CHAPTER 2 DEVELOPMENT OF PDM

PDM (Project Design Matrix) and PO (Plan of Operation) have been revised during the Project. Contents of the revisions of PDM are as shown in Table 2-1.

Table 2-1 Development of PDM and PO

PDM & PO	Version	Date	Approved at	Contents
PDM0 & PO0	Original Version	19th August 2010	Discussion on the Inception Report (IC/R)	PDM0 and PO0, which were prepared based on Record of Discussion (R/D) and Minutes of Meeting (M/M) signed on the 19th August 2010 between JICA and the Egyptian sides, were confirmed in the discussion on the Inception Report.
PDM1 & PO1	1st Revision	27th September 2011	1st JCC	Objectively Verifiable Indicators were determined, and PDM1 was approved together with PO1.
PDM2 & PO2	2nd Revision	26th November 2012	3rd JCC	Performance Indicators (PIs) were determined for model facilities and model areas. PDM2 was approved together with PO2.
PDM3 & PO3	3rd Revision	30th October 2013	4th JCC	Following were confirmed / approved: 1) Modification of Project Director and Project Manager were confirmed. 2) Period of the Project are extended until August 2014.
PO4	4th Revision	31st August 2014	7th Steering Committee	Following were approved: 1) Period of SOP and NRW activities for GHAPWASCO and MCWW are closed in the end of August 2014. 2) Period of WDM activities for SHAPWASCO are extended until April 2015.

Source: JICA expert team

PDM0 to PDM3 are shown in Table 2-2 to 2-5 respectively. PO is broken down to the implementation plans, which are shown in Figure 5-1 to 5-3 in Chapter 5.

Table 2-2 PDM0 (Original at the Discussion of Inception Report)

Draft Project Design Matrix (PDM_1)

Dated August 11, 2010

Project Name : The Project for Improvement of Management Capacity of Operation and Maintenance for Water Supply Facilities in Nile Delta Area Duration : FY2010-FY2013

Project Site : Sharkiya Governorate, Gharbia Governorate, Minufia Governorate (Nile Delta Area) Target Group : Staff of SHAPWASCO, GAPWASCO, MUPWASCO

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
【Super Goal】 Management capacity of operation and maintenance of water supply facilities is improved in Nile Delta Area	Performance Indicators (PIs) in the fields of management capacity of operation and maintenance are improved in Nile Delta Area	Quarterly Reports of all water supply companies in Nile Delta Area submitted to HCWW	
【Overall Goal】 Management capacity of operation and maintenance of water supply facilities is improved in Sharkiya, Gharbia and Minufia Governorates	PIs in the fields of management capacity of operation and maintenance are improved in Sharkiya, Gharbia and Minufia Governorates	Quarterly reports of SHAPWASCO, GAPWASCO and MUPWASCO	Central and local government budget for development of water supply facilities is allocated appropriately
【Project Purpose】 Management capacity of operation and maintenance of water supply facilities is improved at the model areas/facilities in Sharkiya, Gharbia and Minufia Governorates	PIs in the fields of management capacity of operation and maintenance are improved at the model areas/facilities	Quarterly reports of SHAPWASCO, GAPWASCO and MUPWASCO	Governmental policy on water supply sector does not change significantly.
【Output】 1) Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates is strengthened	a. More than ** members each of SOP/NRW teams in SHAPWASCO・GAPWASCO・MUPWASCO are certified as trainers by Steering Committee b. More than ** % of participants rates satisfaction and understanding of workshops more than ** on the 5-scale evaluation	a. Certification of Training b,c. Reports of workshops	Employees who received trainings by the Project will continuously work for SHAPWASCO, GAPWASCO and MUPWASCO Personnel transfer of executive management will not affect the implementation of the Project
2) Based on the experiences of SHAPWASCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates	a. More than ** % of SOP team members rates understanding of trainings more than ** on the 5-scale evaluation b. The model facilities are operated and maintained based on SOP	a, b. Project Progress Reports	
3) The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates	a. More than ** % of NRW teams members rates understanding of trainings more than ** on the 5-scale evaluation b. Water balance analysis is conducted properly for the 3 model areas c. ** % of detected leakage is repaired at the model area	a,b. c Project Progress Report	
4) The water distribution management capacity is improved in Sharkiya Governorate as an advanced model	Water distribution is managed based on SOP at the model areas	Project Progress Reports	
0) The project is managed and coordinated properly	a. Agreement on the cooperation among SHAPWASCO・GAPWASCO・MUPWASCO is prepared b. Project activities are regularly monitored based on PO/APO	a. Agreement Document b. Project Progress Reports	

Source: JICA expert team

Activities	Inputs	Important Assumption
1-1 Conduct management training for the top management 1-2 Conduct Training of Trainers (TOT) for developing SOP 1-3 Conduct TOT for NRW reduction 1-4 Disseminate the contents, the manners and the results of the collaboration among SHAPWASCO, GAPWASCO and MUPWASCO to the water supply companies in Nile Delta Area through reports and workshops 2-1 Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates 2-2 Select 3 model facilities in Gharbia and Minufia Governorates each 2-3 Organize SOP teams 2-4 Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate 2-5 Revise SOPs of Sharkiya Governorate, if necessary 2-6 Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO 2-7 Conduct On-the-Job Training for GAPWASCO and MUPWASCO to apply SOPs in operation and maintenance 2-8 Monitor the progress of SOP activities 2-9 Draft the policy/plan for disseminating SOP to the other Marakazes 3-1 Analyze the current situation on NRW in Gharbia and Minufia Governorates 3-2 Select 3 model areas for NRW reduction in Gharbia and Minufia Governorates each 3-3 Organize NRW reduction teams 3-4 Formulate an action plan for NRW reduction activities based on the action plan for SHAPWASCO 3-5 Conduct training at Mostrod Training Center 3-6 Conduct training at the training yard in Sharkiya Governorate 3-7 Conduct training at model areas for water distribution management in Sharkiya Governorate 3-8 Prepare GIS drawing for model areas in Gharbia and Minufia Governorates 3-9 Make water balance analysis at model areas 3-10 Conduct leakage detection survey at model areas 3-11 Make water balance analysis after repair works 3-12 Draft policy/plan for disseminating NRW reduction activities to the other Marakazes 4-1 Discuss methods and conduct survey for water distribution management 4-2 Conduct training for water distribution management 4-3 Formulate a plan for water distribution management 4-4 Install the equipment for water distribution management at the model area 4-5 Operate the system 4-6 Develop SOP for water distribution management 4-7 Evaluate the operation and SOP for water distribution management 0-1 Establish Steering Committee, consisting of representative of HCWW, SHAPWASCO, GAPWASCO and MUPWASCO 0-2 Discuss the contents, the manners for the cooperation among SHAPWASCO, GAPWASCO and MUPWASCO through the Steering Committee 0-3 Organize JCC at least once a year 0-4 Finalize the Indicators of the Project Design Matrix (PDM) for approval of the first Joint Coordinating Committee (JCC) 0-5 Prepare a draft Annual Plan of Operations (APO) based on the Plan of Operations (PO) for approval of the first JCC 0-6 Monitor the progress of PO/APO and achievement of the Indicators of the PDM	**Japanese side** 1) Japanese Experts • Chief advisor/water supply planning • NRW reduction management • Leakage detection • Water treatment • Water quality • Electrical equipment • Mechanical equipment • Distribution network • Others (if necessary) 2) Local Experts 3) Equipment 4) Training in Japan 5) Local Cost **Egyptian Side** 1) Counterpart Personnel • Project Director : Chairman, HCWW • Project Manager : Chairman, SHAPWASCO • Co-Project Manager : Chairman, GAPWASCO Chairman, MUPWASCO • NRW Team • SOP Team 2) Office space and facilities for experts 3) Equipment 4) Necessary Information 5) Local Cost	**【Pre-condition】** Budget for HRD is allocated properly to SHAPWASCO, GAPWASCO and MUPWASCO by HCWW

Source: JICA expert team

Table 2-3 PDM1 (1st Revision)

Project Design Matrix (PDM1)

Dated September 27,2011

Project Name : The Project for Improvement of Management Capacity of Operation and Maintenance for Water Supply Facilities in Nile Delta Area

Duration : FY2011-FY2013

Project Site : Sharkiya Governorate, Gharbia Governorate, Minufia Governorate (Nile Delta Area)

Target Group : Staff of SHAPWASCO, GHAPWASCO, MCWW

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
【Super Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Nile Delta Area**	Performance Indicators (PIs) in the fields of management capacity of operation and maintenance are improved in Nile Delta Area	Quarterly Reports of all water supply companies in Nile Delta Area submitted to HCWW	
【Overall Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Sharkiya, Gharbia and Minufia Governorates**	PIs in the fields of management capacity of operation and maintenance are improved in Sharkiya, Gharbia, and Minufia Governorates	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	Central and local government budget for development of water supply facilities is allocated appropriately
【Project Purpose】 **Management capacity of operation and maintenance of water supply facilities is improved at the model areas/facilities in Sharkiya, Gharbia and Minufia Governorates**	PIs in the fields of management capacity of operation and maintenance are improved at the model areas/facilities	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	Governmental policy on water supply sector does not change significantly
【Output】 **1) Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates in strengthened**	a. More than 3 members each of SOP/NRW teams in SHAPWASCO・GHAPWASCO・MCWW are approved as trainers by Steering Committee b. More than 20 times of seminars/workshops are organized under inter-company cooperation by the Project team	a. Certification of Training b. Reports of workshops	Employees who received trainings by the Project will continuously work for SHAPWASCO, GHAPWASCO, MCWW Personnel transfer of executive management will not affect the implementation of the Project
2) Based on the experiences of SHAPWSCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates	a. More than 80% of SOP team members rates understanding of trainings more than 3 on the 5-scale evaluation b. The model facilities are operated and maintained based on SOP c. Improvement of PIs for the model facilities are evaluated based on SOP	a, b, c. Project Progress Reports	
3) The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates	a. More than 80% of NRW teams members rates understanding of trainings more than 3 on the 5-scale evaluation b. Water balance analysis is conducted properly for the 3 model areas c. 100% of detected leakage is repaired at the model area	a, b, c. Project Progress Reports	
4) The water distribution management capacity is improved in Sharkiya Governorate as an advanced model	a. Water distribution is managed based on SOP at the model areas b. Issues on water distribution capacity are reported to top management of SHAPWASCO	a, b. Project Progress Reports	
0) The project is managed and coordinated properly	a. Agreement on the coordination among SHAPWASCO・GHAPWASCO・MCWW is prepared b. Project activities are regularly monitored based on PO/APO	a. Agreement Document b. Project Progress Reports	

Source: JICA expert team

No.	Activities	Inputs	Important Assumption
1-1	Conduct management training for the top management	**Japanese side** 1) Japanese Experts ・Chief advisor/water supply planning ・NRW reduction management ・Leakage detection ・Water Treatment ・Water quality ・Electrical equipment ・Mechanical equipment ・Distribution network ・Others (if necessary) 2) Local Expert 3) Equipment 4) Training in Japan 5) Local Cost **Egyptian side** 1) Counterpart Personnel ・Project Director: Chairman, HCWW ・Project Manager: Chairman, SHAPWASCO ・Co-Project Manager: Chairman, GHAPWASCO Chairman, MCWW ・SOP Team ・NRW Team 2) Office space and facilities for the experts 3) Equipment 4) Necessary Information 5) Local Cost	Budget for the Project is allocated as planed by HCWW, SHAPWASCO, GHAPWASCO, and MCWW **【Pre-condition】** Budget for HRD is allocated properly to SHAPWASCO, GHAPWASCO and MCWW by HCWW
1-2	Conduct Training of Trainers (TOT) for developing SOP		
1-3	Conduct TOT for NRW reduction		
1-4	Disseminate the contents, the manners and the results of the collaboration among SHAPWASCO, GHAPWASCO and MCWW to the water supply companies in Nile Delta Area through reports and workshops		
2-1	Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates		
2-2	Select 3 model facilities in Gharbia and Minufia Governorates each		
2-3	Organize SOP teams		
2-4	Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate		
2-5	Revise SOPs of Sharkiya Governorate, if necessary		
2-6	Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO		
2-7	Conduct On-the-Job Training for GHAPWASCO and MCWW to apply SOPs in operation and maintenance		
2-8	Monitor the progress of SOP activities		
2-9	Draft the policy/plan for disseminating SOP to the other Marakazes		
3-1	Analyze the current situation on NRW in Gharbia and Minufia Governorates		
3-2	Select 3 model areas for NRW reduction in Gharbia and Minufia Governorates each		
3-3	Organize NRW reduction teams		
3-4	Formulate an action plan for NRW reduction activities based on the action plan for SHAPWASCO		
3-5	Conduct training on general practice of NRW reduction		
3-6	Conduct training at the training yard in Sharkiya Governorate		
3-7	Conduct training at model areas for water distribution management in Sharkiya Governorate		
3-8	Prepare GIS drawing for model areas in Gharbia and Minufia Governorates		
3-9	Make water balance analysis at model areas		
3-10	Conduct leakage detection survey at model areas		
3-11	Make water balance analysis after repair works		
3-12	Draft policy/plan for disseminating NRW reduction activities to the other Marakazes		
4-1	Discuss methods and conduct survey for water distribution management		
4-2	Conduct training for water distribution management		
4-3	Formulate a plan for water distribution management		
4-4	Install the equipment for water distribution management at the model area		
4-5	Operate the system		
4-6	Develop SOP for water distribution management		
4-7	Evaluate the operation and SOP for water distribution management		
0-1	Establish Steering Committee, consisting of representative of HCWW, SHAPWASCO, GHAPWASCO and MCWW		
0-2	Discuss the contents, the manners for the cooperation among SHAPWASCO, GHAPWASCO and MCWW through the Steering Committee		
0-3	Organize JCC at least once a year		
0-4	Finalize the Indicators of the Project Design Matrix (PDM) for approval of the first Joint Coordination Committee (JCC)		
0-5	Prepare a draft Annual Plan of Operations (APO) based on the Plan of Operations (PO) for approval of the first JCC		
0-6	Monitor the progress of PO/APO and achievement of the Indicators of the PDM		

Source: JICA expert team

Table 2-4 PDM2 (2nd Revision)

Project Design Matrix (PDM2)

Dated November 26, 2012

Project Name : The Project for Improvement of Management Capacity of Operation and Maintenance for Water Supply Facilities in Nile Delta Area
Duration : FY2011-FY2013

Project Site : Sharkiya Governorate, Gharbia Governorate, Minufia Governorate (Nile Delta Area)
Target Group : Staff of SHAPWASCO, GHAPWASCO, MCWW

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
【Super Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Nile Delta Area**	Performance Indicators (PIs) in the fields of management capacity of operation and maintenance are improved in Nile Delta Area	Quarterly Reports of all water supply companies in Nile Delta Area submitted to HCWW	
【Overall Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Sharkiya, Gharbia and Minufia Governorates**	PIs in the fields of management capacity of operation and maintenance are improved in Sharkiya, Gharbia, and Minufia Governorates	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	Central and local government budget for development of water supply facilities is allocated appropriately
【Project Purpose】 **Management capacity of operation and maintenance of water supply facilities is improved at the model areas/facilities in Sharkiya, Gharbia and Minufia Governorates**	PIs (*1) in the fields of management capacity of operation and maintenance are improved at the model areas/facilities	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	~~Governmental policy on water supply sector does not change significantly.~~
【Output】 **1) Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates in strengthened**	a. More than 3 members each of SOP/NRW teams in SHAPWASCO・GHAPWASCO・MCWW are approved as trainers by Steering Committee b. More than 20 times of seminars/workshops are organized under inter-company cooperation by the Project team	a. Certification of Training b. Reports of workshops	Employees who received trainings by the Project will continuously work for SHAPWASCO, GHAPWASCO, MCWW Personnel transfer of executive management will not affect the implementation of the Project
2) Based on the experiences of SHAPWSCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates	a. More than 80% of SOP team members rates understanding of trainings more than 3 on the 5-scale evaluation b. The model facilities are operated and maintained based on SOP c. Improvement of PIs (*1) for the model facilities are evaluated based on SOP	a, b, c. Project Progress Reports	
3) The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates	a. More than 80% of NRW teams members rates understanding of trainings more than 3 on the 5-scale evaluation b. Water balance analysis is conducted properly for the 3 model areas c. 100% of detected leakage is repaired at the model area	a, b, c. Project Progress Reports	
4) The water distribution management capacity is improved in Sharkiya Governorate as an advanced model	a. Water distribution is managed based on SOP at the model areas b. Issues on water distribution capacity are reported to top management of SHAPWASCO	a, b. Project Progress Reports	
0) The project is managed and coordinated properly	a. Agreement on the coordination among SHAPWASCO・GHAPWASCO・MCWW is prepared b. Project activities are regularly monitored based on PO/APO	a. Agreement Document b. Project Progress Reports	

*1 PIs
SOP: a. Energy consumption per m^3 of water production (kWh/m^3) b. Unit consumption of alum sulfate/ chlorine / potassium permanganate used per m^3 of water production (g/m^3)
c. Ratio of effective utilization of raw water (%)
NRW: a. NRW ratio (%) b. Reduction ratio of NRW (%)
WDM: a. Number of complaints per 1000 connections on water suspension and low pressure b. Ratio of low service pressure (%)

Source: JICA expert team

Activities	Inputs	Important Assumption
1-1 Conduct management training for the top management 1-2 Conduct Training of Trainers (TOT) for developing SOP 1-3 Conduct TOT for NRW reduction 1-4 Disseminate the contents, the manners and the results of the collaboration among SHAPWASCO, GHAPWASCO and MCWW to the water supply companies in Nile Delta Area through reports and workshops	**Japanese side** 1) Japanese Experts ・Chief advisor/water supply planning ・NRW reduction management ・Leakage detection ・Water Treatment ・Water quality ・Electrical equipment ・Mechanical equipment ・Distribution network ・Others (if necessary) 2) Local Expert 3) Equipment 4) Training in Japan 5) Local Cost **Egyptian side** 1) Counterpart Personnel ・Project Director: Chairman, HCWW ・Project Manager: Chairman, SHAPWASCO ・Co-Project Manager: Chairman, GHAPWASCO Chairman, MCWW ・SOP Team ・NRW Team 2) Office space and facilities for the experts 3) Equipment 4) Necessary Information 5) Local Cost	Budget for the Project is allocated as planed by HCWW, SHAPWASCO, GHAPWASCO, and MCWW 【Pre-condition】 Budget for HRD is allocated properly to SHAPWASCO, GHAPWASCO and MCWW by HCWW
2-1 Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates 2-2 Select 3 model facilities in Gharbia and Minufia Governorates each 2-3 Organize SOP teams 2-4 Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate 2-5 Revise SOPs of Sharkiya Governorate, if necessary 2-6 Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO 2-7 Conduct On-the-Job Training for GHAPWASCO and MCWW to apply SOPs in operation and maintenance 2-8 Monitor the progress of SOP activities 2-9 Draft the policy/plan for disseminating SOP to the other Marakazes		
3-1 Analyze the current situation on NRW in Gharbia and Minufia Governorates 3-2 Select 3 model areas for NRW reduction in Gharbia and Minufia Governorates each 3-3 Organize NRW reduction teams 3-4 Formulate an action plan for NRW reduction activities based on the action plan for SHAPWASCO 3-5 Conduct training on general practice of NRW reduction 3-6 Conduct training at the training yard in Sharkiya Governorate 3-7 Conduct training at model areas for water distribution management in Sharkiya Governorate 3-8 Prepare GIS drawing for model areas in Gharbia and Minufia Governorates 3-9 Make water balance analysis at model areas 3-10 Conduct leakage detection survey at model areas 3-11 Make water balance analysis after repair works 3-12 Draft policy/plan for disseminating NRW reduction activities to the other Marakazes		
4-1 Discuss methods and conduct survey for water distribution management 4-2 Conduct training for water distribution management 4-3 Formulate a plan for water distribution management 4-4 Install the equipment for water distribution management at the model area 4-5 Operate the system 4-6 Develop SOP for water distribution management 4-7 Evaluate the operation and SOP for water distribution management		
0-1 Establish Steering Committee, consisting of representative of HCWW, SHAPWASCO, GHAPWASCO and MCWW 0-2 Discuss the contents, the manners for the cooperation among SHAPWASCO, GHAPWASCO and MCWW through the Steering Committee 0-3 Organize JCC at least once a year 0-4 Finalize the Indicators of the Project Design Matrix (PDM) for approval of the first Joint Coordination Committee (JCC) 0-5 Prepare a draft Annual Plan of Operations (APO) based on the Plan of Operations (PO) for approval of the first JCC 0-6 Monitor the progress of PO/APO and achievement of the Indicators of the PDM		

Source: JICA expert team

Table 2-5 PDM3 (3rd Revision)

Annex-2: Project Design Matrix (PDM3)

Dated October 30, 2013

Project Name : The Project for Improvement of Management Capacity of Operation and Maintenance for Water Supply Facilities in Nile Delta Area
Duration : FY2011-FY2014
Project Site : Sharkiya Governorate, Gharbia Governorate, Minufia Governorate (Nile Delta Area)
Target Group : Staff of SHAPWASCO, GHAPWASCO, MCWW

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
【Super Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Nile Delta Area**	Performance Indicators (PIs) in the fields of management capacity of operation and maintenance are improved in Nile Delta Area	Quarterly Reports of all water supply companies in Nile Delta Area submitted to HCWW	
【Overall Goal】 **Management capacity of operation and maintenance of water supply facilities is improved in Sharkiya, Gharbia and Minufia Governorates**	PIs in the fields of management capacity of operation and maintenance are improved in Sharkiya, Gharbia, and Minufia Governorates	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	Central and local government budget for development of water supply facilities is allocated appropriately
【Project Purpose】 **Management capacity of operation and maintenance of water supply facilities is improved at the model areas/facilities in Sharkiya, Gharbia and Minufia Governorates**	PIs (*1) in the fields of management capacity of operation and maintenance are improved at the model areas/facilities	Quarterly reports of SHAPWASCO, GHAPWASCO, MCWW	
【Output】 **1) Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates in strengthened**	a. More than 3 members each of SOP/NRW teams in SHAPWASCO・GHAPWASCO・MCWW are approved as trainers by Steering Committee b. More than 20 times of seminars/workshops are organized under inter-company cooperation by the Project team	a. Certification of Training b. Reports of workshops	Employees who received trainings by the Project will continuously work for SHAPWASCO, GHAPWASCO, MCWW Personnel transfer of executive management will not affect the implementation of the Project
2) Based on the experiences of SHAPWSCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates	a. More than 80% of SOP team members rates understanding of trainings more than 3 on the 5-scale evaluation b. The model facilities are operated and maintained based on SOP c. Improvement of PIs for the model facilities are evaluated based on SOP	a, b, c. Project Progress Reports	
3) The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates	a. More than 80% of NRW teams members rates understanding of trainings more than 3 on the 5-scale evaluation b. Water balance analysis is conducted properly for the 3 model areas c. 100% of detected leakage is repaired at the model area	a, b, c. Project Progress Reports	
4) The water distribution management capacity is improved in Sharkiya Governorate as an advanced model	a. Water distribution is managed based on SOP at the model areas b. Issues on water distribution capacity are reported to top management of SHAPWASCO	a, b. Project Progress Reports	
0) The project is managed and coordinated properly	a. Agreement on the coordination among SHAPWASCO・GHAPWASCO・MCWW is prepared b. Project activities are regularly monitored based on PO/APO	a. Agreement Document b. Project Progress Reports	

*1 PIs
SOP: a. Energy consumption per m^3 of water production (kWh/m^3) b. Amount of alum sulfate/ chlorine / potassium permanganate used per m^3 of water production (g/m^3)
c. Ratio of effective utilization of raw water (%)
NRW: a. NRW ratio (%) b. Reduction ratio of NRW (%)
WDM: a. Number of complaints per 1000 connections on water suspension and low pressure b. Ratio of inappropriate pressure of water distribution (%) c. Ratio of public opinion mentioning enough pressure (%)

Source: JICA expert team

Activities		Inputs	Important Assumption
1-1	Conduct management training for the top management	**Japanese side** 1) Japanese Experts ・ Chief advisor/water supply planning ・ NRW reduction management ・ Leakage detection ・ Water Treatment ・ Water quality ・ Electrical equipment ・ Mechanical equipment ・ Distribution network ・ Others (if necessary) 2) Local Expert 3) Equipment 4) Training in Japan 5) Local Cost **Egyptian side** 1) Counterpart Personnel ・ Project Director: Chairman, HCWW ・ Project Manager: Vice Chairman, HCWW ・ Co-Project Manager: Chairman, SHAPWASCO Chairman, GHAPWASCO Chairman, MCWW ・ SOP Team ・ NRW Team 2) Office space and facilities for the experts 3) Equipment 4) Necessary Information 5) Local Cost	
1-2	Conduct Training of Trainers (TOT) for developing SOP		
1-3	Conduct TOT for NRW reduction		
1-4	Disseminate the contents, the manners and the results of the collaboration among SHAPWASCO, GHAPWASCO and MCWW to the water supply companies in Nile Delta Area through reports and workshops		
2-1	Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates		
2-2	Select 3 model facilities in Gharbia and Minufia Governorates each		
2-3	Organize SOP teams		
2-4	Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate		
2-5	Revise SOPs of Sharkiya Governorate, if necessary		
2-6	Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO		Budget for the Project is allocated as planed by HCWW, SHAPWASCO, GHAPWASCO, and MCWW
2-7	Conduct On-the-Job Training for GHAPWASCO and MCWW to apply SOPs in operation and maintenance		
2-8	Monitor the progress of SOP activities		
2-9	Draft the policy/plan for disseminating SOP to the other Marakazes		
3-1	Analyze the current situation on NRW in Gharbia and Minufia Governorates		
3-2	Select 3 model areas for NRW reduction in Gharbia and Minufia Governorates each		
3-3	Organize NRW reduction teams		
3-4	Formulate an action plan for NRW reduction activities based on the action plan for SHAPWASCO		
3-5	Conduct training on general practice of NRW reduction		
3-6	Conduct training at the training yard in Sharkiya Governorate		
3-7	Conduct training at model areas for water distribution management in Sharkiya Governorate		
3-8	Prepare GIS drawing for model areas in Gharbia and Minufia Governorates		
3-9	Make water balance analysis at model areas		
3-10	Conduct leakage detection survey at model areas		
3-11	Make water balance analysis after repair works		
3-12	Draft policy/plan for disseminating NRW reduction activities to the other Marakazes		
4-1	Discuss methods and conduct survey for water distribution management		【Pre-condition】 Budget for HRD is allocated properly to SHAPWASCO, GHAPWASCO and MCWW by HCWW
4-2	Conduct training for water distribution management		
4-3	Formulate a plan for water distribution management		
4-4	Install the equipment for water distribution management at the model area		
4-5	Operate the system		
4-6	Develop SOP for water distribution management		
4-7	Evaluate the operation and SOP for water distribution management		
0-1	Establish Steering Committee, consisting of representative of HCWW, SHAPWASCO, GHAPWASCO and MCWW		
0-2	Discuss the contents, the manners for the cooperation among SHAPWASCO, GHAPWASCO and MCWW through the Steering Committee		
0-3	Organize JCC at least once a year		
0-4	Finalize the Indicators of the Project Design Matrix (PDM) for approval of the first Joint Coordination Committee (JCC)		
0-5	Prepare a draft Annual Plan of Operations (APO) based on the Plan of Operations (PO) for approval of the first JCC		
0-6	Monitor the progress of PO/APO and achievement of the Indicators of the PDM		

Source: JICA expert team

CHAPTER 3 PROJECT ACHIEVEMENT

Achievements of the Project are shown in Table 3-1 and 3-2. They are summarized as follows:

3.1 Achievement for Super Goal

SHAPWASCO, GHAPWASCO and MCWW commenced dissemination activities of the Project experiences to the Nile Delta through seminars under facilitation of HCWW. GHAPWASCO conducted a workshop to share the information on leak detection with the other ACs in Egypt, in September - October 2014. MCWW has commenced contacts with Qalyubya Water and Wastewater Company for assistance of SOP and NRW reduction activities. Those activities contribute to capacity development of the Nile Delta for operation and maintenance of water supply facilities.

3.2 Achievement for Over Goal

The activities in model facilities and areas were completed successfully. As the performance indicators (PIs) are in trend for improvement, the capacity of operation and maintenance for water supply facilities is generally improved for SHAPWASCO, GHAPWASCO and MCWW. Moreover, the 3ACs have commenced the dissemination activities in the respective Governorate.

3.3 Achievement for Project Purpose

Enough trainings and developing activities for the capacity are undertaken by the Project team for model facilities and areas. The capacities of staff members of model facilities and areas are developed for operation and maintenance together with necessary tools and equipment. PIs were improved according to the capacity development.

3.4 Achievement for Outputs

The planned activities were undertaken by the Project team. Through numerous seminars / workshops, the skills and experiences of SHAPWASCO were transferred to GHAPWASCO and MCWW. Enough numbers of skilled engineers / technicians were trained in the Project, and they contributed to achievement of the outputs.

Table 3-1 Project Indicators and Achievement Levels

Narrative Summary	Objectively Verifiable Indicators	Achievement
[Super Goal] Management capacity of operation and maintenance of water supply facilities is improved in Nile Delta Area	1. Performance Indicators (PIs) in the fields of management capacity of operation and maintenance are improved in Nile Delta Area	The 1st and the 2nd seminars were held respectively in Sep. 2011(Phase-1) and Nov. 2012(Phase-2), to share the information of the Project progress among companies in the Nile Delta. The 3rd seminar was held in Mar. 2014(Phase-3) to share the information for results and achievement of the Project. Another workshop, which was initiated by GHAPWASCO, was held in Sep. 2012 to share information on leak detection activity nationwide. SHAPWASCO provided a technical presentation of WDM to Red Sea Company for Water and Wastewater, which visited the WDM activities for observation in Jan. 2015. Such activities would contribute to improvement of operation and maintenance capacity in not only the Nile Delta but also the entire Egypt.
[Overall Goal] Management capacity of operation and maintenance of water supply facilities is improved in Sharkiya, Gharbia and Minufia Governorates	1. PIs in the fields of management capacity of operation and maintenance are improved in Sharkiya, Gharbia, and Minufia Governorates	Activity, toward improvement, has been conducted in the model areas / facilities. SHAPWASCO, GHAPWASCO and MCWW have commenced the dissemination activities in respective Governorate as follows: 1) GHAPWASCO and MCWW prepared a dissemination plans for SOP and NRW reduction activities. They commenced the activities for other than model facilities / areas. 2) The three (3) companies established exclusive departments for SOP, NRW reduction and WDM (WDM is only for SHAPWASCO). They allocated budgets and staff members for the activities. 3) SHAPWASCO commenced expansion of monitoring system for Zagazig City and major water treatment plants in the Governorate although they has not yet prepared the documented plan. The expansion work, including maintenance service, was contracted with a local service provider in Mar. 2015.
[Project Purpose] Management capacity of operation and maintenance of water supply facilities is	1. PIs in the fields of management capacity of operation and maintenance are improved at	PIs to monitor the Project achievements were selected in the 3rd JCC meeting. PIs showing the initial conditions (baselines) were examined

Narrative Summary	Objectively Verifiable Indicators	Achievement
improved in target areas.(1)	the model areas/facilities	in Nov. 2012(Phase-2). Monitoring and analyzing SOP and NRW reduction activities were conducted in Mar. 2013(Phase-3). (1) SOP The model facilities for SOPs achieved the targets for their PIs in the 37.2% of the monitoring period (Sept. 2012 -.Jun. 2014). The model facilities are as follows: 1) GHAPWASCO ・ Tanta EL Teraa El Melahia (surface water treatment plant) ・ Mahalet Marhoom (iron/manganese removal plant) ・ Sberby (well) 2) MCWW ・ Mahatet El Sadat El Satheya (surface water treatment plant) ・ Gezy(iron/manganese removal plant) ・ Ashama (well) (2) NRW Reduction Two (2) out of six (6) model areas reached the target of PI for NRW reduction. Three (3) of four (4) model areas had obvious NRW reductions. The model areas are as follows: 1) GHAPWASCO ・ Tanta Markaz ・ El Mahalla El Kobra Markaz ・ Zefta Markaz 2) MCWW ・ Shebeen El Kom Markaz ・ Quesna Markaz ・ Berket El Sab'a Markaz (3) WDM Low service pressure ratio was improved by WDM activity, although number of complaints was increased. The number of complaints is believed to have been increased due to frequent electricity suspensions. The pilot project area is Zagazig City.

Narrative Summary	Objectively Verifiable Indicators	Achievement
[Outputs] 1. Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates in strengthened	1-1 More than 3 members each of SOP/NRW teams in SHAPWASCO, GHAPWASCO and MCWW are approved as trainers by Steering Committee	Following numbers of C/P members are approved by the steering committee held in Aug. 2014 to be trainers. SHAPWASCO: SOP 4 members NRW 4 members GHAPWASCO: SOP 6 members NRW 3 members MCWW SOP 6 members NRW 3 members
	1-2 More than 20 times of seminars/workshops are organized under inter-company cooperation by the Project team	The following were organized by the Project team till the end of Aug. 2014 : ➢ 3 open seminars in Sep. 2011, Nov. 2012, and Mar. 2014 ➢ 3 mini-seminars in Jun. – Jul. 2011 ➢ 1 site tour to observe the situation of SHAPWASCO in Oct. 2011 ➢ 1 site tour to observe the situation of MCWW in Sep. 2012 ➢ Special workshop (5days) for leak detection in Sep. – Oct. 2012 ➢ Information exchange with Water Authority of Jordan (5days) in Oct. 2012 ➢ 9 internal workshops among 3ACs ➢ 3 series of NRW reduction and leak detection training in SHAPWASCO ➢ 1 tour for observation of WDM activity in SHAPWASCO ➢ Total 23 events were organized
2. Based on the experiences of SHAPWSCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates	2-1 More than 80% of SOP team members rates understanding of trainings more than 3 on the 5-scale evaluation	C/P members for SOP have been conducting activities according to SOP as well as training on operation. Evaluation test for 12 members (6 members for GHAPWASCO and 6 members for MCWW) was conducted in Phase-3. All tested members exceeded scale 3 on the evaluation test. The team has evaluated that the 12 members acquire necessary skills.
	2-2 The model facilities are operated and maintained based on SOP	The Project team prepared SOP for model facilities. Operation in model facilities has been conducted according to the SOP.
	2-3 Improvement of PIs for the model facilities	PIs were selected as targets for improvement. The Project team

Narrative Summary	Objectively Verifiable Indicators	Achievement
	are evaluated based on SOP	commenced to improve values of the PIs since Nov. 2012(Phase-2). PIs of all model facilities are in improving trend.
3. The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates	3-1 More than 80% of NRW teams members rates understanding of trainings more than 3 on the 5-scale evaluation	C/P members for NRW have been conducting activities for NRW reduction. Evaluation test of leak detection was conducted for seven (7) members (2 members for GHAPWASCO and 5 members for MCWW) in Phase-3 (2013). Another Evaluation test of NRW reduction management was also conducted for six (6) members (3 members for GHAPWASCO and 3 members for MCWW) in Phase-3 (2014). All tested members obtained scale 3 or more on both evaluation tests. The team has evaluated that the tested members acquire necessary skills.
	3-2 Water balance analysis is conducted properly for the 3 model areas	The Project team conducted water balance analysis for six (6) model areas. The team examined water meter accuracy and concluded that the meter error should be considered to water balance calculation. One (1) area in GHAPWASCO and one (1) area in MCWW reached the target. Although other four (4) areas didn't reach their targets, one (1) area in GHAPWASCO and two (2) areas in MCWW had obvious NRW reduction.
	3-3 100% of detected leakage is repaired at the model area	Leak detection was conducted for all model areas. Total fifteen (15) leakages (7 for GHAPWASCO and 8 for MCWW) were found and all detected leakages were repaired.
4. The water distribution management capacity is improved in Sharkiya Governorate as an advanced model	4-1 Water distribution is managed based on SOP at the model areas	The pilot areas were selected by the Project team in Dec. 2011 – Jul. 2012(Phase-2). The equipment was installed in Apr. 2013 – Jul. 2014(Phase-3). After installation of the monitoring equipment, the Project team has monitored and analyzed the water distribution situation, and recommended modifications of operation modes of water treatment plant and wells. Those activities are conducted according to SOP.
	4-2 Issues on water distribution capacity are reported to top management of SHAPWASCO	Through the management activities, the following issues were reported to the top management of SHAPWASCO by C/P team. ➢ Replacement of pumps for Zagazig water treatment plant. ➢ Rehabilitation of intake facilities for old plant in Zagazig water

Narrative Summary	Objectively Verifiable Indicators	Achievement
		treatment plant. ➢ Elevated tank at 6 well stations. ➢ Inspection of wells and rehabilitation of wells if necessary. ➢ Water distribution main to A-3 area. ➢ Expansion of monitoring points for well flows (to be all well stations).
0. The project is managed and coordinated properly	0-1 Agreement on the coordination among SHAPWASCO, GHAPWASCO and MCWW is prepared	SHAPWASCO, GHAPWASCO and MCWW agreed on inter-company cooperation. The steering committee was established by HCWW and the Chairmen of the three affiliated companies (ACs). Moreover, the team arranged inter-company cooperation activities such as workshop and site tour. Problems and issues were discussed and solved in the steering committee and inter-company cooperation activities.
	0-2 Project activities are regularly monitored based on PO/APO	PO and APO were prepared by the Project team. Those plans were confirmed and approved by the steering committee and JCC, as well as review of actual progress. PO and APO were modified according to progress of the Project. In the Project, delays due to security conditions and adjustment trouble for WDM equipment were taken into consideration for modification of PO and APO.

