REPUBLIC OF THE PHILIPPINES
METRO COTABATO WATER DISTRICT

DATA COLLECTION SURVEY ON WATER SUPPLY SYSTEMS IN COTABATO CITY

FINAL REPORT

MAY 2023

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CTI ENGINEERING INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD

GE
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23-069

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Exchange Rate (As of December, 2022)

1.00USD＝138.482 YEN

1.00PHP＝2.44976 YEN

Summary

1. Overview of the Country

The Republic of the Philippines ("Philippines") is a maritime nation located in Southeast Asia comprising 7,641 islands and having a land area of 298,170m^2. It has a population of 110 million, of which about 38.6% are concentrated in three regions around the capital Manila. The population growth rate from 2015 to 2020 was 1.63% nationwide, but at a disproportionate rate by regions. The rate peaked at 3.26% in the Bangsamoro Muslim Mindanao Autonomous Region (BARMM)[2]; however, the figure for Region 8 (Samar and Leyte Island) remained 0.5%. (Philippines Static Authority (PSA), Ministry of Foreign Affairs (Japan))

In 2022, the Gross National Income (GNI) growth rate was 9.9%, and the Gross Domestic Product (GDP) was 7.6%, both of which showing high growth. The Philippines concluded an economic partnership agreement with Japan, and regarding the share of trading partner countries on a monetary basis, Japan ranks second (13.9%) after the United States for exports from the Philippines, and third after Indonesia (9.0%) for imports to the Philippines. The most common export goods are electronic and electrical equipment, and the top imports goods are raw materials and intermediate goods. (PSA, Ministry of Foreign Affairs (Japan))

The country has a tropical maritime climate and humid with abundant rainfall. Some regions do not have a rainy or dry season. Typhoons have the greatest impact on the climate in the Philippines, but rarely make landfall on Mindanao island. (Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA))

2. Background and Overview of the Survey

In the Autonomous Region of Muslim Mindanao (ARMM) in Mindanao, Philippines, which has been in conflict for over 40 years, the Bangsamoro Organic Law was approved in 2018, and the BARMM territory was finalized, and the Bangsamoro Transitional Authority (BTA) was established. Efforts are currently underway to transition to BARMM having duty elected officials in 2025. The city of Cotabato had previously been an independent city from ARMM, but was incorporated into BARMM following a referendum in February 2019.

The population of Cotabato City is approximately 300,000 (in 2015) and is expected to further increase in the future, as the city's population has continued to grow at an average rate of 4.1% per year over the past 15 years and is expected to function as a capital city in the BARMM. The Japan International Cooperation Agency (JICA) conducted the "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City" in order to formulate a cooperation program for the

[2] Cotabato City belonged to the Region 12 at the time of the national census in 2020.

comprehensive development of the Cotabato Urban Area, and conducted a Pre-F/S on the development of water supply facilities in Cotabato City and surrounding areas in the same study.

The Metro Cotabato Water District (MCWD), established in 1976, is responsible for water supply in Cotabato City and the adjacent municipalities of Datu Odin Sinsuat (DOS) and Sultan Kudarat (SK). It draws water from three water sources; deep wells, springs and surface water, and it has a water supply of approximately 48,000 m^3/day, of which approximately 25% is considered non-revenue water. The water supply rate in Cotabato City is low, at about 47.4% in 2022, and households without water supply services are dependent on unsanitary and traditional water sources.

In the past data collection survey, proposals were made for the construction of new facilities and the expansion and upgrading of existing facilities. Through this survey with extra data collection and analysis, the feasibility and policy of assistance on water supply section in Cotabato City will be clarified.

3. Overview of the Survey and Water Supply Project Plan by Japan

3.1 Site Survey Schedule

JICA dispatched a survey team as scheduled below:

Inception Report Explanation/ Site Survey: 9/10/2022 - 8/12/2022

Draft Final Report Explanation: 12/3/2023 - 19/3/2023

The survey team conducted data collection of population status required for water demand projection, operation and maintenance status of existing water supply facilities, bulk water supplies, organizational structure and financial status, survey for potential water treatment plant sites and water quality survey at rivers in Cotabato City, adjacent SK and DOS to implement a water supply project by Japan.

3.2 Status of Water Supply Facility

The MCWD has three water intake and treatment facilities in SK (all deep wells with Rebuken, Macaguiling Pump Station (PS) 1 and 2), two in DOS (Tanuel Spring PS, Dimapatoy Water Treatment Plant (WTP) from the surface water), and there are private own bulk water supply facilities; one in SK (Mactan Rock from the surface water) and another one in Cotabato City (HANABANA from the surface water). From those facilities, water provides to Cotabato City. Transmission pipes are mostly installed on Sinsuat Avenue; delivered to two reservoirs in Cotabato City and one in DOS. There are a total of around 200km of transmission pipes and distribution pipes.

MCWD’s multiple transmission pipes from WTP have been integrated into a single pipe on the way to the reservoirs. Furthermore, some distribution pipes are branched directly from the transmission pipes; therefore, the water pressure in the water pipes fluctuates drastically when the booster pumps at each pumping station are activated. Household connections are also affected by these water pressure fluctuations, which is thought to be one of the causes of leakage from household connections.

Table below shows annual production volume by water sources from 2017 to 2022.

No.	Pump Station	Design Production (m3/day)	2017	2018	2019	2020	2021	2022	Actual Production (m3/day)
1	Tanuel (200LPS)	17,280	16,580	15,797	15,659	14,930	15,998	16,420	16,600
2	Rebuken (30LPS)	2,590	2,555	2,189	2,043	1,476	1,350	1,383	1,400
3	Macaguiling No.1 (30LPS)	0	1,350	1,293	1,112	1,373	1,404	1,135	0
4	Macaguiling No.2 (30LPS)	0	627	514	337	0	0	0	0
5	Dimapatoy Treatment (200LPS)	17,280	13,105	16,372	16,626	17,706	18,285	17,496	17,800
6	Bulk Water Supply (Simuay, Mactan Rock)	5,000		4,128	4,682	5,547	5,397	5,700	5,500
7	Bulk Water Supply (Matanpay,Hanabana)	5,000						4,935	5,000
Total Production (m^3/day)		47,150	34,217	40,294	40,459	41,031	44,454	49,091	46,300

Source : MCWD

As of 2022, Tanuel and Dimapatoy occupy 35 and 37% and Dimapatoy of total production respectively. Bulk water supply with two water sources occupies about 20%.

Dimapatoy and Tanuel, which are the main water sources, have stable water production throughout the year due to small seasonal fluctuations.

3.3 Population and Water Demand around Survey Area

The population within MCWD's administrative area is estimated to be approximately 572,000 as of 2022, and the population served by water supply is only approximately 202,000, or about 35% of the total population.

The results of the population projections for 2029 and 2040 and the projected water supply ratio are shown below.

Items	2029	2040
Population in the administrative area (a)	725,608 persons	955,922 persons
Population in the water supply area (b)	528,497 persons	746,816 persons
Population served (c)	394,901 persons	670,822 persons
Water supply ratio in administrative area (=c/a)	54.4%	70.2%
Water supply ratio in service area (=c/b)	74.7%	89.8%
Number of houses supplied	72,557 HHs	123,254 HHs

Source : JICA Survey Team

In establishing water supply areas, the MCWD will select barangays with high priority for the MCWD and establish design water supply area so that water will be supplied to residents in those areas, instead of designating all of the administrative area as water supply area. The population to be served in 2029, the target year, is assumed to be 394,901.

The population served will be set to cover 90% of the population in the water supply area in the Urban Area, based on the results of the willingness-to-connect survey conducted by the United States Agency for International Development (USAID) in 2014. In addition, discussions were held with the MCWD to generally cover 80% of the population in the water supply area in areas other than the Urban Area.

3.4 Financial Status

As a table below shows, assets are increasing year by year, while liabilities are decreasing, and equity (mainly retained earnings) is also increasing year by year.

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
ASSETS	601.03	662.77	711.84	769.98	808.54	207.52	34.5%
LIABILITIES	113.11	96.10	74.90	83.66	80.08	-33.03	-29.2%
EQUITY (NET ASSET/WORTH)	487.92	566.67	636.94	686.32	728.46	240.54	49.3%
GOVERNMENT EQUITY	26.98	26.98	26.98	26.98	26.98	0.00	0.0%
RETAINED EARNINGS	460.94	539.69	609.96	659.34	701.48	240.54	52.2%

Source : Analysis by JICA Survey Team based on MCWD annual financial reports

In addition, although the amount is on a downward trend, surplus (or profit) has remained, and the operating cash flow: Plus, the investment cash flow: Minus, the financial cash flow: Minus (long-term liabilities seem to be almost fully redeemed in FY2021), so MCWD has kept a sound financial situation.

However, as shown in Figure 4-6-1, the rate of increase in operating expenses for the five-year period from FY2017 to FY2021 is approximately double the rate of increase in revenue (income), resulting in a 30.1% drop in surplus or profit. Similarly, as shown in Figure 4-6-2, cash flow from operating activities for the five-year period from FY2017 to FY2021 decreased by 38.3% due to the higher rate of increase in cash outflow compared to cash inflow. Assuming that the current trend will simply continue in the future, MCWD's business operation will be in the red in 2030. Furthermore, if both investment and financing cash flows remain at the same level, operating cash flow will be minus from FY2025 as well as increase/decrease in cash and cash equivalents will also be minus. This means, although accumulated cash and cash equivalents will be sufficient for the time being, the situation is not optimistic such as facing running out of cash (bankruptcy in the black) sooner or later.

3.5 Water Source Development

Spring water, groundwater, and river water are assumed to be the future development water sources within the service area of MCWD. Judging from the current production volume for the current water sources, water source information from the MCWD, and the development situations of the bulk water, the development of the water source would be river water. An overview of four rivers around Cotabato City is described below.

Among the targeted rivers, the Rio Grande de Mindanao (Mindanao River) does not have any major problems with water quantity and water quality. Based on the study results of USAID in 2015, the MCWD would secure a budget from the SDF (Special Development Fund) and implement the project in three (3) phases through the Design and Build Scheme under Republic Act 9184. (Development water volume: 50 MLD, Project cost: PHP 1,570 Million, Approximately 3.93 Billion in Japanese Yen, for the target year of 2035.) The planned project is to take water from the Mindanao River and expand the service area to Sultan Kudarat District, which is located in the northern part of the current water supply area. Therefore, entry into this project with JICA funds is not expected at this time. In addition, the river

improvement project implemented by Department of Public Works and Highway (DPWH) is not expected for the time being, so it would be necessary to protect the intake facilities with land raising to design the same levels as the embankment that would be designed in the river master plan.

The Tamontaka River, like the Mindanao River, does not have any major problems with water quantity and quality among the targeted rivers. According to the Mayor of Cotabato City, the city has been trying to secure water sources within the city administration area for a long time, and the development of water sources in this river is in line with the city's policy. The candidate water intake site is close to houses and public facilities, and it is expected that land acquisition would be difficult. In addition, as confirmed in the post-flood survey for typhoon "Paeng" by JICA, there is a lot of water hyacinth flowing in the river. From the operation and environmental points of view, it is necessary to consider the removal of these in the facility planning and design. According to information from the MCWD, land acquisition is a pending issue, and if resolved, it is determined that there will be no obstacles to the progress of the project. According to information from the MCWD, the tidal affecting zone extends up to around STA 8k000; however, a more precise survey is required. As flood management measures by the DPWH are not expected to be implemented in the Tamontaka River as well, it is necessary to protect the intake facilities by land raising to the same level as the embankment in the river master plan.

In the Simuay River, intake facilities have suffered two times due to flood damages, one in 2018 and the other in 2022 since the starting of the operation of the WTP. Large fluctuations in the river bed and main flow streams and large sediment runoff are confirmed at the intake site. Therefore, taking into account the river situation near the current intake site, it is judged that it is not suitable as a water intake facility. In addition, water is already being taken by Mactan Rock as a bulk water supply, making it difficult for other new business companies to participate.

In terms of the Matampay River, HANABANA has been taking water from the river as a bulk water supply. There is no flood damage, and the quantity and quality of water are excellent, so there is no problem as a site for selecting water intake facilities. Like the Simuay River, it would be difficult for a new business operation to enter the water supply business while the private sector is operating it, considering the operational aspects.

As stated above, the target river for the water supply project would be three rivers, except the Mindanao River, which is an object of the SDF project. Of the three rivers, the Tamontaka River would be the one because its flow rate is abundant, it matches the policy of Cotabato City water source development (having its water source), and land would be acquired by the MCWD.

3.6 Facility Development Plan

(1) Dimapatoy WTP Expansion

As of December 2022, the Dimapatoy WTP is being expanded by the MCWD. The expansion capacity is 8,000 m^3/day and is relied on the surface water from the Dimapatoy River. The water rights for the

Dimapatoy River have been applied for from the MCWD to the Ministry of Environment, Natural Resources and Energy (MENRE) and the water rights for 400 LPS (34,560 m^3/day) required for the expanded WTP have been permitted.

(2) New Rio Grande WTP

Rio Grande Water Supply System Project was proposed by USAID in July 2015. MCWD is currently in the process of submitting a project implementation plan to the Bangsamoro Planning and Development Authority (BPDA) to utilize SDF. The plan is divided into three phases until 2035, with SDF Phase 1 for the construction of a WTP (25,000 m^3/day), SDF Phase 2 for the laying of transmission and distribution pipes and SDF Phase 3 for the construction of a WTP (another 25,000 m^3/day).

The construction of the water treatment plant in SDF Phase 1 is considered to be carried out by design and build at 25,000 m^3/day, and specifications have been prepared by the MCWD and submitted to BPDA. The installation of water pipes in SDF Phase 2 aims to expand the water supply capacity of SK and Cotabato City and the water supply area of SK and Sultan Mastura. In particular, one of the major objectives is to provide water stably to the Cotabato Sanatorium Hospital. In SDF Phase 3, the WTP will be further expanded by 25,000 m^3/day. It is envisaged that the water demand of Cotabato City, SK and Sultan Mastura will increase by around 2031.

(3) HANABANA Bulk Water Supply Expansion

The MCWD contracted with HANABANA bulk water supply for ten years from January 2022. The purchase volume for the first year is 5,000 m^3/day, then increase by 500 m^3/day by year. It would be 10,000 m^3/day in 2032.

The MCWD owns the site for the HANABANA bulk water supply, and the site for future facility expansion has been secured. In addition to the ten pressure filtration tanks currently installed, ten more can be added. Since the filtration capacity per unit is 1,000 m^3/day, if ten units are added to the total of twenty units, it is possible to expand the water treatment capacity to 20,000 m^3/day.

(4) New Tamontaka WTP

No studies or plans by other donors to construct water supply facilities using water from the Tamontaka River have been implemented. The MCWD has been investigating and negotiating with landowners to acquire candidate sites along the Tamontaka River, with a view to securing multiple water sources in Cotabato City in the future as a countermeasure to the recent disasters that have cut off the water supply. The MCWD has already conducted investigations and landowner negotiations for the acquisition of a candidate construction site along the Tamontaka River. This proposal is to distribute water to seven barangays on the right bank (Cotabato City side) along the Tamontaka River via a water treatment reservoir and a water treatment plant.

These barangays are areas with a high population growth rate with plans underway for commercial facilities, factories, schools, public facilities, residential land developments, and resort developments. Water demand is expected to increase rapidly in the future. For the MCWD, the shortage of water supply capacity is an urgent issue, and the expansion of water supply capacity is considered to be a priority issue to be solved.

From the above information, the development of a new Tamontaka WTP is selected, in which water is taken from the Tamontaka River. It also has a high potential for the water source because water can be supplied to the right bank of the Tamontaka River, where rapid water demand increment is expected. This was proposed to the MCWD, and agreed upon. The water supply project plan by Japan is shown below.

3.7 Water Supply Project Plan

(1) Water Supply Facility

Facilities	Equipment	Specification
Water supply area		3~7 barangays (kalanganan2, Tamontaka mother,Tamontaka1~5)
Design intake flow		7,370~12,100 ㎥/day
Maximum daily supply		6,700~11,000 ㎥/day
1. Intake facility	Intake pump : Pump room : 	2~3 (1 standby) 1 building
2.Water treatment facilities	Receiving well : Mixing tank : Flocculation basin : Sedimentation tank : Rapid sand filter : Reservoir : Administration Build. : Drying bed : Drainage basin :	1 pond 2 ponds 2~4 ponds, vertical baffled channel 2~4 lines, Plate settler 7~12 tanks, Multimedia filter 1~2 tank, 2,400~4000 m^3 1 building 2 beds 2 ponds
3.Distribution facilities	Pump station : Booster pump : Distribution main : SP φ500mm : SP φ400mm : HDPE φ300mm : HDPE φ250mm : Flow meter/pressure meter : Pipe beam/bridge-attached pipe :	1 building 3~5 (1standby) L= 9.96~18.74 km L= 3.25~6.12 km L= 6.71km L= 2.50km L= 3.41km 8 places (including for 7 DMA) 2~4
	Distribution branch HDPEφ100: Emergency valve φ400: Emergency valve φ300:	L= 9.0~21.0 km L= 9.0~21.0 km 1 location (non-suspension water method) 1 location (non-suspension water method)

Source : JICA Survey Team

(2) Procurement of Equipment

No.	Equipment	Quantity	Cost (JPY)
1	Equipment for water quality test	1	6,500,000
2	Submergible sand pump	1	1,000,000
3	Generator	1	500,000
4	Poor households connections	1,659~2,676 units	14,000,000~25,000,000
Total（JPY）			22,000,000~33,000,000

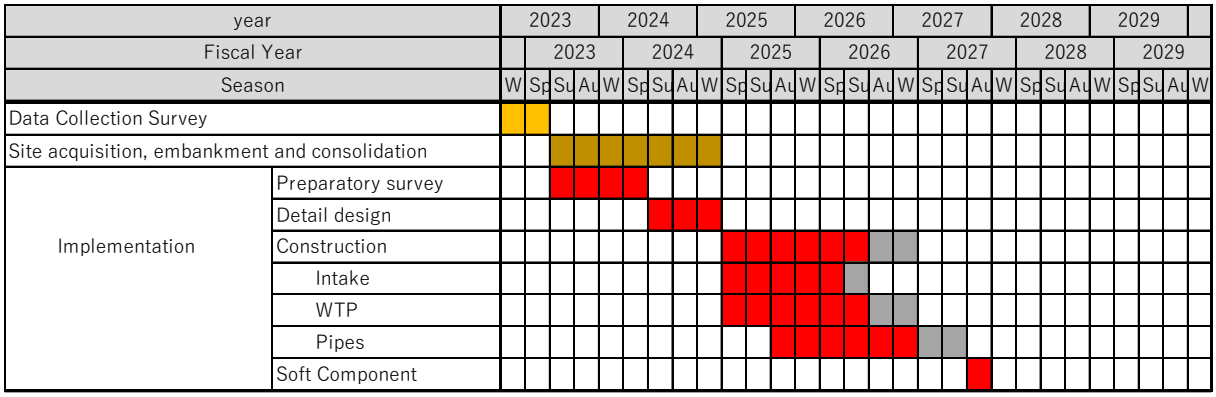
Source : JICA Survey Team

4. Expected Schedule and Project Cost

4.1 Expected Schedule

It is expected to take about one year for preparatory studies and about one year for implementation design and bidding. In addition, during the two years, the period required for land acquisition, embankment and consolidation settlement by the MCWD will be allocated.

Construction of water intake, water treatment and distribution facilities will begin at the same time. The construction period is expected to be approximately two years based on past results.



Source: JICA Survey Team

4.2 Expected Project Cost

Expected project cost is shown below.

Item	Water Supply Project Cost
Water treatment capacity（m^3/day）	6,700~11,000
Construction cost　(Incl. dist. Facilities)	2,545~3,747
Procurement cost	22~33
Design and Supervise（Construction cost×10%）	255~374
Assistance for O&M	19
Preliminary costs（sub-total×5%）	142~209
Project costs（million JPY）	2,983~4,432

Source: JICA Survey Team

5. Evaluation of Expected Water Supply Project by Japan

Implementation of the project is expected to have beneficial quantitative effects below.

No.	Indicator	Design Value			
1	Daily Average Water Supply Amount (m^3/day)	5,360～8,800			
2	Daily Maximum Water Supply Amount (m^3/day)	6,700～11,000			
3	Population Served (persons)	25,660～43,700			
4	Water Supply Ratio in Water Supply Area (%)	Reference Value 2022	Target Value 2029		
		47.4%	72.3 - 74.7%		
			Dimapatoy	+8,000m^3/day	+4.7
			Tamontaka	**+6,700 - +11,000m^3/day**	**+3.6 - +6.1**
			Rio Grande	+25,000m^3/day	+14.5
			HANABANA	+6,000m^3/day	+2.0
			Total	+45,700 - +50,000m^3/day	+24.8 - +27.3 %

Source : JICA Survey Team

In addition, as the qualitative effect, improvement of the living environment for residents (improvement of public health and convenience for residents who used to use spring water, groundwater, etc.) is expected.

6. Recommendations on MCWD

The MCWD has applied for a total of PHP 1.57 billion SDF in three phases. For Phase 1, PHP 450M, an application was submitted in 2022; however, it has not been approved yet. It was mentioned that they are positive about the prospects of budgeting for 2023. The above communication on financial support was non in a document. Looking at the development status around Cotabato, support from JICA and other donors, with or without SDF, will remain necessary.

Regarding the water supply project by Japan, land acquisition, securing a temporary site, electricity installation to new WTP, house connection, etc., shall be done by the MCWD. Especially forced expropriation of land can be a negative factor in terms of resident sentiment and a factor in safety issues. Therefore, if the owner does not agree to purchase the land even under those conditions, the MCWD will look for another candidate site. In addition to implementing the project, it will be necessary to coordinate with the National Water Resources Board (NWRB), and the MENRE about water right, and conduct an environmental impact assessment based on the Environmental Impact System (EIS).

The MCWD is operating a water supply through the efforts its own staff, despite limited resources; however, costs are eating into profitability. Moreover, the MCWD is struggling to manage things efficiently and reduce operation and maintenance costs with multiple water resources and facilities. One of the main causes is the 25% high NRW considered from leakage, and the MCWD needs to invest in human and other resources to reduce this figure through efficient water supply management. It is also recommended to have training facilities to train and educate staff. Planning and evaluation based on

asset management and water tariff revision from mid- and long-term perspective are required for the investment of new resources and counter measurements for costs such as renewal of aged pipes.

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ON WATER SUPPLY SYSTEMS IN COTABATO CITY
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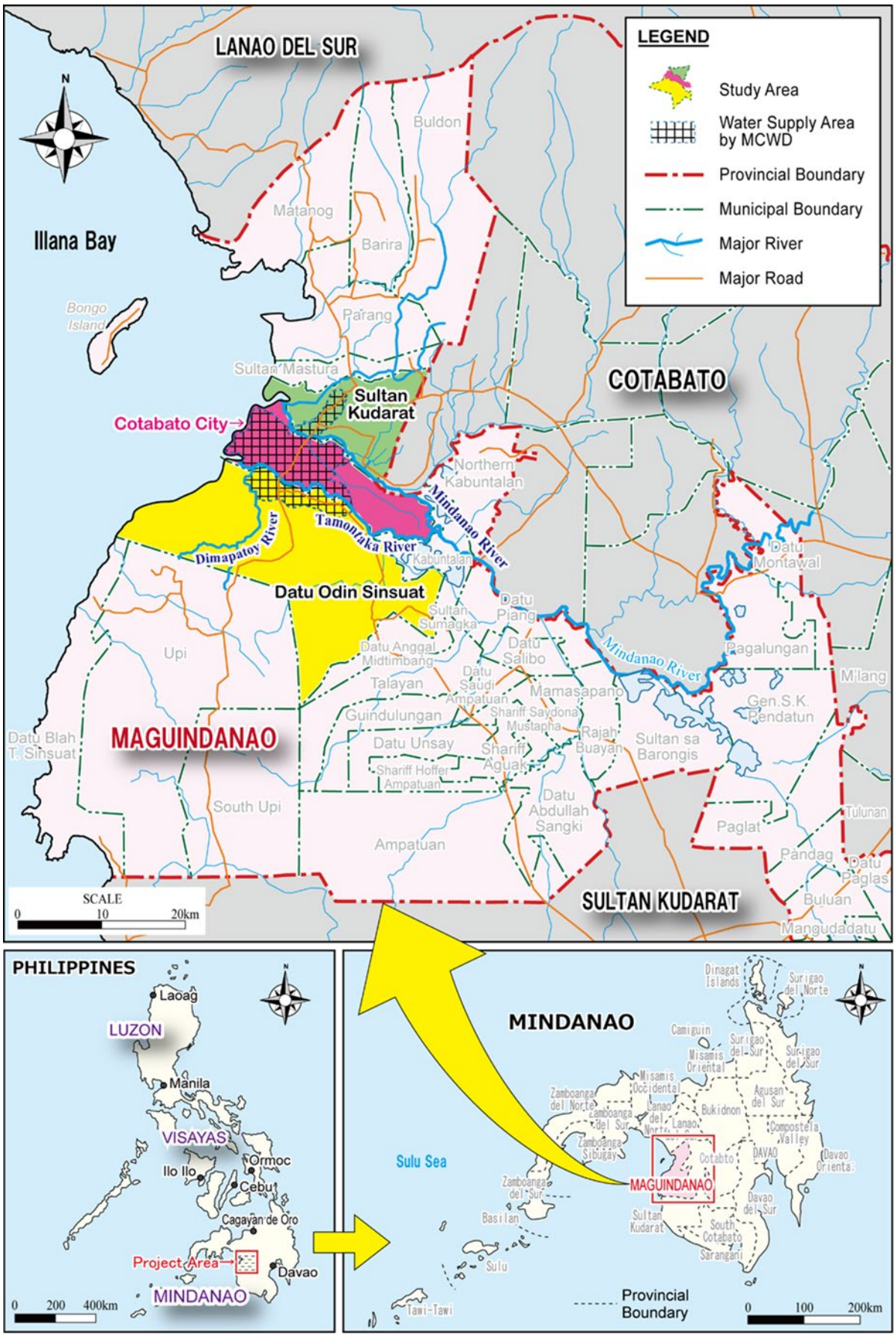

LOCATION MAP

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(Photo-1) Dimapatoy Intake Facility

(Photo-2) Dimapatoy WTP

(Photo-3) Dimapatoy Intake Facility (After Typhoon Paeng has passed)

(Photo-4) Partial Collapse of Dimapatoy River Bank after passing Typhoon Paeng

(Photo-5) Tamontaka River, a Candidate Water Source

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Abbreviations

ADB	Asian Development Bank
AGM	Assistant General Manager
ARMM	Autonomous Region in Muslim Mindanao
ASEP	Association of Structural Engineers of the Philippines
B/C	Cost Benefit Ratio
BARMM	Bangsamoro Autonomous Region in Muslim Mindanao
BDP	Bangsamoro Development Plan
BOD	Board of Directors
BPDA	Bangsamoro Planning and Development Authority
BTA	Bangsamoro Transition Authority
CCEDR	Cotabato City East Diversion Road
CCPL	Central Cebu Protection Landscape Law
CDA	Cooperative and Development Authority
CLUP	Comprehensive Land Use Plan
CSC	Civil Service Commission
D&B	Design and Build
DAO	DENR Administrative Order
DED	Detailed Engineering Design
DENR	Department of Environment and Natural Resources
DMA	District Metered Area
DOF	Department of Finance
DOH	Department of Health
DOS	Datu Odin Sinsuat Municipality
DOST	Department of Science and Technology
DPWH	Department of Public Works and Highway
DRRMP	Disaster Risk Reduction Management Program
DTI	Department of Trade and Industry
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
ECA	Environmentally Critical Areas
ECC	Environmental Compliance Certificate
ECP	Environmental-Critical Projects
EIRR	Equity Internal Rate of Return
EIS	Environmental Impact Statement
EL	Elevation Level
EMB	Environmental Management Bureau
ENCP	Environmentally Non-Critical Project

FIES	Family Income and Expenditure Survey
GDP	Gross Domestic Product
GI	Galvanized Iron
GL	Ground Level
GM	General Manager
GNI	Gross National Income
GOCC	Government Owned and Controlled Corporation
GRDP	Gross Regional Domestic Product
HDPE	High-density Polyethylene
HP	Horsepower
HPC	Heterotrophic Plate Count
HWL	High Water Level
ICC	Investment Coordination Committee
IDB	Independent Decommissioning Body
IFRS	International Financial Reporting Standards
IFSAR	Interferometric Synthetic Aperture Radar
IMF	International Monetary Fund
INFRACOM	Infrastructure and Utilities Development Committee
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JPST	Joint Peace and Security Committee
JWWA	Japan Water Works Association
LDUs	Local Development Units
LGUs	Local Government Units
LPCD	Liter per Capita per Day
LPS	Liters per Second
LWL	Low Water Level
LWUA	Local Water Utilities Administration
MCRAIC	Metro Cotabato Regional Agro-industrial Center
MCWD	Metro Cotabato Water District
MENRE	Ministry of Environment, Natural Resources and Energy
MLD	Million Liters per Day
MP	Master Plan
MPW	Ministry of Public Works
MRB	Mindanao River Basin
MSSD	Ministry of Social Services and Development
NEDA	National Economic and Development Authority
NIPAS	National Integrated Protected. Areas System

NOAH	Nationwide Operational Assessment of Hazards
NPV	Net Present Value
NRW	Non-Revenue Water
NSCP	National Structural Code of the Philippines
NTU	Nephelometric Turbidity Unit
NWRB	National Water Resources Board
O&M	Operation and Maintenance
OCM	Office of Chief Minister
OIC	Office in charge
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PC	Pedro Colina
PDP	Philippine Development Plan
PFRS	Philippines Financial Reporting Standards
PHP	Piso ng Pilipinas
PIU	Project Implementing Unit
PMO	Project Management Office
PNSDW	Philippine National Standards for Drinking Water
POW	Programme of Work
PPA	Programs, Projects, and Activities
PS	Pump Station
PSA	Philippine Statistics Authority
RNDP	Road Network Development Project in Bangsamoro
SDF	Special Development Fund
SEC	Securities and Exchange Commission
SK	Sultan Kudarat Municipality
SOP	Standard Operating Procedures
SP	Steel Pipe
SPDA	Southern Philippines Development Authority
TDH	Total Dynamic Head
TLWO	Teduray Lambangian Women Organization, Inc.
TWG	Technical Working Group
UNICEF	United Nations Children's Fund
uPVC	Unplasticized Polyvinyl Chloride
USAID	United States Agency for International Development
VFD	Variable Frequency Drive
WD	Water District
WDDSP	Water District Development Sector Project
WHO	World Health Organization

WL	Water Level
WTP	Water Treatment Plant

Unit Table

Length /Thickness	:	km, m, cm, mm, μm
Weight	:	mg, g, kg, t
Time	:	second: s, sec・minute: min・hour: h, hr・day: d・year: y, yr
Pressure	:	Pa, kPa, mPa, mmAq, atm,bar
Volume	:	cm^3, m^3, L (L: liter), MCM
Flow Rate (volume)	:	m^3/h, m^3/min, m^3/d, L/min, mL/min
Flow Rate (mass)	:	kg/h, t/h
Density	:	kg/m^3, g/cm^3, mg/L
Velocity	:	cm/s, m/s, km/h
Viscosity	:	Pa･s, mPa･s
Area	:	mm^2, cm^2, m^2, km^2, ha
Frequency	:	Hz
Power	:	W, kW
Voltage	:	V, kV
Electric Current	:	A, mA, kA
Temperature	:	degree C , degC, ℃
Torque	:	N・m
Rotation Speed	:	min-1
Force	:	N
Efficiency	:	%

Chapter 1. Overview of the Survey

1-1 Overview of the Country

The Republic of the Philippines ("Philippines") is a maritime nation located in Southeast Asia comprising 7,641 islands and having a land area of 298,170m^2. It has a population of 110 million, of which about 38.6% are concentrated in three regions around the capital Manila. The population growth rate from 2015 to 2020 was 1.63% nationwide, but at a disproportionate rate by regions. The rate peaked at 3.26% in the Bangsamoro Muslim Mindanao Autonomous Region (BARMM); however, the figure for Region 8 (Samar and Leyte Island) remained 0.5%. (Philippines Static Authority (PSA), Ministry of Foreign Affairs (Japan))

In 2022, the Gross National Income (GNI) growth rate was 9.9%, and the Gross Domestic Product (GDP) was 7.6%, both of which showing high growth. The Philippines concluded an economic partnership agreement with Japan, and regarding the share of trading partner countries on a monetary basis, Japan ranks second (13.9%) after the United States for exports from the Philippines, and third after Indonesia (9.0%) for imports to the Philippines. The most common export goods are electronic and electrical equipment, and the top imports goods are raw materials and intermediate goods. (PSA, Ministry of Foreign Affairs (Japan))

The country has a tropical maritime climate and humid with abundant rainfall. Some regions do not have a rainy or dry season. Typhoons have the greatest impact on the climate in the Philippines, but rarely make landfall on Mindanao island. (Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA))

1-2 Background of the Survey

In the Autonomous Region of Muslim Mindanao (ARMM) in Mindanao, Philippines, which has been in conflict for over 40 years, on 27 July 2018, the former President Rodrigo Duterte approved the Bangsamoro Organic Law, which is necessary for the establishment of an autonomous government, and the BARMM territory was finalized, and the Bangsamoro Transitional Authority (BTA) was established. Efforts are currently underway to transition to BARMM having duty elected officials in 2025. The city of Cotabato had previously been an independent city from ARMM, but was incorporated into BARMM following a referendum in February 2019.

The population of Cotabato City is approximately 300,000 (in 2015) and is expected to further increase in the future, as the city's population has continued to grow at an average rate of 4.1% per year over the past 15 years and is expected to function as a capital city in the BARMM. Under these circumstances, the Interim Chief Prime Minister of the BTA and the City of Cotabato requested assistance from the Government of Japan on the development of a master plan for the Cotabato Urban Area in 2019. In response, the Japan International Cooperation Agency (JICA) conducted the "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City" in order to formulate a cooperation program for the comprehensive development of the Cotabato Urban Area, and conducted a survey on the development of water supply facilities in Cotabato City and surrounding areas in the same study.

The Metro Cotabato Water District (MCWD), established in 1976, is responsible for water supply in Cotabato City and the adjacent municipalities of Datu Odin Sinsuat (DOS) and Sultan Kudarat (SK). It draws water from three water sources; deep wells, springs and surface water, and it has a water supply of approximately 48,000 m^3/day, of which approximately 25% is considered non-revenue water. The water supply rate in Cotabato City is low, at about 47.4% in 2021, and households without water supply services are dependent on unsanitary and traditional water sources.

In the past data collection survey, proposals were made for the construction of new facilities and the expansion and upgrading of existing facilities. Through this survey with extra data collection and analysis, the feasibility and policy of assistance on water supply section in Cotabato City will be clarified.

1-3 Overview of the Survey

1-3-1 Objectives of the Study, Target Areas, etc.

The objectives, target areas, etc. of the survey are as follows.

Table 1-3-1 Objectives, Target Areas, etc. of This Survey

Items	Contents
Purpose of the Work	① Information collection on the current status of water supply, water demand and water supply facility development plans in the survey area ② To study the feasibility of water supply facility development plans based on the information collected. ③ To examine the feasibility of implementing grant aid projects and the policy and content of preparatory survey for assistance.
Target Area	Cotabato City, Maguindanao Province, Philippines and two surrounding municipalities (Municipality of Sultan Kudarat and Datu Odin Sinsuat)
Relevant Authorities and Institutions	Metro Cotabato Water District (MCWD)

Source : JICA Survey Team

1-3-2 Contents of this Survey

The contents of this survey are as follows.

- Collection, arrangement, and analysis of basic data on water supply in Cotabato and surrounding areas and survey of the current status of existing water supply facilities.
- Confirmation of population status, and water demand projections for Cotabato and surrounding areas
- Confirmation of the organizational structure, operation and maintenance capacity of the MCWD
- Confirmation of the water supply area of the MCWD and its phased expansion development plan and schedule
- Survey of water intake facilities in the MCWD
- Review of existing facility development plans and feasibility/issues of MCWD
- Identification of current status and issues in water supply sector development and projects implemented or planned by other donors
- Study of proposed implementation scopes for grant aid, estimated project costs and proposed project effects

- Arrangement of considerations in preparatory surveys for assistance in the case of grant aid project
- Recommendations to the MCWD

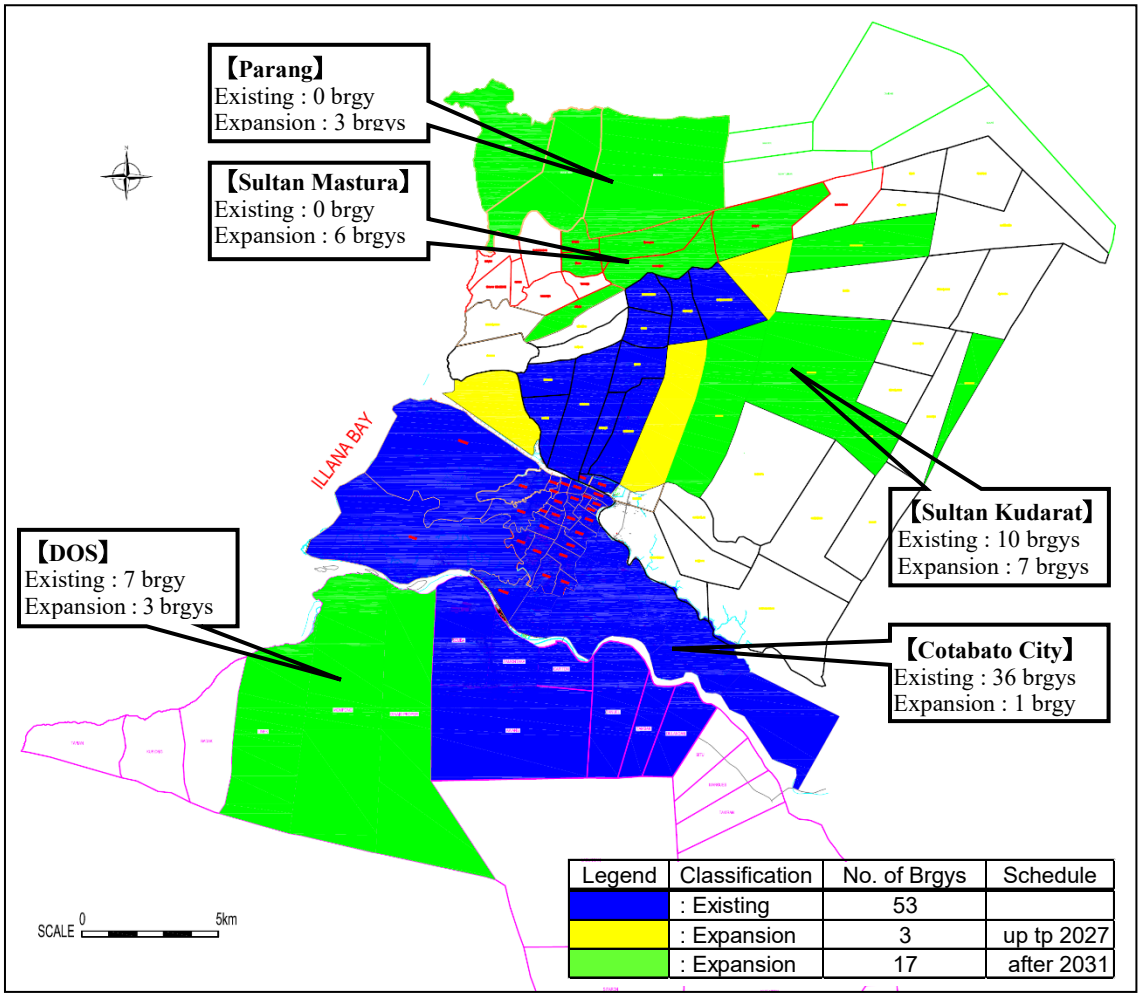
1-4 Target Year and Water Supply Area

1-4-1 Target Year

The target year for the plan is 2029, which is assumed to be three years after the completion of the proposed water supply project identified in this survey. Future water demand projections and water supply area expansion plans will be studied up to 2040, based on the long-term development vision of the Philippines, AmBisyonNatin2040.

1-4-2 Water Supply Area

The water supply area for this survey is shown in Figure 1-4-1. The water supply area for MCWD is, as of 2022, the city of Cotabato and some of the neighboring part of the municipality of SK and the part of barangays in DOS, with future plans to include Parang and parts of Sultan Mastura in the water supply area. The water supply areas as of 2022 and before and after the target year of the water supply project are shown with color coding.



Source : JICA Survey Team

Figure 1-4-1 Expansion of Planned Water Supply Areas

1-5 Natural Socio-Economic Conditions and Development Planning And Related Legislation

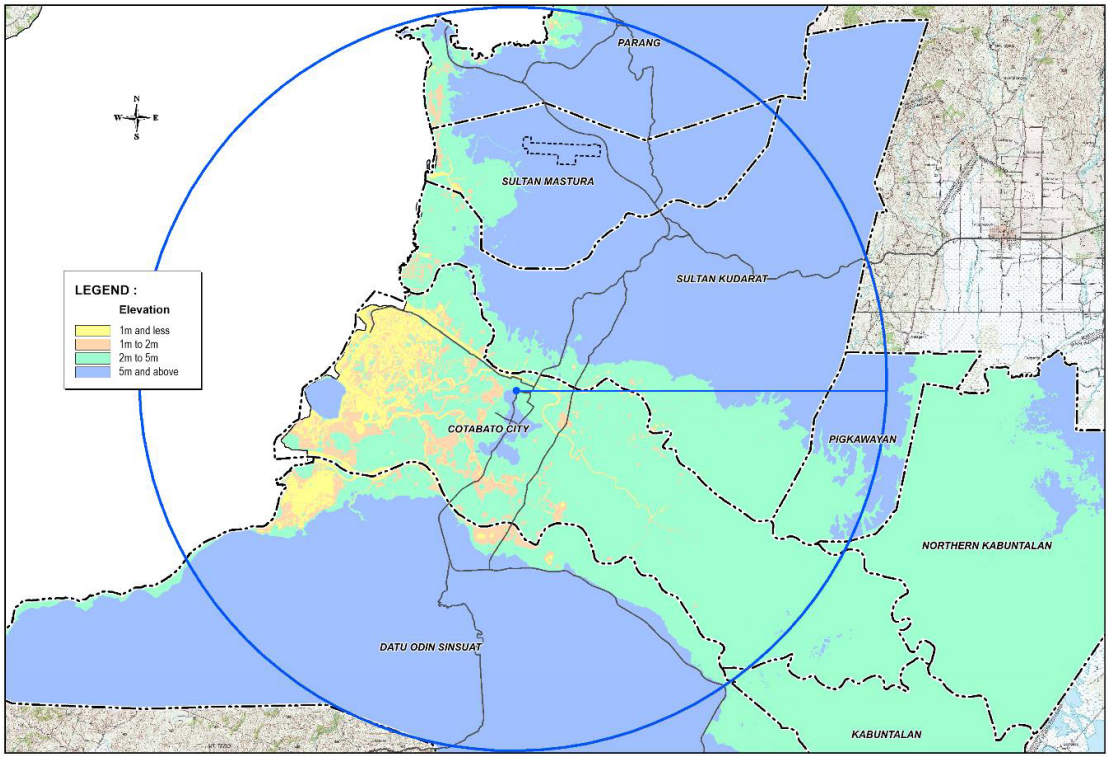
1-5-1 Natural Conditions

1-5-1-1 Topography

Cotabato City is a low-lying delta, bounded by the Rio Grande de Mindanao on the north and Tamontaka River on the south. It is located at the lowest portion of the province of Maguindanao, with around 70% of its total land area below sea level (Local DRRMP (Disaster Risk Reduction and Management Program) 2016-2022). The city is traversed by meandering bodies of water, including the Tarbung River, Pamang Creek, and Matampay River, among others. Low-lying marshlands and fishponds are situated in the outlying areas in the southeast and northwest portions of the city.

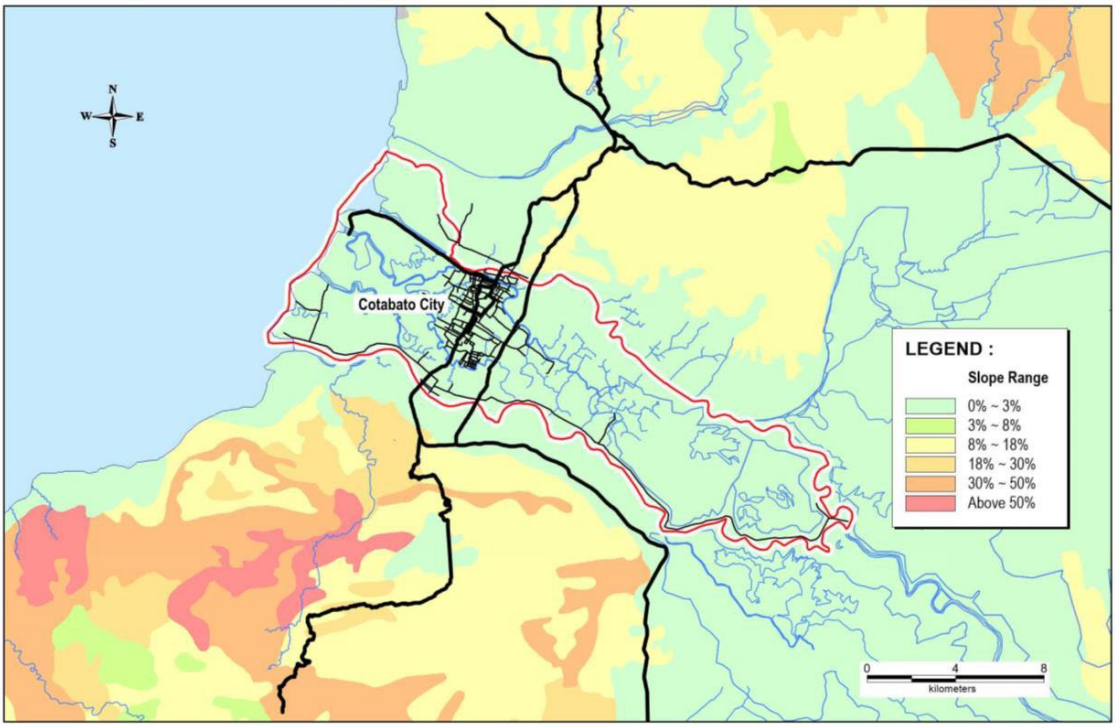
The elevation (Figure 1-5-1) and slope (Figure 1-5-2) profile of the Greater Cotabato Area show that Cotabato City is surrounded by municipalities of higher altitude in the north and south.

The city is generally characterized by low and flat terrains, except for two elevated areas – the Timako Hill along the coastline bordering the Illana Bay, and the Pedro Colina (PC) Hill. The central area of the city, where urban development takes place, is situated within the vicinity of PC Hill, with elevations ranging from 1 to 20 meters. The flat to mildly undulating slope profile of Cotabato City suggests that no significant erosion has occurred within the city.



Source : Interferometric Synthetic Aperture Radar (IFSAR) data of Road Network Development Project in Bangsamoro (RNDP), 2018

Figure 1-5-1 Elevation Profile of Greater Cotabato Area



Source : PhilGIS data

Figure 1-5-2 Slope Profile of Greater Cotabato Area

1-5-1-2 Geology

The soil profile of Cotabato City is primarily made up of soils classified as Tamontaka Clay and Faraon Clay. Tamontaka Clay is commonly found in the marshlands located at the southeastern portion of the city. This type of soil has high fertility and is suited for cultivation. It is also characterized by high water holding capacity, which means that the soil remains waterlogged after precipitation.

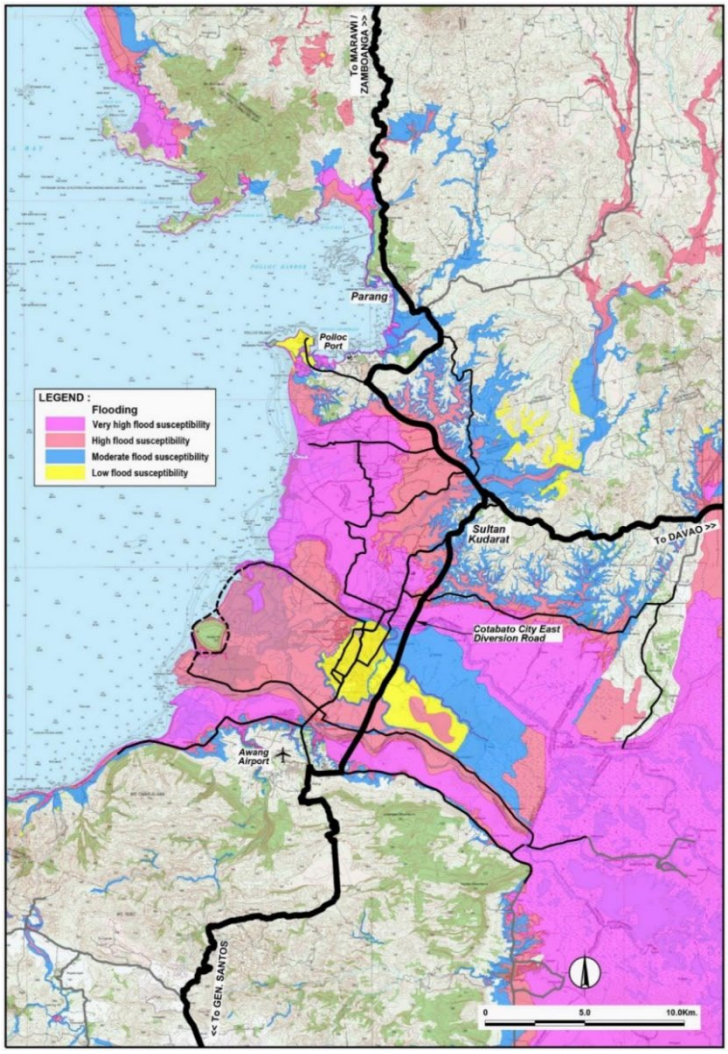
Faraon clay is the dominant soil type in the western portion of the city and is commonly found in fishponds. This type of soil has limited arability and is less suited for urban development due to its soil characteristics.

Currently, settlements continue to concentrate and expand in lands whose soil is classified as San Manuel Clay, which is suitable for cultivation and high-density urban development. The San Manuel clay is considered the best agricultural soil in the Philippines, with moderate sand and clay content. It has high natural fertility and is also suitable for compaction.

1-5-1-3 Flood

Cotabato City is susceptible to flooding, mainly due to the presence of major rivers and tributaries passing through several barangays. More than half of the city's total land area is below sea level and is therefore, highly vulnerable to tidal intrusion from sea water or from the overflow of the river system caused by incessant rains. The flood susceptibility map, as shown in Figure 1-5-3, indicates that the flood-prone areas include the low-lying barangays adjacent to the Rio Grande de Mindanao in the northern portion of the city and Tamontaka River in the southern part.

While Cotabato City experiences low chances of getting hit directly by typhoons, the city is surrounded by areas of higher elevation, and therefore serves as a catch basin for the floodwater of nearby provinces. Headwater coming from the mountain ranges of Agusan del Norte and Bukidnon all flow into the Liguasan Marsh before flowing into the Rio Grande de Mindanao, whose major outlets are in Cotabato City.



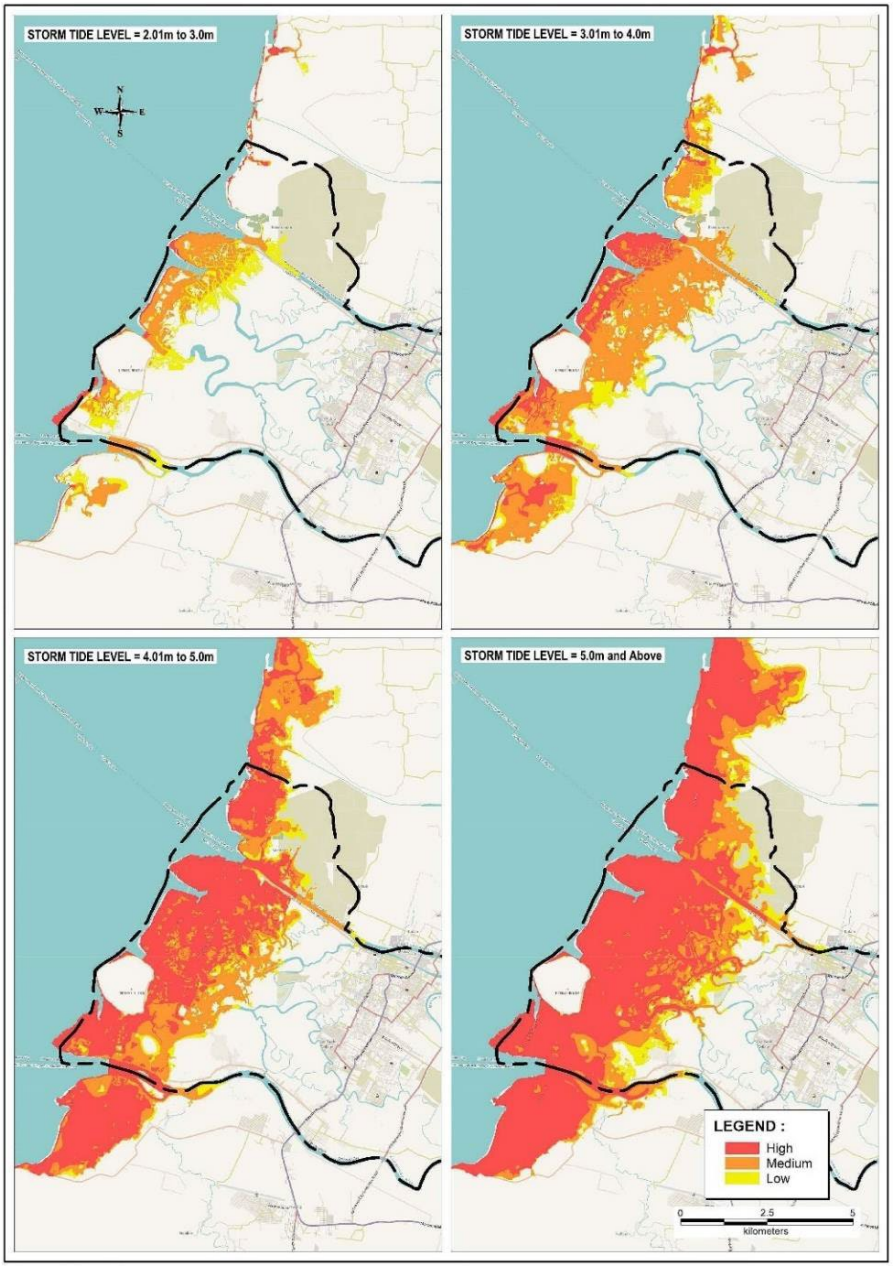
Source : DENR – EMB data

Figure 1-5-3 Flood Susceptibility Map of the Greater Cotabato Area

1-5-1-4 Storm Surge

A storm surge refers to the abnormal rise of seawater that is pushed inland by a storm. Project Nationwide Operational Assessment of Hazard (NOAH) under the Department of Science and Technology (DOST) had identified Cotabato City among the coastal areas of the country which are vulnerable to storm surges.

The project also developed different hazard maps that could predict the level of floodwaters depending on the projected height of the storm surge, as shown in Figure 1-5-4 The map indicates that a storm surge that is up to five meters or above in height could potentially submerge the following barangays near the coastline: Kalanganan Mother, Kalanganan 1, Kalanganan 2 and portions of Bagua 1 and Bagua 2.

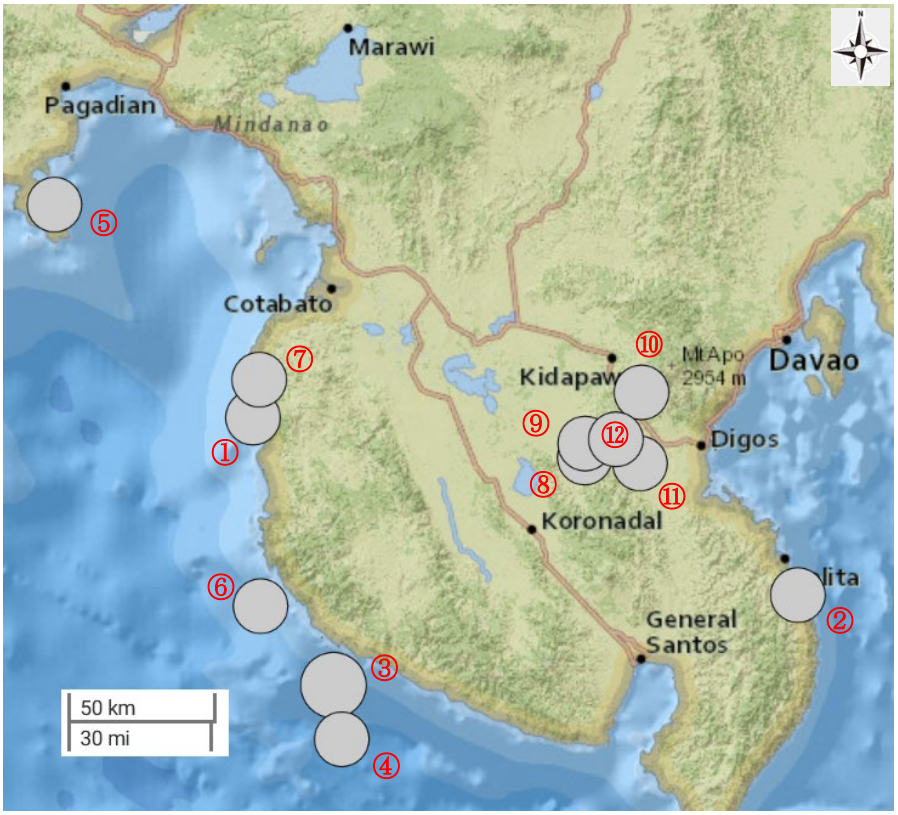


Source : DOST – Project NOAH

Figure 1-5-4 Storm Surge Hazard Map of the Greater Cotabato Area

1-5-1-5 Earthquake

The location of the Philippines, between the Eurasian and Pacific plates, renders the country prone to many intense earthquakes. One of the greatest earthquakes around Cotabato was the Moro Gulf Earthquake in 1976 occurred 60 miles offshore from the city with a magnitude of 7.9. It left an estimated total of 8,000 people dead or missing. (Moro Gulf Tsunami of 17 August 1976, Badillo, V.L. and Astilla, Z.C.) At the same time a tsunami also occurred, and waves went as far as 1 to 2 km inland of Cotabato City damaging at least 1,300 houses, school buildings, and public buildings. Subsequently, intense earthquakes occurred as shown in Figure 1-5-5 and Table 1-5-1.



Source: USGS

Figure 1-5-5 Intense Earthquakes around Cotabato City
(Since 1990, Depth within 150km and Magnitude more than Six(6))

Table 1-5-1 Intense Earthquake Year, Magnitude and Max Intensity

No.	Year	Magnitude	Max. Intensity	No.	Year	Magnitude	Max. Intensity
1	1992	6.2	VI	7	2010	6.0	VI
2	2002	6.3	IV	8	2019	6.4	VIII
3	2002	7.5	VII	9	2019	6.6	VII
4	2002	6.0	V	10	2019	6.5	VII
5	2002	6.3	VII	11	2019	6.8	VII
6	2005	6.4	VI	12	2021	6.0	VII

Source：USGS (Max. Intensity is based on Worden et al (2012), Probabilistic relationships between ground-motion parameters and Modified Mercalli intensity in California Bull. Seism. Soc. Am. 102 (1), 204-221.)

1-5-2 Social Conditions

1-5-2-1 Poverty Rate

The PSA releases data on poverty every three years, with the aim of helping government agencies and policy makers in their efforts to alleviate poverty.

Poverty threshold is defined by the PSA as the minimum income required to meet the basic food and non-food requirements of an individual. Poverty incidence, on the other hand, refers to the proportion of the population with incomes below the poverty threshold.

Cotabato City recorded an annual per capita poverty threshold of PHP 33,890 in 2021. This means that a family of five needed to earn at least PHP 15,372 (≒33,890 * 5.443/12) monthly to meet their essential needs. While poverty incidence among the entire city population decreased from 42% in 2018 to 39.7% in 2021, the proportion of poor people remained well above the national average of 18.1%.

Table 1-5-2 Poverty Threshold and Poverty Incidence of Cotabato City (2015-2021)

Area	Annual Per Capita Poverty Threshold (PHP)			Poverty Incidence among Population (%)			Poverty Incidence among HHs (%)		
	2015	2018	2021	2015	2018	2021	2015	2018	2021
Philippines	22,747	25,813	28,871	23.5	16.7	18.1	18.0	12.1	13.2
Region XII	21,341	25,023	26,443	38.1	28.2	28.1	31.2	22.4	21.4
BARMM	22,650	27,715	28,293	59.4	61.8	37.2	53.8	54.2	29.8
Cotabato City	25,581	30,349	33,890	48.7	42.0	39.7	38.5	35.2	31.3

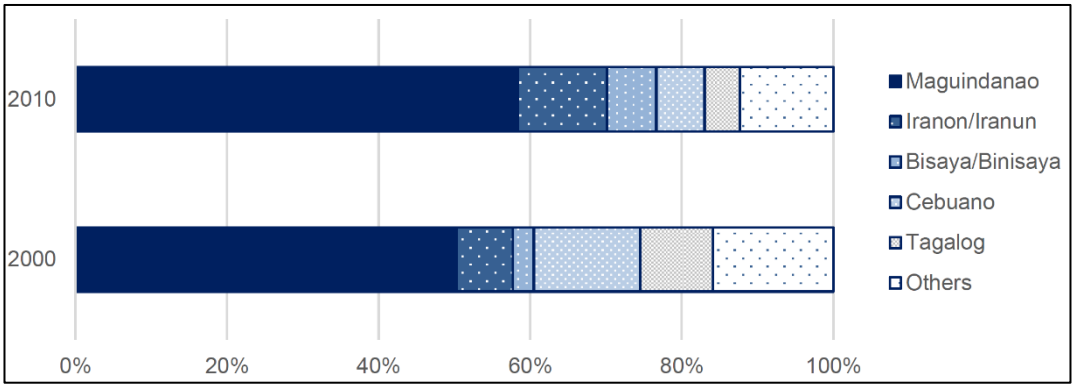
Source : Philippine Statistics Authority

1-5-2-2 Ethnic Diversity

The Cotabato metropolitan area is more diverse than the rest of Maguindanao and the rest of the Philippines. This diversity can be attributed to the influx of people and migration that transformed the area into a community of people with different ethnic origins, religions and languages. In the 16th century, Shariff Muhammad Kabunsuan arrived in Cotabato City from Johor, Malaysia, and introduced Islam to the indigenous people of the region. During the 18th and 19th centuries, the Spanish colonizers of the Philippines made several attempts to subjugate the indigenous peoples of the region and developed settlements, especially in locations within the present-day municipality of Parang. The Americans, who colonized the Philippines on behalf of the Spanish, also established settlements in and around Parang in the early 1900s. Filipinos from Luzon and the Visayas also began to come to the area, seeking better transport links, access to land and opportunities to engage in farming and other agriculture-related activities.

Maguindanaon remained the dominant ethnic group in Cotabato City, with almost three-fifths share of the household population in 2010. The Maguindanaon population increased from 81,205 (50% share) in 2000 to 158,496 (58%) in 2010. Iranon/Iranun was the second most common ethnic group in the city, comprising 11.7% of the household population in 2010. The others identified themselves belonging to the following ethnic groups: Bisaya/Binisaya (6.5%), Cebuano (6.4%), Tagalog (4.6%), Hiligaynon/Ilonggo (2.6%), and others.

The ethnic diversity within the city is visualized in Figure 1-5-6.



Source : Philippine Statistics Authority

Figure 1-5-6 Most Common Ethnic Groups in Cotabato City (2010)

1-5-2-3 Religious Affiliation

Islam was the dominant religious affiliation in the Greater Cotabato Area, as shown in Table 1-5-3. In ARMM, nine in every ten persons belonged to the Muslim population (Census of Population, 2015).

Table 1-5-3 Most Common Religious Affiliations in the Greater Cotabato Area

City/Municipality	Most common religious affiliations among the household population						Source
	1st	% Share	2nd	% Share	3rd	% Share	
Cotabato City	Islam	76%	Roman Catholic	20%	Evangelicals	0.4%	POPCEN 2015
Datu Odin Sinsuat	Islam	76%	Roman Catholic	17%	Philippine Episcopal Church	4%	POPCEN 2015
Sultan Kudarat	Islam	90%	Roman Catholic	4%	Iglesia ni Cristo	3%	POPCEN 2010
Sultan Mastura	Islam	55%	Roman Catholic	32%	Lutherans	8%	POPCEN 2015

Source : Philippine Statistics Authority, Comprehensive Land Use Plan (CLUP)

In Cotabato City, Islam accounted for more than three-fourths of the total population in 2015. The Islam population increased from 99,565 (62% share) in 2000 to 228,036 (76%) in 2015. Roman Catholic was the next largest religious affiliation, comprising 20% of the total population. Others were reported to be affiliated with the Evangelicals (0.4%) and Iglesia ni Cristo (0.3%).

1-5-2-4 Indigenous People (IPs)

The closest known traditional ancestral domains of the Indigenous People in the survey area are those in the Municipalities of Upi, South Upi, and Datu Blah Sinsuat which are inhabited by the Teduray tribe. However due to armed conflict among groups (e.g., AFP vs various armed groups) which affect their communities and further pushed by poverty, some IPs left their homeland to re-settle in some of the towns within the survey area. The estimated number of IPs in the survey area are presented in Table 1-5-4.

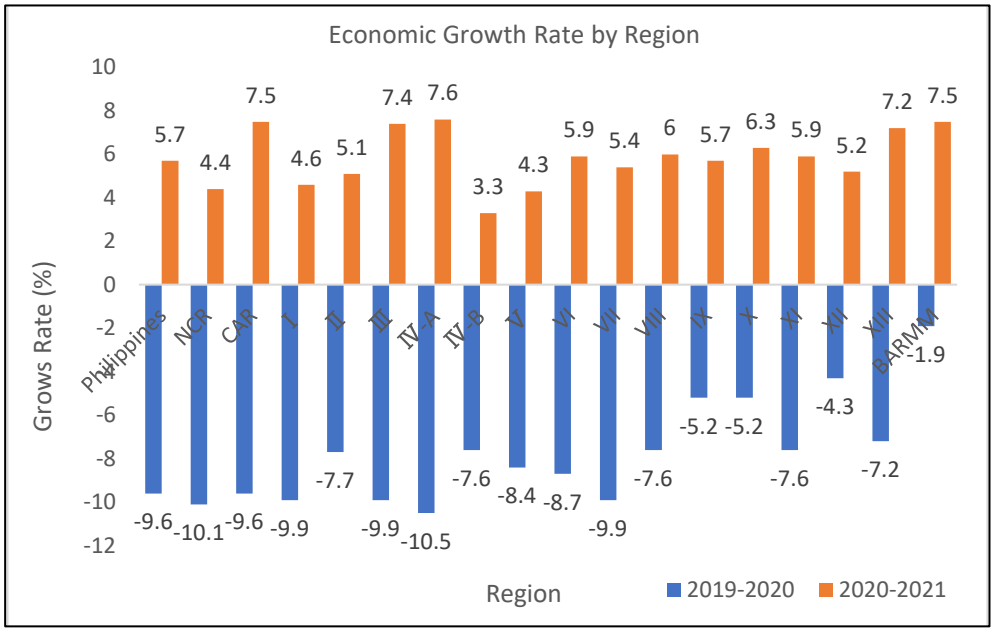
Table 1-5-4 Number of Reported IPs in the Greater Cotabato Area

City/Municipality	Number of reported IPs (year of data)	Remarks	Source of Information and Data
Cotabato City	4,967 (2020)	Around 90% of them are Teduray tribe.	National Commission for Indigenous People, Region 12
Datu Odin Sinsuat	14,170 (2018)		Ministry of Indigenous Peoples' Affairs
Sultan Kudarat	No known significant concentration of IPs (2018)		Froilyn T. Mendoza, Executive Director of the Teduray Lambangian Women Organization, Inc. (TLWO)
Parang	About 1,500 people/ 300 families (2018)	90% of them are Teduray tribe. Migrated in 1970s at the height of the conflict.	Municipal Planning & Development Coordinator of Parang municipality
Sultan Mastura	No known significant concentration of IPs (2018)		Froilyn T. Mendoza, Executive Director of the Teduray Lambangian Women Organization, Inc. (TLWO)

Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

1-5-3 Economic Conditions

GDP at the national level in the Philippines recorded -9.6% in 2019-2020 due to the Covid-19 pandemic, but has recovered to +5.7% in 2020-2021; for Gross Regional Domestic Product (GRDP) in BARMM, it recorded -1.9% in 2019-2020, but has recovered to +7.5% in 2020- 2021, making it the second fastest growing economy in Mindanao compared to other regions in the Philippines.



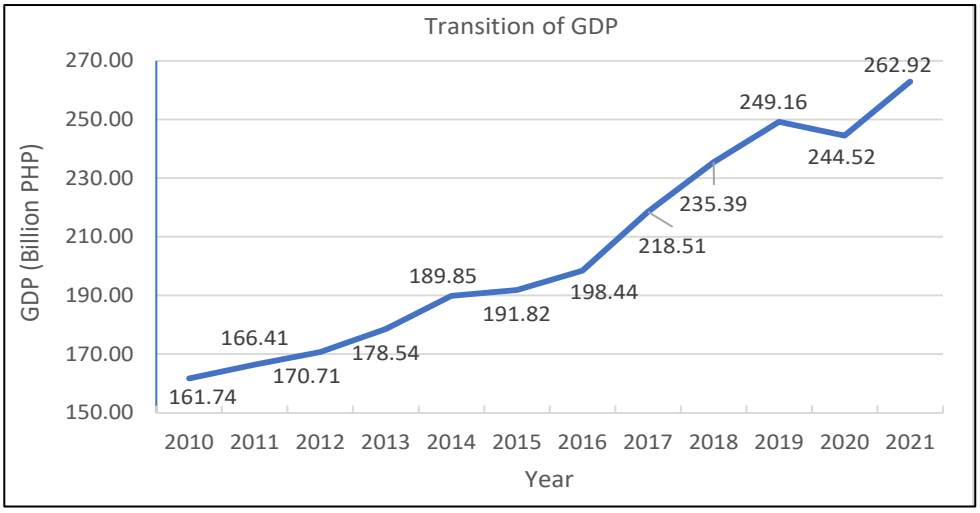
Source : JICA Survey Team based on information from the Philippine Statistics Authority

Figure 1-5-7 GRDP Growth Rate of the Philippines (2019-2020, 2020-2021)

The evolution of the GRDP of BARMM from 2010 to 2021 is shown in Figure 1-5-8. Except for the year 2019-2020, which shows a negative growth of -1.9%, the GRDP has recorded positive growth every year, with a GRDP of 262.92 Billion PHP in 2021.

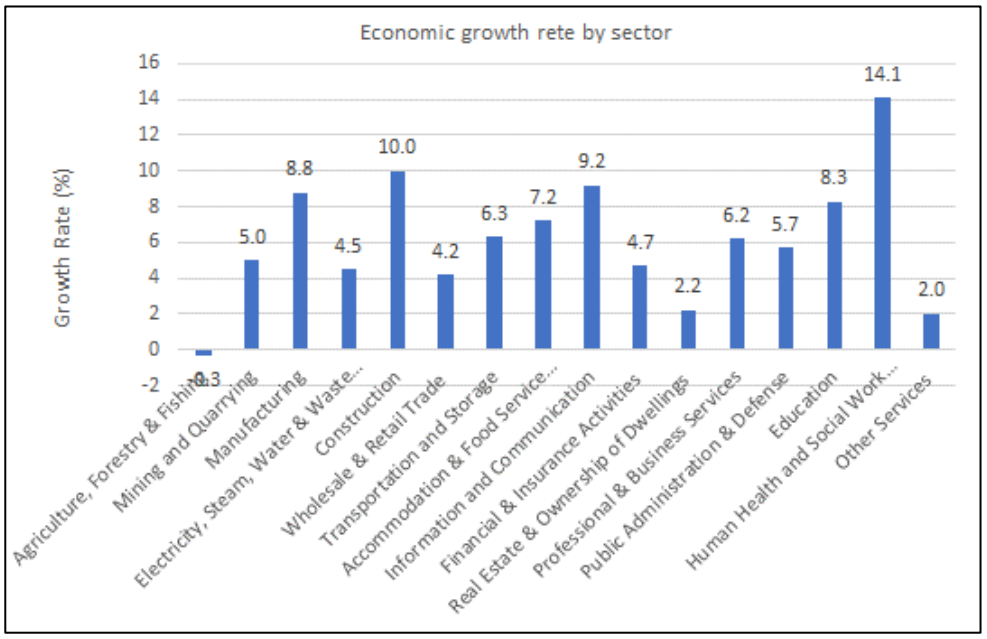
The growth rates by industry sector in BARMM are shown in Figure 1-5-9. 15 of the 16 industry sectors show positive growth in 2020-2021, excluding agriculture, forestry and fishing. The sectors with the

fastest growth rates are human health and social work with +14.1%, construction with +10.0% and information and communications with +9.2%. The percentage of GRDP by amount is also shown in Figure 1-5-10. Agriculture, forestry and fishing occupy the top position in terms of percentage of amount, followed by electricity, stream, water and waste management, and manufacturing in third place.



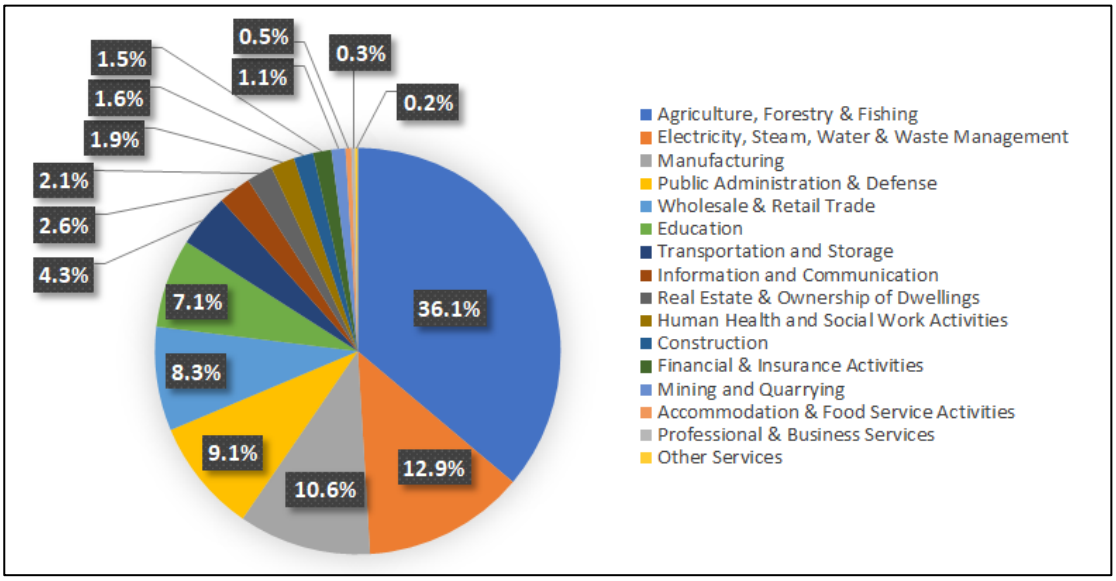
Source : JICA Survey Team based on information from the Philippine Statistics Authority

Figure 1-5-8 GRDP in BARMM



Source : JICA Survey Team based on information from the Philippine Statistics Authority

Figure 1-5-9 GRDP Growth by Sector in BARMM (2020-2021)



Source : JICA Survey Team based on information from the Philippine Statistics Authority

Figure 1-5-10 Amount Breakdown of GRDP by Industry Sector in BARMM (2020-2021)

1-5-4 Development Plans and Relevant Legislation

1-5-4-1 Higher Level Plans

(1) Long-term development vision「AmBisyonNatin2040」(Our Vision)

The Duterte administration set out a long-term vision, AmBisyon Natin 2040, and a six-year (2017-2022) medium-term vision, the Philippine Development Plan (PDP). AmBisyon Natin 2040 sets the goals to eradicate poverty and increase GNI per capita by 2040. AmBisyon Natin 2040 was developed as a vision of where the country and the Filipino people want to be in the next 25 years (the vision was first considered in 2015). The vision states that by 2040, Filipinos will be Matatag (firmly rooted), Maginhawa (economically secure) and Panatag (Living a safe life).

1) Matatag (firmly rooted)

Filipinos become rooted in strong family ties. Work-life balance creates time to spend with family and friends, and provides affordances and opportunities for community activities and volunteering.

2) Maginhawa (economically secure)

Poverty will be eradicated and no Filipinos will go hungry. Families will be able to live in housing of their choice, have access to the amenities of their choice and no longer be threatened by housing.

3) Panatag (living a safe life)

Enjoy security throughout life. Enjoy longevity and can live in retirement with peace of mind. Have income and savings to meet unexpected expenses. Security is guaranteed in all parts of the country. Citizens trust the government to be free from corruption and to provide equal service delivery.

To realize the above, the Vision calls on governments and the private sector

- ✓ To provide opportunities for Filipinos to contribute to the above
- ✓ To strive to provide low-cost, high-quality goods and services to their respective industries

- ✓ To make appropriate investments to this end
- ✓ Government to promote investments conducive to the above
- ✓ Government to provide equal opportunities for growth and distribution of wealth

(2) Medium-term Development Plan, Philippine Development Plan (PDP) 2017-2022

The PDP 2017-2022, prepared at the inception of the Duterte administration, sets targets to reduce the poverty rate from 26% to 17%, to become a law-abiding and peaceful country and to increase per capita GNI from USD 3,000 to USD 4,100 when it was formulated. The PDP 2017-2022 is also positioned as a mid-term goal for the realization of AmBisyon Natin 2040.

Three pillars and five foundational formations are set out. The three pillars are (i) Pillar 1: Restoring trust in government, (ii) Pillar 2: Reducing inequality and (iii) Pillar 3: Raising growth potential.

Infrastructure building comprises five pillars: (i) maintaining external sovereignty, (ii) infrastructure development, (iii) disaster and conflict management, (iv) environmental and ecological improvement, and (v) deregulation.

(3) Medium-term Development Plan, Philippine Development Plan (PDP) 2023-2028

On 19th December 2022, the National Economic and Development Authority (NEDA) issued the Philippine Development Plan (PDP) 2023-2028. The overall goal was titled 'Return to a high economic growth trajectory and accelerate employment revitalization and poverty reduction through economic and social reforms towards a prosperous, inclusive and resilient society'.

Regarding economic growth, the numerical targets for the period up to 2028 are: i) economic growth rate of 6.5-8.0%; ii) unemployment rate of 4.0-5.0%; iii) ratio of salaried workers to total employment of 53-55%; iv) inflation rate of 2.0-4.0%; v) food inflation rate of 2.0%; vi) budget deficit as a percentage of GDP of 3.0%; vii) 51.1% of accumulated debt to GDP, (viii) in the top third of the Global Innovation Index, and (ix) a poverty rate of 9.0%.

The policy was also presented on the content of 'economic and social reforms', which were divided into the household, enterprise and government sectors. With regard to the household sector, the policies include: i) human capital building and social development through the promotion of education and lifelong learning, health promotion and livable communities; ii) reducing vulnerability and protecting purchasing power through food security, promotion of adequate nutrition and strengthening social security; and iii) developing income-earning capacity through improving employment capacity, expanding job opportunities and creating a common labor market management framework.

For the production (enterprise) sector, the measures include (i) modernizing agriculture and agriculture-related businesses, (ii) revitalizing the manufacturing sector and (iii) reinvigorating the service sector through trade promotion through preferential measures, investment in technology development to promote innovation, strengthening inter-industry cooperation and enhancing competition by adjusting regulations.

For the government sector, the report includes (i) improving government discipline and administrative efficiency, (ii) macroeconomic stability through inclusive and innovative financial policies, (iii) ensuring public safety and security and improving the judicial system, (iv) expanding

and renewing infrastructure, and (v) accelerating disaster and climate change preparedness and response.

