OFFICE OF THE SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

NASSRIYA WATER TREATMENT PLANT
NASSRIYA, IRAQ

SUSTAINMENT ASSESSMENT

SIGIR PA-07-116
APRIL 28, 2008

SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

April 28, 2008

MEMORANDUM FOR COMMANDING GENERAL, MULTI-NATIONAL FORCES-IRAQ
COMMANDER, JOINT CONTRACTING COMMAND-IRAQ/AFGHANISTAN
COMMANDING GENERAL, GULF REGION DIVISION, U.S. ARMY CORPS OF ENGINEERS
DIRECTOR, IRAQ TRANSITION ASSISTANCE OFFICE

SUBJECT: Report on Sustainment of the Nassriya Water Treatment Plant, Nassriya, Iraq (Report Number SIGIR PA-07-116)

The Office of the Special Inspector General for Iraq Reconstruction is assessing projects funded by the Iraq Relief and Reconstruction Fund to provide real-time relief and reconstruction information to interested parties to enable appropriate action, when warranted.

This project sustainment assessment report is provided for your information and use. SIGIR assessed the operation of the Nassriya Water Treatment Plant to determine whether it was operating at the capacity planned in the delivery order design. This assessment was made to provide you and other interested parties with real-time information on a completed relief and reconstruction project to enable appropriate action to be taken, if warranted. The assessment team included an engineer/inspector and two auditors/inspectors.

SIGIR received comments on a draft of this report from the Deputy Chief of Mission for the United States Embassy-Iraq, advising that the United States Embassy concurred with the recommendations in the report. Specific comments were also provided to clarify or correct technical aspects of the report. The Gulf Region Division of the United States Army Corps of Engineers also provided comments generally agreeing with the facts and conclusions in the draft report and provided technical comments for clarification. SIGIR reviewed the comments provided and revised the final report as appropriate.

We thank the Gulf Region South of the United States Army Corps of Engineers, Gulf Region Division, and the Iraq Transition Assistance Office of the United States Embassy-Iraq for their assistance in coordinating the visits to the Nassriya Water Treatment Plant. In addition, the Iraq Transition Assistance Office and the Gulf Region South Division representatives provided SIGIR inspectors ready access to key personnel and information in a timely manner.

If you have any questions, please contact Mr. Brian Flynn at brian.flynn@sigir.mil or at 914-360-0607. For public or congressional queries concerning this report, please contact SIGIR Congressional and Public Affairs at publicaffairs@sigir.mil or at (703) 428-1100.

Stuart W. Bowen, Jr.
Inspector General

Special Inspector General for Iraq Reconstruction

SIGIR PA-07-116 **April 28, 2008**

Nassriya Water Treatment Plant
Nassriya, Iraq

Synopsis

Introduction. This project assessment was initiated as part of our continuing assessments of selected sector reconstruction activities for water. The overall objectives were to determine whether selected sector reconstruction contractors were complying with the terms of their contracts or task orders and to evaluate the effectiveness of the monitoring and controls exercised by administrative quality assurance and contract officers. SIGIR conducted this limited scope assessment in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and two auditors/inspectors.

Project Assessment Objectives. The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action, when warranted. Specifically, SIGIR determined whether the completed project was operating at the capacity stated in the original contract or task order objective. To accomplish this, we determined if the project was at full capability or capacity when accepted by the United States government, when transferred to the appropriate Iraqi ministry, and when observed during the site visits.

Project Objective. The objective of the delivery order was to design and construct a new water supply system consisting of a new water treatment plant capable of producing 240,000 cubic meters per day of potable water and approximately 110 kilometers of transmission piping for five cities within the Thi Qar governorate. In addition, the delivery order required a period of operations and maintenance by the contractor after successful performance testing and three training classes, both classroom and on-the-job training for Iraqis identified by the Ministry of Municipalities and Public Works.

Costing approximately $277 million[1], the Nassriya Water Supply project, which includes the Nassriya Water Treatment Plant and associated facilities and conveyance (transmission) lines, is the largest water project funded by the United States government in Iraq and one of the largest reconstruction projects in general.

This project was originally conceived as a cost sharing project with the Government of Iraq. The United States government would fund the water supply project and the Government of Iraq would fund the power from the national grid required to operate it; repair the leaks in the distribution system to allow potable water to flow from the conveyance lines to the end user; and provide a qualified and motivated staff to be trained by FluorAmec to operate and maintain the facility after the project was turned over to the Government of Iraq.

[1] The Iraq Reconstruction Management System database lists the total amount of the Delivery Order 0002 and its modifications as approximately $277 million. In responding to the draft report, the Gulf Region Division indicated that the finalized cost of the project was approximately $272 million. SIGIR used the amount in the Iraq Reconstruction Management System in this report.

To increase the quantity and quality of water available to the citizens living in five cities in the Thi Qar governorate, the Nassriya Water Treatment Plant was designed to operate 24 hours per day, with a total capacity output of 240,000 cubic meters of potable water per day (10,000 cubic meters per hour). Construction began in August 2004, commissioning was completed in June 2007, and the project was officially turned over to the Government of Iraq on 12 September 2007. However, at the time of turnover, the Government of Iraq had failed to provide reliable power from the national grid, repair the leaks in the distribution system, and provide a qualified and motivated staff to be trained.

During commissioning, FluorAmec was unable to test the total operating output of the facility because the Government of Iraq had not established reliable power from the national grid to the water treatment plant.

Conclusions. SIGIR visited the Nassriya Water Treatment Plant twice – on 6 December 2007 and 21 February 2008. During both of the site visits, the plant was operating only one shift, of eight hours, a day and producing between 2,000–2,300 cubic meters per hour of potable water. In addition, the amount of finished water was only enough for three of the five cities. The citizens of the cities of Ad Diwayah and Suq Al-Shoyokh did not have access to the finished water because of illegal taps into the transmission lines and poor distribution systems. Consequently, at the time of our site visits, the water treatment plant was producing only 20 percent of its designed output, operating only one eight hour shift a day, and serving only 60 percent of the intended cities. This was due to the:

- lack of reliable power from the national grid
- old distribution system afflicted with leakages and unable to withstand the higher pressures and flows
- illegal taps in the water transmission line to Ad Diwayah
- unqualified and unmotivated Ministry of Municipalities and Public Works staff unwilling to consistently attend the contractor provided training

For almost four years, the Government of Iraq has not addressed these issues. Due to the Iraqi ministry's inability to install reliable power from the national grid and provide an adequate number of qualified and motivated staff, the water treatment plant, at the time of the second on-site inspection on 21 February 2008, was operating at only 2,300 cubic meters an hour. In addition, the Ministry of Municipalities and Public Works' refusal to address the issue of illegal taps and the dismal state of the distribution system has resulted in potable water being unavailable for the cities of Ad Diwayah and Suq Al-Shoyokh. As a result of Iraqi delays, potable water is only reaching a fraction of the Iraqi people for which it was designed and intended.

The Iraq Transition Assistance Office and the United States Army Corps of Engineers are committed to making this project successful. In an effort to save the significant investment made by the United States government on behalf of and for the benefit of the Iraqi people, the Iraq Transition Assistance Office, the United States Army Corps of Engineers, and the Iraqi Ministry of Municipalities and Public Works created a technical assessment team to determine the present condition of the water treatment plant, the adequacy of the Ministry of Municipalities and Public Works staff, and potential solutions.

Signs of Improvement. Due to the unrelenting efforts of the United States government, specifically the United States Ambassador, the Iraq Transition Assistance Office, and the

United States Army Corps of Engineers, to influence the Government of Iraq, some small, yet significant improvements have been noticed in the time since SIGIR's site visits. For example, while an accurate measurement of finished water cannot be determined because of the disabling of the flow meters, it has been reported that the Nassriya Water Treatment Plant has increased finished water production from 2,300 cubic meters per hour to 6,000 cubic meters per hour. In addition, the governor and city council of Ad Diwayah recently decided to remove the illegal taps, which will allow the water treatment plant to open the line and provide finished water to the city of Ad Diwayah.

While these actions are encouraging, the Government of Iraq still needs to find long-term solutions to the issues of reliable power from the national grid, leaking distribution lines, and a qualified and motivated staff to operate and maintain the water treatment plant 24 hours a day, seven days a week.

Recommendations. To protect the United States government's investment of approximately $277 million, SIGIR recommends that the Iraq Transition Assistance Office Director thoroughly review the technical assessment team's report and subsequent proposal, identify the most effective way to increase operational output to design capacity, avert further deterioration of plant equipment, and expedite the implementation of this plan.

Management Comments. SIGIR received comments on a draft of this report from the Deputy Chief of Mission for the United States Embassy-Iraq, advising that the United States Embassy concurred with the recommendation in the report. Specific comments were also provided to clarify or correct technical aspects of the report. The Gulf Region Division of the United States Army Corps of Engineers also provided comments generally agreeing with the facts and conclusions in the in the draft report and providing technical comments for clarification. SIGIR reviewed the comments provided by both the Deputy Chief of Mission for the United States Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate.

Evaluation of Management Comments. SIGIR appreciates the concurrence by the United States Embassy-Iraq and Gulf Region Division with the recommendation to expedite implementation of the plan to be developed by the technical assessments team to increase operational output to design capacity and avert further deterioration of plant equipment.

SIGIR reviewed the information and clarifying comments provided by the United States Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate.

Scope Limitation. Due to security concerns, SIGIR performed expedited on-site assessments of the Nassriya Water Treatment Plant. The time allotted for each site visit was approximately 30 minutes; therefore, a complete review of all project work completed was not possible.

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Introduction

Background

Water treatment plants (WTP) treat water so that it is safe to drink. Water is pumped from wells, rivers, streams, and reservoirs to WTPs, where it is treated and distributed to the local residents. The Tigris and Euphrates rivers and their tributaries supply approximately two-thirds of the raw water that is treated and used for potable services in Iraq. The rivers generally carry significant levels of silt from erosion, blowing sands, and agricultural runoff. This necessitates the use of water treatment processes that typically include treatment with alum; mixing, flocculation, and sedimentation to remove some of the solids; and sand filtration to remove the remaining solids prior to chlorination and transportation through the distribution system to the end user.

Most of the Iraqi WTPs were commissioned between 1950 and 1985 and were partially modified between 1976 and 1982. The anticipated lifespan of the WTPs, assuming proper operation and maintenance, was approximately 15 to 25 years. However, the anticipated lifespan has been shortened due to improper operation and the absence of proper maintenance. The distribution networks were constructed in a piecemeal fashion without any comprehensive vision or proper design standards.

Additional Deterioration

Iraq's water supply and sanitation systems became further dilapidated in 2003 through bomb damage, looting, shortage of power supply, and lack of maintenance. Specifically, bomb damage to the water network resulted in severe shortages of water leading to the local population tapping into distribution system pipes by puncturing the distribution system and inserting their own takeoff pipes, which subsequently lowered the already stretched pressure in the water network. In addition, the illegal tapping exposed the water distribution system to contamination from damaged sewers, polluted ground water, and stagnant sewage. The looting of transport vehicles, service trucks, consumables, spare parts, maintenance tools, and laboratory testing equipment had a severe adverse impact on the functioning of the water treatment plants. Further, electrical power, crucial for the effective operation of water facilities, became unreliable, which forced the shutdown of many WTPs.

By 2003, many water and sewage treatment plants were providing unacceptable levels of treatment. Specifically, no sewage treatment plant was operational, resulting in raw sewage being discharged directly into rivers and waterways. In 2003, approximately 50 percent of the generated waste water in Iraq was discharged into rivers and waterways each day, with Baghdad contributing a majority of the discharged sewage.

Additional Problems with Iraqi Water Treatment System

The distribution networks for the water treatment plants in Baghdad and central and southern Iraq consist of pipes with different diameters and compositions. For example, the diameter of pipes within the Baghdad network vary from 10 centimeters (cm) to 1.6 meters (m); while the pipe composition throughout Iraq varies from ductile iron, steel, asbestos cement, cast iron, polyvinyl chloride (PVC), and other material. In addition, the age of the pipes varies from 10 to 40 years, depending on the type of pipe composition. Bomb damage and pipes used beyond their lifespan resulted in a significant amount of water loss (through leakage) in the distribution networks. In 2003, the water loss was approximately 45 to 60 percent.

In the early 1980s, Iraq contracted out the maintenance and repair of the water sector to international private companies. The international companies brought into Iraq highly sophisticated mobile, integrated, and relatively small scale but high-output water treatment technologies in compact units. However, when the international companies left prior to the beginning of the first Gulf War, the Iraqis working in the water sector were not adequately trained or equipped to maintain these high maintenance systems.

Need for Water Treatment Plant in the Thi Qar[2] Governorate

The Thi Qar governorate, located in southern Iraq, is bordered in the south by the governorate of Basrah and in the north by the governorates of Qadissiya and Wassit. The Thi Qar governorate is distributed among the following five districts: Nassriya[3], Al-Shatra, Ad Diwayah, Al Garraf, and Suq Al-Shoyokh. Nassriya, the capital city, lies along the Euphrates River approximately 400 kilometers (km) south of Baghdad.

The water network for the Thi Qar governorate, including its existing water treatment plants and compact units, is approximately 50 years old. According to a provincial survey, the existing water treatment plants are inefficient and overloaded; while the distribution pipes are subject to substantial leakage, leading to the spread of a wide range of water-borne illnesses, such as cholera, typhoid, dysentery, and polio. As a result, the quantity and quality of water delivered to homes within the Thi Qar governorate varies, with some homes receiving water contaminated with raw sewage and others receiving potable water.

By the start of the second Gulf War, a critical situation developed in central and southern Iraq in terms of the number of cases of water-borne illnesses, such as typhoid, cholera, and malaria. These diseases are linked to the absence of clean water supply and adequate sanitation systems.

Objective of the Project Assessment

The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action, when warranted. Specifically, SIGIR determined whether the completed project was operating at the capacity stated in the original contract or task order objective. To accomplish this, SIGIR determined if the project was at full capability or capacity when accepted by the U.S. government, when transferred to the appropriate Iraqi ministry, and when observed during our site visits.

Pre-Site Assessment Background

Contract, Costs and Payments

Contract W914NS-04-D-0022, an indefinite delivery/indefinite quantity, cost plus award fee contract to restore, rebuild, and develop national water, wastewater, and solid waste projects in Iraq was awarded to FluorAmec, Greenville, South Carolina, on 23 March 2004.

[2] "Thi Qar" is often referred to as "Dhi Qar." For consistency, throughout the remainder of the report, we will use "Thi Qar."

[3] There are various spellings for the city of Nassriya, such as Nassriya, Nasiriyah, and Nassiriyah. For this report, we will use "Nassriya."

Delivery Order (DO) 0002, which contained at least 24 modifications[4], required the design and construction of a new water supply system, consisting of a new WTP and associated facilities, and transmission piping to five cities in the Thi Qar area.

The project was funded through the Iraq Relief and Reconstruction Fund and administered by the United States Army Corps of Engineers (USACE), Gulf Region Division (GRD).

Project Objective, Pre-Construction Description

The objective of the DO and subsequent DO modifications was to increase the quantity and quality of potable water available to citizens living in the City of Nassriya and the surrounding area through the construction of a new water supply system, thereby improving living conditions.

The $277 million Nassriya Water Supply project, includes the Nassriya WTP, 110 km of transmission lines, three booster pump stations (BPS), and five elevated storage tanks (ESTs) and is the single largest water project funded by the U.S. government in Iraq and one of the largest reconstruction projects.

The Nassriya WTP is located approximately 55 km north of Nassriya in Al Bid'ah. The site is located where the construction of a water treatment plant was started in 1991, but was halted due to the first Gulf War. Some in-ground concrete tanks and other partially completed structures were present on the site. In addition, the administration building from the previous construction was still intact (Figure 1).

The raw water source for the Nassriya WTP is the Garraf River, with the intake located on the western shore of the river.

Statement of Work

The Statement of Work (SOW) required the contractor to:

- design and construct a new water treatment plant capable of producing a current constructed flow of 240,000-cubic meters (m^3) per day
- provide 110 km of conveyance piping lines to the towns of Nassriya, Ad Diwayah, Al-Shatra, Al-Garraf, and Suq Al-Shoyokh
- provide three BPSs
- provide five ESTs for treated water
- provide associated support equipment and buildings
- operational oversight and technical assistance in executing the operations and maintenance (O&M) program
- proper training and capacity strengthening of the Iraqi maintenance staff

[4] At the time of the draft report issuance, GRD was unable to provide a complete list of DO modifications.

Current Project Design and Specifications

The basic contract included requirements for project design and specification submittals and approval. The contract specified that submittals be provided to the contracting officer both electronically and hard copy in accordance with an agreed on submittal log and on occasion of payment for each piece of equipment for which a submittal is required. In addition, submittal approval must be received from the contracting officer prior to commencement of work.

