State of Palestine
Nablus Municipality

دولــــة فلسطين
بلدية نابلس

Wastewater Treatment Plant

Nablus West

Annual Operation Report - 2015

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Abbreviations

µs/cm: Microseimens per centimeter

Al: Aluminum

AT: Aeration tank

B: Boron

BOD: Biological oxygen demand

Ca: Calcium

Cd: Cadmium

cfu: colony fecal unit

CH_4: Methane

CL: Chloride

Cn: Cyanide

Co: Carbon monoxide

C^o: Celsius degree

CO_2: Carbon Dioxide

COD: Chemical oxygen demand

Cr: Chrome

Cu: Cupper

DO: Dissolved oxygen

FC: Fecal coliform

Fe: Ferric

GIZ: Gesellschaft für Internationale Zusammenarbeit

Hg: Mercury

JV: Joint venture

KfW: German Reconstruction Bank

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: Magnesuim

MLSS: Mixed liquor concentration

Mn: Manganese

Na: Soduim

NH4-N: Ammonium as nitrogen

Ni: Nickel

NM Nablus Municipality

NO3-N: Nitrate as nitrogen

Pb: Lead

PE: Population equivalent

PLC: Programmable Logic Controller

PO4-P: Phosphate as phosphorous

SAR: Sodium adsorption ration

SCADA: Supervisory Control and Data Acquisition

Se: Selenium

SO4: Sulphate

TDS: Total dissolved solids

TN: Total nitrogen

TSS: Total suspended solids

TWW: Treated Waste Water

WSSD: Water supply and sanitation department

WWTP: wastewater treatment plant

Zn: Zinc

1. INTRODUCTION

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

In 1998, the financial agreement for the implementation of Sewerage 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 entails construction of 12 km length trunk and interceptor, 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 intersection. The wastewater is collected from Nablus West and from five villages namely; 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 is currently inhibited by approximately 130,000 people. Presently about 95% of the entire population of Nablus west is connected to the sewerage network. The main objective of the sewerage project Nablus West is:

- Improve the environmental and health conditions in upper Wadi Zeimar
- Protect the surface and ground 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 have issued the performance certificate to the contractor the JV of Kinetics- Passavant Reodiger (KPR) on September 23th, 2015.

Operational assistance for two years at the cost of 1.10 million Euros has been secured by 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 to the west of Nablus City and lies on a much lower orthographical level than Nablus City. Ideally, wastewater is polluted with coarse materials that would flow into the treatment plant through gravity.

Figure (1): Topographic map in the project area

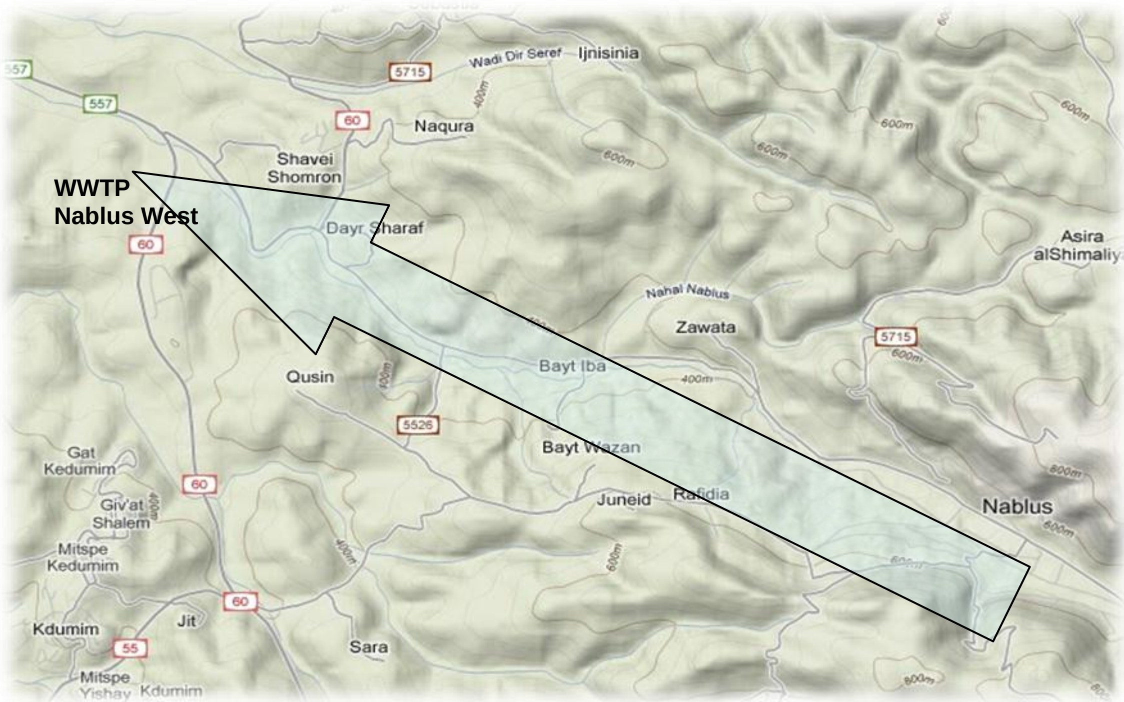


Figure (2): Direction of slope

Figure (3): Overview of WWTP Nablus West from the top of the digester (photo)

2.2 WWTP Nablus West

The WWTP Nablus West is in operation as an activated sludge process with a mechanical treatment, a biological treatment and a sludge treatment step with gas utilization. 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 a design horizon in 2035. During the first construction stage, only the colored parts in green and yellow of the WWTP (Figure 4) were constructed.

Figure (4): WWTP Nablus West

3. GENERAL PERFORMANCE

Around three millions nine hundred and sixty three thousands (3,962,554 m^3) cubic meters of wastewater were treated during 2015, with an electrical consumption of two millions Six hundred sixty one thousands and seven hundred forty six (2,661,746 kWh). In general, average of lab results showed that they were in line with the Palestinian Standards during the course of implementation during the last year. The average concentration of BOD_5 was 14 mg/l and TSS was 28 mg/l. By these results, the treatment efficiency in terms of BOD_5 and TSS were 96% and 93% respectively.

4. OPERATION OF WASTEWATER TREATMENT PLANT FACILITIES

4.1 Screens and grit/grease removal

The wastewater treatment in Nablus west began with a screening unit. The screening unit consisted of two types of screens. The first was coarse screen (bar space of 5 cm), and the second was fine screen (bar space of 5 mm). The main objective of this unit was 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 was designed to remove sand and grits/grease from wastewater. The grease was 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 were settled down in two rectangular tanks forming primary sludge. The primary sludge was thickened in a gravity primary thickener to increase its concentration from 1% to 4% and 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 was the core of the WWTP. High concentration of special aerobic bacteria and other microorganisms were activated in the aeration tanks at existence of high concentration of oxygen called activated sludge. The soluble and other suspended organic material_were 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 these two tanks.

4.4 Nitrification and de- nitrification

The plant was designed for COD reduction. Nitrification and de- nitrification also phosphate elimination was not the aim of the first stage. However, on the 17th of March, 2015 the plant started to perform de-nitrification process in the biological treatment in addition to nitrification process.

The control and potential problems of this process were discussed to be sure how the process control will be optimized. Since then, the de- nitrification has been performed as an additionally treatment step in the aeration tanks.

Required conditions:

- presence of denitrifying bacteria for the process (exist in normal aerobic sludge)
- anoxic conditions (switch-off some aerators)
- enough detention time (reducing velocity, switch-off aerators)
- carbon Source (= H+-donator, wastewater, only one primary settling tank)
- appropriate pH and temperature (normally existing in domestic wastewater)

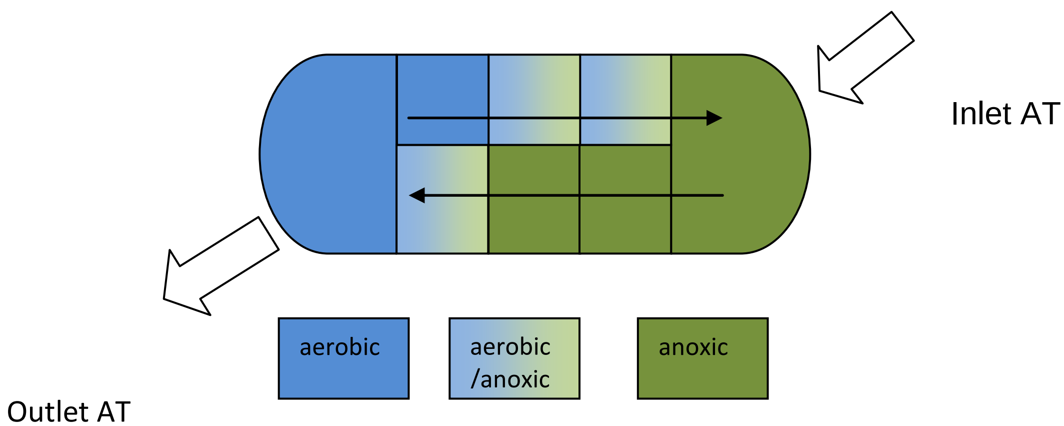


Figure (5): Aeration tank with implemented de- nitrification zone

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.

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

The activated sludge was settled down in the two circular final sedimentation tanks. The settled bacteria was withdrawn from the bottom of the tanks and returned back to the aeration tanks as returned sludge. This recycling of activated sludge was necessary to maintain certain concentration of activated sludge (around 2-3% SS) with optimal sludge age, however the excess sludge was 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 was withdrawn via pumps to the mechanical thickening machines where polymer was added. This machine thickened the excess sludge up to 1% to 6% SS concentration. After thickening it was 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 was sent to the primary gravity thickener circular tank. In this unit, the sludge was thickened to reach 6% which was treated in the anaerobic digester.

5.3 Anaerobic digester (3650 m^3)

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

5.4 Gas balloon holder (660 m^3)

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

5.5 Gas flare

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

5.6 Sludge drying beds

In the summer time, the digested sludge was pumped to the drying beds for drying via natural evaporation. There were 11 beds with total area of 11.5 donums. After drying, the sludge was transported to the sludge storage yard for disposal into Zahret Al-Fenjan sanitary landfill site near Jenin.

5.7 Two mechanical dewatering machines

During winter and even in summer time dewatering machines were used to dewatering the digested sludge coming from the digester to have solids more than 25%. Special polymers were used to improve the efficiency of these machines as shown in Figure (6).