1-5-4-2 Transport Development Plan and Programs

In preparing the future road network, as well as economic and social development, the following items are considered such as prevention of isolation in the event of disasters.

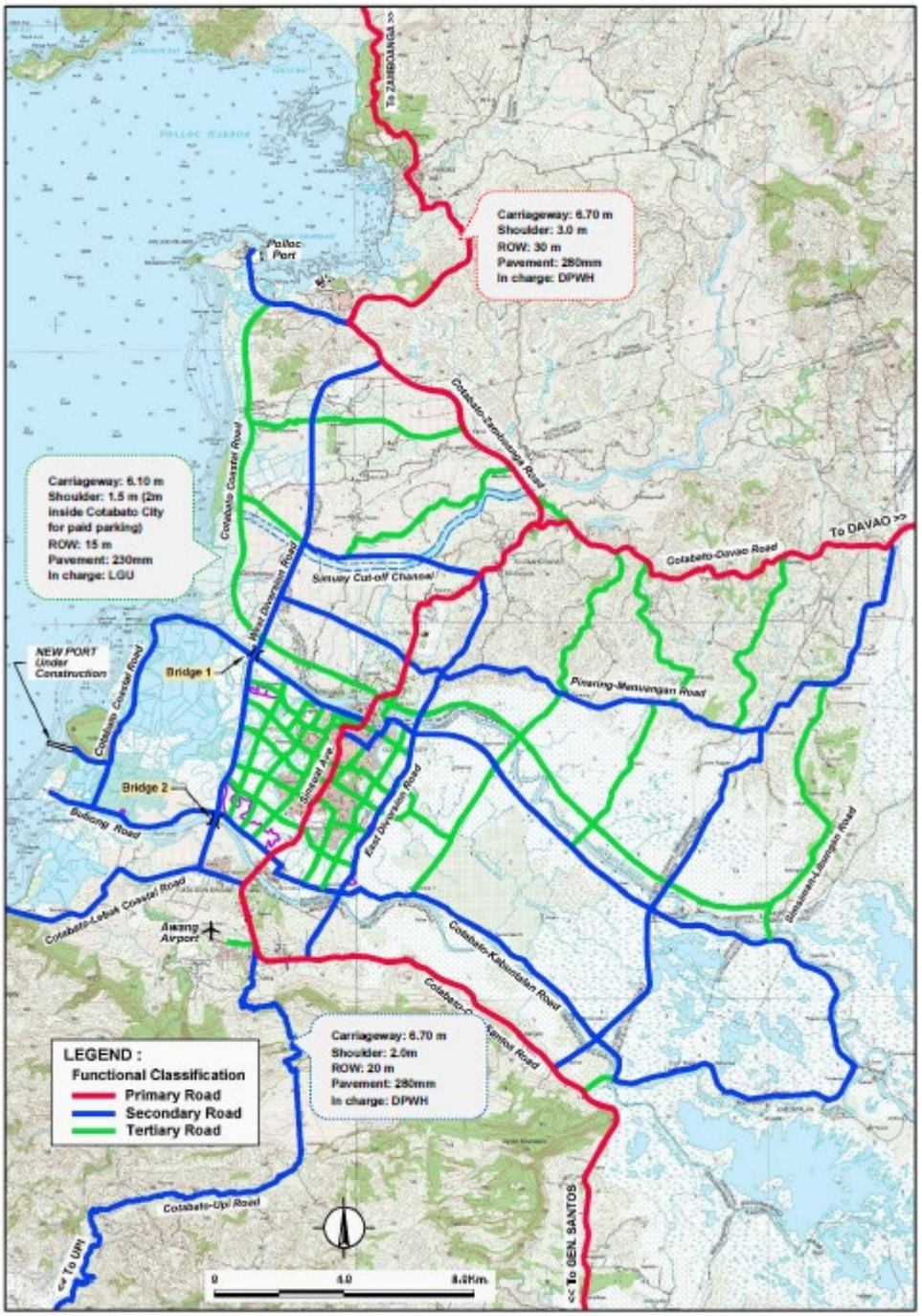
- Distribution of important facilities (airport, port, government centers)
- Distribution of major settlements/populations
- Prevention of isolation in the event of disasters and ensuring resilience and redundancy
- Balanced development of the land area
- Suppression of road density considering areas requiring environmental preservation (coast and green belts)
- Distance between intersections in urban areas between the East Diversion Road (CCEDR) and the West Diversion Road (radius around 400m)
- Future use of public transportation and formation of a grid city

In developing the future road network, economic and social development is taken into account, as well as the importance of a road network that is resilient to natural disasters. The following are taken into account.

Table 1-5-5 Road Types and Functions

	Primary (Arterial Road)	Secondary (Collector Road)	Tertiary (Major Local Road)
Function	・Emergency Road ・Primary carrier of through traffic (inter-city traffic) hence obstruction should be minimal ・Share of local traffic (city traffic) should be minimum	・Second emergency road (to be designated if needed) ・Secondary carrier of through traffic ・Secondary carrier of local traffic (city traffic)	・Primary carrier of local traffic (city traffic) due to its wider coverage

Source : JICA Survey Team

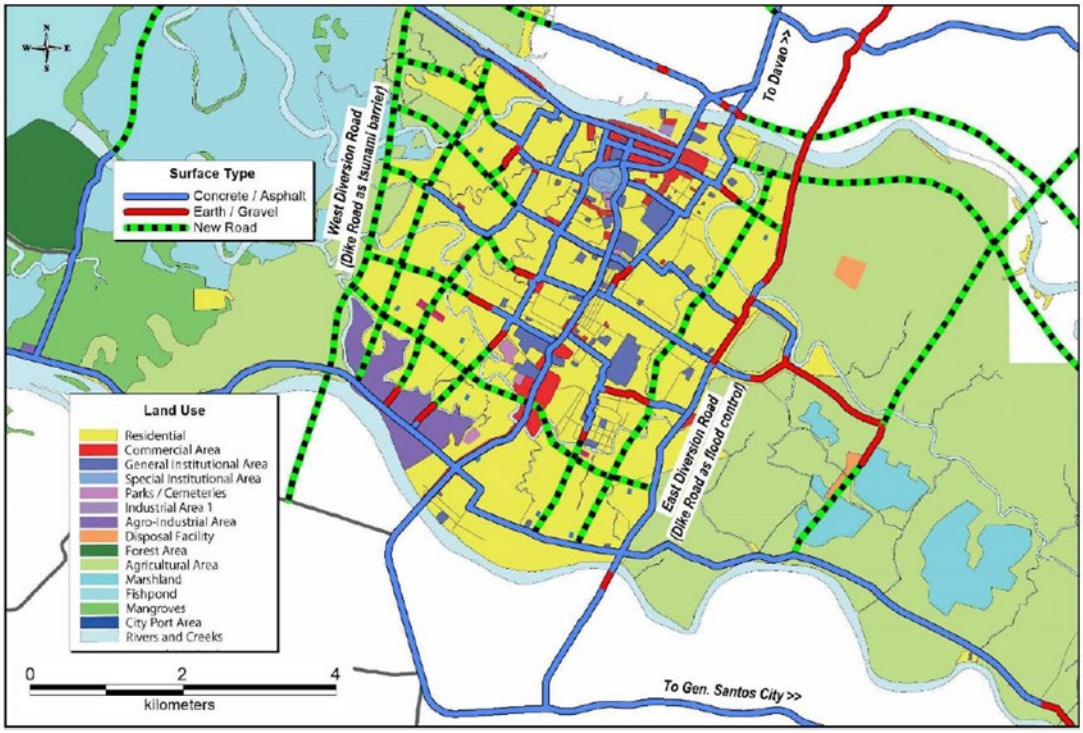


Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

Figure 1-5-11 Proposed Road Functional Hierarchy in Greater Cotabato

The future road network plan (2040) is developed in line with the future land use plan (2040) for Cotabato City. As shown in Figure 1-5-12, the road network is configured to ensure efficient traffic flow, even when large volumes of traffic are expected from newly planned commercial areas. However, a number of new roads will need to be built to ensure that the road network complements future land uses.

As far as the relationship between road hierarchy and land use is concerned, the industrial areas (e.g. part of Tamontaka 1, part of Poblacion 4) are largely served by secondary roads. The most developed commercial areas (former historic center, Rosary Heights 9 and 10) and future designated commercial areas (parts of Rosary Heights 9, Tamontaka 1) are currently located along National Highway 1 and are easily accessible. However, as seen in other cities in the Philippines, traffic congestion will occur if traffic management (e.g. parking policies, separation of through traffic from local traffic) is not properly developed and implemented.



Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

Figure 1-5-12 Relationship of the Future Road Network (2040) (showing Road Surface) and Future Land Use Map (2040)

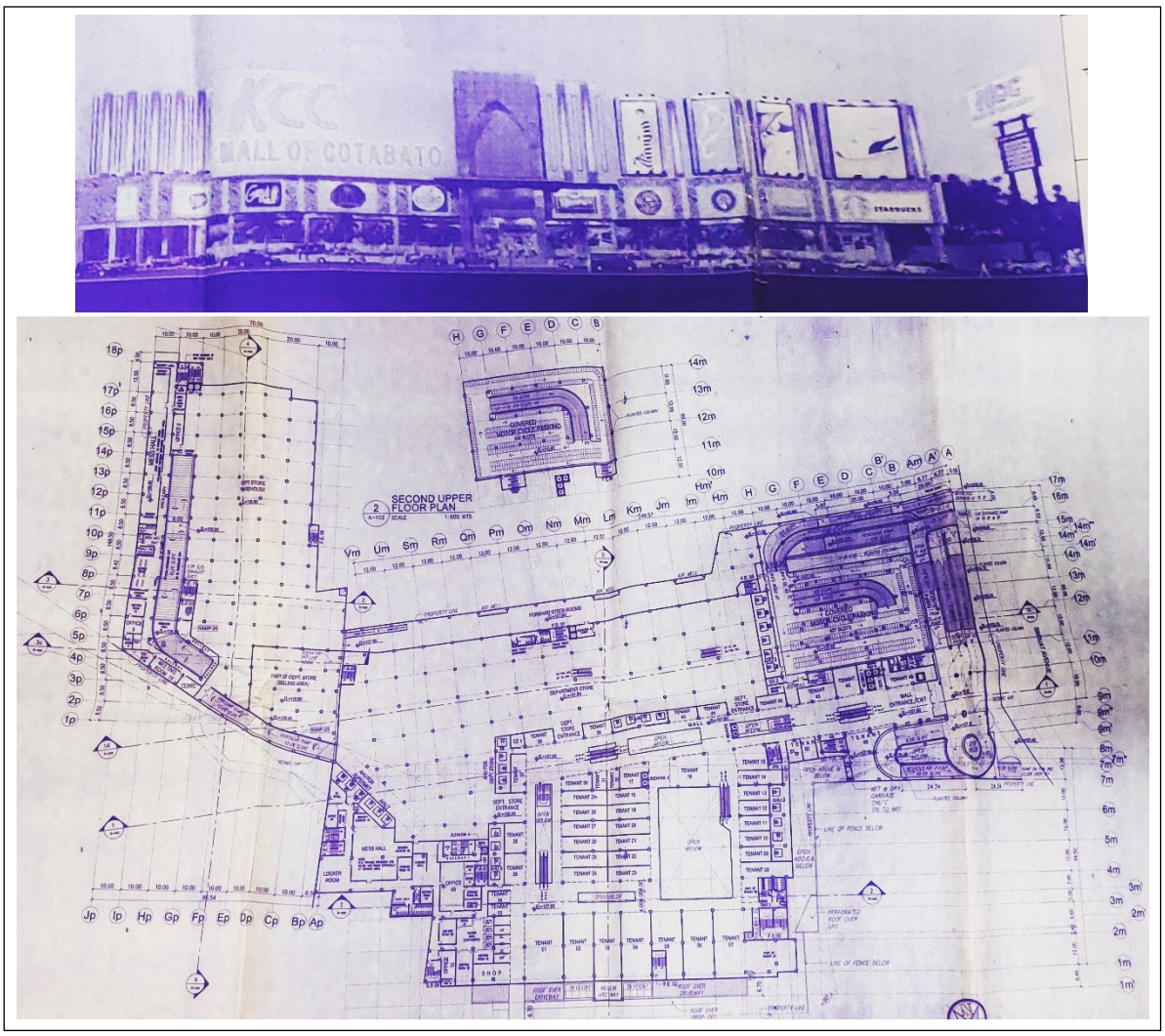
(1) Planning of Shopping Malls

The operator of KCC Mall decided to invest in Cotabato City is constructing a new mall in Rosary Heights 2 with the aim of completing construction in late 2023 or early 2024. The KCC Mall is a mixed-use complex comprising a shopping center, a hotel and a convention center. The overview of the KCC Mall is as follows.

Table 1-5-6 Overview of KCC Mall

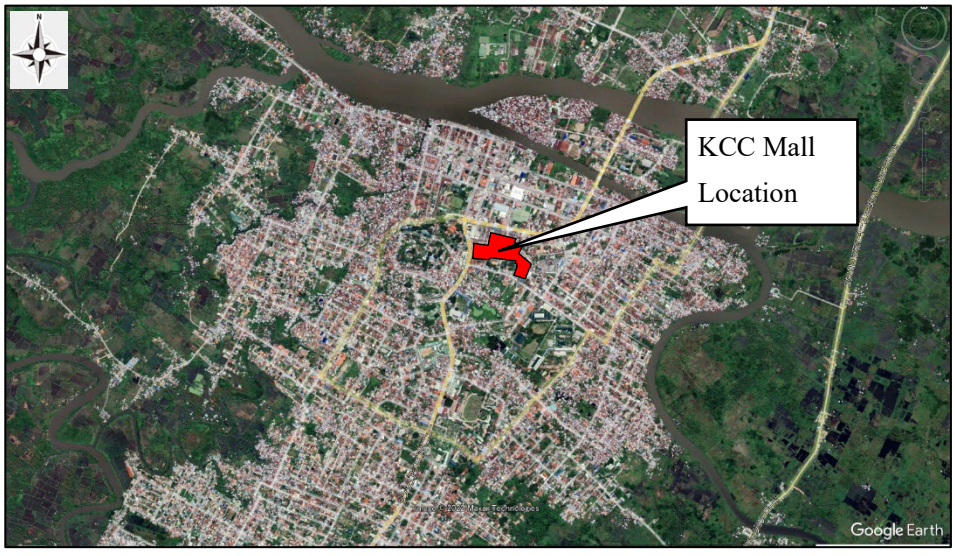
Items	Contents
Building area, number of stories	Approx. 5 ha, 4 stories
Contents	Shops and tenants: 127 units Convention halls: 3 units Cinemas: 8 units Hotels: 200 units Parking

Source : JICA Survey Team



Source : Cotabato City, City Engineering Office

Figure 1-5-13 KCC Mall Exterior View and Floor Plan



Source : JICA Survey Team

Figure 1-5-14 KCC Mall Location Map

(2) Development along the Tamontaka River

The area along the Tamontaka River has a high population growth rate, with plans underway for a slaughterhouse, bus terminal, housing development, school construction and resort development. There are also plans to establish the Cotabato port at Kalanganan 2 to complement Polloc Port which is located in Parang municipality.

	
Newly constructed Grand Mosque	Meat plant under construction

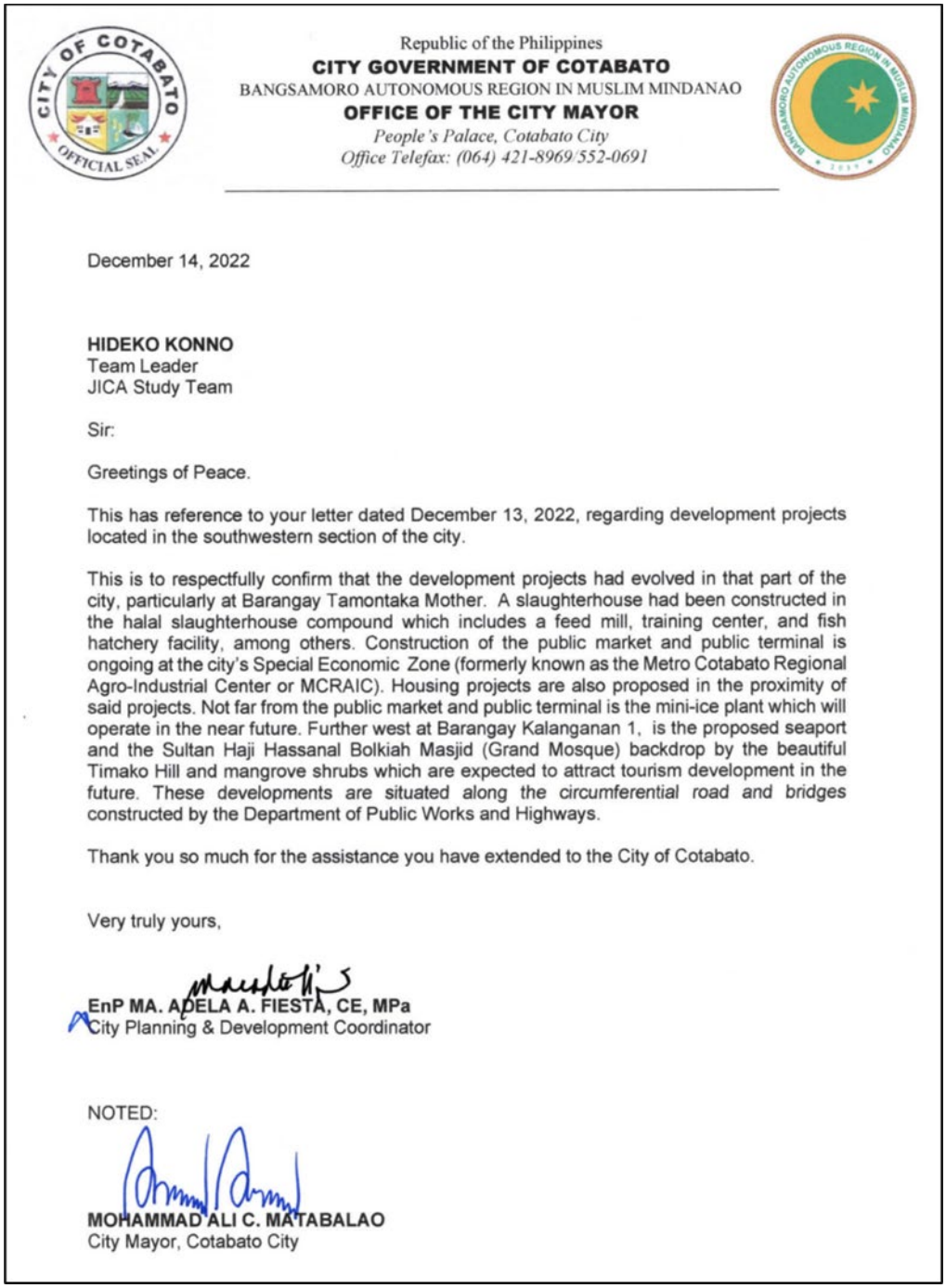
Source : JICA Survey Team

Photo 1-5-1 Areas along the Tamontaka River Undergoing Development

Development plans in these barangays include the following items.

- Halal meat plants, feed mills, training centers, fish hatchery facilities
- Public market and terminal in special economic zones (MCRAIC: Metro Cotabato Regional Agro-industrial Center)
- Schools
- Housing projects
- Ice plant
- Seaport and Sultan Haji Hassanal Bolkiah Masjid (Grand Mosque) (Kalanganan 1)
- Tourism (Timako Hill and mangrove crab forest)

A letter from Cotabato City to the JICA survey team regarding the above developments is shown below.



Republic of the Philippines
CITY GOVERNMENT OF COTABATO
BANGSAMORO AUTONOMOUS REGION IN MUSLIM MINDANAO
OFFICE OF THE CITY MAYOR
People's Palace, Cotabato City
Office Telefax: (064) 421-8969/552-0691

December 14, 2022

HIDEKO KONNO
Team Leader
JICA Study Team

Sir:

Greetings of Peace.

This has reference to your letter dated December 13, 2022, regarding development projects located in the southwestern section of the city.

This is to respectfully confirm that the development projects had evolved in that part of the city, particularly at Barangay Tamontaka Mother. A slaughterhouse had been constructed in the halal slaughterhouse compound which includes a feed mill, training center, and fish hatchery facility, among others. Construction of the public market and public terminal is ongoing at the city's Special Economic Zone (formerly known as the Metro Cotabato Regional Agro-Industrial Center or MCRAIC). Housing projects are also proposed in the proximity of said projects. Not far from the public market and public terminal is the mini-ice plant which will operate in the near future. Further west at Barangay Kalanganan 1, is the proposed seaport and the Sultan Haji Hassanal Bolkiah Masjid (Grand Mosque) backdrop by the beautiful Timako Hill and mangrove shrubs which are expected to attract tourism development in the future. These developments are situated along the circumferential road and bridges constructed by the Department of Public Works and Highways.

Thank you so much for the assistance you have extended to the City of Cotabato.

Very truly yours,

EnP MA. ADELA A. FIESTA, CE, MPa
City Planning & Development Coordinator

NOTED:

MOHAMMAD ALI C. MATABALAO
City Mayor, Cotabato City

Source : Cotabato City

Figure 1-5-15 Letter from Cotabato City on Development along the Tamontaka River

1-5-4-3 Implemented and planned projects by other donors

(1) Feasibility Study (F/S) of the Rio Grande Water Treatment Plant by US-AID

The United States Agency for International Development (USAID) conducted the Metro Cotabato Water Supply Rapid Feasibility Study in 2015 to construct the Rio Grande Water Treatment Plant ("WTP", 50,000 m^3/day rapid filtration) and the installation of a water transmission pipe. The construction plan was developed, consisting of Phase 1 through Phase 3. However, as of October

2022, it remained unclear whether USAID would continue this project. Accordingly, the MCWD has applied to BARMM for the Special Development Fund (SDF) of the BARMM Autonomous Government to proceed independently with a design-build development plan for this construction project. The schedule from approval to implementation of the project is yet to be determined.

(2) Renewal of Main Transmission Pipes by Asian Development Bank

The Asian Development Bank (ADB) provides loans through the Water District Development Sector Project (WDDSP) to provide a quality water supply and sanitation infrastructure and services to water districts in urban areas outside Metro Manila. Local Water Utilities Administration (LWUA) provides loans via the Department of Finance (DOF) to each water district. The MCWD is in the process of applying to utilize this project to renew an aging water pipe (steel pipe φ16", 6.78 km in length) with ductile iron pipe in the section between the Tanuel pumping station and the intersection in front of the Southern Philippines Development Authority (SPDA). Although the bidding process for this project was once conducted and the contractor was selected, the subsequent procedures have not progressed due to the change of signatories for both the LWUA and MCWD. According to LWUA, the process is expected to resume after the next change of signatories.

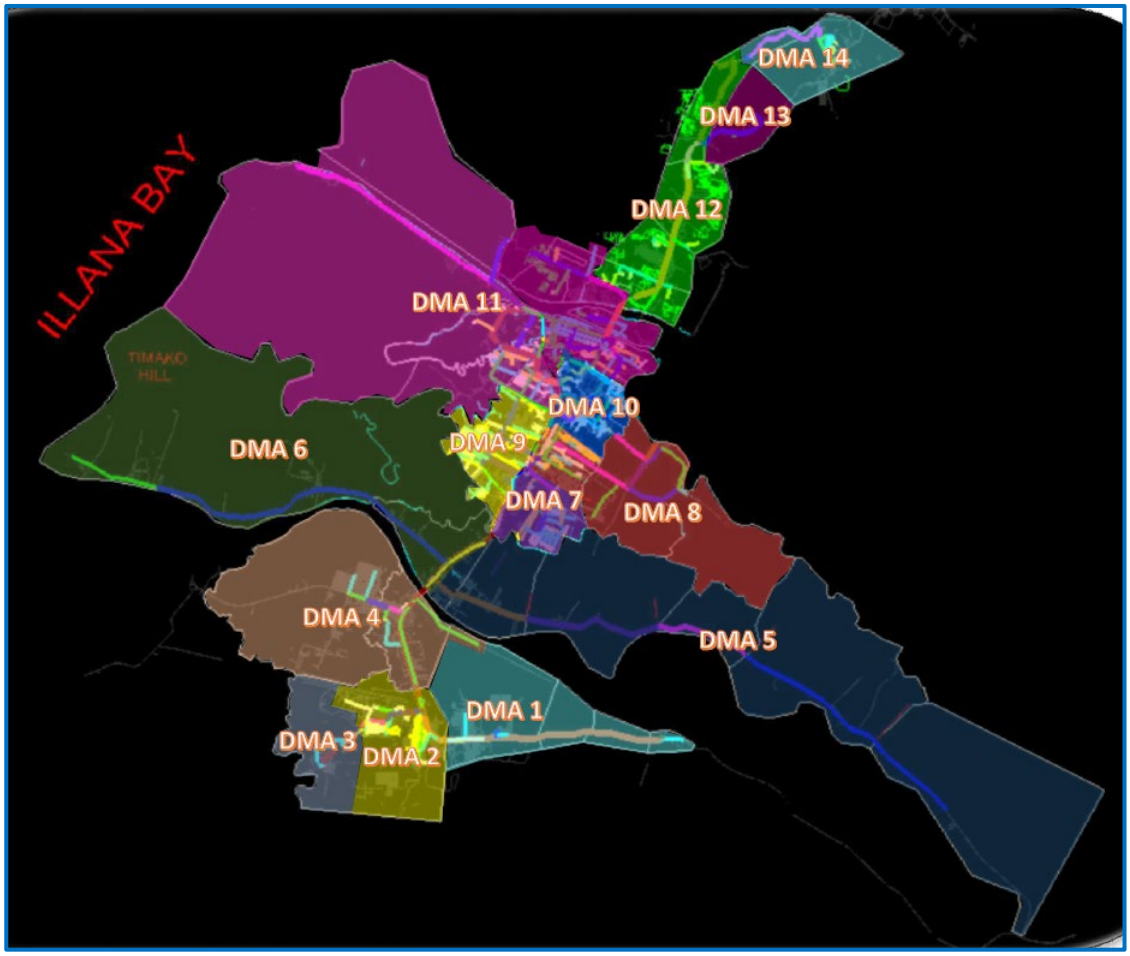
Table 1-5-7 Description of ADB Assistance Projects

Items	Contents
Project Name	Furnishing of Materials, Labor, Tools and Equipment for the Replacement of Existing 400mmØ Steel Transmission Mains to 400mmØ Ductile Iron Pipes and Fittings from Tanuel Pumping Station to SPDA Road Junction
Bid No.	WDDSP-MCWD-IFB-CW12
Project Scope	Transmission mains to ductile iron pipes 400mmØ 100mmØ DI Pipe road crossings 50mmØ GI Pipe distribution lines 25mmØ GI Stand Pipe Transfer of existing water meters to new 25mmØ GI stand pipes
Construction Period	18 months, 2022.2.23~2023.8.23
Contract Amount	PHP124,760,000
Contractor	Rex E. Morales Construction (Head office : Ormoc Leyte)

Source : JICA Survey Team

(3) Non-revenue Water (NRW) Reduction Project by Maynilad Water Services Inc.

Maynilad Water Service Inc. (“Maynilad”) contracted with the MCWD for a period from November 2021 to June 2022 to establish a District Metered Area (DMA) to divide the existing integrated water transmission system and effectively manage water distribution. The plan includes 14 blocks of DMA including the new Rio Grade WTP and the new Tamontaka WTP, and envisions DMAs 12-14 in SK as the first relatively easily feasible DMA. The plan also sets relatively large DMA with existing water distribution operations in mind, while Maynilad underlines the need to further subdivide the DMA in order to achieve fine-tuned water distribution management. The DMA for the other 11 blocks, excluding DMA 12~14, seems to be no prospect due to the cost of construction of flow meters and valves.



Source : Maynilad Water Inc.

Figure 1-5-16 DMA set up by Maynilad Water Inc.

(4) Development Plans with Application of SDF

a) Status of SDF Applications

The MCWD has applied to the BARMM government for a total of 1.57 billion pesos (PHP) in 2022 with the following three phases to utilize the SDF.

- Phase 1: 450M PHP Rio Grande WTP 25MLD + Water Intake
- Phase 2: 650M PHP Water Transmission and Distribution Pipes and Reservoirs
- Phase 3: 470M PHP Rio Grande WTP 25MLD + Water Intake

PHP 1.57 Billion in total

b) Process for SDF Adoption

For an MCWD proposal to be approved, the proposed project must meet the SDF project criteria (SDF Guidelines). The Bangsamoro Planning and Development Authority (BPDA) has an SDF Project Management Office (SDF-PMO), which carries out the initial assessment. The Office of the Chief Minister (OCM) manages the SDF, while review and approval is carried out by an inter-ministerial Technical Working Group (TWG).

If the MCWD's proposed project is approved, the ministry with jurisdiction (e.g. Ministry of Public Works for roads and bridges) is responsible for procurement of the project. If the MCWD is responsible for procurement, permission must be obtained from OCM. The evaluation of proposed

projects under the SDF guidelines is based on environmental, social and technical aspects, including the presence or absence of conflict-affected areas. The areas covered by the SDF are (i) social development, (ii) economic development, (iii) infrastructure, (iv) governance and (v) peacebuilding.

Table 1-5-8 Criteria for SDF Adoption

No.	Requirement	Contents
1	Reconstruction of conflict-affected areas	PPAs (Programs, Projects, and Activities) aim to rebuild, rehabilitate and develop conflict-affected communities.
2	Alignment with BARMM goals and priorities	Support the first Bangsamoro Development Plan ("BDP", 2020-2022) and the BARMM priority agenda.
3	Urgency	The proposed PPA should address pressing development issues; contribute to the achievement of the development objectives of the 2020-2022 First BDP; and Have a direct impact on the needs of conflict-affected communities.
4	Feasibility	The proposed PPA must be feasible and suitable for the development needs of the community.
5	Preparation status	The proposed PPA shall include a project brief, feasibility study (F/S), detailed engineering design (DED), program of work (POW) and deed of donation. Proposals from Local Government Units (LGUs) shall be duly approved by the respective Local Development Councils (LDUs).
6	Other requirements	The project area or location is not within a significant geohazard area or no-build zone identified or certified by the Ministry of Environment, Natural Resources and Energy (MENRE) or competent authorities. Not included in significant ground hazard areas or no-construction zones identified or recognized by MENRE or the competent authorities.
7		Standards for the construction and rehabilitation of infrastructure projects must be consistent with the regulations set by the Ministry of Public Works (MPW). The rules must take into account the structural strength and climate resilience required for all infrastructure projects.
8		All infrastructure projects planned and constructed within the National Integrated Protected Area System (NIPAS) are carried out in a manner that eliminates or minimizes the risk of biodiversity loss and that their specifications comply with those determined by the MENRE or MPW in coordination with the competent bodies.

Source: BPDA

c) Prospects for Obtaining SDF

For Phase 1 of the SDF application under submission, it was envisaged that approval would be granted by the end of 2022. The MCWD submitted the design parameters required for the Phase 1 application to BPDA in early November 2022 and subsequently revised the application in response to several comments.

Next, as of 1 December 2022, a BPDA representative replied that it would be difficult to get Phase 1 approved by the end of the year 2022. The delay in SDF approval is because it is taking time to consider the future transfer of the MCWD from the "current LWUA" to an organization that will replace the "BTA-jurisdictional LWUA". On the other hand, it was mentioned that they are positive about the prospects of budgeting for 2023. The above communication on financial support was verbal and there has not been any commitment in writing of any kind from the BPDA. The MCWD

is aware that, given the current speed of development, support from JICA and other donors, with or without SDF, will remain necessary.

(5) Renewal Plans for Existing Pipes by MCWD

The MCWD's plan for renewing existing water transmission and distribution pipes is as follows. The renewal is planned to start with the main pipes on trunk roads. In addition, counter measurements for leakage are also planned at the same time. Table 1-5-9 shows the MCWD's plans for the renewal of existing water transmission and distribution pipes and other facilities.

Table 1-5-9 MCWD's Plans for Upgrading Existing Facilities

Programs and Plans for 2022 to 2026

Planning and Design Department
Metro Cotabato Water District

Action	Specific Action Plans		Timetable	Estimated Cost (PHP)
1	Prioritization of Pipe Replacement Program for Dilapidated and Ageing Pipes			
	1, Proposed Replacement of Transmission Main (Tanuel Pumping Station			
	a	Tanuel Pumping Station to SPDA (National Highway)	2022 - 2024	130,692,087
	b	Central Bank to PPA Compound (Sinsuat Avenue)	2022	21,600,000
	c	SPDA to Downtown Area	2026	
	2. Proposed Replacement of Distribution			
	a	Sinsuat Avenue to Lugay-Lugay Street (Jose Lim Avenue)	2022 - 2023	15,500,000
	b	San Jose Street to Tamontaka Mother Barangay	2022	2,100,000
	c	San Pablo Village (Phase 1)	2022	1,626,500
	d	SK Pendatun Avenue Extension	2022 - 2023	13,730,000
	e	Kalanganan Mother Barangay	2022 - 2023	17,000,000
	f	Tukananes, Poblacion 7	2023 - 2024	8,172,000
	g	San Francisco, Purisima, and Pagalamatan, Tamontaka Mother Barangay	2023 - 2024	18,743,000
	h	ND Avenue	2023 - 2024	
	I	Delcano Street	2023	884,730
	J	TV Juliano Avenue (Phase 1)	2024 - 2025	
	k	Rosales Street	2024	
	l	Gov. Gutierrez Avenue	2024	
	m	Austria – Mendoza Street	2024	
	n	Tomas Martinez Street (Phase 1)	2024	
	o	San Pablo Village (Phase 2)	2025	
	p	TV Juliano Avenue (Phase 2)	2025 - 2026	
	q	Tomas Martinez Street (Phase 2)	2025	
	r	Tulingan Street	2025 - 2026	
	s	LR Sebastian Street	2025	
	t	Pascual Subdivision	2025	
	u	Bonifacio Street	2025	
	v	Tamse	2026	
	w	Campo Muslim Street	2026	
	x	Mabini Street	2026	
	y	Roales Street	2026	
	z	Banubo, Sultan Kudarat	2026	
2	Ensure immediate response and repair of reported and discovered leaks		2022 - 2026	
3	Proper installation and repair of pipes and appurtenances by following standards		2022 - 2026	
4	Install float valves auto switches in all reservoirs and water tanks to avoid leakages		2022 - 2026	

Source : MCWD

(6) Flood Control Master Plan in the Rio Grande de Mindanao

a) Outline of the Flood Control Master Plan

In March 2017, the Department of Public Works and Highways (DPWH) developed a revised Updating of Mindanao River Basin Flood Management Plan (the "Plan"). In Part 1: Flood Control Master Plan in Rio Grande de Mindanao and Tamontaka River, three studies were conducted on 1) flood inundation analysis, 2) sediment and scour analysis, and 3) structural flood control measures. Detailed Engineering Design (DED), including an outline of the flood control plan and a dredging plan for the river channel, was conducted. The contents of the studies and the structure of the reports are summarized as follows.

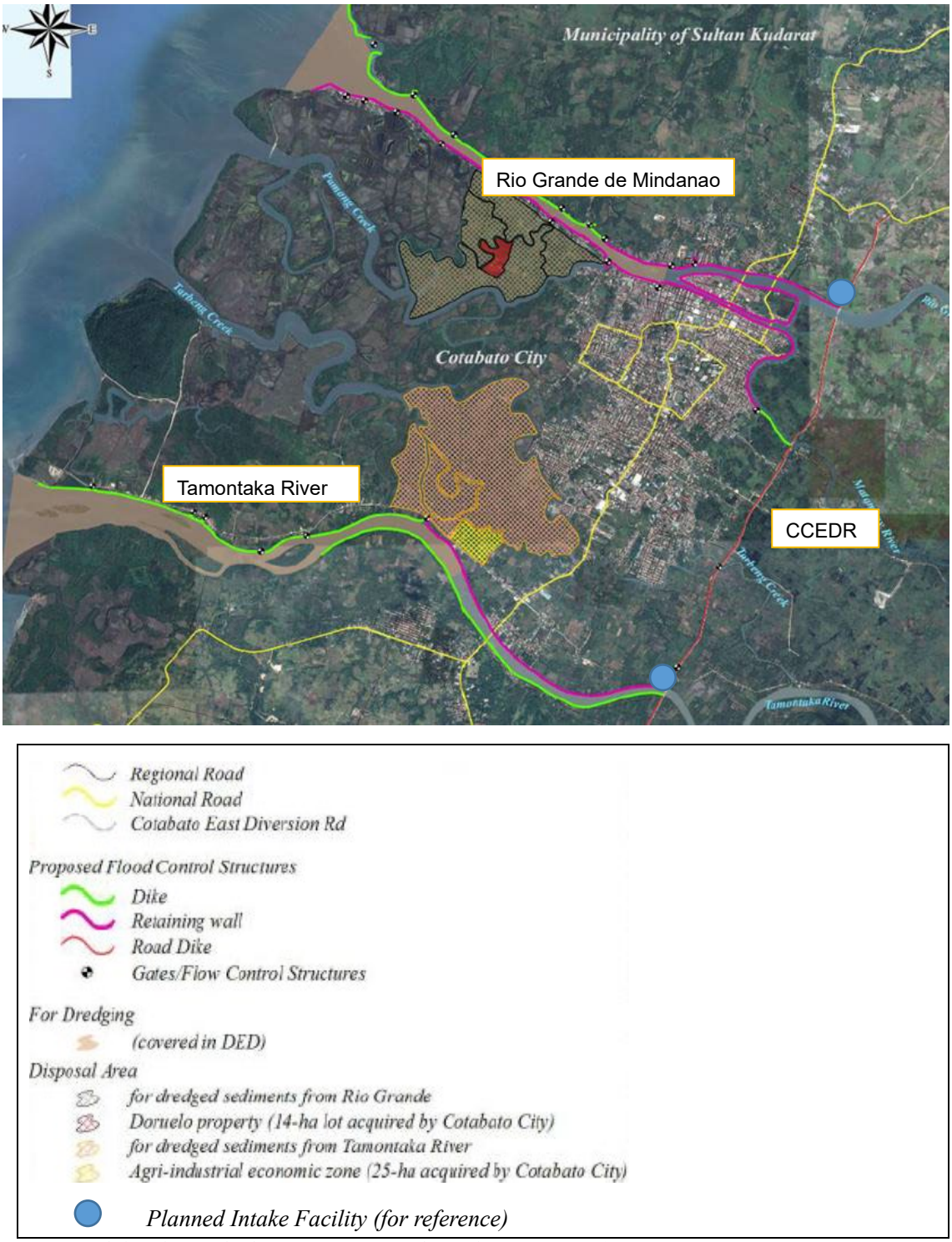
Table 1-5-10 Contents of Updating of Mindanao River Basin Flood Management Plan and the Structure of the Reports

No.	Report	Contents and Structure of the Reports
1	Updating of Mindanao River Basin Flood Management Master Plan	**Part 1: Flood Control Master Plan in Rio Grande de Mindanao and Tamontaka River** Part 2: Flood Control Master Plan in Ambal-Simuay River Part 3: Flood Control Master Plan in Pulangi River Part 4: Flood Control Master Plan in Ala River Part 5: Flood Control Master Plan in Buluan-Alip River
2	Part 1: Flood Control Master Plan in Rio Grande de Mindanao and Tamontaka River	**1) Inundation Analysis** 2) Sediment & Scour Analysis **3) Structural Flood Control Measures**
3	Detailed Engineering Design of Various Flood Management Projects in Mindanao River Basin	Detailed Engineering Design of **Rio Grande De Mindanao** Flood Control Plan 1) Flood Control Plan 2) Design Criteria and Technical Analyses 3) Inundation Analysis 4) Social and Environment Impact 5) Dredging plan and Cost Estimate
4	Detailed Engineering Design of Various Flood Management Projects in Mindanao River Basin	Detailed Engineering Design of **Tamontaka River** Flood Control Plan 1) Flood Control Plan 2) Design Scale and Criteria 3) Flood Reduction Analysis 4) Social and Environment Impact 5) Construction plan and Cost Estimate
5	Reports of Detailed Engineering Design	**Volume I: Detailed Engineering Design Report** Volume II: Tender Drawings Volume III: Survey Report Volume IV: Geological and Geotechnical Report Volume V: Quantity Calculations Volume VI: Bid Documents

Source: DPWH, Unified Project Management Office, (UPMO), Flood Control Management Cluster

b) Flood Control Plan in the Rio Grande de Mindanao and the Tamontaka River

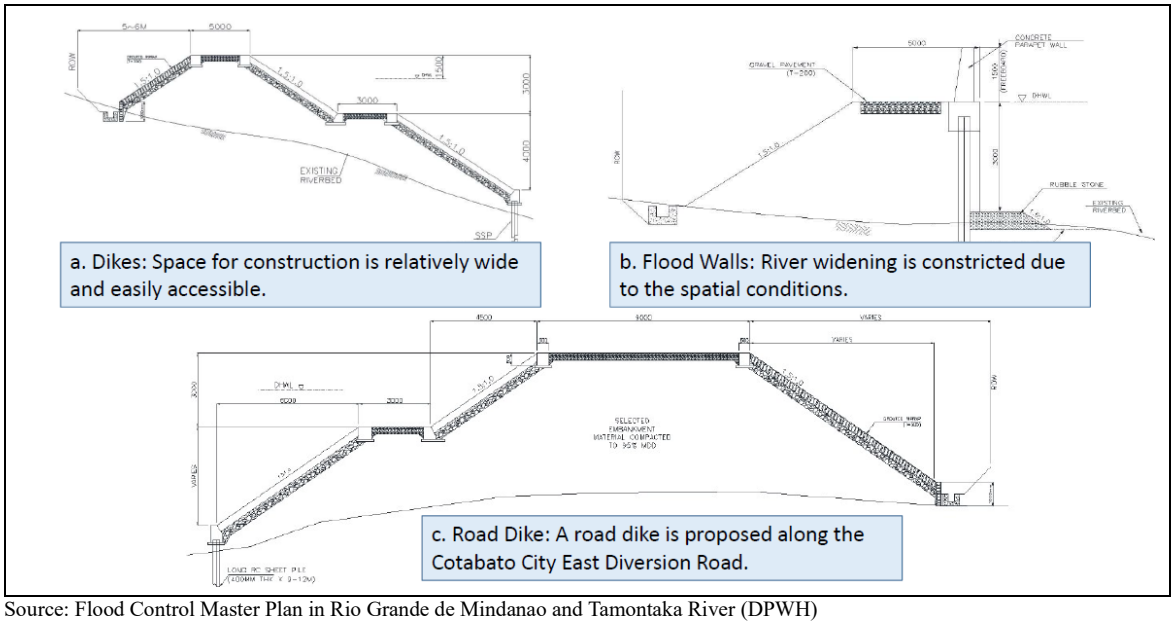
The outline of the flood control plan by the DPWH is shown in the Figure below. The Rio Grande de Mindanao and the Tamontaka River are planned to be dikes, and CCEDR as a road dike, would be constructed in the east side of the project area. Furthermore, in both rivers, dredging works would be carried out in the downstream section to improve the flow capacity.



Source: Updating of MRB Flood Management Master Plan, Main Report (DPWH)

Figure 1-5-17 Flood Control Plan in the Rio Grande de Mindanao and the Tamontaka River

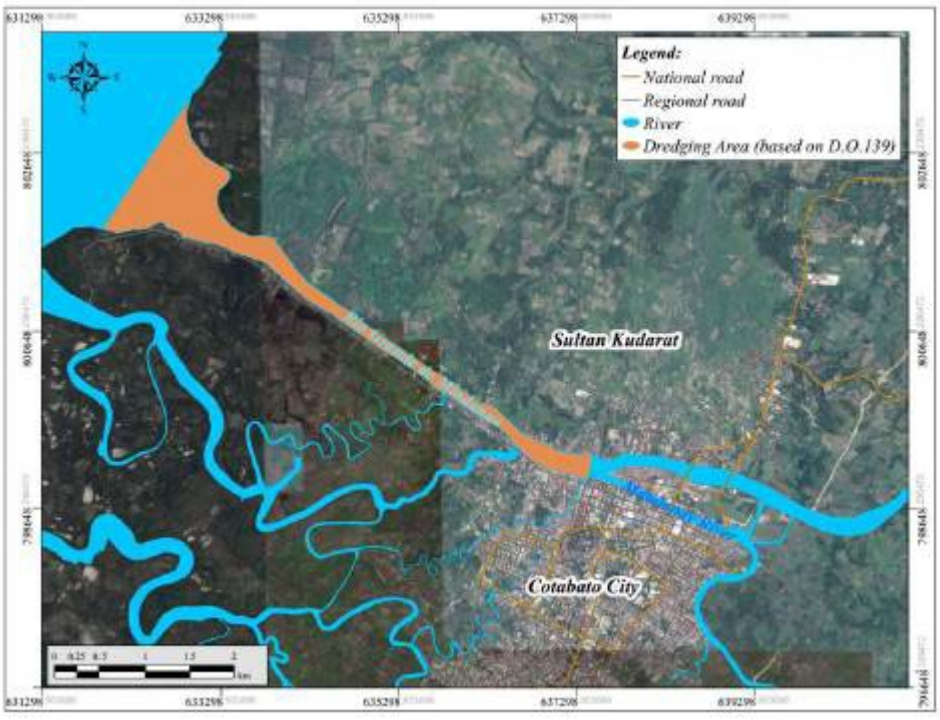
Other than the dredging sections where detailed design were done, the flood control plan is a conceptual plan only for the designed typical cross sections, and detailed examination has not been carried out. As shown in the Figure below, if there is enough space and easily accessible on the site, normal dikes are adopted, and if there is not enough space, flood walls are adopted. The crest width is basically adopted to be 5m and the slope is to be 1:1.5. The freeboard is to be 1.5m.



Source: Flood Control Master Plan in Rio Grande de Mindanao and Tamontaka River (DPWH)

Figure 1-5-18 Typical Cross Sections in the Rio Grande de Mindanao and Tamontaka River

As shown in the Figure below, the length for dredging works along the downstream of the Rio Grande de Mindanao is to be 6.15 kilometers from the river mouth. The design dredging volume is to be 7.56 million m^3.



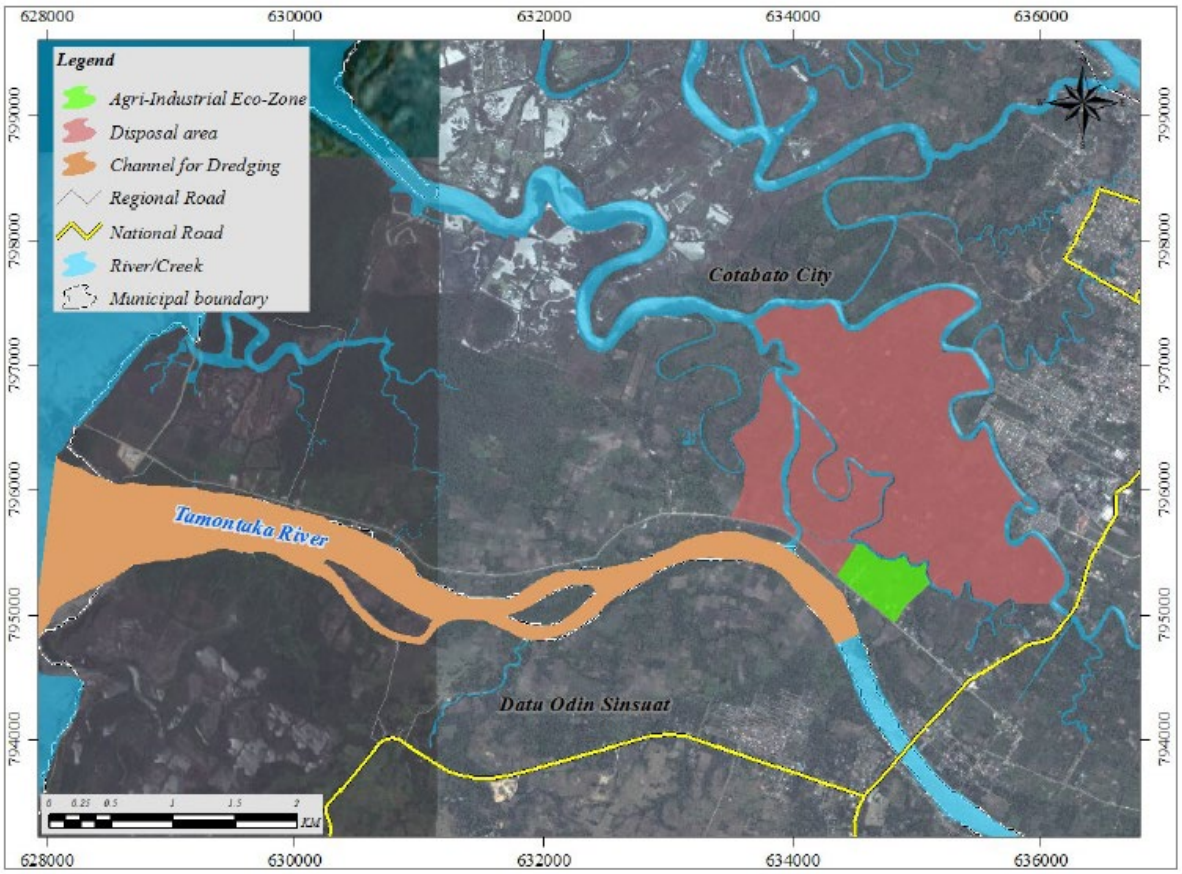
Source: Detailed Engineering Design Report of Rio Grande de Mindanao Flood Control Plan (DPWH)

Figure 1-5-19 Outline of Dredging Works in the Rio Grande de Mindanao (0.0km-6.15km)

As of the 2017 cost estimate, the cost for dredging works would be PHP 8,814 Million (21.6 Billion in Japanese Yen), and the implementation period would be eight years (96 months).

The Tamontaka River is also planned for dredging works to improve the flow capacity. The design section is the length of 7.15 km from the river mouth. The design dredging volume is to be 14.1

million m^3, the dredging project cost would be PHP 14,328 Million (approx. 35.1 Billion in Japanese Yen), and the construction period would be 120 months (10 years).

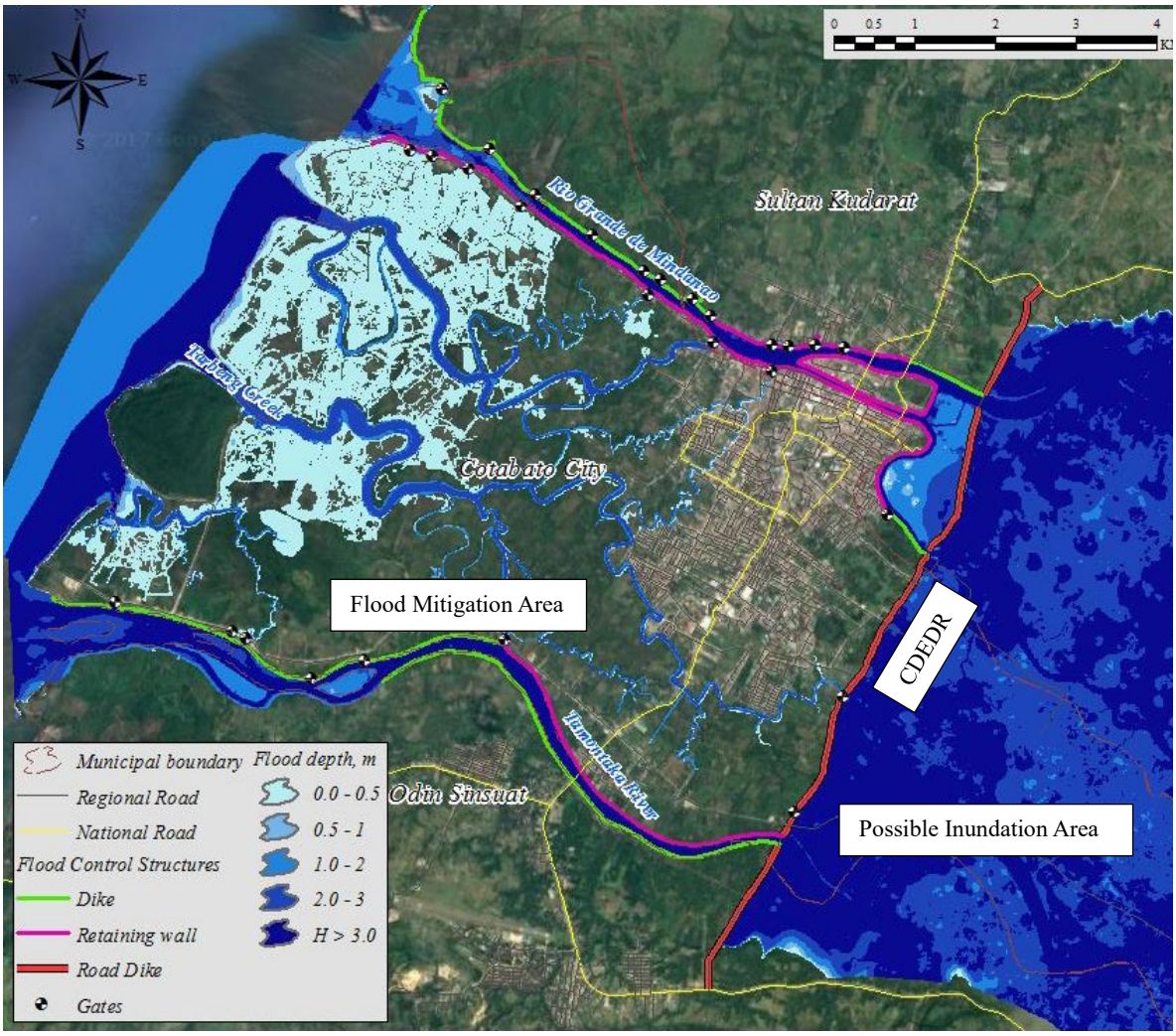


Source: Detailed Engineering Design Report, Part5: Tamontaka River

Figure 1-5-20 Outline of Dredging Works in the Tamontaka River (0.0 km -7.15km)

c) Inundation Area after the Implementation of the Project

The inundation area map based on the inundation analysis results for the 50-year return period flood event under facilities of the above facilities is shown below. As can be seen from the Figure below, the western area of the CCEDR would be the flood mitigation area, and the eastern area would be the "possible inundation area" where river flooding would be expected.



Source: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao and Tamontaka River

Figure 1-5-21 Inundation Area Map based on the Inundation Analysis Results for the 50-year Return Period Flood Event

1-5-4-4 Relevant Laws and Regulations

Relevant laws and regulations related to water supply projects and environmental protection are as follows.

Table 1-5-11 Laws and Regulations related to Water Supply Projects and Environmental Protection

Items	Contents
【Decentralization of Power】	
Laws and Regulations for Province Water-Related Facilities (1973)	Presidential Decree No. 198 established a national policy to delegate the operational management of water resources to the regions, allowing the establishment of regional water districts and their management by local governments, as well as the establishment of a national agency to support this policy.
Local Government Laws and Regulations (1991)	Republic Act No. 7160 establishes the national policy that local administrative regions, as partners in achieving national goals, have the right of local autonomy for their own independent development.
NEDA Board Decision No. 4 (1994)	The Infrastructure and Utilities Development Committee (INFRACOM) adopted the following decisions. a. Registration and approval with the National Water Resources Board (NWRB) for well construction and groundwater pumping

Items	Contents
	b. Capacity building of NWRB staff c. Utilization of LWUA as a "special funding agency" d. Support for privatization of water districts in Metro Manila, Cebu Metropolitan Area, Zamboanga City, and Davao City e. Support for competitive purchase of equipment and materials for water districts f. Submission of Reorganization Action Plan of LWUA to INFRACOM g. Restrictions on recipients of LWUA loans, etc.
NEDA Board Decision No. 6 (1996)	Approval of the Infrastructure and Utilities Development Committee (INFRACOM) proposal for an Implementing Agency Agreement for Competent Authorities to support efficient project implementation through decentralization and delegation of authority.
【Participation of the Private Sector】	
National Laws No. 6957 and No. 7718 (1994)	Recognizing that the private sector is indispensable to the nation's economic growth and development as a major vital force, the laws allowed private financing, construction, and operation and maintenance of social infrastructure projects.
Decree No. 279 (2004)	It provides for institutional reforms to the financial support of water and wastewater systems and promotes institutional reform of the LWUA.
【Environmental Protection】	
National Integrated Protected Area System Law No. 7586 (1992)	The National Integrated Protected Area System (NIPAS) Decree was established in 1992 to protect wildlife and species diversity with biological uniqueness.
Republic Act 9275 Water Pollution Prevention Act (2004)	The law is dedicated to water pollution prevention and shows how to prevent wastewater from dripping out of sewage treatment tanks and sewage pipelines and how to operate facilities for sludge, waste, wastewater, and sewage.
NWRB Decision No.002-1106 / No.004-0507 (2006/2007)	Conditions for desalination of brackish/seawater for urban water use (salinity and nitrate concentration) and promotion of reclaimed water use for groundwater conservation are presented.
Waste Management Act (2000) with a Focus on Environmental Protection	It is a law on waste management with a vision of systematic, comprehensive, and environmentally protective waste management throughout the Philippines. The National Waste Management Board was established as the agency to oversee the implementation of this law.
Implementation of the rules and regulations of Republic Act 9003 (2002)	The MENRE has prepared a document that offers advice to waste management committees at the municipal and regional level according to the decree. It includes information on the structure of each committee, how to collect waste and its segregation, and precautions in the design of sanitary landfills.
Republic Act No. 9486 (2007)	This law, called The Central Cebu Protection Landscape Law (CCPL Law), is designed to conserve forests and water sources in the Cebu metropolitan area.

Source: Prepared by JICA Survey Team based on the Cebu Metropolitan Area Water Supply and Sanitation Improvement Plan Study Report, Philippines, JICA (2010)

1-5-4-5 Water Right

The water rights are stipulated in the Amended Implementing Rules and Regulations under the NWRB is mandated the authority to manage and enforce the provisions. The Implementing Rules and Regulations stipulate that water can be used for various purposes, and the orders of priority for its use are a. Domestic, b. Municipal, c. Irrigation, d. Power generation. , e. Fisheries, f. Livestock raising, g. Industrial, h. Recreational, and i. Others.

The permission of the National Water Resources Board reaches appropriation and alteration of water, lowering and raising of water due to the development of lakes, rivers, wetlands, trans-basin diversion, etc. In the BARMM, items outside the NWRB's jurisdiction, such as hot spring development, are entrusted to the Ministry of Energy, and groundwater recharge is entrusted to external organizations such as the MENRE. In the amended Implementing Rules and Regulations, the application forms are different for each purpose (above a. to i), and even for municipal water, it is necessary to submit to the state NWRB to apply for rights. . In the case of municipal water, it is necessary to prepare the following documents.

List of Application Forms for the Water Rights in the Case of Municipal Water

1. Proof of land ownership of, legal title to, or right to use, the property where the water source is situated;
2. Certificate of Registration from relevant agencies i.e Department of Trade and Industry (DTI), Cooperative and Development Authority (CDA), Securities and Exchange Commission (SEC) with Articles of Incorporation (for Corporation or Association) including Corporate Secretary's Certification on present capital structure stating the citizenship and the number of shares of each stockholder
3. Certificate of Conformance from LWUA (for Water Districts only);
4. Certificate of Registration (if Barangay Waterworks Association, Rural Waterworks and Sanitation Association);
5. Vicinity Map/Location Plan with scale 1:10,000 or 1:50,000 showing the exact location of the point of diversion;
6. Subdivision Plan (if applicable);
7. Well Drilling Data (in case of existing groundwater source authenticated by the well driller) including Physical and Chemical analysis of water;
8. Sangguniang Bayan/Regional Development Council endorsement (for LGU-managed water supply facilities);
9. Environmental Compliance Certificate (for projects considered as Environmentally Critical Projects or projects located in Environmentally Critical Areas) or Certificate of Non-Coverage from DENR -Regional Office; and
10. Such other documents that may be required by the Board

Water right in the MCWD is listed below, and the total water right volume is 973.82 LPS (84,130 m^3/day). According to the MCWD, the water right volume became larger than the designed intake volume as they also considered the development of water resources in the future.

Table 1-5-12 List of Water Right in MCWD

No.	Water Source (Designed Capacity)	Administration	Location of Source	Approved Water Right(LPS)	Converted WR to m3/day	Purpose	Remarks
1	Tanual Springs(200lps)	DOS	Tambak, Datu Odin Sinsuat	314.71	27,190	Domestic	Spring
2	Rebuken Deep Well(30lps)	SK	Rebuken, Sultan Kudarat	50.00	4,320	Domestic	Deep Well
3	Macaguilling No.1 Deep Well(30lps)	SK	Macaguilling, Sultan Kudarat	40.00	3,450	Domestic	Deep Well
4	Dimapatoy River (200lps)	DOS	Awang, Datu Odin Sinsuat	400.00	34,560	Domestic	River Water
5	Bulk Water Supply Simuay River Water (Mactan Rock)	SK	Sultan Kudarat	111.11	9,600	Domestic	River Water (Contract 5,000m3/day)
6	Bulk Water Supply Matanpay River Water(Hanabana)	Cotabato	Biniruan, Cotabaoto City	58.00	5,010	Domestic	River Water (Contract 5,000m3/day)
Total Water Rights				973.82	84,130		

Source：MCWD

1-5-4-6 Water Rates Revision

Revision of water rates for water suppliers in the Philippines is carried out in the following procedures:

① A water district submit request for review of water rates to LWUA.
② LWUA conducts a survey and reviews to determine water rates to cover the Water District's projected cash requirement.
③ LWUA through the Board of Trustees approves the proposed water rates.
④ The water district's Board of Directors makes a resolution adopting and implementing the approved water rates in ③.

⑤ The water district conducts public hearing.
⑥ The approved new water rates are posted within the locality of the water district for a period of seven calendar days before its implementation as required by law.
⑦ The water district informs LWUA of the date when the rates took effect by furnishing a copy of Notice of Implementation together with a certification that the said notice was posted as required.

LWUA uses its own manual to calculate water rates based on the principle of "full-cost pricing (recovery)."

1-5-4-7 Environmental and Social Considerations

The legal framework for environmental and social considerations in the Philippines, known as the Environmental Impact Statement (EIS) system, was first established by Presidential Decree 1586, issued in 1978. The Decree introduced the concept of Environmentally Critical Projects (ECPs), Environmentally Critical Areas (ECAs), and Environmentally Non-Critical Project (ENCPs), and required business activities related to ECPs and ECAs to obtain an Environmental Compliance Certificate (ECC) before undertaking the project. The Department of Environment and Natural Resources - Environmental Management Bureau (DENR-EMB) is responsible for issuing ECCs. The laws and regulations related to environmental and social considerations in the Philippines are as follows.

(i) Presidential Decree 1586, "Environmental Impact Statement (EIS) System in the Philippines," 1978.
(ii) Executive Order 42 of the President, November 2, 2002
(iii) DENR's Executive Order No. 2003-30 (DAO2003-30), "Implementing Bylaws for the Philippine EIS System", 2003
(iv) Implementation Procedures Manual for DAO 2003-30, 2003
(v) Operational Manual for the Social and Environmental Management System (DPWH's own manual)

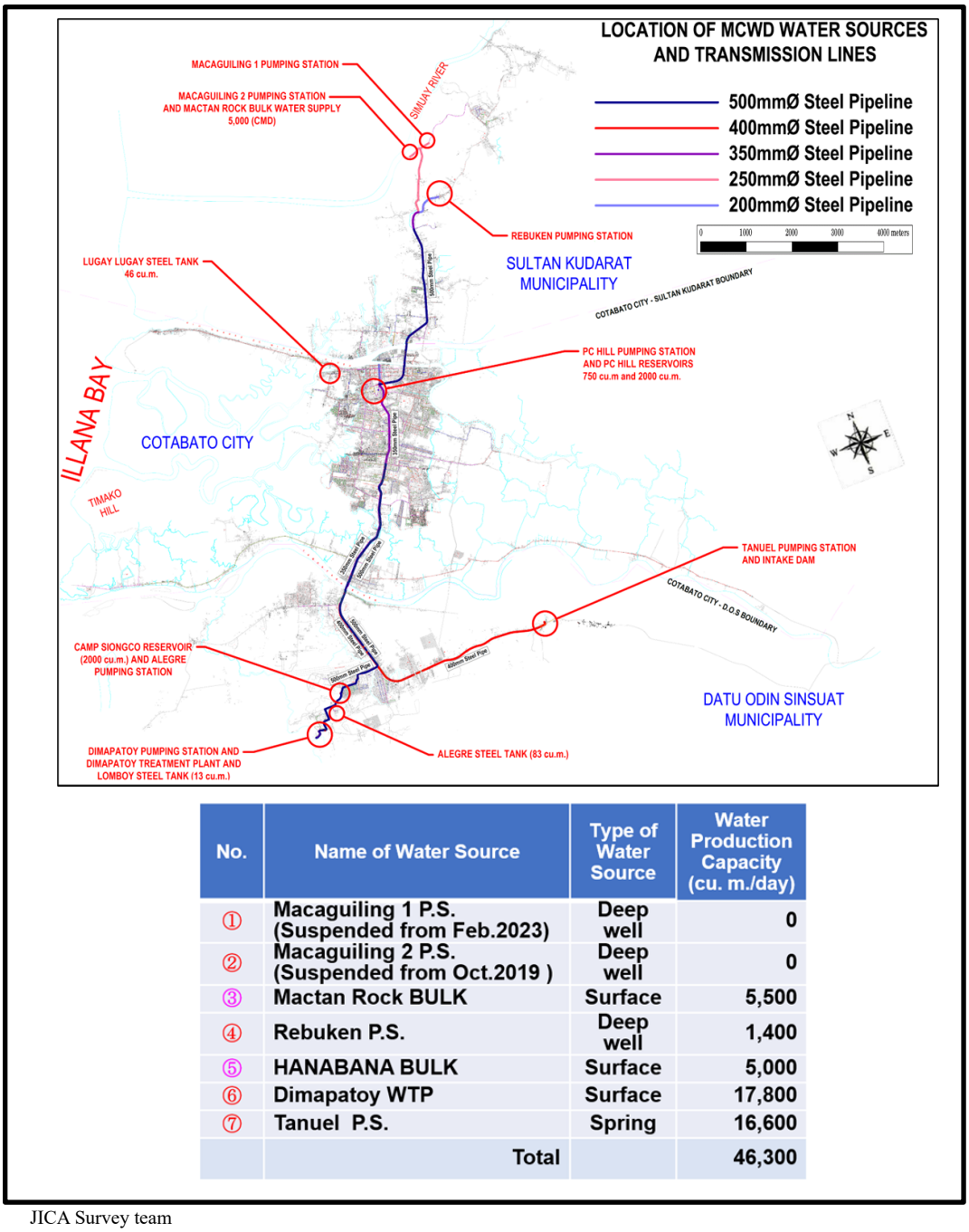
The DENR classifies business activities into the following categories.

Category A: Operations with significant potential to cause negative environmental impacts and are environmentally hazardous (ECP)
Category B: Projects that do not inherently pose a significant hazard to the environment, but are feared to have a negative environmental impact because they are located in environmentally vulnerable areas (ECA)
Category C: Projects that seek to directly improve the quality of the environment or solve existing environmental problems
Category D: Does not fit into the above categories. Or projects that are unlikely to cause negative environmental impacts.

Chapter 2. Current Status of Water Supply in Cotabato City and Surrounding Areas, Outline of Water Supply Facilities

2-1 Overall Composition of Water Facilities Managed by MCWD

Geography of Cotabato City and surrounding areas is generally flat from Cotabato City to Sultan Kudarat Municipality ("SK"). which is located on the north side of the Mindanao River. On the other hand, Datu Odin Sinsuat Municipality ("DOS"). which is located on the south side of the Tamontaka River is a relatively high elevation mountainous area. The MCWD is responsible for water supply for Cotabato city and a part of these surrounding areas.



No.	Name of Water Source	Type of Water Source	Water Production Capacity (cu. m./day)
①	Macaguiling 1 P.S. (Suspended from Feb.2023)	Deep well	0
②	Macaguiling 2 P.S. (Suspended from Oct.2019)	Deep well	0
③	Mactan Rock BULK	Surface	5,500
④	Rebuken P.S.	Deep well	1,400
⑤	HANABANA BULK	Surface	5,000
⑥	Dimapatoy WTP	Surface	17,800
⑦	Tanuel P.S.	Spring	16,600
	Total		46,300

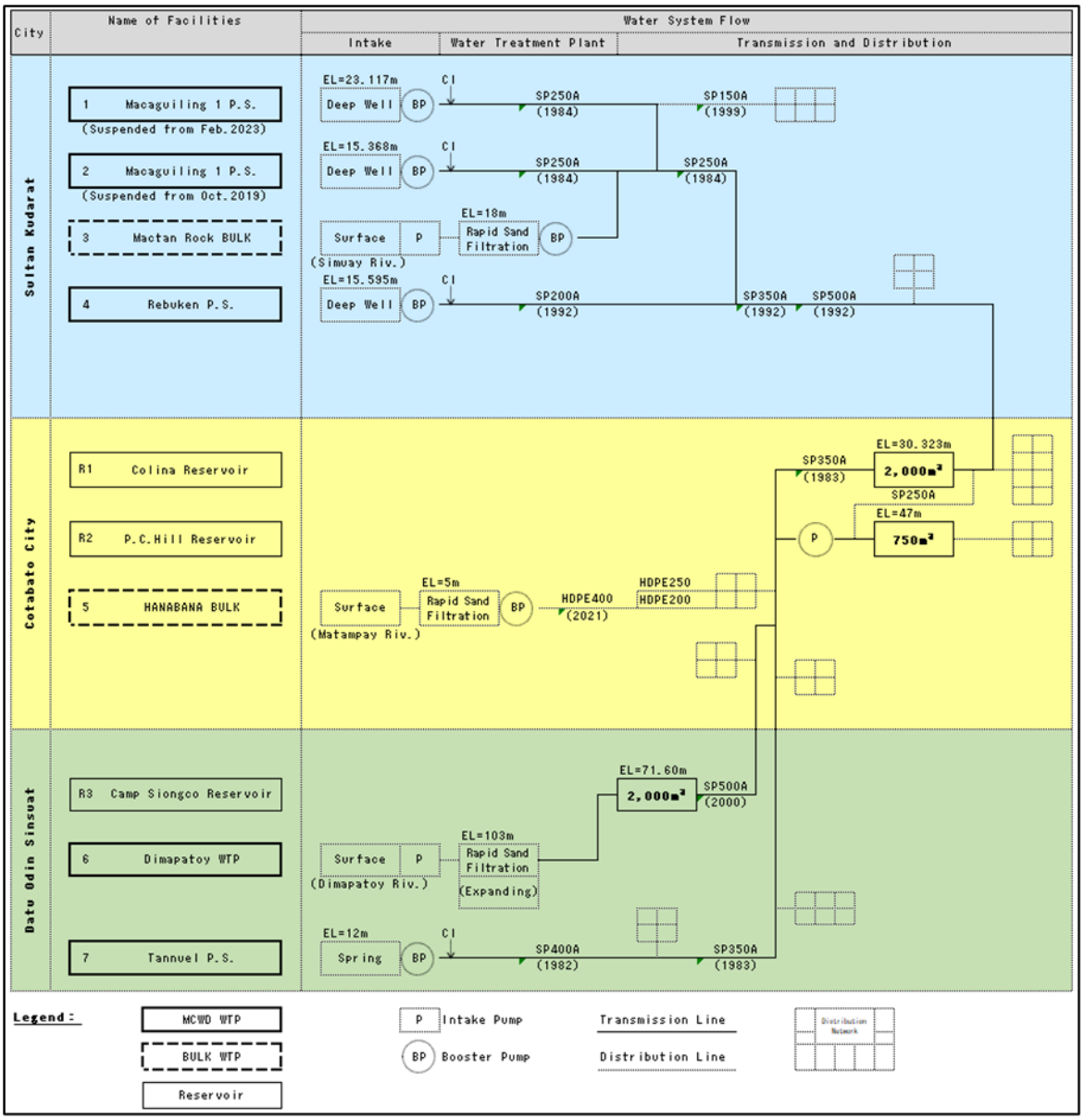
JICA Survey team

Figure 2-1-1 Location of Water Supply Facilities

The MCWD has three water intake and treatment facilities in SK and in DOS, water is distributed to Cotabato City and surrounding areas from these facilities. Transmission pipes are mostly installed on Sinsuat Avenue; delivered to two reservoirs in Cotabato City and one in DOS. There are a total of around 200km of transmission pipes and distribution pipes.

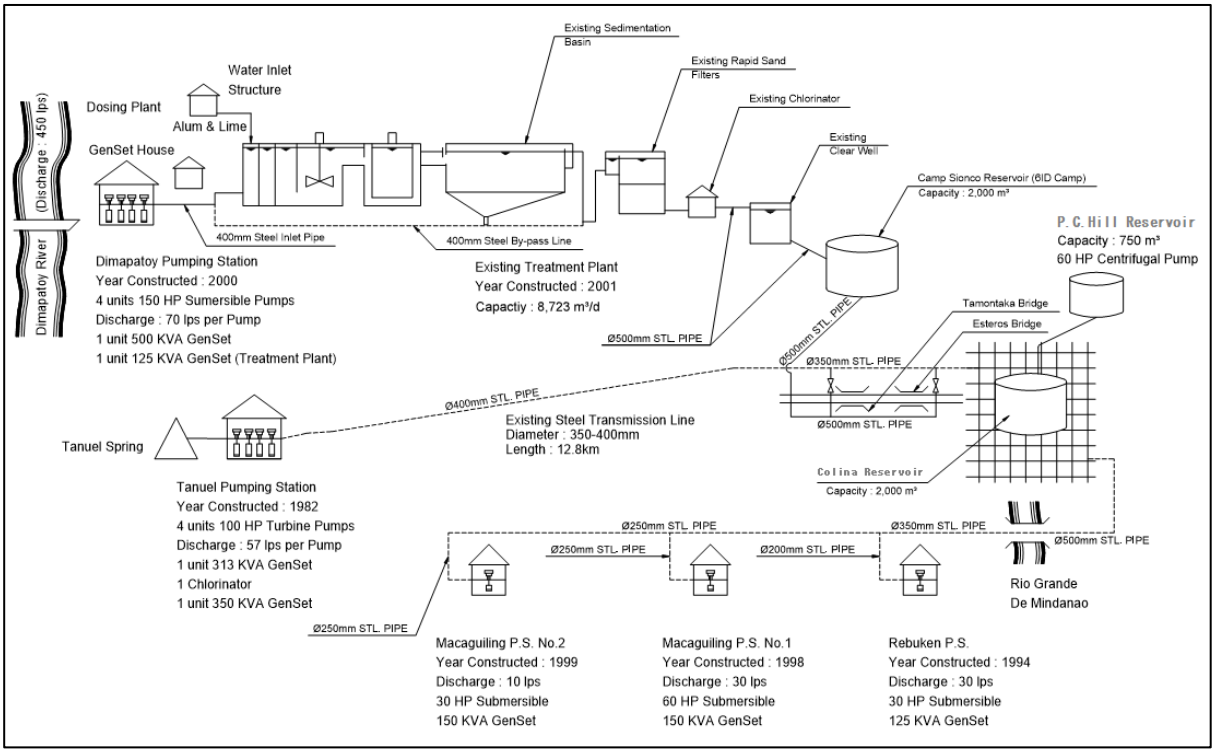
There are two WTP of bulk water suppliers, one each in SK and Cotabato city. The bulk WTP in SK is sourced from the surface water of the Ambal-Simuay River ("Simuay River"), while the bulk WTP in Cotabato City is sourced from the surface water of the Matampay River ("Matampay River").

Figure 2-1-1 shows the location of water supply facilities, Figure 2-1-2 shows a diagram of the water supply flow in MCWD, and Figure 2-1-3 shows the existing facility network diagram.



Source: : JICA Survey Team

Figure 2-1-2 MCWD Water System Flow Diagram



Source: : MCWD

Figure 2-1-3 Existing Facility Network Diagram

MCWD's multiple transmission pipes from WTP have been integrated into a single pipe on the way to the reservoirs. Furthermore, some distribution pipes are branched directly from the transmission pipes; therefore, the water pressure in the water pipes fluctuates drastically when the booster pumps at each pumping station are activated. Household connections are also affected by these water pressure fluctuations, which is thought to be one of the causes of leakage from household connections.

In terms of water distribution management, transmission pipes should be installed only one line from one WTP to one reservoir. In order to properly manage water distribution in the future, distribution areas should be blocked by each different water pressure area (formulating DMAs).

2-2 Specifications of Existing Water Treatment Facilities

2-2-1 Macaguiling PS1 and PS2

Macaguiling Pumping Station, which sources water from deep wells, started its operation in 1999 in SK, and is both an intake and treatment facility. It has been transmitted to the P.C. Hill after being pumped and chlorinated. This transmission line first connects with Mactan Rock transmission line, followed by the Rebuken transmission line. This transmission line has some distribution branches. The water supply also goes to part of SK. The booster pump has a discharge rate of 30 LPS and a head of 88 m.

In recent years, pumping has been declining due to the declining availability of groundwater, and Macaguiling PS No.2 has suspended pumping since October 2019. PS No. 1 also now achieves just 50~60% of its design capacity (30 LPS), which is why an operational suspension was considered. In addition, the water quality has become brownish in recent years, and the water must be blended with

other transmission lines for distribution so that the color does not exceed the standard value. As a result, PS1 was suspended its operation since February 2023.

PS1 and PS2 have a submersible pump that has an ability for a discharge rate of 30 LPS and a head of 88 m.

Table 2-2-1 shows an overview of the pumping stations and site photos.

Table 2-2-1 Overview of Macaguiling Pumping Station

Item	Macaguiling No.1	Macaguiling No.2
Water source:	Deep Well	Deep Well
Critical yield	3,456 (m^3/day) 40 (L/sec)	3,456 (m^3/day) 40 (L/sec)
Current water treatment capacity （Maximum daily water supply）	0 （Suspended）	0 （Suspended）
Treatment method	Chlorine	Chlorine
Intake pump		
Type	Submersible pump	Submersible pump
Number of total pump （Number of standby）	1(0)	1(0)
Discharge rate (L/sec/ea.)	30	30
Total pump head （m）	88	88
Diameter (mm)	150 (6”)	150 (6”)
Specification of motor	37kW (50HP), 60Hz	37kW (50HP), 60Hz
Inverter control	N/A	N/A
Generator （ea.）	1	1
Year of operation	1999	1999

Source: Compiled by survey team based on data from MCWD

Photo: Exterior of No.1 PS

Photo: Inside of Intake Pump Station

Source: : JICA Survey Team

Photo 2-2-1 Photos of Macaguiling PS1

2-2-2 Rebuken PS

Rebuken PS, which sources water from deep wells, started its operation since 1994 in SK as both an intake and treatment facility. Th water is transmitted to the P.C. Hill after being pumped and chlorinated. In recent years, the pumping rate has been declining and is now nearly half of the planned intake (30 LPS). One submersible pump is installed, with a discharge capacity of 30 LPS and a head of 88 m.

Table 2-2-2 shows an overview of the pumping station.

Table 2-2-2 Overview of Rebuken Pumping Station

Item	Rebuken PS
Water source:	Deep well
Critical yield	4,320 (m^3/day) 50 (L/sec)
Current water treatment capacity (Maximum daily water supply)	1,400
Treatment method	Chlorine
Intake pump	
Type of pump	Submersible pump
Number of total pump（Number of standby）	1(0)
Discharge rate (L/sec/ea.)	30
Total pump head（m）	88
Diameter (mm)	150 (6")
Specification of motor	37kW (50HP), 60Hz
Inverter control	N/A
Generator（ea.）	1
Year of operation	1994

Source: Compiled by survey team based on data from MCWD

2-2-3 Dimapatoy Intake and WTP

2-2-3-1 Overview of Dimapatoy Intake and WTP

The Dimapatoy intake facilities and WTP are located in DOS, at the highest elevation of all MCWD water facilities. The water is sourced from the surface water of the Dimapatoy River, which is pumped from the intake pumping station to the WTP. The WTP is a rapid sand filtration system. As of November 2022, the Dimapatoy WTP is undergoing expansion work and scheduled to start its operation in July 2023.

