State of Palestine
Nablus Municipality

دولـــة فلسطين
بلديـة نابلس

Wastewater Treatment Plant

Nablus West

Operation Annual Report

2016

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ABBREVIATIONS

µs/cm: Micro Siemens per centimeter
Al: Aluminum element
AT: Aeration tank
B: Boron element
BOD: Biological oxygen demand
Ca: Calcium element
Cd: Cadmium element
cfu: colony fecal unit
CH_4: Methane
Cl: Chloride
Cn: Cyanide element
C^o: Carbon monoxide
C^o: Celsius degree
CO_2: Carbon Dioxide
COD: Chemical oxygen demand
Cr: Chrome element
Cu: Cupper element
DO: Dissolved oxygen
FC: Fecal coliform
Fe: Ferric element
GIZ: Gesellschaft für International Zusammenarbeit
Hg: Mercury element
JV: Joint venture
kfW : Kreditanstalt für Wiederaufbau
kg/d: Kilogram per day
Km: Kilometer
KPR: Kinetics- Passavant Reodiger
kWh: Kilowatt hour
Li/HEC: Consultant Lahmeyer and Hijjawi Engineering Center
m^3: Cubic meter
MBAS: Methylene blue active substance
MCC: Motorized control centre
Mg: Magnesium element
MLSS: Mixed liquor concentration
Mn: Manganese element
Na: Sodium element
NH_4-N: Ammonium as nitrogen
Ni: Nickel element
NM Nablus Municipality
NO_3-N: Nitrate as nitrogen
Pb: Lead element
PE: Population equivalent
PLC: Programmable Logic Controller
PO_4-P: Phosphate as phosphorous
SAR: Sodium adsorption ration
SCADA: Supervisory Control and Data Acquisition
Se: Selenium element
SO_4: Sulphate compound
TDS: Total dissolved solids
TN: Total nitrogen
TSS: Total suspended solids
WSSD: Water supply and sanitation department
WWTP: wastewater treatment plant
Zn: Zink element

1. INTRODUCTION

Water Supply and Sanitation Department (WSSD) is considered one of the important departments of Nablus Municipality (NM) that provides safe drinking water and sanitation services to Nablus citizens and several surrounding villages in addition to four refugee camps, namely, Balata, Ein Beit Elma, New and Old Askar Camps. It is estimated that 230,000 inhabitants receive drinking water services. Water and sanitation department has a staff of 300 employees including engineers, technicians, skilled and unskilled laborers.

In 1998 the financial agreement for the implementation of Sewage Project Nablus West was signed between the German Government through KfW and Nablus Municipality. So far the allocated fund reached up to 39 million Euros. The Project consisted of construction trunk and interceptor of 12 km and wastewater treatment plant (WWTP) of 150,000 PE. The WWTP was designed to treat 14,000 m^3/day and 8.0 tons of BOD_5 per day. The plant is located near Beit Leed village junction. The wastewater is collected from Zawata, Beit Eba, Beit Wazan, Deir Sharaf and Qusin in the future by gravity after the implementation of relevant sewerage networks.

Nablus West catchment area presently has a population of about 120,000. Presently about 95% of the population of Nablus west is connected to the sewerage network. The main objectives of the sewerage project Nablus West are:

- Improve the environmental and health conditions in upper Wadi Zumer
- Protect the surface and groundwater from pollution
- Reuse of treated wastewater for irrigation purposes

The construction works of the project have been completed in July 2013; however it was put into operation in November 2013. The consultant Lahmeyer and Hijjawi Engineering Center (Li/HEC) who provided the consultancy services for Nablus west sewerage project had issued the performance certificate to the contractor the JV of Kinetics- Passavant Reodiger (KPR) on September 23^{th,} 2015.

Operation assistance (OA) for two years at the cost of 1.10 million Euros has been allocated through KfW to provide operational assistance to operate, guide and train NM WWTP staff. The OA was provided by the KPR which was concluded in November 2015.

A second phase of OA financed through KfW is provided now by Consul Aqua to guide the WWTP staff on part time basis.

2. BACKGROUND

2.1 Location of the WWTP Nablus West

The WWTP Nablus West is located approx. 12 km West of Nablus City and lies on a much lower orthographical level than Nablus City. Ideally, wastewater is flowing into the treatment plant through gravity sewer system.

Figure (1): Section of a topographic map in the project area

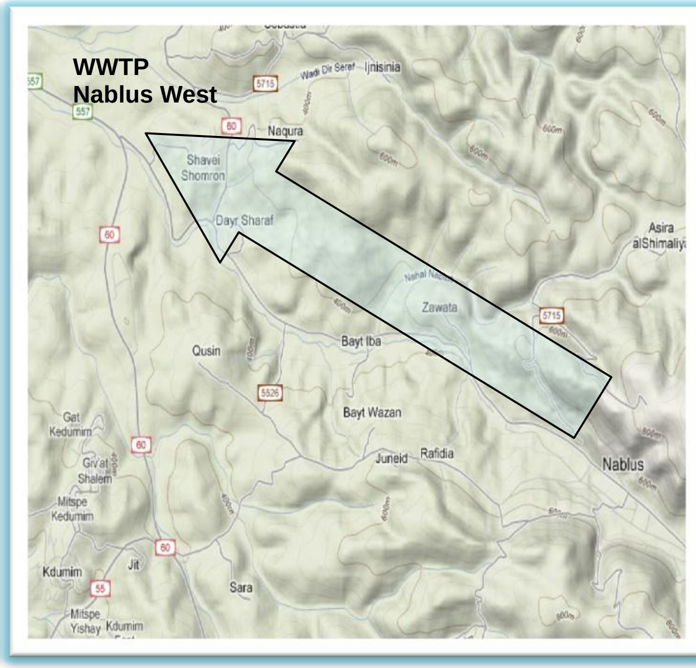


Figure (2): Direction of slope

Figure (3): Overview of WWTP Nablus West

2.2 WWTP Nablus West

The WWTP Nablus West is operated as an activated sludge process with a mechanical treatment, a biological treatment and a sludge treatment steps with gas utilization. In Figure (3) shows an overview of the WWTP Nablus West. Three construction stages have been planned for the WWTP Nablus West: stage 1 with a design horizon in 2020, stage 2 with design horizon in 2025 and a final stage 3 with design horizon in 2035. During the first construction stage the parts marked by green of the WWTP (Figure 4) were implemented.

Figure (4): WWTP Nablus West

3. GENERAL PERFORMANCE

Around three millions nine hundred and forty seven thousand (3,947,000 m^3) cubic meters of wastewater were treated during 2016, with an electrical consumption of two million nine hundred and thirty six thousand (2,936,000 kWh). During last year, in general, the average lab results met the Palestinian standards. The average effluent concentration of BOD_5 was 11 mg/l and TSS was 21 mg/l. By these results, the treatment efficiency in terms of BOD_5 and TSS were 98 % and 95% respectively.

4. OPERATION OF WASTEWATER TREATMENT PLANT FACILITIES

4.1 Screens and grit/grease removal

The wastewater treatment in Nablus West that consisted of two types of screens. The first is coarse screen (bar space of 5 cm), and the second is fine screen (bar space of 5 mm). The main objective of this unit is to protect the facilities from plastics, woods, rubbish and etc. The screened solid material removed by the screen conveyors for disposal.

Grit/grease removal unit is designed to remove sand and grits/grease from wastewater. The grease is sent to the anaerobic digester however, grits/sands were washed out by treated wastewater in the grit classifier to sanitary disposal.

4.2 Two Primary sedimentation tanks with total volume (1,728 m^3)

In this unit, around 60% of organic suspended solids are settled down in two rectangular tanks forming primary sludge. The primary sludge is thickened in a gravity primary thickener to increase its concentration from 1% to 4% to be digested in the anaerobic digester in a later stage.

4.3 Two Aeration tanks with total volume (18,000 m^3)

The biological wastewater treatment in the aeration tanks is the core of the WWTP. High concentration of special aerobic bacteria and other microorganisms are activated in the aeration tanks at existence of high concentration of oxygen called activated sludge. The soluble and other suspended organic material is digested by bacteria .This unit has to be controlled in terms of the concentration of activated sludge and dissolved oxygen content. Almost 90% of the power consumption of the WWTP is required to operate theses two tanks.

4.3.1 Nitrification and de- nitrification

The plant is designed for COD removal. Nitrification and de- nitrification also phosphate elimination is not foreseen in the first stage. However, on the 17th of March, 2015 the plant started to perform nitrification, and de- nitrification process in the aeration tanks in addition to carbon removal process.

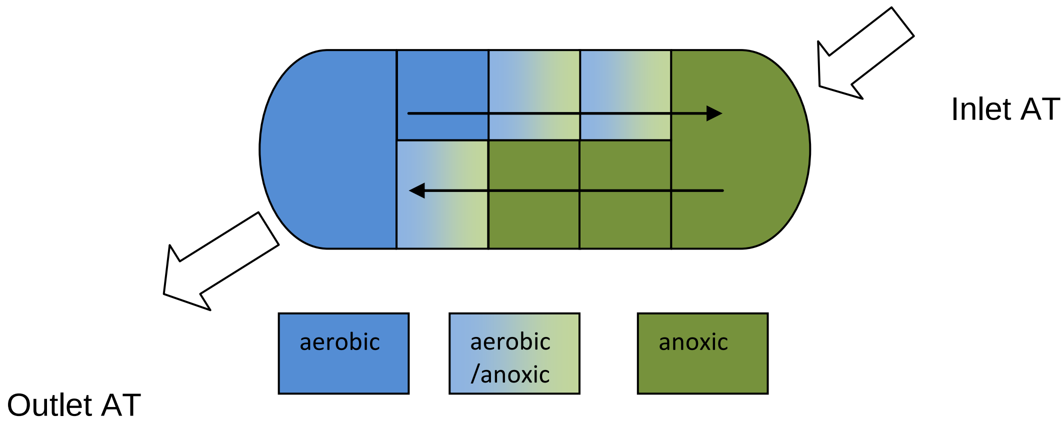


Figure (5): Aeration tank with implemented de-nitrification zone

In areas where oxygen was reduced, there were bacteria starting a de- nitrification process. In de- nitrification, elemental gaseous nitrogen is produced from nitrate and nitrite and released to the atmosphere.

4.4 Two Final sedimentation tanks with total volume (7,718 m^3)

The activated sludge is settled down in the two circular final sedimentation tanks. The settled bacteria is withdrawn from the bottom of the tanks and returned back to the aeration tanks as returned sludge. This recycling of activated sludge is necessary to maintain certain concentration of activated sludge (around 2-3% SS) with optimal sludge age, however the excess sludge is pumped to the mechanical thickeners for further treatment in the anaerobic digester.

5. OPERATION OF SLUDGE FACILITIES

5.1 Two mechanical sludge thickening machines

The excess sludge is withdrawn via pumps to the mechanical thickening machines where polymer is added. This machine thickened the excess sludge up to 1% to 6% SS concentration. After thickening it is mixed with the primary thickened sludge to be pumped later on to the digester.

5.2 Primary thickener tank (548 m^3)

The settled primary sludge in the primary sedimentation tanks is sent to the primary gravity thickener circular tank. In this unit, the sludge is thickened to reach 6% which is treated alert on in the anaerobic digester.

5.3 Anaerobic digester (3650 m^3)

The thickened primary sludge and thickened excess sludge are treated in the anaerobic digester; the retention time is 21 days. Temperature and pH are carefully monitored to maintain optimum conditions for the anaerobic bacteria in the digester (pH= 6.8-7.5), the solid content is around 3-4%. The biogas produced from the digester normally contained 33% of CO_2 and 66% of methane gas. The sludge is heated up via boiler to maintain mesophilic conditions in the digester around 36 C^o. Figure (6) shows the anaerobic digester of Nablus west and the gas flare.

Figure (6): Digester tank in Nablus West WWTP with the gas flare

5.4 Gas balloon holder (660 m^3)

Produced CH_4 gas from the digester is treated in stone filters to remove the humidity and then store it in the gas holder.

5.5 Gas flare

The excess gas is burned by the gas flare. It starts flaring when the storage in the balloon reaches up to 90% and stop when it reaches 80% of the volume of gas balloon.

5.6 Sludge drying beds

In emergency cases, the digested sludge is pumped to the drying beds for drying via natural evaporation. There are 11 beds with total area of 11.5 donum. After drying, the sludge is transported to the sludge storage yard for disposal to Zahret Al-Fenjan sanitary landfill site near Jenin.

5.7 Two mechanical dewatering machines

Two dewatering machines are used to dewatering the digested sludge coming from the digester to have solid content more than 28%. Special polymers are used to improve the efficiency of these machines as shown in Figure (7).

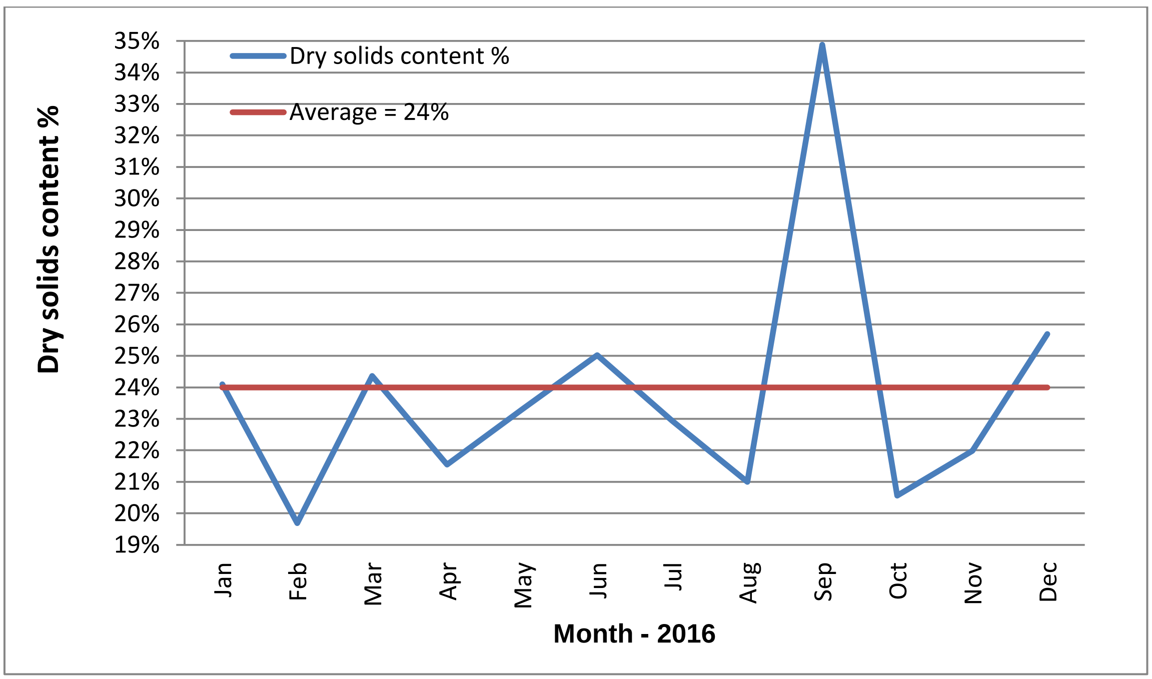


Figure (7): Dry solids content after mechanical dewatering.

