3

North of Greater Tunis wastewater treatment plant

Location:
North of Greater Tunis

Company:
ONAS

Mission:
New wastewater treatment plant

Cost:
TND 257 million

General presentation

Based on the masterplan study developed by the National Sanitation Office (Office National d'Assainissement, ONAS), analysis of the existing situation, and taking into consideration the future situation, ONAS recommended, to establish three ***new wastewater treatment plants*** *(WWTP) in Greater Tunis for a total budget of* ***TND 257 million****.*

- The new WWTP El Hessiane with a capacity of ***60 000 m3/d*** in the North area;
- The new WWTP El Allef with a capacity of ***90,000 m3/d*** in the South zone;
- The new WWTP El Attar with a capacity of ***170,000 m3/d*** in the west zone

This first project will focus on the execution of the new wastewater treatment plant in the North of Greater Tunis (also called El Hessiane WWTP) located in the North of Greater Tunis to meet the required capacity needs for the next 20 years. As per ONAS masterplan study, it is required to increase the hydraulic capacity by an additional 60,000 m3/d to meet the planned demand in line with the forecasts for the year 2035.

Based on the studies, it has been decided to establish the new North WWTP in El Hessiane area, as there is a land available for building the new station away from the urban areas. Constraints were found in relation to soil characteristics and the need for deep foundations during construction works.

There are opportunities for reuse of treated wastewater from the North wastewater plant in the existing Cebela-Borj Touil perimeter, which is the largest irrigated perimeter from treated wastewater in Tunisia. This perimeter, created in 1989, covers a total gross area of 3200 ha and is fed from treated wastewater produced by the three wastewater treatment plants of Cherguia, Choutrana (I and II) and Coastal North.

As per the updated studies, there is a planned extension for the irrigated perimeter of Borj Touil, and therefore, there is a potential for the use of wastewater processed from the new North WWTP.

Site Characteristics

According to the land survey and site visits, the following characteristics are observed:

- The land is far enough away from the residential areas, and is accessible from the RL533 road
- El Hessiane site belongs to the maritime public authority. Accordingly, there is a need for land expropriation in order to be able to establish the new WWTP.
- The site presents a risk of flooding.
- The results of the geotechnical study carried out on this site revealed important construction works such as decanters, clarifiers, aeration channels, etc. The Soil bearing is low. Therefore, it is necessary to build deep foundations by piles.
- The site to be envisaged is in a remote area, which requiring the supply of food, water and electricity.

The map below illustrates the selected site for the North WWTP at El Hessiane

(Figure 1) location of North WWTP at El Hessiane

Area Served by the Tunis North WWTP

The new WWTP is expected to serve the following catchment areas:

- Clean basin at the new treatment plant north of Greater Tunis WWTP (Raoued, Kalâat El Andalous, part of El Mnihla);
- Basin of the Cherguia - Choutrana of WWTP 1 and 2 (Bab Bhar, Sidi El Bechir, Jebel El Jeloud, El Ouardia The Medina, Bab Souika; El Omrane, The bardo; La Goulette; El Menzah, El Khadra City; Ariana City, La Soukra, La Marsa, Kram, Carthage and Gammarth).

Sources of wastewater coming to the North WWTP

- The surplus of the volumes conveyed to Choutrana from the networks of Borj Louzir.
- Ariana and the dispatcher located upstream of La Cherguia.
- Effluents currently transported to Kalâat El Andalous WWTP, which will be abandoned.
- Effluents from the Raoued area, currently partially unconnected, which will be connected to the El Hessiane WWTP via the El Yamama pumping station.
- Effluent from Borj Touil, currently unconnected, which will be connected to the WWTP El Hessiane via the El Yamama pumping station.
- The area of Sidi Amor Bou Khtioua, half of which is not connected and will be connected to El Hessiane.
- The effluents of El Bokri and Sanheji.

Raw water effluent characteristics from adjacent areas and other WWTPs

The effluents received by all stations are of domestic type, the proportion of effluents contained in these waters without affecting the concentrations of the pollutants or the biodegradability of effluents. Only Kalâat Andalous presents concentrations slightly higher than the usual values of domestic effluents, due to uncontrolled discharges in the networks, but the effluents remain largely biodegradable.

The section below illustrates averages of the concentrations that will be incoming to the new WWTP:

- Carbon: All the concentrations of carbon pollution are in conformity with household-type effluents although these are in the high end of the range of usual values.
- MES concentrations: The concentrations of MES are relatively low from 347 to 469 mg/l, compared to BOD5 concentrations.
- NTK concentrations: The values available for concentrations in NTK and Pt are very high. Concentrations for nitrogen are low (44 to 83 mg/l), and rather low concentrations for phosphorus (7 to 12 mg/l). The Kalâat Andalous station has the highest concentrations in NTK at 116 mg/l.
- Ammonia (NH4) concentrations: It appears from the analysis of NH4 + concentrations that this represents in average 71% of the NTK, a value consistent with effluents of the type domesticated.

