

Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies



Work package 3, Deliverable D 313

Demonstration of artificial recharge of treated wastewater
Socio - Economic
Analyses at Bani Zaid wastewater Treatment Plant

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1. General description

In Bani Zaid Municipality, a full-scale wastewater treatment and irrigation system were designed, part of the system were constructed, operated and managed. Bani Zaid Municipality includes the two villages of Der Ghassana and Beit Rima. Like many West Bank villages, sewage is currently inadequately treated and causes serious health and environmental problems. The two villages are among the few West Bank villages to have tap water but no sewerage or central treatment systems.

Together, the villages own more than 1500 hectares of land, mostly used for olive cultivation, and they are renowned for their long-standing agricultural traditions. The Municipality is prepared to allocate about 15 dunums of land for the sewage treatment facilities.

The Town of Bani Zaid is located on the western slopes of the West Bank Mountains and enjoys typical Mediterranean weather conditions. The proper technology for wastewater treatment in Mediterranean climates should be natural, biological, energy-extensive, low-cost, and low-impact technology, which is also reliable and simple in operation. Therefore, it proposed to use the well-known, widely used treatment units. This technology is based on an integrated system, and consists of several extensive units, such as: constructed wetlands, intermittent filtration, lagoons, and wastewater reservoirs. This integrated system should provide for pre-treatment, secondary treatment, post-treatment and winter water storage reservoir.

Due to the fact most of the existing sewage works in Palestine are non-functional and there are no reliable practical data on wastewater characteristics, design and operation of sewage treatment plants. It is essential to run a pilot plant in order to develop design parameters for the large-scale treatment plant and to get practical experience in planning, design, construction, operation, maintenance and process monitoring of the treatment plant.

2. Location

The town of Western Bani Zaid comprises of two villages which are Beit Reema and Deir Ghassaneh located 27 Km North – West from Ramallah city. The centers of the two villages are 25Km far away from each other. Bani Zaid is situated between latitude of 31.5 and longitude of 35.12 and at an elevation of (400-500)m above sea level . Bani Zaid is surrounded by Kufr Al-Deek and Brouqin villages to the north, Deir Nizam and Al-Nabi Saleh villages to the south, Kufr Ein and Qarawet Bani Zaid to the east, and Aboud, Al-Luban, and Rantees to the west.. Bani Zaid can be reached through three main roads. From the north, it is reached through Kufr Al-Deek. From the south it is reached to through Al-Nabi Saleh village. From the east it is reached through Kufr Ein village. Bani Zaid is considered as a center of several surrounding villages such as Al-Nabi Saleh, Kufr Ein, Qarawet Bani Zaid, Deir Nizam and Aboud.



3. Socioeconomic Conditions

Similar to other Palestinian rural areas, the Bani Zaid cluster is an agricultural based community where the main income sources of the residents are agriculture and employment in public institutions. The number of poor people is relatively higher than the country average and, as described in Table 1, the family size is more than 7 members each. An extended family with more than 20 people living in the same house is a common phenomenon. The villages have different social and economic problems such as tribal-based election of councils, large income gap between families, dominant social figures, political factions, etc

Table. 1. Main Socioeconomic Indicators in Comparison with The National Indicators

Indicator	National	Bani Zaid	Remarks
Family size	7.71	7.2	
Poverty (%)	55 ¹	65	Uncertainties are very high and figures are subject to change each month
Unemployment (%)	51	43	
Income (\$/person/yr)	890	720	
Water consumption (m ³ /person/yr)	65	86.4	For connected areas
Price (\$/m ³)	1.5	1.3	This is the average price
Payment (%)	64	32.7	The survey was conducted during the months when the Government was unable to pay the salaries
Number of households/1000 person	112	120	
Population growth rate	3.0	3.9	

3.1. Poverty

Statistics related to poverty indicate that about 65%² (Ministry of Social Welfare, 2007) of the people live under the National Poverty Line while the remainder of the families is slightly above the Poverty Line.

3.2. Income

The main income source of the families is generated by agricultural activities; free labor in the local market also contributes to a large portion of the family income. Despite the relatively large family sizes and vast agricultural area; poor marketing opportunities, closures³ and other factors contribute to an average income in the area being less than 1 US\$/day, which means the average income per household is under the Poverty Line. Another clear indicator is that the revenue generated by agriculture is very dependent on the type of agriculture, since irrigated or greenhouse agriculture reaches 27,000 NIS per dunum (1000 m²) while rain-fed agriculture only 200 NIS. These figures clearly indicate that any rapid decrease in the availability of water resources or the reallocation of water from the agricultural sector to domestic use will cause large reductions in the income of households. The area has a relatively high unemployment rate. As indicated in Table 33, the average unemployment rate is 43%; the high percentage of seasonal work means that during some parts of the year, more than 80% of the people will be jobless. From a water management point of view, people's

¹ According to 2007 statistics

²This number is a dynamic and changeable by the rapid changes of political and socioeconomic situation of the area.