The basic contract required the following submittals:

- O&M manuals, preventative maintenance plans, and approved spare parts lists and illustrated parts guides of all installed building or system components
- completed and approved as-built drawings
- weekly digital construction progress photographs

The USACE provided the assessment team with a set of 30%, 60%, and 90% design drawings and as-built drawings. SIGIR reviewed the 90 percent design drawings submittal, which included approximately 616 architectural, electrical, mechanical, sanitary, and civil work drawings. The design drawings contained:

- site plans
- elevations
- architectural plans
- HVAC plans
- plumbing plans
- electrical plans and electrical single line diagrams

The contractor's design submittals included an overall conceptual site plan, which identified the location of all significant new construction specifically for the WTP. This included the raw water intake structure, chlorine dispenser, alum and polymer feeds, rapid mix tanks, flocculation/clarification tanks, filtration system, sludge collection system, ground storage tanks, and high service pumps (Figure 1).

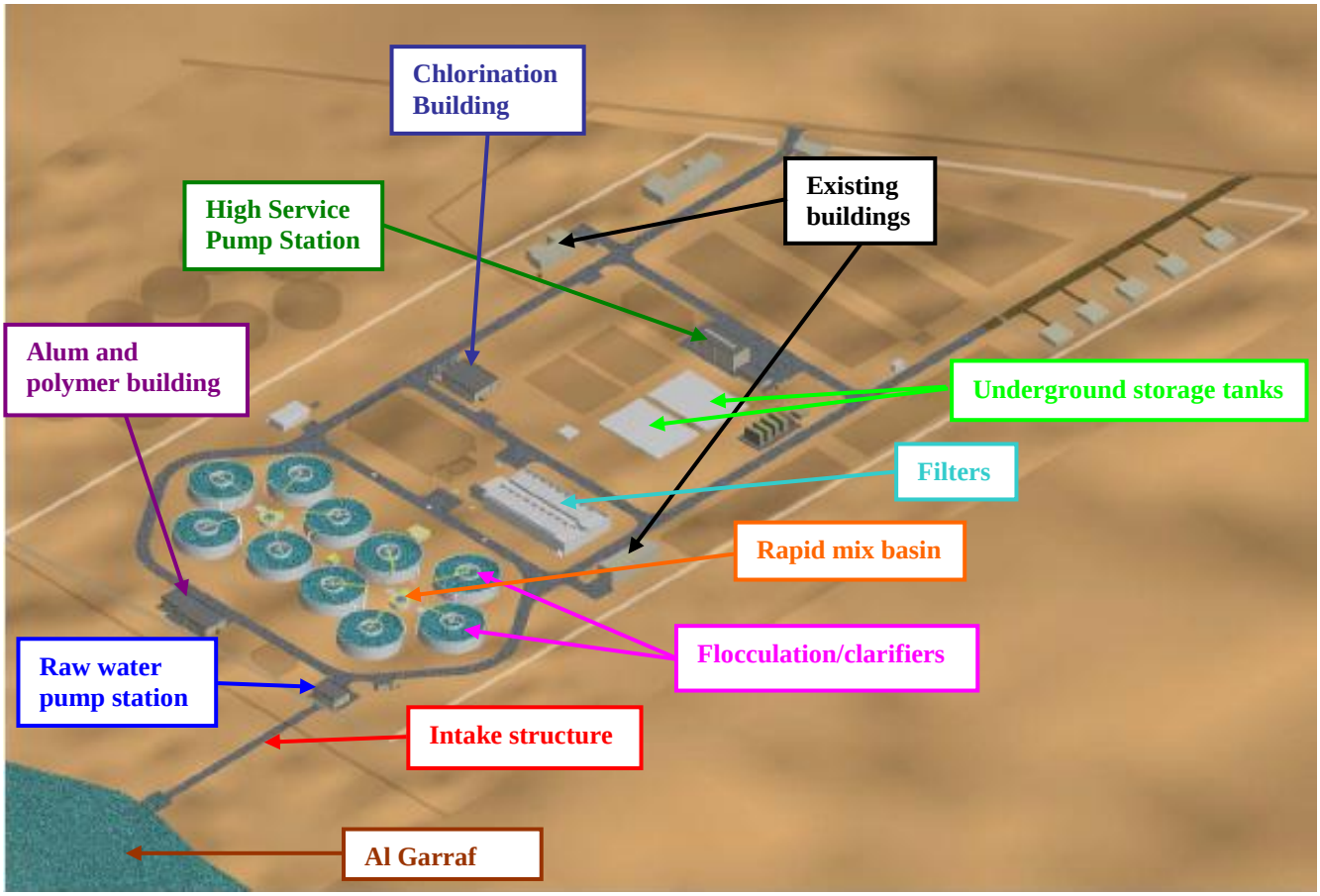


Figure 1. Illustrated overview of the components of the Nassriya WTP

The design package also included the mechanical design featuring flow diagrams, system layouts, electrical distribution system design including flow diagrams, system layouts, and specifications for the WTP's electrical generators.

The contractor's process flow design for the entire Nassriya water supply was to extract raw water from the Garraf River, located approximately four km north of Al-Shatra, using a concrete intake structure. Water from the intake structure flows by gravity approximately 133 m into the raw water pump station, where it is pumped to the rapid mix tanks. According to a FluorAmec technical study report, samples of the raw water were analyzed to determine the water characteristics which could impact operation factors, such as coagulant chemical requirements, settling performance in the clarifiers, sludge volume, and filter backwash frequency.

The water is screened to remove large objects as it exits the raw intake structure. Two principal treatment objectives are turbidity removal and disinfection. The objective of the project design and construction was to achieve a turbidity of 1 nephelometric turbidity unit (NTU), which is significantly lower than the World Health Origination (WHO) standard of 5 NTU, to ensure maximum opportunity for microbial removal. The removal/inactivation requirements were 4-log Giardia inactivation and 5-log Virus inactivation, which is equivalent to 99.99% removal. Gaseous chlorine was used for the disinfection. To reduce the risk of producing objectionable concentrations of disinfection by-products, multiple chlorine injection points were used to dispense chlorine to the process flow stream.

The water is also chlorinated as it is conveyed to the rapid mix tanks, where alum and polymer are added to facilitate the flocculation and coagulation of solids. The alum forms small gel-like precipitate that traps suspended solids and forms sediments. The flocculation process continues in the flocculator portion of the large flocculation/clarification tanks. The design called for 10 flocculator/clarifier tanks and 20 filter cells. As water flows toward the outer rings of the tank, the velocity gradient of the flow causes a large percentage of the floccs to settle at the bottom. The settled solids are collected from the bottom of the tank and ultimately are pumped back into the Garraf River (downstream from the intake structure) as sludge. The effluent from the clarifiers is further chlorinated as it flows to the filters. The filters are made of granular media material. The filters remove additional solids, those that did not settle out in the clarifier. The filtered water is supposed to have drinking water turbidity standards.

The WTP was designed with the option of being operated as two parallel trains, each train consisting of a rapid mixer, five flocculators/clarifiers, and 10 filtration cells. After filtration, there is an additional disinfection by chlorination as the water flows to one of the two ground storage tanks. Each of the ground storage tanks has a capacity of 4,000 m^3. Since the potable water must be conveyed to the end users, there is a system of six high service pumps[5] that lift the water from the ground storage tanks into the transmission lines for conveyance to the five user cities. Each of the high service pumps has a capacity of 2,000-m^3/hour. The target water demand was established with consideration to domestic consumption and also irrigation, industrial, and commercial use. The design considered a peak day demand based on irrigation during the summer and low flow during the winter with more limited irrigation. Storage needs are met at terminal reservoirs.

Expansion Option

The overall master plan was based on an ultimate capacity of 20,000-m^3/hour. The Nassriya WTP, as designed and constructed, incorporates an option to expand its treatment capacity from the current 10,000-m^3/hour to 20,000-m^3/hour. The expansion will involve doubling the present number of flocculators/ clarifiers and the filtration system. A parcel of land on the property has been identified as capable of accommodating the additional units (Figure 2). However, the conveyance system as presently designed (and constructed) was sized to accommodate the present capacity. The conveyance capacity constraint was, according to project documentation, due to funding limitations. There is also an option to provide a sludge bed, to treat sludge prior to disposal, and a pH (measure of the acidity/alkalinity of a solution) adjuster as part of the future expansion.

[5] One of the high service pumps serves as a spare.

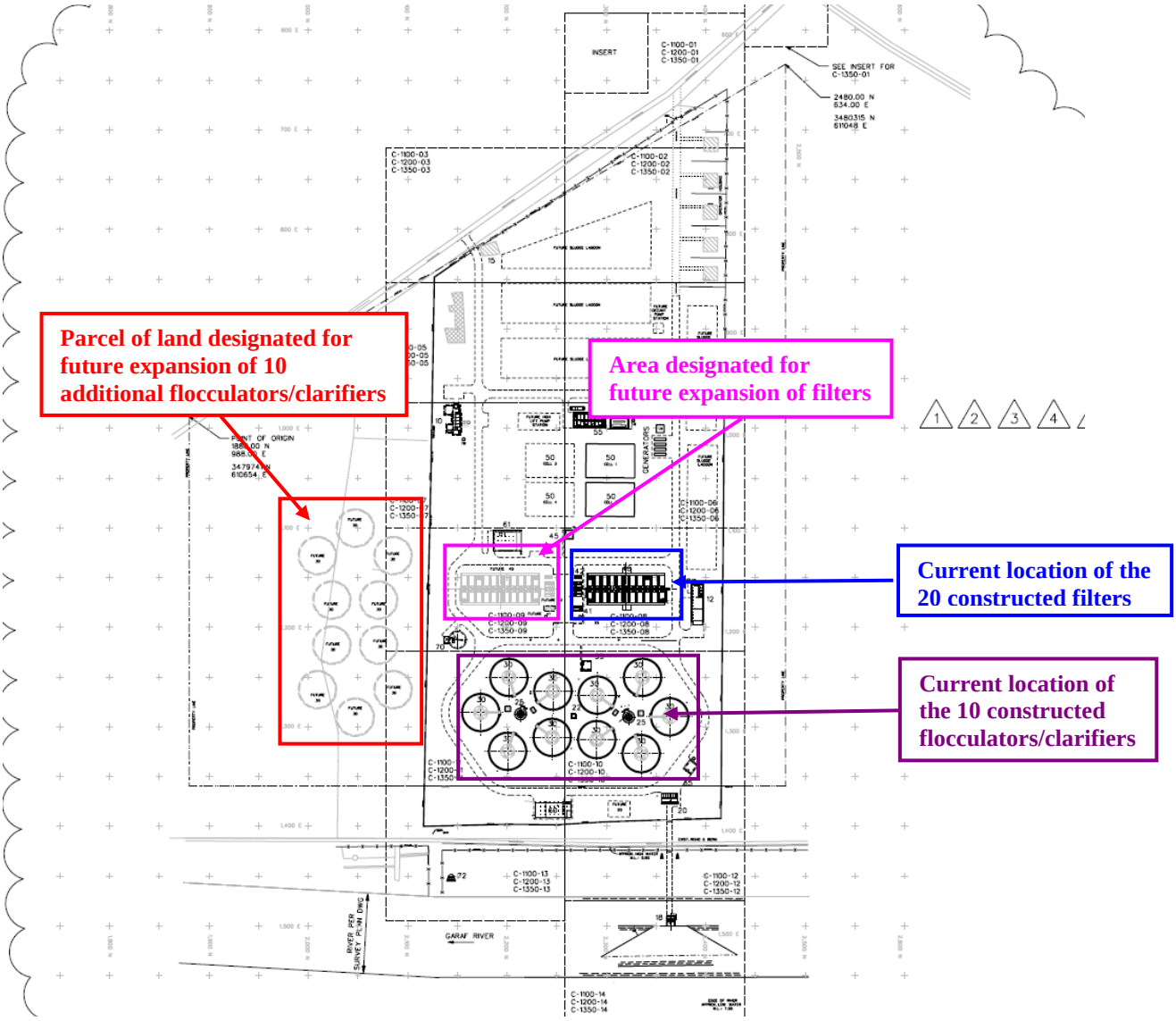


Figure 2. Illustration of potential expansion capabilities at the Nassriya WTP

Transmission System

The transmission line is used to convey the treated (potable) water. The transmission line runs two directions – south approximately 51 km from the WTP to the city of Nassriya, with an additional segment of transmission line conveying a portion of the water past Nassriya approximately 26 km to Suq Al-Shoyokh; while another transmission line segment conveys water northeast from the WTP approximately 25 km to the city of Ad Diwayah.

Appendix D presents a more detailed description and diagram of the treated water distribution system.

Design Submittals and SPCOC

In addition to the contractor's design submittals, we reviewed the comments by the Sector Project and Contracting Office Contractor (SPCOC), who had responsibility for evaluating all contractor design submittals for accuracy and completeness. The SPCOC thoroughly reviewed the contractor's design submittals and identified omissions and required the contractor to correct those omissions.

Based on our review of the design submittal, including the SPCOC's reviews and comments, it appeared to be satisfactory for the contractor to construct the WTP, including the BPS, EST, conveyance piping lines, and associated buildings.

Responsibility of the Government of Iraq

To complement the $277 million investment by the U.S. government, the Government of Iraq (GoI) was responsible for providing:

- power from the national grid for the WTP and the three BPS
- program to repair leakages in the distribution system that will occur due to higher pressures and flows when the WTP is operational
- qualified and motivated MMPW staff to be trained by FluorAmec to eventually operate and maintain the facility

Site Progress During Construction

Throughout the WTP construction project, the contractor provided numerous progress photographs. We reviewed and subsequently relied on selected contractor photographs to document examples of construction performance most likely completed in accordance with the SOW requirements before the project was turned over to the MMWP in September 2007.

Site Photos 1 and 2 document the excavation work performed at the various construction sites (i.e. WTP and EST sites). Early construction work for the chlorination area and clarifiers are captured in Site Photos 3-6. Finally, the progression of work on the BPS is shown in Site Photos 7 and 8.

Site Photo 1. Excavation at the WTP site (Photo courtesy of the USACE)

Site Photo 2. Excavation for an elevated storage tank (Photo courtesy of the USACE)

Site Photo 3. Concrete foundation for the chlorination area (Photo courtesy of the USACE)

Site Photo 4. Steel reinforcement for the chlorination foundation (Photo courtesy of the USACE)

Site Photo 5. Form work for clarifier wall (Photo courtesy of the USACE)

Site Photo 6. Steel reinforcement for clarifier base (Photo courtesy of the USACE)

Site Photo 7. Construction of the booster pump station (Photo courtesy of the USACE)

Site Photo 8. Frame for another booster pump station (Photo courtesy of the USACE)

Concrete Strength Issues

During construction, the SPCOC reported that FluorAmec had requested a reduction in the 28-day compressive strength of concrete from 35-Newton[6] per mm^2 (N/mm^2) to 28-N/mm^2. The SPCOC requested that FluorAmec should accept, in writing, complete responsibility for the adequacy of compressive strength of concrete being used on the project and the structural integrity of all the structures.

FluorAmec took a number of measures to rectify the low concrete test results it was receiving on site. The measures included:

- changing the cement mixture
- implementing surveillance and oversight of production and testing
- taking additional core samples in on-site locations where results had been low
- forwarding samples to Construction Technology Laboratories (CTL), an Illinois-based laboratory, for analysis

According to USACE documentation, CTL concluded that concrete constituents met the design standard. However, the cement had low Tricalcium Aluminate (C_3A) content and a coarse grind, which contributed to the slow rise in strength. As a result, the concrete was likely to achieve its optimum strength in 56 days instead of 28 days. In addition, CTL reported there were compatibility issues between the plasticizer and cement, and suggested a reduction in the quantity of the admixture in the concrete mix. The amount of admixture was reduced and the concrete generated acceptable results. CTL recommended taking a number of core samples from the site to the lab for testing. CTL and the structural engineer of record reviewed the results of the core samples tested by CTL and found them to be acceptable. The USACE project management team was also satisfied with the findings.

[6] Stress and pressure unit conversion method. A Newton is a unit of force. A Newton is equal to the amount of force required to give a mass of one kilogram an acceleration of one meter per second squared.

Status of the WTP at Time of Turnover

According to FluorAmec's quality management plan, a number of measures were taken to ensure that the construction of the Nassriya WTP met the requirements of the contract, applicable codes, and industry standards. The quality control plan included a review of evaluation records of the soil testing laboratory, concrete batch plant, and the concrete testing laboratory to ensure it obtained reliable test results and products. FluorAmec also implemented a program of testing and review of inspection checklists to ensure that the construction of the WTP met the desired standards. The program covered the various disciplines, such as architecture, civil, mechanical, electrical, instrumentation, and materials.

Testing included: pressure testing of the piping, compressive strength tests for the concrete, and generator testing. FluorAmec ensured that all testing and inspections were overseen by the appropriate level of supervisors and carried out by well trained tradesmen. FluorAmec's training material, in the form of PowerPoint presentations, was shared with the sub-contractors and suppliers to ensure that their performance was in compliance with the requirements. At the completion of construction, the various units were checked for leaks and their functionality was tested at the target water flows for which the units were designed to operate. The functionality of the chemical dispensing systems was verified and the optimum dosages and concentrations of alum and polymer were established. The newly constructed treatment plant was disinfected by operating the units with water containing a high concentration of chlorine. The adequacy of disinfection was verified with bacteriological tests.