Treatment requirements

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.

The design parameters are:

- Average hydraulic design load of the WWTP: 94,500 m3 / d;
- Pollutant design load of the WWTP: 45,323 kg BOD5 / d;

Operating Entity

The current facilities, are managed by ONAS (national office of Sanitation)

Project rationale

The main objective is to improve the operation of the existing WWTPs and to provide sufficient capacity to meet future needs.

ONAS has embarked on a capacity expansion program in Greater Tunis from 276,250 m3/d to 336,250 m3/d, by adding an additional 60,000 m3/d.
This extension will be planned considering the following elements:

- The short-term abandonment of the treatment plant in the northern coastal zone, which serves the northern suburbs of Tunis;
- The development in the North water basins of Greater Tunis, notably Raoued and La Soukra;
- The abandonment of the treatment plant Kalâat El Andalous and its connection to the future WWTP of North Tunis.

This project is in response to current environmental requirements, consisting of the selection of a site as well as the establishment of a new WWTP of 60,000 m3/d, sewage and water transfer pipelines and the identification of recipients irrigated by treated wastewater.

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 are involved in the wastewater sector, as follows:

- *Ministry of Public Health*: Helps formulating standards that apply to drinking water and effluent discharge in the environment, with human health as its 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 formulating 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 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)	Created the National Water Supply and Distribution Company (SONEDE)
Law No 74-73 (3 Aug 1974)	Created the National Wastewater Agency (ONAS)
Law No 93-41	Broadened 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) made 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)	Created National Environmental Protection Agency (ANPE)

The water sector's 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. The only sludge that can be used for agricultural purposes is that derived from urban WWTPs. 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

The establishment of a new WWTP 60,000 m3 / d, at El Hessiane site. The scope includes also sewage and water transfer pipelines and the disposal pipeline.

The project is planned to be implemented into phases as follows:

- The **short-term** abandonment of the treatment plant in the **northern coastal zone,** which serves the northern suburbs of Tunis;
- The development in the **North water basins of Greater Tunis,** notably Raoued and La Soukra;
- The abandonment of the treatment plant **Kalâat El Andalous** and its **connection** to the future **WWTP of North Tunis**.

Completed technical studies

- Updated study of the sanitation master plan of Greater Tunis (2014);
- Execution study of the primary sewage networks of the cities of Raoued and La Soukra (2010);
- Flood protection study in the North and East areas of Greater Tunis: Phase1 (2014);
- Reinforcement study of the existing collector between the Cherguia wastewater

treatment plant and that of Choutrana (2013);
- Study of rehabilitation of the water transfer system of WWTP Choutrana - section 1 (2013);
- Annual operating reports of Choutrana 1 and 2 WWTPs, Cherguia, North Coast, Kalâat El Andalous (, 2010-2014); and
- Report on the planning of the purification capacity in Greater Tunis (2008)

Challenges (technical, economic, social and others)

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

Political and social

- 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 land allocated for the North WWTP is a far away from urban areas, and the soil need special deep foundations during construction
- The new location is un-utilized, thus needs water supply, as well as electricity
- The quality of effluent from the treatment facilities represents a challenge for reuse, as salinity is elevated. Farmers at some 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 concessionaires 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 concessionaire 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 significant 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/trained.

Prospective implementation schedule

The project implementation comprises four main phases.

The table below summarizes the deadlines for the main phases of project implementation and their estimated dates of completion.

Project Phases	Duration	Date
Start date of the study		December, 2015
Duration of the study including delay approval	15 months (study) + 8 months for approvals	October, 2017
Tender procedure	12 months	October, 2018
Evaluation phase		
Approval and award phase Markets Works and Supplies		
Duration of work (WWTP & networks)	24 months	October, 2020
start-up period for the new WWTP	6 months	April, 2021

In view of the deadlines for studies, tendering procedures, counting and allocation, and implementation, it is proposed to retain for the rest of the project the horizon of 2041 (i.e. 20 years as a duration for the PPP contract)

Preliminary Risk Matrix

The table (1.a) in Annex 1 shows the main types of risk associated with the construction of wastewater treatment plant under different procurement schemes (BOT, BOO, etc.)

In addition, table (1.b) in Annex 1 illustrates the risk matrix which summaries the risk sharing mechanism for each of the four options of PPP arrangement mentioned above. Political risk has not been included as it is a function of the political stability of the country, the local culture and the socio-economical characteristics of the society and is likely to affect the choice of PPP model rather than constituting a project risk element.