³ Because the political problems many places used to be closed military area for different periods

affordability of water will be at a minimal level, leading to the failure of the water utility or other supply provider.

4. Water supply

As mentioned above, the Municipality purchases water in bulk and distributes it to the people after adding additional costs. The water network was constructed in 1975, and its main problems are: a high percentage of leakage (45%) and low pressure (20% of the residents receive water only after midnight). In the last five years and due to rapid population growth and unplanned urban expansion, the network has been extended by 20%, causing more complicated water supply problems. One of the major problems is that the Municipality has no detailed plan for the network. New connections are usually done by the Water Unit without taking into consideration any engineering parameters (such as future connections, pressures, demand, etc.). Despite the fact that the Municipality is willing to solve the mentioned problems, the institutional capacity, the lack of financial resources, the lack of strategy and vision, the absence of government support, and social conflicts among the people are the main obstacles to overcome the problems mentioned.⁴

3. Description of the treatment plant (TP)

The main components of the TP

1- A septic tank was constructed that consists of three basins as the first stage of purification. It was well plastered to avoid any water leakage. A screen is also placed before the septic tank for large objects removal. The septic tank is about **300 cubic meters** (3.5*12.25*7.15) m³, where the basins are

- a) First basin (9*4.2*3.7) m³ which is equipped with a gas collection system to form UASB reactor.
- b) Second basin (9*2.2*3.7) m³
- c) Third basin (6.65*2.5*3.7) m³

The ceiling of the septic tank was closed by reinforced concrete cover through which steel gates were installed as required. The first chamber is an up-flow anaerobic sludge blanket (UASB). The work inside this chamber included shaping, painting (by coal tar epoxy) and fixing the inclined submerged steel plates with effluent gutters, weirs, deflectors and effluent collection V-notch channels along this compartment. All of the internal concrete and steel sheets body was protected by painting according to EPA specifications for sewage works. The influent was split into 7 portions by a distribution box connected to 7 HDPE pipes which end at the reactor base at equal division distances. The reactor was equipped with a sludge conveyance 6" pipe with gate valve to use gravitational flow, which is allowed by the topography of the site, to dispose excess sludge to the sludge drying bed at the downstream. A gas collection system was installed over the top of the UASB and included 4 bar safety valve and gas storage facility. Gas tightness was ensured in all of the process. The second and the third chambers are sedimentation tanks with openings in the roofs covered by steel gates.

4. Some houses in the high level areas didn't receive water because the lack of water pressure

2- House connection

It is a connection where all hoses coming from the septic tank join and they are four hoses, 75mm supplied with valves which distribute the water going out of the septic tank to the wet land.

3- Constructed Wet land

It is consisted of four parallel basins of plastic, sand and gravel, divided in the middle by channel. One out of these basins is planted with roots of reeds. The basins are about 1800-squared meter with an area of 450m^2 for each.

4- Storage Tank

It is a cement tank with the capacity of 70 m^3 which was constructed to collect water going out of the constructed wet land before using it for agriculture. To that time an agricultural pipe line was constructed for safely disposal to the nearest wadi.

5- Sludge Drying Bed

The sludge drying bed is of 36 m^2 surface area and a depth of 1 m, lined by HDPE (high density polyethylene and constructed very close to the existing UASB) unit

4. Wastewater treatment plant situation

- 1- **Insufficient flow:** Bani Zaid Wastewater Treatment Plant was constructed in 2004, the plant was designed to yield wastewater effluents suitable for direct discharge into the wadis, or reuse in agricultural irrigation under the full capacity of the plant. Till that time few households have been connected to the system and the effluents received are not sufficient and start causing some problems in the system. The plant was designed to receive 80m^3 day, only **31 houses and one school** are connected to the system, the amount of wastewater that currently reach the plant is estimated at only **15 m^3 day**, at a rate which is not exceeding 20% of the design rate.
- 2- **Operation and maintenance:** The municipality of Western Bani Zaid which is the official body responsible for the operation and maintenance of the treatment plant faced several council changes at the time when PHG handed over the project. This resulted in the lack of follow up and created problems in the system. In addition to that, the municipality does not have a separate wastewater department, where the operation and maintenance of the plant should be followed up by a specialized technician. The technician who is responsible for the treatment plant was busy with other priorities and dedicated minimum time to the operation and maintenance activities of the plant.
- 3- **Economic Situation:** The poor economical situation of Bani Zaid citizens prevented most of them from connecting their houses to the established waste water network especially when the municipality applied a connection fee that have been calculated on the basis of $1\text{JD}/\text{m}^2$ of the built up area in addition to the operation and maintenance fees which will be paid in accordance with the amount of water used, ($1.5\text{NIS}/\text{m}^3$).
- 4- Two samples from the Inlet and two samples of the outlet were analyzed chemically. The pH, EC, TDS, TSS and TS are shown in Table 2 and DO and BOD as well as COD are shown in Table 3 and 4 respectively. The microbiological parameters of the Inlet and outlet of the station are shown in Table 5