Table 2-2-3 shows an overview of the Dimapatoy intake facilities and WTP.

Table 2-2-3 Overview of Dimapatoy Intake and WTP

Item	Existing WTP （Year of operation: 2000）	Expansion WTP （Expected year : 2023）
Water source:	Surface of river	
Water Right Volume	34,560 m^3/day　(400 L/sec)	
Current water treatment capacity (Maximum daily water supply)	17,800 m^3/day	8,000 m^3/day
Intake pump		
Type of pump	Vertical pump	Submersible pump
Number of total pump（Number of standby）	4(1)	2(0)
Discharge rate (L/sec/ea.)	70	90
Total pump head（m）	85	84
Diameter (mm)	111kW (150 HP), 60Hz	147kW (200HP), 60Hz
Specification of motor	Absent	Present
Inverter control	1	1
Generator（ea.）	2000	2017
Situation of operation	Alternating operation of 4 units	Operated in emergency only
Conveyance pipe		
Steel pipe 500 mm	380 m	
Steel pipe 400 mm	380 m	
Steel pipe 300 mm	140 m	
HDPE 300 mm	240 m	
WTP		
Water treatment capacity (Maximum daily water supply)	17,800 m^3/day	8,000 m^3/day
Treatment Method	Rapid filtration	Rapid filtration

Item	Existing WTP (Year of operation: 2000)	Expansion WTP (Expected year : 2023)
Sedimentation tank	Horizontal-flow sedimentation basin	Upward flow sedimentation pond
Filtration tank	Multi filtration system 8 units	Multi filtration system (Under Construction)

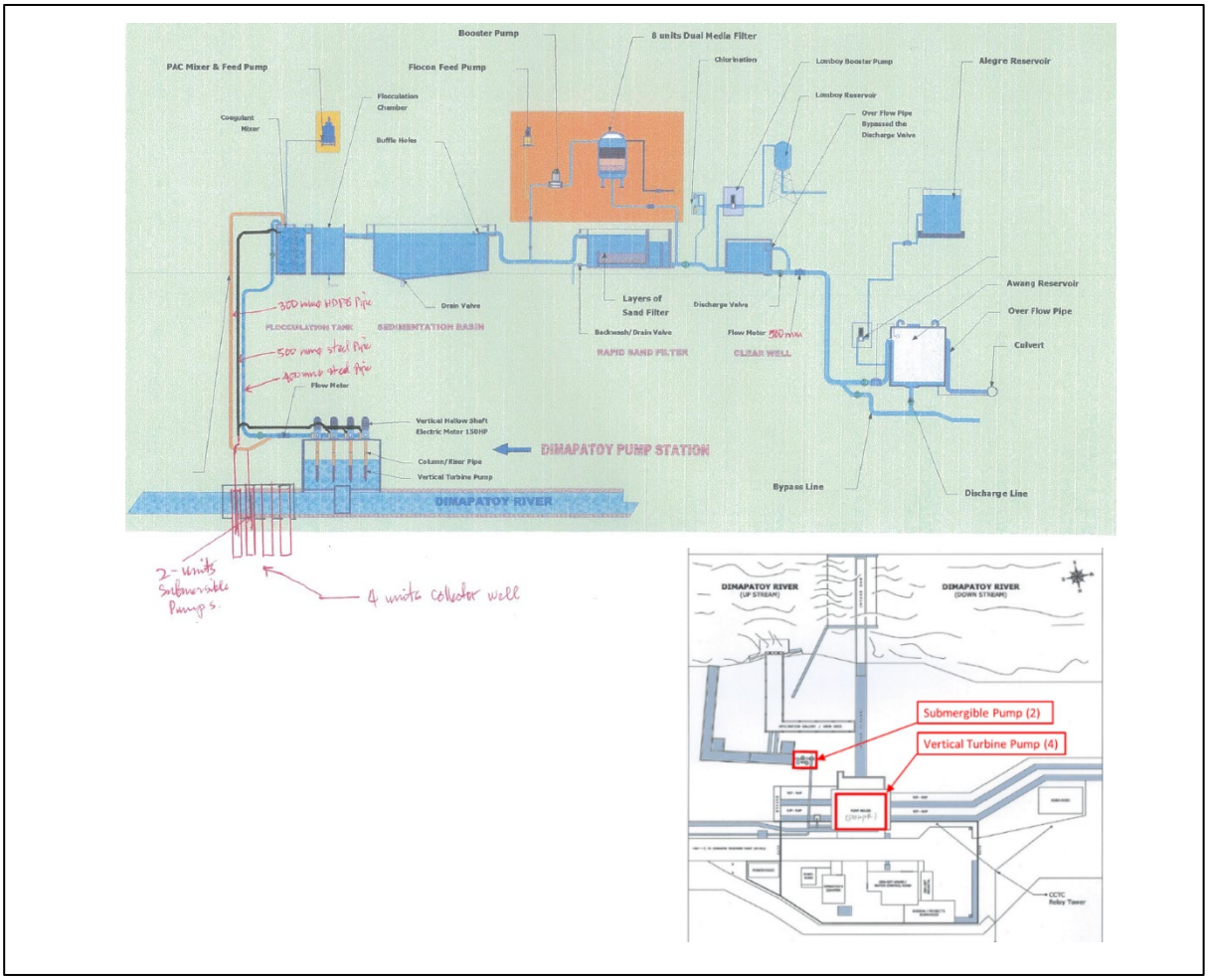
Source: Compiled by survey team based on data from MCWD

The Dimapatoy intake facilities were completed in 2000, and the water right is 34,560 m^3/day (400 L/sec).

There are six water intake pumps, four vertical shaft pumps for the existing WTP (one of which on standby), and two submersible pumps for the expansion WTP. The specifications of the vertical shaft pumps are a discharge rate of 70 L/sec and a head of 85 m. The operation functions of the water intake pump is as follows.

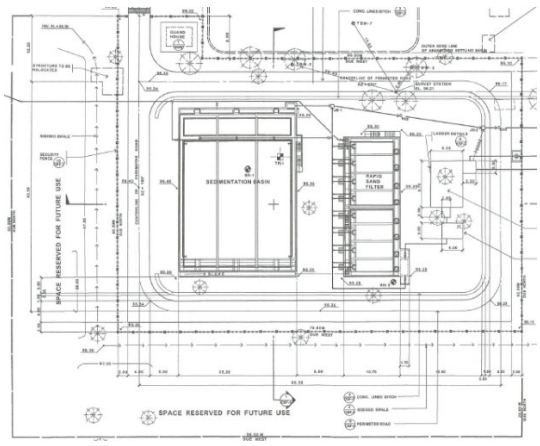
- 3 out of 4 longitudinal shaft pumps are operated alternately to pump to existing water treatment plants.
- Two submersible pumps will be delivered to the new water treatment plant (currently being expanded). In an emergency, water can be supplied to the existing water treatment plant via a communication valve.

Figure 2-2-1 shows a diagram of the Dimapatoy intake facility, Figure 2-2-2 shows an overview, plan view, and cross-section of the WTP, and Photo 2-2-2 shows the status of the WTP and intake facilities.

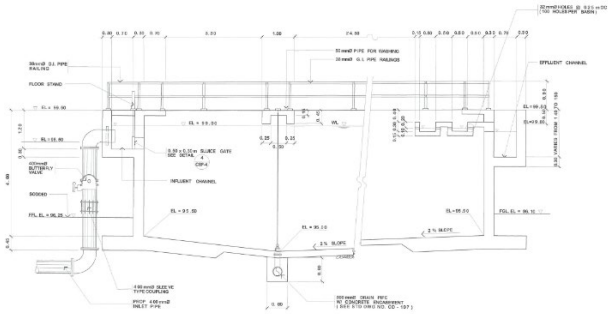


Source: : MCWD

Figure 2-2-1 Overview Drawings of Dimapatoy Intake and WTP



Plan View



Dimension（Flocculation Pond Sedimentation Pond）

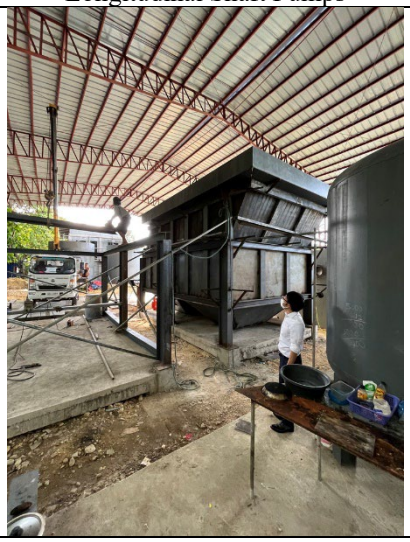
Source: : MCWD

Figure 2-2-2 Planview and Dimension of Dimapatoy Intake and WTP

Panoramic View of Water Intake Facilities

Longitudinal Shaft Pumps

Existing WTP



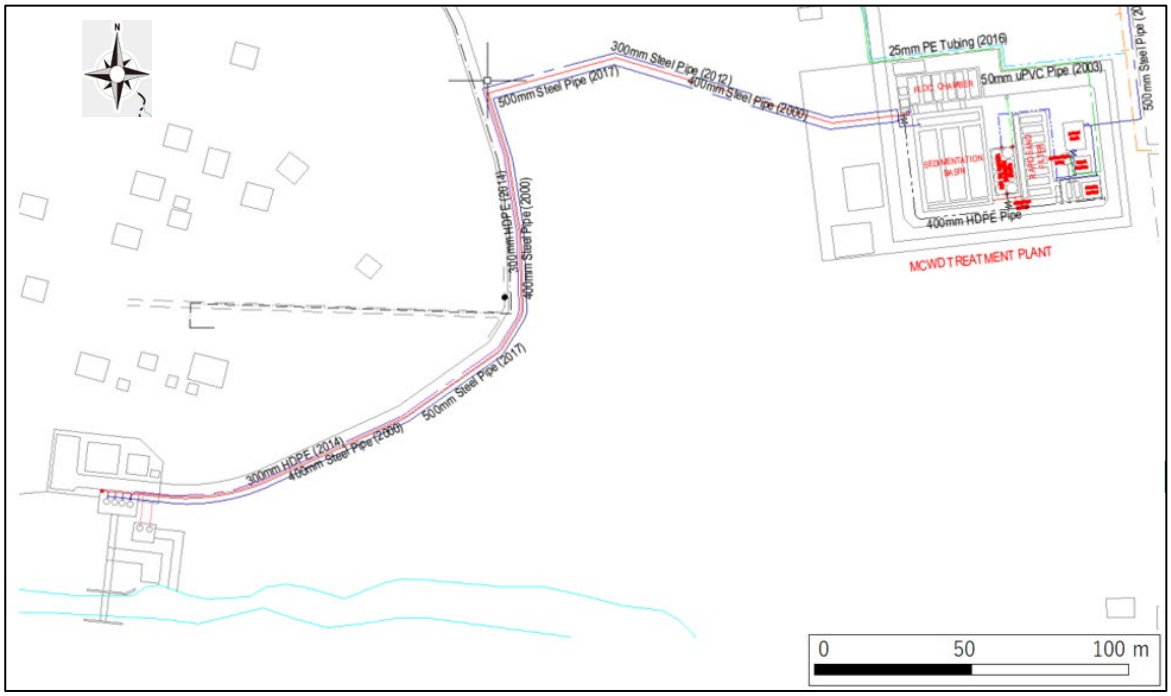
Expansion WTP（Under Construction）

Source:：JICA Survey Team

Photo 2-2-2 Status of the WTP and Intake Facilities

2-2-3-2 Conveyance Pipe from Dimapatoy WTP

Three conveyance pipes are installed as 500 mm Steel pipe(“SP”), 400mm SP and 300mm SP and HDPE, each 380m long. They are mutually connected by connecting valves and operable alongside each other. Figure 2-2-3 shows the outline diagram of the conveyance pipes, and Table 2-2-4 shows the specifications of the conveyance pipes.



Source: : MCWD

Figure 2-2-3 Outline Diagram of Conveyance Pipes

Table 2-2-4 Specifications of Dimapatoy Conveyance Pipes

Category	Spec.	Dia. (mm)	Length (m)
Conveyance Pipe	SP	500	380
		400	380
		300	140
	HDPE	300	240
Total			1,140

Source: Compiled by survey team based on data from MCWD

2-2-4 Tanuel PS

2-2-4-1 Overview of Tanuel PS

The Tanuel Pumping Station, which sources water from a spring, and has been in operation since 1982 in DOS as both an intake and treatment facility. It has a lush green 300-meter-high mountain in its hinterland; the area is blessed with clean water that is drinkable only with chlorine disinfection and an abundance of water. The spring water that springs up in a circular underground tank is supplied to DOS and a part of Cotabato City from the adjacent pumping station. The circular underground tank does not have a bottom plate, and the spring water rises on bedding sand and gravel.

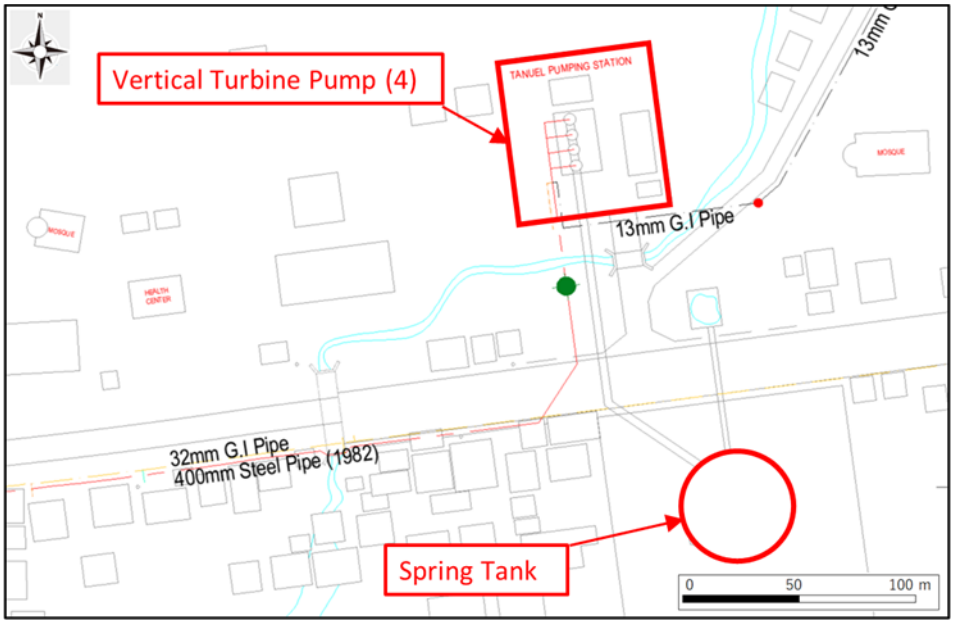
The maximum daily water supply is 16,600 m^3/day. Water quality is stable throughout the year. Four vertical shaft pumps (one of which on standby) are installed, with a discharge capacity of 56.77 L/sec/unit and a head of 89 m.

Table 2-2-5 shows an overview of the facilities, and Figure 2-2-4 and Photo 2-2-3 show a general view of the facilities and photographs of the site.

Table 2-2-5 Overview of Tanuel PS

Item	Tanuel PS
Water source:	Spring
Critical yield	27,190 m^3/day　314.71 L/sec
Current water treatment capacity	16,600 m^3/day
Treatment method	Chlorine
Sprig tank	RC, D 10 m×H 2.0 m
Intake pump	
Type of pump	Vertical pump
Number of total pump （Number of standby）	4(1)
Discharge rate (L/sec/ea.)	56.77
Total pump head （m）	89
Diameter (mm)	200 (8")
Specification of motor	N/A
Inverter control	1
Generator （ea.）	1982

Source: Compiled by survey team based on data from MCWD



Source: Compiled by survey team based on data from MCWD

Figure 2-2-4 Overview of Tanuel PS Facilities

PS Overview

Longitudinal Shaft Pumps

Generators

Spring Tank

Source: : JICA Survey Team

Photo 2-2-3 Tanuel PS Site Photo

2-2-5 Water Transmission and Distribution Facilities

2-2-5-1 Transmission Facilities

Table 2-2-6 shows the overall length of the transmission pipe for which MCWD is responsible.

Table 2-2-6 Overall Length of Transmission Pipes

Category	Spec.	Dia. (mm)	Length (m)
Transmission Pipes	Steel Pipe (SP)	500	12,870
		400	7,148
		350	7,516
		250	3,489
		200	1,761
		150	638
Total			33,422

Source: Compiled by survey team based on data from MCWD

(1) Macaguiling-Rebuken Transmission Pipeline

The Macaguiling-Rebuken pipeline runs through the south side of SK and the north side of Cotabato City to the P.C. Hill area. The transmission pipe from the Mactan Rock Bulk and Macaguiling PS2 is installed with 250mm SP (inner surface concrete lining), and after joining the transmission pipeline from Macaguiling PS1 (250mm SP) and the Rebuken pipeline (200mm SP), its diameter expands to 350mm SP. Subsequently, the diameter was further expanded to 500mm SP, and the water is transmitted to the P.C. Hill area.

Otherwise, apart from the above transmission pipeline, some of the water from Macaguiling PS1 is transmitted in a northeasterly direction via 150mm SP, and supplied a part of SK.

Table 2-2-7 shows a breakdown of the Macaguiling-Rebuken pipeline length as a proportion of the total transmission pipe.

Table 2-2-7 Macaguiling-Rebuken Pipeline Length

Category	Spec.	Dia. (mm)	Pipelines	Length (m)
Transmission Pipe	Steel Pipe (SP)	500	Macaguiling-Rebuken	6,000
		350	Macaguiling-Rebuken	460
		250	Macaguiling	3,489
		200	Rebuken	1,761
		150	Macaguiling（SK）	638
Sub-Total				12,348

Source: Compiled by survey team based on data from MCWD

(2) Tanuel-Dimapatoy Transmission Pipeline

The Tanuel-Dimapatoy transmission pipeline runs through the north side of DOS and the south side of Cotabato city to the P.C. Hill area. The Tanuel pipeline is installed with a 400mm SP and joins the Dimapatoy pipeline in Cotabato City. These transmission pipelines branch into distribution pipes and household connections directly along the way. As of March 2023, a part of the Tanuel pipeline is scheduled for renewal with ADB funds (see 1-5-4-3(2)), and the first ductile iron pipe will be installed in MCWD.

The Dimapatoy transmission pipeline is a 500mm SP installed from DOS to Cotabato City, and after joining the Tanuel pipeline in Cotabato City, the diameter is reduced to 350mm. According to the MCWD, the deposits of lime, which is an abundant component in the Dimapatoy River, on the inner surface of the steel pipes, have the actual pipe diameter of the pipes to narrower. In addition, since it is relatively easy to branch the water supply with steel pipe, water is being stolen through unauthorized branching. As a result, the water supply pressure has decreased, and this is the cause of the insufficient water pressure for distribution. The use of ductile cast iron pipes (inner lining) is desirable from the perspective of preventing lime deposition and water theft and ensuring water supply pressure.

Table 2-2-8 shows the breakdown of the Tanuel-Dimapatoy pipeline length as a proportion of the total transmission pipe.

Table 2-2-8 Tanuel-Dimapatoy Pipeline Length

Category	Spec.	Dia. (mm)	Pipelines	Length (m)
Transmission Pipe	Steel Pipe (SP)	500	Dimapatoy	6,870
		400	Tanuel	7,148
		350	Tanuel-Dimapatoy (after joining)	7,056
Sub-Total				21,074

Source: Compiled by survey team based on data from MCWD

2-2-5-2 Distribution Facilities

(1) Reservoirs

There are two reservoirs in Cotabato city: Colina (2,000 m^3, EL=30 m), which distributes water to the surrounding lower areas of P.C. Hill, and the P.C. Hill (750 m^3, EL=47 m), which distributes water to the higher areas of P.C. Hill via the P.C. Hill pumping station. The Macaguiling-Rebuken transmission pipeline flows in from the north, and the Tanuel-Dimapatoy transmission pipeline flows in from the south.

The Colina Reservoir is controlled by a level-regulating valve with a ball-tap, and there is no intentional control of water distribution by electric valves or other means. The number of ponds is one, making it difficult to clean the inside of the pond on a regular basis for maintenance purposes. In addition, the site is not large enough, making it difficult to expand the capacity to accommodate future increases in demand.

The influent of P.C.Hill Reservoir is controlled by pumps in P.C.Hill PS. The site is located in close proximity to residences, and access to the facility is only possible through a residential walkway. The site has only one pond, and the lack of space makes it difficult to expand the capacity.

There is the Camp Siongco water reservoir (EL=71.60m) in DOS, which receives water from the Dimapatoy WTP (EL=103m). This is the highest water level reservoir in the water supply area, and water is delivered through DOS and Cotabato City to the P.C. Hill area. During the daytime, when water demand is high, the water level in the reservoir is almost zero, and the water level recovers overnight. It is assumed that a large amount of water is distributed to Cotabato City, which is at a lower elevation and then cut off during daytime in the DOS, which is at a higher elevation. It is desirable to implement appropriate water distribution management by setting DMAs.

The specifications for each reservoir are shown in Table 2-2-9, and site photos are shown in Photo 2-2-4.

Table 2-2-9 Specification of Reservoirs

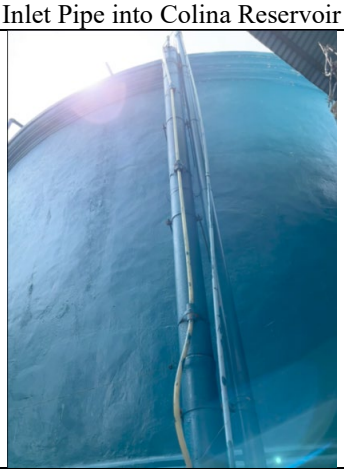
Reservoir	Colina	P.C.Hill	Camp Siongco
Form	RC, above-ground cylindrical type	RC, above-ground cylindrical type	RC, above-ground cylindrical type
Effective Capacity (m^3)	2,000	750	2,000
Number of Pond	1	1	1
Height (m)	5.74	8.6	5.75
Elevation (m)	30.3	47	71.6
Dia. of inlet (mm)	350	100	500
Dia. of outlet (mm)	350	150	500

Source: Compiled by survey team based on data from MCWD

Colina Reservoir 2,000cum

Inlet Pipe into Colina Reservoir

P.C.Hill. Pumping Station
distributed into P.C.Hill Reservoir



P.C.Hill Reservoir 750cum
Built adjacent to residences, no available space

	
Camp Siongco Reservoir 2,000cum	Maintenance Pit on Camp Siongco Reservoir

Source: : JICA Survey Team

Photo 2-2-4 Site Photos of Reservoirs and PS

(2) Transmission and Distribution Pump

Transmission and distribution pumps are installed at Tanuel, Macaguiling, and Rebuken PS, which are also WTP, as well as at the P.C. Hill PS and the Camp Siongco reservoir PS.Table 2-2-10 shows the specifications of transmission and distribution pumps.

Table 2-2-10 Specification of Transmission and Distribution Pumps

Pump Station	Tanuel	Macaguiling	Rebuken	P.C.Hill	Camp Siongco
Purpose	Water Intake (Spring)	Water Intake (Deep Well)	Water Intake (Deep Well)	Distribution	Distribution
Type	Turbine	Submergible	Submergible	Inline Booster	Inline Booster
Number of Unit (pcs)	4	1	1	1	1
Total Head (m)	92	87.5	61	99.97	68.5
Discharge Quantity (m^3/day/ea)	4.90	2.59	2.59	2.18	0.29
Total Discharge Quantity (m^3/day)	19.62	2.59	2.59	2.18	0.29
Dia. of Pumping Pipe (mm)	200	150	150	-	-
Length of Pumping Pipe (m)	4.572	60.96	35.576	-	-

Source: Compiled by survey team based on data from Maynilad and MCWD

(3) Distribution Pipes

The MCWD uses steel pipes (SP) for water distribution mains and Polyvinyl chloride resin pipes (uPVC) for water distribution pipes in accordance with LWUA standards. In addition, the joint pipe connecting the new pipe and the existing pipe due to renewal work of the existing pipe is connected with a cast iron pipe (CIP) with good joinability. HDPE tubes are mainly laid in the Tamontaka area by other donors. However, HDPE pipes are said to have many water leaks, and the cause is due to poor construction of Butt fusion, damage due to other construction, compression of backfill material, etc. Currently, DMA has yet to be established, but it is outsourced to Maynilad to consider the division of DMA so that water distribution is properly managed in the future. The outcome of the DMA proposal was submitted in July 2022.

The length of distribution pipes by pipe type and diameter is shown in Table 2-2-11.

Table 2-2-11 Length of Distribution Pipes by Material Types

Materials	Dia.(mm)	Length(mm)
uPVC	200	10,539
	150	30,268
	100	36,166
	75	29,483
	50	41,120
HDPE	100	10,989
	75	752
	50	3,145
SP	100	261
	75	221
	50	2,082

Source: Compiled by survey team based on data from MCWD

2-2-6 Bulk Water Supply

The MCWD currently receives water from two private bulk water sources. In both cases, if operations are suspended, the MCWD can take over the operating rights.

(1) HANABANA Bulk Water Supply

It commenced operation in January 2022. Construction and operation are implemented by HANABANA, a company based in Cagayan de Oro city. It intakes raw water from the Matampay River and has a capacity of 10,000 m^3/day. It currently supplies 7,000 m^3/day water. The facility consists of rapid dual stirrings (Aluminum Sulfate and Calcium Hypochlorite), normal sedimentation ponds, ten 700 m^3/day class pressure filtering units, activated carbon power equipment (single lane) and (latter) chlorine disinfection facility. The contract is boosting production up to 9500-10000 m^3/day over a decade between 2022 and 2032. Meanwhile, if the water demand exceeds the purchased water volume, the HANABANA bulk water supply is obliged to supply water, so the purchased water volume is different from the actual water supply volume. As no damage was incurred during the heavy rain disaster of 28 October 2022, it urgently increased production. At the same time, even if the demand volume falls below the purchased water volume, the MCWD owes to purchase the contracted water volume. After that, there is a plan to increase to 15,000 m^3/day . It is possible to physically increase to 20,000 m^3/day by increasing the pressure filtering units to twenty. The purchase price per m^3 is fixed at 13.55 PHP/m^3.

The residual chlorine is measured every 15 minutes by the DPD method. The turbidity keeps less than five NTU. The roster is eight hours by three people. One of the two pumps is used at 24 intervals to keep the flow rate of 250 m^3/h by using inverters manually with a flow and pressure meter. Backwashing is conducted from 2 AM every two tanks when the demand is low.

Basically, it is capable of supplying 10,000 m^3/day, but there was an odor complaint (when drinking, it felt like leaves) when the production exceeded 7,000 m^3/day. The JICA Survey Team drank by ourselves; there was no issue. The cause is assumed to be algae growing in the swamp area in the upper reaches of the Matampay River. The HANABANA bulk water supply uses activated carbon made of coconut shells, but it is limited to 7,000 m^3/day production due to the single-lane system. It is desirable to have two-lane system for activated carbon. Regarding another problem, there is no

screen up to the upper part of the intake facility, so flood protection is not sufficient. The pump specification is listed in Table 2-2-12.

Table 2-2-12 HANABANA Pump Specification

Item	Intake	Distribution
Resource	Surface Water (Matampay River)	
Type	Submersible	Double Suction Centrifugal
Number of Pumps	2	2
Flowrate	450 m^3/h	150 m^3/h
Head (m)	10	60
Diameter (mm)	250	150
Motor	40 hp, 60 Hz, 480 V	110 kW, 60 Hz, 480 V
Inverter	No	Yes
Generators（number）	1	
Activated	2022	2022
Status	24h Intervals	24h Intervals

Source: Compiled by survey team based on data from HANABANA

Flocculation

Sedimentation

Filtering Unit

Chlorine Injection Equipment

Overview

Intake Facility

Source：JICA Survey Team

Photo 2-2-5 HANABANA Bulk Water Supply Site Photo

(2) Mactan Rock Bulk Water Supply

Private Mactan Rock bulk water supply commenced operation in January 2018. It currently supplies about 4500-6000 m^3/day. Construction and operation are conducted by Mactan Rock, a company with a head office in Mandaue City, Cebu. It takes water from the Simuay River using submersible pumps and cylinders. Using a cylindrical flocculation tank, then sedimentation and pressure filtering tanks are used. Backwashing is conducted so that the turbidity keeps less than three NTU in the treated water tank. Unlike HANABANA, it has a sludge-drying bed. The intake cylinders were tilted by heavy rain of 28 October, and they stopped production. In addition, the current intake location is considered inappropriate, given the sand mining that takes place just downstream of the facility, which changes the river morphology. The purchase price per m^3 is fixed for ten years at 13.50 PHP. Chlorine injections happen twice (former/latter), and PAC is used. The pump specification is shown below:

a) Intake Pump

Two Ebara-made submersible pumps installed in 2018 with 150/200DL 60HZ 3.7kW

b) Distribution Pump

Two SIEMENS-made vertical pumps, which were brought from other places. The manufactured year was unknown; and they are aged. Only one inverter is under operation, and the operational specification is shown in Table 2-2-13.

Table 2-2-13 Operational Specification of Distribution Pump

Parallel	Mode	Frequency (Hz)	Q (cm^3/h)	Pressure (psi)
BP1	FULL (No Inverter)	60	192-198	
BP2	CONTROL VFD	20-25	208	10
		25-30	209-220	20
		31-35	221-230	30
		36-40	230-240	40
		41-46	240-260	50
		47-50	260-280	60
		50-60	280-300	80

Source: Compiled by survey team based on data from MCWD

Sedimentation Tank

Flocculation Tank

Pressure Filtering Unit

Treated Water Tank (right side) and Sludge Drying Bed

Intake Cylinder

Sand Mining Site

Source：JICA Survey Team

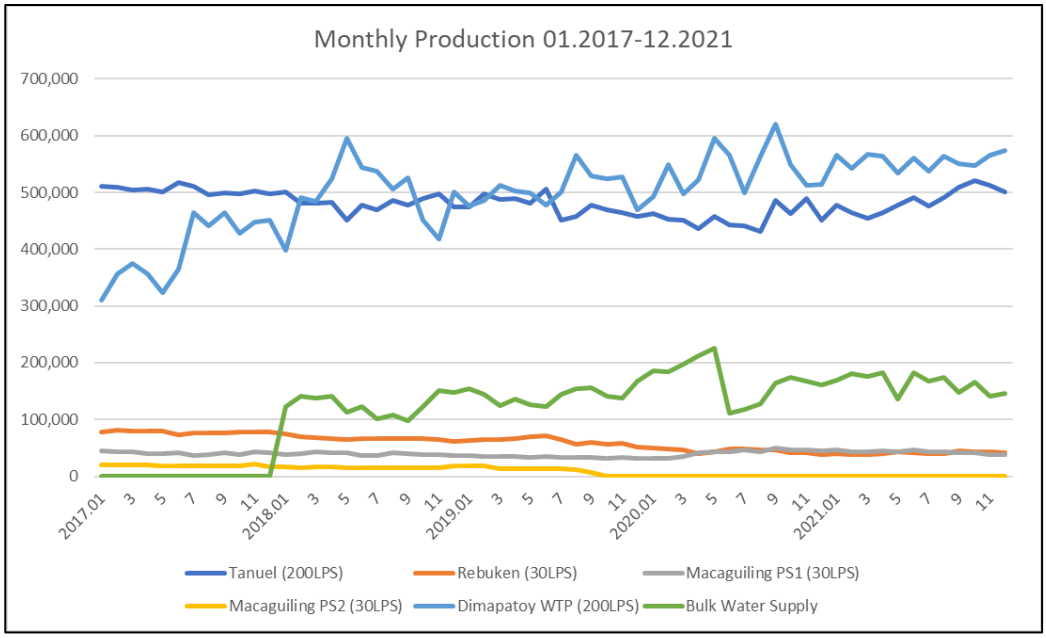
Photo 2-2-6 Mactan Rock Bulk Water Site Photo

2-3 Operation and Maintenance in the Existing Facilities

2-3-1 Production Volume

Figure 2-3-1 shows the production transition between 2017 and 2021 in each facility. Chapter 6 refers to each production. There are seven water sources controlled by the MCWD in 2022, and Tanuel PS and Dimapatoy WTP covers over 70% of the production. These two sources are the main water resources for Cotabato City and DOS. Mactan Rock bulk water supply, commenced in 2028, became the main supply source in SK. On the other hand, Macaguiling PS2 suspended the operation, and Macaguiling PS1 and Rebuken PS decreased their production by 50-60 % of the design capacity. Hence,

the Mactan Rock and the HANABANA bulk water supply increased the production to cover decreased production and to deal with increasing water in the metro Cotabato area.



Source: Compiled by survey team based on data from MCWD

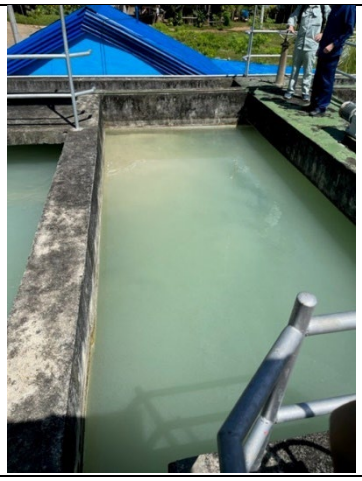
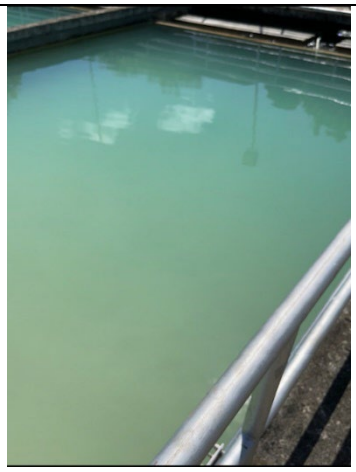
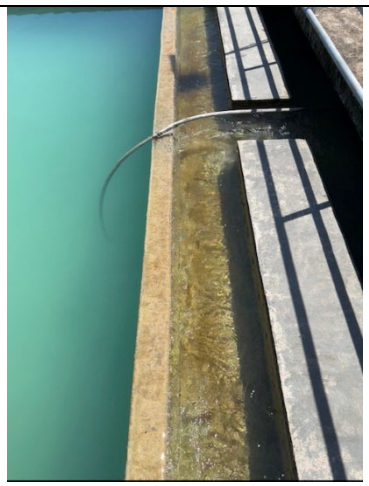
Figure 2-3-1 Production Transition (Past 5 years)

2-3-2 Water Treatment Status of the Dimapatoy Water Treatment Plant

The water treatment status of the Dimapatoy WTP is shown below. The Dimapatoy WTP does not use agitators for flocculants, and the quality of water in the sedimentation pond is undesirable (although visual). Fortunately, the filtration site is functioning, so there is no problem with the water treatment quality, but proper pH adjustment and jar testing make appropriate floc mixing, formulation and sedimentation, rendering operation and maintenance costs lower. (See below in the proposal of soft components)

- When the rapid agitator of the chemical mixing pond is operated, the turbidity increases, so it is not operated.
- In the admixture pond, white sediment, which seems to be a flocculant, was observed to be unevenly settled.
- The normal sedimentation pond is cloudy in the longitudinal direction, and no change in color due to the sedimentation effect is felt. Only the supernatant water overflow port had relatively clear water overflowing.
- The filtration pond is equipped with a pressure type filtration tank procured by performance order. Pressure filtration tanks are products of each manufacturer in the Philippines, and the structure differs depending on the manufacturer. It is said that a multi-filtration system consisting of an anthracite layer, a sand layer and a gravel layer is common.

Photo 2-3-1 shows water treatment status.

	
Mixing Basin：PAC is unevenly distributed	Sedimentation Pond：Color only changed around overflow mouth
	
Supernatant water at over flow mouth: Relatively transparent	Filtration Tank Unit

Source : JICA Survey Team

Photo 2-3-1 Water Treatment Status at Dimapatoy WTP

2-3-3 Water Quality

2-3-3-1 Water Quality Standard

In the General Guidelines of the Philippine National Standards for Drinking Water of 2017 (PNSDW) [Annex] of the Department of Health (DOH), the following triple-pronged framework is required to ensure a safe water supply:

A. Health-based targets established by the health authority
B. Safely managed water systems (application of water safety plan)
C. A system of independent surveillance

The Standards for Drinking-water Quality (VI. Specific Guidelines) to achieve the above framework are as follows:

A. Drinking-water must be clear and does not have objectionable taste, odor and color. It must be pleasant to drink and free from all harmful organisms, chemical substances and radionuclides in amounts which could constitute a hazard to the health of the consumer.
B. The quality of drinking-water shall be measured in terms of its microbiological, physical, chemical

and radiological constituents. Refer to Annex A for the Standard Values and Methods of Analysis.

C. The parameters of drinking-water quality shall be classified as mandatory, primary and secondary. Refer to Annex B.

2-3-3-2 Water Quality Test Result for Existing Facilities

The results of the biological and physicochemical tests conducted by the MCWD at the water treatment facilities (Macaguiling PS, Rebuken PS, Dimapatoy WTP, and Tanuel PS) are shown in the table below.

- Form I: Biological Test Results: June 2022 and July 2022
- Form II: Physicochemical Test Results: April 2021, Reinspection August 2021

Table 2-3-1 Results of Water Quality Test

Table B-1. Mandatory Drinking-Water Quality Parameters												
No.	Item	Standard value	Macaguiling PS		Rebuken PS		Dimapatoy WTP			Tanuel PS		
			source	customer's tap	source	customer's tap	source	WTP outlet	customer's tap	source	WTP outlet	customer's tap
■Form I : MICROBIOROGICAL TEST RESULTS												
Test Date		2022/6/15										
1	Total Coliform&Thermotolerant/E. Coli	*depend on method	-	passed	-	passed	-	-	passed	-	-	passed
	HPC	*depend on method	-	passed	-	passed	-	-	passed	-	-	passed
Test Date		2022/7/26										
1	Total Coliform&Thermotolerant/E. Coli	*depend on method	-	passed	-	passed	-	-	passed	-	-	passed
	HPC	*depend on method	-	passed	-	passed	-	-	passed	-	-	passed
■Form II : Physical and Chemical Test Results												
Test Date		2021/4/27										
2	Arsenic (As)	0.01 mg/L	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
3	Cadmium (Cd)	0.003 mg/L	0.0003	0.003	0.0003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
4	Lead (Pb)	0.01 mg/L	0.37*	0.44*	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5	Nitrate (N03-)	50.00 mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6	Color (Apparent)	10 CU	5	5	5	5	5	5	5	5	5	5
7	Turbidity	5 NTU	0.49	0.49	0.51	0.8	1.52	0.98	1.08	0.45	0.5	0.62
8	pH	6.5 - 8.5	8.35	8.35	8.41	8.46	8.38	8.36	8.41	7.95	7.94	7.97
9	Total Dissolved Solids	600 mg/L	371	371	505	447	172	185	200	311	340	273
10	Disinfectant Residual	0.3 mg/L to 1.5 mg/L	1.32	0.67	1.5	1.5	untreated	1.5	0.6	untreated	1.5	1.5
*Retest Date		2021/8/18										
4	Lead (Pb)	0.01 mg/L	0.01	0.01								

Source : MCWD

Based on the above inspection results, we will consider as follows.

- Lead amount exceeded the standard in the April 2021 physicochemical test results and was retested and passed by another testing laboratory in August 2021. The samples that exceeded the standard were from a deep well at the Macaguiling pumping station and its faucet. This is the only time the lead standard has been exceeded in the past, and there have been no problems since then.
- Turbidity may be higher in treated water or faucet water than in raw water. This may be due to the blending and delivery of water from various sources.
- pH indicates a high value of 8 or more, although it is within the standard value, and needs to be monitored.
- Residual chlorine is within the standard value, it tends to be relatively high and needs to be monitored.

2-3-3-3 Onsite Water Quality Tests by JICA Survey Team

The JICA survey team conducted weekly measurements of turbidity and pH using portable meters from October to December 2022 to understand the water quality of Mindanao and Tamontaka Rivers, and the results are shown in Table 2-3-2.

Table 2-3-2 Turbidity and pH of Rio Grande Mindanao River and Tamontaka River

No.	Date	Name	Rio Grande Mindanao River			Tamontaka River			Remarks
			Turbidity (NTU)		pH	Turbidity (NTU)		pH	
			Max	Min		Max	Min		
1	2022/10/26	CTII	104	86	7.38	167	62.7	7.46	
	2022/10/26	MCWD	-	-	-	155	-	-	
2	2022/11/7	CTII	50.1	5.3	7.87	66.8	1.1	8.32	
3	2022/11/14	CTII	57.2	41.4	8.24	57.5	42.5	8.17	Taken at about 10:30-11:00 AM; Sunny weather; there are many water hyacinth blocking the flow of water especially at Tamontaka River.
4	2022/11/21	CTII	77.6	59	8.02	193	61	7.97	Taken at about 2:30-3:00 PM; Sunny weather; there are many water hyacinth blocking the flow of water especially at Tamontaka River.
5	2022/11/28	CTII	105	92	7.8	126	60.3	7.87	Taken at about 2:34-3:10 PM; Sunny weather; there few water hyacinth both in Rio Grande and Tamontaka River. It rain heavily on the night of Nov. 25, 2022.
6	2022/12/5	CTII	69.3	48.5	7.56	58.6	38.9	7.54	Taken at about 2:43-3:15 PM; Sunny weather; there few water hyacinth both in Rio Grande and Tamontaka River.
7	2022/12/12	CTII	124	86	7.74	136	50.4	7.71	Taken at about 10:45-11:05 AM. Weather is sunny. Short moderate rains occurred in Cotabato City in the evening of Saturday and Sunday (December 10 and 11)

Source : JICA Survey Team

The water quality of the Tamontaka River is apparently yellowish in color and is always turbid, regardless of the weather conditions. The turbidity was around 100 degrees on sunny days, and increased to around 200 degrees after rainfall. On the other hand, the turbidity after settlement decreased to 40~60 degrees and became clear, which indicates that it is effective to remove the soil and sand elements in a primary sedimentation tank.

Sampling

Measurement for turbidity

Source：JICA survey team

Photo 2-3-2 Onsite Water quality test

2-3-4 Operation and Maintenance Cost Information

2-3-4-1 Electricity Usage Volume and Cost

Table 2-3-3 shows facility electricity usage volume and cost.

Table 2-3-3 Facility Electricity Usage Volume and Cost (annual performance in 2022)

	Dimapatoy	Tanuel	Rebuken	Macguiling1
Electricity Usage Volume (kWh)	2,729,708	1,953,912	189,978	315,132
Cost (PHP)	22,456,029	14,431,325	1,615,174	4,096,833

Source: Compiled by survey team based on data from MCWD

2-3-4-2 Chemical Usage

Table 2-3-4 shows facility chemical usage volume and cost. Both gas and solid chlorine are used for chlorine disinfection.

Table 2-3-4 Facility Chemicals Usage Volume and Cost (annual performance in 2022)

	Dimapatoy	Tanuel	Rebuken	Macguiling 1
Chemical Usage Volume (number of bags(50kg.ea))	254	3	40	37
Cost of Chlorine (PHP)	1,651,000	19,500	260,000	240,500
Chemical Usage Volume (number of tanks)	11	57	1	6
Cost of Gas Chlorine (PHP)	77,000	580,384	7,000	42,000
Chemical Usage Volume (number of bags (25kg.ea))	2,789	N/A	N/A	N/A
Cost of Aluminum (PHP)	2,449,144			

Source: Compiled by survey team based on data from MCWD

Calcium Hypochlorite Stocks

Gas Chlorine Stocks

Photo 2-3-3 Chemical Stocks

2-3-4-3 Operational Cost (including labor cost)

Table 2-3-5 shows other operational cost.

Table 2-3-5 Facility Other Operational Cost (annual performance in 2022)

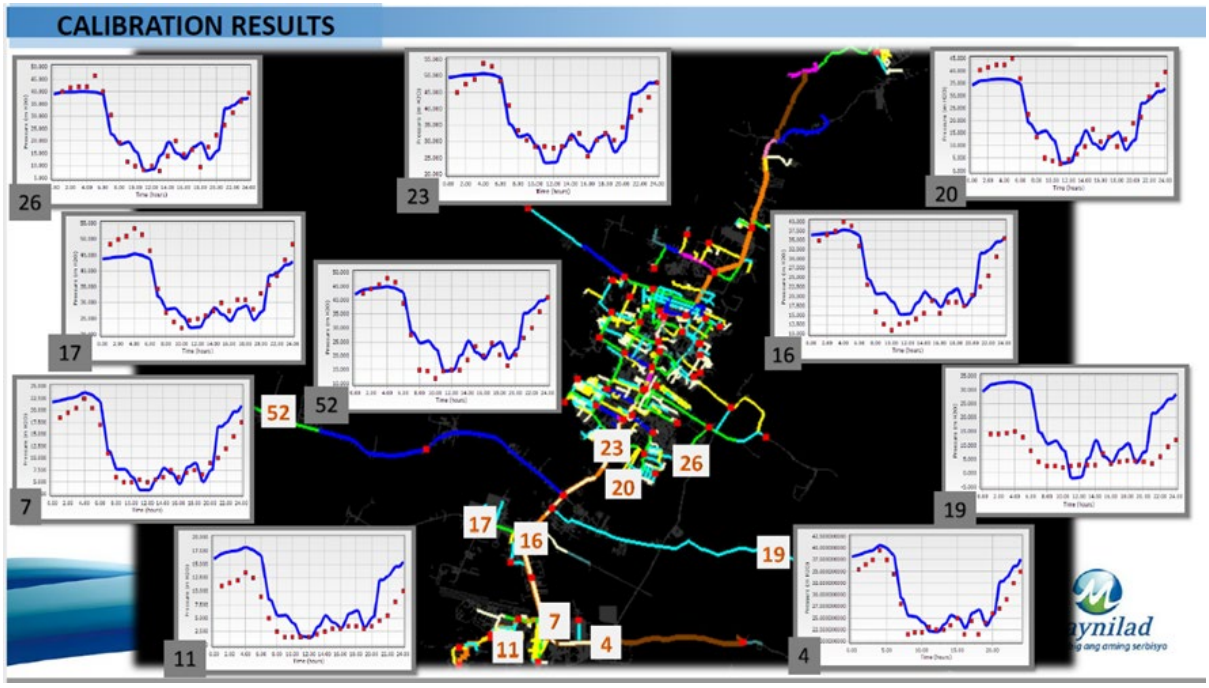
	Dimapatoy	Tanuel	Rebuken	Macguiling1
Other Operation Cost (incl. labor) PHP	783,754	745,707	60,844	123,323

Source: Compiled by survey team based on data from MCWD

2-4 Existing Status of Distribution Facilities

2-4-1 Water Supply Management

Figure 2-4-1 shows the water pressure transition in 24 hours collected by the Maynilad. The lowest pressure was recorded around 11 AM for almost all the locations. The JICA survey team visited there almost simultaneously at Camp Siongco Reservoir, where the upstream pipe water just flew downstream without working as the reservoir. Moreover, 25 telecommunication-able data logger is planned to buy; however, it has yet to be procured.

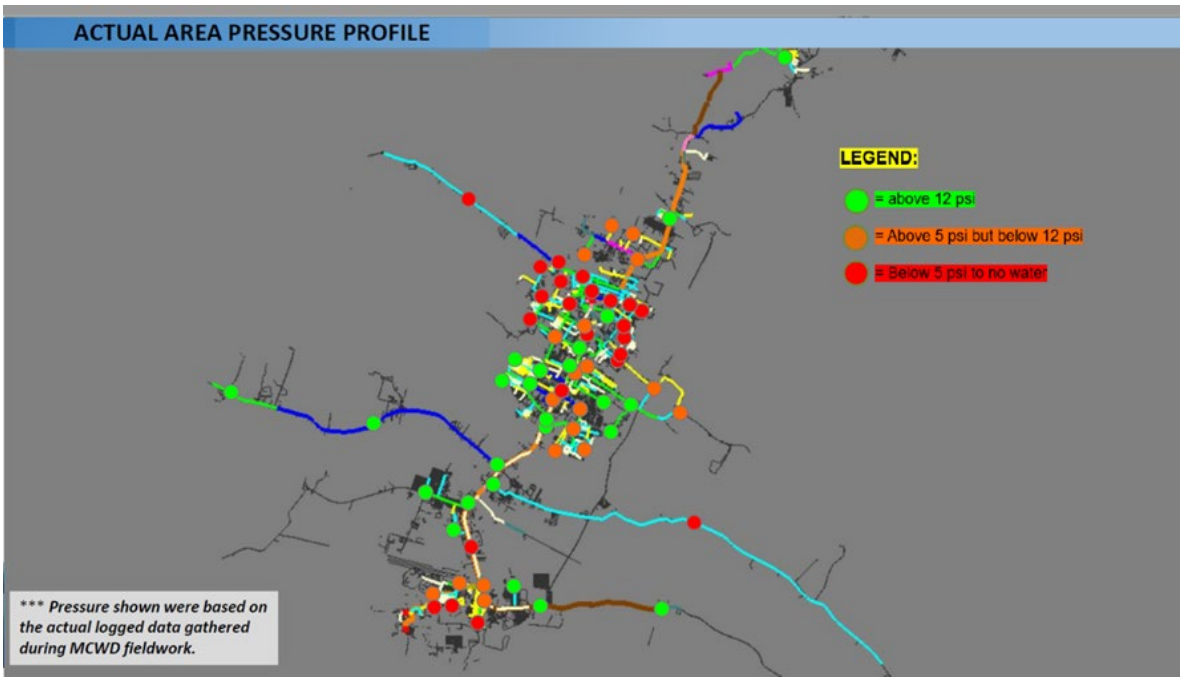


Source：Maynilad Water Service Inc.

Figure 2-4-1 Water Pressure Transition Survey by Maynilad (red dots are observed data)

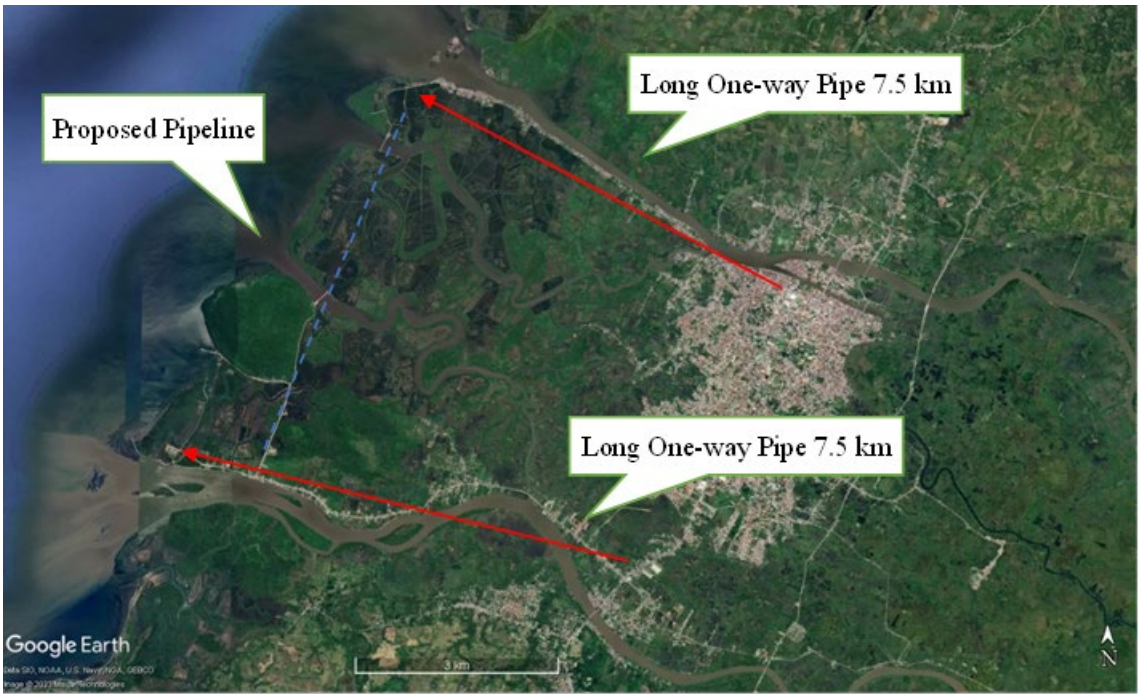
Figure 2-4-2 shows the average water pressure at the observation locations. Less than five psi pressure was recorded in the northern portion of the city around the downtown and the reservoir in DOS., and the minimum pressure was expected to be less. The JICA Survey Team also experienced a water outage in the morning. The MCWD currently relies over 70% of production on two resources in DOS, Dimapatoy WTP and Tanuel PS, following that the water pressure in the southern city is expected to keep a certain level even in the peak hours. On the other hand, three sources in SK., Mactan Rock Bulk Water Supply, Macaguiling PS and Rebuken PS, supply relatively less than other resources; consequently, the water supply to the northern city is not kept up. Moreover, low pressure was observed around the endpoint of one-way pipes. To improve the pressure, developing new resources enlarging

water pipes and looping the network are effective. Currently, a looping plan exists along the west diversion road under construction.



Source ：Maynilad Water Service Inc.

Figure 2-4-2 Average Water Pressure Distribution by Maynilad



Source：JICA Survey Team

Figure 2-4-3 Looping Plan

The biggest issue in water distribution management in the MCWD is the fact that despite the although there are many distribution facilities, they are not divided into blocks, due to the . This is because of the unstable water supply. When the new facility is built and stabilizes the water supply, the formulation of

water distribution blocks and DMAs is enabled, resulting in an improved leakage rate. However, for the formulation of the blocks and DMAs, new valves and flow meters are required with much of the budget.

2-4-2 NRW

NRW is calculated based on the difference and ratio between the total annual water distribution volume and total annual revenue water volume. Table 2-4-1 shows the trend of NRW in recent years. It can be seen that the increment in production in 2018 is because of the operation commencing of the Mactan Rock Bulk Water Supply. While the production and the revenue volume increased, NRW has kept about 25%, and the MCWD is struggling to reduce NRW. As LWUA is asking NRW ratio of 20%, reducing this level is an urgent issue on the MCWD.

Table 2-4-1 Transition of Non-Revenue Water Ratio in MCWD

Items	Unit	2015	2016	2017	2018	2019	2020	2021
Total annual water distribution volume	m^3/year	11,134,470	11,697,112	12,489,178	14,707,193	14,767,572	15,017,404	15,488,093
Total annual revenue water volume	m^3/year	8,187,582	8,715,176	9,212,723	10,386,756	10,756,699	11,373,727	11,564,677
Total annual non-revenue water volume	m^3/year	2,946,888	2,981,936	3,276,455	4,320,437	4,010,873	3,643,677	3,923,416
NRW Ratio	%	26.5	25.5	26.2	29.4	27.2	24.3	25.3

Source: Compiled by survey team based on data from MCWD

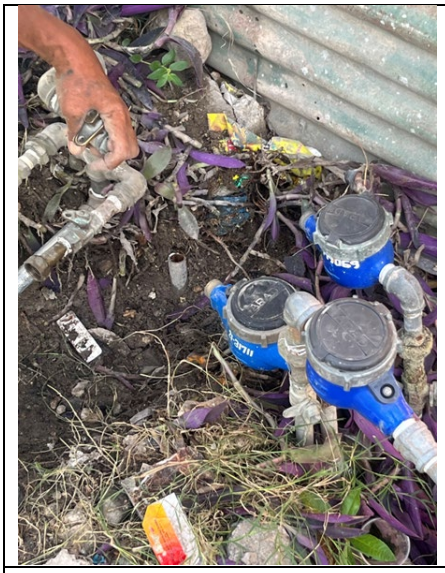
Generally, for the water supplier having a high NRW ratio, the cause of NRW would be water leakage, stealing and meters malfunction. As per the MCWD, stealing is not common in Cotabato City. On the other hand, it can be seen along the pipeline from Tanuel PS in DOS, and the number of stealing is minimal. As the ADB project will replace this pipeline, it is expected that stealing would be eliminated in the near future. In addition, the MCWD conducts meter replacement frequently at 5-year intervals; it cannot be the cause of high NRW. However, the MCWD has lots of issues with water leakage.

2-4-3 Water Leakage

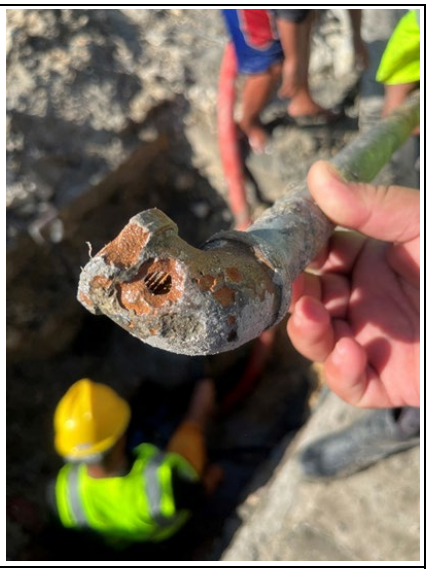
The largest cause of leakage in the MCWD is from aged saddles. Regarding this, the MCWD renews aged pipes making the aged saddles reduced. Simultaneously, they adopted the stab-out method seen in many in the Philippines to reduce the number of connections that could cause leakage. The stab-out method means that one saddle supplies several residences (meters). While in other cities in the Philippines, they align meters parallel, the MCWD installs meters in a multi-layers system to reduce space.

Leakage from these saddles is expected to be influenced by high pressure at night. In terms of the elevation in Cotabato city, it decreases from the peak of Sinsuat Avenue to the east and west, passing the city from north to south. However, these areas experience high pressure at night since no water pressure adjustment is conducted. Some areas recorded 80psi as per the MCWD. The MCWD plans to install pressure reduce valves around the area, but they have not been installed due to budget issues.

In addition, corrosion on Galvanized Iron pipes (GI) occurs around the west low-elevation area in the city due to salt water. GI pipe is used for the uprising part of connections. Such corrosion can result in soil contamination; it is recommended that anti-corrosion pipes such as polyethylene pipes should be used until it exposes to the ground.



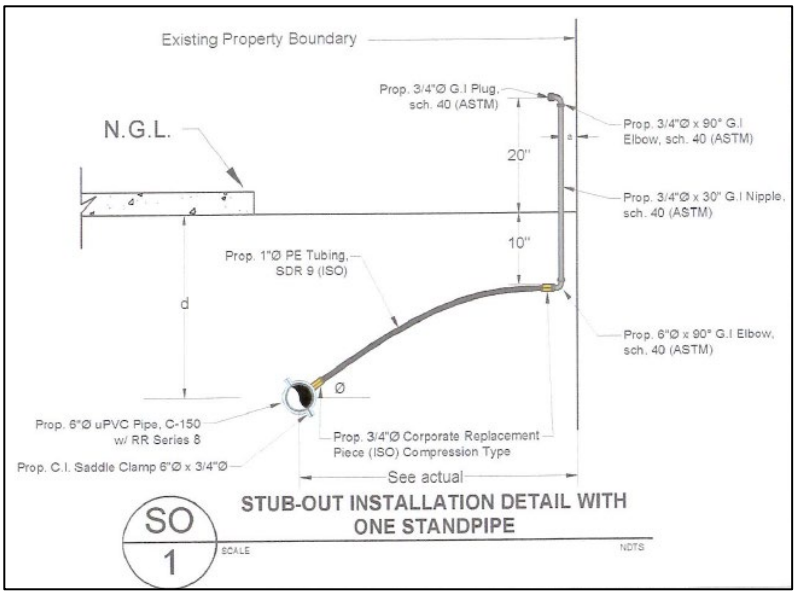
Stab-out Method



Corroded GI Pipe

Source：JICA Survey Team

Photo 2-4-1 Leakage Repair



Source：MCWD

Figure 2-4-4 Standard Drawing from Saddle to the Ground

Regarding leakage detection, only daily road patrol by the MCWD is conducted without investigating leakage in the ground. Once a puddle potentially attributable to leakage is found, a test pit is dug, referring to the GIS system. It is sometimes just a puddle owing to rain since the city belongs to a tropical rainforest climate zone. As stated afterward, since over 0.3mg/l of residual chlorine in the network is detected, this cannot be detected by rain. An assessment if it is leakage or rainwater through

residual chlorine is required to reduce vain test pits. The residual chlorine may reduce on the way to the ground from the leakage point and not be a rough indication of the judgment is stated in Table 2-4-2. Nonetheless, NRW keeps around 25%, which is considered to be because of the well-trained construction technics and the stab-out method.

Table 2-4-2 Rough Indication for Judgement

	Residual Chlorine	pH
Rain	N/A	5.0 approx. (Davao City)[1]
Leakage	Detected	8.0 approx. (MCWD Water Quality Test)[2]

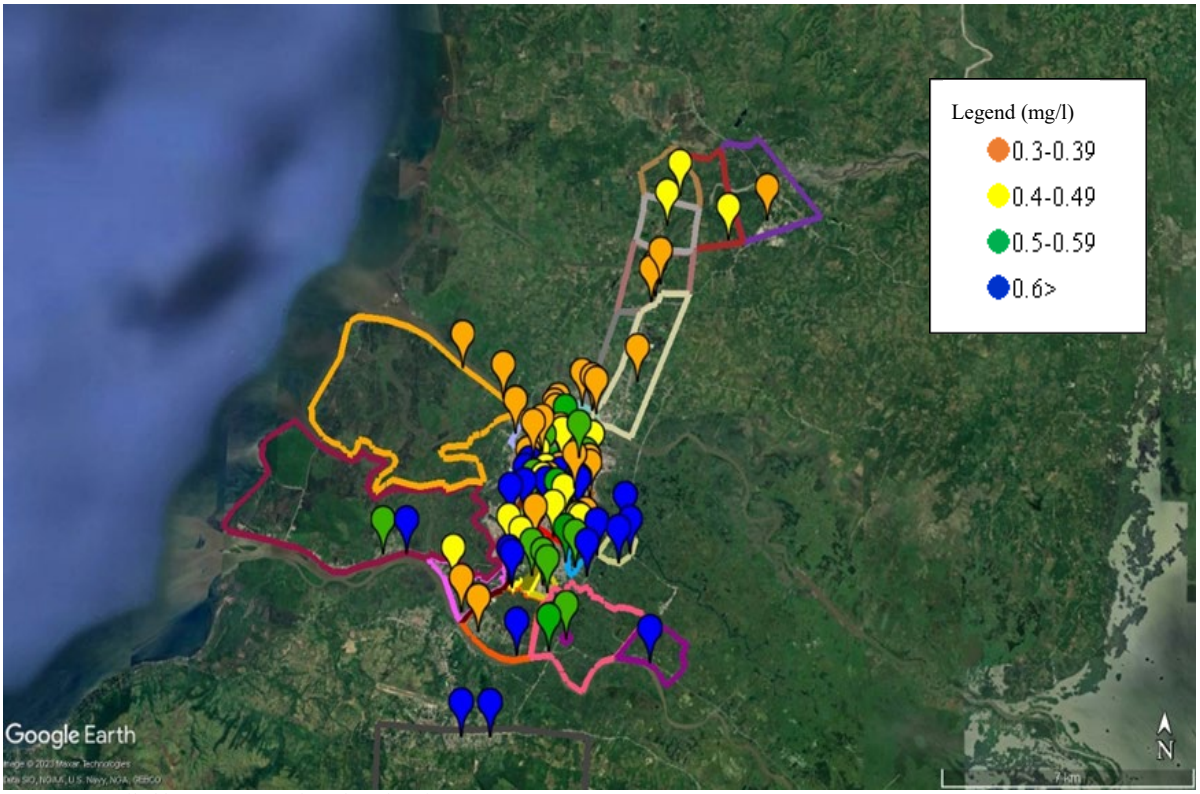
Source：1;Limjuco, et al (2014) The Quality and Effect on Plant Growth of Tap Water and Rainwater in Davao City, UIC Research Journal 2014.20(2) 69-83, 2; MCWD

Leakage is repaired by the MCWD personnel themselves, which is swift; for example, leakage found in the morning is temporarily stopped in the morning and fixed in the afternoon. Leakage found in the afternoon is temporarily stopped and fixed in the morning the next day. Wooden or metal plugs are used as a leakage stopper. When leakage in main conduits, valves are manipulated by a valve-man. Demolishing pavement struggles to repair the leakage since almost all the roads are paved over concrete within the MCWD area, and it is more than eight inches thick, although steel rods are used only at the joints. If the target pipe is shallowly embedded, it is exposed by hand; otherwise, if it is deep, a backhoe is used. As this backhoe is used for general pipe laying, more water leakage repair affects other project timelines. The leakage repair team consists of below:

- ✓ Engineer-1 Permanent
- ✓ Foreman-1 Permanent
- ✓ Plumber-2 Casual

2-4-4 Residual Chlorine

The residual chlorine is needed to keep more than 0.3mg/l following the LWUA standard. The below figure shows the observed residual chlorine for June 2022. Although the more reliability is needed as the observation was conducted on a different day, it met the standard. Regarding the residual chlorine testing, the gap among observation points should be minimal, measuring systems and method manuals are needed to create. The Japanese standard for residual chlorine is more than 0.1mg/l, so the value for the residual chlorine is not the issue so far. It can be mentioned that the recorded value is less around the northwest of the city, where the population is large.

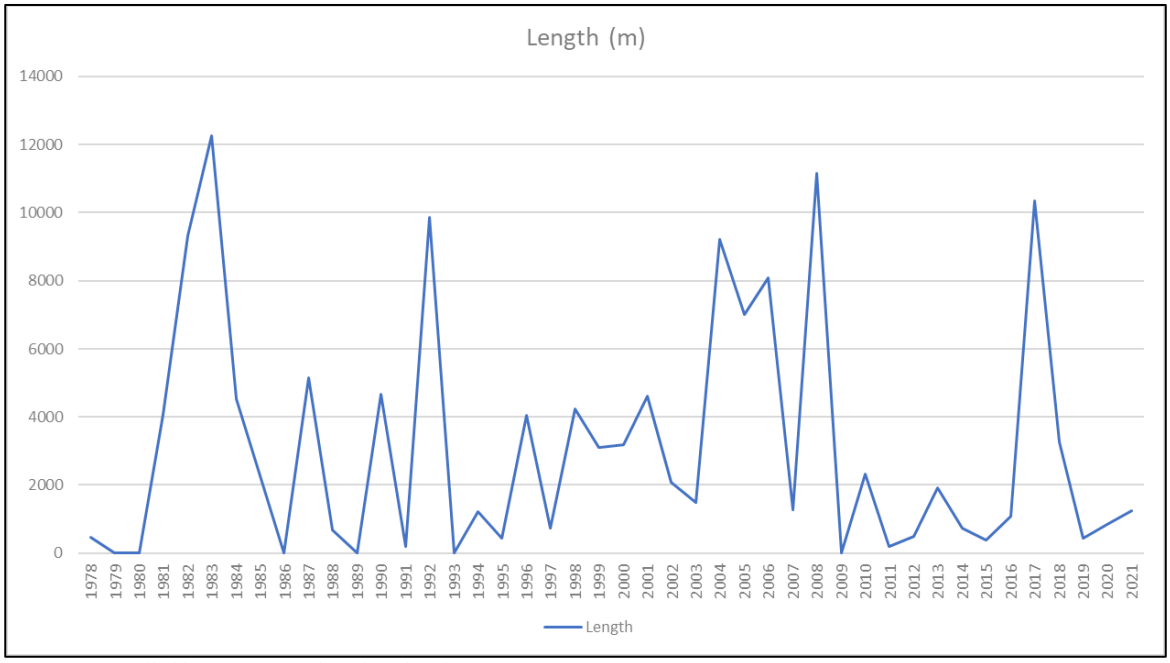


Source: Compiled by survey team based on data from MCWD

Figure 2-4-5 Residual Chlorine Distribution

2-4-5 Aged Pipe Renewal

The MCWD has installed new pipes since its foundation in 1976. Basically, steel pipes are used for the pipe more than 10 inches, and uPVC for less than 6 inches. Eight-inch pipes are used for both steel and uPVC. For pipes, less than four inches, HDPE and GI pipes have been applied in recent years. Figure 2-4-6 shows the total installation length in every year. It experiences peaks in both the early 1980s and late 2000s. Those installed in the early ages has already been passed over 40 years, which should be replaced gradually. Currently, the MCWD has to expand its supply area, mid and long-term pipe renewal plans must be prepared to renew aged pipes and install new pipes simultaneously.



Source: Compiled by survey team based on data from MCWD

Figure 2-4-6 Installed Length by Year

2-4-6 Issues with Current Reservoirs

The Camp Siongco Reservoir is not painted compared to the other two reservoirs, resulting in degradation. Earthquake-resistance diagnosis, operation and maintenance, and renewal plans are needed to be formulated.

Source：JICA Survey Team

Photo 2-4-2 Degraded Condition of Concrete Structure

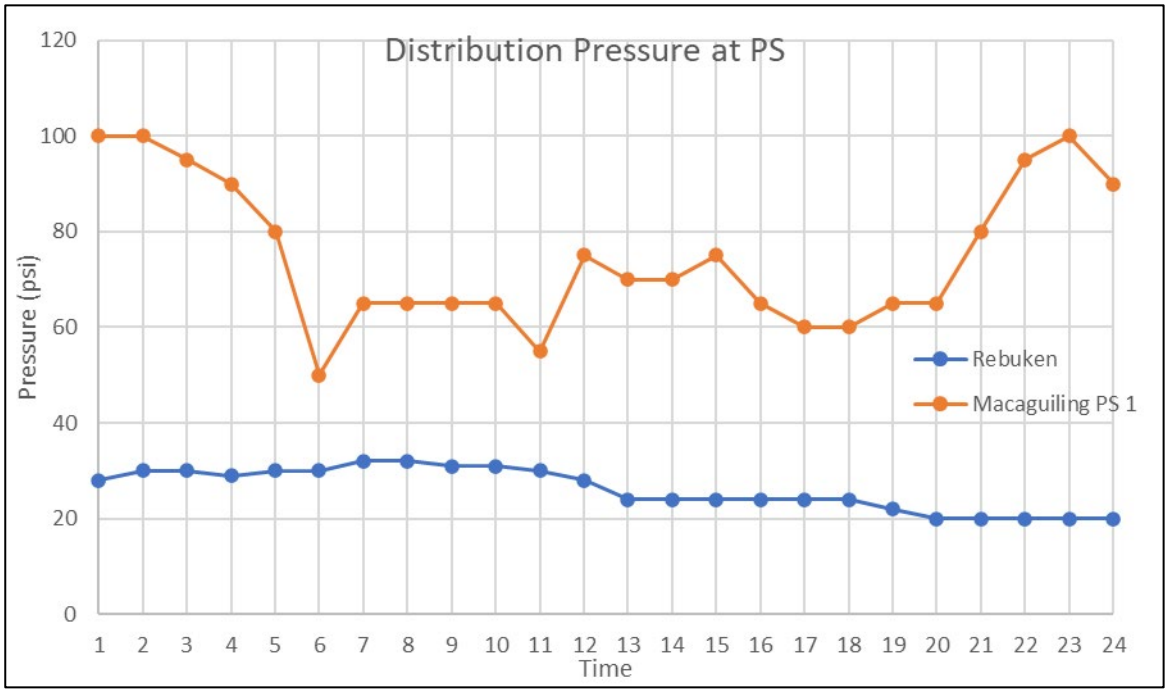
There is a new reservoir construction plan near the Dimapatoy WTP, yet it has not been started due to financial issues. Its purposes is to supply water to the new development area in DOS, which the MCWD considers the priority.

Source：JICA Survey Team

Figure 2-4-7 New Development Area

2-4-7 Issues with Distribution Pumps

Figure 2-4-8 shows the transition of pump pressure of the two welled resources in SK. The water pressure at Macaguiling PS shows fluctuation. Excess pressure occurred at night while using excess electricity. Both pipelines from the two resources are mixed downstream.



Source : Compiled by survey team based on data from MCWD

Figure 2-4-8 Water Pressure Transition at Rebuken, Macaguiling PS 1 (no relations each other not as the same day observation)

2-5 Existing Water Supply

2-5-1 New Connections

Presently, the MCWD conducts installation of new connections. They owe the installation up to an elbow and one GI pipe after the meter. Applicants owe after this. (3000PHP). One day minimum wage for BARMM is 306-341 PHP. (Source: https://nwpc.dole.gov.ph/). Furthermore, the poverty rate in Cotabato city, about 30%, is relatively higher than in other cities in the Philippines. Providing certain equipment is preferable to encourage connections for those in poverty. Moreover, those far from the saddle need to pay more since the MCWD only installs one saddle for several residences.

According to the standard, the saddles should be drilled at a 45-degree angle not to intake air; however, it could have been managed better. The horizontally drilled saddle may easily intake rust, resulting in a meter stack.

Source：JICA Survey Team

Photo 2-5-1 Horizontally Drilled Saddle

2-5-2 Water Meter

ARAD(Israel) meters have been used since 2018. Following the LWUA standard, those are replaced five years intervals. Once found malfunctions, personnel from the meter shop section is able to fix it.

2-5-3 Special Consideration for Low-income Household

Even though the discount measurement for seniors is in service, it is not for low-income households. Based on the premise that such households do not use plenty of water, the MCWD makes the tariff up to 10m^3 low.

2-5-4 Water Tank Trucks

Only one truck procured in 2016 is under operation. Water is injected by high-pressure fire hydrants. They regularly visit and sell water to Independent Decommissioning Body (IDB) every Wednesday and Friday and to Joint Peace and Security Committee (JPST) every Monday and Friday. These authorities are located outside of the supply network of MCWD; this activity is imperative to manage the peace.

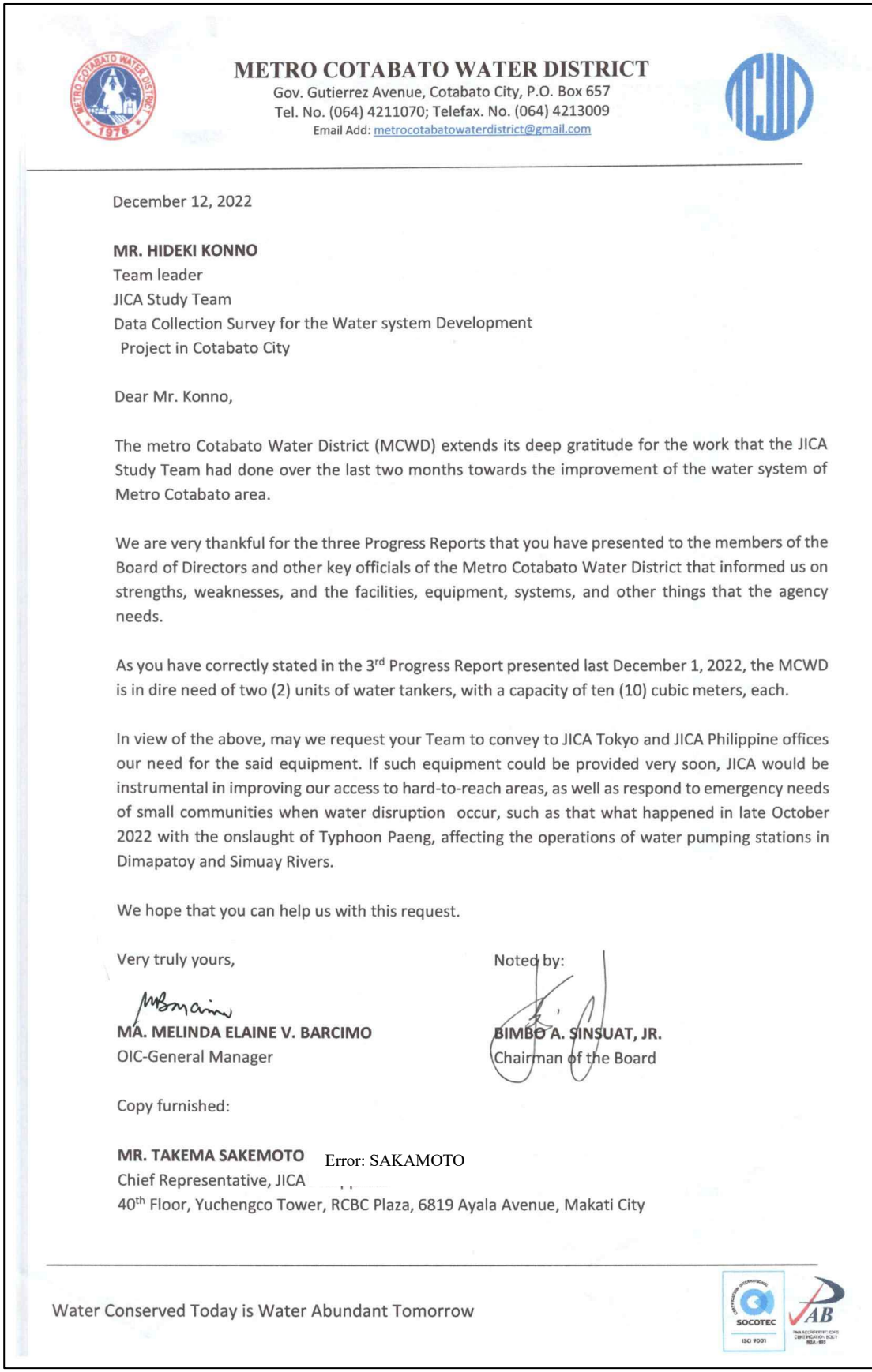
Meantime, they cannot reply to requests under low pressure from residents, and acquiring extra trucks is an urgent issue. Because of such situation, they can only visit two or three locations even though they can reply to requests.

Source：JICA Survey Team

Photo 2-5-2 Water Tank Truck in MCWD Yard

Besides, water tank trucks by the Red Cross (Red Crescent), Ministry of Social Service and Development (MSSD), and Chinese Volunteer Fire Brigade, and the Bureau of Fire Protection are relied on by the MCWD to help transport when there is water outage. At least plenty of trucks that supports essential facilities such as hospitals and government offices in the event of disasters are required.

Following that, the MCWD issued a request letter on the water tank trucks. The letter's background asks for 10t class (minimum 5t class) water tank trucks that supply water efficiency to large water consumers such as peacekeeping authorities. However, this should be accomplished through other types of aid, considering the time frame of implementing the water supply project and the completion of WTP by the MCWD.



METRO COTABATO WATER DISTRICT
Gov. Gutierrez Avenue, Cotabato City, P.O. Box 657
Tel. No. (064) 4211070; Telefax. No. (064) 4213009
Email Add: metrocotabatowaterdistrict@gmail.com

December 12, 2022

MR. HIDEKI KONNO
Team leader
JICA Study Team
Data Collection Survey for the Water system Development
Project in Cotabato City

Dear Mr. Konno,

The metro Cotabato Water District (MCWD) extends its deep gratitude for the work that the JICA Study Team had done over the last two months towards the improvement of the water system of Metro Cotabato area.

We are very thankful for the three Progress Reports that you have presented to the members of the Board of Directors and other key officials of the Metro Cotabato Water District that informed us on strengths, weaknesses, and the facilities, equipment, systems, and other things that the agency needs.

As you have correctly stated in the 3rd Progress Report presented last December 1, 2022, the MCWD is in dire need of two (2) units of water tankers, with a capacity of ten (10) cubic meters, each.

In view of the above, may we request your Team to convey to JICA Tokyo and JICA Philippine offices our need for the said equipment. If such equipment could be provided very soon, JICA would be instrumental in improving our access to hard-to-reach areas, as well as respond to emergency needs of small communities when water disruption occur, such as that what happened in late October 2022 with the onslaught of Typhoon Paeng, affecting the operations of water pumping stations in Dimapatoy and Simuay Rivers.

We hope that you can help us with this request.

Very truly yours,

MA. MELINDA ELAINE V. BARCIMO
OIC-General Manager

Noted by:

BIMBO A. SINSUAT, JR.
Chairman of the Board

Copy furnished:

MR. TAKEMA SAKEMOTO Error: SAKAMOTO
Chief Representative, JICA
40th Floor, Yuchengco Tower, RCBC Plaza, 6819 Ayala Avenue, Makati City

Water Conserved Today is Water Abundant Tomorrow

Source: MCWD

Figure 2-5-1 Water Tank Truck Request Letter

2-5-5 Equipment

The MCWD has a stockyard adjacent to the main building, where lots of materials are neatly stored. In addition, a new stock warehouse is planned to be installed in the different location where the water tank truck is parked.

