Be Secure Project

Water Security for Resilient Economic Growth and Stability

Water Operator Partnership on Hydraulic Modeling

Between

Cagayan de Oro Water District (COWD)

and

Maynilad Water Services, Inc. (Maynilad)

thru

Maynilad Water Academy (MWA)

Prepared for Be Secure Project

2015

PROJECT BACKGROUND AND OVERVIEW

1. INTRODUCTION

Cagayan de Oro City, (CDO), is a highly urbanized and capital city of the province of Misamis Oriental in Mindanao in southern Philippines. It serves as the regional center and business hub for Northern Mindanao (Region X), and is part of the growing Metropolitan Cagayan de Oro area.

The Cagayan de Oro City Water District (COWD) was formed on 1 August 1973 and is recognized as the first water district in the country. It is responsible for providing water supply to Cagayan De Oro City and the Municipality of Opol, and has about 85,000 customers. Like many water utilities in developing Asia, COWD is confronted by issues related to water losses and inadequate supply largely due to system inefficiencies and an ever increasing population. Staff capacity is also limited further adding to the challenge of operating a complex water network. Understanding the behaviour of its distribution network through hydraulic modeling will allow COWD to convert intermittent supply and improve overall pressure. A GIS will further enable COWD to better manage its supply system by integrating a broad collection of information such as asset and customer location, water flow, pressure, water losses, etc.

With assistance from USAID's Water Security for Resilient Economic Growth and Stability (Be Secure) project, a Water Operators Partnership (WOP) was implemented to develop the capacity of COWD in the creation of a hydraulic model, the design of a pressure management program, and an introduction to the development of a Geographic Information System (GIS).

WOP is a twinning program between a mentor utility that has achieved operational efficiency, and a recipient that aspires to learn from it. Maynilad Water Services, Inc. (Maynilad), tapped by WaterLinks as a mentor to COWD, is a private water concessionaire providing water and wastewater services to 17 cities and municipalities that comprise the West Zone of Metro Manila, with over 1 million customers. Its training arm, the Maynilad Water Academy (MWA) served as coordinator of the activities for Maynilad.

MWA is responsible for building and strengthening the technical capabilities of Maynilad personnel in water and wastewater service delivery. Established just two (2) years ago, MWA is taking an active role in building the capacity of Maynilad staff and other key players in the water sector through its training programs and outreach activities targeting water professional and practitioners.

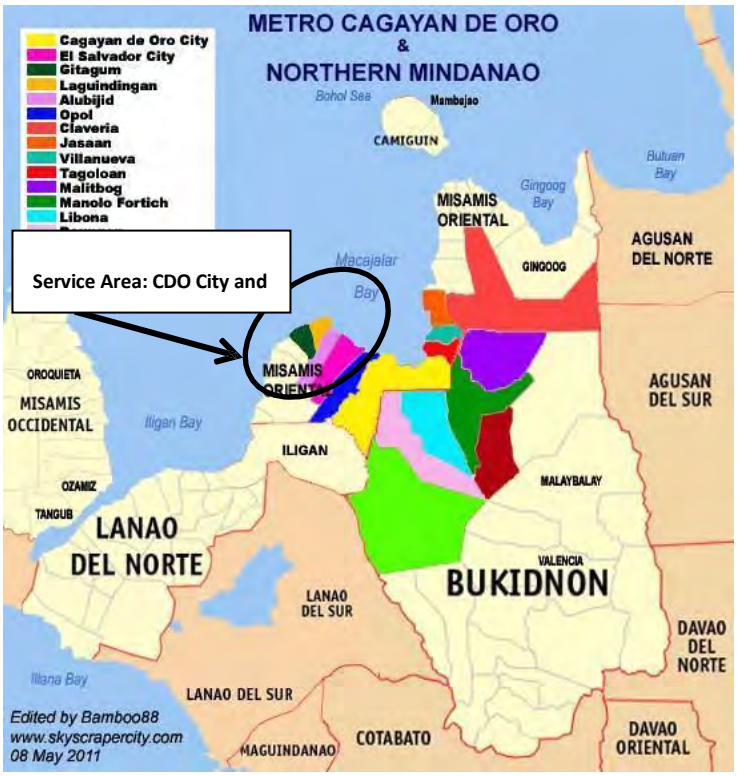
2. BRIEF DESCRIPTION

2.1 CAGAYAN DE ORO

Cagayan de Oro is one of the most important cities in Mindanao. It is the capital of the province of Misamis Oriental and the regional center for Northern Mindanao (Region X). It has an estimated population of 602,088 people in 200,000 households and is considered as the 10th most populous city in the Philippines. It is also the largest city in Northern Mindanao with an area of 57, 851 hectares with 33.27% of the land used for agricultural purposes. Cagayan de Oro is the development hub of the region, with trading and service sectors contributing about 50% of total investment of the province.[1]

2.2 CAGAYAN DE ORO WATER DISTRICT

Formed on 1 August 1973, COWD is the first water district in the country. It was issued its Conditional Certificate of Conformance (CCC) No. 001 on 4 January 1974 by the Local Water Utilities Administration (LWUA). In 41 years, COWD has grown 24 times more in service connections, 10 times more in water production and as much as 12 times more in pipeline length. Its water source is derived from 28 wells distributed in six (6) well fields situated at Macasandig, Balulang, Calaanan, Bugo, Tablon and Agusan. It also has one spring source located at Malasag. Production facilities include three (3) major booster pumping stations and eight (8) reservoirs.