Rapid mix tanks, clarifiers, storage tanks, and filters were checked for leaks. In addition, the transmission lines were checked for leaks through hydrostatic testing and were disinfected prior to being used to transport water to the distribution systems. The hydrostatic testing for the transmission lines involved testing three sections simultaneously – the sections between the WTP to Ad Diwayah EST, between the WTP to the Nassriya EST, and from the Nassriya EST to the Suq Al-Shoyokh EST. The test involved filling the pipes with water and applying pressure by means of a force pump. The amount of leakage was determined by the amount of water needed to maintain the pressure at the desired range. According to FluorAmec documentation, the conveyance system hydrostatic test was witnessed by Gulf Region South (GRS) inspectors and was found to be satisfactory. After the various WTP units were found to be functionally satisfactory, a performance test was carried out. The goal of the performance test was to run the WTP and the conveyance system at the design capacity for seven consecutive days to optimize chemical dosages needed to produce the required water quality. During the performance test, the quality of water was documented for selected locations at the WTP and also along the transmission line. The WTP treatment standards for potable water, which are in line with those of the WHO, are presented in Table 1.

Parameter	Period	Basis	Requirements
Finished Water Quality:			
pH	Daily	Instantaneous	6.5-9.2
Color	Daily	Instantaneous	< 20 - 30 Cobalt Platinum Scale < 15 TCU
Taste and Odor	Daily		Acceptable
Turbidity:			
Maximum	Daily	Maximum	1.0 NTU
Average	Daily	Average	< 0.2 NTU
Iron	Daily	Maximum	< 0.3 mg/L
Manganese	Daily	Maximum	< 0.1 mg/L
Total & Fecal Coliform	Daily	Maximum	0 (MPN/100 ml)
E. Coli	Daily	Maximum	1 (MPN/100 ml)
Disinfection:			
Giardia	Monthly	Minimum	4 logs (99.99%) removal/inactivation
Viruses	Monthly	Minimum	5 logs (99.999%) removal/inactivation
Total Trihalomethane	Monthly	Maximum	100 µg/L
Free Residual Chlorine	Continuous	Instantaneous	1.5-2.0 mg/L @ entrance to distribution system
Halo acetic Acids	Monthly	Maximum	< 60 µg/L

Table 1. Standards for the Nassriya WTP

The inspection checklists included an instrument calibration checklist, a filters checklist, a plumbing checklist, and a soil inspection checklist.

Seven Day Performance Test

The seven day performance test was carried out from 5 to 11 June 2007. There was continuous analysis of the water in the clarifiers and ground storage tanks for turbidity, pH, and free residual chlorine. Water samples were taken and analyzed from the raw water well, filters' effluent tanks, and the ESTs. The turbidity is a measure of the lack of clarity of the water; the higher the turbidity, the less transparent the water. High turbidity is caused by high concentrations of suspended solids, which are invisible to the naked eye. Free residual chlorine and turbidity were measured once a day in the ESTs in Ad Diwayah, Al-Shatra, and Al-Garraf. The testing was stopped when the results met the water quality requirements. There was also monitoring of other operation parameters, such as dosages of the chemicals and flow rates to establish optimum operating conditions.

According to FluorAmec's commissioning plan, the WTP was designed to achieve a treatment goal of 0.5-NTU, with a maximum turbidity rate of 1.0-NTU. Since the WHO standard for treated water is 5.0-NTU, both the design goal and the maximum turbidity rates are significantly lower. During the performance test, the WTP's sample scores ranged from 0.4-NTU to 2.4-NTU as FluorAmec personnel continually adjusted the chemical dosages and overall WTP performance to produce the required water quality in the most consistent and cost effective manner.

The results of the seven day performance test were found to be in compliance with the water quality requirements.

Final USACE Inspection at Turnover

After successful commissioning of the WTP, a 90-day operations and maintenance period began for FluorAmec on 12 June 2007. On 10 September 2007, a final inspection of the completed work for the Nassriya Water Supply project was performed by the USACE GRS representatives. The inspection concluded the following:

> *"Contractor, FluorAmec, LLC has completed all assigned construction work. All parties acknowledge that the work performed under the contract meets the standards set forth in the contract scope of work…All work required by this contract has been accomplished in a satisfactory manner and is accepted subject to the attached FluorAmec Exceptions List, FluorAmec Exclusion List, and GRS Open Punch List."*

The U.S. government officially turned over responsibility for the operation and security of the WTP to the MMPW on 12 September 2007. At the time of turnover, however, the GoI still had not provided dedicated power from the national grid to the water treatment plant. Consequently, the plant was still operating solely on generator power, which resulted in an output rate of 2,000-m^3/hour.

Site Assessment

On 6 December 2007 and 21 February 2008, we performed on-site assessments of the Nassriya WTP. We were accompanied by representatives from the Iraq Transition Assistance Office (ITAO), GRD, and GRS. Due to security concerns, on each occasion we performed an expedited assessment. The time allotted for each site visit was approximately 30 minutes; therefore, a complete review of all project work completed was not possible.

During both site visits, we observed MMPW personnel working at the Nassriya WTP. At the time of our second site visit, according to WTP representatives, there were approximately 15 MMPW staff members working at the plant.

Power from the National Grid

The MMPW was responsible for providing power from the national grid to the Nassriya WTP and the three BPS that distribute the water to the five cities. Smaller substations are required for the three BPS. According to GRS documentation, the Iraqi State Owned Enterprise (SOE) completed the requirement for power from the national grid to the WTP; however, additional parts were required to complete the substations for the three BPS. Consequently, generators are being used to distribute water to the five cities.

At the time of our first site visit, the Nassriya WTP was operated on generator power only; however, during our second site visit, the WTP was operated solely on power from the national grid. According to the WTP representatives, the power from the national grid was unreliable and intermittent; for instance, the power would run for ten minutes and then be off for the next five minutes repeatedly throughout the day. WTP representatives stated this not only affected the WTP's productivity, but also harmed some of the plant's equipment.

Total Finished Water Output

The total design capacity of the Nassriya WTP is 10,000-m^3/hour. At the time of our site visits, the WTP was producing finished water at a rate of 2,000-m^3/hour and 2,300-

m^3/hour, respectively. In addition, the WTP, which was designed and constructed to run continuously 24 hours a day, 7 days a week (through three eight hour shifts), was only being operated for one shift of 8 hours a day, 6 to 7 days a week. According to WTP and USACE representatives, the WTP was producing only approximately 2,000-m^3/hour because demand was low (because it was wintertime) and the distribution lines to homes and businesses in one of the five cities (Suq Al-Shoyokh) could not handle the water pressure. Water demand was also reduced due to the illegal taps in the transmission line to Ad Diwayah, which necessitated shutting water off to Ad Diwayah. USACE and WTP representatives stated that approximately 2,000-m^3/hour is adequate to provide enough finished water to Al-Shatra and Al-Garraf. However, about every three or four days, the WTP operates at a rate of 4,000-m^3/hour in order to provide finished water to Nassriya[7].

However, WTP and USACE representatives stated that the summertime demand for water will require the WTP to produce at least 6-8,000-m^3/hour for more than one shift per day. Further, USACE representatives stated the WTP can only operate one shift a day because of the lack of qualified operators and power from the national grid.

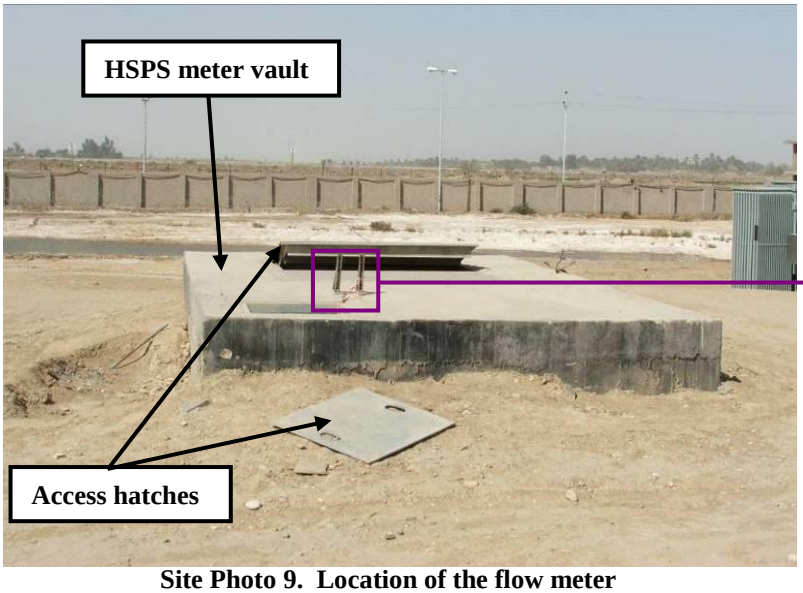
Flow Meters

Flow from the Nassriya WTP is a key operating parameter. Flow from the high service pump station (HSPS) is measured using a Venturi flow meter housed in the HSPS meter vault located 32 meters north of the HSPS. The vault is a below grade concrete structure measuring 5.2-m by 3.2-m and 4.1-m deep. Two access hatches are in place in the roof.

During our second site visit, we inspected the flow meter (Site Photo 9). Upon approaching the flow meter, we noticed one access hatch was on the ground and the flow meter had been disconnected and removed (Site Photo 10). WTP representatives stated they did not know how to operate the flow meter; therefore, they removed it. After several minutes, the WTP representatives were able to locate the flow meter (Site Photo 11).

According to WTP representatives, they do not use the flow meter to determine the actual total finished water output. Instead the WTP operators "back into the number" by figuring the number of clarifiers and filters being operated to determine the amount of total finished water output. However, not only does this negate the purpose of the flow meter, it is not an accurate method to determine the actual amount of total finished water output. Consequently, the reliability of the daily numbers reported on the daily process acceptance report for total finished water output is questionable.

[7] The city of Nassriya does not require finished water daily because it uses water tanks on the top of homes and businesses to store water. Water need only be provided approximately every three to four days because city residents will fill their tanks, which provides enough water for several days.



Site Photo 9. Location of the flow meter

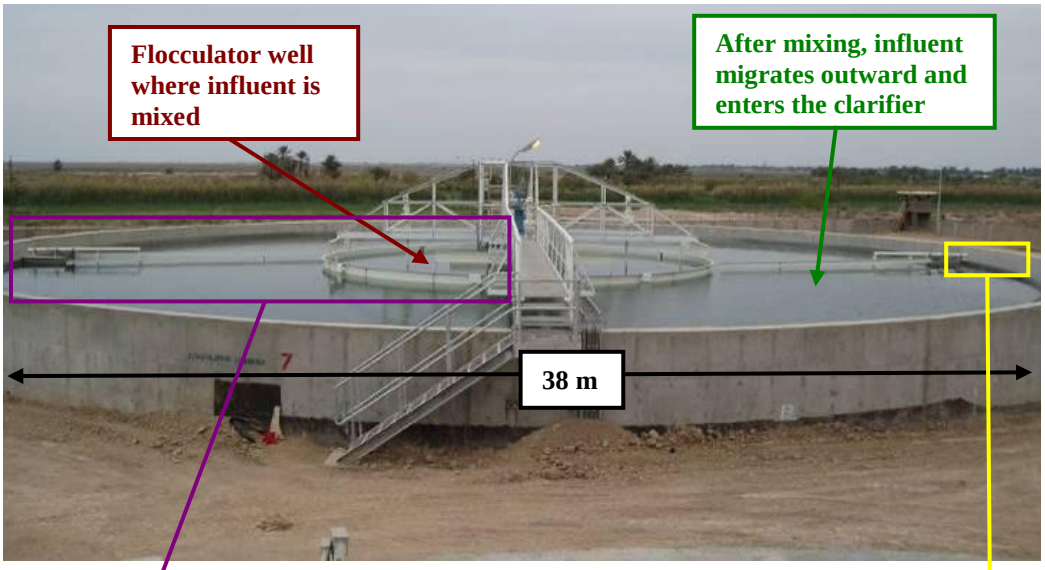
Site Photo 10. Evidence the flow meter was intentionally disabled

Site Photo 11. The disabled flow meter for the HSPS meter vault

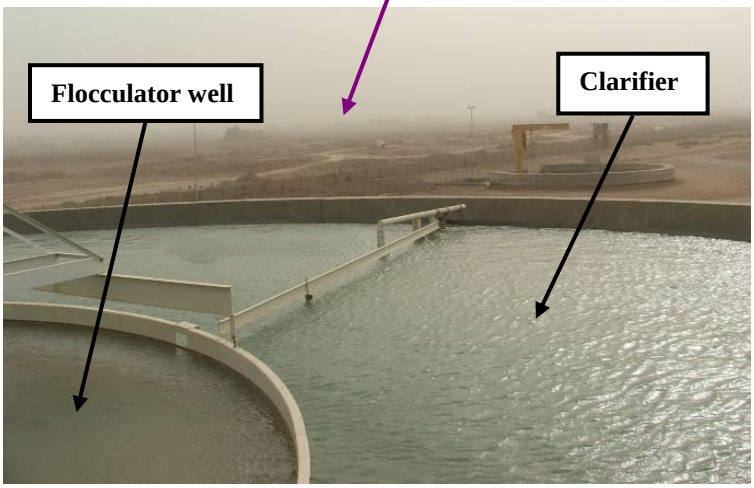
Flocculator Clarifiers

Effluent from the rapid mix structure flows by gravity to the Flocculator clarifiers for the sedimentation process. The purpose of the Flocculator clarifiers is to continue the flocculation process and produce clarified effluent, as well as to collect sludge and scum from the gravity settling basins. Specifically, after the influent is mixed within the flocculator well, it migrates radially outward and enters the clarifier. Sufficient detention time is allowed to permit the solids to settle out in the clarifier during the time of flow to the outer ring of the clarifier. The effluent is removed at the tank periphery. The effluent collection scheme should be adjusted to continuously remove a uniform amount of

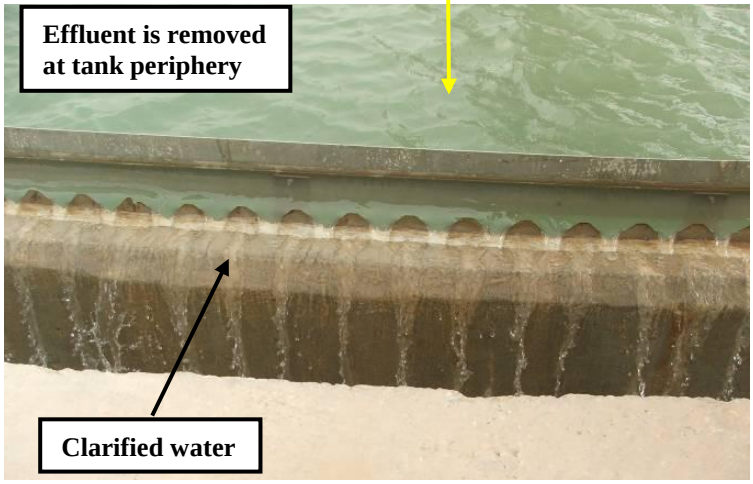
effluent per unit length of periphery and to eliminate irregular flow at any one place. The raking mechanism at the tank bottom collects the solids as they settle (Site Photos 12-15). The rake blades push solids to the sludge trough for removal. According to design specifications, each has an average influent capacity of 1,000-m^3/hour. The Flocculator clarifiers are circular and are constructed of concrete with carbon steel internals. Each Flocculator clarifier utilizes a 38-m diameter tank.



