Technical aspects of water supply and sewerage in Shkodër

MSc. Ing. Dajana ARRTUNDA[1]
ADVISOR: PROF. DR. TANIA FLOQI

Abstract

Water is a natural resource, with limited quantities and unevenly distributed in space and time. All forms of human life and activity are dependent on water.

As is known today, one of the main challenges in the region and the world is the preservation and development of water resources as a basic element for life to cover the basic requirements for drinking, then for agriculture and industry. Shkodra has a hydrographic system "Shkodra Lake - Drin River - Buna River", which collects the waters of a basin with a total area of 19,582 km2. This considerable catchment area, with high and rugged mountainous relief and abundant intense rainfall, with special lithological construction of the terrain, in the presence of permeable limestone formations makes it possible for the hydrographic network of this basin to stand out for high and quiet diverse hydric potential. This network includes Shkodra Lake, Drin, Bune, Kir, and Gjadër rivers. The study aims to improve water supply and increase the effectiveness and sustainability of services to the citizens who are included in the intervention areas, the provision of clean drinking water and the creation of a sanitary clean environment through the administration of polluted waters, against acceptable fees which cover, at least, the operating expenses. The expected results are a good performance of the CUs, ensuring the proper service and operation of the CUs, efficient water supply, and sewerage systems. Knowledge of the technical aspects of the

[1] Dajana Arrtunda is a construction engineer. In 2020, she is graduated in "Geo-Environment" from the Faculty of Geology and Mining, at the Polytechnic University of Tirana. In 2022, she is graduated from the European University of Tirana with a Master of Science degree in "Construction Engineering", profile "Transport Infrastructure". During the years of studies, she worked as an engineer for the Italian company design SGAI Balcani and at the Geological Laboratory Geotest Shpk. Since February 2023, she is part of the K&K engineering company.

CU Shkodër is necessary for citizens as it is directly related to the agent and the future of our children.

Key-words: *water supply, disinfection, treatment, pumping station, natural resource.*

Introduction

Shkodra extends for about 872.71 km2 in the hydrographic node near the lake of the same name and the rivers Drin, Bune and Kir in a lowland "protected" by the lake, the Albanian Alps in the east where the peaks of Cukali (1,722m), Maranaj (1,576 m), Sheldia (Sardonic mountain of Barleti; from Shurdhah) and Tarabosh (about 700 m) to the west and the Adriatic Sea. The area in the middle of a plain, hilly, sub-mountainous, and mountainous relief, and the proximity to the Adriatic Sea and the lake of Shkodra have also defined its climate, a Mediterranean climate with mild and wet winters and hot and dry summers. Average annual temperatures range from 11.8 °C to 14.0 °C. The temperature in January is from 0.9 °C to 6 °C. In winter, the wind of Murrlan (local wind), is cold, strong and dry blows, while at the end of autumn, the wind blows, which is accompanied by precipitation and swelling of rivers. The amount of precipitation in this city is large. On average, 2500 mm of rain falls there per year, so it is one of the wettest areas of Albania. The coldest month of the year is January, while the hottest month of the year is July. Snow falls rarely, while frosts usually occur at the end of the year. The "Shkodra Lake - Drin River - Buna River" hydrographic system collects the waters of a basin with a total area of 19,582 km2. This considerable water catchment area, with high relief and broken mountain and with abundant intense rainfall, with a special lithological construction of the terrain, in the presence of permeable limestone formations makes it possible for the hydrographic network of this basin to stand out for high and quite diverse hydric potential. This network includes Shkodra Lake, Drin, Bune, Kir and Gjadër rivers. The Buna river delta with its characteristic alluvial islands is special in this respect. First, in terms of biodiversity and natural productivity, the water network, especially the hydrographic one of Shkodra, has special and almost unique values. From a scientific point of view and knowledge of the lake, information on its biodiversity is rich. The biological diversity of Lake Shkodra has increased under exceptional geomorphological, geographical, climatic and ecological conditions. Biological diversity is high and the whole area is considered a biogenetic reserve of European importance. Lake Shkodra is located in the northwestern part of Albania and on the border with Montenegro. It has an average height of 5 m above sea level and is the largest lake in the Balkan Peninsula, with an area of 368 km² of which 149 km² lies in Albanian territory and the rest in Montenegro. The average depth is 10 m, the average water temperature is 16.5 °C and the Mediterranean climate prevails. Irrigation canals, aqueducts, dams, bridges - since ancient times, man has created all kinds of structures - in the water, on the water, near water and even under water. Water pipes deserve special attention. These are canals, pipes and water channels necessary to provide the city with water, even if the settlement is higher than itself. A water supply is an integral system and must be considered comprehensively along its entire length from the source to the final point of consumption. According to the United Nations Organization (UN-WATER publication)[2] [27]Globallyy, agriculture (including irrigation, livestock and aquaculture) is by far the largest consumer of water, accounting for 69% of water use at the level globally, industry (including energy production) accounts for 19%, while households only 12%.