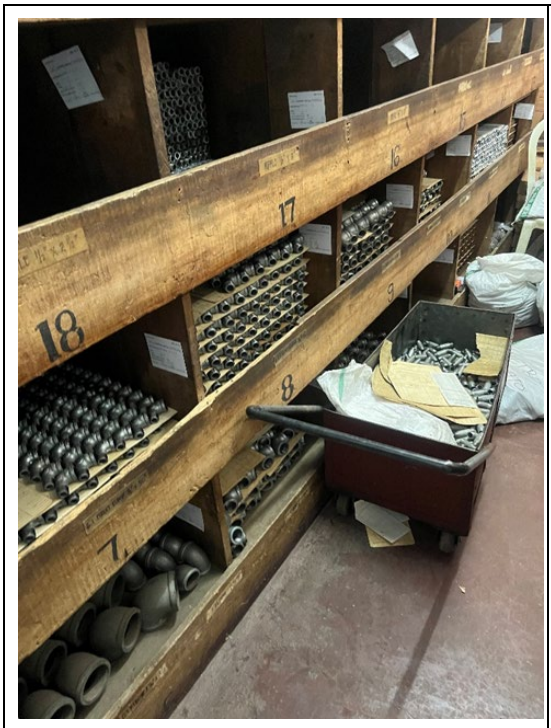


Photo 2-5-3 Stock Yard

Photo 2-5-4 Stock Warehouse Location in Suburb

Source ：JICA Survey Team

The below letter shows the shortage equipment lists, including the water tank truck with urgent levels.

Table 2-5-1 Shortage Equipment List

METRO COTABATO WATER DISTRICT
Gov. Gutierrez Ave. RH 7, Cotabato City

	Name of Equipment	Quantity	Estimated Unit Price	Priority
1	Water Tanker (10 Cu.M.)	2	10,500,000.00	H
2	Wheel Type Mini-Excavator (with Breaker and Dozer)	1	6,000,000.00	H
3	Telescopic Boom Truck	2	2,500,000.00	H
4	Mini-Dump Truck	2	1,900,000.00	L
5	Ground Mic (Leak Detection)	2	300,000.00	M
6	Concrete Mixer (1-Bagger)	1	45,000.00	L
7	Concrete Mixer (2-Bagger)	1	65,000.00	L
8	Data Logger	20	175,000.00	H
9	Ultrasonic Flowmeter (Clamp-on)	1	1,700,000.00	M
10	Concrete Cutter (18" Blade)	2	50,000.00	L
11	Portable/Hand Dredger	2	1,200,000.00	H
12	Truck Mounted Crane (Small)	1	2,000,000.00	H

Prepared by:

DOREBIEN L. SOLANO
Property Officer B

Noted by:

JOSELITO D. NUÑEZ, JR.
OIC DM-Admin Services

WINSTON L. SAPAL
OIC DM- PEM

RANDY MOSES P. LIMBA
OIC DvM- PAMD

Source: MCWD

Chapter 3. Population Status and Water Demand in Cotabato and Surrounding Areas

3-1 Review of Water Demand Projections for Past Projects

3-1-1 Feasibility Study by USAID

3-1-1-1 Basic Data

Population data within the USAID FS report is shown in Table 3-1-1. In USAID's demand projection to 2050, the annual population growth rate is projected as 1.52% for SK, 1.53% for DOS and 1.36% for Cotabato City. The non-revenue water ratio shows a decreasing trend year by year, as shown in Table 3-1-2.

Table 3-1-1 Population Data from USAID Analysis

City/Municipality	Population (persons)			population projection	Area (ha)	Rate of Increase (2000-2010)
	2007	2010	2014	2050		
Sultan Kudarat		82,758	90,063	155,770	71,291	0.47%（2000-2010） 1.52%, Up to 2050
Datu Odin Sinsuat		76,332	83,076	143,948	46,180	0.65%（2000-2010） 1.53%, Up to 2050
Cotabato City	259,153	271,786	293,697	477,748	17,600	1.86%（2015） 1.36%, Up to 2050
Total		430,876	466,836	777,466		

Source : Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-2 Total Production and Non-Revenue Water Ratio

Items	2011	2012	2013	2014
Total Production (m^3)	9,509,384	9,869,214	10,200,944	8,074,612 Jan. to Sept.
NRW (%)	29.46	28.50	27.73	26.86

Source : Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Other basic information is as follows.

- In Cotabato City, 30 out of 37 barangays are classified as urban area.
- In SK, 8 out of 39 barangays are classified as urban area.
- Of the 34 barangays in DOS, only Dalikan Poblacion is classified as an urban area.
- MCWD supplies water to 34 barangays in Cotabato City, 7 barangays in DOS and 10 barangays in SK at the time of the survey.
- As of 2014, the MCWD had 28,118 connections, comprising 26,262 household connections, 334 government connections, 828 commercial[2] connections, 2 industrial connections, 527 semi-commercial A connections and 165 semi-commercial B connections.

3-1-1-2 Population Projections

The USAID study conducted population projections to 2050 and, as mentioned above, projected population growth rates of 1.52% for SK, 1.53% for DOS and 1.36% for Cotabato City. The 2014 willingness to connect survey sets the percentage of connected households. 89% of households are

[2] "commercial" refers to facilities that directly use water such as restaurants and hotels. "Semi-commercial A" refers to customers who use water indirectly such as office, groceries, barbers and pharmacies, and medical authorities. "Semi-commercial B" refers to small-scale businesses.

willing to be connected and 11% of households are not willing to be connected. The population served is therefore set as 89% of the population in the water supply area.

Table 3-1-3 Population Projections in City and Municipalities

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	83,076	84,762	109,630	124,919	143,948
Datu Odin Sinsuat	90,063	91,885	118,784	135,273	155,770
Cotabato City	293,697	299,174	382,144	430,908	477,748
Total	466,836	475,821	610,558	691,100	777,466

Source : Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-4 Population in the Water Supply Area

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	14,361	14,878	53,002	58,172	63,343
Datu Odin Sinsuat	18,511	19,364	37,534	46,080	54,626
Cotabato City	122,903	127,438	195,465	240,816	286,167
Total	155,775	161,680	286,000	345,068	404,136

Source : Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-5 Water Supply Population (Domestic Use)

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	12,986	13,453	47,925	52,600	57,275
Datu Odin Sinsuat	15,128	15,827	30,677	37,662	44,647
Cotabato City	111,491	111,605	177,315	218,455	259,595
Total	139,604	144,884	255,916	308,716	361,516

Note: 89% of the population within the water supply area is set as the population served (based on the results of the willingness-to-connect survey).
Source : Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

3-1-1-3 Projected Number of Connections

For households, the number of connections is calculated at 5.5 persons per connection. The number of commercial and industrial connections is assumed to increase by 0.3 connections for every 100 additional persons in the water supply area. The number of government connections is assumed to increase by 1 connection for every 2 000 additional people in the water supply area.

Table 3-1-6 Number of Domestic Water Connections

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	2,361	2,446	8,714	9,564	10,414
Datu Odin Sinsuat	2,751	2,878	5,578	6,848	8,118
Cotabato City	20,271	21,019	32,239	39,719	47,199
Total	25,383	26,434	46,530	56,130	65,730

Note: Number of connections at 5.5 persons/household
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-7 Number of Commercial/Industrial Water Connections

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	57	59	173	188	204
Datu Odin Sinsuat	83	86	140	166	191
Cotabato City	1,384	1,398	1,602	1,738	1,874
Total	1,524	1,542	1,915	2,092	2,269

Note: Assumed increase of 0.3 connections for every 100 people increase in population in the water supply area.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-8 Number of Government Connections

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	21	21	40	43	45
Datu Odin Sinsuat	59	59	69	73	77
Cotabato City	254	256	290	313	336

City/Municipality	2014	2015	2030	2040	2050
Total	334	337	399	429	458

Note: Assumed increase of 1 connection for every 2000 people increase in population in the water supply area.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-9 Projected Total Number of Connections

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	2,439	2,526	8,927	9,795	10,663
Datu Odin Sinsuat	2,893	3,023	5,786	7,086	8,386
Cotabato City	21,909	22,673	34,131	41,770	49,408
Total	27,241	28,221	48,844	58,651	68,457

Note: Total number of connections in Tables 3-1 6 to 3-1 8 above.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

3-1-1-4 Water Demand Projections

Based on the aforementioned population projections and projected number of connections, water demand is calculated in the following way.

- The amount of water consumed by households is converted to a maximum of 150 lpcd, based on an intensity of 120 lpcd in Cotabato and 110 lpcd in the two surrounding cities at the time of the survey, and assuming an increase in intensity of 1% per year by 2050.
- The water consumption of the commercial and industrial sector is calculated at 2 m^3 per connection.
- The water consumption of governmental organizations is calculated at 7.5 m^3 per connection.
- The non-revenue water rate is projected at 27% at the time of the survey.
- Maximum daily water supply amount = calculated as 1.25 x average daily water supply amount (assuming a load factor of 1.25).
- Maximum hourly water supply amount = calculated as 1.9 x average daily water supply amount/24 (time coefficient=1.9)

Based on the above calculation methodology, the water demand is estimated as follows.
Average daily water supply amount is 31.61 MLD in 2014, 71.07 MLD in 2040 and 83.69 MLD in 2050.Maximum daily water supply amount is 39.51 MLD in 2014, 88.84 MLD in 2040 and 104.61 MLD in 2050.

Table 3-1-10 Projected Domestic Water Demand

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	1.44	1.49	6.05	7.32	8.59
Datu Odin Sinsuat	1.79	1.87	4.19	5.59	6.76
Cotabato City	14.29	14.81	24.97	31.57	37.77
Total	17.52	18.18	35.21	44.48	53.12

Note: Calculated on the assumption that the 120 lpcd at the time of the survey will increase to 150 lpcd at an annual growth rate of 1%.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-11 Commercial/Industrial Water Demand Projections

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	0.11	0.12	0.35	0.38	0.41
Datu Odin Sinsuat	0.17	0.17	0.28	0.33	0.38
Cotabato City	2.77	2.80	3.20	3.48	3.75
Total	3.05	3.08	3.83	4.18	4.54

Note: Calculated as 2 m^3 water consumption per connection.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-12 Government Water Demand Projections

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	0.16	0.16	0.30	0.32	0.34
Datu Odin Sinsuat	0.44	0.45	0.51	0.55	0.58
Cotabato City	1.91	1.92	2.18	2.35	2.52
Total	2.51	2.53	2.99	3.21	3.44

Note: Calculated as 7.5 m^3 water consumption per connection.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-13 Projected Non-Revenue Water

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	0.63	0.65	2.48	2.97	3.45
Datu Odin Sinsuat	0.89	0.92	1.84	2.39	2.85
Cotabato City	7.01	7.22	11.22	13.83	16.29
Total	8.53	8.80	15.55	19.19	22.60

Note: Calculated with NRW as 27%.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-14 Projected Average Daily Water Supply Amount

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	2.35	2.43	9.18	10.99	12.79
Datu Odin Sinsuat	3.29	3.41	6.83	8.86	10.57
Cotabato City	25.97	26.75	41.57	51.22	60.32
Total	31.61	32.59	57.58	71.07	83.69

Note: Sum of water amounts from Tables 3-1-10 to 3-1-13 above.
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

Table 3-1-15 Projected Maximum Daily Water Supply Amount

Unit : MLD

City/Municipality	2014	2015	2030	2040	2050
Sultan Kudarat	2.93	3.03	11.48	13.73	15.99
Datu Odin Sinsuat	4.11	4.27	8.54	11.08	13.22
Cotabato City	32.47	33.44	51.96	64.03	75.40
Total	39.51	40.74	71.98	88.84	104.61

Note: Maximum daily water supply amount = calculated as 1.25 x average daily water supply amount
Source: Metro Cotabato Water Supply Rapid Feasibility Study, USAID (2015)

3-1-2 Development of Water Supply Facility in Greater Cotabato MP

3-1-2-1 Basic Data

The population growth rate of Cotabato City and two surrounding cities in 2010-2015 was 2.7% for SK, 5.1% for DOS and 1.9% for Cotabato city (see Table 3-1-16). Meanwhile, according to the latest data from the PSA, the population growth rates for 2015-2020 are 2.11% for SK, 3.49% for DOS and 1.74% for Cotabato City.

Table 3-1-16 Population and Population Density in City and Municipalities in the Cotabato Metropolitan Area

City/Municipality	Population		Annual Growth Rate 2010-2015	Land Area (ha.)	Population Density 2015 (person/ha)
	2010	2015			
Cotabato City	271,786	299,438	1.9%	17,600	17
Datu Odin Sinsuat	76,332	99,210	5.1%	46,180	2
Sultan Kudarat	82,758	95,201	2.7%	71,291	1
Parang	73,328	89,194	3.8%	85,078	1
Pigcawayan	59,975	66,796	2.1%	34,011	2
Sultan Mastura	21,712	22,261	0.5%	24,207	1

City/Municipality	Population		Annual Growth Rate 2010-2015	Land Area (ha.)	Population Density 2015 (person/ha)
	2010	2015			
Total	585,891	672,100	2.6%	278,367	2

Source : PSA

The number of persons per household is 5.1 in Cotabato City, 5.8 in DOS and 6.1 in SK (see Table 3-1-17). In terms of Cotabato City only, the number of household members has remained between 4.9 and 5.2 between 2000 and 2015, and no significant trends have been observed over the years.

Table 3-1-17 Number of Households and Average Household Size in the Cotabato Metropolitan Area (2015)

City/Municipality	Population	No. of Households	Average Number of People in Household
Cotabato City	298,223	58,866	5.1
Datu Odin Sinsuat	98,774	17,088	5.8
Sultan Kudarat	95,193	15,652	6.1
Parang	89,143	5,307	5.8
Pigcawayan	66,604	15,826	4.2
Sultan Mastura	22,221	3,864	5.8

Source : PSA

Table 3-1-18 Household Data for Cotabato City (2000-2015)

Census Year	Population	No. of Households	Average Number of People in Household
2015	298,223	58,866	5.1
2010	271,609	55,171	4.9
2000	161,517	31,227	5.2

Source : PSA

The number of MCWD water supply connections has generally increased at a rate of about 5% per year over the past three years (Table 3-1-19).

Table 3-1-19 Number of Water Supply Connections (2009-2018)

Item	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
No. of Service Connections	24,142	25,094	26,061	26,862	27,774	28,854	29,960	31,517	33,069	34,776
Growth Rate(%)	4.2%	3.9%	3.9%	3.1%	3.4%	3.9%	3.8%	5.2%	4.9%	5.2%

Source: 2018 Annual Report, MCWD

Water supply in the Philippines is classified into the following three levels. Level 1 refers to water supply from wells or springs in villages. Level 2 refers to water supply by public faucets. Level 3 refers to water supply by pipelines.

The breakdown of households by water supply level in the two municipalities around Cotabato City is shown in Table 3-1-20. The proportion of Level 3 by water districts is around 21% (=3,478/16,880) in DOS and 19% (=2,900/15,331) in SK.

Table 3-1-20 Water Supply Levels in the Five Municipalities around Cotabato City

City/Municipality	*Total # of Households*	*Water Supply Level System*					
		Level 1		Level 2		Level 3	
		# of HH	*% to Total*	*# of HH*	*% to Total*	*# of HH*	*% to Total*
Datu Odin Sinsuat	16,880	11,452	17.22	1,950	2.93	3,478	5.22
Sultan Kudarat	15,331	8,331	12.52	4,100	6.16	2,900	4.36
Parang	3,837	3,166	4.76	450	0.68	221	0.33
Pigcawayan	15,261	14,170	21.30	457	0.69	755	1.14
Sultan Mastura	15,201	13,164	19.79	1,070	1.61	967	1.45
Total	66,510	50,283	75.60	8,027	12.07	8,321	12.50

Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

Table 3-1-21 shows the consumed water volumes for 2016 and 2018, while Table 3-1-22 shows the produced water volumes. Table 3-1-23 also shows the non-revenue water ratio obtained from the ratio of consumed water volume to produced water volume. The non-revenue water ratio has remained between 25% and just under 30% when the values for 2011-2014 in Table 3-1-2 above are also taken into account, but no certain trend can be found.

Table 3-1-21 Annual Water Consumption

Consumer	2016 (a)		2018 (b)		Difference (cu.m.) (b-a)
	Amount of consumption (cu.m.)	Share (%)	Amount of consumption (cu.m.)	Share (%)	
1. Domestic	7,260,187	83.3%	8,512,498	82.0%	1,252,311
2. Government	411,817	4.7%	561,453	5.4%	149,636
3. Pure Commercial	710,779	8.2%	919,850	8.9%	209,071
4. Industrial	24,072	0.3%	13,903	0.1%	(10,169)
5. Semi Commercial	308,321	3.5%	379,052	3.6%	70,731
Total	8,715,176	100.0%	10,386,756	100.0%	1,671,580

Source: 2016 and 2018 Annual Reports, MCWD

Table 3-1-22 Water Sources and the Production

Water Sources	Type of Water Source	Location	Production (cu.m.)	
			2016	2018
1. Tanuel PS	Spring Water	DOS	5,702,550	5,765,981
2. Rebuken PS	Deep Well	Sultan Kudarat	886,948	798,965
3. Macaguiling PS1	Deep Well	Sultan Kudarat	583,463	472,126
4. Macaguiling PS2	Deep Well	Sultan Kudarat	235,745	187,691
5. Dimapatoy PS	Surface Water	Sultan Kudarat	4,288,406	5,975,846
6. Bulk Water Supply (Mactan Rock TGV Builders Corporation)	Surface Water	Sultan Kudarat	-	1,506,584
Total			11,697,112	14,707,193

Source : 2016 and 2018 Annual Reports, MCWD

Table 3-1-23 Total Production and Non-Revenue Water Ratio

Items	2016	2018
Total Production (m^3)	11,697,112/yr (32,047/day)	14,707,193/yr (40,294/day)
Revenue Water (m^3)	8,715,176/yr (23,877/day)	10,386,756/yr (28,457/day)
NRW (%)	25.4	29.4

Source : MCWD

3-1-2-2 Population Projections and Water Demand Projections in Greater Cotabato MP

(1) Population Projection

In the greater Cotabato MP, the population in the administrative area is projected to be 969,500 in 2028 and 1,287,100 in 2040 for the Cotabato City and the five surrounding municipalities in total. The population served is calculated based on the assumption that the 52% water supply ratio in the administrative area in 2018 will be expanded to 70% in 2028 and 80% in 2040 in Cotabato City, and to 20% in 2028 and 50% in 2040 in the five surrounding municipalities. The population to be served is estimated to be 384,150 in 2028 and 785,960 in 2040.

(2) Water Demand Projections

The water demand projection is calculated by multiplying the assumed water supply population by a per unit water consumption of 150 lpcd to calculate the amount of water for domestic use, and then taking into account the proportion of commercial, industrial, and government water use other than domestic water use.

The non-revenue water ratio is assumed to improve to 20% in 2028 and about 15% in 2040.

The percentage of commercial, industrial, and government water use is assumed to increase from 23% to 30% in Cotabato City and from 20% to 25% in the five surrounding municipalities between 2028 and 2040.

Based on this, the water demand is estimated to be 70,346 m^3/day in 2028 and 150,216 m^3/day in 2040, and the required water treatment capacity is estimated to be 86,000 m^3/day in 2028 and 176,000 m^3/day in 2040, taking the non-revenue water ratio into account.

Table 3-1-24 Water Demand Projections Considering the Percentage of Population to be Supplied in the Water Supply Area

Year	2018			2028			2040		
	Population	Served Population		Population	Served Population		Population	Served Population	
Area	Nr	%	Nr	Nr	%	Nr	Nr	%	Nr
Cotabato City	328,400	52	170,768	380,500	70	266,350	474,700	80	379,760
Others	-	-	-	589,000	20	117,800	812,400	50	406,200
Total	328,400		170,768	969,500		384,150	1,287,100		785,960

Year	2028					2040				
	Population	Domestic		Non-Domestic	Total Demand	Population	Domestic		Non-Domestic	Total Demand
Area	Nr	lcd	m^3/day	%	m^3/day	Nr	lcd	m^3/day	%	m^3/day
Cotabato City	266,350	150	39,953	23	49,142	379,760	150	56,964	30	74,053
Others	117,800	150	17,670	20	21,204	406,200	150	60,930	25	76,163
Total	384,150		57,623		70,346	785,960		117,894		150,216

Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

Table 3-1-25 Projected Required Water Treatment Capacity

Items	Unit	2028	2040
Total Water Demand	m^3/day	70,346	150,216
NRW	%	20	15
Losses in the WTP	%	2	2
Required WTP Capacity (Daily Max.)	m^3/day	86,000	176,000

Source : "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City", JICA (2022)

3-1-3 F/S by Maynilad

Maynilad is conducting a hydraulic analysis of the water distribution network to contribute to the planning of the replacement of water distribution pipes managed by the MCWD. In this analysis, water demand in the year 2040 is project.

Table 3-1-26 Required WTP Capacity (Daily Maximum Water Supply) in 2040

City/Municipality	Water demand considering 30% NRW (MLD)
Sultan Kudarat	11.74
Datu Odin Sinsuat	14.53
Cotabato City	79.31
Total	105.58

Maynilad Water Service, Inc.

3-1-4 Consideration of Existing Studies

The following are some considerations based on the three existing studies.

- A comparison of the maximum daily water supply in 2040 for the three studies (USAID F/S, Maynilad F/S and Greater Cotabato MP) are shown below. The reason why Greater Cotabato M/P shows extremely large amounts is that it covers Parang, Sultan Mastura, and Pigcawayan, which are outside of MCWD's administrative area. Other possible reasons include the fact that the intensity is set uniformly at 150 lpcd from the time of the survey to the target year, and the assumption that 100% of the population in the water supply area is willing to be connected.

Table 3-1-27 Comparison of Population Served and Daily Maximum Water Supply (2040)

Study Title	Population Served	Daily Maximum Water Supply	Comment
USAID F/S	308,716	88.84MLD	Cotabato City + 2 surrounding municipalities are covered.
Maynilad F/S	Unknown	105.58MLD	Ditto
Greater Cotabato M/P	785,960	176MLD	Cotabato City + 5 surrounding municipalities are covered.

Source : JICA Survey Team

- The USAID F/S estimate conducted in 2015 projected the population growth rate as SK 1.52%, DOS 1.53%, and Cotabato City 1.36%, while the actual population growth rate from 2015 to 2020 by the PSA was SK 2.11%, DOS 3.49%, and Cotabato City 1.74%, which are larger than the projected values, so the projected values need to be updated to account for this trend.

- To update the water demand projections by re-analyzing the trends in recent years in terms of unit demand, non-revenue water ratio, load factor, and percentage of commercial, industrial, and governmental water use. The results of the willingness-to-connect study will also be reflected.

- Since population trends vary from barangay to barangay, more accurate estimates would be possible if information on the population supplied by each barangay could be obtained.

3-2 Update of Water Demand Projections on this Survey

3-2-1 Target Year

MCWD, which has administrative jurisdiction over water supply services, the current administrative area includes Cotabato City, SK and DOS, prospects to include part of the municipalities of Parang and Sultan Mastura. The water supply project extracted from this project is intended to be completed by the end of 2026. Therefore, it was agreed with the MCWD that the target year is assumed to be 2029, three years after the project completion.

3-2-2 Administrative Areas by MCWD

MCWD's administrative area is currently 37 barangays in Cotabato City, 39 barangays in SK, and 34 barangays in DOS. On the other hand, MCWD plans to expand the administrative area to part of the municipalities of Parang and Sultan Mastura. Table 3-2-1 shows the current and future administrative areas and the number of barangays.

Table 3-2-1 Administrative Areas by MCWD

Province	City/Municipality	Number of Barangays		Number of Barangays in Urban Area
		2022	After 2030	
Maguindanao	Cotabato City	37	37	27
	Sultan Kudarat	39	39	8
	Datu Odin Sinsuat	34	34	1
	Sultan Mastura		6	0
	Parang		3	2
		110	119	38

Source : JICA Survey Team

3-2-3 Current Status of Water Supply and Existing Facilities

The population within MCWD's administrative area is estimated to be approximately 572,000 as of 2022, and the population served by water supply is only approximately 202,000, or about 35% of the total population. In addition, the non-revenue water ratio in recent years has been as high as approximately 25%, requiring the scheduled renewal of aging water transmission and distribution pipes. Since it would require a huge budget and be practically difficult to cover all domestic water supplies in the administrative area, the design water supply area will be established based on a comprehensive assessment of project efficiency, population density, and future expansion potential, as well as MCWD's plans. The water supply area, population served, and existing facilities as of 2022 are summarized in Table 3-2-2.

Table 3-2-2 MCWD Water Supply Status (2022)

Symbol	Items	Value	Remarks
a	Population in the administrative area	572,605 persons	Population within MCWD's administrative area
b	Population in the water supply area	425,796 persons	Population living in areas considered to be able to be served by water distribution pipes
c	Population served	201,975 persons	Population serviced by water supply services
	Water supply ratio in administrative area (=c/a)	35.3%	Ratio of population served to population in the administrative area
	Water supply ratio in service area (=c/b)	47.4%	Ratio of population served to population in water supply area
	Number of houses	37,110 connections	Number of connections by MCWD (domestic

Symbol	Items	Value	Remarks
	supplied		connections)

Source : Compiled by survey team based on data from MCWD and PSA

3-2-4 Population and Population Growth Rate

Census data is published every five years in the Philippines. Population growth rates for cities and municipalities associated with current water supply areas and those proposed for future expansion are shown below.

Table 3-2-3 Population Growth Rate of City and Municipalities Associated with MCWD's Water Supply Area

No.	City/Municipality	2010 (persons)	2015 (persons)	2020 (persons)	Population Growth Rate (2010-2015)	Population Growth Rate (2015-2020)
1	Cotabato City	271,786	299,438	325,079	1.96%	1.66%
2	Sultan Kudarat	82,729	95,201	105,121	2.85%	2.00%
3	Datu Odin Sinsuat	76,284	99,210	116,768	5.40%	3.31%
4	Sultan Mastura	21,712	22,261	25,331	0.50%	2.62%
5	Parang	73,328	89,194	102,914	4.00%	2.90%

Source : Compiled by survey team based on data from PSA

On the other hand, the "Data Collection Survey on Urban Infrastructure Development in Greater Cotabato City" conducted by the JICA project considered an annual population growth rate of 1.9% to 2.0% through 2040 for Cotabato City, which was slightly higher than the 2015-2020 census. Therefore, this survey population growth projection is followed for Cotabato City. For other municipalities around Cotabato City, the population inside the administrative area, future population growth projections and recent trends for each barangay will be taken into account for the estimation.

3-2-5 Design Water Supply Population and Target Water Supply Ratio

Although the population growth rates in Table 3-2-3 represent the population growth rate for the entire municipality, the average annual population growth rate for each barangay is used in the calculation of the water supply population to project the population for the target year, 2029, and for the longer-term projection year, 2040.

The MCWD currently supplies water to a total of 53 barangays (36 barangays in Cotabato City, 10 barangays in SK, and 7 barangays in DOS), and plans to expand its water supply area to an additional 20 barangays in the future as shown in Table 3-2-4.

Table 3-2-4 Barangays to be Extended as Water Supply Areas

City/Municipality	Barangays
Cotabato City	Kalanganan 1
Sultan Kudarat	Crossing Simuay
	Darapanan
	Nara
	Panatan
	Pinaring
	Raguisi
	Ungap
Datu Odin Sinsuat	Dinang Proper
	Mompong
	Linek
Sultan Mastura	Balut

City/Municipality	Barangays
	Macabico
	Solon
	Tambo
	Tapayan
	Tuka
Parang	Landasan
	Compo Islam
	Polloc

Source : JICA Survey Team

The projected population served in each city/municipality as of 2022 and in 2029 and 2040 are as follows.

Table 3-2-5 Water Supply Population in Each City/Municipality

No.	City/Municipality	2022 (persons)	2029 (persons)	2040 (persons)
1	Cotabato City	149,706	300,450	435,693
2	Sultan Kudarat	22,024	49,071	93,395
3	Datu Odin Sinsuat	30,245	45,381	85,192
4	Sultan Mastura	-	-	23,000
5	Parang	-	-	33,542
	Total	201,975	394,901	670,822

Source : Compiled by survey team based on data from MCWD

The results of the population projections for 2029 and 2040 and the projected water supply ratio are shown below.

Table 3-2-6 Population Projection Results for 2029 and 2040

Items	2029	2040
Population in the administrative area (a)	725,608 persons	955,922 persons
Population in the water supply area (b)	528,497 persons	746,816 persons
Population served (c)	394,901 persons	670,822 persons
Water supply ratio in administrative area (=c/a)	54.4%	70.2%
Water supply ratio in service area (=c/b)	74.7%	89.8%
Number of houses supplied	72,557 HHs	123,254 HHs

Source : JICA Survey Team

In establishing water supply areas, the MCWD will select barangays with high priority for the MCWD and establish design water supply area so that water will be supplied to residents in those areas, instead of designating all of the administrative area as water supply area. It is considered appropriate from the perspective of obtaining high investment returns to establish a design water supply area (the area where the current distribution of households is already located and where water demand is expected), which is set separately from the administrative area, and to promote the development of water supply facilities within this area. The population to be served in 2029, the target year, is assumed to be 394,901.

The population served will be set to cover 90% of the population in the water supply area in the Urban Area, based on the results of the willingness-to-connect survey conducted by the USAID in 2014. In addition, discussions were held with the MCWD to generally cover 80% of the population in the water supply area in areas other than the Urban Area.

3-2-6 Unit Requirement for Water Supply (water supply per person per day)

The daily average water consumption per capita calculated from the average daily water consumption for domestic use and the population served is shown in Table 3-2-7.

Table 3-2-7 Daily Average Water Consumption per Capita for Domestic Use

Items	Unit	2017	2018	2019	2020	2021	2022
Daily Average Water Consumption	m^3/day	20,830	23,322	24,061	26,028	26,426	27,526
Population Served	person	181,880	191,268	182,405	189,125	195,210	201,975
Daily Average Water Consumption per Capita	L/day/person	114.5	121.9	131.9	137.6	135.4	136.3

Source: Compiled by survey team based on data from MCWD

Water supply unit demand once increased to just over 130 lpcd from 2017 to 2019, but has generally remained around 135 lpcd since 2019; the water demand projection is taken as 135 lpcd, averaged over the period 2019-2022.

3-2-7 Breakdown of Water Consumption for Domestic, Commercial, and Public Institutions

Table 3-2-8 shows the breakdown of domestic, industrial, and commercial water consumption relative to the total average daily water supply.

Table 3-2-8 Breakdown of Water Consumption for Domestic, Commercial, and Public Institutions

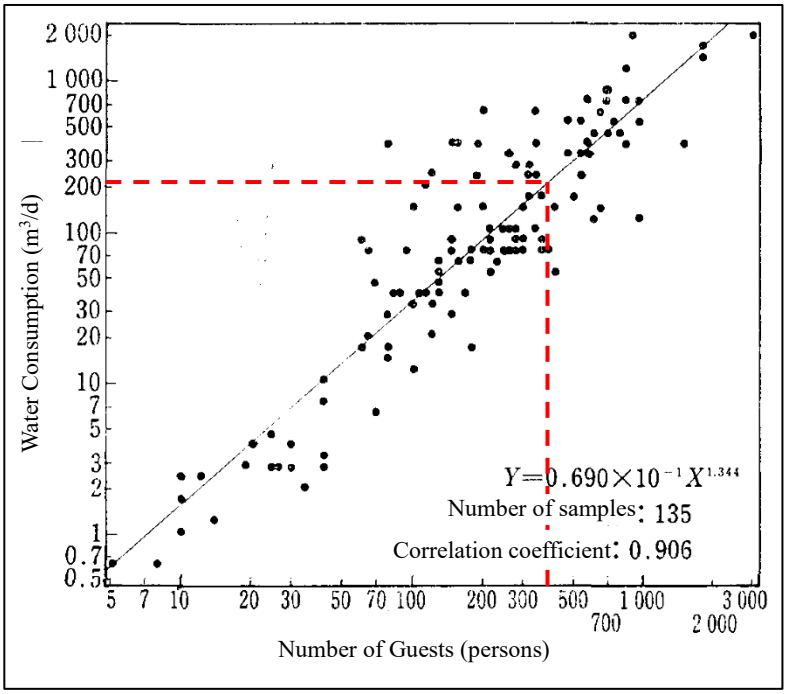
Items	Unit	2017	2018	2019	2020	2021	2022
Domestic	m^3/day	20,830	23,322	24,061	26,028	26,426	27,526
	%	82.5	82.0	81.6	83.5	83.4	82.9
Commercial	m^3/day	3,147	3,597	3,819	3,549	3,583	3,930
	%	12.5	12.6	13.0	11.4	11.3	11.8
Public Institutions	m^3/day	1,263	1,538	1,591	1,583	1,675	1,763
	%	5.0	5.4	5.4	5.1	5.3	5.3
Total	m^3/day	25,240	28,457	29,470	31,161	31,684	33,219

Source : Compiled by survey team based on data from MCWD

In MCWD's concession area, the rapidly growing water supply population has led to an increase in not only domestic water supply, but also commercial and public institutional water supply. In forecasting the water demand for these commercial and public institutional uses, the average of the occupancy ratios over time is adopted to set the water volume. The average of the ratio of domestic water use over the past six years is set at 82.7%, the commercial water use is set at 12.1% of the total revenue water, and the public institutional water use is set at 5.2% of the total revenue water.

3-2-8 Water Demand in Large-scale User (shopping malls)

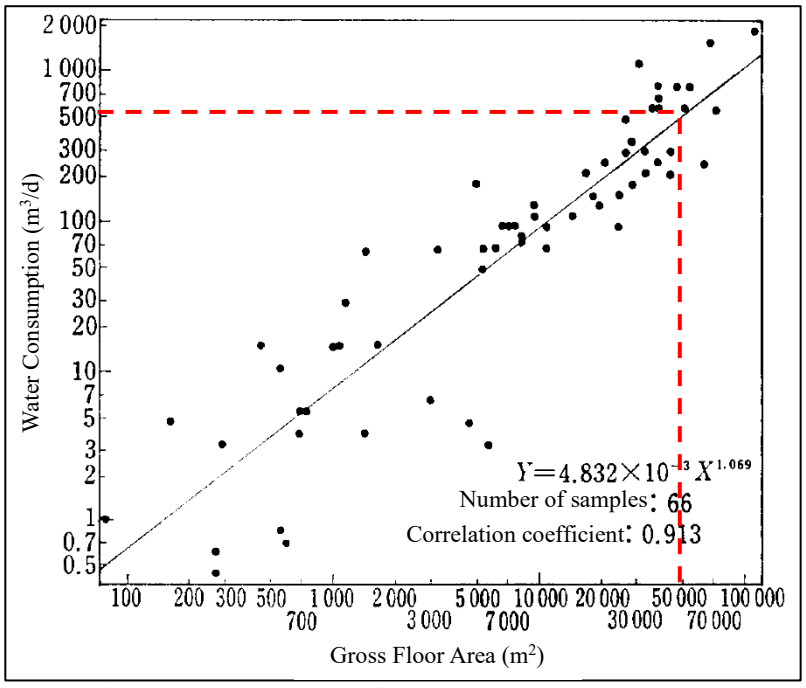
The KCC Mall, which is scheduled for completion in 2024, is a particularly large commercial user, so water demand will be calculated separately. The building area of KCC Mall is approximately 5 ha, but the total floor area for the shopping mall is assumed to be about 15 ha. The hotel will have 200 guest rooms and will accommodate 400 people, assuming that two people will stay in each room.



Source: "The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, No. 32, June 1986"

Figure 3-2-1 Relation between the Number of Guests (Vertical axis-m³/d) and Water Consumption in Hotels (Horizontal axis-pp)

From Figure 3-2-1, the water consumption is assumed to be about 210 m³/day when 400 people are accommodated, and 310 m³/day (= 210 m³/day / 0.85 / (1/1.25)) as the equivalent of the daily maximum water supply amount, taking the leakage ratio and load factor into account.



Source: "The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, No. 32, October 1986"

Figure 3-2-2 Relation between Total Floor Space (Horizontal axis-m²) and Water Consumption (Vertical axis-m³/d) in Department Stores and Mass Retailers

From Figure 3-2-2, the water consumption for a floor area of 5 ha is about 500 m^3/day, and assuming that three floors are occupied, the total floor area of 15 ha would be about 1,500 m^3/day. Considering the leakage rate and load factor, it is assumed to be 2,210 m^3/day (= 1,500 m^3/day / 0.85 / (1/1.25)), which is equivalent of the daily maximum water supply amount.

Hence, the assumed total volume for the hotel and shopping mall is approximately 2,500 m^3/day.

3-2-9 Water Demand for Development along Tamontaka River

Water demand for development along Tamontaka River is listed below.

Table 3-2-9 Water Demand for Development along Tamontaka River

Items	Specification				Water Demand (m^3/day)
	Area	No. of stories	No. of people	Others	
Halal Slaughterhouse	Slaughterhouse=528 m^2 Animal Cage=147 m^2 Training Centers=192 m^2 **Total = 867** m^2	One	With an average of 10 heads of cattle and 4 heads of goats slaughtered every day. There are about 10 people regular employees managing the slaughterhouse.	Operated in year 2017	23 (According to MCWD the slaughterhouse consumes around 680 m^3)
Public market:	**10,224** m^2	One	Estimate of around 1,000 people (vendors and market employees) stay daily.	Still on-going construction. Target completion is before end of 2023.	70 (each employee 70ℓ/day)
Public terminal in special economic zone:	**3,224** m^2	One	Assumption: ½ of the area is for vehicle parking; ½ of the area is always with people. A total of around 400 people (waiting passengers and drivers, conductors, vendors, employees) regularly present in the terminal.	Still on-going construction. Target completion is before end of year 2023.	28 (each 70ℓ/day)
Housing projects:	26,100 m^2 Kalanganan 2: 42 m^2 x 50 units=2,100 m2 Tamontaka M.B.: 80 m^2 x 300 units =24,000 m^2 **Total = 26,100** m^2	One	Estimate of 1,905 people (5.5 x 350 units)	Construction is not yet started.	257.2 (1,905people x 135ℓ/day)
Ice plant	**96** m^2	One	People who will stay in	The ice plant	12

Items	Specification				Water Demand (m^3/day)
	Area	No. of stories	No. of people	Others	
			the facility are workers assumed to be about 8 people.	building is already completed. But it is not yet operational	(10 m^3/day, rest others)
Seaport	Seaport construction was suspended. Only about 240 meter long concrete causeway was constructed	No building structure has been construc ted yet.	No clear Indication if the project will still be continued. Nobody from the Philippine Ports Authority (PPA) could provide information	Construction was stopped since 2019.	No estimate of water demand can be made.
Grand Mosque:	**2,400** m^2	One	Every Friday worship estimate of 1,200 people; and other days estimate of 300 people.	Already completed and operational since 2011.	2 (considering 90% of 3000 people/week worshippers use for ablution (2ℓ) and toilet (20ℓ))
School	**8,640** m^2	Five	4,000 students 120 teachers A total of about 4,120 people	The buildings are already completed but these are not yet being used.	288.4 (4,120 people x 70ℓ/day)

Source : Compiled by survey team based on data from MCWD

3-2-10 Leakage Water Ratio and Effective Water Ratio

MCWD's actual data on the non-revenue water ratio are shown in Table 2-4-1. The definition of NRW by IWA/AWWA consists of non-billed water use, apparent losses (e.g., stolen water, meter readings, meter errors), and actual losses (e.g., leaks in transmission and distribution pipes, leaks in primary house connection pipes, leaks in water storage tanks, etc., and overflow), but the amount of water leakage, which accounts for the majority of actual water losses, is not calculated by the MCWD.

For this reason, the ratio of water leakage to non-revenue water is estimated to be 75%, based on the actual results of water utilities in Japan (estimated results based on water supply statistics for the year 2018) and the values adopted in past grant aid projects.

The non-revenue water ratio has shown a slight downward trend in recent years, and the MCWD plans to systematically renew aging pipes in the future. The MCWD aims to reduce the non-revenue water ratio from the current 25% to 27% to around 20%, and the current non-revenue water ratio will be reflected in the water demand projection as if it will decrease at a rate of approximately 1% per year.

3-2-11 Load Factor

The load factor is the ratio of the daily average water supply to the daily maximum water supply. Since the MCWD does not have organized and useful information on the daily maximum water supply, the load factor is set at 1.25 (80%) following LWUA criteria, as in the 2015 USAID FS study.

3-2-12 MCWD's Water Supply Record

Table 3-2-10 shows MCWD's current water supply record, which summarize the conditions in sections 3-2-1 through 3-2-11 above.

Table 3-2-10 MCWD Water Supply Record

No.	項目				2015	2016	2017	2018	2019	2020	2021	2022	Data Source
a	Tanuel Pumping Stataion				6,051,462	5,702,550	6,051,538	5,765,981	5,715,369	5,464,241	5,839,123		MCWD
b	Rebuken Pump				894,795	886,948	932,727	798,965	745,755	540,181	492,589		MCWD
c	Macaguiling Pump I				696,251	583,463	492,832	472,126	406,034	502,336	512,324		MCWD
d	Macaguiling Pump II				265,291	235,745	228,695	187,691	122,966	-	-		MCWD
e	Dimapatoy Pumping				3,226,671	4,288,406	4,783,386	5,975,846	6,068,483	6,480,412	6,674,042		MCWD
f	Bulk Water Supply				-	-	-	1,506,584	1,708,965	2,030,234	1,970,015		MCWD
1	Annual water supply amount		(m3/year)	= A (result)	11,134,470	11,697,112	12,489,178	14,707,193	14,767,572	15,017,404	15,488,093		MCWD
2	Ave. daily water supply amount		(m3/day)	= B = A / 365	30,505	32,047	34,217	40,294	40,459	41,144	42,433		by calculaton
3	Max. daily water supply amount		(m3/day)	= C (result)	38,132	40,059	42,771	50,367	50,574	51,429	53,041		assumption
4	Annual total water consumption		(m3/year)	= D (result)	8,187,582	8,715,176	9,212,723	10,386,756	10,756,699	11,373,727	11,564,677	12,124,935	MCWD
5	Ave. daily water consumption (Total)		(m3/day)	= E = D / 365	22,432	23,877	25,240	28,457	29,470	31,161	31,684	33,219	by calculaton
6	Domestic	Ave. daily consumption	(m3/d)	F (result)	18,686	19,890	20,830	23,322	24,061	26,028	26,426	27,526	MCWD
		Ratio of Domecsic Water	(%)	= (F/E) x 100	0.833	0.833	0.825	0.820	0.816	0.835	0.834	0.829	83.3% of consumption
		Ave. daily consumption / person	(ℓ/d/person)	= G = (F / P) x 1000			114.5	121.9	131.9	137.6	135.4	136.3	by calculaton
		Connection	(conections)	H (result)			30,561	32,125	33,612	34,910	35,950	37,110	MCWD
7	Business Consumption	Ave. daily consumption	(m3/d)	I (result)	2,692	2,865	3,147	3,597	3,819	3,549	3,583	3,930	MCWD
		Ratio of Business Water	(%)	= (I/E) x 100			0.125	0.126	0.130	0.114	0.113	0.118	11.5% of consumption
		Ave. daily consumption / conection	(ℓ/d/conection)	= G = (F / P) x 1000			1,491	1,602	1,557	1,424	1,350	1,391	by calculaton
		Connection	(conections)	J (result)			2,111	2,246	2,453	2,492	2,654	2,826	MCWD
9	Istitution Consumption	Ave. daily consumption	(m3/d)	M (result)	1,054	1,122	1,263	1,538	1,591	1,583	1,675	1,763	MCWD
		Ratio of Institution Water	(%)	= (M/E) x 100			0.050	0.054	0.054	0.051	0.053	0.053	5.2% of consumption
		Ave. daily consumption / conection	(ℓ/d/conection)	= G = (F / P) x 1000			3,181	3,798	3,825	3,742	3,824	3,841	by calculaton
		Connection	(conections)	N (result)			397	405	416	423	438	459	MCWD
10	Number of connections (Total)		(conections)	= O = H + J + N			33,069	34,776	36,481	37,825	39,042	40,395	MCWD
11	Population served		(persons)	= P (result)			181,880	191,268	182,405	189,125	195,210	201,975	Annual Report, MCWD
12	Population in Waterworks' water supply area		(persons)	= Q (result)			391,791	398,529	405,384	412,357	422,997	427,539	Annual Report, MCWD
13	Revenue water ratio		(%)	= R = (D / A) × 100	73.5	74.5	73.8	70.6	72.8	75.7	74.7		MCWD
14	Non-revenue water amount		(m3/year)	= S = A - D	2,946,888	2,981,936	3,276,455	4,320,437	4,010,873	3,643,677	3,923,416		by calculaton
15	Non-revenue water ratio		(%)	= T = (S / A) × 100	26.5	25.5	26.2	29.4	27.2	24.3	25.3	27.46	MCWD
16	Rate of loading		(%)	= U = (B / C) × 100	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	assumption
17	Rate of service pervasion		(%)	= V = (P / Q) × 100			46.4	48.0	45.0	45.9	46.1	47.2	by calculaton
19	Family Scale		(persons/HH)	= Y = (P / H)			5.951	5.954	5.427	5.418	5.430	5.443	by calculaton

Source: Compiled by survey team based on data from MCWD

3-2-13 Water Demand Projection and Required WTP Capacity

3-2-13-1 Capacity of Existing Facilities

The design production capacity of the existing facilities is about 49,740 m^3/day, but the Rebuken PS and Macaguiling No. 1 and 2 PS have not been able to achieve the design production capacity due to water quality issues and production capacity limitations of the deep wells themselves. As a result, the actual production capacity of the existing facilities as of March 2023 is only about 46,300 m^3/day. At the time of the survey, the Rebuken PS had been operating at 54% of design capacity and the Macaguiling No. 1 PS at 50% of design capacity; however, it suspended operation in February 2023. The Mactan Rock WTP has a facility capacity of about 7,000 m^3/day, but is operated at a reduced

production rate of about 5,500 m^3/day to cope with rising river turbidity (obligation supply water volume is 5,000 m^3/day). The MCWD envisions that the expansion of the Mactan Rock WTP will cover the decline in production at the Rebuken PS and Macaguiling No. 1 PS. However, since the Simuay River, the source of water for the Mactan Rock WTP, is not scalable as a water source, if Mactan Rock WTP and Rebuken PS cannot cover the production, water distribution from the Rio Grande WTP will be required. Based on the above, the production capacity of the existing facilities in the target year of 2029 is assumed to be about 86,600 m^3/day.

Table 3-2-11 Capacity of Existing Facilities

Water Sources	Design Capacity	Actual Capacity	Capacity in 2029
Tanual WTP (Springs)	17,280	16,600	16,600
Rebuken PS (Deep Well)	2,590	1,400	1,400
Macaguilling No.1 &2 PS (Deep Well)	2,590	0	0
Dimapatoy WTP (Dimapatoy River)	17,280	17,800	17,800
Mactan Rock (Simuay River)	5,000	5,500	6,800
Hanabana (Matampay River)	5,000	5,000	11,000
Dimapatoy WTP Expansion			8,000
Rio Grande de Mindanao Ph.1 of SDF			25,000
Total	49,740	46,300	86,600

Source: Compiled by survey team based on data from MCWD

3-2-13-2 Water Demand Projection and Required WTP Capacity

Water demand projections based on the conditions in Sections 3-2-1 through 3-2-12 and MCWD's actual water supply record in Section 3-2-12 are shown below. The required WTP capacity in 2029, which is assumed as the target year, is 97,600 m^3/day, and in 2040, a WTP capacity of about 163,600 m^3/day will be required. Since the proposed production capacity of the existing WTP after expansion is assumed to be 86,600 m^3/day, the production capacity increased by this project is estimated to be 11,000 m^3/day.

Table 3-2-12 Demand Projection (1)

Record ← | → Projection

Items	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Population in Administrative Area	persons	514,078	524,687	535,645	546,968	559,596	572,605	586,012	599,831	614,083	628,785	643,961	708,773
Population in Water Supply Area	persons	386,443	393,533	400,827	408,331	416,959	425,796	434,848	444,121	453,621	463,355	473,332	517,523
Population Served	persons	181,880	191,268	182,405	189,125	195,210	201,975	221,051	241,940	264,814	289,865	330,042	362,772
Water Supply Ratio in Administrative Area	%	35.4	36.5	34.1	34.6	34.9	35.3	37.7	40.3	43.1	46.1	51.3	51.2
Water Supply Ratio in Water Supply Area	%	47.1	48.6	45.5	46.3	46.8	47.4	50.8	54.5	58.4	62.6	69.7	70.1
Water Supply Household	HHs	30,561	32,125	33,612	34,910	35,950	37,110	40,615	44,453	48,656	53,259	60,640	66,654
Average Water Consumption per person per day for Domestic	L/day/person	114.5	121.9	131.9	137.6	135.4	136.3	135.0	135.0	135.0	135.0	135.0	135.0
Average Water Consumption per day for Domestic	m3/day	20,830	23,322	24,061	26,028	26,426	27,526	29,842	32,662	35,750	39,132	44,556	48,974
Average Water Consumption per day for Commercial etc.	m3/day	4,410	5,135	5,409	5,133	5,258	5,693	5,983	6,548	7,167	7,845	8,933	9,818
Total Revenue Water Amount	m3/day	25,240	28,457	29,470	31,161	31,684	33,219	35,825	39,210	42,917	46,977	53,489	58,792
Non-Revenue Water Amount	m3/day	6,183	8,041	7,539	6,932	7,432	8,616	8,678	9,048	9,421	9,793	10,570	10,991
Daily Average Water Supply Amount	m3/day	31,423	36,498	37,009	38,093	39,116	41,835	44,503	48,259	52,338	56,770	64,058	69,783
Daily Average Water Supply Amount per person	L/day/person	173	191	203	201	200	207	201	199	198	196	194	192
Daily Maximum Water Supply Amount	m3/day	39,279	45,623	46,261	47,616	48,894	52,294	55,628	63,408	68,508	74,048	83,158	90,314
Daily Maximum Water Supply Amount per person	L/day/person	216	239	254	252	250	259	252	262	259	255	252	249
Revenue Water Ratio	%	73.8	70.6	72.8	75.7	74.7	73.0	74.0	75.0	76.0	77.0	78.0	79.0
Effective Water Ratio	%	80.3	78.0	79.6	81.8	81.0	79.4	80.5	81.3	82.0	82.8	83.5	84.3
Leakage Water Ratio	%	19.7	22.0	20.4	18.2	19.0	20.6	19.5	18.8	18.0	17.3	16.5	15.8
Load Factor	%	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
Construction Period										←	→		
Water Supply Capacity Expansion Plan	m3/day	37,100	42,600	42,600	42,600	42,600	47,600	54,300	54,300	54,300	68,300	93,300	93,300
Difference between Expanded Facilities and Water Demand	m3/day									14,208	5,748	(10,142)	(2,986)

Source: MCWD (The effective NRW volume in the effective water volume is assumed to be zero due to lack of data, resulting effective water volume = revenue water volume.)

Table 3-2-13 Demand Projection (2)

Items	Unit	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Population in Administrative Area	persons	725,608	743,010	761,010	779,637	798,926	818,912	839,635	861,136	883,464	906,667	930,800	955,922
Population in Water Supply Area	persons	528,497	539,750	613,450	626,704	640,317	654,302	668,673	683,442	698,626	714,238	730,296	746,816
Population Served	persons	394,901	420,254	447,469	476,699	507,108	524,751	549,500	572,194	595,888	617,717	640,760	670,822
Water Supply Ratio in Administrative Area	%	54.4	56.6	58.8	61.1	63.5	64.1	65.4	66.4	67.4	68.1	68.8	70.2
Water Supply Ratio in Water Supply Area	%	74.7	77.9	72.9	76.1	79.2	80.2	82.2	83.7	85.3	86.5	87.7	89.8
Water Supply Household	HHs	72,557	77,216	82,216	87,586	93,174	96,415	100,963	105,132	109,486	113,497	117,730	123,254
Average Water Consumption per person per day for Domestic	L/day/person	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0
Average Water Consumption per day for Domestic	m3/day	53,312	56,734	60,408	64,354	68,460	70,841	74,183	77,246	80,445	83,392	86,503	90,561
Average Water Consumption per day for Commercial etc.	m3/day	10,688	11,374	12,111	12,902	13,725	14,202	14,872	15,486	16,128	16,718	17,342	18,156
Total Revenue Water Amount	m3/day	64,000	68,108	72,519	77,256	82,185	85,043	89,055	92,732	96,573	100,110	103,845	108,717
Non-Revenue Water Amount	m3/day	11,294	12,019	12,797	13,633	14,503	15,008	15,716	16,365	17,042	17,667	18,326	19,185
Daily Average Water Supply Amount	m3/day	75,294	80,127	85,316	90,889	96,688	100,051	104,771	109,097	113,615	117,777	122,171	127,902
Daily Average Water Supply Amount per person	L/day/person	191	191	191	191	191	191	191	191	191	191	191	191
Daily Maximum Water Supply Amount	m3/day	97,583	103,624	110,110	117,076	124,325	128,529	134,429	139,836	145,484	150,686	156,178	163,342
Daily Maximum Water Supply Amount per person	L/day/person	247	247	246	246	245	245	245	244	244	244	244	243
Revenue Water Ratio	%	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
Effective Water Ratio	%	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Leakage Water Ratio	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Load Factor	%	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
Construction Period													
Water Supply Capacity Expansion Plan	m3/day	97,600	97,600	124,600	124,600	124,600	124,600	142,100	142,100	142,100	163,600	163,600	163,600
Difference between Expanded Facilities and Water Demand	m3/day	(17)	6,024	(14,490)	(7,524)	(275)	3,929	(7,671)	(2,264)	3,384	(12,914)	(7,422)	(258)

Source : MCWD (The effective NRW volume in the effective water volume is assumed to be zero due to lack of data, resulting effective water volume = revenue water volume.)

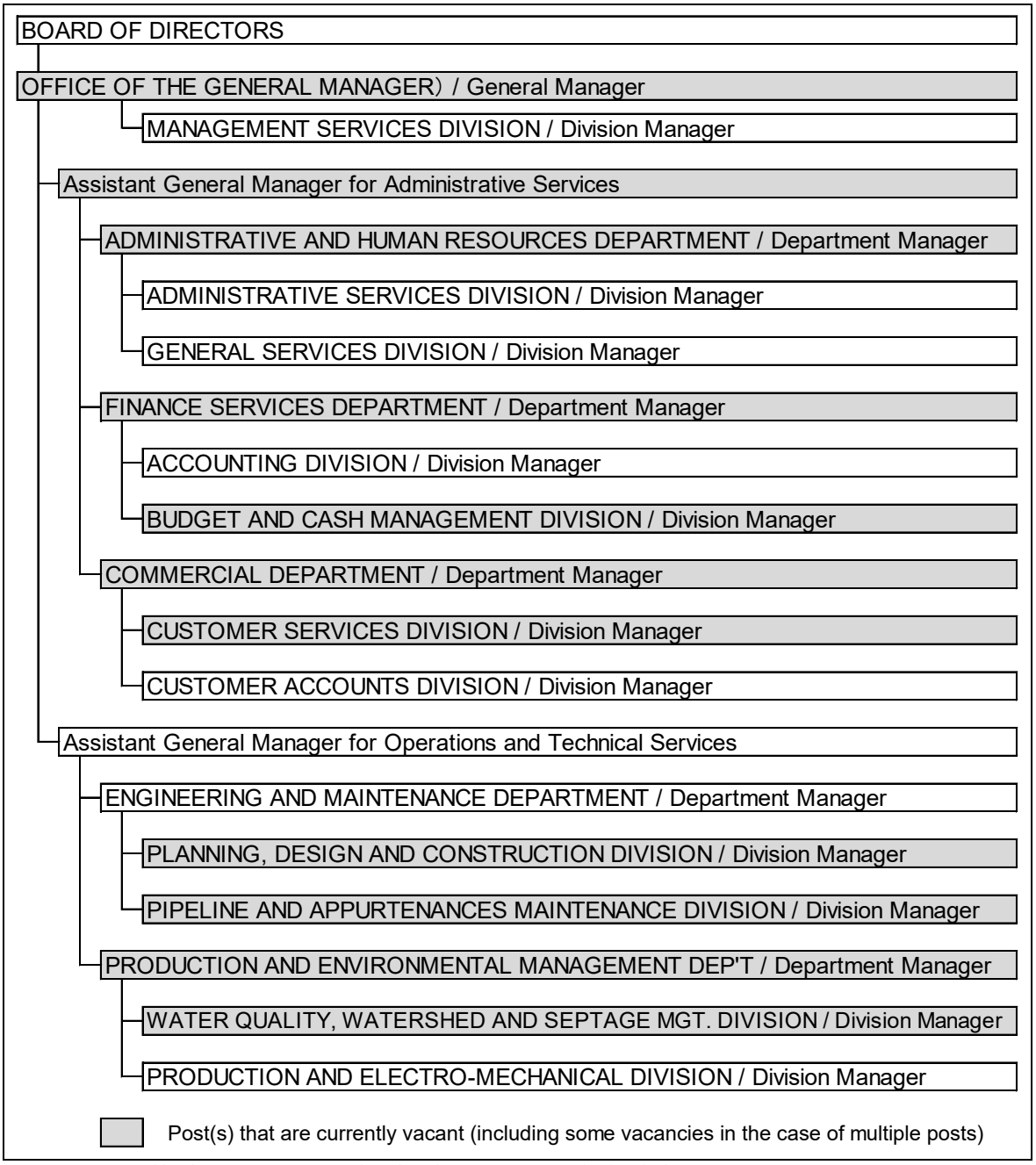
Chapter 4. Overview of Organizational Structure of MCWD

4-1 Organization of MCWD

As a "Category A" water district based on the LWUA classification according to the number of active connections (more than 30,000 active connections; 27 out of 515 water districts nationwide fall into Category A), the MCWD consists of the Board of Directors (BOD), the Office of General Manager under the General Manager (GM), and five major departments: the Administrative and Human Resources Department, the Finance Service Department and the Commercial Department under Assistant General Manager (AGM) for Administrative Services, the Engineering and Maintenance Department, and Production and Environmental Management Department under AGM for Operations and Technical Services.

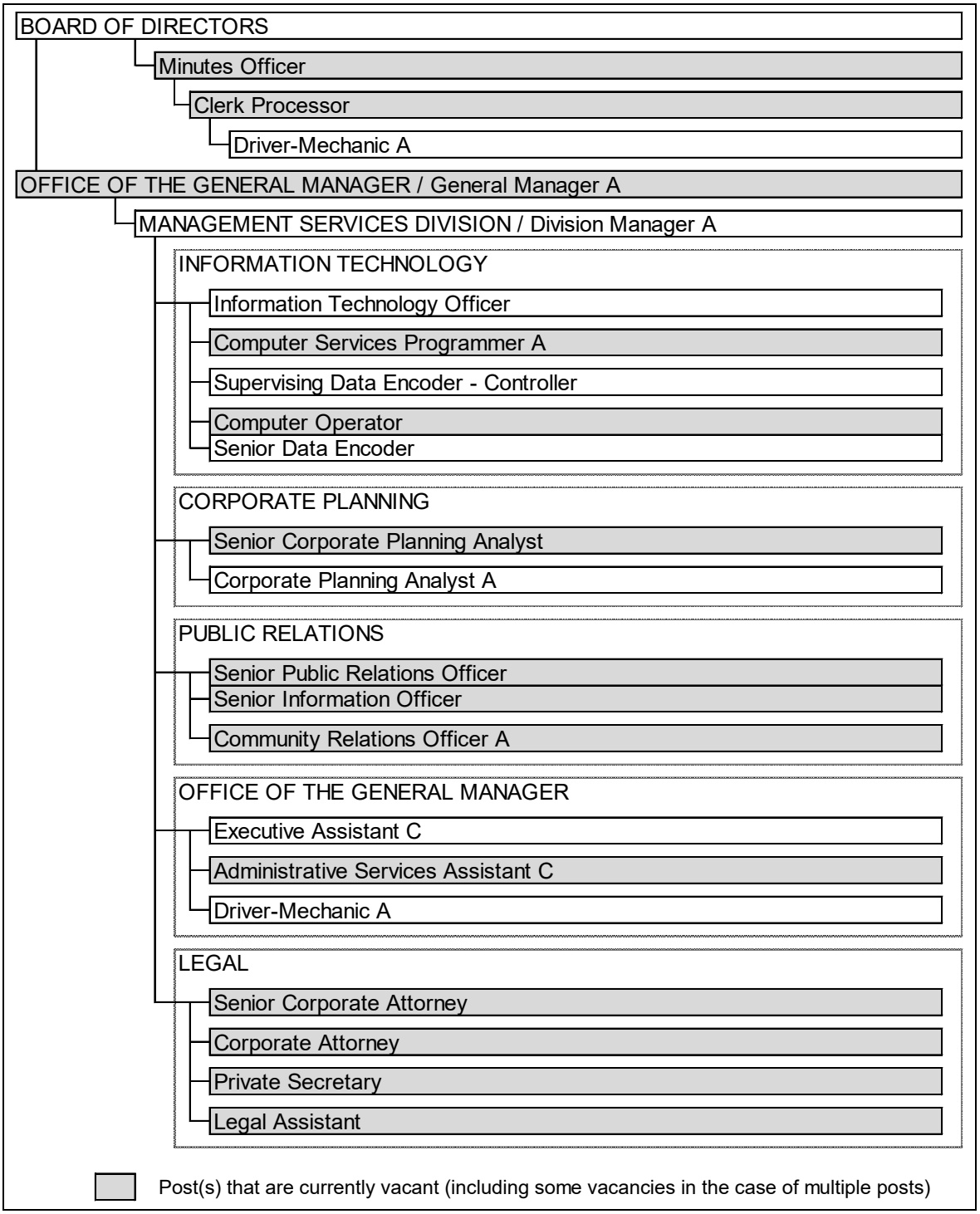
4-1-1 MCWD's Organizational Charts

Figure 4-1-1 shows the MCWD's organizational chart (Board of Directors and managerial level), and Figure 4-1-2 to Figure 4-1-7 show the other charts of each department including Office of the General Manager. More than half of the 19 managerial posts, including General Manager, are vacant, and there are many vacancies in each department as well. The existing lower managerial staff are acting as officers in charge (OIC) for vacant managers, and it seems that there are no major obstacles to water supply services and business operation at present.



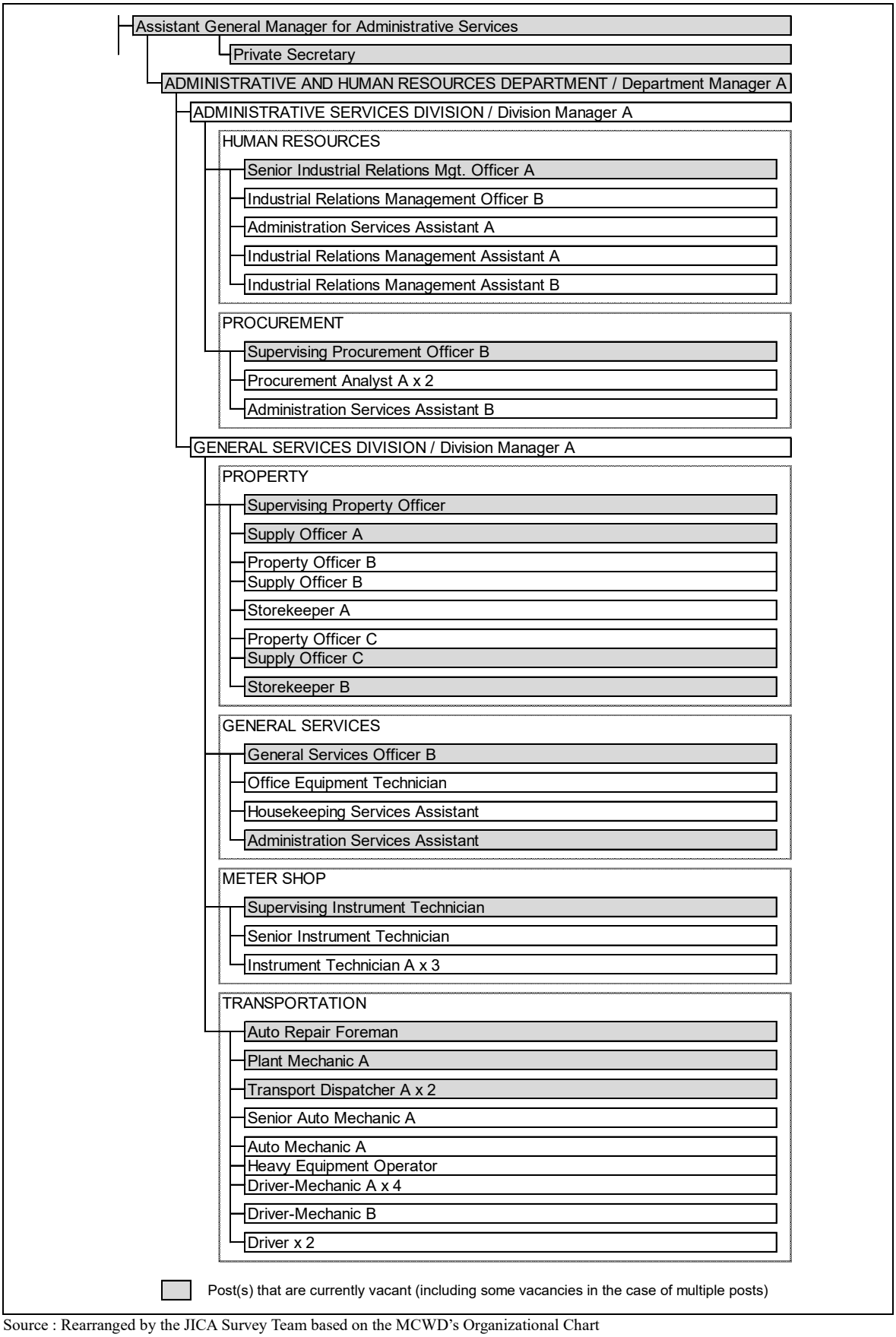
Source : Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-1 MCWD's Organizational Chart (Board of Directors and Managerial Level)



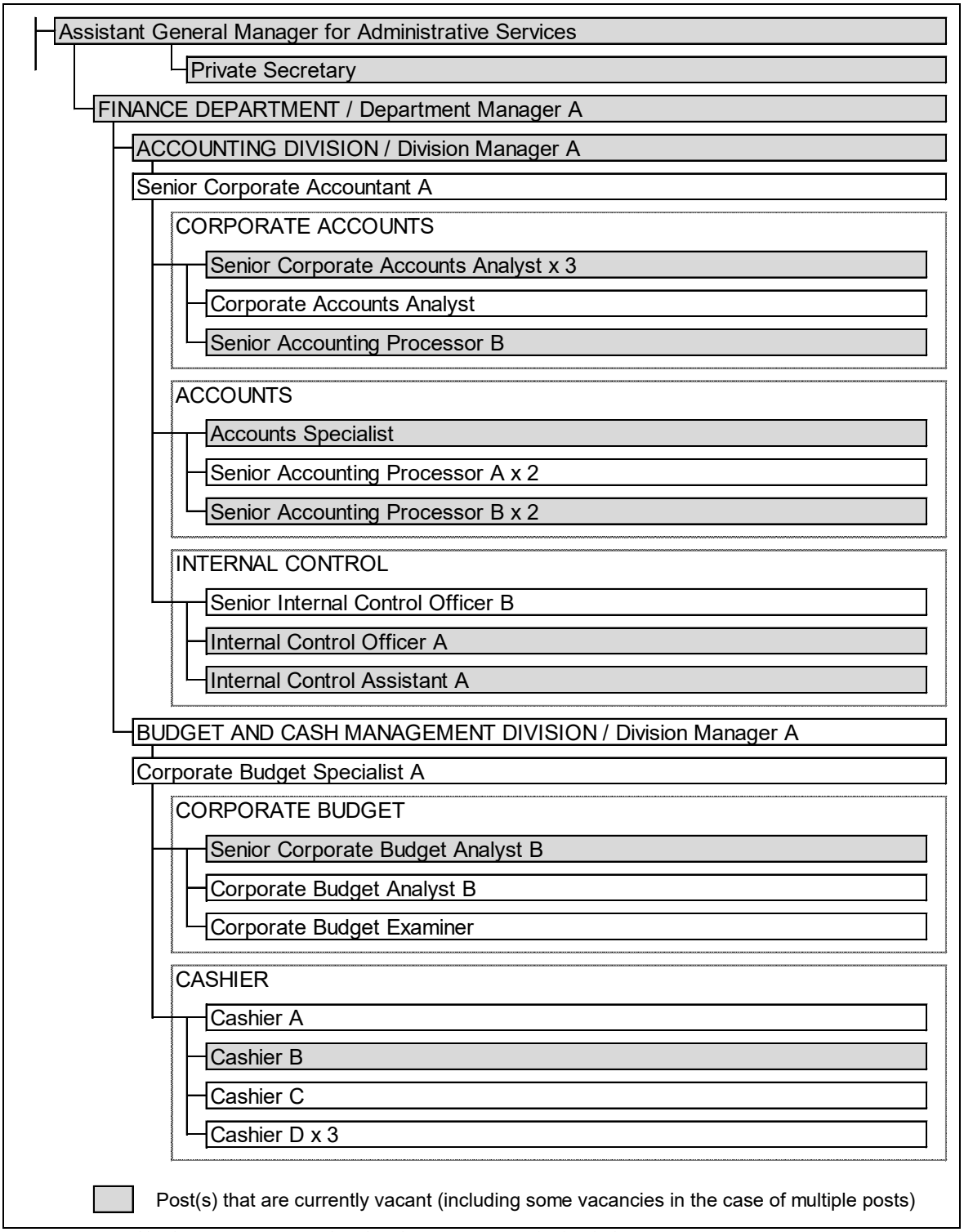
Source : Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-2 MCWD's Organizational Chart (Office of the General Manager)



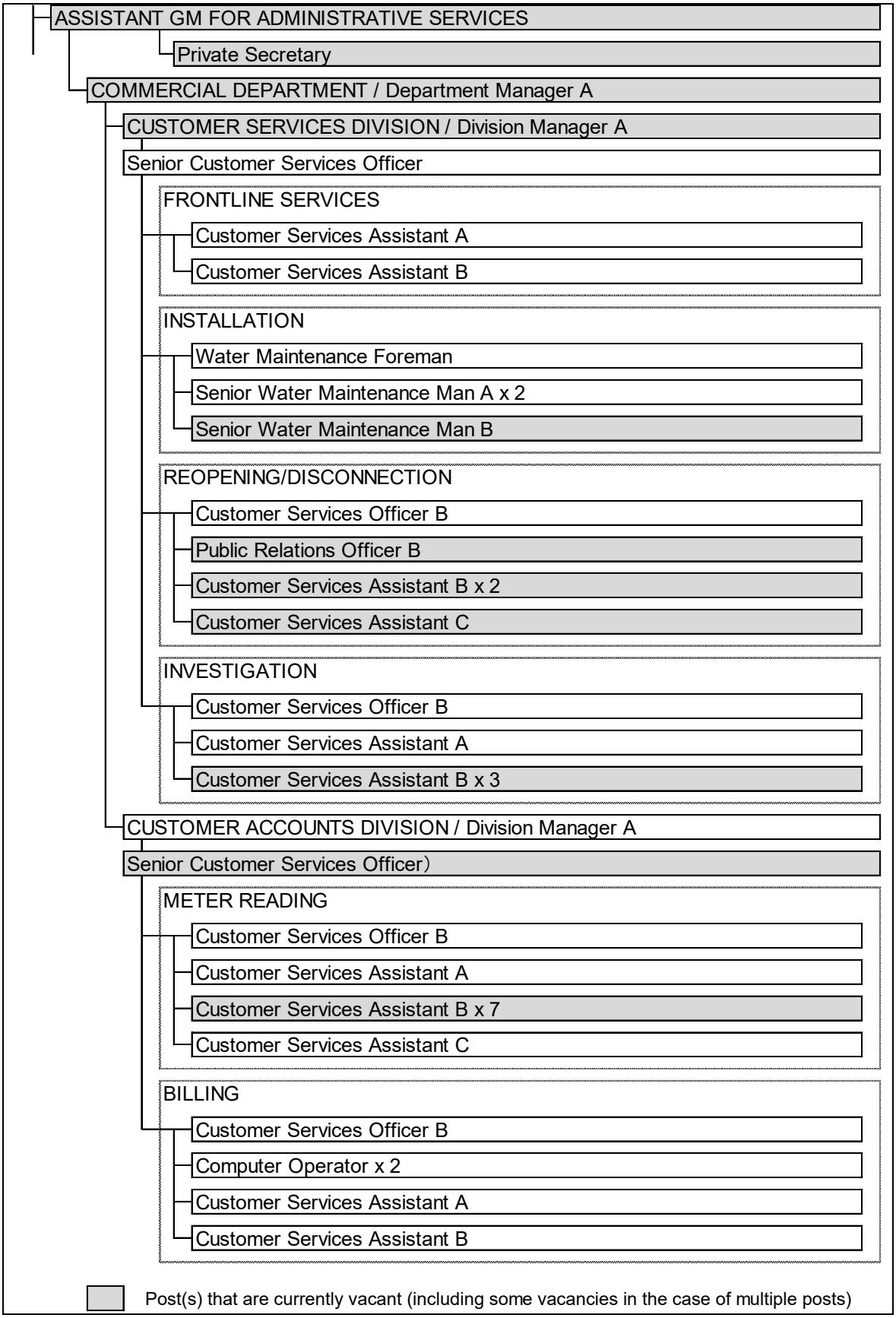
Source : Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-3 MCWD's Organizational Chart (Admin. and Human Resources Department)



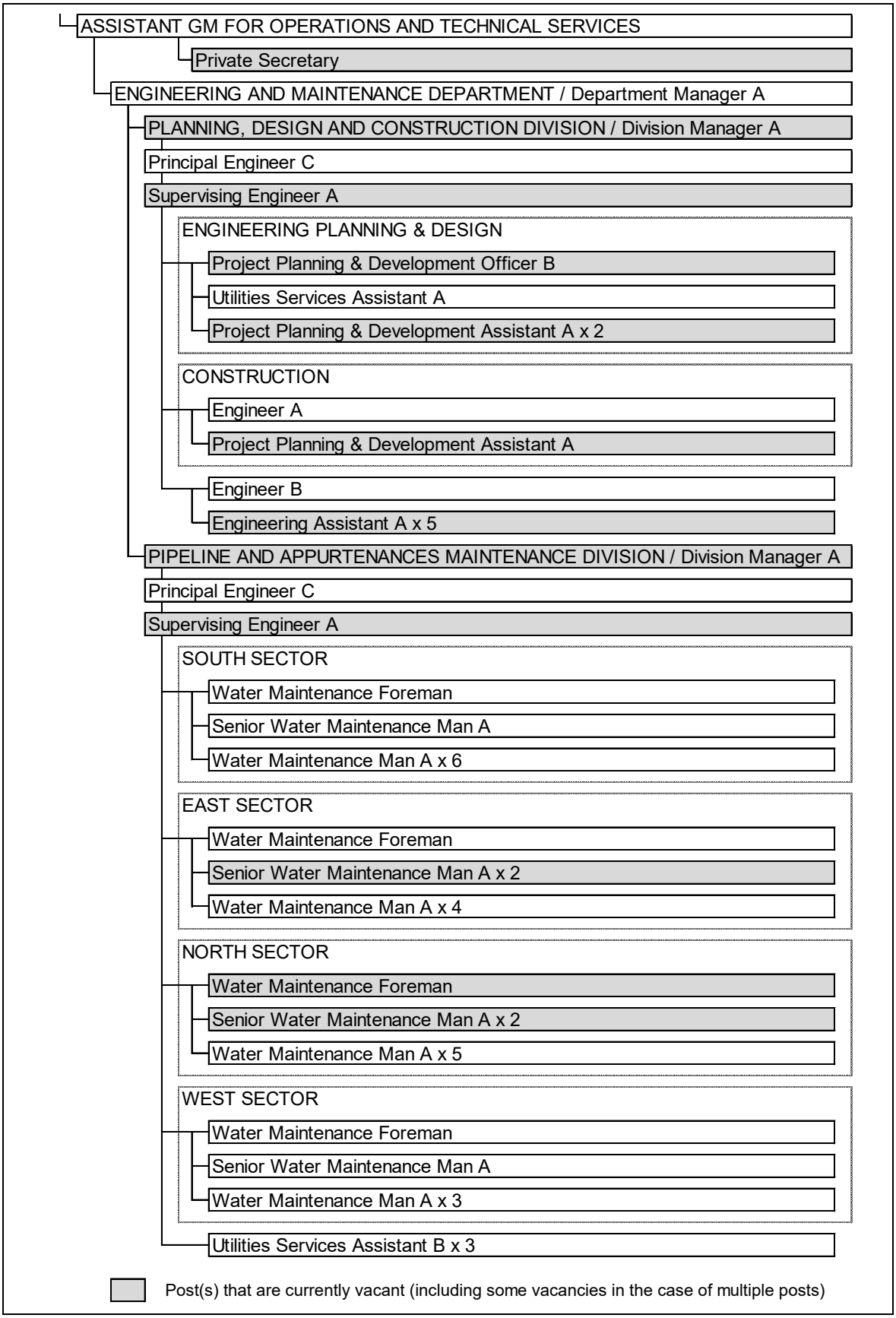
Source: Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-4 MCWD's Organizational Chart (Finance Department)



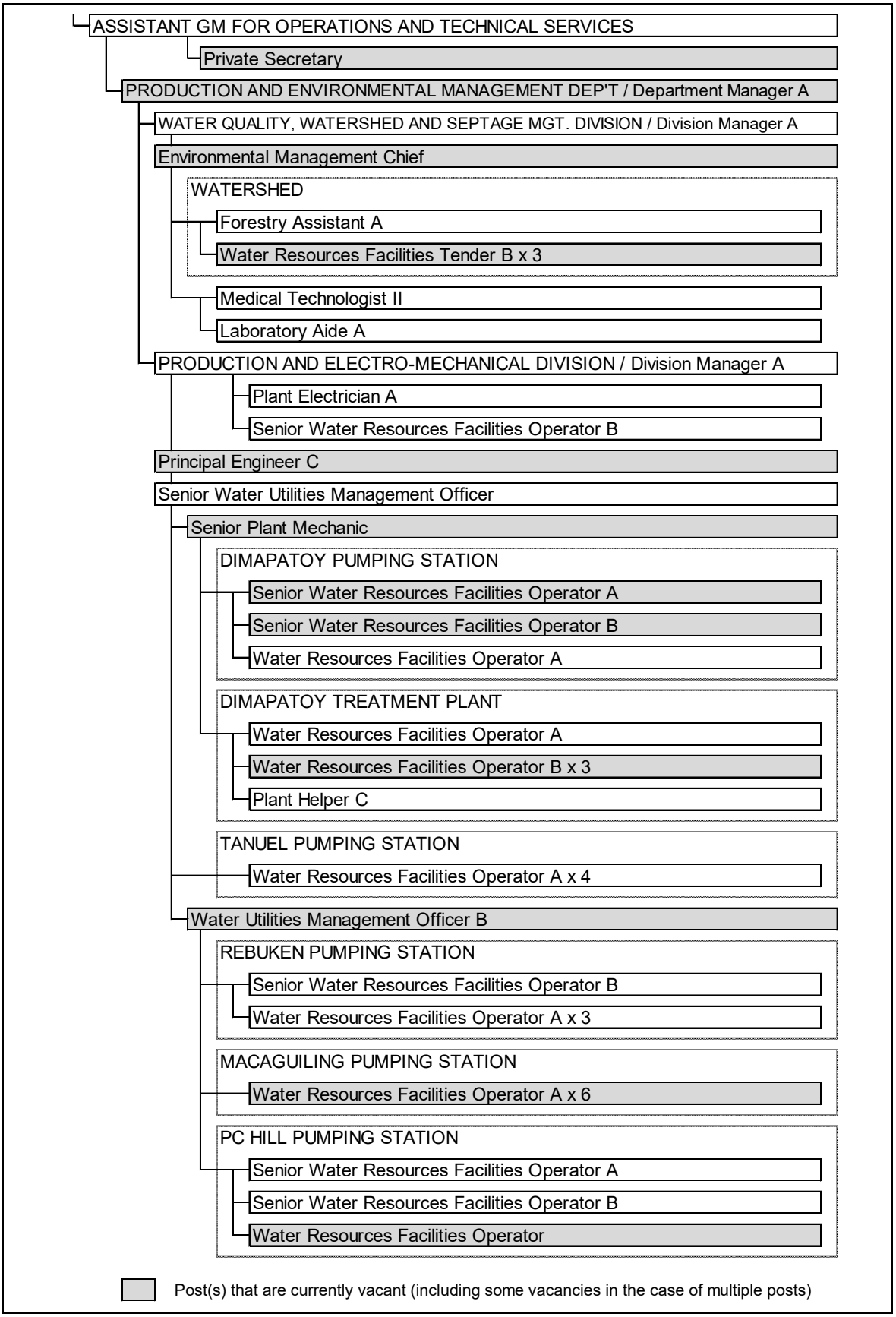
Source: Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-5 MCWD's Organizational Chart (Commercial Department)



Source: Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-6 MCWD's Organizational Chart (Engineering and Maintenance Department)



Source: Rearranged by the JICA Survey Team based on the MCWD's Organizational Chart

Figure 4-1-7 MCWD's Organizational Chart (Production and Environmental Mgt. Dep't)

4-1-2 Number of Employees

Table 4-1-1 shows changes in the number of MCWD's employees from FY2017 to FY2021. While the total number of planned staff posts is 234 since 2018, the number of staff posts occupied as of the end of December 2021 is 162 (occupancy rate 69.2%) as permanent employees and has remained flat. If 60 casual employees are added, which are increasing year by year, the number of both permanent and casual employees is 222 (94.9% of the total number of planned staff posts).