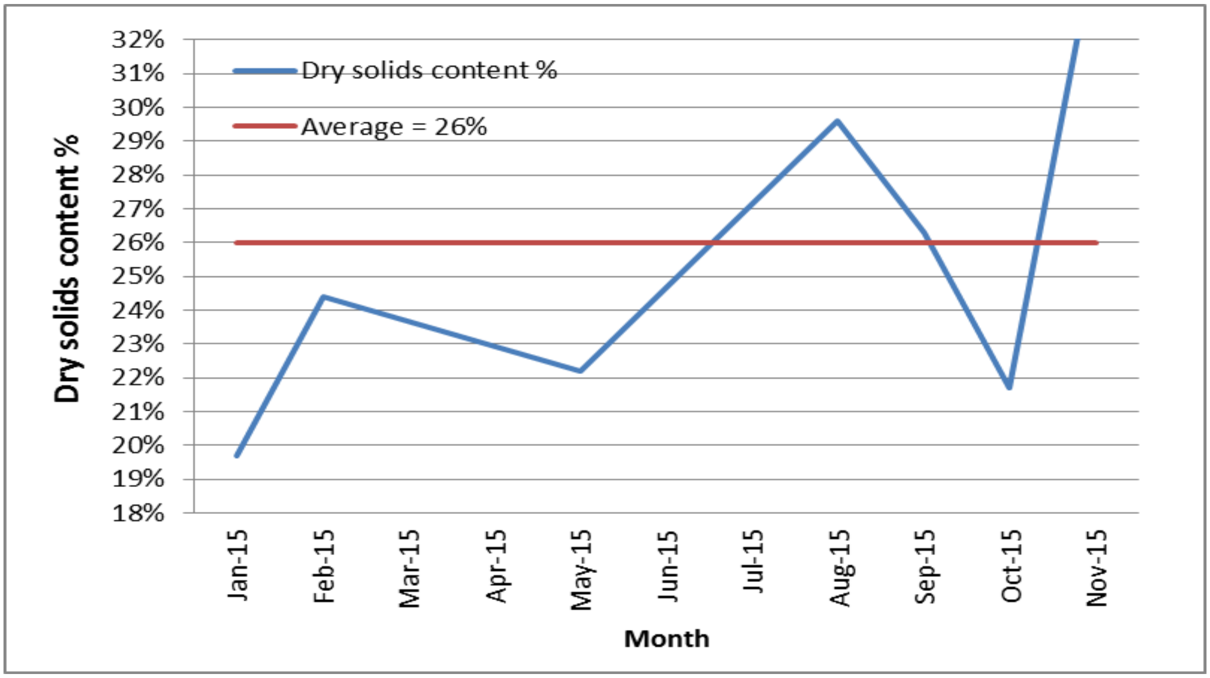


Figure (6): Dry solids content after mechanical dewatering.

5.8 Other facilities

Other equipment was 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 WWTP plant was controlled using Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA). The PLC's were located in several substations (electrical switch rooms) in the WWTP.

The WWTP was controlled by PLC's. PLC's and their support equipment computer controlled system that was capable of remote managing of the plant's operation. The control was executed from the analogous and digital inputs/ outputs received from instruments, drives and MCC and from signals received from the SCADA system.

7. PERFORMANCE OF WWTP

7.1 Influent flow

The performance of WWTP Nablus West during 2015 was analyzed on the basis of the plant loading which had been monitored regularly. Two biological treatment units 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. In the following section, the hydraulic and pollutants loading and the actual performance of WWTP Nablus West from January 2015 to December 2015 were analyzed. The main problems that had been faced were also described. Finally, feasible threshold values for the WWTP effluent and sludge was determined and the tolerance capacity of the plant was reviewed.

Figure (7) Shows the hydrographs of the daily wastewater flows which were treated in WWTP Nablus West. It becomes clear that (apart from singular flow peaks) no strong fluctuation of the daily wastewater flows occurred during summer time. However, in the winter time the inflow increased and the fluctuation was sometimes very high depending on heavy rain events. The capacity of the WWTP Nablus West was mainly adequate but sometimes the inlet main gates had to be throttled for plant protection. In such case, the bypass prior to the WWTP had to be used.

The average of daily wastewater flow in the year 2015 was approximately 11024 m^3/d. In comparison, the total estimated wastewater flow including infiltration for the target amounted to approximately 14,860 m^3/d (design). This shows that the actual treated average total daily wastewater flow did not come close to the designed flow. The amount for incoming wastewater will increase over the next years.

The average flow values in the year of 2015 were shown in Figure (7).

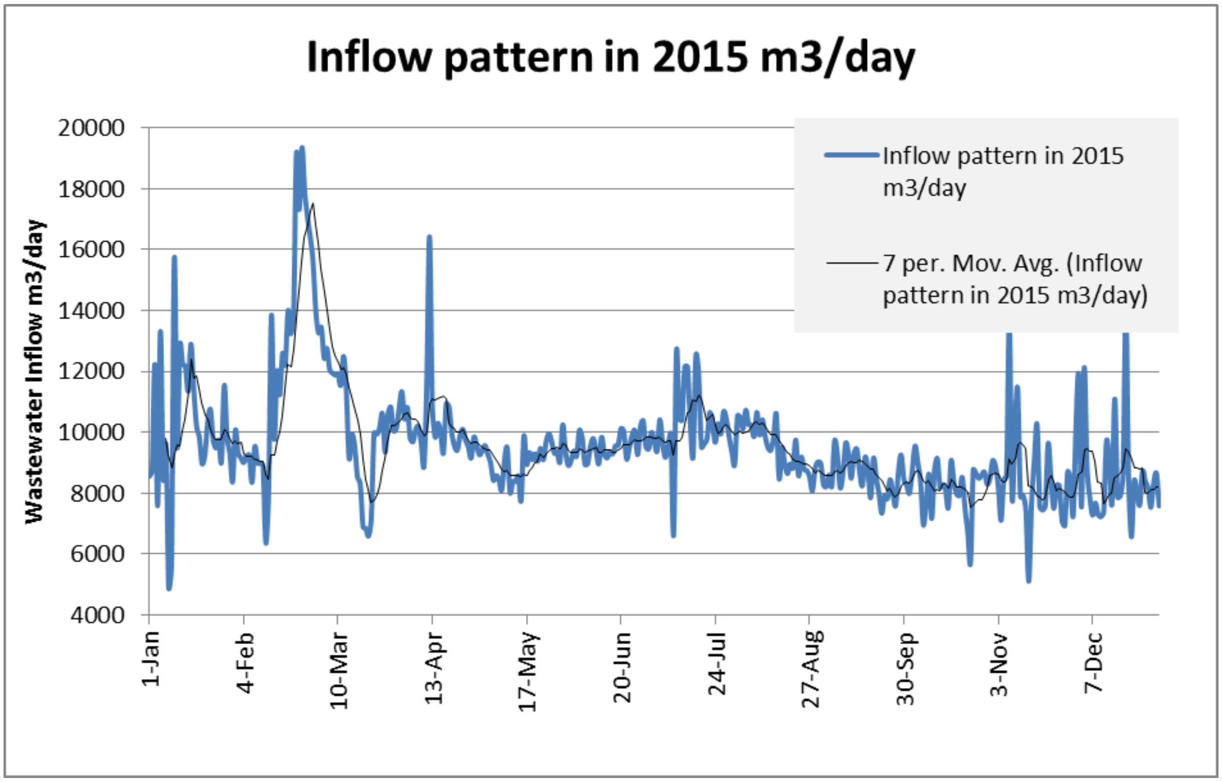


Figure (7): Hydrograph of the daily treated wastewater inflows

Additional villages are expected to be connected to the trunk line and/or interceptor in 2016.

7.2 Cleaning performance

The current daily wastewater pollution load being treated in WWTP Nablus West in terms of COD and SS was calculated by multiplying the daily wastewater flows by the respective concentrations of the pollutants. The average daily COD load was approximately 9470 kg/d and the total COD load over the year of 2015 was 3,456,550 kg. The COD load at the effluent in the same period was 277,639 kg. This means a cleaning performance of approximately 92%. As the treated daily wastewater flows came close to the estimated wastewater flow (in winter times) the very low daily pollution loads were apparently caused by a high rate of infiltration water (heavy rain falls). The measured COD values (inlet/outlet) and the cleaning performance are shown in Figure (8).

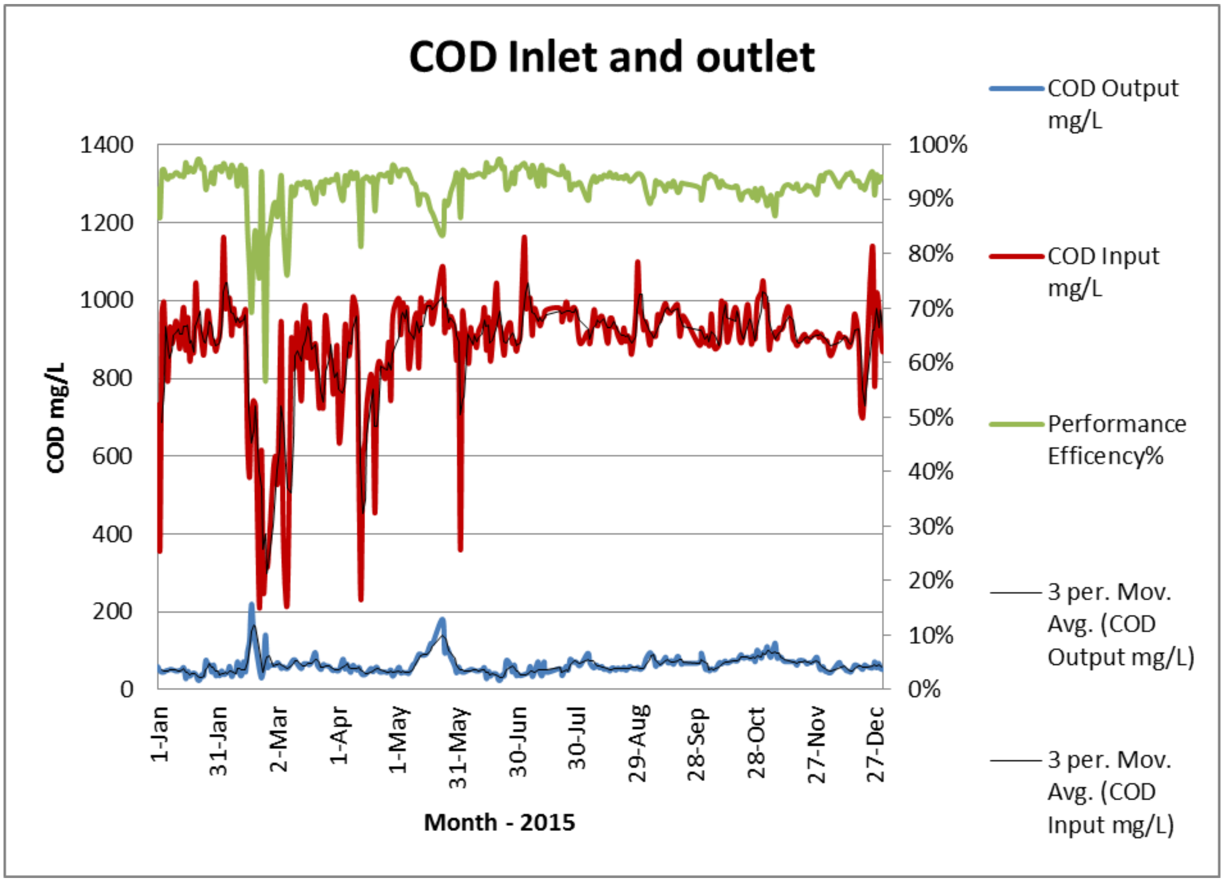


Figure (8): Influent and effluent concentration of COD

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 4,123 kg/d. The reduction of suspended solids was in average approximately 93%. Figure (9) shows the suspended solid values for the WWTP Nablus West.