As of December 2014, COWD had over 85,500 customers.

1. www.cagayandeoro.gov.ph

2.3 MAYNILAD WATER SERVICES INC.

Maynilad is the water and wastewater services provider for the 17 cities and municipalities that comprise the West Zone of Metropolitan Manila.

In 1997, Maynilad was granted a 25-year exclusive concession by the Philippine Government to operate, maintain and invest in the water and sewerage systems for the West Zone of Metro Manila. In 2010, the concession term was extended by another 15 years and will expire in 2037. With 1.2 million customers, Maynilad covers the cities of Manila (all but portions of San Andres and Sta. Ana), Quezon City (west of San Juan River, West Avenue, EDSA, Congressional, Mindanao Avenue, the northern part starting from the Districts of Holy Spirit and Batasan Hills), Makati (west of South Super Highway), Caloocan, Pasay, Parañaque, Las Pinas, Muntinlupa, Valenzuela, Navotas and Malabon, all in Metro Manila; the cities of Cavite, Bacoor and Imus, and the towns of Kawit, Noveleta and Rosario, all in the Province of Cavite.

2.4 MAYNILAD WATER ACADEMY

Launched in 6 October 2011, MWA focuses on educating Maynilad's human capital, the public and, key stakeholders on developments and technologies in water and wastewater operation.

It is focused on developing and initiating model training programs in advancing the development and deployment of new water technologies through structured benchmarking programs, forums, and seminars. MWA has been involved in WOP programs with the goal of engaging, sharing, and exploring new ideas, and creating avenues for developing and delivering clean and potable water, as well as treating wastewater.

3. TASK AND WORKPLAN

3.1 Diagnostic Visit

The WOP began with a two-day diagnostic visit conducted by the mentor on 22-23 May 2014. It was determined at this visit that COWD has 28 production wells with a total capacity of 24,800 gallons per minute (gpm). The wells are divided into three (3) areas with the Central Area having eight (8) production wells, the Eastern Area having nine (9), and the Western Area having 11.

Central Area	Eastern Area	Western Area
		
Production Well #1	Production Well #23	Production Well #10

In 2007, COWD entered into a 25 year Bulk Water Supply Project (BWSP) with a contractor to provide an initial 50,000 cubic meters per day of treated water. The supply agreement scheme is estimated to benefit serve around 90,000 residential customers. Total Production capacity is at 198,262 cu.m/day and is capable of serving elevation above 35 meters. The BWSP is coupled with a Lateral Improvement Project, which includes the laying out of mainline pipes ranging from 300-800 mm in diameter primarily to accommodate the entry of the bulk water supply, expand coverage, and further improve water service to its customers.

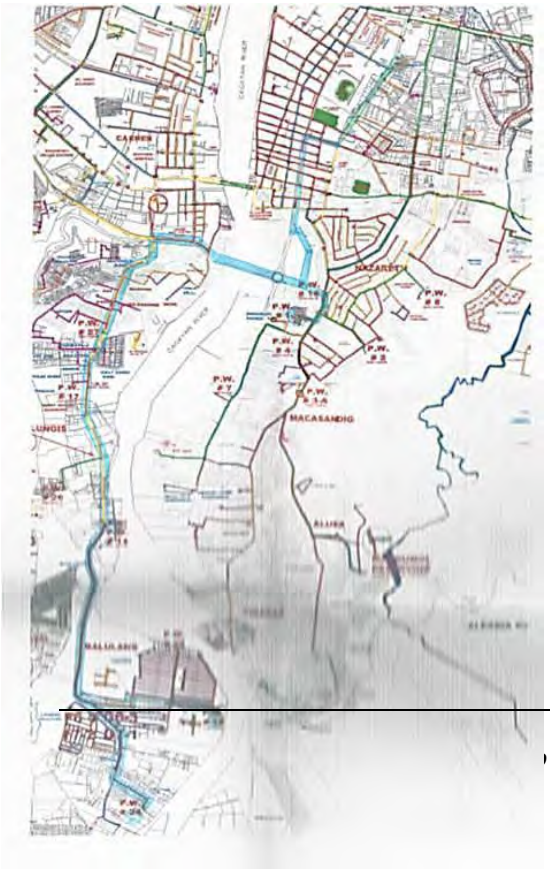
It was further determined that COWD's production wells are operating 24/7 except in Calaanan. Booster operations are dependent on the water level of the sump. Production

output is measured monthly either using flow meters or manual computation with only nine (9) wells having flow meters. Pressure is measured using data loggers.

