



**Supplementary Environmental and  
Social Assessment of North Gaza Emergency Sewage Treatment Project,  
Effluent Recovery & Reuse System and Remediation Works**

**Executive Summary**

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## 1. Introduction

This executive summary is prepared to summarize the deliverable for the Supplementary ESIA consultancy service which involves the preparation of an independent ESIA of the North Gaza Emergency Sewage Treatment Project, Effluent Recovery & Reuse System and Remediation Works.

## 2. Scope of work

The specific objectives related to environmental and social issues in the SESIA are as follow:

1. Highlight the legislations under which the project will be implemented
2. Baseline environment and socio economic conditions of the project components.
3. Identification of the possible positive and negative environmental and social impacts, permanent or temporary, of the project components.
4. Impact analysis and mitigation measures to reduce the negative impacts resulted from the project components
5. Identification of any potential temporary or permanent land acquisition requirements associated with civil works
6. Outline the vulnerable groups that might be affected by the project and identify the appropriate mitigation measures,
7. An Environmental and Social Management Plan (ESMP) to manage mitigate and monitor any possible negative impacts. Moreover, a capacity assessment of the implementing party to implement the ESMP and recommendations for any capacity-building needs
8. Identify the methods of quality assurance and monitoring system needed during the construction and operation phases.

In addition, PWA included a special task for assessing the impacts of sludge management and reuse resulting from the North Gaza Wastewater Treatment Plant.

## 3. Approach

The study was undertaken in throughout July - September 2012. The team has developed a cross-sectional study that uses a multi-data sources approach including:

### a. Site Investigation and Observation

Observation at different areas of the project components were used in order to facilitate the process of environmental baseline studies and community mapping as part of the Baseline studies.

### b. Primary data

b.1. Environmental primary data collected during the preparation of the SESIA including Field measurement for environmental baseline development, conduct groundwater modeling verification of the original design for effluent recovery scheme. In addition, conduct an independent groundwater modeling for pollution identification for the proposed scenario.

b.2. Social primary data conducted during the preparation of the ESIA is by utilizing both quantitative and qualitative tools. Following groups were interviewed:

- Focus group discussion with farmers, potential affected people and stakeholders
- In-depth interview guides with governmental organizations and NGOs
- Structured questionnaire with the wholesalers (51 individuals), consumers (696 individuals) and potential farmers who will use the recovered water (34 individuals)

#### **c. Secondary Data**

The secondary data analysis method was used to review governmental documents including reviewing the design of NGWWTP, original design of NGESTP, EA of NGESTP, Irrigation scheme of effluent recovery and reuse scheme and EA of Beit Lahia Wastewater Treatment Plant.

### **4. Applicable environmental and social legislation**

#### **Palestinian Legislations**

Palestinian Environmental Laws and other related laws and regulation as well as technical specification regarding the groundwater, waste water discharge and sludge and soil characteristics. In addition, the other laws govern the environmental and social related for environmental impact assessment were reviews as well.

#### **World Bank Safeguard Policies and Guidelines**

Among the ten safeguard policies of the WB, five are considered by the Consultant to be relevant to the NGESTP and have been taken into account during this ESIA study:

- Environmental Assessment (OP 4.01)
- Involuntary Resettlement (OP 4.12)
- Disclosure (OP 17.50)
- Natural Habitats (OP 4.04)
- Cultural Property (OPN 11.03)

#### **Regional legal frameworks concerning wastewater reuse and sludge management and reuse and other national and international standard and guidelines**

Lesson learned from regional experience (Jordan, Israel and Egypt) was assessed beside the common practice of treated wastewater reuse and sludge management and reuse; the quality standard of different countries within the region was also assessed for comparison with the Palestinian standard.

### **5. Environmental and Socioeconomic characteristics of project areas (Baseline environmental and socio economic conditions)**

#### **General Characteristic of Gaza Strip**

The Gaza Strip consists of five governorates, including a total of 33 villages and municipalities. It has a total surface area of 365 km<sup>2</sup>, a total length of 40 km and a variable width of 7-10 km. The main source of water in the Gaza Strip is the shallow aquifer that underlies the whole Strip. The population of the Gaza Strip is estimated at 1,416,543, distributed between the five governorates including refugee camps. Gaza City, which is the biggest governorate, has about 400,000 inhabitants. The two other main

Governorates are Khan Younis (population 200,000) in central Gaza, and Rafah (population 150,000) in the South. The majority of people live in refugee camps.

### **Environmental Baseline Condition of the project components**

#### **a. Overview of the project components**

##### *Beit Lahia Wastewater Treatment Plant (BLWWTP) and Effluent Lake*

- BLWWTP is located some 1.5 km east of the town centre of the Beit Lahia in the Northern part of Gaza Strip and it was constructed in 1976.
- The BLWWTP was built in sand dunes overlying a clay layer of variable thickness with impermeable clay layer is not continuous. BLWWTP was constructed in stages and modification and rehabilitation activities were performed in order to increase capacity of the plant.
- During the past few years the situation escalated. Many communities were provided with sewage networks and were connected to the BLWWTP. Consequently, the volume of wastewater inflow has far exceeded the plant's treatment capacity that have led to deterioration of the effluent quality and have led to clogging effects in the neighboring sand dune areas. The ongoing decrease of the infiltration capacity of the flooded areas and the increasing wastewater volumes have resulted in the formation of enduring ponds and finally a lake.
- Over the years the effluent lake has a volume of about 2 million cubic meters of foul wastewater, which covers around 300 dunums. The water level has continued to rise, and was threatening to flood the whole sewage collection system and the neighboring communities.
- Starting in 2007, when NGEWTP was starting to be implemented, almost 90% of the effluent lake had been dried due to weathering and limited discharge to the lake. Currently the wet area occupies around 10% of the total lake.