Water supply, sewerage, drinking water supply

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[2] Sustainable Development Goal 6 Synthesis Report on Water and Sanitation, 2018

In the city of Shkodra, two wastewater treatment plants are operational, one in Shiroka and one in Velipojë. ITUN of Shiroka has been operating since 2013. It occupies a land area of 1,913 m2 with sufficient capacity for an equivalent population of 2 thousand inhabitants. Under the conditions of operation at full capacity, the plant consumes about 22 thousand (kwh) of electricity. ITUN of Velipoja has been operating since 2016. It occupies a land area of 2 hectares with sufficient capacity for an equivalent population of 54 thousand inhabitants. Under the conditions of operation at full capacity, the plant consumes about 22 thousand (kWh) of electricity. In ITUN they do not discharge industrial waters and the secondary level of dirty water treatment is used. There is 1 pumping station that transports/discharges the waters of the main collectors in ITUN and the host water body is Lake Shkodra. The lifespan of ITUN Shiroke according to the project is 15 years.

Drinking Water Production

Sh.a.UK Shkodër uses underground water sources through which it produces an average of 12.6 million m3 of water per year, through 21 systems with mechanical lifting and 2 systems with free flow. The entire volume of produced water is estimated at (100%). Sh.a. UK Shkodër implements a regular work program for the detection of water losses and has a formalized system for registering consumer complaints. The study mainly deals with the water supply system connected to the area of the Dobrac wells. From the above, it will be seen that about 80,300 people living in Shkodër and its suburbs are supplied by this main source of water, including the two villages of Dobrac and Golem. The Dobrac well area generally provides sufficient water of good quality, but the water needs to be protected from pollution from residents living near the well field.

The large number of consumers with "0" consumption can be due to two reasons:

a) The emigrant population abroad - these houses are closed and in many cases are only used for a few weeks during the summer holidays.
b) Houses with illegal connections and/or bypassing of the water meter, which is expected in many cases in Dobrac and Golem. At the moment, the village of Golem has 0 (zero) registered consumers, but it is known that many houses are connected to the old pipes, which are related to the field of Dobrac wells.

Ten wells equipped with submersible pumps raise the water to an intermediate tank nearby, from where it is pumped directly into the supply system and also to the reservoirs located on Tepe Hill. From there, distribution is by gravity. While the entire network of Shkodra (approximately 263 km) is interconnected, at the moment no well-organized supply concept it is possible.

Dobrac Wells Field

The city of Shkodra is supplied by an underground water source, called "Field of Dobraci Wells", which is located in the north of the city, between the Kir River in the east and Lake Shkodra in the west. Characteristics of the Wells field with its eleven (11) wells. Three (3) wells were equipped in 2000 with submersible pumps funded by the ADA, along with pressure and flow meters. The pumps were inspected and found to have corrosion, both in the pump itself and in the pipe going up, moreover, the current condition of the mechanical works and civil structure is very bad. Close inspection of pumps and pipes Current situation inside the wellbore. Recently, three (3) of the well pumps were replaced with KSB pumps and are assumed to still be performing well. Well, No. 9 is currently out of service due to the lack of a pump while the well is reported to be filled with stones. Although the pumps are monitored by the recently installed "SCADA system", none of them are connected to the Intermediate Reservoirs using the smart remote control system, so the pumps are switched on and off manually by the Operator when signaled with the mobile phone.

Main Pumping Station

Untreated water is pumped from the wells to the Intermediate Reservoir by pumping pipes DN250 to DN400, with lengths from 150 m to 1 km. The connecting pipes between the wells, as well as those of the reservoirs, are made of steel, and pass under private and agricultural plots.

