogen 10mg/L".

(1) Confirmation using the Nitrate Concentration Distribution Chart

Based on water quality measurements, we confirmed Nitrate concentration distributions of cells and city water taps in the DMA area with a central focus on G3, G4, G5B, and K3.2. The initial Nitrate concentration distribution chart is shown in Figure 2-3-12. The Nitrate concentration target value, less than 50mg/L, is satisfied at the Tisa WTP and water supply area from the Tisa distribution basin, but the area where water is directly supplied from wells exceeds 50mg/L. However, we determined that the number of measurement points at that time was not enough to discover the true state of the Nitrate mixture in the supply water from the Tisa WTP and wells, so we decided to add measurement points (9 points for water taps, 1 point for PWRI supply point).

The Nitrate concentration distribution during the 4th Field Operation based on the new measurement results is shown in Figure 2-3-13. With this measurement, all Nitrate concentration distributions in this DMA area could be understood. This became a big factor in deciding a method for Nitrate concentration reduction. As the result of closing the deep well K3.2 with a high Nitrate concentration in DMA6E area and water supply was switched to the Tisa Series in November 2012, Nitrate concentration in areas related to 6A and 6E decreased. Taking measures for what could be done and acting quickly were key to the success.

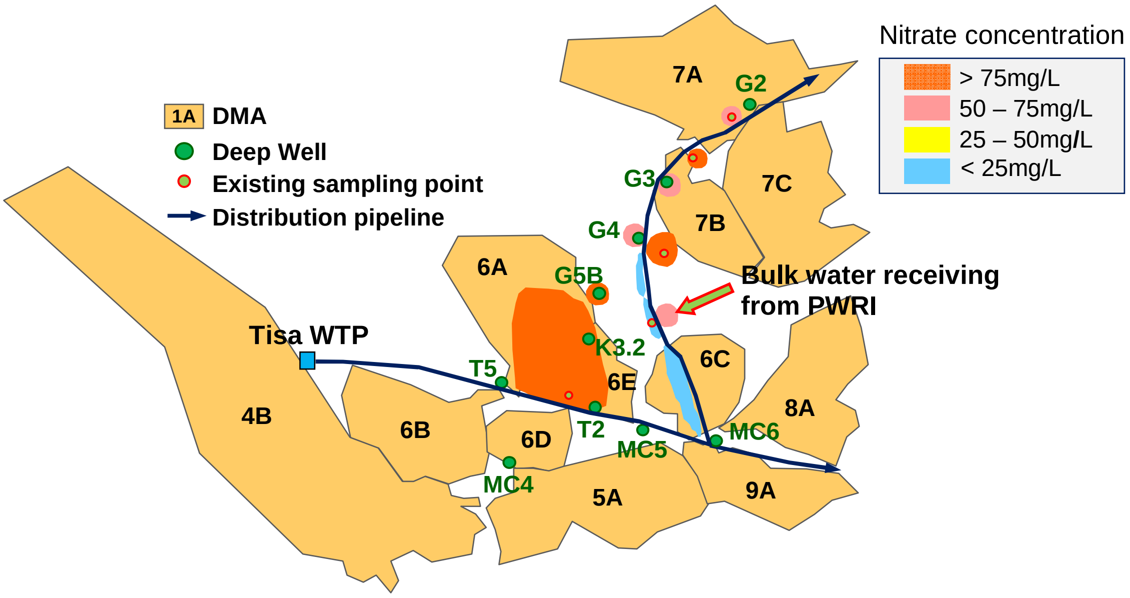


Figure 2-3-12 Nitrate Concentration Distribution Chart (Initial Period)

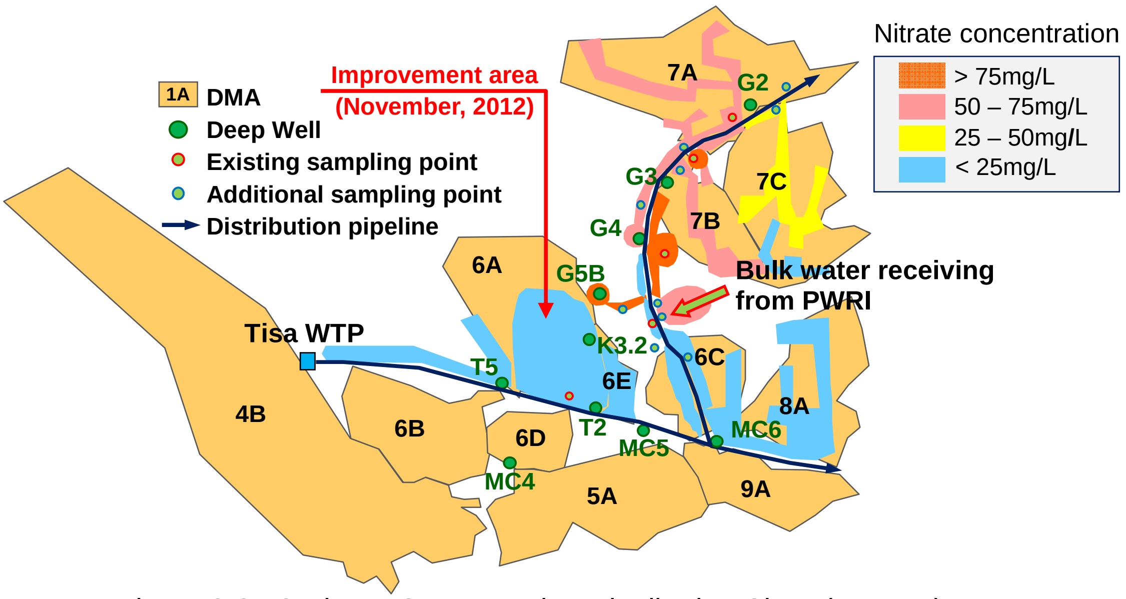


Figure 2-3-13 Nitrate Concentration Distribution Chart (Present)

(2) Determining Dilution Method

To decide on a dilution method, cooperation between the water quality laboratory and the water distribution division based on the Nitrate concentration measurement results is important. First, the Water Quality Laboratory took water from water taps, etc. once a month and performed water quality analyses. Then the Nitrate concentration distribution chart was made. Based on the data, we discussed with MCWD and confirmed a dilution plan to use water supplied by the Tisa WTP and PWRI. At that time, we confirmed the water volume that could be diluted by checking pump up volume from each well and measuring distribution water volume from the Tisa Series.

As the confirmation result, total flow volume of G3, G4, G5B, and PWRI receiving water was 3,200m^3/day maximum, and the flow volume through the laid distribution main pipe (DN400mm) of the Tisa system was 2,700m^3/day (actual measurement). If everything flowed together, the conventional Nitrate concentration would be diluted to approximately 55%.

According to the current distribution network (Figure 2-3-14), deep wells with high Nitrate concentrations, G3, G4 and G5B are not connected to the distribution main pipe (DN400mm) of the Tisa system but connected to the distribution branch pipe (DN200mm), which was branched off from the main pipe. Deep wells, G3 and G5B could be slightly diluted by PWRI receiving water, but a high concentration of Nitrate of the deep well, G4, could not be reduced by supplied water from the branch pipe.

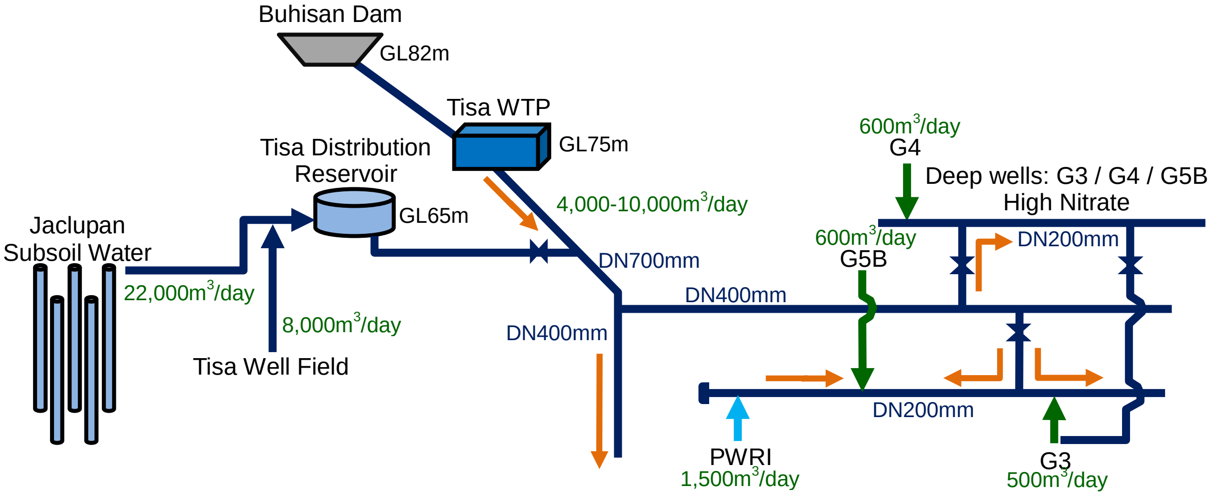


Figure 2-3-14 Dilution of Water Treatment Plant Outlet Series and Group of Deep Wells with High Nitrate Concentration (The Current Pipe Laying)

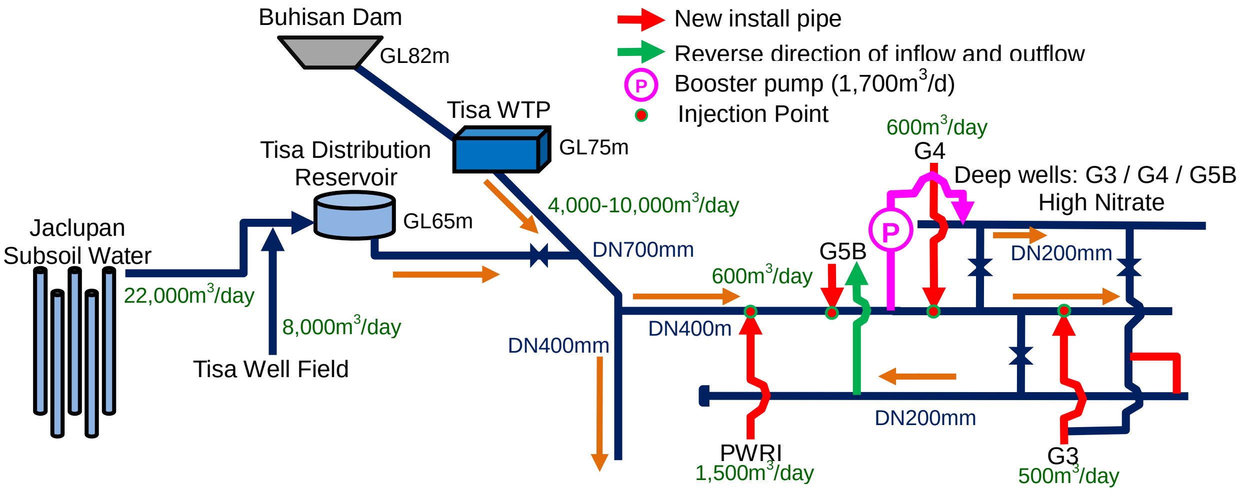


Figure 2-3-15 Nitrate Dilution Idea

As an improvement idea, we can propose that water be supplied after being diluted with purified water from the Tisa Series by connecting all deep wells, G3, G4, and G5B containing a high concentration of Nitrate as well as all PWRI water receiving points to the distribution main pipe of the Tisa Series. This will fully satisfy the concentration target value, less than 50mg/L, in the future.

The improvement idea is shown in Figure 2-3-15.

We proposed to prioritize the MCWD's pipeline renewal plan and expect that the pipeline network improvement construction will be implemented early.

2.3.4 Developing Measures for Deferrization and Demagnetization of Groundwater Containing Excesses of Iron and Manganese that Exceed Water Quality Standard

Water quality issues of drinking water supply which MCWD are facing are that there are points containing high concentrations of Nitrate, Iron, and Manganese in groundwater, which accounts for approximately 95% of water supply, and those concentration figures are close to the upper limit of the water quality standards in the Philippines. There are two types of such groundwater, one is directly supplied to citizens after adding disinfectant chloride to groundwater, and another is collected to the distribution basin and supplied.

There are 2 places where the groundwater wells with high concentrations of Iron and Manganese, W34B and W35. The groundwater quality is shown in the Table 2-3-3. MCWD had examined the method of oxidizing water by chloride treatment, etc. and having filter media absorb it. During the Confirmatory Investigation in 2011, the research group proposed to MCWD to install verification experimental equipment for lowering Manganese concentration by adding disinfectant oxidizer, and MCWD selected an experiment target well (W34B) 6 months later, implemented a construction to install the oxidization equipment, and conducted an experiment using the verification plant (photo below).

Table 2-3-3 Major Water Quality and Pumping Capacity of Wells W34B and W35

Water Examination Item	W34B	W35
Iron (mg/L)	0.12 ~ 2.9	0.32 ~ 0.86
Manganese (mg/L)	0.30 ~ 0.77	1.3 ~ 1.7
pH	6.86	6.86
Color	2	2.7
Total Hardness [Ca, Mg] (mg/L)	490	480
Ammonium Nitrogen (mg/L)	Non Detection	Non Detection
Pumping Capacity (m^3/day)	600	600

The verification plant was operated for about 1 year until the middle August 2012. Iron and Manganese figures after the filtration treatment decreased under the target figures, and we confirmed that the plant had a certain level of effect to deferrization and demagnetization from the measurement record. However, the plant was often stopped due to issues of discharging overflow water caused by backwashing and electric power shortages (frequent power outage). Furthermore, the road in front of the plant is planned to be expanded in 2013 or later, forcing the plant to be removed. The plant will be used as an experiment facility until it is removed, and the tank's base plate was replaced with one made of epoxy resin for rust prevention. Their highly-motivated actions are worth of praise. Iron and Manganese concentrations are low in the area where water is supplied from W34B at present, and water supply in the area has switched to receiving water from PWRI which currently has no water quality issues.

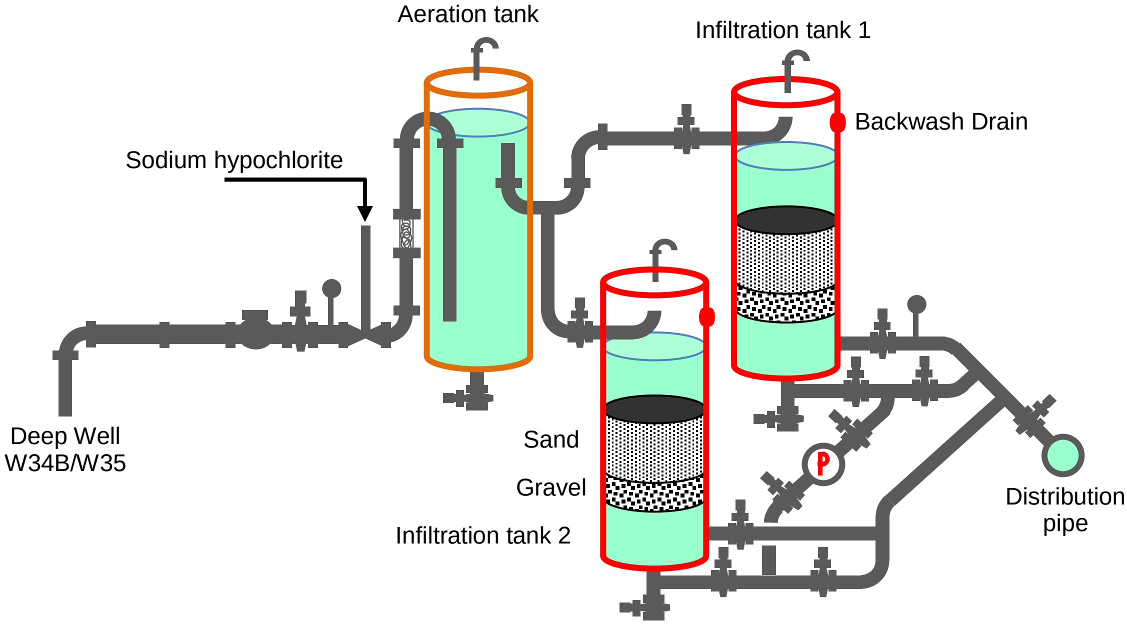


Figure 2-3-16 Deferrization and Demagnetization Treatment Plant

MCWD started a new verification experiment with W35 which a high Iron and Manganese concentrations equivalent to that of W34B. The experiment was to introduce a filtration device using Manganese-Zeolite (product name: Birm Water Filtration Media) (photo on the right) which works as a catalyst for the oxidation of Iron and Manganese. The device consists of a tubular container made of glass fiber, where grained Manganese-Zeolite is filled in, and a control section where and inflow pipe and an effluent pipe are connected to the upper section to cover the top. The control section has normal mode and backwash mode. Power supply is required for the timer-control.

MCWD plans not to conduct timer-control but manual operation of backwashing if they introduce the device in the future. W35 and W34B are branched off of the same pipe. The bench test using Manganese-Zeolite was implemented in July 2012, and deferrization and demagnetization effects were confirmed. As for the on-site experiment, a continuous experiment is being implemented at W35. Establishment of an operation method based on confirmation of the effect duration is expected.

To introduce the device, it is necessary to have the larger sized device considering the flow volume. A certain effect was confirmed with W34B on the verification plant. Making a downsized verification plant (photo on the right) started. We proposed to change a part of the iron materials for rust prevention. We discussed with MCWD that comparison of water quality and cost was important for deciding this measure.

2.3.5 Assessing the Actual Conditions and Issues of Groundwater Quality and On-going Water Quality Improvement Measures

Regarding high concentrations of Nitrate, Iron, and Manganese in groundwater which are easily influenced by the nature of the soil, water quality improvement by Nitrate dilution was examined in 2.3.3 and an examination of Iron and Manganese was made in 2.3.4. A verification experiment of deferrization and demagnetization was implemented using deep wells (W34B/W35).

Water quality inspection results of the groundwater wells are described in "MCWD Artesian Well Monthly/Annual Reports Physical chemical section". Items to be inspected once a year are Chloride ion, Fluorine, Nitrate, Nitrous acid, Cyanogens, Sulfuric acid, Calcium, Magnesium, Iron, Manganese, Aluminum, Copper, Chrome, pH, Color, Total Hardness, Turbidity, Specific Electric Conductivity, Basicity, Suspended Substance, and Evaporation Residue.

When comparing the inspection results in 2012 with the Philippine's water quality standards, items whose concentrations are close to the upper limit of the standards were Nitrate, Chloride ion, Fluorine, Total hardness, and Evaporation residue. Among them, the high concentration of Fluorine requires attention because it causes mottled teeth. To remove Fluorine by chemical treatment, special equipment such as electrolization, etc. is required. The equipment is costly, so physical treatment such as dilution, switching the water source, etc. is preferable. Wells with a high concentration of Iron and Manganese do not supply water now, so they are not indicated in the inspection report.

The future groundwater quality improvement of Nitrate, Iron, and Manganese is described below.

(1) Nitrate

The area containing G3, G4, G5B and K3.2, which are wells with a high concentration of Nitrate, was elected as a model this time to improve water quality by dilution as described in 2.3.3. We confirmed that there are other deep wells (G1, L5, W2B, W13) containing high concentrations of Nitrate at several points. MCWD started a new examination on how to solve such issues including the utilization of chemical treatment.

As a method, using ion-exchange resin or RO film can be pointed out. However, to remove Nitrate only, not the RO film method, which is more expensive than other methods, but the ion-exchange resin method can create sufficient benefit. Therefore, an examination was started by setting the ion-exchange resin to the first plan for using chemical treatment.

(2) Iron and Manganese

To reduce concentrations of Iron and Manganese, the sand filtration and the Manganese-Zeolite experiment are being continued at W34B and W35. Due to an electric supply issue and the road expansion plan, the actual supply of treated water was not implemented. The areas where water is supplied from both wells have been switched to be supplied by PWRI, which does not have water quality issues. Water quality in those areas has been improved. However, MCWD expects that a new water supply area expansion will be realized if high quality pumping water volume from both wells can be supplied. Establishment of deferrization and demagnetization technology is expected.