##### *Agriculture Land Proposed for irrigation / Sludge use*

- The area in the vicinity of NGWWTP is assigned designated to benefit from the recovery water and the treated sewage sludge in the agricultural activities.
- The proposed area is divided into two zones according to its location from NGWWTP. Zone A (northern part of NGWWTP) with about 10,100 dunum whereas, Zone B (southern part of NGWWTP) with about 5,000 dunum. Most of the area is considered as under rain-fed conditions.
- Citrus, Olives, fruits and vegetables are among the crops grown in the proposed agriculture land for reuse scheme.

#### **b. Physical Environment**

- The Gaza Strip is located in a transitional zone between the temperate Mediterranean climate to the West and North and the arid desert climate of the Negev and Sinai deserts to the East and South. There are two well defined seasons: the wet season (October to April), and the dry season (May to September).
- The project sites have a typical semi arid Mediterranean climate with long hot summer and dry. The proximity of the Mediterranean Sea has a moderating effect on temperatures and promotes high humidity throughout the year. The average daily temperature ranges from 25°C in summer and 13°C in winter with maximum daily temperature can reach 29-30°C and the minimum temperature is around 9°C. The

prevailing wind direction is SW with an average speed of 4.2 m/s in winter and from NW during summer.

- The irrigation scheme was done with taking into account the climate change through the mentioned 10 years by increase the air temperature of 1.5°C / year.
- The average annual evaporation rate is around 1900 mm/y (5.2 mm/day). The maximum evaporation rate increases during the summer and may reach over 6 mm/day between June and August.
- Ambient air and noise quality at the project sites are consider normal with a slightly high on BLWWTP due to more rapid population surrounding the area.
- The dominate soil type in the irrigation area can be considered as heavy soil with a deep soil profile, which means will not limit root penetration for deep rooted crops.
- The soil at different locations of the effluent lake has a normal range of pH, Organic Matter (OM) content, with negative and low Faecal Coliform present in the soil. In addition, the Electrical Conductivity (EC) at the wet part indicates the higher number due to remaining heavy metal from the stabilized sludge that is present in the top layers of the effluent lake.
- No major fault type formations have been observed in Gaza Strip area.

### c. Biological Environment

- Mainly aquatic birds and the reptiles are present at the BLWWTP and the Effluent Lake. The effluent lake provides breeding, nesting, roosting and feeding habitats for different birds' species.
- Rats, snake crows barn owl and other wild species were and still common vertebrate pets in North Gaza particularly at BLWWTP area.
- The typical landscape of the effluent lake consists of sand dunes covered with Acacia shrubs.
- In the proposed agriculture land for effluent recovery reuse, many Olive, Plum, Almond, Citrus or orchards have been encountered at agriculture land allocated for irrigation of water distribution network of recovery water and sludge reuse. Many wildlife species; particularly birds were found to inhabit these agro-ecosystems.

### d. Groundwater quality of the project components

- The water quality in this study focused on chloride and nitrate concentrations since these are the most important contamination indicators in the groundwater in the Northern Gaza aquifer.
- The highest chloride sources are expected in the areas affected by seawater intrusion and the deeper groundwater layer (generally exceed 250 mg/l). The seawater intrusion zone covers the western part with 2 to 3 km inland the aquifer. Most of the municipal wells were concentrated in this zone and due the high pumping rate of these wells resulted in accelerating the seawater intrusion.
- NO<sub>3</sub> concentration exceeds the WHO drinking water guidelines in most of the Northern Gaza aquifer. In 2003 at the infiltration site, the maximum nitrate concentration in the groundwater was about 30 mg/l due to the operation of the infiltration basin using partially treated wastewater.
- Cl concentration in the wells close to the infiltration basin ranges between 350 to 650 mg/l in the wells surrounding the infiltration basins, up to the middle of 2012. The

trend of the chloride concentration seems to be steady since 2011 in some wells. In addition, Nitrate concentration for the same period ranges between 20 to 120mg/l.

- From the analysis it found that the groundwater is free of Salmonella, Nematodes and Amoeba & Gardia. However, the total Bacteria ranges between 30 to 395 cfu/ml and the total coliform ranges between 6 to 50 cfu /100 ml.
- The heavy metals concentrations in all analyzed wells were less than the Palestinian standard values for irrigation. However, there are some wells that have concentrations of Boron and Mercury higher than the standard values.
- The groundwater quality is improving after drying the lake.

### **Social Baseline Condition of the project components**

#### **a. Demographic characteristics**

- The population growth in Gaza is high and was increase during the last five years.
- The community has the potential for rapid, continuous growth. Taking into consideration that two thirds of the population is under 25 years old.
- The total fertility rate in the Palestinian Territories has declined with 4.6 births per thousand in 2007 compared to 6.0 births in 1997.