In accordance with standards, COWD is monitoring its water quality by conducting regular bacteriological tests comprised of 80 samples per month and an annual physical and chemical analysis. Regular flushing is likewise undertaken.

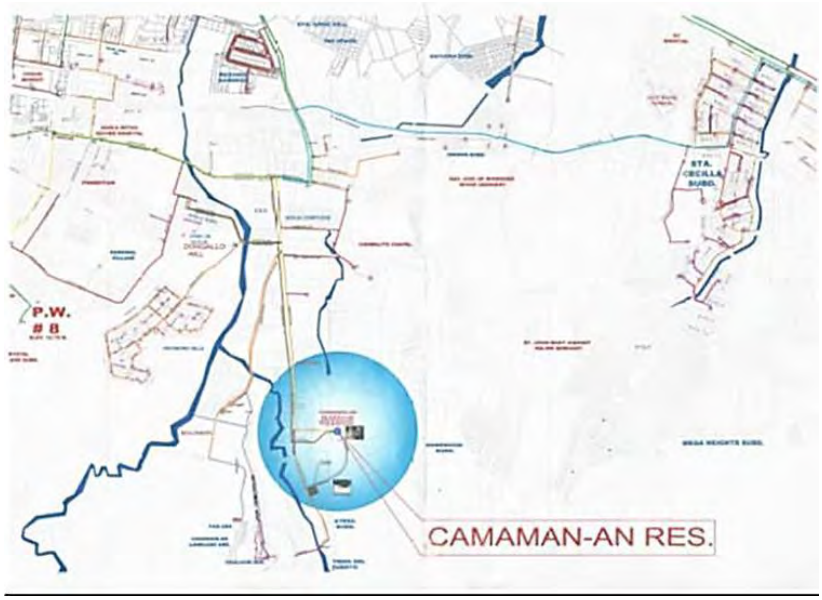
COWD plans to replace its booster pumps using RVAT with variable frequency drives. Pumps are also planned to be replaced from vertical turbine pumps to submersible pumps. With a pumping cost of P1.40 per cubic meter, COWD plans to utilize energy-efficient equipment and practices. In the future, COWD will also venture on SCADA operations and automation.

Map of COWD Eastern Area Production Wells



Map of COWD Central Area Production Wells

Map of COWD Central Area – Camaman-an Production Wells



COWD had identified various issues that Maynilad could assist them with but given the limited period of the WOP, the parties agreed to focus their efforts at buidling COWD's capacities in hydraulic modeling and pressure management, meter management, and GIS.

3.2 WOP Objectives

During the diagnostic visit, the parties agreed on the following WOP objectives:

- Equip COWD with the basic knowledge on hydraulic modeling and analysis that will be applied to a pilot area using EPANET
- Assist COWD in the implementation of a Pressure Management Program in the selected pilot area
- Provide COWD with a roadmap for the implementation of a GIS

Baranggay Camaman-an was jointly selected by the parties as the pilot area for the WOP activities because the area was experiencing intermittent supply despite its proximity to four (4) water sources that supplies the area: 1) production well #1 in Macasandig which is 5 kilometers away, 2) production well # 23 in Agusan which is 13 kilometers away, 3) production well well # 20 in Bugo which is 14 kilometers away, and 4) production well # 10 in Calaanan which is 10 kilometers away. COWD wanted to understand the situation in the area as Baranggay Camaman-an which has 1,593 households, has water service at only four (4) hours per day.

3.3 Work Plan

With the support of WaterLinks, both partners developed and implemented a joint 12-month work plan that provided the basis for the WOP activities. These included executive and technical workshops, and the sharing of innovation/knowledge from Maynilad to COWD through remote and on-line consultations, classroom discussions, on-the-job training, study visits, and peer review of existing model, plans and activities. Below is the agreed joint work plan.

