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Establishing Gabès wastewater treatment plants

Location:
Gabès

Company:
ONAS

Mission:
Establishing Gabès wastewater treatment plants

Cost:
TND 175 million

General presentation

The region of Grand Gabès currently has about 190,000 inhabitants. It is equipped with a sewerage network that covers 90% of the region, and a wastewater treatment plant (WWTP) with a capacity of 17,800 m3 / d) built since 1995 and which no longer meets the technical, social and environmental requirements and also to the urban and economic growth of the governorate.

The Government of Tunisia currently is aiming to improve the quality of the sanitation service and the living environment of the citizens in addition to protection of the environment in the region of Grand Gabés.

That require the setting up of a new treatment system, based on two wastewater treatment plants separated by the diversion channel of the wadi of Gabès (south plant and north plant) and this, in accordance with the recommendations of the master plan of the governorate of Gabès developed in 2017. The estimated costs of the project is TND 175 million

Accordingly, adding new treatment capacity and improving treatment efficiency are considered the main two objectives of this project in order to utilize and reuse the treated wastewater. Moreover, that could help to significantly reduce gap in water demand in this area specially for agriculture purposes.

In order to enhance the current situation and improve treatment efficiency, we shall have a deep understanding of the current situation and current treatment scheme. Therefore, we will provide in the next section a comprehensive description for the existing WWTP at Gabès.

Current situation of the Gabès existing WWTP

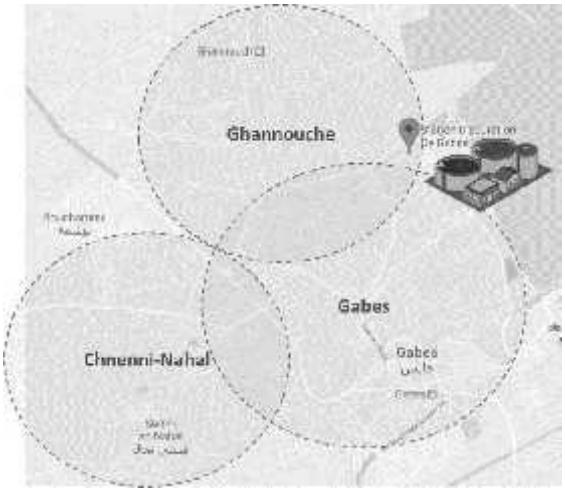
The Gabès City Wastewater Treatment Plant currently receives 20,000 m3/d of municipal wastewater from Gabès City. Under normal circumstances, sludge would be removed regularly; however, following the Tunisian revolution of 2010-2011, the treatment plant did not receive this routine maintenance, and the treatment efficiency has decreased as a result. During the revolution, the laboratory and some of the equipment at the facility were vandalized, and historical records were destroyed by fire.

Despite these challenges, the facility continues to operate, and a portion of the effluent is pumped to the Dissa Agricultural Area, located 8 km northwest of Gabès City, for irrigation purposes.

Area Served by the Gabès WWTP

The figure below show the areas currently served by the Gabès WWTP which are

- Gabès
- Ghannoche
- Chennai - Nahal



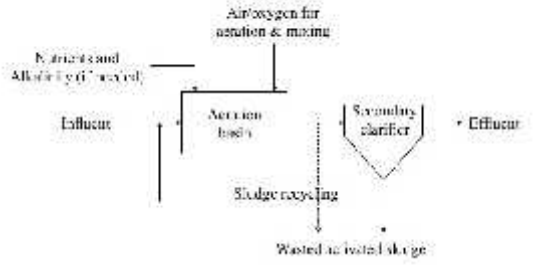
Area currently served by the Gabès WWTP

Current treatment scheme

The treatment process currently adopted is considered as one of the conventional treatment processes that provides a secondary treatment for wastewater, which is the activated sludge process.

The section below provides a general overview on the system used in the treatment

An important part of the municipal wastewater treatment is the BOD-removal. A biological process, such as the suspended growth treatment process, does the removal of BOD. This biological process is an aerobic process and takes place in the aeration tank, in where the wastewater is aerated with oxygen. By creating good conditions, bacteria will grow fast. The grow of bacteria creates flock and gases. These flock will be removed by a secondary clarifier. Figure (2) illustrates a schematic diagram of an Activated-Sludge System.