Intermediate Reservoirs

Wells No. 8, 9, 10 & 11 pump water through two (2) separate lines to the 40-year-old "Old Intermediate Reservoir", with a volume of 150 m^3, (single tank), while wells No. 1, 2, 4, 5, 6 & 7 are connected first to the recently reconstructed well, and then to the "New Intermediate Reservoir" with a capacity of 1000 m^3, (double tank), also newly built, with Contract Works No. 3.

However, in the last project financed by KfW-SECO-ADA, it was envisaged to reconnect all the wells to the new Intermediate Reservoir, but this turned out to be impossible due to a lack of funds. The general condition of the "Old Intermediate Reservoir" (civil structure and mechanical equipment) can be described as bad. The "New Intermediate Reservoir" was built recently, but it is noted that neither the water overflow nor the water level measurement valves have been installed, while the butterfly valves for starting the engine are opened and closed manually.

Disinfection

In the "New Intermediate Reservoir," the automatic chlorination plant (liquid hypochlorite) and the Chlorine Analyzer have been installed and are functioning. However, since the EFMs at the New Pumping Station are out of order, Chlorine dosing is at the discretion of the operator.

Pumping Stations

From the Intermediate Reservoirs, water is pumped into the network from two pumping stations, located in the Dobrac Well Field. The old pumping station has been built for about 50 years but continues to operate, while only one (1) pump out of four (4) is currently in operation.

The New Pumping Station (funded by ADA and built-in 1999), consists of three (3) pumps, all operational. In principle, there are two main lines for the supply of Shkodra from the "New Pumping Station The so-called New Main Pipe, (NTM) acts as the main transmission, which sends water from the New Pumping Station to the so-called Hill Reservoirs, (R4, R3, and R2) and consists of a pipeline installed with a length of 5 km DN400 ductile iron, implemented by ADA in 2000. A part of this line lies under agricultural and private areas from the Old Pumping Station. The Old Main Pipe (OTM), a DN 400mm steel pipe, was previously used as the main transmission to supply tanks R1, R, 2 and R3

Distribution Wells

To supply the city with water, there are two wells (rooms) that are connected to the "Old Pumping Station",

Dobrac well

a) Manhole in Dobrac The well of Dobrac is located in the north of the city and is currently surrounded by houses built without permission. The access to the newly built well, with the financing of the KfW-SECO-ADA project, is closed with a high concrete wall, to prevent the entry of residents and illegal interventions in the system. The following areas are supplied from the well;

b) Industrial Wells (IND) served as distribution wells for the former timber processing industry, in the industrial area, in the northeast of Shkodra. Today a steel pipe, DN300, extends to the southeast to supply the city. 2.7.2.3.3 Reservoirs Currently there are four (4) reservoirs of which only three (3) have water while one is out of order. All reservoirs are located on Kodër Tepe, south of the city, with a total capacity of 13,800 m^3. The entire holding capacity is/would be sufficient to meet all current water demands, also accounting for the 30% reserve capacity required to meet peak demand cases.

Contaminated Water, Sewerage Network

The existing Wastewater network was designed to function as a separate system, but due to faulty connections, it now functions as a combined system. Discharge to the Main Sewage Pumping Station located in the south of the city, near the Buna, is done by gravity and mainly through three (3) Main Collectors. These three collectors are connected and discharged by gravity through a DN 1200 transmission (K0 with a length of 1.1 km) to the mentioned MSPs. All the polluted water collected inside the urban area is pumped from the Main Sewage Pumping Station to the Drin River without any treatment. This is done to eliminate spillage in Lake Shkodra to protect it from pollution. MPS (Station) Shkodra has recently been rehabilitated, within the framework of the KfW-SECO-ADA project. The rehabilitation works aimed to completely replace the E&M equipment, replace the DN500 discharge pipeline, build a new sand trap, as well as build a new emergency discharger, in addition to renovating the structure itself. MPS is equipped with five submersible pumps, (Q = 540 m^3/h, h= 15 m) with a total capacity of 2,700 m^3/h. The main priorities for the wastewater system in Shkodër expressed by the client for the current project are the implementation of a WWTP and all measures required to start operation as soon as possible.