#### **b. Living conditions**

- There is generally a high tendency for large family sizes that exceed seven persons. Regarding the type of dwelling, it is notified that the majority of the population (in the Gaza Strip live in a house followed by larger residential buildings.
- Connectivity to the public water system was around 88% in 2008 and 2009. Almost all households are connected to the public electricity network. 52.1% of households have access to the public sewage network and 42.2% of the total households is serves the telephone line.

#### **c. Human Development Profile**

- The literacy level is generally high in the Gaza Strip, reaching almost 95% of the population above 15 years of age. Gender discrepancy is not significant, except in the groups above 45 years of age. The largest portion of literate population attained preparatory education 36.0%, followed by the secondary education certificate 25.0%.
- The general unemployment rate is considered high, at 24.5% of the labor force.
- Real GDP per capita is close to 30 % below 1999 levels. The overall economic picture is one of negative growth. The majority of employees work in services (63.3%). The diversity according to gender is relatively high.

#### **d. Wastewater network and disposal**

One of the main sources of wastewater is disposal from the public sewage network, which might reach 60.9% in the urban. However, the connectivity among those who live in rural areas is 10.3%. The highest connectivity rate reported was in the camps 90.9%.

**e. Archeological status in the project sites**

Field surveys in the area of the BLWWTP did not identify any archaeological sites. The nearest archaeological remains in the area is Tell al-Khirb, situated in the eastern part of Beit Lahya, 500 m south of the WWTP.

**6. Potential Impacts and Analysis****a. Potential impact and their enhancements**

The aim of the effluent recovery scheme of NGESIP is to achieve environmental and social improvements in the project areas through providing sustainable and safe reuse of recovery water and sludge to areas which were previously deprived of these services. The positive impacts of the project are:

1. The recovered effluent from the groundwater will be an important source of irrigation water, as water resources in the Gaza Strip are scarce.
2. The groundwater quality is suitable for Unrestricted Use. The only restriction is for the Total-N, which is higher than 15 mg/l. This could be considered as an advantage for agricultural use.
3. The recovery will limit the horizontal dispersion and the vertical building up of the water table, which without recovery will have a negative impact on current land use.
4. Sludge has a high content of organic matter that can help conserving soil organic matter, and sludge stimulates biological activity in the soil.
5. The fertilizer effect of sludge enables a reduction in cost for nitrogen and phosphorus mineral fertilizers and may improve crops yield on sludge treated at low costs. Moreover, the sludge will be reliably available compared to imported fertilizers which are subjected to import difficulties due to the political instability and the imposed blockade on Gaza.
6. It is environmentally the best solution compared to disposal inland fills or incineration plants.
7. The groundwater quality after drying the lake is improving.
8. In addition, reduction of health risks associated with exposure of villagers or inhabitant surrounding the effluent lake and BLWWTP to environmental risks and nuisance released from the BLWWTP, such as effluent lake flooding and the risk of water borne disease, will be seen.
9. Solving the problem of water scarcity especially during summer time, as a source of water will be continuously available
10. Solving the problem of the disposal of wastewater, as it will be treated and injected for agricultural use,
11. The provision of good quality water will reduce the cost of water needed for irrigation in the area. The utilization of the recovered water of high quality and of less price might work for the benefit of the farmers, increasing their profits
12. Sludge is one of the outputs of the project, and will increase the income for those who work in sludge trading, Sludge reuse will work for reduction of chemical fertilizers that affect the health of people.
13. The new lands gained due to the decommissioning of BLWWTP will be used in agriculture activities or as a recreational or residential place.

14. Potential increase of the price of lands and dwellings due to the implementation of the project,
15. Provision of jobs due to the implementation of the project components,
16. Protect the livelihood status of people who suffered due to the flooding of BLWWTP,
17. Reduction of the odour, mosquitoes and flies resulted from BLWWTP.
18. As soon as the completed WWTP starts its operation in 2013 the infiltration of a high quality effluent in the infiltration ponds will begin to compensate the negative effects on groundwater
19. The construction of the site and the carrier line will improve the road network connecting the existing and the emergency area.

### **b. Negative environmental impact and their mitigations**

#### **During Construction Phase**

##### **1. Air Quality and Noise Pollution (low impact and temporary)**

No mitigation measured is developed.

##### **2. Gaseous Emissions (low impact and temporary)**

No mitigation measured is developed.

##### **3. Noise (low impact and temporary)**

The generation of noise is not expected to represent a significant issue to local residents.

However, there is a significant impact on the workers. The main impact on workers should be mitigated by providing noise protection equipment for the workers operation equipment that generates noise, especially the equipment that generates noise levels greater than 80 dBA. The protective earmuffs should be use especially for the workers who work continuously for 8 hours near heavy equipment.

##### **4. Vibration (low to medium impact and temporary for the water distribution networks and low impact and temporary for other project components)**

The closest sensitive structure to the site is the El Shuhada cemetery (around 10 m away from where the water distribution network will be laid.