Schematic diagram for Activated sludge process

Wastewater Plant main components

Activated sludge refers to a mixture of microorganisms and suspended solids. The bacterial culture is cultivated in the treatment process to break down organic matter into carbon dioxide, water, and other inorganic compounds. The typical activated sludge process has following basic components:

- Primary Clarifier to separate the solids carried along with Sewage/Effluent
- A reactor in which the microorganisms are kept in suspension, aerated, and in contact with the waste they are treating
- liquid-solid separation; and
- A sludge recycling system for returning activated sludge back to the beginning of the process.

There are many alternatives of activated sludge processes, including alternatives in the aeration method and the way the sludge is returned to the process.
Activated sludge process offers efficient reduction of BOD, COD and nutrients when designed and operated correctly. The process itself has flexibility and numerous modifications can be tailored to meet specific requirements (e.g. for nitrogen removal).

Pictures illustrating aeration units at the existing Gabès WWTP

Operating Entity

The current facility, is managed by ONAS (national office of Sanitation)

Project rationale

Aiming to overcome water quality and capacity issues in the city of Gabes and the surrounding areas, the project's main objectives are focused on adding new treatment capacities and improving treatment efficiency in order to utilize and reuse the treated wastewater. Therefore, that could help to significantly reduce gap in water demand in this area specially for agriculture purposes.

The sanitation master plan of the governorate of Gabès approved in December 2017, studied several sewage treatment scenarios of different cities and regions of the governorate of Gabès.

Proposed solution for treatment in Gabès Scope of work

For the sanitation of Grand Gabès the master plan proposed the following configuration:

- The creation of two new treatment plants with the creation and reconfiguration of corresponding networks and the eventual abandonment of the existing wastewater plant.
- A North WWTP of Gabès receiving wastewater from areas of North Gabès (collection basins located north of the diversion channel of the Gabed wadi), Ghannouche, Chnenni-Nahal and the industrial zone of Gabès and;
- Another WWTP on the southern coast of Gabès that receives wastewater from the southern Gabés areas (collection basins south of the diversion channel of Gabés wadi), Kettana, Zrig-El Guendri and the future tourist zone of Gabés (325 ha)
- Agricultural and industrial upgrading of treated wastewater (disposal of 10,000 m3 / d for the factories of the chemical group in Gabés and reinforcement of the reuse of the existing agricultural perimeter in the Eddissa zone (located in the Gabés Nord region)
- Development of an outfall at sea at the southern Step Gabés estimated length of 2900 meters

Legal and institutional framework

Institutional framework

Tunisia's water sector is organized on the basis of highly centralized sectoral, this translates into a multitude of strategies and sectoral programs. New reforms, particularly in the area of decentralization should lead the country to review its methods of water management.

Many public bodies established to implement the management of different sectors as follows:

- *Ministry of Public Health*: Helps formulate standards that apply to drinking water and effluent discharge in the environment, with human health as its main focus.
- *Hygiene and Environmental Protection Directorate (DHMPE):* A division of the

ministry of public health which regularly tests drinking water and treated wastewater to ensure that they comply with drinking water and wastewater discharge standards.

- *Ministry of the Environment and Sustainable Development:* Helps formulate regulation relating to environmental protection and the prevention of pollution, including effluent discharge standards and reuse standards.
- *National Environmental Protection Agency (ANPE):* Agency in charge of preventing and controlling pollution in Tunisia. It is the sole body controlling direct discharge of effluents in the environment.
- *National Sanitation Office (ONAS):* Tunisia's wastewater body is responsible for the country's wastewater infrastructure. It collects, treats and discharges municipal (and some industrial) effluents and sells (heavily subsidised) treated wastewater for reuse.
- *Ministry of Agriculture and Water Resources:* Helps formulate regulation that applies to water resources, including irrigation and water reuse for agricultural purposes.
- *National Water Supply and Distribution Company (SONEDE):* Tunisia's bulk water supplier and main water utility. It serves all urban areas and about half the country's rural areas.

The involvement of departments and agencies is ensured through a thoroughly developed institutional and regulatory framework.