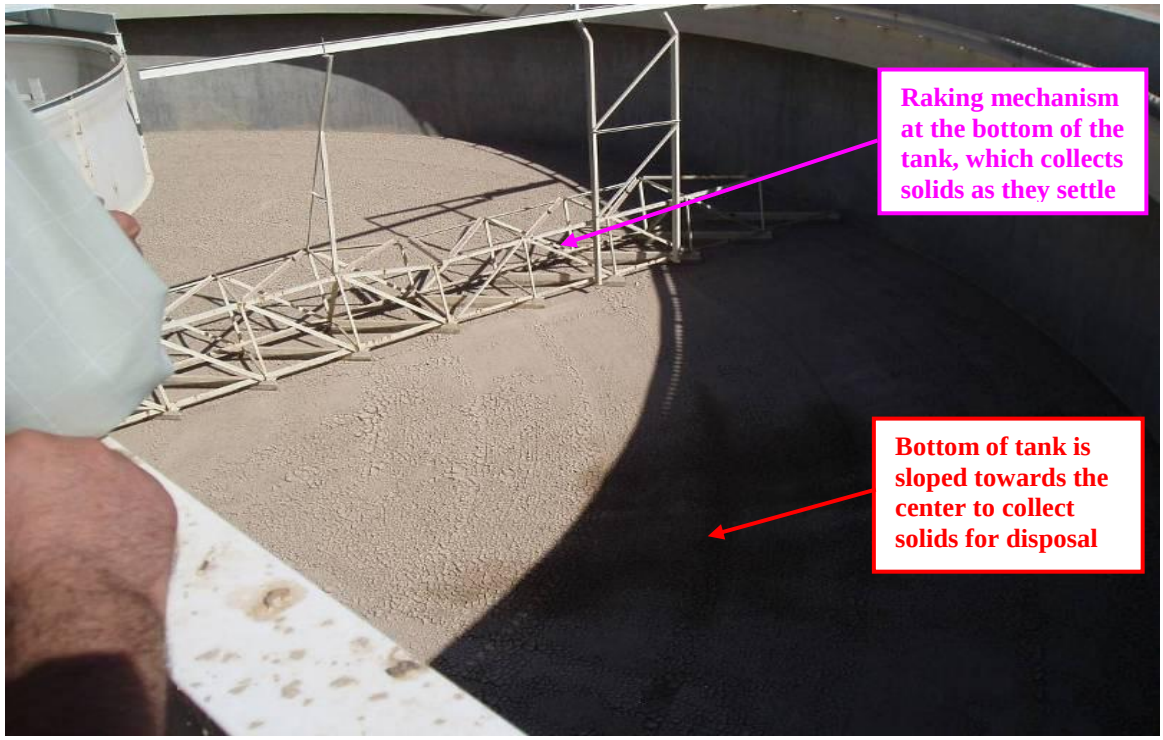
Site Photo 12. Flocculator clarifier in operation during our site visit



Site Photo 13. Close up view of the Flocculator clarifier

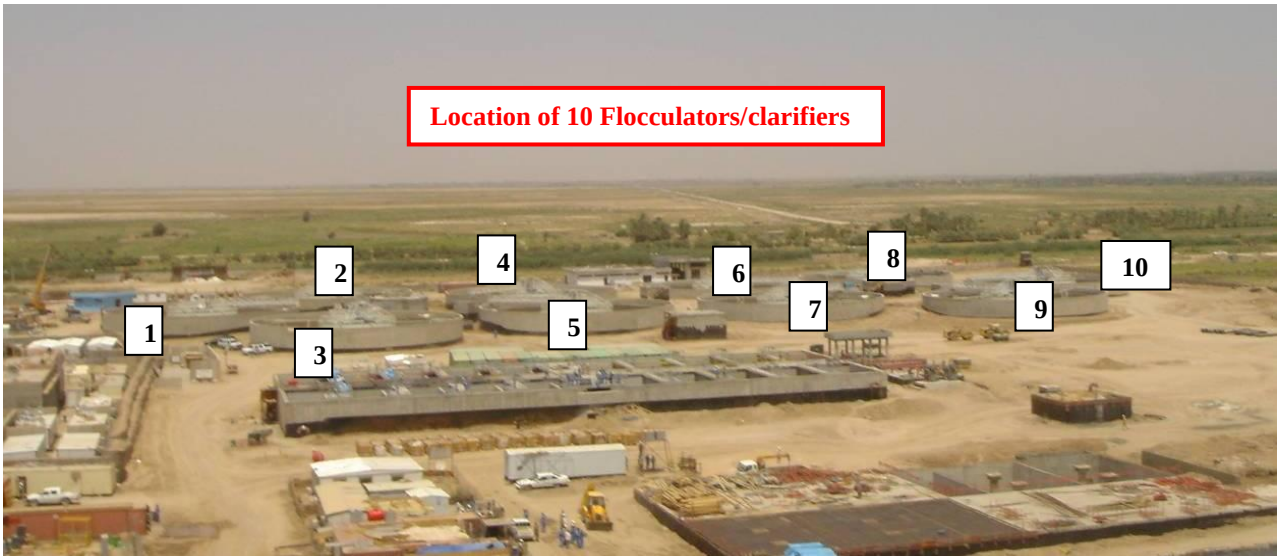


Site Photo 14. Close up view of the Flocculator clarifier



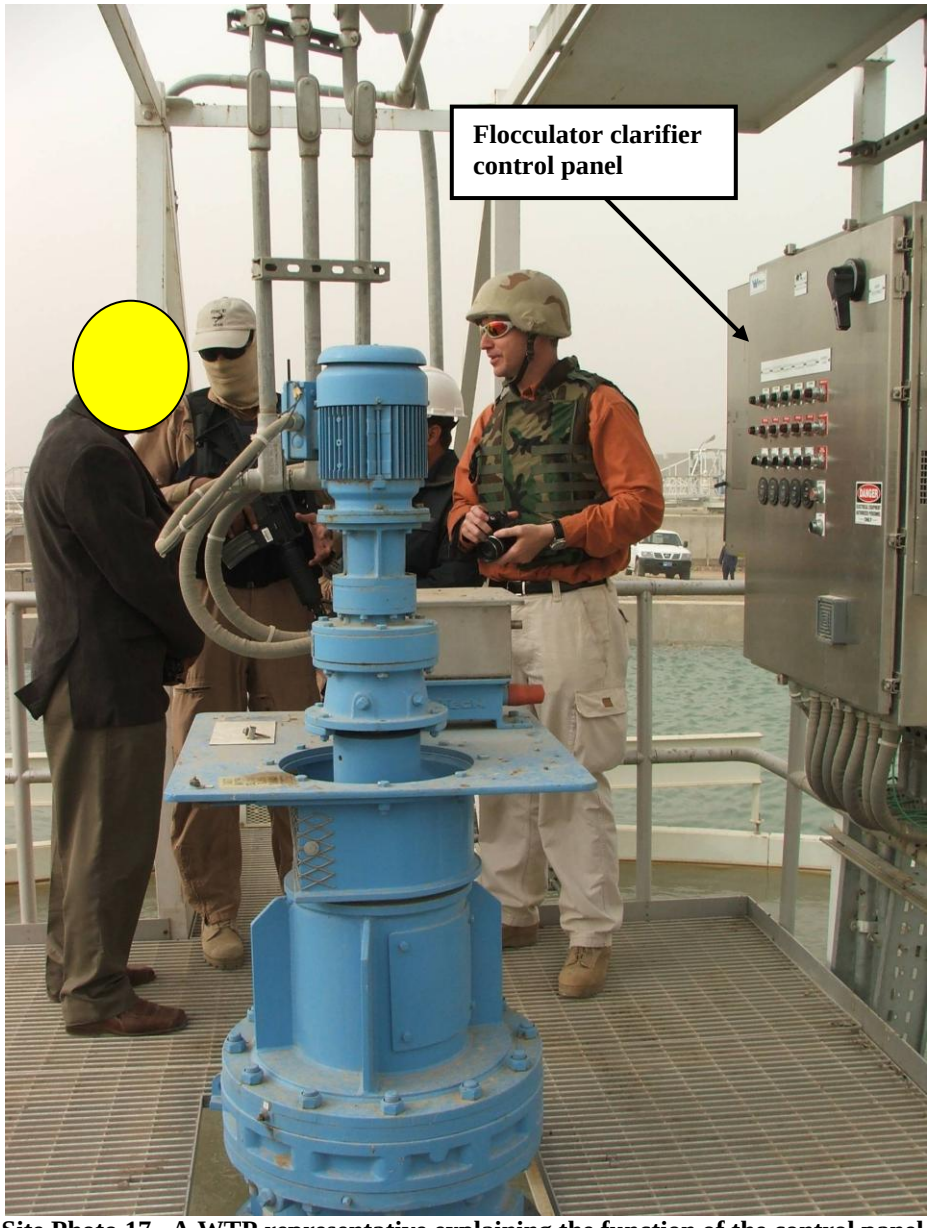
Site Photo 15. Empty Flocculator clarifier raking the bottom of the tank (Photo courtesy of ITAO)

We identified the 10 Flocculator clarifiers at the Nassriya WTP (Site Photo 16). At the time of our site visits, two Flocculator clarifiers were operating. The two operating Flocculator clarifiers appeared to adequately clarify the influent and remove sludge. During our first site visit, a WTP representative showed us the Flocculator clarifier control panel and explained its functions (Site Photo 17).



Site Photo 16. Aerial view of the 10 Flocculator clarifiers at the Nassriya WTP (Photo courtesy of USACE)

At the time of our second site visit, a USACE representative stated Flocculation clarifier #4 was not operational because too much sludge collected at the tank bottom. Specifically, the USACE representative stated that the WTP operators did not regularly clean the sludge out of the tank bottom; now the clarifier is non-operational until the tank bottom is thoroughly cleaned. While this clarifier will again be operational (once it is carefully cleaned), it highlights the lack of any routine maintenance being performed by the MMPW personnel throughout the WTP.



Site Photo 17. A WTP representative explaining the function of the control panel

Gravity Filters

Rapid sand filtration is the flow of water through a bed of granular media to remove any particulate matter left over after flocculation and sedimentation. The filter process operates based on two principles, mechanical straining and physical adsorption. Sand filtration is of particular importance because it effectively removes pathogenic

microorganisms, such as Giardia lamblia. This organism is a major concern in drinking WTPs because it cannot be killed by traditional chlorination. If ingested, the organism can form cysts.

The filter structure for the WTP consists of two portions; each portion has six sequential declining rate filters. The filters are hydraulically connected and the influent water level for each filter is the same. Filter effluent flow rate will decrease as the filter media becomes clogged with debris. Filters should be periodically backwashed to remove debris from the media. Filter operation is controlled by twenty filter control panels. The control panels are interlocked through one main filter control panel; only one filter can be backwashed at a time.

We identified the gravity filters and control panels (Site Photos 18-20). According to the WTP representatives, the gravity filters and control panels were operating correctly. At the time of our second site visit, three filters and control panels were in use.

Site Photo 18. Gravity filter control panels

Site Photo 19. Filter tank

Site Photo 20. Control monitoring screen

High Service Pump Station

The energy input required to convey the potable water to the end users is provided through pumps. The pumps within the high service pump station (HSPS) provide the energy needed for the initial stage of finished water conveyance. The HSPS is comprised of two clearwells, six-high service pumps (with one serving as a spare) with their associated controls and electrical equipment, a hydro-pneumatic surge control system, and a flow measuring station.

We observed the six vertical turbine pumps installed (three for each HSPS clearwell) and the high service pump control panel (Site Photos 21 and 22). At the time of our second visit, one vertical turbine pump was in use; while another vertical turbine pump was being repaired (Site Photo 23).

Site Photo 21. Vertical turbine pumps inside the high service pump station

Site Photo 22. High service pump control panel

Site Photo 23. A vertical turbine pump being repaired by WTP representatives

Chlorination Building

Disinfection of drinking water is a traditional element in public health protection. It is one of the standard practice barriers used by water suppliers against the microbiological contamination of drinking water. The goal of disinfection is to kill or render harmless microbiological organisms that cause disease. Chlorine is a widely accepted disinfectant for drinking water because it is effective against a broad spectrum of pathogens, including bacteria, viruses, and protozoa. Another requirement for a disinfectant is its ability to continue to prevent or inhibit microbial growth after the treated water enters the distribution system. Chlorine residual can protect against some post-treatment contamination that may result from improper cross-connections or main breaks and provides a way to monitor microbial water quality after the water leaves the WTP.

Pre-chlorination is provided to prevent microbial growth in the treatment system, while post-chlorination is necessary to provide treatment, residual chlorine, and disinfection. Chlorination also improves the water quality by controlling taste and odor, while removing iron and manganese. The WTP benefits from the use of chlorine as it aids in sedimentation, assists in maintaining clear filter media, prevents algae growth, and controls slime growth thereby preserving process integrity.

We inspected the WTP's chlorination building, where we saw the chlorine cylinders, weigh scales, four vacuum regulators, leak detectors, and three remote chlorine injectors (Site Photos 24 and 25). Three chlorinators provide chlorine solution to the treatment process. Specifically, the chlorinators control the correct amount of chlorine based on the quantity of water detected at the flow meter installed at the rapid mix influent. The chlorinator dose rate is adjusted by the operator; while in automatic, the chlorinator is flow paced by a signal from the raw water influent flow meter. The chlorine leak detector provides a one part per million chlorine leak alarm to the supervisory control and data acquisition system.

At the time of our first site visit, the chlorinators were operational. According to WTP representatives, the leak detectors were functional; however, they admitted the leak detectors had not been recently tested (Site Photo 26).

Site Photo 24. Chlorine cylinders

Site Photo 25. Remote chlorine injector

Site Photo 26. Chlorine leak detector

On-Site Laboratory

The Nassriya WTP has an on-site water quality laboratory. The objective of an on-site laboratory is to monitor the quality of the raw water, finished water, and treated water at various stages of the treatment process for process/operational control purposes. According to the O&M manual, "to be of value, laboratory data must be obtained regularly and be used to the fullest possible extent."

Raw water samples are analyzed to determine the treatment required. Raw water samples need to be taken at least daily from the intake channel between the intake structure located on the Garraf River and the wetwell. The sample point is located before any chemical addition. Water from this sample location is used to determine the raw water quality and the extent of chemical treatment.

Finished water samples should also be collected from a location on the high service discharge piping after post-chlorination. These samples are used to monitor the level of chlorine in the treated water. The WTP is designed to achieve a treated water turbidity of 0.5-NTU which is much lower than the WHO standard of 5.0-NTU

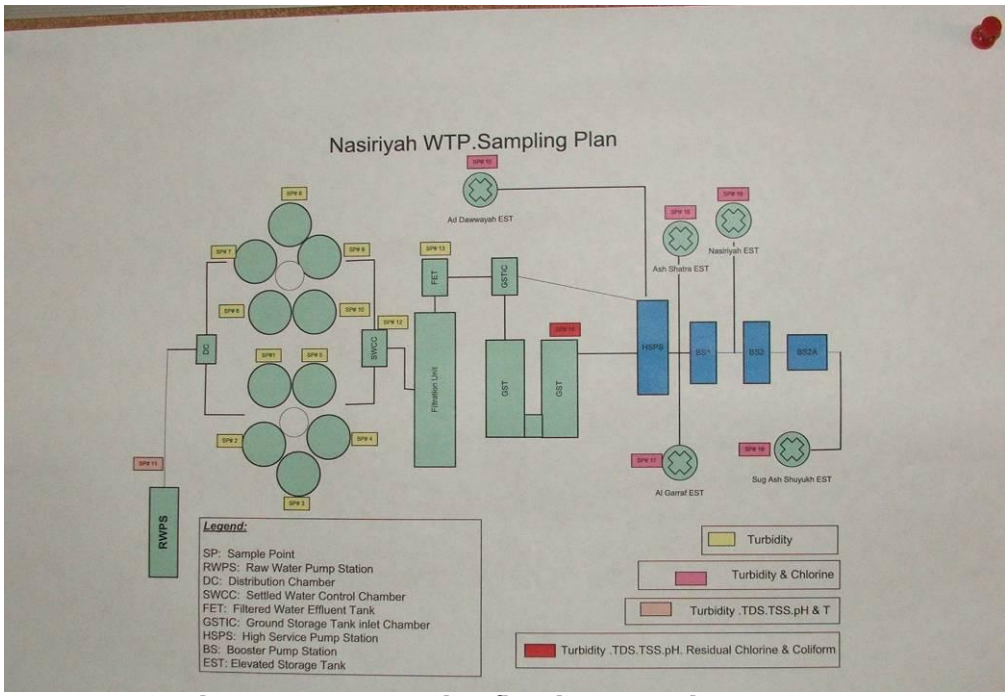
Water samples should also be obtained from sampling points throughout the WTP, such as the raw water after chemical addition, flocculator/clarifier effluent, and filter effluent.

According to GRD representatives, FluorAmec provided the WTP with the necessary equipment to perform the required testing (Site Photo 27) and a water sampling flow diagram identifying the locations for water samples to be obtained for testing (Site Photo 28). During our second site visit, we toured the water quality laboratory. We could not locate the laboratory equipment necessary to perform the required tests; instead we saw elementary laboratory equipment not capable of performing the required, technical tests (Site Photos 29and 30).

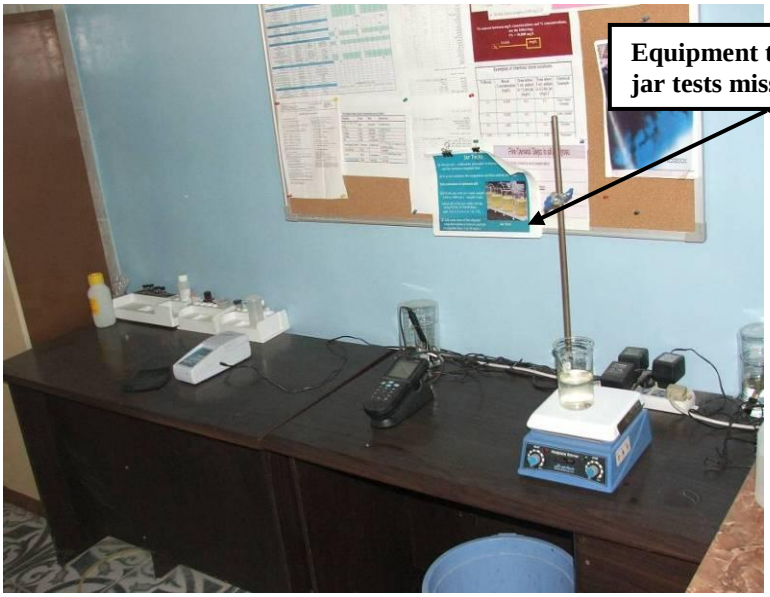
While in the laboratory, we requested the daily test results for the current month. The WTP representatives provided a three-ring binder with the raw data for the current month. The daily report for the day of our visit, 21 February 2008, stated testing was performed and the results were within WHO tolerances (Figure 3). However, due to the lack of appropriate laboratory equipment, we question the validity of the reported results. Consequently, at least for the day of our site visit, the WTP's water quality laboratory could not positively assert that the quality of the finished water met design standards.