Source: JICA expert team

Table 3-2 Project Activities and Achievements

Project Activities		Achievements	Inputs
1	**Human Resource Development through collaboration among water supply companies in Sharkiya, Gharbia and Minufia Governorates in strengthened**		**[Inputs from the Japanese side]** 1) Japanese Experts ・Chief advisor/water supply planning ・NRW reduction management ・Leakage detection ・Water Treatment ・Water quality ・Electrical equipment ・Mechanical equipment ・Distribution network ・Others (if necessary) 2) Local Expert 3) Equipment 4) Training in Japan 5) Local Cost **[Inputs from the Egyptian side]** 1) Counterpart Personnel ・Project Director: Chairman, HCWW ・Project Manager: Vice Chairman, HCWW ・Co-Project Manager: Chairman, SHAPWASCO Chairman, GHAPWASCO Chairman, MCWW ・SOP Team ・NRW Team
1-1	Conduct management training for the top management	➢ General guidance on governing system of Japan for water supply was conducted by JICA experts. ➢ Training in Japan for top management was conducted in Oct. 2011. The contents cover wider fields of water supply management from the law establishment to O&M of treatment facilities. The contents include systems for human resources development, cooperation among water service providers, functions of association for water service providers.	
1-2	Conduct Training of Trainers (TOT) for developing SOP	➢ TOT for coaching skills was conducted for trainer candidates of SHAPWASCO in Oct. 2011(Phase -1). ➢ TOT was conducted for trainer candidates of GHAPWASCO and MCWW in Aug. 2014(Phase-3). ➢ Technical skills of members in SHAPWASCO, GHAPWASCO and MCWW were improved through the Project activities on SOP and NRW reduction activities.	
1-3	Conduct TOT for NRW reduction	Same as the above description.	
1-4	Disseminate the contents, the manners and the results of the collaboration among SHAPWASCO, GHAPWASCO and MCWW to the water supply companies in Nile Delta Area through reports and workshops	Three seminars were organized in Sept. 2011, Nov.2012 and Mar. 2014 for inviting all ACs in the Nile Delta. All companies for water supply in Nile Delta were invited to the seminar. Moreover, a special workshop was initiated by GHAPWASCO to share the information of leak detection among stakeholders in Egypt. Those are disseminating activities of information obtained in the Project.	

Project Activities		Achievements	Inputs
2	**Based on the experiences of SHAPWSCO, SOPs are developed and utilized at the model facilities in Gharbia and Minufia Governorates**		2) Office space and facilities for the experts 3) Equipment 4) Necessary Information 5) Local Cost
2-1	Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates	C/P team members, together with JICA experts, conducted the survey on current conditions of water supply facilities in Jun. – Oct. 2011(Phase-1). Results were summarized as short list of candidates for model facilities in Jun. – Oct. 2011(Phase-1).	
2-2	Select 3 model facilities in Gharbia and Minufia Governorates each	In Oct. – Nov. 2011, based on the short list, the Project team selected three model facilities (one water treatment plant, one iron/manganese removal plant and one well plant) were selected for each of Gharbia and Minufia Governorates. The treatment plant for GHAPWASCO and the well for MCWW were replaced, in Oct. – Nov. 2011(Phase-2), with other ones for better trial activities.	
2-3	Organize SOP teams	SOP team (headquarters team) was established in each of Gharbia and Minufia Governorates in May 2011(Phase-1). Site teams were organized for the model facilities in Jan. 2012(Phase-2).	
2-4	Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate	Site tours, which are events to invite the members of GHAPWASCO and MCWW to facilities in SHAPWASCO, were done in Oct. 2011 and Nov. 2012.	
2-5	Revise SOPs of Sharkiya Governorate, if necessary	SOP for emergency cases is prepared as an improvement of the existing SOP of SHAPWASCO in Sep. – Nov. 2012(Phase-2).	
2-6	Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO	Draft SOPs were prepared in Dec. 2011 – May 2013 (Phase-2), and finalized in Jun. 2013 (Phase-3).	
2-7	Conduct On-the-Job Training for GHAPWASCO and MCWW to apply SOPs in operation and maintenance	Effectiveness of SOP activities is verified by numerical value of PIs. JET conducted OJT to have C/P team clarify the objectives of SOP and necessary activities toward the target achievement.	

Project Activities		Achievements	Inputs
2-8	Monitor the progress of SOP activities	During OJT, the Project team monitored the operation and maintenance condition in each model facility, and checked the achievement of PIs along with the verification of effectiveness of SOPs.	
2-9	Draft the policy/plan for disseminating SOP to the other Markazes	Toward the achievement of overall goal, JET and C/P team jointly drafted disseminating plans of SOP in Feb. – Mar. 2014(Phase-3).	
3	**The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates**		
3-1	Analyze the current situation on NRW in Gharbia and Minufia Governorates	C/P team members, together with JICA experts, conducted the survey/analysis on situations on NRW by Markaz in Jun. – Nov. 2011(Phase-1). Results were summarized as short list for model areas in Jun. – Nov. 2011(Phase-1).	
3-2	Select 3 model areas for NRW reduction in Gharbia and Minufia Governorates each	In Oct. – Nov. 2011, based on the short list, the Project team selected three model areas for each of Gharbia and Minufia Governorates in Oct. – Nov. 2011(Phase-1).	
3-3	Organize NRW reduction teams	NRW team (headquarters team) was established in each of Gharbia and Minufia Governorates in May 2011 (Phase-1). It was strengthened and reformed in Jan. 2012 – Aug. 2014(Phase-2 and Phase-3), including Markazes teams.	
3-4	Formulate an action plan for NRW reduction activities based on the action plan for SHAPWASCO	The Project team compiled all necessary activities for the Project as the action plan in Oct. 2011(Phase-1). It was prepared for each of Gharbia and Minufia Governorates.	

Project Activities	Achievements	Inputs
3-5 Conduct training on general practice of NRW reduction	Training for general practice of NRW, including some part of leak detection, was conducted in Oct. 2011 at SHAPWASCO. It includes the initial training for water leak detection in the training yard. In Mar. 2012, a supplemental training was conducted by SHAPWASCO to have trainers in GHAPWASCO and MCWW. Trainers of SHAPWASCO explained their experiences in several mini-seminars and workshops.	
3-6 Conduct training at the training yard in Sharkiya Governorate	Initial training was done as described above. In Jan. – Feb. 2013, further leak detection training was done at the training yard to have more skilled members in GHAPWASCO and MCWW.	
3-7 Conduct training at model areas for water distribution management in Sharkiya Governorate	Observation tour for GHAPWASCO and MCWW was conducted in Aug. 2014. The purpose and beneficial effect of WDM activity were discussed and confirmed through obtained data and site observation in Sharkiya governorate.	
3-8 Prepare GIS drawing for model areas in Gharbia and Minufia Governorates	It was done for the selected model areas in Jan. 2012 – Feb. 2013(Phase-2). According to the drawings, network isolations and location of chambers were examined.	
3-9 Make water balance analysis at model areas	Pilot project areas in six (6) model areas were determined through minimum night flow (MNF) survey and field survey in Mar. 2012(Phase-2). After selection of pilot project areas, all water balance analyses for the six (6) areas before leak detection were completed in Jan. 2012 – Aug. 2014(Phase-2 and Phase-3). Metering error was considered into water balance analysis.	
3-10 Conduct leak detection survey at model areas	Leak detection survey at all six (6) model areas was conducted in Jan. 2012 – Aug. 2014(Phase-2 and Phase-3).. All leak points were repaired during the Project	

Project Activities		Achievements	Inputs
3-11	Make water balance analysis after repair works	All water balance analyses at six (6) model areas after repair works were properly completed in Jan. 2012 – Aug. 2014(Phase-2 and Phase-3).	
3-12	Draft policy/plan for disseminating NRW reduction activities to the other Markazes	"Five (5) years plan for NRW reduction activity" for GHAPWASCO and MCWW was established as "Draft policy/plan for disseminating NRW reduction activity" in Jul. 2013. MCWW revised the plan for "One (1) year plan" in Aug. 2014.	
4	**The water distribution management capacity is improved in Sharkiya Governorate as an advanced model**		
4-1	Discuss methods and conduct survey for water distribution management	C/P team members discussed the purpose of water distribution management in May - Sept. 2011(Phase-1), as well as methods and necessary equipment, together with JICA experts. It was continued until May - Sept. 2011.	
4-2	Conduct training for water distribution management	Project team organized an internal workshop in Sept. 2011, in order to understand purposes and options for activities as well as necessary equipment.	
4-3	Formulate a plan for water distribution management	The Project team selected Zagazig city for the target area of pilot project. It was divided into 6 DMAs (candidates). In Jul. 2012, together with JICA HQ team, the pilot project plan was discussed. After the discussions, A-4 area was selected as pilot area while water pressure is monitored in whole Zagazig at 10 points. The Project team compiled the plan of pilot project in Dec. 2012.	
4-4	Install the equipment for water distribution management at the model area	JICA purchased the equipment for water flow/pressure monitoring. SHAPWASCO constructed a central monitoring room and chambers for the equipment installation. The equipment installation was commenced in Apr. 2013. Adjustments of the equipment and system verification, however, were conducted until Jul. 2014.	

Project Activities		Achievements	Inputs
4-5	Operate the system	Water flow/pressure monitoring system is operated according to manuals prepared by the equipment manufacturers and SOP. The operation includes the following: ➢ Data monitoring on screen. ➢ Data analysis such as average / maximum flow. ➢ Low service pressure ratio ➢ Complaints from the citizen for water suspension and weak pressure. ➢ Recommendation of modification for operation modes of water treatment plant and wells.	
4-6	Develop SOP for water distribution management	Draft SOPs for monitoring activities were prepared in the middle of Mar. 2013 – Aug. 2014(Phase-3). It was improved through activities of WDM and finalized in Nov. 2014.	
4-7	Evaluate the operation and SOP for water distribution management	WDM including SOP was evaluated by the Project team. The Project team evaluates the system as necessary for Zagazig. As a result of the pilot activities, the following improvement are realized: 1) Awareness of operators of water treatment plant was much improved to secure sufficient water pressure. 2) Issues are able to be explained by analyzed data and graph. 3) The provision of analyzed data facilitates the decision making for rehabilitation.	
0	**The project is managed and coordinated properly**		
0-1	Establish Steering Committee, consisting of representative of HCWW, SHAPWASCO, GHAPWASCO and MCWW	The steering committee was established. 7 times of meeting were conducted.	
0-2	Discuss the contents, the manners for the cooperation among SHAPWASCO, GHAPWASCO and MCWW through the Steering Committee	All problems and issues, including progress monitoring, were discussed in the above mentioned meetings.	

Project Activities		Achievements	Inputs
0-3	Organize JCC at least once a year	6 times of meeting were conducted.	
0-4	Finalize the Indicators of the Project Design Matrix (PDM) for approval of the first Joint Coordination Committee (JCC)	PDM1 was discussed and approved in the 1st JCC meeting. PIs were described in PDM2 and it was approved in the 3rd JCC meeting. Finally, PDM3 was formulated and approved in the 4th JCC meeting.	
0-5	Prepare a draft Annual Plan of Operations (APO) based on the Plan of Operations (PO) for approval of the first JCC	PO1 and APO1 were discussed and approved in the 1st JCC meeting. They have been modified / revised according to progress of the Project. Finally, PO4 was formulated and approved in the 7th Steering committee.	
0-6	Monitor the progress of PO/APO and achievement of the Indicators of the PDM	Progress is managed according to the PO/APO. Progress is reported in the steering committee and JCC meetings.	

Source: JICA expert team

CHAPTER 4 TECHNICAL COOPERATION OUTPUTS

4.1 SOP Activities

4.1.1 Overview on SOP Activities

4.1.1.1 Basic Policy of SOP Activities

The Project has a clear target which is "Operation and maintenance capacity of water supply facilities is improved through SOP activities". In addition, Operation & Maintenance skill is planned to be expanded effectively to not only whole Gharbia and Minufia Governorates but also whole Nile Delta. Basic policies for the SOP activities were discussed in the course of formulation of "Action Plan" and implementation of the actions.

(1) The Purpose and Output of SOP Activity

- Management capacity of operation and maintenance of water treatment facilities is improved at the model facilities in Gharbia and Minufia Governorates.
- The institutional skills and experiences of SHAPWASCO for SOPs are transferred to SOP teams at the model facility in Gharbia and Minufia Governorates.

In order to obtain the above-mentioned output, followings were implemented:

- C/P team members of SHAPWASCO transfer their experience to GHAPWASCO and MCWW.
- SOPs for model facilities in Gharbia and Minufia Governorates are developed based on SOPs for SHAPWASCO.
- On-the-Job Training for GHAPWASCO and MCWW is conducted applying SOPs in operation and maintenance

(2) Implementation of SOP Activities Based on "Action Plan"

SOP activities taken in the Project are summarized as shown in Table 4.1-1.

Table 4.1-1 Actions to be Taken in SOP Activities

Action	Title	Contents	Period
1	Survey the current conditions of water supply facilities in Gharbia and Minufia Governorates	➢ Survey of existing conditions for SWTPs, IMRPs and well facilities. ➢ Collection of basic data for SWTPs, IMRPs and well facilities regarding operation and laboratory.	Jun. 2011 - Nov. 2011
2	Select Three (3) model facilities in Gharbia and Minufia Governorates	➢ Conducting detail survey. ➢ Discussion on the selection criteria. ➢ Decision of three (3) model facilities	Jun. 2011 - Oct. 2011

Action	Title	Contents	Period
3	Organize SOP teams in Gharbia and Minufia Governorates	➢ Selection of fulltime SOP members in GHAPWASCO and MCWW. ➢ Selection of SOP members for model facilities.	May 2011 - Nov. 2011
4	Conduct training for developing and applying SOPs at the facilities of Sharkiya Governorate	➢ Assessment of the effectiveness of SOPs in Sharkiya Governorate. ➢ Extraction of the problematic points.	Sep. 2011 - Oct. 2012
5	Revise SOPs of Sharkiya Governorate, if necessary	➢ Revision of SOPs for Sharkiya Governorate.	Sep. 2012 - Oct. 2012
6	Develop SOPs for model facilities in Gharbia and Minufia Governorates based on SOPs for SHAPWASCO	➢ Examination for the model facility conditions. ➢ Examination of water quality management. ➢ Preparation of unified forms of O&M records and reports. ➢ Preparation of SOPs for operation and maintenance in conjunction with site training. ➢ Preparation of SOPs for water quality management.	Dec. 2011 - Jun. 2013
7	Conduct On-the-Job Training for GHAPWASCO and MCWW to apply SOPs in operation and maintenance	➢ Preparation of basic system drawings (P&ID, and Single line diagram). ➢ Trial operation with using SOPs.	Feb. 2012 - Dec. 2013
8	Monitor the progress of SOP activities	➢ Monitoring of activity conditions on On-the-Job Training.	Sep. 2012 - Aug. 2014
9	Draft the policy/plan for disseminating SOP to the other Markazes	➢ Proposal of long-term targets for SOP activity. ➢ Preparing the draft policy/plan of SOP activity for whole Gharbia and Minufia Governorates.	Feb. 2014 - Mar. 2014
Activities related to SOP activity			
1	Holding SOP workshops and seminars for transferring of experience from SHAPWASCO to GHAPWASCO and MCWW	➢ Holding internal workshops. ➢ Holding internal seminars.	Through the Project

Source: Project Team

(3) Performance Indicators

The outcomes of the SOP activities should be finally assessed by numerical performance indicators (PIs). In order to grasp the baseline data for PIs, it was necessary to know the operation efficiency before SOP commencement for both Surface Water Treatment Plants (hereinafter referred to as "SWTPs") and Iron and Manganese Removal Plants (hereinafter referred to as "IMRPs"). The

baseline data was collected in Sep. 2012(Phase-2), and the target value of PIs to be improved was determined through the assessment of operation modes and the analysis of operation efficiency.

PIs which are selected in accordance with the practical performance in the previous Project in Sharkiya and determined in the 3rd JCC held on the 26th November 2012 are as follows;

- **Ratio of effective utilization of raw water (%)**
  "Production volume of plant (m^3)" / "Intake volume of plant (m^3)"
  It should be monitored monthly.

- **Unit consumption of alum sulfate / chlorine / potassium permanganate used per one cubic meter of water produced (g/m^3)**
  "Consumption of alum sulfate / chlorine / potassium permanganate in SWTP / IMRP (g)" / "Water production (m^3)"
  It should be monitored monthly.

- **Energy consumption per cubic meter of water produced (kWh/m^3)**
  "Energy consumption in SWTP / IMRP (kWh)" / "Water production (m^3)"
  It should be monitored monthly.

(4) SOP Based on the Understanding of the Process and System for the Facility

In order to operate the water treatment facility effectively, proper understanding of water treatment process and system is indispensable. However, it was difficult because any documents are not available in most of facilities managed by GHAPWASCO and MCWW for design calculation sheet, As-Built drawings and operation manuals, which are guidelines for effective operation. It was therefore required that proper technical skills are transferred through the preparation of P&ID, class room training for water treatment process and OJT training.

(5) Application of On-the Job Training by Selected Theme

There are several treatment processes in the water treatment facilities. It is difficult, within limited activity period, to review and improve the treatment efficiency in all process. Therefore, the Project team focused on the improvement of filter efficiency, coagulation & settlement efficiency in sedimentation tanks and reduction of chemicals.

(6) Expansion of SOP Activity to the Other Markazes

Overall goal of the Project is to improve management capacity regarding the operation and maintenance of water supply facilities in Gharbia and Minufia Governorates. JET and C/P team jointly drafted plans toward the expansion and the achievement of the goal. In addition, the activity to root the SOP in daily routine works was conducted in additional facilities other than the model facilities, during the Project.

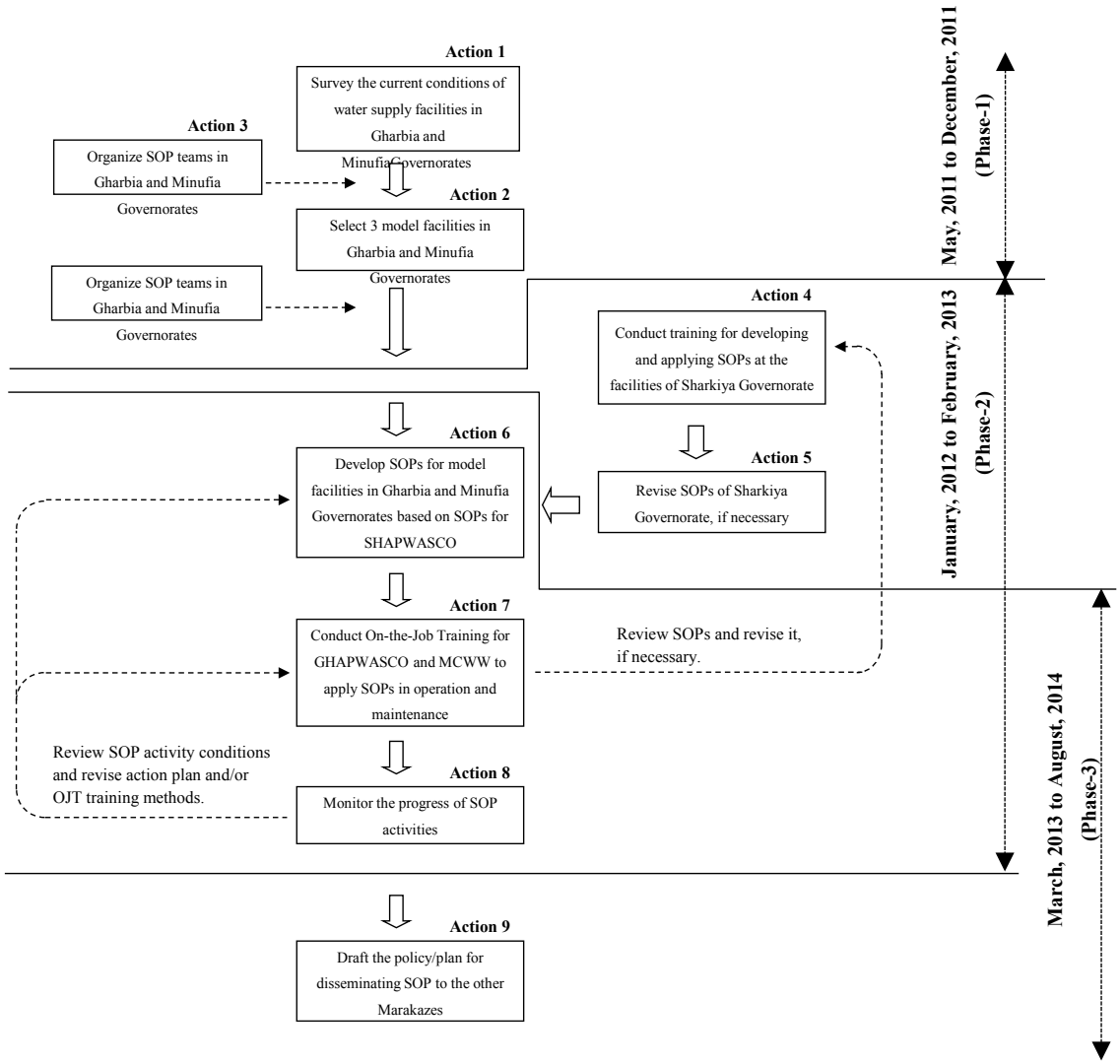
(7) Rehabilitation and Calibration of Equipment in the Model Facilities

In order to fully utilize water treatment capacity, damages should be repaired and stable operation

should be maintained without any malfunctions of equipment. The 2ACs, therefore, prepared a rehabilitation plan for damaged and malfunctioning equipment, which were found during the Project. As a result of their efforts, major damages and malfunctions, including calibration of instrumentation devices such as level meter and flow meter, which may obstruct the activities, were remedied.

4.1.1.2 Procedure of SOP Activities

SOP activities was conducted according to the flow shown in Figure 4.1-1.



Source: Project Team

Figure 4.1-1 Flow on the Actions of SOP Activity

4.1.2 Summary of SOP Activities Based on Action Plan

Summary of SOP activities based on Action Plan is mentioned hereinafter.

4.1.2.1 Action-1 (Survey the Current Conditions of Water Supply Facilities in Gharbia and Minufia Governorates)

In order to select model facilities, a long list was prepared in both Governorates. The basic survey was conducted for following numbers of facilities in operation and maintenance conditions. And then, the short list was prepared based on the evaluation of survey result.

Table 4.1-2 Candidates for the Basic Survey

Company	Facility	Numbers of Candidates
GHAPWASCO	Surface Water Treatment Plant	5
	Iron and Manganese Removal Plant	14
	Well Station	18
MCWW	Surface Water Treatment Plant	5
	Iron and Manganese Removal Plant	25
	Well Station	18

Source: Project Team

Table 4.1-3 Shortlisted Facilities

Company	Type of Facility	Facility Name
GHAPWASCO	Surface Water Treatment Plant	Tanta El Gedeeda El Morshaha
		Zefta El Morashaha
		El Mahalla El Kobra El Gedeeda (Phase-IV)
		Kafr El Zayat El Morashaha
	Iron and Manganese Removal Plant	Mahalet Marhoom
		Manyal El Howaishat
		El Gaefareya
	Well Station	El Kharasana
		El Montaza
		Seberbay
		Abou Dawoud
		Kfr Sebtas
MCWW	Surface Water Treatment Plant	Shebeen El Kom El Gedeeda
		Mahatet Menouf El Morashaha
		Mahatet El Sadat El Satheya
	Iron and Manganese Removal Plant	Shemiates
		Kafr El Arab
		Gezy
	Well Station	Shubra Bas
		Kom Akhdar
		Dekma
		Kfr El Batunoun

Source: Project Team

(1) Output from the Action

Output-1: Basic Survey Report

Through the basic survey, basic data for the facilities was collected and compiled as the report. The reports and selection criteria for shortlist are attached in Supporting Report S2.2.

(2) Issues to be Tackled in Later Stages

Issue-1: Use of the Report

The basic survey report summarizes the components and conditions of the facility including operation and maintenance. It is necessary to be shared in ACs, since the described contents in the report are useful for SOP planning.

4.1.2.2 Action-2 (Select Three (3) Model Facilities in Gharbia and Minufia Governorates)

For the final selection of model facilities, detail surveys were conducted for the short listed facilities, taking into consideration the equipment conditions and effect of SOP. Model facilities were determined based on the evaluation of survey results as shown in Table 4.1-4.

Table 4.1-4 Nominated Model Facilities

Company	Facility	Remarks
GHAPWASCO	Tanta El Gedeeda El Morshaha SWTP	Canceled on July 2012
	Tanta El Teraa El Melahia SWTP	Applied on July 2012
	Mahalet Marhoom IMRP	
	Seberbay Well Station	
MCWW	Mahatet El Sadat El Satheya SWTP	
	Gezy IMRP	
	Dekma Well	Canceled on November 2012
	Ashama Well Station	Applied on November 2012

Source: Project Team

(1) Output from the Action

Output-1: Detail Survey Report

Detail information regarding equipment condition and necessity of rehabilitation, were collected and compiled in a report. The detail survey reports are attached in Supporting Report S2.3.

(2) Issues to be Tackled in Later Stages

Issue-1: Methodology for the Selection of Model Facility

C/P team of GHAPWASCO, MCWW and SHAPWASCO shall expand SOP to whole Nile Delta in the future. In order to expand SOPs effectively, it should be spread from the model facility in each Governorate as same as this Project. Accordingly, the logical selection of model facility through the basic and detail survey will be expected as guideline for the activity.

4.1.2.3 Action-3 (Organize SOP Teams in Gharbia and Minufia Governorates)

C/P team in headquarters and each model facility was organized in each of GHAPWASCO and MCWW to start SOP activity together with JET. Furthermore, C/P team in SHAPWASCO was also selected in order to transfer their knowledge and experience to GHAPWASCO and MCWW.

(1) Output from the Action

Output-1: Organization of C/P Team in Headquarters and Model Facilities

C/P team for the implementation of SOP activities was organized in headquarters and model facilities. Member list of C/P team is as shown in Section 1.4 in Chapter 1.

(2) Issues to be Tackled in Later Stages

Issue-1: Establishment of SOP Section in Each Company

Because SOP sections were officially established in GHAPWASCO and MCWW during the Project term, it is expected that the SOP sections disseminate SOP to whole Governorate continuously. In order to transfer the knowledge and experiences of SOP to younger generations, staffing should be balanced in generations like senior, mid-level, and junior, etc.

4.1.2.4 Action-4 (Conduct Training for Developing and Applying SOPs at the Facilities of Sharkiya Governorate)

SOP documents prepared in the Previous Project in Sharkiya Governorate were being revised so as to be suitable for the actual situation in the course of self-activities after completion of the project.

(1) Output from the Action

Output-1: Assessment for the Effectiveness of SOP

- Modification of Operation Records

C/P team in SHAPWASCO modified operation records after the previous project. Modified points are listed as Table 4.1-5.

Table 4.1-5 Modifications on Previous Operation Records

No.	Recording Item	Modification	Modification Reason
1	Pump Operation Record	1) Recording format was separated in Water Treatment Plants, Fe/Mn Removal Plants and Production Wells.	This modification is to improve operation records.
		2) Operation records for the well condition monitoring and the management of pump operation hours were newly established.	This modification is to improve well management.
		3) Operation records were divided into raw water pump and treated water pump	This modification is to improve operation records.
2	Chemical Consumption Record	1) Calculation formula for Alum consumption was reconsidered. (Alum concentration has been examined periodically by actual measurement at the site.)	This modification is to improve management method for the Alum concentration.
3	Filter Backwash Record	1) Backwash operation time was divided into air scouring and water backwash.	This modification is to grasp backwash operation time in detail.
4	Monthly Record	1) Technical terms were improved for wording.	This modification is to have deep-understanding of operation staffs in water treatment facilities.
5	Sludge Removal Record (Clarifier)	1) Operation record for sludge removal in a sedimentation process was newly established.	This modification is to improve management method for sludge removal in a sedimentation process.

Source: Project Team

- Modification of SOPs

Object facilities of SOPs in SHAPWASCO were SWTPs, IMRPs, Booster Pump Stations and Well Stations in the previous project. Since, direct filtration facilities, which adopt unique water treatment system, are also used as other water treatment system in Sharkiya Governorate, SHAPWASCO has been developed SOPs for the direct filtration facility as a part of expansion activity.

Output-2: Extraction of the Problematic Point

Preparation for the SOPs on the safety management was behind schedule because the previous activities had focused on the operation and maintenance manner. Accordingly, the quick approaches for the safety measures against emergency situation such as blackout, gaseous chlorine leakage, etc. were required.

(2) Issues to be Tackled in Later Stages

Issue-1: Periodical Assessment for the Activities

In order to balance the continuity and expansively, SOPs including OJT approach for operation records shall be updated periodically through assessment of problems on the activities. Management ability will be developed through such modifications process.

4.1.2.5 Action-5 (Revise SOPs of Sharkiya Governorate, if necessary)

As described in Action-4, current SOPs are specialized for operation and maintenance work. The other hand, safety measures against the emergency situation are not mentioned in detail. In addition, although the emergency generator is installed in water treatment facilities, SOP for the generator is not arranged in facilities. The activity of Action-5 is summarized as follows:

(1) Output from the Action

Output-1: Additional SOP Documents for SHAPWASCO

Following SOP documents were prepared together with C/P and JET. These documents are attached on Supporting Report S2.6.

- Definition of Emergency Situation and Emergency Planning
- Emergency Plan for Gaseous Chlorine Leakage
- Operation and Maintenance Program for the Emergency Generator

(2) Issues to be Tackled in Later Stages

Issue-1: Arrangement of SOPs Suitable for the Components of Facility

Because facility and equipment components are different by facility, an exclusive SOP should be correspondingly established per facility.

4.1.2.6 Action-6 (Develop SOPs for Model Facilities in Gharbia and Minufia Governorates Based on SOPs for SHAPWASCO)

C/P team in GHAPWASCO and MCWW prepared appropriate SOPs for the model facilities together with JET in reference to the previous ones in SHAPWASCO. Prepared documents are as follows:

- Basic System Drawing (Piping and Instrumentation Diagram and Single Line Diagram)
- SOPs (including Water Quality Management)
- Unified Forms of O&M Record

(1) Output from the Action

Output-1: Basic System Drawing

To grasp the water treatment flow and facility components, piping and instrumentation diagrams (P&ID) and single line diagrams (SLD) are indispensable before applying SOPs. These schematic drawings show piping, equipment including capacity and instrumentation for the water treatment process. Along with the SOP activities, P&ID and single line diagrams were prepared for each model facility of SWTP and IMRP in Dec. 2011 – Jun. 2013(Phase-2), as attached in Supporting Report S2.4 and Supporting Report S2.5.

Output-2: SOPs

SOP is a set of documents, which describe operation and maintenance steps dividing into normal operation and emergency situation, aiming at sufficient management quality on water treatment process. SOPs for each model facility and for water quality management were prepared as attached in Supporting Report S2.6.

Output-3: Unified Forms of O&M Record

Operation records were prepared for each model facility, as attached in Supporting Report S2.7. In order to calculate a value of PIs, the calculation and measurement methods of 1) water balance between raw and production waters, 2) chemical and 3) electrical consumptions are standardized in a recording format.

Output-4: Smooth Implementation of the Routine Work

The model facilities and the laboratories became to be able to report systematically utilizing the SOPs and various forms. Moreover, the visualized criteria of water quality were contributed to the smooth implementation of the routine work.

(2) Issues to be Tackled in Later Stages

Issue-1: Arrangement of SOP Documents Suitable for the Components of Facility

As well as the issue on Action-5, it is required to prepare exclusive SOP documents per facility. When utilizing the existing SOP and developing the SOP for additional facility, basic information should be examined before the SOP application, and the documents should be re-arranged exclusively to be suitable to capability of staff members.

4.1.2.7 Action-7 (Conduct On-the-Job Training for GHAPWASCO and MCWW to Apply SOPs in Operation and Maintenance)

Operation and maintenance skills on water treatment facilities are transferred through the OJT training. The purpose of OJT training is to learn proper operation and maintenance methods by theory and site trainings through SOPs. Furthermore, the effectiveness of SOP activities is verified by numerical value of PIs. The training was conducted, therefore, according to a program to improve the value of PIs.

(1) Output from the Action

Output-1: PIs to be Monitored in the Project

PIs to be monitored and to be achieved in each model facility are shown in following Tables.

Table 4.1-6 Target of PIs in Tanta El Teraa El Melahia SWTP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Initial Value	85.0	8.87	38.45	0.39
Target Setting	90.0	8.00	35.00	0.35

Source: Project Team

Table 4.1-7 Target of PIs in Mahalet Marhoom IMRP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Calcium Hypochlorite (g/m^3)	Potassium Permanganate (g/m^3)	
Initial Value	-	7.05	3.04	0.76
Target Setting	**96.0**	6.00	2.00	0.60

Source: Project Team

Table 4.1-8 Target of PIs in Mahatet El Sadat El Satheya SWTP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Initial Value	88.0	9.20	26.00	0.45
Target Setting	92.0	6.50	18.00	0.36

Source: Project Team

Table 4.1-9 Target of PIs in Gezy IMRP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Potassium Permanganate (g/m^3)	
Initial Value	84.0	3.50	2.00	0.80
Target Setting	92.0	**6.50**	1.00	0.50

Source: Project Team

(2) Issues to be Tackled in Later Stages

Issue-1: Periodical Calibration of Instrumentation Devices

The outcomes of the SOP activities are assessed by PIs for improvement of operation conditions. Accurate recording of the operation condition is required to assess the achievement of PIs. Accordingly, in order to manage accurate reading, instrumentation devices, such as flow meter, level meter, etc. shall be calibrated periodically based on the annual O&M plan.

4.1.2.8 Action-8 (Monitor the Progress of SOP Activities)

During the OJT training, the Project team monitored operation and maintenance condition in each

model facility, and checked the achievement of PIs along with the verification of effectiveness of SOPs. Activity result is described in the Section 4.1.3 in Chapter 4 in detail.

(1) Output from the Action

Output-1: Activity Monitoring

Monitoring result toward the achievement of PIs is as attached in Supporting Report S2.8.

As a result of the activity monitoring, the achievement ratio of PIs was 38% (3 out of 8 are achieved) at GHAPWASCO and 50% (4 out of 8 are achieved) at MCWW. However, because all PIs tend to improvement, it is expected for model facilities to achieve and exceed the target in the near future.

Output-2: Improvement of Awareness in C/P Team

By visualization of PI data in graph, C/P team became aware of the inefficient operation and the necessity of improvement. In addition, they became able to evaluate the monitoring result and find the issues to be improved. In this manner, the capability was developed through the Project to solve problems on SOP activities.

(2) Issues to be Tackled in Later Stages

Issue-1: Development of O&M Capability

Purpose of the Action 7 & 8 is to improve management level of water treatment facilities and O&M capability of facility staffs toward the achievement of PIs. The capacity improvement has appeared gradually along with the improvement of PIs. The improvement of PIs contributed to the promotion of motivation of C/P members. Since the activity procedures taken in the Project were effective, the same procedures are expected to be taken in the SOP dissemination works.

4.1.2.9 Action-9 (Draft the Policy/Plan for Disseminating SOP to the Other Markazes)

In order to achieve the overall goal; "Management capacity of operation and maintenance of water supply facilities is improved in each Governorate", GHAPWASCO and MCWW are required to expand their activities to the Governorate level. The self-activity regarding SOP dissemination was conducted, and C/P teams applied SOPs to the facilities other than model facilities. Activity statuses are described in the Section 4.1.6 in Chapter 4.

(1) Output from the Action

Output-1: Plan for Expanding SOP Activities to the Other Markazes

JET and C/P team jointly drafted disseminating plans for applying successful improvement to facilities, as attached in Supporting Report S2.9.

Output-2: Development of Independence and Autonomy of C/P Team

C/P team commenced SOP disseminating activity to the facilities other than the model facilities by themselves (less inputs of JET). In addition, the meeting regarding the expansion of SOP has been held between Qalyubia Water Company and MCWW at Chairmen level. This is an example of developed autonomy.

(2) Issues to be Tackled in Later Stages

Issue-1 Expansion of SOPs to the Whole Nile Delta

The Project has the super goal to improve water supply operation efficiency over the Nile Delta by sharing technology, successful experiences and mutual cooperation among ACs. Toward the goal, the technology gained through the Project is expected to be extended to the whole Nile Delta under the cooperative framework of 3ACs.