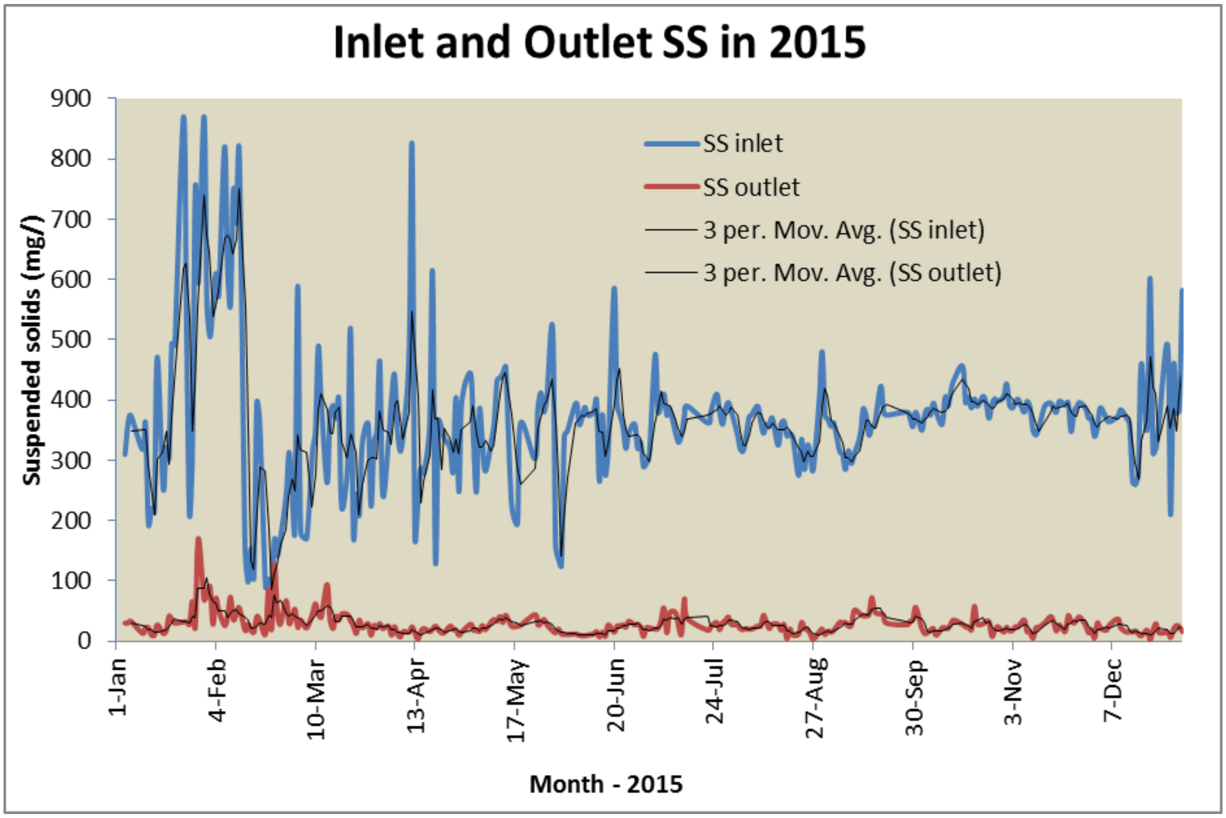


Figure (9): Suspended solids of the inlet and outlet of the treatment plant

7.3 Power consumption

Optimization of operation cost was one of the most important challenges in municipal WWTPs. The specific power consumption of similar WWTPs likely to be below 0.85 kWh per m^3 of treated wastewater. Deviations from this value can be attributed to the circumstances of daily plant operation. For example, if the oxygen measurement is not clean and the measured value was much lower than the real situation of dissolved oxygen inside the aeration tank the power consumption would increase because of increased activity of the aerators. Economic benefits through optimal treatment contribute significantly to the reduction of energy consumption. Figure (10) shows the average power consumption (monthly) per treated m^3 of wastewater.

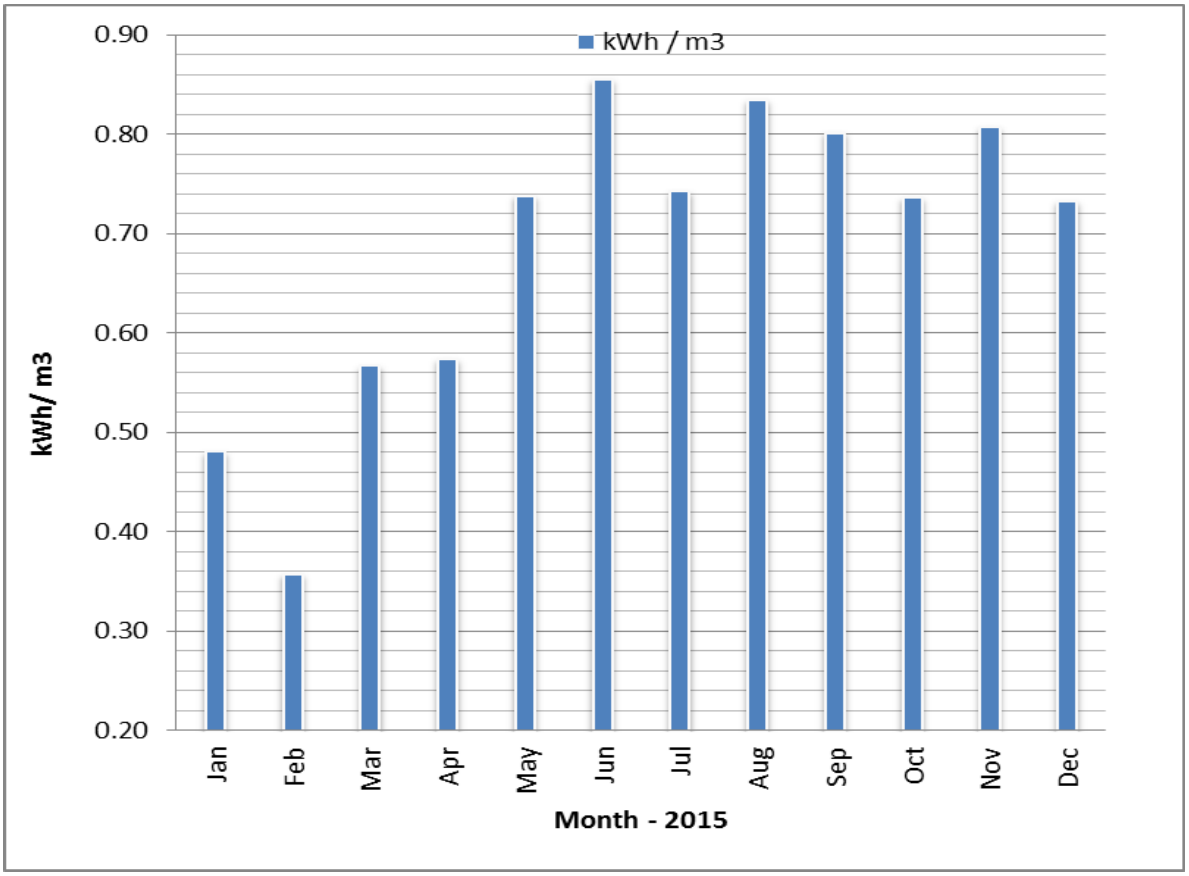


Figure (10): Monthly values of power consumption per treated m^3 wastewater

7.4 Gas production

The gas production from the digester could be much more than the WWTP needs to cover the electricity demand. Part of produced gas at this stage was used for heating the digester. However, the excess biogas was burnt by the flare. The average gas production in the year of 2015 was 2,908 kg per day.

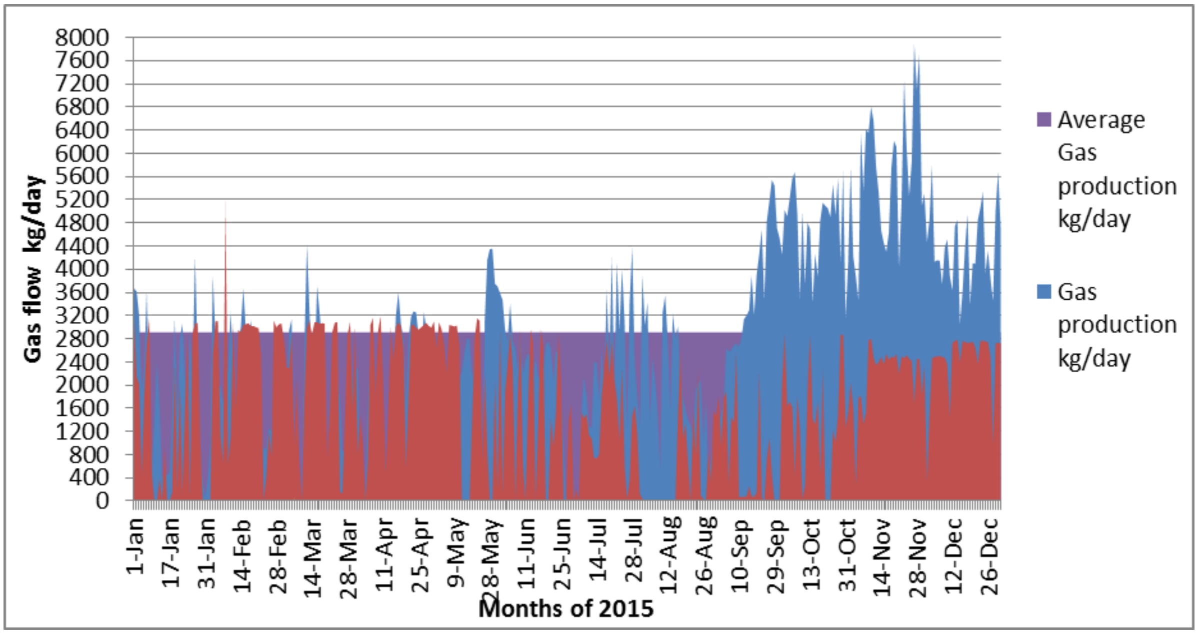


Figure (11) shows the daily gas production from the digester.

However, in the last three months of the year 2015 the gas production was increased within an average of 4500 kg per day. The reason behind this was more regular stable operations of the digester were established and due to the improvements of collecting pits procedures in the primary settling tanks and thus more fresh sludge was fed to the digester.

8. PREVENTIVE MAINTENANCE

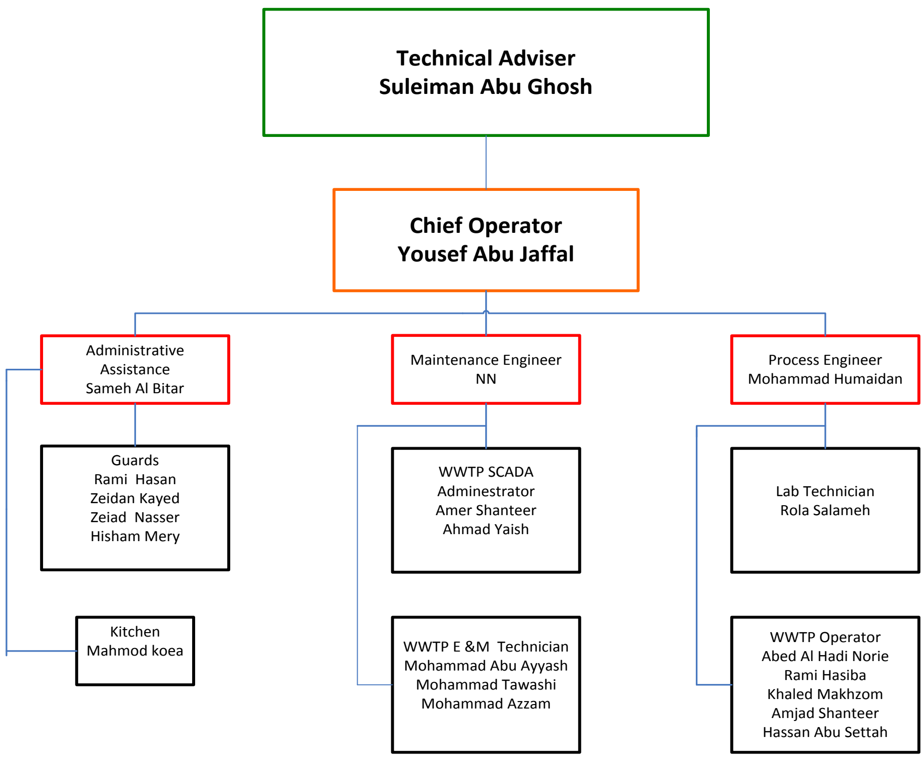
From the beginning of the plant operations maintenance works and plans had been conducted in accordance with the periodic and routine works of machines manuals. These works could be classified as preventive maintenance and failure ones. Preventive maintenance was conducted under supervision of operational assistance provided by the main contractor and Consul Aqua since December 2015.