The mitigation measures proposed during the construction of water distribution network component, near the El Shuhada area are as follow:

- The base camp and the place for storage of the equipment have to be on the future land dedicated for the booster pumps and the storage tanks.
- The construction of the storage tank and the booster pumps room including the generators and the electrical rooms have to be separated and not overlapped. The time management plan of separation works has to be prepared.
- The ready mix concrete is preferred to be used instead of onsite concrete mix. In addition, the ready mix concrete mix tanker with pump will be advantageous.

##### **5. Construction Waste and Handling of Hazardous Waste (low to medium impacts)**

The following mitigation measures are proposed:

- a. Onsite domestic sewage collection and disposal shall be provided by the contractor for construction workers needs.

- b. Site waste management plan should be developed by the contractor prior to commencement of construction works. This should include the designation of areas to store different type of wastes, collection and removal schedule in addition to the provision of onsite conventional wastewater treatment.
- c. The burning of any type of wastes should be avoided.
- d. The reused clay or excavated sand should be stockpile and stored away from any waterway, drainage networks, existing wastewater networks and any other drainage patterns.
- e. Nearby sanitary landfill should be notified to receive the unusable construction wastes or damaged construction materials.

#### 6. Soil Contamination during Decommissioning of BLWWTP (medium impacts)

Mitigation measures proposed are as follows:

- a. Preventive maintenance for any vehicle or equipment that has an engine that leak oil or fuel
- b. Prepare special fuelling and oil change station on site to contain any possible fuel or engine oil spill. Otherwise fuelling and oil change should be conduct in the private oil stations out of site.
- c. If any machine is broken on site, a containment system should be used to prevent the spill of oil or fuel on the soil.
- d. The vehicle moving in and out of site should be checked at the inlet gates of BLWWTP to assure that no importing pollutants through the wheels.

#### 7. Remediation Works at the Effluent Lake

A special and well developed tool is used to identify the best remediation option. It is recommended to use “Phytoremediation” as the best technique to remove the residual Cadmium from the soil. This option is recommended because it is well developed, cost is relatively less than other possible options, and the expertise is readily available in the region.

The mitigation measures during the “Phytoremediation” activities are:

1. Selection of the plants in coordination between PWA and MoA based on the Consultant recommendation.
2. Plant has to be harvested maximum in a year period.
3. The water that will be used irrigate the plants must be checked periodically (every 2-3 months) for pH which should be neutral or slightly alkaline to avoid adsorption and travelling of Cd to the groundwater.
4. The harvested plant has to be disposed at the landfill (it is not advisable for animal fodder). The coordination between PWA and the NJCS has to be established.

#### 8. Changes in Hydrology and Groundwater Quantity and Quality (low impact)

During the construction of the recovery scheme and decommissioning of BLWWTP there will be no impact on groundwater. Therefore, there will be no mitigation measures.

#### 9. Health and Safety (low to medium impacts)

During the construction phase, as the proposed project is at a large distance from the nearest population or residential area and on the agriculture land, the health of the population is not expected to be significant. However, there is always risk of injury to the workers.

As a mitigation measure, safety measures should be put into consideration and addressed with the workers. The contractor and the PMU are mainly responsible for any safety procedures to be applied

#### 10. Archaeological Disturbance (low impact)

Field surveys in the area of the BLWWTP did not identify any archaeological sites. The chance find procedure should outline the chain of events put in motion if previously unknown heritage resources, particularly archaeological resources, are encountered during the project's construction phase. The procedure should include provisions for:

- Record keeping
- Expert verification procedures
- Chain of custody instructions for movable finds
- Clear criteria for potential temporary work stoppages that could be required for rapid disposition of issues related to the finds.

#### 11. Ecological Disturbance (medium impacts)

The biodiversity disturbance of the site due to the removal and cleaning of the site will be compensated with the long term positive impact. There is an opportunity that the water distribution network will be laid in agricultural land, and impose on the crops and animals around the site.

Mitigation measures develop to avoid the crop and animal disturbances in the vicinity are as follow:

- a. Fences have to be installed prior to the construction of the water networks and other components for recovery water distribution.
- b. In case the destruction of the crops or plants at the farms near the construction of the recovery water distribution network, compensation has to be settled.
- c. Strictly standard procedure for health and safety of the workers, especially for the worker at the wetland site, should be observed.
- d. Equipment to handle the vertebrates has to be prepared.
- e. The fauna found to be dangerous must be isolated and handled with care.

#### 12. Land Use and Accessibility (medium impacts)

The main impact on roads traffic will be during possible lying of water distribution networks. Excavation on village roads will cause impact to vehicles traffic, as most of village roads are mainly used for pedestrian and field animal traffic.

Mitigation measures proposed are as follow:

- a. Selection of suitable location for temporary storage of construction materials, equipment, tools and machinery prior to starting construction, especially on the site that is close to El Shuhada cemetery.
- b. The employed machinery drivers should receive training on safe utilization of their machines to minimize accidents risks.

- c. Clear signs indicating the project site and fences shall be installed prior to the preparation of the site, especially the water distribution networks area.
- d. All the activities have to be during the daytime and have to be scheduled to avoid conjunction with the school and working peak hours.
- e. The traffic authority should be informed and involved to manage the traffic during the congested time. In addition, the preferred route and an alternative road have to be recommended by the traffic authority.
- f. Temporary resettlement that might occur during the preparation and the construction phase has to be defined and accordingly has to be prepared and compensated.