4.1.3 Activity Achievement in Each Model Facilities

The achievement of activity in each Model Facility is mentioned hereinafter. As the activity result, the operation efficiency in model facilities tends to be improved. During the monitoring period (GHAPWASCO: Dec. 2012 - Jun. 2014, MCWW: Sep.2012 - Jun. 2014), the targets of PIs were achieved in 37.2% of the total months (= 116 / 312)). Although some PIs do not reach to the target, it is expected that these items will be achieved for the target in near future because C/P members have enough motivation to improve the efficiency.

4.1.3.1 Surface Water Treatment Plant in GHAPWASCO

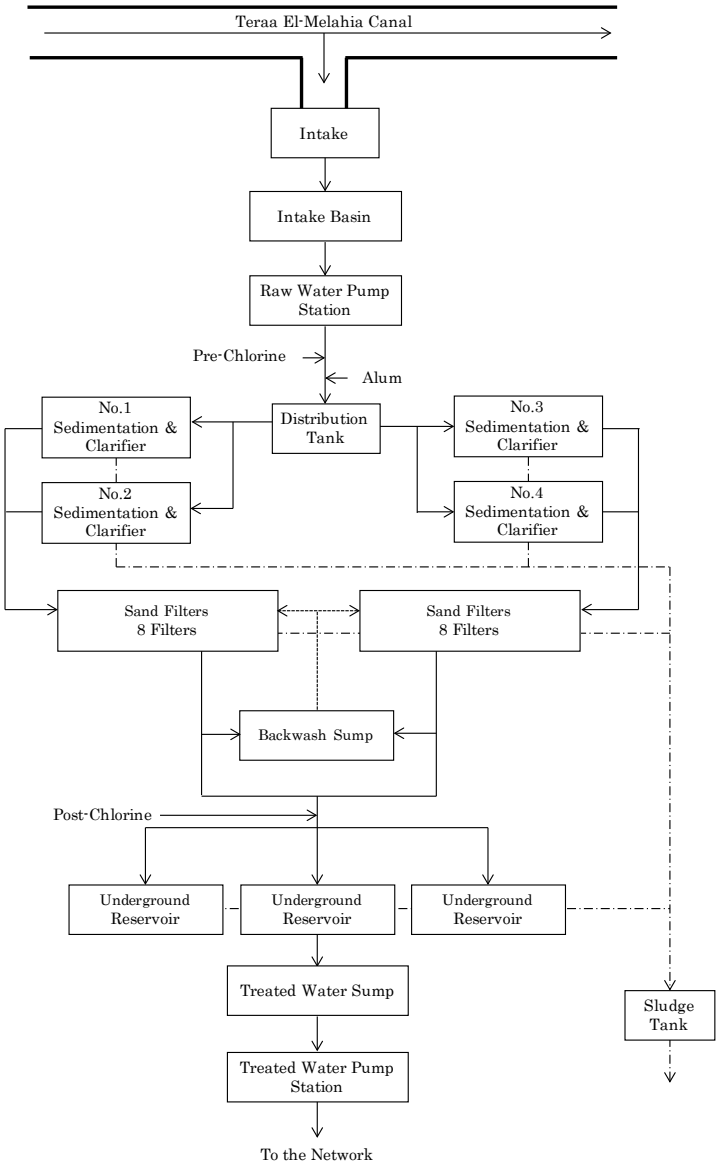
(1) Summary of Model Facility

Model facility of SWTP in GHAPWASCO is Tanta El Teraa El Melahia SWTP which is located in the center of Gharbia Governorate. General information of the facility is as follows;

General information

- Capacity : 1,400 L/sec- Design Capacity
  (600 L/sec- Actual Production)
- Water source : El Melahia Canal
- Covered Area : Tanta City and some village in Tanta Markaz
- Establishment : Year 2011

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-2 Schematic Water Flow and Facility Component of Tanta El Teraa El Melahia SWTP

(2) Applying SOP to Operation and Maintenance Activities

Operation efficiency of water treatment facilities will be developed through the class room training and site training for SOPs. The class room training brought understandings on water treatment theory and operation procedure. The other hand, the capability to judge proper operation and to propose the improvement points is nurtured through the site trainings. The improvement effect in the facilities appeared after the two (2) trainings. The site training in Tanta El Teraa El Melahia SWTP was conducted along with following themes and approaches.

Table 4.1-10 Major Training Themes in Tanta El Traa El Melahia SWTP

No.	OJT Training Themes
1	**Sand level and weir level adjustment of collecting trough in filters** As a sand filter configuration, sand layer is divided into two (2) banks across the collecting trough although the under-drain system is shared by the two (2) banks. Before applying SOP, a filter head loss and backwash efficiency were uneven in each bank by the difference of water load flowing into a filter caused by unevenness of installation height of sand layer and weir of collecting trough. Aiming at an extension of filter run time and improvement of backwash efficiency, sand level and weir level of collecting trough was adjusted.
2	**Improvement of the settlement efficiency in sedimentation tanks** In Tanta El Teraa El Melahia SWTP, proper operation for sedimentation tank has not been conducted due to the trouble of mixers and clarifiers, and undeveloped working schedule. Improvement of coagulation efficiency in the sedimentation tank produces the reduction of Alum dosage and extension of filter runtime. Accordingly, following training was applied as OJT program. (1) Improvement of sludge discharge schedule Sludge accumulating at the bottom of the sedimentation tank should be discharged at least once a day because it disturbs the settlement of floc. Proper sludge discharge cycle was examined. (2) Improvement of coagulation efficiency by proper operation of mixers and clarifier Coagulation efficiency was examined by proper operation of mixers and clarifier, aiming at the reduction of turbidity.
3	**Improvement of filtration efficiency in sand filters** The point to improve the effective utilization ratio of water is to decrease the water loss consumed during backwash. In order to decrease water loss, extension of filter runtime was examined based on the improvement effect of sedimentation tanks and the review of backwash time.
4	**Improvement of the usage of chlorine cylinder** Gaseous chlorine had leaked out from cylinders usually in the cylinder room because the facility doesn't have any experienced persons who deal with chlorine system properly. Due to this reason, improvement of chlorine usage was an immediate task for the facility from not only reduction of chlorine consumption but safety. Through the technical exchange with MCWW and OJT training, the leakage was stopped.
5	**Improvement of Alum concentration control** Liquid aluminum sulfate is used in the facility by water dilution. However, dilution control method was not unified and a dosing rate was not stable. Improvement activity to control proper concentration was applied by the standardization of dilution work based on SOPs.

Source: Project Team

Improvement Effect to the Achievement of PI

Summary of activity result is as shown in Table 4.1-11 and Figure 4.1-3.

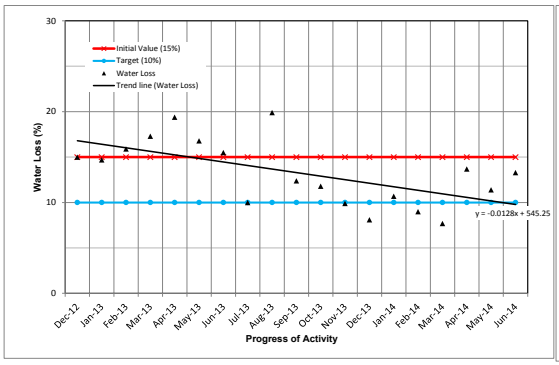
Table 4.1-11 Output for the SOP Activities in Tanta El Teraa El Melahia SWTP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Initial Value	**85.0**	**8.87**	**38.45**	**0.39**
Target Setting	**90.0**	**8.00**	**35.00**	**0.35**
Month	Monthly Average Value			
Dec 2012	85.0	8.87	38.45	0.39

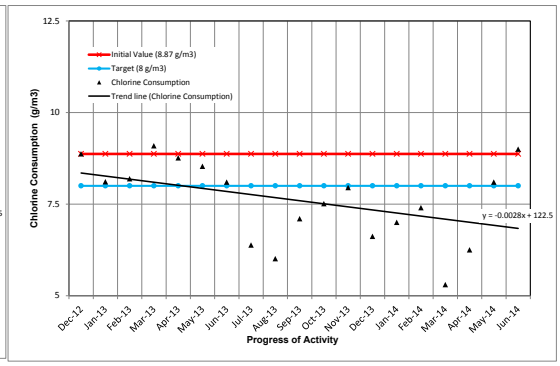
	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Jan 2013	85.3	8.11	39.47	0.38
Feb 2013	84.1	8.19	38.14	0.40
Mar 2013	82.7	9.09	37.00	0.39
Apr 2013	80.6	8.76	42.56	0.37
May 2013	83.2	8.53	39.08	0.38
Jun 2013	84.5	8.10	43.74	0.36
Jul 2013	90.0	6.38	36.18	0.37
Aug 2013	80.1	6.01	34.42	0.39
Sep 2013	87.6	7.10	34.00	0.39
Oct 2013	88.2	7.51	33.14	0.34
Nov 2013	90.1	7.95	33.43	0.41
Dec 2013	91.9	6.62	42.14	0.38
Jan 2014	89.3	7.00	37.90	0.41
Feb 2014	91.0	7.40	34.90	0.49
Mar 2014	92.3	5.30	38.00	0.34
Apr 2014	86.3	6.25	29.70	0.30
May 2014	88.6	8.10	48.00	0.40
Jun 2014	86.7	9.00	34.00	0.39
Output Value[*1]	**87.2**	**7.78**	**37.20**	**0.36**
Evaluation[*2]	○	◎	○	○

[*1)] Output value is average from April 2014 to June 2014.
[*2)] Marking : ◎=Sufficient, ○=Satisfactory, △=further improvement is expected

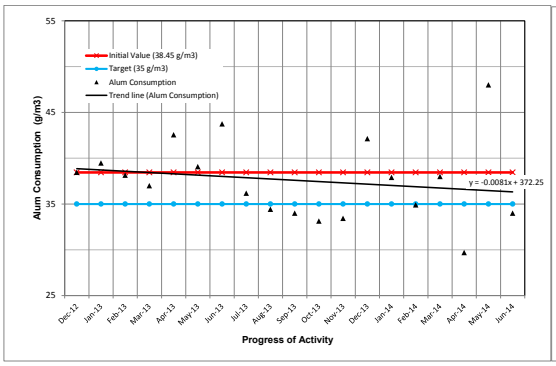
Source: Project Team



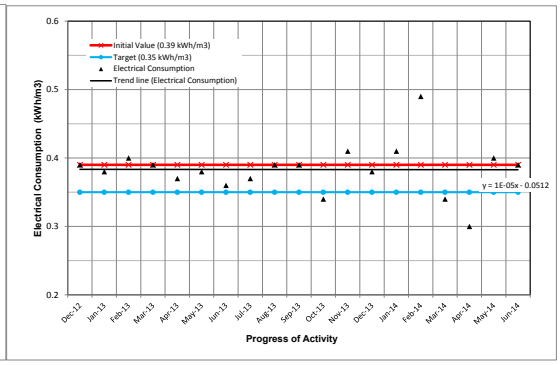
Water Loss (Effective utilization Ratio of Water)



Gaseous Chlorine Consumption



Liquid Aluminum Sulfate Consumption



Electrical Consumption

Source: Project Team

Figure 4.1-3 Output for the SOP Activities in Tanta El Teraa El Melahia SWTP

Although there are items that couldn't be achieved for the target, all PIs tend to be improved toward the target as shown in Figure 4.1-3. It is therefore concluded that the Project gives good impact for the improvement of operation and maintenance capacity.

Achievement of PI strongly depends on raw water quality fluctuated by climatic condition, and the establishment of optimal PIs needs further analysis of the data collected in several years' monitoring. According to the data, the target should be verified for appropriateness. After then, all of PIs will satisfy the targets. The factors hindering the achievement of PIs are summarized in the following column.

The other hand, mechanical equipment, especially the equipment for flocculation & sedimentation process like rapid and slow mixer and clarifier, is relatively bad in condition and repeating breakage and repair due to quality of equipment and installation. Moreover, a weighing balance of chlorine cylinder is out of order in Mar. 2015.

To repair it, GHAPWASCO has requested budgetary allocation of approx.16 million LE to HCWW, for the overall improvement. Nevertheless, the repairs are a little more than to patch over each problem temporally since it is difficult for GHAPWASCO and HCWW to allocate the enough budget for overall rehabilitation of quite new facilities.

Obstructive Factor for Achieving PI

i) Large fluctuations / errors are observed in monitored data. In order to acquire appropriate data, the periodical calibration for instrumentation devices is required.
ii) The liquid Alum dosing rate is influenced by raw water quality. It is as one of disincentives to the achievement of PI that the liquid Alum dosing rate gets worse from the end of winter to early summer due to the degradation of raw water quality.
iii) Electrical power meter installed in the facility counts not only the power consumed by facility operation but also miscellaneous usage. It was therefore difficult to measure the exact value, and it is supposed to be a one of the disincentives to the achievement of energy consumption.

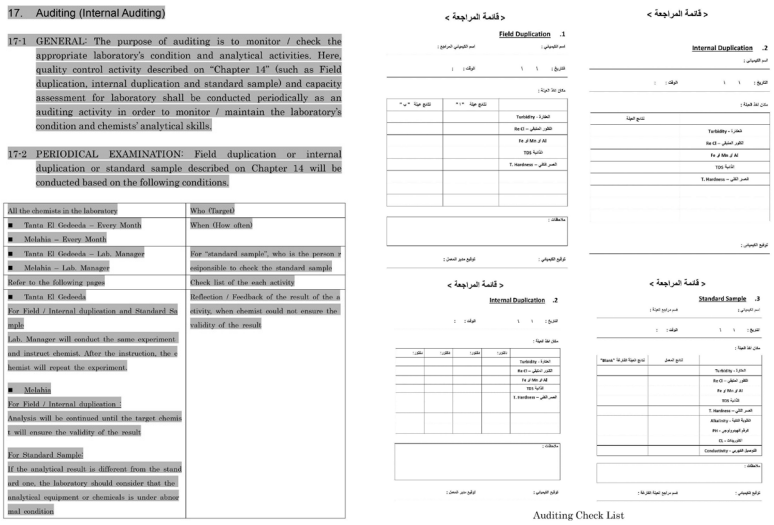
(3) Developing Water Quality Management

As for water quality management, C/P team checked the capacity of the laboratory, such as personnel organization, examination items, possession of analytical instruments, sampling frequency, etc., in order to prepare for SOP at the model facility in the first year. Moreover, a chemist of the central laboratory in GHAPWASCO was added to the C/P team. C/P team implemented the following activities relating to water quality management.

Joint training for development and implementation of SOP and the training for internal auditing targeting laboratory chemists were held at Zagazig SWTP in May 2011 –Dec. 2011(Phase-1) and Jan. 2012 – Feb. 2013(Phase-2). In addition, joint workshops related to water quality management were held in Gharbia and Minufia, inviting SHAPWASCO's C/P team.

The draft SOPs of quality control and laboratory for the model facility were developed based on the SOPs developed in the previous project in Jan. 2012 – Feb. 2013(Phase-2). After trials, the SOPs are finalized in May 2013 – Aug. 2014(Phase-3). The SOPs include the various sorts of recording

forms which will be used for the daily routine. The forms were customized to each facility and laboratory. Especially for SOP of laboratory, the forms of internal auditing and reporting were developed as shown in Figure 4.1-4.



Source: Project Team

Figure 4.1-4 Examples of SOP of Laboratory and the Internal Auditing Form

Using the draft SOPs and the recording forms, OJT have been implemented in the model facility since Jan. 2012 – Feb. 2013(Phase-2). C/P team instructed the chemists of model facility on usage of the SOPs and the recording forms. The forms used in the model facility are as shown in Table 4.1-12.

Table 4.1-12 Recording Forms for SWTP

Document	Contents / Purpose
SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control
SOP of Laboratory	To standardize and clarify the laboratory operation
Daily analytical record	To understand the daily/monthly variation and to check the abnormal condition
Visual check sheet	To standardize and clarify the operation procedure of the visual check
Troubleshooting	To facilitate smooth response to the troubles
Emergency report	To compile and utilize the response took in the emergency case to the future emergency cases
Emergency network	To facilitate smooth reporting when the trouble occurred
Criteria of quality control	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe
Instructions by laboratory / WPS Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations
Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	To check and keep the same analytical level among the chemists / doctors
Customer claim survey	To double-check the supplied water quality is analytically safe and customer satisfies with it
Capacity Assessment	To Audit / monitor the laboratory condition by external auditor

Source: Project Team

SWTP provides the treated water which meet Egyptian standards for drinking water. On the other

hand, even though the water quality is good at the facility, the water becomes bad in quality at the network. The customers, therefore, are not satisfied with the supplied water. Since the laboratory checks the water quality at the network periodically, C/P team proposed to survey the customer claim and compare the analytical result of the water quality with the customer's opinion. Survey report includes the recommendation, and it is shown in Supporting Report S2.11.

The progress of the SOP activities were monitored according to three performance indicators, such as 1) Effective utilization ratio of water, 2) Chemical consumption, and 3) Energy consumption, which are mentioned in the Section 4.1.1 "Basic Policy of SOP Activities" in Chapter 4. As for the water quality management, C/P team monitored the activity situation and evaluated the each recording form (refer to Figure 4.1-5).

	Activity / Format	Purpose	Applicable (if not, the reason)	Outcome (after the activity)
1	SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control	✓	Organizing and reducing the cost of operation
2	SOP of Laboratory	To standardize and clarify the laboratory operation	✓	Unifying the work procedures between all the staff
3	Daily analytical record (for SWTP and IMRP)	To understand the daily/monthly variation and to check the abnormal condition	✓	Easy way for supervising and monitoring the results of analysis
4	Visual check sheet	To standardize and clarify the operation procedure of the visual check	×	-
5	Troubleshooting	To facilitate smooth response to the troubles	×	-
6	Emergency report	To compile and utilize the response took in the emergency case to the future emergency cases	×	-
7	Emergency network	To facilitate smooth reporting when the trouble occurred	✓	Reducing the time needed to handle emergencies
8	Criteria of quality control	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	✓	Showing the criteria in a simple and easy way for easier follow up
9	Instructions by laboratory / WPS Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	✓	Making sure that the Chemical dosage is used in operation
10	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	To check and keep the same analytical level among the chemists / doctors	✓	Unifying the skills of the staff and at the same time try to improve it
11	Customer claim survey	To double-check the supplied water quality is analytically safe and customer satisfies with it	×	-
12	Capacity Assessment	To Audit / monitor the laboratory condition by external auditor.	✓	-

Source: Project Team

Figure 4.1-5 Check and Evaluation List of Water Quality Management Activity (GHAPWASCO, SWTP)

SOP team expanded the activity to the extra model facility in the Governorates. Moreover, the draft expansion plan was prepared. C/P teams commenced managing the progress for expansion of water quality management SOP, using the Check and Evaluation List as shown in Figure 4.1-6.

No.	Activity / Format	Applied facility (Example in GHAPWASCO)								
		Tanta El Teraa El Melahia WTP	Tanta El Gedeeda El Morshaha SWTP	Zefta El Morashaha WTP	Samaod SWTP	Mahalet Marhoom IMRP	El Ramleya IMRP	El Gaefareya IMRP	Seberbay Well Facility	Shobra Beel Well Facility
1	SOP of Quality Control	√	√	√	√	√	√	√	√	√
2	SOP of Laboratory	√	√	√	√					
3	Daily analytical record (for SWTP and IMRP)	√	√	√	√	√	√	√	√	√
4	Visual check sheet	√	√	√	√	√	√	√	√	√
5	Troubleshooting	√	√	√	√	√	√	√	√	√
6	Emergency report	√	√	√	√	√	√	√	√	√
7	Emergency network	√	√	√	√	√	√	√	√	√
8	Criteria of quality control									
9	Instructions by laboratory / WPS Operation for Chlorine dosage									
10	Auditing - 1) Field duplication, 2) Internal duplication, 3) Standard sample	√	√	√	√					
11	Customer claim survey									
12	Capacity Assessment									

Source: Project Team

Figure 4.1-6 Expansion Plan of Water Quality Management Activity

As a result of the water quality management activity, the laboratory of the model facility became possible to report the emergency case systematically utilizing the SOPs and the forms. Moreover, the laboratory became possible to monitor the water quality variation according to time, using the daily analysis form. The visualized criteria of quality control could contribute to the smooth implementation of the routine work (refer to Outcome on Figure 4.1-5).

4.1.3.2 Iron Manganese Removal Plant in GHAPWASCO

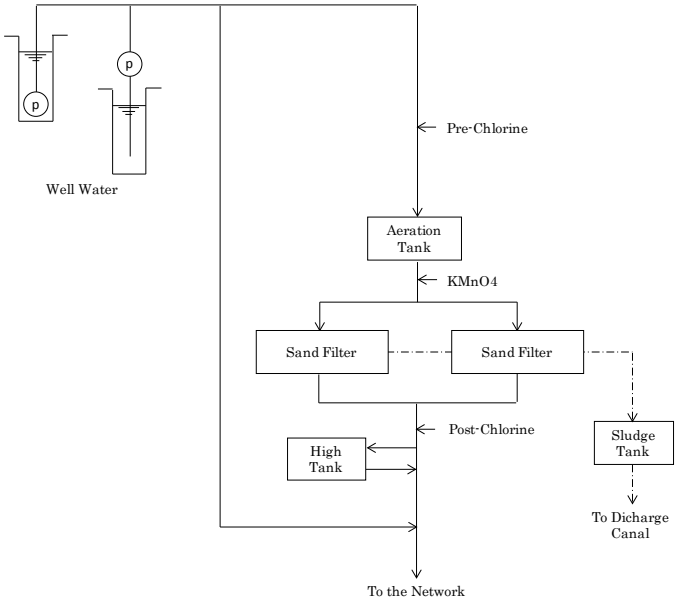
(1) Summary of Model Facility

Model facility of IMRP in GHAPWASCO is Mahalet Marhoom IMRP which is located in the west side of Gharbia Governorate. General information of the facility is as follows;

General information

- Capacity : 2,400 m^3/day- Design Capacity
  (1,500 m^3/day- Actual Production)
- Water source : Well water
- Covered Area : 3 villages (Mahalet Marhoom, El Groharia, Kafr El Arab)
- Service population : Approx. 1,500 people
- Establishment : Year 1968 (Expanded in year 2010)

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-7 Schematic Water Flow and Facility Component of Mahalet Marhoom IMRP

(2) Applying SOP to Operation and Maintenance Activities

The site training in Mahalet Marhoom IMRP has conducted along with following themes.

Table 4.1-13 Major Training Themes in Mahalet Marhoom IMRP

No.	OJT Training Themes
1	**Monitoring of water quality at the site** In iron and manganese removal plants which are comparatively small in capacity, water quality had not measured even if for major items, such as residual chlorine, soluble manganese, etc. Through the OJT training, measurement activity of residual chlorine and soluble manganese, which are the minimum items for the Plant, was introduced in routine work.
2	**Reduction of potassium permanganate consumption** In order to keep sufficient quality to satisfy the Egyptian Water Quality Standards, green sand is used as filter media for the removal of iron and manganese. Potassium permanganate is indispensable for the re-generation of green sand. At the present, re-generation by potassium permanganate is conducted every two (2) days after backwash. However, the frequency can be extended as long as the concentration of manganese at the filter outlet doesn't exceed the standard (0.4mg/L). The activity to reduce potassium permanganate consumption was conducted.
3	**Reduction of calcium hypochlorite consumption** Constant and excessive amount of calcium hypochlorite liquid had been dosed into treated water even if the treated water volume is fluctuated. Accordingly, proper adjusting method of calcium hypochlorite dosing pump, which is adjusted by the operation numbers of pump, was established in order to reduce consumption.
4	**Reduction of water loss** A huge volume of well water had wasted by over flow from aeration tank. In order to reduce the water loss, the operation schedule was modified and coordinated for well pumps and aeration tank.

Source: Project Team

Improvement Effect to the Achievement of PI

Summary of activity result is as shown in Table 4.1-14 and Figure 4.1-8.

Table 4.1-14 Output for the SOP Activities in Mahalet Marhoom IMRP

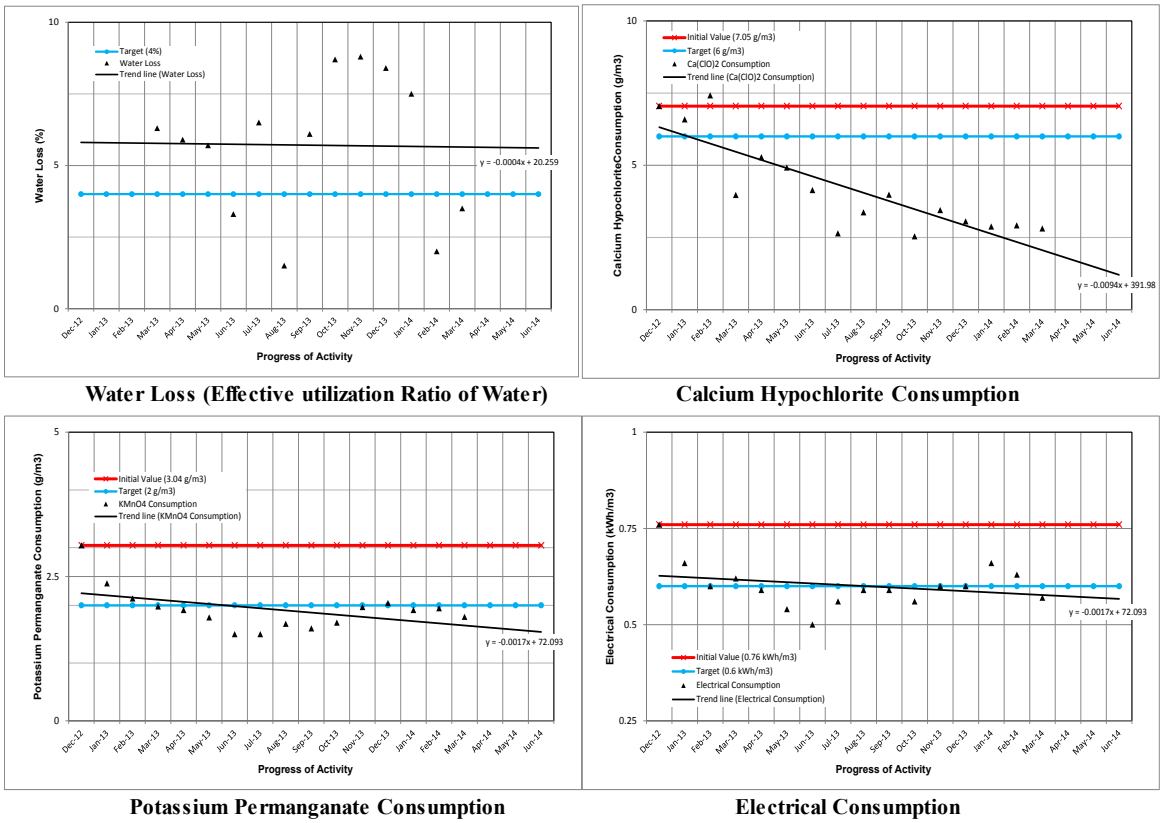
	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Calcium Hypochlorite (g/m^3)	Potassium Permanganate (g/m^3)	
Initial Value	**-**	**7.05**	**3.04**	**0.76**
Target Setting	**96.0**	**6.00**	**2.00**	**0.60**
Month	Monthly Average Value			
Dec 2012	N/A	7.05	3.04	0.76
Jan 2013	N/A	6.59	2.38	0.66
Feb 2013	N/A	7.42	2.12	0.60
Mar 2013	93.7	3.97	1.98	0.62
Apr 2013	94.1	5.28	1.92	0.59
May 2013	94.3	4.92	1.79	0.54
Jun 2013	96.7	4.14	1.50	0.50
Jul 2013	93.5	2.64	1.50	0.56
Aug 2013	98.5	3.37	1.68	0.59
Sep 2013	93.9	3.98	1.60	0.59
Oct 2013	91.3	2.54	1.70	0.56
Nov 2013	91.2	3.45	1.97	0.60
Dec 2013	91.6	3.06	2.04	0.60
Jan 2014	92.5	2.88	1.92	0.66
Feb 2014	98.0	2.92	1.95	0.63
Mar 2014	96.5	2.81	1.80	0.57
Apr 2014	N/A	N/A	N/A	N/A
May 2014	N/A	N/A	N/A	N/A
Jun 2014	N/A	N/A	N/A	N/A
Output Value[*1]	**95.7**	**2.87**	**1.89**	**0.62**
Evaluation[*3]	○[*2]	◎	◎	○

[*1)] Output value is average from January2014 to March 2014.

[*2)] Achievement level for effective utilization ratio of water is temporally evaluated by comparison of earliest data recorded on March 2013.

[*3)] Marking : ◎=Sufficient, ○=Satisfactory, △=further improvement is expected

Source: Project Team



Water Loss (Effective utilization Ratio of Water) | **Calcium Hypochlorite Consumption**

Potassium Permanganate Consumption | **Electrical Consumption**

Source: Project Team

Figure 4.1-8 Output for the SOP Activities in Mahalet Marhoom IMRP

Iron manganese removal plants in GHAPWASCO face the shortage of manpower and technical skills on water treatment, in comparison with surface water treatment plants. However, capability of facility staffs has much improved through the Project activities. It is confirmed by the improvement of PIs.

Nevertheless, PIs are not calculated properly in March 2015 since cables were stolen and the facility is under repair.

Obstructive Factor for Achieving PI

The ultrasonic flow meter, which is for the measurement of water distribution volume, has to be calibrated at short interval due to deterioration. Moreover, effective utilization ratio has not been calculated since April 2014 due to the breakage and the repair of the flow meter.

The reason of large fluctuation of the monitored effective utilization ratio is supposed by the low accuracy of flow meter.

(3) Developing Water Quality Management

Water quality management activity in IMRP is similar to the activity in SWTP. C/P team implemented a series of activities for SOP However, C/P team instructed the operators at this facility to check the Residual Chlorine, Iron and Manganese, since there is no laboratory in this model facility. OJT is also implemented toward improvement of the operators. The forms used

in the model IMRP are as shown in Table 4.1-15.

Table 4.1-15 Recording Forms for IMRP (GHAPWASCO)

Document	Contents / Purpose
SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control
Daily analytical record	To understand the daily/monthly variation and to check the abnormal condition
Criteria of quality control	To visualize and specify the criteria of Turbidity, residual chlorine, Aluminum, Mn and Fe
Instructions by laboratory / Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations

Source: Project Team

As for the above mentioned forms, C/P team monitored the activity situation and evaluated the each recording form in Mar. 2013 – Aug. 2014(Phase-3) (refer to Figure 4.1-9).

	Activity / Format	Purpose	Applicable (if not, the reason)	Outcome (after the activity)
1	SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control	✓	Organizing and reducing the cost of operation
2	SOP of Laboratory	To standardize and clarify the laboratory operation	× **(No Laboratory)**	-
3	Daily analytical record (for SWTP and IMRP)	To understand the daily/monthly variation and to check the abnormal condition	✓ **(Only Re Cl and Mn are checked)**	Easy way for supervising and monitoring the results of analysis
4	Visual check sheet	To standardize and clarify the operation procedure of the visual check	×	-
5	Troubleshooting	To facilitate smooth response to the troubles	×	-
6	Emergency report	To compile and utilize the response took in the emergency case to the future emergency cases	×	-
7	Emergency network	To facilitate smooth reporting when the trouble occurred	×	-
8	Criteria of quality control	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	✓	Based on the instruction by C/P, Re Cl and Mn are checked and compared with the criteria by operator. In case the Re Cl and Mn exceeds the criteria(less or more) they could report immediately and directly to Laboratory.
9	Instructions by laboratory / WPS Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	✓	
10	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	To check and keep the same analytical level among the chemists / doctors	× **(No Laboratory)**	-
11	Customer claim survey	To double-check the supplied water quality is analytically safe and customer satisfies with it	× **(Customer claim is collected via "Hotline 125")**	-
12	Capacity Assessment	To Audit / monitor the laboratory condition by external auditor.	× **(No Laboratory)**	-

Source: Project Team

Figure 4.1-9 Check and Evaluation List of Water Quality Management Activity (GHAPWASCO, IMRP)

As a result of the water quality management activity, treated water quality was routinely monitored by the operators and the C/P team. Moreover, the laboratory has monitored the water quality variation, using the daily analysis form. The monitoring system of water quality is enhanced through the mentioned activities (refer to Outcome on Figure 4.1-9).

4.1.3.3 Well Station in GHAPWASCO

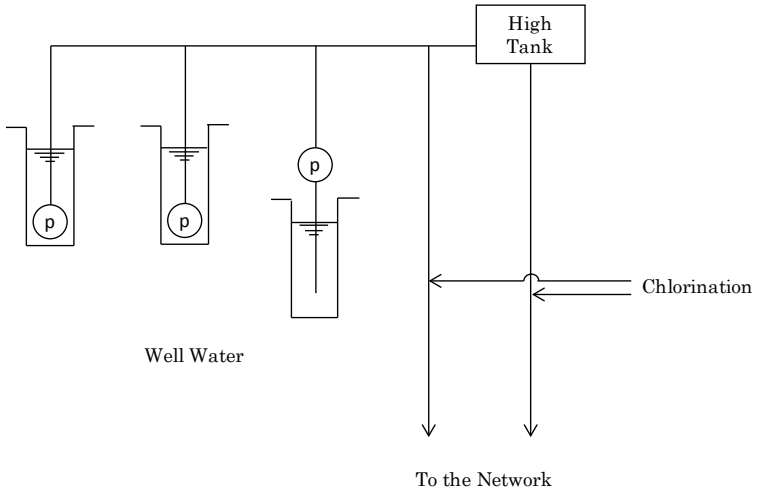
(1) Summary of Model Facility

Model facility of the Well Station in GHAPWASCO is Seberbay Well Station which is located in the northern part of Tanta. General information of the facility is as follows;

General information

- Capacity : 3,700 m^3/day- Nominal Capacity
- Water source : Well water
- Service population : Approx. 40,000 people
- Establishment : Year 1956 (Expanded in year 2007, 2008 and 2013)

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-10 Schematic Water Flow and Facility Component of Seberbay Well Station

(2) Preparation of SOP for Operation and Maintenance of Well and Well Station

Draft SOPs were arranged based on the SOPs developed by the previous project in Sharkiya. Through the trial program of draft SOPs and the confirmation of effectiveness at the site, SOPs were finalized in Mar. 2013 – Aug. 2014(Phase-3). Activity process in the model facility is summarized as follows;

STEP-1	**Rehabilitation of flow meters for checking water extraction volume from wells** Two (2) submersible pumps were installed and operated in the Seberbey Well Station from the beginning of the Project. Since large measurement errors were found on the existing flow meters, they were repaired prior to the commencement of activity.
STEP-2	**Installation of flowmeters and pressure gauges for measuring water distribution volume and pressure from the well station** Well water is distributed to three (3) service areas by three (3) pipelines. However, no flowmeters and pressure gauges had been installed in each line. Accordingly, three (3) flowmeters and pressure gauges were installed respectively.
STEP-3	**Implementation of pumping test for checking yield capacity of well** Pumping test was carried out to check the water extraction capability for two (2) wells. At the pumping test, yield capacities were examined by following two cases;

	(1) Individual operation (2) Simultaneous operation by two (2) wells
STEP-4	**Rehabilitation of wells** By the result of activity in Step-3, it was identified that one of two wells was less in extraction volume. As a result of the examination, it was confirmed that many small pits and/or holes on the riser pipe due to corrosion caused the shortage of the extraction volume. After replacement of riser pipe, the extraction volume was recovered.
STEP-5	**Recording of water extraction and distribution volume** In this well station, although daily water extraction volume from each well had been recorded before the commencement of the Project, distribution volume was not managed and recorded. Accordingly, following instructions were provided toward the preparation of appropriate well operation schedule, and preparation and application of SOP; (1) To record hourly water extraction volume from each well (2) To record hourly distribution volume to each service area
STEP-6	**Examination of appropriate well operation schedule and preparation of draft SOP** Based on the result of activity in Step-5 and hydraulic analysis, appropriate well operation schedule was examined and draft SOPs were prepared, taking into consideration the hourly fluctuation of water demand in each service area.
STEP-7	**Trial operation based on the Draft SOPs** Monitoring and analyzing the effectiveness of well operation, SOPs for well pump and chlorination system were finalized in accordance with realistic operation procedures. As a result, SOPs were completed for practical operation.

(3) Technical Transfer regarding Operation of Well Station

Through the aforementioned activities, implementation procedure and necessity of each activity have been transferred by JET, along with compiling the SOP documents regarding operation methods for the well station. C/P team recognized following necessary points for the operation and maintenance of the well from the view point of safety and economic efficiency.

- Utilization of operation records
- Improvement of well operation system which was being operated by experienced practice

There are around 200 well stations in GHAPWASCO. It is expected that C/P team extends the activity and effectiveness gained through the Project to well stations other than model facility, and promotes safe, economical and stable water supply to the customer.

(4) Hydraulic Analysis

The Purpose of hydraulic analysis is to assist a preparation of operation plan for pumps of the model Well Station. Activity has been done in accordance with following procedure.

(a) Operation Condition for the Well Facility

Seberbay well station covers three (3) water service areas, named Supply-1, Supply-2 and Supply-3.