In addition, when asked, the WTP representatives could not explain the location of the laboratory equipment provided under the contract or how they performed the testing for the day of our visit without the laboratory equipment.

Site Photo 27. Nassriya WTP laboratory equipment required to perform jar tests (Photo courtesy of ITAO)



Site Photo 28. Water sampling flow diagram at the Nassriya WTP identifying locations where water should be tested



Site Photos 29 and 30. Current state of Nassriya WTP's laboratory equipment
(NOTE: the equipment to perform the jar tests – Site Photo 29 – was missing during our site visit)

NASIRIYAH WTP.

Daily Process Acceptance Report

Date: 21 / 2 / 2008

Sampling Record of Raw Water		
Parameter	Period	Comments
Temperature (oC)	1 time per Shift	
Turbidity (NTU)	1 time per Shift	
PH	1 time per Shift	
Total Suspended Solids (mg/L)	1 time per Shift	
Total Dissolve Solides (mg/L)	1 time per Shift	

Sampling Record of Clarified Water		
Parameter	Period	Comments
Turbidity (NTU)	1 time per Shift at 9:00 AM	
Turbidity (NTU)	1 time per Shift at 7:00 PM	

Sampling Record of Filterd water Effluent Tank		
Parameter	Period	
Turbidity (NTU)	1 time per Shift	
Total Chlorine (PPM)	1 time per Shift	

Sampling Records of Treated Water from Ground Storage Tank			
Parameter	Period	Basis	Requirement
Total & fecal coliform	1 time per day	Maximum	0(MPN/100ml)
E.Coli	1 time per day	Maximum	0(MPN/100ml)
Temperature (oC)	Continuous		
Turbidity (NTU)	Continuous	Maximum	5 NTU
Free Residual Chlorine (PPM)	Continuous	Instantianeous	1.5-2.0 PPM
PH	Continuous	Instantianeous	6.5-9.2
Total Dissolve Solides (mg/L)	1 time per shift	Maximum	1500 mg/l
Taste&Odor	1 time per shift		Acceptable
Color	1 time per shift	Instantianeous	<20-30CPS,<15TCU

Process Records		
Parameter	Period	Requirement
Raw Water Flow M3/H	Continuous	2000 M3/H Per Pump
Alum Solution Flow Rate (L / hr)	Continuous	20-50 PPM Dosing Rate
Polymer Solution Flow Rate (L / hr)	Continuous	1-5 PPM Dosing Rate
Chlorinator # 1 Dosing Rate (Kg/h)	Continuous	1-3 PPM
Chlorinator # 2 Dosing Rate (Kg/h)	Continuous	1-3 PPM
Chlorinator # 3 Dosing Rate (Kg/h)	Continuous	1-6 PPM
Water Produce Flow M3/H	Continuous	2000 M3/H Per Pump

Sampling Records of Elevated Storage Tanks		
Parameter	Period	Requirement
Turbidity (NTU)	1 time per day	5 NTU
Free Residual Chlorine (PPM)	1 time per day	1-1.5 PPM

Elevated Storage Tank Location: AD Dawwayah | Ash Shatra | Al Garaf | Nasiriyah | Sug Ash Shuyukh | Comments

Clarifier # 1 2 3 4 5 6 7 8 9 10 SWCC

Turbidity NTU measurements of 1.8, 2, 2.8, and 2.5

Water produce flow of 2300, 2300, 2300, and 2300

Field Process Eng:

Laboratory Supervisor:

Reviewed By:

Figure 3. Daily process acceptance report for 21 February 2008 (day of our second site visit)

Turbidity Readings

According to the daily process acceptance report for the date of our site visit, 21 February 2008, the turbidity NTU measurements were made at four separate times with the following readings: 1.8-NTU, 2.0-NTU, 2.8-NTU, and 2.5-NTU. While all readings are significantly lower than the WHO standard of 5.0-NTU, the WTP's turbidity rates are well outside the design goal of 0.5-NTU. SIGIR reviewed daily process acceptance reports subsequent to our site visits and found turbidity rates that never reached the design goal of 0.5-NTU, with one daily rate as high as 3.0-NTU.

Continuing Problems for the WTP

At the inception of this project, the U.S. government explained to the GoI that this would be a cost sharing project, with the U.S. government committing the funding for the construction of the WTP, training of MMPW staff on the operations and maintenance of the facility, and 90-day oversight (mentoring) of MMPW staff; while the GoI would be responsible for providing the following:

- power from the national grid for the WTP and the three BPS
- program to repair leakages in the distribution system that would occur due to higher pressures and flows when the WTP is operational
- qualified and motivated MMPW staff to be trained by FluorAmec to eventually operate and maintain the facility

Power from the National Grid

Since specific units of equipment at the WTP require a significantly large amount of power to operate (such as the high service pumps), the decision was made to install power from the national grid and use generators as a backup source. The current generator capacity can only operate one single high service pump, which limits the WTP's capacity to approximately 20 percent. In addition, according to WTP representatives, diesel fuel has not been provided for the generators since the project was turned over from FluorAmec to the MMPW.

In 2004, the MMPW agreed to provide electrical power to the Nassriya WTP; consequently the Nassriya WTP contract with FluorAmec was definitized without funding for a power supply to the WTP or the BPS. Specifically, for the WTP the MMPW was responsible for a 33 kilovolt (kV) power line from the existing Al Shatra substation to the WTP with associated switchgear and transformer. By early 2006, it was recognized that the MMPW was not taking action to have power to the site in time for start up of the plant.

Using Development Fund for Iraq funds, a contract valued at $3.5 million was awarded to the Ministry of Energy SOE in early 2006 to install the electrical power to the WTP and BPS.

Status of the Contract for Power from the National Grid

At the time of our first site visit, the WTP relied solely upon generator power; however, the generators were not designed for continuous operation. According to USACE documentation, "if continuous operation [of the generators] is required, we can expect frequent outages and at least one general overhaul of each of six gen sets before March 2008 at a cost from $25,000 to $40,000 per generator."

At the time of our second site visit, the WTP relied solely on power from the national grid. However, according to WTP and USACE representatives, this power is unreliable since it often goes down without notice and also suffers from surges. As a result, the electrical induction motors within the expensive, technical equipment will be degraded significantly faster if the WTP continues to use this unreliable power source.

In addition, the three BPS are not operational due to the Iraqi SOE, which used non-standard transmission line cables instead of the standard cables recommended by the U.S. government. The non-standard transmission line cables require the use of load break elbows and bushings to connect the power lines to the transformers. Since the load break elbows and bushings are not available in Iraq, the Thi Qar provincial reconstruction team (PRT) is attempting to order the parts from a supplier in the U.S. The order was made several months ago and the parts still have not arrived. Consequently, until the needed parts arrive and are installed, the three BPS run solely on generator power. To further complicate the problem, according to USACE and WTP representatives, the ministry is not providing an adequate amount of diesel fuel to operate the three BPS generators.

Further, when the needed parts arrive and are installed, the WTP and BPS will continue to rely on the sporadic power from the national grid. If power from the national grid is still unreliable (i.e. frequent interruptions without notice), it will continue to degrade the technical equipment. According to USACE representatives, a potential solution would be the use of a 16-megavolt ampere transformer, which would be connected directly to the national grid backbone and would eliminate the unreliability of the incoming power.

Distribution Systems

The Nassriya WTP was designed to supply water to five cities in the Thi Qar governorate. Included with the construction of the WTP were five new ESTs as part of the conveyance pipeline system. The new ESTs are located at Ad Diwayah, Garraf, Nassriya, Al-Shatra, and Suq Al-Shoyokh.

City Connections to the New Elevated Storage Tanks

During the planning phase of the water supply project, the U.S. government advised the GoI that even after the completion of the WTP construction, water would not be available to the five cities until connections were made from the newly constructed conveyance lines to the five cities' distribution systems.

In 2005, the MMPW agreed to address the issue of connecting the ESTs to the five city water distribution systems. However, by July 2006, the GRD determined the MMPW did not make the necessary connections. Specifically, GRD stated the "MMPW have advised they do not have funding to install the connections to the distribution systems nor have the local resources to implement the work". Consequently, a project scope change, in the amount of approximately $10.8 million, was authorized for FluorAmec to complete the connection of the newly constructed Nassriya WTP and associated transmission pipeline to the distribution networks of the cities of Ad Diwayah, Al-Shatra, Al-Garraf, Nassriya and Suq Al-Shoyokh.

Program to Repair Leaks in the Distribution System

In addition to the connection problems to the ESTs, the local network distribution systems of the five cities were in such a condition that they would not be able to withstand the increased pressure and flows; consequently, it will suffer major leakages when the WTP becomes operational. Since 2005, the U.S. government has advised the

MMPW that there would be considerable leakage in the distribution networks in the five cities served by the new WTP once it became operational.

According to ITAO officials, the MMPW committed, for over six months in late 2006, to provide the resources needed to repair the leaks prior to the WTP being brought on line in 2007. In addition, ITAO officials stated the MMPW received extensive training by the U.S. government on repairing pipe leakages under the U.S. funded program in 2005 and 2006. Therefore, the repairs of leaking pipes should have been accomplished. Further, according to ITAO documentation, approximately 130-150 MMPW workers in the Thi Qar area had been trained on performing leak repairs and the MMPW received approximately $1.6 million in heavy equipment, hand tools, pipe fittings, and parts to complete the repair of the leaking pipes.

The U.S. Embassy-Iraq informed SIGIR that in anticipation of the leakage problems due to higher pressures in the existing distribution networks, GRD and ITAO directed FluorAmec in 2006 to install pressure reducing valves at the discharge side of each elevated storage tank (as part of their additional work to connect the storage tanks to the network). However, FluorAmec, at the request of MMPW, deleted this work from their scope and neither GRD nor ITAO was informed of this decision until after the work was completed. Although the pressure reducing valves would not have necessarily eliminated the leakage within distribution networks, they could have reduced to some degree the potential damage caused by high pressures on the fragile and deteriorated networks until MMPW made necessary repairs or replacements to the networks.

FluorAmec performed an assessment in January 2007, which concluded that the new WTP would create pressures in the existing distribution system that is on the order of 10 to 50 times higher than the current pressures. Specifically, pressures in the order of 0.1 – 0.5-bar were originally experienced; however, during operation of the WTP the pressures in the distribution system will be in the order of 5-bar. (A bar of pressure is 14.5 pound-force per square inch.) The assessment stated the following:

> *"…it is likely that there will be multiple pipe failures, innumerable leaks and resultant flooding once the plant start up occurs. Although it is impossible to predict the extent of the problem prior to pressurizing the system, it is strongly recommended that the actions included in this assessment be implemented as a minimum to correct existing problems and provide capability to deal with the network issues as they arise."*

In addition, the 2007 FluorAmec report assessed the distribution systems for all five cities and identified the essential requirements of each city prior to the WTP coming on line. Specifically, FluorAmec provided the scopes of work and illustrations necessary to repair the distribution systems in each city. For example, for the Ad Diwayah distribution network replacement and repair program, the assessment report stated to "Supply and install 17,500 m of 4" Unplasticised Polyvinyl Chloride (UPVC) pipe with all fittings needed to achieve the work in Al-Sob Al-Kabeer District, (Existing 4" Asbestos pipe and fittings to remain in place). The work will include all the reinstatement of pavement."

However, in May 2007, the Thi Qar governorate council raised the concern regarding leakages in the distribution systems in As Shatra and Al Garraf. The council requested the U.S. government postpone the pressuring testing, until the "Ministry and U. S. Government have taken actions to ensure the distribution network will not be damaged during testing." Delaying the pressuring testing not only meant not operating the WTP, but also incurring additional costs from the contractor. According to USACE

representatives, when the distribution system was tested in June 2007, the city of Suq Al-Shoyokh was flooded within hours.

The U.S. Embassy-Iraq informed SIGIR that the Thi Qar PRT submitted an $8.8 million proposal to expand the distribution network in the five cities served by the Nassriya WTP. However, the expansion was not considered advisable until the existing networks were repaired and the MMPW confirmed that there was excess capacity at the treatment plant to justify a network expansion. MMPW committed at the inception of the project to rehabilitate the distribution networks in the five cities and has reaffirmed its commitment numerous times over the years. The U.S. Embassy-Iraq indicated that a need clearly existed to repair the existing networks and the MMPW has the resources to complete this work. The Embassy felt that further investment of U.S. funds is unwarranted. The provincial government could also invest a portion of its annual budget in the network rehabilitation. An expansion of the existing distribution networks would exacerbate the situation by connecting more users to a system that is not currently capable of providing a reliable supply of water to existing customers.

Illegal Taps into the Transmission Line

Another issue impacting the distribution of finished water to one of the five cities served by the WTP is the problem of illegal taps. In the city of Ad Diwayah, the local population has illegally tapped into the transmission lines by puncturing the line and inserting their own takeoff pipes. Along the 23 km transmission line from the WTP to the Ad Diwayah EST, approximately 80 illegal taps have been identified (Figure 4). Site Photos 31 and 32 are examples of typical illegal taps found throughout Iraq. Apparently, Iraqi farmers tapped into the transmission line to irrigate their farmlands. At least 20 illegal taps, approximately 2" in diameter, have lowered the pressure in the water network so much that the water cannot reach the EST at Ad Diwayah. According to USACE representatives, the MMPW and the local council were informed of the illegal taps and the need to quickly eliminate them. However, the USACE stated the MMPW and local council refused to confront the issue of the illegal taps and instead requested the U.S. government install a bypass line around the EST. According to USACE representatives, the U.S. government rejected installing bypass lines around the EST and in November 2007, shutoff water to Ad Diwayah.

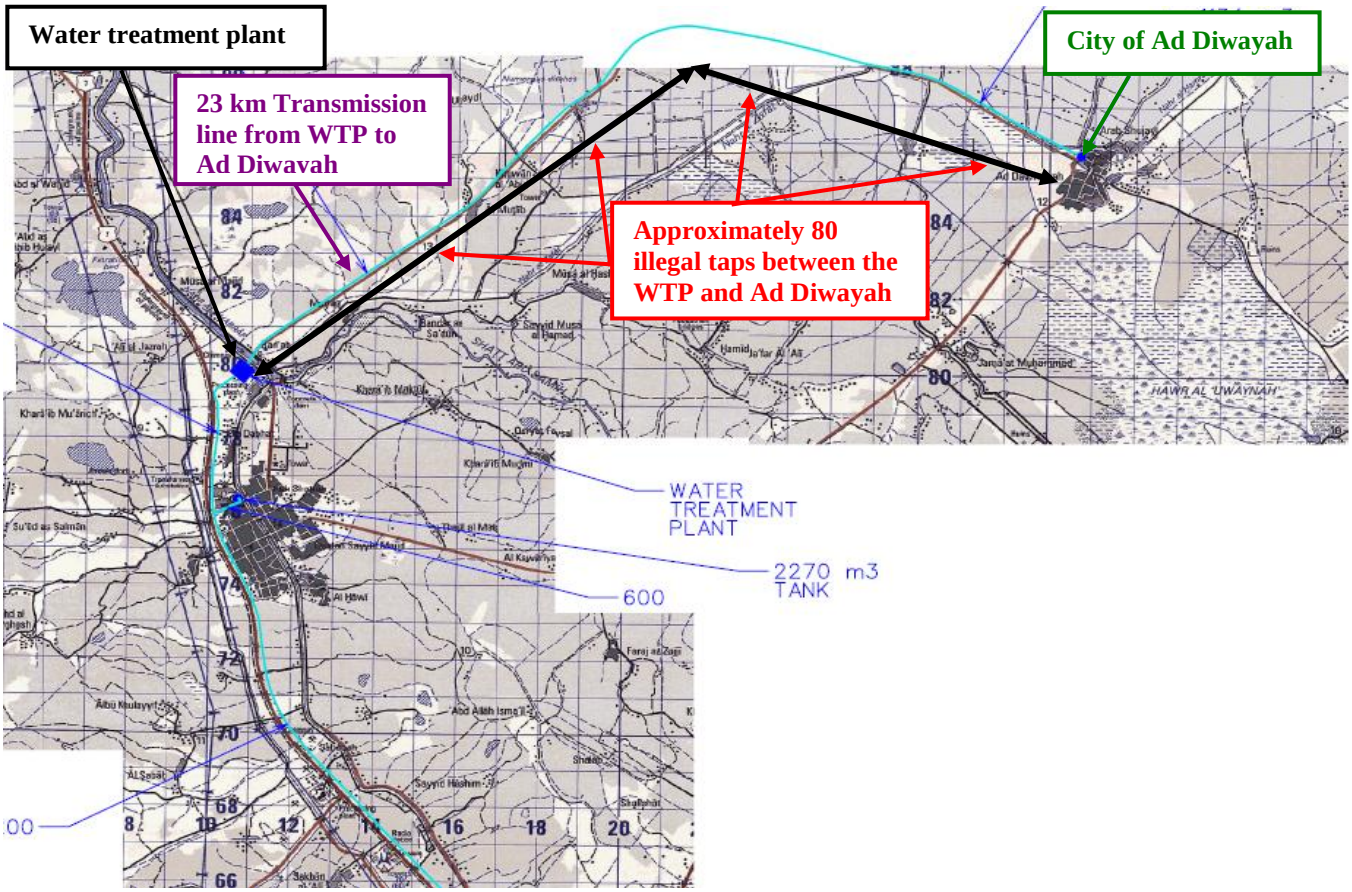


Figure 4. Map showing the line where illegal taps between the Nassriya WTP and Ad Diwayah

Site Photos 31 and 32. Examples of typical illegal taps and leaks in the distribution lines throughout Iraq

Training of MMPW Staff to Operate and Maintain the WTP

Under the contract, FluorAmec was required to provide O&M training to MMPW workers for the WTP and its associated facilities. In mid-2005, the MMPW was informed that approximately 100 skilled workers (and 20 unskilled workers) would be needed to operate and maintain the WTP (Appendix C lists the required skilled and unskilled workers). The MMPW was told to "staff this project with an emphasis on the Operations & Maintenance job skills…correct and appropriate staffing of this facility by the MMPW will ensure the future sustainability of the [Nassriya] WTP."