Legal framework

Tunisia's Water Code (31 Mar 1975) is the overarching legislation covering the water sector. It covers aspects such as the sector's organisation, rights to water, the protection of water resources and the penalties that should be applied should its principles be breached. All decrees and ordnances that apply to water and wastewater treatment reference the water code

Laws affecting the responsibilities of stakeholders in drinking water and wastewater standards are illustrated in the following table

Law	Description
Law No 68-22 (2 Jul 1968)	Creates National Water Supply and Distribution Company (SONEDE)
Law No 74-73 (3 Aug 1974)	Creates National Wastewater Agency (ONAS)
Law No 93-41	Broadens ONAS's remit from wastewater network operator to Tunisia's main body for the protection of water resources. Law No 2004-70 (2 Aug 2004) makes concessions in the wastewater sector possible and Law No 2007-35 (4 Jun 2007) spells out the rights and obligations of concessionaires
Law No 88-91 (2 Aug 1988)	Creates National Environmental Protection Agency (ANPE

The water sector policy is in line with the water code first developed in 1975 and later updated in 2011. Included in the policy is the allocation of water resources which gives priority to satisfy the demand for drinking water in the urban and rural areas and then the needs for industry, tourism and agriculture.

The section below outlines the relevant laws related to the wastewater and re-use activities in Tunisia

- Laws / Decrees related to domestic effluents

  According to Decree No 79-768 (8 Sep 1979), modified by Decree No 94-2050 (3 Oct 1994) and Decree 2001-1534 (25 Jun 2001), domestic effluents must be discharged into the public sewerage network, unless ONAS deems the connection not feasible, in which case the premise's owner will be advised on alternatives

- Laws / Decrees related to Wastewater emission standards

  Tunisian standard NT106.02 contains three categories. The standard for rivers and lakes apply to all effluents being discharged into the environment, whether directly by the emission source or by ONAS's WWTPs. It is up to the emitter to decide how it complies with the standard. The standard relating to the wastewater network applies to non-domestic effluents aiming to use the wastewater network.

- Laws / Decrees related to Water used for drinking water production

  Standard NT09-13 distinguishes three categories of water and the kind of treatment required to produce drinking water from each category. There are two values for each parameter: the desirable standard (G) and the compulsory standard (I). The standard only applies to surface water.

- Laws / Decrees related to Sludge reuse regulation

  Tunisian standard NT106.20 (2002) regulates the use and application of sludge derived from wastewater treatment as a fertiliser. Sludge from pre-treatment and sludge recovered from cleaning of wastewater infrastructure cannot be used as fertiliser. Sludge cannot be applied to land used for the cultivation of vegetables.

- Regulations related to re-use of treated wastewater

  Treated wastewater is produced by ONAS and collected by regional representatives of the Ministry of Agriculture called Regional Rural Development Commissions (CRDA) for irrigation.

  CRDAs are responsible for transferring the treated effluents, storing it and pumping it to the end user. According to Decree No 89-1047, CRDAs must test the quality of the treated effluents before using them, with regular controls from ANPE and DHMPE. The water must be tested for bacteriological load fortnightly. Tests for the water's pH, BOD5, COD, TSS, chloride, sodium, ammonia, nitrogen and electrical conductivity must be carried out at least monthly. And tests for arsenic, boron, cadmium, chromium, cobalt, copper, iron, fluoride, manganese, mercury, nickel, organochlorine, selenium, lead and zinc must be carried out at least once every six months.

Project scope

Based on the Master Plan, the project include the following components:

1. Gabès North Wastewater treatment plant

- *Alternatives for plant location*

  The master plan proposed two alternatives:
  - A first alternative on a site in the *Eddissa zone 10 km west of the city of Gabès* and close to the existing reuse area for treated wastewater and the controlled landfill and solid waste disposal in Gabès.
  - A second alternative on a site located on the *northern coast of Gabès*, 1.5 km from the oasis of Ghannouche and 4 km north of the city of Gabès.

- *Plant required characteristics*

  The Gabès north wastewater plat's characteristics in order to meet the 2036 plan / horizon are as follows:
  - Hydraulic average load: 21640 m3 /d
  - Hydraulic peak load: 30400 m3/d
  - Daily biological load: 11700 Kg BOD5/d

2. Gabés north network

- *Collection networks*

  The configuration of the network is based on the integration of most of the existing collectors with the rehabilitation and

recalibration of a few main collectors and structures (pumping stations).