2.3.6 Assessing the Actual Condition and Issues of Water Quality and Coagulant Injection Rate Settings and Studying Improvement Measures

Water quality inspection at MCWD is conducted by the water quality laboratory. The current system is desirable for inspecting water taps and distribution basins, but water quality inspection items or inspection frequency for the water treatment process were insufficient, and the coagulant injection rate setting was decided based on the empirical rule. We assessed the actual conditions and issues of water quality inspections on site and examined improvement plans.

(1) Review of Water Quality Inspection

MCWD describes water quality inspection items, inspection frequency, and inspection spots in "WSP SCHEDULE OF VERIFICATION". While discussions were made in this project, we improved water quality control by increasing the number of inspection spots. Changes are indicated in Table 2-3-4. As for residual chlorine, the number of inspection spots needs to be increased for confirming safety of MCWD supply areas. It was difficult to cope with inspection with one set of portable type Residual Chlorine meter owned by MCWD, and a new set was procured. In the future, efforts to visualize the Residual Chlorine conditions by making Residual Chlorine map of the supply areas are desired.

Table 2-3-4 Changes of Water Quality Inspection in This Project

Examination Item	Before Project	After Project
Nitrate	No sampling and testing for consumer	Sampling and testing for consumer
Residual Chlorine	25 sampling points testing for direct supply well	50 sampling points testing for direct supply well

(2) Water Quality Inspection for Water Treatment Process

Under the current water quality monitoring system at the Tisa WTP, water quality is monitored by personnel belonging to the Production Division in 3 shifts for 24 hours. Water quality inspection on site is implemented on pH and turbidity using a portable meter every 8 hours, 3 times a day, and the results are recorded on paper. Inspection spots are 6 points, the receiving well, the sedimentation basin, the rapid filtration basin, the slow filtration basin, the water supplying well, and the water reservoir. Water supply volume is recorded once a day. After the modification of the WTP, plans of new important control points, including the sedimentation treatment water and rapid filtration water, and measurement items are being made.

Through discussions with MCWD during this project, we confirmed that MCWD had envisioned the installation of a water quality laboratory branch in the Tisa WTP to control water quality. Realization of this is desirable as it will ensure constant monitoring of water quality and the result of any actions or issues of water treatment will be readily available.

Tisa WTP have decided the coagulation injection rate not by the Jar test but by following the injection rate chart that corresponds to water receiving volume per turbidity of raw water. We proposed a method to conduct a Jar test on site and decide the optimal coagulation injection rate during the Confirmatory Investigation in 2011. However, they do not have a Jar tester on site, so they use the injection rate chart. By modification of the Tisa WTP, it is planned to renew the injection rate chart and reconsider the Jar test.

The Tisa WTP mainly uses PAC as a coagulant. When PAC supply is not made in time, they use Aluminum Sulfate. PAC injection is controlled by an electric pump. Calibration of the equipment was appropriately performed. The electric pump was immediately installed after the research group proposed its introduction to MCWD during the Confirmatory Investigation in 2011, which is a reflection on their desire to improve operation management.

During the 1st Field Operation, an experiment (photo below) using the Jar test was conducted. The purpose of the experiment was "to provide instruction of the Jar test to the staff at the WTP" and "to confirm floc formation conditions by slow agitation". The experiment consisted of Jar tests by MCWD's sedimentation treatment method (rapid mixing for 3 minutes + still standing for 15 minutes) and by YWWB's method (rapid mixing for 2 minutes + slow mixing for 5 minutes + still standing for 15 minutes), and floc formation and settling conditions in each method were compared. As the result, it was clearly and visually confirmed that water quality of treated water (supernatant) by YWWB method was better. Necessity of floc formation device could be recognized by the staff of MCWD.

In the seminar during the 2nd Field Operation, we emphasized an importance of Jar test and the Jar test was introduced on site. The Jar test was manually conducted in the past (manual Jar test is possible now), the experiment can be fully implemented without the equipment like a Jar tester.

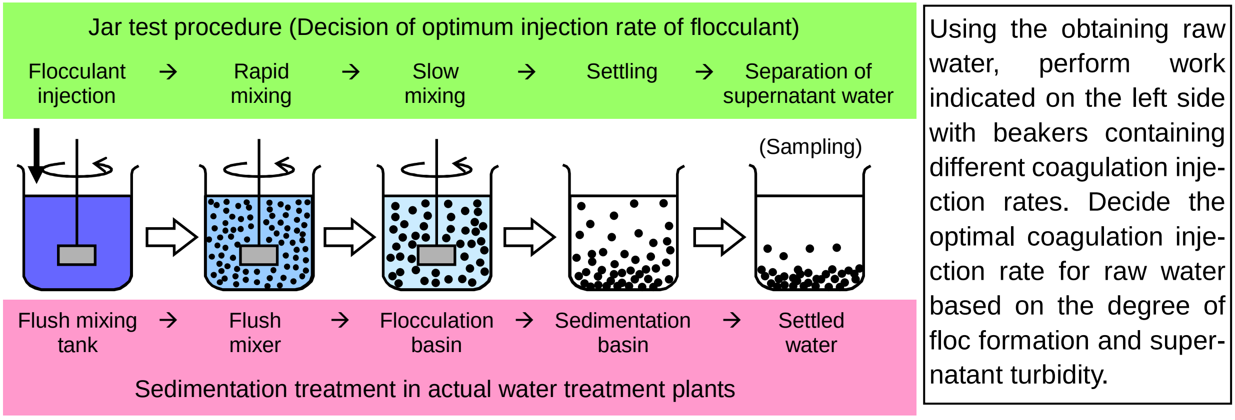


Figure 2-3-17 Deciding the Optimal Coagulation Injection Rate by Jar Test

Before this project started, the sedimentation basin was not functioning at all. It became clear that floc formation could be helped and burden to the filtration basin could be lessened by performing not only the rapid mixing but also the slow mixing to increase the sedimentation effect in the sedimentation basin. Based on the Jar test results, we discussed with MCWD and decided on introducing a slow mixing device to the entrance section of the sedimentation basin. Refer to 2.3.1 above for the structure and size, etc. of the slow mixing device.

During the 2nd Field Operation, the Chlorine injection equipment at the Tisa WTP was broken, and Residual Chlorine could not be maintained at the exit of the plant from the aspects of a safe and stable water supply. Therefore, they maintained Residual Chlorine by joining the process to the water from the Tisa distribution reservoir exit right after the exit of the WTP. Repair of the Chlorine injection equipment was completed, and safe water supply is being implemented now.

A valve is provided at the exit of the WTP and at the exit of the Tisa distribution reservoir, making the flow rate controllable. However, the valve chamber is overlaid by road pavement and cannot be operated. This requires immediate attention.

2.4 Training in Japan

2.4.1 Course Outline

The training course in Japan for the MCWD employees was named "Training on Water Supply Operation and Management for Metropolitan Cebu Water District". It was held over a two-week period from Monday, July 23 to Friday, August 3, 2012, and was attended by ten (10) MCWD employees. Figure 2-4-1 shows an outline of the training.

The training comprehensively covered Field Operation activities in various fields of the current water supply operation and management technical support project for MCWD, mainly water supply systems, leak control, purification control and water quality control. Action plans encompassing the excellent water project operation and management know-how of water services in Japanese cities were devised to improve the water projects conducted by each attending supervisor.

↓

1. Discussions based on reports from the 1st and 2nd Field Operations were conducted between MCWD, YWC and YWWB to gain mutual understanding of issues at MCWD. 2. Trainees learned water supply operation and management know-how possessed by Japanese local governments (mainly relating to supply systems, leak countermeasures and water quality control) and used this to consider and discuss solutions to their own issues. 3. Trainees learned about project operation and management know-how possessed by Japanese local governments (relating to water supply blocks; backup; rehabilitation plans for aged pipelines; leak countermeasures; operation, maintenance and management of water treatment plants; water quality control; business plans, etc.). In addition to lectures teaching the trainees about actual efforts, visits and practical training were conducted for even more effective learning. The trainees then considered solutions to their own issues. 4. The trainees assessed the current situation and issues in the Philippines by comparative analysis of discussions conducted on the first day of training and the technologies they learned about during training. Their understanding was then deepened through presentations (from one member of each training course) and group discussion so that practical plans could be made to improve projects.

↓

Promotion of efforts to improve MCWD's operations based on the discussed proposals and improvement measures.

Figure 2-4-1 Conceptual Diagram of Overall Course

The schedule and training curriculum were as shown in Table 2-4-1 and 2-4-2. We asked MCWD about their needs for training content during the 1st and 2nd Field Operation and reflected these needs in the training items as much as possible.

The ten (10) trainees were as shown in Table 2-4-3. Eight (8) technical employees attended the water distribution course, including one (1) technology-related business employee, and two (2) chemical employees attended the water quality course.

Table 2-4-1 Training Schedule

Course		[Water Distribution] 8persons		[Water Quality Management] 2sersons	
Date		9:30 - 12:00	13:30 - 16:00	9:30 - 12:00	13:30 - 16:00
Jul. 22	Su	Arrival in Japan			
Jul. 23	Mo	[C00] JICA Briefing @YIC/SR	[C01] Courtesy call / Discussion @YWWB HQ	[C00] JICA Briefing @YIC/SR	[C01] Courtesy call / Discussion @YWWB HQ
Jul. 24	Tu	[C02] Overview of Yokohama and Japan waterworks / Business management @YIC/SR	[D03] Waterworks planning / Distribution planning @YIC/SR	[C02] Overview of Yokohama and Japan waterworks / Business management @YIC/SR	[Q04] Overview of inspection for water quality @YIC/SR
Jul. 25	We	[C05] Water treatment operation / O&M of WTP / Rehabilitation of sand filter material @Kosuzume WTP		[C05] Water treatment operation / O&M of WTP / Rehabilitation of sand filter material @Kosuzume WTP	
Jul. 26	Th	[D06] Distributing block system / Water supply operation (Back-up system) @YIC/SR		[Q07] Water resource research @Nishiya WTP >> Sagami Lake	
Jul. 27	Fr	[D08] Water leakage inspection planning / Water leakage inspection training (pipe facilities) @Pipeline Training Yard (Nishiya WTP)		[Q09] Chemical analysis (ICP: Inductively Coupled Plasma - Atomic Emission Specryometry) @Water Quality Laboratory	
Jul. 28	Sa	Sorting out materials			
Jul. 29	Su	Prepare for Training results presentation			
Jul. 30	Mo	[D10] Designing of pipeline training facilities @ Western Area Construction Division [M11] Marketing Policy / Application Process @YWWB		[Q12-1] Biological analysis 1 @Water Quality Laboratory (Nishiya WTP)	
Jul. 31	Tu	[D13-1] Field Trip for Mapping system company (Planning, Designing, Programing, Drawing) @Kokusai Kogyo Company		[Q12-2] Biological analysis 1 @Water Quality Laboratory (Nishiya WTP)	
Aug.1	We	[D13-2] Mapping system 1 (Waterworks' viewpoint) @Nishiya WTP BO	[D13-3] Mapping system 2 (Operator's viewpoint) @Nishiya WTP BO	[Q14] Water quality management in pipeline network @Kikuna Water Plaza	[Q15] Taking sample water at the point in the city
Aug.2	Th	[D16] Water meter management / Service pipe management @Meter Yard	[D17] Pipeline renewal plan @YIC/SR [M18] PR / CS / ES / Kaizen @YWWB	[Q19] Participation in Parent-Child Water Treatment Classroom @Kawai WTP	
Aug.3	Fr	[D20] Preparation for Training results presentation @YIC/SR	[C21] Training results presentation / Finalizing @YIC/SR	[D20] Preparation for Training results presentation @YIC/SR	[C21] Training results presentation / Finalizing @YIC/SR
Aug.4	Sa	Departure			

[C]: Common / [D]: Distribution / [Q]: Water Quality / [M]: Business Management

YIC: JICA Yokohama International Center / SR: Seminar Room / BO: Branch Office

2-4-2 Training Curriculum

Item	Date Time	Content, Aims and Format [Format is written in parentheses]	Venue
[C01] Kick-off Discussion	7/23(Mo) PM	Trainees were asked to fill out a questionnaire relating to water business operations before training started. Discussions were conducted based on their answers to determine issues in the trainees' cities. Consultation based on YWWB's prior experience and know-how may help to solve some issues. Discussing this at the start of training made it possible for the trainers to confirm what the trainees needed to learn and help them to solve their issues. [Discussion]	Ken Yokoyama (YWC) @YWWB
[C02] Overview of Yokohama and Japan waterworks / Business management	7/24(Tu) AM	Before commencing training, we told the trainees about the state of waterworks at YWWB and in Japan. We gave an outline of Japanese waterworks, from the role of the national Ministry of Health, Labor and Welfare to the water companies in Japan's cities, and an explanation of the waterworks system designed for Yokohama. We compared this with Cebu and provided on-the-spot answers to trainees' questions about the different water project environments. [Lecture]	Takeo Tanaka, Akiko Takeuchi (YWWB) @YIC/SR
[D03] Waterworks planning / Distribution planning	7/24(Tu) PM	A waterworks plan is a plan that anticipates future demand for water (growing use of water supplies among the population) in order to gradually set up suitable water facilities for this growing scale of use. We told the trainees about YWWB's water plan, water demand projections and water supply plans. We also told them about YWWB's water rights at the request of the trainees, although some areas do not have water rights. [Lecture]	Ken Yokoyama (YWC) @YIC/SR
[Q04] Overview of inspection for water quality	7/24(Tu) PM	The trainees learned about the kinds of water quality testing conducted at the water quality laboratory at Nishiya WTP and aspects such as water quality testing plans, test items and frequency, with information on relevant Japanese water laws. All of YWWB's WTPs are accredited with the ISO9001 international quality control standard, and water quality testing for quality control is conducted in laboratories accredited with the ISO/IEC17025 international testing standard. The trainees learned about the strict quality control and high technical standards of our water quality testing system and absorbed it as a reference for quality control in their own cities. [Lecture]	Takahiko Nakai (YWWB) @YIC/SR
[C05] Water treatment operation / O&M of WTP / Rehabilitation of sand filter material	7/25(We)	The trainees learned about purification treatment processes, operational management methods and maintenance management methods at Kosuzume WTP, YWWB's largest WTP. The settling method is used, with a settling tilt plate installed in the transverse ventilation sedimentation basin and rapid filtration performed. The trainees learned about aspects such as the setting of the coagulant injection ratio to form a good floc, rapid mixing, surface and backwashing by rapid filtration, the volume of water for backwashing, time allocation, and maintenance management of treatment of the created sludge. They received a lecture on the operational management of the WTP and maintenance management of electrical facilities at the WTP, and toured the inside of the WTP. Tour course: Receiving well → Mixing well → Sedimentation basin → Filtration basin (Sand washing process for filtration basin) → Wastewater treatment facility → Water Quality Laboratory (included a tour of the Chemical closet, Self-powered power supply equipment, Power receiving room, Fish monitoring equipment and Equipment for measuring water quality in the survey area) [Lecture/Tour]	Tomohito Furuya (YWWB) @Kosuzume WTP

Item	Date Time	Content, Aims and Format [Format is written in parentheses]	Venue
[D06] Distributing block system / Water supply operation (Back-up system)	7/26(Th)	We told the trainees about the SCADA system, YWWB's comprehensive water monitoring system in which a computer is used to perform total system monitoring and process control of every aspect, from water sources outside Yokohama to the WTPs and water distribution network in YWWB. We also told them about our operation plans. YWWB's water supply uses a DBS consisting of small, medium and large blocks, with the small blocks similar to DMA. In 1971, large blocks were formed with the distribution reservoirs as constituent units. Each large block was divided into medium blocks with pump systems or gravity flow systems. These were in turn divided into small blocks, of which there are now around 250. All of these are monitored. We also told the trainees about the backup system between blocks so that customers' water is not cut off if an accident occurs in a water supply facility, and how water supply systems are built to ensure that water is supplied at a suitable pressure. [Lecture]	Ken Yokoyama (YWC) @YIC/SR
[Q07] Water resource research	7/26(Th)	Although surface water from dams currently accounts for only 5% of MCWD's water, dam construction will see it account for a larger percentage in the future. The trainees attended a water source quality investigation by the waterworks department and compared it to MCWD's, allowing them to find the best way to collect raw water from water sources. The raw water collected here was used for the chemical and biological testing conducted in later lectures, showing the trainees what an important role water collection plays in the process and allowing them to draw comparisons. [Lecture/Practical]	Minako Mashino (YWWB) @Nishiya WTP → Sagami Lake / Tsukui Lake
[D08] Water leakage inspection planning / Water leakage inspection training (pipe facilities)	7/27(Fr)	YWWB has maintained a leakage rate of around 5% in recent years, compared to a reported leakage rate of 70%~80% immediately after World War II. We told the trainees about how we decreased the leakage rate, the history of our leak countermeasures, and our leak detection equipment. We also explained our leak detection theory with a correlating formula that is effective for discovering leaks, and gave an outline of our nighttime minimum flow measurements that are effective for measuring leaks in a DMA. The trainees received practical leak detection training at the pipeline training facilities in YWWB's Nishiya WTP. If a leak discovery site was awaiting repair, they tried inspecting the area to find the leak. They also observed the repair work process at a leak repair site, from the perspective of Japan's focus on safety and efficiency. [Lecture/Practical]	YWWB Technical Members @Pipeline Training Yard (Nishiya WTP)
[Q09] Chemical analysis (ICP-AES)	7/27(Fr)	We told the trainees about the role of chemical analysis in water quality testing based on YWWB's water quality testing plan. We explained ICP (Inductively Coupled Plasma - Atomic Emission Specryometry) emission spectrometry, an area of interest for MCWD, and the trainees received practical training in testing methods. Chemical testing was done with the raw water collected on the previous day. [Lecture/Practical]	Yasuaki Honjo (YWWB) @Nishiya WTP
[D10] Designing of pipeline training facilities / Service pipe material	7/30(Mo)	Part of the contract between JICA and MCWD, and an important part of this project, was support for the design of pipeline training facilities. MCWD viewed these facilities as something that would be greatly important in the future, and creating the basic concept of these facilities and producing a basic design was of high priority in this training. As YWWB has pipeline training facilities, these were used as a reference and the features of the pipeline training facilities to be implemented at MCWD were primarily decided by the trainees. It is also hoped that this will be a part of their action plans. [Lecture/Practical]	Ken Yokoyama (YWC) @Western Area Construction Division

Item	Date Time	Content, Aims and Format [Format is written in parentheses]	Venue
[M11] Business Planning / Water tariff / Marketing Policy / Service Application Process	7/30(Mo)	When expanding a business, it is important to have a short-, medium- and long-term direction for the business and devise a financial plan accordingly. We explained how YMMB creates a long-term vision (10+years) and devises three-year medium-term business plans for the running of its business. Although the financial situation of the Philippines is very different to Japan's, this lecture provided an opportunity for the trainees to learn the principles of creating plans to further their businesses. Each city has a different water tariff system to suit its specific situation, and it is difficult to discern which system is correct. We used YWWB's water tariff system as a base to explain how to balance income and expenditure when running a water company with an independent accounting system. We explained cases relating to various aspects of water tariffs, from meter reading to billing practices and collection, and compared these to cases in the trainees' cities. [Lecture]	Akiko Takeuchi, Takayuki Ichikawa (YWWB) @YWWB
[Q12] Biological analysis	7/30(Mo) ~ 7/31(Tu)	We told the trainees about the role of biological analysis in testing water quality according to a water quality testing plan. Biological testing is done by MCWD as the majority of their collected water is subsoil water, but more biological analysis will become necessary with the future switch to surface water. We therefore explained biological analysis and gave practical training in aspects such as testing methods. Biological testing was conducted on the raw water collected the previous week. [Lecture/Practical]	Shinichi Sasaki (YWWB) @Nishiya WTP
[D13] Mapping System	7/31(Tu) ~ 8/1(We)	Where WTPs are the cornerstone of water supply preparation, water distribution facilities (distribution pipes) are the cornerstone of supplying water to customers. If there is insufficient mapping of the distribution network, pipeline network information cannot be obtained when making designs for replacement of aged pipelines, expansion of pipeline networks or system changes. YWWB now uses a digital pipeline ledger (mapping) system, but paper information was used in the past. We looked back on that period to find a pipeline ledger system that the trainees could apply in their cities. Lectures, tours and practical training were conducted, with trainees learning about mapping not only from YWWB's perspective but from that of the operators also. At the beginning of this section, the trainees learned about mapping design at an operator's head office. [Lecture/Tour]	Masahiro Chiba (YWWB) @Nishiya BO Sanyu Nakamura (KKC) @KKC Tokyo Office
[Q14] Water quality management in pipeline network	8/ 1(We) AM	Water quality management and testing does not end at the WTP; it is also required in the distribution network that stretches a long way from the plant and accounts for 3/4 of a water supply system. We gave a lecture on the main points of water quality in distribution networks, centering on photographs. [Lecture]	Hitoaki Sato (YWWB) @Kikuna Water Plaza
[Q15] Taking sample water at the point in the city	8/1(We) PM	MCWD has few designated urban water sampling points. Its water system includes wells with a high Nitrate concentration, and this water and treated water from the WTPs is diluted to reduce the Nitrate concentration. Regular measurements need to be taken to monitor this process. Water sampling points are decided based on the purpose of sampling, the number of employees involved in sampling, and the length of the analysis cycle. The more sampling points, the better, but it is also important to balance this with efficiency and cost. Therefore, this lecture aimed to enable the trainees to select points where sampling can be done easily. [Inspection/Practical]	Koji Oki (YWWB) @In the city