Table 2: Hydrochemical parameters of the inlet and outlet of the WWTP in Bani Zaid

sample	PH	EC μs/L	TDS mg/L	TSS mg/L	TS mg/L
inlet 1	6.5	1440	720	736	1456
inlet 2	6.6	1460	730	730	1460
outlet1	6.9	1650	820	707	1527
outlet 2	7	1690	840	650	1490

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Table 3: DO and BOD 5 parameters of the inlet and outlet of the WWTP in Bani Zaid

sample	D .O bef 5	D .O aft 5	G - F	BOD5
inlet 1-1	6.76	0.99	5.77	360.625
inlet1- 2	6.9	1.24	5.66	353.75
inlet 2-1	7.06	1.66	5.4	337.5
inlet 2-2	6.77	1.73	5.04	315
outlet 1-1	6.64	1.93	4.71	294.375
outlet 1-2	6.72	1.31	5.41	338.125
outlet2-1	6.86	1.34	5.52	345
outlet 2 -2	7.04	1.12	5.92	370
std 1	7.2	4.34	2.86	143
std 2	7.35	4.11	3.24	162

Table4: COD parameter of the inlet and outlet of the WWTP in Bani Zaid

sample	abs	COD
inlet 1-1	0.392	653.3333
inlet1- 2	0.382	636.6667
inlet 2-1	0.375	625
inlet 2-2	0.372	620
outlet 1-1	0.389	648.3333
outlet 1-2	0.393	655
outlet2-1	0.384	640
outlet 2 -2	0.4	666.6667

Table 5: Microbiological parameters of the inlet and outlet of the WWTP in Bani Zaid

sample	TPC ufu	T C ufu	F C ufu
inlet 1	8800000	1100000	110000
inlet 2	10800000	900000	80000
outlet1	8900000	400000	70000
outlet 2	9600000	420000	60000

5. WWTP General objectives

1. Supporting the economic development and contributing to the well being of the community of Bani Zaid through the provision of sustainable sanitation system.
2. Providing alternative resources other than fresh water for irrigation purposes.
3. Protecting the environment through replacing the cesspits by sewage networks and also protecting the aquifers from pollution.
4. Developing a system that is replicable in other rural and suburban regions in Palestine.
5. Enhancing the awareness of the community and developing its capacity with respect to environmental protection, and benefits derived from a clean environment.

6. Rehabilitation Goal

Improving the operation and maintenance for Bani Zaid wastewater treatment plant.

7. Rehabilitation activities were already done :

- 1- Rehabilitate the WWTP civil works including plastering and isolation.
- 2- Fencing and Protecting the WWTP area.
- 3- Increasing the flow through installing new branch in the wastewater network.
- 4- Modifying and redesign the inlet channel.
- 5- Maintaining the gas collection system.
- 6- Maintaining the sludge drying bed.
- 7- Maintaining the distribution system.
- 8- Maintaining the constructed wetland (first basement CWL).
- 9- Installing stairs in the constructed wet lands area.
- 10- Redesign the WWTP gates.

Rehabilitation already completed and the municipality signed the agreement with PHG for guarantee the sustainability of the plant

The reuse status

As planned from the beginning the organization attempted to plant 50 Olive trees and to irrigate more than 50 old trees already exist and irrigated , however the Palestinian Authority didn't authorized the plant for reuse without finishing the rehabilitation process and rechecking the qualitative indicators , also the season to plant trees is early November , however July ministry of agriculture endorsed the guidelines and the approval from municipality has been obtained , PWA and PHG signed an agreement to scale up the plant and to expand the reuse area , the scale up tender already announced . it is very difficult from one year monitoring to conclude the impact of reuse on product.

Recommendations

The following are the main recommendations

- The treatment plant should be connected with more houses since the average consumption per household is very low 12 l/c/day (no regularity of running water 3 hours a week)
- To assess the impact on ground water Long term monitoring is needed
- The future expansion in cooperation with PWA and environmental quality authority needs to be cooperated with local farmers to convince them to reuse waste water for different crops
- The municipality staff need intensive training to maintain the plant

Annex

1. Rehabilitate the WWTP civil works.



5. Fencing and protecting the WWTP area.



3. Increasing the flow through installing new branch in the wastewater network.



4. Modifying and redesign the inlet Channel.



5. Maintaining the Gas collection system.



6. Maintaining the sludge drying bed.



7. Maintaining the distribution system.



8. Maintaining the wetland (first level).



9. Installing stairs in the wet lands area.



10. Redesign the WWTP gates.