- *Transfer Networks*
  The transfer of wastewater collected on the collection basins of Gabès city, Gabès north and Chnenni-Nahal to the North Gabès treatment plant is through a transfer system. This system includes a pumping station with a capacity of 516 l/s and a DN630 diameter discharge pipe leading to a DN800 gravity connecting manifold carrying wastewater to the site of Gabès north treatment plant.

  The transfer of wastewater collected in the catchment area of the town of Gannouche via pump station SP11 (to be recalibrated) and a discharge pipe DN315 (for a flow rate of 133 l / s) leading to Gravity sewer pipe collector with Gabès north treatment plant.

  The gravity sewer line (pipe DN800) which will convey the reprocessed wastewater from the different transfer pumping stations to the Gabès north treatment plant (Figure 10 & 11) in Annex 2 and 3.

3. Gabés South wastewater treatment plant:

- *Plant location*
  The proposed site for the alternative selected by the master plan is located on the coast north of the town of Kettana and 5 km south of the city of Gabès and 2 km from the future tourist area of Gabès (325 ha).
- *Plant required characteristics*
  The characteristics of the South Gabés wastewater plant required to meet the 2036 horizon are as follows:
  - Hydraulic average load: 14700 m3 /d
  - Hydraulic peak load: 21140 m3 / d
  - Daily biological load: 7500 KgDBO5 /d

  Offshore disposal composed of a pumping station with a capacity of 250 l / s and a discharge pipe DN 400 of length 3500 meters (600 meters land part and 2900 meters marine part)

4. Gabés South networks:

- *Collection Network*
  The configuration of the network chosen for the 2036 horizon is based on:
  - The extension of the collection network and the pumping stations to the new zones located in the south of the coastal region of M'torech
  - The deflection and recalibration of the collector K and the interception of the collector E
  - The abandonment of the SR9 and SP3 pumping stations located in the littoral zone whose collection basins can be connected by gravity for the new configuration
  - The creation of a SPR3 main pumping station that transfers wastewater collected from the South Gabés watershed
  - The creation of collection networks (primary and secondary) for the sanitation of the localities of Kettana and Zrig-El Guendri
  - The connection of the future tourist area and localities Zrig-El Guendri and Kettana

- *Transfer Networks*
  The transfer of wastewater from collection basins in the South Gabès region by the creation of two pumping stations SPR3 and SPR3bis (each with a capacity of 285 l / s) and a DN630 discharge pipe with a length of 12 km

  The transfer of wastewater from the El M'dou and Kattana collection basins to Gabés South WWTP with two Zrig-El Guendri SP1 pumping stations (8 l / s, 4 mce) and SP1 Kettana (20 l / s, 20 mce) and two discharge pipes DN110 and DN200 of total length 3.1 Km

Completed technical studies

ONAS has completed in 2004 its comprehensive study on the information master plan, and it incepted the implementation of the applications listed in the action plan for 2004, which involved in particular:

- "Subscriber" management;
- Management of wastewater treatment plant operating, water quality and client queries and complaints;
- Management of procurement, and maintenance.

In that regards, and based on the increasing needs for sanitation and purification generated by the socio-economic development of the city of Gabès and to have treated water of a regular quality and in compliance with the standards of rejection and reuse. ONAS proposed the rehabilitation and extension of the treatment plant of the city of Gabès to meet a need of 22 100 eq Hab in the horizon 2021 and 32 500 eq.Hab for the horizon 2036.

For Gabès WWTPs, and in line with the masterplan, the project proposed to split into two parts:

- The immediate rehabilitation of the current treatment plant to ensure a regular and acceptable quality of treated water. The flow rate to be treated: 22 100 m3 / d
- Strengthening wastewater treatment capacity to cope with increased needs in the medium term. The flow to be treated: 32 407 m3 / d

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Challenges (technical, economic, social and others)

Political and social

There are some key challenges currently associated with the operation of Gabès wastewater treatment plants, which can be summarized as follows:

- Farmers at Edissa agriculture area claimed that they often experienced ten or more days in a row without irrigation water as a result of operation and maintenance issues.

- The negative perception of treated wastewater – at some levels - is a significant obstacle to increasing the adoption of treated wastewater irrigation. Whether the water is found to be safe or not, farmers are frequently misinformed or lack knowledge about the use of treated wastewater in agriculture.