WORK PLAN

WaterLinks Twinning Partnership Maynilad (through Maynilad Academy) and COWD														
Activities	Action	2014								2015				
		May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Preparatory Activities for Hydraulic Modeling														
Initial data gathering	Submission of required data													
	Assessment of COWD's existing data													
	Inventory of hydraulic modeling requirements													
Training module	Overview on basics of hydraulic modeling and pressure management													
	Actual hydraulic model creation													
	Data analysis on created model and model calibration													
Creation of a Hydraulic Model														
Model Creation	Application of training knowledge on actual COWD data													
	Analysis and Checking of Created Model													
	Model Calibration (if applicable)													
Training	Onsite refresher training on Basic Hydraulics and EPANET													
Pressure Management														
Pilot Area Selection	Determination of pilot area with Maynilad providing COWD with technical guidance													
Improvement of the Hydraulic Model	Detailed activities that will be done is based on the recommendations that will arise from the created hydraulic model for the area													
GIS Roadmap														
Training	General requirements in having a GIS													
Final Assessment														
Workshop	Discussion on the outcome of the pilot hydraulic model creation and pressure management													
	Sharing of lessons learned													
	Further recommendations on possible replication and scale-up													
Visits														
Maynilad Academy visits to COWD (Diagnostics, Training and Monitoring)	Conduct rapid assessment on COWD system; provide training; check on progress and advise on improvements.													
COWD Visit to Maynilad Academy	Overview on hydraulic modeling, training and hands-on exercises on hydraulic modeling and calibration, site visits to observe technologies and good practices													
Reporting and Monitoring														
Twinning Progress Reporting by COWD to WaterLinks and Maynilad Academy	Prepare One-Page Monthly Reports													
Twinning Reporting by Maynilad Academy	Prepare diagnostic and brief trip reports.													

4. WOP IMPLEMENTATION

During the WOP period from May 2014 to May 2015, four (4) mentor visits were made by Maynilad to COWD while the recipient visited the mentor's facilities once.

4.1 TRAINING ON HYDRAULIC MODELING

After the diagnostic visit and the signing of MOU, a training on hydraulic modeling and pressure management was conducted by Maynilad at its office in Aroceros, Manila on 21-25 July, 2014. Topics covered by this training were the basic principles of hydraulic modeling, data logging and requirements for implementation of a GIS, as well as a hands-on exercise on the configuration of a hydraulic model by COWD participants.

At the end of the week-long training, COWD was tasked to log the pressure and flow of water from four of its sources, the inlet entering Baranggay Camaman-an, and five (5) points inside Camaman-an with varying elevations, over a period of at least three (3) consecutive days. Information gathered from this exercise was then incorporated in the hydraulic model being created.

Training in Maynilad Arroceros Office

7 COWD Trained for Hydraulic Modeling with Maynilad Water Academy and WaterLinks

4.2 CREATING A HDYDRAULIC MODEL

On 3-6 November 2014, Maynilad visited COWD to review the progress of the data gathering exercise previously agreed. An on-site inspection in the proposed pilot area, Barangay Camaman-an was also carried out.

During this visit, the hydraulic model of Camaman-an (figure 1) was calibrated with the flow and pressure data gathered by COWD personnel. Based on the initial assessment of the model, it was determined that the area is not being sufficiently supplied with water (figure 2), particularly the areas with high elevation due to the low pressure recorded from the supply entry point. It was agreed that on the next mentor visit, a new model will be created to replicate the network system of the East Area of COWD. This will help determine the primary source of water into the area, the level of pressure, as well as the reasons for the insufficiency of water coming from the four (4) sources that supplies barangay Camaman-an.

Figure 1: Hydraulic Model of Barangay Camaman-an

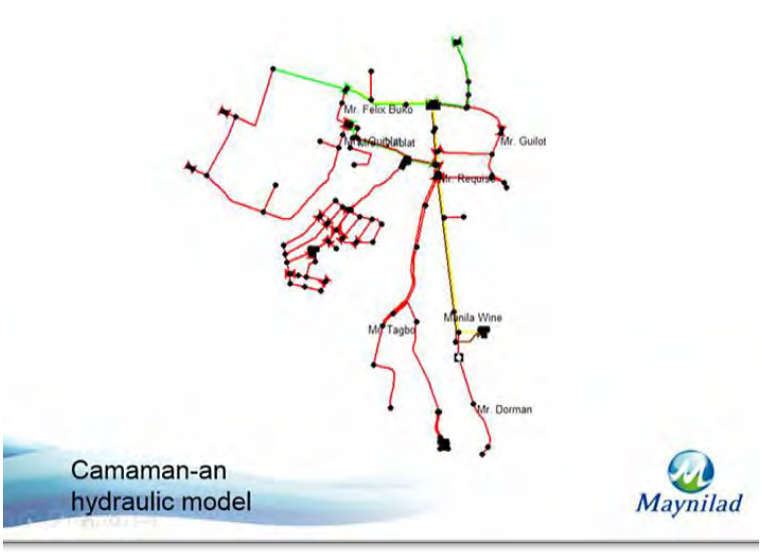
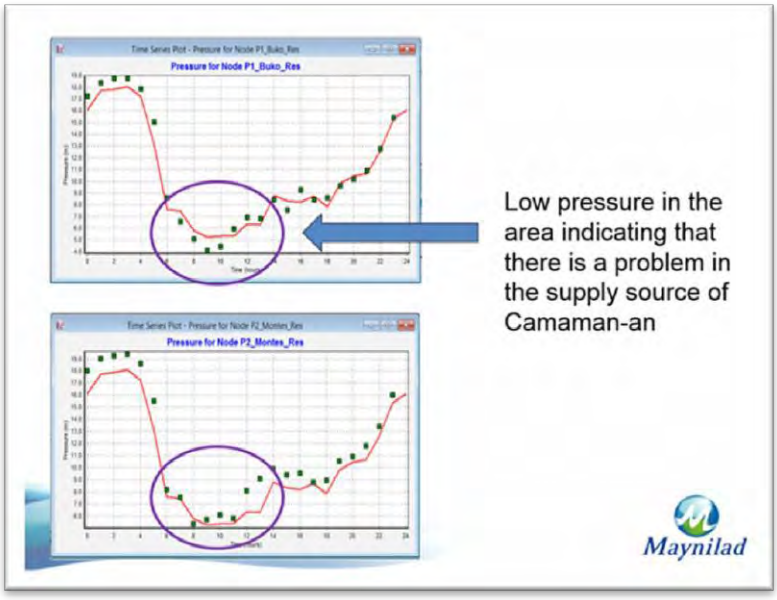