### During Operation Phase

#### 1. Air Emissions and Noise Pollution (low to medium impacts)

The impact of such air emissions are considered minor, because the diesel generators are only expected to operate temporarily during power cut-offs. The compliance of generator emissions with Palestinian Standard for Ambient Air will be sufficient to safeguard against unacceptable air emissions impacts to the neighbouring areas.

A relatively higher impact will be on the Pumping Station staff, which may be exposed to intermittent pumping noise. The standard protection of the workers, including earmuffs, has to be practiced all the time, especially at the Pumping Station area.

#### 2. Odour

The operation of the water distribution network system is not expected to have significant impacts from odour. However, due to the remaining Pond #7 that will be used as the emergency sewage pond, the operation of anaerobic ponds will have significant impact associated with generation of odours and vectors that mostly generated from raw sewage storage.

The mitigation measures proposed for Pond #7 to reduce mainly H<sub>2</sub>S generated from the untreated storage raw sewage is as follow:

1. Maintaining high performance of biological treatment of wastewater. Other means of mitigation is to be as far as possible from odour recipients, and keeping buffer zones between odorous units and neighbours.
2. As the Pond #7 will not have a treatment process, the aerator from the aeration tank can be installed on the pond to maintain reasonable dissolved oxygen in the water to avoid anaerobic conditions.
3. There is an odour scrubber unit nearby the pumping station at BLWWTP. The additional pipeline is suggested to extract the odour release from the sewage to be treated at the scrubber unit.

#### 3. Vibration

Although the pumps and the generator will be installed in the room, but special attention has to be made to reduce the vibration impact at the pumping station and the generator to minimize the impact due to the close distance with the El Shuhada cemetery.

The mitigation measures to be developed to minimize the vibration impacts of the machines are:

1. Tree plantation, heavy leaf trees to absorb the vibration and noise generated, is recommended to be planted at the cemetery area along the proposed main road at the other side of the pumping station.
2. Maintenance of the machines and equipment has to be maximized and if it is required less than the standard period required for maintenance and spare parts changes.

#### 4. Water Resource Contamination

The impacts on groundwater is one of the most important issues that is being associated with the project, as part of the project has been designed to prevent impacts on the groundwater from infiltrating partially treated sewage.

The groundwater monitoring programme is the key mitigation measures to indicate the water resource contamination. The groundwater monitoring programme will be explained in detail on the following section, Environmental and Social Management Plan (ESMP).

#### 5. Impacts on Local Agriculture, Public Health and Water Resources

Based on the design project report three scenarios that considered the expected water quality were recommended as follows:

- Scenario I: In this Scenario it is more advisable to cultivate orchards on the available area to the west of the project along Al Karama Road. Based on crops water requirements, the available reclaimed water (16,500 m<sup>3</sup> daily) is just enough to irrigate 5375 dunum divided into citrus, olives, fruit trees, alfalfa and grains. The expected quality of recovered water is suitable and has no impact on the crops selected under this scenario.
- Scenario II: In the wastewater will be treated more effectively and consequently the effluent will be of better quality in general. The quantity of effluent diverted to the infiltration basin will increase to approximately 23,100 m<sup>3</sup> daily. This reclaimed water will be used to irrigate additional land amounting to 7525 dunum in total.
- Scenario III: This Scenario assumes that the planned WWTP in East Jabalia will work with its full capacity by year 2025. The quality of reclaimed water (39,160 m<sup>3</sup>/day which equals 35,600 plus 10% extra) is expected for unrestricted use. The quantity of reclaimed water will be enough to irrigate about 12,577 dunum. In this scenario vegetable crops will be introduced with an area of 1258 dunum, as it is difficult to convince the farmers to accept the recovered water for cultivation of vegetables at the beginning of the project.

#### 6. Impacts of decommissioning of BLWWTP on Groundwater Quality (positive impacts)

After decommissioning the lake and BWWTP, a positive impact will be clearly found on the groundwater quality in the aquifer under the lake.

#### 7. Recovery Water Quantity and Quality (medium impacts)

Based on the groundwater modeling and analyses, the expected recovery water quantity and quality is expected to be acceptable for agricultural irrigation for unrestricted crops, but unacceptable to be used for drinking water. Besides continuous groundwater monitoring, public awareness is needed to ensure that the community is not using the recovery water as a drinking water.

8. Land Use of Effluent Lake Remediate and Decommission of Beit Lahia Wastewater Treatment Plant (medium impacts)

After the soil remediation by phytoremediation, the remediate effluent lake can be used for agriculture purposes or residential area, depending on the Urban Planning of the area.

At a nearby location, a new landfill will be built to replace the existing landfill (Johr Eldeek site). The excavation of the landfill will generate a huge volume of soil. The first investigation indicated that the soil is of good quality. Therefore, the good excavated soil can be transported for filling the site and used for agricultural purposes or residential area.

Similar to the future land use of the effluent lake, the option to transport the soil from the closest landfill (Johr El Deek) is feasible. In addition, due to the remain pond # 7, the mitigation measures has to be develop to minimize the impacts due to the operation of pond # 7.