5.1 Other facilities

Other equipment is available for the sustainability of the operation of the WWTP such as well-equipped lab, stand by generator, spare parts, administration building and workshop.

6. SCADA SYSTEM

The sewage treatment plant is controlled by using Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA). The PLC's is located in several substations (electrical switch rooms) within the wastewater treatment plant.

The wastewater treatment plant is controlled by PLC's. PLC's and their support equipment are computer controlled system that is capable of remote managing of the plant's operation. The control is executed from the analogous and digital in-puts / outputs received from instruments, drives and MCC and from signals received from the SCADA system. Figure (8) shows the main electrical panels and SCADA rooms.

Figure (8): Nablus WWTP SCADA system

7. PERFORMANCE OF WWTP

7.1 Influent flow

The performance of WWTP Nablus West during 2016 was analyzed on the basis of the plant loading which had been monitored regularly. Two aeration treatment tanks were mainly in operation, the hydraulic treatment capacity of the plant was sufficient and the amount of inflow in most cases under design capacity. Only extreme weather conditions (heavy rain) led to capacity problems. The hydraulic and pollutants loading and the actual performance of WWTP Nablus West from January 2016 to December 2016 were analyzed. The main problems that had been faced were also described. Finally, feasible threshold values for the WWTP effluent and sludge was determined

Figure (9) Shows the hydrographs of the daily wastewater flows which were treated in WWTP Nablus West. It became clear that no strong fluctuation of the daily wastewater flows occurred during summer time. However, in the winter time the fluctuation was sometimes very high due to heavy rain events. In such cases, the bypass to Wadi prior to the WWTP had to be used for plant protection design capacity.

The average daily wastewater flow in the year 2016 was approximately 10,775 m³. The amount of incoming wastewater will increase gradually over the next years. The average flow values in the year of 2016 are shown in Figure (9). Additional villages are expected to be connected to the trunk line and interceptor in 2017.

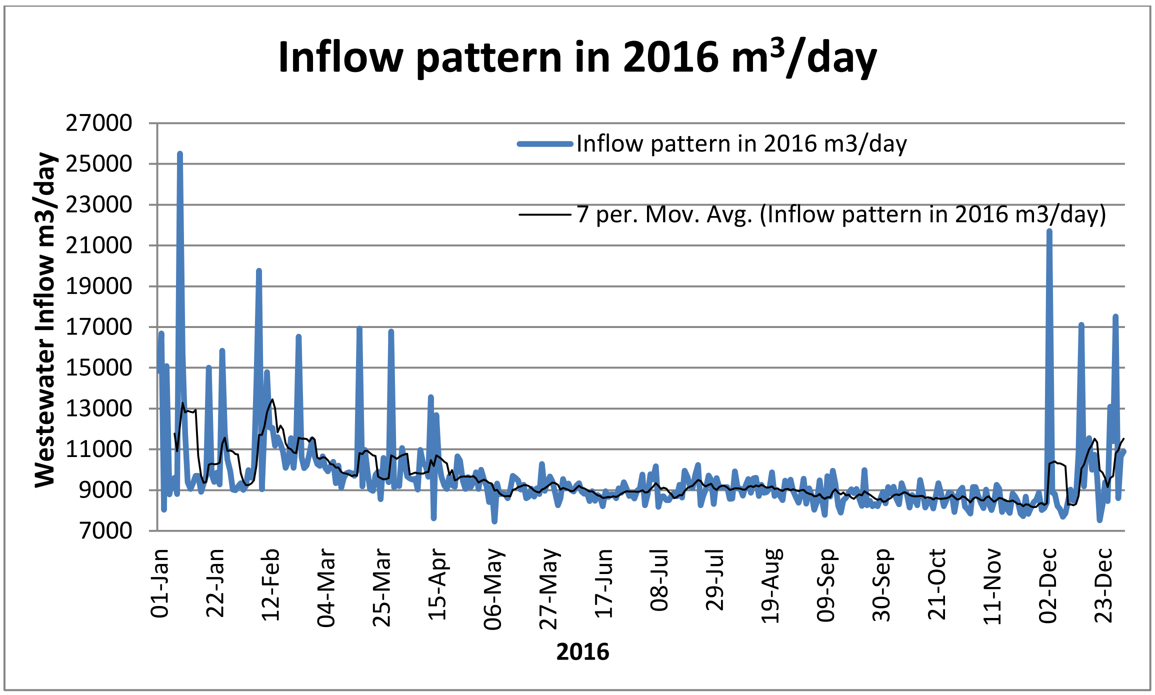


Figure (9): Hydrograph of the daily treated wastewater inflow

7.2 Cleaning performance

The current daily wastewater pollution load treated in WWTP Nablus West in terms of COD and SS were estimated. The average daily COD load was approximately 10,075 kg/d and the total COD load during the year of 2016 was 3,687,313 kg. The COD load at the effluent during the same period was 224,788 kg. The cleaning performance was approximately 94%. The measured COD values (inlet/outlet) and the cleaning performance are shown in Figure (10).

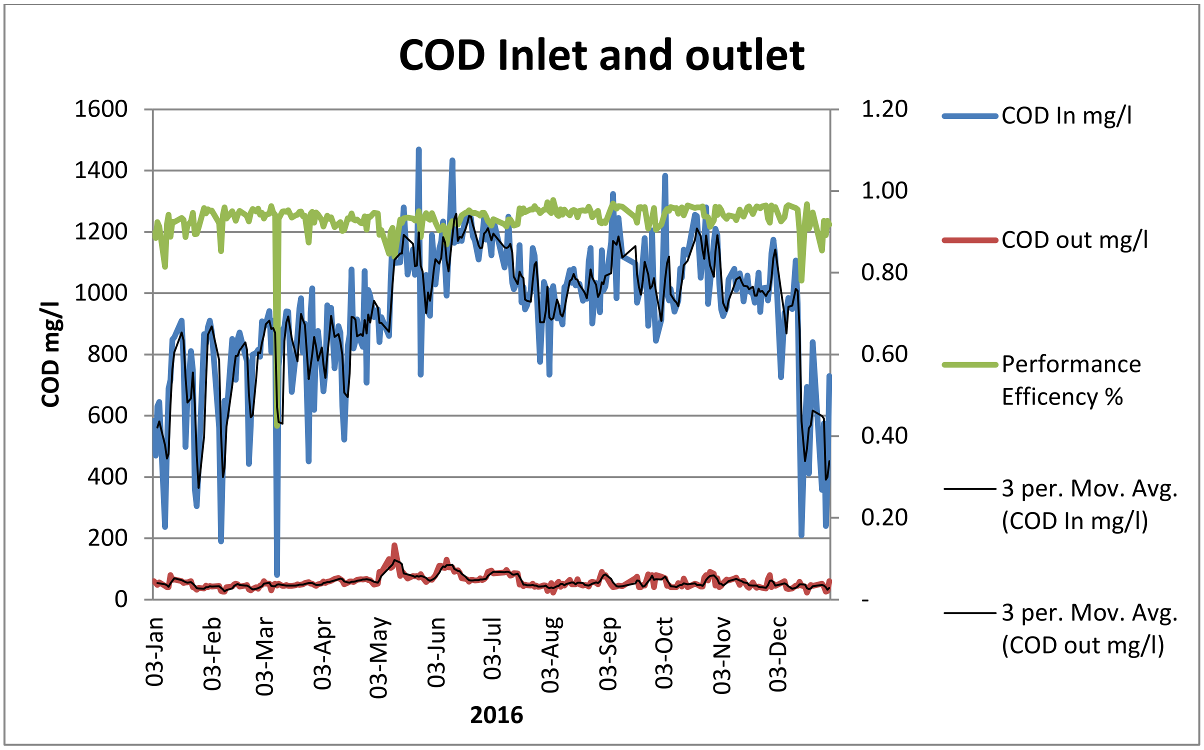


Figure (10): Influent and effluent concentration of COD

The hydraulic and pollutant load of WWTP Nablus West as well as site conditions had an effect on the performance of the WWTP. The average daily suspended solids inflow was approximately 4,526 kg/d. The reduction of suspended solids was in average approximately 95%. Figure (11) shows the suspended solid values for the WWTP Nablus West.

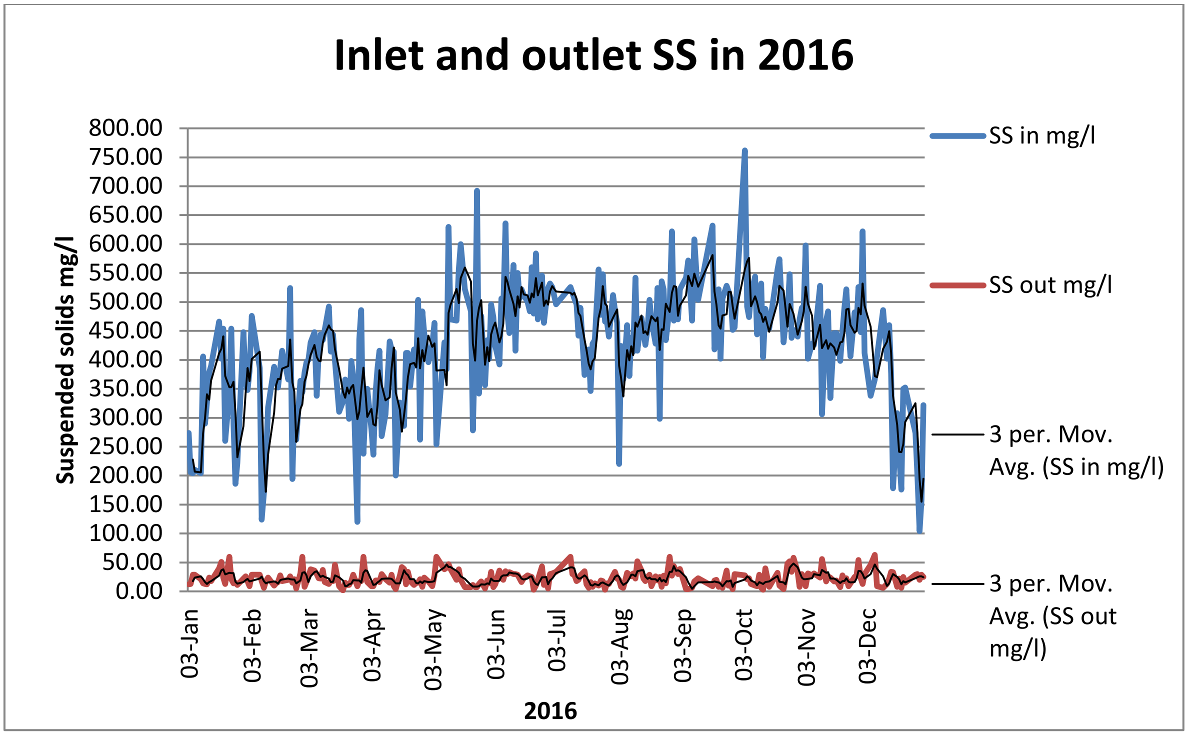


Figure (11): Suspended solids of the inlet and outlet of the treatment plant

7.3 Power consumption

Optimization of operation is one of the most important challenges in municipal WWTPs. The specific power consumption of similar WWTP is about below 0.85 kWh per m³ of treated wastewater, however in Nablus WWTP was 0.75 kwh/m3 during 2016. Deviations from this value can be attributed to the circumstances of daily plant operation.

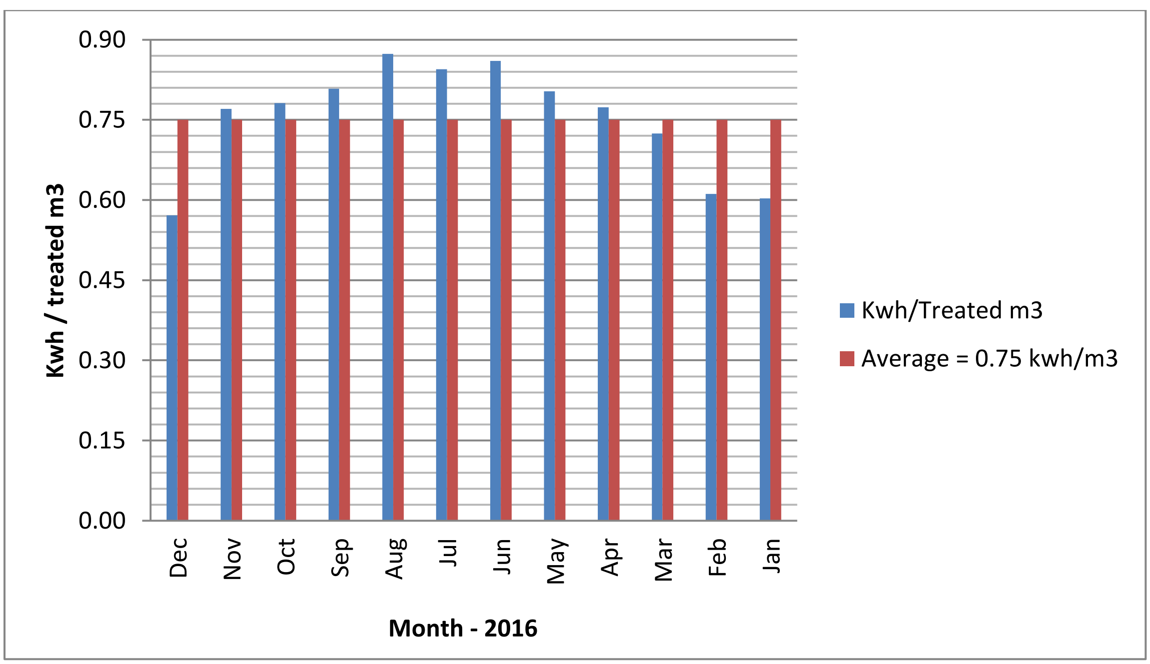


Figure (12): Monthly values of power consumption per treated m³ of wastewater

7.4 Gas production

Part of produced biogas at this stage was used for heating the digester. However, the excess biogas was burnt by the flare. The average gas production during 2016 was 4,052 kg per day. Figure (13) shows the daily gas production from the digester of WWTP Nablus West.