After examining the fluctuation of water demand based on the record on hourly water extraction volume from the well and the distribution volume to each service area, which are collected by C/P team as a part of the well improving activities, it was confirmed that peak time of the water demand is from 8:00 to 22:00. The night period from 23:00 to 7:00 is categorized as low demand time. Although two (2) well pumps constantly were being operated in this facility, the operation schedule for the well pumps is assumed for the hydraulic analysis as follows;

- Period in High water demand: 2 duties
- Period in Low water demand: 1 duty, and a stand-by

(b) Hydraulic Analysis

Hydraulic analysis should be conducted, considering the hourly fluctuation of water demand. As a result of the simulation predicting the change of water demand by the Water-CAD, it was confirmed that water pressure is secured at more than 3.0 bar for the end of water network at any period of time. Water pressure at the end of water network is recommended to be more than 2.0 bar at minimum because most of buildings in water service area are in 3 to 4-story. Accordingly, operation schedule of pumps was officially determined as following table;

Operation Period	Operation Nos. of Pump
8:00 - 22:00	2 duties
22:00 - 8:00	1 duty, and 1 stand-by

(c) Verification of the Hydraulic Analysis Result

In order to verify the result of hydraulic analysis, hourly fluctuation of water demand and water distribution pressure in each service area was monitored by portable ultrasonic flow meter and pressure gauge, with the cooperation of NRW team. As a result, it was verified that there was no large difference between actual operation and the simulation result. In addition, C/P team learned data collection methods by flow meters and pressure gauges.

(d) Future Task

C/P team learned how to use the Water-CAD and how to utilize it for planning the well operation schedule, through the hydraulic analysis activity. It is expected that comprehensive hydraulic analysis for water networks including IMRPs and SWTPs will be done in the near future.

(5) Developing Water Quality Management

Water quality management activity in the well station is similar to the activity in other types of facilities. C/P team implemented a series of SOP activities. However, C/P team instructed the operators at the facility to check the Residual Chlorine, since there is no laboratory in this model facility. OJT, such as operation of chlorine dosage, is also implemented for the operators. The forms used in the model well station are as shown in Table 4.1-16.

Table 4.1-16 Recording Forms for the Well Station (GHAPWASCO)

Document	Contents / Purpose
SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control
Criteria of quality control	To visualize and specify the criteria of Turbidity, residual chlorine, Aluminum, Mn and Fe
Instructions by laboratory / Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations

Source: Project Team

As for the above mentioned forms, C/P team monitored the activity situation and evaluated the each recording form in Mar. 2013 – Aug. 2014(Phase 3) (refer to Figure 4.1-11).

	Activity / Format	Purpose	Applicable (if not, the reason)	Outcome (after the activity)
1	SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control	✓	-
2	SOP of Laboratory	To standardize and clarify the laboratory operation	× **(No Laboratory)**	-
3	Daily analytical record (for SWTP and IMRP)	To understand the daily/monthly variation and to check the abnormal condition	× **(Only Re Cl is checked)**	-
4	Visual check sheet	To standardize and clarify the operation procedure of the visual check	×	-
5	Troubleshooting	To facilitate smooth response to the troubles	×	-
6	Emergency report	To compile and utilize the response took in the emergency case to the future emergency cases	×	-
7	Emergency network	To facilitate smooth reporting when the trouble occurred	×	-
8	Criteria of quality control	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	✓	Based on the instruction by C/P, Re Cl is checked and compared with the criteria by operator. In case the Re Cl exceeds the criteria(less or more) they could report immediately and directly to Laboratory.
9	Instructions by laboratory / WPS Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	✓	
10	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	To check and keep the same analytical level among the chemists / doctors	× **(No Laboratory)**	-
11	Customer claim survey	To double-check the supplied water quality is analytically safe and customer satisfies with it	× **(Customer claim is collected via "Hotline 125")**	-
12	Capacity Assessment	To Audit / monitor the laboratory condition by external auditor.	× **(No Laboratory)**	-

Source: Project Team

Figure 4.1-11 Check and Evaluation List of Water Quality Management Activity (GHAPWASCO, Well Station)

As a result of the water quality management activity, treated water quality was routinely monitored by the operators and the C/P team. The Project activity contributed to the appropriate chlorine dosage and improvement of operational efficiency. (Refer to Outcome on Figure 4.1-11)

4.1.3.4 Surface Water Treatment Plant in MCWW

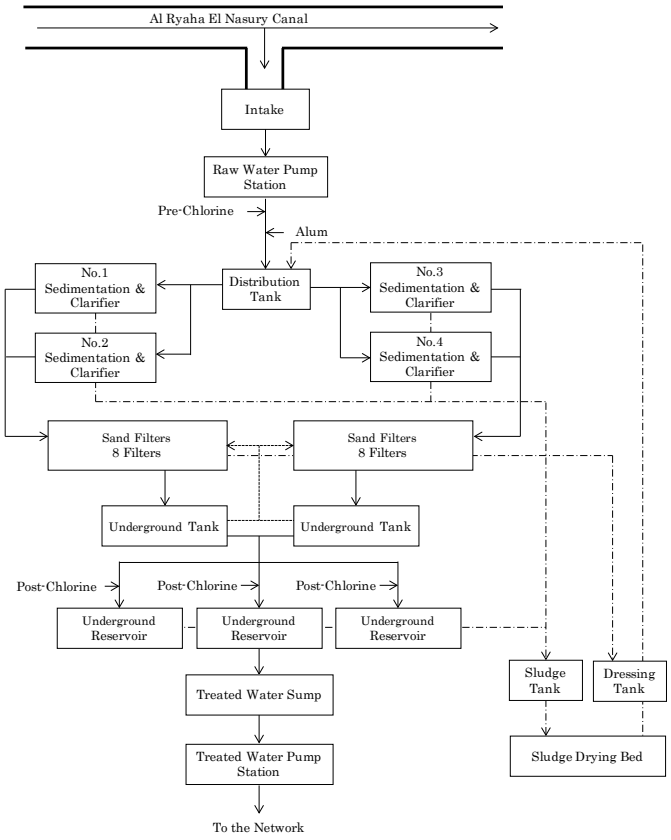
(1) Summary of Model Facility

Model facility of SWTP in MCWW is Mahatet El Sadat El Satheya SWTP which is located in the south west of Minufia Governorate. General information of the facility is as follows;

General information

- ◆ Capacity : 102,000 m^3/day- Design Capacity (50,860 m^3/day- Actual Production)
- ◆ Water source : Alriah El Nasery Canal
- ◆ Covered Area : El Sadat city
- ◆ Service population : Approx. 50,000 people
- ◆ Establishment : Year 2009

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-12 Schematic Water Flow and Facility Component of Mahatet El Sadat El Satheya SWTP

(2) Applying SOP to Operation and Maintenance Activities

The site training in Mahatet El Sadat El Satheya SWTP was conducted along with following themes and approaches after the explanation of water treatment theory based on draft SOPs.

Table 4.1-17 Major Training Themes in Mahatet El Sadat El Satheya SWTP

No.	OJT Training Themes
1	**Refill of the sand into filter** Egyptian Code for the Design and Implementation of Potable Water says "the sand layer thickness should be in a range of 50 -70 cm". However, it was found through the site examination that the thickness of sand layer in the facility was 45 cm of average. The shortage of sand layer thickness may cause the increase of turbidity in filtered water. Accordingly, the thickness of sand layer has been adjusted by additional sand.
2	**Improvement of water balance (Activation of drained water recirculation system)** The facility has a recirculation system for drained water from backwash and sludge drying bed systems. However, it has not been utilized. Utilization of recirculation system contributes to improve water balance between intake and production waters. Through the OJT training, it has been demonstrated that utilization of the system doesn't affect the water quality. Accordingly, it is recommended to utilize the system effectively.
3	**Reduction of turbidity in sedimentation tank** The flash mixer is operated for the rapid mixing of coagulant. However, floc have been grown up before the mixing tank when the turbidity is higher in raw water. Destruction of flocs by the mixer may occur. Although it should be carefully examined for different cases of raw water's turbidity depending on season, operation of flash mixer should be controlled according to fluctuation of turbidity.

Source: Project Team

Improvement Effect to the Achievement of PI

Summary of activity result is as shown in Table 4.1-18 and Figure 4.1-13.

Table 4.1-18 Output for the SOP Activities in Mahatet El Sadat El Satheya SWTP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Initial Value	**88.0**	**9.20**	**26.00**	**0.45**
Target Setting	**92.0**	**6.50**	**18.00**	**0.36**
Month	Monthly Average Value			
Sep 2012	88.0	9.20	26.00	0.45
Oct 2012	90.0	8.50	24.00	0.42
Nov 2012	90.0	7.50	22.00	042
Dec 2012	88.6	6.56	22.60	0.36
Feb 2013	90.4	6.41	20.00	0.41
Mar 2013	92.5	6.02	16.00	0.41
Apr 2013	91.2	6.00	18.00	0.39
May 2013	91.0	6.20	18.00	0.38
June 2013	91.0	6.70	20.00	0.37
July 2013	90.5	6.30	35.00	0.36
Aug 2013	92.0	6.20	26.00	0.38
Sep 2013	93.0	6.50	24.00	0.35
Oct 2013	92.0	6.60	22.00	0.37
Nov 2013	92.0	7.00	20.00	0.36
Dec 2013	91.0	7.00	20.00	0.37
Jan 2014	91.0	6.90	22.00	0.40
Feb 2014	89.0	8.10	28.50	0.30
Mar 2014	94.6	7.68	49.10	0.42

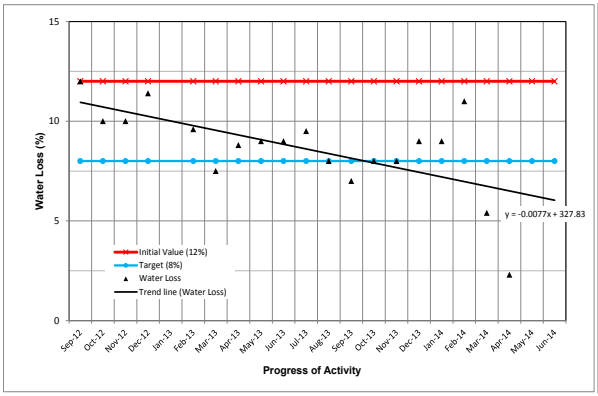
	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Liquid Aluminum Sulfate (g/m^3)	
Apr 2014	97.7	6.51	30.80	0.39
May 2014	N/A	6.58	52.67	0.33
Jun 2014	N/A	6.32	54.14	0.36
Output Value*1	**93.8**	**6.47**	**25.30**	**0.36**
Evaluation*2	◎	◎	○	◎

*) Due to the inaccuracy of flow meter and suspension of water treatment system, it was impossible to obtain the data in January 2013.

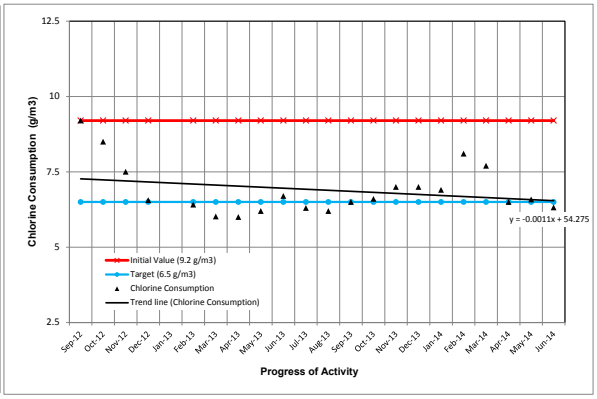
*1) Output value is average from April 2014 to May 2014, except for effective utilization ratio of water and liquid Aluminum Sulfate consumption.
(Effective utilization ratio of water: Average from February 2014 to April 2014,
Liquid Aluminum Sulfate consumption: Average from January 2014 to February 2014)

*2) Marking : ◎=Sufficient, ○=Satisfactory, △=further improvement is expected

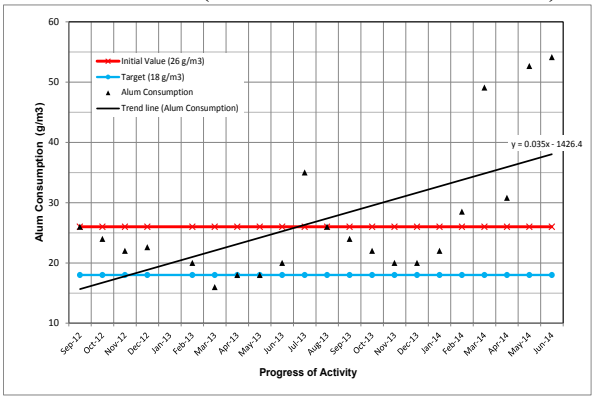
Source: Project Team



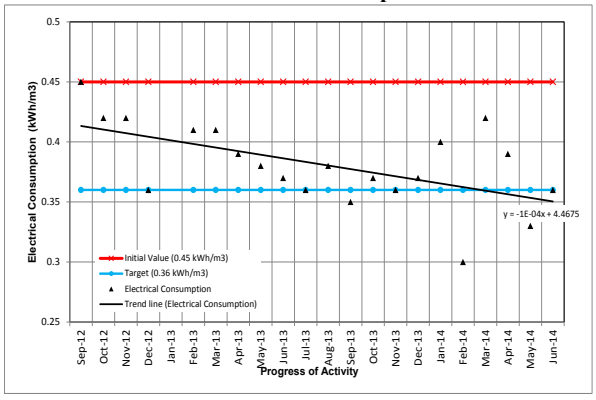
Water Loss (Effective utilization Ratio of Water)



Gaseous Chlorine Consumption



Liquid Aluminum Sulfate Consumption



Electrical Consumption

Source: Project Team

Figure 4.1-13 Output for the SOP Activities in Mahatet El Sadat El Satheya SWTP

Facility staffs were highly motivated for the improvement of facility operation, and a chain of command for the operation and maintenance activity were established sufficiently under the facility manager. Although there are items that were not achieved for the target, it was confirmed that excellent improvement has been confirmed by improvement of PIs.

Obstructive Factor for Achieving PI

i) As well as a water source in GHAPWASCO, it is considered as one of the obstacles to the achievement of PI that a liquid Alum dosing rate becomes worse from the end of winter to early summer due to the degradation of raw water quality. Mahatet El Sadat El Satheya SWTP takes raw water from the canal, which branches before the flow regulating gate in north Cairo. It is, therefore, influenced by the heavy rain occurring in the Upper-Egypt, and it is known that the raw water quality rapidly becomes worse than other surface water treatment facilities. Since a heavier storms hit the Upper-Egypt in year 2014, the liquid Alum consumption much increased from March by degradation of raw water quality. The analysis of the relation between raw water quality and Alum dosing rate should be carefully managed through continuous monitoring, and the target should be modified according to the data. It will lead the PI to improvement.

ii) In addition, a coagulant used in MCWW has changed from Solid Alum to Liquid one in summer of 2013. Due to this reason, Alum dosing volume temporary increased because facility staffs couldn't respond to the sudden change of management methods for solution concentration, dosing volume, etc.

iii) Due to the brakeage and the repair of ultrasonic flow meter, which is for the measurement of raw water volume, PI monitoring was suspended from April to May 2014.

(3) Developing Water Quality Management

Water quality management activities in SWTP are similar to ones in GHAPWASCO. A chemist of the laboratory department in MCWW was added to the SOP team (C/P team). C/P team implemented the water quality management using the SOPs and the forms which are similar to ones of GHAPWASCO (refer to Table 4.1-14). C/P team monitored the activity and evaluated the each recording form in Mar. 2013 – Aug. 2014(Phase 3) (refer to Figure 4.1-14).

Outcome (after the activity)	Applicable (if not, the reason)	Purpose	Activity / Format	
This activity contributed to the application of SOP in reducing the consumption of chemicals, such as reducing the dose of chlorine and alum	√	To standardize and clarify the operation procedure regarding quality control	SOP of Quality Control	1
	√	To standardize and clarify the laboratory operation	SOP of Laboratory	2
	√	To understand the daily/monthly variation and to check the abnormal condition	Daily analytical record (for SWTP and IMRP)	3
The use of emergency sheet results to discover a high turbidity in the clarifiers one in March 2014 and it so stopped it and then make necessary maintenance work and then take it back to work again	√	To standardize and clarify the operation procedure of the visual check	Visual check sheet	4
	√	To facilitate smooth response to the troubles	Troubleshooting	5
	√	To compile and utilize the response took in the emergency case to the future emergency cases	Emergency report	6
	√	To facilitate smooth reporting when the trouble occurred	Emergency network	7
	√	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	Criteria of quality control	8
	-	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	Instructions by laboratory / WPS Operation for Chlorine dosage	9
Contributing to this application is to make sure the efficiency of chemists in the WTP's lab as well as the accuracy of the analysis conducted by the WTP's lab. Work experiences are among chemists who are in the lab every month and take a sample and analyzed by four chemists were discovered substantial convergence in the results. This laboratory of the plant. Either outside the scope of the WTP's lab there were exchanging between WTP's labs all over the governorate for example: the lab of Shebin SWTP had send a sample to a laboratory of Sadat SWTP and the work required analysis found substantial convergence between the results	√	To check and keep the same analytical level among the chemists / doctors	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	10
	The work of a field survey of customer complaints which done by members of the HQ-C/P team on 2012 was good, but did not continued, and we are going to recommend to the continuation of this activity by the new SOP department.	To double-check the supplied water quality is analytically safe and customer satisfies with it	Customer claim survey	11
	√	To Audit / monitor the laboratory condition by external auditor.	Capacity Assessment	12

Source: Project Team

Figure 4.1-14 Check and Evaluation List of Water Quality Management Activity (MCWW, SWTP)

As a result of the water quality management activity, utilizing the forms, such as visual check sheet, an emergency report led to early detection of the emergency case (high turbidity in the clarified water). The emergency report is prepared in order to accumulate the past responses against the emergency case. Moreover, internal auditing based on the joint training has been implemented periodically. It contributed to sustain the appropriate analysis skill of chemists (refer to Outcome on Figure 4.1-14).

In addition, C/P members serve in the training institution of MCWW to train new laboratory chemist and to introduce the Project. It is considered as a self-reliant activity of MCWW. Training contents are as shown in Table 4.1-19.

Table 4.1-19 Training Contents at the Training Institution of MCWW

Purpose	Instruct the students of high technical water school (grade : senior) for the laboratory work and the facility in MCWW
Teaching Content	Technology of purification for potable water (surface water and well water) - Chemical experiments Including introduction of JICA project (SOP) and its activity, effort and result, such as chemical dosage
Frequency	Twice a week (5hours a week), Every Tuesdays and Wednesdays
School Term	October 2013 to June 2014
Number of Students	31
Place	High technical water school in Quesna Markaz (in cooperation with Ministry of Education)

Source: Project Team

4.1.3.5 Iron Manganese Removal Plant in MCWW

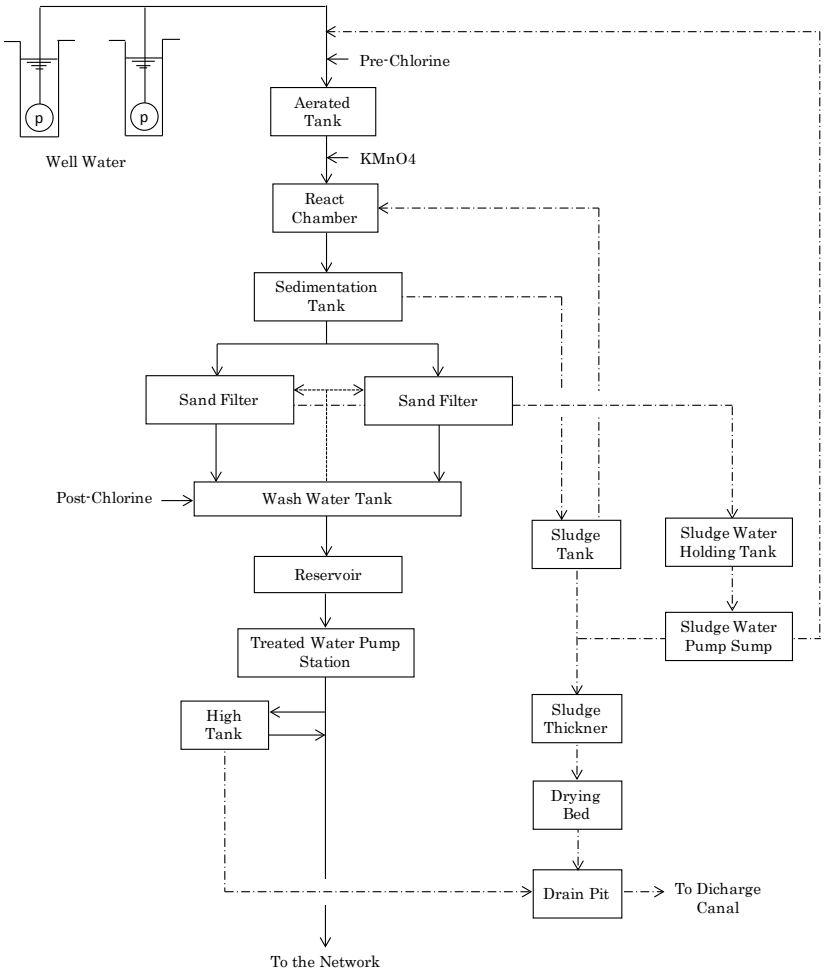
(1) Summary of Model Facility

Model facility of IMRP in MCWW is Gezy IMRP which is located in the south west of Minufia Governorate. General information of the facility is as follows;

General information

- Capacity : 2,160 m^3/day- Design Capacity
  (1,800 m^3/day- Actual Production)
- Water source : Well water
- Covered Area : Mainly 1 village (Gezy) and some other small villages
- Service population : Approx. 40,000 people
- Establishment : Year 2009

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-15 Schematic Water Flow and Facility Component of Gezy IMRP

(2) Applying SOP to Operation and Maintenance Activities

The site training in Gezy IMRP was conducted along with following themes and approaches after the explanation of water treatment theory based on draft SOPs.

Table 4.1-20 Major Training Themes in Gezy IMRP

No.	OJT Training Themes
1	**Improvement of chemical consumption** Aeration process accelerates consumption of chlorine in water. Accordingly, this activity aims at adjusting chlorine and potassium permanganate consumption properly by changing the order of treatment process. As a result of this activity, potassium permanganate consumption was reduced through oxidation by chlorine.
2	**Improve of filter runtime** In order to improve filter runtime, the activity for the water loss reduction to sand filter is required. It was conducted by following approaches. (1) Proper drainage of Sediment in Sedimentation Tank (2) Adjustment of weir level in Sedimentation Tank
3	**Improvement of water balance (Activation of drained water recirculation system)** As well as the activity in Mahalet El Sadat El Satheya SWTP, the utilization of the system did not affect the water quality. Accordingly, it is recommended to utilize the system effectively.

Source: Project Team

Improvement Effect to the Achievement of PI

Summary of activity result is as shown in Table 4.1-21 and Figure 4.1-16.

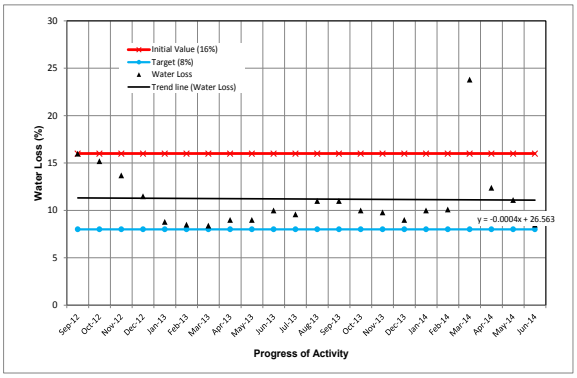
Table 4.1-21 Output for the SOP Activities in Gezy IMRP

	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Potassium Permanganate (g/m^3)	
Initial Value	**84.0**	**3.50**	**2.00**	**0.80**
Target Setting	**92.0**	**6.50**	**1.00**	**0.50**
Month	Monthly Average Value			
Sep 2012	84.0	3.50	2.00	0.80
Oct 2012	84.8	4.03	1.61	0.81
Nov 2012	86.3	6.40	1.07	0.80
Dec 2012	88.5	6.00	0.91	0.80
Jan 2013	91.2	6.30	1.09	0.76
Feb 2013	91.5	6.80	1.17	0.80
Mar 2013	91.6	6.80	1.08	0.80
Apr 2013	91.0	7.00	1.10	0.81
May 2013	91.0	6.50	0.96	0.79
June 2013	90.0	6.90	0.99	0.75
July 2013	90.4	6.40	0.94	0.77
Aug 2013	89.0	6.50	0.95	0.76
Sep 2013	89.0	6.50	1.00	0.80
Oct 2013	90.0	6.06	1.02	0.79
Nov 2013	90.2	6.50	1.07	0.76

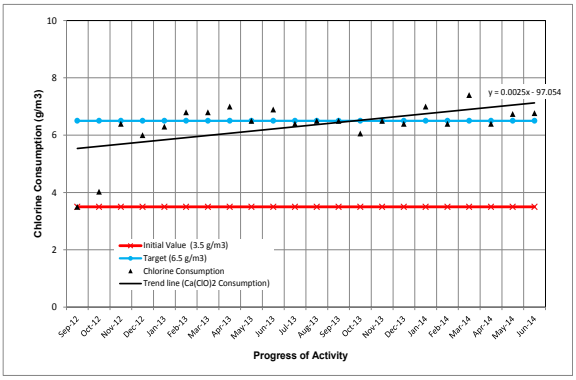
	Effective utilization Ratio of Water (%)	Unit consumption of Chemicals		Energy Consumption (kWh/m^3)
		Gaseous Chlorine (g/m^3)	Potassium Permanganate (g/m^3)	
Dec 2013	91.0	6.40	1.03	0.75
Jan 2014	90.0	7.00	0.98	0.79
Feb 2014	89.9	6.37	0.95	0.83
Mar 2014	76.2	7.40	1.09	0.94
Apr 2014	87.6	6.44	1.00	0.80
May 2014	88.9	6.74	0.93	0.80
Jun 2014	91.5	6.77	0.91	0.76
Output Value*1	**89.3**	**6,65**	**0.95**	**0.79**
Evaluation*2	○	○	◎	○

*1) Output value is average from April 2014 to May 2014.
*2) Marking : ◎=Sufficient, ○=Satisfactory, △=further improvement is expected

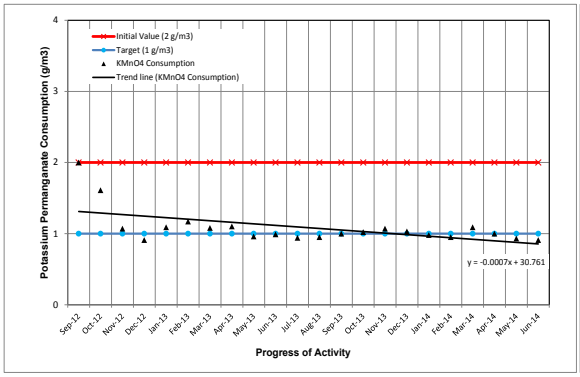
Source: Project Team



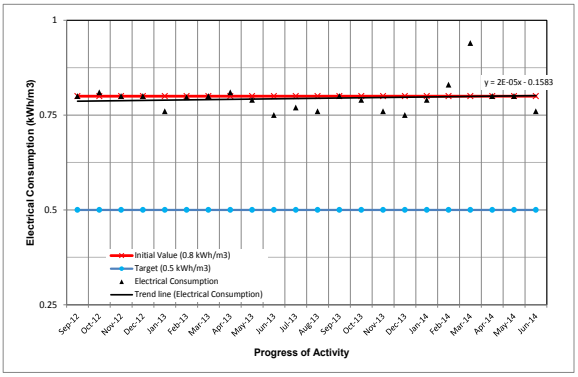
Water Loss (Effective utilization Ratio of Water)



Gaseous Chlorine Consumption



Potassium Permanganate Consumption



Electrical Consumption

Source: Project Team

Figure 4.1-16 Output for the SOP Activities in Gezy IMRP

Although there are items, which are not achieved for the target, PIs tend to be improved toward the target. It is therefore expected that the facility achieve the target by continuous activities in the future.

Market price of the potassium permanganate suddenly increased to 130 LE/kg on February 2014. Accordingly, the PI target for the chemical consumption should be urgently reviewed for the further reduction of annual cost.

This iron and manganese removal system is designed by German technology, and MCWW has

several facilities similar to Gezy IMRP.

Obstructive Factor for Achieving PI

i) Pumping head for the well pump is too large for required head. The reason is supposed that direct distribution was planned from well to network in the design stage. However, the well water should be treated. The large pump is not necessary. At a present, MCWW is preparing replacement of pump with proper one.

ii) The obstacles to the achievement of effective utilization ratio of water are supposed that the activation of drained water recirculation system was delayed in a schedule. In case that the system is operated effectively, PI achievement is expected.

iii) Utilization ratio of water much decreased on March 2014. This was caused by a large amount of water leakage due to the breakage of raw water pipeline.

(4) Developing Water Quality Management

Water quality management activities in IMRP are similar to ones in GHAPWASCO. C/P team implemented a series of SOP activities. Since model facility has the small laboratory and there is a chemists in the facility, the recording forms was customized according to the management conditions. The forms used in the model IMRP are as shown in Table 4.1-22.

Table 4.1-22 Recording Forms for IMRP (MCWW)

Document	Contents / Purpose
SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control
Daily analytical record	To understand the daily/monthly variation and to check the abnormal condition
Visual check sheet	To standardize and clarify the operation procedure of the visual check
Troubleshooting	To facilitate smooth response to the troubles
Emergency report	To compile and utilize the response took in the emergency case to the future emergency cases
Emergency network	To facilitate smooth reporting when the trouble occurred
Criteria of quality control	To visualize and specify the criteria of Turbidity, residual chlorine, Aluminum, Mn and Fe
Instructions by laboratory / Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations
Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	To check and keep the same analytical level among the chemists / doctors
Capacity Assessment	To Audit / monitor the laboratory condition by external auditor

Source: Project Team

As for the above mentioned forms, C/P team monitored the activity and evaluated the each recording form in Mar. 2013 – Aug. 2014(Phase-3) (refer to Figure 4.1-17).

Outcome (after the activity)	Applicable (if not, the reason)	Purpose	Activity / Format	
This activity contributed to increase the laboratory sufficient and ability to adjust the dose of chlorine and permanganate.	√	To standardize and clarify the operation procedure regarding quality control	SOP of Quality Control	1
	As the laboratory of the WTP depending on the facility operation, thus we shall follow the facility' SOP X	To standardize and clarify the laboratory operation	SOP of Laboratory	2
	√	To understand the daily/monthly variation and to check the abnormal condition	Daily analytical record (for SWTP and IMRP)	3
The use of emergency sheet and visual check aiming to discover and occur any problems and documenting it.	√	To standardize and clarify the operation procedure of the visual check	Visual check sheet	4
	√	To facilitate smooth response to the troubles	Troubleshooting	5
	√	To compile and utilize the response took in the emergency case to the future emergency cases	Emergency report	6
	√	To facilitate smooth reporting when the trouble occurred	Emergency network	7
	√	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	Criteria of quality control	8
	√	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	Instructions by laboratory / WPS Operation for Chlorine dosage	9
	√	To check and keep the same analytical level among the chemists / doctors	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	10
	–	To double-check the supplied water quality is analytically safe and customer satisfies with it	Customer claim survey	11
	√	To Audit / monitor the laboratory condition by external auditor.	Capacity Assessment	12

Source: Project Team

Figure 4.1-17 Check and Evaluation List of Water Quality Management Activity (MCWW, IMRP)

As a result of the water quality management, internal auditing based on the joint training has been implemented periodically with other laboratory in MCWW. It contributes to sustain the appropriate analysis skill of chemists. Moreover, the Project activity contributed to the appropriate chlorine dosage and enhanced operational efficiency (refer to Outcome on Figure 4.1-17).

4.1.3.6 Well Station in MCWW

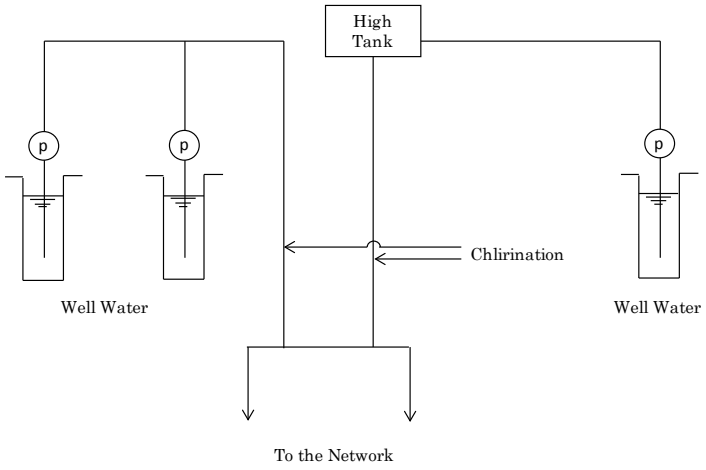
(1) Summary of Model Facility

Model facility of the Well Station in MCWW is Ashama Well Station which is located in the north part of Minufia Governorate. General information of the facility is as follows;

General information

- Capacity : 4,000 m^3/day- Design Capacity
- Water source : Well water
- Service population : Approx. 40,000 – 50,000 people
- Establishment : Year 1952 (Expanded in year 2000, 2005 and 2009)

Schematic Water Flow and Facility Component



Source: Project Team

Figure 4.1-18 Schematic Water Flow and Facility Component of Ashama Well Station

(2) Preparation of SOP for Operation and Maintenance of Well and Well Station

Main activity for the well station in MCWW was done in almost same manner as GHAPWASCO. Activity process in the model facility is summarized as follows;

STEP-1	**Installation of flow meters for checking water extraction volume from wells** Three (3) jet pumps, the horizontal pumps, were installed and operated in the Ashama Well Station from the beginning of the Project. However, water extraction volume had not been managed because no flow meters were installed in each well.
STEP-2	**Installation of flowmeters and pressure gauges for measuring water distribution volume and pressure from the well station** Well water is distributed to two (2) service areas by two (2) pipelines. However, no flowmeters and pressure gauges had been installed in each line. Accordingly, two (2) flowmeters and pressure gauges were installed respectively.
STEP-3	**Implementation of pumping test for checking yield capacity of well** Pumping test was carried out to check the water extraction capability for two (2) wells. At the pumping test, yield capacity were examined by following two cases; (1) Individual operation (2) Simultaneous operation by two (2) or three (3) wells
STEP-4	**Rehabilitation of wells** Rehabilitation work was done by the result of activity in Step-3. In addition, operation procedure of well rehabilitation was organized as SOP.
STEP-5	**Recording of water extraction and distribution volume** In this well station, daily water extraction volume from each well had been calculated by nominal capacity of pump, and distribution volume was not measured. Accordingly,

	following instructions were provided toward the preparation of appropriate well operation schedule, and preparation and application of SOP; (1) To record hourly water extraction volume from each well (2) To record hourly distribution volume to each service area
STEP-6	**Examination of appropriate well operation schedule and preparation of draft SOP** Same Activity as GHAPWASCO.
STEP-7	**Trial operation based on the Draft SOPs** Same Activity as GHAPWASCO.

(3) Technical Transfer regarding Operation of Well Station

As well as the activity result in GHAPWASCO, C/P team recognized followings necessary points for the operation and maintenance of the well from the view point of safety and economic efficiency.

- Utilization of operation records
- Improvement of well operation system which was being operated by experienced practice
  Especially, when the plural numbers of wells are operated at the same time, reduction of water extraction volume from wells will be occurred due to well interference. It is, therefore, necessary to consider combination of operation wells.
- To maintain a pumping efficiency by a periodical rehabilitation

There are around 200 well stations in MCWW. It is expected that C/P team extends the activity and effectiveness gained through the Project to well stations other than model facility. It is also expected to promote safe, economical and stable water supply to the customers by technical cooperation with GHAPWASCO and SHAPWASCO.

(4) Hydraulic Analysis

The hydraulic analysis in MCWW has been done by same procedure as GHAPWASCO.

(a) Operation Condition for the Well Facility

Ashama well station covers three (3) water service areas, which are Kafr Ashma, Ashma and El Eraqia. After examining the fluctuation of water demand based on the record on hourly water extraction volume and the distribution volume to each service area, it was confirmed that peak time of the water demand is from 8:00 to 2:00. The other hand, early morning from 3:00 to 7:00 is categorized as off-peak demand time.

Although eight (8) well pumps were installed in this station, six (6) units had not been ready for the operation due to breakage or repair. In addition, water network covered by this station is connected mutually with other networks covered by El Shohada SWTP and other well stations. Considering the above condition, single operation of pump is prioritized for hydraulic analysis, because one (1) pump may be able to cover almost the required demand.

(b) Hydraulic Analysis

As a result of the simulation by the Water-CAD, it was confirmed that water pressure can be secured more than 2.5 bar at the end of water network and at any period of time, for the case of single operation of pump. From the above point of view, operation schedule of pumps was determined as following table;

Operation Period	Operation Nos. of Pump
24 hours	Individual Operation (1 duty, and 1 stand-by)

(c) Verification of the Hydraulic Analysis Result

As a result of monitoring of hourly fluctuation for the water demand and water distribution pressure in each service area by portable ultrasonic flow meter and pressure gauge, it was verified that there was no large difference between actual operation and the simulation result.