Item	Date Time	Content, Aims and Format [Format is written in parentheses]	Venue
[D16] Water meter management / Service pipe management	8/2(Th) AM	We told the trainees about the structure and measuring method of Japanese-made water meters and explained how water meters record usage with an accuracy of 90% or higher (Japanese national average) and how water is supplied. During practical training, the trainees took apart and reassembled a water meter. They were also shown the tools used when stopping a water supply and the structure of a water meter box. They received practical training in measurement testing of a small diameter (DN13mm) and large diameter (DN300mm) water meter in the water volume measurement laboratory. [Lecture/Practical]	Ken Yokoyama (YWC) @Nakamura Meter Yard
[D17] Pipeline renewal plan	8/2(Th) PM	We told the trainees about YWWB's rehabilitation plan for aged pipelines and gave a talk about the risks of using aged pipelines and programs for rehabilitating these, based on the report of a 2008 plan for improvement (quake-proofing) of aged pipelines. [Lecture]	Ken Yokoyama (YWC) @YIC/SR
[M18] PR / CS / ES / Kaizen	8/2(Th) PM	Customer Service and PR activities are a connection between a water company and its customers (and prospective customers). Therefore, in addition to learning about various activities done by YWWB, the trainees shared information on the activities done in their own cities and determined strong points and points for improvement. [Lecture]	Miyabi Yamashita, Akiko Kuniyasu (YWWB) @YWWB
[Q19] Participation in Parent-Child Water Treatment Classroom	8/2(Th)	As part of YWWB's PR and customer service work, employees visit local elementary schools and use models and experiment equipment to teach them about the processes by which their water reaches them. The trainees participated in a Parent-Child water treatment classroom, which included a tour of facilities, summer holiday exercises and tips for self-study projects, water experiments, and water tasting. [Tour/Practical]	YWWB Water Quality / Kawai WTP Staff @Kawai WTP
[C20] Preparation for Training results presentation	8/3(Fr) AM	Prior to the action plan creation coaching, we gave an explanation on action plans. The trainees then gave a presentation of their action plans, with YWC verifying the suitability of the content (practical viability) and structure (visual appeal of the presentation). [Coaching]	Ken Yokoyama (YWC) @YIC/SR
[C21] Training results presentation / Finalizing	8/3(Fr) PM	A trainee from each course presented their action plan to the trainers from YWC and YWWB. Each trainee was given a total of 25 minutes, with 20 minutes for the presentation and 5 minutes for questions. The trainees also evaluated the training using a questionnaire they had answered beforehand. [Presentation/Discussion]	Ken Yokoyama (YWC) @YIC/SR

Table 2-4-3 Participant list

No.	Name	Post	Occupation	Picture
1 [D]	Edgar Dy ORTEGA	Division Manager C	Production and Distribution Department	
2 [D]	Jose Eugenio Buenconsejo Jr SINGSON	Department Manager C	Maintenance Support Services Department	
3 [Q]	Rico Cesar BONTILAO	Principal Engineer	Production and Distribution Department	
4 [M]	John Neville Torres MACABINTA	Division Manager C	Corporate Planning Department / Planning & Monitoring Division	
5 [D]	Veronico Perino CASTRO	Principal Engineer C	Pipelines Maintenance Department – North	
6 [D]	Jorge Luna GABRIENTE	Department Manager C	Pipelines Maintenance Department – South	
7 [Q]	Rebecca Lagunzad HUSAYAN	Supervising Chemist	Production and Distribution Department	
8 [D]	Andrew Laput MAGNO	Division Manager C	Engineering Department / Planning Division	
9 [D]	Richard Gemarino MISAL	Division Manager C	Engineering Department / Planning Division	
10 [D]	Rainier Kho QUINONES	Supervising Engineer A	Pipelines Maintenance Department – South	

2.4.2 Training Evaluation

(1) Lectures

The aim of the lectures was for trainees to be able to devise an action plan based on the excellent water project operation and management know-how possessed by Japan's urban water services to improve issues in MCWD's water supplies such as high leakage rate and water quality improvement. Trainees' potential to do this after training was graded on a scale of 1 to 5, with 4 as the passing grade. All 10 trainees passed. This is likely a result of the needs and feedback from trainees being reflected in the training content for the 2nd Field Operation.

Table 2-4-4 Training Evaluation

	← Achieved			Not achieved →		No response	Average
	[5]	[4]	[3]	[2]	[1]		
Lecture (Training Course) Evaluation	9	1					4.9

(2) Discussions and Presentations

1) Kick-off Discussion

The state of operations at MCWD up to the 2nd Field Operation was confirmed through a start of training discussion between the trainees and YWC and YWWB employees based on reports from the project team up to the 2nd Field Operation.

Items for confirmation included the implementation of slow mixing equipment, regeneration of filter media for rapid filtration basins, leak detection situation, formation of blocks to dilute the concentration of Nitrates, and water business operation. YWWB and YWC provided advice on MCWD's current issues. Below are the main points on which advice was given.

- ◆Regeneration of filter media for rapid filtration basins
- ◆Methods for setting coagulant injection ratio
- ◆Improvement of test plants for deferrization and demanganization
- ◆Hydraulic calculation and formation of water supply blocks for distribution pipes involved in Nitrate dilution
- ◆Causes and solutions for areas without a 24-hour water supply

2) Final Discussion

We received feedback that the training provided timely information for solving MCWD's issues, including:

- ◆Implementation plan and evaluation for leak detection
- ◆Structure and operational situation of mapping systems (YWWB and KKC zones)
- ◆Basic design of pipeline training facilities
- ◆Water supply block and DMA backup

- ◆Operational and maintenance management of WTPs using surface water from dams as a water source
- ◆Customer Service, Employee Satisfaction, PR, use of the KAIZEN principle

3) Action Plan Presentation

One trainee from the water supply course, one trainee from the water quality course and the business department supervisor from the water supply course each gave a presentation on what they learned during the training, which items they would include in their reports to their superiors and inform their colleagues about, and future activities that the trainees would perform in light of the activities in this project.

(a) Water Distribution Course

The presentation covered a plan, basic design and implementation schedule for pipeline training facilities, backup for water supply blocks, cause analysis and solution efforts to provide 24-hour water supplies, rehabilitation plan for aged pipelines, and improvements of mapping systems.

(b) Water Quality Course

The presentation covered implementation of slow mixing equipment in sedimentation basins, regeneration of filter media and inspection and repair of the basin of rapid filtration basins, training on aeration treatment for the Buhisan Dam, and budget approval and future scheduling for research on water quality monitoring at dams and water treatment plants.

(c) Business Management

The presentation explained how YWWB's Customer Service, Employee Satisfaction, PR and use of the KAIZEN principle would be reflected in the "2020PLAN", a mid-term business plan devised by MCWD.

4) Tours, Practical Work and Drills

Although surface water accounts for only an extremely small part of MCWD's water treatment systems, the trainees learned information that will become necessary when dams are developed in the future and surface water is more widely used. The operational training (leak detection) drill and facility design drill for the future implementation of pipeline training facilities were also extremely significant.

(3) Training Period, Layout and Content

Like last year (2011), there were two courses: a Water Distribution Course and a Water Quality Course. With only two trainees in the Water Quality Course, it was possible to give individual attention to the trainees. The Water Distribution Course contained 7 trainees from the fields of water

supply, leak control and mapping. The course was designed to extensively cover each of these three fields, and satisfactory feedback was considered to have been received from all of the trainees.
One trainee from the Water Business Management Field attended the training in Japan for the 2nd Field Operation. We therefore ascertained this trainee's needs for a special administrative course and added a day and a half of business-related training.
Sufficient opinion exchange about the content of this training was performed during the 2011 MCWD executive training and previous field operations. This played a major role in the feedback received for this training.
Final confirmation of the training content was done during the 2nd Field Operation and additional requests were incorporated as much as possible. As a result, the training content is considered to have been suited to the current progress of the Field Operations.

Questionnaires were answered and discussions were held as necessary during each lecture. This appeared to increase the trainees' understanding and provide good material for comparing cases from MCWD and YWWB.
The Water Distribution Course included a tour of the facilities at Kosuzume WTP. This gave the trainees a deep understanding of the effectiveness of installing slow mixing equipment and baffle plates in sedimentation basins, measures that have been suggested to solve issues at Tisa WTP. Before the lecture on designing pipeline training facilities, the trainees received a variety of training at pipeline training facilities. This gave them a specific image of such facilities, which is considered to have helped them when they worked on a basic design of their own. The training on mapping included lectures from KKC, which provided trainees with an understanding of the process by which various types of information is digitized. Discussions were also conducted about organizations that combine lifeline information from water companies and other companies (such as road management organizations), providing a large number of hints about how to solve MCWD's issues.
In the Water Quality Course, trainees took raw water samples from water sources (Lake Sagami and Lake Tsukui) which were then used in the lectures and practical training on chemical and biological testing. This provided trainees with a specific image of a water source that they could envision in their work. The trainees showed an interest in the equipment used in the lectures, such as the water sampling equipment and electronic microscopes, and were seen discussing whether to adopt it at MCWD.
The Business Management Course was attended by only one trainee and the course was composed according to requests submitted by the trainee in advance, with the result that a productive course was considered to have been conducted in only one and a half days.

There was overlap between many sections of the lectures, such as overall outlines, and there were requests to remove some items in the evaluation session. YWWB had already received requests to omit overlapping content such as the overviews of Yokohama and the content at the beginning of the lectures, but this feedback made us aware that these requests had not been sufficiently met. In future, overlapping content such as the overview of Yokohama will be thoroughly omitted to allow for smooth progression of lecture content throughout the training period.

This year, the lectures for the Water Distribution Course were mainly conducted by YWC and the lectures for the Water Quality Course were conducted by YWWB. Although some of the communication during the Water Quality Course was in Japanese, we also made use of our extensive experience in international cooperation in fields such as leak countermeasures and water quality control, and believe that we did these justice in our lectures and practical training.

This was the second training conducted, after the 2011 training in Japan for MCWD executives, and was held after conducting Field Operations for this project. This resulted in smooth running of the courses, even with two or even three courses running concurrently due to the division of roles between YWC and YWWB in advance.

The questionnaires submitted by the participants for the evaluation showed the training to be suitable, but during the evaluation session they requested that the training be longer. The curriculum was extremely highly regarded, partly as a result of sufficient discussions between MCWD and the project team prior to the training.

(4) Texts, Equipment and Facilities

The texts were distributed in advance, filed in separate folders for each lecture. A large amount of time was allowed for questions in each lecture, with the questions answered on the spot. No daily reports were assigned.

Many trainees criticized the temperature of the JICA seminar room, saying that it was hot and uncomfortable compared to the fairly strong air conditioning used in Cebu.

2.4.3 Trainees and Training Environment

(1) Prerequisites

There were delays with the application forms made by YWC and supplied by MCWD, with the result that one applicant was unable to obtain a passport in time for the Visa issuance date. In future, when receiving applications, we will need to be sure to check that applicants have received the application form and obtained a passport.

The trainees represented a variety of roles within the MCWD organization, from top executives the equivalent of assistant directors or section chiefs in Japan to site leaders such as senior technicians and supervising technicians. Every trainee was an important member of their respective area of MCWD and was sufficiently qualified for the training.

As mentioned below, their language (English) abilities were above the prerequisite.

(2) Motivation for Training and Attitude during Lectures

In the central Visayas region of the Philippines, in addition to the standard language of Cebuano and the official Filipino language of Tagalog, English is extremely widely spoken due to the large influx of American culture. Although Filipino children receive the same amount of English education as Japanese children, learning it as part of the curriculum from the time they graduate elementary school, Filipino people speak English at a much higher level than Japanese people.

A large number of the trainers who gave lectures for this training were able to do so in English, which made lectures run smoothly with no time needed for interpreting. Being able to conduct discussions without interpreting kept the trainees' motivation for the lectures high, and the trainees were seen working earnestly throughout the lectures.

A large number of systems in which lectures can be conducted without interpreting need to be set up in countries like the Philippines and African countries, where English is used almost as a common language.

(3) Training Environment

Electricity was being conserved due to the March 2011 disasters, and the trainees apparently found the low level of air conditioning in the facilities extremely uncomfortable.

Unrelated to the lectures themselves, criticisms of the living conditions during the training were raised in the evaluation session. Common criticisms were that the trainees only had access to wireless LAN (Wi-Fi) in JICA Yokohama, with none in their accommodation facilities, and that there were no English TV channels and no English-speaking staff in their accommodation facilities.

Many trainees were also unhappy that they could not ask Yokohama citizens for directions as many Japanese people cannot speak English. Although this occurred at a time when the trainers and host staff were not around, we would like to try to devise countermeasures for this issue.

2.4.4 Use of Training Results

As this training is one of the programs in this project, MCWD has asked the trainees about the knowledge they gained and details about activities they will conduct in the future as their next step, such as designing a mapping system and pipeline network, and distribution network calculations for model cases. It is hoped that the trainees will play an integral role in the operations of the technical support project, working with the project team and using the knowledge they gained during training to further the project. We are happy with what we have seen them achieve.

Photographs (1/3)

[C01] Courtesy call to YWC&YWWB (Jul.23)

[C01] Group photo in Courtesy call (Jul.23)

[C01] Kick-off Discussion (Jul.23)

[C02] Overview of Yokohama waterworks (Jul.24)

[Q04] Overview of inspection for water quality (Jul.24)

[C05] Water treatment operation (Jul.25)

[Q07] Water resource research (Jul.26)

[D08] Water leakage inspection planning (Jul.27)

[D08] Water leakage inspection training (Jul.27)

[D08] Service pipe installation training (Jul.27)

Photographs (2/3)	
 [Q09] Chemical analysis (ICP) (Jul.27)	 [D10] Designing of pipeline training facilities (Jul.30)
 [Q12-1] Biological analysis 1 (Jul.30)	 [M11] Marketing Policy / Application Process (Jul.30)
 [Q12-2] Biological analysis 2 (7/31)	 [D13-2] Mapping system 1 (Aug.1)
 [D13-3] Mapping system 2 (Aug.1)	 [Q14] Water quality management in pipeline (Aug.1)
 [Q15] Taking sample water in the city (Aug.1)	 [D16] Water meter management (Aug.2)

Photographs (3/3)	
 [Q19] Parent-Child Water Treatment Classroom (Aug2)	 [M18] PR / CS / ES / Kaizen (Aug.2)
 [C21] Final Discussion (Aug.3)	 [C21] Finalizing (Aug.3)
 [C21] Closing Ceremony (Aug.3)	 [C21] Group Photo in Closing Ceremony (Aug.3)

3. Issues, Measures and Training during Project Implementation and Operation (Administrative Implementation Methods, Operational Framework, etc.)

3.1 Differences in Principles and Policies

MCWD is now aware of the excellent skills, know-how and systems of Japanese waterworks after information on water projects in Japan was provided in executive training (7 people including the General Manager) and worker training (10 people). However, in terms of the skills required for each project, business and work process, MCWD are confident in their organization's implementation and operation of past projects. Therefore, before implementing skills from Japan, it is necessary to sufficiently explain how they differ from what MCWD has done in the past and how reasonable they are, and receive MCWD's understanding.

This technical support project is for water companies. It will be difficult to gain these companies' acceptance of something outside of MCWD's principles and policies and convince them that the implementation of Japanese skills is in their best interest if we do not have a long history and extensive experience in applying these methods in actual water utilities. For example, if MCWB is 30 years behind YWWB in a particular field, it will be easier to gain their understanding and convince them to accept the costs if we explain the state of YWWB around 20 years ago and propose the technology used then, rather than suddenly implementing the latest technology. Instead of using the latest technology, we recommended technical know-how with which YWWB had past experience. To cite specific examples, a handmade vertical baffled mixing unit was installed at a sedimentation basin and on-site Jar testing was performed by hand by 2~3 employees. Employees also undertook the onerous job of rebuilding a rapid filtration basin by themselves. The site operators were also skeptical of these measures at first, but after considering and discussing it together, they implemented the system. Upon seeing its effects, they showed their approval with satisfied smiles and even cheers.

3.2 Methods for Transporting and Implementing Technology in MCWD Organizations

Various proposals have been made during the course of this project. The purpose of these has always been for MCWD to understand our point of view and train a sustainable workforce that can pass along know-how and make improvements by their own discretion in the future. Therefore, instead of simply giving instructions and orders, we generally endeavor to convince MCWD to accept our proposal and implement the system by gaining their understanding and approval. Specific implementation requires the consent of MCWD's top executives and an organization-wide decision. Proposals to MCWD have therefore been attended by the top executives in addition to general employees, after which everybody discussed and deliberated on the matter.

It takes time for mutual agreement to be reached and consent to be given. We have therefore endeavored to use the short period of 13 months wisely to ensure good project progress, mutually confirming which matters need to be decided during the Field Operation and which matters require mutual deliberation during nationwide work until the next Field Operation.

Waterworks also include a wide range of fields such as water quality, purification, supply, leak control, business operations and Customer Service. It is important that all of these are interlinked and a focus is placed on integrated operation. Throughout this project, we have endeavored to create an environment and practices in which MCWD's general employees are included in discussions by making sure that all expert members agree and including MCWD's general employees in our discussions. This means that water quality and water supply staff contribute to the operational management of WTP, and water quality, supply, leak control and business staffs discuss matters at the same table.

3.3 Know-how Obtained through Technical Support

One endeavor we asked of the project team, both in this project and in the Confirmatory Investigation in 2011, was to identify the strengths of the MCWD employees. While this is a technical support project, we did not want to simply give advice and recommendations. We were sure that there were things we could learn from MCWD, and believed that having them point out and share these things would not only build the confidence of MCWD but be a learning experience for YWWB. Indeed, meetings and briefing sessions saw MCWD employees point out methods that were better than Yokohama's and that we would like to implement in YWWB. These were met by cheers and applause, with smiles all round.

MCWD held a thorough orientation for users of the new water supply, in which the contents of the contract were fully explained. As a result, a fine system for non-payers has been implemented smoothly and a discount system for excellent payment performance has also been adopted. These systems have not been implemented by YWWB, and while discussion would be needed in order to implement them here, it can be said that they are excellent systems. MCWD also cuts off the water supply of non-payers more quickly than YWWB. YWWB can only do this after 6 months of non-payment, but MCWD do it after two months. These contractual obligations were explained at the orientation and approval was received from residents.

MCWD employees were extremely astute and dedicated to research. When oxidation and sand filtration methods for removing Iron and Manganese from the water were suggested, the water quality department immediately built a testing plant. They were so determined to test the vertical baffled mixing unit while we were there that they worked around the clock to build it. When a suggestion was made to use stones for the rapid filtration instead of grinding up the gravel layer of the ground, they immediately began gathering stones from a river bed owned by MCWD. They impressed us in many ways.