Mitigation measures develop to reduce the impacts are:

- a. Fences surrounding pond # 7 has to be constructed to reduce the accessibility of the community to the pond area.
- b. There should be between 10-15 m distance between the pond area and the fences to be constructed.
- c. The trees shall be planted nearby the fences, beside to reduce the odour or nuisance and separate the pond site with the surrounding neighbouring area and future land use of the other decommissioning ponds, also, to bring positive impact on the visual impact.
- d. The site is only connected to one main gate and access road, to be connected with the pumping station at the vicinity.

9. Public Health related to Using Recovery Water for Irrigation (medium impacts)

Health protection measures which can be applied to the agricultural use are:

- Crop restriction
- Human exposure control and promotion of hygiene
- Treatment of drainage water

Adopting crop restriction as a means of health protection in reuse schemes will require a strong institutional framework and the capacity to monitor and control compliance with regulations and to enforce them. Farmers must be advised why such crop restriction is necessary and be assisted in developing a balanced mix of crops so that production of surplus of a specific crop is avoided.

Control measures aimed at protecting agricultural field workers and crop handlers include:

- The provision (and insistence on the wearing) of protective clothing, the maintenance of high levels of hygiene and immunization against (or chemotherapeutic control) selected infections.
- Risks to consumers can be reduced through cooking the agricultural products before consumption and by high standards of food hygiene, which should be emphasized in the health education associated with irrigation schemes.



As the expected contaminant sludge will not be expected to be in a huge amount to be transported to the landfill, the impact is considered medium. As the capacity is considered small (only around maximum of 1-2% of the sludge generated) the agreement shall be reached only between PMU (as the responsible entity for sludge monitoring at the NGESTP) and the landfill management (Joint Council Committee).

### **Negative Socio Economic Impacts and Their mitigations**

1. Decommission of the BLWWTP will reduce water that some of the farmers relied upon to water their plants. Indicating that their income might be affected that will be mitigated through: i) Provision of recovered water of a competitive price to minimize the potential impacts. ii) Due to the fact that the sewage untreated water should be banned, the legislators should develop appropriate laws that criminalize the use of untreated water
2. Potential risk for the people in the adjacent areas due to having no fence around Pond 7 that might affect children. Mitigation measures will be through constructing a fence
3. The use of lands might be limited due to the pond 7 as having recreational activities, especially in case of not having a fence that surrounds the pond. In addition, The construction of residential compounds in decommissioned area will be limited due to the existence of the pond. Again the fence will be the most appropriate mitigation.
4. The construction of the carrier pipe will have some negative impact due to noise and obstruction of traffic and use of agricultural land during the construction stages. In order to apply mitigations. The project should try to reduce the disturbance to community using most appropriate environmental mitigation measures. In addition to information sharing
5. Due to the unfavourable odour, mosquitoes and flies might affect the health of the adjacent communities. The flies should be combated using hygienic and environmentally friendly procedures.
6. The use of the sludge as fertilizer might affect those who work in the chemical fertilizers sector in Gaza Strip, especially, those who import fertilizers from abroad. Integrating labourers in the new market might be an appropriate mitigation measure.
7. Negative impact on the livelihood status of those who operate wells. Potential loss of income for those who own and operate the wells that will be closed due to project implementation. The labourers and the well owners might be affected severely. Provision of appropriate compensation i.e jobs or monetary.
8. Put limitation to the plantation of certain crops in the beneficiaries who will use the recovered water. Orientation sessions should be presented to raise farmers awareness regarding the type of crops that should be planted using recovered water
9. During the construction of the infiltration ponds there was temporary and minor local nuisance for visitors of the cemetery caused by exhaust fumes from

transport vehicles moving to and from the construction site. This should be mitigated by reducing odour.

10. Expropriation for the areas of lands needed to construct the recovery well and lands needed for the project. The 27 well and the expansion of the treatment plant need about 18,175 m<sup>2</sup>. Protective procedures should be applied to limit the resettlements. Avoiding small plots in order not to raise poverty. Compensation should be paid in a full market price. It is recommended to develop a Resettlement Policy Framework and a Resettlement Action Plan in order to apply land acquisition with the least disturbance to the community and to be adherent with the WB regulations.

## 7. Potential affected parties

- 1- **The operators of wells** who are uneducated, untrained might suffer due the termination of wells. They are maximum 10 people, therefore, the magnitude of their vulnerability might be mitigated
- 2- **The owners of wells** who might be terminated will be badly affected due to losing a valuable asset (the well) As well as, being in critical need for alternative source of water which will cost a lot. In addition, some of them used to gain his income through selling water which will not be available indicating that his income will be badly affected
- 3- **Those who rent lands from *Awkaf*** for a few amount of money that includes the cost of water. They will be affected in sense of losing their lands and paying for water.
- 4- **The owners of small plots of lands** who will be expropriated during the construction of the 27 wells. Some of them have small plot of lands that don't exceed one dunum. The wells will pass in the middle of such plots of lands. They will not be able to make use of their lands.