(d) Future Task

As well as GHAPWASCO, C/P team learned how to use the Water-CAD and how to utilize it for planning the well operation schedule, through the hydraulic analysis activity. It is expected that comprehensive hydraulic analysis for water networks including IMRPs and SWTPs will be done in the near future, under the cooperative frame work with other 2ACs.

(5) Developing Water Quality Management

Water quality management in the well station is similar to the activity in GHAPWASCO. C/P team implemented a series of activities relating to water quality management. Since there is no laboratory in the model facility, C/P team instructed the nearest laboratory which is in charge of the model facility, to follow the SOP. The forms used in the model well station are as shown in Table 4.1-23.

Table 4.1-23 Recording Forms for the Well Station (MCWW)

Document	Contents / Purpose
SOP of Quality Control	To standardize and clarify the operation procedure regarding quality control
SOP of Laboratory	To standardize and clarify the laboratory operation
Criteria of quality control	To visualize and specify the criteria of Turbidity, residual chlorine, Aluminum, Mn and Fe
Instructions by laboratory / Operation for Chlorine dosage	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations
Customer claim survey	To double-check the supplied water quality for safety and customers satisfaction

Source: Project Team

As for the above mentioned forms, C/P team monitored the activity and evaluated the each recording form in Mar. 2013 – Aug. 2014(Phase-3) (refer to Figure 4.1-19).

Outcome (after the activity)	Applicable (if not, the reason)	Purpose	Activity / Format	
	√	To standardize and clarify the operation procedure regarding quality control	SOP of Quality Control	1
	–	To standardize and clarify the laboratory operation	SOP of Laboratory	2
	–	To understand the daily/monthly variation and to check the abnormal condition	Daily analytical record (for SWTP and IMRP)	3
	–	To standardize and clarify the operation procedure of the visual check	Visual check sheet	4
	–	To facilitate smooth response to the troubles	Troubleshooting	5
	–	To compile and utilize the response took in the emergency case to the future emergency cases	Emergency report	6
	–	To facilitate smooth reporting when the trouble occurred	Emergency network	7
To increase knowledge of the operators allow them to know the suitable safe chlorine ratio.	√	To visualize and specify the criteria of Turbidity, Re Cl, Aluminum, Mn and Fe	Criteria of quality control	8
Adjust the dose of chlorine when running any group of pimps and how to adjust the dose of chlorine required for each pump so that the ratio of residual chlorine kept in the allowable limits	√	To instruct the clear chlorine dosage to the engineer and keep the ideal chlorination for the well stations	Instructions by laboratory / WPS Operation for Chlorine dosage	9
	–	To check and keep the same analytical level among the chemists / doctors	Auditing 1)Field duplication, 2)Internal duplication, 3)Standard sample	10
Scanning for customers complaint shall be done through branch laboratory by taking samples from all places of the network	√	To double-check the supplied water quality is analytically safe and customer satisfies with it	Customer claim survey	11
	–	To Audit / monitor the laboratory condition by external auditor.	Capacity Assessment	12

Source: Project Team

Figure 4.1-19 Check and Evaluation List of Water Quality Management Activity (MCWW, Well Station)

As a result of the water quality management, the laboratory which is in charge of the model facility applied the SOPs and the forms, and instructed the operators at the facility about the appropriate chlorine dosage. It enhanced operational efficiency of the facility (refer to Outcome on Figure 4.1-19).

4.1.4 Economic Effect to be Expected by Continuous SOP Activity

4.1.4.1 Surface Water Treatment Plant in GHAPWASCO

SOP activity directly contributes to the reduction of operation and maintenance cost for the facility. Cost reduction gained through the activity in the 19 months of the Project, and the comparison of the initial value with an cost reduction to be expected by maintaining the output at Tanta El Teraa El Melahia SWTP, are as follows:

Table 4.1-24 Unit Cost to be Used for the Cost Evaluation in Tanta El Traa El Melahia SWTP

	Item	Unit Price (LE)
1	Produced Water (per 1 m^3)	1.00
2	Gaseous Chlorine (per 1 kg)	1.53
3	Liquid Aluminum Sulfate (per 1 kg)	0.64
4	Electricity (per 1 kWh)	0.26

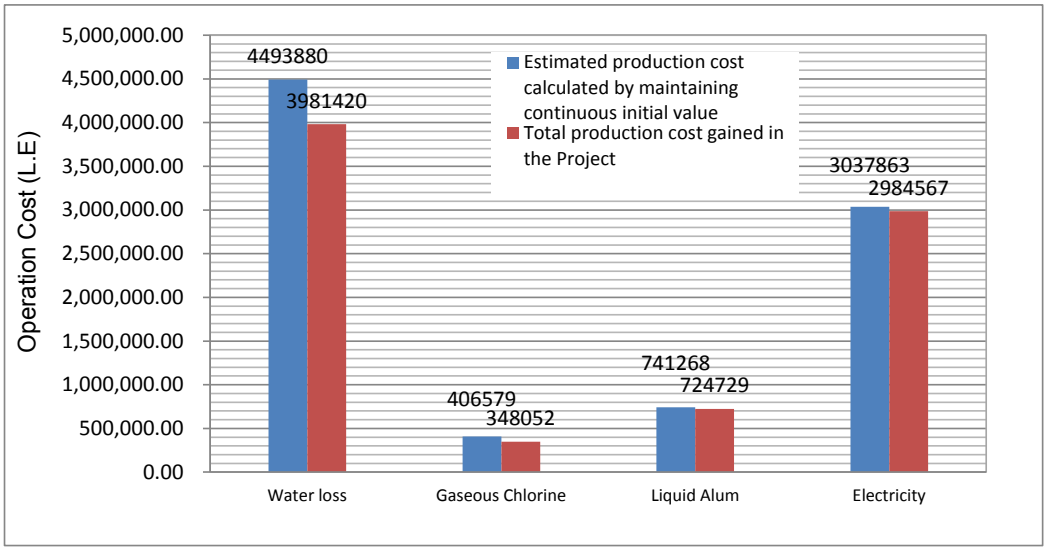
Source: Project Team

Table 4.1-25 Cost Reduction Result Gained through the SOP Activity in Tanta El Traa El Melahia SWTP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Liquid Aluminum Sulfate	
A: Estimated production volume calculated by maintaining continuous initial value[*1]	4,493,880.00 m^3 (25,465,320.00 m^3)	265,738.10 kg	1,151,931.24 kg	11,684,088.00 kW
B: Total production volume gained in the Project[*1]	3,981,420.00 m^3 (25,977,780.00 m^3)	227,484.94 kg	1,126,229.40 kg	11,479,104.00 kW
Cost Reduction (A-B)	512,460.00 m^3	38,253.17 kg	25,701.84 kg	204,984.00 kW
	512,460.00 L.E	58,527.35 L.E	16,539.13 L.E	53,295.84 L.E
Reduction Ratio (%)	11.40	14.40	2.23	1.75
			Total	**640,822.32 L.E**

[*1)] Production volume is calculated by actual production volume (600 L/s) mentioned in Figure 4.1-2 and monitoring record of 19 months, from December 2012 to June 2014.

Source: Project Team



Source: Project Team

Figure 4.1-20 Cost Comparison Chart on Production Outputs in Tanta El Traa El Melahia SWTP

Table 4.1-26 Economic Effect to be Expected by Maintaining the Output in Tanta El Traa El Melahia SWTP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Liquid Aluminum Sulfate	
Initial Value	**15.0% (85.0%)**	**8.87 g/m^3**	**38.45 g/m^3**	**0.39 kWh/m^3**
Output Value	**12.8% (87.2%)**	**7.78 g/m^3**	**37.20 g/m^3**	**0.36 kWh/m^3**
A: Expected improvement effect*1	416,275.20 m^3/year	20,561.47 kg/year	23,021.28 kg/year	504,576.00 kWh/year
	416,275.20 L.E/year	31,459.05 L.E/year	14,814.19 L.E/year	131,189.76 L.E/year
B: Activity Cost for C/Ps in Head Quarter	Printed and instruction stickers : 8,000.00 L.E /year Transportation : 22,000.00 L.E /year Preparation cost for work-shops : 6,000.00 L.E /year Trainer and Lecturer cost : 3,000.00 L.E /year Total : 39,000.00 L.E/year			
		Economic Effect (A-B)	**Total**	**554,738.21 L.E/year**

*1) Expected improvement effect is shown as the annual cost reduction impact calculated by the difference between "Output Value" and "Initial Value". This effect is expected in case that the output value is maintained for a year.

Source: Project Team

Figures in Table 4.1-26 is assumed annual economic effect, including the activity cost of C/P team. It is the cost reduction from the initial value. From the calculation result, it is assumed that the annual cost on facility operation can be reduced for approximately 554,738.21 LE. In addition, further cost reduction is expected if PI will be reduced more.

If the SOPs are spread to water works facility in whole Gharbia Governorate, GHAPWASCO will gain large benefit.

4.1.4.2 Iron Manganese Removal Plant in GHAPWASCO

Cost reduction in the 16 months' monitoring and an cost reduction to be expected by maintaining the output at Mahalet Marhoom IMRP are as follows.

Table 4.1-27 Unit Cost to be Used for the Cost Evaluation in Mahalet Marhoom IMRP

	Item	Unit Price (LE)
1	Produced Water (per 1 m^3)	1.00
2	Calcium Hypochlorite (per 1 kg)	11.65
3	Potassium Permanganate (per 1 kg)	25.00
4	Electricity (per 1 kWh)	0.26

Note: Unit prices are based on hearing from GHAPWASCO.

Source: Project Team

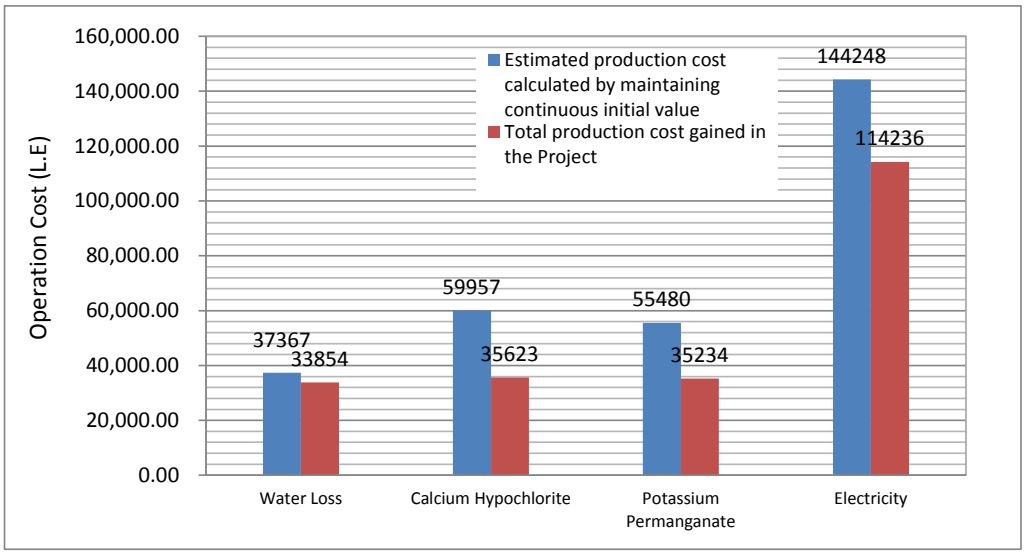
Table 4.1-28 Cost Reduction Result Gained through the SOP Activity in Mahalet Marhoom IMRP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Calcium Hypochlorite	Potassium Permanganate	
A: Estimated production volume[*2] calculated by maintaining continuous initial value[*1]	37,366.88 m^3 (555,758.13 m^3)	5,146.50 kg	2,219.20 kg	554,800.00 kW
B: Total production volume gained in the Project[*2]	33,853.75 m^3 (559,271.25 m^3)	3,057.79 kg	1,409.36 kg	439,368.75kW
Cost Reduction (A-B)	3,513.12 m^3	2,088.71 kg	809.84 kg	115,431.25 kW
	3,513.12 L.E	24,333.50 L.E	20,246.09 L.E	30,012.13 L.E
Reduction Ratio (%)	9.40	40.59	36.49	20.81
			Total	**78,104.84 L.E**

[*1)] Regarding to the effective utilization ratio of water, the initial value of 93.7%, which was recorded on March 2013, is assumed as initial value.

[*2)] Production volume is calculated by actual production volume (1,500 m^3/day) mentioned in Figure 4.1-7 and monitoring record of 16 months, from December 2012 to March 2014, except for water utilization ratio of water. (13 months form March 2013 to March 2014: Effective utilization ratio of water)

Source: Project Team



Source: Project Team

Figure 4.1-21 Cost Comparison Chart on Production Outputs in Mahalet Marhoom IMRP

Table 4.1-29 Economic Effect to be Expected by Maintaining the Output in Mahalet Marhoom IMRP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Calcium Hypochlorite	Potassium Permanganate	
Initial Value	**6.3% (93.7%)**	**7.05 g/m^3**	**3.04 g/m^3**	**0.76 kWh/m^3**
Output Value	**4.3% (95.7%)**	**2.87 g/m^3**	**1.89 g/m^3**	**0.62 kWh/m^3**
A: Expected improvement effect[*1]	10,767.50 m^3/year	2,288.55 kg/year	629.63 kg/year	76,650.00 kWh/year
	10,767.50 L.E/year	26,661.61 L.E/year	15,740.63 L.E/year	19,929.00 L.E/year
B: Activity Cost for C/Ps in Head Quarter	Printed and instruction stickers : 8,000.00 L.E /year Transportation : 22,000.00 L.E /year Preparation cost for work-shops : 6,000.00 L.E /year Trainer and Lecturer cost : 3,000.00 L.E /year Total : 39,000.00 L.E/year			
		Economic Effect (A-B)	**Total**	**34,098.73 L.E/year**

[*1)] Expected improvement effect is shown as the annual cost reduction impact calculated by the difference between "Output Value" and "Initial Value". This effect is expected in case that the output value is maintained for a year.

Source: Project Team

From the calculation in Table 4.1-29, annual cost on facility operation can be reduced for approximately 34,098.73 LE.

4.1.4.3 Surface Water Treatment Plant in MCWW

Cost reduction for the 21 months' monitoring, and annual cost reduction to be expected by maintaining the output at Mahatet El Sadat El Satheya SWTP, are as follows;

Table 4.1-30 Unit Cost to be Used for the Cost Evaluation in Mahatet El Sadat El Satheya SWTP

	Item	Unit Price (L.E)
1	Produced Water (per 1 m^3)	1.25
2	Gaseous Chlorine (per 1 kg)	1.50
3	Liquid Aluminum Sulfate (per 1 kg)	0.60
4	Electricity (per 1 kWh)	0.26

Note: Unit prices are based on hearing from MCWW.

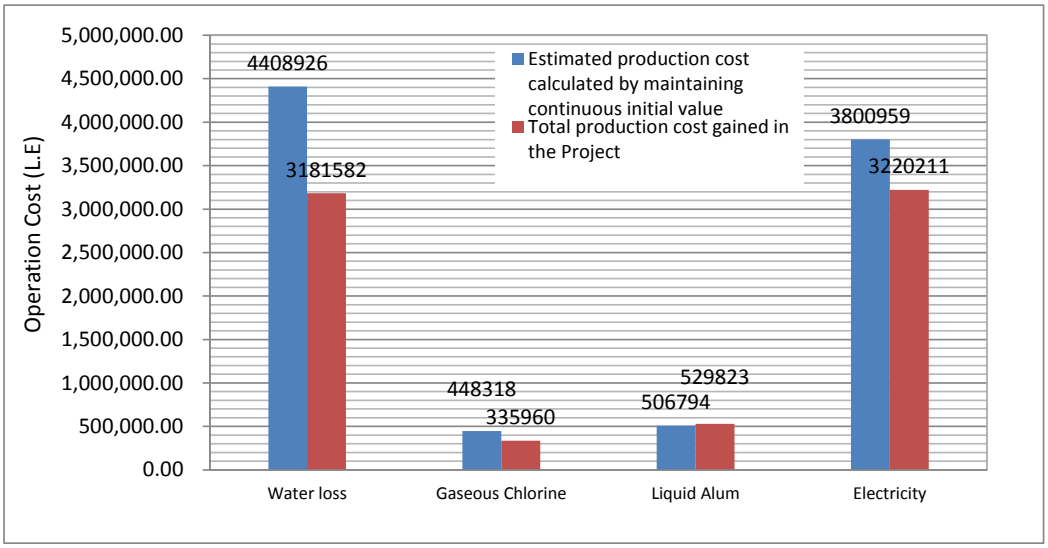
Source: Project Team

Table 4.1-31 Cost Reduction Result Gained through the SOP Activity in Mahatet El Sadat El Satheya SWTP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Liquid Aluminum Sulfate	
A: Estimated production volume calculated by maintaining continuous initial value[*1]	3,527,141.00 m^3 (25,865,700.67 m^3)	298,878.79 kg	844,657.45 kg	14,619,071.25kW
B: Total production volume gained in the Project[*1]	2,545,265.39 m^3 (26,847,576.28 m^3)	223,973.45 kg	883,038.31 kg	12,385,428.23 kW
Cost Reduction (A-B)	981,875.61 m^3	74,905.34 kg	-38,380.86 kg	2,233,643.02 kW
	1,227,344.51 L.E	112,358.00 L.E	-23,028.52 L.E	580,747.19 L.E
Reduction Ratio (%)	27.84	25.06	-4.54	15.28
			Total	**1,897,421.19 L.E**

[*1)] Production volume is calculated by actual production volume (50,860 m^3/day) mentioned in Figure 4.1-12 and monitoring record of 21 months, from September 2012 to June 2014, except for the effective utilization ratio of water. (Effective utilization ratio: 19 months from September 2012 to April 2014)

Source: Project Team



Source: Project Team

Figure 4.1-22 Cost Comparison Chart on Production Outputs in Mahatet El Sadat El Satheya SWTP

Table 4.1-32 Economic Effect to be Expected by Maintaining the Output in Mahatet El Sadat El Satheya SWTP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Liquid Aluminum Sulfate	
Initial Value	**12.0% (88.0%)**	**9.20 g/m^3**	**26.00 g/m^3**	**0.45 kWh/m^3**
Output Value	**6.2% (93.8%)**	**6.47 g/m^3**	**25.30 g/m^3**	**0.36 kWh/m^3**
A: Expected improvement effect[*1]	1,070,518.23 m^3/year	50,679.45 kg/year	13,922.93 kg/year	1,644,118.17 kWh/year
	1,338,147.79 L.E/year	76,019.17 L.E/year	8,353.76 L.E/year	427,470.72 L.E/year
B: Activity Cost for C/Ps in Head Quarter	Calibration : 14,000.00 L.E /year Printed and instruction stickers : 6,000.00 L.E /year Transportation : 16,000.00 L.E /year Preparation cost for work-shops : 5,000.00 L.E /year Trainer and lecturer cost : 4,000.00 L.E /year Total : 45,000.00 L.E/year			
		Economic Effect (A-B)	**Total**	**1,804,991.44 L.E/year**

[*1)] Expected improvement effect is shown as the annual cost reduction impact calculated by the difference between "Output Value" and "Initial Value". This effect is expected in case that the output value is maintained for a year.

Source: Project Team

Analyzed value in Table 4.1-32 is assumed annual economic effect, including the activity cost of C/P team. It is the cost reduction effect from the initial value. From the calculation result, it is assumed that the annual cost on facility operation can be reduced for approximately 1,804,991.44 LE.

If the SOPs are spread to water works facility in whole Minufia Governorate, MCWW will gain large benefit. In addition, in case that all PIs are achieved for the target, further cost reduction is expected.

4.1.4.4 Iron Manganese Removal Plant in MCWW

Cost reduction result in the 22 month's monitoring and an annual cost reduction to be expected by maintaining the output at Gezy IMRP are as follows.

Table 4.1-33 Unit Cost to be Used for the Cost Evaluation in Gezy IMRP

	Item	Unit Price (L.E)
1	Produced Water (per 1 m^3)	1.25
2	Gaseous Chlorine (per 1 kg)	1.50
3	Potassium Permanganate (per 1 kg)	25.00 **(Price escalated to 130.00 L.E from February 2014.)**
4	Electricity (per 1 kWh)	0.26

Note: Unit prices are based on hearing from MCWW.

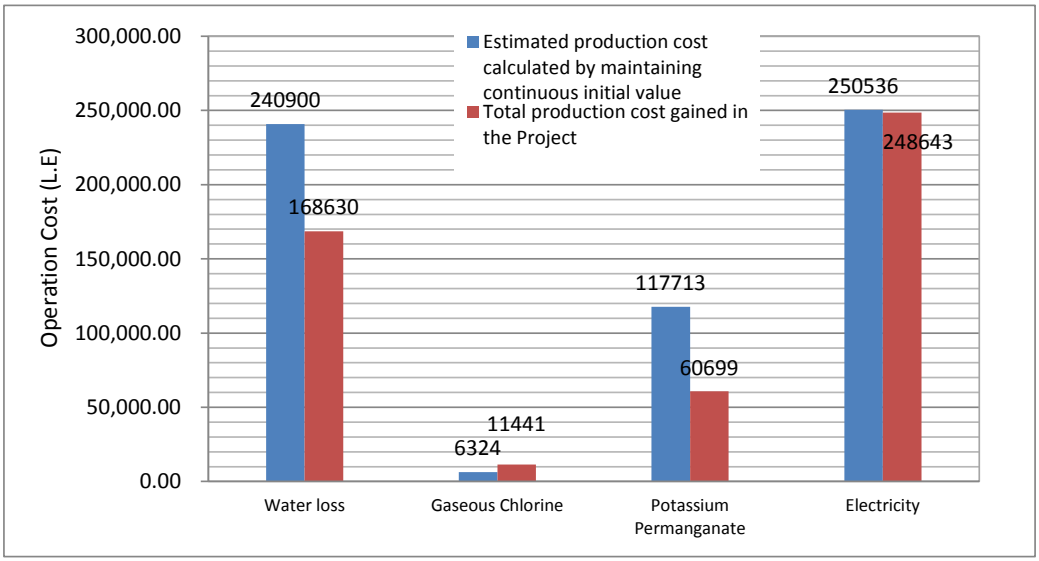
Source: Project Team

Table 4.1-34 Cost Reduction Result Gained through the SOP Activity in Gezy IMRP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Potassium Permanganate	
A: Estimated production volume calculated by maintaining continuous initial value[*1]	192,720.00 m^3 (1,011,780.00 m^3)	4,215.75 kg	2,409.00 kg	963,600.00 kW
B: Total production volume gained in the Project[*1]	134,904m^3 (1,069,596.00 m^3)	7,627.22 kg	1,305.79 kg	956,318.25 kW
Cost Reduction	57,816.00 m^3	-3,411.47 kg	1,103.21 kg	7,281.75 kW
(A-B)	72,270.00 L.E	-5,117.21 L.E	57,013.91 L.E[*2]	1,893.26 L.E
Reduction Ratio (%)	30.00	-80.92	48.43	0.76
			Total	**126,059.96 L.E**

[*1)] Production volume is calculated by actual production volume (1,800 m^3/day) mentioned in Figure 4.1-15 and monitoring record of 22 months, from September 2012 to June 2014.
[*2)] Cost for the potassium permanganate is calculated based on the cost condition in Table 4.1-35

Source: Project Team



Source: Project Team

Figure 4.1-23 Cost Comparison Chart on Production Outputs in Gezy IMRP

Table 4.1-35 Economic Effect to be Expected by Maintaining the Output in Gezy IMRP

	Cost Reduction Impact			
	Water Loss (Effective Utilization Volume of Water)	Chemical Consumption		Electricity
		Gaseous Chlorine	Potassium Permanganate	
Initial Value	**16.0% (84.0%)**	**3.50 g/m^3**	**2.00 g/m^3**	**0.80 kWh/m^3**
Output Value	**10.7% (89.3%)**	**6.65 g/m^3**	**0.95 g/m^3**	**0.79 kWh/m^3**
A: Expected improvement effect[*1]	35,040.00 m^3/year	-2,069.55 kg/year	692.04 kg/year	8,760.00 kWh/year
	43,800.00 L.E/year	-3,104.33 L.E/year	89,965.20 L.E/year[*2]	2,277.60 L.E/year
B: Activity Cost for C/Ps in Head Quarter	Calibration : 14,000.00 L.E /year Printed and instruction stickers : 6,000.00 L.E /year Transportation : 16,000.00 L.E /year Preparation cost for work-shops : 5,000.00 L.E /year Trainer and lecturer cost : 4,000.00 L.E /year Total : 45,000.00 L.E/year			
		Economic Effect (A-B)	**Total**	**87,938.47 L.E/year**

[*1)] Expected improvement effect is shown as the annual cost reduction impact calculated by the difference between "Output Value" and "Initial Value". This effect is expected in case that the output value is maintained for a year.
[*2)] Cost for the potassium permanganate is calculated by 130 L.E.

Source: Project Team

From the calculation result in Table 4.1-35, annual cost on facility operation will be reduced at approximately 87,938.47 LE.

4.1.5 Verification for the Understanding of SOP Training

In order to verify the understandings of SOP, evaluation test was conducted to SOP C/P teams. Purpose of the evaluation test is to confirm the basic knowledge of SOP and water treatment process learned through the Project. Understanding level was evaluated by 5-grades. As a result of evaluation test, all of SOP team members were rated as higher than grade-4. This is supposed that the necessary technical skills of SOP are transferred to GHAPWASCO and MCWW. Evaluation criteria and result are as shown in Table 4.1-36 and 4.1-37.

Table 4.1-36 Verification Criteria

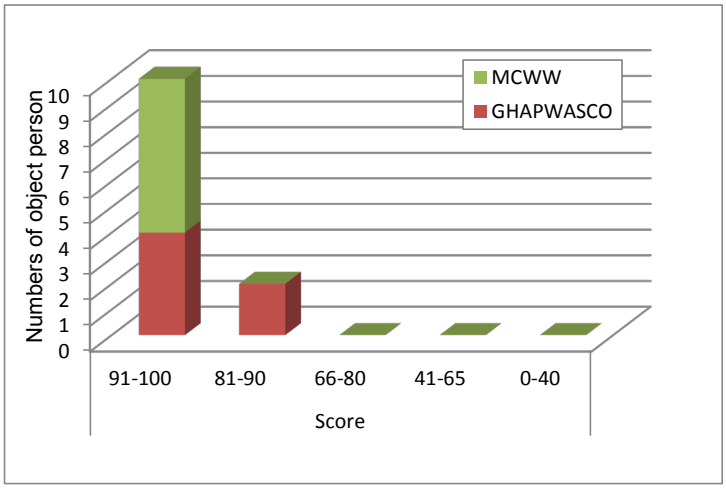
Assessment		Definition	Score
5	Very High Value	The purpose of SOP and water treatment system is understood excellently.	91-100
4	High Value	The purpose of SOP and water treatment system is almost understood.	81-90
3	Moderate Value	The purpose of SOP and water treatment system is understood moderately.	66-80
2	Low Value	The purpose of SOP and water treatment system is understood a little.	41-65
1	No Value	The purpose of SOP and water treatment system is not understood.	0-40

Source: Project Team

Table 4.1-37 Verification Result

	Score					Total
	91-100	81-90	66-80	41-65	0-40	
Total Numbers	10	2	0	0	0	12
GHAPWASCO	4	2	0	0	0	6
MCWW	6	0	0	0	0	6
Rate (%)	83.3	16.7	0.0	0.0	0.0	100.0

Source: Project Team



Source: Project Team

Figure 4.1-24 Verification Result

4.1.6 Expansion of SOPs to Other Markazes and Other Governorates

In order to disseminate the skills of SOP to other Markazes, C/P teams in both GHAPWASCO and MCWW have selected further model facilities. And they conducted the training by less input of JET. In addition, JET and C/P team jointly drafted disseminating plans, which mention required organization, responsibility, task and activity plan.

4.1.6.1 Activity Situation in each Company

Next Facility for SOP in GHAPWASCO and MCWW

The C/P team selected next model facilities to expand SOP activities, considering easiness for the expansion such similar ones to the models in the Project. Moreover, relatively new facilities were selected to commence the activities immediately. Selected facilities are shown as follows;

GHAPWASCO

- Samanod SWTP
- Zefta SWTP
- El Ramleya IMRP
- Shobra Beel Well Station

MCWW

- Shebeen El Kom El Gadeeda SWTP
- Menouf SWTP
- Kafr El Batanon IMRP
- Batanon Well Station
- El Kom El Akhdar Well Station

SOP Activities

Further SOP activity will be conducted under the cooperation of C/P team and each AC. Until Aug. 2014, MCWW completed the preparation of P&ID and provision of SOPs. PI improvement activities are conducted in each facility. GHAPWASCO has started the PI reduction activities at SWTPs. They have a plan to start the activities soon in the IMRPs and the well station. Activities in each AC are summarized as follows:**(1) Facility Improvement**

・Conducting rehabilitation work to damaged equipment or inaccurate devices.

(2) Application of SOPs

・Managing operation records (Daily / Monthly).
・Conducting OJT Training.
・Determining the target of PI and conducting the activities toward achievement of PI.

(3) Others

・Conducting internal workshops for the technical exchange regarding SOP.

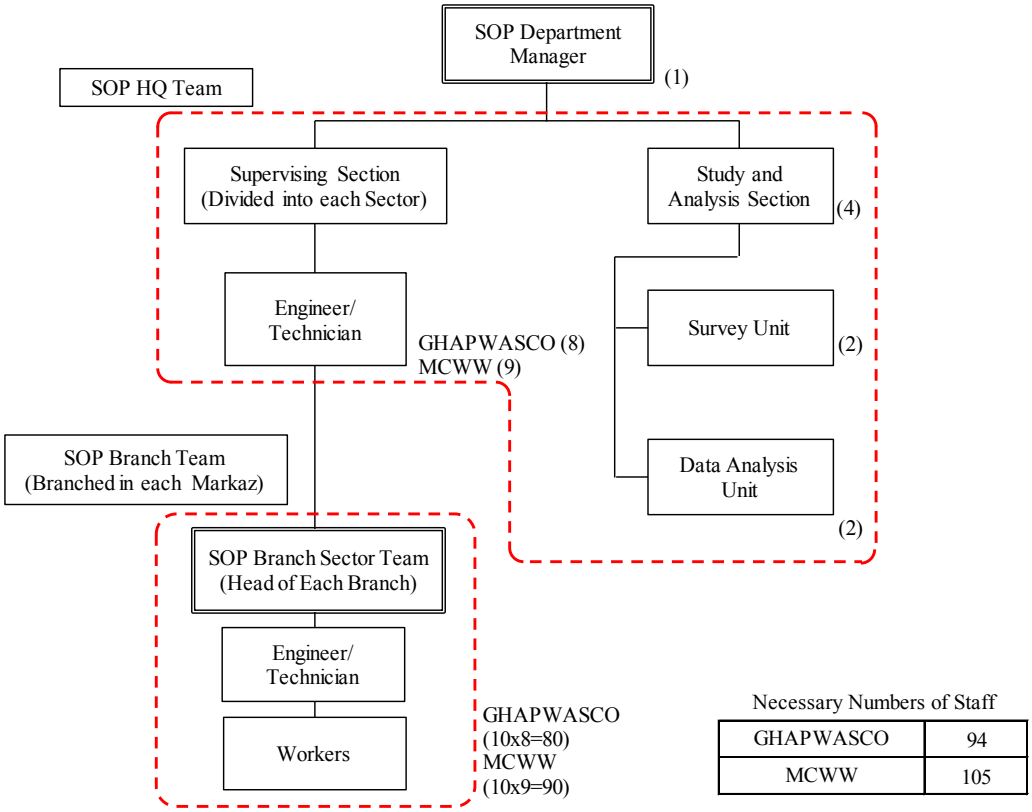
(4) Expansion to Other Governorate

In addition, discussion regarding the expansion of SOP has been held between Qalyubia Water Company and MCWW, as a first step of the expansion to other Governorate. Dissemination will be expected to Qalyubia Water Company from MCWW.

4.1.6.2 Undertakings for the Expansion of SOP to Other Markazes

In Aug. 2014, which is the closing time of the Project for SOP, number of staff member of HQ team is six (6) persons in each of GHAPWASCO and MCWW. It may be insufficient in number to disseminate the activity appropriately. In order to expand SOP activities to whole Governorate, and not only the Nile Delta but whole Egypt in the future, optimal organization of the SOP headquarters team shall be required in each Governorate for continuous activity. The rules and authority for the SOP team have to be clarified and transferred to the staffs. In addition, branch sector teams shall be organized separately from headquarters (HQ) team for conducting the activities in each Markazes smoothly. Cooperation between HQ team and branch sector teams will bring further effects for the achievement of the expansion of SOPs. SOP expansion plan was prepared for each AC as attached in Supporting Report S2.9. Desirable organization and activity plan for long-term operation are described as follows;

(1) Desirable Organization for SOP Headquarters Team and Branch Sector Teams in the Future



Source: Project Team

Figure 4.1-25 Desirable Organization for SOP Headquarters Team and Branch Sector Team

(2) Tasks for SOP Headquarters Team and SOP Branch Sector Team

Tasks for SOP headquarters team and SOP branch sector team are as follows;

SOP Headquarters Team

- Formulating action plan for SOP activity
- Preparing training program to branch sector members
- Preparing training schedule and conducting the training to branch sector members
- Supervising SOP activities in each facility and laboratory to check the treatment efficiency
- Analyzing survey result and examining data
- Conducting correction measures to the facility which has low treatment efficiency
- Conducting a procurement of spare parts and maintenance of equipment, which includes calibration of instrumentation devices such as flow meter, level meter, etc.
- Preparing an annual budgetary plan for SOP department (HQ team and branch sector team)

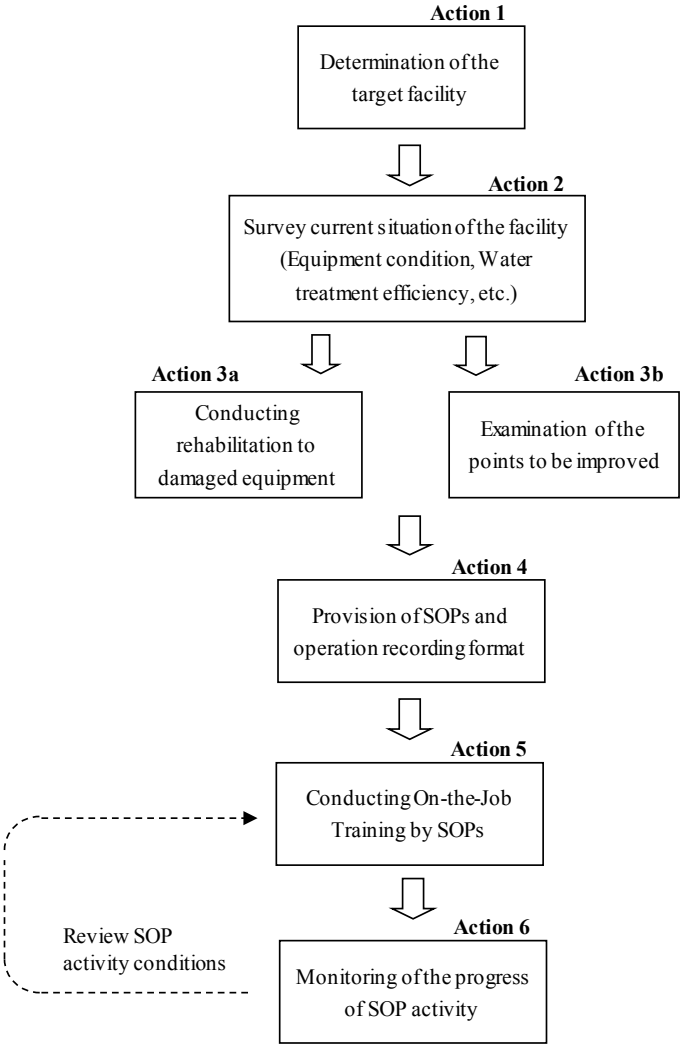
SOP Branch Sector Team

- Determining target facility for SOP through the consultation with HQ team

- Monitoring daily routine work of facility staffs
- Conducting regular check-up for facility and equipment according to the action plan
- Supporting facility staffs for the daily recording work
- Repairing minor damage of facility or equipment
- Reporting the result of the above works to HQ team at regular basis

4.1.6.3 Methodology for Practicable SOP Activity

In order to conduct SOP activity efficiently and practicably, the activity shall be focused on a small number of target facility, and then spread it gradually. Example of annual action plan is as shown in Figure 4.1-26.



Source: Project Team

Figure 4.1-26 Example of Annual Action Plan for SOP Activity

4.2 NRW Reduction Activities

4.2.1 Basic Policy

4.2.1.1 Implementation of NRW Reduction Activities Based on "Action Plan"

(1) The Purpose and Output of the Project:

- Management capacity of operation and maintenance of water supply facilities is improved at the model areas/facilities in Sharkiya, Gharbia and Minufia Governorates.
- The institutional skills and experiences of SHAPWASCO for NRW reduction are transferred to NRW teams at the model areas in Gharbia and Minufia Governorates.