Figure 2:



During the second mentor visit on 3-6 March 2015, Maynilad reviewed the new hydraulic model created for the East Area of COWD (figure 4). This was then partially calibrated with some modifications in the process of data input. However, it was observed that the output of the hydraulic model is limited due to the lack of information on how COWD operates the distribution system i.e. settings of valves, additional new service connections tapped on the mainlines, measurement of flow of pressure coming from Bugo production well is not representative since a throttled valve is placed after the logger. There is also the possibility that the area is not receiving ample water supply due to water losses either in the forms of physical loss i.e. leaks; or commercial losses i.e. theft, or both, which must be investigated.

Previously, COWD believed that Baranggay Camaman-an should be sufficiently supplied since there are four (4) contributory sources to the area. Based on the hydraulic model however, only the Macasandig production well is supplying it. It was also shown that when the other sources shut-down or lowers its production, Macasandig supplements the service area of the other production wells which significantly reduces the supply and pressure reaching Camaman-an. Hence, the intermittent supply in Baranggay Camaman-an.

Figure 4

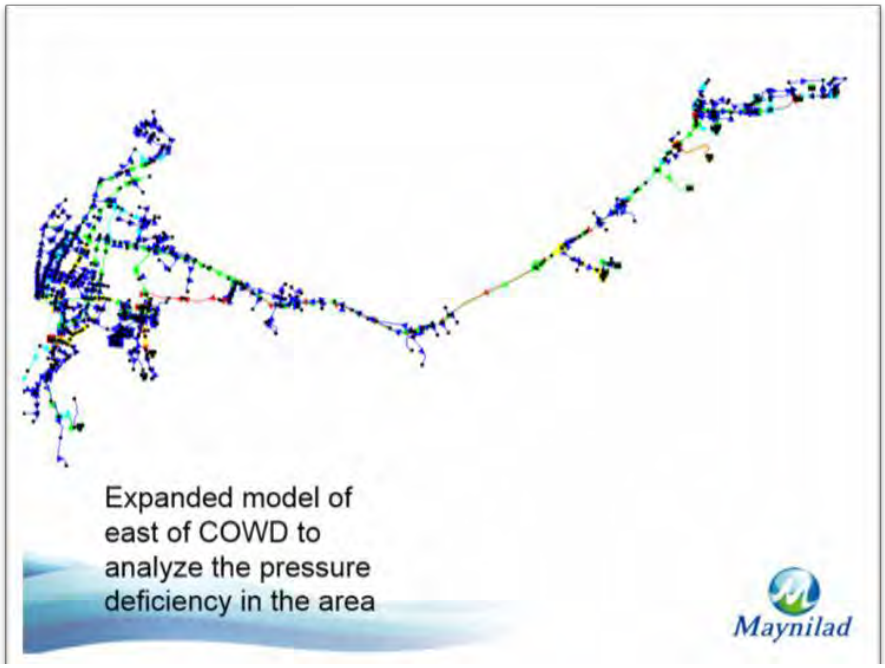
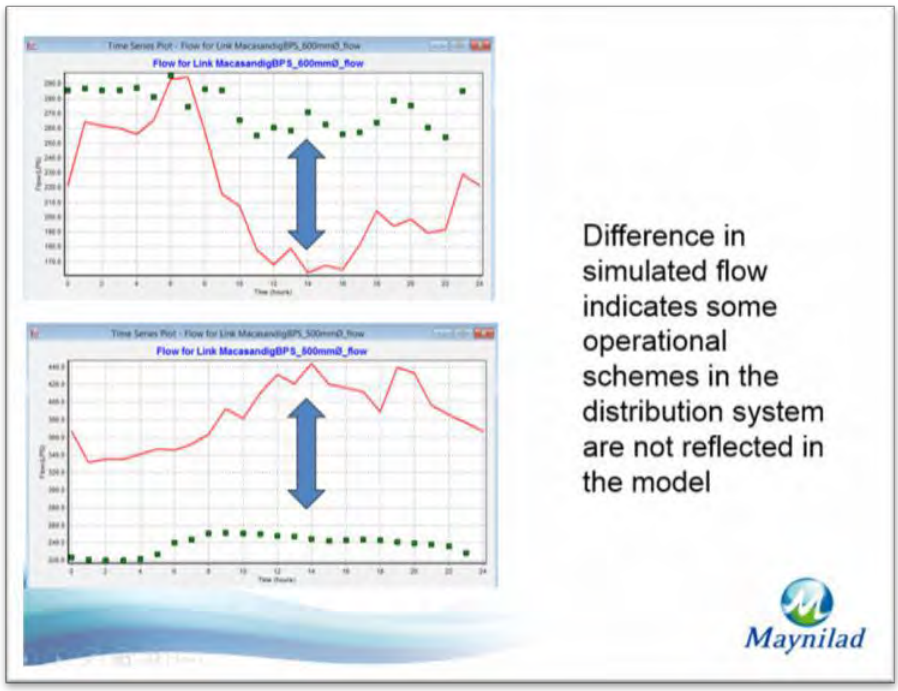