The operation of the new leak detector "D305" and ultrasonic water flow meter implemented in this project was met with a great deal of curiosity and a positivity that we would like to emulate ourselves. These qualities are shared by every MCWD employee from the executives to the site staff.

3.4 New Growth Strategies

Throughout this project, there was a sense of camaraderie, that we were one company working together to operate and manage the waterworks. As a result, everybody from local site staff to the executives explained their various needs.

During deliberations on the implementation of a mapping system, additional reinforcement from a specialist company was approved and we were able to have discussions with MCWD about transporting technology from an advanced Japanese company. Additionally, although MCWD have acknowledged that maintenance and management of the rapid filtration basin requires periodic regeneration work, we would like to create opportunities to introduce Japanese companies with knowledge of mechanized and automated regeneration work, so that we can expand this method throughout Southeast Asia in addition to MCWD. We introduced some using slides and videos at the seminar conducted during the 2nd Field Operation.

Additionally, to achieve and maintain a low leakage rate in the future, it is important to maintain manhole covers on the roads for facilities such as gate valves to ensure rapid response to accidents such as burst water pipes. We believe that it is necessary to introduce some of the excellent products from Japanese companies. A Japanese company provided six small manhole chambers and lids free of charge for this project. These were adopted during the 4th Field Operation and have been installed at sites.

3.5 Government Subsidies and Implementation of General Accounting Transfer Systems

While the Japanese system changes to meet the needs of each era, at present there is a government subsidy system for work such as building additional distribution reservoirs and quake-proofing water pipe networks. Subsidies are provided for projects such as the development of water supply systems and sources, expansion of water supply systems, installation of facilities such as advanced purification systems, and improvement of lifeline functions. Yokohama City government also provides general accounting transfers for purposes such as expenses relating to the installation, maintenance and management of fire hydrants, firefighting water, water tariff reductions and exemptions for households on welfare, and installation of water supply facilities for disaster response measures.

However, no such systems exist in the Philippines. Conversely, there is a 5% water tariff subsidy system in which the water companies provide discounts for senior citizens aged 60 and over.

Water is a necessity. It is vital for the lives of citizens and is an important infrastructure facility for supporting society. Therefore, we believe that the responsibility for covering the costs lies not only with the water companies but also with the municipal, state and national governments. Japanese water companies work in an alliance and conduct periodic personnel exchange with relevant national agencies and municipal and state finance departments. This has seen the creation various subsidy systems. With this history in mind, we have recommended that MCWD form alliances with other companies and work tenaciously to persuade their national, municipal and state governments to implement subsidy systems.

3.6 Unification of Specialist Terminology

Specialist terminology relating to waterworks varies even within Japan. When organizations from different countries work together, communicating in a language that is not their own, specialist terminology is sometimes misunderstood. Parties involved in Japanese waterworks use the English terms in the Water Terminology Guide issued by the JWWA as standard terms, but different terms are often used by MCWD and on an individual level. Although various terms are used in our experience, we would like to standardize the terms worldwide, as they have been standardized in ISO24510~12.

3.7 Documentation

When the project team conducted interviews and discussions with MCWD's general employees, there were many cases in which figures and data provided by employees varied greatly. This is because little information relating to plans and projects had been documented (shared), and employees were often unaware of the existence of information that was documented.

Information that is not documented needs to be obtained by interviewing multiple people in charge, and a detailed audit needs to be done if the information provided is not consistent.

No documentation on existing leak detection plans can be found; employees simply follow day-to-day instructions from their team leaders. In terms of pipeline rehabilitation construction plans, the planning department designates targets for rehabilitation each year, but this information is not shared. Additionally, as there were no documented definitions, purposes, annual objectives or ultimate objectives for leak detections or pipeline rehabilitation construction, tables were interpreted inconsistently, with different employees making different judgments. It was determined that previously unknown system diagrams and manuals would exist in future as a result of the mapping system.

Management of documentation has important implications for the operation of organizations. Therefore, in our discussions with general employees during this project, we asked them to show us as much paperwork and documented data as possible. If no documentation existed, we discussed this and recommended creating some. We also recommended evaluating completeness of documentation as PI to clarify the basic positions of employees, who are the driving force of an organization.

4. Project Accomplishment

4.1 Enhanced Processing Capacity of Existing Water Treatment Plant

4.1.1 Coagulation/Sedimentation Treatment

By making, installing, and using the vertical baffled mixing unit, the turbidity removal rate in the sedimentation basin has been improved. As mentioned in paragraph 2.3.1, introduction of a baffled mixing unit has improved the turbidity which can be removed in the sedimentation basin by 57% (as of March 2013). In fact, the baffled mixing unit was highly valued by the staff in charge of operation and management of the WTP, who constantly monitored the sedimentation basin, and this is the reason we received a hearty welcome during the 4th Field Operation.

Not having operated this unit (the blue unit at the right center of the photo) at its maximum capacity during the verification period of this project, we expect production of floc which will settle more easily. This is because this unit operates by mixing water flow and the larger the treatment quantity is the larger mixing effect becomes.

It is possible to improve the coagulant pouring rate by introducing a mixing unit. We will determine the optimum rate based on a Jar test.

Through this project, MCWD employees understood the importance of coagulation treatment in the process of sedimentation. We are expecting the quality of purified water to improve in the future by reducing turbidity in the sedimentation basin as much as possible through proper coagulation treatment based on the transferred know-how.

4.1.2 Rehabilitation of Rapid Sand Filtration Basin

We implemented filtration basin rehabilitation work at one (photo in the back) of the existing three rapid filtration basins (photo on the right), which was the first rehabilitation work of MCWD. Though work such as cleaning of filter media, adjustment of mounding and concaving of the filter layer and unclogging of the lower catchment were managed directly by MCWD employees and required a huge amount of effort, they resulted in improvement.

Since the recovery of filtration capacity will improve the quality of filtered water, extend the filtration duration and reduce the frequency of rapid filtration basin backwashing, which is currently implemented once a day (every 24 hours), it is expected for the recovery to reduce the loss volume of clean water. The change in backwashing frequency will be determined through trials at the actual basin in the future. Further, the effect of back washing itself will be recovered by unclogging the filter layer and lower catchment.

As MCWD employees deeply understood the maintenance, operation and rehabilitation work of the rapid filtration basin through this project, it is expected that such rehabilitation work of the other two remaining basins will take place using the transferred know-how and that the handling capacity of the rapid filtration basin will be maintained by continuous and regular rehabilitation in the future.

4.2 Improvement of Tap Water Quality

4.2.1 Reduction of Nitrate

We chose a model area of deep wells, centering on G3, G4, G5B and K3.2, having notably high Nitrate levels and targeted reduction of those levels. As for the reduction methods, there are chemical treatment and physical treatment. From the viewpoint of cost, we decided to choose a physical treatment which is much cheaper which entailed dilution using the clean water of the Tisa Series.

We closed the wells in deep well area K3.2 and switched the water supply to the Tisa Series because the said area is near the Tisa WTP. As a result, the level was reduced successfully. On the other hand, as for deep well water supply areas G3, G4 and G5, we considered a plan to improve the distribution pipe system after confirming whether enough water could be obtained for dilution by keeping track of pump discharge volume and Nitrate concentration of each well and by measuring distribution volume of the Tisa Series.

This project entailed solving the longstanding problems of water supply in an area with high levels of Nitrate by constructing pipeline networks which considerably improved water quality.

In MCWD, the engineers from the Distribution Department and those from Water Treatment / Water Quality Department had never worked together to solve problems in the past. Keeping them together, this project served as a base to solve problems and played a part in the process of solving problems by MCWD.

4.2.2 Reduction of Iron and Manganese

There were two deep wells with high levels Iron and Manganese, W34B and W35 (within DMA27), and the current reduction work could be accomplished by changing the supply source for these areas from both wells to PWRI with no problem of water quality. In the beginning, this project attempted reduction with sand filtration and an experiment of using Manganese-Zeolite, but treated water was not actually supplied due to an electricity supply issue and a road expansion plan. MCWD considers, however, that if they can supply water as much as the volume discharged from both wells, it will lead to expansion for a new water supply area so they will continue experiments to acquire the technologies to reduce Iron and Manganese in the future.

This paragraph has importance in the point that the demonstration plant, which was proposed to MCWD at the Confirmatory Investigation in 2011, was actually made and reached the stage where a practical test could be executed. It most likely will serve as a big lesson for MCWD in the future as it showed how MCWD made an effort and showed ingenuity to solve a problem, thereby realizing results.

4.3 Review of Water Quality Test

While continuing consultation in this project, we provided advice to increase the points for water quality test and could further improve the water quality management.

The test items changed were Nitrate and Residual Chlorine. Regarding Nitrate, no water quality test at the tap had been implemented for customers before the project. It was, however, recognized that those two are health-affecting items and the distribution condition in the water supply areas must be understood. Accordingly, measurements at the tap were conducted once a month. Regarding Residual Chlorine, the number of typical direct supply wells in each DMA doubled from 25 points to 50 points to be tested. Presence or absence of Residual Chlorine is an item which must be understood to supply drinkable water, and this led to a more precise understanding of the condition of Residual Chlorine.

To supply "Safe Water" to the customers is the selling of water as a product. The question is whether a manufacturer can take responsibility for the product quality. As manufacturers always want to assure the quality, they should not cut any corners on quality tests until a reliable test system has been established. In Japan, "Safe Water" has been maintained since the modern waterworks were installed in Yokohama. We felt that this general idea was spreading to the entire organization of MCWD and they were coming close to the level of Japanese waterworks.

4.4 Comprehensive Measures for NRW Rate Reduction

4.4.1 Reduction of Leakage

NRW rate means a rate that is calculated by dividing the volume of water other than the part billable in the entire distributed water by the entire distributed water, and most of the volume not billable is mainly leaked water, meter insensitive water and unexplained water (stolen water).

Reduction of the leakage rate is reduction of the leaked volume. The right approach is reduction of (a) leak points and (b) leak time, and (c) elimination of the chances of leakage (preventive measures).

Surface leakage can be easily found, because when the pooling on the surface is clearly visible. As for subsurface leakage, however, it may take much time to discover as it creates a water way under the ground and does not blow water to the surface areas with low distribution pressure. Leak detection can stop leaks by detecting leak points and repairing them. The "stop leak" work means only to stop leaks which have occurred in the past and are continuing at present. Accordingly, leakage has been reduced from the present viewpoint, but the state has just gone back from the past viewpoint (see the left of Figure 4-4-1). In order to get a better leakage rate than the past state (to reduce), what we should do is find "many" leak points and reduce the rate by early-stage fixing and pipeline renewal (see the right of Figure 4-4-1). In this situation, it will just become possible to reduce the rate through obtaining a larger effect of leakage reduction with leak detection of shorter cycles, followed by countermeasure work. As for pipelines with many leak points, it is more effective to replace with a new one than to fix the leak points. Even if many leak points of the pipeline have been fixed, other leaks will start from other points. Therefore, the leakage possibility should be eliminated by replacing such a pipeline before its service life as a preventive measure.

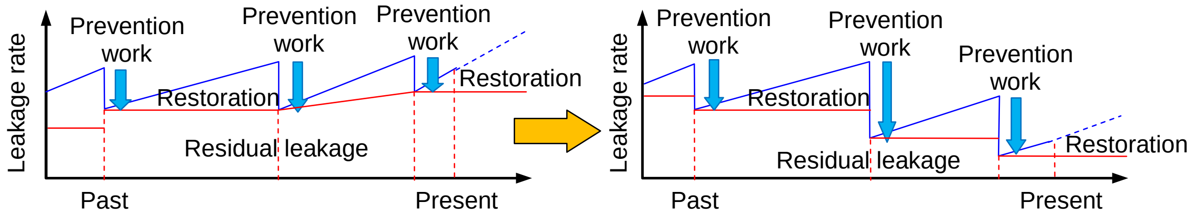


Figure 4-1-1 Restoration and Reduction of Leakage Rate

With a thorough understanding of Figure 4-4-1, MCWD has increased the number of leak detection teams from three to four in order to raise the detection rate and implement early-stage fixing to reduce the NRW rate. Through discussions with the project team and the training in Japan, MCWD decided to change the pipe material from PVC pipe to DIP. The reason is to implement protective measures against water leakage by replacing PVC pipe with DIP.

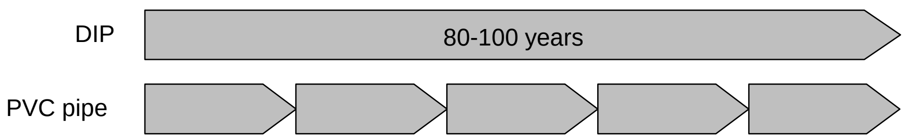


Figure 4-4-2 Service Life Comparison between DIP and PVC Pipe

DIP is expensive, compared with PVC pipe. However, its service life is very long, five times longer than that of PVC pipe, making it possible for continued use without digging, replacing or repeated road repair. Further, the leakage occurrence rate is about 40 times lower than that of PVC pipe. Therefore, sufficient countermeasures can be executed for leakage preventive measures. The decision of adopting DIP by MCWD is a major result of this project.

4.4.2 Leak Detection Instruments

Starting from an acoustic rod for acoustic detection, the innovation of leak detection instruments has progressed from leak detectors, to leak detection correlators for linear and surface detection and a data logger. Since not only sound, vibration and acoustic pressure but also electric current and Argon gas are used for detection, detection instruments, which can find leaks easily after a short training period

with knowledge of the analytical theory used by the instrument, have become available in the market without needing a trained ear which could only be developed though years of experience as was the case in the past. Moreover, the leak detection instruments were too expensive in the past and a developing country could afford to buy even one unit. However, with the efforts of European, American and Japanese instrument manufacturers, rapid developments have occurred to considerably lower the price. An environment where a developing country could buy several units has been created.
In developing countries, it seems that leak detection instruments obtained (bought) some decades ago have been shut away carefully like a family treasure or have been stored as they have broke and could not be repaired. Leak detection instruments have become so affordable that it is no exaggeration to say that they can be replaced as if they were Personal Computers. It is better not to keep a clumsy, heavy or old leak detection instrument forever but to use of a state-of-the-art instrument to perform leak detection efficiently.
MCWD is interested in GOODMAN Company's leak detection products, especially the "D305" which was brought this time, and would like to buy several units during the next replacement. Thus, it is proof that MCWD is working on leakage countermeasures seriously because they did not decide to buy such an expensive product only based on an explanation by the manufacturer's salesperson, but through discussions on leak detection products which have actually been used by YWWB or products under their consideration.

It can be highly possible that since they bought leak detection instrument but used it without thoroughly understanding its usage, the unit's full potential was not realized. A leak detection instrument was brought to MCWD for the 2nd Field Operation and local training was held. Since then, they have been learning usage by OJT, but we saw some individuals using it improperly. Corrections were made during the term of the 3rd Field Operation, so we were able to obtain considerably better leak detection results by the 4th Field Operation. Thus, leak detection can be accomplished sufficiently using the detection instrument properly and through repeated practice. On the other hand, if there is no occasion to practice, things would not happen. When the NRW rate falls below 20%, there is little significant (apparent) leakage in the distribution network. In such circumstances, problems of practicing leak detection are solved by preparing a training yard to perform effective training. MCWD has great interest in such a training yard since the 2011 managing staff training, and they had expectations on how a training yard could be installed in this project. Through the training in Japan, the pipeline training facilities have progressed to the stage of detailed design by the 3rd Field Operation and are ready to start construction immediately after preparing a budget.
These facilities provide not only a training yard of distribution facilities for leak detection, DIP pipe jointing to be introduced by MCWD in the future, removal of distribution branch pipes, leakage repair, and other practices for leakage fixing and branching of PVC pipes of fairly long length but also a training yard of water supply equipment connection practices for installation (connection) of water meters at each house.

At present, the NRW rate of MCWD could fall below 25% (the initial goal for this year; 2012 was 27%), but the rate still remains high. They are on the way to attempt the target of 15% of NRW rate in the future through the "2020 PLAN" established by MCWD.

4.5 Implementation of Continued 24-hour Water Supply Service

As of February 2013, the average service hours in MCWD are 23.15 and almost 24-hour water supply service has been accomplished in some areas, but in a small number of areas the service hours are still about 10 hours.

If water is continuously supplied for 24 hours, the inside of pipe is always under pressure. Therefore, even if water leakage has occurred, the water inside goes out of the pipe, and the water outside seldom enters from the leak point. When water supply stops, the pressure disappears, resulting in contaminated (not clean) water outside the pipe entering (contamination). When water supply restarts, water is supplied in a state mixed with the contaminated water. Air may come in from the leak point. When water supply restarts, the air not removed causes a distribution network to generate unsymmetrical pressure and air bubbles. YWWB cleanses the inside of a pipeline where water supply has been suspended once with discharging waste water from fire hydrants, confirms whether air inside the pipe has been discharged from a rapid air valve, and performs a water quality test of the waste water with care. If the quality of water is not certain, the water cannot be supplied. Even so, they receive many complaints because when a little air gets mixed in with tap water some fine bubbles arise and it appears turbid. MCWD is making efforts to improve the quality of tap water but will not be able to accomplish the improvement of water quality without a 24-hour water supply.

We discussed measures on DMA having less than 24-hour water supply through this project. The staff of the Hydraulic Calculation Division received many requests and we often discussed the results in each case. Among the three model DMAs, the issue of DMA19&20 (Nivel) has been solved by installing a booster pump, and as for DMA16 (Guadalupe), a solution by installing an elevated tank to receive supplied water was confirmed. As for DMA17 (Capitol), a solution by installing an elevated tank or a booster pump was proposed, but the decision has not been made yet. We await the outcome of future discussions.

Through this project, MCWD has already found a method to solve this problem and they will be able to solve it entirely in several years.

Implementation of a 24-hour water supply is the first step to "supply Safe Water" which is what MCWD seeks. Without solving this issue, they cannot secure safe water. We hope MCWD will implement immediate measures to a few of the remaining DMAs having less than a 24-hour water supply and accomplish a 24-hour water supply throughout MCWD.

4.6 Preparation for Expansion of Supply Service Area

Though the share of private water suppliers is only small percent in total compared with that of MCWD, they are competitors for MCWD who have a plan to expand the service for business use by acquiring customers like big commercial facilities.

It is necessary for MCWD to make efforts to acquire new business customers without fail by means of surveys of business users' awareness to reflect the needs identified in business operations.

A new survey of non-serving areas as well as of business customers will be implemented according to "Corporate Plan 2013". MCWD is scheduled to implement surveys with 3,000 samples of general customers including those in non-serving areas (about 135,000 connections in total) and those with 100 samples of business customers (about 700 entities in total).

As it makes no sense to implement a survey like the above only once, MCWD recognizes that continuous implementation would be useful in understanding tendencies as well as drafting plans so they have decided to implement continuous and systematic surveys.

MCWD Environmental Water Resource Knowledge Center (EWRKC) has implemented a survey of the current state of the water supply in the non-serving area. It is possible to take measures such that MCWD expands the service area through coordination with private water suppliers providing services in the areas not covered by MCWD or acquires new customers of private entities.

As it seems possible for Japanese companies to take part in such a business, they can develop water business in cooperation with MCWD. Though it is a business based on cooperation, there is a possibility for MCWD to expand the service areas and for Japanese companies to take the first step to develop a water business.

4.7 Cultivation of Human Resources toward Enhancement of Organizational Operation

4.7.1 Efforts to Reward Employees for Their Voluntary Improvement Suggestion and Proposal

MCWD is making efforts to promote outsourcing as well as planning an organizational restructuring for the future. Considering the future necessity of management by a few selected persons, it will become essential to cultivate not only executive level employees but also respective employees who can think and act by themselves.

Newly proposed PI has an "Employee Proposal Rate". In order to raise this figure, rewarding employees for their proposals will contribute to create an environment where self-motivating proposals are made positively. The point is to introduce such efforts effectively to cultivate next leaders and raise the level of employees' abilities in the future.

When we introduced the fact that we have established an occasion for rewarding like this in YWWB, MCWD has also just started consideration of rewarding employees at anniversaries.