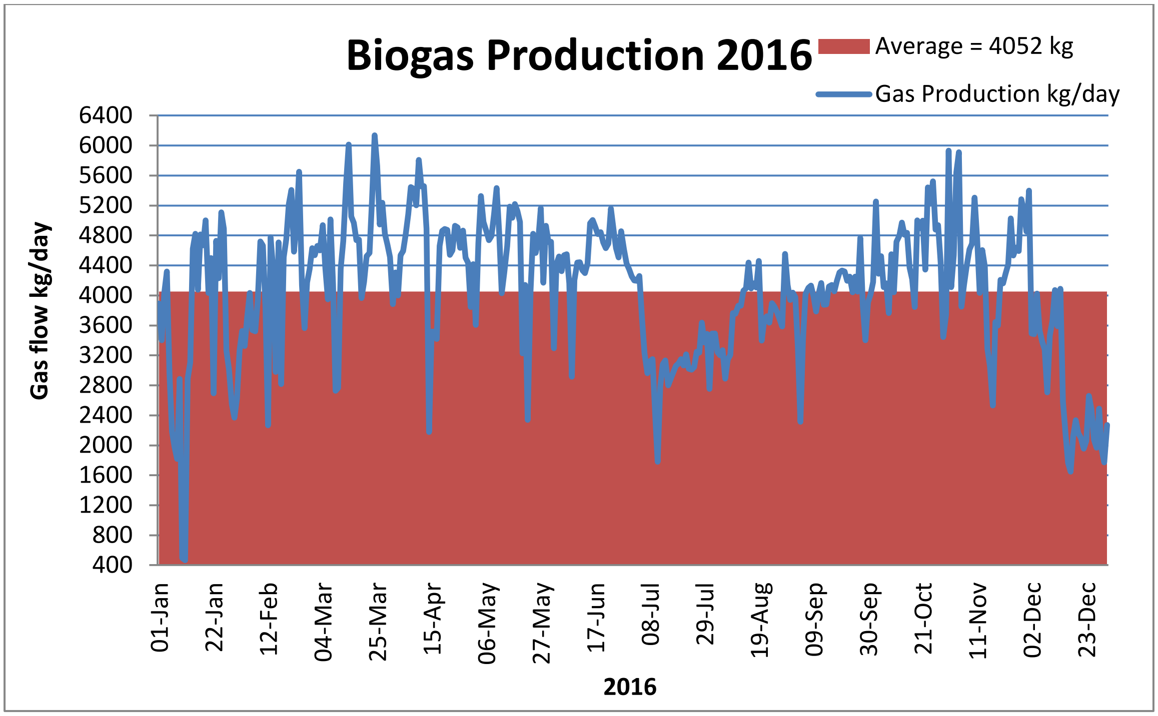


Figure (13): Gas production of the digester

In 2016 more regular operation of the digester was done and as a result a substantial increase in biogas occurred. It is expected that CHP unit will be installed in 2017 to produce electricity from biogas and will almost cover 80% of the electricity demand of the WWTP.

8. PREVENTIVE MAINTENANCE

From the beginning of the plant operations maintenance works and plans had been conducted in accordance with the periodic and routine works of machines manuals. These works could be classified as preventive maintenance. Preventive maintenance was done by Nablus WWTP staff.

9. STAFF TRAINING AND ORGANIZATION STRUCTURE

Training is essential for the sustainability of the plant. The staff of Nablus plant had been trained by the main contractor and GIZ in many fields of plant operations such as:

- Refreshing practical and theoretical off job training in Hamburg-Germany through GIZ.
- Practical and theoretical on the job training to all units of WWTP.
- Trouble shooting in emergency cases under normal operation conditions.
- Practical and theoretical on the job shadowing in Hamburg-Germany through KfW.

10. REUSE PROJECTS

In view of the limited water resources in the West Bank, reuse of treated wastewater has a great potential to reduce part of these problems and improve crop yield. Designing wastewater treatment plants for reuse in irrigation could potentially increase agricultural yields, conserve surfaces water and balance chemical fertilizer demand. Nablus Municipality adopted the policy to reuse treated wastewater in agriculture. With reference to Ministry of Agriculture by-law 34-2012 the treated wastewater quality of Nablus WWTP has Grade (A). Four reuse projects are foreseen in the time being as shown in the following Table.

Reuse Projects by Treated Wastewater Table

No	Project	Area (Donum)	Crops	Financing	Objective	Quantity of TWW (m^3) \Year	Operating party	Cost (Euro)	Status Taking Over/foreseen steps
1	**Reuse Inside WWTP scheme Figures 14,15**	40	Avocado-Olive-Apple-Almond-Pomegranate-Pirsamon-Pistachio-Apricot-Walnut-Pecan-Citruss-peach-Alfalfa-Barly-Vetch	EU+ German Government through KfW	Educational Pilot project	35,000	Nablus Municipality	462,000	Jan-2017
2	**Reuse outside WWTP scheme Figure 16**	120	Olive-Almond- Alfalfa	EU+ German Government through KfW	Pilot project	115,000	Deir Sharaf WUA	1,500,000	End-2017
3	**Compete Project Figure 17**	140	Olive-Almond - Pomegrante-Apple-Fig	USAID	Pilot project	80,000	Deir Sharaf WUA	500,000	Mar-2017
4	**Reuse outside 2800 Figure 18**	2800	Alfaalfa-Pecan-Walnut - almond-alfalfa-olive	German Government through KfW	To reuse all TWW in Agriculture	3,000,000	Deir Sharaf WUA	10 millions	End 2019

Figure (14): Reuse inside scheme

Figure (15): Sand filtration and ultraviolet disinfection units

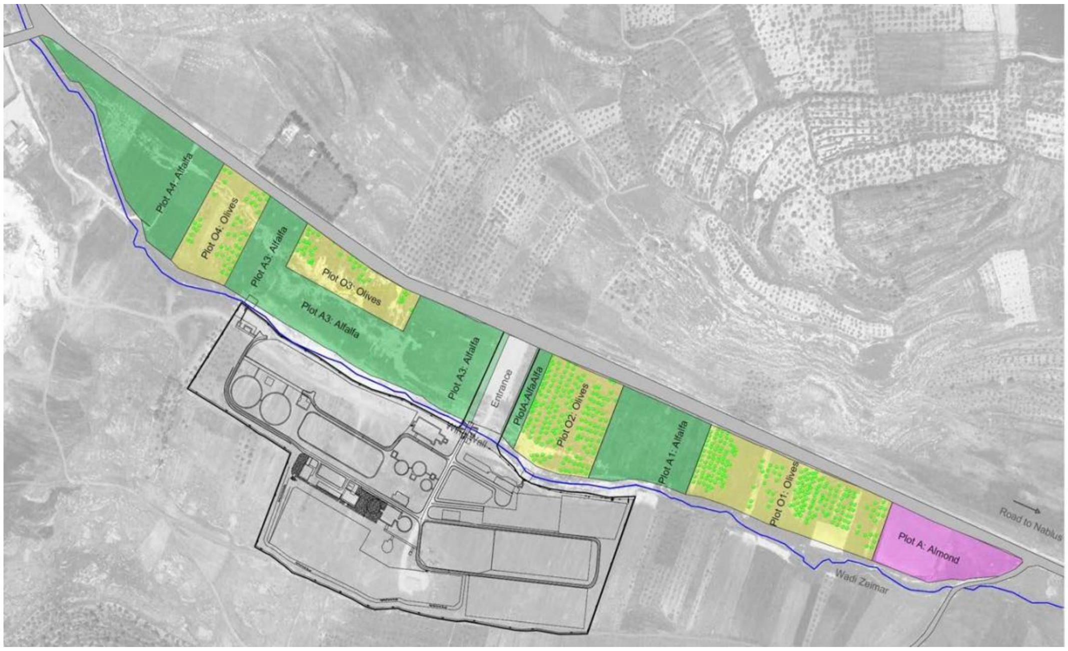


Figure (16): Reuse outside scheme

Figure (17): Reuse outside scheme

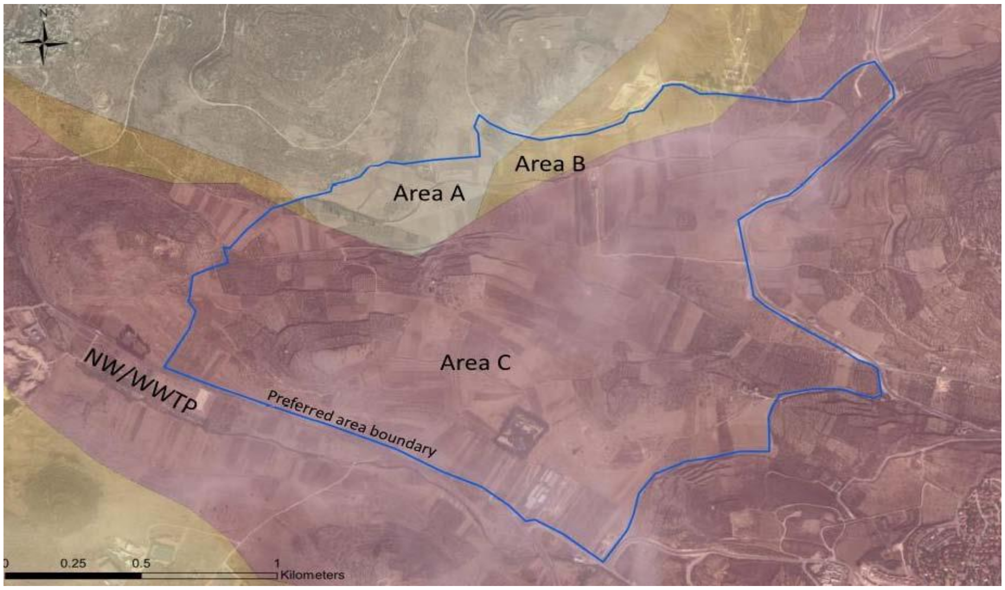


Figure (18): Reuse outside scheme 2800 donum

11. Future improvements

- Construction of CHP Unit to produce electricity from Bio-gas from the Anaerobic Digester at the cost of 0.75 M€ agreed by KfW. NM contribution 10%. Reduction/savings in electricity cost up to 80-85%.
- Implementation of a stone trap at the inlet of WWTP to protect screens.
- 50 KW Pilot Project of PV Solar Panel financed through Nuremberg City- Germany. Agreement to be signed in March 2017.
- 500 KW PV project is foreseen with Nuremberg City- Germany for pumping TWW for reuse in agriculture.
- Covering primary thickener tank and the sludge storage yard.

12. Problems & Challenges in 2016

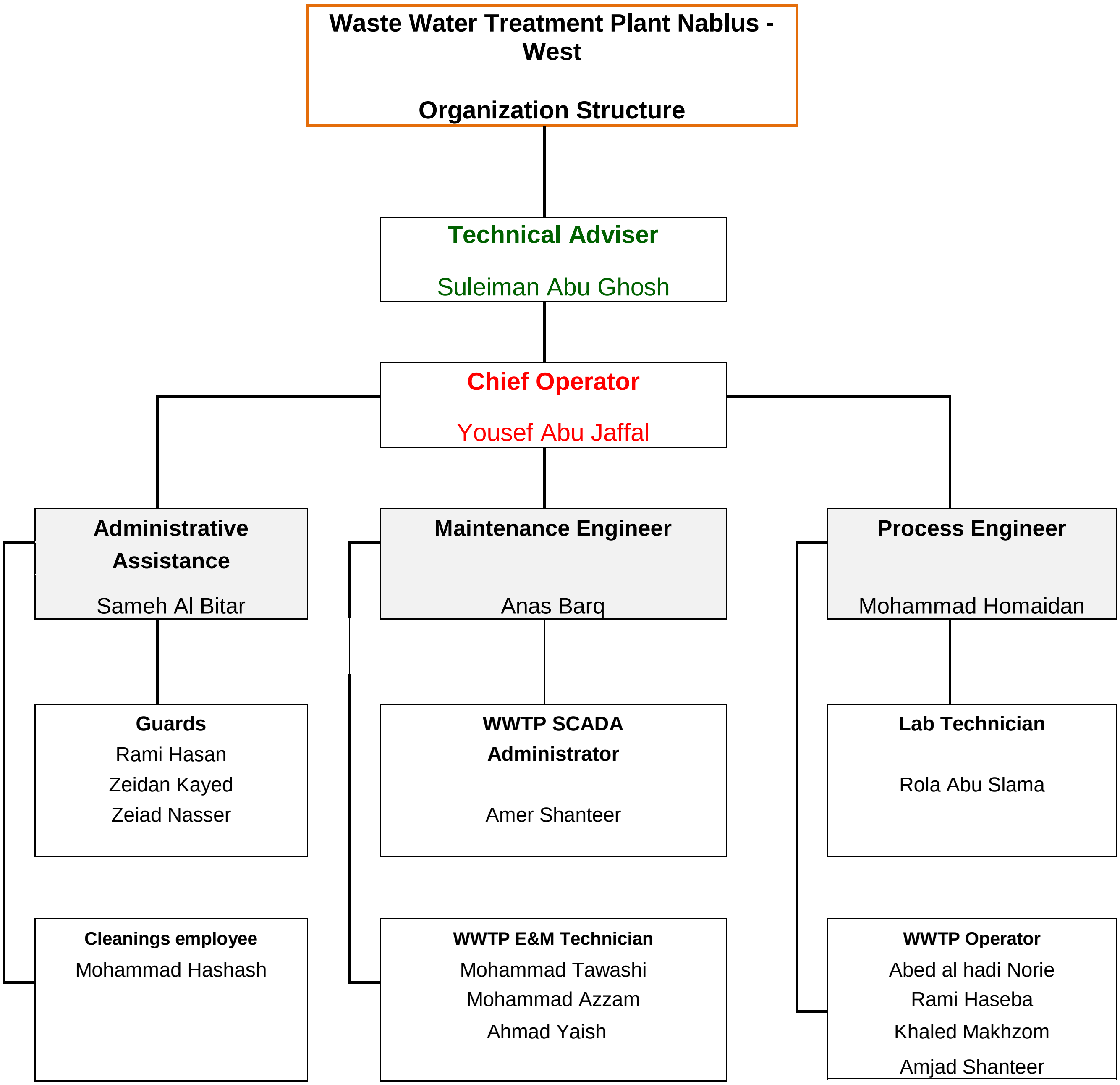
- Unavailability of spare parts in the local market.
- Keep the staff of the WWTP.
- Sludge Disposal:
  1. High Cost of sludge disposal in Zeharet Al-Fenjan about 75 NIS/ton.
  2. As per Palestinian standard, it is not allowed to reuse sludge in agriculture due to high water content in sludge about 75%.

13.Visits

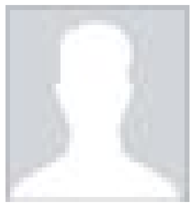
During 2016 many delegations visited NWWTP site which intends to view progress of projects and express their admiration of the effort by Nablus Municipality and relevant staff.