9. STAFF TRAINING AND ORGANIZATION STRUCTURE

Training was essential for the sustainability of the plant. The staff of Nablus plant had been trained by the main contractor in different fields of plant operations such as:

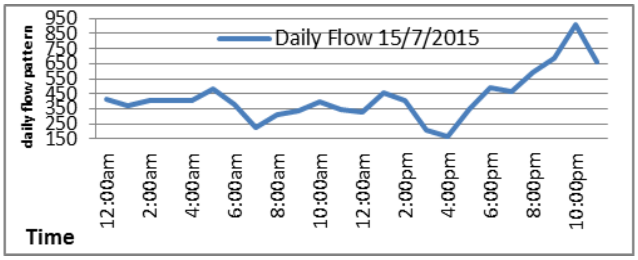
- Refreshing practical and theoretical off job training in Hamburg-Germany through GIZ.
- Practical and theoretical on the job training for all facilitates of WWTP for two years.
- Trouble shooting in emergency cases under normal operation conditions.
- Preventive maintenance.

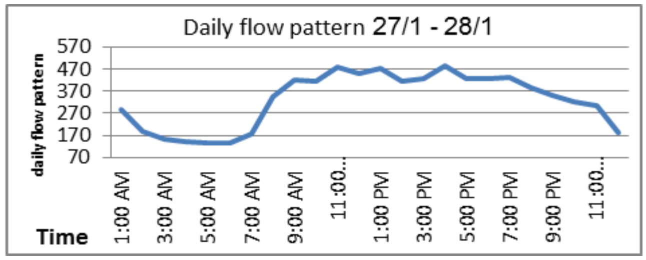
Waste Water Treatment Plant Nablus- West
Organization Structure

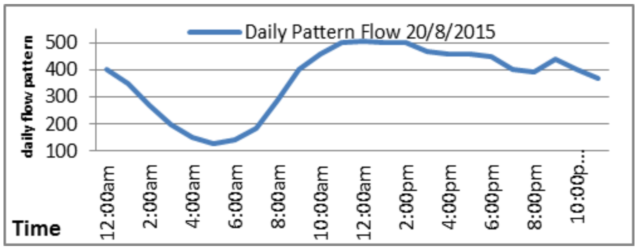


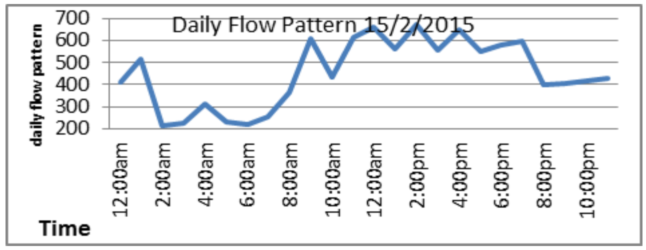
10. Annexes

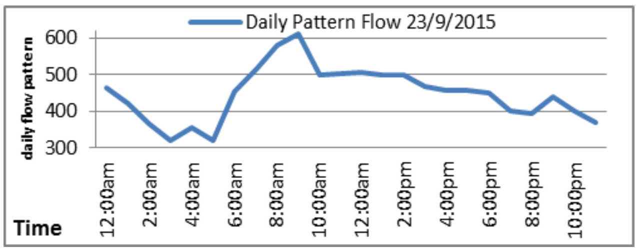
Annex 1: Daily pattern readings of daily inlet flow