4.7.2 Efforts toward Employee Satisfaction

MCWD Personnel Department is planning to introduce employee evaluations and to review positions together with reviewing the number of employees and considering outsourcing of various works. In the process of implementation of management by a few selected persons, the essential measures are to listen to employees and reflect on the systems of personnel affairs and human resources development.

When introducing the YWWB's Employee Satisfaction survey and analytical procedure, MCWD started consideration of efforts to understand their employees' consciousness and satisfaction in respect to work, public welfare, salaries, labor environment, company policies, et cetera and to apply them in the measures. The survey will start in the second half of the year. It must be a result of this project that executive employees in charge participated in the training in Japan and the know-how obtained there was introduced into the MCWD measures.

4.8 Appeal to the Municipal, Provincial and Central Governments to Secure Finances

Subsidy requirement is an agenda to be discussed continuously for sustainable water business operation. Unlike Japan, that is a very difficult agenda for the Philippines today, but still very important one for MCWD, who is keeping an eye on securement of not only groundwater source but also surface water sources, to secure a budget for dam construction.

We have recommended this repeatedly through this project, and MCWD has started consideration of making appeals to the provincial government. Though it will most likely take a considerable amount of time, we are looking forward to the future progress.

5. Recommendations to Achieve Overall Purpose

5.1 Making a "Water Safety Declaration"

5.1.1 Aspiring to Stable 24-hour Water Supply

In general, a water source must be secured in order to provide a stable 24-hour water supply. Currently, the groundwater source accounts for about 95%, so in order to handle the anticipated increase in demand in the future, the construction of a new water treatment facility using dams and surface water as the water source should be considered, assuming that a sufficient volume of water can be secured without any quality problems. Forecasting water demand is important in these considerations since the planned water supply volume forms the basis of the facility construction. The necessary data on population projections for the related towns and cities, city plans and regional development must be compiled and analyzed.

The treated water depends on whether an amount commensurate with demand can be supplied on a regular basis, and if a pump is used in the water feed, electricity must be available to ensure 24-hour continuous operations.

In setting up a distribution facility, a distribution reservoir and elevated tank must be built, and a sufficient volume of water to meet demand even if the WTP and pump equipment temporarily stop working must be available. In this case, the distribution reservoir and elevated tank should be built on the highest ground possible (although avoiding high water pressure); a broad water supply region must be secured via gravity flow, and reservoirs must be available to absorb hourly fluctuations in water supply during the course of a day. In addition, when building a distribution facility, water distribution blocks based on the distribution reservoir and the back-up concept must be effectively utilized.

MCWD has introduced a DMA system, but currently the DMA cannot supply water 24 hours a day because water pressure is not sufficient on high ground due to low pump capacity and water cannot be transmitted in adequate volumes to meet demand since the distribution pipes are narrow. The problems with the water supply system were discussed and it was suggested that the pumps be extended and an elevated tank installed to resolve the issues, but a stable supply of power is essential for continuous operation of the pumps. This cannot be entirely resolved by MCWD alone, but private power generation may also have to be considered, depending on the extent of demand at the facility. Without resolving this, the goal to have all DMA providing a 24-hour water supply by 2015 cannot be achieved.

At the same time, a water pressure distribution map for the water supply area must be prepared, and water pressure must be managed and monitored in all DMA.

During this process, unexpected water suspension cannot be avoided, but in order to prevent the influx of contaminated water into the pipes due to negative pressure in the pipes, water pressure must be constantly monitored, the weak aspects of the distribution network improved, and efforts made to reduce leakage points.

5.1.2 Map of Water Pressure Distribution and Residual Chlorine Concentration Distribution Map

(1) Map of Water Pressure Distribution

In making a "Water Safety Declaration", in addition to securing safe water and an adequate supply of water, the facility construction and maintenance and management must take into account the supply of water at appropriate pressure. To this end, preparing a water pressure distribution map is effective for maintenance and management.

By comparing water pressure through pipe distribution analysis and actual measurements of water pressure, the potential for leaks and the unexpected decrease in the cross section caused by blistering and rusting of DIP can be ascertained. This is also essential in considering the optimum placement of decompression valves in order to prevent pipe breakages and leaks in areas with high water pressure.

In terms of maintenance and management, water pressure can be appropriately managed by installing water pressure gauges so that it can be measured continuously on high ground within the water supply area. In particular, when providing a 24-hour water supply, it is important to ascertain water pressure deviations in the event that demand varies significantly in the afternoon and evening.

(2) Residual Chlorine Concentration Distribution Map

A "Water Safety Declaration" represents the objective of providing potable tap water; confirming the concentration of Residual Chlorine is one safety indicator that can be easily ascertained with a single parameter.

Pipelines within the distribution network that have high Residual Chlorine consumption can be detected by setting measuring points in the map's mesh and regularly measuring Residual Chlorine concentration and entering this data on the map, while linking to the mapping system. The pipeline can thus be improved and given priority in rehabilitation plans. Highlighting the problems in this way is also effective in managing daily water quality. Moreover, when the Residual Chlorine concentration is high, users may complain about the odor of Chlorine, so plotting the Residual Chlorine concentration on the map to better manage it makes it easier to address the problem. As such, the data can be utilized in many ways.

In the future, securing Residual Chlorine and balancing the concentration in the water supply area overall will be essential, but in some water supply areas, Chlorine supply facilities will have to be set up.

5.1.3 Providing a Direct Water Supply and Receiving Tank Management

(1) Providing a Direct Water Supply

In general, when the water supply is not provided consistently for 24 hours, the user sets up their own receiving tank to ensure a supply of water. Some users keep tap water and rainwater in the same receiving tank, and the water quality clearly deteriorates.

A direct water supply is ideal to provide fresh tap water, but if the water supply cannot reliably provide a stable water supply, users will continue to use receiving tanks, given their experiences. When providing a direct water supply, the water company should examine the water volume used, application and availability of distribution pipes as a fact-finding survey of the user, and attempt to expand the direct water supply.

Direct water supply can be provided through either a water service system that directly supplies water through dynamic water pressure in the distribution pipe, or through a pressure water service system in which a pump or other pressure booster is set up in the middle of the service pipe so that water can be supplied at higher pressure. In particular, care must be taken because if a pressure water service system is used without sufficient consideration, the pressure in the distribution pipe can be reduced, and can lead to accidents such as absorption of external contaminated water from pipeline damage and leakage points. In addition, steps must be taken to prevent backflow from the receiving tank and devices connected to the service pipe during water suspensions in the distribution pipe.

Given this, the scope of targets for direct water supply should be expanded in conjunction with the water supply capacity, such as the distribution pipe's water pressure, and plans to install distribution pipes.

(2) Receiving Tank Management

While the receiving tank has the merits of being able to maintain the water pressure and water supply at fixed levels below the receiving tank even if the distribution pipe's water pressure fluctuates, being able to use a large amount of water temporarily, and provide a supply of water even during water suspensions and disasters, it should be understood that appropriate management, including regular inspections and cleaning, is essential.

In particular, a small-scale receiving tank tends to be carelessly maintained, with regular inspections and cleaning neglected, so MCWD staff must be well aware of the importance of management and must instruct, advise and monitor the receiving tank installers.

When the receiving tank is installed, measures should be taken to ensure that there are no impediments to nearby water supply if the receiving tank's intake volume per unit hour is high compared to the capacity of the distribution pipe. This can be done by installing either a valve to adjust the intake volume, such as a constant flow valve, or a motor-operated valve with a time switch so that water is only taken in during periods when the water pressure is high.

5.2 Improving Customer Satisfaction and Strengthening Organizational Operations

5.2.1 Statistical Customer Awareness Survey (Typical Households and Business Customers)

Reliably carrying out a customer awareness survey planned in MCWD Corporate Plan 2013 would provide statistical understanding of the needs of business customers, the satisfaction of household customers, and the needs of customers living in areas that do not yet receive services. Moreover, setting the questions is a means of obtaining information helpful in running operations, such as ascertaining the extent of awareness of Public Relations (PR) measures and effective PR methods. Going forward, it will be important to set questions that will be useful in operations and carry out surveys on an ongoing basis to understand trends in customer awareness and needs.

Needless to say, it is important to analyze the results of the survey and reflect them in operations, but it is also important to share the results internally and release them to the public.

5.2.2 Raising Customer Satisfaction

In terms of enhancing customer convenience, expanding points at which rates can be paid and the means by which they can be made is very urgent and would also have a great effect were they to be adopted. MCWD has taken a wide range of initiatives and also has plans for further initiatives, so it is to be hoped that payment methods will be continuously expanded to include Internet banking and convenience store payment.

Moreover, there has been talk of outsourcing various divisions and operations, but maintaining the level of service after outsourcing must be considered, as well as the establishment of a monitoring system.

Constant efforts must be made to ensure that every employee is aware of the need to carry out operations with Customer Satisfaction in mind since this will not only raise the level for the organization overall, but also improve customer satisfaction. Initiatives related to human resource development, such as encouraging employee activities to make improvements and seminars on improving customer response, can be expected.

5.2.3 Devising a Public Relations Strategy

MCWD carries out various PR activities, but it is important that it ensure cost-effectiveness and plan by goal and target audience. Moreover, the effect of PR activities can be raised by clarifying the message conveyed through events and PR measures (for example, MCWD's reliability and environmental contributions as a company).

PR initiatives carried out in conjunction with companies and other groups (events and advertising) are also more effective in terms of cost and effect than if MCWD were to carry out such activities independently, and should thus be proactively encouraged.

5.2.4 Strengthening Organizational Operations and Human Resource Development

Given that MCWD will have to run its operations with a small group of select employees as a result of future plans for reorganization and business outsourcing, MCWD will need to strategically consider administrative and human resource development measures, such as maintaining data and documents that enable objective understanding of operations and training employees with wide-ranging knowledge and techniques in the water service industry.

When considering these issues, employee satisfaction surveys and interviews should be conducted in tandem, and the effect of measures should be examined using PDCA, while also taking steps to reflect employee opinions.

5.3. SCADA system

Management control in the water supply area requires that human errors be controlled with automatic control of facilities and centralized management, and that operators conserve energy and run facilities in a stable and efficient manner. Recent IT advances make it easier and cheaper than ever to collect information on operating conditions at water supply facilities and infrastructure as well as measurement signals on flow volume, water pressure, water levels and water quality and to control operations of equipment.

A SCADA system collects and analyzes information on measurement signals on flow volume, water pressure, water levels and water quality and conditions pertaining to equipment operation and malfunction, and uses the individual data to monitor, operate and regulate. It plays an important role in stabilizing the water supply process and ensuring safe management and efficient and effective operations. The main functions are as follows.

(1) Accurately ascertaining facility operating conditions

(2) Operating accurately and responding promptly to irregularities

(3) Automatically regulating facilities

By using a SCADA system for remote monitoring and automatic regulation and to optimize the placement of instrumentation devices based on a Water Safety Plan (WSP), a system that can make major contributions to Safety Water can be built.

Moreover, YWWB has the knowhow, including manuals on operation management and maintenance engineering based on its achievements thus far, and is able to operate a stable system on an ongoing basis.

By utilizing DMA and the SCADA system together, MCWD can manage leaks more efficiently and effectively, for example through the minimum night flow measure method. This would make significant contributions to lowering the NRW rate.

MCWD also sees the need for SCADA and has begun to take steps to introduce this system, so we look forward to its early adoption.

5.4 Training Topics, Facilities and Operation Methods for Establishing a Training Center

In this project, a simple design and detailed design were devised for pipeline training facilities, MCWD completed its construction estimates, and now the start of construction after the budget has been approved. This section looks not only at training facilities related to pipelines, but also extends to training covering water services overall.

MCWD was established about 40 years ago, and its technical level is quite high for the Philippines. Accordingly, it can be expected to become a top-runner in the Philippines' water service industry by training engineers and staff with even more sophisticated technical skills, based on the knowledge that it has built up thus far. Moreover, by cultivating training instructors at MCWD, these technologies can be expected to spread laterally throughout the Philippines.

However, even if its technology level is high, teaching about technology in areas such as rapid filtration facility operation and management, water quality management, NRW measures and distribution pipelines requires different knowledge and skills. The instructors' skills need to be improved through training.

We anticipate that training, training facilities and training courses will be established to meet these needs.

5.4.1 Training Facilities within and outside MCWD

In terms of a stable supply of Safety Water, the main areas in which MCWD's capacity needs to be enhanced are as follows.

(1) Maintenance and operation management for water treatment using chemical sedimentation and rapid filtration
(2) Water quality analysis
(3) Distribution network management
(4) NRW countermeasures (leak detection and repairs)
(5) Business operations, financial planning, facility upgrade plans
(6) Other

The necessary training facilities for these items are described below.

(1) Maintenance and Operation Management for Water Treatment using Chemical Sedimentation and Rapid Sand Filtration

A simulation facility that would enable trainees to learn the appropriate chemical injection volume in the chemical sedimentation basin and mixing intensity would be effective. The goal would be to install a contraction type of inclined plate transverse ventilation sedimentation basin, or a large Jar test device, so that the floc formation process and appropriate injection volumes can be learned.

A simulation facility that would enable participants to learn consecutive operation times, backwashing times and washing water amounts would be effective in filtration, and a simulation filtration basin using a transparent column would enable participants to learn the aforementioned points to be wary of in operations.

In the case of both of these facilities, a sampling pipe or automatic water quality gauge should be installed to collect water samples for analysis and changes in the water quality of sedimentation treated water and sand filtered water through the treatment process should be ascertained so that water quality data such as turbidity can be measured in each process.

This could not only be used for training purposes, but could also be used as a demonstration experiment facility in which the appropriate treatment process for raw water could be considered, since there is a chance that MCWD would develop new water sources in the future. This facility could take a leading role in treatment technology in the Philippines. Moreover, as a maintenance and management facility, it should be able accommodate training on daily inspections and repairs for pump equipment, such as pumps often used in water treatment facilities and motor-driven pumps.

(2) Water Quality Analysis

Decisions on appropriate coagulant injection rates through Jar tests must be firmly established among employees to ensure compliance with changes in the quality of raw water, the existing water source, and address the development of new surface water sources in the future. Accordingly, related equipment should be augmented. The fact that MCWD is considering establishing a laboratory in the Tisa WTP would support the facility's amplification. This is intended not only to ensure constant monitoring of water quality within the plant and prompt reflection in water treatment, but in addition, using it for external training would be an efficient use of the facility as it would spread onsite monitoring methods throughout the Philippines.

ICP emission spectral analysis is commonly used in Japan to analyze Iron and Manganese, which are currently problems, while the ion chromatographs method is used for Nitrate. MCWD plans to adopt these devices, so the water quality laboratory could be augmented, and also utilized in practice within MCWD and even in other Water Districts (WDs).

This would also be effective in raising capacity to comply with water quality standards, supply safety water through thorough turbidity management and Residual Chlorine concentration management, and address contamination caused by toxic substances such as agricultural chemicals.

(3) Distribution Network Management

Appropriate management of distribution networks is extremely important in supplying safety water consistently, reducing leakage volume, effectively utilizing water resources through these means, and effectively utilizing energy through optimal water pressure. Moreover, this thorough management can be expected to improve management. To achieve these objectives, MCWD must be able to ascertain actual flow volume and water pressure, simulate changes in conditions such as flow volume, water pressure, pipe diameter and pipe materials, and ascertain detailed conditions in the pipe network. Accordingly, an environment in which pipeline distribution analysis software can be used for distribution network calculations needs to be provided.

The best location within the pipeline in which to install a device that can monitor actual flow volume and water pressure (such as a flow meter or pressure gauge) must be ascertained, and forming a pilot area within the pipeline and monitoring the water volume and water pressure would likely be effective, but we would like to see the pipeline training facility's distribution pipe field, prepared in this project, be utilized. Moreover, conditions must be ascertained by accumulating data using a data logger or ascertaining current conditions using an always-on remote monitoring system. Using this pilot area as a field for external training and carrying out training to ascertain pipeline conditions is also effective in enhancing pipeline management technology.

(4) NRW Countermeasures (Leak Detection and Repairs)

Creating leaks by drilling holes in a pipe for simulation purposes and setting up a training yard in which the use of acoustic rods and leak detectors can be learned in the pipeline training facility's leak detection field created in this project would be helpful in enhancing leak detection skills. This facility could be used both in training within MCWD and for other WDs.

It would also be helpful to prepare materials and equipment so that employees could be trained in repairing the types of pipes generally used in MCWD and other WDs (primarily PVC pipes and PE pipes) and the DIPs that MCWD plans to introduce in the future.

(5) Business Operations, Financial Planning, Facility Upgrade Plans

In addition to improving technical skills, sustainable management is essential in appropriately running and maintaining facilities and equipment. Support in establishing various plans is provided with the aim of providing an opportunity to learn about reliable rate collection, efficient budget allocation, establishing medium- and long-term plans, and devising maintenance and management plans, facility improvement plans, and upgrade plans based on asset management. After familiarizing MCWD with the concepts and methods of devising plans so that these plans can be established, they should be expanded laterally to other WDs.

(6) Other

In other areas, lectures that provide understanding of the water service system overall are essential. When technicians and employees carry out separate operations in the water treatment field and water supply field, an understanding of the role and significance of the various operations in the overall water service system is effective for a "Water Safety Declaration" and "Stable Water Supply", even if they already have an understanding of the individual fields such as water treatment and water supply. Moreover, efforts should also be made to improve the awareness of executive officers since the top management above the manager class must have a better understanding of this kind of information than on-site workers.

5.4.2 Developing Training Instructors

Simply having Japanese experts provide instruction to specific employees in order to enhance the capacity of MCWD employees would not have an adequate spillover effect on employees overall, and would also be difficult in terms of maintaining technical skills. Accordingly, training MCWD's core employees and utilizing them as catalysts would be effective in improving and maintaining MCWD's overall technical capacity. Moreover, the employee capacity in WDs in the Philippines could be raised by having these employees transfer technology to other WDs in their role as training instructors.

Japanese experts will provide Training of Trainers (TOT) to MCWD employees that are instructor candidates, utilizing the aforementioned facility. Prior to teacher training in the respective fields, overall training on the significance of WSP and the role of each process at general water service facilities will be provided to clarify the objective of a "Water Safety Declaration". An independent framework for improving technology capacity can also be expected within the Philippines. Subsequently, dedicated TOT on technology related to the field in which the instructor candidates specializes will be provided to train instructors for the organization. In addition to techniques in their assigned fields, the candidates much learn teaching skills. The instructors trained here will work as instructors in MCWD's internal training and work to enhance the skills of MCWD employees. Thereafter, they will work as instructors in training targeting other WDs, and strive to enhance the capacity of the Philippines' utilities with MCWD as the core.

5.4.3 Work Trips and Training

Dispatching the instructors trained as described above to other WDs to provide instruction and having them remain stationed there for a period of time for OJT (On the Job Training) would enhance the capacity of engineers in other WDs as well. At the same time, it would also be efficient to bring employees from several other WDs to MCWD as trainees, and use the facilities set up there for training.

5.4.4 Turning Training into a Business

By providing training externally to other WDs as described above, the capacity of water service engineers in the Philippines can be improved over a broad range, and the training facilities set up can be used effectively.

However, since MCWD would be providing training while also performing its own operations, it should consider a training scheme that provides incentives such as training fees that would generate revenue for MCWD. Its current human resource and operations system should be taken into account since MCWD employees would serve as the instructors.

In addition, MCWD can be expected to consider a business model in which it could carry out training in cooperation with existing related organizations (such as WHO).

5.5 Transition to Comprehensive Mapping System

5.5.1 Accurate Distribution Pipeline (Facility) Management

In order to present accurate distribution pipeline (facility) information on a mapping system, all of the information currently held by the water service facility can be recorded as data. This has its advantages, such as the fact that the more types of recorded data, the more data that can be used, but this also means that more data will have to be updated, and the work required to make corrections and the cost of maintaining the system also increase.

Data on pipeline routes, the fiscal year in which it was constructed, the type of pipe, pipe diameter, bifurcation part, fire hydrant, valve and other information all have to be entered into the system.