## 8. Perception and willingness results

- 1- High acceptance for using recovered water and sludge among different farmers. While those who own private wells are not much in favour of using such water.
- 2- Sludge is widely accepted due to no health problems and being more fertile for the plants
- 3- Consumers pay no attention to water used or type of fertilizers as the end result is a product of a good quality with appropriate pricing
- 4- The supermarkets are more reluctant to use such products as the typical consumer is of a higher socio-economic status and pays more attention to healthy products. As well, the supermarkets pay more attention to their own reputation.
- 5- The community is willing to use both recovered water and the sludge due to many rational reasons. The main reluctance reported was due to health problems
- 6- The farmers were willing to use recovered water at an appropriate price. While the affected owners of wells reported that water should be provided to them free of charge as part of the compensation
- 7- The multi-phases of sludge pricing and water tariff is the best mechanism to merchandize recovered water and sludge

- 8-The appropriate pricing for the cubic water meter varies between 0.5-0.7 shekel. While the acceptable cost for sludge is 100 shekel annually. However, there should be additional studies (such as a Market Analysis Study) to develop the appropriate techniques to trade in sludge and reused water

## 9. Institutional framework

### A. Proposed institutional frame for wastewater collection

The consultant examined various options to propose the institutional needs to tackle the responsibilities of the wastewater collection process. Options were considered at various levels, described as follows:

- **The policy making level:** The Cabinet will be responsible for developing all policies related to wastewater collection
- **The legal level:** As the National Water Council is the main regulatory department for water related issues, it is recommended to develop the regulation framework guided by the needs raised by the Palestinian Water Authority.
- **Operational level:** It was proposed that the Coastal Municipalities of Water Utilities (CMWU) should be the sole institute responsible for the collection of wastewater as they are now the responsible entity for sewage related activities.
- **Monitoring level:** Two levels of monitoring were proposed. Internal monitoring should be implemented by the CMWU monitoring department. External monitoring should be done by the Ministry of Environmental Affairs for environmental related standards and parameters, and by the PWA for operational monitoring.

### B. Proposed institutional frame for water and sludge distribution

- **The policy making level:** The Cabinet in cooperation with the juridical department
- **The legal level:** The National Water Council will be the key player to determine the needed legislations and regulatory framework for recovered water distribution. Potential support from the Juridical Department to provide legal guidance to enhance the proposed Laws.
- **Operational level:** The first unsupported option is the involvement of the PWA in the operational process.
  1. Create a new utility named “Wastewater Distribution Utility” to take care of the recovery water. Not supported due to the cost.
  2. Public Private Partnership (PPP). The private sector is not ready to play significant role to manage this scheme. However, private sector firms could work in cooperation with the CMWU.
  3. Coastal Municipalities of Water Utility (CMWU): The CMWU is mandated as “Operator” of the water and wastewater systems in Gaza Strip. The consultant highly recommends this option .
  4. Finally the consultant proposes a multi-entity body which consists of a steering committee from PWA, CMWU, PPP, and MoF. The steering committee will

consist of representative from each entity, and the body will be named the “Recovered Water Utility”

5. **Monitoring level:** Different levels of Monitoring should be applied according to the tasks performed. i.e. Ministry of Finance will do the financial auditing, The MENA will do environmental inspections...etc

### C. Proposed institutional frame for water distribution

- **The policy making level:** the Cabinet
- **The legal level:** The Ministry of Agriculture is the potential entity to develop the sludge related legal framework, as they are fully aware of sludge, hazards of using sludge, and potential treatment for the sludge.
- **Operational level:** Running the project under the Ministry of Agriculture will raise a conflict of interest between regulation and operational responsibilities. Then the body allocated for recovered water should handle the sludge as well.
- **Monitoring level:** Internal self-monitoring monitoring will be the responsibility of a representative from each institution. It is essential that external monitoring be done by inspection from MENA and MoH, in addition to Palestinian Society for Consumer Protection.

The discussion of the legal framework drew the attention to the importance of having the following legislation:

- 1-The most important law should cover the financial implications (water collection and recovered water tariff).
- 2-The second main regulation needed is one that tackles sludge collection, treatment, or dumping and sludge management.
- 3-Identifying the responsibilities of different entities in each legislation is crucial in order to warrant the commitment of different institutions and their dedication to the project according to the articles of Laws.
- 4- A detailed Law that criminalizes the usage of untreated water should be set in force in order to put limitations on unorganized usage of water

### 10. Environmental and Social Management plan

Environmental and Social Management Plan was developed to reduce or eliminate or reduce the negative impacts of the project component. This plan was developed for each project component during construction and operation phase to reduce the impact associated to Environmental and Social aspects. The detailed plan was presented in the main SESIA report.

As an important part of the social management plan, all grievances received verbally or in written shall be documented in a grievance register, handled by the PMU in PWA. It is of importance to react as quickly as possible to the grievance of the citizens. A best practice standard is to acknowledge all complaints within 10 days. Due to the different character of the complaints, some of them cannot be resolved immediately. In this case medium or long-term corrective actions are required, which need a formal procedure recommended to be implemented within 30 days:

- 1.The petitioner has to be informed of the proposed corrective measure.

2. In case if a corrective action is not required, the petitioner has also to be informed accordingly.
3. Implementation of the corrective measure and its follow up has to be communicated to the complainant and recorded in the grievance register

## 11. Environmental and Social Monitoring Plan

### Groundwater Monitoring Plan

#### Monitoring Wells Locations

The first monitoring well row should be located before the first row of recovery wells in the direction infiltration basin, and the second row of the monitoring wells should be located after the second row of the recovery wells, to check the quality of groundwater outside the recovery wells areas. The monitoring network will also use the existing 5 monitoring wells constructed recently by PWA and used to monitor the infiltration basin.