#	Visitors	No.
1	An-Najah university student - environmental club	25
2	Nor shams secondary school	20
3	Talae'e Alamal schools (3 × 35)	100
4	Birzeit university	20
5	Direstia secondary school	20
6	FAO (food and agricultural organization)	10
7	Ibn sena college for nursing	10
8	Vocational Training Center of Jericho	20
9	Al-badan secondary school	30
10	Birzeit university – mechanical engineering department	50
11	Housewives – public awareness campaign	10
12	Rehabilitation Centre for Girls - Jericho	20
13	Birzeit university – civil engineering department	20
14	European Commission	10
15	EQA (Palestinian Environmental Quality Authority)	10
16	German representative office in Ramallah	30
Total		**385**

14. Organizational Chart



Staff Members

Suleiman Abu Ghosh - Technical Adviser 	Yousef Abu Jaffal -Nablus WWTP Chief Operator 
Mohammad Homeidan -Process Engineer & Lab Officer in Nablus WWTP 	Anas Barq - Electrical Engineer 
Sameh Bitar -Administrative Secretary & Accountant 	Rola Abu Slama -Lab Technician 
Amer Shanteer - WWTP SCADA Administrator 	Yazan Oudeh -Agricultural engineer 

<u>Operators</u>

			
Khaled Makhzom	Amjad Shanteer	Rami Hasiba	Abed alhadi Norie

Electro mechanic Technicians

Mohammad Tawashi

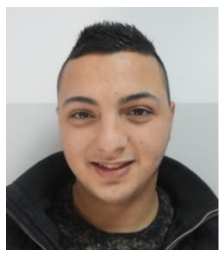
Mohammad Azzam

Ahmad Yaish

Labour

Mohammad Antar

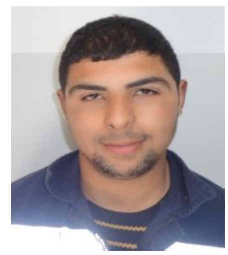
office boy



Mohammad Hashash

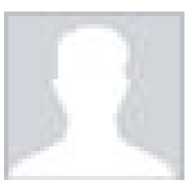
Agriculture

Ibrahem Rameha



Bara’a Fakrldeen

Guards



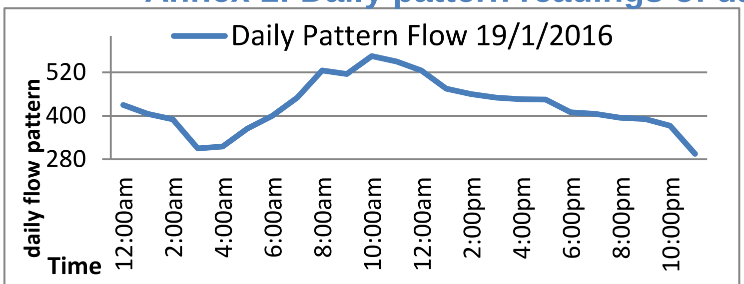
Rami Hasan

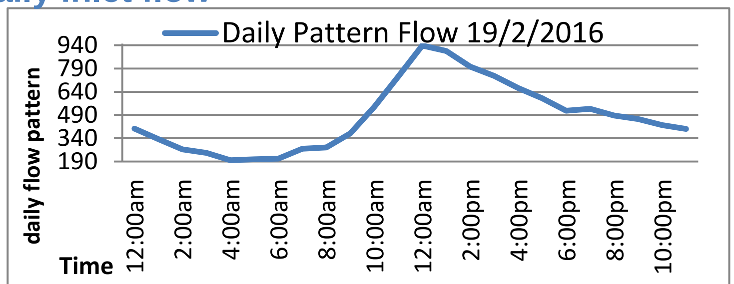
Zeidan Kayed

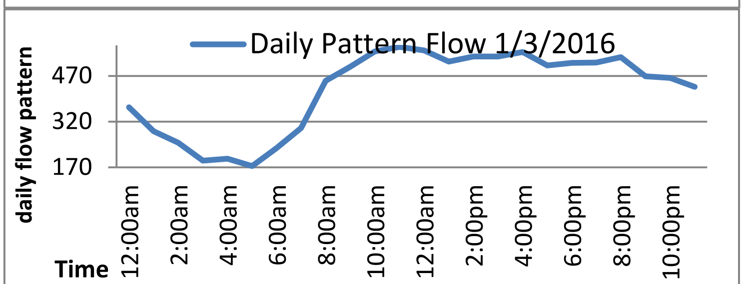
Zeiad Nasser

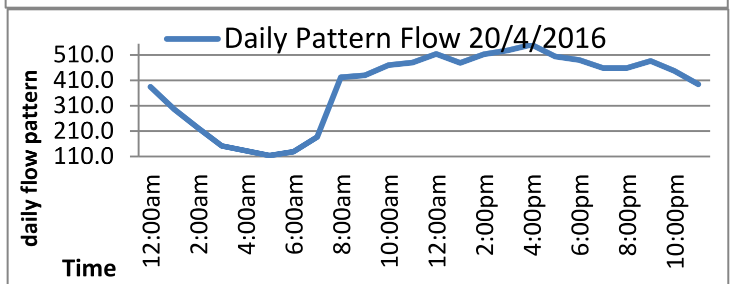
15.Annexes

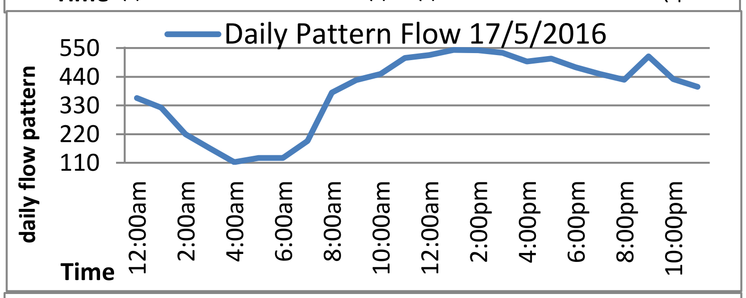
Annex 1: Daily pattern readings of daily inlet flow