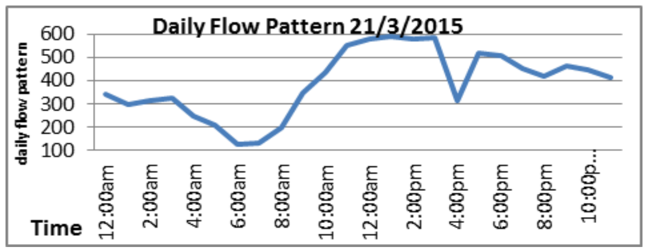


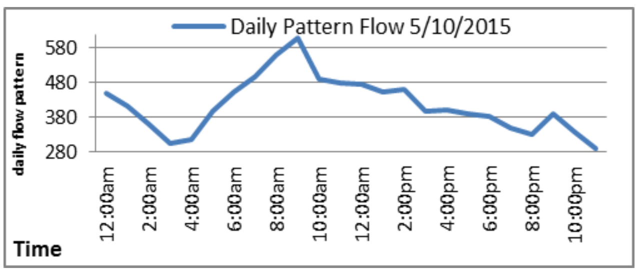


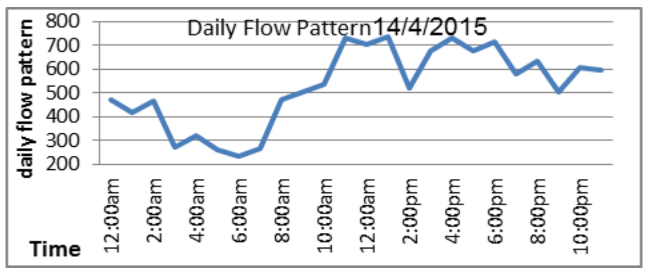


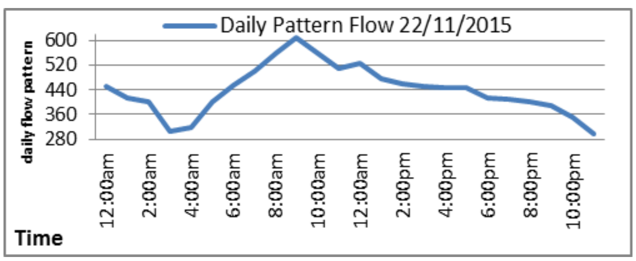


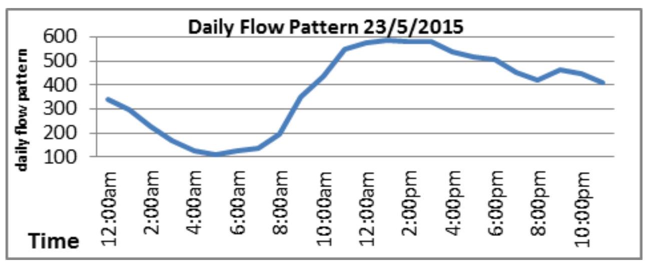


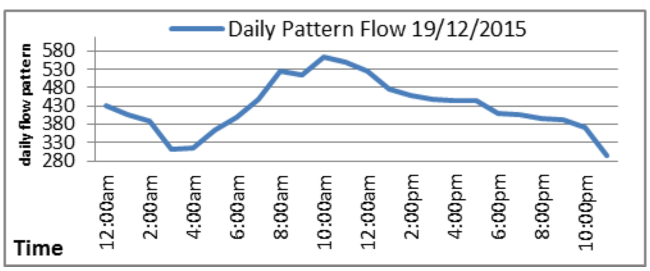


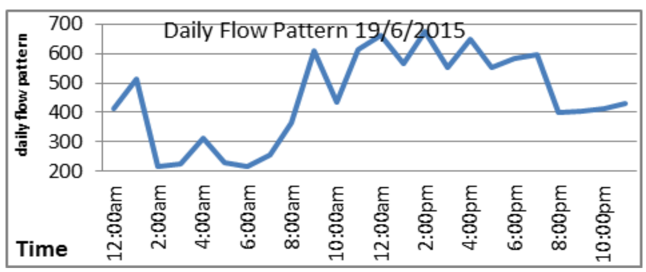




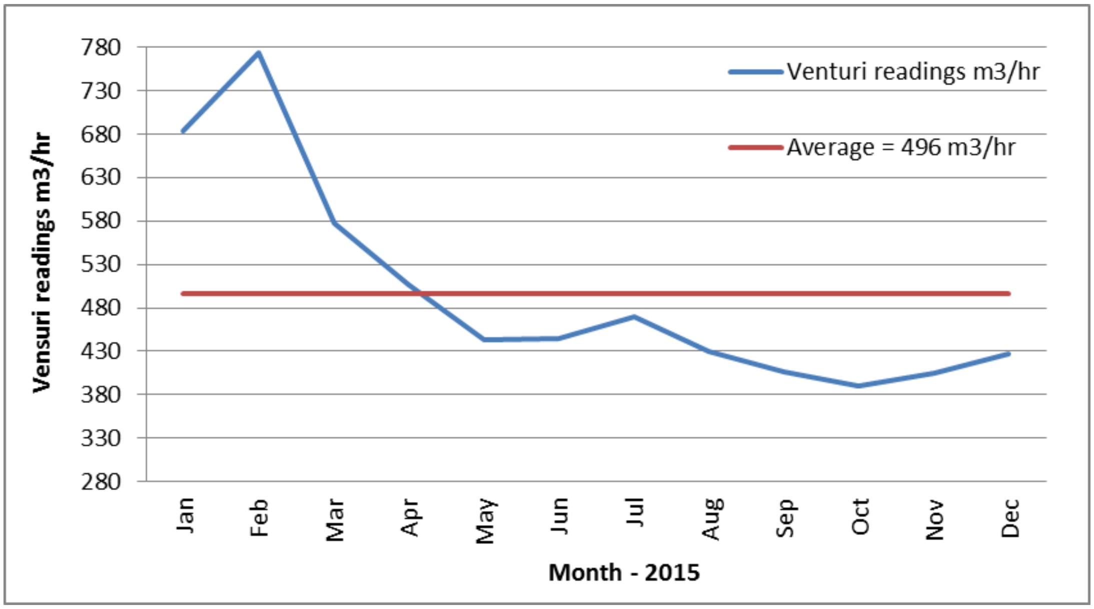




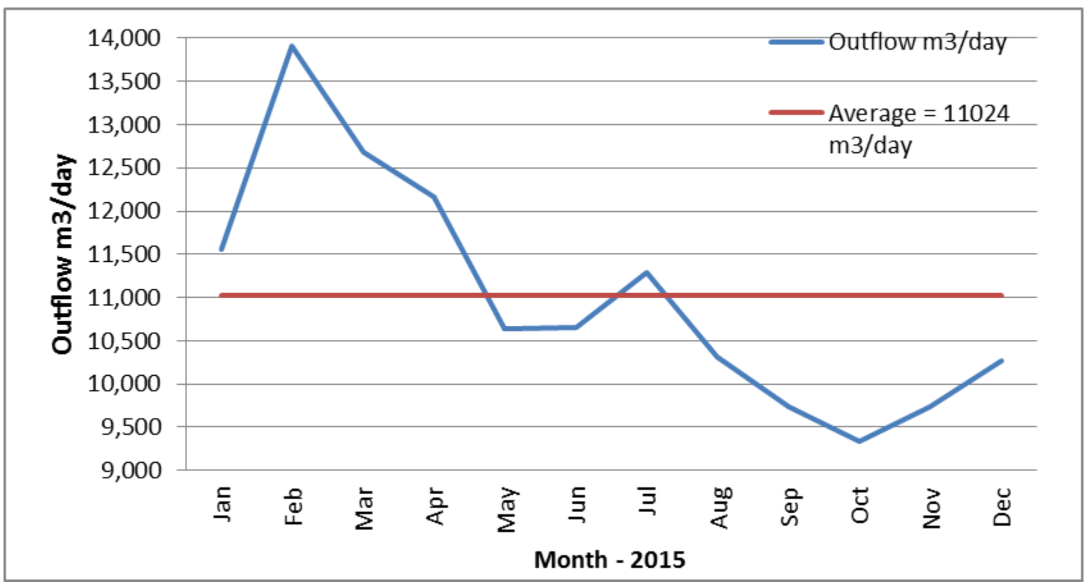




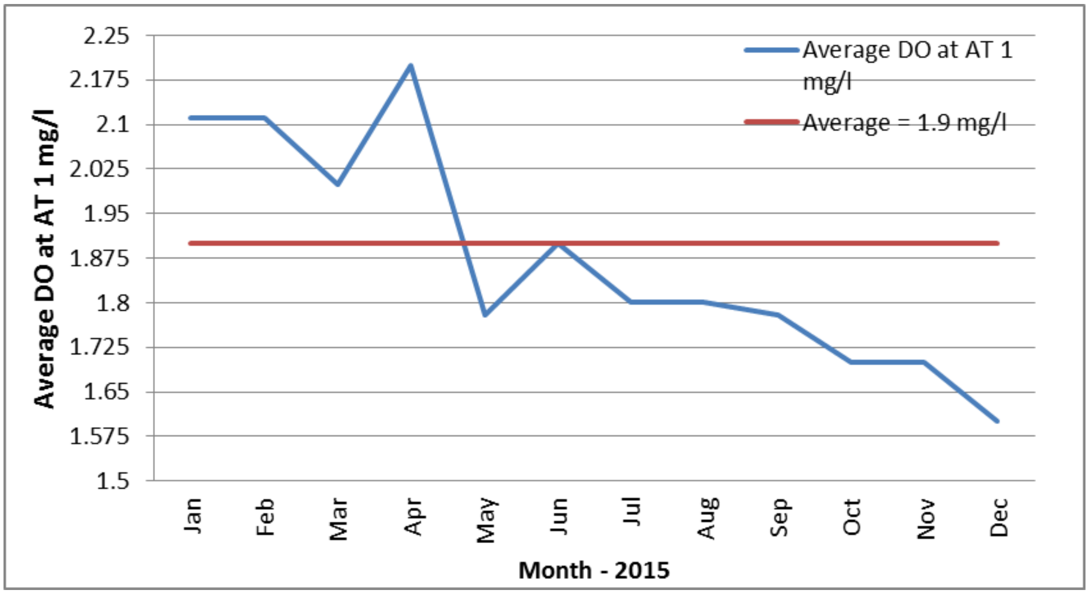
Annex 2: Graphs



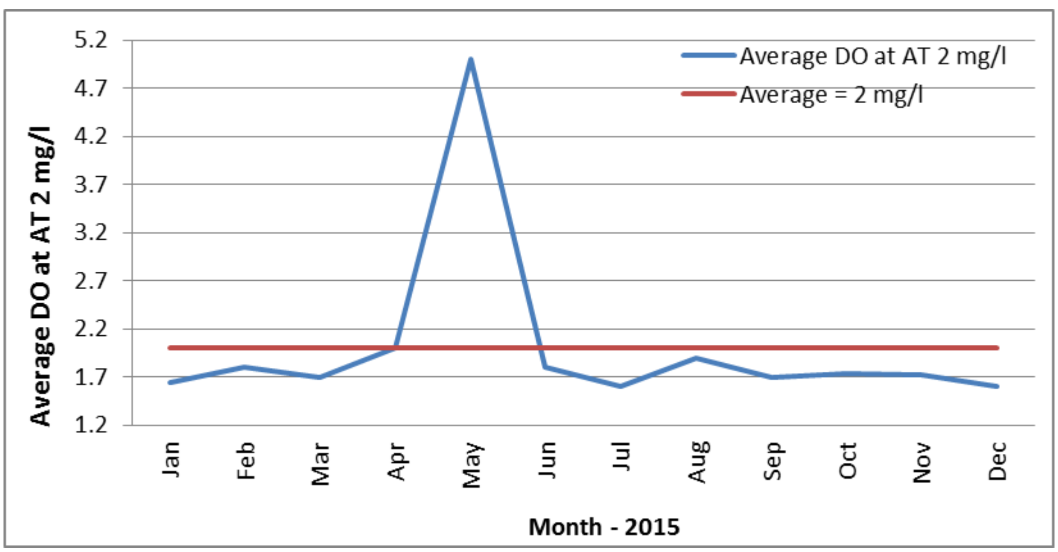
Graph 1: Average wastewater influent



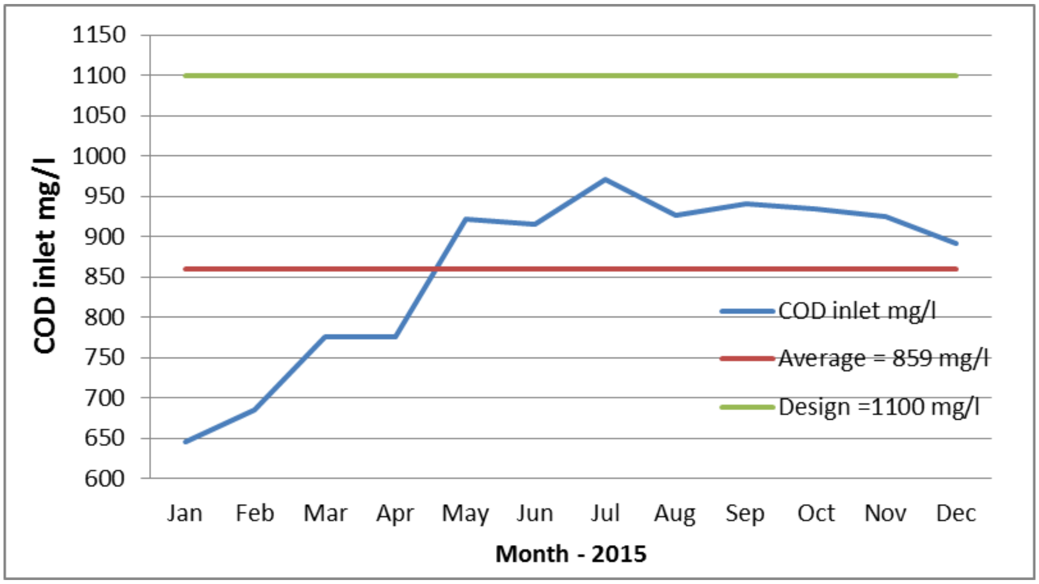
Graph 2: The average treated effluent



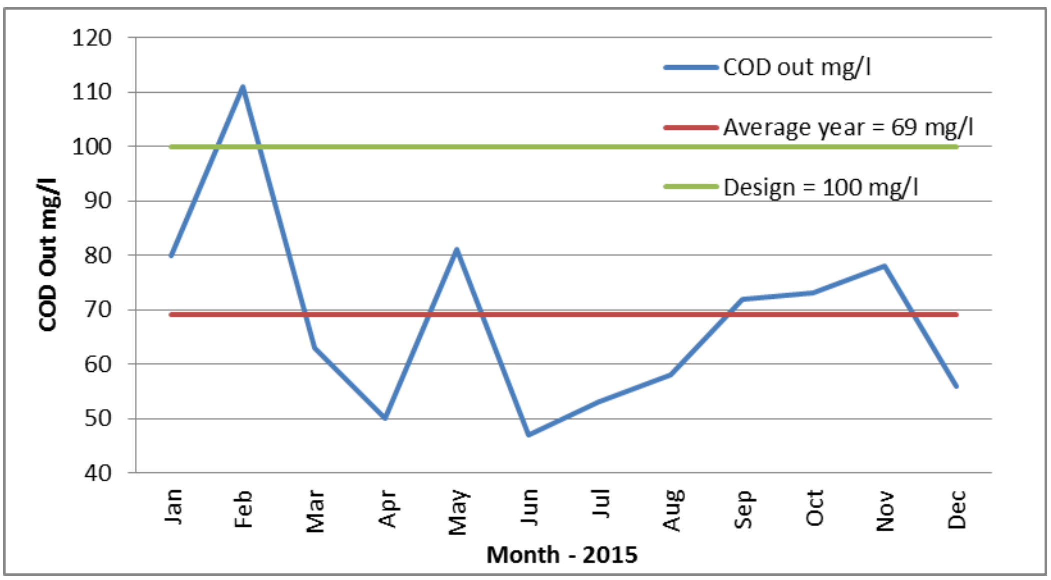
Graph 3: Daily dissolved oxygen concentration pattern in the aeration tank no. (1)



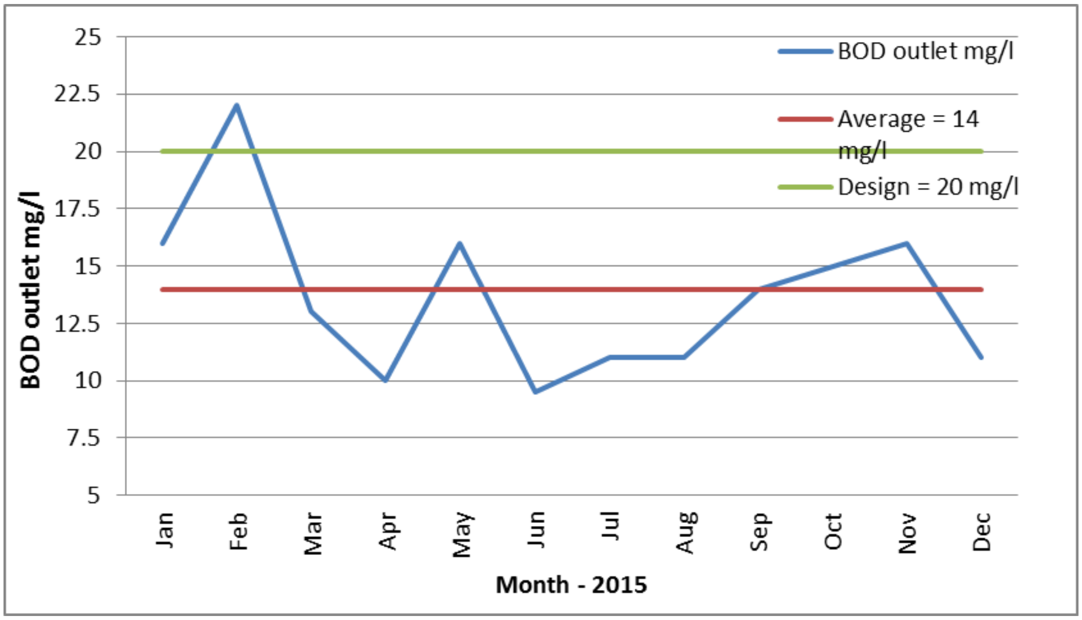
Graph 4: Daily dissolved oxygen concentration pattern in tank no. (2)