Figure 5



To bring the WOP to a close, a final technical visit was conducted by the mentor on 19-22 May 2015 to validate the hydraulic model of Barangay Camaman-an. During the visit, Maynilad assisted COWD in further calibrating the hydraulic models for both sites: Camaman-an and the simplified model of the East Area.

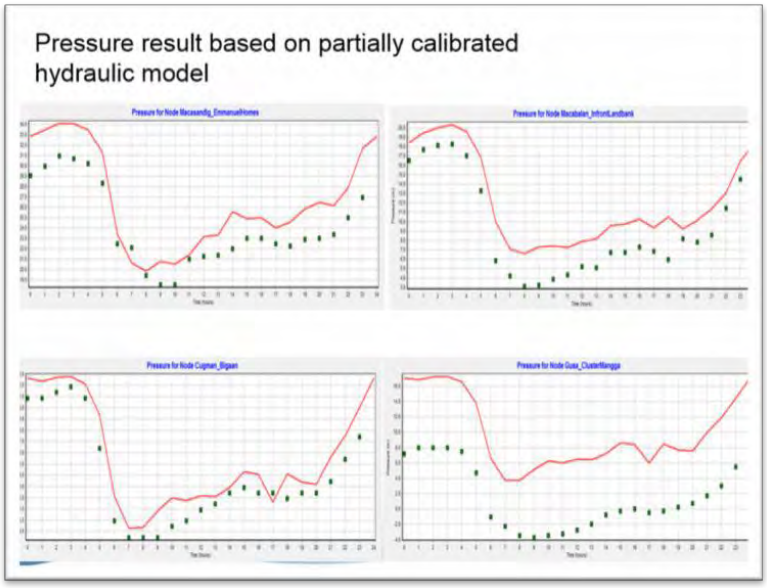
Maynilad also performed a pressure survey starting from Baranggay Camaman-an to Macasandig booster station, the water pumping station that supplies the Baranggay. COWD and Maynilad also discussed schemes to improve the existing network operations supplying Camaman-an to increase the supply hours in the area.

Pressure Survey

While, the addition of pressure point measurements along the sources going to Camaman-an contributed to the accurate calibration of the hydraulic model, it was observed that some operational schemes were not reflected in the model making it difficult to fully calibrate it. Moreover, the database of appurtenances was not completed by COWD which is essential in calibrating the model i.e. valve settings, by-passes. To complete the full calibration of the model, COWD has to continue implementing the recommendations of Maynilad particularly, isolating the hydraulic boundaries of each source, developing a database of appurtenances, etc.

Maynilad further recommends the use of a standardized unit of measurement for pressure (meters, psi, cu.m. per hour) for easier analysis of data.

Figure 6



Finally, should Camaman-an reservoir be utilized in the future, its structural integrity needs to be evaluated and retrofitting from the inside should be considered to address leakages.

4.3 GEOGRAPHIC INFORMATION SYSTEM (GIS)

COWD is determined to make use of a GIS to improve operational efficiency. A GIS enables a water utility to integrate a broad collection of information allowing it to better understand the situation in the distribution network in terms of supply, pressure, water losses, etc.