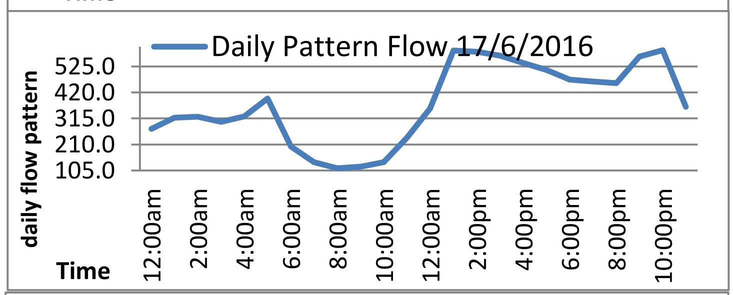


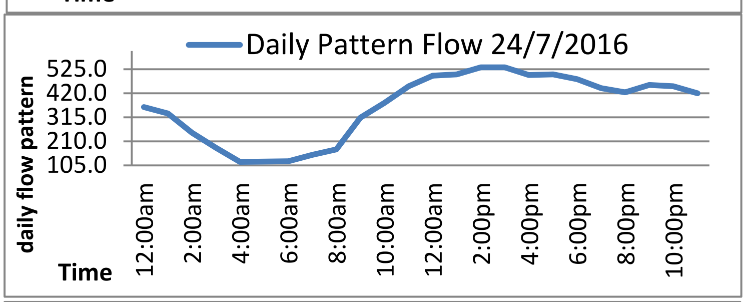


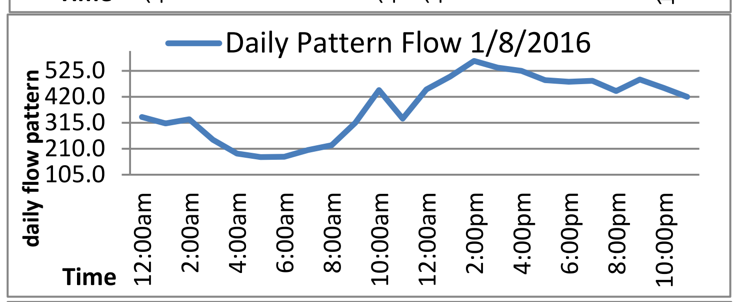


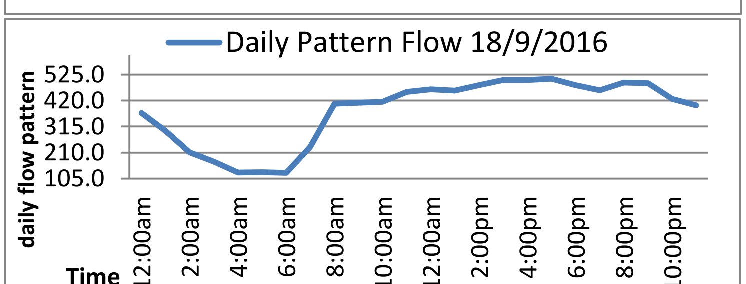


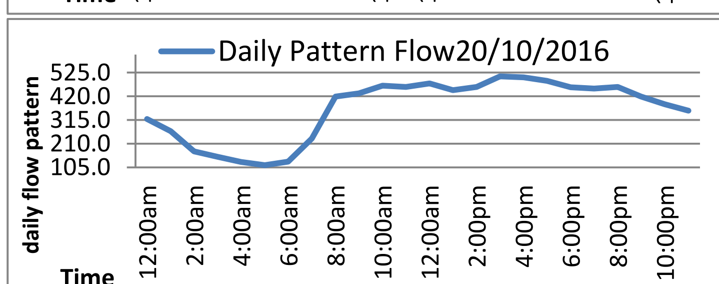


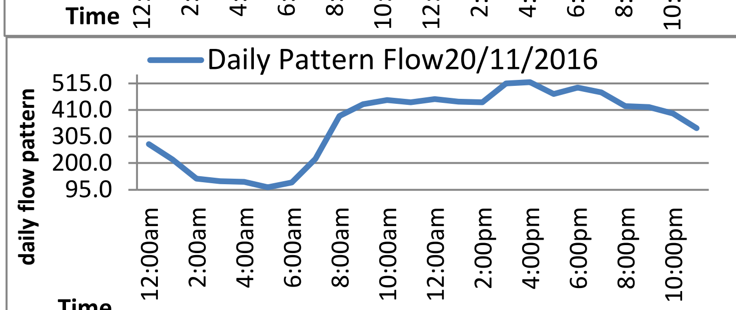


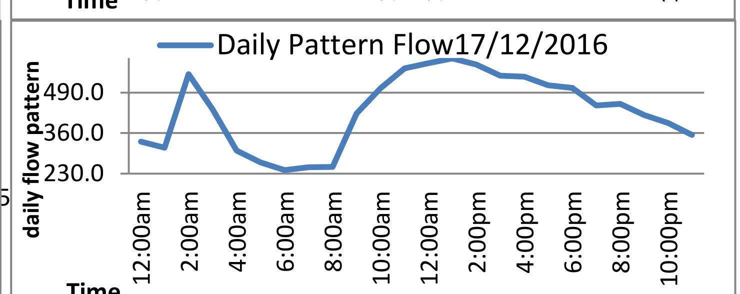




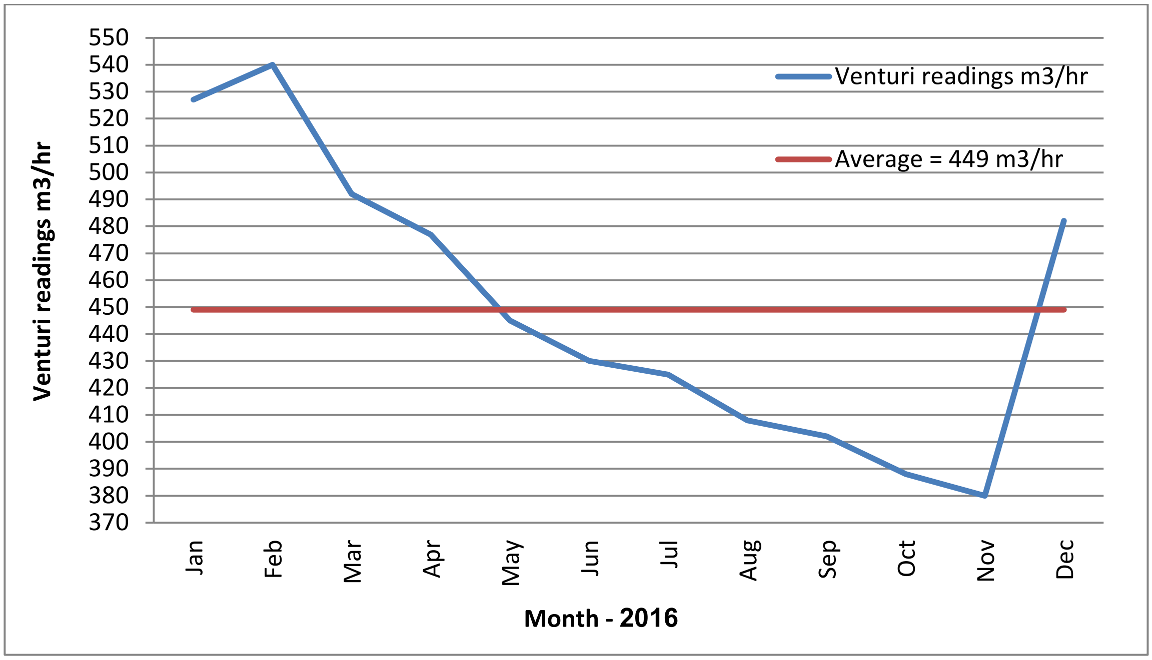




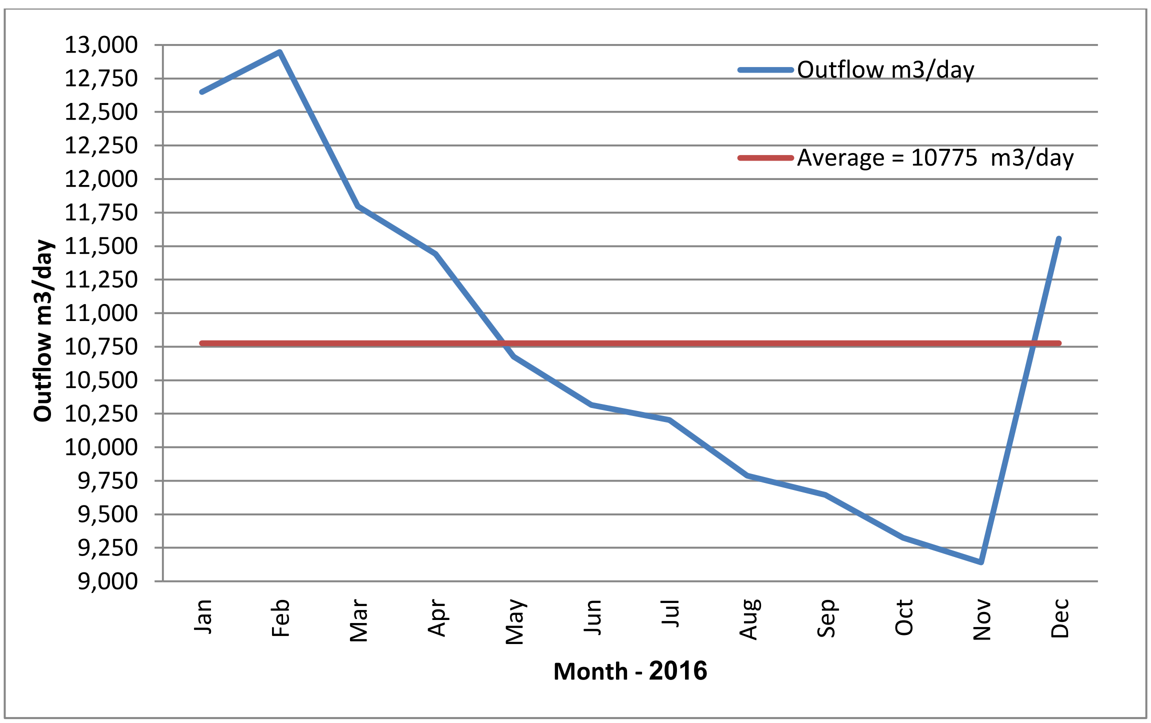




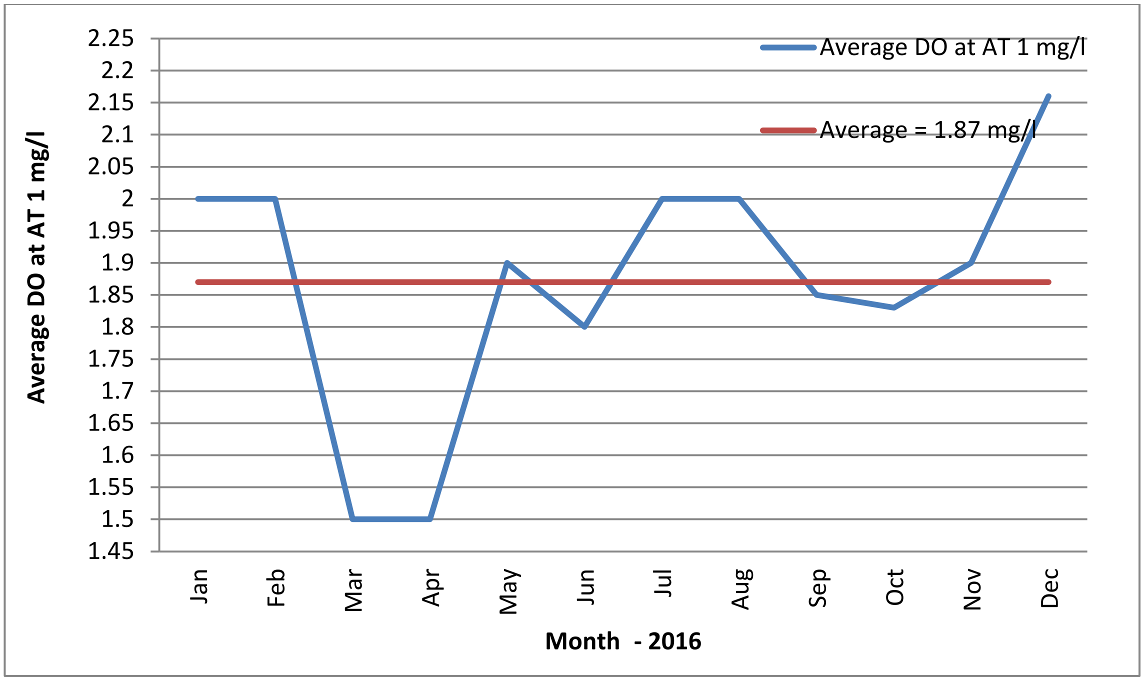
Annex 2: Graphs



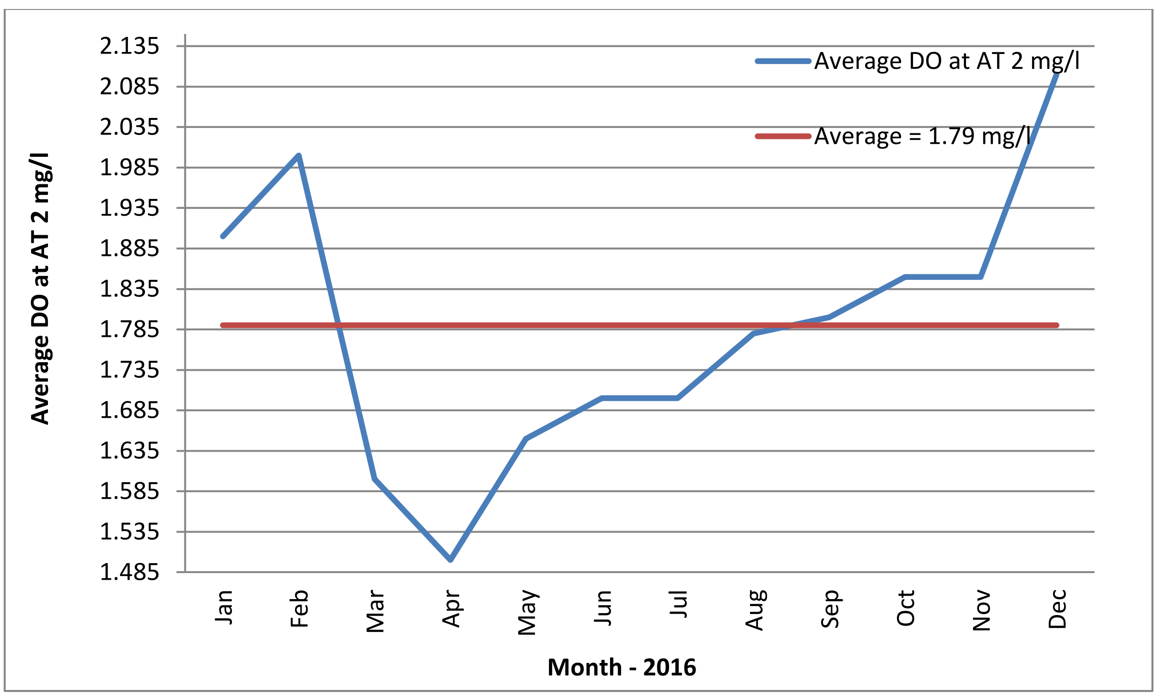
Graph 1: Average wastewater influent



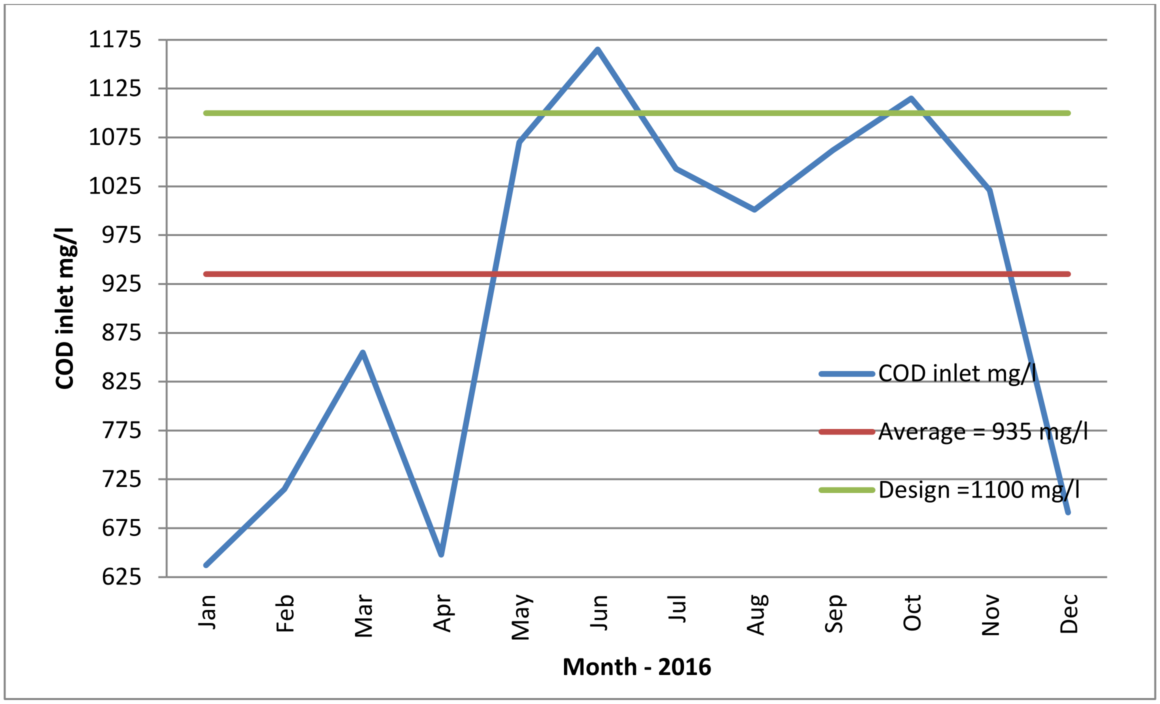
Graph 2: Average treated wastewater effluent



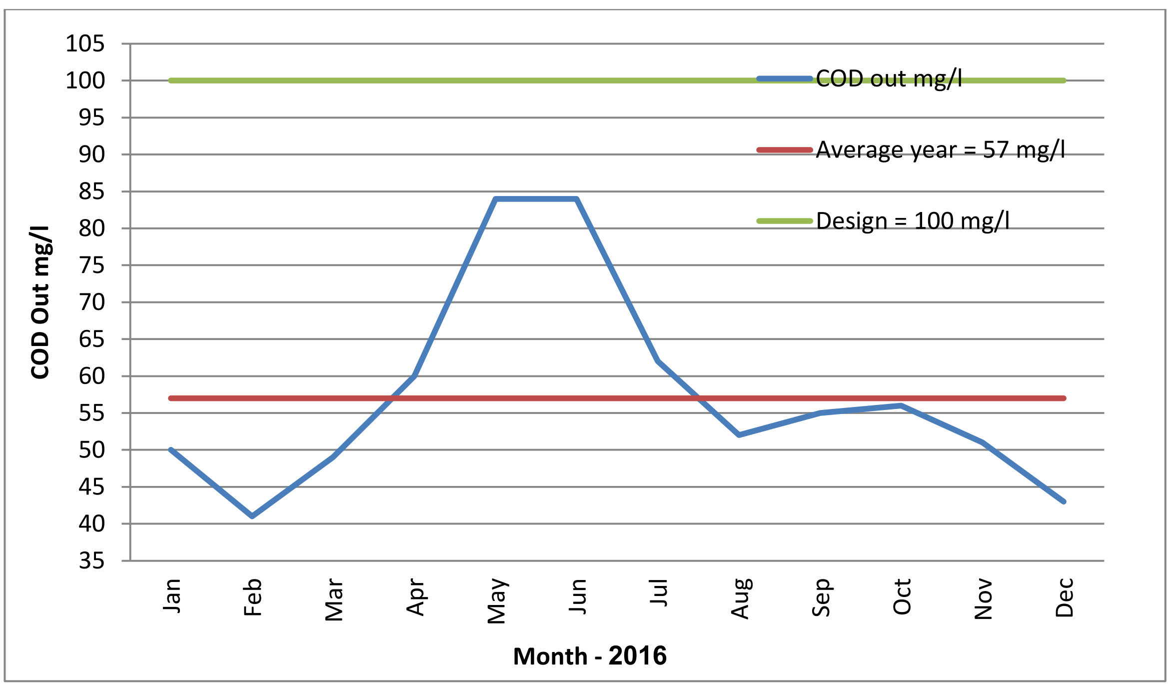
Graph 3: Daily dissolved oxygen concentration pattern in the aeration tank no. (1)



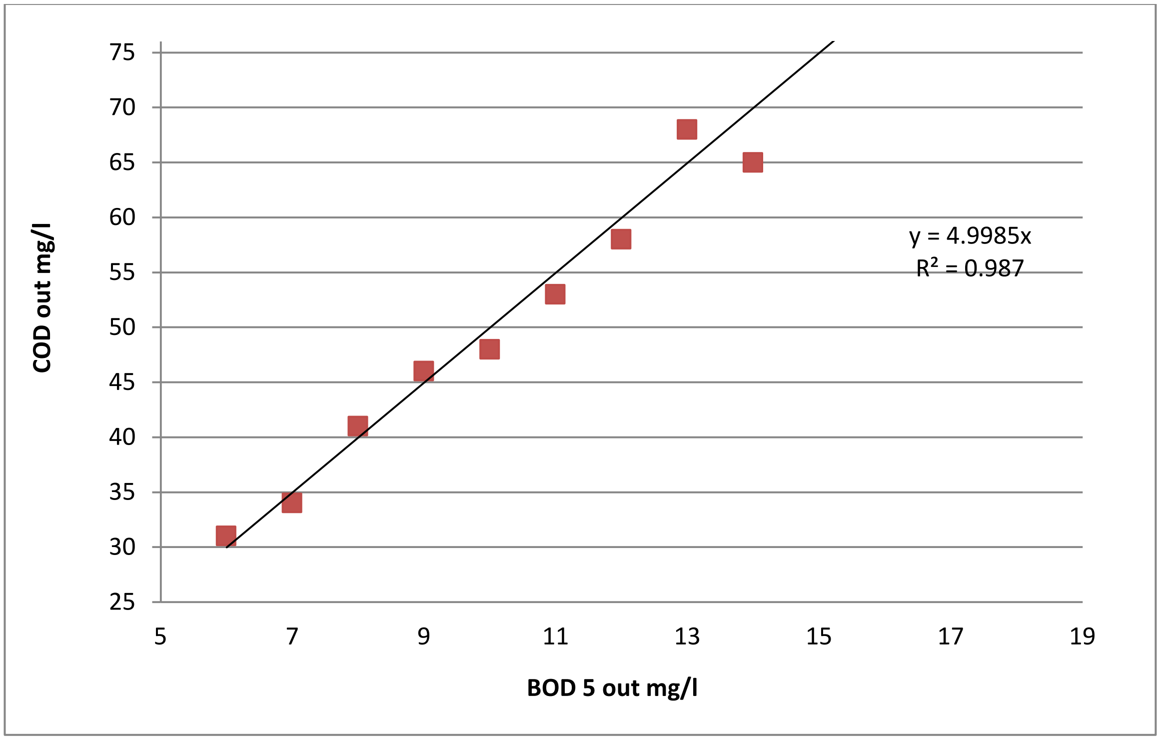
Graph 4: Daily dissolved oxygen concentration pattern in tank no. (2)