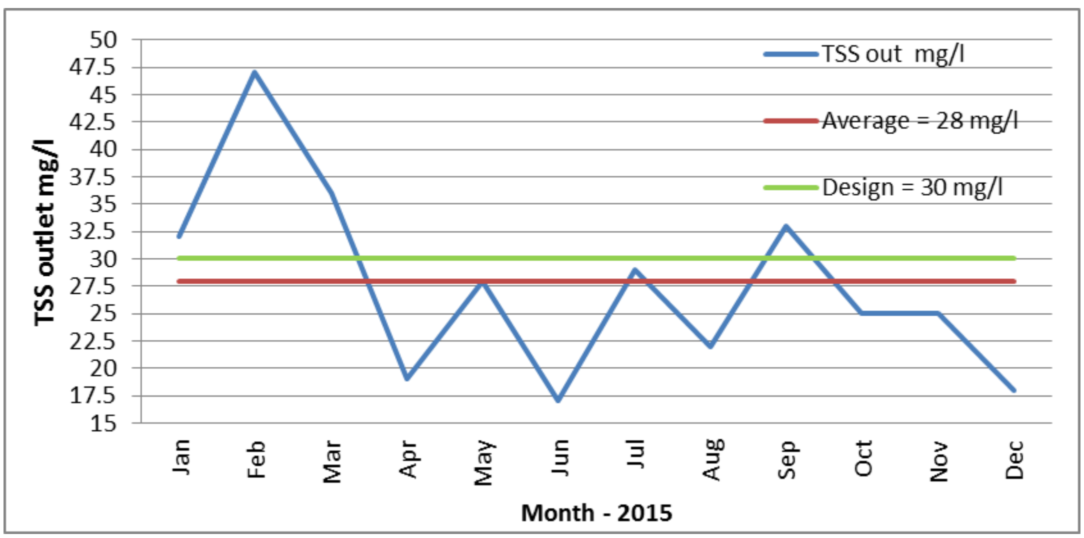
Graph 5: The COD concentration in the influent of WWTP



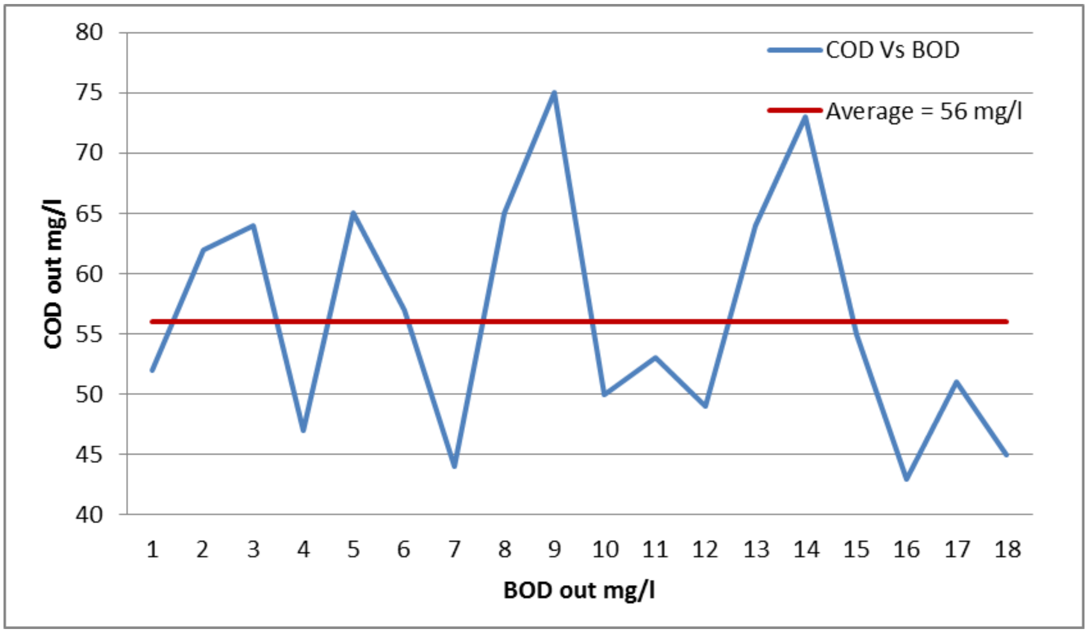
Graph 6: The COD concentration in the effluent of the treated waste water



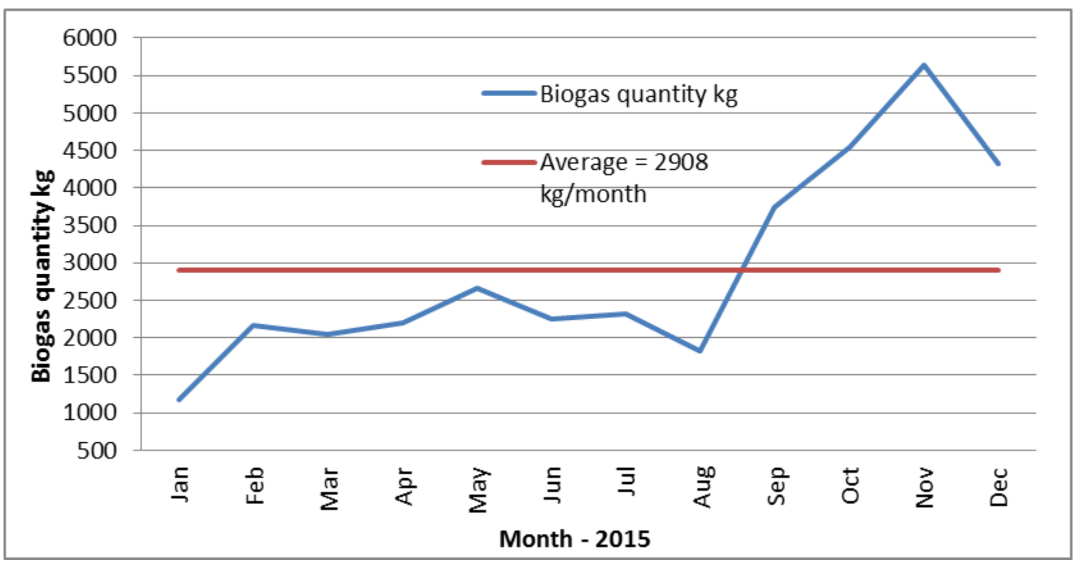
Graph 7: The BOD_5 concentration in the effluent of the treated wastewater



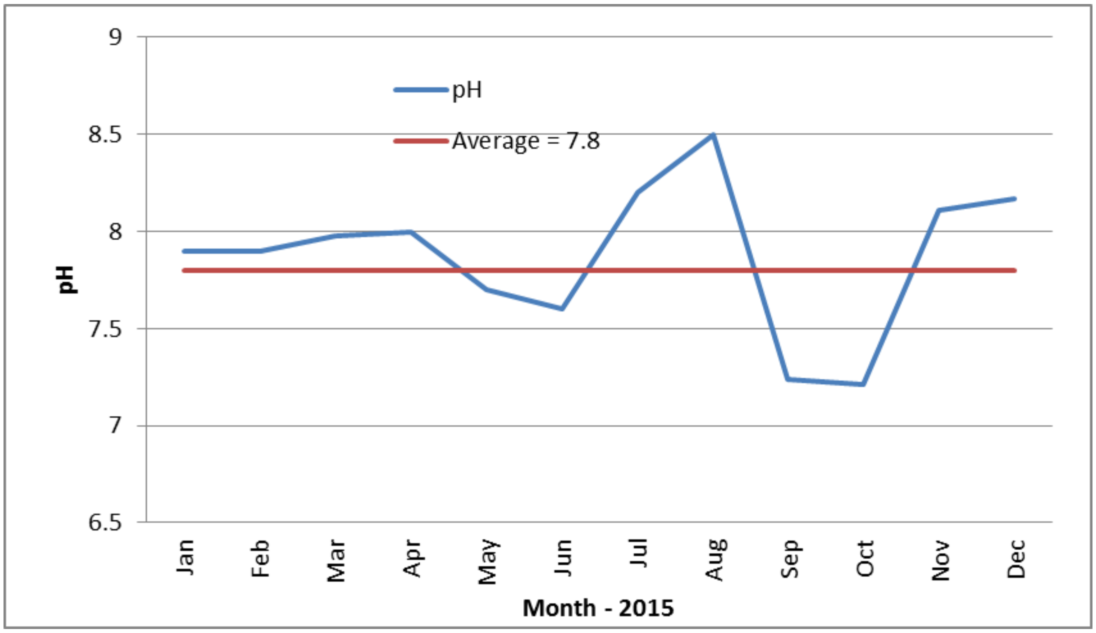
Graph 8: TSS concentration of the treated wastewater (TSS)



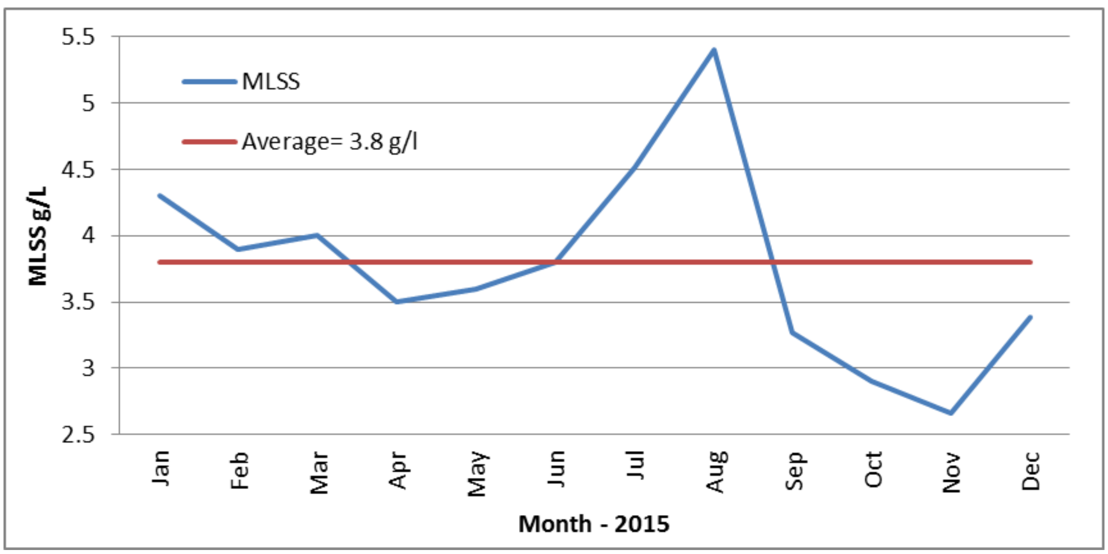
Graph 9: The correlation between COD_{out} and BOD_{out}



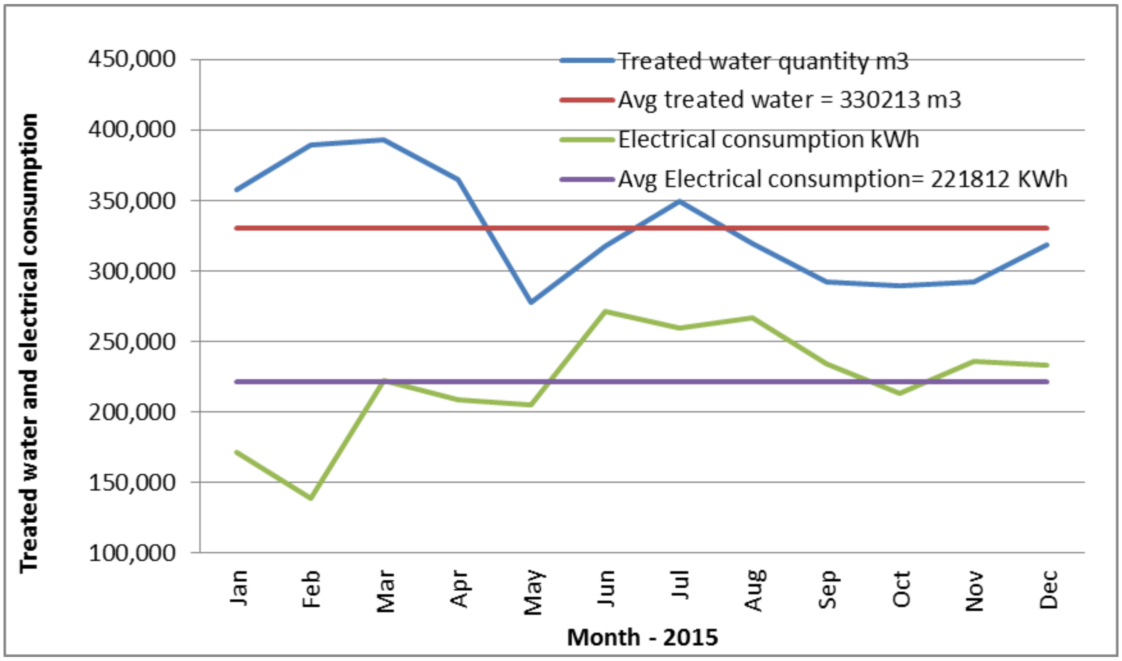
Graph 10: The average produced quantities of biogas