In order to obtain the above-mentioned output, followings were implemented:

- Volume of Non-revenue water (NRW) is properly measured.
- NRW ratio is reduced compared with the baseline data obtained at the Project.
- C/P team members of SHAPWASCO transfer their experience to GHAPWASCO and MCWW.

(2) Implementation of NRW Reduction Activities Based on "Action Plan"

NRW reduction activities taken in the Project are summarized as shown in Table 4.2-1. The action plan is attached in Supporting Report S3.1.

Table 4.2-1 Actions to be Taken in NRW Reduction Activity

Action	Title	Contents	Period
1	Analyze the current situation of NRW in Gharbia and Minufia Governorates	➢ Analysis of the balance between water distribution amount and water consumption ➢ Analysis of the number of claims in each Markaz, etc.	Jun. 2011 – Sep. 2011
2	Organize NRW reduction team in Gharbia and Minufia Governorates	➢ Selection of fulltime NRW members in GHAPWASCO and MCWW ➢ Selection of NRW members for each branch ➢ Organizing NRW teams	May 2011 – Oct. 2011
3	Select three (3) model areas (Markazes) for NRW reduction in Gharbia and Minufia Governorates	➢ Discussion on selection criteria for model area (Markaz) and candidate pilot area ➢ Arrangement of long list for candidate pilot area ➢ Conducting site survey of candidate pilot area for isolation ➢ Selection of three (3) model areas (Markazes) ➢ Selection of more than three (3) candidate pilot areas in model areas	Jun. 2011 – Oct. 2011
4	Conduct training on general practice of NRW reduction	➢ Conducting training of NRW teams in SHAPWASCO ➢ Learning of principle and mechanism for leak detection equipment	Oct. 2011

Action	Title	Contents	Period
		➢ Training of Minimum Night Flow Survey equipment in the Hihya training yard	
5	Conduct training at the training yard in Sharkiya Governorate	➢ Conducting training of NRW teams at the Hihya training yard in Sharkiya ➢ Training on water leak detection survey and water leak detection equipment	Mar. 2012, Jan. 2013, Feb. 2013
6	Prepare Geographical Information System (GIS) drawing for model areas in Gharbia and Minufia Governorates	➢ Preparing GIS drawings for distribution pipelines of the candidate pilot areas in model areas (Markazes)	Nov. 2011 – Aug. 2012
7	Make water balance analysis at model areas before repair		Mar. 2012 – Mar. 2013
7-1	Conducting Minimum Night Flow (MNF) survey for candidate pilot area	➢ Conducting MNF survey for nine (9) (or more) candidate pilot areas	Mar, 2012 – Aug, 2012
7-2	Determining pilot area for each model area (Markazes)	➢ Selection one (1) candidate pilot area in the pilot area for three (3) model areas (Markazes)	Jun. 2012 – Aug. 2012
7-3	Making field survey of distribution network	➢ Collection of exact distribution network data for pilot area ➢ Site survey for exact boundary of pilot area	Apr. 2012 – Oct. 2012
7-4	Conducting water flow measurement	➢ Conducting distributed water volume measurement of the pilot area ➢ Conducting water meter reading (approx. for one week) of the customers in the pilot area	Apr. 2012 – Feb. 2013
7-5	Measuring metering error for working and waste in the house	➢ Collection and data of customers in the pilot areas ➢ Survey of current conditions of water meter ➢ Measuring water meter error ➢ Measuring metering error for 20 to 30 working water meters selected at random in the pilot area	Apr. 2012 – Feb. 2013
7-6	Making water balance analysis before repair	➢ Conducting current leakage rate by minimum night flow (MNF) ➢ Analyze total distributed water volume and consumed water volume in the pilot area in 24 hours ➢ Calculation of water balance analysis before leak repair	Apr, 2012 – Mar, 2013
8	Conduct leak detection survey at model areas		Sep. 2012 – Apr. 2013
8-1	Conduct leak detection survey at model areas	➢ Leak detection survey (invisible or underground) ➢ Preparation of the repairing items	Sep. 2012 – Apr. 2013
8-2	Repairing leaking parts	➢ Acquiring construction permits from the authorities concerned ➢ Inspection by the authority concerned, if necessary	Jan. 2013 – Apr. 2013
8-3	Improvement of water meter	➢ Replacement of non-working water	Sep. 2012 – Apr. 2013

Action	Title	Contents	Period
	condition	meters with new water meters ➢ Installation of new water meters for houses without water meter	
9	Make water balance analysis after repair		Dec. 2012 – Jun. 2013
9-1	Conducting water flow measurement	➢ Conducting distributed water volume measurement of the pilot area ➢ Conducting water meter reading (approx. for one week) of the customers in the pilot area	Dec. 2012 – May. 2013
9-2	Making water balance analysis after repair and evaluation	➢ Analysis NRW rate	Jan. 2013 – Jun. 2013
10	Conduct training at model areas for water distribution management in Sharkiya Governorate	➢ Exchanging experience with the SHAPWASCO for WDM activity	Aug. 2014
11	Draft policy/plan for disseminating NRW reduction activities to the other Markazes	➢ Draft policy/plan for disseminating NRW reduction activities to the other Markazes ➢ Implementation of NRW reduction activity dissemination to the other Markazes	Jun. 2013 – Aug. 2014
Activities related to NRW reduction activity			
1	Holding NRW workshops and seminars for transferring of experience from SHAPWASCO to GHAPWASCO and MCWW and presenting the activity results by GHAPWASCO and MCWW	➢ Holding internal workshops and open workshops ➢ Holding open seminars	Through the Project

Source: Project team

(3) Definition and Benefit of NRW

1) Definition of NRW and Water Balance Analysis on the Project

Non-Revenue Water (NRW) is defined as shown in the water balance analysis table (Table 4-2.2) introduced by International Water Association (IWA). As seen in the table, NRW is the amount of the unbilled authorized consumption and water losses (apparent losses plus real losses).

Table 4.2-2 Water Balance Analysis Table by IWA

<table>
<tr><td rowspan="8">Raw Water</td><td rowspan="7">Water Distribution Volume</td><td rowspan="2">Authorized Consumption</td><td>Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td>Revenue Water (RW)</td></tr>
<tr><td></td><td>Billed Unmetered Consumption</td><td></td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="6">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
<tr><td colspan="4">Treatment Losses (Backwash, etc.) Evaporation</td></tr>
</table>

Source: International Water Association (IWA)

“Unbilled authorized consumption” and “Apparent losses” shall be referred to as “Commercial losses”, while “Real losses” referred as “Physical losses” in this Project. In the previous project in SHAPWASCO, the Project team used following water balance sheet as shown in Table 4.2-3. In the Project for GHAPWASCO and MCWW, the same balance sheet is utilized.

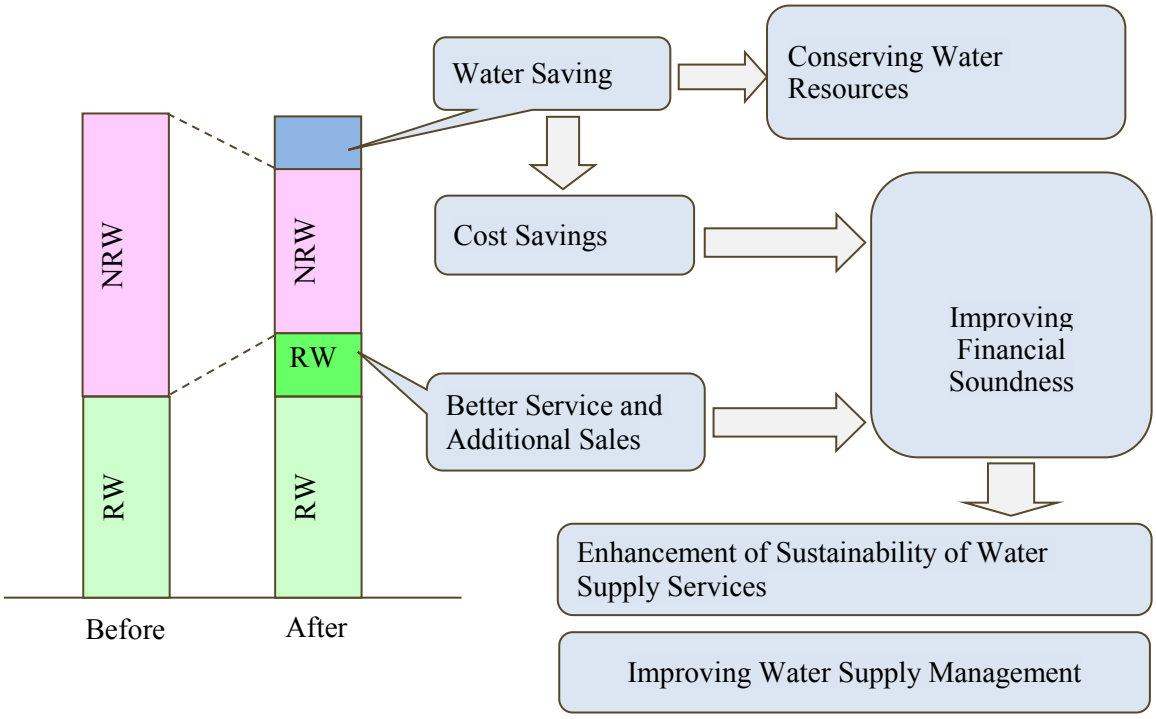
Table 4.2-3 Water Balance Analysis Table by IWA

<table>
<tr><td rowspan="8">Raw Water</td><td rowspan="7">Water Distribution Volume</td><td rowspan="2">Authorized Consumption</td><td>Billed Authorized Consumption</td><td>Billed Metered Consumption (Subtract over-registration volume)</td><td>Sold Water</td><td>Revenue Water (RW)</td></tr>
<tr><td></td><td>Billed Unmetered Consumption</td><td></td><td></td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="3">Commercial Loss</td><td rowspan="5">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td><td rowspan="3">Physical Loss</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
<tr><td colspan="4">Treatment Losses (Backwash, etc.) Evaporation</td><td colspan="2">Categorized as NRW</td></tr>
</table>

Source: Project Final Report for the Project for Improvement of Management Capacity of Operation and Maintenance for SHAPWASCO

2) Benefits of NRW Reduction Activity

The benefits of reducing NRW are as indicated in Figure 4.2-1.



Source: Project Final Report for the Project for Improvement of Management Capacity of Operation and Maintenance for SHAPWASCO

Figure 4.2-1 Benefits of Reducing NRW

Reduction of NRW ratio increases the revenue water and/or decreases the losses. It means an additional profit source for water companies. The increase in revenue could be used as an investment capital to promote the level of service and/or the coverage area of service. And the reduced volume of water could be available after NRW reduction as sources for the increasing demand. The reduced volume of water may conserve the water resources and hence extend the life time of the resources in particular groundwater, if not needed by the customers. In addition to water savings, immediately un-required capital investments may be generated, delaying development of new water production facilities and/or renovation and upgrading of existing ones.

The mentioned savings shall improve the financial soundness of water companies and enhance the sustainability of the water supply facilities, which leads to the improvement of the water supply management and service.

(4) Performance Indicators for NRW Reduction Activities

In order to evaluate the effectiveness of the activity, a target of the Project is necessary. For the target, Performance Indicators (PIs) for the Project were determined in the 3rd JCC held on the 26th November 2012 as follows.

1) NRW Ratio (%)

"NRW (m^3)" / "System input volume (m^3)"

"NRW (m^3)" = "System input volume (m^3)" – "Billed water (m^3)"

2) Reduction Rate of NRW

Reduction rate of NRW (%)

("NRW ratio before improvement (%)" - "NRW ratio after improvement (%)) / "NRW ratio before improvement (%)"

The target should be determined, considering the interim result of the activity. The Project team recommended the target as shown in Table 4.2-4, utilizing the result of the previous project (experiences of SHAPWASCO) as well as the interim result.

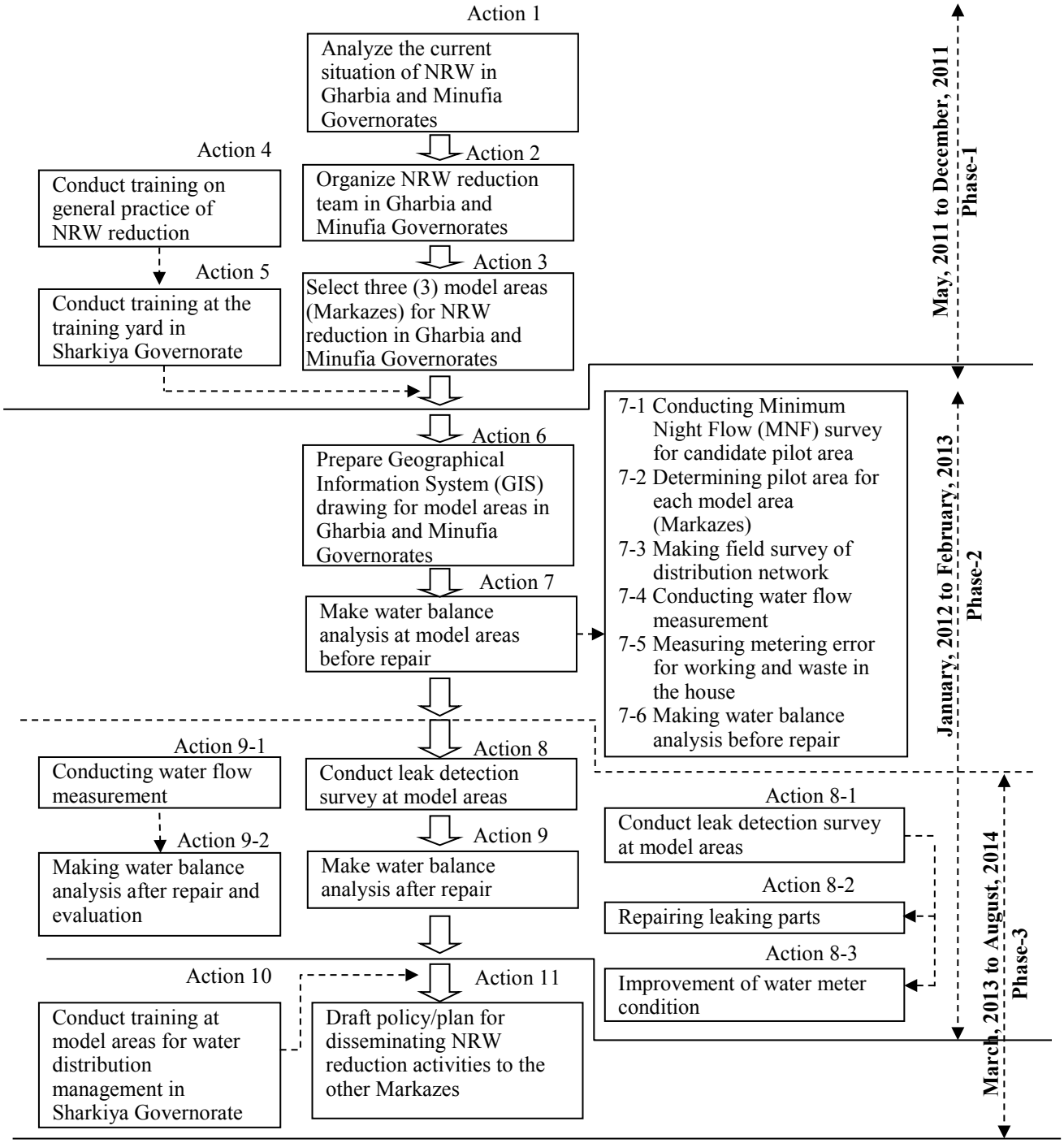
Table 4.2-4 Target of Performance Indicator

NRW Ratio before Improvement	Target of Reduction Rate of NRW
More than 30%	To reduce 30%
Not more than 30%	To reduce 25%

Source: Project team

4.2.1.2 Procedure of NRW Reduction Activities

The Project team developed Action Plan for NRW Reduction Activity in Phase-1 (Jun. 201). Flow of Actions Plan for NRW reduction activities is shown in Figure 4.2-2. Detailed action plan are attached in Supporting Report S3.1.



Source: Project team

Figure4.2-2 Flow of Actions for NRW Reduction Activity

4.2.2 Summary of NRW Reduction Activities Based on Action Plan

4.2.2.1 Action-1 (Analyze the Current Situation of NRW in Gharbia and Minufia Governorates)

(1) Output from the Action-1

Output-1: Basic Survey Report

C/P team in each AC and JET collected data regarding the water distribution, such as population, production volume, billed water volume and piping information, for the selection of model area.

(2) Issues to be Tackled in Later Stages

Issue-1: Urban Area and Rural Area

Since 2ACs have appropriate data for basic operation for water management, the detailed data was collected comparatively easier.

Since the unit demand and number of complaints are higher in the city (urban) area such as Tanta, Shebeen El Kom Markaz, the Project team needed to investigate reasons of the complaints and the unit demand to grasp water use conditions in more detail for practical NRW reduction.

Issue-2: Accuracy of Data

Distribution volume in some areas is calculated by the capacity and number of pumps. And sold water volume includes estimated ones for customers who have no water meter. Some of the acquired data were therefore estimated. In other words, the data are not always measured. The Project team found that the ACs needs to measure these kinds of data more accurately, for the purpose to improve water distribution management capacity. The data is one of the bases for the NRW reduction activities. Therefore, distribution volume in treatment plant and well station and consumption volume should be metered accurately.

4.2.2.2 Action-2 (Organize NRW Reduction Team in Gharbia and Minufia Governorates)

(1) Output from Action-2

Output-1: Organize NRW Reduction Team and Conduct Workshop

NRW reduction team (hereinafter referred to as “C/P team”) in HQ was organized in each AC to start NRW reduction activity together with JET. C/P members in SHAPWASCO were also selected in order to transfer their experiences in the previous project to GHAPWASCO and MCWW. Through the activity, C/P teams of each branch office have been also organized to conduct the activity.

Action Plan for NRW reduction activity was prepared together with JET, using the previous project’s plan as a reference. A workshop for Action Plan was held in order to explain the activity for C/P members of each branch office. List of C/P team members of HQ and branches are shown in Chapter 1.4 (7).

(2) Issues to be Tackled in Later Stages

Issue-1: NRW Team Organized for Dissemination Activities

NRW section was officially established in each AC. During the Project, the C/P team was expected to disseminate continuously procedures of NRW reduction and the practical activity to whole Governorate. In order to expand the knowledge and experiences to whole Governorate smoothly, the senior, mid-level and junior staff members were nominated as members of C/P team. Nevertheless, the C/P team and organizations related to NRW reduction need to be reviewed and reorganized periodically for the purpose of disseminating to whole Nile Delta.

4.2.2.3 Action-3 (Select Three (3) Model Areas (Markazes) for NRW Reduction in Gharbia and Minufia Governorates)

(1) Output from the Action-3

Output-1: Selection of Model Area and Pilot Area

NRW reduction activity was conducted at three (3) Markazes in each AC. Moreover, three (3) candidate pilot areas were selected in each Markaz. Each AC, therefore, prepared nine (9) candidate pilot areas in total. Leak detection survey and water balance analysis were conducted at the three (3) pilot areas.

Definition of model area and pilot area in the Project is shown in Table 4.2-5. The C/P team selected the three (3) Markazes and the three (3) candidate pilot areas in accordance with selecting criteria through site surveys. The results are shown in Table 4.2-6 for GHAPWASCO and in Table 4.2-7 for MCWW.

a) Criteria for selecting Model Markazes

- Number of complaints (Leakage–pipe break-color change) is high.
- Water distribution volume is high.
- Length of pipelines is high.
- Importance of Markaz is high.

b) Criteria for selecting pilot project areas

- Pilot areas should have controlling valves to be isolated.
- It should have various activities (domestic, Governmental, commercial, etc.) for suitable numbers.
- Pressure in the network should be 1 - 2 bar.
- Number of connections should be suitable number, and site area should be around 2 - 3km^2.
- Water meters are installed, and billed data are recorded regularly.
- Accurate GIS maps are available to confirm the valve location.

Table 4.2-5 Definition of Model Area and Pilot Area

	Definition
Model Area	➢ Model Areas are three (3) selected Markazes. ➢ Each selected Markaz has three (3) candidate pilot areas. ➢ Each company has nine (9) candidate pilot areas in total. ➢ Minimum night flow (MNF) survey shall be conducted at nine (9) candidate pilot areas in the model areas.
Pilot Area	➢ One (1) pilot area is selected in each model area. ➢ Each company has three (3) pilot areas in total. ➢ Leak detection survey and water balance analysis shall be conducted at the pilot areas.

Source: Project team

Table 4.2-6 Model Areas and Candidate Pilot Areas for GHAPWASCO

Markaz Name	Name of Candidate Pilot Area	
1.Tanta	Area-1	Mohamed Farid
	Area-2	Boreg
	Area-3	Seberbay
2.El Mahalla El Kobra	Area-1	Zahraa
	Area-2	Omar Ebn Abd El Aziz
	Area-3	Abou Deraa
3. Zefta	Area-1	Masry
	Area-2	Masaraf
	Area-3	Ibrahim Khatab

Source: Project team

Table 4.2-7 Model Areas and Candidate Pilot Areas for MCWW

Markaz Name	Name of Candidate Pilot area	
1.Shebeen El Kom	Area-1	Arafa
	Area-2	Abo Agwa
	Area-3	Menshat Esam Village
2.Quesna	Area-1	Mahkama
	Area-2	Taimor
	Area-3	El Agaiza
3. Berket El Sab'a	Area-1	Abdel Salam Aref
	Area-2	El Teratin
	Area-3	Myet Abo Saleh

Source: Project team

Output-2: Result of MNF Survey and Selection Pilot Area

The C/P team conducted isolation survey at the nine (9) candidate pilot areas in the three (3) model areas. MNF survey was also conducted and analyzed at the nine (9) candidate pilot areas. The result of MNF survey in GHAPWASCO and MCWW are shown in Table 4.2-8 and Table 4.2-9. The selected model area and pilot area, and the selection criteria are summarized in action plan. The action plan is attached in Supporting Report S3.1.

MNF is not always the leakage in the area because the pressure and flow fluctuate even though in the nighttime according to water consumption. The C/P team created graphs of pressure and flow, and they learnt a phenomenon indicated on the graphs for MNF. They studied also a consumption trend in the pilot areas in MNF survey.

Table 4.2-8 Result of MNF Survey and Selected Pilot Area for GHAPWASCO

Model Area			Number of House Connection	MNF (L/s) *1	Distribution Volume (m^3/day)	Estimated Leakage Volume (m^3/day)*2	Estimated Leakage Ratio by MNF (%)	Selection Pilot Area
Tanta	Area-1	Mohamed Farid	400	1.81 (5:02 a.m)	350.95	135.40	38.6	Selected
	Area-2	Boreg	760	2.68 (2:54 a.m)	536.32	179.00	33.4	-
	Area-3	Seberbay	430	2.89 (2:48 a.m)	728.38	220.12	30.2	-
El Mahalla El Kobra	Area-1	Zahraa	200	1.24 (6:31 a.m)	208.33	92.20	44.3	-
	Area-2	Omar Ebn Abd El Aziz	380	3.38 (4:02 a.m)	430.74	228.00	52.9	Selected
	Area-3	Abou Deraa	90	0.28 (5:46 a.m)	112.34	21.87	19.5	-
Zefta	Area-1	Masry	830	1.46 (3:44 a.m)	466.30	122.26	26.2	-
	Area-2	Masaraf	240	0.88 (4:36 a.m)	731.92	244.28	35.0	Selected
	Area-3	Ibrahim Khatab	340	0.27 (2:49 a.m)	180.10	22.39	12.4	-

Source: Project team

Table 4.2-9 Result of MNF Survey and Selected Pilot Area for MCWW

Model Area			Number of House Connection	MNF (L/s) *1	Distribution Volume (m^3/day)	Estimated Leakage Volume (m^3/day)*2	Estimated Leakage Ratio by MNF (%)	Selection Pilot Area
Shebeen El Kom	Area-1	Arafa	600	0.82 (4:37 a.m)	228.10	58.81	25.8	-
	Area-2	Abo Agwa	500	0.73 (1:28 a.m)	183.88	64.88	35.3	Selected
	Area-3	Menshat Esam Village	800	2.12 (2:51 a.m)	650.10	183.95	28.3	-
Quesna	Area-1	Mahkama	760	1.74 (4:43 a.m)	530.64	152.39	27.7	Selected
	Area-2	Taimor	900	4.71 (4:03 a.m)	988.93	342.46	34.6	-
	Area-3	El Agaiza	500-1,000	4.08 (2:06 a.m)	977.65	341.26	34.9	-
Berket El Sab'a	Area-1	Abdel Salam Aref	880	2.45 (3:27 a.m)	554.90	212.16	38.2	Selected
	Area-2	El Teratin	550	2.53 (2:50 a.m)	590.52	221.14	37.4	-
	Area-3	Myet Abo Saleh	500-1,000	1.03 (3:34 a.m)	296.13	81.57	27.6	-

Source: Project team

Notes;

1. MNF (Minimum Night Flow) shows the minimum flow at certain time after midnight measured by flow meter and this MNF contains real water loss and consumption. ( ) is measurement time at minimum night flow.
2. Estimated leakage volume is calculated by MNF taking into consideration of pressure fluctuation. Therefore, the indicated leakage volume is not equal to volume calculated by equation of "MNF x 60 x 60 x 24hours".
   The estimated leakage during the day could be determined by following equation.
   The estimated leakage (m^3/d) = accumulation of Q1 (m^3/min) for 24hours (1,440min)
   Example: Q1 of 0:01 + Q1 of 0.02 + Q1 of 0:03・・・・・・・Q1 of 24:00
   Q1 = (P1 / P2)^1/2 x Q2
   Where
   Q1=estimated leakage flow (m^3/min)
   P1=Pressure at the time of estimated leakage Q1
   P2=Pressure at minimum night flow time
   Q2=Minimum night flow at pressure P2(m^3/min)

(2) Issues to be Tackled in Later Stages

Isssue-1: Network for Isolation

Isolation survey was conducted for the select pilot areas, to check if candidate pilot area is able to be separated from the network. All candidate pilot areas were confirmed successfully to be isolated from the network. Meanwhile, the candidate pilot areas are small and limited to about 500 - 1000 houses. In order to continue the NRW reduction activities, improvement of water distribution network is required to separate metering areas. Pipeline network should be designed deliberately for realization of the block management system of distribution.

Isssue-2: Organize Water Meter Reading System

The MNF survey was conducted and analyzed in the nine (9) candidate pilot areas to select the pilot areas according to criteria. The criteria of pilot project area selection were discussed among the Project team members together with members of branch offices. The criteria to select the pilot area are as follows.

- Estimated leakage ratio is high, and improvement effect can be expected.
- Condition of the pilot area represents other areas in model area.
- The water pressure is high.
- The number of water meters is not so large, in order to complete water meter reading.
- More than two (2) water meter readers are able to attend the survey at the pilot area.
- Water meter condition and the access are good.

Some water meter readers in branch offices gave information that there are customers having no water meter and meters hardly to be read in certain areas. An organization to manage water meter and the improvement of metering condition are necessary for the purpose to improve water tariff collection.

4.2.2.4 Action-4 (Conduct Training on General Practice of NRW Reduction)

(1) Output from the Action-4

Output-1: Conduct Training on General Practice of NRW Reduction and Field Training in Pilot Area

Training for NRW reduction was conducted at SHAPWASCO and their training yard in Hihya. The detail is shown in Chapter 9.4 Table 9-3. The C/P team of SHAPWASCO planned the training schedule and program for GHAPWASCO and MCWW. In addition, training for NRW reduction was conducted periodically during the Project.

Discussions on the actions to be challenged were conducted before starting site survey in each Markaz. The discussions were conducted by a few C/P members to discuss more deeply and carefully for smooth implementation at the sites.

(2) Issues to be Tackled in Later Stages

Isssue-1: Accreditation of Trainers for NRW Reduction

The Hihya training yard in SHAPWASCO is one of the advantages of this Project. The Project team was able to utilize it for the leak detection training. The training in Hihya gave not only the mentioned training but also opportunities to share technology and successful experiences from the previous project, and to have mutual guidance among the companies.

It is necessary that C/P team is officially accredited as the trainer of the training of NRW reduction activity by the ACs, and the training should be planned periodically.

4.2.2.5 Action-5 (Conduct Training at the Training Yard in Sharkiya Governorate)

(1) Output from the Action-5

Output-1: Conduct Training at the Training Yard in SHAPWASCO

The practical training in Hihya training yard in SHAPWASCO, which focused on learning usage of flowmeter and basic instrument for leak detection survey, was conducted on 23rd October 2011. The SHAPWASCO C/P team conducted the practical training to C/P team of HQ in GHAPWASCO and MCWW. On 7th March 2012, the 2nd training of flowmeters and pressure loggers, data management, and leak noise correlator was conducted in the same yard.

Output-2: Conduct Training C/P Team of Each Branch Office at the Training Yard in SHAPWASCO

Furthermore, trainings for NRW reduction were conducted for branch offices C/P members of GHAPWASCO and MCWW in Hihya training yard, on 15th January 2013 for GHAPWASCO, and on 13th February 2013 for MCWW.

HQ members of GHAPWASCO and MCWW noticed the necessity to train the branch offices members for leak detection. Accordingly, the mentioned trainings were planned and conducted by the HQ members, together with SHAPWASCO C/P team. The training program was framed for learning leak detection survey using acoustic rod, water leak detector, and leak noise correlator.

Table 4.2-10 Training at the Training Yard in Sharkiya Governorate

Trainer	Trainee	Date	Place	Program
SHAPWASCO HQ C/P team	GHAPWASCO/ MCWW HQ C/P team	7th March 2012	SHAPWASCO Workshop room and Training yard in Hihya	Class room training Pressure logging and the management Flow logging and the management Field training Usage of acoustic rod, water leak detector, and leak noise correlator
GHAPWASCO HQ C/P team and SHAPWASCO	GHAPWASCO branch office C/P members	15th January 2013	SHAPWASCO Training yard in Hihya	Field training Learning usage of acoustic rod, water leak detector, and leak noise correlator.

Trainer	Trainee	Date	Place	Program
MCWW HQ C/P team and SHAPWASCO	MCWW branch office C/P members	13th February 2013	SHAPWASCO Training yard in Hihya	Field training Learning usage of acoustic red, water leak detector, and leak noise correlator.

Source: Project team

(2) Issues to be Tackled in Later Stages

Isssue-1: Continual Use of Training Yard

The Project team utilized the Hihya training yard not only for the leak detection training but also for the opportunity to share successful experiences and learnt technologies, and to have consultation meetings among ACs.

In order to utilized the yard for long time and to maintain it in good conditions, it should be necessary to organize trainings continuously.

4.2.2.6 Action-6 (Prepare Geographical Information System (GIS) Drawing for Pilot Areas in Gharbia and Minufia Governorates)

(1) Output from the Action-6

Output-1: Preparation of GIS Data

In order to conduct the isolation survey and Minimum Night Flow (MNF) survey, GIS drawings were prepared through confirmation of piping network at the site. After selection of candidate pilot areas, the Project team has focused to prepare the GIS drawings of the candidate pilot areas. GHAPWASCO and MCWW have prepared GIS maps with followings.

- Pipe diameter
- Pipe material
- Pipe location
- Valve location
- Street information
- House information

(2) Issues to be Tackled in Later Stages

Isssue-1: Update GIS Base Map Data

Both 2ACs have GIS section as one of the departments. Their GIS data were helpful for preparation of the activities of the Project. Nevertheless, base maps for roads and buildings were necessary to be updated for some pilot areas.

Since GIS data are helpful for not only NRW activities but also other ones, the ACs should improve the management system of GIS especially for updating. The updated system will be more helpful for NRW reduction for efficiency.

Isssue-2: GIS Linked to Customer Data

Service connection (house connection) is not included in the current GIS system. If the GIS data covered service pipe and linked to customer information, NRW reduction procedures, such as water meter reading, water meter cleaning and house connection survey, would be easier and would be done more effectively. In addition, there were cases that the location of valve was not clear in GIS drawings. It is necessary to draw valves more detailed.

As the first step, the location of service connections was reported to GIS section when the C/P team conducted house connection survey in accordance with NRW reduction 5 years plan.

4.2.2.7 Action-7 (Make Water Balance Analysis at Pilot Areas Before Repair)

(1) Output from the Action-7

Output-1: Conduct Water Balance Analysis

Simply stated, the essential point of water balance analysis is to calculate the ratio of the distribution volume to consumption volume in the same area, at the same time. Water balance analysis was conducted in the three (3) pilot areas with cleaning of water meters. The detail is described in Chapter 4.2.3, achievement in each model area.

Output-2: Measuring Water Meter Accuracy

The Project team has conducted the water meter accuracy test and discovered that many water meters have high error percentage in particular for older water ones. Water meters should be cleaned and/or replaced with new ones as much as possible before measuring consumption in order to grasp accurate NRW ratio. Water meter error ratio after cleaning is basically applied to water balance analysis.

Output-3: Conditions of Water Meter

During the consumption survey, the Project team found non-working water meters and not-clear water meters which is hard to read the indicated value due to dirtiness. The Project team used the average consumption to correct such inappropriate figures. It is one of reasons of inaccuracy of NRW ratio.

(2) Issues to be Tackled in Later Stages

Issue-1: Change of Water Meter Ownership

The most of water meters, in particular older water meters, indicate positive errors. In other words, it is the over registration. In the current system, the property of meter belongs to the customer and the cost of a water meter should be borne by the customer. The water meters, therefore, are not able to be replaced easily by the ACs. To facilitate the replacement at appropriate interval, JET recommended taking countermeasures for the matter through modifications of regulation or legislation, which includes the change of ownership from customers to ACs. It will contribute to promotion of meter accuracy and the reliance of consumers.

4.2.2.8 Action-8 (Conduct Leak Detection Survey for Model Area)

(1) Output from the Action-8

Output-1: Conduct Leak Detection Survey

The leak detection survey was conducted in the three (3) pilot areas in each AC. In addition, the survey was conducted in other areas after the pilot activities. Leak detection surveys were carried out with following three stages. All fifteen (15) detected leaks (GHAPWASCO: Seven (7) leaks, MCWW: Eight (8)leaks) have been repaired. The detail is described in Chapter 4.2.3 Achievement in each model area.

1st Stage : Leak detection survey for expected leak area
(House connection survey using acoustic rod, leak noise correlator survey)
2nd Stage : Leak detection survey for determination of leak point
(Ground surface survey using water leak detector)
3rd Stage : Confirmation
(Noise confirmation)

(2) Issues to be Tackled in Later Stages

Issue-1: Sharing Successful Experience

The C/P team conducted the leak detection survey and learned the leak detection method in the Project. They have enough knowledge, skills and confidence to expand their activity to whole Governorate. It is indispensable to expand NRW reduction activity to whole Nile Delta. It is further expected to have more experience and to verify the effectiveness more deeply for leak detection survey.

Issue-2: Improve Efficiency of Leak Detection Survey

The C/P team conducted “leak confirmation” for suspected leak points which found by water leak detector.

The leak confirmation is to make a small hole on the ground at the suspected points and to check the leak sound by listening stick. To make a hole, hammer drill is often utilized for asphalt pavement.

In the Project, C/P team often excavated the road for repair before detail examination by the listening stick for leaking points. Since it generates a lot of useless excavation, C/P team should take necessary steps for detail examination of leaking point. The proper procedure contributes to improvement of working speed.

Isure-3: Pavement Restoration

There were cases that the restoration of pavement is insufficient after leak repair. Even after several days since the repair, the backfilled point remained and became a hindrance to vehicles and pedestrians. The restoration or recovery of the pavement is directly connected to customer satisfactions. It is, therefore, necessary to provide the pavement restoration immediately. This issue should be addressed as soon as possible.

Issue-4: Plumbing Procedures and Regulations

All detected leaks were repaired in the Project, and C/P team made reports for the analysis of leakages for cause, point, pipe material, repair methods, etc. In the report, the Project team found that some leaks are caused by poor repairs. In addition, excavated soil is used for the backfilling of the excavated trench. Since the soil which excavated for leak repair includes debris (concrete and/or bricks), it may cause the water leaks again with the traffic load. Furthermore, tampering and compaction of the trench are not enough in backfilling process, comparing with the Japanese way. Since proper procedures and regulations for repair, excavation and plumbing are not standardized, the plumbing and leak repair standards should be documented.

4.2.2.9 Action-9 (Make Water Balance Analysis After Repair)

(1) Output from the Action-9

Output-1: Improvement of NRW Ratio from the Baseline

After finishing leak detection survey on house connections and pipe network, the Project team conducted second water balance analysis to check the reduction amount of NRW. The Summary of water balance analysis before and the after repair are shown in Table 4.2-11.