Expanding and rehabilitating the wastewater collection network is ranked lower than the WWTP in the ranking of priorities. None of the connected dwellings use septic tanks or septic tanks for water discharge, so the liquid matter coming from the waste is infiltrated into the ground. When needed, the tanks are emptied by suction trucks brought by private individuals. The current wastewater network was designed to function as a separate system, but due to faulty connections, it now functions as a combined system. The current state of the polluted water network is as follows;

The grating cleaning elements must be of the adaptable type to ensure a high discharge capacity. Due to the installation depth and limited space, the grate must be of the vertical type with the incorporation of a dewatering and compaction mechanism. The waste is automatically discharged into a container, which is placed at ground level, while the grate installation should be approx. 4 mbgl

The main uncovered areas are the informal areas in the east, north and west of the city (respectively the village of Dobraci [the part that belongs to the urban area of Shkodra and is not connected], Ish-Zotekniku, Livade and Mark Lula). Currently, unconnected/uncovered households mainly use pits or septic tanks to remove Dirty water. As a result, polluted water from those pits infiltrates into the ground. When necessary, these tanks are emptied by suction trucks organized at a private level, which is outside the control of the UKS. Therefore, it is of great importance to connect these areas with the collector system of Shkodra.

Wastewater Treatment Plant

Wastewater that is generated by all human activities must be treated in a wastewater treatment plant. ITUNs are wastewater treatment plants and serve to achieve the highest degree of purification of these waters. This is the water that results from human activities that come from cities, industry, agriculture, etc. Being a potential risk for the host environment and human health since spills and leaks of toxic substances that contain them also in special cases cause ecological damage.

To return to the natural environment of the host without causing ecological damage to it, the main goal is to reduce the pollutants, to reduce them within the permitted limits. Treatments vary depending on the characteristics of the wastewater and its final destination. We know that urban wastewater is collected through a circuit of drains and collectors that make it reach wastewater treatment plants. Water in the plant is subjected to different treatments to achieve the level of purification needed for different purposes or according to the respective destination.

Through these plants they undergo the following treatments:

I. Pre-treatment: It consists of the removal of solids of different dimensions, and the removal of fats, and oils. This process is necessary to remove most of the pollutants that would hinder subsequent treatments.
II. The primary treatment removes a large amount of pollution, after the primary treatment 30% has been removed
III. Secondary treatment. It is the further treatment of water and as a treatment, it has a high cost.

Primary Treatment

It consists of several physicochemical processes that are applied to reduce the content of suspended particles in water. Most of the suspended solids found may be sedimentable or floating. Those that are sedimentable usually reach the bottom after a short period, while the latter are particles so small that they are already integrated into the water and cannot float my sediment. To eliminate these smaller particles, other more demanding treatments are needed.

Some methods used in primary treatment include the following:

- Sedimentation: is the process by which sedimentary particles can fall to the bottom thanks to the action of gravity. In this process, which is simple and inexpensive, up to 40% of the solids contained in the water can be eliminated. Inside the treatment plant, there are tanks called decanters and this is where sedimentation takes place.
- Float: It consists of the removal of foams, fats and oils since, due to their low density, they tend to settle in the surface layer of water. In this process, it is also possible to remove lower-density particles. For this, it is necessary to inject air bubbles to facilitate their adhesion and elimination. With this float, up to 75% of suspended solids can be removed. This process takes place in other tanks called dissolved air floats.
- Neutralization: it is a process that consists in normalizing the pH. This means that the water should be adjusted to a pH between 6-8.5.

Other processes: if you want to achieve greater purification of polluted water, some techniques are applied such as the use of septic tanks, lagoons, green filters, or other chemical processes such as ion exchange, reducing the biological need for oxygen, etc.

Secondary treatment

As we have mentioned before, unless a high degree of purification is required, this secondary treatment is not carried out in urban wastewater plants. It consists of a series of biological processes that aim to almost eliminate the organic matter present. They are biological processes in which certain bacteria and microorganisms are used to convert organic matter into cellular biomass, energy, gases and water. The advantage of this treatment over others is that it achieves a high degree of pastrami up to 90%.