Preliminary Cost estimation: CAPEX, OPEX and preliminary Revenue

CAPEX

Based on unit prices from ONAS markets, the net investment costs for the construction of the treatment plant have been estimated.

Capex is calculated based on the activities necessary for establishing the WWTP on the selected site (El Hessiane) and that include the following:

- Civil works
- Architectural &Finishes
- Structural works
- Process and Mechanical works
- Electrical works
- Yard Piping
- Site and landscape works
- Instrumentation and piping works

CAPEX calculations also include the following;

- Engineering (design works)
- Commissioning (startup)
- Contingency
- Mobilization
- Bonds
- Insurance

The total cost of the for establishing the WWTP at the selected site (El Hessiane) Is estimated at **TND 257.3 million** distributed as follows:

Item	TND million
Cost of civil works + equipment Cost of foundations and soil work	170.0 33.0
Cost of transferring of raw water to the WWTP	42,0
Cost of transferring of treated effluent wastewater	12.3

OPEX

The following section summarizes rough estimates of the operational costs necessary to implement the North 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 0,5% 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 2300 DT including transportation, customs clearance, steerage, transit, etc.

The polymers are estimated at 10 DT / 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;
- intermediate pumping within the station;
- Auxiliary consumption (lighting, lab, etc.).

The cost of electrical energy from the operation of the pumping stations is estimated according to the method set out in the update study of the master plan for the remediation of Grand Tunis.

The tariff used to estimate the energy consumption of pumping stations is that of Tunisian Company of Electricity and Gas: Price of KWh (average uniform tension) = 0.205DT.

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.

The estimate cost of the for operation and maintenance of the the WWTP at the selected site (El Hessiane) is estimated at 2.27 million Tunisian Dinars (DT) per year

Conclusion

Analyses on the current policy of water management in Tunisia show serious problems in the structure of the function of aggregate demand. Indeed, it may be mentioned that the expected decrease in the available capacity of conventional resources forces us to think of additional resources to overcome the future crisis. The reuse of treated wastewater may be a promising technique.

Increasing global wastewater production and food demand highlight an opportunity for better management through the reuse of treated municipal wastewater in global agricultural production, particularly in Tunisia who suffers from water shortage.

Challenges are facing the water Authorities in Tunisia in relation to reuse of treated wastewater as: (i) Public and farmer perceptions of the practice are varied and often misinformed; (ii) the cost of connecting urban population centers where wastewater is produced to rural areas where agriculture is practiced is quite high; (iii) some public health risks are well understood (e.g., pathogens, heavy metals). All these above-mentioned factors create the need for enhancing the current scheme adopted for wastewater treatment in Tunisia in general and in Tunis in particular, as well as expanding the treatment services to increase the capacity of re-used water for irrigation purposes.
In addition, and based on international practices, there should be robust mechanisms and innovative approaches, in order to achieve success in implementing these initiatives. PPPs can be one of the solutions that depend on involving the private sector as a real partner that could provide several solutions like financing packages, innovative solutions in terms of design, construction, and operation activities.

Recommendation

Based on the conclusions, the following aspects should be taken into consideration while establishing the new wastewater plant at El Hassiane area (plant North)

Addressing community requirements

To address sanitation challenges in El Hessiane area, engineers and developers must select a wastewater treatment technology that is appropriate for the local community, considering the local environmental conditions and technical constraints as well as the unique political, economic, and social factors that may impact how wastewater is managed, valued, and perceived.

And in our situation there is a demonstrated technical capacity for reusing treated wastewater (or gray water) in agricultural production, and there is a basic public acceptance of the practice. In addition, Tunisia's policies for reuse of treated wastewater in agriculture seem to be well matched with the country's wastewater treatment capacity.

With a return to the high standards in the water sector that existed prior to the 2010 / 2011 revolution, and continued agricultural extension to farmers, we expect that treated wastewater receiving secondary treatment will play an important role in the production of tree and fodder crops in Tunisia.

As per international practices, it worth mentioning that under proper maintenance and monitoring conditions, most of the wastewater treatment facilities evaluated are capable of producing effluent that is safe for use in certain types of agricultural production; however, the risks to public and environmental health, particularly salinity and decentralized management and monitoring, cannot be ignored.

In addition, daily and seasonal variability in water quality should be taken into account. Water sector policies, national and local governance, health considerations, and perception of farmers and consumers are critical factors in determining the viability of treated wastewater reuse in any location

Annex 1: Project map illustrating Purification scheme selected by the update study of the sanitation master plan of Greater Tunis