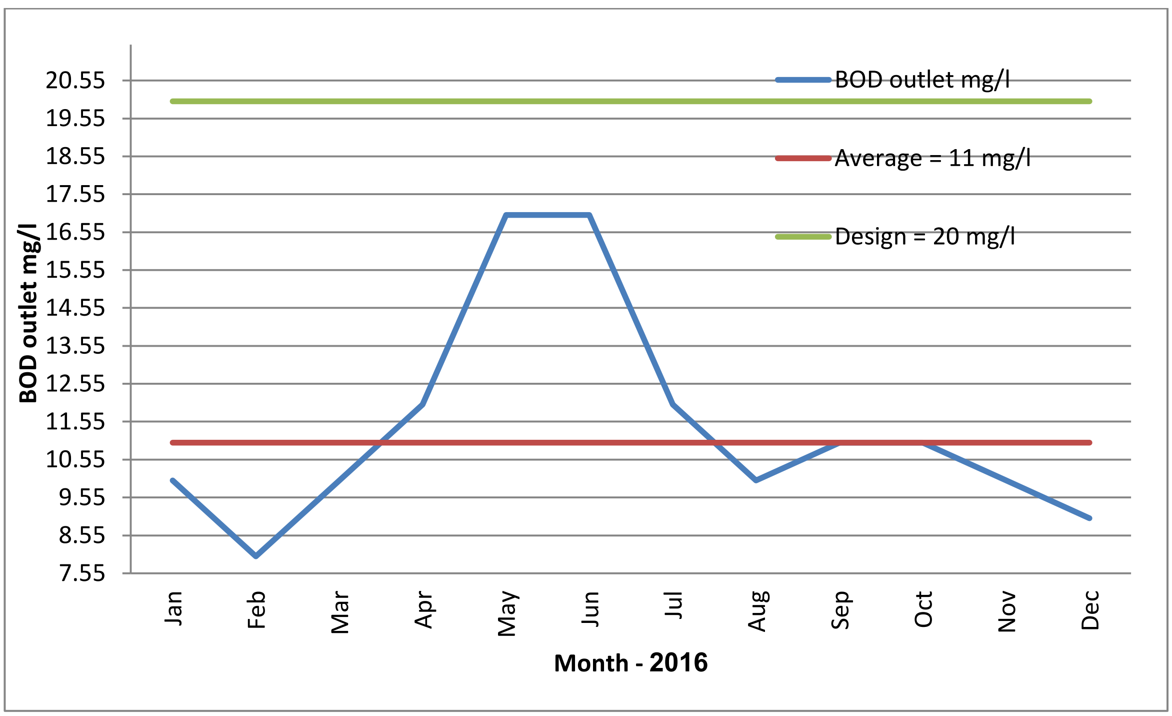
Graph 5: The COD concentration in the influent of WWTP



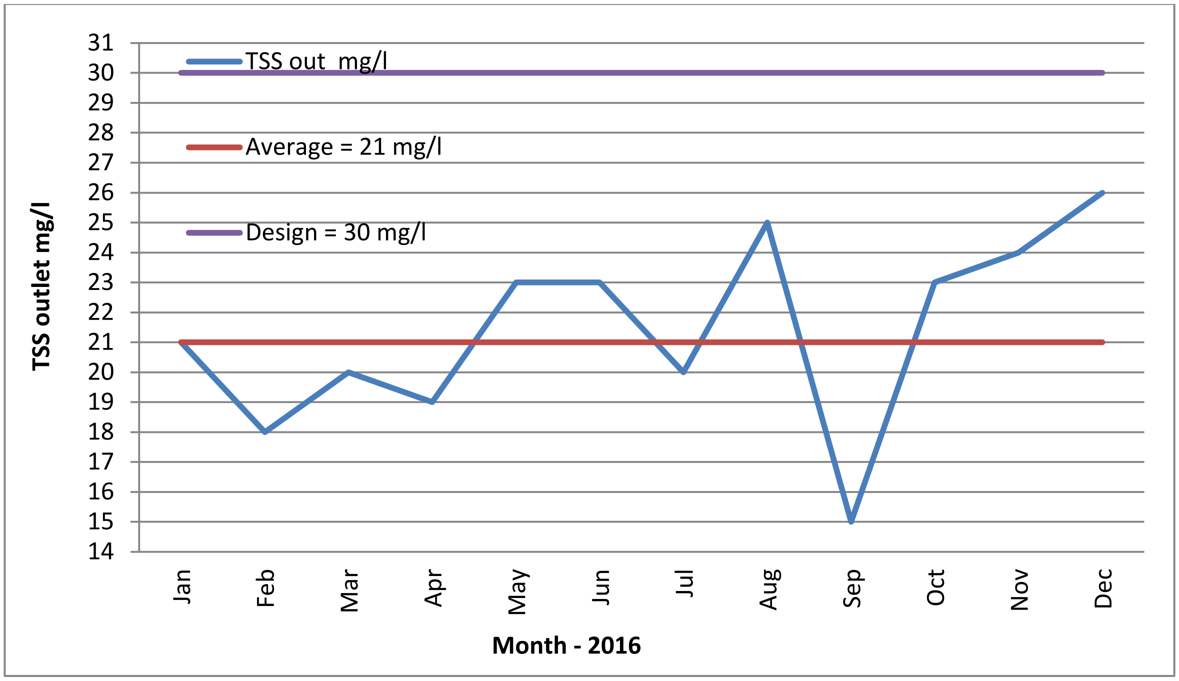
Graph 6: The COD concentration in the effluent of the treated waste water



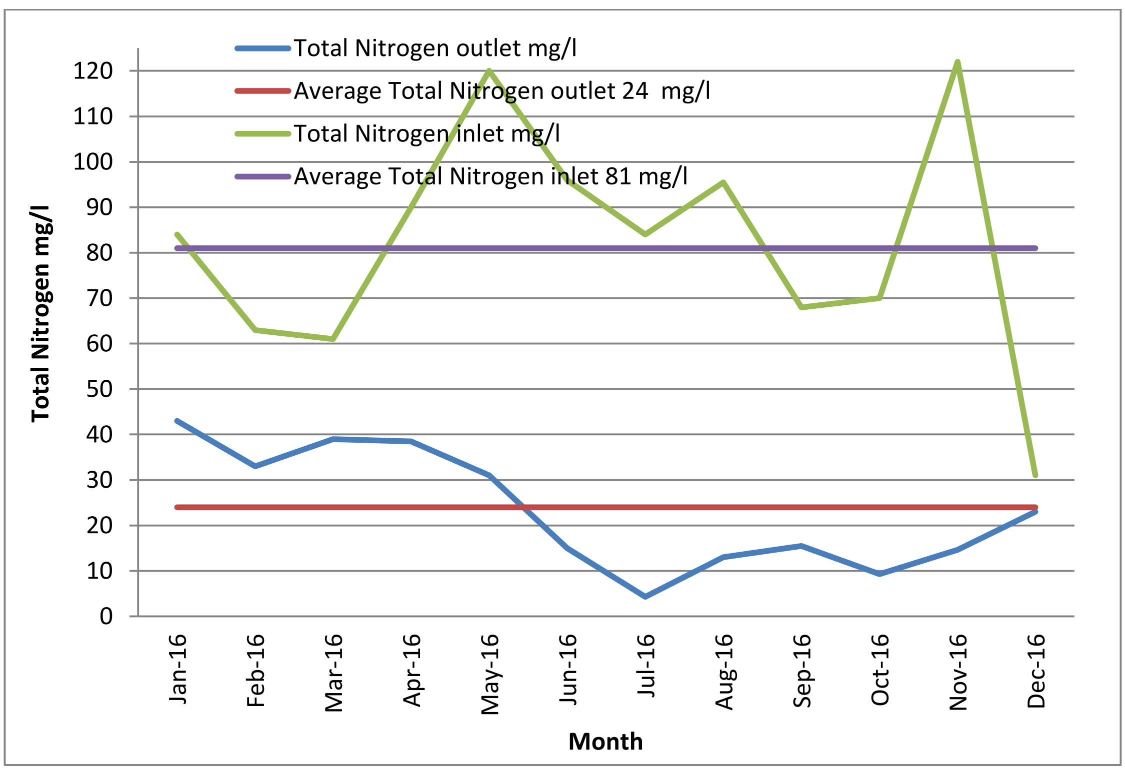
Graph 7: The correlation between COD_{out} and BOD_{5eff}



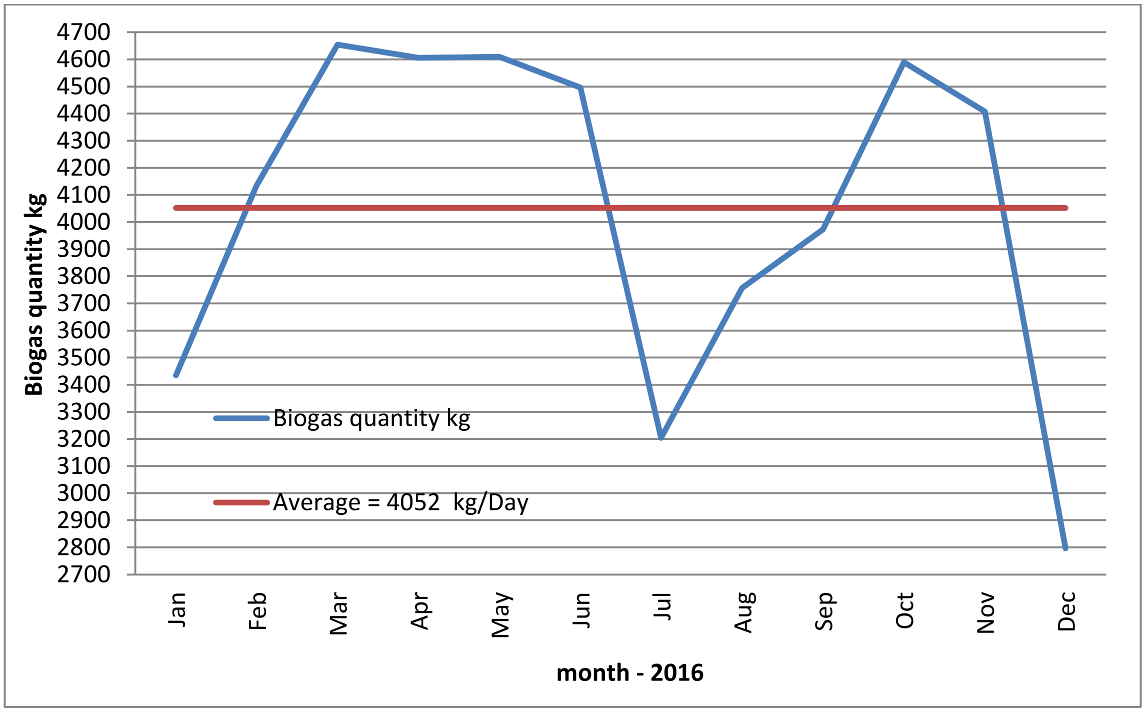
Graph 8: The BOD_5 concentration in the effluent of the treated wastewater



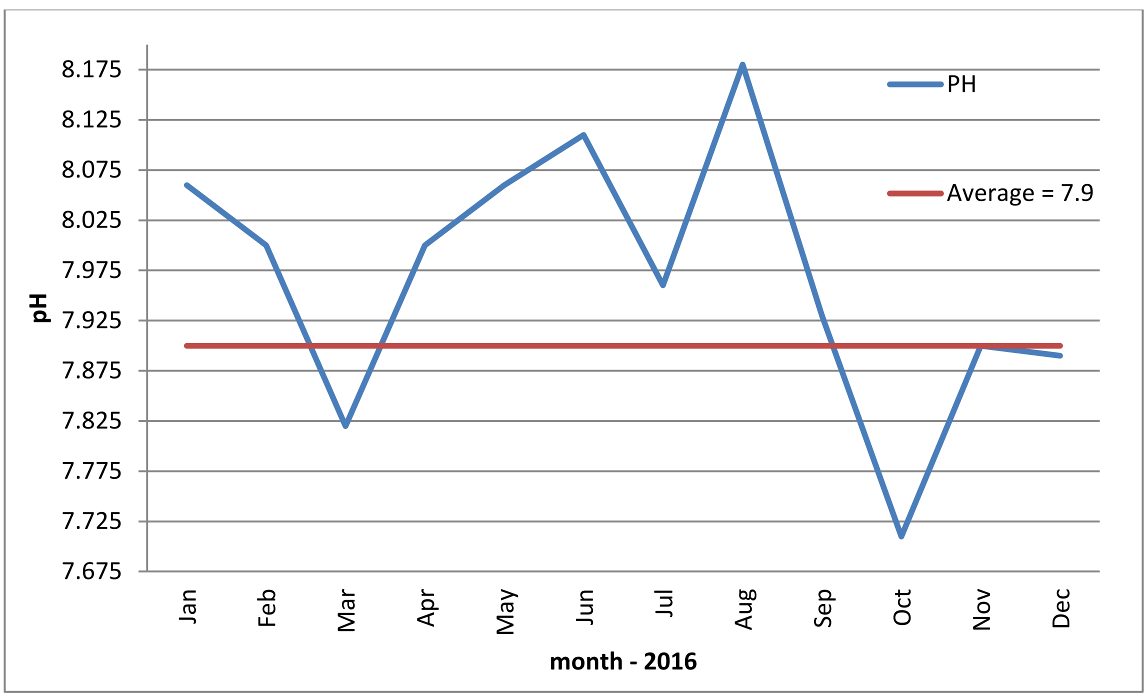
Graph 9: TSS concentration of the treated wastewater (TSS)