As of FY2021, there are 39,042 active connections, so the number of connections per staff is 176 (Reference: the LWUA standard value is 120 or more) and the number of staff per 1,000 connections is 5.69. Both MCWD's staff productivity values have deteriorated by about 10% in the past five years, but still remain high.

Table 4-1-1 Changes in MCWD's Employees and Staff Productivity from FY2017 to FY2021

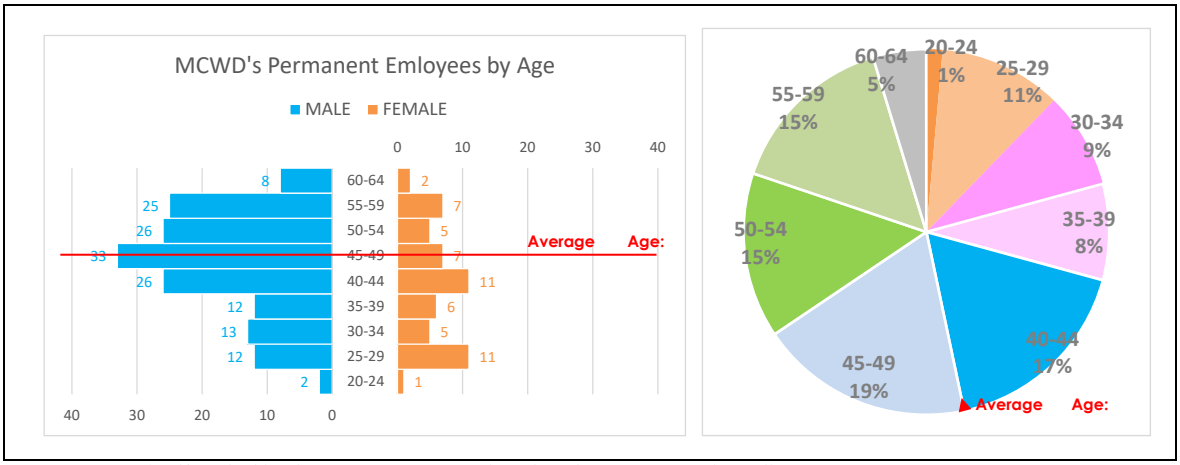
	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
Total No. of Planned Staff Position	198	234	234	234	234	36	18.2%
Permanent Employees							
Occupied	157	165	166	160	162	5	3.2%
Vacant	41	69	68	74	72	31	75.6%
Occupancy Ratio	79.3%	70.5%	70.9%	68.4%	69.2%	-10.1	-
Casual Employees	12	24	29	45	60	48.0	400.0%
Permanent & Casual Employees							
Total No. of Employees	169	189	195	205	222	53	31.4%
Total Employees / Total Position	85.4%	80.8%	83.3%	87.6%	94.9%	9.5	-
Staff Productivity							
Active Connections	33,069	34,776	36,481	37,825	39,042	5,973	18.1%
Per-Staff Active Connections	196	184	187	185	176	-20	-10.1%
Per-1,000 Connections Staff	5.11	5.43	5.35	5.42	5.69	0.58	11.3%

Source: Summarized/analyzed by the JICA Survey Team based on the MCWD annual reports

4-1-3 MCWD by Employee Age

As of FY2022, the average age of MCWD's permanent employees (the number of valid data: 212) is 44.5 years old, and Figure 4-1-8 shows the number of employees and composition by age. Employees aged 40 or over account for 70% of the total, and recruitment of employees aged under 40 is an issue. The MCWD deals with the case of post vacancies due to retirement by promotion, new recruitment and appointment of casual employees to permanent employees.

Out of 212 permanent employees, 157 are male (74.1%) and 55 are female (25.9%). With the average age as the boundary, the number of female is 21 (18.6%) for employees aged 45 and over, and 34 (34.3%) for employees aged under 45, which indicates that gender equality is progressing among young generation.



Source: Summarized/graphed by the JICA Survey Team based on the MCWD employee list

Figure 4-1-8 MCWD's Permanent Employees and Composition by Age

4-2 Organizational Development

In accordance with the LWUA guideline, the organizational will be reviewed and structured together with increase in the number of employees including casual ones in line with future expansion of water supply facilities and service areas, and enlargement of the number of connections as well.

Although the MCWD does not have a comprehensive program for human resources development and skill/knowledge succession, the MCWD provides all employees with training at least once a year, and customary on-the-job (OJT) in routine works and utilization of successor development plans when retirement.

In-Service Group Training (Mental Health)

In-Service Group Training (Gender)

Source: JICA Survey Team

Photo 4-2-1 MCWD's Trainings

The MCWD also provides eligible employees with the opportunity to participate in external trainings, however it is subject to budget and execution. External trainings include technical training for junior plumbers, as well as training program provided by LWUA (such as government procurement, policy making, water supply business plan and cash flow analysis, gender and development, non-revenue water reduction, water quality control, water safety plan, hydraulic analysis and EPANET, commercial practices system, meter reading and billing, etc.), and also training program provided by the Civil

Service Commission (CSC) (such as leave benefit management, supervisory development, omnibus regulation about appointment and human resources activities, etc.).

4-3 Water Rates

As of November 2022, the water rates revised in 2006 have remained unchanged in the MCWD for 16 years, shown in Table 4-3-1. A water rates schedule is "progressive one by customer classification and meter diameter"; the rate is fixed for consumption of less than 11 m^3 as basic charge and increases every 10 m^3 for consumption of 11 m^3 or more. The MCWD has seven customer categories: "Residential", "Government", "Pure Commercial", "Industrial", "Semi-Commercial A", "Semi-Commercial B" and "Bulk/Wholesale".

Although there were movement to revise the rates twice in 2008 and 2011, they have not been revised to date due to the views of the Board of Directors that the MCWD is not able to persuasively explain to the citizens about the water rate revisions due to insufficient water supply services. However, the rates revision in FY2023 has been discussed by the Board of Directors.

Table 4-3-1 Water Rates Schedule of MCWD (January 2006 up to now as of November 2022)

CLASSIFICATION	Meter Size	Minimum Charge	COMMODITY CHARGES			
		0 - 10 Cu.m.	11 - 20 Cu.m.	21 - 30 Cu.m.	31 - 40 Cu.m.	41 - up
Residential / Government	1/2 "	184.00	20.35	23.50	26.70	29.95
	3/4"	294.40	20.35	23.50	26.70	29.95
	1"	588.80	20.35	23.50	26.70	29.95
	1 1/2"	1,472.00	20.35	23.50	26.70	29.95
	2"	3,680.00	20.35	23.50	26.70	29.95
	3"	6,624.00	20.35	23.50	26.70	29.95
	4"	13,248.00	20.35	23.50	26.70	29.95
	6"	22,080.00	20.35	23.50	26.70	29.95
	8"	35,328.00	20.35	23.50	26.70	29.95
	10"	50,784.00	20.35	23.50	26.70	29.95
Pure Commercial/ Industrial	1/2 "	368.00	40.70	47.00	53.40	59.90
	3/4"	588.80	40.70	47.00	53.40	59.90
	1"	1,177.60	40.70	47.00	53.40	59.90
	1 1/2"	2,944.00	40.70	47.00	53.40	59.90
	2"	7,360.00	40.70	47.00	53.40	59.90
	3"	13,248.00	40.70	47.00	53.40	59.90
	4"	26,496.00	40.70	47.00	53.40	59.90
	6"	44,160.00	40.70	47.00	53.40	59.90
	8"	70,656.00	40.70	47.00	53.40	59.90
	10"	101,568.00	40.70	47.00	53.40	59.90
Semi - Commercial A	1/2 "	322.00	35.60	41.10	46.70	52.40
	3/4"	515.20	35.60	41.10	46.70	52.40
	1"	1,030.40	35.60	41.10	46.70	52.40
	1 1/2"	2,576.00	35.60	41.10	46.70	52.40
	2"	6,440.00	35.60	41.10	46.70	52.40
	3"	11,592.00	35.60	41.10	46.70	52.40
	4"	23,184.00	35.60	41.10	46.70	52.40
	6"	38,640.00	35.60	41.10	46.70	52.40
	8"	61,824.00	35.60	41.10	46.70	52.40
	10"	88,872.00	35.60	41.10	46.70	52.40
Semi - Commercial B	1/2 "	276.00	30.50	35.25	40.05	44.90
	3/4"	441.60	30.50	35.25	40.05	44.90
	1"	883.20	30.50	35.25	40.05	44.90
	1 1/2"	2,208.00	30.50	35.25	40.05	44.90
	2"	5,520.00	30.50	35.25	40.05	44.90
	3"	9,936.00	30.50	35.25	40.05	44.90
	4"	19,872.00	30.50	35.25	40.05	44.90
	6"	33,120.00	30.50	35.25	40.05	44.90
	8"	52,992.00	30.50	35.25	40.05	44.90
	10"	76,176.00	30.50	35.25	40.05	44.90
Bulk/Wholesale	1/2 "	552.00	61.05	70.50	80.10	89.85
	3/4"	883.20	61.05	70.50	80.10	89.85
	1"	1,766.40	61.05	70.50	80.10	89.85
	1 1/2"	4,416.00	61.05	70.50	80.10	89.85
	2"	11,040.00	61.05	70.50	80.10	89.85
	3"	19,872.00	61.05	70.50	80.10	89.85
	4"	39,744.00	61.05	70.50	80.10	89.85
	6"	66,240.00	61.05	70.50	80.10	89.85
	8"	105,984.00	61.05	70.50	80.10	89.85
	10"	152,352.00	61.05	70.50	80.10	89.85

Source: MCWD

Remarks: Semi-Commercial A customers correspond to the customers who indirectly use water in their daily commercial activities (e.c. office, grocery, barbershop, pharmacy) and medical institutions, and Semi-Commercial B customers correspond to the small business operating customers. Industrial customer is only one “Cotabato Light And Power Company” in the MCWD’s service area.

4-4 Billing and Collection of Water Bill

4-4-1 Customer Classification by Bills Issued, Amount Billed and Amount of Water Billed per Month

Table 4-4-1 shows changes in the number of bills issued, the amount billed in PHP and the amount of water billed in m^3 per month by customer classification and their percentages of each current year from FY2017 to FY2021. Over the five years, the total number of bills issued increased by 119.1%, and both the amount billed and the amount of water billed increased by 125.5%. The percentage of each customer classification differs in each item, but there are no significant changes over the five years except for industrial customer. In FY2021, the ratio of residential customers to all customers is the highest, with 92.2% in the number of bills issued, 71.6% in the amount billed, and 83.4% in the amount of water billed.

Table 4-4-1 Changes in Bills Issued, Amount Billed and Amount of Water Billed per Month by Customer Classification and their Percentages

	2017		2018		2019		2020		2021		Increase
MONTHLY BILLS-ISSUED AND PERCENTAGE BY CUSTOMER CLASSIFICATION											
Residential	29,977	92.5%	31,534	92.4%	32,991	92.2%	34,377	92.2%	35,594	92.2%	118.7%
Government	388	1.2%	403	1.2%	408	1.1%	420	1.1%	425	1.1%	109.7%
Pure Commercial	1,074	3.3%	1,143	3.3%	1,238	3.5%	1,311	3.5%	1,375	3.6%	128.0%
Industrial	2	0.0%	2	0.0%	2	0.0%	2	0.0%	2	0.0%	100.0%
Semi-Commercial A	783	2.4%	853	2.5%	929	2.6%	989	2.7%	1,017	2.6%	129.8%
Semi Commercial B	197	0.6%	201	0.6%	198	0.6%	201	0.5%	194	0.5%	98.6%
Total	32,420	100.0%	34,135	100.0%	35,766	100.0%	37,300	100.0%	38,606	100.0%	**119.1%**
MONTHLY AMOUNT-BILLED (,000PHP) AND PERCENTAGE BY CUSTOMER CLASSIFICATION											
Residential	13,843	69.7%	15,623	69.1%	16,078	68.6%	17,609	71.7%	17,850	71.6%	129.0%
Government	1,077	5.4%	1,324	5.9%	1,369	5.8%	1,384	5.6%	1,491	6.0%	138.4%
Pure Commercial	3,730	18.8%	4,239	18.7%	4,491	19.2%	4,164	17.0%	4,237	17.0%	113.6%
Industrial	90	0.5%	76	0.3%	67	0.3%	28	0.1%	12	0.0%	13.6%
Semi-Commercial A	933	4.7%	1,130	5.0%	1,210	5.2%	1,159	4.7%	1,134	4.5%	121.6%
Semi Commercial B	184	0.9%	217	1.0%	225	1.0%	218	0.9%	215	0.9%	117.1%
Total	19,857	100.0%	22,609	100.0%	23,440	100.0%	24,562	100.0%	24,940	100.0%	**125.6%**
MONTHLY AMOUNT WATER-BILLED (m^3) AND PERCENTAGE BY CUSTOMER CLASSIFICATION											
Residential	633,578	82.5%	709,375	82.0%	731,857	81.6%	791,694	83.5%	803,776	83.4%	126.9%
Government	38,429	5.0%	46,788	5.4%	48,380	5.4%	48,159	5.1%	50,960	5.3%	132.6%
Pure Commercial	67,634	8.8%	76,654	8.9%	81,488	9.1%	75,291	7.9%	77,013	8.0%	113.9%
Industrial	1,397	0.2%	1,159	0.1%	1,006	0.1%	358	0.0%	82	0.0%	5.9%
Semi-Commercial A	21,402	2.8%	25,438	2.9%	27,336	3.0%	26,169	2.8%	25,826	2.7%	120.7%
Semi Commercial B	5,288	0.7%	6,150	0.7%	6,324	0.7%	6,140	0.6%	6,066	0.6%	114.7%
Total	767,727	100.0%	865,563	100.0%	896,392	100.0%	947,810	100.0%	963,723	100.0%	**125.5%**

Source: Summarized/analyzed by the JICA Survey Team based on the MCWD data

Remarks: The number of bills (equivalent to active connections) is calculated by dividing the number of bills issued a year by 12 months, so differs from the number of active connections in the annual reports (as of the end of December each fiscal year).

4-4-2 Average Monthly Amount Billed and Amount of Water Billed per Connection by Customer Classification

Table 4-4-2 shows the average monthly amount billed in PHP and amount of water billed in m^3 per connection by customer classification. As of FY2021, those of residential customers, which account for most of the customers, are approximately PHP500 and 22.58 m^3.

Table 4-4-2 Average Monthly Amount Billed and Amount of Water Billed per Connection by Customer Classification

	2017	2018	2019	2020	2021
MONTHLY AVE. AMOUNT-BILLED (PHP) PER-CONNECTION BY CUSTOMER CLASSIFICATION (PHP/CONNECT./MONTH)					
Residential	461.78	495.45	487.35	512.23	501.50
Government	2,778.23	3,288.27	3,351.52	3,295.00	3,506.69
Pure Commercial	3,474.41	3,709.06	3,627.66	3,175.71	3,082.60
Industrial	45,111.47	37,983.37	33,418.49	14,124.03	6,121.97
Semi-Commercial A	1,191.35	1,325.50	1,303.04	1,171.70	1,115.90
Semi Commercial B	933.76	1,078.91	1,137.81	1,085.37	1,109.09
Total Average	612.48	662.33	655.38	658.50	646.01
MONTHLY AVE. AMOUNT WATER-BILLED (m^3) PER-CONNECTION BY CUSTOMER CLASSIFICATION (m^3/CONNECT./MONTH					
Residential	21.14	22.50	22.18	23.03	22.58
Government	99.15	116.24	118.46	114.69	119.88
Pure Commercial	63.00	67.08	65.82	57.42	56.03
Industrial	698.29	579.29	503.08	178.92	41.17
Semi-Commercial A	27.32	29.83	29.43	26.46	25.41
Semi Commercial B	26.90	30.57	31.99	30.51	31.29
Total Average	23.68	25.36	25.06	25.41	24.96

Source: Analysis by JICA Survey Team based on MCWD data (Commercial Department)

As shown in Table 4-4-3, the 2018 Family Income and Expenditure Survey (FIES 2018) reports that the percentage of utilities expense (water, electricity, gas and other fuels) for average monthly family expenditure (PHP10,561) is 6.46% in BARMM. If the same reported value is applied, the percentage of average monthly amount billed of residential customer in MCWD (PHP500) for average monthly family expenditure is 4.73% in BARMM. In addition, income and expenditure in BARMM are both about half of the national average, but according to the survey, the Gini coefficient is 0.4267 at the national level and 0.2819 in BARMM, indicating that income disparity is lower in BARMM.

Table 4-4-3 Data from FIES 2018

Items	National	BARMM
Average monthly family income (PHP)	26,112	13,426
Average monthly family expenditure (PHP)	19,887	10,561
Percentage of utilities expense for average monthly family expenditure	8.16%	6.46%
Percentage of average monthly amount billed of a residential customer in MCWD (PHP500) for average monthly family expenditure	-	4.73% (=500/10,561)
Gini coefficient	0.4267	0.2819
Family income sources and percentage	Wage/Salary 56.57% Entrepreneurial 19.85% Other sources 23.57%	Wage/Salary 20.67% Entrepreneurial 68.80% Other sources 10.53%

Source: FIES 2018

4-4-3 Collection Ratio of Water Bill (Sales)

Table 4-4-4 shows the collection ratio of water bill (sales) based on the amount billed in PHP. The MCWD has achieved about 90% of the collection ratios for both: the sum of the amount billed of the current fiscal year and carry-over from the previous fiscal year, and the amount billed of the current fiscal year only.

Table 4-4-4 Collection Ratio of Water Bill (Sales)

(Million PHP)	2017		2018		2019		2020		2021	
	Amount Billed	Amount Collected	Amount Billed	Amount Collected	Amount Billed	Amount Collected	Amount Billed	Amount Collected	Amount Billed	Amount Collected
CURRENT BILLING & OLD ACCOUNTS										
Metered Sales	273.73	234.83	311.37	268.50	325.53	280.57	335.83	288.59	337.70	300.16
Collection Efficiency		85.8%		86.2%		86.2%		85.9%		88.9%
CURRENT BILLING ONLY										
Metered Sales	238.28	220.20	271.30	247.66	281.29	261.48	294.75	265.22	299.28	273.50
Collection Efficiency		92.4%		91.3%		93.0%		90.0%		91.4%

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

4-5 Customer Services and Public Relations

The Commercial Department mainly provides the following customer services:

- Reception works (Investigation and registration of new connection, cancellation, suspension, reconnection, and corresponding to complaints, etc.))
- Meter installation, service opening and closing
- Meter reading
- Bill adjustment and billing
- Measures against arrears of customers
- Measures against illegal cases such as unauthorized connections, meter bypassing, tampering, etc.

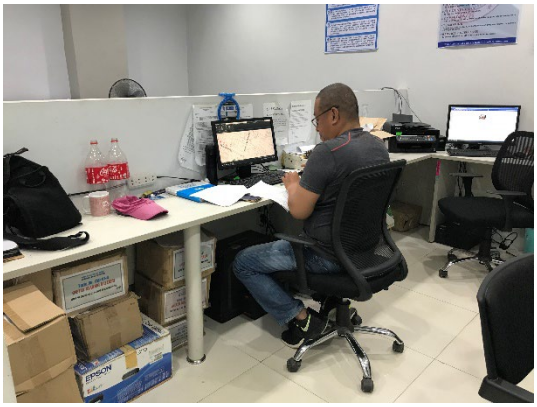
The MCWD uses conventional mechanical (velocity type) water meters, and in recent years has procured small diameter meters from ARAD Israeli company. In addition to a regulation that water meters should be replaced every five years, the MCWD has a quality control system by the Meter Shop section under the General Services Division that conducts accuracy tests on newly procured meters and existing malfunctioning meters for returning, exchanging or repairing according to certain conditions. However, there seems to currently be no attempt to utilize the results of accuracy tests comprehensively for statistical and systematic strategies and decision-making regarding water meters.

Water meter reading is performed monthly by manual recording and input by meter readers (staff), and the meters are read (and bills are distributed) using motorcycles in order each of 20 zones. Payments by customers are available at the tellers, by credit cards, e-money, mobile payments, etc.

Regarding the billing and collection system, the on-premise type “JBU Systems Billing and Collection” was introduced in 2006, and has been used jointly by the Commercial Department (meter reading and billing) and the Finance Services Department (collection). The MCWD is considering introducing a new system using handy (portable) terminals in the near future.

There is no existing structure in place to carry out specialized and strategic public relations activities due to vacancies in all relevant posts in the Public Relations section of the Office of the General Manager. However, utilizing the tools of the website, SNS, and local media (radio, newspaper, etc.), necessary

information such as water supply planned suspension and rationing is disseminated to citizens, while reports and opinions from citizens are accepted.

	
Counters for New Connection Registration	Orientation to a New Connection Customer
	
MCWD's Official Water Meter (ARAD, Israel)	Test Bench for Meter Accuracy (Meter Shop)
	
Checking a Location of Water Meter Installation in CAD System	A Vehicle of Water Meter Installation Team

	
Installation Work of Water Meter (at Stub-out)	Pay Counters (under Finance Department)

Source: JICA Survey Team

Photo 4-5-1 Divisions and Activities related to Customer Services

4-6 Financial Statements and Recommendations for Improvement

4-6-1 Financial Statements of MCWD

The MCWD prepares "Annual Financial Report" for each fiscal year (January to December) for clarification and disclosure of the MCWD's financial situation.

As a Government Owned and Controlled Corporation (GOCC) and based on the financial principle "Full-cost pricing (recovery)", the report consists of financial statements: "Statement of Financial Position", "Statement of Income and Expenses" and "Statement of Cash Flow" in conformity to "Philippine Financial Reporting Standards (PFRS)" equivalent to "International Financial Reporting Standards (IFRS)".

Table 4-6-1 to Table 4-6-4 show financial statements (summary) for the fiscal years 2017 to 2021.

Table 4-6-1 Statement of Financial Position (Summary) from FY2017 to FY2021

(PHP)	2017	2018	2019	2020	2021
ASSETS	**601,025,966.60**	**662,768,590.59**	**711,840,212.99**	**769,978,869.14**	**808,543,314.70**
CURRENT ASSETS	**222,799,073.67**	**248,194,114.24**	**255,519,128.06**	**283,494,088.53**	**306,092,185.95**
CASH ON HAND / CASH IN BANK (CASH)	**166,237,957.99**	**206,212,436.83**	**196,843,511.80**	**217,069,895.65**	**234,000,328.00**
RECEIVABLES (NET)	**30,446,510.58**	**33,131,422.19**	**33,261,022.04**	**38,514,401.85**	**36,652,390.60**
INVENTORIES	**16,108,817.63**	**5,959,308.35**	**18,728,495.33**	**22,124,723.60**	**22,325,456.30**
PREPAYMENTS & DEFERRED CHARGES	**6,651,418.72**	**436,960.03**	**3,759,348.77**	**2,721,873.28**	**9,948,207.70**
GUARANTY DEPOSITS	**2,801,656.90**	**2,235,179.96**	**2,222,195.96**	**2,400,970.84**	**2,464,470.84**
OTHER ASSETS	**552,711.85**	**218,806.88**	**704,554.16**	**662,223.31**	**701,332.51**
NON-CURRENT ASSETS	**378,226,892.93**	**414,574,476.35**	**456,321,084.93**	**486,484,780.61**	**502,451,128.75**
LONG TERM INVESTMENTS	**45,529,826.72**	**46,561,245.64**	**48,424,368.17**	**58,289,443.75**	**23,669,181.47**
PROPERTY PLANT & EQUIPMENT	**300,805,428.59**	**331,190,299.16**	**366,397,972.57**	**383,825,111.02**	**432,688,703.53**
Land	*39,205,694.18*	*39,205,694.18*	*39,205,694.18*	*37,229,643.66*	*57,787,728.66*
Other Land Improvement	*6,140,684.81*	*5,570,573.44*	*5,832,372.41*	*10,165,569.25*	*13,835,215.16*
Less: Accumulated Depreciation - Other Land Improvements	*-4,657,308.30*	*-4,605,536.91*	*-4,694,603.94*	*-5,358,013.73*	*-6,239,306.03*
Infrastructure Assets	*136,551,310.87*	*136,551,310.87*	*136,811,403.10*	*138,840,481.49*	*141,267,514.25*
Less: Accumulated Depreciation - Infrastructure Assets	*-88,965,810.65*	*-91,179,632.01*	*-93,655,804.16*	*-96,413,411.80*	*-98,962,272.44*
Building and other Structures	*239,652,608.26*	*239,458,603.69*	*240,891,106.97*	*253,197,603.85*	*296,247,200.65*
Less: Accumulated Depreciation - Building and other Structures	*-96,229,800.13*	*-99,308,163.27*	*-103,936,458.36*	*-109,035,086.49*	*-116,481,019.60*
Machinery and Equipment	*116,092,722.85*	*133,621,128.66*	*154,354,246.66*	*164,124,580.32*	*174,407,495.36*
Less: Accumulated Depreciation - Machinery and Equipment	*-69,580,242.50*	*-70,081,473.40*	*-77,356,353.69*	*-89,211,659.05*	*-100,488,773.00*
Transportation Equipment	*13,157,416.95*	*21,390,502.95*	*26,608,571.50*	*26,608,571.50*	*28,478,291.50*
Less: Accumulated Depreciation - Transportation Equipment	*-10,495,666.79*	*-11,259,567.11*	*-11,878,246.57*	*-13,439,401.29*	*-15,019,832.37*
Furniture, Fixtures and Books	*757,070.43*	*635,556.88*	*1,312,971.88*	*1,468,651.88*	*6,382,756.38*
Less: Accumulated Depreciation - Furniture, Fixtures and Books	*-293,991.94*	*-297,445.26*	*-373,847.82*	*-486,571.74*	*-919,386.49*
PPE Sub-Total	*551,557,508.35*	*576,433,370.67*	*605,016,366.70*	*631,635,101.95*	*718,406,201.96*
Less: Accumulated Depreciation PPE Sub-Total	*-270,222,820.31*	*-276,731,817.96*	*-291,895,314.54*	*-313,944,144.10*	*-338,110,589.93*
Net Book Value	*281,334,688.04*	*299,701,552.71*	*313,121,052.16*	*317,690,957.85*	*380,295,612.03*
Construction in Progress	*19,470,740.55*	*31,488,746.45*	*53,276,920.41*	*66,134,153.17*	*52,393,091.50*
INTANGIBLE ASSETS	**654,399.04**	**1,037,618.77**	**1,322,463.48**	**1,341,062.50**	**633,009.19**
Computer Software	*253,095.00*	*476,269.00*	*476,269.00*	*476,269.00*	*1,107,154.50*
Less: Accumulated Depreciation - Computer Software	*-225,785.50*	*-428,642.10*	*-428,642.10*	*-428,642.10*	*-474,145.31*
Net Book Value	*27,309.50*	*47,626.90*	*47,626.90*	*47,626.90*	*633,009.19*
Development in Progress	*627,089.54*	*989,991.87*	*1,274,836.58*	*1,293,435.60*	*0.00*
OTHER NON-CURRENT ASSETS	**31,237,238.58**	**35,785,312.78**	**40,176,280.71**	**43,029,163.34**	**45,460,234.56**
Items in Transit	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Restricted Funds	*31,184,874.47*	*34,106,806.05*	*37,740,361.01*	*40,593,243.64*	*42,782,239.43*
Others	*52,364.11*	*1,678,506.73*	*2,435,919.70*	*2,435,919.70*	*2,677,995.13*
LIABILITIES	**113,108,592.29**	**96,102,751.57**	**74,904,807.62**	**83,657,791.00**	**80,081,939.88**
CURRENT LIABILITIES	**38,661,917.68**	**45,418,061.66**	**22,097,021.53**	**21,419,628.83**	**13,110,546.64**
PAYABLE	9,288,409.19	5,141,749.58	10,786,916.53	8,480,506.89	6,650,140.26
BILLS/BONDS/LOANS PAYABLE	23,185,516.00	25,233,692.33	3,014,478.45	0.00	0.00
INTER-AGENCY PAYABLES	438,770.86	38,168.04	100,707.64	91,317.01	327,233.39
INTER-AGENCY PAYABLES (OTHERS)	4,450,612.92	5,705,861.12	6,885,398.65	8,347,643.45	0.00
OTHER PAYABLE	1,298,608.71	9,298,590.59	1,309,520.26	4,500,161.48	6,133,172.99
NON-CURRENT LIABILITIES	**74,446,674.61**	**50,684,689.91**	**52,807,786.09**	**62,238,162.17**	**66,971,393.24**
LONG TERM LIABILITIES	30,843,042.69	4,026,453.46	0.00	0.00	0.00
TRUST LIABILITIES	32,789,802.65	34,770,713.00	38,610,304.71	46,154,140.13	48,154,673.09
DEFERRED CREDITS - OTHERS	360,823.70	441,113.50	625,893.70	629,819.03	787,728.76
PROVISIONS	10,453,005.57	11,446,409.95	13,571,587.68	15,454,203.01	18,028,991.39
EQUITY (NET ASSET/WORTH)	**487,917,374.31**	**566,665,839.02**	**636,935,405.37**	**686,321,078.14**	**728,461,374.82**
GOVERNMENT EQUITY	**26,978,966.81**	**26,978,966.81**	**26,978,966.81**	**26,978,966.81**	**26,978,966.81**
RETAINED EARNINGS	**460,938,407.50**	**539,686,872.21**	**609,956,438.56**	**659,342,111.33**	**701,482,408.01**
RETAINED EARNINGS - BEGINNINGS	388,257,541.63	460,938,407.50	539,686,872.21	609,956,438.56	659,342,111.33
LESS: PRIOR PERIOD ADJUSTMENTS	-4,866,406.18	-7,311,598.94	-8,333,582.88	-17,449,906.75	-12,035,325.18
ADD: NET INCOME FOR THE PERIOD	77,547,272.05	86,060,063.65	78,603,149.23	66,835,579.52	54,175,621.86

Source: MCWD Annual Financial Reports

Table 4-6-2 Statement of Income and Expenses (Summary) from FY2017 to FY2021

(PHP)	2017	2018	2019	2020	2021
REVENUE	**251,613,153.31**	**290,672,940.67**	**301,264,537.29**	**308,342,517.14**	**316,174,655.34**
SERVICE INCOME	**9,498,909.85**	**10,620,644.68**	**10,650,998.87**	**8,052,392.47**	**10,744,065.64**
OTHERS	2,416,442.96	2,724,253.67	2,613,400.08	2,376,213.32	2,473,730.77
FINES & PENALTIES	7,082,466.89	7,896,391.01	8,037,598.79	5,676,179.15	8,270,334.87
BUSINESS INCOME	**240,442,695.89**	**273,564,891.80**	**285,378,829.41**	**298,161,700.53**	**301,540,747.38**
INCOME FROM WATERWORKS SYSTEMS	238,190,064.18	271,207,028.87	281,188,677.96	294,663,479.95	299,202,017.15
INTEREST INCOME	2,252,631.71	2,357,862.93	4,190,151.45	3,498,220.58	2,338,730.23
OTHER NON-OPERATING INCOME	**1,671,547.57**	**6,487,404.19**	**5,234,709.01**	**2,128,424.14**	**3,889,842.32**
MISCELLANEOUS INCOME	1,389,836.95	6,487,404.19	5,234,709.01	2,128,424.14	3,889,842.32
ASSISTANCE AND SUBSIDY (e.c. LGUs)	0.00	0.00	0.00	0.00	0.00
GRANTS AND DONATIONS	0.00	0.00	0.00	0.00	0.00
GAINS (SALE OF PPE)	281,710.62	0.00	0.00	0.00	0.00
CURRENT OPERATING EXPENSES	**174,065,881.26**	**204,612,877.02**	**222,661,388.06**	**241,506,937.62**	**261,999,033.48**
PERSONNEL SERVICES	**84,921,228.87**	**84,431,164.34**	**93,055,991.05**	**109,279,302.15**	**116,341,334.63**
SALARIES AND WAGES	45,749,564.16	44,258,515.67	51,129,379.70	57,900,547.24	62,320,426.76
OTHER COMPENSATION	28,398,922.97	29,372,618.36	29,191,198.16	36,748,354.14	36,152,320.42
PERSONNEL BENEFIT CONTRIBUTIONS	5,863,287.28	6,181,891.10	7,249,356.73	8,134,383.40	10,163,266.61
OTHER PERSONNEL BENEFITS	4,909,454.46	4,618,139.21	5,486,056.46	6,496,017.37	7,705,320.84
MAINTENANCE AND OTHER OPERATING EXPENSES	**71,748,900.42**	**101,928,903.05**	**109,097,947.68**	**110,626,524.99**	**119,837,816.76**
TRAVELING EXPENSES	4,890,862.39	4,126,064.80	5,042,685.81	1,009,109.89	561,658.00
TRAINING AND SCHOLARSHIP EXPENSES	815,659.93	1,102,729.30	679,900.00	383,473.38	745,708.94
SUPPLIES AND MATERIALS EXPENSES	14,052,486.83	12,852,727.17	18,538,643.45	17,948,914.06	23,537,492.56
UTILITY EXPENSES	35,757,810.52	61,419,785.36	63,319,960.00	66,148,163.78	3,010,570.25
COMMUNICATION EXPENSES	615,036.94	712,933.12	645,698.44	612,138.50	575,883.28
AWARDS/REWARDS, PRIZES AND INDEMNITIES	134,792.00	133,500.00	119,500.00	95,953.23	135,250.00
SURVEY, RESEARCH, EXPLORATION AND DEVELOPMENT EX	0.00	187,000.00	0.00	0.00	55,000.00
GENERATION, TRANSMISSION AND DISTRIBUTION EXPENSES	0.00	0.00	0.00	0.00	66,691,995.93
CONFIDENTIAL, INTELIGENCE, EXTRAORDINARY & MISCELLA	1,033,093.55	1,165,427.43	1,035,734.47	1,006,549.44	1,328,107.74
PROFESSIONAL EXPENSES	131,982.65	4,684,020.60	3,312,827.81	4,104,558.85	3,248,872.71
GENERAL SERVICES	2,765,188.00	2,247,731.74	2,648,616.00	3,380,061.32	3,362,306.60
REPAIRS AND MAINTENANCE	4,376,753.34	5,125,859.05	5,235,537.24	6,819,149.02	7,454,314.07
FINANCIAL ASSISTANCE/SUBSIDY/CONTRIBUTION - OTHERS	59,340.00	21,500.00	2,087.50	939,798.60	38,250.00
TAXES, INSURANCE, PREMIUMS AND OTHER FEES	5,353,757.12	6,397,426.48	6,601,950.37	7,107,626.40	7,673,831.24
OTHER MAINTENANCE AND OPERATING EXPENSES	1,762,137.15	1,752,198.00	1,914,806.59	1,071,028.52	1,418,575.44
FINANCIAL EXPENSES	**3,801,341.53**	**2,479,321.59**	**1,184,070.21**	**229,599.64**	**290,268.34**
INTEREST EXPENSE	3,555,452.60	2,276,999.83	923,053.59	17,066.01	0.00
BANK CHARGES	355.00	0.00	150.00	0.00	1,225.00
OTHER FINANCIAL CHARGES	245,533.93	202,321.76	260,866.62	212,533.63	289,043.34
NON-CASH EXPENSES	**13,594,410.44**	**15,773,488.04**	**19,323,379.12**	**21,371,510.84**	**25,529,613.75**
DEPRECIATION	13,583,530.07	15,649,335.83	18,071,702.37	21,221,026.21	24,419,689.12
AMORTIZATION	3,888.00	0.00	0.00	0.00	45,503.21
IMPAIRMENT LOSSES	6,992.37	55,432.35	22,657.94	150,484.63	1,003,695.26
LOSSES	0.00	68,719.86	1,229,018.81	0.00	60,726.16
SURPLUS (DEFICIT) *PROFIT(LOSS)	**77,547,272.05**	**86,060,063.65**	**78,603,149.23**	**66,835,579.52**	**54,175,621.86**

Source: MCWD Annual Financial Reports

Table 4-6-3 Statement of Cash Flow (Summary) from FY2017 to FY2021

(PHP)	2017	2018	2019	2020	2021
CASH FLOWS FROM OPERATING ACTIVITIES	**63,871,353.99**	**93,139,290.90**	**52,025,470.55**	**41,831,528.61**	**39,429,584.10**
CASH INFLOWS	250,796,982.46	287,930,235.52	301,116,533.19	303,535,154.07	322,030,729.26
CASH OUTFLOWS	186,925,628.47	194,790,944.62	249,091,062.64	261,703,625.46	282,601,145.16
CASH FLOWS FROM INVESTING ACTIVITIES	**-69,830,034.02**	**-26,119,499.33**	**-34,225,624.65**	**-18,573,600.30**	**-22,499,026.74**
CASH INFLOWS	1,818,477.72	965,825.10	1,362,974.85	1,461,886.22	45,477,880.25
CASH OUTFLOWS	71,648,511.74	27,085,324.43	35,588,599.50	20,035,486.52	67,976,906.99
CASH FLOWS FROM FINANCING ACTIVITIES	**-26,880,770.54**	**-27,045,312.73**	**-27,168,770.93**	**-3,031,544.46**	**-125.00**
CASH INFLOWS	73,737.50	100.00	0.00	0.00	0.00
CASH OUTFLOWS	26,954,508.04	27,045,412.73	27,168,770.93	3,031,544.46	125.00
INCREASE(DECREASE) IN CASH AND CASH EQUIVALENTS	**-32,839,450.57**	**39,974,478.84**	**-9,368,925.03**	**20,226,383.85**	**16,930,432.36**
EFFECTS OF EXCHANGE RATE CHANGES ON CASH AND CASH EQUIVALENT	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CASH AND CASH EQUIVALENTS, JANUARY 1	**199,077,408.56**	**166,237,957.99**	**206,212,436.83**	**196,843,511.80**	**217,069,895.65**
CASH AND CASH EQUIVALENTS, DECEMBER 31	**166,237,957.99**	**206,212,436.83**	**196,843,511.80**	**217,069,895.65**	**234,000,328.01**

Source: MCWD Annual Financial Reports

4-6-2 Financial Analysis: Overview

Table 4-6-4 to Table 4-6-6 show summaries of the financial statements with the amount and rate of increase/decrease from FY2017 to FY2021. Assets are increasing year by year, while liabilities are decreasing, and equity (mainly retained earnings) is also increasing year by year. In addition, although the amount is on a downward trend, surplus (or profit) has remained, and the operating cash flow: Plus, the investment cash flow: Minus, the financial cash flow: Minus (long-term liabilities seem to be almost fully redeemed in FY2021), so MCWD has kept a sound financial situation.

However, as shown in Figure 4-6-1, the rate of increase in operating expenses for the five-year period from FY2017 to FY2021 is approximately double the rate of increase in revenue (income), resulting in a 30.1% drop in surplus or profit. Similarly, as shown in Figure 4-6-2, cash flow from operating activities for the five-year period from FY2017 to FY2021 decreased by 38.3% due to the higher rate

of increase in cash outflow compared to cash inflow. Assuming that the current trend will simply continue in the future, MCWD's business operation will be in the red in 2030. Furthermore, if both investment and financing cash flows remain at the same level, operating cash flow will be minus from FY2025 as well as increase/decrease in cash and cash equivalents will also be minus. This means, although accumulated cash and cash equivalents will be sufficient for the time being, the situation is not optimistic such as facing running out of cash (bankruptcy in the black) sooner or later.

Table 4-6-4 Changes in Primary Items of Statement of Financial Position from FY2017 to FY2021

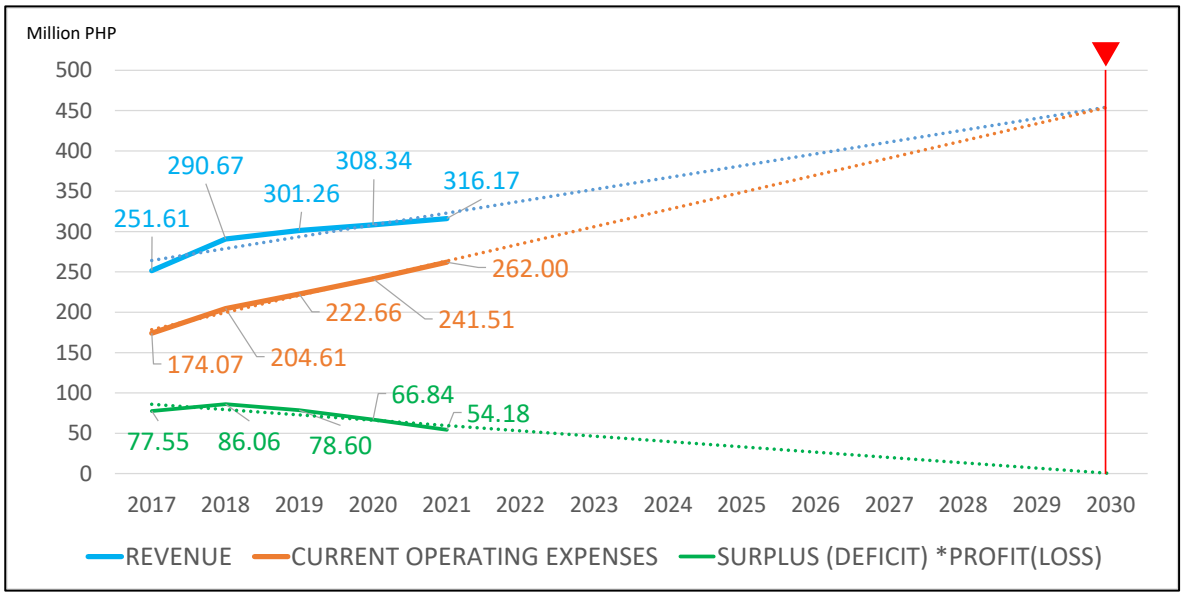
(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
ASSETS	601.03	662.77	711.84	769.98	808.54	207.52	34.5%
LIABILITIES	113.11	96.10	74.90	83.66	80.08	-33.03	-29.2%
EQUITY (NET ASSET/WORTH)	487.92	566.67	636.94	686.32	728.46	240.54	49.3%
GOVERNMENT EQUITY	26.98	26.98	26.98	26.98	26.98	0.00	0.0%
RETAINED EARNINGS	460.94	539.69	609.96	659.34	701.48	240.54	52.2%

Source : Analysis by JICA Survey Team based on MCWD annual financial reports

Table 4-6-5 Changes in Primary Items of Statement of Income and Expenses from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
REVENUE	251.61	290.67	301.26	308.34	316.17	64.56	25.7%
CURRENT OPERATING EXPENSES	174.07	204.61	222.66	241.51	262.00	87.93	50.5%
SURPLUS (DEFICIT) *PROFIT(LOSS)	77.55	86.06	78.60	66.84	54.18	-23.37	-30.1%

Source: Analysis by JICA Survey Team based on MCWD annual financial reports



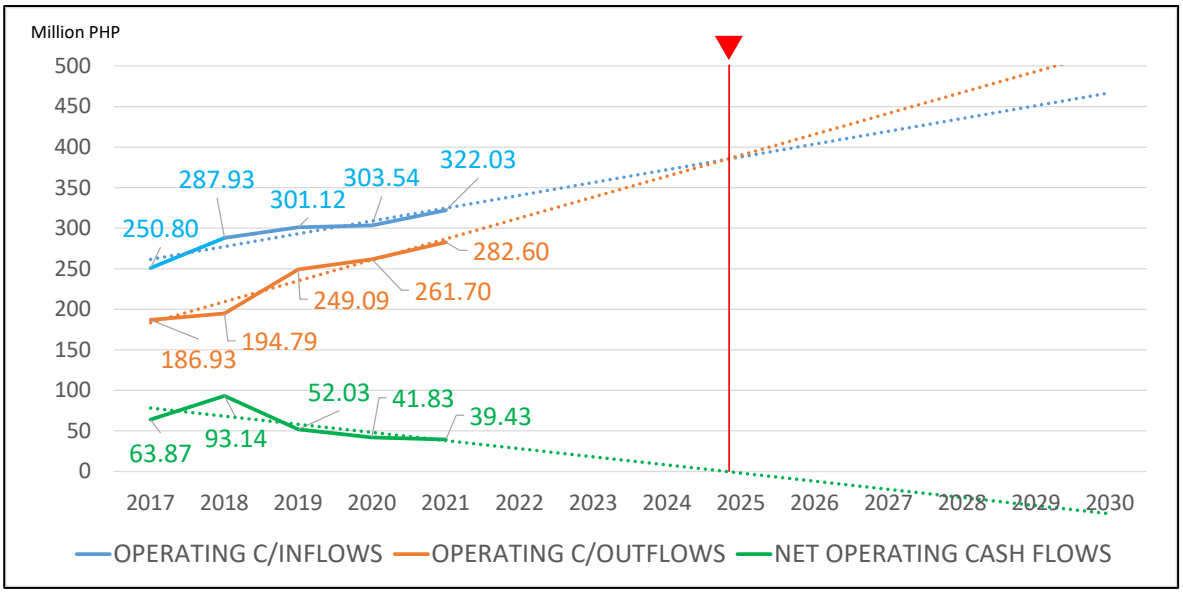
Source: Analysis by JICA Survey Team based on MCWD annual financial reports

Figure 4-6-1 Trend of Revenue, Expense and Surplus (Deficit) and Approximate Curve (Line Shape) from FY2017 to FY2021

Table 4-6-6 Changes in Primary Items of Statement of Cash Flow from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
CASH FLOWS FROM OPERATING ACTIVITIES	63.87	93.14	52.03	41.83	39.43	-24.44	-38.3%
CASH FLOWS FROM INVESTING ACTIVITIES	-69.83	-26.12	-34.23	-18.57	-22.50	47.33	-
FREE CASH FLOWS	-5.96	67.02	17.80	23.26	16.93	22.89	-
CASH FLOWS FROM FINANCING ACTIVITIES	-26.88	-27.05	-27.17	-3.03	-0.00	26.88	-
INCREASE(DECREASE) IN CASH AND CASH EQUIVALENTS	-32.84	39.97	-9.37	20.23	16.93	49.77	-
CASH AND CASH EQUIVALENTS, JANUARY 1	199.08	166.24	206.21	196.84	217.07	17.99	9.0%
CASH AND CASH EQUIVALENTS, DECEMBER 31	166.24	206.21	196.84	217.07	234.00	67.76	40.8%

Source: Analysis by JICA Survey Team based on MCWD annual financial reports



Remarks: Refer to Table 4-6-3 for operating cash-in and cash-out
Source: Analysis by JICA Survey Team based on MCWD annual financial reports

Figure 4-6-2 Operating Cash-In and Cash-Out, Trend of Operating Cash-flow, and Approximate Curve (Line Shape) from FY2017 to FY2021

4-6-3 Financial Analysis: Cost Recovery by Water Bill

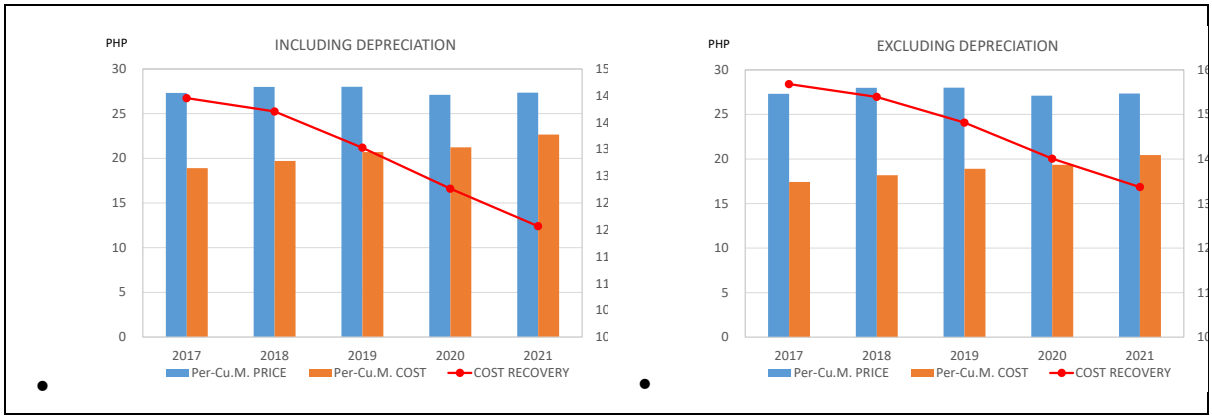
Table 4-6-7 and Figure 4-6-3 shows "Per-m^3 Price (Revenue / Amount of Water Billed)", "Per-m^3 Cost (Cost / Amount of Water Billed)" and "Cost Recovery Ratio (Per-m^3 Price / Per-m^3 Cost)". The MCWD does not receive any subsidies or grants from government ministries and agencies, local government such as Cotabato City, etc., and has recovered the cost of 120.7% including depreciation and 133.7% excluding depreciation.

However, due to the high rate of increase in operating expenses of 50.5% over the five-year period from FY2017 to FY2021 (see Table 4-6-5), while the per-m^3 price has remained at PHP27-28/m^3 over the same five-year period, the per-m^3 cost has increased both with/without depreciation, resulting in 23-24 points drop in the cost recovery ratio.

Table 4-6-7 Per-m³ Price and Per-m³ Cost, Cost Recovery and their Changes from FY2017 to FY2021

(PHP/m³)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
INCLUDING DEPRECIATION							
Per-Cu.M. PRICE	27.31	27.98	28.01	27.11	27.34	0.03	0.1%
Per-Cu.M. COST	18.89	19.70	20.70	21.23	22.66	3.76	19.9%
COST RECOVERY	**144.6%**	**142.1%**	**135.3%**	**127.7%**	**120.7%**	**-23.9**	**-**
EXCLUDING DEPRECIATION							
Per-Cu.M. PRICE	27.31	27.98	28.01	27.11	27.34	0.03	0.1%
Per-Cu.M. COST	17.42	18.18	18.90	19.35	20.45	3.03	17.4%
COST RECOVERY	**156.8%**	**153.9%**	**148.2%**	**140.1%**	**133.7%**	**-23.1**	**-**

Source: Analysis by JICA Survey Team based on MCWD annual financial reports



Source: Analysis by JICA Survey Team based on MCWD annual financial reports

Figure 4-6-3 Per-m³ Price and Per-m³ Cost, Cost Recovery and their Changes from FY2017 to FY2021

4-6-4 Financial Analysis: Solvency (Safety)

(1) Equity Ratio

Table 4-6-8 shows the "Equity Ratio (Equity / Asset x 100)" from FY2017 to FY2021. The equity ratio has been increasing year by year, and the MCWD's financial position (balance sheet) is good with a very high ratio of over 90%.

Table 4-6-8 Equity Ratio from FY2017 to FY2021

	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
EQUITY RATIO	**81.2%**	**85.5%**	**89.5%**	**89.1%**	**90.1%**	**8.91**	**-**

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

(2) Solvency: Short-term Financial Safety (Current Ratio, Quick Ratio and Short-term Liquidity)

As short-term financial safety indicators, Table 4-6-9 shows "Current Ratio (Current Assets / Current Liabilities x 100)", "Quick Ratio (Quick Assets / Current Liabilities x 100)", "Short-term Liquidity (Cash and Cash Equivalents as of December 31st / Sales / 12 months. Sales = Revenue for convenience sake because of no subsidies and grants)" from FY2017 to FY2021. While both current assets and quick assets increases, they are high (Reference: the LWUA's standard value of the current ratio is

150% or more) due to the small amount of accounts payable and loans payable. Therefore, as short-term liquidity, the MCWD maintains sufficient cash on hand and in bank for about 8 to 9 months of monthly sales.

Table 4-6-9 Current Ratio, Quick Ratio and Short-term Liquidity from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
CURRENT ASSETS	222.80	248.19	255.52	283.49	306.09	83.29	37.4%
CURRENT LIABILITIES	38.66	45.42	22.10	21.42	13.11	-25.55	-66.1%
CURRENT RATIO	**576.3%**	**546.5%**	**1156.4%**	**1323.5%**	**2334.7%**	**1,758.4**	**-**
QUICK ASSETS	196.68	239.34	230.10	255.58	270.65	73.97	37.6%
CURRENT LIABILITIES	38.66	45.42	22.10	21.42	13.11	-25.55	-66.1%
QUICK (ACID TEST) RATIO	**508.7%**	**527.0%**	**1041.3%**	**1193.2%**	**2064.4%**	**1,555.7**	**-**
SHORT-TERM LIQUIDITY (MONTH)	**7.9**	**8.5**	**7.8**	**8.4**	**8.9**	**1.0**	**12.0%**

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

(3) Solvency: Long-term Financial Safety (Non-Current Assets to Equity Ratio, and Non-Current Assets to Non-Current Liabilities & Equity Ratio)

As long-term financial safety indicators, Table 4-6-10 shows "Non-Current Assets to Equity Ratio (Non-Current Assets / Equity x 100)", "Non-Current Assets to Non-Current Liabilities & Equity Ratio (Non-Current Assets / (Non-Current Liabilities + Equity) x 100)" in FY2017 to FY2021. The fact that both are 100% or less means that the non-current assets that generate income are covered by stable financial resources (equity), and the financial situation is sound.

Table 4-6-10 Non-Current Assets to Equity Ratio, and Non-Current Assets to Non-Current Liabilities & Equity Ratio from FY2017 to FY2021

	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
NON-CURRENT ASSETS TO EQUITY RATIO	**77.5%**	**73.2%**	**71.6%**	**70.9%**	**69.0%**	**-8.54**	**-**
NON-CURRENT ASSETS TO NON CURRENT LIABILITIES	**67.3%**	**67.2%**	**66.2%**	**65.0%**	**63.2%**	**-4.09**	**-**

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

4-6-5 Financial Analysis: Profitability

(1) Net Profit Margin

As a financial profitability indicator, Table 4-6-11 shows "Net Profit Margin (Surplus or Profit / Sales x 100. Sales = Revenue for convenience sake)" from FY2017 to FY2021. Revenue is increasing year by year while maintaining surplus, but the net profit margin has decreased by 13.7 points from 30.8% to 17.1% in the five-year period from FY2017 to FY2021, indicating a decline in profitability.

Table 4-6-11 Net Profit Margin from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
REVENUE	**251.61**	**290.67**	**301.26**	**308.34**	**316.17**	**64.56**	**25.7%**
SURPLUS (DEFICIT) *PROFIT(LOSS)	**77.55**	**86.06**	**78.60**	**66.84**	**54.18**	**-23.37**	**-30.1%**
NET PROFIT MARGIN	**30.8%**	**29.6%**	**26.1%**	**21.7%**	**17.1%**	**-13.7**	**-**

Source : Analysis by JICA Survey Team based on MCWD annual financial reports

(2) Return on Assets (ROA)

As a financial profitability indicator, Table 4-6-12 shows "Return on Assets: ROA (Surplus or Profit / Assets x 100)" from FY2017 to FY2021. The net profit margin on assets has decreased by 6.2

percentage points from 12.9% to 6.7% over the five years from 2017 to 2021, indicating a decline in profitability.

Table 4-6-12 Return on Asset (ROA) from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
ASSETS	601.03	662.77	711.84	769.98	808.54		
SURPLUS (DEFICIT) *PROFIT(LOSS)	77.55	86.06	78.60	66.84	54.18	-23.37	-30.1%
ROA	12.9%	13.0%	11.0%	8.7%	6.7%	-6.2	-

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

(3) EBITDA and EBITDA Margin

As a financial profitability indicator, Table 4-6-13 shows "Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA)", "EBITDA Margin (EBITDA / Sales x 100. Sales = Revenue for convenience sake)" from FY2017 to FY2021. EBTIDA margin has decreased by 12.6 points from 36.7% to 24.1% in the five-year period from FY2017 to FY2021.

Table 4-6-13 EBITDA and EBITDA Margin from FY2017 to FY2021

(Million PHP)	2017	2018	2019	2020	2021	5yrs Increase (Decrease)	Percentage
EBITDA	92.44	101.63	93.41	84.58	76.30	-16.14	-17.5%
EBITDA MARGIN	36.7%	35.0%	31.0%	27.4%	24.1%	-12.6	-

Source: Analysis by JICA Survey Team based on MCWD annual financial reports

4-6-6 Financial Analysis: Growth Potential

As financial growth potential indicators, Table 4-6-14 shows "Assets Growth Ratio", "Sales Growth Ratio (Sales = Revenue for convenience sake)" and "Profit (or Surplus) Growth Ratio" from FY2017 to FY2021, which are calculated by "(Current FY Value–- Previous FY Value) / Previous FY Value x 100". Although assets are increasing every year, the growth (increase) ratio is declining (because of lower profitability, progress in depreciation and limited large-scale capital investment, etc.). Sales also is increasing as well but it has slowed down especially in the last three years. On the other hand, profit (or surplus) growth ratio has decreased by 30.1% over the past five years (average annual decrease of 8.6%), and as mentioned above both surplus and operating cash flow are on a decline, indicating an anxieties in growth potential.

Table 4-6-14 Assets Growth Ratio, Sales Growth Ratio and Profit Growth Ratio from FY2017 to FY2021

	2017	2017-2018	2018-2019	2019-2020	2020-2021	5yrs Growth	CAGR
ASSETS GROWTH RATIO	-	10.3%	7.4%	8.2%	5.0%	34.5%	7.7%
SALES GROWTH RATIO	-	15.5%	3.6%	2.3%	2.5%	25.7%	5.9%
PROFIT GROWTH RATIO	-	11.0%	-8.7%	-15.0%	-18.9%	-30.1%	-8.6%

Source : Analysis by JICA Survey Team based on MCWD annual financial reports

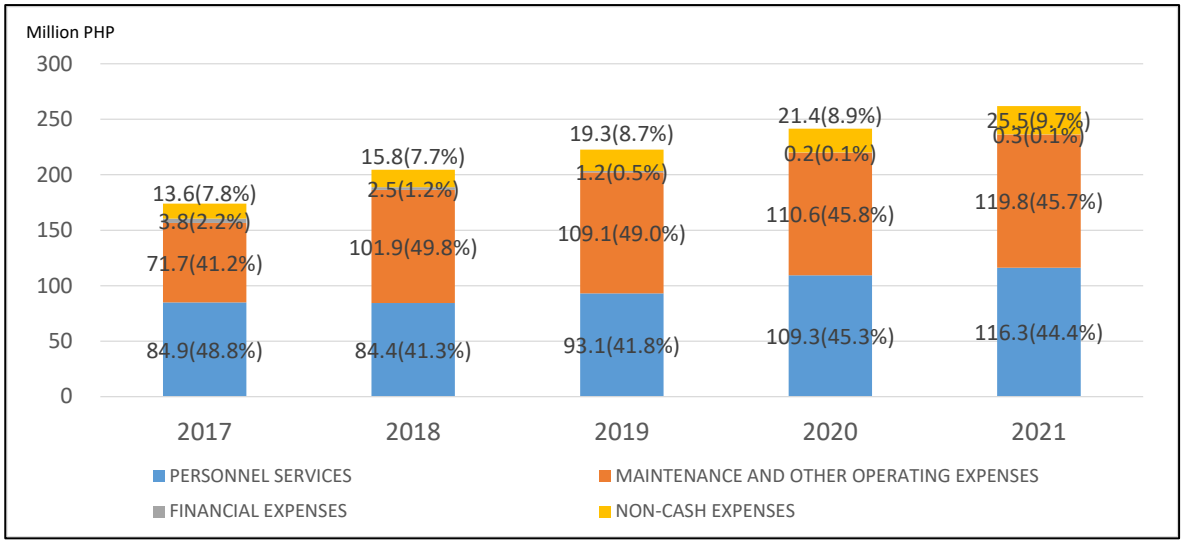
4-6-7 Financial Analysis: Others

(1) Operating Expenses

Figure 4-6-4 shows composition and changes of "Operating Expenses (Personnel expenses, Maintenance and other operating expenses, Financial expenses, Non-cash expenses)" from FY2017 to FY2022. With the exception of financial expenses, all other expenses are increasing year by year. Non-cash expenses (including depreciation) account for only about 10% of total because large-scale

capital investment has been limited. Personnel expenses and maintenance and other operating expenses have accounted for about 45% respectively.

Furthermore, behind the increase in both personnel expenses and maintenance and other operating expenses, there are likely the "Salary Standardization Law of 2019, HB 5712 (Average increase of 23.2% from January 2020 to January 2023)" as well as price escalation (5-year average inflation rate of 3.37%, World Economic Outlook Databases, International Monetary Fund (IMF)).



Remarks: Depreciation is included in non-cash expenses.
Source: Analysis by JICA Survey Team based on MCWD annual financial reports

Figure 4-6-4 Operating Expenses Composition and Changes from FY2017 to FY2021

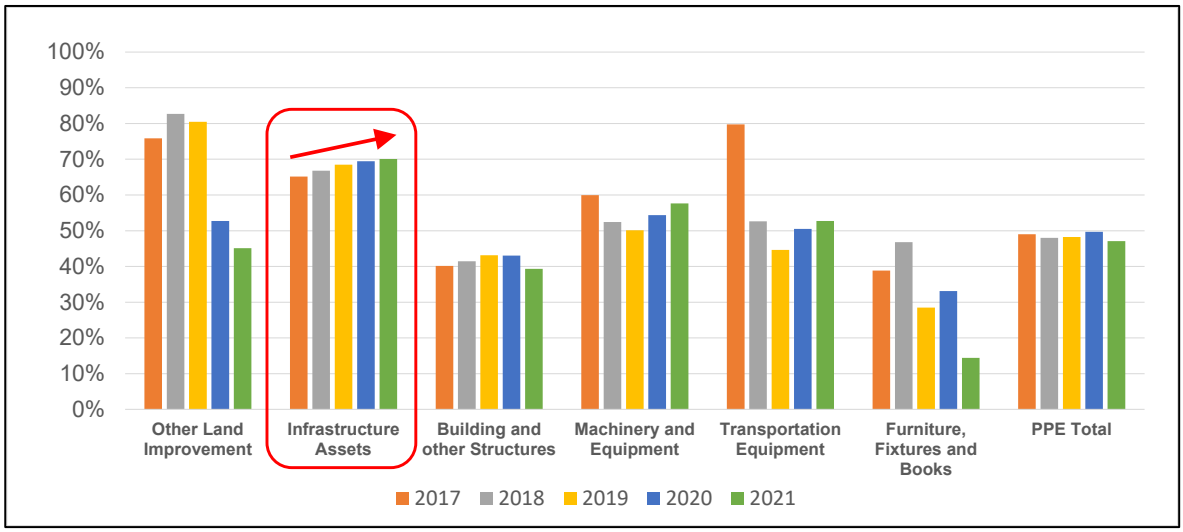
(2) Depreciation Rate (Aging Ratio) of PPE

Table 4-6-15 and Figure 4-6-5 show the "Depreciation ratio of Property, Plant and Equipment (PPE) (accumulated depreciation / acquisition value x 100" that indicates the degree of aging of facilities and equipment from FY2017 to FY2021. The depreciation ratio is around 50% on the whole, but the depreciation ratio of infrastructure assets in particular is increasing and high at about 70%, indicating that the deterioration is progressing.

Table 4-6-15 PPE Depreciation Ratio (Aging Ratio) and Changes from FY2017 to FY2021

	2017	2018	2019	2020	2021
Other Land Improvement	75.8%	82.7%	80.5%	52.7%	45.1%
Infrastructure Assets	65.2%	66.8%	68.5%	69.4%	70.1%
Building and other Structures	40.2%	41.5%	43.1%	43.1%	39.3%
Machinery and Equipment	59.9%	52.4%	50.1%	54.4%	57.6%
Transportation Equipment	79.8%	52.6%	44.6%	50.5%	52.7%
Furniture, Fixtures and Books	38.8%	46.8%	28.5%	33.1%	14.4%
PPE Total	49.0%	48.0%	48.2%	49.7%	47.1%

Source : Analysis by JICA Survey Team based on MCWD annual financial reports



Source: Analysis by JICA Survey Team based on MCWD annual financial reports

Figure 4-6-5 Depreciation Ratio (Aging Ratio) of PPE and their Changes from FY2017 to FY2021

4-6-8 Recommendations for Improvement

So far, the MCWD has achieved full-cost pricing (recovery) with only water sales without receiving any subsidies or grants, and consequently has attained the high financial safety through sound (prudent) management. On the other hand, profitability and growth are declining and slowing down because of sluggish increases in revenue (sales) and surplus (profit) as well as because of recent increases in costs and expenses.

Furthermore, assuming future increases in personnel expenses (increase in the number of employees due to development and expansion, and revisions to salaries by government policies), price escalation, and the repayment of LWUA/ADB loans for the renewal of main transmission pipes, further costs and expenses are expected to increase, and thereby financial situations of income & expenses and cash flow will degrade in the near future.

Under these circumstances, in preparation for the expansion of the service scale (area expansion, increases in water supply volume and customers, etc.) by future development including the improvement of water sources and water production capacity, MCWD's management issues are as follows:.

- Securing adequate income by water rates revision(s) from the medium- and long- term perspectives
- Increase in revenue by NRW reduction currently at approx. 25%
- Cost reduction by improvement of productivity and efficiency
- Strengthening of organizational structure
- Capacity development on business planning, and project planning to consolidate financing, financial plan and budget plan.

- Capacity development on investment and renewal of facilities and equipment based on asset management, etc.

4-7 Impact of Local Government Code

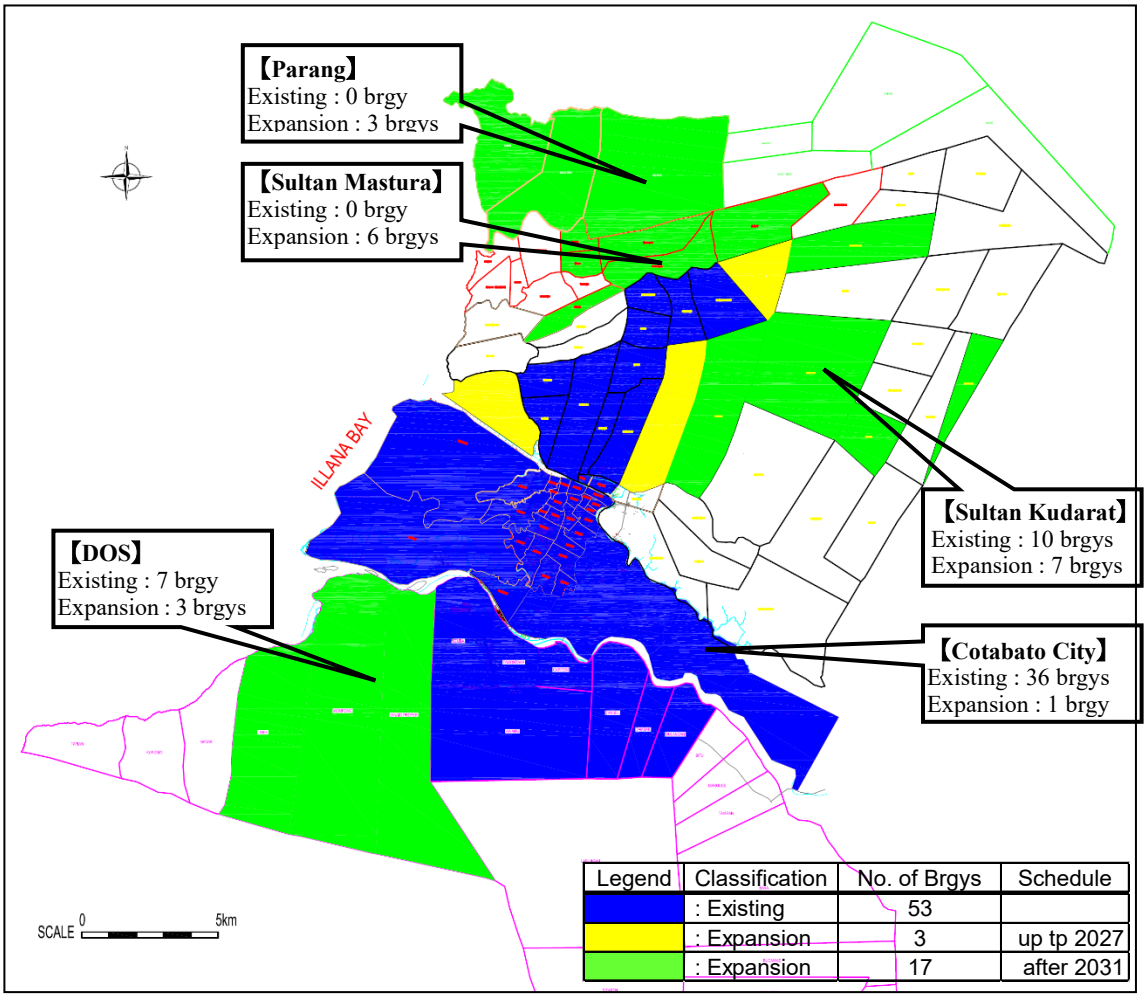
The National Government Code provides general content, while the Local Government Code (LGC) stipulates more factual content such as administrative services (education, medical care, transportation, etc.) for residents by municipalities and barangays. The National Government Code provides general content, while LGC provides more specific content. Currently, regarding the relationship between BARMM and local governments, due to the enhancement of LGC in 2025, the local autonomy act will not weaken the authority of local governments. In addition, it will not impact local governments' operations in terms of economic and social aspects. Besides, the MCWD is responsible for Level 3: the waterworks system (a fully reticulated system with individual connections) as a public service provider separate from local governments. Therefore, the Local Government Code that stipulates the rules for local government administration will not affect MCWD's management, operation and maintenance.

Chapter 5. Water Supply Area of Metro Cotabato Water District, and Water Supply Area Expansion Plan

5-1 Future Expansion Plan of Water Supply Area

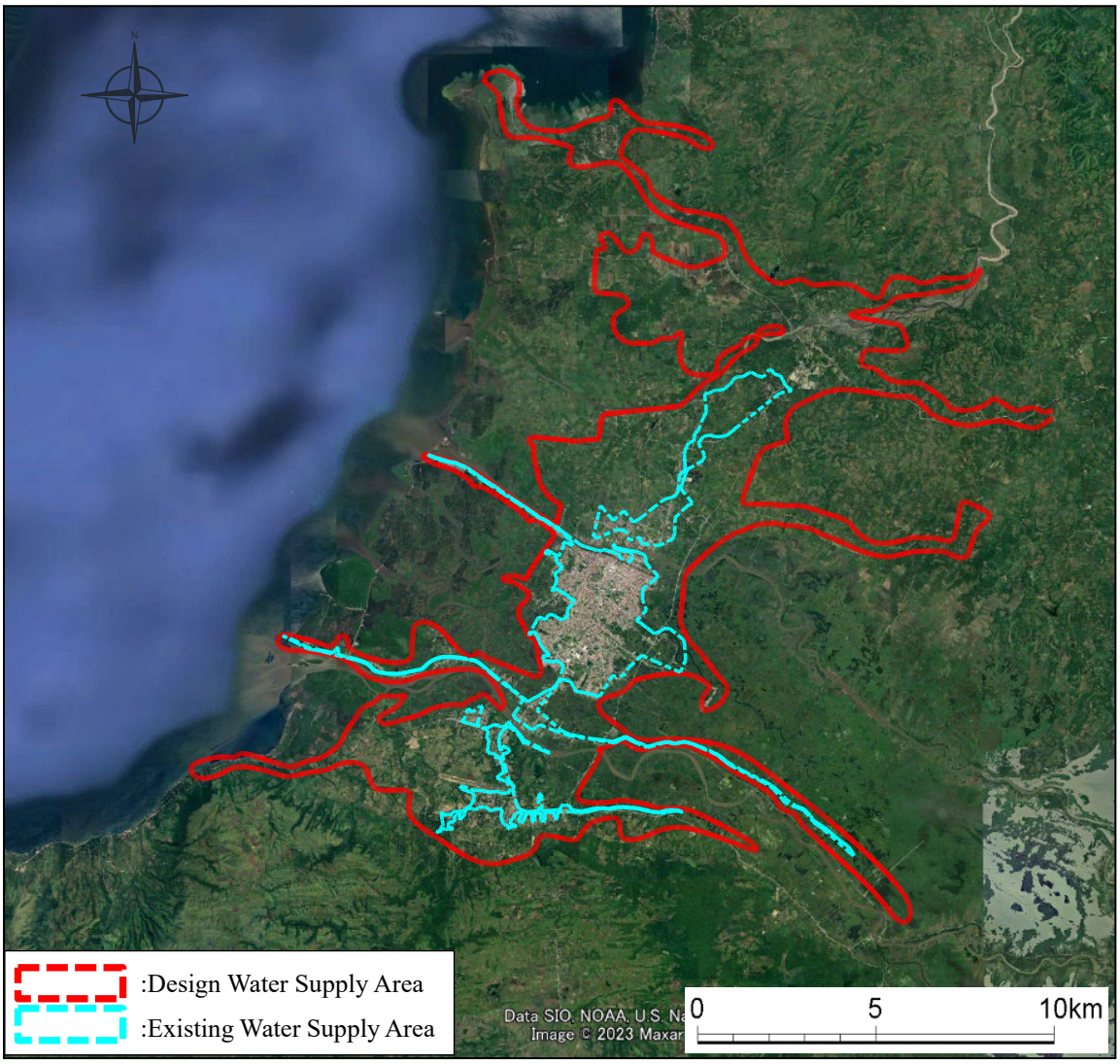
The MCWD currently supplies water to 53 barangays, and plans to expand the water supply area to 20 barangays, including parts of Sultan Mastura and Parang.

Of the 20 barangays to be expanded, one barangay in Cotabato City and two barangays in SK will be able to distribute water after the pipeline expansion that is the subject of SDF's Phase 2 assistance. The other barangays of Sultan Mastura, Parang, and DOS will not be able to receive water until after the expansion of the WTP under SDF Phase 3.



Source : JICA Survey Team

Figure 5-1-1 Expansion of Design Water Supply Area (barangay boundary level)



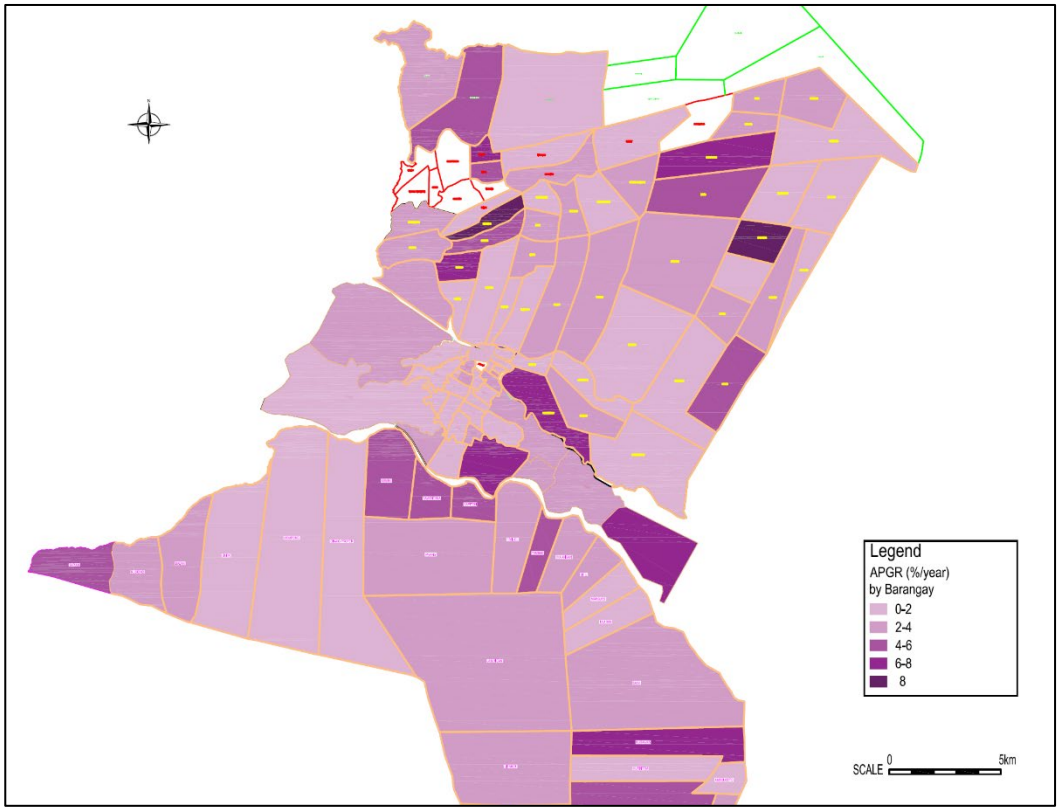
Source : JICA Survey Team

Figure 5-1-2 Expansion of Design Water Supply Area

The current MCWD water distribution area extends north to the south side of the Simuay River, east and west to the area between the East Diversion Road and West Diversion Road, and south along the main water transmission pipeline from the Tanuel PS to the SPDA junction. In the future, the water supply area will be expanded to the north to near the port of Parang, to the west to near the coastline of Illana Bay, to the east to near the eastern border of SK, and to the south to southeast of Tanuel PS and west of the Dimapatoy WTP.

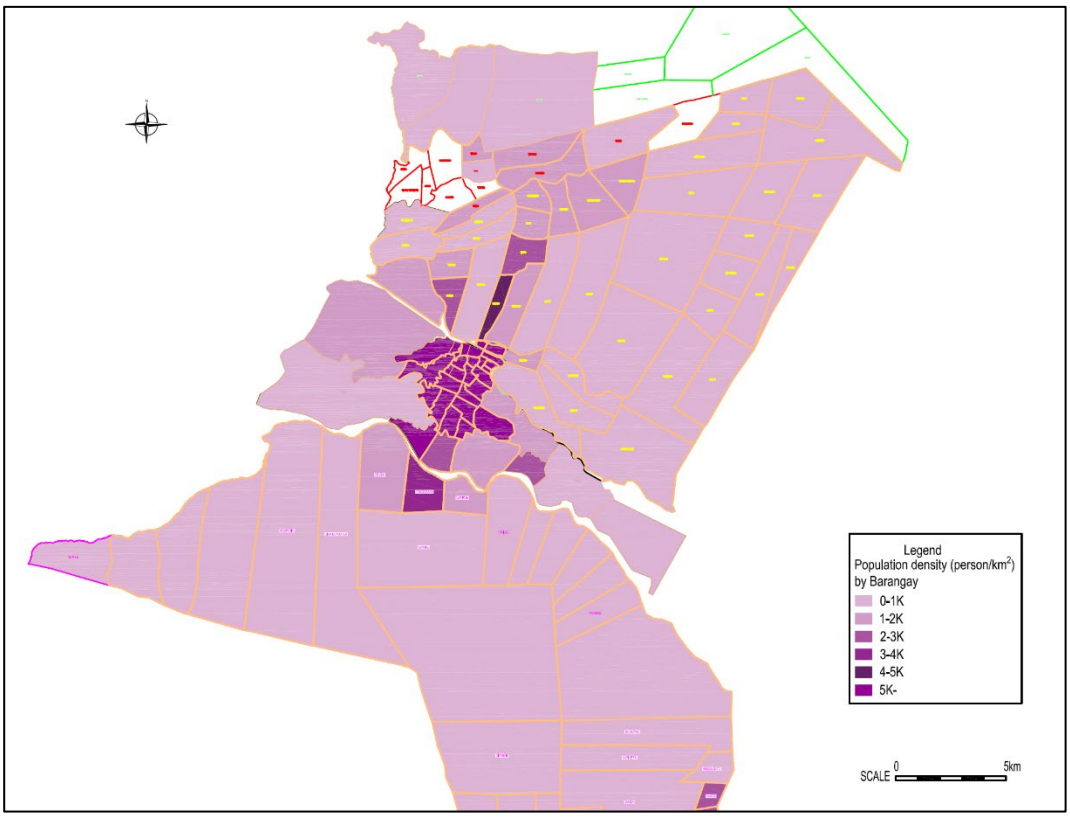
5-2 Distribution of Population Density (water demand)

Figure 5-2-1 and Figure 5-2-2 show the distribution of population growth rate and population density in the water supply-related areas of MCWD, respectively. The situation shows a high population growth rate mainly along the Rio Grande de Mindanao and Tamontaka River, west and north of SK, and to the direction of Sultan Mastura and Parang.