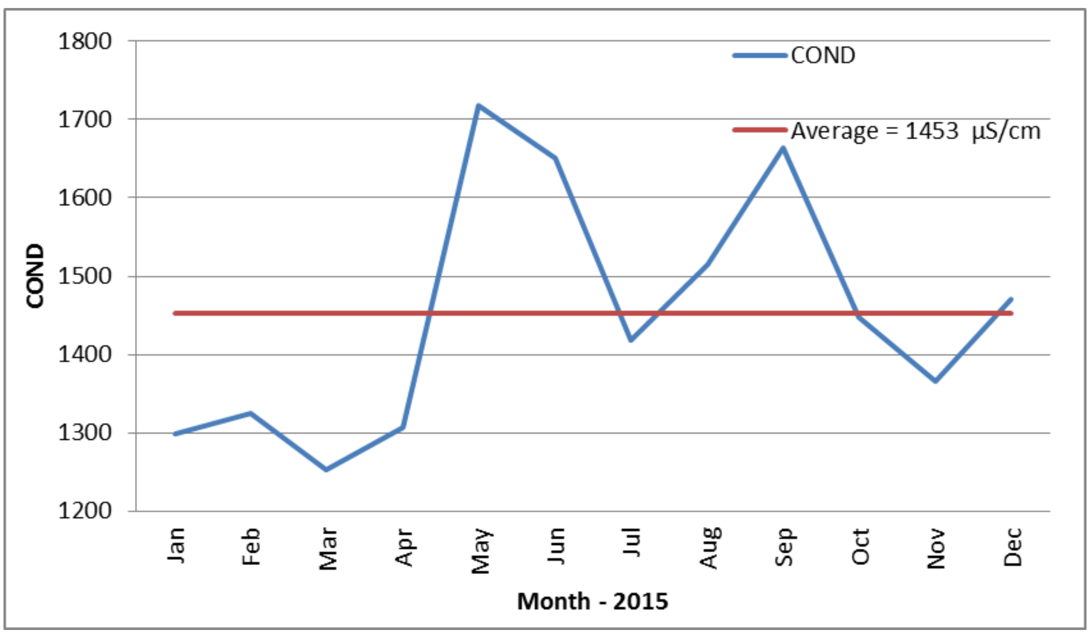
Graph 11: Average pH measurements of the inlet wastewater



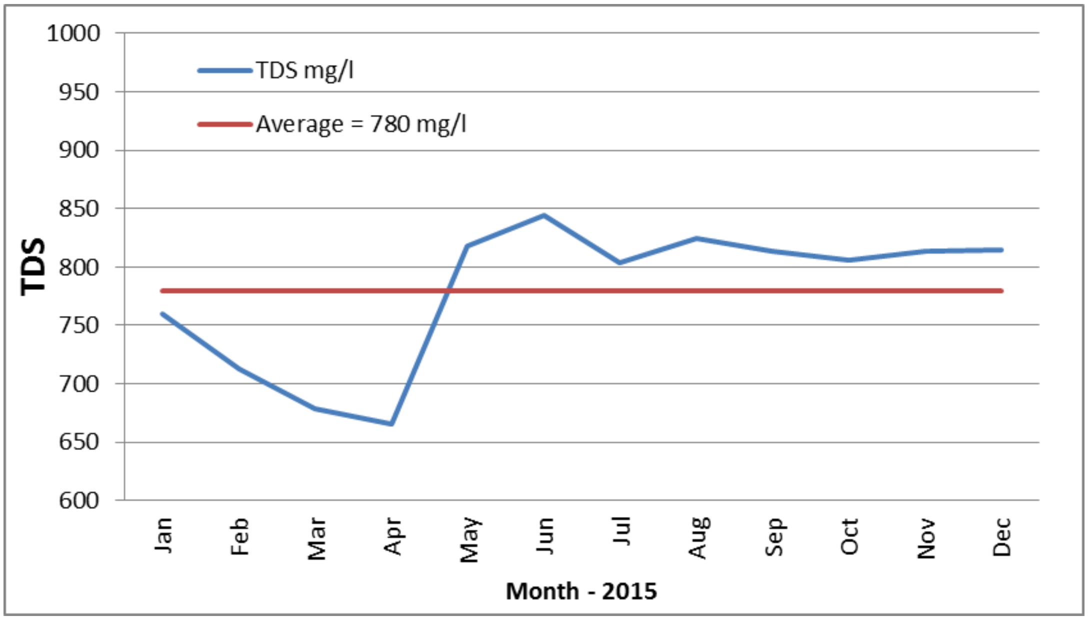
Graph 12: Mixed liquor concentration (MLSS) in aeration tanks



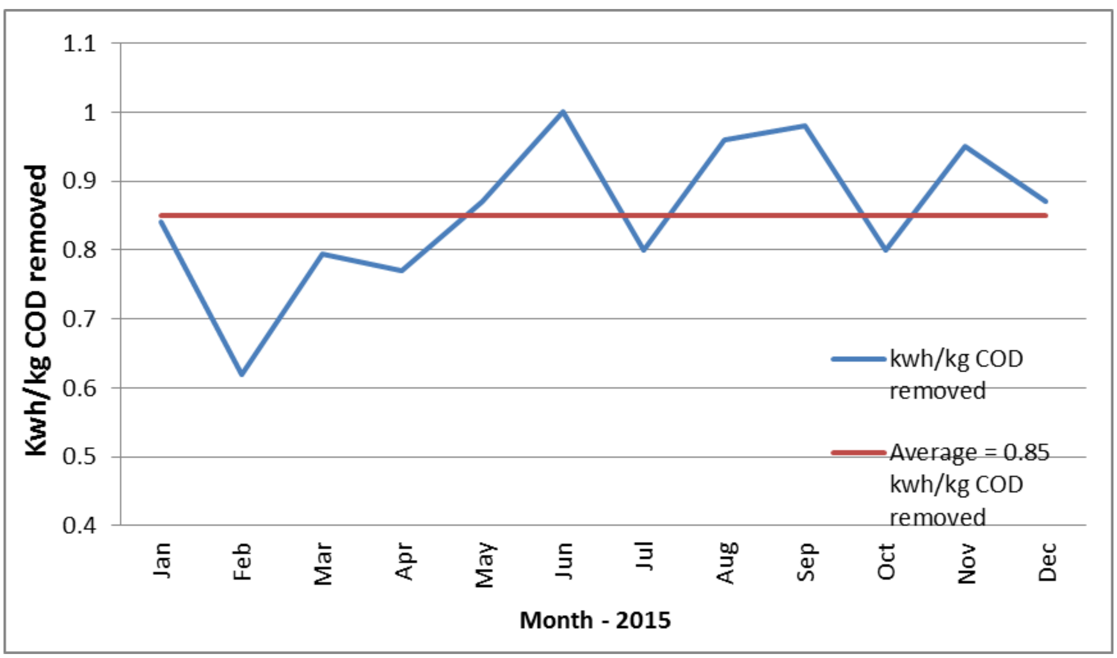
Graph 13: Average monthly treated wastewater and power consumption



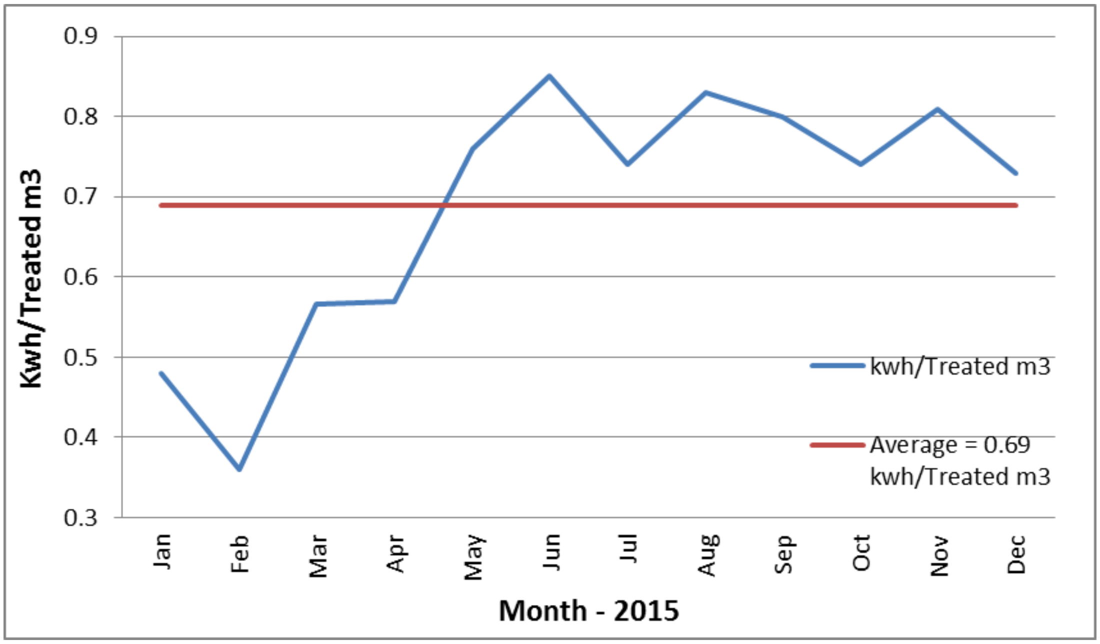
Graph 14: Conductivity results in the inlet



Graph 15: Total dissolved solids in the effluent



Graph 16: Power requirement kWh/kg COD treated



Graph 17: Power requirement kWh/m^3 treated

Annex 3: Summary performance

Parameters	Design value 2020	Treatment efficiency %	Average 2015	2015											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average inlet flow m^3/d	14000	-----	11024	11556	13913	12685	12161	10636	10651	11285	10319	9740	9340	9738	10267
Inlet COD mg/L	1100	-----	859	645	685	775	776	921	915	971	926	941	935	924	891
Outlet COD mg/L	100	92%	69	80.00	111.00	63.00	50.00	81.00	47.00	53.00	58.00	72.00	73.00	78.00	56.00
Outlet BOD_5 mg/L	20	96%	14	16.00	22.00	13.00	10.00	16.00	9.50	11.00	11.00	14.00	15.00	16.00	11.00
Inlet BOD_5 mg/L	550		430	323	343	387	388	461	458	485	463	471	468	462	445
Sludge age (days)	13.7	-----	14	19	13	18	11	12	13	12	9	10	16	16	15
MLSS g/L	3	-----	3.8	4.30	3.90	4.00	3.50	3.60	3.80	4.50	5.40	3.30	2.90	2.66	3.38
TSS_{inlet} mg/L	500		374	448	436	319	359	340	358	374	347	351	394	385	374
TSS_{outlet} mg/L	30	93%	28	32.00	47.00	36.00	19.00	28.00	17.00	29.00	22.00	33.00	25.00	25.00	18.00
(kWh/kg COD)	0.8	-----	0.85	0.84	0.62	0.80	0.77	0.87	1.00	0.80	0.96	0.98	0.80	0.95	0.87