In operating the system, the frequency of construction on the distribution pipe and the most recent data must be updated so that the actual distribution pipeline (facility) can be accurately presented. As a way of correcting the system, data must be corrected so that it is up-to-date and accurate with the aim of (a) providing optimal water operations so that water suspension areas can be minimized during construction and accurate system changeover work can be performed, (b) accurate asset management can be provided for distribution pipelines (facilities), (c) accurate simulations through the sub-program's pipe network analysis can be carried out, and (d) damage is not caused to underground pipes (distribution pipes, etc.) during other companies' construction work (electric utilities, transportation and communications companies, etc.).

Below, we will introduce the correction approach taken at YWWB. The construction company prepares documents on the construction work, and the YWWB construction supervisor checks these documents. If there are any problems with them, the construction company makes corrections and resubmits them. The construction supervisor passes the correction request document, with the construction-related materials attached, on to the mapping system supervisor, who checks these documents and reflects them into the system. The paper materials such as diagrams are scanned and digitally filed. This process ensures that the numerical data entered into the mapping system as well as the diagrams are updated.

One point to keep in mind is that if the quality of the person entering the data into the mapping system is low, erroneous information may be entered, causing problems, and considerable work time will be needed to make the corrections. This means that it is important to improve the skills of the person doing this work.

The time until this distribution pipeline (construction) information is reflected in the mapping system can be shortened by improving the efficiency of the work other than entering data into the mapping system (the time it takes for the construction company to prepare the construction-related diagrams and submit it to the mapping system supervisor).

5.5.2 Rapid Leak Response and Improving Revenue Water Ratio

By using data on distribution pipes compiled in the mapping system on the year in which the distribution pipes were laid in order to define and identify aged pipelines, pipeline rehabilitation can be prioritized, which enables preventative leak measures to be taken.

In the event that soil affecting pipelines is distributed, an upgrade plan for each type of soil can be formulated by, for example, creating a database of areas with corrosive soil and liquefied soil in the mapping system and plotting the scope of this area.

Moreover, ascertaining traffic conditions may reveal changes, such as a situation in which heavy vehicles did not travel the road in question when the pipeline was laid, but heavy vehicle traffic became more frequent with regional development. This enables leak prevention measures to be taken by deepening the installation depth and protecting the pipeline, and also enables the Revenue ratio to be raised.

5.5.3 Utilization in Asset Management

With a limited budget, accurately ascertaining asset conditions is essential in considering facility construction and upgrades in order to ensure sustainable water service operations. Asset management is inadequate in the water service operations of not only MCWD, but developing countries in general, and yet it is an important issue. Appropriate asset management is essential in managing water service operations in a stable and sustainable manner, and mapping systems are effective in ascertaining the conditions of pipelines, which account for a significant weight of water service assets.

By using information on distribution pipelines (facilities) in the mapping system, such as the type of pipe, pipe diameter, piping extension, year of pipe laying construction, an efficient rehabilitation plan for distribution pipelines can be established. In calculating upgrade priority and construction expenses, which are so important in formulating rehabilitation plans, the priority can be calculated using data such as the fiscal year of piping and number of leak repairs, while the pipeline rehabilitation construction costs can be calculated from the standard construction costs per unit extension for the type of pipe and pipe diameter. By using this kind of information to consider upgrades, questions of whether to bring forward or delay the upgrade plan can be examined, and upgrade plans can be carried out within the scope of a standardized budget.

5.6 Utilization of Water Meter Recycling Technology

Selecting a highly reliable water meter enables it to be used for a long time and also cuts costs. Raising measurement accuracy reduces problems with customers over the measured water volume, and can improve trusting relationships between MCWD and customers as well as facilitating the smooth collection of water tariffs, leading to an increase in the water tariff collection rate.

MCWD replaces its water meters, installed at about 135,000 connections in the water supply area, every 10 years (in Japan, the Measurement Law requires that meters be replaced when the official certification expires, which is every 8 years). This amounts to a replacement of about 1,100 water meters every month. MCWD has a recycling system whereby it disassembles, inspects, tests and assembles the meters for reuse at its water meter testing laboratory. This is a process that YWWB also used to follow. By integrating the techniques built up in YWWB with MCWD's technique and knowledge on maintenance and recycling of water meters, we can expect even greater use of this water meter recycling technology.

5.6.1 Maintaining and Managing Water Meters

MCWD imports water meter parts from Israel, Japan (Japanese company in a Southeast Asian) and China, and then assembles its water meters.

Putting together a manual is essential if water meter technology is not to be dependent on the knowhow and skill of experienced workers. Moreover, in order to upgrade 1,100 different water meters every month, about 50 water meters a day have to be disassembled, inspected and repaired and tested for instrumental errors. When inspecting and repairing the meters, shortages of parts interfere with this pace. This means that parts management is an important operation as well.

Moreover, since these water meters are used on an ongoing basis, the assessment as to whether they can continue to be used is also important. The process of determining whether meters that could break down in the middle of use should still be used should be recorded in a manual, given that they are used for the long period of 10 years. By selecting highly reliable parts in terms of durability and reliability, water meters can be used for the long term, which will also reduce costs. Improving measurement accuracy reduces problems with customers related to water measurements, and deepens trust between MCWD and its customers. In turn, this facilitates the smooth collection of water tariffs, leading to an increase in the water tariff collection rate.

MCWD also carries out instrumental error tests of its water meters. The functions of water meters must be adequately understood to maintain measurement accuracy. When flow is minimal, the instrumental error is more heavily on the negative side (water flow is less than in reality), and although it is not an instrumental error since it falls outside the bounds of the scope of the water meter functions being measured, the measurement accuracy of minimal flow volumes must be ascertained.

5.6.2 Water Meter Upgrades

Currently, MCWD upgrades its water meters every 10 years, and it must inspect the water meters when it carries out the upgrade. In Japan, the replacement period when the official certification expires is as follows.

(1) At what point in which year will the water meter be replaced as part of the regular upgrade?

(2) Examine the accuracy of the used (new parts) water meter.

(3) To collect data to calculate the recommended usage period, the water meter is installed for inspection, the period until water meter accuracy declines is examined and the usage period is considered.

MCWD must carry out these inspections and research independently to lead other WDs as a top runner in the Philippines, and must also be respected by other WDs.

5.6.3 Expansion into Other Water Districts

MCWD is overwhelmingly dominant compared to other WDs in terms of the number of employees and type of jobs, and has the human resources needed to carry out its normal operations as a single WD. Conversely, other WDs tend to have far fewer operations other than basic operations.

Water meter maintenance depends to a large degree on the capacity of the employees. Currently, MCWD has technical margin in its meter maintenance and management, so by raising employees' capacity and developing manuals, MCWD can undertake operations from other WDs. Moreover, MCWD is expected to accept trainees from other WDs for employee education.

5.6.4 Path to Business Development

If MCWD establishes water meter recycling technology, this could be the basis for commissions from other WDs in the country. Moreover, affiliating with Japan's excellent water meter manufacturers would enable it to provide water meters with greater reliability and longer lives. MCWD could also be entrusted with operations from outside of the Philippines, which could provide opportunities for both MCWD and Japanese companies to prosper together.

5.7 Spread to Other Water Districts

5.7.1 Model Water District as a Top Runner

The majority of WDs in the Philippines are small in scale, and many carry the heavy liabilities incurred with the initial capital spending so that their financial conditions are poor. Unable to deal with failing and decrepit facilities, the quality of service falls, and as a result, the number of taps also falls, creating a negative cycle. In these conditions, regression is a concern in terms of safe water supply.

In this project, activities to improve water services were carried out with a focus on addressing the problem of NRW and enhancing the capacity of existing WTP. In order to sever the negative cycle described above, it is important to carry out realistic initiatives, and this project developed sustainable and specific proposals that effectively utilize local facilities. This approach was partly based on the experiences that YWWB had in the water utility process.

As a result of this project's success in improving water services with a minimum investment, we expect that the negative cycle in which various problems pile up in a chain reaction transforms into a positive cycle, and that MCWD will become a model WD that is healthy in terms of both technology and finances and can attract new investment.

5.7.2 Developing Businesses Aimed at Other Water Districts

As noted above, MCWD needs to make technical improvements using effective methods while keeping down investments as much as possible. At the same time, MCWD needs to raise its own money to improve the health of its finances.

There are also high needs for Japan's advanced water utility expertise, such as the technology introduced in this project, the aforementioned "Water Safety Declaration", training, and water meter recycling in other WDs. By using this technology locally and developing it as a business with local prices, MCWD could make a financial contribution, and other WDs could learn how to raise the quality of its water services at local prices, creating a broad-ranging positive cycle between WDs in the Philippines.

If this kind of business development and affiliation between regions takes place, it would generate sound financial demand and lead to injections of private-sector funds and public loans such as ODA. Japan's support will be needed to reach this stage, but we believe that this is an opportunity for Japanese private companies to step up and potentially play a role in a New Growth Strategy.

5.8 Water Sewage Development

This project provided technical support for water utilities overall, and MCWD's water utility is expected to be a top runner in the Philippines.

At the same time, MCWD is a water service and sewage infrastructure company that supports the foundation of this city, which is not only the second largest metropolitan area in the Philippines but also a well-known tourist city in Southeast Asia.

As a metropolitan area expected to develop further and become a sustainable tourist city, Cebu faces the urgent task of upgrading its water sewage services as it aspires to support a leading sanitary city and model water service and sewage WD.

6. Closing

6.1 Throughout This Project

YWC conducted the "Confirmatory investigation on operation & management state of the MCWD" (conducted from February 25 to March 31, 2011) as a preliminary survey to investigate the outline of the MCWD's issues and develop a friendship with the president and other executives of MCWD. At the "Training Program for operation & management of the MCWD" (conducted from July 19 to July 27, 2011), seven executives including the General Manager of MCWD were brought in as trainees to recognize the current state of the water business in Japan. Furthermore, the "Training Program for operation & management of the MCWD" (conducted from July 23 to August 3, 2012) for this project was implemented and 10 person-in charge of practical business centering C/P of MCWD were brought in as trainees to experience the actual state of the water business in Japan around Yokohama.

We deeply appreciate MCWD for not only their passionate welcome which we received from the General Manager and executives, persons in charge of practical business centering C/P and employees of the local office but also the enthusiastic discussions we had. Though this project is for technological support and that there are different histories and environment between Yokohama and Metropolitan Cebu, we acknowledge that we should esteem the fact that Metropolitan Cebu used to be the capital of the Philippines, is the second largest national capital region even now and a famous tourist city, and that MCWD has a history of operation and maintenance of the Buhisan dam, which was constructed by the United States a hundred years ago, as well as their 38-year experience of business administration.

Under the above environment, our project team has tried not to give MCWD any one-sided proposals or advice but to hold mutual discussions repeatedly and provide them with improvement proposals and advice based on the actual conditions in the local area from the viewpoint of those who have similar experiences in water utility. For example, we disclosed with what background MCWD had developed their current leak detection system, shared the same background among the entire MCWD's leak detection team, introduced YWWB's development examples, applied them to the MCWD's actual situation, discussed an efficient way for improvement, satisfied MCWD employees and introduced a new method of leak detection mesh administration. This procedure was also developed in the Water Treatment Department, Water Quality Department, Distribution Department and Business Administration Department. MCWD employees' extremely positive and enthusiastic attitudes made this development possible. We think that our project team was also inspired by them and could promote the project with a sense of satisfaction.

MCWD is aiming to realize a 24-hour water supply in all service areas, accomplishment of 15% of NRW rate, "Water Safety Declaration" and further improvement of the water supply pervasion. Also, they have a plan to enhance training facilities for the general water business including pipeline training facilities with thoroughly reviewing the actual conditions of other Water Districts (WDs) in the Philippines. We were impressed by the positive attitude of the General Manager and employees of MCWD and can easily understand why MCWD is active as a front runner in the Philippines.

We hope each of the activities performed with MCWD through this project will provide a clue to other WDs in the Philippines facing similar problems.

We sincerely appreciate MCWD for their full support on the promotion of this project.

7. Annex

7.1 Materials used for Local Seminar

During the 1st Field Operation execution, MCWD requested a seminar of each category of this project, and a similar was held in the 2nd Field Operation period (on June 19, 2012).

Table of Contents

Technical Assistance on Water Supply Operation and Management for MCWD

Seminar Material

June 19, 2012

Metropolitan Cebu Water District

Yokohama Water Co., Ltd.

Technical Assistance on Water Supply Operation and Management for Metropolitan Cebu Water District: The second field operation

Date: June 19 (Tue) Time: 9:30 - 15:00 At: MCWD Training Room (6F)

No.	Time (Min.)	Title	Speaker	Remarks
1	9:30 - 9:40 (10)	Opening Address	Mr. A. Parades (MCWD) Mr. Y. Nagai (YWC)	
2	9:40 - 10:30 (50)	Presentation-1 Introduction of Water Purification method in Yokohama / Flocculation, Filtration Washing	Mr. K. Kojima Mr. S. Takahashi (YWWB)	
3	10:30 - 10:50 (20)	Coffee Break		
4	10:50 - 11:30 (40)	Presentation-2 Demonstration movie of Leak Detecting for Plastic Pipe (PVC, PEP)	Mr. K. Nakanosono (YWC)	
5	11:30 - 11:45 (15)	Question & Answer		
6	11:45 - 13:00 (75)	Lunch Time		
7	13:00 - 13:45 (45)	Presentation-3 Introduction of Digital mapping system	Mr. K. Yokoyama Mr. K. Kobayashi Mr. Y. Masago (Kokusai Kogyo Com.)	
8	13:45 - 14:15 (30)	Presentation-4 Sustainable Water Service Management - Yokohama's effort of Business Plan / CS / PR -	Ms. A. Takeuchi (YWWB)	
9	14:15 - 14:40 (25)	Presentation-5 Introduction of PI and BM for evaluation Toward 24hours water supply	Mr. K. Yokoyama (YWC)	
10	14:40 - 14:55 (15)	Question & Answer		
11	14:55 - 15:00 (5)	Closing Address	Mr. Y. Nagai (YWC)	

Introduction of Water Purification method in Yokohama

Kazuhiro KOJIMA (Mr.)
Water quality div.
Shunsuke TAKAHASHI (Mr.)
Western area construction div.

Contents

- Jar test
- Rapid mixing / Slow mixing
- Surface washing / Back washing
- Rehabilitation of filter medium

Jar test

- Information of sample (160NTU with Kaolin)
- Test condition
  - Case 1 (comparison)
  - Case 2 (Rapid mixing only, PAC=10mg/L)
  - Case 3 (Rapid mixing only, PAC=20mg/L)
  - Case 4 (Rapid and Slow mixing, PAC=10mg/L)
  - Case 5 (Rapid and Slow mixing, PAC=20mg/L)

Jar test

condition

Slow mixing 5min

Rapid mixing 2min

Result	Raw water	160NTU
PAC 20mg/L	Rapid only	16NTU
PAC 20 mg/L	Rapid & Slow	3NTU

Rapid mixing / Slow mixing

- Aim
  - Rapid mixing : To diffuse coagulant uniformly
  - Slow mixing : To enlarge flocks
- Type of mixing energy
  - Natural energy (ex. Baffle)
  - Mechanical energy (ex. Flash mixer)

Rapid mixing / Slow mixing

Mechanical

Flash Mixer

Cross Flow Paddle type Flocculator

Natural

Vertical Baffle type Flocculator

Horizontal Baffle type Flocculator

Surface washing / Back washing

- Aim
  - To remove turbid substances which retained by filter medium
- Role
  - Surface washing : Smash flocks adhered to filter surface with water jet
  - Back washing : Discharge flocks from filter medium with ascending flow

Surface washing / Back washing

(01’00”) Surface Washing start

(04’00”) Back Washing only

(02’00”) Surface + Back Washing start

(10’00”) End of Washing

Rehabilitation of filter medium

- Problems with the lapse of time in filtration basin
  - Adhesion of sludge to sand particles
  - Emergence of agglomerated flocks (called “mad ball”)
  - Ununiformity in depth of sand bed

  Then…

  - Length of filtration continue time becomes short.
  - Turbidity of filtrated water becomes high.

Rehabilitation of filter medium

Measure

Wash and Screen

Wash and Screen

pave

Contact

**su-jigyokaihatsu@
city.yokohama.jp**

Kazuhiro KOJIMA (Mr.)
Shunsuke TAKAHASHI (Mr.)

Leakage Prevention Works
MCWD'S

Leak Detector & Pipe Locater D305

Kenji Nakanosono

Stable supply of safe, better tasting water Vision of Water Supply Management MCWD' S

- Promotion of customer satisfaction management.
- Water service with high satisfaction of customers.
- Build an eco-friendly water supply system.
- Make safety and tasty water with top - level.
- Supply fresh water to a faucet anytime.

Compare The MCWD Vision

Stable supply of safe, better tasting water
Necessity of leakage prevention

MCWD network of distribution pipes and the service pipes connected to them is constantly exposed to the danger of leakage due to the influence of vibration from passing vehicles, road construction and corrosive soil.

Stable supply of safe, better tasting water
Necessity of leakage prevention

- **The leakage not only wastes valuable water resources, but also causes secondary accidents such as poor water service, road depression and flood into the buildings.**
- **Leakage control-corresponds to the development of water resources.**
- **The leakage prevention is one of the most important tasks for the MCWD 'S.**

Stable supply of safe, better tasting water

Water service with high satisfaction of customer

- Constant supply of water
- Safe supply of water
- Safe drinking water

Leakage prevention works is very important
Leakage prevention works point :

Early found / Quickly repair

5

Stable supply of safe, better tasting water

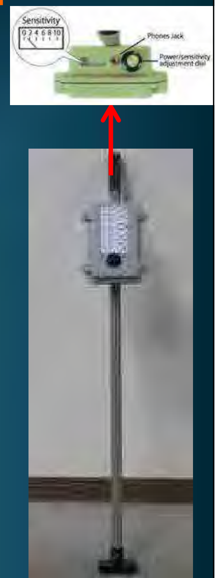
Necessity of leakage prevention

It is necessary for the MCWD 'S water to implement leakage prevention measures.

We will Leakage survey together (YWC & MCWD)

Leak Detector & Pipe Locater D305

Leak Detector & Pipe Locater D305



Transmitter

① **Red jack**(+): Connect Water Meter, Ground cock, Valves, Hydrant.

② **Black jack**(-): Connect Earth ground.

How to use Transmitter

(1) **Power Button** ; Push the Button (**Switch on**)

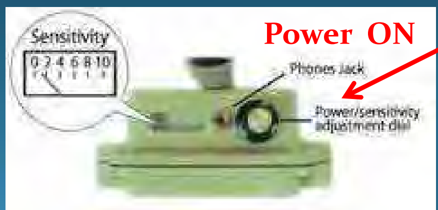
(2) **Impedance Matching Dial** ; Turn and adjust.

(3) **Output Adjustment Dial** ; Set the between 1～2A

Receiver :

Manual Operating Procedure

(2)



(1)

(1) Power on Sensitivity adjustment dial ;
move the receiver

(2) Adjust the dial to the sensitivity meter 8～10.