#### Parameters to be Monitored

The main objective of monitoring is to check the groundwater quality after infiltration and check the operation of the Soil Aquifer Treatment process.

### Sludge Monitoring Plan

#### Sludge Quality Monitoring

Required monitoring includes:

1. Monitoring of sewage sludge for 10 heavy metals (As, Cd, Cr, Hg, Mo, Ni, Se, and Zn)
2. Monitoring to determine pathogen concentrations (Fecal coliforms, Salmonella, Viable nematode eggs, Intestinal viruses)
3. Monitoring to ensure that conditions for vector attraction reduction (VAR) are maintained. Five samples of sewage sludge are analyzed for volatile solids content over a period of two weeks.

#### Monitoring frequency

Minimum frequency of monitoring for heavy metals, pathogen requirement and vector attraction depends on the amount of sewage sludge used or disposed annually. Five samples of sewage sludge should be analyzed for volatile solids content over a period of two weeks to guarantee that the minimum reduction volatile solids are 38%.

#### Sludge sampling location

Sampling locations should be as close as possible to the stage before final land application. In the NGWWTP, the sewage sludge should be sampled at the storage area from the sludge that has completed the 100 days storage period. For the sample to be representative, it should be a composite of samples from many locations within the storage area and at different depths.

### Emergency Response Plan (ERP) for Operation of Pond # 7

The expected emergency situation that may be encountered under the scope of this study is related to the sudden failure of pond # 7, as it will be used as an overflow pond for the north central pumping station after the decommissioning of the BLWWTP.

### Risks to the treatment plant structures and its operation (NGWWTP)

1. Power failure may occur during the operation of the NGWWTP. In case of complete power failure, no sludge (nor water) will be produced in or out of the treatment plant.
2. Partial power failure may occur when the main power supply is cut and the treatment plant can use the gas storage available in the gas holder. The sludge quality during the partial power failure will not be affected since the treatment plant will be operating at its normal conditions in terms of treatment processes.
3. Another option that may be adapted during partial power failure is reducing the air supply to the oxidation ditches (by 50% for example). This option will give the opportunity of increasing the time of the treatment plant operation.
4. In all cases, the sludge quality following the power shortage should be carefully monitored and to dispose it to landfill in case it does not meet the standards of sludge use for agriculture.

### **PUBLIC HEALTH RELATED MONITORING PLAN FOR USING RECOVERY WATER (TREATED WASTEWATER)**

#### Irrigation Water

All parameters presented in the SESIA report should be measured twice a year, during the minimum and maximum flows in February & August respectively (from the existing sampling sites in the pilot area).

#### Soil

The parameters should be measured in the soil once a year: Arsenic, Cadmium, Chromium, Lead, Nickel, Copper, Zinc, Atrazine

#### Crops

The parameters should be measured in crops at the harvesting period: Arsenic, Cadmium, Chromium, Lead, Nickel, Copper, Zinc, Atrazine

### **Social Monitoring Guidelines**

It was notable that the main activities that should be monitored are those related to expropriation of lands and valuation of assets and lands. Moreover, the grievances should be also highlighted and reported. This monitoring process necessitates some forms in order to be able to process the management and monitoring system appropriately:

The results of the monitoring and management system should be reported quarterly to the Headquarter of PWA. The monitoring and management will be implemented by the Project Management Unit.

In order to achieve this monitoring system the following personnel are needed are (1) The Compensation Committee is responsible for the valuation of the compensation, and should be assessed by the governorates during the process of compensation. And (2) Social officer should be hired in order to do the following tasks as part of the monitoring system

## **12. Required Human Resources and Training**

PMU-EM and SDO will be recruited on full time basis for the project. It is recommended to nominate staff from PWA from the existing training staff members from Environmental sector with background of monitoring and laboratory experience,

while the SDO is trained in socio-economic issues, with a strong background in involuntary resettlement and public awareness campaigns. Site supervision is also needed. For back to back activities, it is recommended to have 2 staff under supervision. In addition, site supervision will help in documentation and recording during the project phases.

After completion of the construction phase, another staff will need for follow up operation and maintenance including recording and documentation for the effluent recovery system. For the operation of the effluent lake, after complete removal of residual contaminant from the soil, the land will be returned back to El Awqaf for future use, and the remaining pond will be similar to the existing set up.

### **13.ESMP Budget**

For distinguishing the ESMP budget from other cost items needed to implement the project, it has been assumed that all the measures are included in the project budget. It is worth nothing that it has been assumed that NGWWTP will have an equipment laboratory to carry out wastewater analysis and sludge analysis. In addition, as the design of the treatment plant has a odor treatment, the air emission monitoring acvities especially for H2S recommended in the ESMP part as a part of the project budget.

### **14.Public Consultations**

The project is characterized by the importance and considerable weight given to socio-economic dimensions. The SESIA, thus, was produced in a highly participatory manner that managed to fully engage stakeholders groups. The SESIA is particularly sensitive to the interests of the primarily affected vulnerable groups like land owners and farmers who will be restricted from access to their source of livelihoods, using the effluent recovery for reuse in their agricultural land and the local population near the project sites.