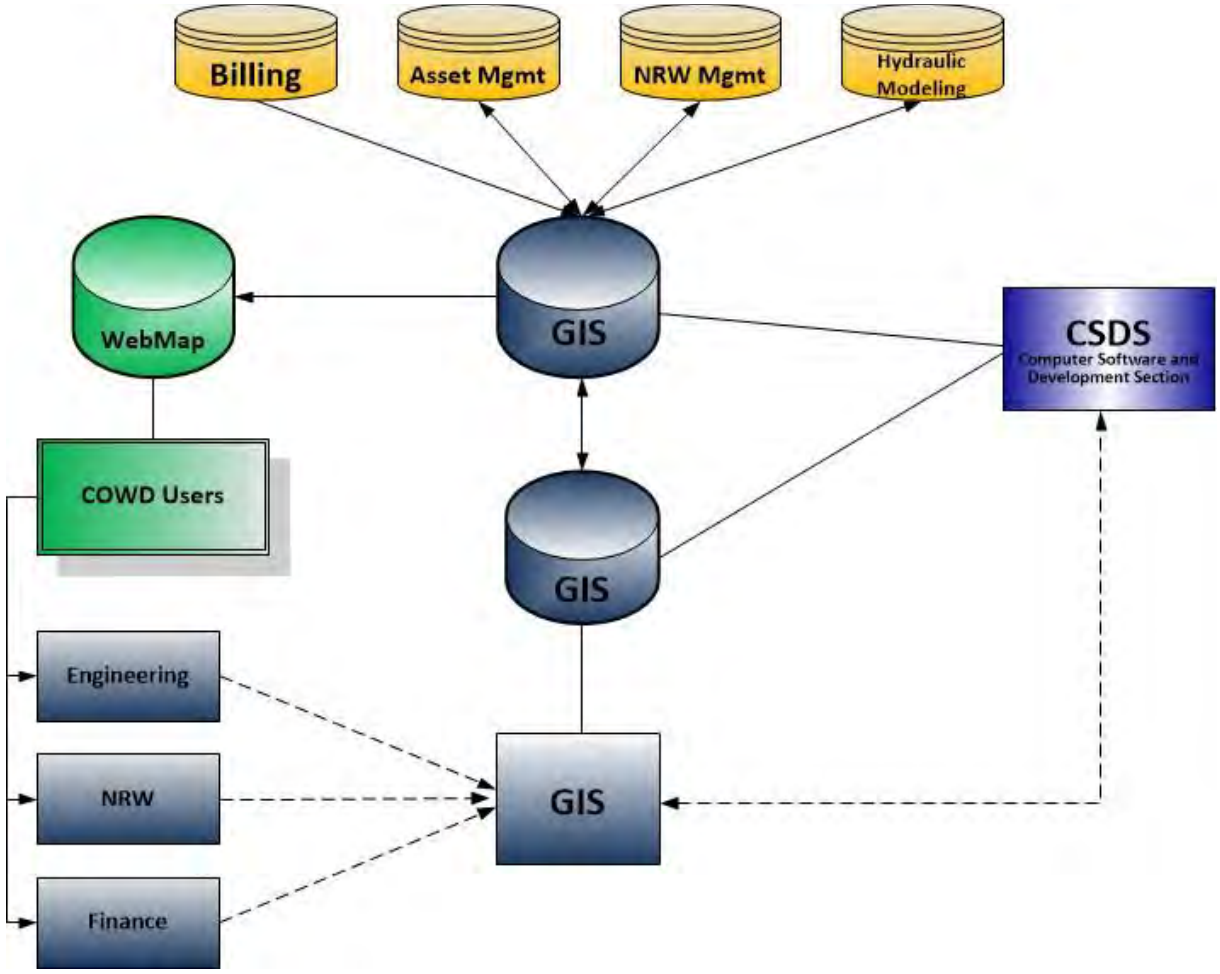
Maynilad observed that COWD does not keep good records of its assets and data in general resulting in conflicts between the inventory of assets and what is actually exisitng in the field. Specifically, the:

- AutoCAD Map used is not projected in any coordinate system.
- AutoCAD Map used is possibly scaled with minor offsets
- AutoCAD Map have multiple layered objects
- Asset Inventory being conducted by the Finance Department is meeting some challenges, due to conflicting data of AutoCAD Map and actual assets
- Asset Inventory includes a database of installed assets but the same is not up to date. Nonetheless it can be used as a data source for the attributes of assets
- As-built drawings were not properly kept and stored, and some are damaged or lost through mishandling.
- Databases for existing as-built drawings is also not available.

Maynilad recommends that COWD organise its data better as this is the backbone of an effective GIS. It needs to begin with a central repository of data within COWD and devise a strong mechanism for good coordination among the different operational departments to ensure that the regular capture of data is made and updated. At the moment, maps are being shared throughout the organisation that may result in possible duplication, and consequently leading to further confusion on what was actually installed in the field. Finally, COWD needs to develop and agree on standards for creating its as-built drawings and digitization of the same.