In mid-2006, as the project completion progressed, FluorAmec proposed conducting three sequential training sessions for approximately 35 trainees each, starting in September 2006. Each session would consist of five to six weeks of classroom training and a month or more of on-the-job training (OJT), depending upon the qualifications of the workers. The OJT portion of the training consisted of working alongside the FluorAmec staff at the WTP, BPS, and ESTs and participating directly in hands-on O&M activities under the guidance of FluorAmec and reviewing printed vendor materials on equipment for the project.

First Classroom Training Session

The MMPW provided a list of trainees and training commenced in September 2006. In response, the USACE wrote a letter to the Deputy Minister, MMPW, which stated the following:

> *"Thank you for sending us the names of the key staff members allocated to the [Nassriya] Water Treatment Plant. Please ensure that they will attend the first Operations & Maintenance training session scheduled for the 17th September. The newly appointed key personnel need all your support to build the workforce that is capable of operating and maintaining the Plant."*

However, the trainees stopped attending the classes shortly after training started. The reason in the drop in attendance was the local tribes were threatening the trainees because the tribes wanted the permanent positions for their own members, not regular MMPW workers. The local tribes had provided much of the labor during the construction phase of the project and had anticipated that their members would be hired to operate the plant when it was completed. However, the operations phase required higher skilled workers, and the MMPW selected other workers from the area and the local tribes resented not being provided the permanent positions. The intimidation of the MMPW workers was intended to force the MMPW to select some of the tribes own members as permanent workers for the plant.

In response to the attendance drop of initial trainees, the first training class was postponed until the conflict with the local tribes was resolved. The MMPW conducted discussions with the tribe authorities and subsequently submitted a new list of trainees, the vast majority of which were from the tribes. The first training session resumed in October 2006, but it became apparent almost immediately that the tribal members were unqualified to fill the skilled positions because most of the trainees were illiterate.

In addition, the designated MMPW WTP plant manager and several members of his office did not attend the training sessions on a regular basis. For example, the plant manager only attended three training sessions. In response, on 21 November 2006, the

Iraq Reconstruction Management Office (IRMO)[8] wrote a letter to the Deputy Ministry of MMPW, which stated:

> *"We wanted to bring to your attention that key MMPW personnel have not been attending the Nasiriyah Water Treatment Plant O&M training on a regular basis which will cause us problems in the near future…Please take the necessary steps/action to refocus the Nasiriyah WTP plant management key staff to understand the importance of this O&M training and to start attending the training again on a regular basis."*

Second Classroom Training Session

The second classroom training session began in December 2006, but it too was hindered by a lack of qualified trainees (only three out of the 31 trainees were literate), as well as poor attendance. Specifically, trainees complained about the following:

- lack of transportation to the WTP (where the training was being conducted)
- lack of a free lunch
- too long of a workday – in particular, the trainees wanted the work day to be 8:00 am to 2:00 pm with overtime for any work past 2:00 pm
- poor salaries (the trainees wanted a $200/month raise each)

Third Classroom Training Session

The third classroom training session commenced in February 2007. However, the session was halted after approximately three weeks due to poor quality of trainees and extremely poor attendance. For example, on 18 April 2007, IRMO wrote to the MMPW:

> *"…the six ministry trainees who have come to the treatment plant for on-the-job training over the past few weeks …have refused to participate in any hands-on O&M activities…[the trainees] do not appear to be very motivated to participate in the actual operations and maintenance of the plant. The Ministry must take immediate steps to improve the motivation for the trainees and ensure that the trainees participate in the actual hands-on O&M activities under the guidance of FluorAmec. Without this hands-on practice, we do not think the Ministry staff will be capable of performing or overseeing the O&M activities once FluorAmec has left the site."*

In addition, an internal IRMO memorandum expressed the frustration over efforts to get an adequate staff trained to operate and maintain the WTP. The memorandum stated:

> *"To illustrate the difficulties that we have encountered in getting qualified and motivated workers, the Ministry provided a list of 59 workers for the treatment plant on February 1, 2007 but the vast majority of these workers did not want to attend the training and informed the USG that they would not work at the treatment plant."*

Further, a field report from April 2007 stated the following with respect to the current training session:

> *"Thirteen (13) MMPW staff showed up for training today; this is the best attendance to date. The personnel continue to arrive late, anywhere from past 08:00 to 10:00 hours, and they all depart at 12:00 noon. The personnel have stated they WILL NOT stay past 12:00 noon."*

[8] IRMO later became the Iraq Transition Assistance Office.

On 20 April 2007, the IRMO issued a letter to the MMPW, which stated that the required staffing for the WTP, BPS, and ESTs had grown to 121 workers. The IRMO requested the MMPW identify a list of 69 trainees for the skilled worker positions for the next training session. The MMPW provided a revised list of trainees in May 2007 and the third classroom training session resumed.

Fourth Classroom Training Session

By May 2007, the U.S. government had determined that an additional 69 skilled trainees beyond the trainees that had already participated in the three training sessions conducted by FluorAmec were needed for the WTP. The MMPW subsequently conducted a more extensive recruitment process and identified an additional 70 trainees in June 2007. FluorAmec initiated a fourth classroom training session in July 2007, which was completed in September 2007.

Results of the Four Classroom Training Sessions

Since September 2006, the U.S. government continuously tried to complete training of MMPW workers, but encountered significant problems. Approximately 100 skilled workers are needed to operate and maintain the WTP. The conclusion of the fourth classroom training session coincided with the turnover of the WTP to the MMPW. By the end of the fourth training session, FluorAmec estimated that there were approximately 30 skilled workers that were considered somewhat qualified for their positions, of which approximately 10 were ready to assume their duties; however, even the 10 skilled workers required additional OJT. In addition, the 10 workers who are sufficiently skilled will only be able to operate and maintain the WTP at a basic level, not at a level to ensure the WTP's long term sustainment.

Effects of the Lack of Qualified Operators on the WTP

Within weeks of the turnover of the WTP to the MMPW, maintenance issues were already being reported. For example, on 28 October 2007, ITAO wrote a letter to the MMPW, which stated the following:

> *"Since September when the water project was turned over to the Ministry, we have been receiving regular reports from FluorAmec on the operational status of the treatment plant and associated facilities, such as booster pump stations and elevated storage tanks, and these reports indicate that the Ministry workers not properly operating or maintaining the plant and associated facilities. In addition, we have been informed that the Ministry workers are not following the advice and guidance of Fluor Amec engineers on how to operate and maintain the plant, resulting in equipment being damaged or taken out of service. As an example, the status report for October 26, 2007 listed the following equipment as being out of service:*
>
> - *Clarifiers 1, 4, 6, 9, and 10*
> - *Filter cells 8, 9, 10, 11, and 12*
> - *All three chlorinators not functioning*
> - *WTP high service pumps #1 and #6*
> - *BPS1 reservoir 30mm drains are damaged in the open position*
> - *BSP2 high service pumps #2 and #6*
>
> *We are deeply concerned by the unwillingness of Ministry workers to perform proper O&M in accordance with the training they have received and guidance provided by Fluor Amec, as it results in short-term or long-term damage to the*

treatment plant and related facilities and does not serve the best interests of the residents of ThiQar."

On 4 November 2007, ITAO and GRD representatives conducted a site visit to the WTP to determine the site conditions. According to a letter from ITAO to the MMPW, the site visit concluded that the "treatment plant is not being properly operated and maintained." The letter stated two primary reasons – the plant manager is not qualified and very counterproductive and the lack of highly qualified workers. Specifically, the "MMPW workers that are on site still are capable of basic operation, but are not competent to operate and maintain all major components of the treatment plant, especially the high tech components." The ITAO letter recommended the MMPW hire qualified engineers from FluorAmec who were available and willing to work for the MMPW.

On 17 November 2007, an on-site FluorAmec representative identified problems at the WTP such as the following:

- algae growth and poor state of cleanliness of all filter cells
- control panel problems for the sludge pumps
- sustaining valve located prior to BPS 1 control setting has drifted

In addition, the FluorAmec representative stated the following:

"Scheduled Preventative Maintenance tasks are not being performed. Minor tasks such as greasing and checking mechanical assemblies are getting done, but not on a set schedule. Some preventative maintenance tasks are not being done at all. [The WTP plant manager] agreed this was an important issue, but indicated that he did not have enough trained maintenance staff to be able to accomplish this task."

Future Plans for the Nassriya WTP

Actions Taken Since Turnover to the MMPW

The U.S. government officially turned over responsibility for the operation and security of the WTP to the MMPW on 12 September 2007. The U.S. government provided the MMPW with an additional 90-day extension of continued operational support of the WTP by FluorAmec[9]. According to ITAO documentation, during the extended period of operational support, FluorAmec reports stated that MMPW workers were "not properly operating or maintaining the plant and associated facilities." In addition, the FluorAmec reports also provided examples of "equipment being damaged or taken out of service." Further, as a result of limited qualified staff, the WTP, as of 21 February 2008, was operating at 2,300-m^3/hour for one shift of 8 hours a day.

ITAO representatives are "deeply concerned" about the current state of O&M, and the future wellbeing of the WTP. Specifically, in less than two months after the U.S. government turned over the WTP to the MMPW, FluorAmec documented a list of technical, expensive equipment, which was either damaged or not operational. In addition, ITAO and GRD representatives made two site visits in November and December 2007 and found that the WTP was "not being properly operated and maintained."

[9] The U.S. government extended FluorAmec's O&M contract for an additional 90 days of technical assistance and mentoring support for the WTP.

ITAO and GRD representatives are committed to making this project successful. In an effort to save the significant investment made by the U.S. government on behalf of and for the benefit of the Iraqi people, ITAO, GRD, and MMPW created a technical assessment team that initiated site visits in February 2008 to determine the condition of the WTP, the adequacy of the MMPW staff, and potential solutions.

Technical Assessment Team

The technical assessment team is comprised of two GRD representatives, one local national Iraqi construction engineer (ICE) working for the USACE GRS office, and two MMPW representatives[10]. In addition, the MMPW sent a team of five representatives to conduct an assessment of the WTP workers' skills and experience.

The technical assessment team planned a thorough and comprehensive review of the entire WTP and associated facilities (i.e. BPS). The inclusion of ICE and MMPW representatives in the technical assessment team was critical for performing a meticulous evaluation of the WTP. While the two GRD representatives could only visit the site once for approximately 30 minutes, the ICE engineer and MMPW representatives spent several full days at the WTP providing a methodical and systematic review of the WTP equipment and workers. Their results were transmitted back to the GRD representatives, who also met with the ICE engineer to review and discuss the preliminary findings.

Currently, the technical assessment team is finalizing its detailed analysis of the status of the WTP. After completing the assessment, the team will then focus on a comprehensive proposal to provide the U.S. government with potential solutions to increase finished water output to design capacity and prevent further deterioration of WTP production capacity.

Signs of Improvement

Due to the unrelenting efforts of the U.S. government, specifically the U.S. Ambassador, ITAO, and USACE, to influence the GoI some small, yet significant improvements have been noticed since our site visits. For example, while an accurate measurement of finished water cannot be determined because of the disabling of the flow meters, it has been reported that the Nassriya WTP has increased finished water production from 2,000 m^3/hour to 6,000 m^3/hour. Figure 5 provides the daily finished water output an hour for the period of one week prior to our second site visit through two weeks after. Please note Figure 5 is based solely upon data provided by the MMPW without the use of the required flow meters and the increase in finished water produced is for only one shift of 6-8 hours a day.

In addition, the GRS local national has stated that the governor and city council of Ad Diwayah recently decided to remove the illegal taps into the transmission lines, which will allow the water treatment plant to provide finished water to the city of Ad Diwayah.

The U.S. Embassy informed SIGIR that the Qar PRT was instrumental in facilitating the intervention of the Governor of the Thi Qar Province to replace the Facility Protection Service guards at the water treatment plant with Iraqi Army personnel; assigned personal security details to protect the plant manager and assistant plant manager to ensure their freedom of movement to and from the plant site; and agreed to pay overtime on Fridays (the Muslim day of rest and religious observance) as well as monthly bonuses to workers.

[10] The two MMPW representatives are the head of the O&M for the water directorate in Baghdad and a senior engineer from the water directorate in the Thi Qar governorate.

The Minister of Municipalities and Public Works also replaced the previous plant manager in January 2008 at the request of the U.S. government and the Thi Qar Governor. These steps are intended to improve the motivation and caliber of the workers but are probably not sufficient to completely resolve the lack of qualified and motivated workers for the project.

While these actions are encouraging, the GoI still needs to find permanent solutions to the issues of permanent, reliable power, leaking distribution lines, and qualified and motivated staff to operate and maintain the WTP 24 hours a day, seven days a week. The U.S. Ambassador, ITAO, and USACE are dedicated to assisting the GoI with finding and implementing the necessary solutions.

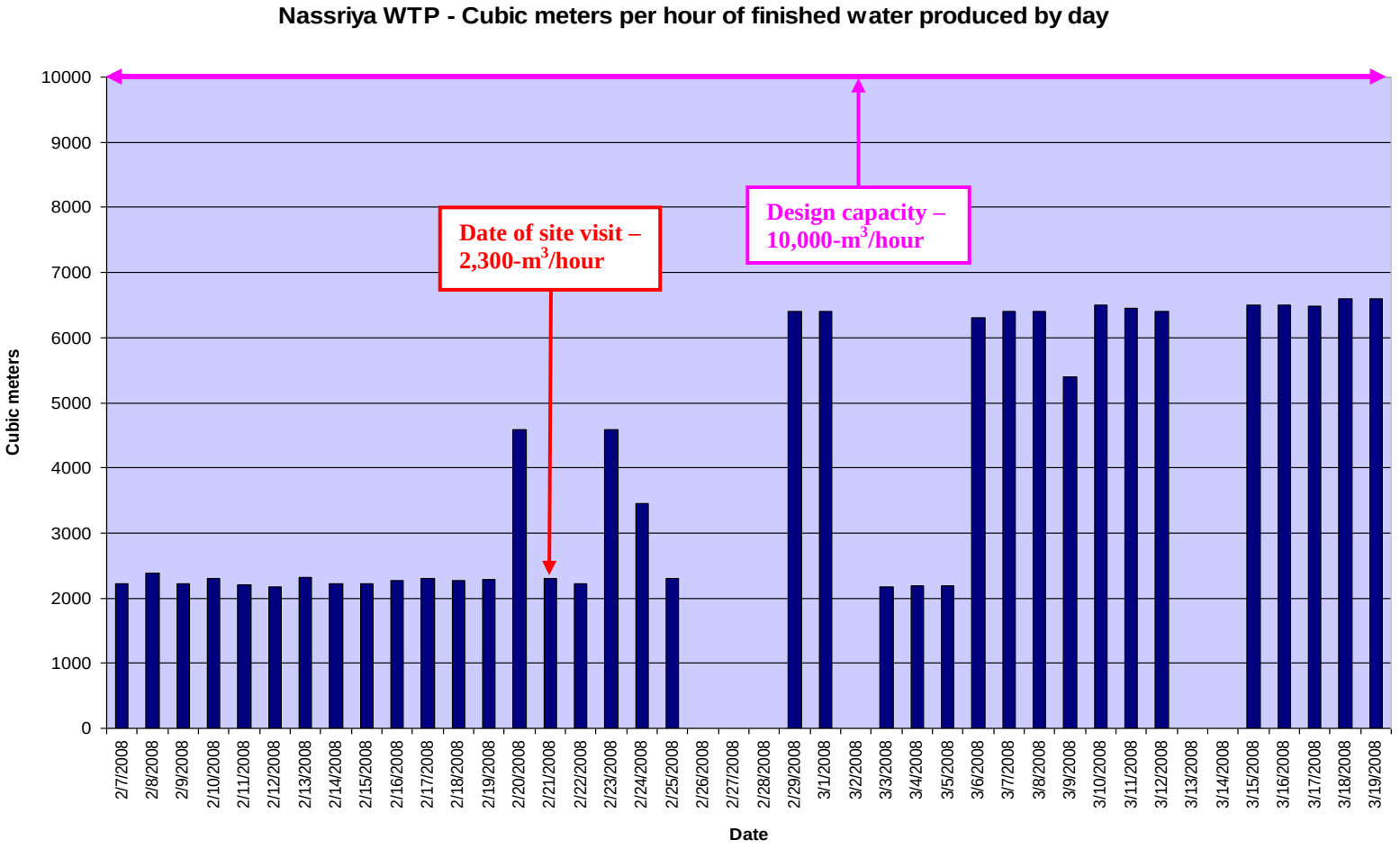


Figure 5. Amount of cubic meters of finished water produced hourly at the WTP during the period of 7 February 2008 through 19 March 2008 (Data provided by the USACE)[11]

Conclusions

SIGIR visited the Nassriya WTP twice – on 6 December 2007 and 21 February 2008. During both of the site visits, the plant was operating only one shift, of eight hours, a day

[11] Each number of the chart is an average of the daily finished water output claimed on the daily process acceptance reports. For most days, output was measured at two hour intervals, four times per day. We assumed output was constant during each two hour interval throughout the day.

and producing between 2,000–2,300-m^3/hour of potable water. In addition, the amount of finished water was only enough for three of the five cities. The citizens of the cities of Ad Diwayah and Suq Al-Shoyokh did not have access to the finished water because of illegal taps into the transmission lines and poor distribution systems. Consequently, at the time of our site visits, the water treatment plant was producing only 20 percent of its designed output, operating only one eight hour shift a day, and serving only 60 percent of the intended cities. This was due to the:

- lack of reliable power from the national grid
- old distribution system afflicted with leakages and unable to withstand the higher pressures and flows
- illegal taps in the water transmission line to Ad Diwayah
- unqualified and unmotivated MMPW staff unwilling to consistently attend the contractor provided training

For almost four years, the GoI has not addressed these issues. Due to the Iraqi ministry's inability to install reliable power and provide an adequate number of qualified and motivated staff, the WTP, at the time of the second on-site inspection on 21 February 2008, was operating at only 2,300-m^3/hour. In addition, the MMPW refusal to address the issue of illegal taps and the dismal state of the distribution system has resulted in potable water being unavailable for the cities of Ad Diwayah and Suq Al-Shoyokh. As a result of Iraqi delays, potable water is only reaching a fraction of the Iraqi people for which it was designed and intended.