In the secondary treatment of urban wastewater treatment plants, there are two types of aerobic and anaerobic processes. The first is in the presence of oxygen and the second is in the absence of oxygen.

- Aerobic processes: these processes take place in the presence of oxygen, which is blown in different ways and passes into the aeration tanks, where the polluted water enters. During this phase, organic matter degrades and water and carbon dioxide are released, the rest of the organic matter serves as food for the microorganisms that multiply and serve as food for them. In addition to these microorganisms, we have protozoa, algae and other species up to intervertebral "worms". Nitrogen products such as ammonia, which is a highly toxic nitrogen derivative, are eliminated in this phase. Although nitrate is no longer toxic, it is a form that can be taken up by plants, so it can cause algae to grow and regenerate their nutrients. After secondary treatment, the waters containing nitrogen and phosphorus compounds being discharged into the host environment cause eutrophication, i.e. the increase of macrophytes.
- Anaerobic processes: These processes take place in the absence of oxygen and the fermentation process takes place in which the organic matter is transformed into carbon dioxide and methane gas 60-70%

The plant in Shkodër has a biological filter, where the water is thrown from above the tank in the form of a shower and during the shower, it is enriched with oxygen from the air.

The biological filter is a concrete tank filled with plastic materials that have empty spaces between them exactly, in the waters of these plastics, a biological layer is created through which oxygen-enriched waters pass and the pollutants of these waters serve as food for the biological layers, the biological active sludge is in continuous movement with the waters, while here the biological layer is motionless, then through the drainage they pass to the secondary decanter where the water is separated from the biological layer "sludge".Water comes from above the biological layer comes from below.

Tertiary Treatment

For the second phase of implementation, biological phosphorus removal will be done by adding Disc Filters (Microscreening-Microgrid).

The P- elimination will require the following additional units:

- Anaerobic Bio-Phosphorus Tank (phase 2)
- Chemical dosing station;

Tertiary treatment will respond to the improvement needs for waste discharge standards, especially concerning the expected classification of the received water as a sensitive water body with stricter phosphorus requirements.

Alternatives Proposed for Biological Treatment during Project Concept

ITUN Alternative 1: Traditional activated sludge process.

Sludge processing tanks in the first phase of implementation will be dimensioned for the removal of organic pollution with BOD / COD with a sludge treatment time of only four to five days.

The sludge processing plant will consist of the following units:

- Deposits (cisterns - to be expanded in phase 2)
- Ventilation Station
- Secondary Sedimentation/Cleaning Deposits;
- Return of activated sludge (RAS) and excess sludge pumping station.

Detailed process calculation and item description of the Activated Sludge Plant for alternative 1 are provided in Appendix 3.2 and related drawings of the Final Project Concept Report.

WWTP Alternative 2: SBR-Technology

The SBR plant will consist of the following units:

- Intermediate pumping station;
- SBR deposits (to be upgraded in phase 2);
- Ventilation Station (Diffuser).

A detailed process calculation and item description of the SBR Plant for Alternative 2 is provided in Appendix 3.3 and related drawings of the Final Project Concept Report

The following interventions are not necessary in the case of SBR technology:

- Final sedimentation deposits;
- Sludge return cycle.

This means that the main differences compared to the traditional system (Activated sludge) are related to the volume of the biological reactor, the aeration capacity and the measurement/regulation of this phase. Furthermore, the sludge load and its treatment are reduced to some extent. The capacities of subsequent purification measures such as filtration and UV irradiation have increased to some extent due to the permanent operation of biological reactors.

Selected Option

As mentioned above, the biological treatment of polluted water should be based on the One-Phase Activated Sludge Plant. To avoid zooming a measured implementation was suggested. In the first phase, a One-Stage Activated Sludge plant with simultaneous aerobic sludge stabilization is envisaged to treat wastewater with at least 36,000 PE. The activated sludge tanks in phase 1 are already dimensioned to cover 100% of the necessary biological treatment capacity of phase 2 with special stabilization of anaerobic sludge. For phosphorus elimination, a chemical dosing station will be implemented in phase 1.

In stage 2, an anaerobic Bio-Phosphorus deposit is added to reduce chemical demand. The secondary concentration tanks in stage 1 are designed to cover at least 50% of the hydraulic capacity of stage 2.