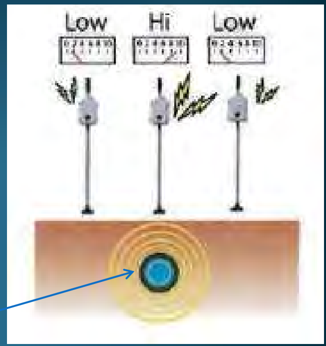
Receiver :

Manual Operating Procedure

(3) Move the receiver away :
Adjusting the dial to keep 8 ～ 10

Receiver :

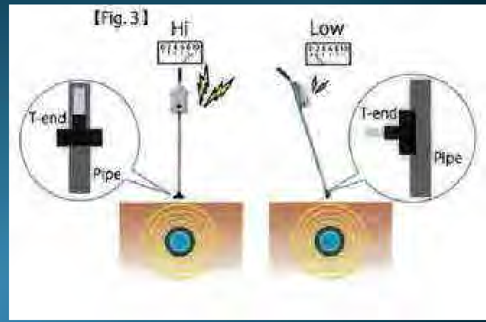
Manual Operating Procedure



(4) The subject pipe : maximum Level

Receiver :

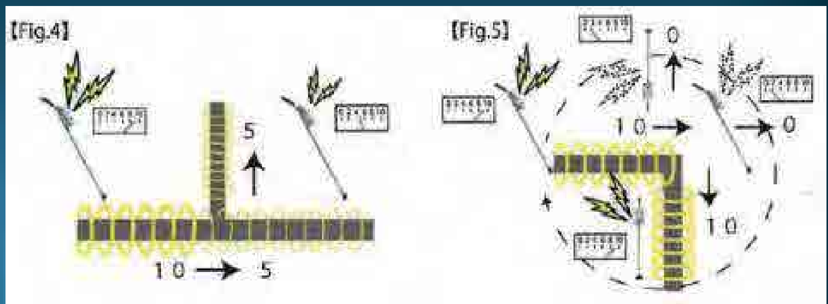
Manual Operating Procedure



(5) T-end : Signal will decrease

Receiver :

Manual Operating Procedure

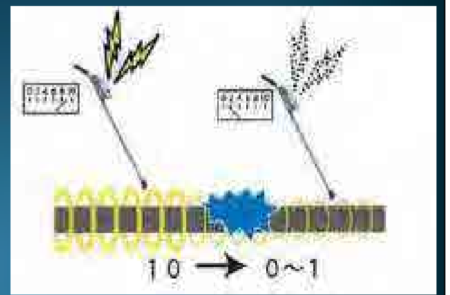


Service branch pipe 90 ° Bend pipe

(6) Decrease rapidly : Blanch or Curve
Turn the receiver around 360

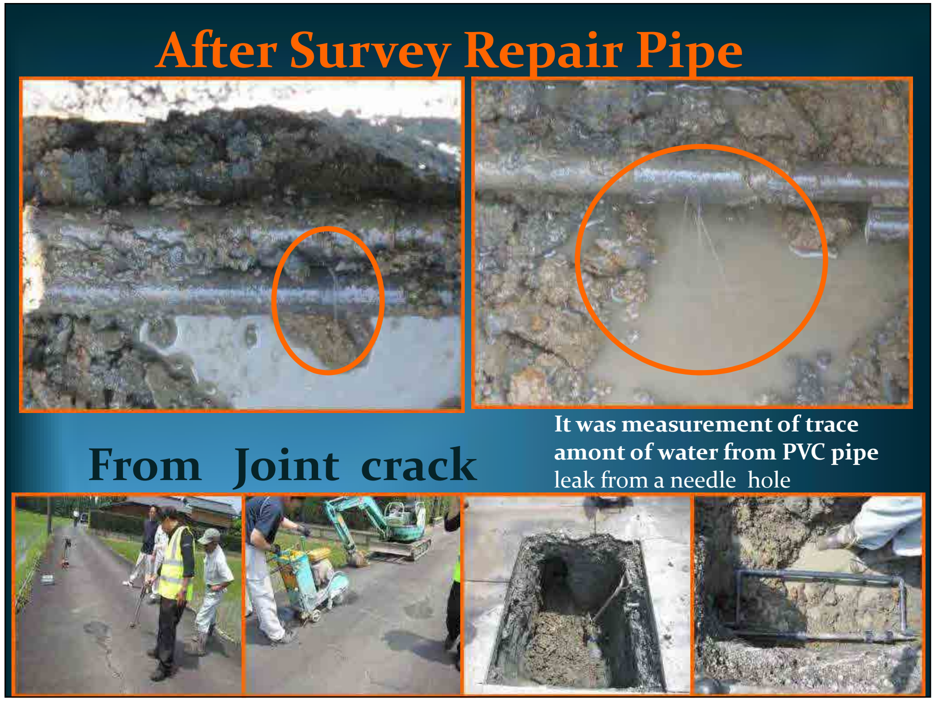
Receiver :

Manual Operating Procedure



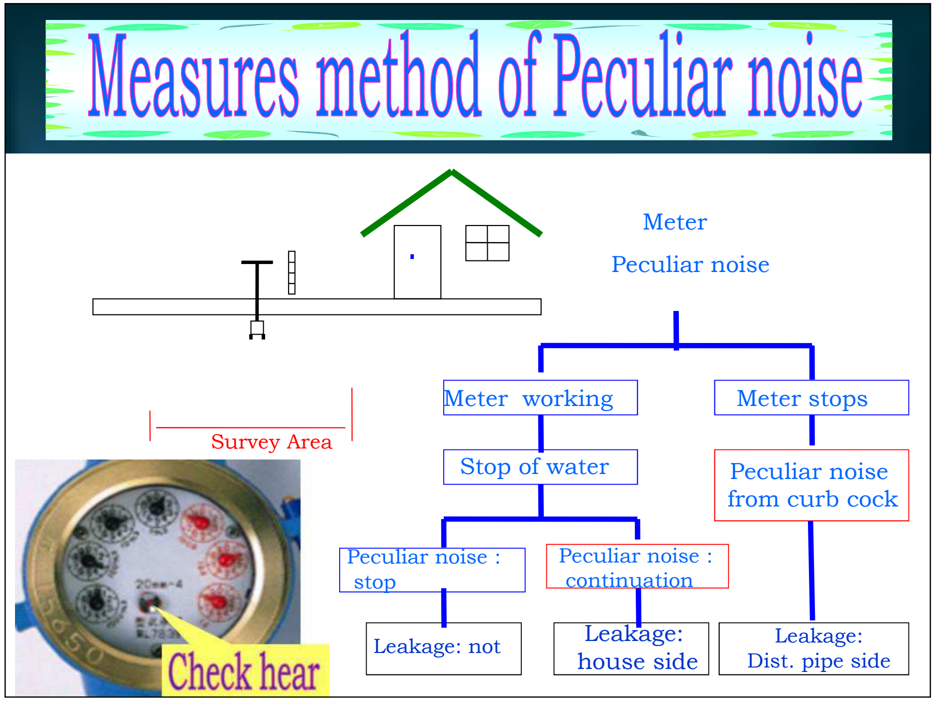
Leaking point

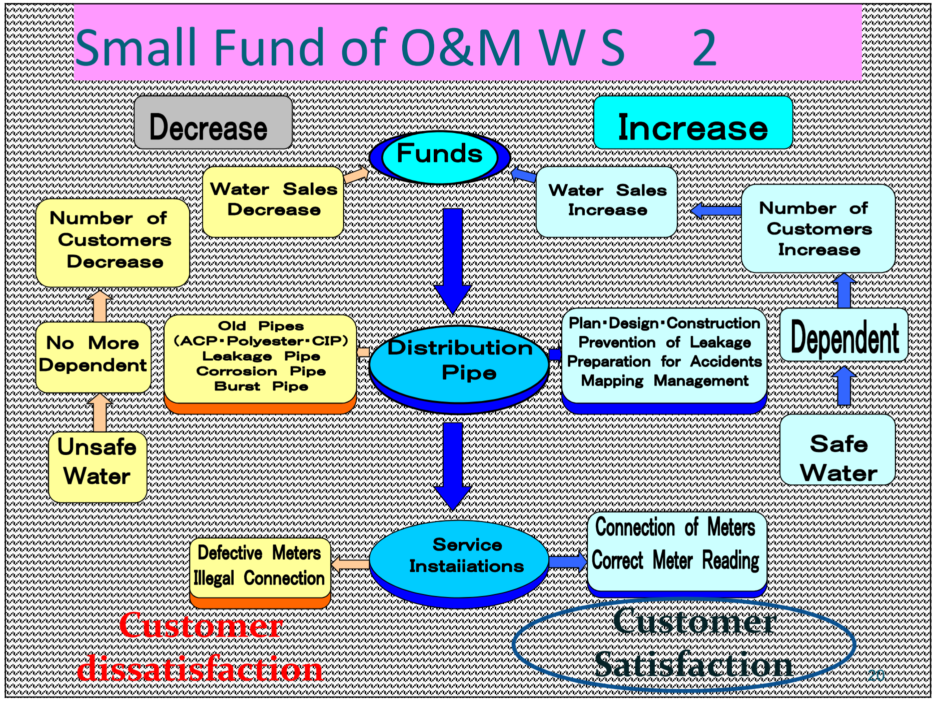
(7) the leaking point :
The signal will be diminish rapidly and Lost comletely.



Survey cycle plan

Rank	Number of incidences discovered in previous survey	Survey frequency
A	More than 10 locations	Once a year
B	5 to 9 locations	Once a year
C	1 to 4 locations	Once every two years
D	0 locations	Once every three years





OK : Let's start

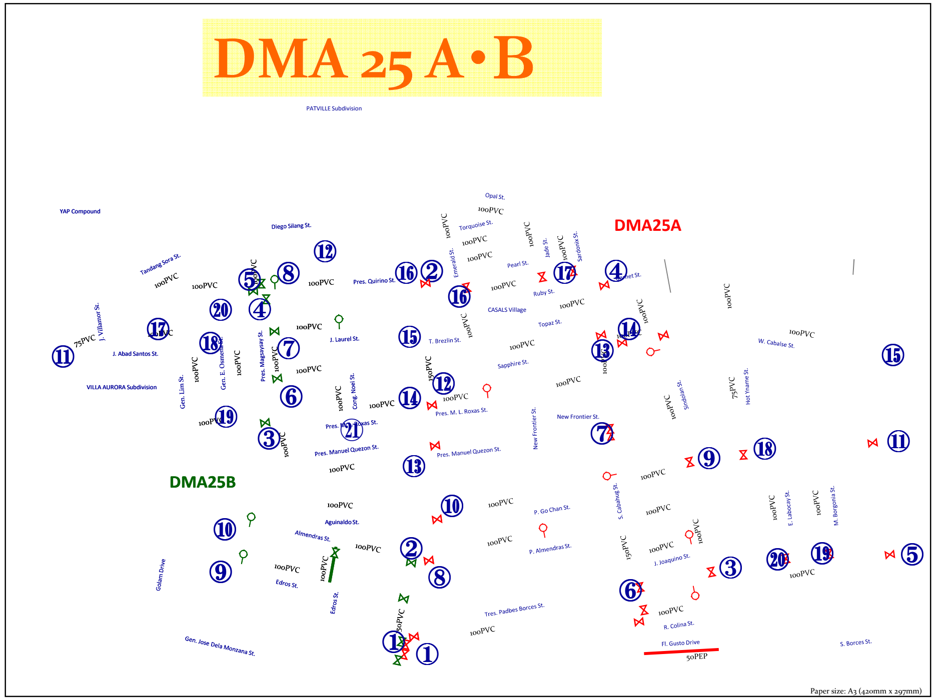
YWC・MCWD **STAFFs**

Leakage detection & locating works

NRW 25A:52. 1%

25B:19. 2%

○○%



Leakage Survey Report (Daily Report)

DMA		Year / Month / Day			Survey team		Sign	

No Line			Pipe size	Material	Length		Leakage suvey DATA (Number of Detect) 1	2	3	4	5	6	7	8	9	10	Total	Rank	Lemark
1	—	2	150	PVC		P													
						V													
1	—	5	100	PVC		P													
						V													
3	—	4	100	PVC		P													
						V													
6	—	4	150	PVC		P													
						V													
10	—	11	100	PVC		P													
						V													
12	—	13	100	PVC		P													
						V													

Leakage Detection Report

Survey Date		Y		M		D
Leakage Point	DMA No.					
	Adress					
	Name					

Manager	Chief	Staff	Staff

Survey Staff	
Manager	

DMA Map

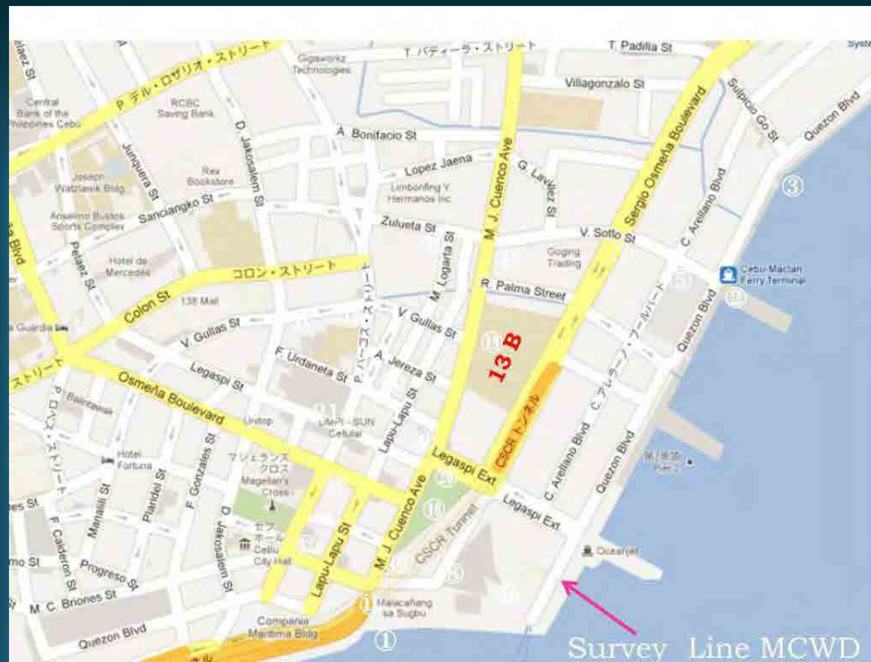
Detail Map

Details Design

Leakage Point Excavation Plan							City Road
							Private Rord
							Private Land
DMA No.	Leakage Adress						
		name			Detection Date		
Staff Name	Excavation		×	=			Instruction No.
	Square		×	=		m²	

Repair Record Note

No.	DMA No.	Team No.	Detection Date	Adress	Name	Leakage Volume	Pipe Size	Pipe Material	Leakage Conditions
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									



Water Leak&Pipe Locator D 3 0 5 Quick Manual

Transmitter

①Plug red test lead into red jack(+) on the transmitter, and connect red clip on the otherside to metal portion of the objective pipe.

②Plug black lead wire into a black jack on the transmitter, and connect the other side to separated earth ground;
a metallic material such as a pole for street signs over 10m away from the transmitter.

Note1: Guard rails are multiple grounded, so they are not suitable for earth ground in this purpose.

Note2: if necessary, an Screwdriver or 25m cable drum accompanied in this kit can be used to get proper earth ground.

③Push the "Power Button" on the transmitter, and set the "Output Adjustment Dial" between 1~2A.

④Turn and adjust the "Impedance Matching Dial" to get the strongest output.

Receiver

①Turn the power/sensitivity adjustment dial on, and move the receiver close to the transmitter.
If the tone signal will be heard from the receiver, it shows both the transmitter and receiver are working.

②Adjust the dial so as to the sensitivity meter shows 8~10. (Fig.1)

③Move the receiver away from the transmitter, then the sensitivity level will be slightly decreasing.
Trace the path with adjusting the dial to keep the sensitivity meter level between 8~10.

④The signal receipt will be strongest on the subject pipe (the sensitive meter shows maximum level) and will decrease when moving away from it.(Fig.2)

⑤The antenna with T-end should be oriented perpendicular to the path of the subject. When putting the T-end antenna parallel to the path, the reception of signal will decrease and you will know the direction of the path. (Fig.3)

⑥When reception of the signal will decrease rapidly, it shows there might be blanch or curve in this point.
Turn the receiver around 360° around this point if any branch lines are existing.(Fig.4,5)

⑦At the water leaking point, the reception of the signal will be diminish rapidly and be lost completely.(Fig.6)
If it will recover again after increasing the sensitivity of the receiver, there might be another reason such as branch, curve or etc.

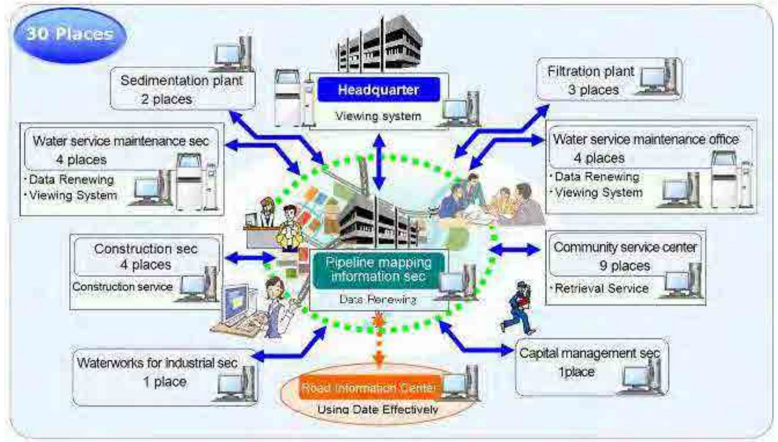
7–15

Introduction of Water Supply GIS
Yokohama Water - Kokusai Kogyo

KOKUSAI KOGYO GROUP

System Layout

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



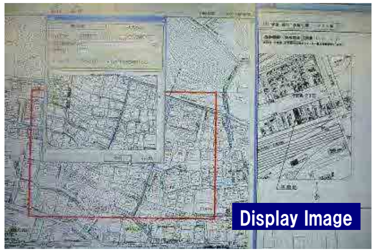
Work Site

Main Office

Work Site

Work site

Work Site



Work Site

Improvement on managing water

Adopting GIS can…

①Increase management efficiency thru new mapping methods

②Optimize management system/methods

③Improving annual planning

④Provide valuable insights from Yokohama' s system

Efficient water managing due to GIS

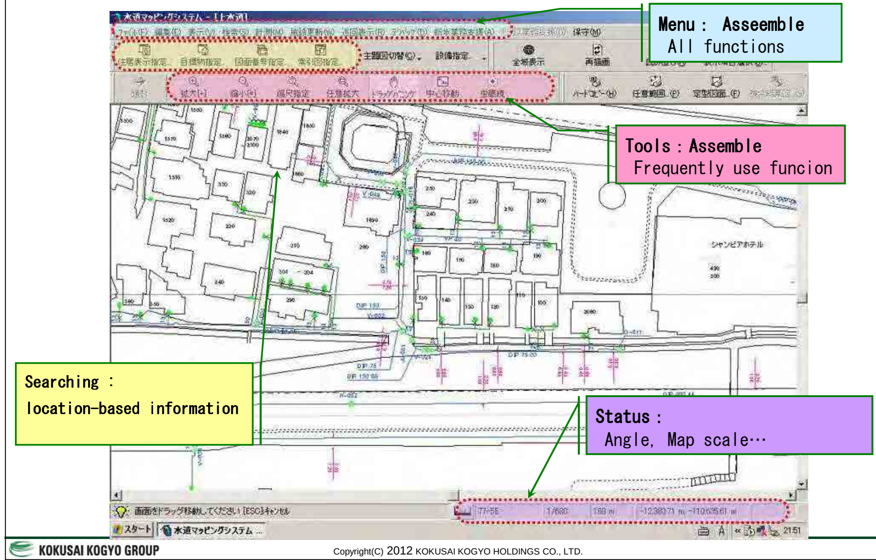
Reduce cost

Reduce NRW%

Greater efficiency by cooperating/sharing data with other organization

For the operation of Water Supply GIS
～Demonstaration～

Operational Image



Features - 1

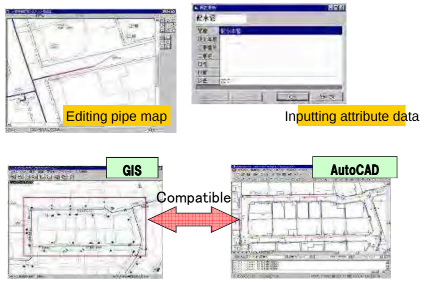
Can handle all range of waterworks O&M tasks

High security

Passwords can be set to restrict access such as to 'manager' with data edit/update privileges and 'guest' for viewing only.

Data input/updating

Data can be easily inputted and updated whenever new water pipes or valves are added, and pipe maps can be drawn by mouse.
Maps made with CAD software can also be imported.



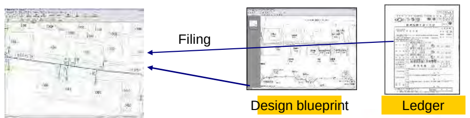
Planning water works

Maximizes planning efficiency with search function that allows specific data to be found such as "pipe laid in __month __ year" to pinpoint which water pipes will need repairs or replacing.