The ITAO and the USACE are committed to making this project successful. In an effort to save the significant investment made by the U.S. government on behalf of and for the benefit of the Iraqi people, the ITAO, the USACE, and the Iraqi MMPW created a technical assessment team to determine the present condition of the water treatment plant, the adequacy of the MMPW staff, and potential solutions.

Signs of Improvement

Due to the unrelenting efforts of the U.S. government, specifically the U.S. Ambassador, the ITAO, and the USACE, to influence the GoI, some small, yet significant improvements have been noticed in the time since SIGIR's site visits. For example, while an accurate measurement of finished water cannot be determined because of the disabling of the flow meters, it has been reported that the Nassriya WTP has increased finished water production from 2,300-m^3/hour to 6,000-m^3/hour. In addition, the governor and city council of Ad Diwayah recently decided to remove the illegal taps, which will allow the WTP to open the line and provide finished water to the city of Ad Diwayah.

While these actions are encouraging, the GoI still needs to find long-term solutions to the issues of permanent, reliable power, leaking distribution lines, and a qualified and motivated staff to operate and maintain the WTP 24 hours a day, seven days a week.

Recommendations

To protect the U.S. government's investment of approximately $277 million, SIGIR recommends that the ITAO Director thoroughly review the technical assessment team's report and subsequent proposal, identify the most effective way to increase operational

output to design capacity, avert further deterioration of plant equipment, and expedite the implementation of this plan.

Management Comments

SIGIR received comments on a draft of this report from the Deputy Chief of Mission for the U.S. Embassy-Iraq, advising that the U.S. Embassy concurred with the recommendation in the report. Specific comments were also provided to clarify or correct technical aspects of the report. The GRD of the USACE also provided comments generally agreeing with the facts and conclusions in the in the draft report and providing technical comments for clarification. SIGIR reviewed the comments provided by both the Deputy Chief of Mission for the U.S. Embassy-Iraq and the GRD and revised the final report as appropriate.

Evaluation of Management Comments

SIGIR appreciates the concurrence by the U.S. Embassy-Iraq and GRD with the recommendation to expedite implementation of the plan to be developed by the technical assessments team to increase operational output to design capacity and avert further deterioration of plant equipment.

SIGIR reviewed the information and clarifying comments provided by the U.S. Embassy-Iraq and the GRD and revised the final report as appropriate. The complete text of the U.S. Embassy-Iraq's comments and the GRD's comments are in Appendices G and H respectively.

Appendix A. Scope and Methodology

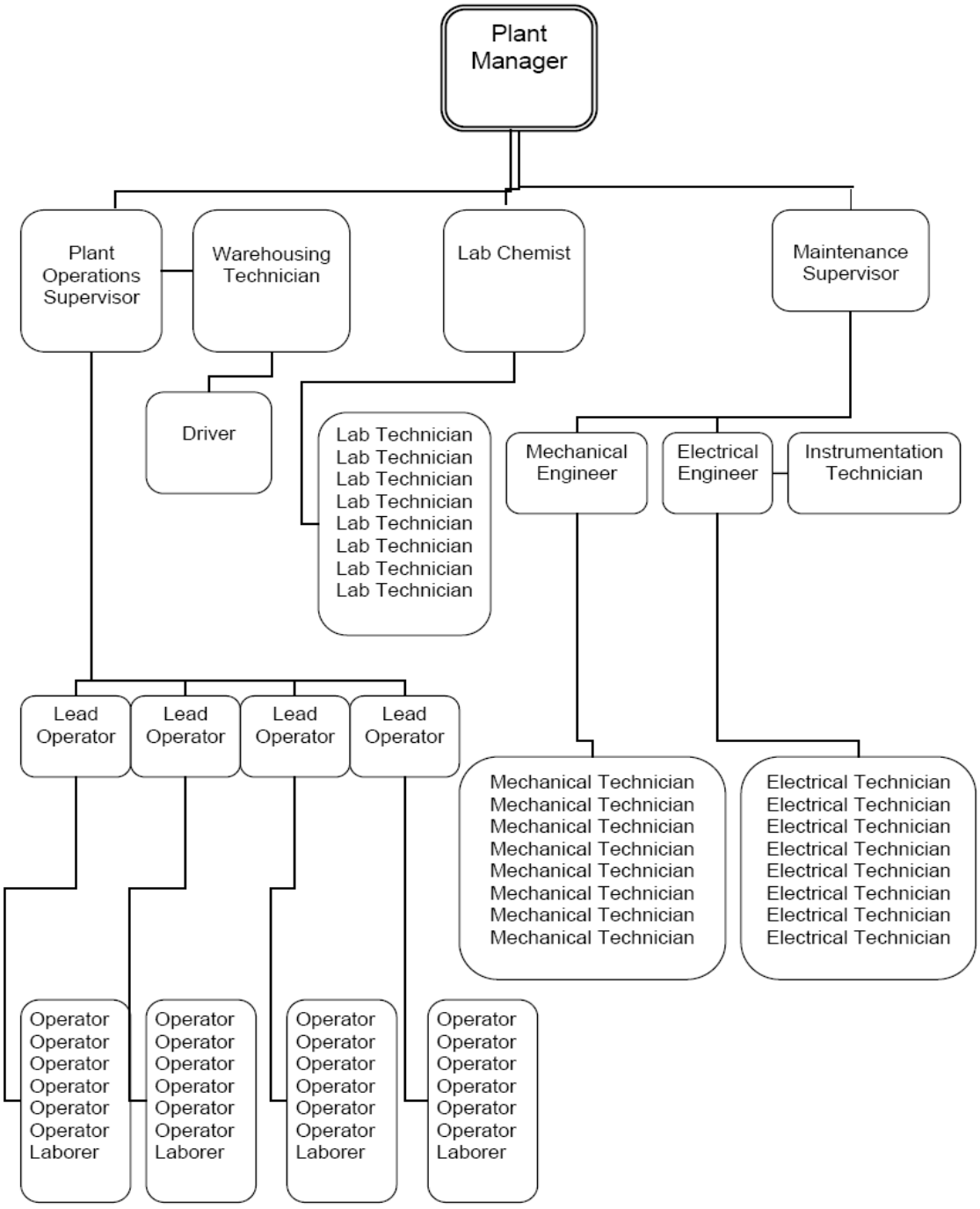
This project assessment was performed from November 2007 through April 2008 in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and two auditors/inspectors.

In performing this Project Assessment we:

- Reviewed contract documentation to include the following: Contract W914NS-04-D-0022, Delivery Order 0002, Delivery Order 0002 Modifications, Statements of Work, Invoices, and Material Inspection and Receiving Reports;
- Reviewed the available design package (drawings and specifications);
- Interviewed the U.S. Army Corps of Engineers Gulf Region Division personnel, Iraqi Transition Assistance Office personnel, and Nassriya Water Treatment Plant personnel; and
- Conducted two on-site assessments and documented results at the Nassriya Water Treatment Plant project in Nassriya, Iraq.

Scope Limitation. Due to security concerns, SIGIR performed expedited on-site assessments of the Nassriya Water Treatment Plant. The time allotted for each site visit was approximately 30 minutes; therefore, a complete review of all project work completed was not possible.

Appendix B. FluorAmec's Suggested Organizational Structure for the Nassriya WTP



Appendix C. FluorAmec's Proposed Nassriya WTP Staffing Plan

	Job Title	Responsibility	Personnel Per Shift		
			Shift 1	Shift 2	Shift 3
1	Plant Manager	O&M Management of WTP	1	0	0
2	Safety Manager	Ensure Safe Working Practices are Adopted and Applied	1	0	0
3	Lab Chemist	Laboratory Analysis	1	0	0
4	Lab Technician	Conducts Laboratory Sampling	2	2	2
5	Electrical Engineer	Electrical Maintenance & Trouble Shooting	3	1	1
6	Mechanical Engineer	Mechanical Maintenance & Trouble Shooting	3	1	1
7	Maintenance Superintendent	Daily Maintenance Supervision	1	1	1
8	Lead Plant Operator	Daily Operation Supervision	1	1	1
9	Raw Water & Elec. BLDG No.65 Operator	Operate Raw Water Pumps	1	1	1
10	Distribution Chambers & Clarifier Operator	Operate Chambers, Mixers & Clarifiers	1	1	1
11	Alum & Polymer Operator	Operate Alum & Polymer Systems	1	1	1
12	Filter Operator	Operate Gravity Filters & Backwash System	2	2	2
13	Solids Handling Operator	Operate Sludge Waste from Clarifiers, Tanks and Sludge Pump Station to River	1	1	1
14	High Service Pump Station Operator	Operate High Service Pumps	2	2	2
15	Chlorination Building Operator	Operate Chlorination System	1	1	1
16	Mechanical Technician	Mechanical Maintenance	4	1	1
17	Generator Technician	Operate Plant Generators	1	1	1
18	Electrical/Instrument Technician	Electrical / Instrumentation Maintenance	4	1	1
19	Unskilled Workers	Support General WTP Operations	10	5	5
20	Administrative Assistant	Administration Services	1	0	0
21	Electrical Engineer & Technician	BPS 1 Operations	2	2	2
22	Electrical Engineer & Technician	BPS 2 Operations	2	2	2
23	Electrical Engineer & Technician	BPS 2A Operations	2	2	2
24	Technicians	Dawaya, Shatra & Garaff EST Observation	2	2	2
25	Technicians	Nasiriyah & Suq Ash Shuykh EST Observation	2	2	2
26	Warehouse Keeper	Manage and Control Stores and Supplies	1	1	1
		Total Per Shift	53	34	34
		Total	121		

Appendix D. Water Transmission Lines

The conveyance system consists of five elevated storage tanks (ESTs), three booster pump stations (BPS), and a network of large diameter pipes. The high lift pumps discharge water into the conveyance system.

Extensive analysis was done to determine the type of pipe for the conveyance system. Three types of material–fiber glass, mild steel and ductile iron – were considered. Ductile iron was selected after considering cost, discharge capacity and the resistance to the harsh ambient soil conditions.

There is 18 km (approximately 11 miles) of pipe between the treatment plant and the first booster pump station (BPS 1). The initial three kilometer length has diameter of 1200-mm (48inches) and the additional 15 km is a 1000-mm pipe. A 600-mm pipe branches off to the Al-Shatra EST at the juncture where the pipe size changes from 1200 to 1000-mm.

Three kilometers upstream of BPS 1 on the same line, a 600-mm pipe branches off to the EST for Al-Garraf. There is 20 km of 1000-mm mains between the two booster pumps, BPS 1 and BPS 2. There is another 18 km of transmission line between BPS 2 and BPS 3.

An 800-mm diameter line branches off five km upstream of BPS 3 to the EST for Nassriya. The line between BPS 2 and BPS 3 consists of 13 km of 1000-mm pipe and 5 km of 800-mm pipe. At the juncture for where the two different diameter pipes meet, an 800-mm pipe branches off to the EST for Nassriya.

The EST for Suq-Al-Shoyokh is 21 km downstream of BPS 3 and it is connected to the pump station by an 800 mm diameter line. BPSs 1 and 2 have capacities of 6,500-m^3/hour each while BPS 3 has a capacity of 2280-m^3/hr.

For an illustration of the transmission line from the WTP to the five Thi Qar cities, please see Figure 6.

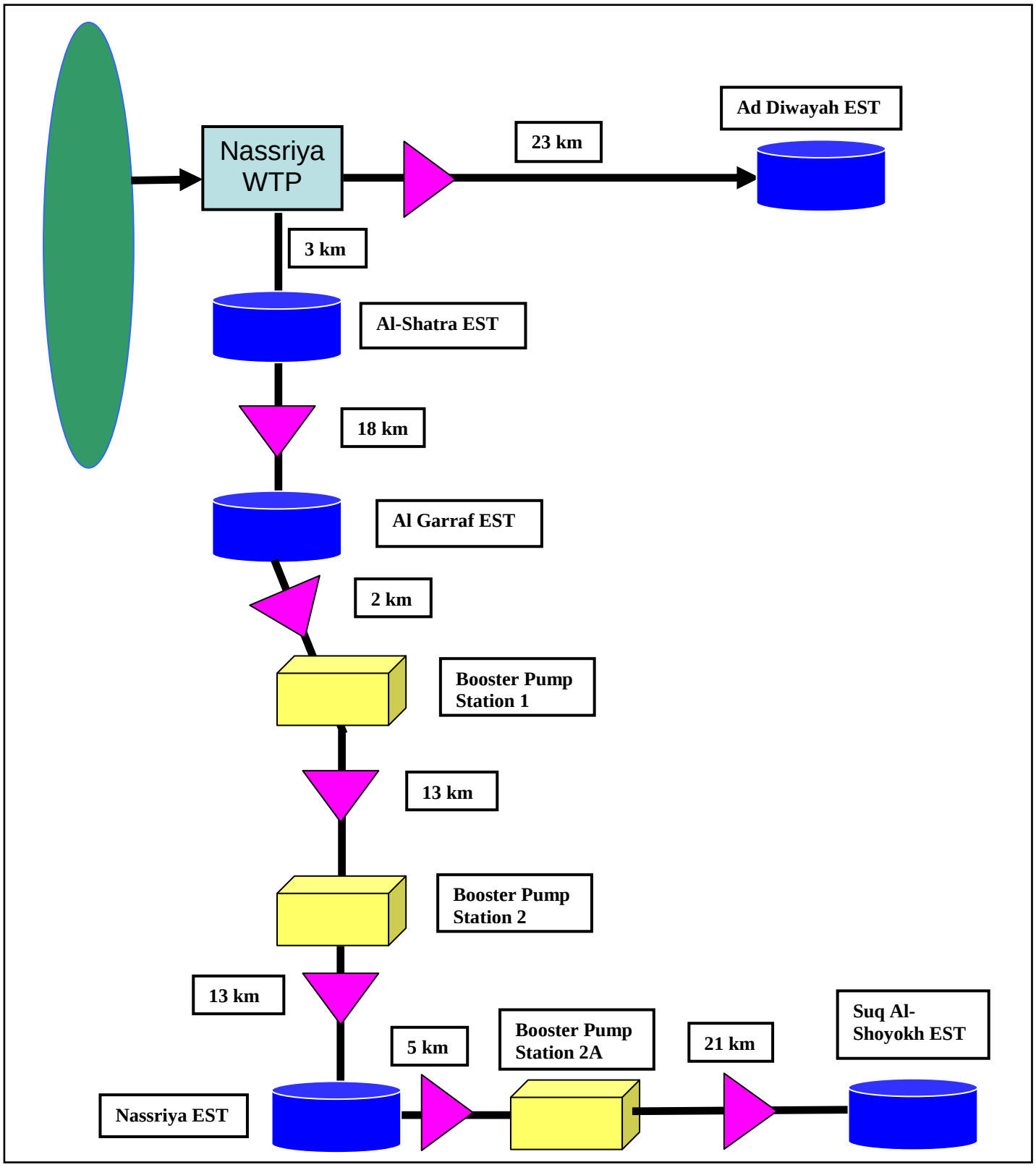


Figure 6. Transmission line conveying potable water from the WTP to the five Thi Qar cities