Sludge treatment

To achieve DS $\geq$ 35%, it is envisaged that the sludge treatment process will consist of the following units:

- Excess sludge gravity thickener;
- Simultaneous aerobic stabilization of sludge in activated sludge deposits (phase 1)
- Anaerobic digester and CHP for Anaerobic stabilization of sludge (phase 2);
- Sludge storage tanks;
- Centrifuges for drying sludge;
- Lime deposit in cylinders for liming treatment (Optional)
- Sludge solidification area (compost).
- Filtration storage tank.
- (Optional facility for solar sludge drying)

Risks of the Study

Population Development

The rate of population growth is always an assumption that depends on the economic development of a region, local, regional and international factors, political influence and also climate changes, and therefore are not 100% predictable.

Available official figures show a slightly negative growth rate in the Shkodra district, but this may vary for some specific suburbs of the city of Shkodra or the city center. As a compromise, it has been agreed to calculate a growth rate of "0" until the duration of the project 2045 for the project area and to use the current figures of the Municipality of Shkodër as a baseline.

The ambiguity of population data

It is a fact that many people are emigrating from Albania to other countries but continue to remain registered in their towns and villages. They usually come back for some are home during the holidays, but during the rest of the year, no one lives in their houses or apartments. This may be one of the reasons for the high number of connections with "0" water consumption. For the calculation of pipes and main components of the water supply and sewage system, the total number of connections was used. But for the Plant, it was agreed to apply a much lower number of connections to avoid enlarging the plant. The base for phase 1 was set at 36,000 PE and for phase 2 an increase of 69,000 PE (in total 105,000 PE). The basis for phase 2 can be adjusted according to new data, which will be collected during the operation of the complete system and which will be even more accurate and a better basis for further considerations.

Uncertaiabouty of the Water Balance

As a general approach, it is assumed that by the end of the implementation phase consumption per capita will increase from 102 l / c * d to 120 l / c * d and will remain stable until the duration of the project 2045. Also, the figure actual is a calculated value and varies between 76 L/C*d for household connections with water meters and 140 L/C*d for connections that pay the water fee according to the flat rate. Inactive connections are included in this calculation. Applying only the active connections, the specific water consumption could have been calculated with 102 L/C*d (connection with water meter), with 186 L/C*d for connections with afrofe and an average of 135 L/C*d. The reality may be somewhere in between, and the applied and internationally accepted value of 120 L/C*d seems realistic for future considerations. By having all connections equipped with water meters, as is an objective of this project, it may happen that the average consumption per capita normally decreases instead of increasing.

The division of losses into apparent losses and real losses according to the IWA is based on several assumptions, because only a few measured values are available. With the proposed measures mainly replacing the old network, connecting unserved households (which are actually illegally connected) and completely disconnecting the old network, it is expected that the apparent losses will be significantly reduced.

This will depend on the strength of the Water Company, how strictly they will staff and maintain the system with full billing based on water meters, identification of illegal connections, proper DMA-based water balance calculations, management of pressure, active leak detection and immediate response to reported problems.

Coordination with other projects

It is a well-known risk that poor coordination with other ongoing or anticipated projects can lead to duplication of investments, and non-adjustment of concepts developed by different parties. The reality shows that collecting the possible information about the envisaged projects is quite difficult and there is also no guarantee that the project ideas will be implemented.

In the case of Shkodra, it is important to have the certainty of the government project, which aims to rehabilitate the main pumping station and one of the feeder lines, before the implementation starts and the same concept is followed.

Financial Insecurity

Project funding is pre-agreed and guaranteed by KfW on behalf of all other donors. But the submission of offers may exceed the fixed funds. In this case, it will be necessary to remove some small works, but with additional funds applied as the contingency of 10% and other expenses of 5%, it is not very likely that such a situation will occur.

Recommendation

As some feeder lines pass through private land and residential areas without a distribution network, there are many illegal connections and because of this fact, UK Shkodër is facing huge losses. The main priorities for the Shkodër water supply system expressed by the client for the current project are:

- Structuring the entire water supply system in the DMA with sizes between 3,000 and 5,000 connections per area
- Reducing water losses through the elimination of illegal connections and the replacement of supply lines that cross private land
- Rehabilitation of old networks within highly populated sectors of the city center (which have a low specific cost per person)