Annex 4: Power consumption

Parameters	Avg	Month/ 2015											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Treated wastewater m^3	330,213	357,231	389,550	393,244	364,834	277,848	318,017	349,840	319,898	292,197	289,500	292,125	318,270
Power Consumption kWh	221,812	171,474	139,101	222,721	209,234	204,990	271,837	259,617	266,860	234,126	213,000	235,684	233,102
KWh/m^3	0.67	0.48	0.36	0.57	0.57	0.74	0.85	0.74	0.83	0.80	0.74	0.81	0.73

Annex 5: Additional lab results of TWW

Parameters	Values	Average	Month/ 2015											
			Dec	Nov	Oct	Sep	Aug	Jul	Jun	May*	Apr#	Mar#	Feb#	Jan#
COD out mg/l	Average	71	56	78	73	72	58	53	47	81	79	63	111	80
	Max	114	72	120	102	95	94	78	75	181	50	96	220	189
	Min	43	44	51	48	40	48	34	28	42	34	49	51	41
BOD out mg/l	Average	14	11	16	15	14	11	11	9.5	16	16	13	22	16
	Max	23	14.4	24	20	19	18	16	15	36	10	19	44	38
	Min	8	8.5	10	10	8	5	7	5.6	8.4	7	10	10	8
NH4-N out mg/l	Average	3	3.5	0.7	0.6	3	0.93	8.08	4.5	44	1.58	5.7	67	26
	Max	12.9	3.9	1	1.2	5	0.72	12.9	10.7	69	5.7	77	-	38
	Min	0	3.2	0.1	0.1	0.3	0	1.7	0	20	0	0.1	-	14.2
NO3-N out mg/l	Average	7	7.4	18.5	12.7	1.8	0.6	3	0.8	1	3.55	3.2	-	-
	Max	11	35.8	31	20.2	2.2	0.6	3	1.4	1.3	9.1	9	-	-
	Min	3	8	5.7	4.9	1.5	0.6	3	0.1	0.8	-	0	-	-
TN out mg/l	Average	15	11	35.3	16	7	3.33	13.16	9	39	8.2	11.2	-	-
	Max	25	11	53	30	14	4	17.8	15	74	18.1	16	-	-
	Min	6	11	12	9	6	3	6	4	5.3	3.5	5.7	-	-
PO4-P out mg/l	Average	4	5.15	5	2	4.4	3.4	4.4	2.8	-	2.95	6.37	-	-
	Max	5	5.3	7.1	2	6.2	3.4	4.4	2.8	-	4.6	13	-	-
	Min	3	5	2.5	2	4.1	3.4	4.4	2.8	-	3.6	2.9	-	-
TSS out mg/l	Average	28	18	25	25	33	22	29	17	28	19	36	47	32
	Max	61	37	42	58	51	54	55	33	44	66	94	127	69
	Min	8	2	5	8	13	3	12	7	16	3	10	12	10
MLSS mg/l	Average	4	3.38	2.66	2.9	3.27	5.4	4.5	3.8	3.6	3.44	4	3.9	4.3
	Max	5	3.92	3.1	3.23	3.57	7.92	4.95	4.5	4.7	4	5	5.82	5.8
	Min	3	3.07	2.2	2.67	2.67	3.4	3.66	3.7	2.7	2.2	2.6	3.24	2.9

*in May, the plant was out of operation for 4 days to make maintenance of the outlet weirs of the aeration tanks, * Nitrification and denitrification process start in June

Annex 6: Third party analysis TWW 19-12-2015

1st Campaign: Quality of the treated wastewater in 19-12-2015 with comparison of reuse standard (34/2012)						
	Comparison	Quality of Treated Water				
Maximum limits for chemical and biological properties	Sampled	High Quality (A)	Good Quality (B)	Medium Quality (C)	Low Quality (D)	Method of Testing
(BOD5) mg/l	5	20	20	20	60	NWWTP Lab, Oxidirect instrument without ATH
suspended solids (TSS) mg/l	18	30	30	30	90	NWWTP Lab, gravimetric
FC (Colony/100ml)	22000	200	1000	1000	1000	Birzeit Lab, StMe method
(COD) mg/l	52	50	50	100	150	NWWTP Lab, Nanocolor spec.
Dissolved Oxygen (DO) mg/l	6.2	>1	>1	>1	>1	NWWTP Lab, PONSEL DO
dissolved Solids (TDS) mg/l	829	1200	1500	1500	1500	NWWTP Lab, gravimetric
pH	8.22	6--9	6--9	6--9	6--9	NWWTP Lab, WTW sensor
Fat, Oil, & Grease mg/l	<1	5	5	5	5	Birzeit Lab, StMe method
Phenol mg/l	<0.001	0.002	0.002	0.002	0.002	
MBAS	<0.01	15	15	15	25	
NO3-N mg/l	8	20	20	30	40	NWWTP Lab, Nanocolor spec.
NH4-N mg/l	3.9	5	5	10	15	
Total Nitrogen mg/l	12	30	30	45	60	
CL mg/l	167	400	400	400	400	
SO4 mg/l	47.4	300	300	300	300	Birzeit Lab, ICP instrument
Na mg/l	138.2	200	200	200	200	
Mg mg/l	16.75	60	60	60	60	
Ca mg/l	52.5	300	300	300	300	
SAR	3.0	5.85	5.85	5.85	5.85	Calculated
PO4-P mg/l	5	30	30	30	30	NWWTP Lab, Nanocolor spec.
Al mg/l	0.107	5	5	5	5	Birzeit Lab, ICP instrument
Cu mg/l	0.032	0.2	0.2	0.2	0.2	
Fe mg/l	0.109	5	5	5	5	
Mn mg/l	0.012	0.2	0.2	0.2	0.2	
Ni mg/l	0.006	0.2	0.2	0.2	0.2	
Pb mg/l	Absent	0.2	0.2	0.2	0.2	
Se mg/l	Absent	0.02	0.02	0.02	0.02	
Cd mg/l	Absent	0.01	0.01	0.01	0.01	
Zn mg/l	0.116	2	2	2	2	
Cn mg/l	<0.03	0.05	0.05	0.05	0.05	
Cr mg/l	0.014	0.1	0.1	0.1	0.1	
Hg mg/l	1.3*10-4	0.001	0.001	0.001	0.001	
Co mg/l	Absent	0.05	0.05	0.05	0.05	
B mg/l	0.137	0.7	0.7	0.7	0.7	
E. coli (Colony/100ml)	2600	100	1000	1000	1000	Birzeit Lab, StMe method
Nematodes (eggs/L)	Absent	1>=	1>=	1>=	1>=	

Annex7: Third party analysis TWW 13-10-2016

2nd Campaign: Quality of treated wastewater in 13-1-2016) with comparison of reuse standard (34/2012)						
		Quality of Treated Water				
Maximum limits for chemical and biological properties	Sampled 13/01/2016	High Quality (A)	Good Quality (B)	Medium Quality (C)	Low Quality (D)	Method of Testing
(BOD_5) mg/l	<10	20	20	20	60	Birzeit Lab, StMe method
suspended solids (TSS) mg/l	24	30	30	30	90	NWWTP Lab, gravimetric analysis
FC (Colony/100ml)	80	200	1000	1000	1000	Birzeit Lab, StMe method
(COD) mg/l	20	50	50	100	150	Birzeit Lab, ICP instrument
Dissolved Oxygen (DO) mg/l	7.1	>1	>1	>1	>1	NWWTP Lab, PONSEL DO sensor
dissolved Solids (TDS) mg/l	696	1200	1500	1500	1500	Birzeit Lab, ICP instrument
pH	7.17	6--9	6--9	6--9	6--9	Birzeit Lab, ICP instrument
Fat, Oil, & Grease mg/l	<1	5	5	5	5	Birzeit Lab, StMe method
Phenol mg/l	<0.001	0.002	0.002	0.002	0.002	
MBAS	<0.01	15	15	15	25	
NO3-N mg/l	26.26	20	20	30	40	Birzeit Lab, ICP instrument
NH4-N mg/l	0.08	5	5	10	15	
Total Nitrogen mg/l	26	30	30	45	60	
CL mg/l	176.65	400	400	400	400	
SO4 mg/l	70.22	300	300	300	300	Birzeit Lab, ICP instrument
Na mg/l	151.2	200	200	200	200	
Mg mg/l	16.96	60	60	60	60	
Ca mg/l	86.77	300	300	300	300	
SAR	3.87	5.85	5.85	5.85	5.85	Calculated
PO4-P mg/l	2.59	30	30	30	30	Birzeit Lab, ICP instrument
Al mg/l	0.054	5	5	5	5	Birzeit Lab, ICP instrument
Cu mg/l	0.013	0.2	0.2	0.2	0.2	
Fe mg/l	0.036	5	5	5	5	
Mn mg/l	0.009	0.2	0.2	0.2	0.2	
Ni mg/l	Absent	0.2	0.2	0.2	0.2	
Pb mg/l	Absent	0.2	0.2	0.2	0.2	
Se mg/l	Absent	0.02	0.02	0.02	0.02	
Cd mg/l	Absent	0.01	0.01	0.01	0.01	
Zn mg/l	0.083	2	2	2	2	
Cn mg/l	Absent	0.05	0.05	0.05	0.05	
Cr mg/l	Absent	0.1	0.1	0.1	0.1	
Hg mg/l	$1.3*10^{-4}$	0.001	0.001	0.001	0.001	
Co mg/l	Absent	0.05	0.05	0.05	0.05	
B mg/l	Absent	0.7	0.7	0.7	0.7	
E. coli (Colony/100ml)	23	100	1000	1000	1000	Birzeit Lab, StMe method
Nematodes (eggs/L)	Absent	1>=	1>=	1>=	1>=	

Annex 8: Third party sludge analysis

Sludge Analysis Campaign						
Elements	PS/-898:2010			Obligatory	Nablus West /sludge	Note
	1st class	2nd class	3rd class	Tech. Ins 59/2015		
Cd (ppm)	40	40	85	20	0.4	Comply with All
Cu (ppm)	1500	3000	4300	1000	141.8	Comply with All
Ni (ppm)	300	400	420	300	19.4	Comply with All
Pb (ppm)	300	840	840	750	11.8	Comply with All
Zn (ppm)	2800	4000	7500	2500	175.1	Comply with All
Cr (ppm)	900	900	3000	400	31.2	Comply with All
Hg (ppm)	17	57	57	16	N.A	Analysis method not Available
PH	N.A	N.A	N.A	N.A	8.2	No Reference
Electrical Conductivity (µs/cm)	N.A	N.A	N.A	N.A	832	No Reference
Phosphorus total (ppm)	N.A	N.A	N.A	N.A	12.23	No Reference
(TKN) ppm	N.A	N.A	N.A	N.A	43.71	No Reference
Density g/cm3	N.A	N.A	N.A	N.A	1.02	No Reference
Moisture %	10%	50%	N.A	N.A	68.62	Comply with PS/-898:2010 3rd class
Dry matter %	N.A	N.A	N.A	N.A	31.38	No Reference
Organic matter %	N.A	N.A	N.A	N.A	59.31	No Reference
Helminthes eggs (egg/g)	1	N.A	N.A	N.A	2.4	Comply with PS/-898:2010 2rd class
FC (cfu/g)	1000	2000000	N.A	N.A	4300	Comply with PS/-898:2010 2rd class
E.coli (cfu/g)	N.A	N.A	N.A	N.A	810	No Reference
Salmonella (cu/g)	3	N.A	N.A	N.A	Nil	Comply with PS/-898:2010 1rd class

General Photos