Source : JICA Survey Team

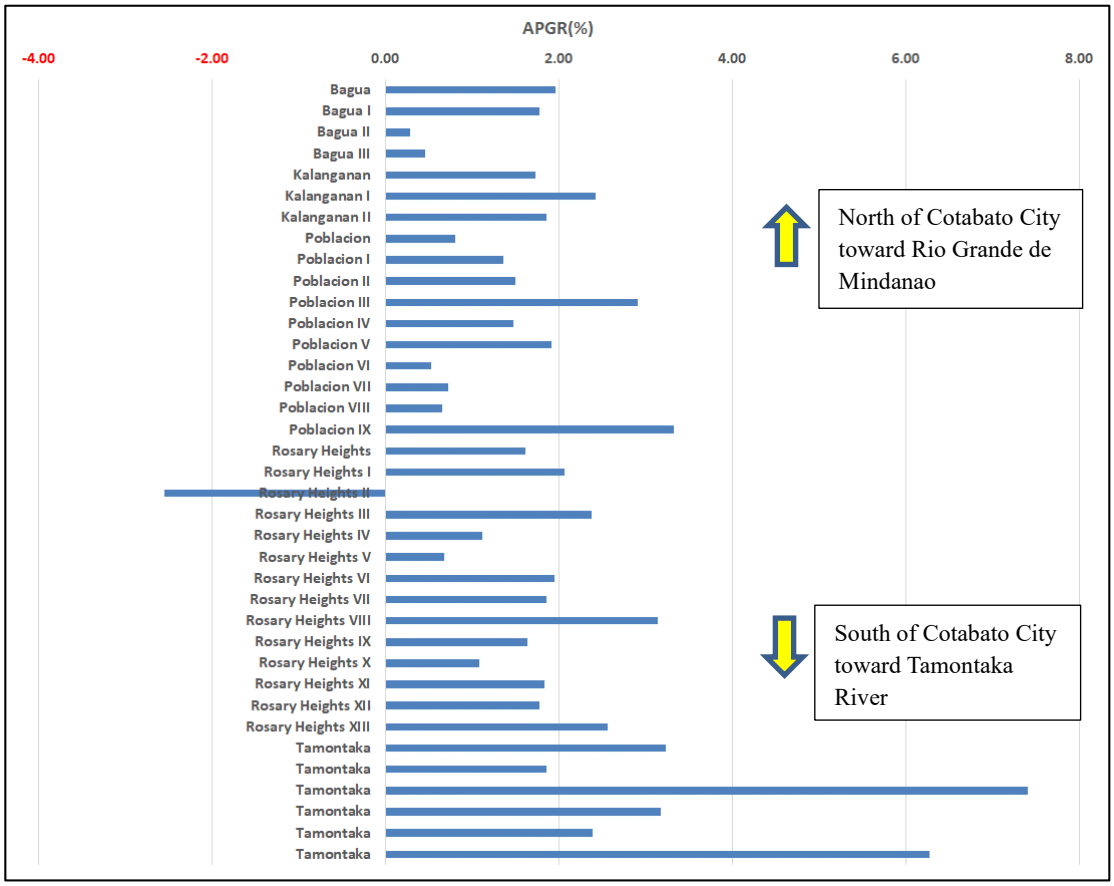
Figure 5-2-1 Distribution of Population Growth (2015-2020)



Source : JICA Survey Team

Figure 5-2-2 Distribution of Population Density (2022)

Focusing particularly on the Tamontaka Riverside, it contains barangays with a population growth rate of 6-8%, which is higher than the average population growth rate of 1.7% in Cotabato City. In particular, when limited to Cotabato City, Figure 5-2-3 shows that although the area closer to the Rio Grande de Mindanao in the north has a higher population density, the area along the Tamontaka River in the south has higher development potential in recent years in terms of the degree of development promotion.



Source : JICA Survey Team

Figure 5-2-3 Distribution of Population Growth Rate by Barangay in Cotabato City (2015-2020)

5-3 Establishment of Water Distribution Area from each WTP

Table 5-3-1 shows the area classification in which water will be distributed in the future water treatment facilities to be constructed. The following water distribution plan assumes a long-term target year of 2040. The area of each WTP's service area is set so that the maximum daily water supply in the service area matches the capacity of the neighboring WTPs, based on the geographical location of the WTPs and their capacity.

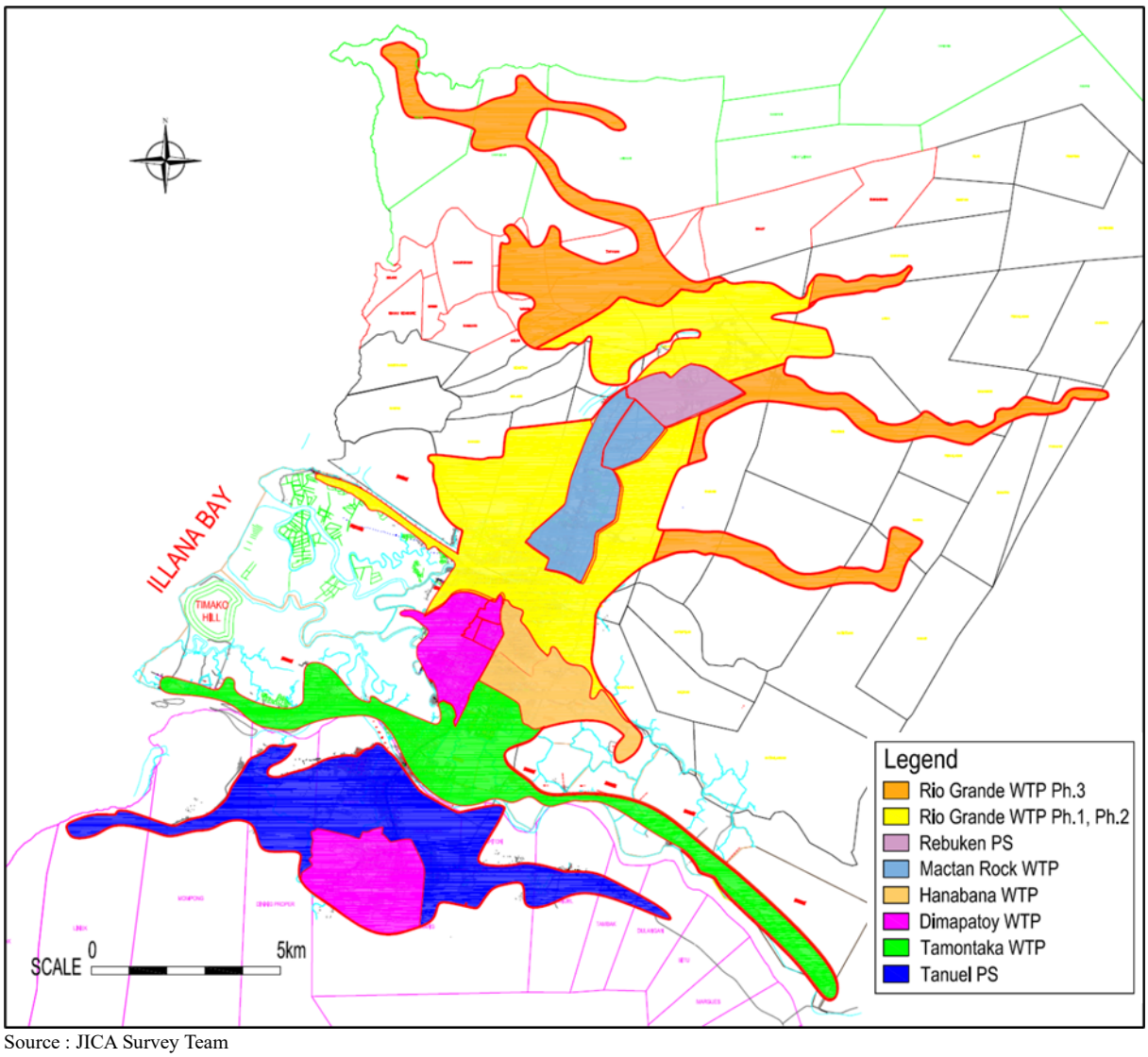
Table 5-3-1 Relation between Water Distribution Area and the Capacity of WTP (2040)

Water Supply Area	City/Municipality	Capacity of WTP
North of Rio Grande de Mindanao	Parang, Sultan Mastura, Sultan Kudarat	Rio Grande WTP, Ph.1,Ph2 : 50,000 m^3/day (of which 16%) Rio Grande WTP, Ph.3 : 21,500 m^3/day Mactan Rock WTP : 6,800 m^3/day Rebuken PS : 1,400 m^3/day **Sub-total : 37,700 m^3/day (23.0%)**
Center of Cotabato City	Cotabato City	Rio Grande WTP, Ph.1,Ph2 : 50,000 m^3/day (of which 84%) HANABANA WTP : 15,500 m^3/day Tamontaka WTP, Ph1, Ph.2, Ph.3 : 25,000 m^3/day Dimapatoy WTP : 25,800 m^3/day (of which 80%)

Water Supply Area	City/Municipality	Capacity of WTP
		Sub-total : 103,140 m^3/day (63.46%)
South of the Tamontaka River	Datu Odin Sinsuat	Tanuel PS : 16,600 m^3/day Dimapatoy WTP : 25,800 m^3/day (of which 20%) **Sub-total : 21,760 m^3/day (13.43%)**
Total		**Total : 163,600 m^3/day (100%)**

Source : JICA Survey Team

Based on the water demand projections in Chapter 3, the required WTP capacity in 2040 is assumed to be about 163,600 m^3/day. Of this amount, 37,700 m^3/day (23.0%) will be distributed to Parang, Sultan Mastura, and SK, north of the Rio Grande de Mindanao. 103,140 m^3/day (63.46%) will be distributed to Cotabato City, and 21,760 m^3/day (13.43%) will be distributed to DOS, south of the Tamontaka River. Figure 5-3-1 shows the relation between the location of the future water distribution area and the WTPs from which water will be distributed.



Source : JICA Survey Team

Figure 5-3-1 Setting of Water Distribution Area

The scale of each WTP and target water distribution areas are as follows.

Table 5-3-2 Relation between WTPs to be Constructed and Water Distribution Areas (barangays) (2040)

WTP, Capacity	Breakdown of Water Distribution	City/Municipality	Barangay
Rio Grande WTP, Ph.3 21,500 m^3/day	9,500 m^3/day	Parang	Landasan, Campo Islam, Polloc **3 brgys**
	6,500 m^3/day	Sultan Mastura	Balut, Macabico, Solon, Tambo, Tapayan, Tuka **6 brgys**
	5,500 m^3/day	Sultan Kudarat	Darapanan, Nara, Panatan, Pinaring, Raguisi **5 brgys**
Rio Grande WTP WTP, Ph.1,Ph2 50,000 m^3/day (25,000+25,000)	42,000 m^3/day	Cotabato City	RH3, Kalanganan MB, Kalaganan1, BAG MB, BAG1, BAG3, POB MB, POB1, POB2, POB3, POB4, POB5, POB6, POB7 **14 brgys**
	8,000 m^3/day	Sultan Kudarat	Calsada, Banubo, Katuli, Dalumangcob, Crossing Simuay, Ungap **6 brgys**
Rebuken PS 1,400 m^3/day	1,400 m^3/day	Sultan Kudarat	Macaguiling, Rebuken **2 brgys**
Mactan Rock WTP 6,800 m^3/day	6,800 m^3/day	Sultan Kudarat	Bulalo, Salimbao, Limbo **3 brgys**
HANABANA WTP 15,500 m^3/day (5,000+3,000+3,000+2,000+2,500)	15,500 m^3/day	Cotabato City	RH2, RH4, RH5, RH6, RH7, POB8, POB9 **7 brgys**
Dimapatoy WTP 25,800 m^3/day (17,800+8,000)	20,640 m^3/day	Cotabato City	RH MB, RH1, RH10, RH11, RH12, RH13, BAG2 **7 brgys**
	5,160 m^3/day	Datu Odin Sinsuat	Awang **1 brgy**
Tamontaka WTP, Ph1, Ph.2, Ph.3 26,000 m^3/day (11,000+15,000)	26,000 m^3/day	Cotabato City	Tamontaka1, Tamontaka2, Tamontaka3, Tamontaka4, Tamontaka5, Tamontaka Mother, Kalaganan2, RH8, RH9 **9 brgys**
Tanuel PS 16,600 m^3/day	16,600 m^3/day	Datu Odin Sinsuat	Tamontaka, Capiton, Tanuel, Tambak, Dulangan, Semba, Dinaig Proper, Mompong, Linek **9 brgys**
Total	**163,600 m^3/day**		**73 brgys**

Note: Figures in parentheses indicate the breakdown of phased expansion of WTP scale.
Source : JICA Survey Team

Table 5-3-3 Relation between WTPs to be Constructed and Water Distribution Areas (barangays)

City/Municipality	ID	WTP	Distribution Area (Barangay)	2029 Population Served (person)	2040 Population Served (person)	2029 Daily Max. Water Supply Amount (m^3/day)	2040 Daily Max. Water Supply Amount (m^3/day)
Parang	P01	Rio Grande Ph.3	Landasan	0	18,301	0	4,362
	P02	"	Campo Islam	0	4,588	0	1,093
	P03	"	Polloc	0	10,653	0	2,539
Sultan Mastura	SM01	"	Balut	0	2,456	0	585
	SM02	"	Macabico	0	6,695	0	1,596
	SM03	"	Solon	0	2,265	0	540
	SM04	"	Tambo	0	4,582	0	1,092
	SM05	"	Tapayan	0	4,810	0	1,146
	SM06	"	Tuka	0	2,193	0	523
Sultan Kudarat	S06	Rio Grande Ph.1,2	Calsada	4,516	5,515	1,076	1,314
	S03	"	Banubo	2,662	6,967	634	1,661
	S18	"	Katuli	4,152	5,552	990	1,323
	S04	Mactan Rock	Bulalo	7,027	8,945	1,675	2,132
	S36	"	Salimbao	5,375	6,832	1,281	1,628
	S20	"	Limbo	5,910	8,681	1,409	2,069
	S22	Rebuken	Macagiling	2,023	3,217	482	767
	S35	"	Rebuken	2,111	3,591	503	856
	S11	Mactan Rock	Gang	3,083	5,042	735	1,202
	S08	Rio Grande Ph.1,2	Dalumangcob	5,682	7,913	1,354	1,886
	S07	"	Crossing Simuay	4,746	8,200	1,131	1,954
	S10	Rio Grande Ph.3	Darapanan	0	6,799	0	1,620
	S26	"	Nara	0	2,568	0	612
	S29	"	Panatan	0	2,520	0	601
	S32	"	Pinaring	0	4,665	0	1,112
	S34	"	Raguisi	0	2,974	0	709
	S39	Rio Grande Ph.1,2	Ungap	1,783	3,414	425	814
Cotabato City	C33	Tamontaka	Tamontaka1	4,246	6,103	1,012	1,454
	C34	"	Tamontaka2	6,932	20,358	1,652	4,852
	C35	"	Tamontaka3	2,588	4,898	617	1,167
	C36	"	Tamontaka4	3,099	5,522	739	1,316
	C37	"	Tamontaka5	1,583	4,352	377	1,037
	C32	"	Tamontaka Mother	14,424	24,710	4,403	6,854
	C07	"	Kalaganan2	6,287	8,949	1,498	2,133
	C26	"	RH8	11,396	17,494	2,716	4,169
	C27	"	RH9	8,766	11,268	2,089	2,685
	C24	Hanabana	RH6	7,831	10,593	1,866	2,525
	C25	"	RH7	9,469	13,716	2,257	3,269
	C16	"	POB8	6,927	9,533	1,651	2,272
	C17	"	POB9	6,939	12,494	1,654	2,978
	C28	Dimapatoy	RH10	16,118	19,787	3,841	4,716
	C29	"	RH11	9,649	12,074	2,300	2,878
	C18	"	RH MB	14,917	19,835	3,555	4,727
	C21	Rio Grande Ph.1,2	RH3	12,365	18,269	2,947	4,354
	C22	Hanabana	RH4	4,515	5,390	1,076	1,285
	C23	"	RH5	5,805	6,745	1,383	1,608
	C05	Rio Grande Ph.1,2	Kalaganan MB	14,421	21,427	3,437	5,107
	C06	"	Kalaganan1	5,373	9,575	1,281	2,282
	C01	"	BAG MB	18,075	27,385	4,308	6,527
	C02	"	BAG 1	9,267	13,362	2,209	3,185
	C03	Dimapatoy	BAG 2	16,651	20,053	3,969	4,779
	C04	Rio Grande Ph.1,2	BAG 3	5,984	7,291	1,426	1,738
	C08	"	POB MB	17,190	23,479	4,097	5,596
	C09	"	POB1	4,947	6,905	1,179	1,646
	C10	"	POB2	6,122	8,565	1,459	2,041
	C11	"	POB3	3,035	5,164	723	1,231
	C12	"	POB4	6,595	8,829	1,572	2,104
	C13	"	POB5	3,063	4,587	730	1,093
	C14	"	POB6	4,055	5,435	966	1,295
	C15	"	POB7	13,340	17,602	3,179	4,195
	C19	Dimapatoy	RH1	5,007	6,198	1,193	1,477
	C20	Hanabana	RH2	3,211	2,638	3,265	3,129
	C30	Dimapatoy	RH12	4,559	6,371	1,086	1,519
	C31	"	RH13	5,700	8,736	1,358	2,082
Datu Odin Sinsuat	D30	Tanuel	Tamontaka	12,414	24,923	2,959	5,940
	D10	"	Capiton	4,953	8,207	1,180	1,956
	D31	"	Tanuel	1,733	2,472	413	589
	D29	"	Tambak	1,100	2,124	262	506
	D14	"	Dulangan	811	1,338	193	319
	D02	Dimapatoy	Awang	14,887	20,936	3,548	4,990
	D26	Tanuel	Semba	9,483	16,418	2,260	3,913
	D13	"	Dinaig Proper	0	4,994	0	1,190
	D23	"	Mompong	0	1,658	0	395
	D20	"	Linek	0	2,123	0	506

Source : JICA Survey Team

5-4 Phased Expansion of Water Supply Area

(1) Policy for Phased Expansion

As mentioned above, the MCWD reported that BPDA informed them in early December 2022 that approval of SDF Phase 1 within 2022 would be difficult. Therefore, assuming that the expansion of the new Rio Grande WTP through Phase 1 is budgeted within 2023, D&B procurement is expected in the first quarter of 2024, and completion of facility construction is expected around 2026. Next, the pipeline expansion in Phase 2, assuming it is budgeted within 2024 after Phase 1, would be completed with D&B procurement in the first quarter of 2025 and completion of facility construction in late 2027 or early 2028. Furthermore, water distribution from the WTP to be expanded in Phase 3 would not be available until 2031 or later. Table 5-4-1 shows the schedule for the phased expansion of the required WTP capacity of 163,600 m^3/day in 2040, which is obtained from the water demand projections in 2-5-4

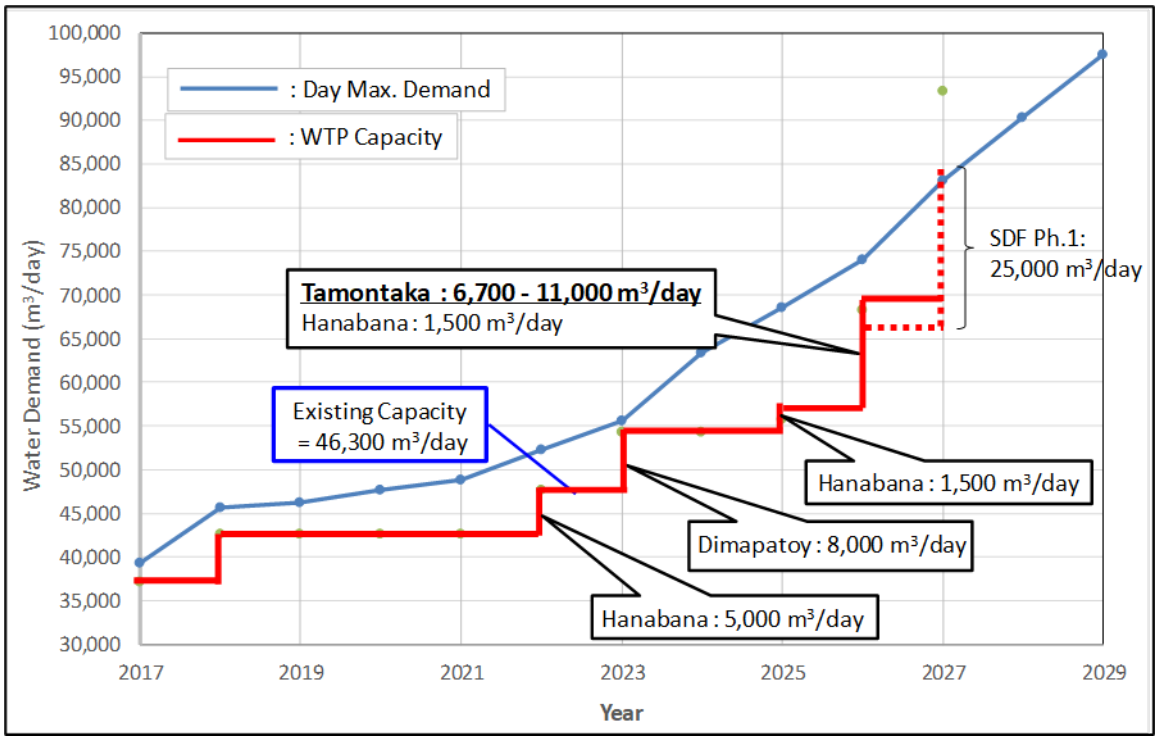
Table 5-4-1 Schedule for Expansion of WTP Capacity

Unit : m^3/day

Year	2022	2023	2025	2026	2027	2029	2031	2035	2038
Tanuel	16,600								
Rebuken	1,400								
Mactan Rock	5,500					+1,300			
Dimapatoy	17800	+8,000							
HANABANA	5000		+1,500	+1,500		+3,000	+2,000	+2,500	
Tamontaka				+6,700 - +11,000				+15,000	
Rio Grande					+25,000		+25,000		+21,500
Total	46,300	54,300	55,800	64,000 – 68,300	89,000 – 93,300	97,600	124,600	142,100	163,600

Source : JICA Survey Team

Figure 5-4-1 shows the relation between the design daily maximum water supply amount based on the results of the demand projection and the capacity of the WTPs to be expanded. As of March 2023, after the expansion of the HANABANA WTP, which began operation in January, the WTP capacity in 2022 will be about 46,300 m^3/day, lower than the 52,294 m^3/day demand. This suggests that the plant is overloaded. The Dimapatoy WTP is currently being expanded (+8,000 m^3/day) and is expected to be operational in 2023. The expansion of the Dimapatoy WTP will temporarily cover the required water demand, but will not be able to meet the further increase in water demand starting in 2024. Therefore, there is an urgent need to expand WTP capacity with the assistance of SDF and other donors.



Source : JICA Survey Team

Figure 5-4-1 Plan for Expansion of WTP Scale

(2) Beneficiary Effect

a) Quantitative Effects

The expansion of water supply in the Cotabato metropolitan area is expected to have the effects shown in Table 5-4-2.

Table 5-4-2 Quantitative Effects

<table>
<tr><th>No.</th><th>Indicator</th><th>Design Value</th></tr>
<tr><td>1</td><td>Daily Average Water Supply Amount (m³/day)</td><td>
<table>
<tr><th>WTP, PS</th><th>2022</th><th>2029</th><th>2040</th></tr>
<tr><td>Tanuel</td><td>13,280</td><td>13,280</td><td>13,280</td></tr>
<tr><td>Rebuken</td><td>1,120</td><td>1,120</td><td>1,120</td></tr>
<tr><td>Macaguiling</td><td>1,040</td><td>0</td><td>0</td></tr>
<tr><td>Mactan Rock</td><td>4,400</td><td>5,440</td><td>5,440</td></tr>
<tr><td>Dimapatoy</td><td>14,240</td><td>20,640</td><td>20,640</td></tr>
<tr><td>HANABANA</td><td>4,000</td><td>8,800</td><td>12,400</td></tr>
<tr><td>Tamontaka</td><td>-</td><td>5,360–-8,800</td><td>20,800</td></tr>
<tr><td>Rio Grande</td><td>-</td><td>20,000</td><td>57,200</td></tr>
<tr><td>Total</td><td>38,080</td><td>74,640–-78,080</td><td>130,880</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>Daily Maximum Water Supply Amount (m³/day)</td><td>
<table>
<tr><th>WTP, PS</th><th>2022</th><th>2029</th><th>2040</th></tr>
<tr><td>Tanuel</td><td>16,600</td><td>16,600</td><td>16,600</td></tr>
<tr><td>Rebuken</td><td>1,400</td><td>1,400</td><td>1,400</td></tr>
<tr><td>Macaguiling</td><td>1,300</td><td>0</td><td>0</td></tr>
<tr><td>Mactan Rock</td><td>5,500</td><td>6,800</td><td>6,800</td></tr>
<tr><td>Dimapatoy</td><td>17800</td><td>25,800</td><td>25,800</td></tr>
<tr><td>HANABANA</td><td>5000</td><td>11,000</td><td>15,500</td></tr>
<tr><td>Tamontaka</td><td>-</td><td>6,700–-</td><td>26,000</td></tr>
</table>
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<table>
<tr><th>No.</th><th>Indicator</th><th>Design Value</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td></td><td>11,000</td><td></td></tr>
<tr><td>Rio Grande</td><td>-</td><td>25,000</td><td>71,500</td></tr>
<tr><td>合計</td><td>47,600</td><td>93,300–-97,600</td><td>163,600</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Population Served (persons)</td><td>
<table>
<tr><th>WTP, PS</th><th>2022</th><th>2029</th><th>2040</th></tr>
<tr><td>Tanuel</td><td>69,650</td><td>69,650</td><td>69,650</td></tr>
<tr><td>Rebuken</td><td>5,870</td><td>5,870</td><td>5,870</td></tr>
<tr><td>Macaguiling</td><td>5,450</td><td>0</td><td>0</td></tr>
<tr><td>Mactan Rock</td><td>23,080</td><td>28,530</td><td>28,530</td></tr>
<tr><td>Dimapatoy</td><td>74,690</td><td>108,250</td><td>108,250</td></tr>
<tr><td>HANABANA</td><td>20,980</td><td>35,670</td><td>54,550</td></tr>
<tr><td>Tamontaka</td><td>0</td><td>25,660 - 43,700</td><td>106,640</td></tr>
<tr><td>Rio Grande</td><td>0</td><td>104,900</td><td>300,000</td></tr>
<tr><td>合計</td><td>199,720</td><td>378,530 - 396,570</td><td>673,500</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Water Supply Ratio in Water Supply Area (%)</td><td>
<table>
<tr><th>Year</th><th colspan="2">2022</th><th colspan="2">2029</th><th colspan="2">2040</th></tr>
<tr><th>Expanded WTP</th><th>Expansion Capacity</th><th>Water supply ratio increments</th><th>Expansion Capacity (increase from 2022)</th><th>Water supply ratio increments</th><th>Expansion Capacity (increase from 2022)</th><th>Water supply ratio increments</th></tr>
<tr><td>Dimapatoy</td><td>0</td><td>0</td><td>+8,000</td><td>+4.7</td><td>+8,000</td><td>+3.0</td></tr>
<tr><td>HANABANA</td><td>0</td><td>0</td><td>+6,000</td><td>+2.0</td><td>+10,500</td><td>+3.0</td></tr>
<tr><td>Tamontaka</td><td>0</td><td>0</td><td>+6,700 - +11,000</td><td>+3.6 - +6.1</td><td>+26,000</td><td>+9.46</td></tr>
<tr><td>Rio Grande</td><td>0</td><td>0</td><td>+25,000</td><td>+14.5</td><td>+71,500</td><td>+26.9</td></tr>
<tr><td>Total</td><td>0</td><td>0</td><td>+45,700 - +50,000</td><td>+24.8 - +27.3</td><td>+116,000</td><td>+42.4</td></tr>
<tr><td>Cumulative Total</td><td></td><td>47.4</td><td></td><td>72.2–-74.7</td><td></td><td>89.8</td></tr>
</table>
</td></tr>
</table>

Source : JICA Survey Team

Table 5-4-3 shows the quantitative effects in the target year for the expansion of the Tamontaka WTP, which is identified in this project as a candidate for the subsequent water supply project.

Table 5-4-3 Quantitative Effects of the Tamontaka WTP Expansion

<table>
<tr><th>No.</th><th>Indicator</th><th colspan="2">Design Value</th></tr>
<tr><td>1</td><td>Daily Average Water Supply Amount (m^3/day)</td><td colspan="2">5,360～8,800</td></tr>
<tr><td>2</td><td>Daily Maximum Water Supply Amount (m^3/day)</td><td colspan="2">6,700～11,000</td></tr>
<tr><td>3</td><td>Population Served (persons)</td><td colspan="2">25,660～43,700</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Water Supply Ratio in Water Supply Area (%)</td><td>Reference Value 2022</td><td>Target Value 2029</td></tr>
<tr><td>47.4%</td><td>72.3–- 74.7%
Dimapatoy +8,000m^3/day +4.7
Tamontaka +6,700 - +11,000m^3/day +3.6 - +6.1
Rio Grande +25,000m^3/day +14.5
HANABANA +6,000m^3/day +2.0</td></tr>
</table>

No.	Indicator	Design Value			
			Total	+45,700 - +50,000m^3/day	+24.8 - +27.3%

Source : JICA Survey Team

b) Qualitative Effects

The qualitative effect is as follows.

- Improvement of the living environment for residents (improvement of public health and convenience for residents who used to use spring water, groundwater, etc.)

Based on the above, the project is judged to be highly appropriate and expected to be effective.

Chapter 6. Water Intake Plan in the Service Area of MCWD

6-1 Existing Water Sources

6-1-1 Actual Production Volume of Water Sources

The actual production volume (in m^3, 2017-2022) for all water sources obtained from the MCWD is summarized below. As for annual trends, the production volume in 2017 was 12.5 million m^3 with a total of five water sources, but it exceeded 15 million m^3 in 2020. Furthermore, in 2022, it increased 16.8 million m^3 with a total of six water sources.

As for the actual monthly trend in production volume during the year, despite no big change from month to month, with the entry of new water sources, the production volume shows a tendency to increase year on year, from 1.2 to 1.3 million m^3 in 2020, and 1.35 to 1.45 million m^3 in 2022 respectively.

Table 6-1-1 Total Annual Actual Production Volume and Production Ratio

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total Production (m^3)
2017	964,152	1,010,207	1,021,457	1,002,819	963,409	1,014,356	1,107,377	1,070,068	1,100,108	1,058,635	1,092,090	1,084,500	12,489,178
2018	1,150,643	1,235,405	1,229,921	1,272,773	1,280,798	1,262,752	1,226,455	1,222,601	1,222,099	1,181,288	1,184,475	1,237,983	14,707,194
2019	1,222,411	1,245,315	1,239,318	1,242,803	1,223,009	1,227,756	1,208,382	1,277,396	1,261,645	1,222,084	1,220,540	1,176,913	14,767,572
2020	1,222,038	1,265,166	1,227,668	1,252,317	1,366,162	1,211,284	1,153,798	1,211,108	1,367,161	1,273,875	1,257,253	1,209,574	15,017,404
2021	1,299,605	1,269,394	1,278,110	1,296,236	1,233,184	1,320,939	1,264,941	1,313,931	1,292,953	1,316,979	1,300,376	1,301,445	15,488,093
2022	1,404,815	1,350,645	1,341,788	1,424,124	1,363,759	1,322,142	1,374,694	1,437,421	1,513,212	1,442,829	1,383,386	1,452,391	16,811,206

Source : MCWD

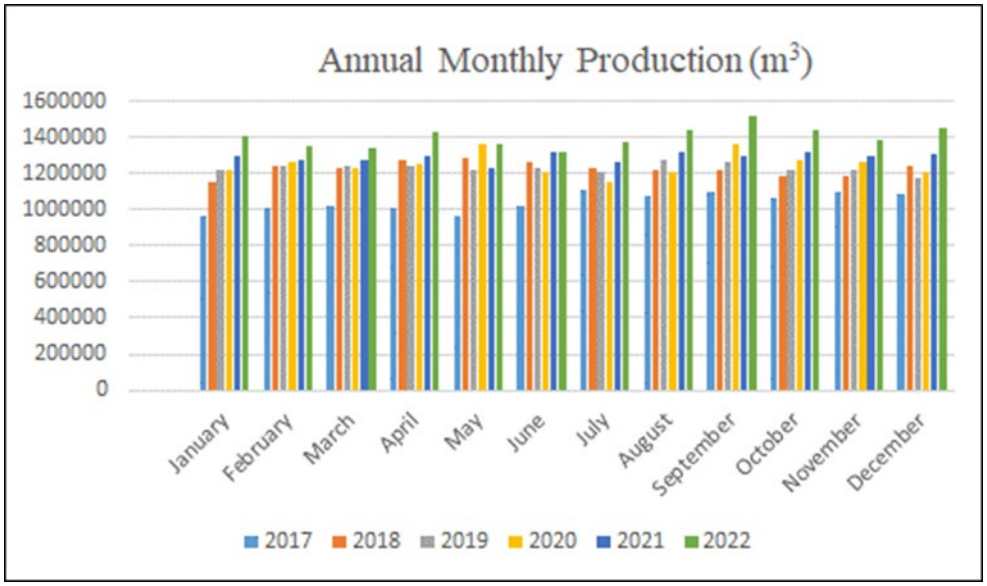


Figure 6-1-1 Annual Total Actual Production Volume in MCWD

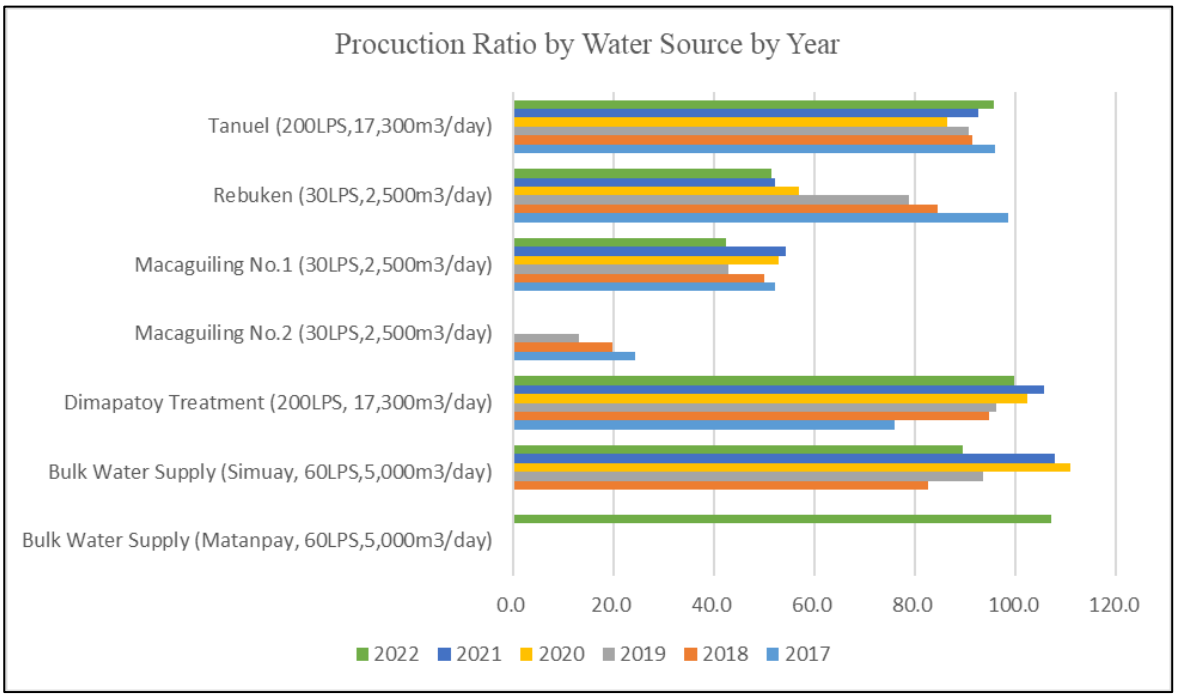
6-1-2 Percentage of each Water Source to the Total Actual Production

In order to analyze the actual production volume relative to the design production volume, the production ratio was calculated. This is defined as the ratio (in %) of the actual production (water intake) to the design production. Based on the data obtained from the MCWD, the actual production ratio of each water source was calculated and shown in the Table below.

Table 6-1-2 Percentage of each Water Source to the Total Actual Production (Annual. %)

No.	Pump Station (Design Production)	2017	2018	2019	2020	2021	2022	Average (%)
1	Tanuel (200LPS,17,300m3/day)	95.9	91.4	90.6	86.4	92.6	95.7	92.1
2	Rebuken (30LPS,2,500m3/day)	98.6	84.5	78.8	56.9	52.1	51.4	70.4
3	Macaguiling No.1 (30LPS,2,500m3/day)	52.1	49.9	42.9	53.0	54.2	42.4	49.1
4	Macaguiling No.2 (30LPS,2,500m3/day)	24.2	19.8	13.0	-	-	-	19.0
5	Dimapatoy Treatment (200LPS, 17,300m3/day)	75.8	94.7	96.2	102.5	105.8	99.8	95.8
6	Bulk Water Supply (Simuay, 60LPS,5,000m3/day)		82.6	93.6	110.9	107.9	89.5	96.9
7	Bulk Water Supply (Matanpay, 60LPS,5,000m3/day)						107.2	107.2
Average Production Rate (%)		80.8	85.1	85.5	91.7	94.8	92.6	88.4

Source : MCWD



Source：JICA Survey Team

Figure 6-1-2 Annual Production Ratio by Water Source by Year

The average production ratio of all water resources in the MCWD is approximately 88%. Water sources with a high production ratio exceeding 90% include Dimapatoy, Tanuel, Mactan Rock and Hanabana. On the other hand, water sources with low production ratios are the Macaguiling No.1 and No.2 Wells, among which No.2 stopped water production in 2019 due to increased in salinity. As for Macaguiling No. 1 Well, water production was suspended by February 2023 because the actual production volume showing 42% in 2022 was less than the designed production. The production ratio at Rebuken Well has also been declining year by year in recent years, showing 51% in 2022.

6-1-3 Percentage of each Water Source

The Table below shows the percentage of each water source relative to the total actual production. As shown, Tanuel Spring water and Dimapatoy water comprised 36 and 38% respectively (2022) and these two water sources comprise around 80% of all production. Of the water sources, bulk water supply, Mactan Rock, which started production in 2018, occupies 10% (2022), and Hanabana, which started production in 2022, occupies 12% (2022). As of 2022, Tanuel and Dimapatoy water sources comprise around 70% of all water sources and two water sources by bulk water supply occupy about 20% in the MCWD.

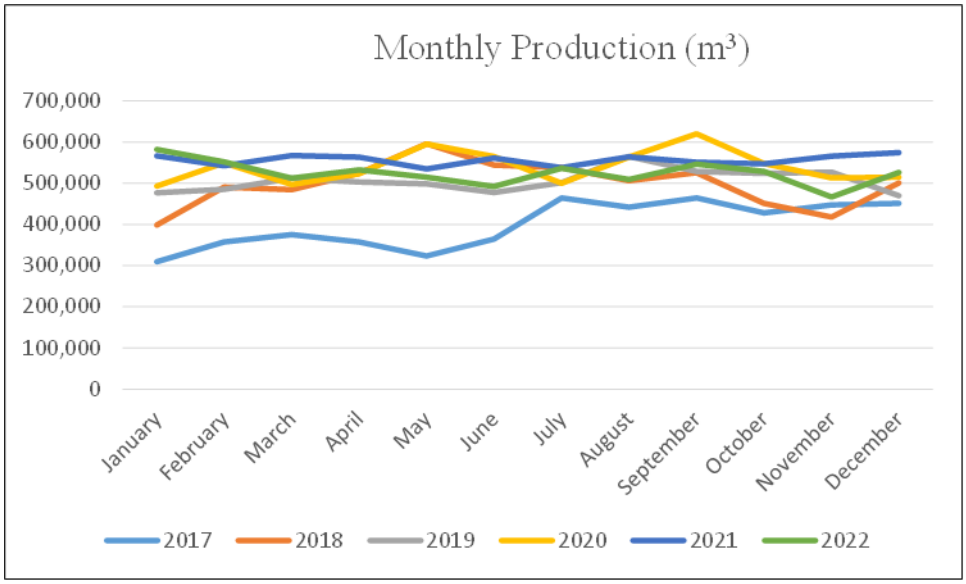
Table 6-1-3 Percentage of each Water Source

No.	Pump Station	2017	2018	2019	2020	2021	2022
1	Tanuel (200LPS)	48.5	39.2	38.7	36.4	37.7	35.9
2	Rebuken (30LPS)	7.5	5.4	5.0	3.6	3.2	2.9
3	Macaguiling No.1 (30LPS)	3.9	3.2	2.7	3.3	3.3	2.4
4	Macaguiling No.2 (30LPS)	1.8	1.3	0.8	No Production	No Production	No Production
5	Dimapatoy Treatment (200LPS)	38.3	40.6	41.1	43.2	43.1	37.5
6	Bulk Water Supply (Mactan Rock)		10.2	11.6	13.5	12.7	9.7
7	Bulk Water Supply-(Hanabana)						11.6
Total (%)		100.0	100.0	100.0	100.0	100.0	100.0

Source: MCWD

6-1-4 Annual Monthly Production Trends at Dimapatoy Water Source

The Figure below shows the annual and monthly production trends at Dimapatoy water source, which is the main water source in the MCWD. Although the production showed a low trend of 300,000 to 400,000 m^3 in the first half of 2017, monthly fluctuations of 470,000 m^3 to 570,000 m^3 have been small since then, making it a stable water source.

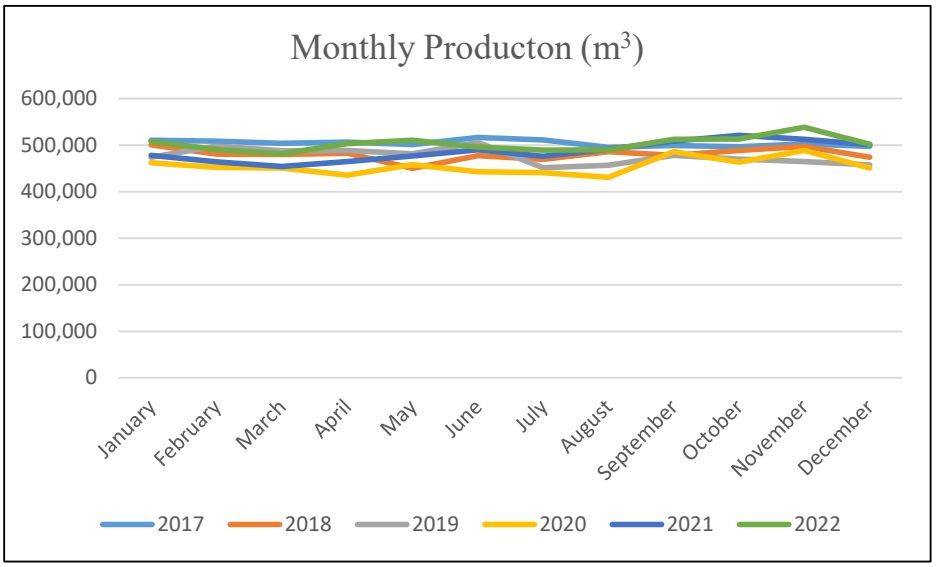


Source: JICA Survey Team

Figure 6-1-3 Annual Monthly Production Trends at Dimapatoy Water Source

6-1-5 Annual Monthly Production Trends at Tanuel Water Source

The Figure below shows the annual and monthly production trends at the major Tanuel water source, along with the Dimapatoy water source. Because it is spring, the monthly increase and decrease trends are modest, the production volumes are stable throughout the year, there is also little change in production.



Source: JICA Survey Team

Figure 6-1-4 Annual Monthly Production Trends at Tanuel Water Source

6-1-6 Actual Production Volume by Water Source

The Table below summarizes the actual daily production volume by water source. In assessing the current production volume, trends showing any increase and decrease over five years were taken into consideration. From these data, the actual production volume in the MCWD was assessed at 46,300 m^3/day. As for the Macaguiling No.1 well, water production stopped in February 2023, so the production volume was set as none. The production ratio relative to the design production volume (47,150 m^3/day) for the five water sources is said to be 98.2%.

Table 6-1-4 Actual Production Volume by Year and Current Actual Production

No.	Pump Station	Design Production (m3/day)	2017	2018	2019	2020	2021	2022	Actual Production (m3/day)
1	Tanuel (200LPS)	17,280	16,580	15,797	15,659	14,930	15,998	16,420	16,600
2	Rebuken (30LPS)	2,590	2,555	2,189	2,043	1,476	1,350	1,383	1,400
3	Macaguiling No.1 (30LPS)	0	1,350	1,293	1,112	1,373	1,404	1,135	0
4	Macaguiling No.2 (30LPS)	0	627	514	337	0	0	0	0
5	Dimapatoy Treatment (200LPS)	17,280	13,105	16,372	16,626	17,706	18,285	17,496	17,800
6	Bulk Water Supply (Simuay, Mactan Rock)	5,000		4,128	4,682	5,547	5,397	5,700	5,500
7	Bulk Water Supply (Matanpay,Hanabana)	5,000						4,935	5,000
Total Production (m^3/day)		47,150	34,217	40,294	40,459	41,031	44,454	49,091	46,300

Source: MCWD

6-1-7 Summary of the Current Situations on Existing Water Sources

The current situations on the existing water sources and assessment results for actual production are summarized as follows.

a. The annual production volume was around 16.8 million m^3 in 2022, which is 92% of the design production volume with 18.2 million m^3 of six water sources. Reviewing the monthly production

volume trends for the year reveals limited monthly fluctuation and actual monthly production of 1.35 to 1.45 million m^3.

b. Looking at the actual production ratio relative to the design production volume, the ratio of all water resources shows around 90%. Dimapatoy, Tanuel, Mactan Rock and Hanabana have a high production ratio of 90%, while the production ratio at Rebuken shows about 70%, and has declined to about 50% in recent years. From 2020, the production ratio of Macaguiling No. 1 also remained in in the 40% range, and water production stopped in February 2023.

c. The water sources developed in the MCWD comprise one spring, three deep wells, one river water, and two bulk water at rivers, for a total of seven water sources. Of these, Macaguiling Deep Well No. 2 stopped water production in 2019 due to rising salinity. Macaguiling Deep Well No. 1 also stopped water production in February 2023 due to low production. As of 2022, the water sources in the MCWD comprise one spring, one deep well, one river water, and two bulk water in the rivers, for a total of five water sources. Of these, Tanuel and Dimapatoy occupy 35 and 37% and Dimapatoy of total production respectively. Bulk water supply with two water sources occupies about 20%.

d. Dimapatoy and Tanuel as the main water sources, have stable water production throughout the year due to minimal seasonal fluctuations.

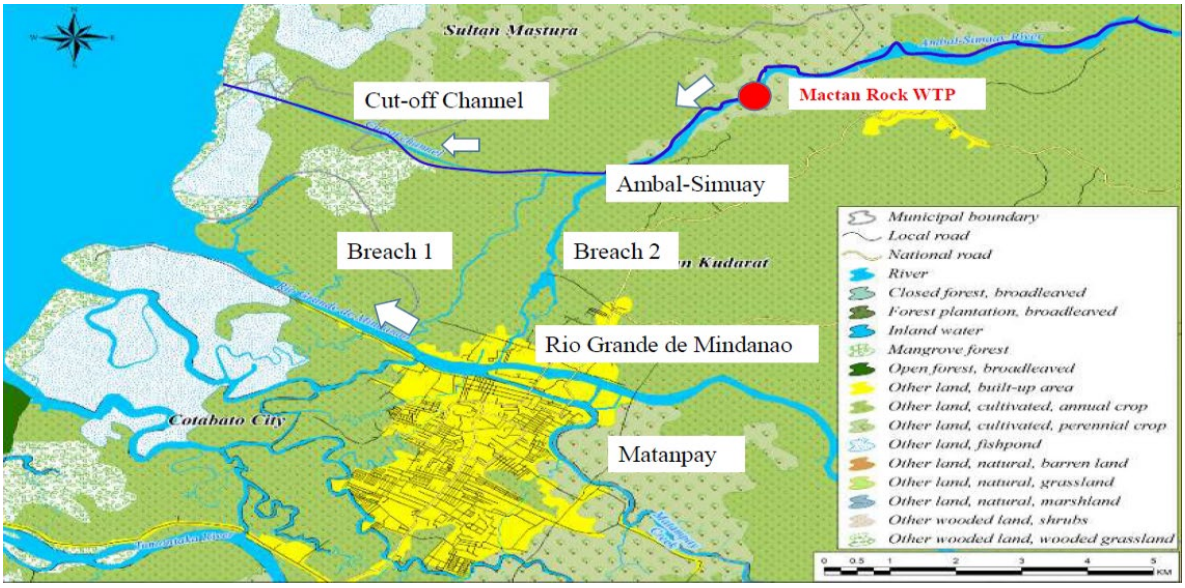
e. Based on the assessment of tendencies of actual production, the current actual production volume in the MCWD was assessed at 46,300 m3/day. As for the Macaguiling No.1 well, water production stopped in February 2023, so the production volume is set at zero.

6-2 Selection of Future Water Sources

6-2-1 Development Water Sources in MCWD

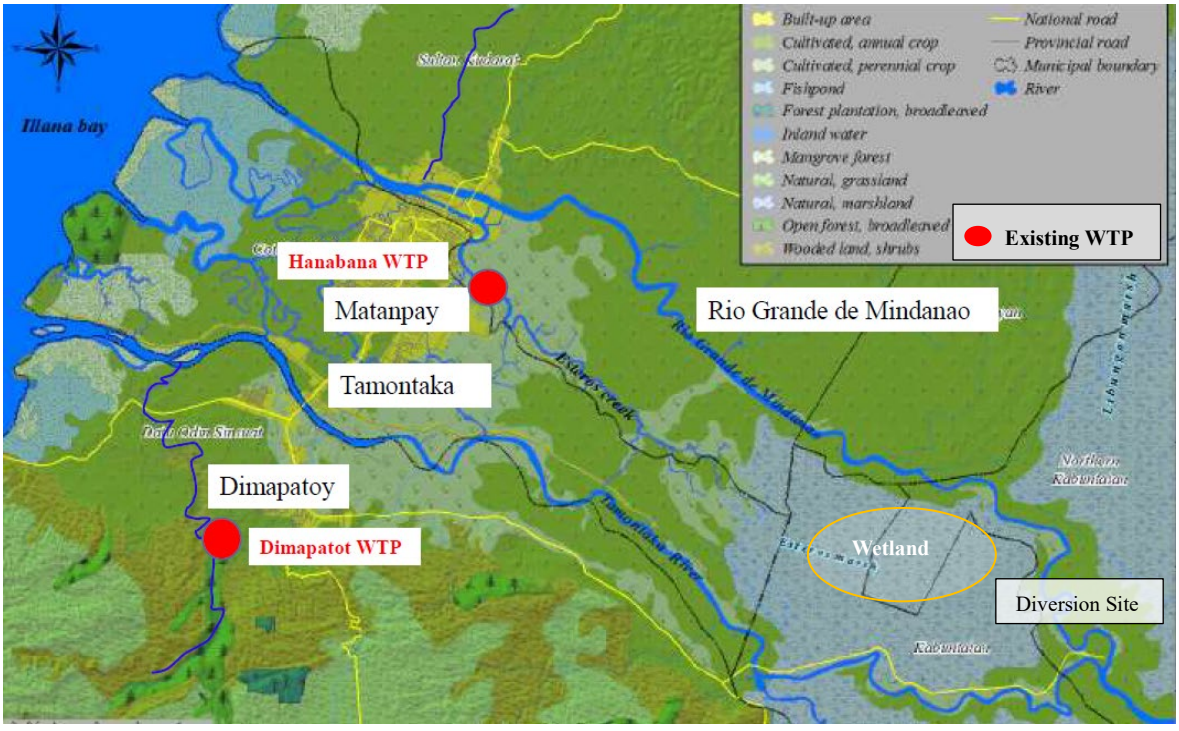
Spring water, groundwater, and river water are assumed to be the future development water sources within the service area of MCWD. As mentioned in 6-1, main water sources in the MCWD are Tanuel, which is spring water, and Dimapatoy, which is river water. These two water sources account for more than 70% of the water supply. The Tanuel water source, which uses spring water as its water source, has little fluctuation in annual production and has a stable production rate of 92% to the design production. In addition, the Dimapatoy water source, which is a river water source, has a small annual fluctuation and a stable production rate of 96%.On the other hand, regarding Rebuken Well and Macaguiling No.1 Well, which use groundwater as a water source, as can be seen in the annual trends mentioned in 6-1, the former is about 50% of the design production volume, and the latter is about 40% of the design production. The decreasing trends of water production for two wells in recent years have become remarkable. Regarding spring water, according to information from the MCWD, there is no promising spring water source. In the vicinity of Pedro Colina Hill, where the PC Hill Reservoir is located, there are small spring water sources that are used by local residents. Judging from the current production volume for the current water sources, water source information from the MCWD, and the development situations of the bulk water, the development of the water source would be river water. The river that flows through the area of MCWD is the Rio Grande de Mindanao (“Mindanao River”), and its catchment area is 21,500 km^2 (according to the Mindanao River Basin Management and Development Master Plan). The tributaries are the Ambal-Simuay River (“Simuay River”), the right tributary that

joins downstream, the Tamontaka River that diverts upstream in the wetlands, and the Matampay River that has its water source in the wetlands. The Dimapatoy River is the major left tributary of the Tamontaka River and joins it downstream. The locations of these rivers are shown below.



Source: Mindanao River Basin (MRB) Proposed Master Plan (Presentation Slides, DPWH, 2018), MCWD

Figure 6-2-1 Location of the Rivers for Development (Simuay-Rio Grande de Mindanao)



Source: Mindanao River Basin (MRB) Proposed Master Plan (Presentation Slides, DPWH, 2018), MCWD

Figure 6-2-2 Locations of the Rivers for Development (Rio Grande de Mindanao – Dimapatoy River)

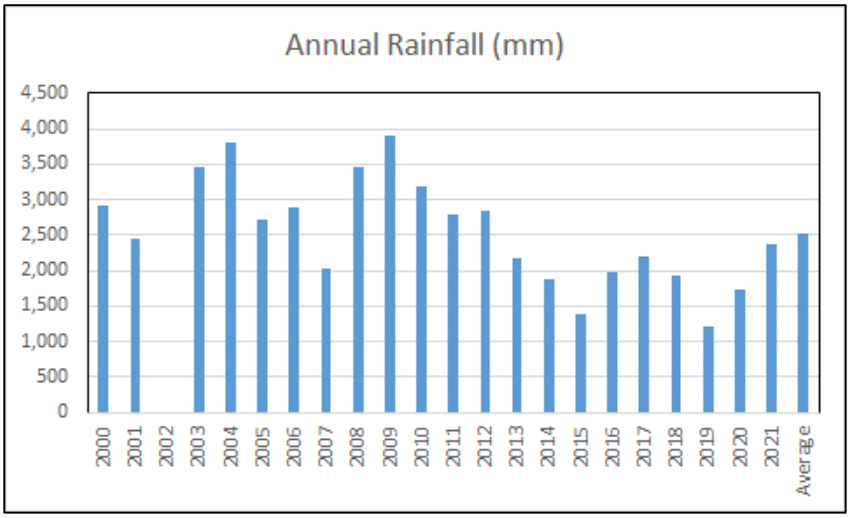
The Simuay River is a river located on the north part of the MCWD area, and around 1950, it joined the Mindanao River, but now due to the construction of the cut-off channel, it was diverted and flows into

Illana Bay. The Tamontaka River is a tributary of the Mindanao River diverts from the Mindanao River in the upper wetlands area. The Matampay River, which is the left tributary of the Mindanao River that joins in the area of Cotabato City, also has its source in the wetlands. The Dimapatoy River, which is a left tributary of the Tamontaka River and joins it in its downstream section, has its source in the mountainous area in the southern part of the area.

Among the four rivers, water intake facilities have been constructed and operate the plant in the Simuay and Dimapatoy Rivers. The amount of water production is shown in Table 6-1-4**.**

6-2-2 Rainfall Characteristics in Cotabato City

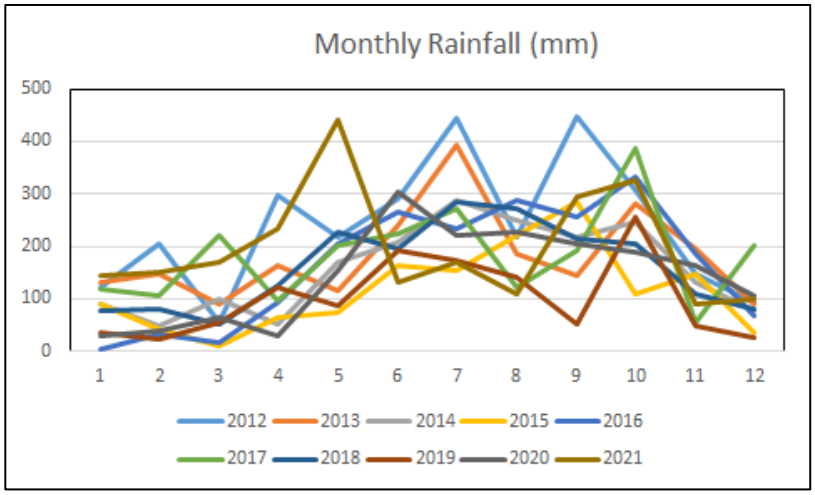
In order to understand rainfall characteristics, rainfall data for the last 20 years were collected and the trends are shown in the Figure below. Among the monthly rainfall data collected, data for 2002 was excluded from analysis due to lack of data. The average annual rainfall is to be 2,520 mm, the maximum annual rainfall is to be 3,893 mm (2009), and the minimum annual rainfall is to be 1,213 mm (2019). Focusing on trends in recent 10 (ten) years, since 2013, annual rainfall of 2,500 mm or more has not occurred.



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

Figure 6-2-3 Annual Rainfall Trends in Cotabato City (2000-2021)

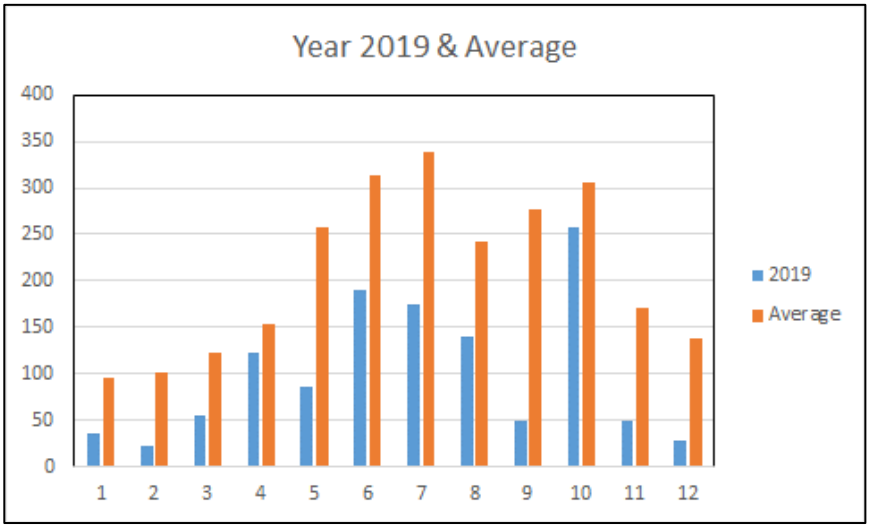
The monthly rainfalls by year trends for the last 10 years (2012 to 2021) are shown below. The rainfall tends to be high from May to October, and the rainfall tends to be low from November to April.



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

Figure 6-2-4 Monthly Rainfall by Year Trends in Cotabato City (2012-2021)

The Figure below compares the monthly rainfall in 2019, when the annual rainfall showed low rainfall trends, with the monthly rainfall in the average year. Monthly rainfall in 2019 shows a trend of low rainfall in May, and these trends continue until around November. In response to the trends of low rainfall in 2019, looking at the impacts on the water production volume in 2019 at Dimapatoy and Tanuel water sources, which are the major water sources in the MCWD. Both water sources have not been affected by monthly rainfall trends. No effects of rainfall for water sources were confirmed.



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

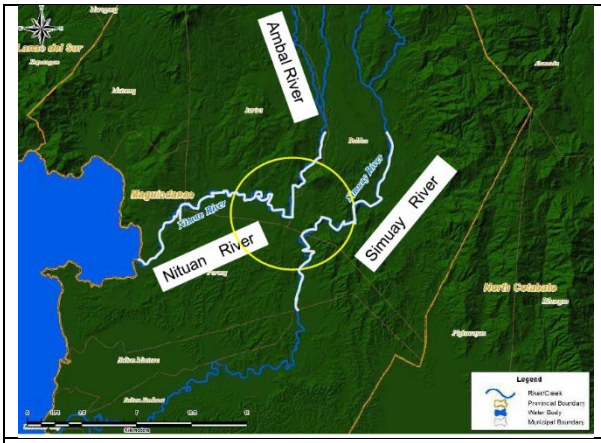
Figure 6-2-5 Comparison of Monthly Rainfall between Year 2019 and Average Year

6-2-3 River Morphology and Flow Characteristics of Major Rivers in MCWD Service Area

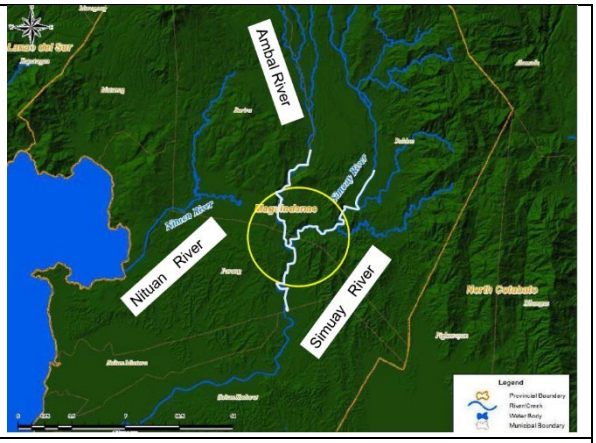
According to the Rio Grande de Mindanao Basin (MRB) Master Plan Report, the morphology of the Mindanao River has undergone various changes over the years. Between 1947 and 1953, the lower section of the Mindanao River bends to the right bank side and joins the Simuay River. In the early 1970s, a cut-off channel was constructed downstream of the Mindanao River, making it a straight river. As a result, the former river bend sections of the Mindanao River are now converted to agricultural lands. The Simuay River is now separated from the Mindanao River by dykes built by the DPWH as

the Ambal-Simuay River. In terms of the Tamontaka River, the river morphology has not changed much compared to the Mindanao River.

The Simuay River, which runs north of the Mindanao River, has a sediment runoff problem. The sources of this river are the Lanao del Sur Mountains, which are the main sources of sediments. When floods occur, pyroclastic deposits from mountains and sediments from riparian erosion throughout the river systems are transported and deposited in downstream sections. Sedimentation activity in the basin has altered the flow of the Simuay River and caused major river changes due to flooding. Prior to the 1950s, the Ambal River separated from the Simuay River and flowed directly into Illana Bay via the Nituan River. After diverting by cut-off, the Ambal River joined the Simuay River.



Ambal River Course before Joining with Simuay River



Ambal River joined Simuay River

Source: Updating of MRB Flood Management Master Plan, Main Report

Figure 6-2-6 Historical Changes in River Course in Simuay and Ambal Rivers

The confluence of these rivers made an increase in the total catchment area of the Simuay River and significantly increased flood runoff, causing in the transport of more sediments to downstream areas. The source of the sediment deposits of the Simuay River is pyroclastic sediments from the mountains and bank erosion of the river, and the Simuay River would be expected to undergo sediment damage and riverbed changes due to sedimentation. Sand mining in the Simuay River is conducted downstream at the Mactan Rock Intake Facility.

Sand Mining in Simuay River

Storing Site for Sand Mining

Source: JICA Survey Team

Photo 6-2-1 Sand Mining in the Simuay River（Downstream at Mactan Rock Intake）

The river morphology and hydrologic parameters of the Mindanao River, Tamontaka River, and Simuay River, which are being studied by the DPWH and USAID, are summarized below.

Table 6-2-1 River Morphology and Hydrologic Parameters of the Rivers

River	Catchment Area (km^2)	Longitudinal Slope (Downstream Section)	Flood Discharge(C/C) (1/100, m^3/sec)	Low Flow Discharge (1/10, m^3/sec)
Mindanao	21,500	1/5,000	6,340	53.16
Tamontaka	-	1/10,000	6,368	-
Ambal-Simuay	656	1/600	3,089	12.92

Sources: 1. Updating of MRB Flood Management Master Plan, Main Report (DPWH), C/C: with Climate Change Condition
2. Low flow discharges are referred based on "Metro Cotabato Water Supply, Rapid Feasibility Study (USAID, 2015)"

The low flow discharges shown in the above Table, discharge with the probability of exceedance of 90% (1/10) is adopted from the water availability analysis results of the F/S by USAID. The low flow discharges by probability are shown below. These flow discharges at the water intake sites of each river were calculated based on the Pulangul gauging station (catchment area: 12,991 km^2) in the Mindanao River, and Simuay gauging station (catchment area: 431 km^2) in the Simuay River.

Table 6-2-2 Discharges by Probability in the Mindanao River and the Simuay River (USAID)

Probability of Exceedance	Rio Grande de Mindanao (A=16,259 km^2)	Simuay River (A=442 km^2)
95 % (1/20)	45.28m^3/sec.	8.61 m^3/sec.
90 (1/10)	53.16	12.92
80 (1/5)	74.05	18.77
70 (1/3.3)	100.06	24.00
60 (1/2.5)	120.33	27.69
50 (1/2)	144.84	31.69
40 (1/1.67)	213.26	38.40
30 (1/1/1.43)	213.26	45.48
20 (1/1.25)	251.16	50.05
10 (1/1.1)	320.20	66.84

Source: Metro Cotabato Water Supply, Rapid Feasibility Study (USAID, 2015)
Notes: 1. "A" shows catchment area at water intake site in the river.
2. Figures in ( ) are converted from the provability in % to return period in 1/year.

When calculating the specific discharge per 100 km^2 with 1/10 probability, the Mindanao River is to be 0.33 m^3/s/100 km^2 and the Simuay River is to be 2.92 m^3/s/100 km^2. From these results, the Simuay River has a better water availability as for discharge condition.

6-2-4 Water Quality in Rio Grande de Mindanao

The results of the water quality survey for the Rio Grande de Mindanao River (F/S by USAID) is shown Table below. In the comparison of PNSDW, heavy metals meet the standards, but Coliforms (>23 MPN/100ml) and Turbidity (80 degrees) do not meet the standards (Coliform < 1.1 MPN/100ml, Turbidity: 5 degrees).

Table 6-2-3 Water Quality Results in the Rio Grande de Mindanao (USAID)

Parameter	Unit	PNSDW Limit	Results Rio Grande River
Total Coliform	MPN/100ml	< 1.1	>23
Fecal Coliform	MPN/100ml	< 1.1	>23
Apparent Color	PCU	10	100
Turbidity	NTU	5	80
Biochemical Oxygen Demand	mg/L	-	15
TS	mg/L	-	214
TDS	mg/L	500	194
Phosphate-P	mg/L	0.1[2]	15
Total Alkalinity, as $CaCO_3$	mg/L	-	98
Carbonate as $CaCO_3$	mg/L	-	<0.3
Sulfate	mg/L	250	42
Total Hardness	mg/L	300	21
Chloride	mg/L	250	6.3
Nitrate-N	mg/L	50	2.7
Boron	mg/L	0.5	-
Sulfide	mg/L	0.05	<0.01
Dissolved Silica	mg/L	-	63
Fluoride	mg/L	1	0.2
Mercury	mg/L	0.001	<.001
Arsenic	mg/L	0.05	<0.001
Cadmium	mg/L	0.003	<0.003
Chromium, Total	mg/L	0.05	<0.02
Iron	mg/L	1.0	0.6
Lead	mg/L	0.01	<0.0001
Manganese	mg/L	0.4	<0.01

Source: Metro Cotabato Water Supply, Rapid Feasibility Study (USAID, 2015)
Note: PNSDW: Philippine National Standards for Drinking Water

6-2-5 Damages in Target Rivers by Tropical Storm (TS) Paeng

From October 25th to 29th, 2022, Tropical Storm (TS) "Paeng" hit in Maguindanao Area, causing landslides and inundation damages in rivers within the service area of MCWD. A summary of the damages is shown below.

(1) Disaster Situations in Maguindanao Area

Based on the Situation Report obtained from the Office of Civil Defense BARMM Branch, the damage situations in the Maguindanao area are shown in the Table below. Rainfall characteristics during TS Paeng at the Cotabato Airport arranged by PAGASA are also collected for the reference of the scale of the floods. According to the situation report released as of November 18, 2022, 68 deaths, 13 missing persons reported, and 216,000 households affected in Maguindanao area due to the effects of TS "Paeng".

Table 6-2-4 Damage Situations and Rainfall Characteristics due to TS "Paeng"

No.	Item	Rainfall/Damages	Remarks (Sites, Sources)
1	Total Rainfall(mm)	226.9	Cotabato Airport (PAGASA, 10/25-10/29)
2	Maximum Daily Rainfall(mm)	132.2	Cotabato Airport (10/27)
3	Death (Persons)	68	As of November 18, 2022
4	Missing (Persons)	13	Same as above
5	Injured(Persons)	169	Same as above
6	Affected Households(Families)	215.961	Same as above
7	Affected People(Persons)	1,077,388	Same as above

Source : Situational Report No 27 for Effects of TS "PAENG" in BARMM (Department of National Defense, Office of Civil Defense, BARMM)

(2) Damage of Intake Facilities at the WTP in the Dimapatoy River

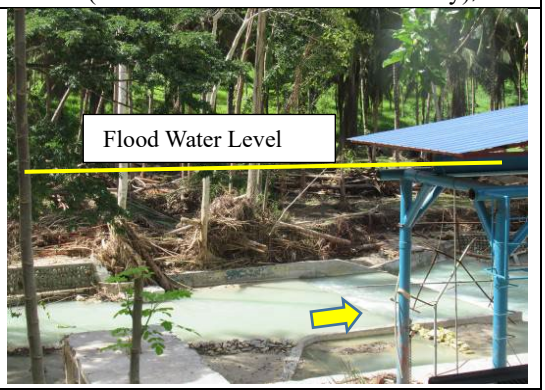
In terms of the water intake facilities at the Dimapatoy WTP, a field survey by JST was conducted on November 15th, 2022. According to the MCWD engineer, the restoration work was carried out only by the MCWD personnel. Since there was no heavy machinery, the restoration work was done by manpower alone, and it took a long time. At the time of the field survey, water intake facilities were possible to work.

The major damage was caused by a slope failure on the right bank upstream of the intake facility, and no restoration measures have been taken yet. As for other damages, regarding water intake weirs and waterways, the damages are the washed away of handrails and steel covers of waterways, and the burial of waterways and water intake wells by driftwoods and sediments. Timbers, bananas and wastes which were transported by the flood flows, and still accumulated on the left bank which is the opposite bank of the facility.

Water Intake Facilities before the Disaster
(With Handrails)

Water Intake Facilities after TS Paeng
(No handrails due to Washed Away))

Slope Failure on the Right Bank



Situations on the Left Bank

Source: JICA Survey Team

Photo 6-2-2 Damage Situations at Dimapatoy WTP (November 15, 2022)

The damage situation and consideration are as follows:

- The water intake facility and primary sedimentation basin were covered with sand to be removed manually. It took about three days to restore normal intake volume.
- Although the operation resumed in three days, it took seven days of 24-hour operation to remove sand and debris in the water source.
- This is the first time such a intense disaster has occurred.

➢ The collapsed slope will be restored by the municipality and the DPWH in the future.

Although the civil facilities along the river were damaged, the machinery and electrical equipment (pumps and an emergency generator) located on high place escaped damage, resulting in quick recovery.

When a flow rate exceeding the capacity of the river, the river water in the curved section is shortcut and flew into the upstream right bank of the intake facility. This becomes the collision points, it is assumed that the damage occurred in this flood event. Similar damage would occur in the future if the similar scale of flood flow occurs.

(3) Damage to Intake Facility in the Simuay River (Mactan Rock WTP)

The survey on the intake facility (Bulk Water Supply by Mactan Rock) located in the Simuay River was conducted on November 17th, 2022. According to the engineer working at the plant, although the water intake facility was tilted, restoration work was mostly completed, and the contracted water intake volume of 5,000 m^3/day was secured. It is said that the highest water level during the flood reached the upper part of the intake facility. The JST also conducted a field survey on October 13th, before the flood event, and found that the slope on the left bank of the river had collapsed due to the flood water, and that the water intake tower had tilted due to the flood water. On the right bank, the banana plantations and coconut forests were severely damaged, and a large topographical change was observed. The water intake facility also experienced damage by floods in 2018, and the current intake tower was installed upstream of the existing facility in 2019.

Damaged Intake Tower（Tilted by Water Forces）

Intake Tilted and Damaged on the Right Bank Side

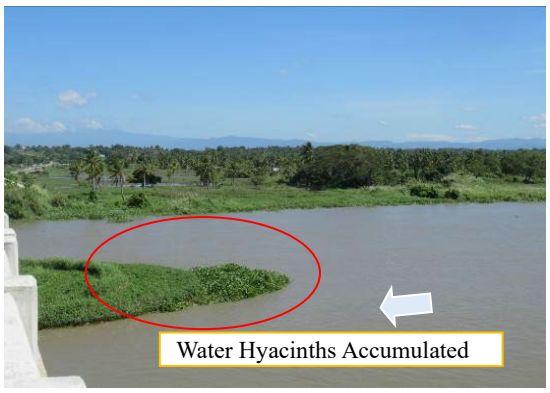
Source: JICA Survey Team

Photo 6-2-3 Damage Situations at Mactan Rock WTP in the Simuay River (November17, 2022)

(4) Rio Grande de Mindanao and Tamontaka River

For the Rio Grande de Mindanao and the Tamontaka River, the survey was conducted on November 14th , 2022.The situations in the river are shown in the Figures below, and it was judged that there was no major damage to the river. Both rivers had a lot of water hyacinth flowing down, and especially in the Tamontaka River, the amount of water hyacinth flowing out was so large that the water surface could not be seen at all upstream from the CCEDR Bridge as shown in the Figures. In the downstream part of the bridge, a small amount of water hyacinths outflow was observed due to the running water.

It is considered necessary to take measures to remove water hyacinths when design and planning of water intake.

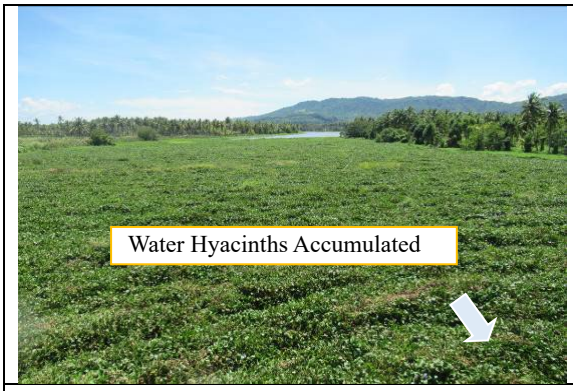


Upstream of Mindanao Delta 2 Bridge

Planned Intake Site at Right Side of the River

Source: JICA Survey Team

Photo 6-2-4 Post Flood Situations at Delta 2 Bridge and Planned Intake Site (RG de Mindanao)



Water Hyacinths Accumulated in the Water Surface

Water Hyacinths Flowing to the Downstream of the Bridge

Source: JICA Survey Team

Photo 6-2-5 Accumulation of Water Hyacinths at CCEDR Bridge (Tamontaka River)

(5) Matampay River (HANABANA WTP)

The survey for Bulk Water Supply by HANABANA WTP located along the Matampay River was conducted on November 17th, 2022. According to the engineer in charge of the operation, the flood water in the Matampay River was not so high and there was no damage to the pumping station. The situation at the time of the survey is shown in the Figure below, and it was judged that there was no major damage to the river and facilities.

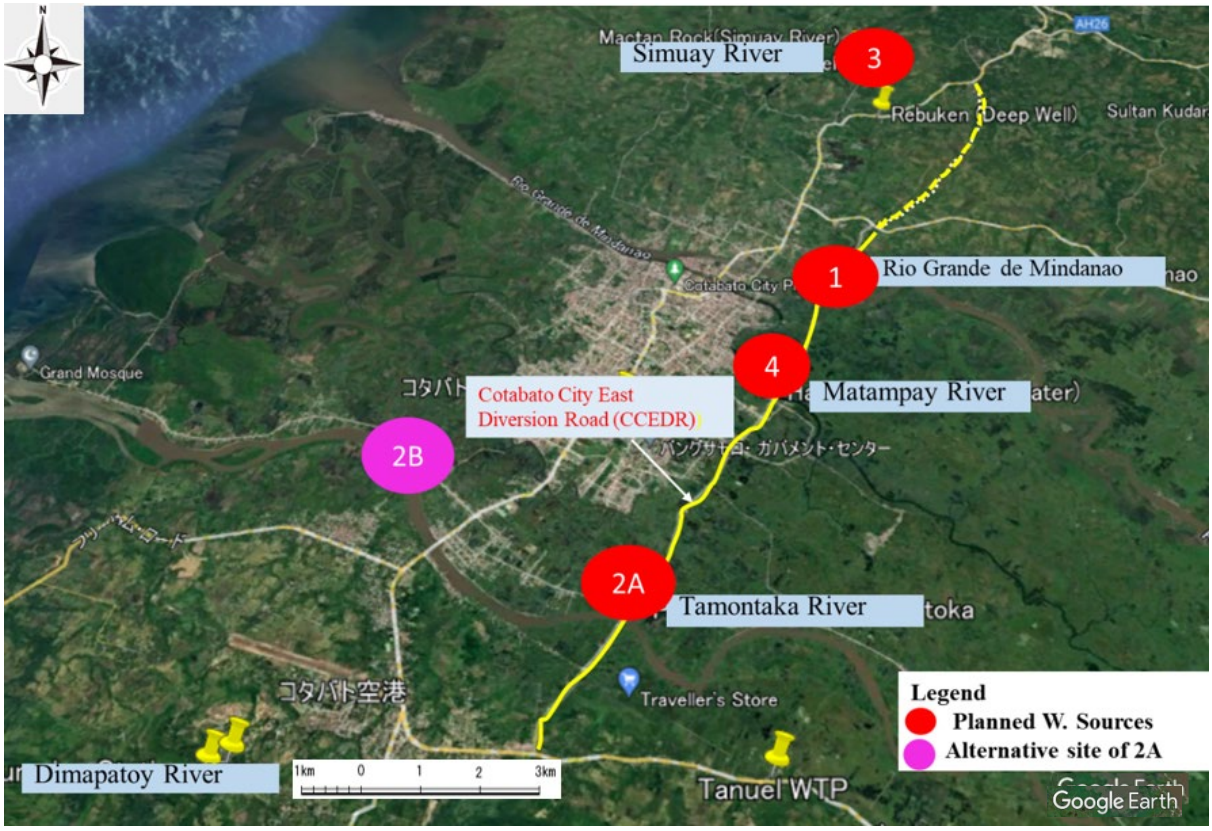
HANABANA Bulk Water WTP	Pumping Station (No Damages)

Source: JICA Survey Team

Photo 6-2-6 HANABANA WTP along the Matampay River (November 17, 2022)

6-2-6 Selection of the Targeted Rivers for Development of Water Source

The targeted rivers for the development of water sources are the Simuay River, Rio Grande de Mindanao, Matampay River, and Tamontaka River, excluding the Dimapatoy River, which is already undergoing water intake expansion work. The locations of these rivers are shown Figure below. The planned water sources (intake sites) were selected based on the current intake point of Mactan Rock WTP for the Simuay River, and the crossing points with CCEDR for other rivers. Regarding the Tamontaka River, as shown below, there was a proposal site of "2" from the MCWD in the Figure as an alternative site of "2A"



Source: JICA Survey Team

Figure 6-2-7 Targeting Rivers for the Development of Water Intake

The items for comparison of the water sources development were the flow conditions and water quality of each river, the effects of floods, land acquisition, the environment issues, and the results of an interview with the Mayor of Cotabato City that they should develop their own water source within the city administration area, and water supply development plans in the MCWD. The comparison and selection results are shown in the Table below.