Technical

- The quality of effluent from the Gabès treatment facilities represents a challenge for reuse, as salinity levels have been elevated. Farmers at the Dissa and El Hamma agricultural areas indicated some challenges in growing certain types of crops, particularly pomegranates and olive trees. High salinity of the treated wastewater, combined with the lack of drainage networks at the farms, may explain these difficulties.

- The selection of the concessionnaires must consider the difficulty of the project and therefore opt for a consortium including companies with international reputation in PPP contracts.

- During contract negotiation, it is important to define in detail the technical obligations in terms of routine maintenance and periodic maintenance, and linking performance of the concessionnaire to the reimbursements.

- ONAS needs to ensure the availability of skilled technical staff to supervise the technical activities of the construction and operations phase to support the decisions of the ONAS contract managers.

Legal and institutional

A big challenge will be the capacity of the ONAS to monitor the PPP contract on behalf of the Tunisian State.

It is common that States must deal with concessionaires more experienced in PPP preparation and management. Hence, to avoid such unbalance in skills and experience, and to ensure that the contract is designed and managed in a satisfactory way for Tunisia, it is essential that specialist staff is hired.

Preliminary Cost estimation: CAPEX, OPEX and preliminary Revenue

CAPEX

On the basis of unit prices from ONAS markets, the net investment costs for the realization of the treatment plant have been estimated.

These investments will be increased with the following supplements to arrive at the costs gross:

- Cost of studies and supervision of works: 8% of net investments.
- Physical contingencies: 10% of net investments.
- Financial risks: 2% of net investments

The total cost of the project is estimated at one hundred and seventy five million Tunisian Dinars (TND) distributed as follows:

Investment Costs for Gabès WWTP

Plant	Phase / Milestone	Estimated investment Cost (million TND)
North Wastewater treatment plant	North Wastewater treatment plants	70
	North network and Pumping stations and Transfer networks	20
South Wastewater treatment plant	South Wastewater treatment plants	55
	South network and Pumping stations and Transfer networks	18
	Rejection pump at sea	12
Total		175

OPEX

The following section summarizes the basis of operational costs necessary to implement the wastewater treatment plant. The actual Costs shall be calculated upon the detailed technical study that will be conducted

For estimating operating costs, four (4) main types of costs were considered to know:

- Costs of maintenance and maintenance of the works.
- Costs of the operating staff of the treatment plant.
- Costs of consumables (the necessary chemicals, etc.).
- Energy costs.

Operating costs include fixed costs and variable costs

- *Fixed costs*

  Costs of maintenance and maintenance of the works can generally be reported to initial net investment costs of the infrastructure. In the context of this study and on the basis of observations made in Tunisia over a long period, the percentages given below after, seem well adapted.

  - Civil Engineering 1.5% per year
  - E + M equipment 5.0% per year

- Staff costs

  The cost illustrates the overall staffing requirements according to the studied solution as well as annual salaries including all expenses. A 30% surcharge on costs staffing was applied to account for management costs (administration, etc.).

  Costs shall be calculated upon the detailed technical study that will be conducted

- Variable costs

  1. *Costs of consumables*

     These are mainly the costs of ferric chlorides and polymers. Currently, the cost per ton of ferric chloride powder is TND 2300 including transportation, customs clearance, steerage, transit, etc.

     The polymers are estimated at 10 TND / kg of product, they also include the ancillary costs of transport on the site. Quantities of consumables and their annual costs shall be calculated upon the technical study that will be conducted

  2. *Costs of energy*

     For the treatment plant, energy is consumed mainly by the following units.

     - Pretreatment and primary treatment;
     - Aeration in biological treatment;
     - Bearings and intermediate pumping within the station;
     - Auxiliary consumption (lighting, lab, etc.).

     The energy quantities and corresponding costs evaluated shall be calculated upon the detailed technical study that will be conducted.

  3. *Expenses for the disposal of dewatered sludge and by-products of wastewater treatment plant.*

     Sludge from the treatment plant and other by-products will be transported to the landfill controlled, or stored in an appropriate site.
     Sludge quantities, and disposal costs shall be calculated upon the detailed technical study that will be conducted.