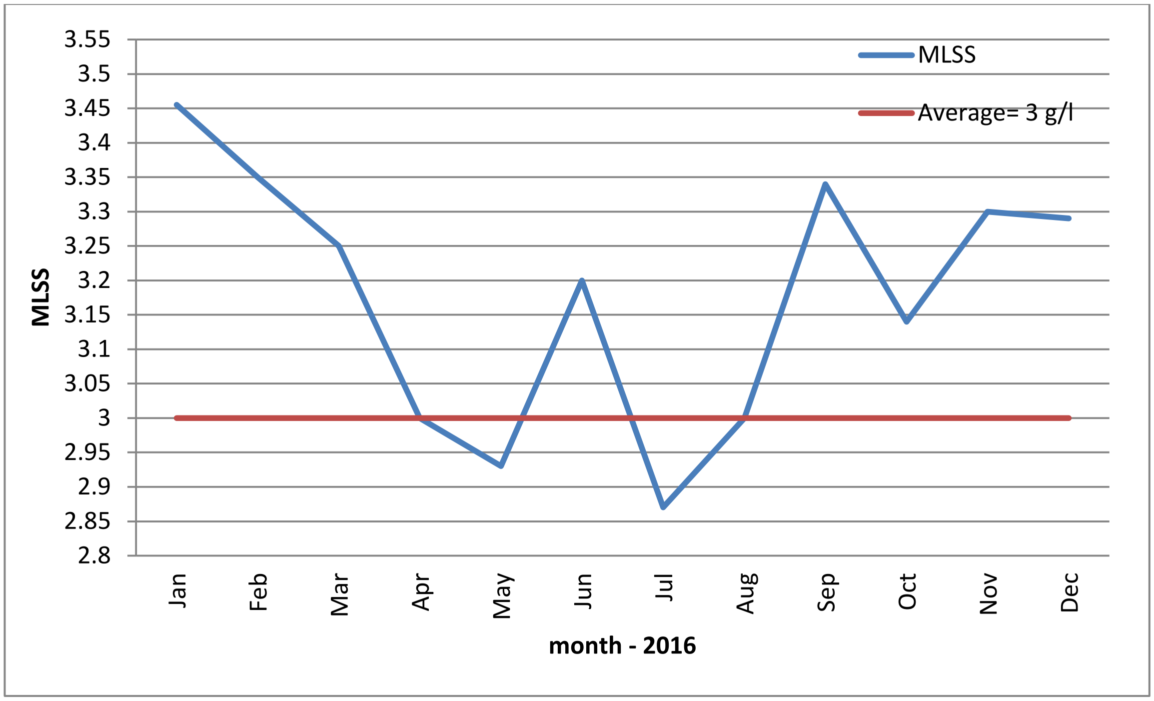
Graph 10: Total Nitrogen for influent and effluent (TN)



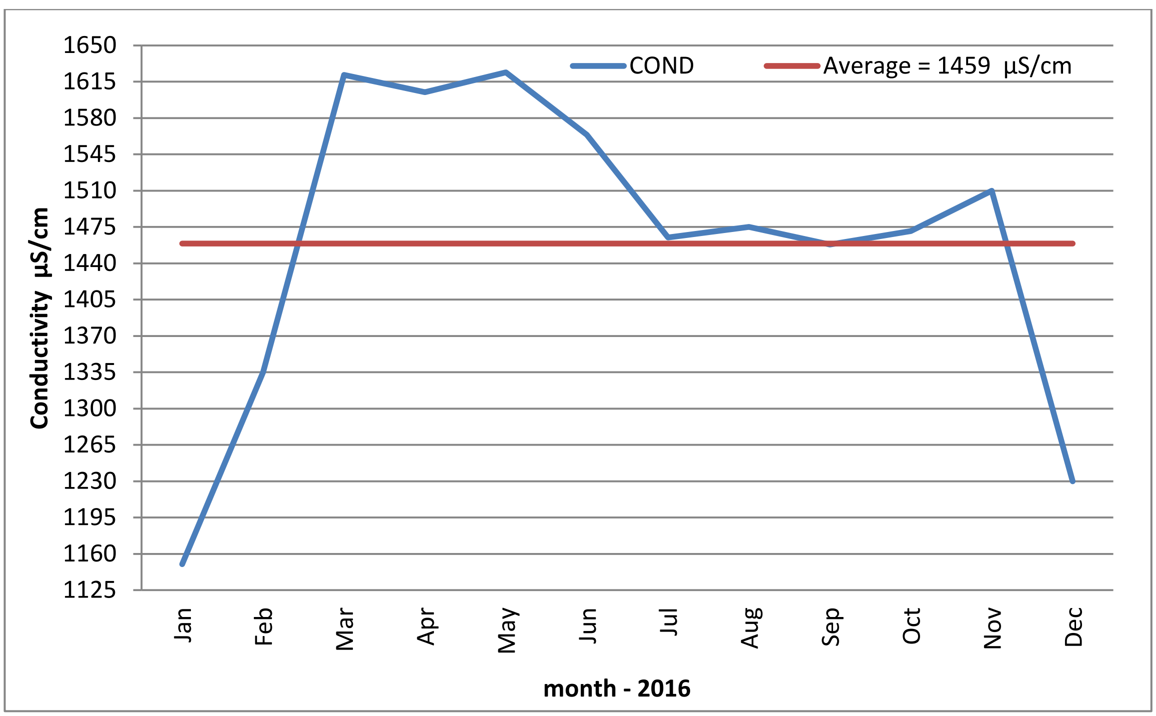
Graph 11: The average produced quantities of biogas



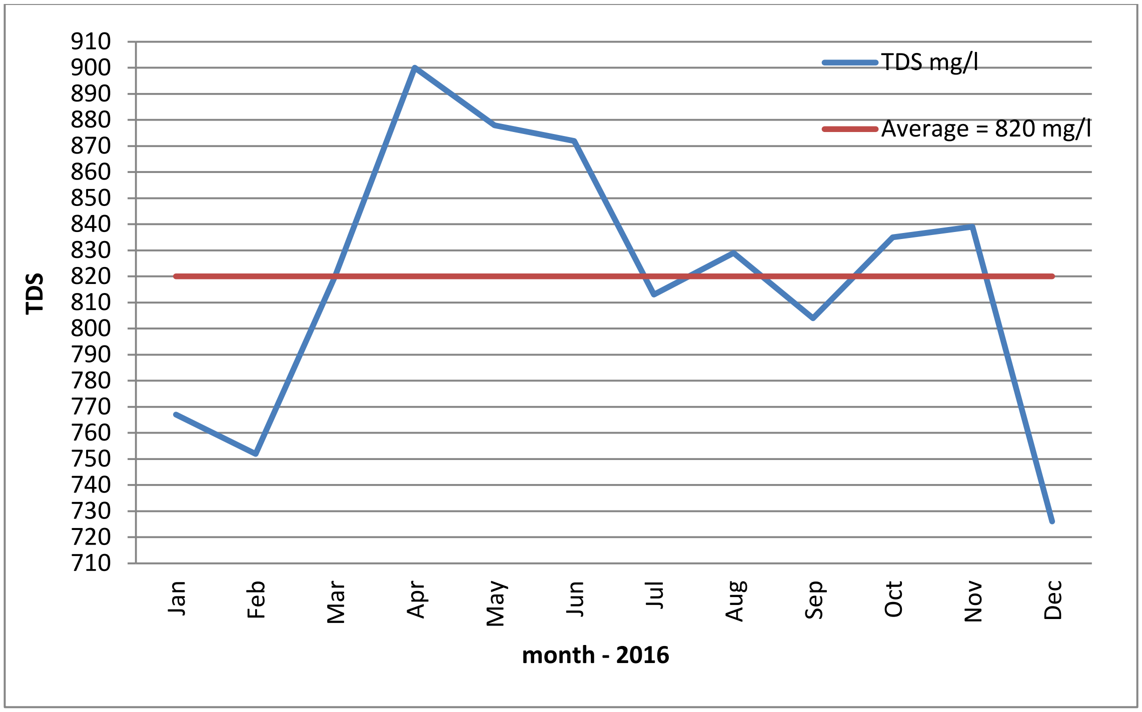
Graph 12: Average pH of the inlet wastewater



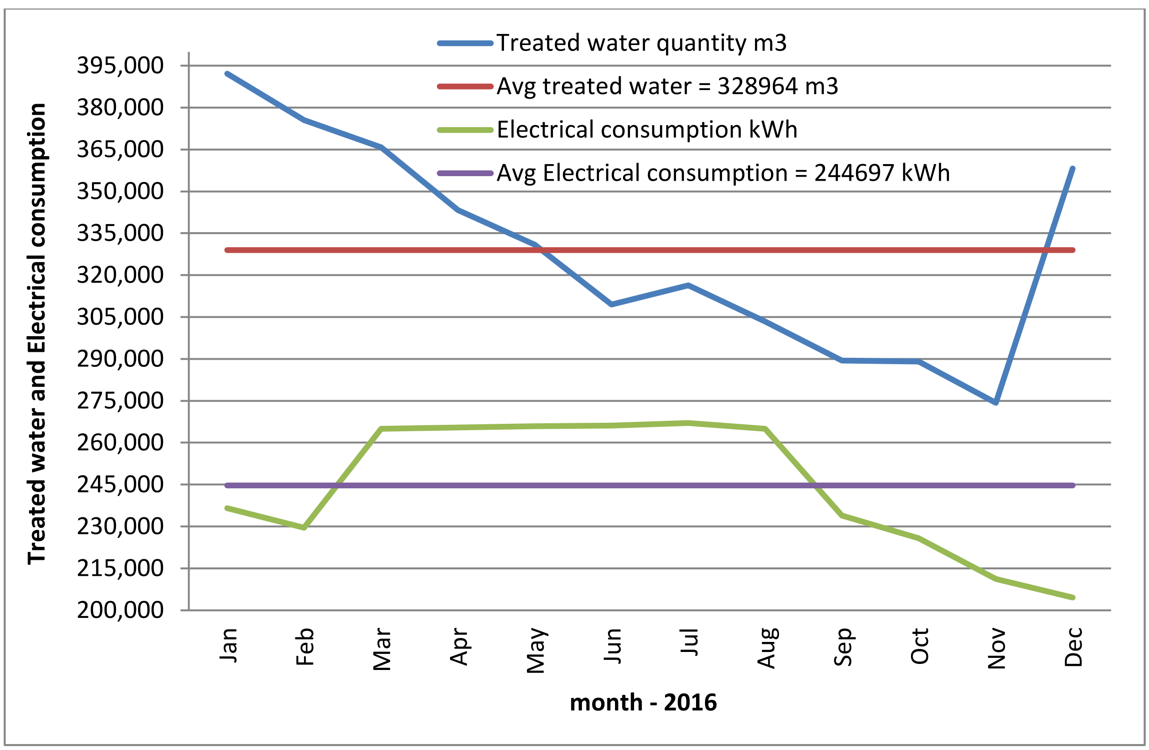
Graph 13: Mixed liquor suspended solids concentration (MLSS) in aeration tanks



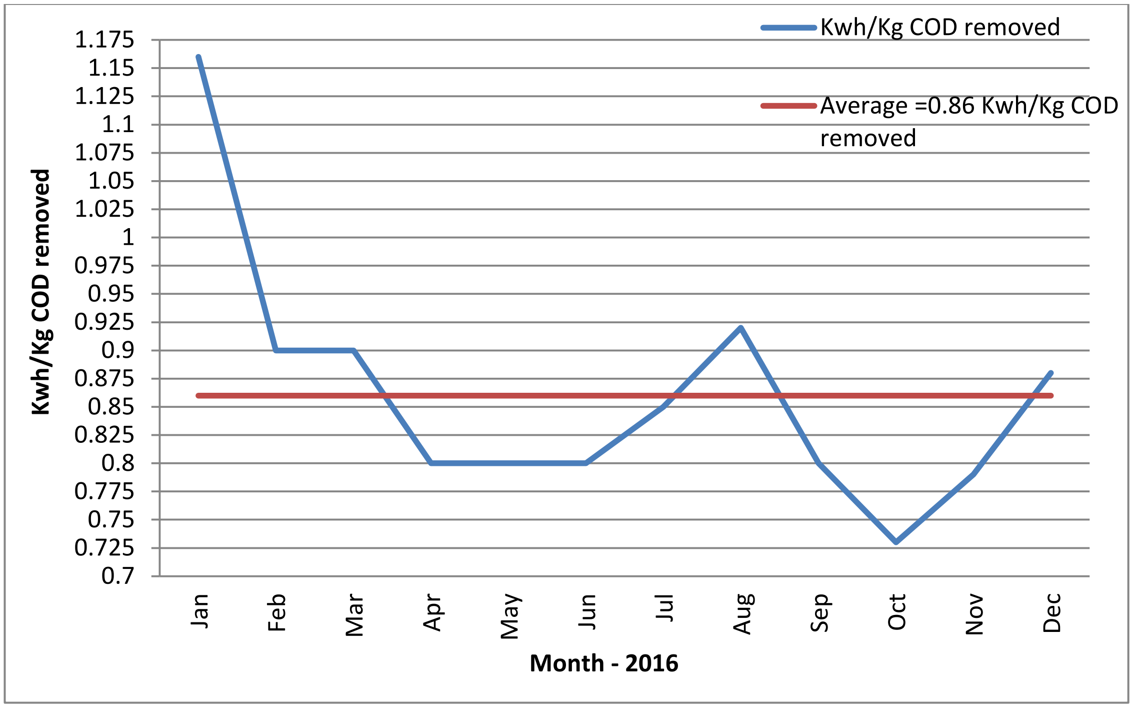
Graph 14: Conductivity of the inlet flow



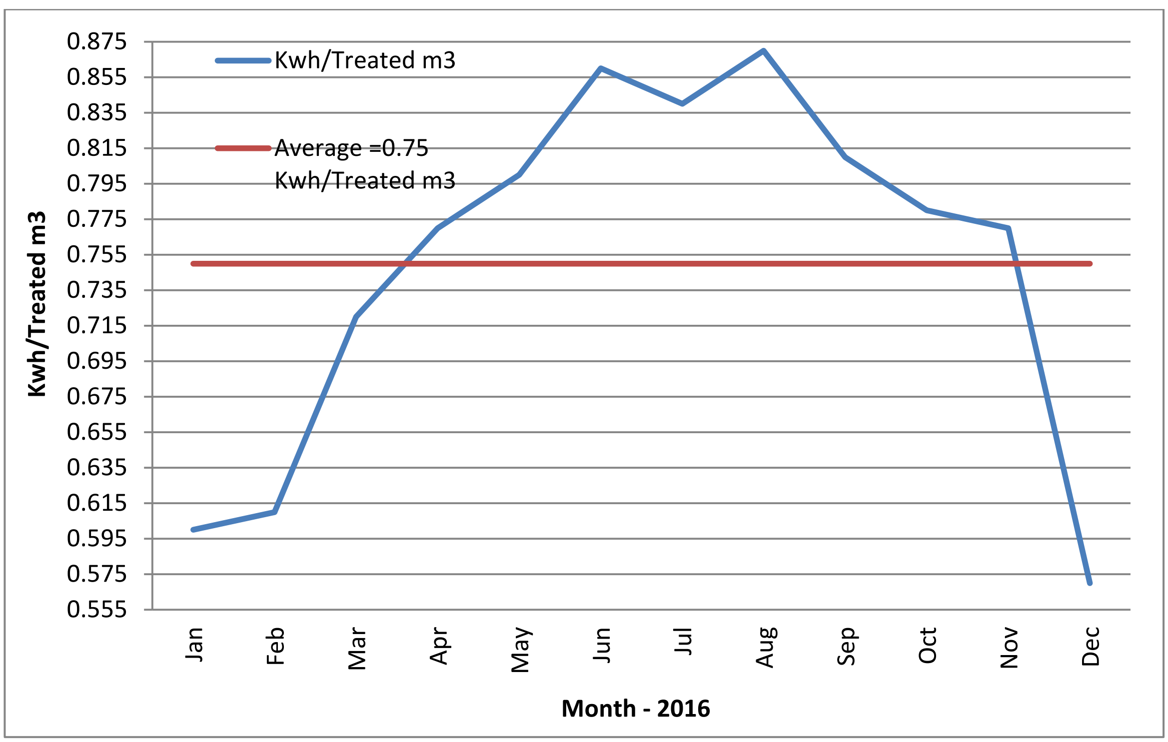
Graph 15: Total dissolved solids in the effluent