Table 6-2-5 Selection Results for Development of Water Intake among Rivers

River Water Source	Flow Rate of the River	Water Quality	Flood Water Effects	Land Acquisition	Environment Issues	Development Policy of MCWD & Cotabato City	Evaluation Scores (+:1, -:-1)
Rio Grande de Mindanao	++	+	+	++ (SDF)	++	+ (S.Kudarat Area)	9
Tamontaka River	++	+	+	+	+ (Water Hyacinths)	+ (Own Source)	7
Simuay River Water (Mactan Rock)	++	+	- (Flood Water Force)	+	++	No Rating	5
Matampay River Water(HANABANA)	+	++	+	+	+ (Sanitary TP)	No Rating	6
Legends for Evaluation of Item	Very rich:++ / Rich:+	Very good:++ / Good:+	Small effects:+ / Large effects:--	Acquired:++ / Not yet:+	No issues:++ / Small issues:+	In line with policy:+ / Neutral: No rating	

Source: JICA Survey Team

Among the targeted rivers, the Rio Grande de Mindanao (Mindanao River) does not have any major problems with water quantity and water quality. Based on the study results of USAID in 2015, the MCWD would secure a budget from the SDF (Special Development Fund) and implement the project in three (3) phases through the Design and Build Scheme under Republic Act 9184. (Development water volume: 50 MLD, Project cost: PHP 1,570 Million, Approximately 3.93 Billion in Japanese Yen, for the target year of 2035.) The planned project is to take water from the Mindanao River and expand the service area to Sultan Kudarat District, which is located in the northern part of the current water supply area. Therefore, entry into this project with JICA funds is not expected at this time. In addition, the river improvement project implemented by the DPWH is not expected for the time being, so it would be necessary to protect the intake facilities with land raising to design the same levels as the embankment that would be designed in the river master plan.

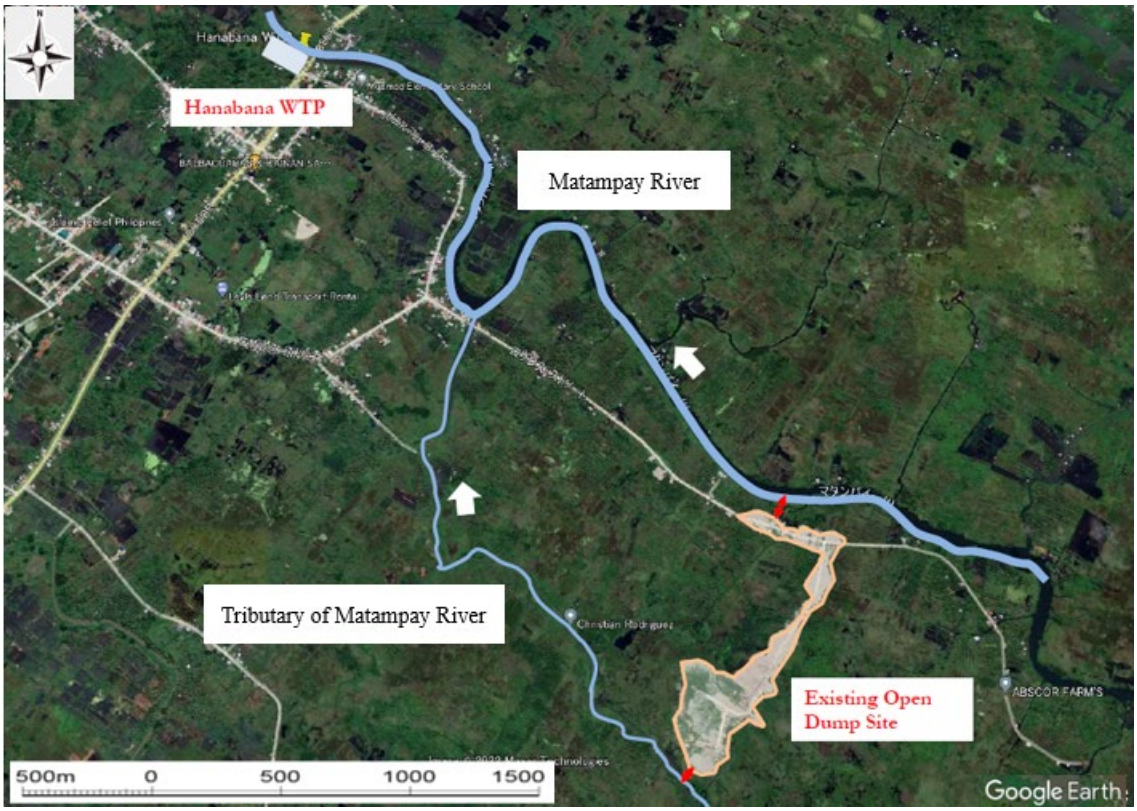
The Tamontaka River, like the Mindanao River, does not have any major problems with water quantity and quality among the targeted rivers. According to the Mayor of Cotabato City, the City has been trying to secure water sources within the city administration area for a long time, and the development of water sources in this river is in line with the city's policy. The candidate water intake site 2A is close to houses and public facilities, and it is expected that land acquisition would be difficult. In addition, as confirmed in the post-flood survey for typhoon "Paeng" by the JICA survey team, there is a lot of water hyacinth flowing in the river. From the operation and environmental points of view, it is necessary to consider the removal of these in the facility planning and design. According to information from the MCWD, land acquisition is a pending issue, and if resolved, it is determined that there will be no obstacles to the progress of the project. During the JICA survey, the MCWD proposed an alternative downstream site (2B in the Figure) instead of the site 2A near the CCEDR. This site is located at the distance of 7K200

(Based on the DPWH Chainage) from the river mouth of the Tamontaka River and located within a tidal affecting zone. Therefore, it was judged that it is not appropriate as a water intake site. According to information from the MCWD, the tidal affecting zone extends up to around STA 8k000. As flood management measures by the DPWH are not expected to be implemented in the Tamontaka River as well, it is necessary to protect the intake facilities by land raising to the same level as the embankment in the river master plan.

In the Simuay River, although flow rates are rich in the river, there are sedimentations and the effects of floods. The intake facilities have suffered two times due to flood damages, one in 2018 and the other in 2022 since the starting of the operation of the WTP. Large fluctuations in the river bed and main flow streams and large sediment runoff are confirmed at the intake site. Therefore, taking into account the river situation near the current intake site, it is judged that it is not suitable as a water intake facility. In addition, water is already being taken by Mactan Rock as a bulk water supply, making it difficult for other new business companies to participate.

In terms of taking water from the Matampay River, there is no flood damage, and the quantity and quality of water are excellent, so there is no problem as a site for selecting water intake facilities. An expansion plan up to 10,000 m^3/day by the operating company for HANABANA was also planned and designed at the initial design stage of the facilities. According to the comments of the MCWD engineer, it would be difficult for a new business operation to enter the water supply business while the private sector is operating it, considering the operational aspects.

There are sanitary landfill dumping sites operating in the area of the Matampay River. Judging from the situations with the open dump disposal at the site, it is likely that rainwater would flow into the waste materials in the future. There are concerns about contamination from “leachate” that seeps out through the waste materials and the outflow of waste materials due to flooding because it is located in the possible flooding areas.



Source: JICA Survey Team

Figure 6-2-8 Location of Cotabato City Sanitary Landfill Site within the Matampay River

Based on the comparison results shown in the above Table, the JICA survey team decided to select a river which would develop water source among the three rivers, excluding the Mindanao River, which was the targeted river of the SDF project. Among the three rivers, the Tamontaka River was selected because it was in line with the water resource development policy, rich in flow rates and the MCWD would secure the land for water intake facilities.

6-3 Water Intake Facility Plan in the Tamontaka River

6-3-1 Planning Policy for Water Intake Facility

The planning policy for the water intake facility is shown as follows.

1) The targeted river for water intake is the Tamontaka River, and the water intake site is the right bank upstream of the CCEDR Bridge (New Tamontaka Bridge), which is a straight section in consideration of the river plan alignment. As for the river chainage “STA”, although it is not covered within the section of the river improvement plan by the DPWH, if it is set according to the chainage of the Tamontaka River improvement plan, it would be “STA 11k30”.

Source: JICA Survey Team

Figure 6-3-1 Planned Water Intake Site in the Tamontaka River（STA 11k300）

Source: JICA Survey Team

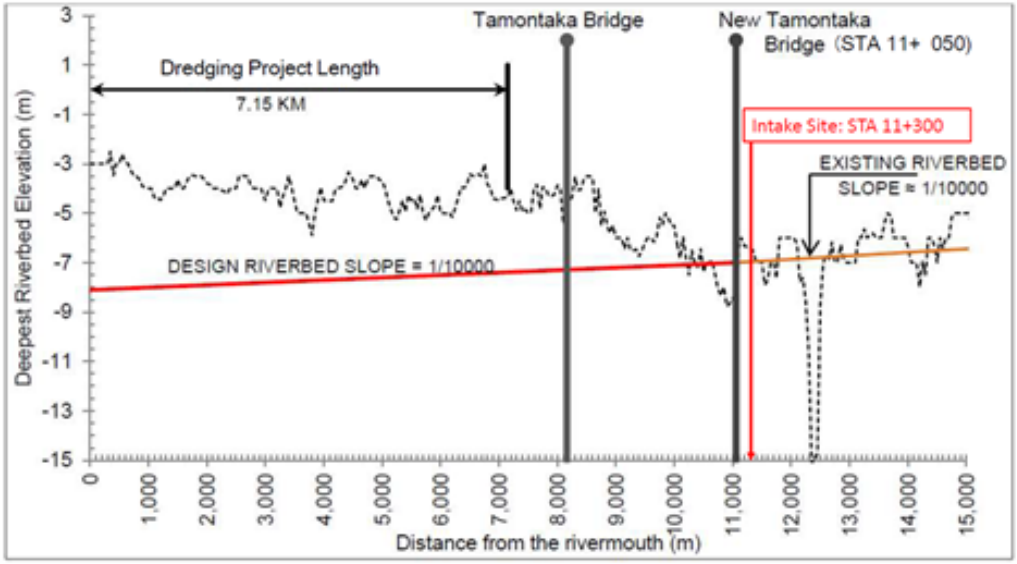
Photo 6-3-1 Current Situation at the Planned Water Intake Site (Tamontaka River, STA11+300)

2) Based on the water supply and demand plan, the maximum design water intake shall be set at 12,100 m^3/day (1.1 times for the design water intake). If the unit system is the same as the river discharges, it is converted to be 0.140 m^3/sec.
3) As for the design flood level at the planned site, which is the basis of the embankment level, since the longitudinal profiles of water level under the river rehabilitation plan by the DPWH has been obtained, it is estimated by extrapolating these design flood levels to the site of the water intake. The low water level would be estimated from the measured water level at the time of topographic survey.
4) As for the elevation of the ground level for the facility plan, it would be estimated from satellite images (Google Earth) as survey results could not be obtained. (The ground level was set at GL +4.0m.)
5) Taking into account the inundation and sedimentation due to flooding, for the planning and design water intake facilities, inundation to the facilities shall be protected with land raising or

surrounding dikes, and inflow sediments shall be reduced by the installation of the settling pond. At the stage of this survey, the JICA survey team would only make recommendations for installation of these facilities.

6-3-2 Design Flood Level and Embankment Level at Planned Water Intake Site

According to the DPWH report "Consulting Services for the Detailed Engineering Design of Various Flood Management Projects in the Mindanao River Basin: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao & Tamontaka River" The longitudinal profiles are shown the Figure below.



Source: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao & Tamontaka River (DPWH)

Figure 6-3-2 Longitudinal Profiles under the Flood Management Plan in Tamontaka River

As can be seen from the above Figure, the dredging works section is designed up to 7.15 km from the mouth of the river in the master plan. The design riverbed slope is set at 1/10,000. The intake site was planned at 11.3 km (STA 11k300) from the river mouth. The results of flood inundation analysis results including the minimum channel elevation, the maximum water surface elevation and average channel velocity under the river improvement plan are shown in the Table below. The two-dimensional inundation analysis was performed on the premise of the dredging plan, and CCEDR is located at the eastern end (upstream end). As a result, the water level for the design flood at the New Tamontaka Bridge is to be 3.83m.

Table 6-3-1 Water Surface Elevation and Channel Elevation based on the Inundation Analysis

River Sta	Profile	Min Channel Elevation (m)	Max Water Surface Elevation (m)	Discharge at Max WS (m^3/s)	Average Channel Velocity (m/s)	Flow Area (m^2)	Top Width (m)
0+000	Max WS	-8.100	1.220	136.000	0.010	15232.150	1977.290
10+000	Max WS	-5.500	3.500	2872.950	2.250	1462.500	259.790
10+050	Max WS	-6.250	3.500	2872.950	2.330	1444.060	252.890
10+10	Max WS	-6.830	3.500	2872.950	2.410	1403.720	240.500
10+15	Max WS	-5.970	3.470	2872.950	2.630	1283.800	228.830
10+200	Max WS	-6.800	3.500	2872.950	2.560	1319.580	219.320
10+250	Max WS	-7.500	3.510	2872.950	2.570	1322.010	213.490
10+300	Max WS	-6.500	3.490	2872.950	2.770	1230.080	206.230
10+350	Max WS	-7.000	3.500	2872.950	2.790	1218.270	202.550
10+400	Max WS	-7.190	3.500	2872.960	2.860	1187.300	203.010
10+450	Max WS	-6.450	3.480	2872.950	3.060	1106.440	202.940
10+500	Max WS	-7.390	3.490	2872.960	3.090	1094.930	203.190
10+550	Max WS	-7.000	3.510	2872.960	3.140	1091.390	201.080
10+600	Max WS	-7.000	3.540	2872.960	3.100	1104.290	199.520
10+650	Max WS	-6.920	3.590	2872.960	2.970	1153.730	197.880
10+700	Max WS	-7.500	3.660	2872.970	2.740	1230.380	194.710
10+750	Max WS	-8.060	3.650	2872.970	2.830	1188.420	193.000
10+8	Max WS	-7.900	3.650	2872.960	2.900	1157.860	191.320
10+850	Max WS	-7.900	3.620	2872.970	3.130	1096.900	191.240
10+900	Max WS	-8.780	3.670	2872.970	3.030	1143.220	193.260
10+950	Max WS	-8.650	3.700	2872.970	3.020	1156.560	200.250
11+000	Max WS	-8.430	3.790	2872.970	2.690	1301.950	207.910
11+023	Max WS	-8.600	3.830	2872.970	2.540	1376.440	211.000
11+046	Max WS	-9.380	3.830	2872.970	2.550	1333.010	208.640

STA + 0+000

New Tamontaka Bridge

Source: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao & Tamontaka River, Table A.3-2 Results of the T=100-yr Flood Simulation under the Scenario "with project" in Tamontaka River

From the above Table, the design maximum water level at the intake site is calculated as follows. The longitudinal profiles for water surface elevation in the Table are as follows, and the results are obtained by extrapolation to the intake site (11km300).

Gradient of Water Surface Level= Water Level Difference (m)/Distance(m)

= (3.830-1.220)/11,046m = 2.61m/11046m=1/4,232 (1/4230=0.0002364)

Design Flood Level at Intake Site

= 3.830 + (11,300-11,046)×0.0002364=3.830+0.060= 3.890 (m)

Based on the above calculation results, the design parameters such as design flood level and embankment level at the intake site are shown as follows. The freeboard was adopted as 1.5m based on the river improvement plan of DPWH.

Table 6-3-2 Design Water Level and Embankment Level at Water Intake Site

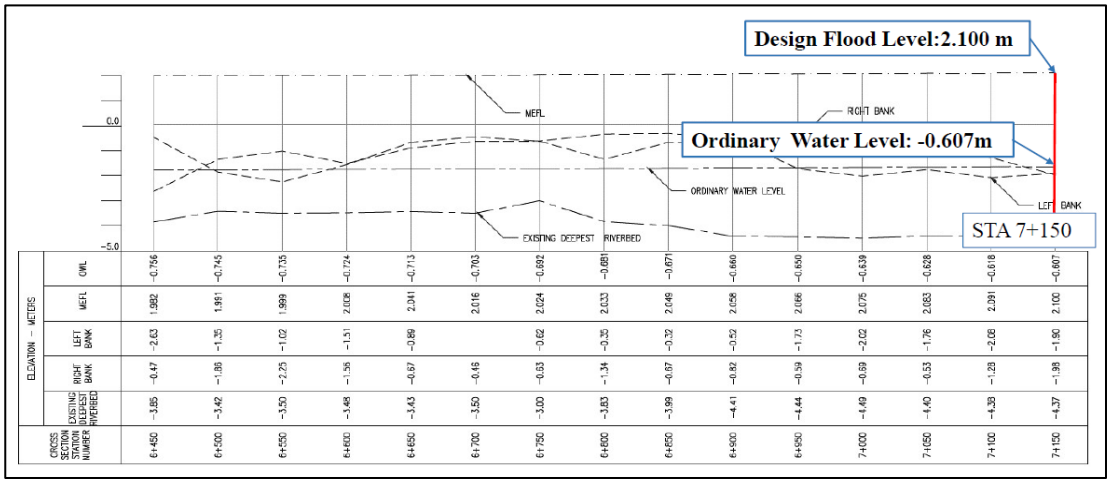
No.	Item	Parameter	Remarks
1	Design Flood Level (HWL)	WL 3.89 m	STA. 11K300
2	Freeboard	1.50 m	
3	Design Embankment Level	GL 5.39 m	

Source: JICA Survey Team

6-3-3 Design Water Intake Level at the Planned Water Intake

The design water level at the planned water intake site is usually calculated using a rating curve (or H-Q curve) based on cross-sectional survey drawing and water level calculation with discharge data. However, these materials were not obtained during the JICA survey so that it is estimated based on the river improvement plan prepared by the DPWH.

According to the DPWH report "Consulting Services for the Detailed Engineering Design of Various Flood Management Projects in the Mindanao River Basin: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao & Tamontaka River" The longitudinal profiles for dredging works section (STA 0k000–7k150) are shown below, and the design flood level and the ordinary water level are indicated. This water level is based on the results of a river survey and is assumed to be the measured water level.



Source: Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao & Tamontaka River (DPWH)

Figure 6-3-3 Water Levels at STA 7k150 based on the Longitudinal Profiles in Dredging Works

From the above Figure, the difference between the design flood level and normal water level is 2.707m. Applying this difference to the water intake site and deducting this difference from the design flood level gives WL 1.207m (WL=3.914 -2.707=1.207m). The water level during low discharges (LWL) is qualitatively lower than the normal water level, but it cannot be set because there is no river discharge (flow) data. Finally, the minimum water level provisionally was set at WL 1.000. Based on the above examination, parameters for water level and embankments at the intake site are summarized as follows.

Table 6-3-3 Design Parameters at Planned Water Intake Site (Tamontaka 11k300)

No.	Item	Parameters	Remarks, (Basis & Sources)
1	Design Flood Level (DFL)	WL +3.89 m	DPWH Report
2	Design Low Water Level	WL +1.00 m	Based on longitudinal profiles for dredging works
3	Embankment Top Level	GL + 5.39 m	Freeboard1.50m＋DFL
4	Design Riverbed Level	GL–- 7.00 m	Longitudinal Profiles
5	Grand Level at Land Side	GL + 4.00 m	Satellite Image (Google Earth)

Source: JICA Survey Team

6-3-4 Design Parameters for Water Intake Facility

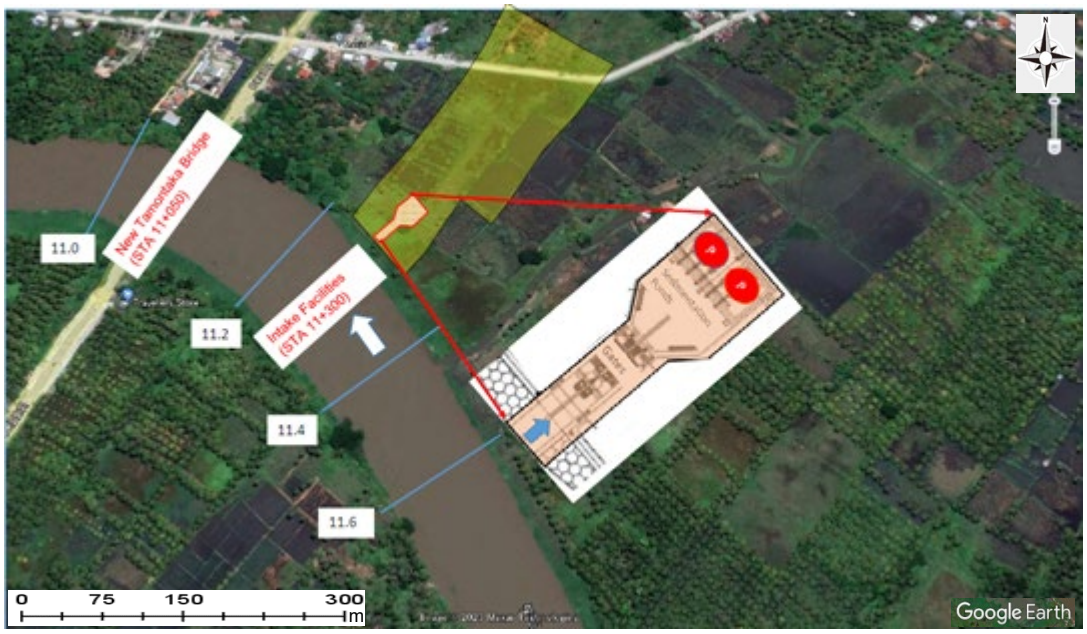
The design parameters for the water intake facilities examined in the previous section are summarized below. Since the planned intake site is not included in the Tamontaka River improvement plan, embankment or construction of a surrounding embankment up to the same level as the design embankment level in the river improvement plan would be required for the water treatment facilities including water intake.

Table 6-3-4 Design Parameters for Water Intake Facility

No.	Item	Specification/Dimension	Remarks
1	Planned Water Intake	STA 11+300	Tamontaka River
2	Maximum Design Water Intake	12,100 m^3/day (0.140 m^3/sec)	1.1 times for the design water intake
3	Method for Water Intake	Water Pumping	With facilities such as channels, gates and settling pond
4	Design Flood Level (DFL)	WL +3.89 m	Inundation Analysis in the DPWH Report
5	Design Low Water level	WL +1.00 m	Based on longitudinal profiles for dredging works
6	Embankment Top Level	GL + 5.39 m	Freeboard1.50m +DFL
7	Design Riverbed Level	GL–- 7.00 m	Longitudinal Profiles
8	Grand Level at Land Side	GL + 4.00 m	Satellite Image (Google Earth)
9	Area for Water Intake	1,326 m^2	W(34m)×L(39m)=1326m^2

Source: JICA Survey Team

An image of the water intake facility at the planned site is shown below.



Source: JICA Survey Team

Figure 6-3-4 An Image of Water Intake Facility in Tamontaka River (STA 11+300)）

Regarding the installation of weirs such as estuary weirs, compared to the water intake volume (0.140 m^3/sec), the flow rate of the main river is several tens of m^3/sec. It was determined that sufficient water intake was possible. In addition, when selecting the water intake point, it is also taken into consideration that the plan shape of the river is a straight section, making it a suitable point for water intake.

6-3-5 Countermeasures against Removal of Water Hyacinths

In the Rio Grande de Mindanao basin, the removal of water hyacinths is a concern, and according to the Updating of MRB Flood Management Master Plan, Main Report, countermeasures are already being considered in the Buluan-Alip River. Removal methods include: i) Manual removal (using hands/or tools such as nets, rakes, shovels, etc.), ii) Mechanical removal (water weeds harvester and transport machines), iii) Chemical removal (use of herbicides), and iv) Biological control (utilizes of weevils, an

insect that feeds on water hyacinths). However, in general, it is processed by a combination of ii) and iii) or iii) and iv).


Source: Websites

Photo 6-3-2 Examples of Water Weeds Harvester

After removal, water hyacinth can be used as a phytoremediation agent (use as a treatment agent that can absorb heavy metals and phenolic compounds), biomass energy (combustion, gasification, thermal decomposition, etc.), soil conditioner (including nitrogen and phosphorus).) and livestock feeds.

Among the above removal methods, it is usually judged that there are many cases of removal by machines, but it is difficult for the MCWD to own these machines independently, and removal by owners of removal machines such as the DPWH would be needed. In addition to these, as water hyacinths inflow countermeasures that are unique to the water intake facility, the installation of floating nets found in dam reservoirs and oil fences seen in the incidents of oil outflows would be also available.


Source: Websites

Photo 6-3-3 Installation of Floating Nets at Gate Facilities

6-4 Key Issues to be considered in the Next Phase

Based on the results of the facility plan for the water intake, the key issues to be considered in the next phase are discussed below.

a) Confirmation of the River Improvement Plan in the Tamontaka River

According to the result of the flood analysis by the DPWH, the intake candidate site is located at the east side of the CCEDR. The east side area of the CCEDR is located within the possible inundation (flood) area. The water intake site is planned about 250m to 300m east side from this CCEDR, and in order to protect the water intake facilities from flood damage, the facility should

be protected with land raising or surrounding dikes independently. It is necessary to consult with the DPWH on related to the embankment design in the river improvement plan.

b) Topographic Survey and Geotechnical Survey around the Planned Water Intake Facility

During the survey by JST, there was no result of topographic and geotechnical surveys on the candidate site for the water intake. Prior to the design of water intake facilities, topographic surveys including the river survey (planes, longitudinal profiles and cross sections) are necessary. In addition, as a geotechnical survey, it is necessary to conduct the Standard Penetration Test by drilling to confirm the supporting layer for the foundation, and soil tests to evaluate the settlements due to embankments and facility installation.

c) River Water Level and Discharge (flow rate) Survey

As shown in the Figure 6-2-2, the Tamontaka River branches off from the Rio Grande de Mindanao, and then flows through wetlands in its lower reaches. For this reason, it is not possible to simply calculate the flow rate (discharge) at the facility planning site based on the gauging station located nearby the site, using “the catchment area ratio”. As the hydrological survey related to the water intake, it is necessary to monitor the water level and flow rate, especially for the low flow rate during the dry season. The monitoring period is needed about one year, and the frequency is proposed to be once a week. The monitoring site is recommended at New Tamontaka Bridge.

Chapter 7. Facility Development Plan for MCWD

7-1 Policy of facility development

Established in 1976, the MCWD is the only public water district supplying drinking water in Cotabato City, SK and DOS. It has the capacity to produce 46,300 m^3/day from three types of water sources: s: deep wells, springs and surface water. On the other hand, the NRW ratio in 2021 is about 25.3%, which means that out of 46,300 m^3/day, about 17,000 m^3/day is wasted. Water demand continues to increase due to high population growth rates and regional development. In addition, the water supply rate in the service area is currently 47.4% (As of 2022 result), and expansion of the water supply capacity remains an urgent issue for the MCWD.

Under these circumstances, the MCWD has two main policies of its facility development: “Increasing of water supply capacity” and “NRW measures” For measures to increase water supply capacity, the expansion of WTPs is underway, new WTPs and work to boost the capacity of private bulk water supply projects are being planned. Regarding the NRW measures, the establishment of DMAs, the renewal of old pipes, leakage prevention measures and the integration of water service pipes are planned.

7-2 Plan of Facility Development

7-2-1 Expansion of Dimapatoy WTP

As of December 2022, the Dimapatoy WTP is being expanded by the MCWD. The expansion capacity is 8,000 m^3/day and is relied on the surface water from the Dimapatoy River. The water rights for the Dimapatoy River have been applied for from the MCWD to MENRE and the water rights for 400 LPS (34,560 m^3/day) required for the expanded WTP have been permitted.

The expansion of the water treatment plant is being implemented on a design-build basis with MCWD’s own funds, with planning, design and construction being undertaken by Hydrochem Plus Industrial Sales & Services Inc, based in Manila. The water treatment plant under expansion will use a rapid sand filtration and consist of two flocculation tanks, four sedimentation tanks with upward-flowing sloping plates and eight pressure filtration tanks (multimedia filters). The pressure filtration tanks, also called dual-media filters, have a filter layer comprising anthracite, sand, and gravel layers, with a treatment capacity of 1,000 m^3/day per unit.

The construction is funded by MCWD’s own resources.

The second edition of the Technical Standards Manual (LWUA, 1979), which is the design standard for water supply facilities in the Philippines, mainly describes pipelines and lacks any information on the design of water treatment plant. Accordingly, water treatment plants are generally ordered based on performance orders rather than specification orders.

An overhead view of the WTP under expansion are shown in Figure 7-2-1-Figure 7-2-5, and construction photographs are shown in Photo 7-2-1.

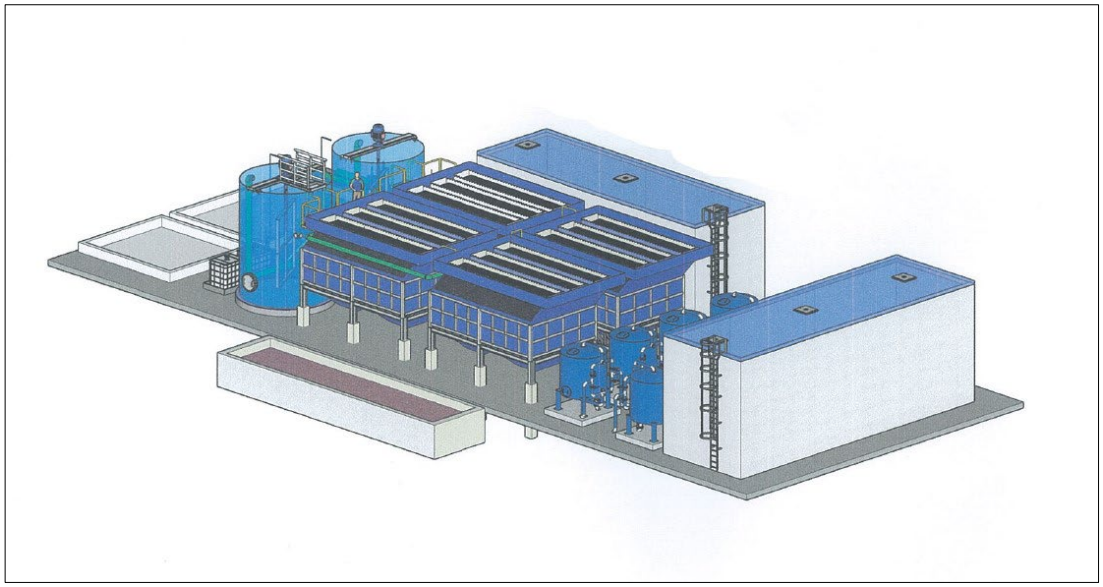


Figure 7-2-1 Dimapatoy Expansion WTP（Overhead view）

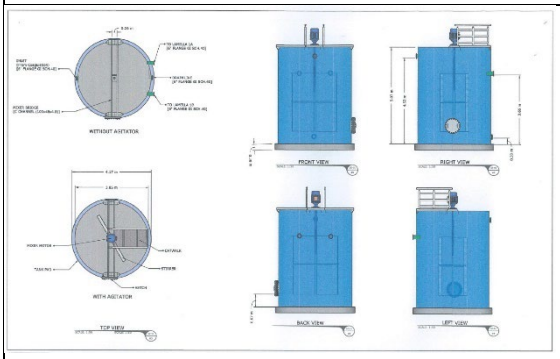


Figure 7-2-2 Flocculator（Dimension）

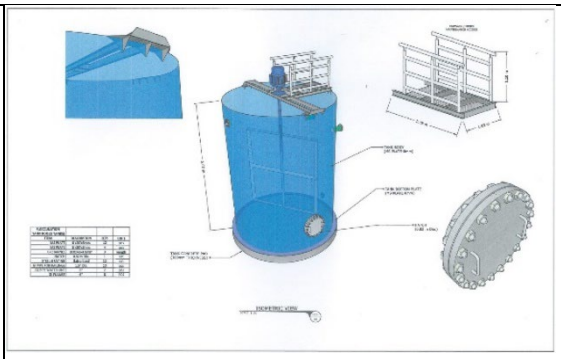


Figure 7-2-3 Flocculator（Detail）

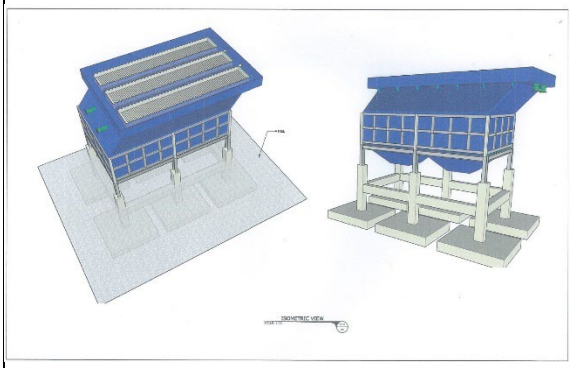


Figure 7-2-4 Upward Flow Sedimentation Basin（Overhead View）

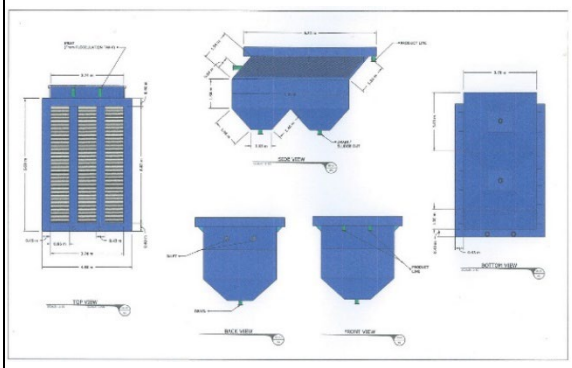
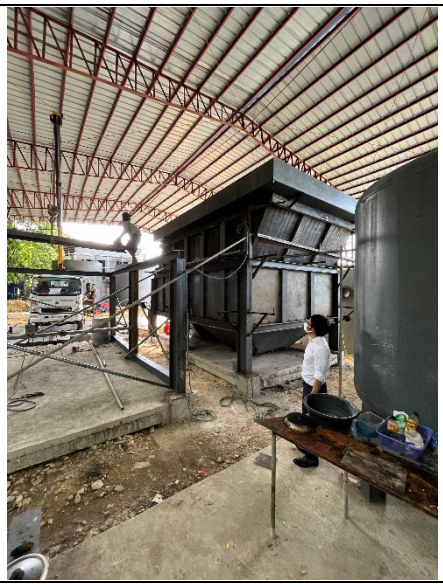
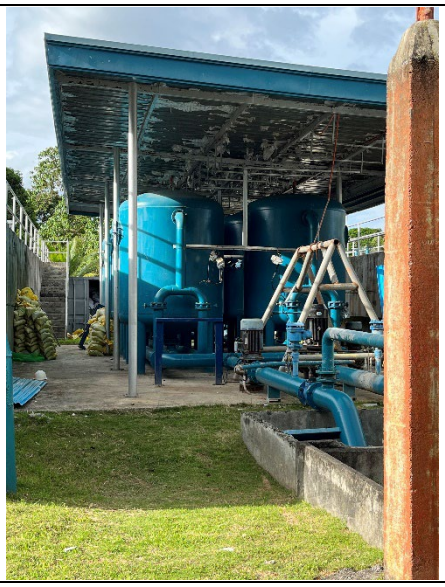


Figure 7-2-5 Upward Flow Sedimentation Basin（Plan View・Dimension）

Source:：MCWD

	
Upward flow sedimentation basin	Pressure filter

Source: : JICA Survey Team

Photo 7-2-1 Expansion WTP Under Construction

7-2-2 Project of Rio Grande Water Supply System

(1) Rio Grande Water Supply System Plan

Rio Grande Water Supply System Project was proposed by the USAID in July 2015. The MCWD is currently in the process of submitting a project implementation plan to the BPDA to utilize SDF. The plan is divided into three phases until 2035, with SDF Phase 1 for the construction of a WTP (25,000 m^3/day), SDF Phase 2 for the laying of transmission and distribution pipes and SDF Phase 3 for the construction of a WTP (another 25,000 m^3/day).

The construction of the water treatment plant in SDF Phase 1 is considered to be carried out by design and build at 25,000 m^3/day, and specifications have been prepared by the MCWD and submitted to BPDA. The installation of water pipes in SDF Phase 2 aims to expand the water supply capacity of SK and Cotabato City and the water supply area of SK and Sultan Mastura. In particular, one of the major objectives is to provide water stably to the Cotabato Sanatorium Hospital. In SDF Phase 3, the WTP will be further expanded by 25,000 m^3/day. It is envisaged that the water demand of Cotabato City, SK and Sultan Mastura will increase by around 2031.

In addition, the long-term plan until around 2040 requires an additional expansion of the water treatment capacity by 21,500 m^3/day, which is expected to be expanded by laying water pipes from Sultan Mastura to Parang and Panatan, and to the northeast area of SK. By 2040, the Rio Grande WTP will require a total of 71,500 m^3/day of water treatment capacity, but if the target year is FY2029, only 25,000 m^3/day will be secured. Here, we describe the phased development plan required for the water supply area planned by the MCWD based on the amount of water demand in 2040 estimated by the JICA survey team.

As mentioned in Chapter 5, the Rio Grande WTP will be in Phase 1: 25,000 m^3/day (SDF Phase 1) in 2027, Phase 2: 25,000 m^3/day (SDF Phase 3) in 2031, and another Phase 3: 21,500 m by 2038 maintenance required for m^3/day.

Table 7-2-1 Schedule for Expansion of WTP

unit：m^3/day

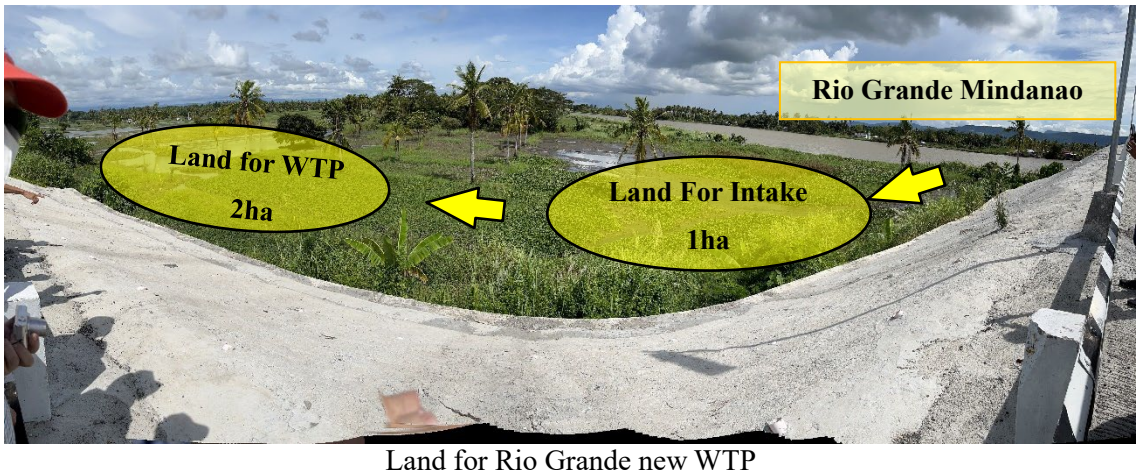
year	2022	2023	2026	2027	2029	2031	2035	2038
Rio Grande				+25,000		+25,000		+21,500

Source:：JICA Survey Team

The proposed construction site has already been acquired on the corner where the right bank of the Mindanao River, the second largest watershed area in the Philippines, meets the East Diversion Road. The acquired area is 1 ha for water intake and 2 ha for the water treatment plant.

The site is a wetland where rice cultivation used to take place. The water quality of the Mindanao River always exhibits an earthy brown color, and according to the simple water quality test of the JICA survey team, the turbidity of 100 NTU or more immediately after the sampling is separated and separates after a few minutes and drops to about 50 NTU or less, increasing permeability.

Photo 7-2-2 shows the photos of the acquisition site.



Land for Rio Grande new WTP

Land for WTP: 2ha

Land for Intake :1ha

Source: JICA Survey Team

Photo 7-2-2 Candidate Site of Rio Grande New WTP

The details of the maintenance planned for Phase 1 are shown in Table 7-2-2.

Table 7-2-2 Facility Construction Overview of Phase 1

Facilities	Construction Overview
Water Intake Facilities	➢ Structure/Buildings: Mechanical Screen/Racks Intake Channel Sump Tank Pump House w/Control Room Genset House Operators' Quarter Stock Room and Equipment Bay Guard House ➢ Electro-Mechanical Equipment: Centrifugal Pump & Motor, 3 sets,188LPS, H60m 500KVA Generator set Electric Hoist and Trolley ➢ Pipelines, Valves and Flowmeter Raw Water Lines, Steel Pipeφ700 L=800m Butterfly Valve φ700, 1set Electromagnetic Flow Meter φ700, 1set Motorized Sluice Gate,1set Check Valves φ500, 4set Butterfly Valves φ500, 4set Air Release Valves φ100, 5set Bends, Flange, Gaskets and Fittings, 1lot Bolts, Nuts, Acetylene/Oxygen and Welding Rods, 1lot ➢ Chemical Facilities: Pre-chlorination system, 2sets In-line Coagulation System 2sets
Water Treatment Facilities	➢ Flocculation Basin 450m^3 ➢ Lamella Plate Clarifiers 675m^3 ➢ Sand and Anthracite Filters High-Rate Dual Media Filters ➢ Clear Well/Product Tank and Pipes & Fittings 2,000m^3 ➢ Electro-Mechanical Equipment Booster Pumps 2 set for Storage Tank (SK & City) @30m Head 2 set for SK and SM 2 set Backwash pumps 6 set Motor Controls and Wiring System Generator 400KVA. 1set ➢ Pipelines, Valves and Flowmeter Processed Water Lines, Steel Pipeφ300～φ700, 1 lot Butterfly Valvesφ500, 4set Electromagnetic Flow Meterφ500, 2set Check Valves φ500, 4set Butterfly Valves φ500, 2set Air Release Valves φ100, 5set Bends, Flange, Gaskets and Fittings, 1lot Bolts, Nuts, Acetylene/Oxygen and Welding Rods, 1lot ➢ Chemical Facilities (Post Chlorination) ➢ Structure/Buildings Operator's Quarter, Stock Room and Equipment Bay Guard House Booster Pump House Filter House Chlorine House Visitors Lounge and Conference Room
Site Development	Fence Solar Perimeter Lights Earth Works/Earth fill Access Roads Drainage/Canal Land Scape

Source: : JICA Survey Team

(2) Rio Grande Water Transmission and Distribution Plan

Two transmission pipelines will be installed from the Rio Grande WTP. The transmission pipeline (1) will be connected to the existing Rebuken transmission pipeline to increase the water supply capacity to the existing water supply areas of Cotabato City and SK. The transmission pipeline (2) system will distribute water to SK, Sultan Mastura and Parang to expand the water supply area.

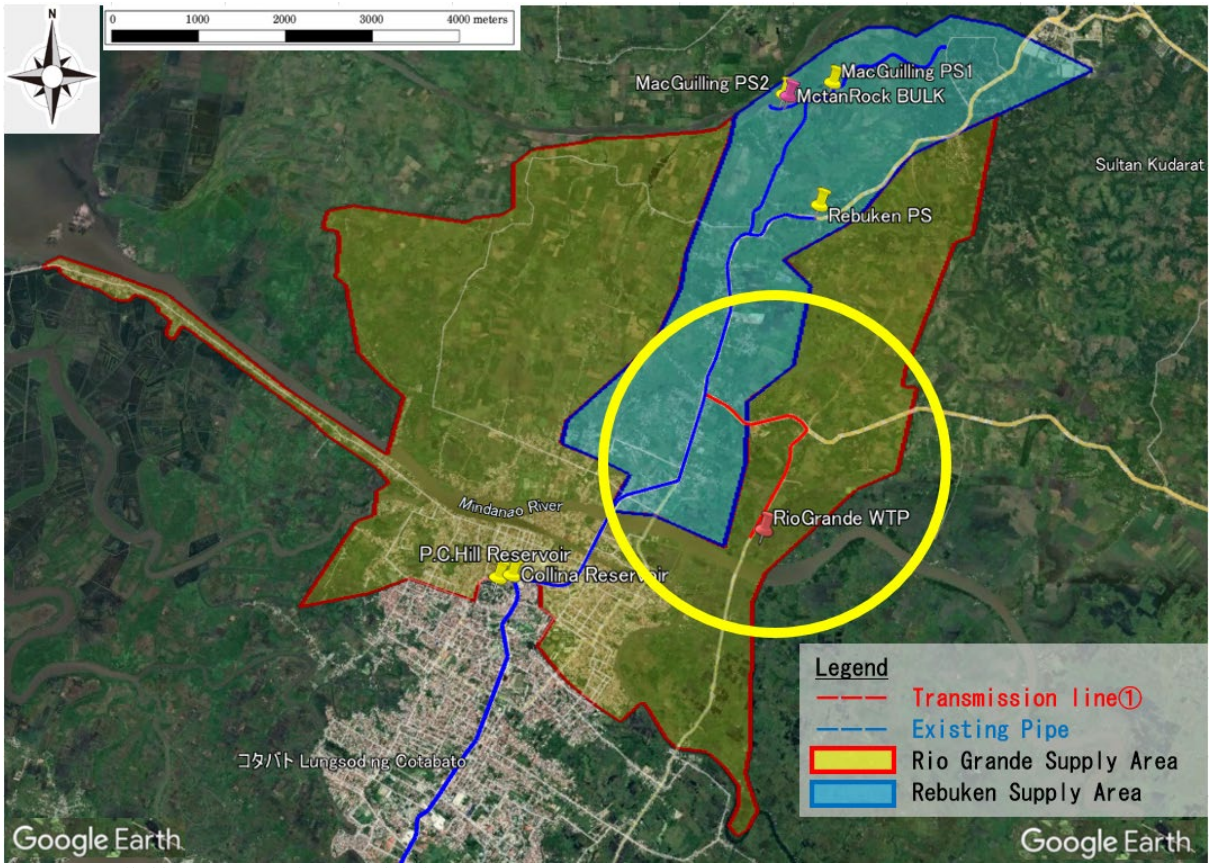
- Transmission Pipeline (1): Cotabato City and SK (connected to existing transmission line)
- Transmission Pipeline (2): SK, Sultan Mastura and part of Parang

The Rio Grande water transmission and distribution plan is shown below.

1) Transmission Pipeline (1): Cotabato City and SK

The Rio Grande transmission pipeline (1) will install a water pipe in a section of about 2.6 km from the booster pump newly installed at the Rio Grande WTP to Sinsuat Avenue and connect it to the existing Rebuken transmission pipeline system. The main objective is to increase the water supply capacity of the existing water supply area in 14 barangays.

Figure 7-2-6 shows the transmission pipeline (1) route and water supply area.



Source: Compiled by survey team based on data from MCWD

Figure 7-2-6 Rio Grande Transmission Pipeline (1) and Supply Area

Table 7-2-3 shows the flow rates of the 14 barangays that transmission line (1) will receive by Phase 2 in 2040.

Table 7-2-3 Water Flow of Rio Grande Transmission Pipeline (1) (2040)

City/Municipality	ID	Phase of Rio Grande	Supply Area /Barrangay	Target Year 2040	
				Maximum daily supply Q	Maximum Hourly supply Q/1.25x1.9 q
				m3/day	m3/sec
Cotabato city	C21	Rio Grande Ph.1,2	RH3	4354.7	0.01826
	C05	"	Kalanganan MB	5107.5	0.02141
	C06	"	Kalanganan1	2282.5	0.00957
	C01	"	BAG MB	6527.5	0.02737
	C02	"	BAG 1	3185.1	0.01335
	C04	"	BAG 3	1737.9	0.00729
	C08	"	POB MB	5596.5	0.02347
	C09	"	POB1	1646.0	0.00690
	C10	"	POB2	2041.5	0.00856
	C11	"	POB3	1230.9	0.00516
	C12	"	POB4	2104.5	0.00882
	C13	"	POB5	1093.5	0.00458
	C14	"	POB6	1295.4	0.00543
	C15	"	POB7	4195.6	0.01759
Cotabato city total				42399.2	0.17777

Source: : JICA Survey Team

The diameter was calculated from the maximum hourly flow rate using the Hazen-Williams formula. The flow rate of the transmission pipe used the maximum daily water supply, the flow coefficient was 110, the length was 2.6 km, and the head loss was within 10 m for convenience.

Table 7-2-4 shows the details of the Rio Grande transmission pipeline (1).

Table 7-2-4 Facilities of Rio Grande Transmission Pipeline (1)

Facilities	Outline of construction
Transmission Pipeline (1)	1. Transmission pipe: steel pipe 400mm, L=2.6km ➢ Water supply capacity: Approx. 42,000m^3/day (From Table 5-3-1 Relationship between water treatment facilities and water distribution areas (barangays) to be developed (2040))

Source: : JICA Survey Team

2) Transmission Pipeline (2): SK, Sultan Mastura and part of Parang

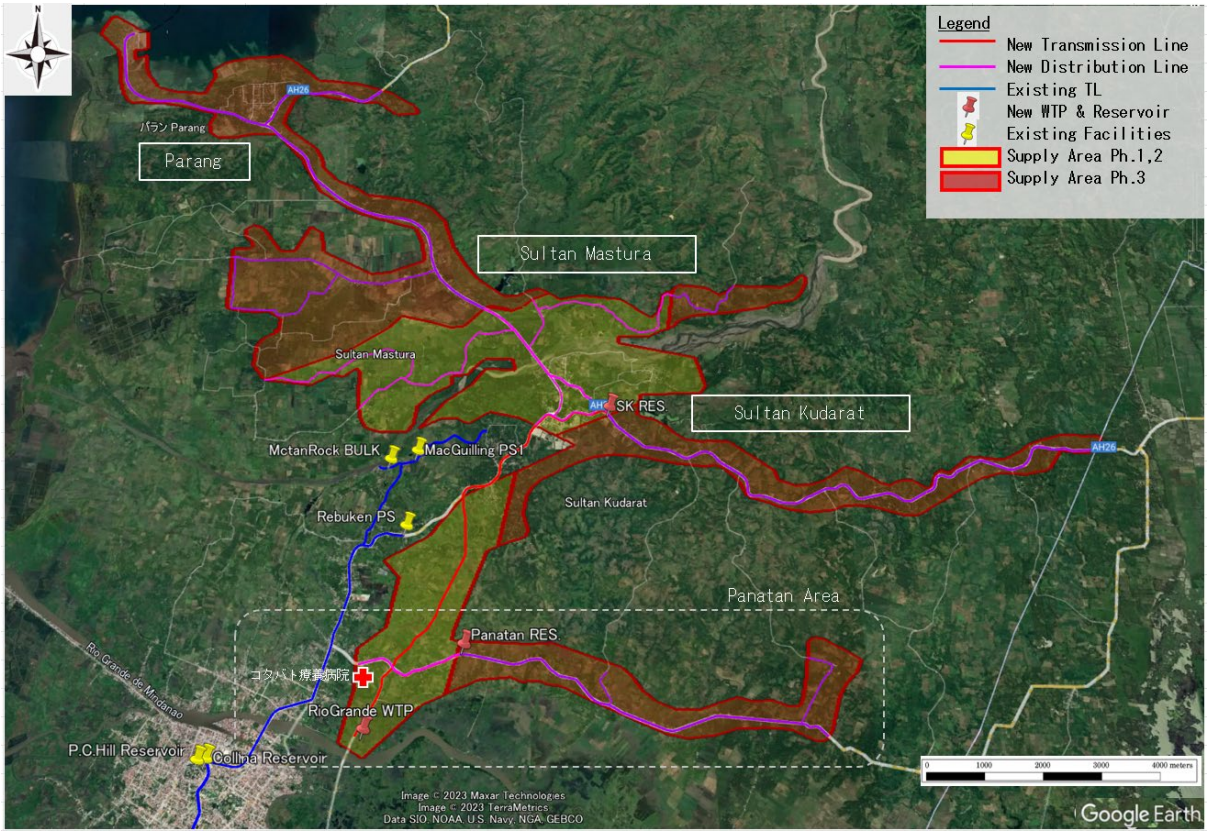
The Rio Grande transmission pipeline (2) aims to expand the water supply area. The transmission pipeline will be laid for approximately 8.6 km, including the East Diversion Road from the booster pump to be built at the Rio Grande WTP to the new SK reservoir. The new SK reservoir will be newly constructed for water distribution to SK, Sultan Mastura and Parang.

The water supply area in Phase 2 is six barangays of northern SK and Sultan Mastura and requires the installation of approximately 3.3 km of the distribution main and approximately 14.5 km of the sub-main.

The water supply area of Phase 3 is planned to be expanded to 14 barangays north of SK, Sultan Mastura and Parang adjacent to Phase 2. It is necessary to install about 32.4 km as the distribution main and about 12.2 km as the sub-main.

The Panatan area of SK is located near the Rio Grande WTP. It is a district where concrete roads have been developed recently, and future residential land development is planned. Since this area is far from the new SK reservoir, it is desirable to branch the transmission pipeline and build a separate Panatan reservoir (tentative). In addition, water supply to Cotabato Sanitarium Hospital will also be provided by installing water pipes from this Panatan reservoir.

Figure 7-2-7 shows the route of the water transmission and distribution pipeline (2), the location of the new SK reservoir, the new Panatan reservoir, the Phase 2 and Phase 3 water supply areas, and the Cotabato Sanitarium Hospital.



Source: Compiled by survey team based on data from MCWD

Figure 7-2-7 Rio Grande Transmission and Distribution (2), and Supply Area

Table 7-2-5 shows the flow rate of 20 barangays handled by the transmission pipeline (2) in Phase 2 and Phase 3.

Table 7-2-5 Rate of Rio Grande Water Transmission and Distribution (2) (2040 estimate)

City/Minicipality	ID	WTP and Phase	Supply barangay	Target year 2040	
				Maximum Daily Supply Q	Maximum hourly Supply Q/24/3600/1.25x1.9 q
				m3/day	m3/sec
Parang	P03	Rio Grande Ph.3	Polloc	2539	0.01065
	P02		Campo Islam	1093	0.00458
	P01		Landasan	4362	0.01829
Sultan Mastura	SM01		Balut	585	0.00245
	SM02		Macabico	1596	0.00669
	SM03		Solon	540	0.00226
	SM04		Tambo	1092	0.00458
	SM05		Tapayan	1146	0.00481
	SM06		Tuka	523	0.00219
Total for Paran and Sultan-Mastura				13476	0.05650
SK	S06	Rio Grande Ph.1,2	Calsada	1314	0.00551
	S03		Banubo	1661	0.00696
	S18		Katuli	1323	0.00555
	S08		Dalumangcob	1886	0.00791
	S07		Crossing Simuay	1954	0.00819
	S39		Ungap	814	0.00341
	Sub-total for SK Ph.1, 2			8952	0.03753
	S10	Rio Grande Ph.3	Darapanan	1620	0.00679
	S26		Nara	612	0.00257
	S29		Panatan	601	0.00252
	S32		Pinaring	1112	0.00466
	S34		Raguisi	709	0.00297
	Sub-total for SK Ph.3			4654	0.01951
Total for SK (Ph1+Ph2+Ph3)				13606	0.05705

Source: : JICA Survey Team

From this flow rate, the diameter of the water transmission and distribution pipelines was calculated using the Hazen-Williams formula, as shown in the table below. The maximum daily water supply amount was used for the transmission pipe flow rate, and the maximum hourly water supply amount was used for the distribution pipe flow rate. The flow velocity coefficient was 110, and the loss head was within 5 m.

Table 7-2-6 shows the details of the Rio Grande water transmission and distribution (2).

Table 7-2-6 Facilities of Transmission Pipeline and Distribution (2)

Facilities	Pipeline/area	Phase	Outline of construction
Transmission Pipeline (2)	Rio Grande WTP to SK reservoir	Phase 2	➢ SP500mm, L=8.54km ➢ Flow rate : approximately 29,500m^3/day =(phase2) 8,000 + (phase3) 21,500m^3/day
Reservoir	SK reservoir and Panatan reservoir	Phase 2	➢ SK reservoir: Capacity 29,500m^3/day×8 / 24 hours =10,000m^3 ➢ Panatan reservoir for Ungap and Nara: Capacity (2,000+6,850) × 8 / 24 hours = 3,000m^3
Distribution	SK reservoir to Parang	Phase 2	➢ Distribution Main : SP500mm, L=3.3km, SP400mm, L=1.3km ➢ Distribution branch: uPVCφ150, L=14.5km
		Phase 3	➢ Dist. Main : (Prang) SP400mm, L=5.2km SP300mm, L=4.5km ➢ Dist. Sub-main : (SM) uPVCφ150, L=12.2km
	SK reservoir to North-east SK	Phase 3	➢ Dist. Main : (SK) SP300mm, L=10.6km
	Panatan reservoir to Ungap, Panatan reservoir to Nara	Phase 2	➢ Dist. Main : (SK) SP150mm, L=2.0km (Ungap)
		Phase 3	➢ Dist. Main : (SK) SP150mm, L=6.9km (Nara) ➢ Dist. Sub-main : (SK) uPVCφ100, L=2.4km (Nara)

Source: : JICA Survey Team

7-2-3 HANABANA Bulk WTP Expansion

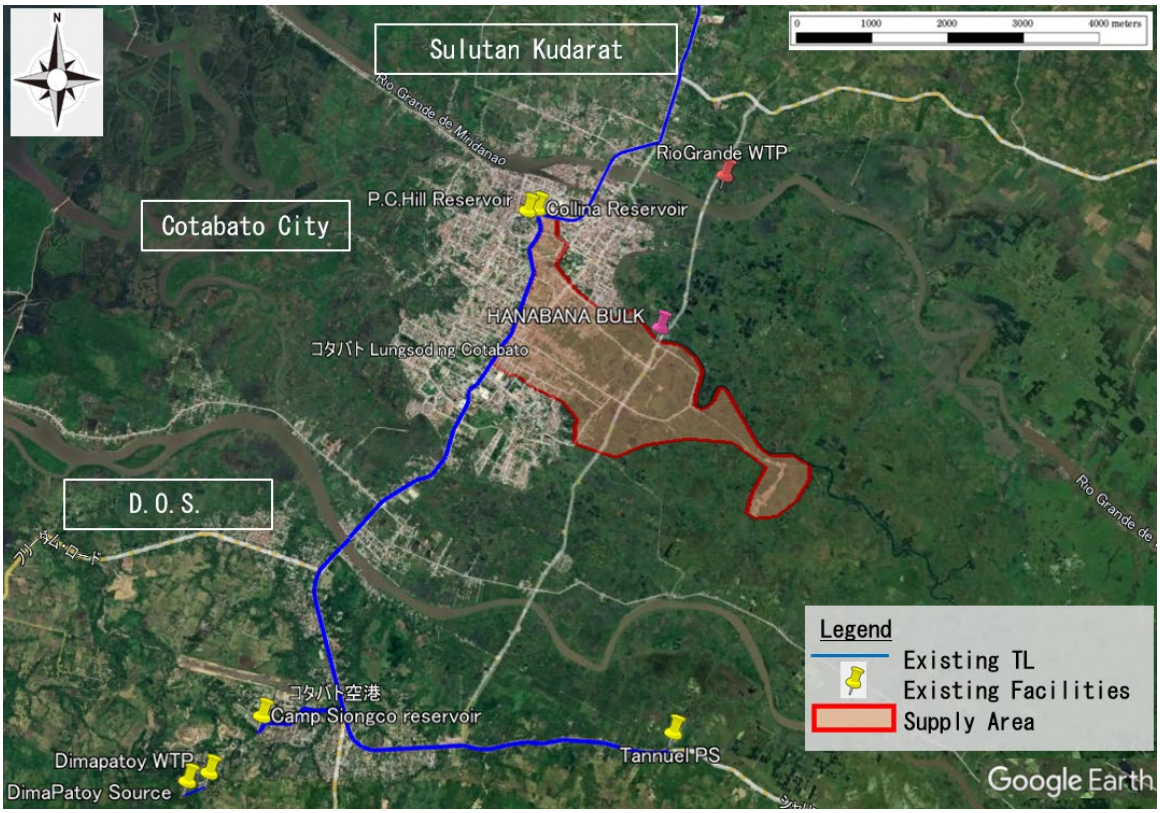
(1) Supply Area

The existing HANABANA bulk water supply area is mixed with the water supply area branched from the Dimapatoy and Tanuel water pipes, and there is no clear water distribution block at this time. This is because the MCWD is operating mutually interchangeably in each water transmission and distribution system to secure the increasing water demand in Cotabato City. On the other hand, the reality is that there is no system in place to monitor the water volume and pressure of each transmission and distribution system and manage water distribution appropriately.

Before the operation of the HANABANA bulk water supply project, the water pressure in this area was relatively low. Yet, the water pressure in the area increased due to the start of the operation of booster pumps. On the other hand, the number of cases of leakage from water supply pipes is increasing, which is one of the issues in this area. It is said that residents often close the meter valve to avoid meter rotation due to water leakage when the water supply is not in use. As a result, when the valve is opened, the water pressure in the water supply system rises all at once, leading to water leakage, and red water due to rust in the pipe is generated; consequently, the staff is busy dealing with these accidents every day.

It is hoped that stable water distribution management will be implemented in the future to solve these problems, and the MCWD has outsourced the study and planning to Maynilad to study the use of water distribution blocks.

The water distribution block expected for future DMA construction is Figure 7-2-8.



Source: Compiled by survey team based on data from MCWD

Figure 7-2-8 HANABANA Bulk Water Supply Area

(2) Expansion Plan

The MCWD owns the site for the HANABANA bulk water supply, and the site for future facility expansion has been secured. In addition to the ten pressure filtration tanks currently installed, ten more can be added. Since the filtration capacity per unit is 1,000 m^3/day, if ten units are added to the total of twenty units, it is possible to expand the water treatment capacity to 20,000 m^3/day.

The expansion schedule of the HANABANA WTP desired from the water demand estimated in Chapter 5 is as follows. At least 15,500 m^3/day of water treatment capacity must be secured by 2040.

Table 7-2-7 Schedule of Expanding Treatment Facility (HANABANA)

Unit：m^3/day

Year	2022	2023	2025	2026	2027	2029	2031	2035	2038
HANABANA	5000		+1,500	+1,500		+3,000	+2,000	+2,500	

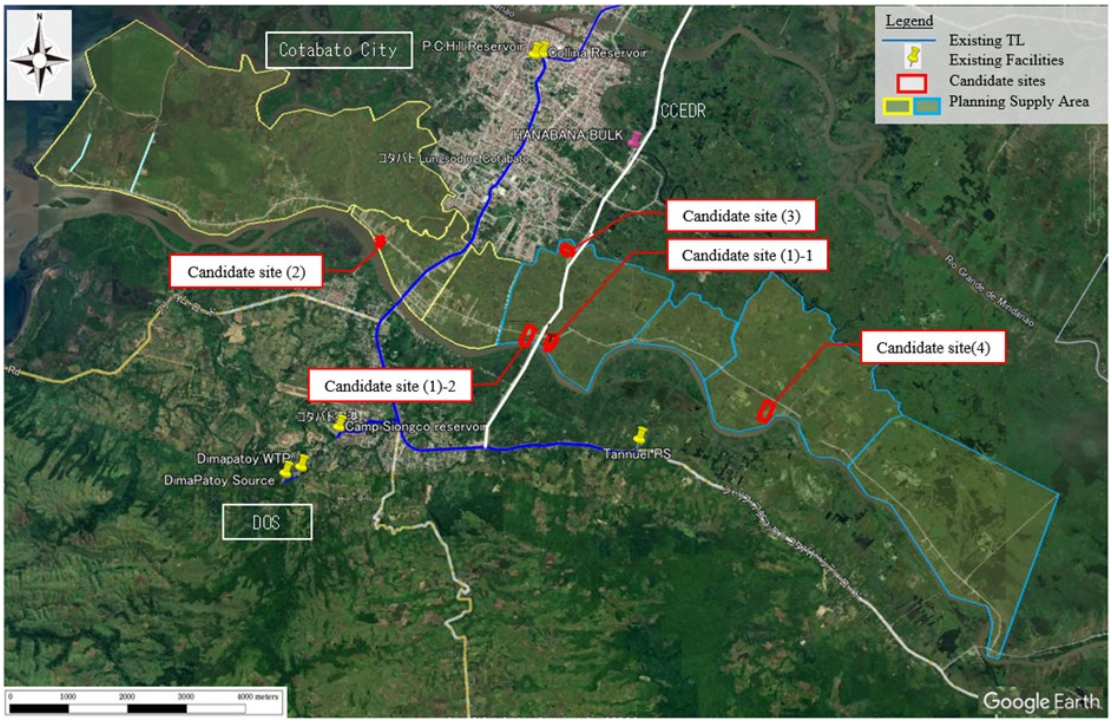
Source:：JICA Survey Team

7-2-4 New Tamontaka WTP

(1) Candidate Sites for Construction

No studies or plans by other donors to construct water supply facilities using water from the Tamontaka River have been implemented. The MCWD has been investigating and negotiating with landowners to acquire candidate sites along the Tamontaka River, with a view to securing multiple water sources in Cotabato City in the future as a countermeasure to the recent disasters that have cut off the water supply. The MCWD has already conducted investigations and landowner negotiations for the acquisition of a candidate construction site along the Tamontaka River.

Figure 7-2-9 shows the candidate sites that the MCWD is investigating and negotiating.



Source: Compiled by survey team based on data from MCWD

Figure 7-2-9 Candidate Sites of New Tamontaka WTP

- Candidate site (1)-1: This site is approximately 9 ha in size and is large enough not only for new water intake and treatment facilities but also for future expansion. In addition, this vast area allows an all-inclusive facility comprising an intake, treatment facility and reservoir to be developed. Moreover, the reservoir is located in the center of the entire water supply area, which is considered an advantageous on the water distribution pipe network. The MCWD has already confirmed the landowner's intention to sell the land. On the other hand, it should be noted that the site is located in the east side of CCEDR and an assumed "flood inundation zone[3]". Measurement survey and geological survey should be carried out at the preparatory survey stage of the JICA project, and the foundation form, flood protection and facility elevations should be set appropriately. If it is concluded that it is difficult to maintain stable water treatment facilities, careful consideration is required, for example, by constructing the water treatment plant on a different site from the intake facility.
- Candidate site (1)-2: This site is located on the opposite side of the CCEDR bridge from the site (1)-1, and its characteristics resemble those of the candidate site (1)-1, but it is more advantageous than the candidate site (1)-1 in that it would be within the "flood protection zone[4]" if the planned river embankment is constructed in future. It is also considered advantageous as a water intake because it is located downstream of the bridge pier and is less affected by water hyacinths than the upstream side. The land is currently under investigation by the MCWD, and the landowner's intention to sell remains unclear.
- Candidate site (2): The site is located in the flood protection zone and the landowner's intention to sell has been confirmed. On the other hand, the site is relatively close to the river mouth, and at high tide, seawater could run upstream and turn it into a tidal zone. In such a case, ion exchange and ultrafiltration membrane treatment would be required to treat the salt water, which would be extremely expensive. Careful consideration is required in terms of water quality.
- Candidate site (3): This site is located in the flood protection zone and the landowner's intention to sell has been confirmed. It is located further inland than the other candidate sites, and depending on the ground elevation, and may be the least prone to flooding. The site is a likely candidate for the construction of a WTP. Surveying and geological investigation should be conducted during the preparatory survey phase, and the foundation shape, flood protection measures, and facility elevation should be set appropriately.
- Candidate site (4): The site is privately owned grassland in the flood inundation zone. The landowner's intention to sell the land remains unclear. The site is protected by a riverbank, and the water level does not exceed the top of the embankment during a flood situation. On the other hand, the past record of flooding due to internal flooding was about 1 m. For this reason,

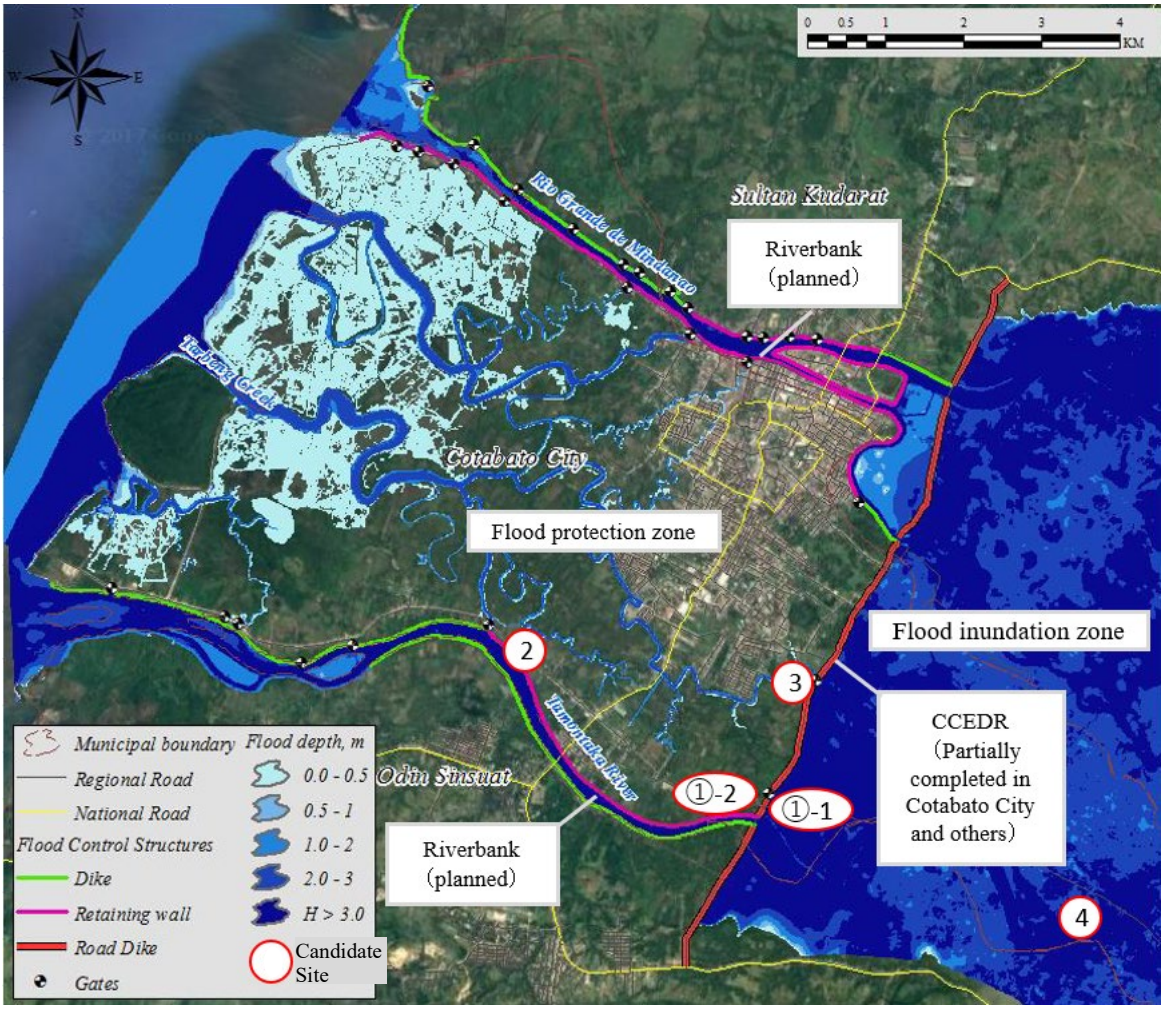
[3] Flood inundation zone: The areas expected to be inundated even after construction of riverbank and embankment roads (CCEDR) as a result of inundation analysis in the DPWH report "Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao and Tamontaka River". (See Figure 1-5-21)

[4] Flood protection zone: The areas that would be mitigated by riverbank and embankment road (CCEDR) measures as a result of the inundation analysis in the DPWH report, "Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao and Tamontaka River". (See Figure 1-5-21)

houses in the surrounding area are built on high floors. The water supply is piped to this area, but the water is supplied from nighttime to noon the next day, rather than around the clock. This area could be a potential site for future expansion of water supply capacity in this area.

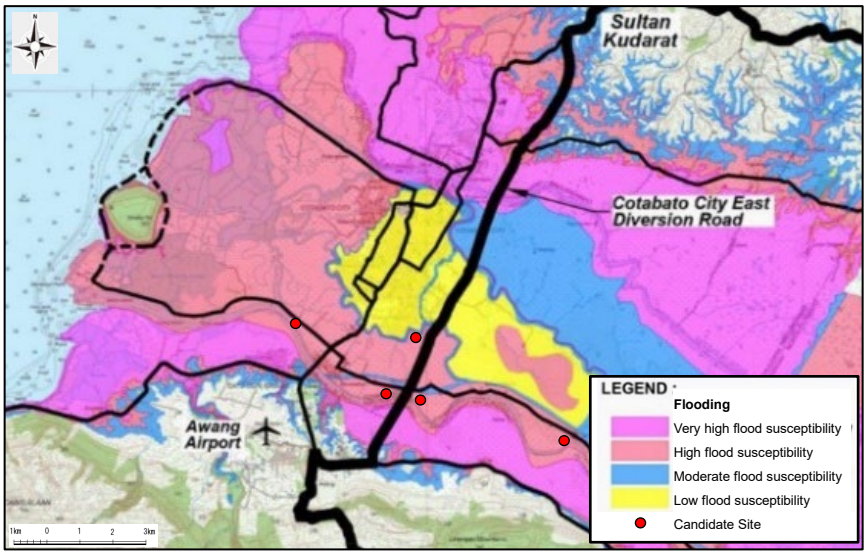
In the DPWH report "Updating of MRB Flood Management Master Plan" Part 1: Rio Grande de Mindanao and Tamontaka River, a riverbank and embankment road (CCEDR) to mitigate flood damage in Cotabato City is planned. The construction of the Cotabato City section of the CCEDR has already been completed, but riverbank works have not been conducted as of March 2023. Therefore, unless this riverbank is completed, there will be little difference in the candidate site's vulnerability to flooding, even if the site is in a flood protection zone.

Figure 7-2-10 shows the relationship between the inundation map (Figure 1-5-21) and the location of the candidate sites. Figure 7-2-11 shows the relationship between the flood susceptibility map (Figure 1-5-3) and the location of the candidate site. All the candidate sites are classified as "High flood Susceptibility" area, but the candidate sites (1)-2, (2) and (3) would be within the flood protection zone if CCEDR and the future river bank were developed.



Source: JICA survey team based on DPWH report "Updating of MRB Flood Management Master Plan, Part 1: Rio Grande de Mindanao and Tamontaka River"

Figure 7-2-10 Relationship between the Flood Inundation Map and Candidate Locations



Source: DENR-EMB data

Figure 7-2-11 Relationship between the Flood Susceptibility Map and Candidate Locations

Photos of each candidate site are shown below.

	
Candidate site (1)-1	Candidate site (1)-1（Hyacinth removal situation）
	
Candidate site (1)-2	Candidate site (2)
	
Candidate site (3)	Candidate site (4)

Source: JICA survey team

Photo 7-2-3 Site Photos for Candidates

(2) Desired Policy in Land Acquisition

In selecting the location of water abstraction and water treatment facilities, it is desirable that land acquisition should take into account the following.

- It should be near a water source.
- It should be within the flood protection zone and less exposed to flood damage. (In this case, the west area of East Diversion Road is relevant.)
- The location should allow for efficient water supply and distribution.
- It should be close to a major road for easy transport of water supply equipment and chemicals.
- It should be easy to secure a power supply.

(3) Expansion Plan for Tamontaka Supply Area

Table 7-2-8 shows the desired expansion schedule for the Tamontaka WTP, based on Table 5-4-1. A total of 6700-11,000 m^3/day of water treatment plant construction is planned in this project by 2029, and a further 15,000 m^3/day expansion is required by 2035. In total, 26,000 m^3/day of water treatment capacity will be required in the Tamontaka water supply area itself by 2035.

Table 7-2-8 Schedule of Expanding Treatment Facility (Tamontaka WTP)

Unit：m^3/day

Year	2022	2023	2026	2027	2029	2031	2035	2038
Tamontaka			+6,700~ +11,000				+15,000	

Source: JICA Survey Team

Chapter 8. Project Proposals for Grant Aid and Issues in Preparatory Studies

8-1 Planning Policy

8-1-1 Issues of Water Access

The issues of water access in the surveyed areas are as follows.

- The proportion of patients admitted to Cotabato Sanitarium and General Hospital with diseases related to unsafe or dirty water rises to 20%-30% of the total number of patients treated in hospitals. These diseases include typhoid fever, acute gastroenteritis, amebiasis, gastritis, and diarrhea, and these are caused due to the use of water for domestic use and drinking water (water sources from springs, rivers, rainwater, and deep wells, etc.) that has not been properly treated. Although the number of waterborne diseases as a percentage of all patients has been declining in recent years, public sanitation still needs to be improved.
- Households that do not have the means to obtain water purchase expensive water from neighbors who have deep well facilities and use it for washing and other domestic water.
- Even households with deep well facilities are burdened by the maintenance and management of pumps and electricity bills.
- For drinking and cooking water, they buy more expensive water[5] from water supply stations. If the water supply station is far away, gasoline costs for vehicles for water transportation will also be charged, and procuring water is a major burden on people's lives.
- Hand washing with water and soap is one of the most important measures to prevent the spread of COVID-19 (WHO/UNICEF 2020).

Access to water is a huge burden for households not connected to the MCWD water system, especially those who cannot afford to purchase more expensive water, who are forced to rely on unsanitary water, causing waterborne diseases. The table below shows the number of patients sourced by Cotabato Sanitarium and General Hospital in the past three years.

Table 8-1-1 Number and Percentage Treated by Cotabato Sanitarium and General Hospital

Disease	2020		2021		2022	
	No. of Patients	In %	No. of Patients	In %	No. of Patients	In %
Total Discharge:	3,725		2,726		3,749	
Water-Borne Disease						
Typhoid Fever	27	0.72%	7	0.25%	34	0.90%
Acute Gastroenteritis	810	21.74%	321	11.77%	231	6.16%
Cholera	0	0.00%	0	0.00%	0	0.00%
Amoebiasis	24	0.64%	20	0.73%	30	0.80%
Gastritis	255	6.66%	188	6.89%	92	2.45%
Diarrhea	4	0.10%	8	0.29%	9	0.24%
Other Disease						
Intestinal Parasitism	29	0.77%	3	0.11%	6	0.16%
H. Pylori Infection	2	0.05%	3	0.11%	2	0.05%
Total:	1,151	30.89%	550	20.17%	404	10.80%[6]

Source: Cotabato Sanitarium and General Hospital

[5] Water price is around 0.019PHP/L by MCWD. On the other hand, the water price from private-own Water Refilling Stations or neighbors having deep wells is around 0.08-0.4 PHP/L.