Appendix E. Acronyms

BPS	Booster Pump Station
cm	Centimeter
CTL	Construction Technology Laboratories
C_3A	Tricalcium Aluminate
DO	Delivery Order
EST	Elevated Storage Tank
GoI	Government of Iraq
GRD	Gulf Region Division
GRS	Gulf Region South
HSPS	High Service Pump Station
ICE	Iraqi Construction Engineer
IRMO	Iraq Reconstruction Management Office
ITAO	Iraqi Transition Assistance Office
km	Kilometer
km^2	Square Kilometer
m	Meter
m^3	Cubic Meters
$m^{3/}$day	Cubic meters per day
mm	Millimeter
MMPW	Ministry of Municipalities and Public Works
N/m	Newton per millimeter
NTU	Nephelometric turbidity units
O&M	Operations and Maintenance
OJT	On-the-Job Training
pH	Measure of acidity or alkalinity of a solution
PRT	Provincial Reconstruction Team
PVC	Polyvinyl Chloride
SIGIR	Special Inspector General for Iraq Reconstruction
SOE	State Owned Enterprise
SOW	Statement of Work
SPCOC	Sector Project Contracting Office Contractor

UPVC	Unplasticised Polyvinyl Chloride
USACE	United States Army Corps of Engineer
USAID	United States Agency for International Development
WHO	World Health Organization
WTP	Water Treatment Plant

Appendix F. Report Distribution

Department of State

Secretary of State
- Senior Advisor to the Secretary and Coordinator for Iraq
- Director of U.S. Foreign Assistance/Administrator, U.S. Agency for International Development
  - Director, Office of Iraq Reconstruction
- Assistant Secretary for Resource Management/Chief Financial Officer, Bureau of Resource Management

U.S. Ambassador to Iraq
- Director, Iraq Transition Assistance Office
- Mission Director-Iraq, U.S. Agency for International Development

Inspector General, Department of State

Department of Defense

Secretary of Defense
Deputy Secretary of Defense
Under Secretary of Defense (Comptroller)/Chief Financial Officer
- Deputy Chief Financial Officer
- Deputy Comptroller (Program/Budget)

Deputy Assistant Secretary of Defense-Middle East, Office of Policy/International Security Affairs
Inspector General, Department of Defense
Director, Defense Contract Audit Agency
Director, Defense Finance and Accounting Service
Director, Defense Contract Management Agency

Department of the Army

Assistant Secretary of the Army for Acquisition, Logistics, and Technology
- Principal Deputy to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology
- Deputy Assistant Secretary of the Army (Policy and Procurement)
- Commanding General, Joint Contracting Command-Iraq/Afghanistan

Assistant Secretary of the Army for Financial Management and Comptroller
Chief of Engineers and Commander, U.S. Army Corps of Engineers
- Commanding General, Gulf Region Division
- Chief Financial Officer, U.S. Army Corps of Engineers

Auditor General of the Army

U.S. Central Command

Commanding General, Multi-National Force-Iraq
- Commanding General, Multi-National Corps-Iraq
- Commanding General, Multi-National Security Transition Command-Iraq
- Commander, Joint Area Support Group-Central

Other Federal Government Organizations

Director, Office of Management and Budget
Comptroller General of the United States
Inspector General, Department of the Treasury
Inspector General, Department of Commerce
Inspector General, Department of Health and Human Services
Inspector General, U.S. Agency for International Development
President, Overseas Private Investment Corporation
President, U.S. Institute for Peace

Congressional Committees and Subcommittees, Chairman and Ranking Minority Member

U.S. Senate

Senate Committee on Appropriations
- Subcommittee on Defense
- Subcommittee on State, Foreign Operations, and Related Programs

Senate Committee on Armed Services
Senate Committee on Foreign Relations
- Subcommittee on International Development and Foreign Assistance, Economic Affairs, and International Environmental Protection
- Subcommittee on International Operations and Organizations, Democracy and Human Rights
- Subcommittee on Near Eastern and South and Central Asian Affairs

Senate Committee on Homeland Security and Governmental Affairs
- Subcommittee on Federal Financial Management, Government Information, Federal Services, and International Security
- Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia
- Permanent Subcommittee on Investigations

U.S. House of Representatives

House Committee on Appropriations
- Subcommittee on Defense
- Subcommittee on State, Foreign Operations, and Related Programs

House Committee on Armed Services
- Subcommittee on Oversight and Investigations

House Committee on Oversight and Government Reform
- Subcommittee on Government Management, Organization, and Procurement
- Subcommittee on National Security and Foreign Affairs

House Committee on Foreign Affairs
- Subcommittee on International Organizations, Human Rights, and Oversight
- Subcommittee on the Middle East and South Asia

Appendix G. United States Embassy-Iraq Comments

Embassy of the United States of America
Baghdad, Iraq

April 18, 2008

INFORMATION MEMORANDUM
UNCLASSIFIED

TO: Special Inspector General for Iraq Reconstruction

FROM: The Deputy Chief of Mission - Ambassador Patricia A. Butenis

SUBJECT: Management Comments on Draft Interim Report to SIGIR PA-07-116, Nassariya Water Treatment Plant, Sustainment Assessment

Thank you for the opportunity to respond to Draft SIGIR report PA-07-116, Nassariya Water Treatment Plant, Sustainment Assessment. The U.S. Embassy concurs with the recommendations of this report. ITAO offers the following points in an effort to address several discrepancies found within the report. We request that these comments be included in the final version of the report, and furthermore, be kept in mind when drafting any follow-on documents (referenced in the Report).

ITAO Water Sector Comments
SIGIR PA-07-116, Nassariya Water Treatment Plant, Sustainment Assessment

1. **"Signs of Improvement"**(discussed in several sections of the report):

   a. In addition to the small improvements noted in several sections of the report, the Governor of ThiQar Province has also replaced the Facility Protection Service (FPS) guards at the treatment plant site with Iraqi Army personnel, assigned personal security details to protect the plant manager and assistant plant manager to ensure their freedom of movement to and from the plant site, and agreed to pay overtime on Fridays as well as monthly bonuses to workers. The Minister of Municipalities and Public Works (MMPW) also replaced the previous plant manager in January 2008 at the request of the USG and ThiQar Governor. These steps are intended to improve the motivation and caliber of the workers but are probably not sufficient to completely resolve the lack of qualified and motivated workers for the project.

   b. The ThiQar Provincial Reconstruction Team (PRT) was instrumental in facilitating the interventions of the Governor and should be recognized for their efforts along with the Ambassador, ITAO, and USACE.

UNCLASSIFIED

2. **Cost Share Components** (discussed in several sections of the report):

   a. In addition to the cost share components identified in several sections of the report, the MMPW also committed to complete the connection of the elevated storage tanks (ESTs) to the existing distribution system. This commitment is described more fully on page 34, but it is not explicitly stated anywhere else in the report.

   b. Repair of Distribution Networks – in anticipation of the leakage problems due to higher pressures in the existing distribution networks, GRD and ITAO directed FluorAmec in 2006 to install pressure reducing values (PRVs) at the discharge side of each elevated storage tank (as part of their additional work to connect the storage tanks to the network). However, FluorAmec, at the request of MMPW, deleted this work from their scope and neither GRD nor ITAO was informed of this deletion until after the work was completed. Although the PRVs would not have necessarily eliminated the leakage within the distribution networks, they could have reduced to some degree the potential damage caused by high pressures on the fragile and deteriorated networks until the MMPW made the necessary repairs or replacements to the networks.

3. **Background of Status of Water Sector in Iraq**

   a. Although not strictly pertinent to the evaluation of the NWTP, the background section is intended provide the broader context of water supply in Iraq. However, ITAO does not believe that the UN/WB Assessment report and other reports cited in this section are credible documents and much of the information in the background section is anecdotal at best, completely unfounded at worse. The sad truth is that there are no accurate data on the condition of the water systems or supply in Iraq for the pre or post-2003 period.
   b. In general, the report provides more history than is necessary and the comments on sewage do not add to the main purpose of the report. This may confuse the core issue, especially for the layperson. We request that pages 1 through 8 be reworked to address these concerns.

4. ThiQar PRT Proposal to Repair Networks:

   a. The description and discussion of the ThiQar PRT proposal for repairs to the networks is not accurate. The proposal was intended to ***expand***, not ***repair***, the distribution networks in ***all*** five cities served by the Nassariyah project. An expansion of the distribution networks is not advisable this point in time until the existing networks are repaired and the MMPW confirms that there is excess capacity at the treatment plant to justify network expansions. MMPW committed at the inception of the project to rehabilitate the distribution networks in the five cities and has reaffirmed its commitment numerous times over the years. There is clearly a need to repair the existing networks and the MMPW has the resources to complete this work, no further USG investment is warranted. The Provincial Government could also invest some of its annual budget into network rehabilitation. An expansion of the existing distribution networks would exacerbate the situation by connecting more users to a system that is not currently capable of providing a reliable supply of water to existing customers.

5. Miscellaneous Corrections and Clarifications

a. Page 7, Al Garraf – Iraqi Industrial Ministry should be Iraq Ministry of Industry and Minerals.
b. Page 9, 6th paragraph – should read **five** elevated storage tanks, not **three**.
c. Page 11, third paragraph – replace free chlorine with gaseous chlorine.
d. Various sections of the report refer to "permanent power" or "municipal power"; a more appropriate description would be power from the national grid. The lack of power from the national grid was a limiting factor for the treatment plant as well as all three booster pump stations. The backup power generation capacity was not sufficient for any of these facilities, so even after the plant was connected to the grid, the BPS were still limited to partial operation.
e. Page 16, last paragraph - the correct formula for tricalcium aluminate is: 3CaO.Al2O3.
f. Page 25, first paragraph - Giardia is ingested as a cyst, the illness it can cause is giardiasis which is a serious but generally non-life threatening condition characterized by diarrhea, cramps, nausea and fatigue. Giardia lamblia is a specific species of Giardia, there are other Giardia species that also cause human illness.
g. Page 30, On Site Laboratory – the discussion on the lab equipment required to perform certain tests is confusing and should be clarified if possible.

Drafted: **ITAO Water - L. Allen**

Cleared: **ITAO CFO - S. Hill**
ITAO SIGIR Liaison - A. Jones
ITAO Director - M. Tokola

Appendix H. Gulf Region Division Comments

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
GULF REGION DIVISION
BAGHDAD, IRAQ
APO AE 09348

REPLY TO
ATTENTION OF

CEGRD-CG

18 April 2008

MEMORANDUM FOR Special Inspector General for Iraq Reconstruction, US Embassy Annex, M-202, Old Presidential Palace, APO AE 09316

SUBJECT: Draft SIGIR Sustainment Assessment Report – Nassriya Water Treatment Plant Nassriya, Iraq , (SIGIR PA-07-116)

1. This memorandum provides the U.S. Army Corps of Engineers, Gulf Region Division response to the subject draft assessment report.

2. The Gulf Region Division reviewed the subject draft report and generally agrees with the facts and conclusions contained in the draft report. We have provided additional technical comments for clarification in the enclosure.

3. Thank you for the opportunity to review the draft report and provide our written comments for incorporation in the final report.

4. If you have any questions, please contact Mr. Robert Donner at (540) 665-5022 or via email Robert.L.Donner@usace.army.mil.

Encl

JEFFREY J. DORKO
Brigadier General, USA
Commanding

COMMAND REPLY
to
SIGIR Draft Sustainment Assessment Report – Nassriya Water Treatment Plant Nassriya, Iraq
SIGIR Report Number PA-07-116
(Project PA-07-116)

Overall Comment. The Gulf Region Division (GRD) reviewed the report and provides the following technical comments for clarification.

1. **Draft Report, Page ii, third paragraph, second sentence.** In an effort to save the significant investment made by the United States government on behalf of and for the benefit of the Iraqi people, the Iraq Transition Assistance Office and the United States Army Corps of Engineers created a technical assessment team to determine the present condition of the water treatment plant, the adequacy of the Ministry of Municipalities and public Works staff, and potential solutions.

Command Comment. Change the sentence to read, "In an effort to save the significant investment made by the United States government on behalf of and for the benefit of the Iraqi people, the Iraq Transition Assistance Office the Iraq Transition Assistance Office, the United States Army Corps of Engineers and the Ministry of Municipalities and Public Works (MMPW) created a technical assessment team to determine the present condition of the water treatment plant, the adequacy of the MMPW staff, and potential solutions."

2. **a. Draft Report, page ii under Recommendations.** To protect the United States government's investment of approximately $277 million

b. Draft Report page 1, fourth paragraph under Background. The $277 million Nassriya Water Supply project, which includes the Nassriya …government in Iraq

c.) Draft Report page 9, second paragraph under Project objective, Pre-Construction Description, The $277 million Nassriya Water Supply …reconstruction projects.

d.) Draft Report, page 14, first sentence under Responsibility of the MMPW. To complement the $277 million investment by the U.S. government, the MMPW was responsible for providing:

e.) Draft Report, page 44, first sentence under Recommendations and Management Comments. To protect … approximately $277 million …implementation of this plan.

Command Comment. Change $277 million to $272 million, the finalized cost of the project.

3. **Draft Report, page 3, Site Photo 1,** Caption reads: Sewage water bypassing WTPs and exposing children to diseases.

Enclosure

Command Comment. Caption should read: "Sewage water bypassing Waste Water Treatment Plants (WWTPs) and exposing children to diseases."

4. **Draft Report, page 4, second paragraph third sentence.** With steadily deteriorating water distribution systems (both water supply and sewage), the leaking sewage pipes mix into the water supply.

Command Comment. Change sentence to read, "With steadily deteriorating water distribution and waste water collection systems, the leaking sewage pipes mix into the water supply.

5. **Draft Report, page 7, last sentence.** For an illustration of the cities served by the proposed Nassriya WTP, see Figure 2.

Command Comment. Change sentence to read, "For an illustration of the cities served by the Nassirya WTP, see Figure 2."

6. **Draft Report, page 16, next to the last sentence.** FluorAmec continued to reduce the cement mixture and provided oversight for the production and testing of concrete.

Command Comment. Information leading up to this sentence indicated a concern with the plasticizer admixture. The amount of admixture was reduced and the concrete generated acceptable concrete test results.

7. **Draft Report, Page 16, footnote 8.** Stress and pressure unit conversion method.

Command Comment. Footnote 8 refers to Newton, which is a unit of force. A Newton is equal to the amount of force required to give a mass of one kilogram an acceleration of meter per second squared.

8. **Draft Report, page 20, first paragraph.** In addition, the WTP, which was designed and constructed to run continuously 24 hours a day, 7 days a week (through three eight hour shifts), was only being operated for one shift of 8 hours a day, 6 to 7 days a week.… finished water to Nassriya.

Command Comment. Need to add the sentence, "Water demand is also reduced due to the illegal taps in the transmission line to Ad Diwayah, which necessitated shutting water off to Ad Diwayah."

9. **Draft Report, page 25, first sentence…"**microorganisms, such as Giardia lamlia."

Command Comment: The correct spelling is ***lamblia***.

10. **Draft Report, page 33, third paragraph under Permanent Power.** Using Development Fund for Iraq (DFI) funds, a contract valued at $3.5 million was awarded to one of the Ministry of Energy (MoE) SOE in early 2006 to install the electrical power to the WTP and BPS.

Command Comment. Change the sentence to read: Using Development Fund for Iraq (DFI) funds, a contract valued at $3.5 million was awarded to one of the Ministry of Electricity (ME) SOE in early 2006 to install the electrical power to the WTP and BPS.

Draft Report Page 50, Appendix E, Acronyms. MoE - Ministry of Energy.

Command Comment: Change" MoE - Ministry of Energy" to "ME Ministry of Electricity."

11. **Draft Report, page 41, third paragraph, second sentence.** In an effort to save the significant investment made by the U.S. government on behalf of and for the benefit of the Iraqi people, ITAO and GRD created a technical assessment team that initiated site visits in December 2007 to determine the condition of the WTP, the adequacy of the MMPW staff, and potential solutions..

Command Comment. Change the sentence to read. **"**In an effort to save the significant investment made by the U.S. government on behalf of and for the benefit of the Iraqi people, ITAO, GRD and MMPW created a technical assessment team that initiated site visits in February 2008 to determine the condition of the WTP, the adequacy of the MMPW staff, and potential solutions."

12. **Draft Report, page 41, fourth paragraph, first sentence.** The technical assessment team is comprised of two GRD representatives, one local national Iraqi construction engineer (ICE) working for the USACE GRS office and five MMPW representatives.

Command Comment. Change the sentence to read, "The technical assessment team is comprised of two GRD representatives, one local national Iraqi construction engineer (ICE) working for the USACE GRS office and two MMPW representatives."

13. **Draft Report, page 43, bullets under Conclusions.** This was due to the: etc.

Command Comment. Add a fourth bullet, "illegal taps in the water transmission line to Ad Diwayah"

14. **Draft Report, page 43, second paragraph, first sentence.** For almost four years, the Government of Iraq has not addressed these issues.

Command Comment. Recommend deleting "For almost four years, the Government of Iraq has not addressed these issues."

Appendix I. Project Assessment Team Members

The Office of the Assistant Inspector General for Inspections, Office of the Special Inspector General for Iraq Reconstruction, prepared this report. The principal staff members who contributed to the report were:

Angelina Johnston

Kevin O'Connor

George Baffoe, P.E.