Table 4.2-11 Summary of Water Balance Analysis Before and After Leak Repair

GHAPAWSCO					
Model Markaz	PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
Tanta	NRW ratio	40.1%	28.0%	24.7%	4
	Reduction rate of NRW		30.0%	38.4%	
El Mahalla El Kobra	NRW ratio	27.1%	20.3%	22.0%	2
	Reduction rate of NRW		25.0%	18.8%	
Zefta	NRW ratio	21.2%	15.9%	21.0%	1
	Reduction rate of NRW		25.0%	0.0%	
MCWW					
Shebeen El Kom	NRW ratio	19.6%	14.7%	16.5%	1
	Reduction rate of NRW		25.0%	15.8%	
Quesna	NRW ratio	29.8%	22.3%	22.5%	3
	Reduction rate of NRW		25.0%	24.5%	
Berket El Sab'a	NRW ratio	27.1%	20.3%	20.2%	4
	Reduction rate of NRW		25.0%	25.4%	

Source: Project team

(2) Issues to be Tackled in Later Stages

Issue-1: Block Water Distribution System

One of the selection criteria of pilot area was number of house connections, since leakages are often found on the service connections between water meter and distribution pipeline.

There are a lot of buildings having many apartments in most of the pilot areas. Only service connection is often branched to a water meter of the buildings. The numbers of service connection were, therefore, less than the initial plan of the Project team which was expected by population. The detected leaks, consequently, were less than expected. In the meantime, if the Project team chose

larger pilot areas, the hydraulic isolation will be hard in the existing water distribution network, and a lot of difficulties are expected to water consumption survey with meter reading works.

The block water distribution system is, therefore, one of the issues for the future. It will lead to efficient metering and management of NRW.

4.2.2.10 Action-10 (Conduct Training at Model Areas for Water Distribution Management in Sharkiya Governorate)

(1) Output from the Action-10

Output-1: WDM Training in SHAPWASCO

The purpose of this training is to share knowledge for more advanced water distribution management through the experience of WDM in SHAPWASCO. The C/P team in GHAPWASCO and MCWW was invited to SHAPWASCO on 28th August 2014. They learnt necessary equipment and methodology for WDM through a project site tour. The outputs from the monitoring activity were presented from SHAPWASCO, and exchanged opinions among the 3ACs.

Table 4.2-12 Training Summary of WDM in SHAPWASCO

Target	Date	Place	Program
GHAPWASCO MCWW	28th August 2014	Central monitoring room in SHAPWASCO	Class room training Equipment and methodology for WDM. The outputs from the monitoring activity Site tour Equipment and methodology for WDM.

Source: Project team

(2) Issues to be Tackled in Later Stages

Issue-1: Future Improvement of Water Service Management

This was also one of good practices for information sharing among the 3ACs. The practice of WDM gave a good example of integrated management system of WTPs and wells, which may be introduced in GHAPWASCO and MCWW. This kind of technical cooperation should be continuously conducted by the ACs.

4.2.2.11 Action-11 (Draft Policy/Plan for Disseminating NRW Reduction Activities to the Other Markazes)

(1) Output from the Action-11

Output-1: Five (5) Years Plan for NRW Reduction Activity

In order to expand the activity to other Markazes, "5 years plan for NRW reduction activity" was established on July 2013. Both English version and Arabic version are attached in Supporting Report S3.4. This plan consists of six (6) items with focusing to reduce of physical loss as follows:

- Strategy and approach to tackle NRW reduction

  Approach to tackle NRW and necessity of PDCA cycle for NRW reduction.
- Organization

  Organization and the role for tasks.
- Operation Process Chart

  Chart of Operation Process for activities in each branch.
- Methodology for activities

  Details for "Preparation Work", "Safety Control", "Survey Method", "Reporting System" and "Analysis".
- Recommendation

  Current issues and recommendations for the future activity.
- Equipment Manual

  Equipment manuals for main equipment (attached to the "5 years plan").

(2) Issues to be Tackled in Later Stages

Issue-1: Reporting System

Monthly report should be submitted to HQ. In the reports, the leaks detected by the survey should be reported separately from ones found by visual inspection, as well as process of the survey works. C/P team needs to make efforts to promote survey efficiency through analysis on relation of number of leaks with number of customers.

4.2.3 Achievement in Each Model Area

The achievement of NRW activity in each model area is mentioned hereinafter.

4.2.3.1 GHAPWASCO

(1) Tanta Markaz on GHAPWASCO

1) Making Field Survey of Water Distribution Network

The Project team selected Mohamed Farid area as the pilot area in Tanta Markaz. In order to confirm the condition of the pilot area, the Project team conducted site survey and updated the GIS map. In parallel, water distribution network information was collected from GIS section. The pilot area has following characteristics:

- A service pipe from distribution pipe is installed under the building, and the service pipe has branched to several smaller service pipes with a water meter at a space in the building.
- The pipe length, area and number of service pipes are less compared with number of customers.
- Street surface is paved by asphalt.

- There are some difficulties to enter into the building because most of the entrances of buildings are locked in daytime.
- Installation condition of service pipe and water meter at this area represents the condition of Tanta city.

Table 4.2-13 Water Distribution Network Survey Result on Mohamed Farid Area in Tanta Markaz

Diameter of distribution pipe for area	150 mm (6")
Length of water distribution network pipes (Material: Asbestos)	899 m
150 mm (6")	375 m
100 mm (4")	524 m
Number of customer	Approx. 408
Number of working water meters	Approx. 320

Source: GIS section

2) Measuring Water Meter Accuracy

The Project team conducted water meter accuracy test for 42 water meters out of around 320 working meters at the workshop in Tanta branch office. The number of working water meters was collected from the revenue department.

The revenue department selected old water meters in the pilot area for more than ten percent (10%) of total working water meters for water meter accuracy test. The Project team checked the errors, comparing with new water mater in the workshop. The result of average error was recorded almost as Zero (Some water meters indicated positive errors and some others indicated negative ones.). There were few water meters to be necessary for repair. Nevertheless, they were cleaned before reinstallation. The Project team applied "Zero" as the error percentage to water balance analysis.

3) Making Water Balance Analysis Before Repair

This survey consists of distribution volume measurement and consumption volume measurement. The consumption volume measurement is to read all the meters in the pilot area twice at a certain time. The distribution volume measurement is to measure the total inflow into the pilot area, using ultrasonic flowmeter. It continues from the beginning of 1st reading of the water meters to the end of 2nd reading. At the same time, the detail of water meter status is confirmed. According to water meter readers at this area, average number of living people in a household is about four (4) persons. Following table is the status of the water meter at this stage.

Table 4.2-14 Summary of Status for Water Meter at Mohamed Farid Area in Tanta Markaz

Item	Unit	Status
Number of read water meters	pcs	296
Number of locked flat (includes difficult to read water meter)	pcs	46
Number of no water meters	pcs	66
Illegal connection	pcs	9

Source: Project team

The Project team applied the following procedures for water balance analysis.

1- Count water distribution volume flowing into the pilot area.
2- Analyze the average billed and metered consumption through water meter reading.
3- Count the authorized consumption according to the volume of metered consumption.
4- Count the unbilled and unmetered consumption through the average consumption and add it to the authorized consumption as an estimated value.
5- Count the volume of meter inaccuracies according to estimated flow error. Sensitivity test at Mohamed Farid area was not conducted at this stage. 0.17L/min was applied, which is a result of the pilot area in Zefta area, since the accuracy test was difficult to be carried out in a short period due to a problem of meter property.

In accordance with the above procedure, water balance analysis sheet before repair for the pilot area in Tanta Markaz is estimated as shown in Table 4.2-15.

Table4.2-15 Water Balance Analysis Before Repair for Mohamed Farid Area in Tanta Markaz

<table>
<tr><td rowspan="9">Water Distribution Volume
359.474
(m³/day)
(100%)</td><td rowspan="5">Authorized Consumption
215.237
(m³/day)</td><td rowspan="3">Billed Authorized Consumption (m³/day)
215.237</td><td>Billed Metered Consumption (m³/day)</td><td>150.67</td><td rowspan="3">Sold Water
215.2371429
(m³/day)
(59.9%)</td><td rowspan="3">Revenue Water (RW)
(m³/day)
215.237
(59.9%)</td></tr>
<tr><td>Metering Error (over registration) (m³/day)</td><td>0</td></tr>
<tr><td>Billed Unmetered Consumption (m³/day)</td><td>64.5711</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (m³/day)
0</td><td>Unbilled Metered Consumption (m³/day)</td><td>0</td><td rowspan="4">Commercial Loss
15.54803896
(m³/day)
(4.3%)</td><td rowspan="4">Non Revenue Water (NRW)
(m³/day)
144.237
(40.1%)</td></tr>
<tr><td>Unbilled Unmetered Consumption (m³/day)</td><td>0</td></tr>
<tr><td rowspan="4">Water Losses
144.237
(m³/day)</td><td rowspan="2">Apparent Losses (m³/day)
15.5480</td><td>Unauthorized Consumption (m³/day)</td><td>8.48</td></tr>
<tr><td>Metering Inaccuracies (m³/day)</td><td>7.07</td></tr>
<tr><td rowspan="3">Real Losses (m³/day)
128.689</td><td>Leakage on Transmission and/or Distribution Mains (m³/day)</td><td>0</td><td>Physical Loss
128.6888182
(m³/day)
(35.8%)</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks (m³/day)</td><td>0</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering (m³/day)</td><td>128.69</td></tr>
</table>

Source: Project team

4) Conducting Leak Detection Survey

The leak detection survey was conducted in three (3) steps; the 1st stage is survey to narrow the area that leak is occurring, house connection survey using acoustic rod and leak noise correlator survey. The 2nd stage is leak detection survey. The 3rd stage is survey to confirm leak.

a) Leak Detection Survey for Expected Leak Area

a-1) House Connection Survey

As the 1st approach to detect leak in pipe network, the Project team listens to the sound of house connection, using acoustic rod and digital sound detector. When leak occurs, the leak sound travels through the pipe. The method of house connection survey is shown on Figure 4.2-3.

Figure 4.2-3 House Connection Survey using Acoustic Rod on GHAPWASCO

a-2) Leak Noise Correlator

Leak noise correlator is used when the leak sound is not detected from the ground surface even if the two (2) different house connections have suspected noise. The equipment shows the distance from the sensors to the leak point. After the leak noise correlator survey, the ground surface survey should be done again.

Figure 4.2-4 Leak Noise Correlator Survey on GHAPWASCO

b) Leak Detection Survey for Determination of Leak Point

Water leak detector is used to detect leak sound which traveled through soil to the ground surface. The ground surface survey method using the water leak detector is shown in Figure 4.2-4. When its operation was launched, the Project team conducted the survey in the nighttime to avoid background or environmental noise. GHAPWASCO arranged security police for safety purpose, but it took cost and time. Therefore, the Project team modified to do it in daytime for the pilot area in Tanta Markaz.

Figure 4.2-5 Ground Surface Survey using Water Leak Detector on GHAPWASCO

c) Confirmation

After the survey by water leak detector, the Project team conducts leak confirmation to know the presence of leak. Using hammer drill and Boring bar, the Project team makes some small bore holes to insert acoustic rod to check if the detected point has leak noise and/or water from pipeline. The confirmation is a key to success for accurate leak detection survey.

Figure 4.2-6 Drilling for Confirmation on GHAPWASCO

d) Pipe & Valve Locating Devices

a- Metallic Pipe Locator

Metallic pipe locator is used to locate the metal pipeline from ground surface, in advance of the ground surface survey.

b- Non-Metallic Pipe Locator

Non-metallic pipe locator is used when the suspected leak sound is on PVC or PE pipes and the location is not clear.

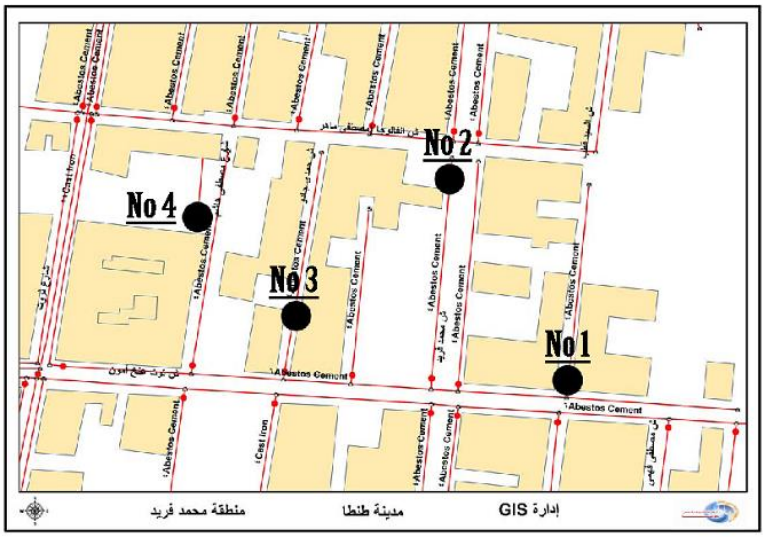
c- Metal Locator

Metal locator is used to locate valves when the valve cover is buried underground by soil or asphalt.

Figure 4.2-7 Training of Metal Locator for Buried Manhole Cover Location on GHAPWASCO

5) Results of Leak Detection Survey

As a result of leak detection survey, four (4) leaks were found at Mohamed Farid area in Tanta Markaz and all leaks were repaired. Locations of leak points are shown in Figure 4.2-8.



Source: Project team

Figure 4.2-8 Location of Detected Leaks at Mohamed Farid Area in Tanta Markaz

6) Making Water Balance Analysis After Repair

After the leak detection survey, the Project team conducted the second water balance analysis to check the reduction amount of NRW. Result of the water balance analysis after repair is shown in Table 4.2-16.

Table 4.2-16 Water Balance Analysis After Repair for Mohamed Farid Area in Tanta Markaz

<table>
<tr><td rowspan="8">Water Distribution Volume
280.102
(m³/day)
(100%)</td><td rowspan="4">Authorized Consumption
210.810
(m³/day)</td><td rowspan="3">Billed Authorized Consumption (m³/day)
210.810</td><td>Billed Metered Consumption (m³/day) 147.567</td><td rowspan="3">Sold Water
210.810
(m³/day)
(75.3%)</td><td rowspan="3">Revenue Water (RW)
(m³/day)
210.810
(75.3%)</td></tr>
<tr><td>Metering Error (over registration) (m³/day) 0</td></tr>
<tr><td>Billed Unmetered Consumption (m³/day) 63.24</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (m³/day)
0</td><td>Unbilled Metered Consumption (m³/day) 0</td><td rowspan="3">Commercial Loss
10.2631
(m³/day)
(3.7%)</td><td rowspan="5">Non Revenue Water (NRW)
(m³/day)
69.292
(24.7%)</td></tr>
<tr><td>Unbilled Unmetered Consumption (m³/day) 0</td></tr>
<tr><td rowspan="4">Water Losses
69.292
(m³/day)</td><td rowspan="2">Apparent Losses (m³/day)
10.263</td><td>Unauthorized Consumption (m³/day) 3.19</td></tr>
<tr><td>Metering Inaccuracies (m³/day) 7.07</td></tr>
<tr><td rowspan="3">Real Losses (m³/day)
59.029</td><td>Leakage on Transmission and/or Distribution Mains (m³/day) 0</td><td>Physical Loss
59.029
(m³/day)
(21.1%)</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks (m³/day) 0</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering (m³/day) 59.03</td></tr>
</table>

Source: Project team

7) Summary of Water Balance Analysis

Following table is a summary of water balance analysis for Mohamed Farid area in Tanta Markaz.

Table 4.2-17 Summary of Water Balance Analysis Before and After Repair for Mohamed Farid Area in Tanta Markaz

PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	40.1%	28.0%	24.7%	4
Reduction rate of NRW		30.0%	38.4%	

Source: Project team

(2) El Mahalla El Kobra Markaz on GHAPWASCO

1) Making Field Survey of Water Distribution Network

The Project team selected Omar Ebn Abd El Aziz area in El Mahalla El Kobra Markaz as the pilot area. El Mahalla El Kobra Markaz is generally facing problem of low service pressure. Meanwhile, this Markaz is very important Markaz for Gharbia Governorate. The pilot area has the following characteristics:

- There are several water meter types in the pilot area. Some water meters are very old and difficult to read.
- Some street surface of pilot area is not paved by asphalt.
- Condition of this area represents the condition of El Mahalla El Kobra area.

Table 4.2-18 Water Distribution Network Survey Result for Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

Diameter of distribution pipe to area	150mm (6")
Length of water distribution network pipes (Material: PVC)	1,625 m
150 mm (6")	180 m
100 mm (4")	1,445 m
Number of customers	Approx. 376
Number of working water meters	Unknown

Source: GIS section

2) Measuring Water Meter Accuracy

The Project team conducted water meter accuracy test at the site with a graduated tank. There are seven types of water meter at the pilot area; around a half of total is Masara type and Qaha type, and Harby type follows. As a result of water meter accuracy test, the average of water meter error was around 45% as over registration. The Project team started water meter cleaning in the area as much as possible. After the cleaning, the average error percentage was improved to 33%.

3) Making Water Balance Analysis Before Repair

The Project team conducted flow measurement and water meter reading simultaneously. And water meter error was 33% over registration as the result of water meter accuracy test for the water balance analysis of Omar Ebn Abd El Aziz area. Status for water meter is shown as Table 4.2-19, and water balance analysis sheet before repair for the pilot area is estimated in Table 4.2-20.

Table 4.2-19 Summary of Status for Water Meter at Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

Item	Unit	Status
Number of read water meters	pcs	227
Non-working water meters & Not-clear water meters	pcs	130
Number of locked flat (difficult to read water meter)	pcs	21

Source: Project team

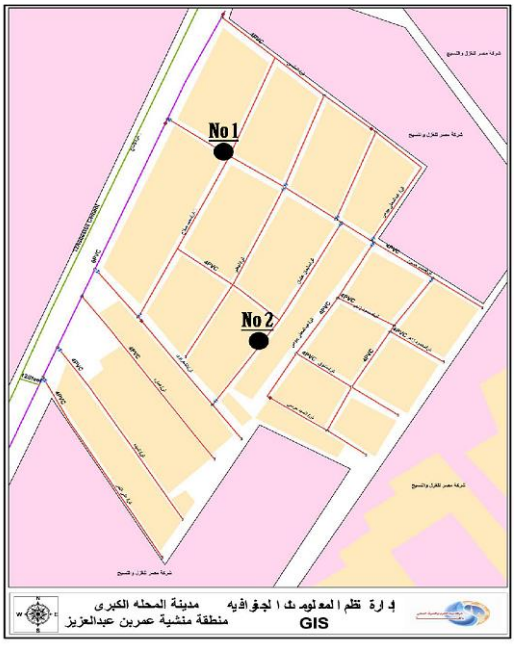
Table 4.2-20 Water Balance Analysis Before Repair for Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

Water Distribution Volume **354.544** (m³/day) *(100%)*	Authorized Consumption **258.370** (m³/day)	Billed Authorized Consumption (m³/day) **258.370**	Billed Metered Consumption (m³/day)	**218.50**	Sold Water **258.370** (m³/day) *(72.9%)*	Revenue Water **(RW)** (m³/day) **258.370** *(72.9%)*
			Metering Error (over registration) (m³/day)	**-85.26**		
			Billed Unmetered Consumption (m³/day)	**125.13**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**	Commercial Loss **6.946** (m³/day) *(2.0%)*	Non Revenue Water **(NRW)** (m³/day) **96.174** *(27.1%)*
			Unbilled Unmetered Consumption (m³/day)	**0**		
	Water Losses **96.174** (m³/day)	Apparent Losses (m³/day) **6.946**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**6.95**		
		Real Losses (m³/day) **89.228**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **89.228** (m³/day) *(25.2%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**89.23**		

Source: Project team

4) Conducting Leak Detection Survey

As a result of leak detection survey, two (2) leaks were found at Omar Ebn Abd El Aziz area and the leaks were repaired. Locations of the leak points are shown in Figure 4.2-9.



Source: Project team

Figure 4.2-9 Location of Detected Leaks at Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

5) Making Water Balance Analysis After Repair

After the repair of leaks, the Project team conducted the second water balance analysis to check the reduction amount of NRW. Result of water balance analysis is shown in Table 4.2-21.

Table 4.2-21 Water Balance Analysis After Repair for Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

Water Distribution Volume **337.304** (m³/day) *(100%)*	Authorized Consumption **263.030** (m³/day)	Billed Authorized Consumption (m³/day) **263.030**	Billed Metered Consumption (m³/day)	**209.34**	Sold Water **263.030** (m³/day) *(78.0%)*	Revenue Water **(RW)** (m³/day) **263.030** *(78.0%)*
			Metering Error (over registration) (m³/day)	**-86.80**		
			Billed Unmetered Consumption (m³/day)	**140.49**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**		
	Water Losses **74.274** (m³/day)	Apparent Losses (m³/day) **10.607**	Unauthorized Consumption (m³/day)	**3.72**	Commercial Loss **10.607** (m³/day) *(3.1%)*	Non Revenue Water **(NRW)** (m³/day) **74.274** *(22.0%)*
			Metering Inaccuracies (m³/day)	**6.89**		
		Real Losses (m³/day) **63.667**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **63.667** (m³/day) *(18.9%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**63.67**		

Source: Project team

6) Summary of Water Balance Analysis

Following Table is summary of water balance analysis for Omar Ebn Abd El Aziz area in El Mahalla El Kobra Markaz.

Table 4.2-22 Summary of Water Balance Analysis Before and After Repair for Omar Ebn Abd El Aziz Area in El Mahalla El Kobra Markaz

PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	27.1%	20.3%	22.0%	2
Reduction rate of NRW		25.0%	18.8%	

Source: Project team

(3) Zefta Markaz on GHAPWASCO

1) Making Field Survey of Water Distribution Network

The Project team selected Masaraf area in Zefta Markaz as the pilot area. The pilot area has the following characteristics:

- Many water meters are installed at entrance of the building.

- Number of non-working water meters is comparatively small.
- Street surface is not paved by asphalt.
- Condition of this area represents the condition of Zefta Markaz.

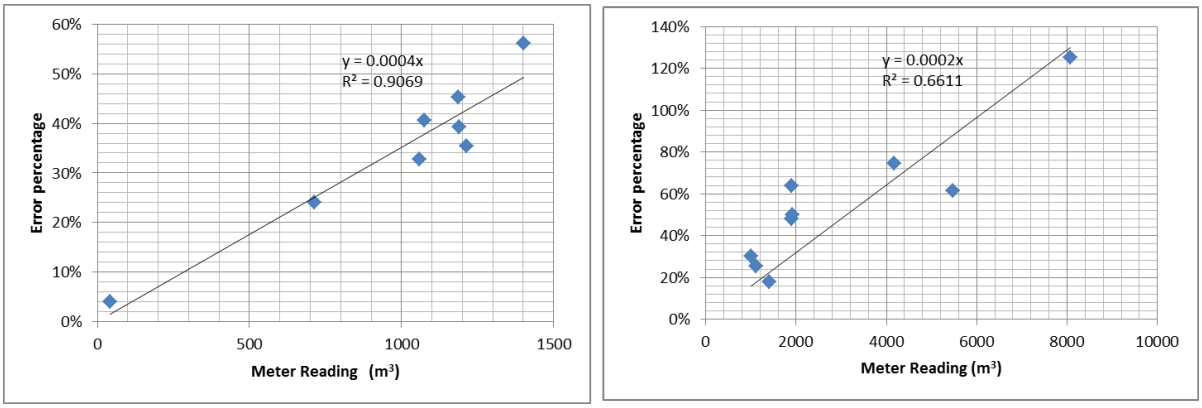
Table 4.2-23 Water Distribution Network Survey Result for Masaraf Area in Zefta Markaz

Diameter of distribution pipe to area	100mm (4")
Length of water distribution network pipes (Material: PVC)	4766 m
250 mm (10")	50 m
200 mm (8")	5 m
150 mm (6")	1662 m
100 mm (4")	3049 m
Number of customer	Approx. 242
Number of working water meters	Approx. 230

Source: GIS section

2) Measuring Water Meter Accuracy

The Project team conducted water meter accuracy test at the site with a graduated tank. There are two types of water meter in the pilot area; one is Masara type and the other is Company type. The both types of water meter have a trend of error and the Project team applied the trend to the water balance analysis. Figure 4.2-10 is the trend for each type of water meter. After the test, worse water meters in condition were cleaned.



Source: Project team

Figure 4.2-10 Trend of Error Percentage for Masara Type and Company Type (Left; Masara Type, Right; Company Type)

The Project team conducted the sensitivity test to know starting flow, of which volume is too small to measure by water meter, for ten (10) water meters. The starting flow was measured by graduated tank and the result of average is 0.17L/min. The Project team applies this flow to water balance analysis.

3) Making Water Balance Analysis Before Repair

Table 4.2-24 is a summary of distribution volume analysis in Masaraf area. The Project team estimated that the leakage volume was low in the area because low MNF had been recorded.

Table 4.2-24 Summary of Result for Flow Measurement for Masaraf Area in Zefta Markaz

Item	Unit	Value
Measurement period	day	6
Minimum Night Flow (MNF)	L/min	31.8
Estimated NRW ratio (at MNF measured date)	%	21.57
Average distribution volume	m^3/day	198.646
Average estimated leakage volume	m^3/day	52.013
Estimated NRW ratio (Average)	%	26.18%

Source: Project team

During the consumption survey, condition of water meters was confirmed. According to the information of water meter readers in this area, the average number of persons in a household is about five (5) or six (6) persons. Following table is the status of the water meter.

Table 4.2-25 Summary of Status of Water Meter for Masaraf Area in Zefta Markaz

Item	Unit	Status
Number of read water meters	pcs	203
Number locked flat (difficult to read water meter)	pcs	20
Number of No water meters	pcs	10
Number of no living house	pcs	9

Source: Project team

Water balance analysis before repair in Zefta Markaz is shown in Table 4.2-26.

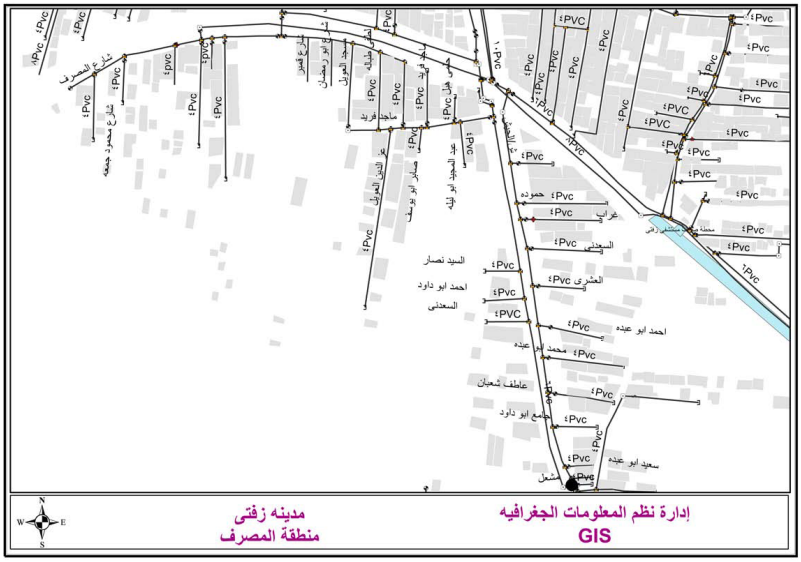
Table 4.2-26 Water Balance Analysis Before Repair for Masaraf Area in Zefta Markaz

Water Distribution Volume **198.646** (m³/day) *(100%)*	Authorized Consumption **156.585** (m³/day)	Billed Authorized Consumption (m³/day) **156.585**	Billed Metered Consumption (m³/day)	**188.885**	Sold Water **156.585** (m³/day) *(78.8%)*	Revenue Water **(RW)** (m³/day) **156.585** *(78.8%)*
			Metering Error (over registration) (m³/day)	**-38.26**		
			Billed Unmetered Consumption (m³/day)	**5.96**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **7.405** (m³/day) *(3.7%)*	Non Revenue Water **(NRW)** (m³/day) **42.061** *(21.2%)*
	Water Losses **42.061** (m³/day)	Apparent Losses (m³/day) **7.405**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**7.41**		
		Real Losses (m³/day) **34.656**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **34.656** (m³/day) *(17.4%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**34.66**		

Source: Project team

4) Conducting Leak Detection Survey

As a result of leak detection survey, one (1) leak was found at Masaraf area in Zefta Markaz. It was very small in leakage volume. Location of the leak point is shown in Figure 4.2-11.



Source: Project team

Figure 4.2-11 Location of Detected Leak at Masaraf Area in Zefta Markaz

5) Making Water Balance Analysis After Repair

Although the Project team did not expect much reduction of leakage at the pilot area due to less number of leaks, water balance analysis was conducted after cleaning water meters.

During the Mid-term review, concerned parties agreed that water meter cleaning should be completed before leak detection survey and repair. Nevertheless, the Project team had already finished the leak detection survey in this area at that time of Mid-term review. The Project team, therefore, conducted the following procedures for this area:

(Step1) Water balance analysis before repair without water meter cleaning

(Step2) Leak detection and repair of leak

(Step3) Water meter cleaning

(Step4) Water balance analysis after repair with water meter cleaning

Result of water balance analysis is shown in Table 4.2-27.

Table 4.2-27 Water Balance Analysis After Repair for Masaraf Area in Zefta Markaz

Water Distribution Volume **212.315** (m³/day) *(100%)*	Authorized Consumption **167.694** (m³/day)	Billed Authorized Consumption (m³/day) **167.694**	Billed Metered Consumption (m³/day)	**185.623**	Sold Water **167.694** (m³/day) *(79.0%)*	Revenue Water **(RW)** (m³/day) **167.694** *(79.0%)*
			Metering Error (over registration) (m³/day)	**-19.609**		
			Billed Unmetered Consumption (m³/day)	**1.68**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **7.405** (m³/day) *(3.5%)*	Non Revenue Water **(NRW)** (m³/day) **44.621** *(21.0%)*
	Water Losses **44.621** (m³/day)	Apparent Losses (m³/day) **7.405**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**7.41**		
		Real Losses (m³/day) **37.216**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **37.216** (m³/day) *(17.5%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**37.22**		

Source: Project team

6) Summary of Water Balance Analysis

Following Table is summary of water balance analysis for Masaraf area in Zefta Markaz.

Table 4.2-28 Summary of Water Balance Analysis Before and After Repair for Masaraf Area in Zefta Markaz

PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	21.2%	15.9%	21.0%	1
Reduction rate of NRW		25.0%	0.0%	

Source: Project team

7) Additional Leak detection Survey at Masry Area in Zefta Markaz

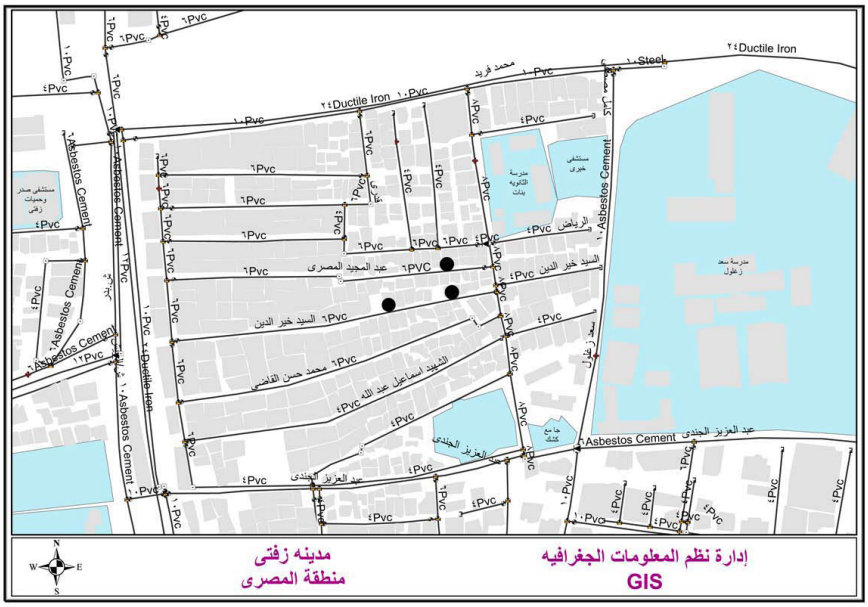
As described before, the Project team did not achieve the target for NRW reduction at the pilot area. They, therefore, expanded the survey for another area. The leak detection survey found three (3) leaks in Masry area. The detected leaks are pointed in the following map. The causes of two (2) leaks were poor repair. And the other leak was by pipe deterioration. GHAPWASCO needs to reconsider the repair method, because the two (2) leaks were just covered with rubber band. These leaks were caused by lack of standard of plumbing work.

In order to grasp the reduced leakage volume, the Project team measured the inflow volume at this area before repair and after repair. Table 4.2-29 is a comparison between before and after repair. The Project team evaluated that three (3) % of distribution volume was reduced per day.

Table 4.2-29 Comparison of Distribution Volume between Before Repair and After Repair for Masry Area in Zefta Markaz

Item	Value
Distribution volume before repair	574,887.9 m^3
Distribution volume after repair	557,087.1 m^3
Water saving	17,800.8 m^3
Percentage of saving	3.2%

Source: Project team



Source: Project team

Figure 4.2-12 Location of Detected Leaks at Masry Area in Zefta Markaz

4.2.3.2 MCWW

(1) Shebeen El Kom Markaz on MCWW

1) Making Field Survey of Water Distribution Network

The Project team selected Abo Agwa area in Shebeen El Kom Markaz as the pilot area.

Table 4.2-30 Water Distribution Network Survey Result for Abo Agwa Area in Shebeen El Kom Markaz

Diameter at Inflow point	100mm (4")
Length of water distribution network pipes (Material: Asbestos)	2,465.9 m
Number of customer	Approx. 495
Number of working water meters	Unknown

Source: Project team

During field survey, the Project team found one visible leakage on a street surface. The leakage was repaired immediately although before water balance analysis.

2) Measuring Water Meter Accuracy

There are four types of water meters at this area; Masara type, Company type, Qaha type, and Poland type. Each type of water meter indicated errors as same trend as ones in the other pilot areas. While the Project team conducted the cleaning of water meters, the number of cleaned water meter is limited to less than 25% of all water meters, because other water meters were rejected by the customers for temporary removal and cleaning.

As a result of water meter accuracy test, the average of water meter error was around 32% as over registration.

3) Making Water Balance Analysis Before Repair

Status for water meter is shown as Table 4.2-31 and water balance analysis before repair for Abo Agwa area in Shebeen El Kom Markaz is estimated as Table 4.2-32.

Table 4.2-31 Status for Water Meter for Abo Agwa Area in Shebeen El Kom Markaz

Item	Unit	Status
Number of read water meters	pcs	358
Non-working water meters & Not-clear water meters	pcs	98
No consumption water meters (No living house)	pcs	40

Source: Project team

Table 4.2-32 Water Balance Analysis Before Repair for Abo Agwa Area in Shebeen El Kom Markaz

Water Distribution Volume **347.149** (m³/day) *(100%)*	Authorized Consumption **278.999** (m³/day)	Billed Authorized Consumption (m³/day) **278.999**	Billed Metered Consumption (m³/day)	**288.036**	Sold Water **278.999** (m³/day) *(80.4%)*	Revenue Water **(RW)** (m³/day) **278.999** *(80.4%)*
			Metering Error (over registration) (m³/day)	**-87.885**		
			Billed Unmetered Consumption (m³/day)	**78.85**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		Non Revenue Water **(NRW)** (m³/day) **68.150** *(19.6%)*
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **15.361** (m³/day) *(4.4%)*	
	Water Losses **68.150** (m³/day)	Apparent Losses (m³/day) **15.361**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**15.361**		
		Real Losses (m³/day) **52.789**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **52.789** (m³/day) *(15.2%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**52.7886**		

Source: Project team

4) Conducting Leak Detection Survey

Same procedure was taken for the leak detection survey as described for "Tanta Markaz on GHAPWASCO". At first, in order to narrow the area that leak is occurred, was conducted the survey by acoustic rod and leak noise correlator. Next, was conducted ground surface survey using water leak detector. At last, was conducted noise confirmation survey.

a) Leak Detection Survey for Expected Leak Area

a-1) House Connection Survey

Figure 4.2-13 shows house connection survey by acoustic rod.

Figure 4.2-13 House Connection Survey using Acoustic Rod on MCWW

a-2) Leak Noise Correlator

Figure 4.2-14 shows survey using the leak noise correlator.

Figure 4.2-14 Leak Noise Correlator Survey on MCWW

b) Leak Detection Survey for Determination of Leak Point

The ground surface survey method using the water leak detector is shown in Figure 4.2-15.

Figure 4.2-15 Ground Surface Survey using Water Leak Detector on MCWW

c) Confirmation

Figure 4.2-16 shows confirmation of leak place by drilling.

Figure 4.2-16 Noise Confirmation on MCWW

d) Pipe & Valve Locating Devices

a- Metallic Pipe Locator

Metallic pipe locator is used to locate the metal pipeline from ground surface, in advance of the ground surface survey.

b- Non-Metallic Pipe Locator

Non-metallic pipe locator is used when the suspected leak sound is on PVC or PE pipes and the location is not clear.