[6] The reduction in waterborne diseases in 2021 and 2022 was attributed to people refraining from visiting hospitals to avoid COVID-19 infection and the requirement for a negative PCR test result for admission except in emergencies.

8-1-2 Insufficient Water Supply Capacity

This proposal is to distribute water to seven barangays on the right bank (Cotabato City side) along the Tamontaka River via a water treatment reservoir and a water treatment plant.

These barangays are areas with a high population growth rate with plans underway for commercial facilities, factories, schools, public facilities, residential land developments, and resort developments. Water demand is expected to increase rapidly in the future. For the MCWD, the shortage of water supply capacity is an urgent issue, and the expansion of water supply capacity is considered to be a priority issue to be solved. The development plan in these barangays is as follows.

- Halal meat plants, feed mills, training centers, fish hatchery facilities
- Public market and terminal in special economic zones (MCRAIC)
- Schools
- Housing projects
- Ice plant
- Seaport and Sultan Haji Hassanal Bolkiah Masjid (Grand Mosque) (Kalanganan 1)
- Tourism (Timako Hill and mangrove crab forest)

8-1-3 Water Source: dispersal for disasters

Due to flood damage caused by Typhoon Paeng at the end of October 2022, water intake at Dimapatoy WTP and Mactan Rock Water Supply WTP was unavailable for several days, causing water outages in the water supply area. In December 2021, Super Typhoon RAI (local name Odette) caused enormous damage in the Visayas region, causing a disaster that took several months to restore infrastructure. Dispersion of water sources in the event of a disaster is an effective measure to reduce the risk of water outages, and is one of the major reasons why the MCWD requests the Tamontaka WTP proposal.

Damage to water intake facilities caused by Typhoon Paeng (Oct 2022)

Damage caused by Typhoon RAI (Dec 2021)

Source : JICA Survey Team

Photo 8-1-1 Typhoon Damage in the Philippines in Recent Years

8-1-4 Facility Planning Policy

Facilities should be planned in accordance with the following policies.

- The target year for the plan is 2029. That is three years after the facility is put into service.
- The maximum daily water supply shall be 11,000 m^3/day, taking into account the water demand of the planned target year and the water supply capacity of existing facilities.

- The technical standards of the LWUA are followed in designing facilities. For those not included in the LWUA, the design should be in accordance with the Japanese Guidelines for the Design of Water Supply Facilities (JWWA).
- Since the Philippines is a country with a particularly high risk of earthquakes, the facility shall have the necessary earthquake resistance performance .
- In view of recent heavy rainfall disasters, necessary flood control measures should be taken to ensure that WTPs can continue to operate in a disaster.
- Water intake facilities should be capable of stable intake against fluctuations in river levels. In addition, necessary measures should be taken against hyacinth retention.
- Water treatment facilities shall provide the required water quality by disinfection treatment, rapid filtration, powdered activated carbon treatment or other methods, depending on the quality of the raw water and its fluctuations.
- Material and equipment should be considered to ensure necessary quality and economic efficiency. In addition, materials and equipment should be easily replaced and maintained by the MCWD.
- The procurement of equipment will respect the MCWD's request and procure the equipment necessary for the operation and maintenance of the facility.
- Provide water supply equipment for poor households to support increasing water supply coverage.
- Assistance should be planned for the start-up and operation phases to ensure smooth operation and maintenance of not only new water supply facilities but also existing facilities. .

8-2 Phasing of Facilities Construction

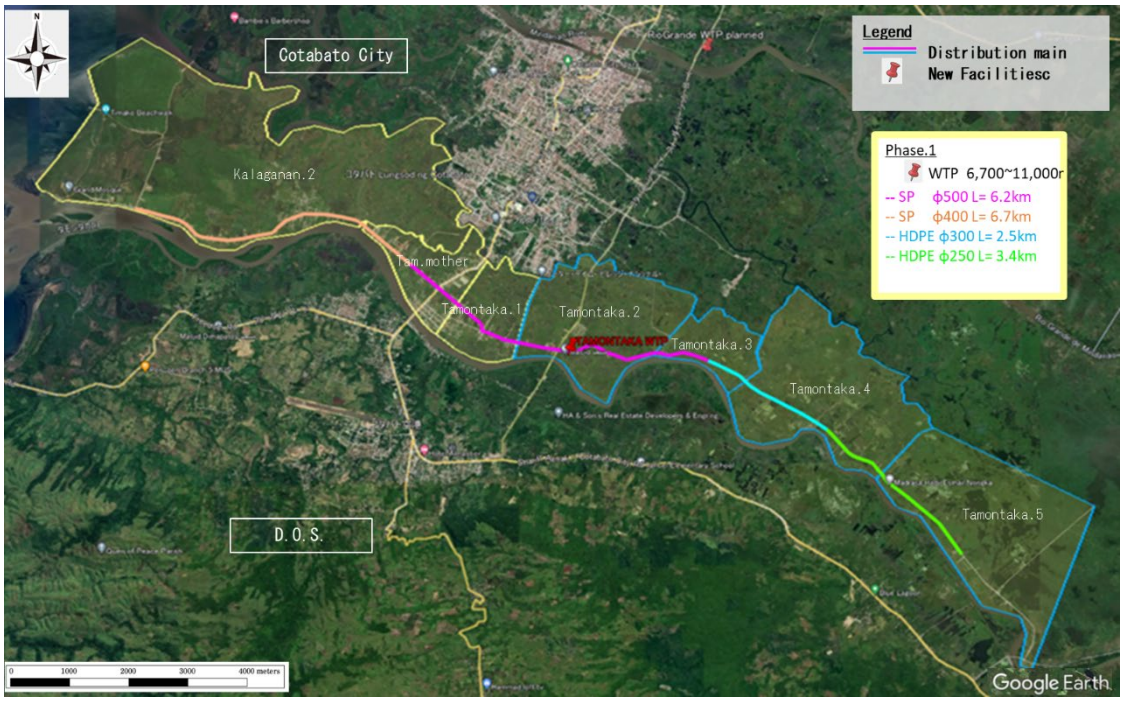
8-2-1 Overview of Facilities Map and Treatment Flow

The main components of the project are water intake facilities, a WTP, water purification and distribution reservoir, water distribution mains and distribution branch pipes. The water supply area is the following seven barangays, which will be set as water distribution blocks (DMA) in the future.

1. Kalanganan.2
2. Tamontaka. Mother
3. Tamontaka.1
4. Tamontaka.2
5. Tamontaka.3
6. Tamontaka.4
7. Tamontaka.5

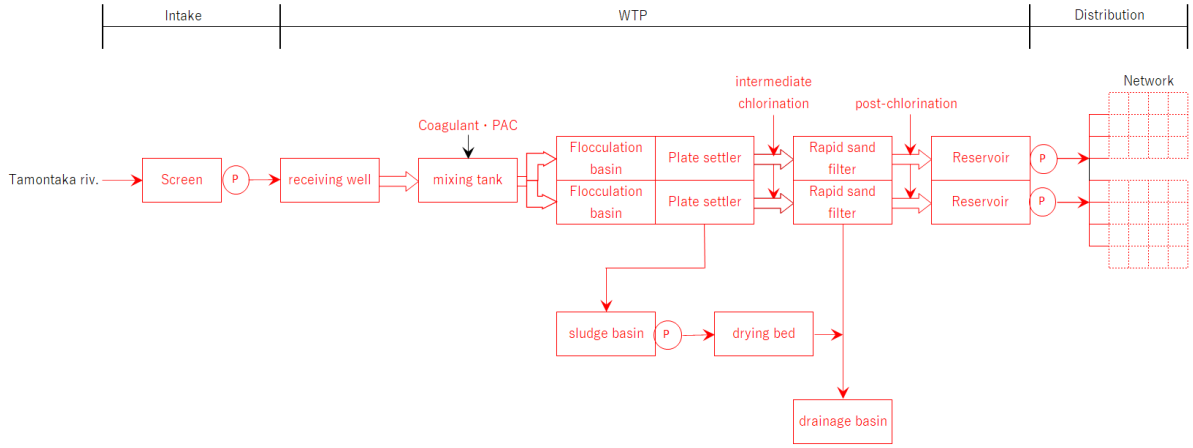
This project is planned as a water supply project with the water supply area divided into east and west.

The overview map of the facilities and the treatment flow is shown below.



Source : JICA Survey Team

Figure 8-2-1 Outline Diagram of the Facility Development Plan



Source: JICA Survey Team

Figure 8-2-2 Water Treatment Flow

8-2-2 Construction

8-2-2-1 Intake Facilities

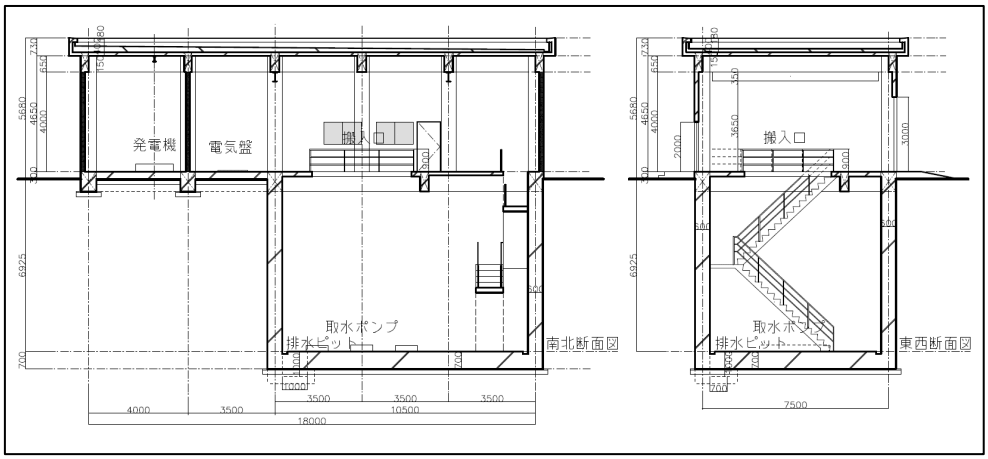
Water intake facilities are sourced from the surface water of the Tramontana River. An intake gate, screen pit and pump room will be installed to adapt to fluctuating water levels. The pump room is equipped with a power receiving panel, operation panel, pump panel, control panel, auxiliary panel and emergency private generator, pump suction piping, a crane for maintenance, and a floor drainage pump. The design intake flow is calculated as follows in anticipation of losses such as the amount of water for filtration sand cleaning, the amount of wasted water, and the amount of maintenance and management water in the rapid sand filtration, and “design intake flow= design maximum daily supply ×1.1”.

Table 8-2-1 Intake Facilities to Construct

Facilities	Specification
Design intake flow	7,370~12,100 ㎥/day
Intake facility	Intake pump：2~3 pcs （1 standby）
	Pump housing：1 house

Source: JICA Survey Team

- Design intake flow: 6,700~11,000m^3/day x 1.1 =7,370~ 12,100m^3/day
- Water intake pump: Single suction centrifugal pump φ150xφ125, q=5.0 m^3/min, H=10.0m, 11.0kW
- Mechanical and electrical equipment: full set



Source : JICA Survey Team

Figure 8-2-3 Example of Water Intake Pump Station (cross-sectional view)

8-2-2-2 Water Treatment Facilities

The new WTP will use a rapid sand filtration and will be equipped with a series of water treatment facilities such as receiving well, mixing tank, flocculation basins, plate settler, and rapid filter.

The flocculation basin is vertical baffled channel flocculator, and the sedimentation pond is equipped with inclined plate. Inclined plate should be designed to prevent short-circuit flow, and drainage systems should be designed with consideration of maintainability. Chlorination is not only post-chlorination, but also intermediate chlorination depending on raw water quality.

The above proposed water treatment flow is only assumed at the time of this survey and does not preclude future modifications based on the results of water quality tests and field investigations. It should preferably be finalized up to the preparatory survey stage.

In addition, as a result of hearings on flooding damage caused by Typhoon Paeng (October 2022), about 3 m of embankment might be required to prevent flooding. If embankment is to be carried out, the process should take into account the consolidation settlement period. The construction site and foundation shape shall be determined based on the results of the survey and geological survey in the preparatory survey stage.

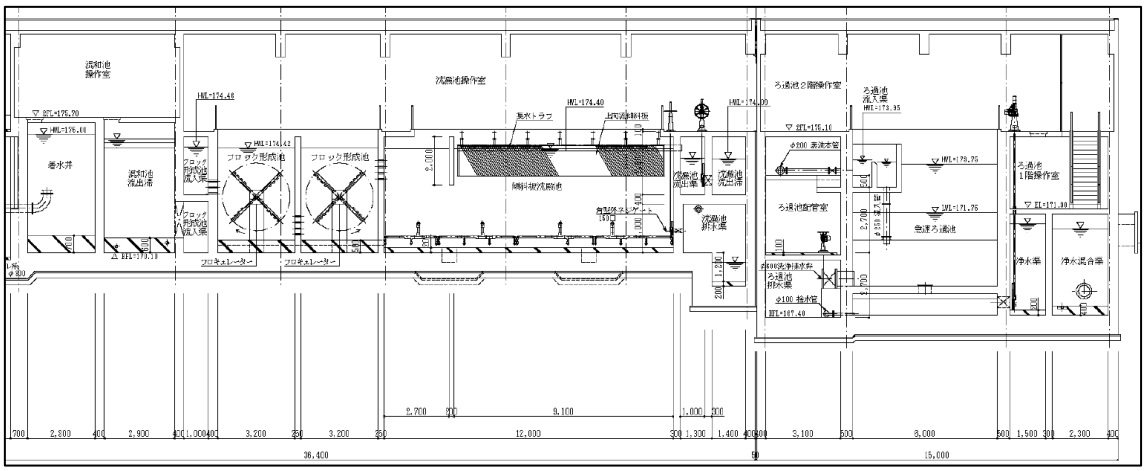
Table 8-2-2 shows the water treatment facilities envisaged in this survey.

Table 8-2-2 Water Treatment Facilities to Construct

Facilities	Specification	
Maximum daily supply		6,700 ㎥/day(62%)~11,000 ㎥/day
Water treatment facilities	Receiving well：	1 pond
	Mixing tank：	2 ponds,
	Flocculation basin：	2~4 ponds, vertical baffled channel
	Sedimentation tank：	2~4 lines, Plate settler
	Rapid sand filter：	5~12 tanks, Multimedia filter
	Reservoir：	1~2 tank, 2,400~4000 m^3
	Administration Build.：	1 building
	Drying bed：	2 beds
	Drainage basin：	2 ponds

Source : JICA Survey Team

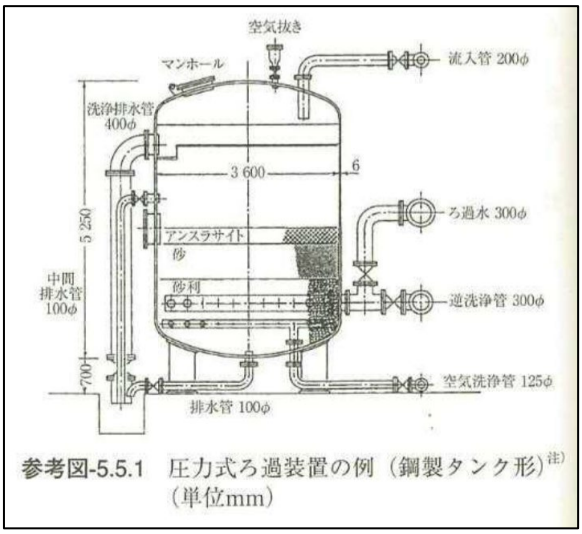
- Inclined sedimentation pond: Pneumatic sludge removal device
- Rapid filter: Pressure type filtration tank (treatment capacity: 1 unit 1,000 m^3/day)
- Water treatment reservoir: Underground RC structure (8 hours, total 2,400~4,000 m^3)
- Embankment works: H=3.0m
- Foundation pile: φ400, H=10m, 991~2335m^2, 336~583 piles (assuming one sedimentation pond, filtration pond and water treatment reservoir, every 4m^2)



Source : Water Bureau of Muroran City

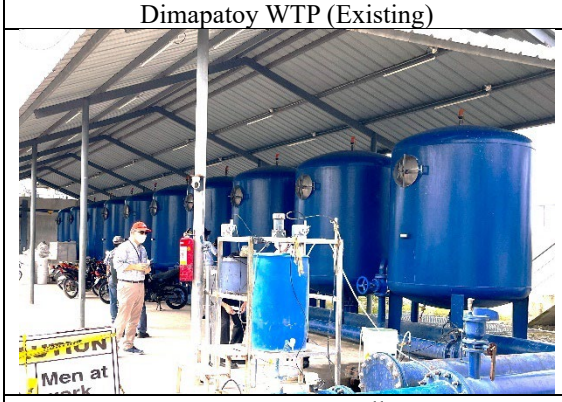
Figure 8-2-4 Example of Rapid Sand Filtration WTP

In the design guidelines, the general structure of the filtration pond is a gravity type, but the pressure type tank filtration pond (see Figure 8-2-5) is the mainstream locally. The installation of a pressure filtration tank should be considered during the preparatory survey phase so that the MCWD can easily maintain and manage the tank.



Source: Water Design Standard of JWWA

Figure 8-2-5 Example of Multimedia Filter (pressure filter)

	
Dimapatoy WTP (Existing)	Dimapatoy WTP (Expansion)
	
HANABANA Bulk	Mactan Rock Bulk

Source: JICA Survey Team

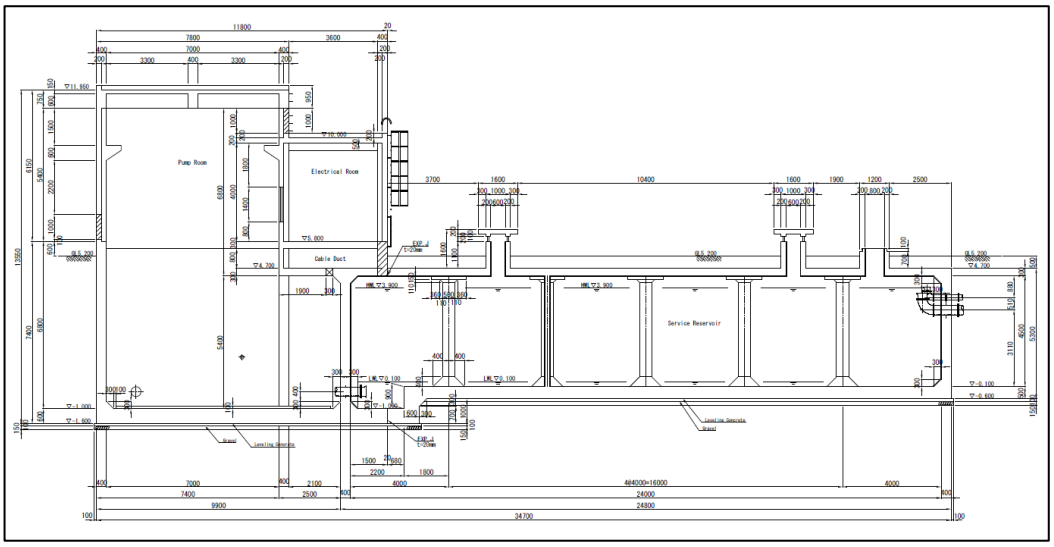
Photo 8-2-1 View of Multimedia Filter

8-2-2-3 Reservoir

Treated water reservoir that is used in conjunction with distribution reservoir is assumed to be an underground water reservoir made of reinforced concrete. The standard capacity is 12 hours of the planned maximum daily water supply in the design guidelines. On the other hand, since in recent years, the JICA water supply project would be planned to take about 8 hours, this proposal will first be prepared for 8 hours in advance, and it will be expanded to 12 hours in the future.

【Facilities of Reservoir】

- Design capacity: 8 hours: 2,400~4,000 m^3
- Planned capacity: 12 hours min: 4,000~5,500 m^3 (future expansion 1,500 m^3)
- Ball Tap Valve
- Flowmeter



Source : JICA Survey Team (Cambodia Svay Rieng Grant Aid Project)

Figure 8-2-6 Example of RC Reservoir

8-2-2-4 Booster Pumps

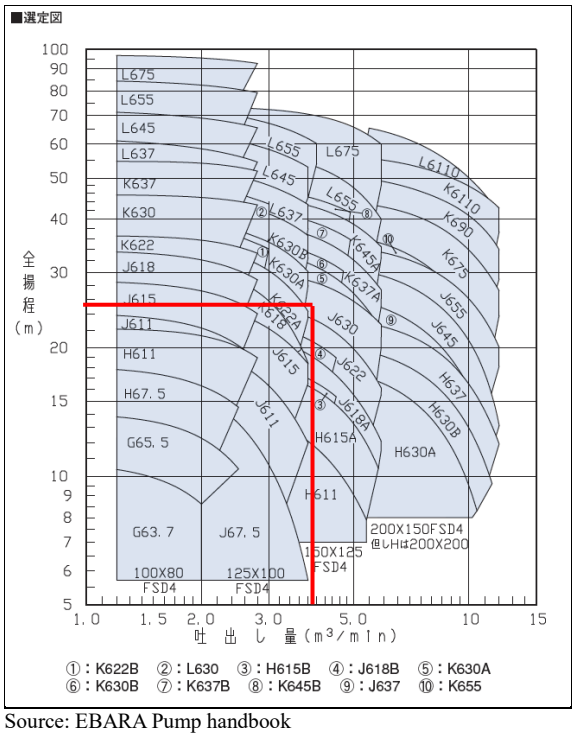
Cotabato City has a relatively flat terrain and there are almost no undulations along the Tamontaka River, so the water distribution system is a booster pump. Ensure a pump capacity that can hold 15 m of remaining water head on the ground at the branch point of the distribution main to the distribution branch. In addition, in the event of an emergency, the pumping capacity to deliver water to the P.C. Hill pumping station through an emergency contact valve will be secured.

Three water distribution pumps will be installed for the west part, one of them will be as standby. For the East part, more two pumps will be installed. Pump specifications obtained from hydraulic calculations by the Hazen-Williams equation and pump characteristic curves are shown below.

Table 8-2-3 Pump Specification

Specification Items	Total
Design distribution flow (L/sec)	124~202.4
Pumping Head (m)	20~25
Output power (kW)	30
Amount (ea.)	3 ~5(1)
Discharge quantity (L/sec/ea.)	67.47
Discharge quantity (m^3/min/ea.)	4.048

Source: JICA Survey Team



Source: EBARA Pump handbook

Figure 8-2-7 Pump Characteristic Curve

In addition, regarding water flow monitoring, we are not considering the introduction of Supervisory Control And Data Acquisition (SCADA). Yet, it is desirable to learn how to maintain and manage water distribution through soft components plans after installing pressure gauges and flow meters.

8-2-2-5 Distribution Main

A total length of 18.74 km of water distribution mains will be newly constructed. The pipe type shall be steel pipe (SP) and high-density polyethylene pipe (HDPE). Both are earthquake-resistant and can be procured locally. In addition, steel pipes can be welded with local technology. Air valves, drainage valves and fire hydrants shall be installed at key points, and waterways or small rivers shall be crossed by bridge-attached pipes or water pipe bridges. In the future, a DMA will be established and flow meters and pressure gauges will be installed at the branch points of the water distribution pipes for constant monitoring.

The western part, where demand is growing remarkably, will be laid first, and the eastern part will be installed later.

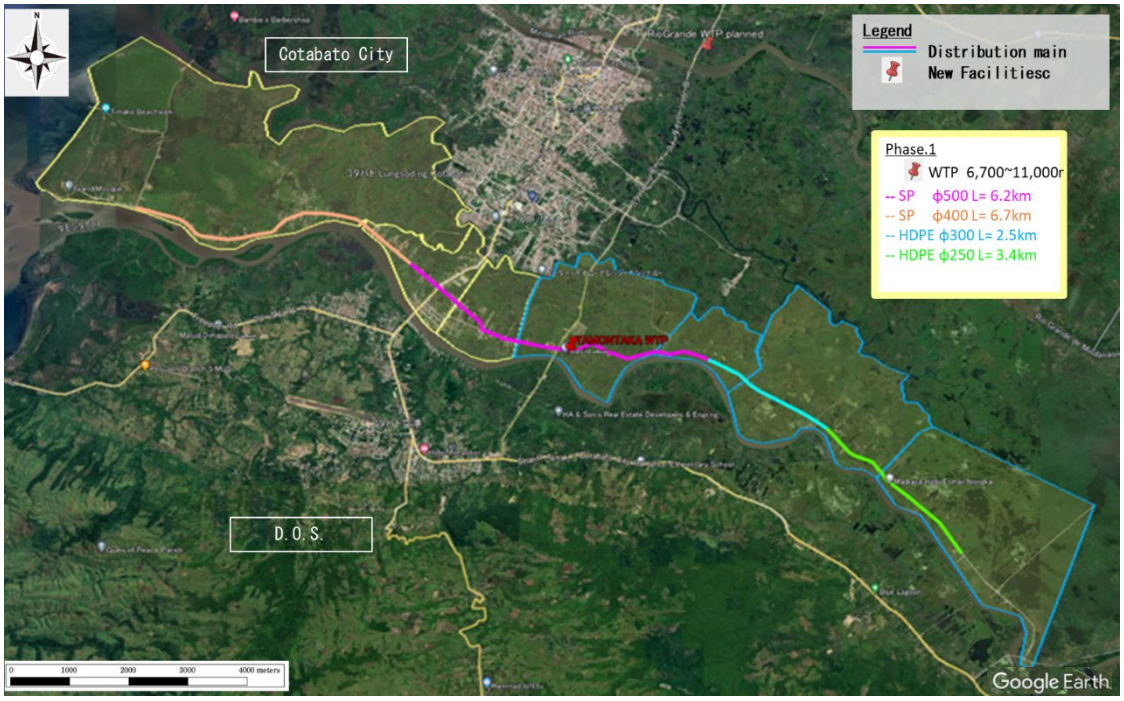
Table 8-2-4 shows distribution facilities envisaged in this survey.

Table 8-2-4 Installation of Distribution Facilities

Facilities	Equipment	Specification
Distribution facilities	Pump station：	1 building
	Booster pump：	3~5 (1standby)
	Distribution main：	L= 9.96~18.74km
	SP φ500mm：	L= 3.25~6.12km
	SP φ400mm：	L= 6.71km
	HDPE φ300mm：	L= 2.50km
	HDPE φ250mm：	L= 3.41km

Facilities	Equipment	Specification
	Pipe bridge/bridge-attached pipe :	2~4

Source: JICA Survey Team



Source : JICA Survey Team

Figure 8-2-8 Installation Place of Distribution Main

8-2-2-6 Distribution Branch

The existing water distribution pipes will be used for the water distribution branch pipes, and the connection work with the new distribution main pipes will be carried out after the water flows. (Assuming construction by the MCWD)

Since there is no description of house connections in the water distribution network map obtained in this survey, it is not possible to specify where the new distribution pipe should be installed. Here, the provisionally newly constructed water distribution branch pipes will be set as follows and the approximate amount will be determined.

Table 8-2-5 Installation of Distribution Branch

Facility	Equipment/Specifications	Water Supply Project
Distribution facilities	Distribution branch Total Length: HDPEφ100: Emergency valve φ400: Emergency valve φ300:	 L= 9.0~21.0 km L= 9.0~21.0 km 1 location (non-suspension water method) 1 location (non-suspension water method)

Source : JICA Survey Team

- Length of distribution branch per barangay: 3 km
- Total length: 9 ~ 21km
- Pipe type/diameter: High-density polyethylene pipe (HDPE) φ100
- Excavation method, soil cover: 0.8m

➢ The selected tube types were selected from the economic comparison in the table below as follows.

- Diameter 75~350: HDPE
- Diameter 400~500: SP

Table 8-2-6 Economic Comparison of Adopted Pipe Types by Diameter

Comparison per m (JPY/m)

Spec.	SP				DIP()	HDPE			Min.price
Diameter	Japan	MCWD	Phillipine	Cambodia	Japan	JAWWA	Phillipine	Cambodia	(JPY/m)
75	6,269	2,786	3,000	5,504	6,210	2,632	1,153	1,304	1,153
100	8,716	3,870	4,375	7,154	9,338	4,246	1,561	1,452	1,452
150	16,160	6,286	7,500	12,038	12,960	7,480	3,321	4,765	3,321
200	24,589	9,574	11,042	17,741	16,940	13,434	4,627	6,059	4,627
250	34,524	13,438	15,498	24,816	20,842	24,864	7,169	12,223	7,169
300	43,245	16,841	20,833	31,944	26,535	31,574	11,374	-	11,374
350	55,096	21,454	24,744	39,125	30,945	-	19,279	-	19,279
400	63,235	24,626	28,402	50,490	37,278	-	27,858	-	24,626
450	71,233	27,741	31,994	63,030	44,332	-	34,358	42,900	27,741
500	79,389	30,913	35,653		61,978	-	44,303	-	30,913

Source: JICA Survey Team

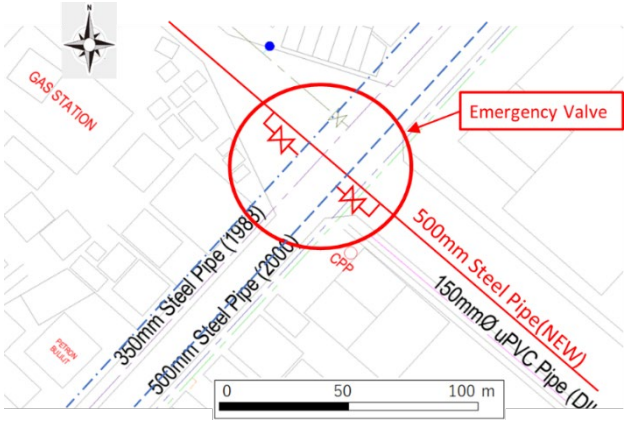
8-2-2-7 Emergency Valve

An emergency communication valve (butterfly valve) will be installed to allow water to flow to the existing area in an emergency. The connection point shall be the point where the newly constructed water distribution main and the existing water pipe intersect. The existing pipes are the Dimapatoy transmission pipeline SP500 and the Tanuel transmission pipeline SP350. This communication valve is operated at all times and is open when one area is short of water due to water outage, etc., so that water can be supplied from the other area.

【Emergency valves】

・Manual butterfly valve φ300 (continuous water supply work, SP500 x existing Tanuel SP350)

・Manual butterfly valve φ 450 (continuous water supply work, SP500 x existing Dimapatoy SP500)



Source: JICA Survey Team

Figure 8-2-9 Emergency Valve Connection Point (butterfly valve)

8-2-3 Electricity and Telecommunication

8-2-3-1 High-voltage Transmission Lines

Cotabato Light and Power Company has installed a 3-phase AC 460V on Sinsuat Avenue. A request on the Cotabato Light and Power Company to extend to the vicinity of the new WTP is required. Pulling into the facility from the demarcation point of responsibility will be borne by Japan.

The three-phase alternating current line along the Tamontaka River is shown in Figure 8-2-10.

Source: : Cotabato Light Corp.

Figure 8-2-10 Location of Power Lines Near the New WTP

8-2-3-2 Information and Communication Networks

Information and communication lines are not laid.

8-2-4 Necessary Site Area

The approximate required land area from the set dimensions of the water intake facility and the water treatment facility is shown below. A total of about 2.25 hectares of water intake and water treatment facilities will be required.

【Required Floor Area】

- Required land area: Approximately 2.25 ha

Table 8-2-7 Calculation of Required Land Area

■Area of Tamontaka WTP Project

Land Acquisition Area			W(m)	L(m)	A(m2)
	WTP 11,000m3/day	Sedimentation	25	32.5	812.5
		Sand Filtration	20	10	200.0
		Administrator Building	15	22	330.0
		Chemical Building	10	15	150.0
		Drying bed	25	30	750.0
		Drainage basin	10	20	200.0
		Reservoir	40	40	1,600.0
		Pump station	12	26	312.0
		Sub-Total			4,354.5
		Land development			4,354.5
		Total (1)			8,709.0
		Land for expansion			8,709.0
		Total (2)			17,418.0
		Approximately	120	150	18,000.0
		Outline (Embankment H3m)	129	159	20,511.0
		Land for WTP (m2)			**20,511.0**
	Intake 12,100m3/day	Pump station	15	20	300.375
		Land area	25	30	750.625
		Outline (Embankment H3m)	34	39	1,326.9
		Land for Intake (m2)			**1,326.9**
	Land Acquisition Area	**Land for WTP (m2)**			20,511.0
		Land for Intake (m2)			1,326.9
		Total			21,837.9
		Acquired land area(m2)	150	150	22,500.0
		Acquired land area(ha)			**2.25**

Source: JICA Survey Team

8-2-5 Summary of Facility Development Plan

Overview of facility construction plan is shown in Table 8-2-8

Table 8-2-8 Facility Construction Plan

Facilities	Equipment	Specification
Water supply area		3~7 barangays (kalanganan2, Tamontaka mother,Tamontaka1~5)
Design intake flow		7,370~12,100 m^3/day
Maximum daily supply		6,700~11,000 m^3/day
1. Intake facility	Intake pump : Pump room :	2~3 (1 standby) 1 building
2.Water treatment facilities	Receiving well : Mixing tank : Flocculation basin : Sedimentation tank : Rapid sand filter : Reservoir : Administration Build. : Drying bed : Drainage basin :	1 pond 2 ponds 2~4 ponds, vertical baffled channel 2~4 lines, Plate settler 7~12 tanks, Multimedia filter 1~2 tank, 2,400~4000 m^3 1 building 2 beds 2 ponds

Facilities	Equipment	Specification
3.Distribution facilities	Pump station： Booster pump： Distribution main： SP φ500mm： SP φ400mm： HDPE φ300mm： HDPE φ250mm： Flow meter/pressure meter： Pipe beam/bridge-attached pipe：	1 building 3~5 (1standby) L= 9.96~18.74 km L= 3.25~6.12 km L= 6.71km L= 2.50km L= 3.41km 8 places (including for 7 DMA) 2~4
	Distribution branch HDPEφ100: Emergency valve φ400: Emergency valve φ300:	L= 9.0~21.0 km L= 9.0~21.0 km 1 location (non-suspension water method) 1 location (non-suspension water method)

Source : JICA Survey Team

8-2-6 Procurement Plan

The equipment to be procured shall be water quality meters, submersible sand pumps and generators necessary for operation management. It will also provide water supply materials for poor households. The number of water supply materials was calculated as follows.

- Benefit population× rate of poor households* ÷ average number of people per household: 1,659~2,676 households

* The rate of poor households was 31.3% (Cotabato City) based on the latest statistics. (Source: PSA)

Table 8-2-9 shows planning list of procurement.

Table 8-2-9 List of Procurement

No.	Equipment	Quantity	Cost (JPY)
1	Equipment for water quality test	1	6,500,000
2	Submergible sand pump	1	1,000,000
3	Generator	1	500,000
4	Poor households connections	1,659~2,676 units	14,000,000~25,000,000
Total（JPY）			22,000,000~33,000,000

Source: JICA Survey Team

8-2-7 Soft Component Plans in Preparatory Survey

Technical assistance from Japan is necessary to operate the new WTP sustainably and efficiently, and it also enables to improve the stated issues. Expected achievement after assistance on operation and maintenance from Japan is listed below:

① Master operation and maintenance of new WTP and improve the ability of production management
② Master distribution management system from new WTP
③ Encourage applications for new connections and reinforce supervision of new connection installation
④ Review Standard Operation Procedures (SOP)s
⑤ Reduce NRW
⑥ Establish a system to prepare for the new entry of private entities
⑦ Structure backup systems in case of emergency

Those are explained below table.

Table 8-2-10 Issues and Current Status on MCWD

	Issue	Current Status
①	Production Management in WTP	MCWD needs to consider, plan and understand the efficient operation of several WTPs under experts since they do not have such experience. Chemical dosage management such as jar testing that is currently not conducted must be mastered. Moreover, the expansion is under construction, and the production management measure must be mastered to coexist with the current facilities.
②	Distribution Management	All the pipes are mutually distributed without distribution blocks to support water shortage. When the new WTP is constructed, pressure management at the end of pipes and setting of DMA are preferable. To reduce electricity usage, distribution management, and maintenance measurement based on water demand and pressure fluctuation must be mastered.
③	Encouragement of New Connection	As welled water is easy to access from the swamp area, new connections must be encouraged for those in this area. Water pressure with stable pressure is needed to be improved as it is one of the important factors. A quality check system for new connections must be established considering the private business use.
④	Review/Draft SOP	Currently, SOPs are prepared for acquiring certificate of International Organization for Standardization (ISO). Indicated concrete number for management, it is too mechanistic and not practical. Specific technics of operation and maintenance management in each facility are mastered when the new facilities are constructed. New SOPs and a review of the SOPs are required since east to understanding SOP is useful in emergencies and training operation technicians.
⑤	Leakage Detection and Repair	Only road patrol is conducted. As a leakage detector will be procured, and leakage detection and repair within limited equipment are required to master. In addition, technics to find leakage in the ground must be mustered by setting pilot areas toward creating distribution block systems and DMAs.
⑥	Preparation of Private Entities Entry	Currently, almost all the new connections and operation and maintenance rely on the MCWD. As they cannot deal with increasing water demand in the future, preparation of private entities entry and its supervision system are required since swift response against new applications for the connection is a direct benefit to increase the number of subscribers. As per the MCWD, they are currently dealing with the operation, this could be a feasible idea.
⑦	Risk Management in Emergency	In the Philippines there are many disasters such as earthquakes and heavy rains. An emergency distribution manual is required for priority supply to hospitals and government offices dealing with disasters.

Source: Compiled by survey team based on data from MCWD

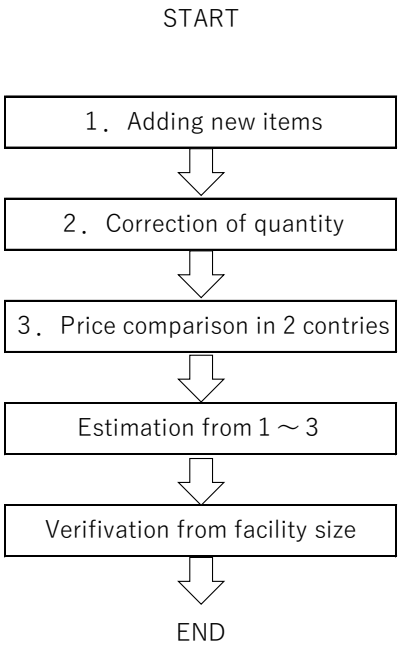
Maynilad, the water supplier in Metro Manila, conducted DMA plans for the MCWD and has a proper organizational and operational system, and maintenance management technics with Japanese assistance from the past. When it comes to the cooperation project, cooperation from Maynilad would be one potential idea.

8-3 Project Cost and Effects

8-3-1 Project Cost Estimation

Calculate the project cost for the assumed facility development plan. The calculation method is (Detailed Design of S City, Cambodia "S City Estimate"), which is an example of accumulation in the most recent 2022. Based on. The S City Estimation covers the construction of a series of water supply facilities, including water intake facilities (lakes), rapid filtration water treatment plants, water reservoirs, and water distribution pipe laying, and has many similarities with this proposal. In addition, since the price increase in 2022 is reflected in the estimated amount of material costs, pipe material costs, equipment and transportation costs, etc., the reliability is higher in terms of material costs and construction unit prices than in previous projects. On the other hand, since there are differences in added items, the number of corrections and additions, the scale of facilities, and the price aspects between Cambodia and the Philippines, we will make corrections for them.

The calculation flow is shown in Figure 8-3-1.



Source: JICA survey team

Figure 8-3-1 Project Costing Flow

8-3-1-1 Adding New Items

The following new items will be added to the S City Estimate.

- Foundation piles: PC piles φ400 H=10m 653 piles, approx. 60 million yen (as direct construction cost)

Upward flow type plate settler device: 1 set 80 million yen (material cost, based on domestic results)

Table 8-3-1 Estimation of Embankment Volume and Foundation Pile Numbers

■Embankment and Foundation Piles

Embankment Estimation			W(m)	L(m)	A(m2)
	Tamontaka WTP	Area (Int.)	120	150	18,000.0
		Embankment (Ext., H=3.0m, 1:1.5)	129	159	20,511.0
		Slope Arrangement			**503.0**
		Volume Obelisk (m3)			**57,726.0**
	Tamontaka Intake	Area (Int.)	25	30	750.625
		Embankment (Ext., H=3.0m, 1:1.5)	34	39	1326.85
		Slope Arrangement			**115.4**
		Volume Obelisk (m3)			**3,073.5**
Foundation Pile Estimation			W(m)	L(m)	A(m2)
	Tamontaka WTP	Sedimentation Bldg.	25	32.5	812.5
		Filtration Bldg.	20	10	200.0
		Reservoir(Int. 32mx32mxH4m)	40	40	1,600.0
		Area Total			2,612.5
		No. of Piles (Est. 4m^2/ea.)			653.0
		Length of Piles(Est. 10m/ea)	(m)		**6,530.0**

Source: JICA Survey Team

8-3-1-2 Modification of Items

The following quantities and unit prices are corrected as shown in Table 8-3-2.

Table 8-3-2 Modification of Items

Item	S city estimation	Water Supply Project
Water treatment capacity (m^3/day)	6,700	6,700~11,000
Concrete amount for body	1.0	0.53~0.8 times （as Pressure tank）
Civil work	1.0	0.33~0.5 times（semi-underground）
Civil work for pipes	---	No pavement Earth cover 0.80 m No earth retaining wall
Unit price of machinery	1.0	0.83~1.0 times

Source: JICA Survey Team

8-3-1-3 Comparison of Prices between the Two Countries

The unit price of materials shown in Table 8-3-3 is converted to Japan yen and prices in both countries are compared.

Table 8-3-3 Price Comparison

	a) S CITY ESTIMATION（USD）	b) unit price in MCWD（PHP）	rate (=b/a)
Sand（per m^3）	10.00	1,100	2.04
（JPY/m^3）	1,350	2,750	
Gravel（per m^3）	28.00	1,200	0.81
JPY conversion（JPY/m^3）	3,780	3,000	
Foreman（per day）	31.80	964.00	0.56
JPY conversion（JPY/day）	4,293	2,410	
Driver（per day）	18.00	522.00	0.54
JPY conversion（JPY/day）	2,430	1,305	

Source : JICA Survey Team

From the results in the above table, it can be seen that the price difference of purchased sand and gravel varies greatly depending on the extraction area. In addition, the price difference in labor costs is considered to be about 0.5~0.6 times.

Based on the above, the unit price used in this proposal shall be corrected as follows.

- Material price: 1.0 times
- Labor cost price: 0.55 times

8-3-1-4 Project Cost Calculation

As a result of reflecting 8-3-1-1~8-3-1-3 above, the project costs are Table 8-3-4.

Table 8-3-4 Estimation of Project Cost

Item	Water Supply Project
Water treatment capacity（m^3/day）	6,700~11,000
Construction cost　(Incl. dist. Facilities)	2,545~3,747
Procurement cost	22~33
Design and Supervise（Construction cost×10%）	255~374
Assistance for O&M	19
Preliminary costs（sub-total×5%）	142~209
Project costs（million JPY）	2,983~4,432

Source : JICA Survey Team

8-3-1-5 Validation from Other Cases

The validity of the results of section 8-3-1-4 is verified by comparing the construction cost of water treatment capacity 1,000 m^3 / day in other cases.

In Table 8-3-5, while the total amount for S City is 253 million yen, and for S City, which is constructing a rapid filtration water treatment plant in Japan this year, is 243 million yen.

Since the construction cost per unit in each case is almost the same, and it is considered that the construction cost per unit becomes cheaper as the scale increases, this project cost is considered to be appropriate.

Table 8-3-5 Comparison of Project Costs with Other Cases

Item	Other cases		This Proposal
	S CITY ESTIMATION	S city in Japan	Total
Construction cost for WTP（million JPY）	1,720	37,215	1,330~2,663
Maximum daily supply（m^3/day）	6,800	153,000	6,700~11,000
Construction cost per 1,000 m^3 of water treatment capacity (JPY million/1,000 m^3)	253	243	198~242

※Exchange rate：133.00JPY/USD

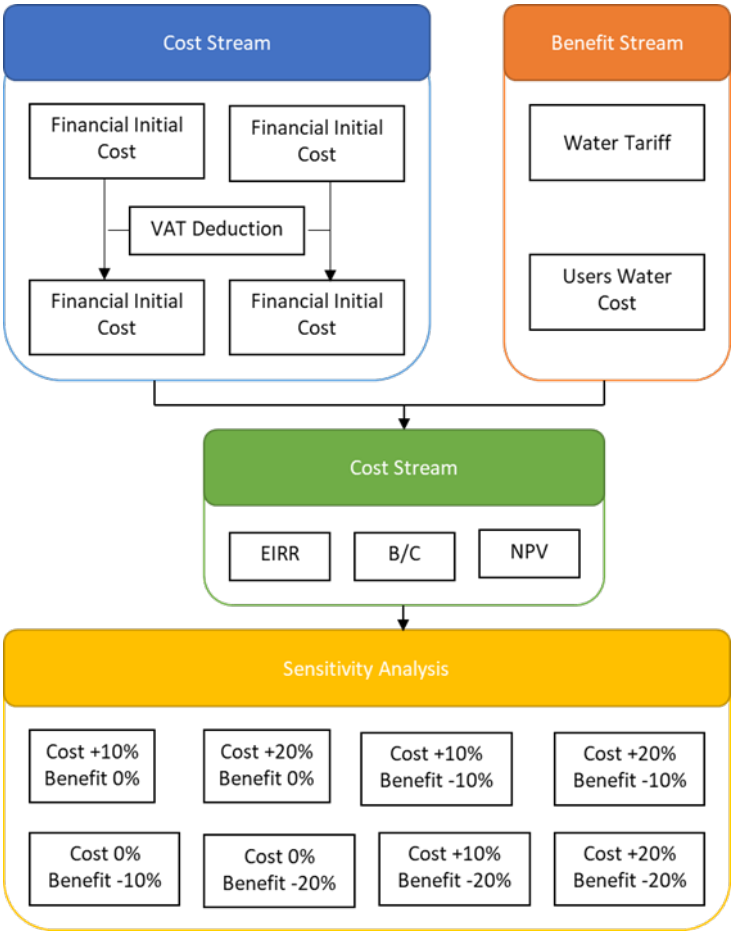
8-3-2 Verification of Business Effects

The NEDA obtained the following guidelines on project evaluation methods:

- Investment Coordination Committee (ICC) PROJECT EVALUATION PROCEDURES AND GUIDELINES

The guidelines aim to clarify the technical, financial, economic and social benefits on which the procedures for evaluating development programs and projects are based.

The economic valuation methodology is shown in Figure 8-3-2.



Source: JICA Survey Team

Figure 8-3-2 Economic Evaluation Procedure

Table 8-3-6 Economic Evaluation Indicator

No.	Indicator	Calculation Formula or Value
1	Project Evaluation Period	Period for 2021-2057 (37 years)
2	Discount Rate	10% is currently adopted as an opportunity cost (Benchmark for EIRR)
3	EIRR (Equity Internal Rate of Return)	$\sum \frac{Bn}{(1+r)n} = \sum \frac{Cn}{(1+r)n}$ r = satisfying B = Benefit, C = Cost
4	B/C	$\sum \frac{Bn}{(1+DR)n} = \sum \frac{Cn}{(1+DR)n}$ DR = Discount Rate
5	NPV (Net Present Value)	$\sum \frac{Bn - Cn}{(1 + DR)n}$

Source: JICA Survey Team

Table 8-3-6 shows the economic evaluation indicator used. The project cycle is set to 40 years following the JICA IRR Estimation Manual. The social discounted rate is set to 10% following the NEDA guideline. Following the ICC standard, the VAT equivalent price is deducted when converting from financial cost to economic cost. The general case will be compared with that when new connections decrease by 30% from the number expected. Table 8-3-7 shows the conversion from financial cost to economic cost.

Table 8-3-7 Financial Cost and Economic Cost

(million PHP)	Construction Cost	Consulting Service	Total
Financial Cost	1118.1	114	1232.1
Economic Cost	985.2	101.8	1087

Source：JICA Survey Team

(1) Cost

The service life of electromechanical facilities is set to 16 years based on the manual about cost and benefit analysis for water supply by the Ministry of Health, Labour and Welfare of Japan, then renewal cost is added at 16-year intervals.

Regarding the operation and maintenance costs, the annual cost is set to 1% of the construction cost considering the extra expense for the new WTP and operation system based on the maintenance cost of Dimapatoy WTP (8.26PHP/m^3).

(2) Benefit

The extra water tariff revenue from this proposal and the reduction in the water purchase fee using this system are taken for the benefit. Following Chapter 4, the expected annual revenue is calculated by calculating the average revenue/m^3 in 2021(25.88PHP/m^3), then multiplying the daily average supply volume. Since the new facility is separated from the existing facilities, and it is expected that the soft component assist will achieves proper operation and maintenance, the revenue water ratio is set to 90%.

The Number of connections is expected to increase gradually by 2029. As described in 8-1-1, those without a connection purchase water at the price of 1-5PHP/20l at water riffing stations. The price is set to 3PHP/20l; and the difference from the above-average revenue is taken as benefit.

(3) Analytical Results

The analysis results are shown below.

Table 8-3-8 Economic Evaluation (Case 1)

Economic Benefit		
EIRR	B/C	NPV (Million PHP)
17.4%	1.78	867.9

Source：JICA Survey Team

Table 8-3-9 Economic Evaluation (Case 2)

Economic Benefit		
EIRR	B/C	NPV (Million PHP)
12.6%	1.24	272.8

Source：JICA Survey Team

The cost and benefit fluctuated within the 10-20% range for sensitivity analysis following the NEDA guidelines, and the result is shown below.

Table 8-3-10 Sensitivity Analysis (Case 1)

EIRR		Benefit		
		0%	-10%	-20%
Cost	0%	17.40%	15.90%	14.30%
	10%	16.10%	14.60%	13.10%
	20%	14.90%	13.50%	12.00%

Source：JICA Survey Team

Table 8-3-11 Sensitivity Analysis (Case 2)

EIRR		Benefit		
		0%	-10%	-20%
Cost	0%	12.60%	11.30%	9.90%
	10%	11.40%	10.20%	8.80%
	20%	10.40%	9.20%	7.80%

Source：JICA Survey Team

In the sensitivity analysis in Case 2, EIRR suppressed 10%. The number of new connections is encouraged by the soft component assistance and providing equipment during the actual project to maximize the benefit.

Table 8-3-12 Detail of Analysis (Case 1)

Million Peso

Year	Econoomic Cost	O&M	Cost Total	Traffic Benefit	Benefit	Benefit - Cost
2024	20.4	0.0	20.4		0.0	-20.4
2025	543.5	0.0	543.5		0.0	-543.5
2026	523.1	0.0	523.1		0.0	-523.1
2027	0.0	4.5	4.5		0.0	-4.5
2028	0.0	9.9	9.9	79.2	79.2	69.4
2029		9.9	9.9	293.5	293.5	283.6
2030		9.9	9.9	293.5	293.5	283.6
2031		9.9	9.9	293.5	293.5	283.6
2032		9.9	9.9	293.5	293.5	283.6
2033		9.9	9.9	293.5	293.5	283.6
2034		9.9	9.9	293.5	293.5	283.6
2035		9.9	9.9	293.5	293.5	283.6
2036		9.9	9.9	293.5	293.5	283.6
2037		9.9	9.9	293.5	293.5	283.6
2038		9.9	9.9	293.5	293.5	283.6
2039		9.9	9.9	293.5	293.5	283.6
2040		9.9	9.9	293.5	293.5	283.6
2041		9.9	9.9	293.5	293.5	283.6
2042		9.9	9.9	293.5	293.5	283.6
2043		498.4	498.4	293.5	293.5	-204.9
2044		9.9	9.9	293.5	293.5	283.6
2045		9.9	9.9	293.5	293.5	283.6
2046		9.9	9.9	293.5	293.5	283.6
2047		9.9	9.9	293.5	293.5	283.6
2048		9.9	9.9	293.5	293.5	283.6
2049		9.9	9.9	293.5	293.5	283.6
2050		9.9	9.9	293.5	293.5	283.6
2051		9.9	9.9	293.5	293.5	283.6
2052		9.9	9.9	293.5	293.5	283.6
2053		9.9	9.9	293.5	293.5	283.6
2054		9.9	9.9	293.5	293.5	283.6
2055		9.9	9.9	293.5	293.5	283.6
2056		9.9	9.9	293.5	293.5	283.6
2057		9.9	9.9	293.5	293.5	283.6
2058		9.9	9.9	293.5	293.5	283.6
2059		498.4	498.4	293.5	293.5	-204.9
2060		9.9	9.9	293.5	293.5	283.6
2061		9.9	9.9	293.5	293.5	283.6
2062		9.9	9.9	293.5	293.5	283.6
2063		9.9	9.9	146.7	146.7	136.9
	1,087.0	1,336.2	2,423.2	10,203.6	10,203.6	7,780.4

Million Peso

sq	Year	Discounted	Econoomic Cost	O&M	Cost Total	Traffic Benefit	Benefit	Benefit - Cost
1	2024	1.00	20.4		20.4		0.0	-20.4
2	2025	1.10	494.1		494.1		0.0	-494.1
3	2026	1.21	432.3		432.3		0.0	-432.3
4	2027	1.33	0.0		0.0		0.0	0.0
5	2028	1.46	0.0	6.7	6.7	54.1	54.1	47.4
6	2029	1.61		6.1	6.1	182.2	182.2	176.1
7	2030	1.77		5.6	5.6	165.7	165.7	160.1
8	2031	1.95		5.1	5.1	150.6	150.6	145.5
9	2032	2.14		4.6	4.6	136.9	136.9	132.3
10	2033	2.36		4.2	4.2	124.5	124.5	120.3
11	2034	2.59		3.8	3.8	113.1	113.1	109.3
12	2035	2.85		3.5	3.5	102.9	102.9	99.4
13	2036	3.14		3.1	3.1	93.5	93.5	90.4
14	2037	3.45		2.9	2.9	85.0	85.0	82.2
15	2038	3.80		2.6	2.6	77.3	77.3	74.7
16	2039	4.18		2.4	2.4	70.3	70.3	67.9
17	2040	4.59		2.1	2.1	63.9	63.9	61.7
18	2041	5.05		1.9	1.9	58.1	58.1	56.1
19	2042	5.56		1.8	1.8	52.8	52.8	51.0
20	2043	6.12		81.5	81.5	48.0	48.0	-33.5
21	2044	6.73		1.5	1.5	43.6	43.6	42.2
22	2045	7.40		1.3	1.3	39.7	39.7	38.3
23	2046	8.14		1.2	1.2	36.1	36.1	34.8
24	2047	8.95		1.1	1.1	32.8	32.8	31.7
25	2048	9.85		1.0	1.0	29.8	29.8	28.8
26	2049	10.83		0.9	0.9	27.1	27.1	26.2
27	2050	11.92		0.8	0.8	24.6	24.6	23.8
28	2051	13.11		0.8	0.8	22.4	22.4	21.6
29	2052	14.42		0.7	0.7	20.3	20.3	19.7
30	2053	15.86		0.6	0.6	18.5	18.5	17.9
31	2054	17.45		0.6	0.6	16.8	16.8	16.3
32	2055	19.19		0.5	0.5	15.3	15.3	14.8
33	2056	21.11		0.5	0.5	13.9	13.9	13.4
34	2057	23.23		0.4	0.4	12.6	12.6	12.2
35	2058	25.55		0.4	0.4	11.5	11.5	11.1
36	2059	28.10		17.7	17.7	10.4	10.4	-7.3
37	2060	30.91		0.3	0.3	9.5	9.5	9.2
38	2061	34.00		0.3	0.3	8.6	8.6	8.3
39	2062	37.40		0.3	0.3	7.8	7.8	7.6
40	2063	41.14		0.2	0.2	3.6	3.6	3.3
			946.8	168.9	1,115.7	1,983.6	1,983.6	867.9

Net Present Value (Million peso)	867.9
B/C Ratio	1.78
EIRR	17.4%

Source : JICA Survey Team

Table 8-3-13 Detail of Analysis（Case 2）

Million Peso

Year	Econoomic Cost	O&M	Cost Total	Traffic Benefit	Benefit	Benefit - Cost
2024	20.4	0.0	20.4		0.0	-20.4
2025	543.5	0.0	543.5		0.0	-543.5
2026	523.1	0.0	523.1		0.0	-523.1
2027	0.0	4.5	4.5		0.0	-4.5
2028	0.0	9.9	9.9	55.5	55.5	45.6
2029		9.9	9.9	205.4	205.4	195.6
2030		9.9	9.9	205.4	205.4	195.6
2031		9.9	9.9	205.4	205.4	195.6
2032		9.9	9.9	205.4	205.4	195.6
2033		9.9	9.9	205.4	205.4	195.6
2034		9.9	9.9	205.4	205.4	195.6
2035		9.9	9.9	205.4	205.4	195.6
2036		9.9	9.9	205.4	205.4	195.6
2037		9.9	9.9	205.4	205.4	195.6
2038		9.9	9.9	205.4	205.4	195.6
2039		9.9	9.9	205.4	205.4	195.6
2040		9.9	9.9	205.4	205.4	195.6
2041		9.9	9.9	205.4	205.4	195.6
2042		9.9	9.9	205.4	205.4	195.6
2043		498.4	498.4	205.4	205.4	-293.0
2044		9.9	9.9	205.4	205.4	195.6
2045		9.9	9.9	205.4	205.4	195.6
2046		9.9	9.9	205.4	205.4	195.6
2047		9.9	9.9	205.4	205.4	195.6
2048		9.9	9.9	205.4	205.4	195.6
2049		9.9	9.9	205.4	205.4	195.6
2050		9.9	9.9	205.4	205.4	195.6
2051		9.9	9.9	205.4	205.4	195.6
2052		9.9	9.9	205.4	205.4	195.6
2053		9.9	9.9	205.4	205.4	195.6
2054		9.9	9.9	205.4	205.4	195.6
2055		9.9	9.9	205.4	205.4	195.6
2056		9.9	9.9	205.4	205.4	195.6
2057		9.9	9.9	205.4	205.4	195.6
2058		9.9	9.9	205.4	205.4	195.6
2059		498.4	498.4	205.4	205.4	-293.0
2060		9.9	9.9	205.4	205.4	195.6
2061		9.9	9.9	205.4	205.4	195.6
2062		9.9	9.9	205.4	205.4	195.6
2063		9.9	9.9	102.7	102.7	92.9
	1,087.0	1,336.2	2,423.2	7,142.5	7,142.5	4,719.3

Million Peso

sq	Year	Discounted	Econoomic Cost	O&M	Cost Total	Traffic Benefit	Benefit	Benefit - Cost
1	2024	1.00	20.4		20.4		0.0	-20.4
2	2025	1.10	494.1		494.1		0.0	-494.1
3	2026	1.21	432.3		432.3		0.0	-432.3
4	2027	1.33	0.0		0.0		0.0	0.0
5	2028	1.46	0.0	6.7	6.7	37.9	37.9	31.2
6	2029	1.61		6.1	6.1	127.6	127.6	121.4
7	2030	1.77		5.6	5.6	116.0	116.0	110.4
8	2031	1.95		5.1	5.1	105.4	105.4	100.4
9	2032	2.14		4.6	4.6	95.8	95.8	91.2
10	2033	2.36		4.2	4.2	87.1	87.1	82.9
11	2034	2.59		3.8	3.8	79.2	79.2	75.4
12	2035	2.85		3.5	3.5	72.0	72.0	68.5
13	2036	3.14		3.1	3.1	65.5	65.5	62.3
14	2037	3.45		2.9	2.9	59.5	59.5	56.6
15	2038	3.80		2.6	2.6	54.1	54.1	51.5
16	2039	4.18		2.4	2.4	49.2	49.2	46.8
17	2040	4.59		2.1	2.1	44.7	44.7	42.6
18	2041	5.05		1.9	1.9	40.6	40.6	38.7
19	2042	5.56		1.8	1.8	36.9	36.9	35.2
20	2043	6.12		81.5	81.5	33.6	33.6	-47.9
21	2044	6.73		1.5	1.5	30.5	30.5	29.1
22	2045	7.40		1.3	1.3	27.8	27.8	26.4
23	2046	8.14		1.2	1.2	25.2	25.2	24.0
24	2047	8.95		1.1	1.1	22.9	22.9	21.8
25	2048	9.85		1.0	1.0	20.9	20.9	19.9
26	2049	10.83		0.9	0.9	19.0	19.0	18.1
27	2050	11.92		0.8	0.8	17.2	17.2	16.4
28	2051	13.11		0.8	0.8	15.7	15.7	14.9
29	2052	14.42		0.7	0.7	14.2	14.2	13.6
30	2053	15.86		0.6	0.6	12.9	12.9	12.3
31	2054	17.45		0.6	0.6	11.8	11.8	11.2
32	2055	19.19		0.5	0.5	10.7	10.7	10.2
33	2056	21.11		0.5	0.5	9.7	9.7	9.3
34	2057	23.23		0.4	0.4	8.8	8.8	8.4
35	2058	25.55		0.4	0.4	8.0	8.0	7.7
36	2059	28.10		17.7	17.7	7.3	7.3	-10.4
37	2060	30.91		0.3	0.3	6.6	6.6	6.3
38	2061	34.00		0.3	0.3	6.0	6.0	5.8
39	2062	37.40		0.3	0.3	5.5	5.5	5.2
40	2063	41.14		0.2	0.2	2.5	2.5	2.3
			946.8	168.9	1,115.7	1,388.5	1,388.5	272.8

Net Present Value (Million peso)	272.8
B/C Ratio	1.24
EIRR	12.6%

Source：JICA Survey Team

8-4 Attention Notes for Grant Aid Preparatory Additional Survey

The followings are the survey contents and attention notes for the project implementation.

8-4-1 Water Quality Survey for Potential Source

The quality of the water source in the Tamontaka River, which is assumed to be the water supply project, will be confirmed and its suitability as a source of drinking water investigated. These would be the basic steps to take when designing WTP and intake facilities. Besides, the planned intake point may be affected by saltwater intrusion given the proximity of Cotabato City to the ocean, hence the need to conduct a water quality survey confirming that the water intake point will be unaffected by saltwater intrusion.

In February 2023, water quality tests were conducted on the Tamontaka River, with MCWD cooperating to collect water and transport samples to a testing institution, with the results rolled out in March. As described in 2-3-3, the DOH established the drinking water quality standard. It is classified as 1) Microbiological, 2) Inorganic Chemical, 3) Organic Chemical, 4) Organic Chemical (Pesticides), 5) Physical and Chemical, 6) Chemicals used in treatment and disinfection and disinfection by-products and 7) Radiological parameters. This time only 1), 2) and 5) are targeted for the water quality test. Surface water samples were collected twice at low tide (Sample 1) and high tide (Sample 2) at the Tamontaka River at the same location as the next section. Table 8-4-1 shows the water quality test results and comparison.

Table 8-4-1 Water Quality Test in Tamontaka River

Microbiological Quality of the Drinking Water					
			Result		
	Item	Quality of Drinking Water Standard	Sample 1	Sample 2	Unit
1	Total Coliform	<1.1MPN/100mL	5400	22000	MPN/100mL
2	Thermotolerant Coliform/E.coli	<1.1 MPN/100mL	33	27	MPN/100mL
3	Heterotrophic Plate Count (HPC)	<500 CFU/mL	>6500	>6500	ECFU/mL
Inorganic Chemical Parameters of the Drinking-Water					
	Item	Max. Allowable Level	Sample 1	Sample 2	Unit
1	Antimony (Sb)	0.02 mg/L	N/A		mg/L
2	Arsenic(As)	0.01 mg/L	<0.002	<0.002	mg/L
3	Barium (Ba)	0.70 mg/L	N/A		mg/L
4	Boron (B)	2.00 mg/L	0.15	0.16	mg/L
5	Cadmium (Cd)	0.003 mg/L	<0.003	<0.003	mg/L
6	Chromium, Total (Cr)	0.05 mg/L	<0.001	<0.001	mg/L
7	Cyanide, Total (CN-)	0.50 mg/L	0.0032	<0.002	mg/L
8	Fluoride (F-)	1.50 mg/L	<0.1	<0.1	mg/L
9	Lead (Pb)	0.01 mg/L	<0.01	<0.01	mg/L
10	Manganese (Mn)	0.4 mg/L	0.009	0.002	mg/L
11	Mercury, Total (Hg)	0.001 mg/L	<0.002	<0.002	mg/L
12	Nickel (Ni)	0.07 mg/L	<0.006	<0.006	mg/L
13	Nitrate (NO3-)	50.00 mg/L	<0.89	<0.89	mg/L
14	Nitrite (NO2-)	3.00 mg/L	<0.007	<0.007	mg/L
15	Selenium (Se)	0.04 mg/L	N/A		mg/L
Physical and Chemical Quality for Acceptability Aspects of Drinking-Water					
	Item	Max. Allowable Level	Sample 1	Sample 2	Unit

Microbiological Quality of the Drinking Water					
1	Taste	No objectionable taste	N/A		
2	Odor	No objectionable	No objectionable	No objectionable	
3	Color	10 CU	25	15	TCU
4	Turbidity	5 NTU	32	<5.0	NTU
5	Aluminum	0.2 mg/L	0.05	0.04	mg/L
6	Chloride	250 mg/L	5.03	5.53	mg/L
7	Copper	1.0 mg/L	0.009	<0.004	mg/L
8	Total Hardness	300 mg/L	116	118	mg/L
9	Hydrogen sulfide	0.05 mg/L	<0.02	<0.02	mg/L
10	Iron	1.0 mg/L	1.09	0.041	mg/L
11	p H	6.5 - 8.5	8.4	8.0	
12	Sodium	200 mg/L	10.39	9.66	mg/L
13	Sulfate	250 mg/L	0.46	<0.31	mg/L
14	Total Dissolved Solids	600 mg/L	72	288	mg/L
15	Zinc	5.0 mg/L	0.048	0.284	mg/L
Other Tested Items					
	Item	Max. Allowable Level	Sample 1	Sample 2	Unit
1	Temperature	N/A	12.3	25.3	℃
2	Organo-Phosphorus	N/A	<0.01	<0.01	mg/L
3	Test for Carbamates	N/A	Negative	Negative	
4	Oil and Grease	N/A	2	1	mg/L

Source：JICA Survey Team

It is the point furthest downstream in a large river. Since many bacteria, many bacteria including E.coli were detected in the test results, appropriate water treatment and residual chlorine management on the pipe network are required. Other indicators were relatively good, and indicators showing brackish water were absent; however, it is different from river to river, so a more precise survey is required.

In addition, a water quality analysis of existing water taps should be conducted to use as baseline data before the project. Moreover, a water quality analysis on private wells within the MCWD water supply area should be conducted to use for ideas to improve the house connection rate.

8-4-2 Geological Survey

A geological survey at the intake, treatment and distribution facilities will be conducted to confirm the geological information necessary for examining the foundation type and cost estimation. It is assumed that structures must be built on the high embankment to prevent flooding events along the rivers. Therefore, in the geological survey, consolidation tests must be conducted to apply for the examination of the settlement degree and its convergence period.

8-4-3 Surveying

Surveying will be conducted to grasp the topographical information necessary for facility planning and design.

Table 8-4-2 Survey Items

Contents	Target	Objective
Route Survey	Route for transmission pipes and distribution mains	Confirmation of pipe laying route and obtaining contact point information for pipe network analysis
Plane Survey	Intake and WTP facilities	Confirmation of topography necessary for facility plane plan

Contents	Target	Objective
River Cross-section Survey	Intake point at Tamontaka River	Confirmation of topography to estimate intake facility design, temp. site design and flood level

Source: JICA Survey Team

8-4-4 Environmental and Social Consideration Survey

In this proposal, large-scale land acquisition and involuntary resettlement are not foreseen. However, land acquisition is required for the WTP and impacts on the environment and society, albeit limited, are expected. Hence, the category classification based on the "JICA Guidelines for Environmental and Social Considerations, January 2022" is assumed to be B. In the subsequent preparatory survey, categorization will be again confirmed, and alternatives will be compared from the environmental and social consideration view. Then, mitigation measurements for environmentally essential items and the preparation of monitoring plans will be supported. In addition, after discussion with the Philippines, a draft of the JICA environmental checklist will be created by organizing the survey results.

8-4-5 Social Survey

To ensure the survey accuracy of the preparatory survey, a social survey will be conducted. It grasps the social condition, such as awareness and living environment at the project site. Based on this, the proper functions and scale required for the target facilities will be determined and contributed to the design, construction plan and cost estimation. Besides, the social survey to collect baseline information and to contribute to setting the project effect and evaluation will be conducted with the following contents.

- Household general information (household composition, occupation, etc.) and household economy (income, assets, etc.)
- Availability of sanitation facilities (toilets, sewage, etc.), availability of drinking water (source, consumption, tariff) and private well usage
- Expectation for the expansion water supply project (willingness for new connection and amount willingness to pay)

8-4-6 Facility Planning And Design

In planning and designing facilities, in addition to following the technical standards of LWUA, which governs local water supply facilities in the Philippines, the design will be in accordance with the JWWA of the Japan. In addition, since the Philippines is a country with a particularly high earthquake risk, the facility must have the necessary seismic performance. and so on.

In the arrangement of water intake facilities and the examination of facility plans, the following considerations shall be given.

- It is located at a point where the difference between the raw ground and the flood level is as small as possible and the embankment height for the construction base of the water intake facility can be suppressed.

- It is desirable to avoid the water immersion area to reduce the effect of scouring from the river flow, but if it is unavoidable to install it in the water immersion area, provide a seawall for necessary scouring protection.
- After considering the results of raw water quality tests over a certain period of time, place the site in a position where the effects of saltwater run-up will not be affected.
- Considering that floating objects such as hyacinths may accumulate, take necessary measures for the structure of the water intake.

The following considerations shall be given to the layout of water treatment facilities and the study of facility plans.

- When examining the location of the water treatment plant, consideration should be given to saving energy as much as possible according to the shape and height difference of the facility site.
- Take the minimum necessary flood countermeasures so that water treatment plants can continue to operate even in the event of a flood.
- Chlorination for power outage countermeasures, algae countermeasures, and inclined plates in sedimentation ponds will be studied.
- Regarding the earthquake-resistant design for WTP buildings etc., the National Structural Code of the Philippines (NSCP), which is defined by the Association of Structural Engineers of the Philippines (ASEP) and approved by the DPWH, is used.

8-5 Interview with Bidders

The following results are from interviews with several construction companies regarding the bidding for areas classified as "Risk Level 3" by the Ministry of Foreign Affairs or higher. "F", "G" and "H" answered that they cannot bid on projects with the risk level 3 or higher. The other companies said that they would contract based on their own survey before the project, or the authorizer made a decision in consideration of local condition. All in all, all the construction companies are cautious about participating.

Table 8-5-1 Bidding Status in Risk Level 3 or Higher Area

Construction Companies	Answers
A	There is no internal regulation according to the risk level. Before the project, risks are considered (countermeasures against them), and the authorizer makes a decision.
B	There is no internal regulation according to the risk level. Before the project, risks are considered (countermeasures against them), and the authorizer makes a decision.
C	There is no internal regulation according to the risk level. It is necessary to make a judgment separately, including the head office. Regarding the safety, the risk level both by the Ministry of Foreign Affairs and themselves will be considered for the time of bidding.
D	There is no internal regulation according to the risk level. Before the project, risks are considered (countermeasures against them), and the authorizer makes a decision. There is no record of bidding in the risk level 3 area, it would be difficult.
E	There is no internal regulation according to the risk level. We are refraining from bidding for projects in the Philippines as we posted large losses there in the past.
F	The current policy does not participate in invitations of bidding in the risk level 3 or higher. Evacuation orders are issued by the embassy and the JICA when the risk level reaches 3.
G	There is a company policy that they cannot bid on the risk level 3 or higher.
H	There is a company policy that they cannot bid on the risk level 3 or higher.

Source: JICA Survey Team

If it is difficult for a Japanese company to bid, it may be possible to apply for another grant aid sub-scheme.

Chapter 9. Recommendations to the Cotabato Metropolitan Water District and Facility Development Schedule

9-1 Obligations of Recipient Country

9-1-1 Follow-up for SDF Adoption and Obtaining Support from Other Donors

The MCWD has applied for a total of PHP 1.57 billion SDF in three phases. For Phase 1, PHP 450m, an application was already submitted in 2022. The SDF, unlike the budgets for local governments and government agencies in general, allows unspent funds from one financial year to be utilized the following year and not returned to the national treasury.

For Phase 1 of the SDF application under submission, it was envisaged that approval would be granted by the end of 2022. The MCWD submitted the design parameters required for the Phase 1 application to BPDA in early November and subsequently revised the application in response to several comments.

The MCWD was aiming for approval by the end of 2022 for its budget application, but then on 1 December 2022, a BPDA representative replied that it would be difficult to get Phase 1 approved by the end of the year 2022.

On the other hand, it was mentioned that they are positive about the possibility of budgeting for 2023. The above communication on financial support was verbal, and there has not been any commitment in writing of any kind from the BPDA.

The MCWD is aware that, given the current pace of development, support from JICA and other donors, with or without SDF, will remain necessary.

9-1-2 Land Acquisition and Site Preparation for Intake Facility and WTP

The sites for the intake facility and WTP shall be acquired by MDWD. Figure 7-2-9 shows the locations that the MCWD has identified as candidate sites for the construction of the facilities. In selecting a site, the possibility of securing the required site area (assumed to be 2.3 ha for intake facility and WTP), the impact of flood levels, the impact of brackish water runoff, and water distribution efficiency, etc. are comprehensively considered in the selection process. In addition, it is assumed that the Philippine side will perform land preparation and land fill for construction of the formation level at the selected site. In acquiring land, the Bureau of Land under the MENRE evaluates the land and negotiates with the owner up to the amount of the evaluated value. One way to deal with difficulties in acquiring land for a site is to exercise the right of expropriation, but forced expropriation of land can be a negative factor in terms of resident sentiment and a factor in safety issues. Therefore, the upper limit is set at about 1.5 times the government-appraised value, and if the owner does not agree to purchase the land even under those conditions, the MCWD will look for another candidate site.

9-1-3 Permission to Take Water from the Tamontaka River

The NWRB is in charge of water rights, and the following documents shall be prepared for urban water use.

- Documents proving Land Ownership and Usage Rights to the Water Source
- Certificate of Registration from the Relevant Agency
- Certificate of Conformity from LWUA
- Location Map showing Exact Location of Watershed Boundary
- Environmental Compliance Certificate

The total amount of surface water intake from the Tamontaka River is expected to be maximum 12,100 m^3/day (= maximum daily water supply: 11,000 m^3/day x 1.1) in the potential water supply project.

9-1-4 Electricity Installation to New Intake Site and WTP Site

The water supply project proposed in this proposal will install a new power receiving and transforming facility on the premises of the intake facility and WTP. The power feed-in from the 3-phase 460V AC line installed by Cotabato Light Corp. on Sinsuat Avenue to the new substation will be at the expense of the recipient country and will be performed prior to the start of construction work.

9-1-5 Occupancy Permits for Intake Facility, WTP, and Transmission and Distribution Pipe Routes

The land for the intake facility and WTP is currently privately owned and will be acquired by the MCWD. In addition, transmission and distribution pipes will be laid on public roads. The MCWD will apply to the LWUA for permission to construct intake facility and WTP and to install water transmission and distribution pipes on these sites. Occupancy permits for the intake facility and WTP will be obtained prior to the public announcement of prequalification, and permits for laying water distribution pipes will be obtained prior to the start of construction.

9-1-6 Service Pipe Connection and Water Meter Installation for Each Household

Water supply facilities (water meters, water pipes and fittings, etc.) that are branched off from distribution pipes are installed by the MCWD at the request of the residents. The connection fee will be borne by the residents (beneficiary pays). In order to improve the water supply ratio through the water supply project, it is necessary to connect water supply pipes to each house and procure and install water meters for those (applicants) who wish to be newly connected to the water services. The connection work will be carried out by the MCWD's technicians at the expense of the new connection applicants. The proposal expects to connect 5,164 households, including the poor, to water pipes by the target year of 2029. In order to expand water supply to the poor, the procurement of water supply equipment (meters, pipe materials, and other accessories) for poor households will be included in the proposed water supply project, but the cost of connecting this water supply equipment will be borne by the Philippine side (MCWD).

9-1-7 Environmental and Social Considerations

9-1-7-1 Acquisition of ECC

The environmental classification of the project (ECPs, ECAs, or ENCPs) shall be verified based on the EIS system, which is the legal framework for environmental and social considerations in the Philippines. should obtain an ECC from the DENR.

9-1-7-2 Implementation of Environmental Management and Monitoring Plans

The MCWD is responsible for overseeing the steady implementation of the environmental management plan and monitoring plan.

This proposal, which aims to expand the water supply capacity, will not involve large-scale construction in a short period of time, but will require construction in urban and residential areas, so care must be taken with regard to the neighborhood environment. When constructing water supply and treatment facilities and laying pipe networks, the project will require careful attention to air pollution, water pollution, noise, and traffic congestion in the vicinity of the facilities. When operating the facilities, consideration must be given to the noise and vibration caused by the operation of intake pumps and water distribution pumps, and the effects of sludge disposal.

9-1-8 Securing Temporary Site

The MCWD will provide the temporary office yards, and temporary storage areas needed during the construction period, which will need to be secured through leases. The lease contract will be at an appropriate price based on market prices. The site for the temporary yard should be a suitable site accessible from the construction site with an area of at least 1 ha.

9-1-9 Potential of Solar Panel Installation to Reduce Operation and Maintenance Cost

Cotabato city is one of the areas having the highest photovoltaic potential in the Philippines. Besides, the influence of typhoons is rare, with the stable climate throughout the years, and it appropriates the photovoltaic generation. Figure 9-1-1 shows the expected potential at the Tamontaka new WTP.

A pump distribution system in the planning WTP site by the grant aid project is required from the low-level land less than 10m. Solar panels are effectively reduce electricity consumption, and they can lower operation and maintenance costs. Else, the electricity in the daytime can be used to supply water to a water tower.

Source :https://globalsolaratlas.info/

Figure 9-1-1 Photovoltaic Generation Potential

9-1-10 Suggestions for Operation Improvement

The MCWD is operating a water supply through the efforts its own staff, despite limited resources; however, costs are eating into profitability. Moreover, the MCWD is struggling to manage things

efficiently and reduce operation and maintenance costs with multiple water resources and facilities. One of the main causes is the 25% high NRW considered from leakage, and the MCWD needs to invest in human and other resources to reduce this figure through efficient water supply management. It is also recommended to have training facilities to train and educate staff. Planning and evaluation based on asset management and water tariff f revision from mid- and long-term perspective are required for the investment of new resources and counter measurements for costs such as renewal of aged pipes.

9-1-11 Others

In addition to the above, the following items are expected to be borne by the recipient country in the implementation of this proposal.

- Establishment of a Project Implementing Unit (PIU) organized by MCWD
- Increase Water Department Staffing and Appropriate Staffing and Training
- Inventory Control of Procured Materials and Equipment, and Proper Maintenance of Constructed Facilities
- Ongoing Collection and Accumulation of Indicator Values for Project Monitoring
- Tax Exemption for Construction Contractors

9-2 Project Schedule

It is expected to take about one year for preparatory studies and about one year for implementation design and bidding. In addition, during the two years, the period required for land acquisition, embankment and consolidation settlement by MCWD will be allocated.

Construction of water intake, water treatment and distribution facilities will begin at the same time. The construction period is expected to be approximately two years based on past results.

Table 9-2-1 shows the project implementation process (draft).

Table 9-2-1 Project Schedule

year		2023				2024				2025				2026				2027				2028				2029				
Fiscal Year			2023				2024				2025				2026				2027				2028				2029				
Season		W	Sp	Su	Au	W	Sp	Su	Au	W	Sp	Su	Au	W	Sp	Su	Au	W	Sp	Su	Au	W	Sp	Su	Au	W	Sp	Su	Au	W
Data Collection Survey																														
Site acquisition, embankment and consolidation																														
Implementation	Preparatory survey																													
	Detail design																													
	Construction																													
	Intake																													
	WTP																													
	Pipes																													
	Soft Component																													

Source: JICA Survey Team