Maynilad further recommends the use of the guide below in the implementation of its GIS:

Figure 3



Specifically, before implementing a GIS, COWD must first do the following:

- Take account of all as-built drawings and create a database system for easier access and storage.
- In the preparation of Maps- CAD, COWD must:
  - properly layer objects and if possible project it in a coordinate system
  - verify data on map for future reference
  - identify the most updated map and keep it as the single source
  - do not duplicate maps
- Update asset inventory
- Create standards for as-built drawings
- Prepare Operational Procedures to capture changes in the field
- Design a system architecture to deliver the most efficient solution to address the implementation of GIS
- Update customer information in the billing system and verify the same before uploading to the GIS

Overall, COWD is in need of more capacity building in the use of GIS. Given the current situation however, it must seriously consider outsourcing the development of the GIS as this task will be too big for COWD to handle alone. Through outsourcing, the capacities of COWD personnel will also be development in the process.

4.4 METER MANAGEMENT

Water meters are the cash register of any water company and should be handled with utmost care. Improper management will result to inaccurate data and consequently, loss of revenue to the company. During the visit, Maynilad assessed COWD's meter management practices from production to distribution. The mentor was only able to visit four (4) production meters due to the unavailability of COWD staff.

In respect of production, COWD uses four (4) full bore electromagnetic flow (EMF) meters for measuring water produced. All EMF meters assessed are made by Siemens with model # MAG6000/5000. Data loggers are attached to the converter to record the flow rate on each meter. Maynilad observed that one (1) out of four (4) meters has shown a coil excitation alarm which has not been resolved since the supplier advised the COWD engineers that it was not a problem. Maynilad recommends however, that this alarm be addressed sufficiently by the supplier. It was further observed that one of the meters is not on its standard manufacturing settings. The maximum flowrate setting is set to a lower value from the original flowrate setting of the flowmeter. As such, this wrong setting may already be creating errors.

COWD has a portable test bench which it uses for field verification of customer meters. It also has a stationary test bench. Further, Maynilad observes that COWD's stationary test bench does not have enough capacity to test a 15 mm meter to its maximum flowrate, thus it does not complete the accuracy curve of a 15 mm meter during testing. Accordingly, COWD reported that meters in residential areas are not tested for overload flow or max flowrate capacity.

COWD also does not keep a database of results collected from these meter tests which could be used as a tool in choosing more effective water meters.

Finally, Maynilad observed that COWD's meter set assembly has a bypass pipe to supply water to the customer in case the meter will not work. It was recommended that COWD remove this bypass as it may entice the customer to illegally tap into the pipe.

After the visit, Maynilad recommends to conduct field meter assessment and audit by:

- Installation of loggers on large meters
- On-site meter testing and calibration periodically based on meter type, as follows:

Meter Type	Schedule of Testing
Production meter	100% of meters once a year
Distribution – Large meter (40mm and above)	100% of meters every five years
Distribution – small meter (below 40mm)	Random, every five years

It was further recommended that COWD develop a water meter management program starting with:

- Creating standard specifications for all meter types depending on its use and results of past data.
- Creating a preventive maintenance program for all meters i.e. recalibration or replacement over a period of time depending on its use
- Creating standard procedures for meter acceptance to minimize the purchase of low quality meters.
- Creating a database to gather and store meter laboratory results which can be used as a basis when choosing a good water meter.

5. CONCLUSIONS/ OUTPUT

At the end of the WOP, COWD learned the basics for creating a hydraulic model, piloted the lessons learned by developing a calibrated hydraulic model for the pilot site, Barangay Camaman-an, allowing it to better understand the behavior of the water system in the area, optimizing the current network and operations, and, provide better water services to the customers in the area. By isolating boundaries of each source using the hydraulic model, it was identified that the production well in Macasindag is the main supply source for Camaman-an and that its production is not enough during peak hours.

Moreover, having determined that the Macasandig well is the primary source, pressure management activities were implemented along the network i.e. installation of air release valves at locations where the pipeline has sudden change in elevations, constant pressure monitoring, exercise of valve settings; contributing to improved water services. Although a 24/7 water supply was not achieved in Barangay Camaman-an, there was an increase in the number of supply hours from four (4) to eight (8) hours a day.

6. SCALE-UP ACTIVITIES

The initial model of Barangay Camaman-an was extended to include the major pipes of the Eastern Area of COWD. This was essential to understand the behavior of the network that causes the intermittent water supply in the pilot area. With the hydraulic model, COWD can use the data as reference for their pressure management plans i.e analysis of production data (reservoir level, discharge pressure, flow) versus network pressures (entry point, critical high, critical low)

Moreover, with a better understanding of the value of a GIS in improving the efficiency of operations, COWD has tendered the implementation of its GIS to a third party supplier. The project will be partially funded by USAID and will begin in the third quarter of 2015.