Features - 2

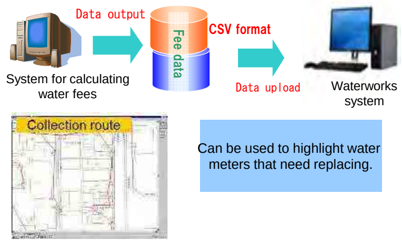
Filing system

Allows integrated management of various data such as waterworks ledger, construction schedules, pictures, maps and Excel files.



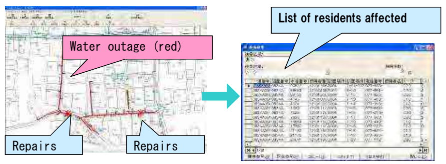
Supporting water fee collection

This system can be coupled with a water fee collection system to upload necessary data (valve and water supply number, volume used, meter number, resident name, water fee, etc.), and plan the most efficient collection route based on mapped route data of the meter readers. This ensures no houses are missed by the fee collectors.



Simulating water outages

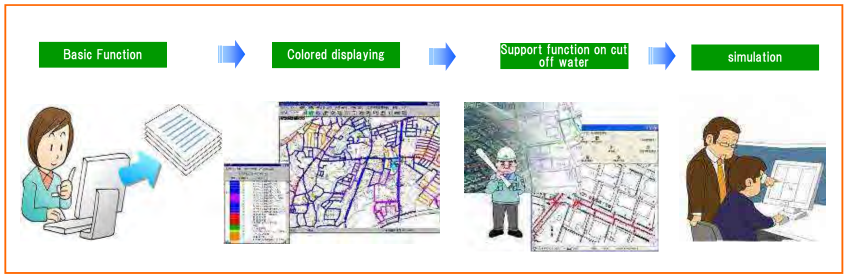
When there is a water leak, areas effected by repair works can be simulated.
By inputting the location of repair works, the closest valve can be found and a list of residents affected by the water cut-off once the valve is closed can easily be produced.



Demonstration

Searching ～Simulation of water outage～

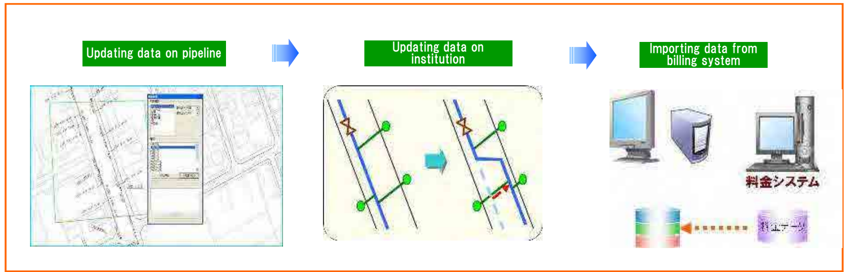
- Searching broken pipelines, display its distribution condition
- Investigation effect of water outage due to waterworks



Demonstration

Data updating

- Newly laid water pipelines
- Newly Input facility water supply
- Import data from billing system and reflect them into mapping system



Conclusion

Establishing reliable and efficient water management system and Database are vital for…

①Centralization of pipeline information
→ Adequate management

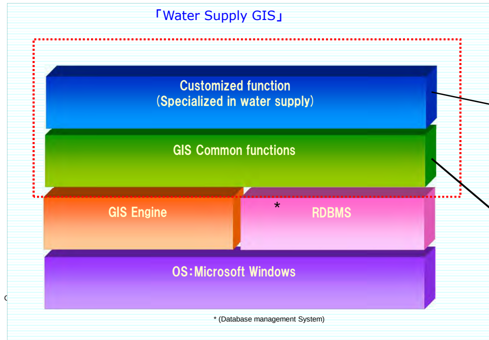
②Optimization of works
→ Cost reduction

③ Reduce NRW% and increased fee collection rate

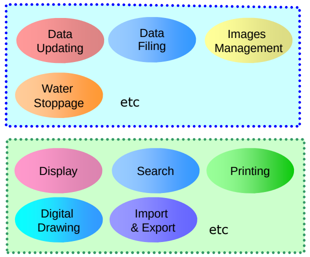
Reference materials

Features of system

Water Supply GIS	• Full support on water supply management business • Useful functions(Filing, support for water stoppage, security,etc) • Common platform with water sewage management system



Functions
Sophisticated Functions that support for water supply maintenance & management



Workflow

1st Phase

1. Planning & Arrangement
2. Data gathering
3. System architecture

2nd Phase

4. Data preparation
5. Set up system
6. Trial run with PC
7. Arrangement of system
8. Learning on operation

Implement

POINT!! Analyze present works

4. Pipeline data
- Input data on water pipe
- diagrammatic input on facility(meter,)
- Field work (investigation)

4-2. Importing data on billing system
- Matching billing data with meter

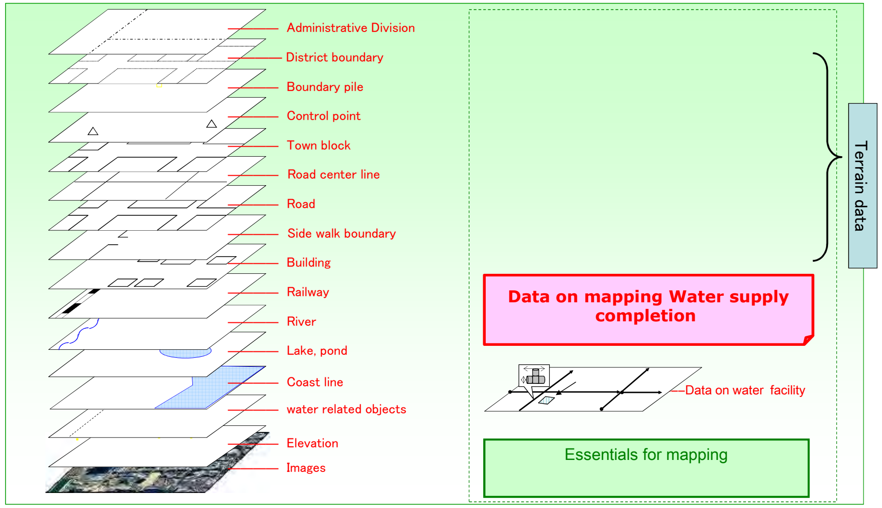
4-3. Data filing
- Filing data for water supply mapping
- Filing as built drawings

POINT!! Establish making base map method

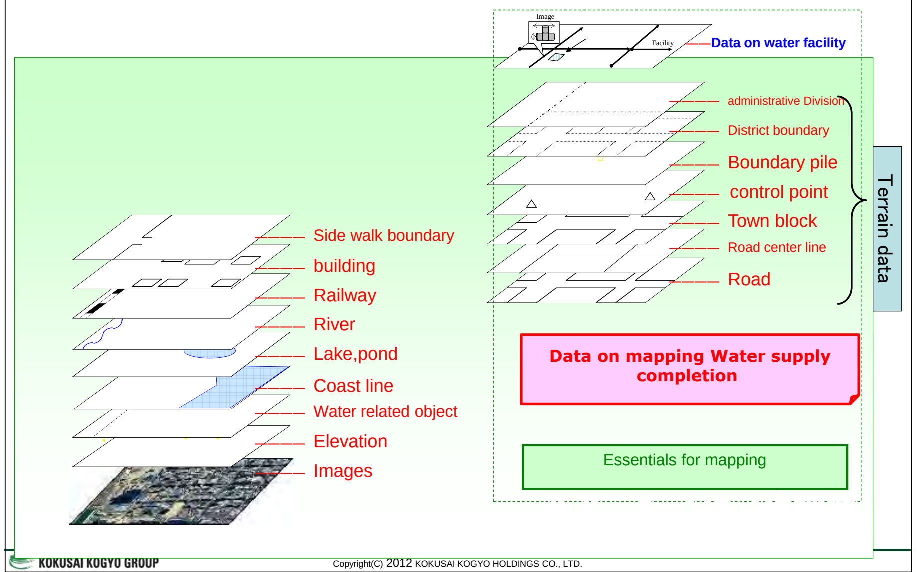
5. Set up system
- Mapping system, Administration of information
- Operating together with existing system

5-2. Newly system architecture
- Pipeline network analyze system architecture
- Billing system architecture

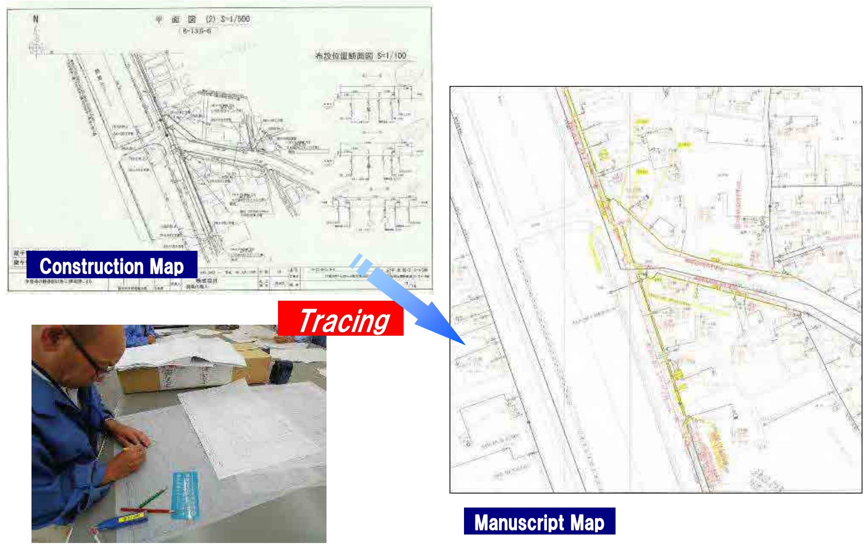
Database architecture



Database architecture

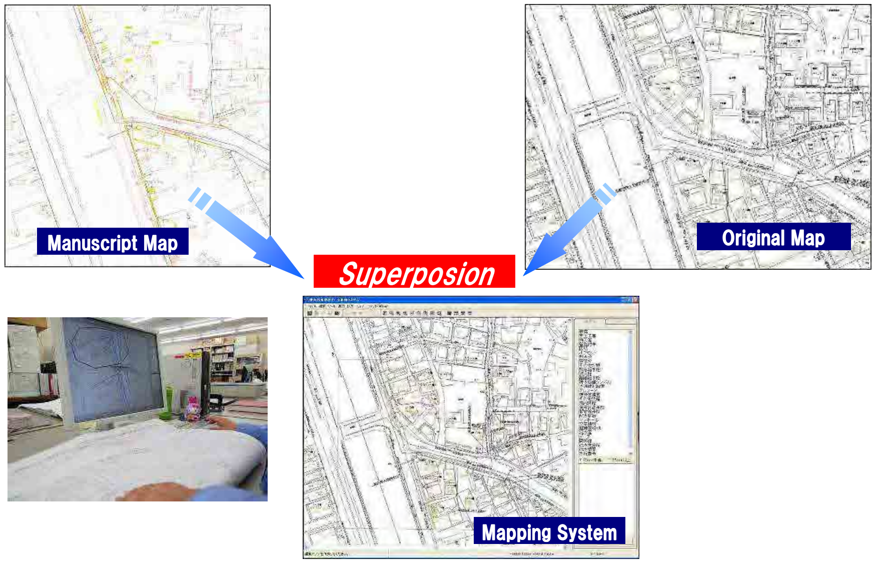


Data Updating



7−20

Data Updating



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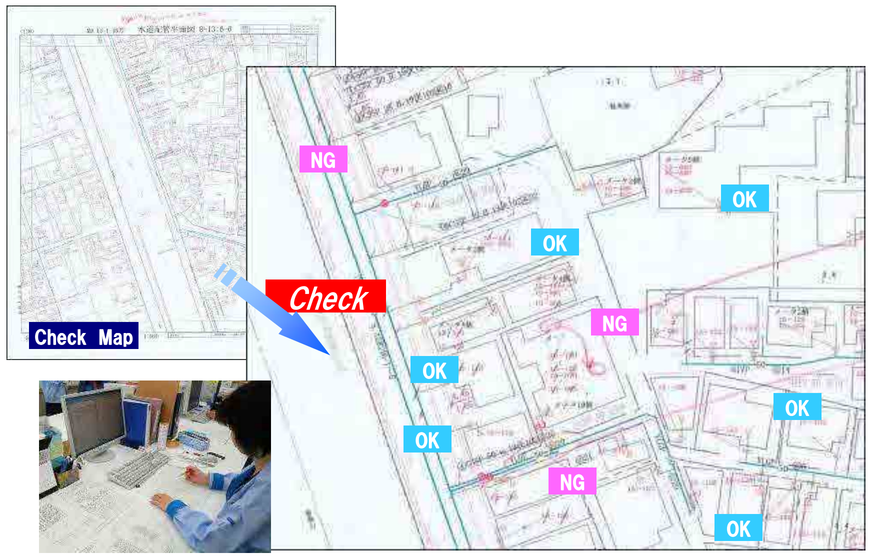
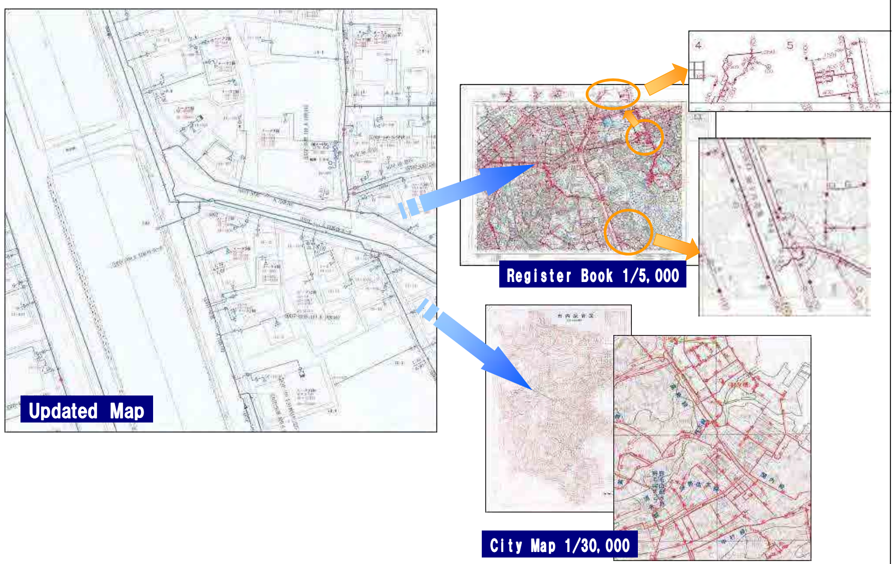


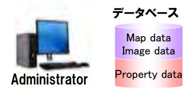
Data Updating



Introduction of system

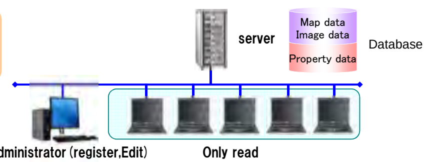
Case1

Register,Read,Edit data by only one administrator



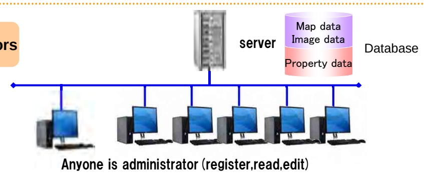
Case2

- Register,Read,Edit data by only one administrator
- Read data on server with web application by persons



Case3

- **Sharing data's register,read,edit among administrators**



Structure of KOKUSAI KOGYO GROUP

KOKUSAI KOGYO HOLDINGS CO., LTD.
Tokyo Stock Exchange (code : 9234)

56 subsidiaries
7 associate companies

- KOKUSAI KOGYO CO.,LTD. (KKC) — Spatial Information Consulting
- KOKUSAI ENVIRONMENTAL SOLUTIONS CO., LTD. — Environmental Conservation
- KOKUSAI LAND & DEVELOPMENT CO., LTD. — Real Estate
- KOKUSAI EUROPE GmbH — Development of solar power generation facilities

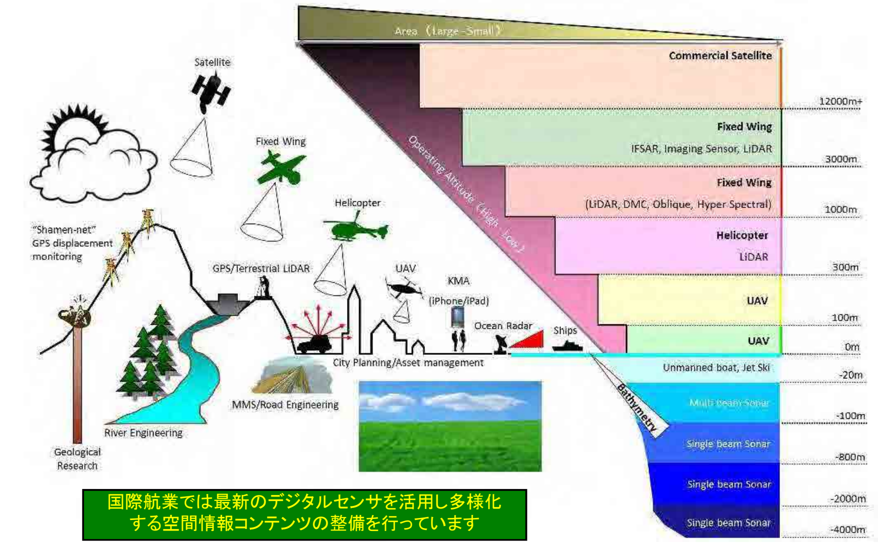
KOKUSAI KOGYO CO.,LTD. (KKC)

Corporate Data (March, 2011)	
Established	September 12, 1947
Capital	US$ 167.2 million
Net sales (※1)	US$ 385 million
Number of Employees	1,163
Domestic Bases	47
Scope of Business	Engineering and consulting services - Spatial Information services - Geological surveying and National land design solutions - Energy related business (new) , etc

Headquarters (Tokyo)

80% of KKC project volume is made up of national and local government contracts.

Spatial Information Technology

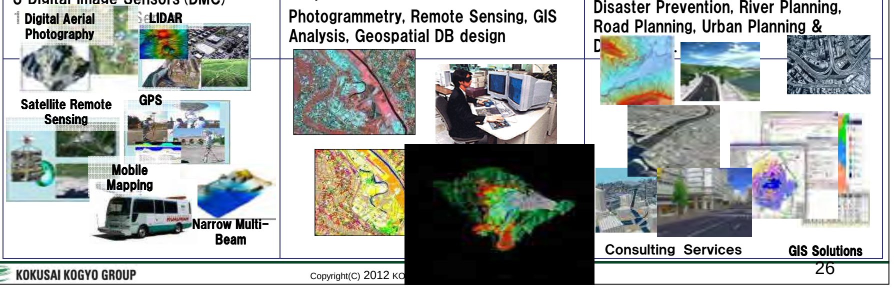


国際航業では最新のデジタルセンサを活用し多様化する空間情報コンテンツの整備を行っています

Retaining "*well-balanced*" three Strengths

- KKC can provide the total solution from Data capturing to Consulting

1 Data Capturing	2 Data Processing & Analysis	3 Consulting & Engineering Services
Various kind of sensors and ability to capture geospatial data	**High quality data processing technology and ability to interpret it**	**Ability to utilize a processed data and its technology consulting**
Various Satellite Sensors 3 Lidar sensors 3 Digital Image Sensors (DMC)	・10 PhDs, 271 registered surveyors ・Specialties Photogrammetry, Remote Sensing, GIS Analysis, Geospatial DB design	・6 PhDs, 254 Professional Engineers ・Specialties Disaster Prevention, River Planning, Road Planning, Urban Planning & D...



Spatial Information Business - 2

E-Government Implementation - Large Share for Administrative Affair & Inventory Maintenance -

Administrative Affair: Huge number of Inventories related to maps are stored

Administrative Support

- Urban Facility Management
  - ･Water & Sewerage Database
- Fix Property Tax Management
- Road Management
  - ･Facility Management Database
- Urban Planning Support
  - ･Database Production/Development
- Integrated GIS* Installation Support