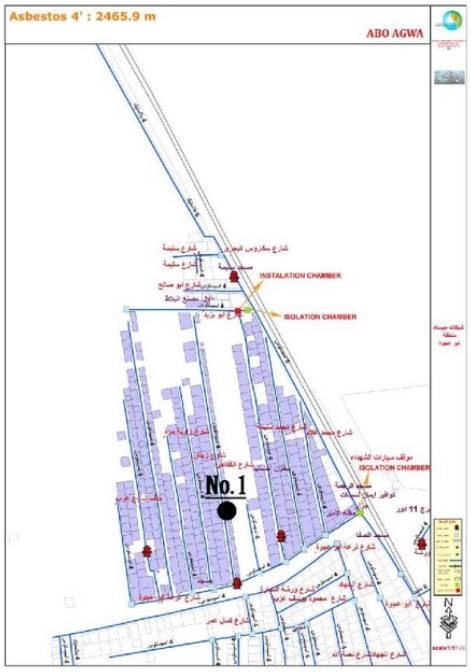
c- Metal Locator

Metal locator is used to locate valves when the valve cover is buried underground by soil or asphalt.

Figure 4.2-17 Training of Metal Pipe Locator on MCWW

Figure 4.2-18 Training of Metal Locator for Buried Manhole Cover Location on MCWW

As a result of leak detection survey, one (1) leak was found at Abo Agwa area and the leak was repaired. Location of the leak point is shown in Figure 4.2-19.



Source: Project team

Figure 4.2-19 Location of Detected Leak at Abo Agwa Area in Shebeen El Kom Markaz

5) Making Water Balance Analysis After Repair

After the repair of leak, the Project team conducted the second water balance analysis to check the reduction amount of NRW. Result of water balance analysis is shown in Table 4.2-33.

Table 4.2-33 Water Balance Analysis After Repair for Abo Agwa Area in Shebeen El Kom Markaz

Water Distribution Volume **356.90** (m³/day) *(100%)*	Authorized Consumption **298.06** (m³/day)	Billed Authorized Consumption (m³/day) **298.06**	Billed Metered Consumption (m³/day)	**293.099**	Sold Water **298.06** (m³/day) *(83.5%)*	Revenue Water **(RW)** (m³/day) **298.06** *(83.5%)*
			Metering Error (over registration) (m³/day)	**-93.888**		
			Billed Unmetered Consumption (m³/day)	**98.85**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**	Commercial Loss **15.361** (m³/day) *(4.3%)*	Non Revenue Water **(NRW)** (m³/day) **58.85** *(16.5%)*
			Unbilled Unmetered Consumption (m³/day)	**0**		
	Water Losses **58.85** (m³/day)	Apparent Losses (m³/day) **15.361**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**15.361**		
		Real Losses (m³/day) **43.49**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **43.49** (m³/day) *(12.2%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**43.4854**		

Source: Project team

6) Summary of Water Balance Analysis

Following Table is the summary for water balance analysis for Abo Agwa area in Shebeen El Kom Markaz.

Table 4.2-34 Summary for Water Balance Analysis Before and After Repair for Abo-Agwa Area in Shebeen El Kom Markaz

PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	19.6%	14.7%	16.5%	1
Reduction rate of NRW		25.0%	15.8%	

Source: Project team

(2) Quesna Markaz on MCWW

1) Making Field Survey of Water Distribution Network

The Project team selected Mahkama area in Quesna Markaz as the pilot area. The pilot area has following characteristics:

- Around 1500m of distribution pipes are replaced with PVC in 2008-2009. The material of the other pipes is asbestos.
- A part of streets is not paved.

Table 4.2-35 Water Distribution Network Survey Result for Mahkama Area in Quesna Markaz

Diameter at Inflow point	100mm (4”)
Length of water distribution network pipes (Material: PVC and Asbestos)	3,650 m
100 mm (4”) PVC	1,500 m
150 mm (6”) Asbestos	600 m
100 mm (4”) Asbestos	1,550 m
Number of customer	Approx. 760
Number of working water meters	Unknown

Source: GIS section

2) Measuring Water Meter Accuracy

The Project team conducted water meter accuracy test for 64 meters. As a result of water meter accuracy test, the average of water meter error was around 31.5% as over registration.

3) Making Water Balance Analysis Before Repair

Status of the water meter is shown as Table 4.2-36 and water balance analysis before repair for Mahkama area in Quesna Markaz is estimated as Table 4.2-37.

Table 4.2-36 Summary of Status for Water Meter for Mahkama Area in Quesna Markaz

Item	Unit	Status
Number of read water meters	Pcs	396
Non-working water meters & Not-clear water meters	Pcs	207
No consumption water meters (No living house)	Pcs	31

Source: Project team

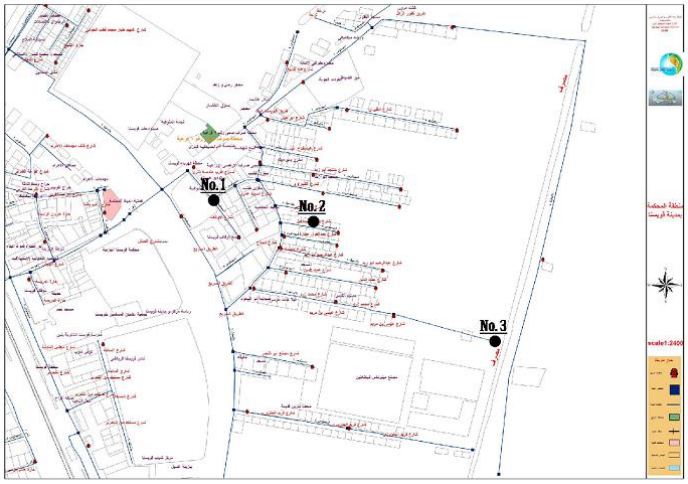
Table 4.2-37 Water Balance Analysis Before Repair for Mahkama Area in Quesna Markaz

Water Distribution Volume **495.838** (m³/day) *(100%)*	Authorized Consumption **348.073** (m³/day)	Billed Authorized Consumption (m³/day) **348.073**	Billed Metered Consumption (m³/day)	**300.59**	Sold Water **348.073** (m³/day) *(70.2%)*	Revenue Water **(RW)** (m³/day) **348.073** *(70.2%)*
			Metering Error (over registration) (m³/day)	**-109.64**		
			Billed Unmetered Consumption (m³/day)	**157.127**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **12.026** (m³/day) *(2.4%)*	Non Revenue Water **(NRW)** (m³/day) **147.764** *(29.8%)*
	Water Losses **147.764** (m³/day)	Apparent Losses (m³/day) **12.026**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**12.03**		
		Real Losses (m³/day) **135.738**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **135.738** (m³/day) *(27.4%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**135.738**		

Source: Project team

4) Conducting Leak Detection Survey

As a result of leak detection survey, three (3) leaks were found at Mahkama area in Quesna Markaz, and all detected leaks were repaired. Locations of the leak points are shown in Figure 4.2-20.



Source: Project team

Figure 4.2-20 Location of Detected Leaks at Mahkama Area in Quesna Markaz

5) Making Water Balance Analysis After Repair

Following table is the water balance analysis after repair for Mahkama area in Quesna Markaz.

Table 4.2-38 Water Balance Analysis After Repair for Mahkama Area in Quesna Markaz

Water Distribution Volume **444.100** (m³/day) *(100%)*	Authorized Consumption **344.277** (m³/day)	Billed Authorized Consumption (m³/day) **344.277**	Billed Metered Consumption (m³/day)	**259.12**	Sold Water **344.277** (m³/day) *(77.5%)*	Revenue Water **(RW)** (m³/day) **344.277** *(77.5%)*
			Metering Error (over registration) (m³/day)	**-108.45**		
			Billed Unmetered Consumption (m³/day)	**193.60**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **12.026** (m³/day) *(2.7%)*	Non Revenue Water **(NRW)** (m³/day) **99.823** *(22.5%)*
	Water Losses **99.823** (m³/day)	Apparent Losses (m³/day) **12.026**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**12.03**		
		Real Losses (m³/day) **87.797**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **87.797** (m³/day) *(19.8%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**87.80**		

Source: Project team

6) Summary of Water Balance Analysis

Following Table is summary for water balance analysis before repair for Mahkama area in Quesna Markaz.

Table 4.39 Summary for Water Balance Analysis Before and After Repair for Mahkama Area in Quesna Markaz

PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	29.8%	22.3%	22.5%	3
Reduction rate of NRW		25.0%	24.5%	

Source: Project team

(3) Berket El Sab'a Markaz on MCWW

1) Making Field Survey of Water Distribution Network

The Project team selected Abdel Salam Aref area in Berket El Sab'a Markaz as the pilot area. The pilot area has the following characteristics:

- Most of water meters are installed at entrance of the building.
- New water meters were installed recently.

- Costumers are categorized in several types such as domestic household, governmental organization, hospital, etc.
- A part of streets is not paved.
- Condition of this area represents the ones of Berket El Sab'a area.

Table 4.2-40 Water Distribution Network Survey Result for Abdel Salam Aref Area in Berket El Sab'a Markaz

Diameter at Inflow point	200mm (8")
Length of water distribution network pipes (Material: PVC and Asbestos)	5,600 m
150mm (6") PVC	540 m
100 mm (4") PVC	1,500 m
200 mm (8") Asbestos	420 m
150 mm (6") Asbestos	2,000 m
100 mm (4") Asbestos	1,140 m
Number of customer	Approx. 883
(Residential)	(749)
(Governmental)	(9)
(Commercial)	(121)
(Investment)	(4)
Number of working water meters	Unknown

Source: GIS section

2) Measuring Water Meter Accuracy

The Project team conducted water meter accuracy test for 72 meters comparing with new one. As a result of water meter accuracy test, the average of water meter error was around 20% as over registration.

3) Making Water Balance Analysis Before Repair

Status for water meter is shown in Table 4.2-41 and water balance analysis sheet before repair for the pilot area in Berket El Sab'a Markaz is estimated in Table 4.2-42.

Table 4.2-41 Summary of Status for Water Meter at Abdel Salam Aref Area in Berket El Sab'a Markaz

Item	Unit	Status
Number of read water meters	pcs	502
Non-working water meters & Not-clear water meters	pcs	342
No consumption water meters (No living house)	pcs	38

Source: Project team

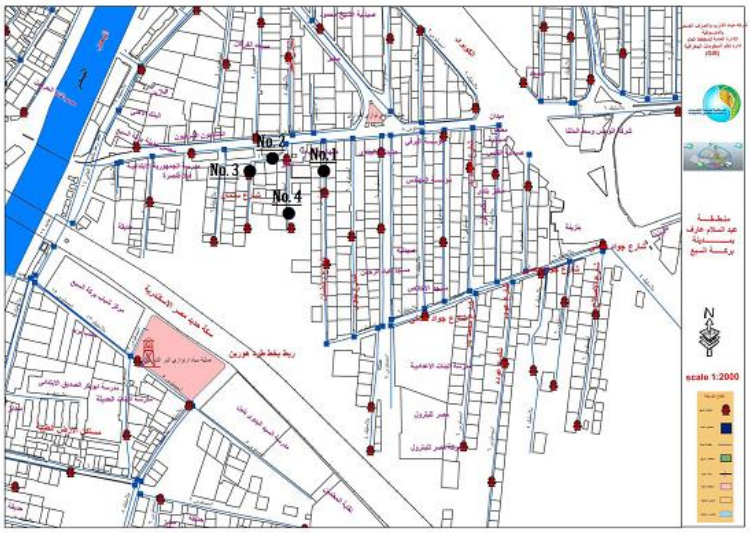
Table 4.2-42 Water Balance Analysis Before Repair for Abdel Salam Aref Area in Berket El Sab'a Markaz

Water Distribution Volume **588.656** (m³/day) *(100%)*	Authorized Consumption **429.081** (m³/day)	Billed Authorized Consumption (m³/day) **429.081**	Billed Metered Consumption (m³/day)	**306.25**	Sold Water **429.081** (m³/day) *(72.9%)*	Revenue Water **(RW)** (m³/day) **429.081** *(72.9%)*
			Metering Error (over registration) (m³/day)	**-85.82**		
			Billed Unmetered Consumption (m³/day)	**208.64**		
		Unbilled Authorized Consumption (m³/day) **0**	Unbilled Metered Consumption (m³/day)	**0**		
			Unbilled Unmetered Consumption (m³/day)	**0**	Commercial Loss **15.361** (m³/day) *(2.6%)*	Non Revenue Water **(NRW)** (m³/day) **159.575** *(27.1%)*
	Water Losses **159.575** (m³/day)	Apparent Losses (m³/day) **15.361**	Unauthorized Consumption (m³/day)	**0**		
			Metering Inaccuracies (m³/day)	**15.36**		
		Real Losses (m³/day) **144.214**	Leakage on Transmission and/or Distribution Mains (m³/day)	**0**	Physical Loss **144.214** (m³/day) *(24.5%)*	
			Leakage and Overflows at Utility's Storage Tanks (m³/day)	**0**		
			Leakage on Service Connections up to point of Customer metering (m³/day)	**144.21**		

Source: Project team

4) Conduct Leak Detection Survey

As a result of leak detection survey, four (4) leaks were found at Abdel Salam Aref area in Berket El Sab'a Markaz and all leaks were repaired. Location of leak points is shown in Figure 4.2-21.



Source: Project team

Figure 4.2-21 Location of Detected Leaks at Abdel Salam Aref Area in Berket El Sab'a Markaz

5) Making Water Balance Analysis After Repair

After the repair of the leaks, the Project team conducted the second water balance analysis to check the reduction amount of NRW. Result of water balance analysis is shown in Table 4.2-43.

Table 4.2-43 Water Balance Analysis After Repair for Abdel Salam Aref Area in Berket El Sab'a Markaz

<table>
<tr><td rowspan="8">Water Distribution Volume
654.360
(m³/day)
(100%)</td><td rowspan="4">Authorized Consumption
522.651
(m³/day)</td><td rowspan="3">Billed Authorized Consumption (m³/day)
522.651</td><td>Billed Metered Consumption (m³/day)</td><td>351.07</td><td rowspan="3">Sold Water
522.651
(m³/day)
(79.9%)</td><td rowspan="3">Revenue Water (RW)
(m³/day)
522.651
(79.9%)</td></tr>
<tr><td>Metering Error (over registration) (m³/day)</td><td>-104.26</td></tr>
<tr><td>Billed Unmetered Consumption (m³/day)</td><td>275.84</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (m³/day)
0</td><td>Unbilled Metered Consumption (m³/day)</td><td>0</td><td rowspan="4">Commercial Loss
15.361
(m³/day)
(2.3%)</td><td rowspan="6">Non Revenue Water (NRW)
(m³/day)
131.709
(20.1%)</td></tr>
<tr><td>Unbilled Unmetered Consumption (m³/day)</td><td>0</td></tr>
<tr><td rowspan="4">Water Losses
131.709
(m³/day)</td><td rowspan="2">Apparent Losses (m³/day)
15.361</td><td>Unauthorized Consumption (m³/day)</td><td>0</td></tr>
<tr><td>Metering Inaccuracies (m³/day)</td><td>15.36</td></tr>
<tr><td rowspan="3">Real Losses (m³/day)
116.348</td><td>Leakage on Transmission and/or Distribution Mains (m³/day)</td><td>0</td><td rowspan="3">Physical Loss
116.348
(m³/day)
(17.8%)</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks (m³/day)</td><td>0</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering (m³/day)</td><td>116.348</td></tr>
</table>

Source: Project team

6) Summary of Water Balance Analysis

Following Table is summary of water balance analysis for Abdel Salam Aref area in Berket El Sab'a Markaz.

Table 4.2-44 Summary of Water Balance Analysis Before and After Repair for Abdel Salam Aref Area in Berket El Sab'a Markaz

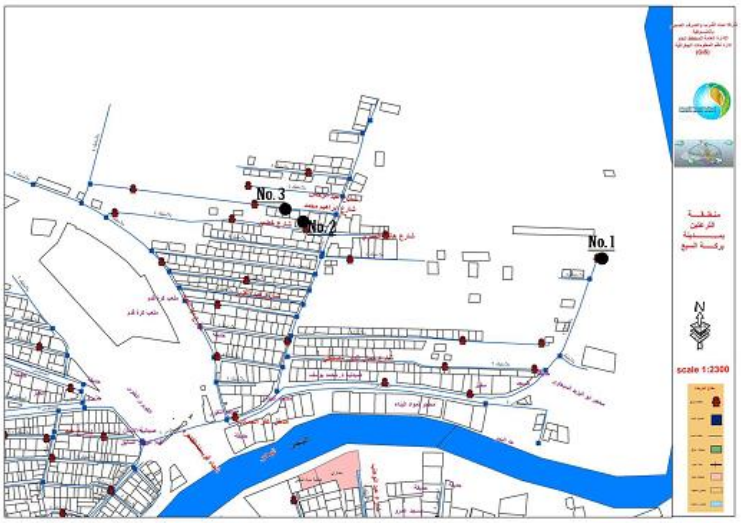
PIs	Initial Value before Project	Target Value	Output Value after Project	Leaks Repaired
NRW ratio	27.1%	20.3%	20.2%	4
Reduction rate of NRW		25.0%	25.4%	

Source: Project team

4.2.3.3 Additional Leak Detection Survey at the Other Candidate Pilot Area

The Project team additionally conducted the leak detection activity to the remained candidate pilot areas in both GHAPWASCO and MCWW. Nevertheless, the Project team conducted the leak detection and leak repair, but not the water balance analysis, since it is difficult to ensure water meters' accuracy necessary for the water balance analysis and to implement meter readings in a short period.

As an example, locations of detected leak points in Elterreten area in Berket El Sab'a Markaz are shown in Figure 4.2-22. In the area, three (3) leaks were found and all leaks were repaired.



Source: Project team

Figure 4.2-22 Location of Detected Leaks at Elterreten Area in Berket El Sab'a Markaz

4.2.4 Confirmation of Nurtured Skills for NRW Reduction

In order to confirm the nurtured skills and leant knowledge on NRW reduction activity, two (2) categories of evaluation tests were conducted for NRW C/P members.

The first category was for skills of leak detection. The contents of the evaluation test were for equipment settings, principle of leak detection and site operation. The evaluation criteria and result are as shown in Table 4.2.45 and 4.2-46. Sufficient skills and knowledge were confirmed that the all members exceeded grade-4 of the evaluation score.

Table 4.2-45 Confirmation Criteria for Leak Detection Skill

Assessment		Definition
5	Excellent	Advanced use with Q&A
4	Good	Advanced use
3	Average	Basic use
2	Fair	Assistance required
1	Poor	Ignorance

Source: Project team

Table 4.2-46 Confirmation Result for Leak Detection Skill

Classification of Test		Score & Number					Total Number
		Excellent	Good	Average	Fair	Poor	
1	Flow & Pressure measurement in DMA	G : 0 M : 3	G : 2 M : 0	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 3
2	Leak detection using Listening stick & Ground microphone	G : 1 M : 2	G : 1 M : 3	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 5
3	Leak detection using Correlator	G : 1 M : 3	G : 1 M : 2	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 5
4	Locate metallic pipe	G : 2 M : 4	G : 0 M : 1	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 5
5	Locate Non-Metallic pipe	G : 2 M : 5	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 5
6	Manhole cover detection	G : 0 M : 1	G : 2 M : 4	G : 0 M : 0	G : 0 M : 0	G : 0 M : 0	2 5
Rate		60%	40%	0%	0%	0%	100%

Notes; Upper number "G" is for GHAPWASCO, the under number "M" is for MCWW.
Source: Project team

The second category is to confirm the basic knowledge of NRW reduction management. The contents of the evaluation test are basic policy/strategy for NRW reduction activity, the purpose of isolating, flow measurement, water balance analysis, and methodology of pressure control and active leakage control. To evaluate achievements of knowledge, a paper test was conducted by JET. The evaluation criteria and result are as shown in Table 4.2-47 and 4.2-48. Sufficient skills and knowledge were confirmed that the all members exceeded grade-3 of the evaluation score.

Table 4.2-47 Confirmation Criteria for NRW Reduction Management Knowledge

Assessment		Definition	Score
5	Very High Value	Understanding of NRW reduction management skills are excellent.	90-100
4	High Value	Understanding of NRW reduction management skills are very good.	80-89
3	Moderate Value	Understanding of NRW reduction management skills are good.	60-79
2	Low Value	Understanding of NRW reduction management skills are fair.	40-59
1	No Value	Understanding of NRW reduction management skills are poor.	0-39

Source: Project team

Table 4.2-48 Confirmation Result for NRW Reduction Management Knowledge

	Score					Total
	90-100	80-89	60-79	40-59	0-39	
GHAPWASCO	1	2	0	0	0	3
MCWW	0	0	3	0	0	3
Total Numbers	1	2	3	0	0	6
Rate	16.7%	33.3%	50.0%	0.0%	0.0%	100%

Source: Project team

4.2.5 Expansion of NRW Reduction to the Other Markaz

4.2.5.1 GHAPWASCO

GHAPWASCO has been expanding the activity / information to the other Markazes and the other Governorates since Phase-2 (Jan. 2012). Followings are expansion activities and the strategy of GHAPWASCO.

(1) Establishment of "5 Years Plan for NRW Reduction Activity"

Through the activity and experience at model areas, "5 years plan for NRW reduction activity" for disseminating to other Markazes is prepared on July 2013. It is a plan to complete the first round survey in all Markazes with in 5 years. Both English and Arabic versions are attached in Supporting Report S3.4. This plan consists of six (6) items as follows:

- Strategy and approach to tackle NRW reduction
  Approach to tackle NRW and necessity of PDCA cycle for NRW reduction.
- Organization
  Organization and the role for tasks.
- Operation Process Chart
  Chart of Operation Process for activities in each branch.
- Methodology for activities
  Details for "Preparation Work", "Safety Control", "Survey Method", "Reporting System" and "Analysis".
- Recommendation
  Current issues and recommendations for the future activity.
- Equipment Manual
  Equipment manuals for main equipment (attached to the "5 years plan").

1) Organization

In May 2014, NRW reduction department was organized officially under "Operation & Maintenance Sector" (Refer to Supporting Report S1.3). In parallel with this re-organization, GHAPWASCO selected staff members for leak detection in each branch. Some of them had been already trained in Hihya training yard and in the pilot areas. Basically, staff members trained in the Project were assigned to implement "5 years plan for NRW reduction activity".

2) Activity and Implementation for 5 Years Plan for NRW Reduction Activity

C/P team commenced NRW reduction activities in November 2013, according to "5 years plan". Since then, the C/P team in HQ has been holding workshops and site trainings for branch members to transfer necessary information and skills of leak detection survey. As of June 2015, the activities were commenced in six (6) Markazes out of eight (8), except El Mahalla El Kobra Markaz and Tanta Markaz.

GHAPWASCO started the leak detection survey from urbanized areas of each Markaz. As of June 2015, leak detection surveys were finished for most of cities in Gharbia, except El Mahalla El Kobra Markaz and Tanta Markaz.

El Mahalla El Kobra Markaz and Tanta Markaz are principal Markazes in the Governorate. Since number of customers and length of pipelines are large / long, GHAPWASCO has been still in preparation stage for implementation (as of June 2015).

3) Equipment

GHAPWASCO purchased 20 acoustic rods for all branches in Phase-2. NRW department distributed it and trained branch members for usage of acoustic rods and water leak detector to detect leak points. Moreover, GHAPWASCO is planning to purchase and distribute one (1) water leak detector for each branch office for more efficient activity.

4) Estimated Leakage Volume

In the "5 years plan", the water balance analysis is not included in implementation items. Since no water balance is metered, estimation of detected leakage volume is necessary to evaluate effectiveness of the leak detection survey. The estimation of the leakage volume, however, is not easy for the surveyors. The Project team had discussed the estimation means such as measurement by bucket, assumption from leak sound, calculation, etc. In the end, the Project team concluded to use an estimation table which prepared by IWSP (Improvement Water & Wastewater Services Program) which is an EU (European Union) funded project for the Nile Delta.

According to IWSP, the leakage volume is estimated by the following basic formula, and the estimated flows are summarized in a table as shown in Table 4.2-49. Moreover, the mentioned formula and table has been utilized in SHAPWASCO.

$$q = C_d A\sqrt{2gh}$$

Where,
q: Estimated Amount
C_d: Discharge Coefficient (un-constant and approx. 0.5-0.8)
A: Area of leak hole
g: Acceleration of gravity
h: Water head

Table 4.2-49 Estimation Table for Leakage Amount

water loss table

comparison of water losses relating to pressure and orifice diameter of the leackage

bar	leakage hole diameter [mm]	l/min	l/hour	m³/ day	m³/month	m³/year
10	2	7	420	10	305	3,650
	4	27	1,620	39	1,190	14,230
	6	60	3,600	86	2,623	31,390
	8	100	6,000	144	4,392	52,580
8	2	7	390	9	274	3,280
	4	23	1,380	33	1,006	12,040
	6	50	3,000	72	2,196	26,280
	8	85	5,100	122	3,721	44,530
6	2	5	288	7	213	2,550
	4	18	1,080	26	793	9,490
	6	40	2,400	58	1,769	21,170
	8	70	4,200	101	3,080	36,880
4	2	4	228	5	152	1,820
	4	14	840	20	610	7,300
	6	32	1,920	46	1,403	16,790
	8	55	3,300	78	2,409	28,830
3	2	3	192	5	138	1,650
	4	12	720	17	516	6,190
	6	27	1,620	39	1,164	13,920
	8	48	2,880	69	2,073	24,870
1.5	2	2	108	3	75	900
	4	7	420	10	300	3,600
	6	15	900	21	648	7,776
	8	27	1,620	39	1,164	13,968

(Source: IWSP Project)

5) Result of Leak Detection Survey

Results of leak detection surveys are shown in Table 4.2-50 for a period from November 2013 until June 2015. Branch offices of El Santa, Bassyoun, Kotor, Kafr El Zayat, and Samanod finished most of the urbanized areas.

Table 4.2-50 Result of Leak Detection Survey in GHAPWASCO (November 2013 - June 2015)

Branch Name	Number of Surveyor	Surveyed House Connections	Leaked Numbers							Surveyed Days	Leakage Amount (m^3/day)
			Total	House Connection			Main Pipe				
				Steel	PVC	Others	Steel	PVC	Others		
Zefta	2	4,100	18	7	8	0	1	2	0	60	103.70
El Santa	4	3,581	33	13	13	0	0	7	0	55	522.70
Bassyon	2	3,100	14	3	9	0	1	1	0	45	355.64
Kotor	2	3,462	16	2	12	0	0	2	0	60	141.10
Kafr El Zayat	2	5,180	53	3	42	0	0	8	0	45	508.32
Samanod	2	2,900	44	5	12	2	3	4	18	40	550.08
Total	14	22,323	178	33	96	2	5	24	18	305	2,181.54

Source: Project team

6) Basic Policy in the Future

In March 2014, HCWW instructed all ACs to complete the leak detection surveys for all distribution pipelines within one (1) year. Before the instruction, HCWW and GHAPWASCO discussed the implementing period for the survey. GHAPWASCO explained the difficulty to complete the survey within one (1) year and both parties agreed that GHAPWASCO follows “5 years plan”.

(2) Expansion to other Governorate

The C/P team had a special workshop with authorities related to water supply services in Egypt from the 30th September until the 4th of October 2012. The C/P contacted a private company (leak detection equipment agency) and they collaborated to manage the workshop. The purpose of this workshop is to share information of the current activity and to discuss issues for NRW reduction activity for the future.

- Attendance

  Water and Wastewater Companies for Gharbia Governorate, Giza Governorate, Alexandria Governorate, Red Sea (Al Bahr Al Ahmar) Governorate, Menia Governorate, Sohag Governorate, Kafr El Shiekh Governorate, Qina Governorate, and Private Company (UPS: Utilities and Positioning Systems).

- Conclusion

  - ✓ To conduct activity continuously
  - ✓ To establish organization concerning NRW reduction
  - ✓ To develop the strategy and action plan

4.2.5.2 MCWW

MCWW also has expanded the activity to the other Markazes since Phase-2 (Jan. 2012). The "5 Years Plan for NRW Reduction" was prepared on July 2013. The contents of the plan are basically same as ones of GHAPWASCO.

1) Implementation of 5 Years Plan for NRW Reduction

The Project team commenced implementing the "5 years plan" in November 2013 in all branch offices of MCWW. They started the survey from rural areas because of suitable environment for initial stage (less noises to be obstacles for leak detection).

According to HCWW's instruction (March 2014) to complete leak detection survey for all distribution pipelines, MCWW re-formulate the "5 years plan" to "1 year plan".

2) Establishment of " 1 Year Plan for NRW Reduction Activity"

MCWW prepared "1 year plan" instead of "5 years plan" without support of JET on August 2014. The comparison between the 1 year and 5 years plans is shown in Table 4.2-51.

Table 4.2-51 Comparison between "1 Year Plan" and "5 Years Plan"

	One (1) Year Plan	Five (5) Years Plan
Program Operation	MCWW	The Project (only initial stage) and MCWW
Completion period for leak detection survey	One (1) year	Five (5) years
Target Markaz	Whole Minufia Governorate.	Minufia Governorate except Sadat Markaz (incl. Sadat City)
Total number of surveyor	80 surveyors for 10 branches.	8 main surveyors and 8 assistant for 8 Markazes.
Provided equipment to branches	- 80 acoustic rods - 4 water leak detector in branches - 1 water leak detector in NRW department (in future, it has planned water leak detector is provide to all branches)	- 20 acoustic rods - 4 water leak detector in branches - 1 water leak detector in NRW department

Source: Project team

3) Result of Leak Detection Survey

NRW department in MCWW had estimated leakage volume by a formula which was provided by USAID. MCWW concluded, however, to use the estimation table same as GHAPWASCO, which was provided by IWSP, because of easier method.

Result of the leak detection survey is shown in Table 4.2-52 for a period from November 2013 until March 2014. The report which provided by MCWW was not detailed about the number of surveyed connections, materials and estimated leakage volume. The Project team, therefore, assisted the members of NRW department to fill the table as well as estimation of detected leakage volume.

Table 4.2-52 Result of Leak Detection Survey in MCWW

Branch Name	Number of Surveyor	Surveyed House Connections	Leaked Numbers			Surveyed Days	Leakage Amount (m^3/day)
			Total	House Connection	Main Pipe		
Tala	2	4,000	1	1	0	40	13.7
El Shohada	2	800	14	14	0	8	191.5
Berket El Sab'a	2	3,200	18	18	0	32	326.9
Quesna	2	2,400	11	11	0	24	150.5
Shebeen El Kom	2	2,400	18	18	0	24	246.2
Ashmoon	2	1,600	1	1	0	16	13.7
El Bagoor	2	3,200	7	0	0	32	95.8
Menouf	2	1,600	1	0	0	16	13.7
Total	16	19,200	71	71	0	192	1,051.9

Source: Project team

4.2.5.3 Undertakings for the Expansion of NRW Ruduction Activity to Other Markazes

GHAPWASCO and MCWW are planning to purchase water leak detection equipment for each branch for finding leakage without cooperation of the headquarters. Furthermore, transportation for activity in all Markazes of Governorate will be required. The ACs will be able to carry out efficiently the leak detection activities after preparation of the mentioned equipment and transportation.

At the moment, the hand writing reports are prepared by each branch and submitted to the headquarters. And the headquarters analyze their reports. If each branch office prepares computerized reports with analysis, the autonomy will be promoted and NRW reduction activity will be developed further under initiatives of the staff members.

4.2.6 Cost and Benefit Analysis

(1) Scenarios for Cost-Benefit Analysis

In order to evaluate effectiveness of the activity, the Project team analyzed the cost and benefit on following two (2) scenarios.

Table 4.2-53 Scenario Table for Cost-Benefit Analysis

Scenario	Conditions
Scnario-1 Activity making small DMAs at 8 Markazes	"Implementation according to the same procedure as activity of pilot area" Making isolated area / district metered area (DMA) Water balance analysis Four (4) areas per year in each of 8 Markazes Applying the average of saved water volume by water balance analysis in pilot areas under the Project to the cost - benefit analysis
Scnario-2 Activity concentrating on leak detection survey	"Implementation of the five (5) years plan" Without making isolation area and water balance analysis Applying actual saved water amount by estimation table according to the five (5) years plan (but the data acquired in the Project period)

Source: Project team

1) Unit Cost for Analysis

The Project team discussed unit cost. The unit cost was estimated with the following condition:

a) Equipment Cost

Cost of all of equipment for leak detection survey which provided by JICA. The depreciation period is 10 years.

b) Chamber for Flow Measurement

Construction cost of chamber, based on the pilot project.

c) Labor Cost

Labor cost, estimated by the C/P team.

d) Other Miscellaneous Cost

Fuel cost for a car of branch offices. Repair cost, based on experience of C/P team.

e) Water Production Cost

LE 1.00 per m^3 according to information of C/P team.

(2) Result of Analysis

1) Scenario-1

Scenario-1 is the leak detection survey conducted in one (1) isolated area for measurement of both consumption and inflow, and it is to calculate the reduction of NRW from balance between the

consumption and inflow. The isolated area is similar to district metering area (DMA). Scenario-1 requires chamber(s) for inflow measurement and water meter readings for all customers in the area. Through the experience of the Project, it will take one (1) year to complete the activity in four (4) DMAs.

The examination result of Scenario-1 shows that total expenditure exceeds the annual revenue. One of the reasons is the assumption of DMA size, which were determined by the experience of the Project. In the Project, the Project team selected relatively smaller area for quick implementation of trainings. Consequently, the revenue was estimated as lower than the expenditure.

Meanwhile, the ACs may secure larger revenue if they can prepare larger DMA for the activity. There are, however, some difficulties to prepare larger DMA for isolation under the current network conditions and for meter inaccuracy in appropriate reading and consumption analysis.

Scenario-1 is, therefore, a reserved program to challenge in the future.

Table 4.2-54 Analysis Table for Scenario-1

Item	Quantity	Unit	Notes
I. Expenses			
1 Equipment Cost			
Cost of equipment provided by JICA	790,077	LE	
Cost of equipment provided by Water Company	32,000	LE	
Total equipment cost for 10 years	822,077	LE	As depreciation period of 10 years
Total equipment cost for 1 year	**82,208**	**LE**	
2 Chamber cost			
Unit cost of chamber	17,000	LE	
Number of required chamber	32	pcs	
Total chamber cost for 1 year	**544,000**	**LE**	
3 Labor Cost			
Average labor cost for each working day	75	LE	
Number of working labors in head quarter	4	person	
Number of working days in head quarter	260	day	Full time
Number of working labors in 8 branches	16	person	
Number of working days in branches	104	day	Average 2days per week
Total labor cost for 1 year	**202,800**	**LE**	
4 Others Miscellaneous Cost			
Fuel for car	9,600	LE	2LE*50L*12months*8branchs
Repair cost of leakage	32,000	LE	200LE*20pcs*8branches
Total miscellaneous cost for 1year	**41,600**	**LE**	
Total Expense for 1 year	**870,608**	**LE**	a)
II. Revenue			
Average saved amount for 1 DMA	33	m^3/day	
Saved amount in 32 areas per day	1,056	m^3/day	
Saved amount in 32 areas per year	385,440	m^3/year	
Production water cost	1.0	LE/m^3	
Total revenue for 1 year (Cost Reduction)	**385,440**	**LE**	b)
III. Cost Recovery Period			
a) / b)	2.26	year	

Source: Project team

2) Scenario-2

Scenario-2 is the leak detection survey to be conducted according to the "5 years plan" / "1 year plan". It requires neither the chamber (s) for water flow measurement nor water meter readings.

To analyze the efficiency of Scenario-2, the Project team applied the saved water amount experienced in GHAPWASCO for eight (8) months from November 2013.

In case of the Scenario-2, the revenue perfectly recovers the total annual expenditure by a period of less than half year (0.41 year) as shown in Table 4.2-55. It is reasonable to be selected by ACs in the Nile Delta, as well as by GHAPWASCO and MCWW.

Table 4.2-55 Analysis Table for Scenario-2

Item	Quantity	Unit	Notes
I. Expenses			
1 Equipment Cost			
Cost of equipment provided by JICA	790,077	LE	
Cost of equipment provided by Water Company	32,000	LE	
Total equipment cost for 10 years	822,077	LE	As depreciation period of 10 years
Total equipment cost for 1 year	**82,208**	**LE**	
2 Labor Cost			
Average labor cost for each working day	75	LE	
Number of working labors in head quarter	4	person	
Number of working days in head quarter	260	day	Full time
Number of working labors in 8 branches	16	person	
Number of working days in branches	104	day	Average 2days per week
Total labor cost for 1 year	**202,800**	**LE**	
3 Others Miscellaneous Cost			
Fuel for car	9,600	LE	2LE*50L*12months*8branchs
Repair cost of leakage	35,600	LE	200LE*178pcs at 6 branches
Total miscellaneous cost for 1year	**45,200**	**LE**	
Total Expense for 1 year	**330,208**	**LE**	a)
II. Revenue			
Average saved amount per day	2,182	m^3/day	Result of 8 months at 6 branches
Saved amount per year	796,262	m^3/year	
Production water cost	1.0	LE/m^3	as cost reduction
Total revenue for 1 year (Cost Reduction)	**796,262**	**LE**	b)
III. Cost Recovery Period			
a) / b)	0.41	year	

Source: Project team