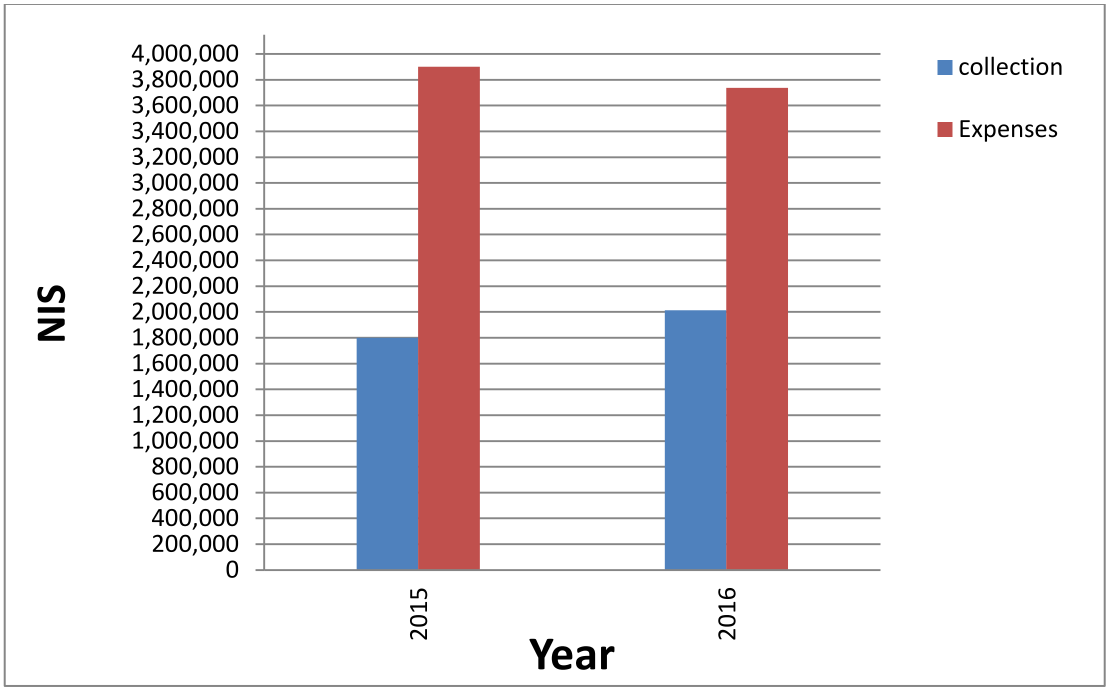
Graph 16: Average monthly treated wastewater and power consumption



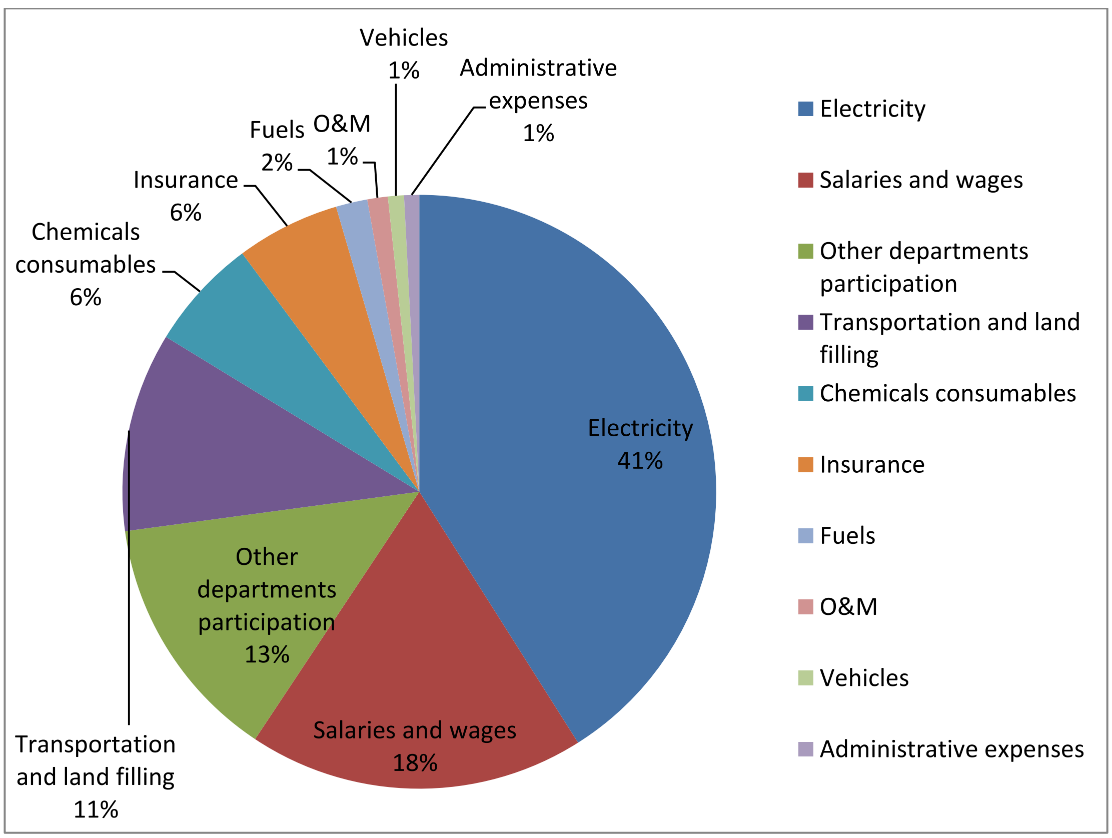
Graph 17: Power requirement kWh/kg COD treated



Graph 18: Power requirement kWh/m^3 treated



Graph 19: Expenditures versus collection



Graph 19: Expenditures breakdown 2016

Annex 3: Performance summary

Parameters	Design value 2020	Treatment efficiency %	Average	Month - 2016											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average inlet flow m^3/d	**14000**	**-----**	10775	12648	12948	11798	11442	10675	10315	10204	9787	9464	9325	9141	11556
Inlet COD mg/L	**1100**	**-----**	935	637	715	855	848	1070	1165	1043	1001	1062	1115	1021	691
Outlet COD mg/L	**100**	**94%**	57	50	41	49	60	84	84	62	52	55	56	51	43
Outlet BOD_5 mg/L	**20**	**98%**	11	10	8	10	12	17	17	12	10	11	11	10	9
Inlet BOD_5 mg/L	**550**		468	318	358	428	424	535	583	521	500	531	557	510	346
Sludge age (days)	**13.7**	**-----**	19	20	23.5	23	15	14	22	15.5	17.5	19	24.7	17	19.2
MLSS g/L	**3**	**-----**	3	3.46	3.35	3.25	3	2.93	3.2	2.9	3	3.34	3.14	3.3	3.29
TSS_{inlet} mg/L	**500**		420	322	321	380	362	463	498	471	451	505	496	461	312
TSS_{outlet} mg/L	**30**	**95%**	21	21	18	20	19	23	23	20	25	15	23	24	26
kWh/kg COD	**0.8**	**-----**	0.86	1.19	0.9	0.9	1	0.8	0.8	0.85	0.92	0.8	0.73	0.73	0.88

Annex 4: Power consumption

Parameters	Avg	Month - 2016											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Treated wastewater m3	328,964	392,100	375,505	365,728	343,248	330,912	309,444	316,320	303,396	289,380	289,075	274,235	358,228
Power consumption kWh	244,697	236,543	229,587	265,030	265,470	265,906	266,148	267,095	265,026	233,923	225,821	211,216	204,602
Kwh/m3	0.75	0.60	0.61	0.72	0.77	0.80	0.86	0.84	0.87	0.81	0.78	0.77	0.57

Annex 5: Additional lab Tests in WWTP Lab

			Month-2016											
/ Test	Values	Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
COD out mg/l	Average	**57**	50	41	49	60	84	84	62	52	55	56	51	43
	Max	**89**	80	52	60	71	177	130	97	90	82	90	80	60
	Min	**36**	32	26	44	49	52	58	41	22	20	40	25	26
BOD out mg/l	Average	**11**	10	8	10	12	17	17	12	10	11	11	10	9
	Max	**18**	16	10	12	14	35	26	19	18	16	18	16	12
	Min	**7**	6	5	9	10	10	12	8	4	4	8	5	5
NH4-N out mg/l	Average	**4**	2	1	14	9	17	1	1	2	0	3	0	0
	Max	**8**	3	2	27	12	32	3	1	4	0	8	1	0
	Min	**1**	0	0	1	5	2	0	0	0	0	0	0	0
NO3-N out mg/l	Average	**12**	3	23	18	23	10	8	1	8	11	4	8	30
	Max	**19**	34	27	37	26	14	13	2	13	16	5	10	36
	Min	**16**	30	20	72	20	5	4	1	4	7	3	6	21
TN out mg/l	Average	**24**	43	33	39	39	31	15	4	15	16	9	15	32
	Max	**30**	48	36	49	42	40	22	5	23	18	11	23	39
	Min	**19**	38	30	27	36	22	7	4	7	13	8	8	25
PO4-P out mg/l	Average	**5**	4	3	0	5	5	4	5	19	2	5	3	2
	Max	**5**	4	3	0	5	5	4	5	19	2	5	4	4
	Min	**5**	3	3	0	5	5	4	5	19	2	5	2	2
TSS out mg/l	Average	**21**	21	18	20	19	23	23	20	25	15	23	24	26
	Max	**48**	51	31	38	42	64	43	35	52	39	58	56	63
	Min	**5**	11	5	2	4	5	3	3	6	4	3	7	6
MLSS mg/l	Average	**3**	3	3	3	3	3	3	3	3	3	3	3	3
	Max	**4**	4	4	4	4	3	4	4	3	4	4	4	4
	Min	**3**	2	3	3	2	2	2	2	3	3	3	3	3

Annex 6: External laboratory analysis of treated water in Beirzeit labs.

Quality of the treated water (NWWTP) with comparison of reuse standard (34/2014)

Maximum limits for chemical and biological properties	Sampled on		Quality of Treated Water/Tech Spec 34-2014			
	05/09/2016	With SF + UV 15/1/2017	High Quality (A)	Good Quality (B)	Medium Quality (C)	Low Quality (D)
(BOD_5) mg/l	<10	BDL	20	20	20	60
suspended solids (TSS) mg/l	3	BDL	30	30	30	90
FC (Colony/100ml)	31000	14	200	1000	1000	1000
(COD) mg/l	21	BDL	50	50	100	150
(TDS) mg/l	780	758	1200	1500	1500	1500
pH	7.63	7.39	6--9	6--9	6--9	6--9
Fat, Oil, & Grease mg/l	BDL	BDL	5	5	5	5
Phenol mg/l	Not Detected	-	0.002	0.002	0.002	0.002
MBAS	Below Detection Limit	-	15	15	15	25
NO3-N ppm	1.38	13.45	20	20	30	40
NH4-N mg/l	0.75	2.6	5	5	10	15
CL ppm	194.6	189.03	400	400	400	400
SO4 ppm	86	73.31	300	300	300	300
Na ppm	171	167	200	200	200	200
Mg ppm	18.92	16.6	60	60	60	60
Ca ppm	57.27	79.95	300	300	300	300
SAR	4.99	4.43	5.85	5.85	5.85	5.85
PO4-P ppm	10.8	12.35	30	30	30	30
Al ppm	Not Detected	0.28	5	5	5	5
Cu ppm	0.007	0.123	0.2	0.2	0.2	0.2
Fe ppm	0.24	0.115	5	5	5	5
Mn ppm	0.037	0.047	0.2	0.2	0.2	0.2
Ni ppm	Not Detected	Not Detected	0.2	0.2	0.2	0.2
Pb ppm	0.014	Not Detected	0.2	0.2	0.2	0.2
Se ppm	Not Detected	Not Detected	0.02	0.02	0.02	0.02
Cd ppm	Not Detected	Not Detected	0.01	0.01	0.01	0.01
Zn ppm	0.08	0.154	2	2	2	2
Cn ppm	Below Detection Limit	-	0.05	0.05	0.05	0.05
Cr ppm	0.2	Not Detected	0.1	0.1	0.1	0.1
Co ppm	Not Detected	Not Detected	0.05	0.05	0.05	0.05
B ppm	0.06	0.04	0.7	0.7	0.7	0.7
Ag ppm	Not Detected	-				
E. coli (Colony/100ml)	26200	11	100	1000	1000	1000
Nematodes (eggs/L)	Absent	-	1>=	1>=	1>=	1>=
cfu\100ml	133000	185				

BDL= below detection limit

Annex 7: External laboratory analysis of the cake sludge, done by Birzeit university labs.

Quality of the sludge (NWWTP) with comparison of standard (59/2015)

Elements	Sampled on		Obligatory	Method of Testing
	05/09/2016	15/1/2017	Tech.Ins 59/2015	
Cd (ppm)	0.27	0.48	20	Birzeit Lab, ICP instrument
Cu (ppm)	71.63	123.9	1000	Birzeit Lab, ICP instrument
Ni (ppm)	6.21	11.2	300	Birzeit Lab, ICP instrument
Pb (ppm)	7.5	13.1	750	Birzeit Lab, ICP instrument
Zn (ppm)	243.46	360.3	2500	Birzeit Lab, ICP instrument
Cr (ppm)	6.93	13.4	400	Birzeit Lab, ICP instrument
As (ppm)	Not Detected	0.29	N.A	Birzeit Lab, ICP instrument
Mo (ppm)	1.21	0.40	N.A	Birzeit Lab, ICP instrument
Se (ppm)	Not Detected	Not Detected	N.A	Birzeit Lab, ICP instrument
Hg (ppm)	0.58	0.47	16	Birzeit Lab, DMA-80 instrument
Phosphorus (ppm)	3299	6771	N.A	Birzeit Lab, ICP instrument
FC (cfu/g)	4300	-	N.A	Birzeit Lab, iso instrument
Salmonella (cu/g)	Nil	Nil	N.A	Birzeit Lab, iso instrument
Conductivity µs/cm	-	1180		Birzeit Lab, iso instrument