

New Strategies for Wastewater Management and Reuse in Alexandria in 2037



October 2010

Copyright © CEDARE 2010

Study Team

Team Leader: Prof. Dr. Khaled M. Abu-Zeid, CEDARE

International Coordinator: Dr. Peter Van Der Steen, UNESCO-IHE

Local Specialists:

Dr. Helaly Abdel Hady Helaly, Alexandria Sanitary Drainage Company

Dr. Ahmed Kassem, Helwan University

Dr. Mahmoud El-Sheikh, Helwan University

Dr. Samaa Maher Abdel Aziz, Alexandria Sanitary Drainage Company

CEDARE Coordinator: Eng. Mohamed Elrawady, CEDARE

Table of contents

List of Tables.....	5
List of Figures.....	7
List of Annexes.....	9
Chapter 0 : Introduction	10
Chapter 1 : Description and assessment of current wastewater system	12
1-1. Land use and population of Alexandria.....	12
1-2. Areas covered by a sewer system, type of sewer system, connection rate per area.....	16
1-3. Areas and population relying on on-site sanitation forms. Type of on-site sanitation.....	18
1-4. Main sewer lines, pumping stations.....	19
1-5. Location, capacity (current and planned), type of technology, points of discharge of all WWTPs.....	21
1-6. Monitoring data (quality, quantity) for municipal WWTPs (influent and effluent) and surface water.....	23
1-7. The irrigation and drainage canal network within the Governorate.....	25
1-8. Points of industrial effluents discharge (quality, quantity).....	26
1-9. Sludge generation (location, quantity, and quality), processing and disposal.....	28
1-10. Overview of the institutions involved in wastewater management in the city (mandate, operations).....	30
.....	
1-11. Overview of relevant legislation and policies.....	33
1-12. An overview of the various projects on wastewater management in the city.....	35
1-13. Assessment of the wastewater system in terms of: public health, environmental pollution, implementation of legislation and policies, financing, equity,etc.....	37
 Chapter 2 A Vision for a future wastewater system	 44
2-1 Introduction.....	44
2-2 The challenges.....	44
2-3 Alexandria City Development Strategy.....	44
2-4 Alexandria Sanitary Drainage Company Mission , Vision and Strategic goals.....	45
2-5 Vision for a future water and wastewater systems 2037.....	46
2-5-1 Effective wastewater system Establishment.....	47
2-5-2 Ensuring and improving aquatic environment of Lake Maryout as one of the major priorities for improving future Alexandria wastewater system.....	47
2-5-3 Achieving full cost recovery of operation and maintenance expenses and ultimately total cost recovery of future wastewater system through.....	48
2-5-4 Sustain, preserve, and enhance the quality of the wastewater system.....	48
 Chapter 3 : Scenarios affecting the wastewater system	 49
3-1 Population growth, city expansion and wastewater flows.....	49
3-2 Wastewater composition, industrial discharges and the enforced effluent standards....	52
3-2-1 Priority pollutants and industrial discharge	52
3-2-2 Wastewater composition	53

3-3	Demand for effluent (industrial, urban and agricultural reuse; location, required qualities and potential quantities).....	56
3-3-1	Alexandria water challenges	56
3-3-2	Effluent demand	57
3-3-2-1	Industrial demand	57
3-3-2-2	Urban demand	57
3-3-2-3	Agricultural demand	58
3-3-3	Required qualities	58
3-3-4	Quality of treated effluent	61
3-4	Intrusion of saline water into the sewer system.....	63

Chapter 4 : Potential strategies to achieve a sustainable urban wastewater system 65

4-1	Strategy 1: Conventional collection and treatment for disposal	65
4-1-1	Disposal options	66
4-1-1-1	Lake Bypass –East treatment plant	66
4-1-1-2	Lake Bypass –West treatment plant	67
4-1-1-3	Sea discharge both ETP and WTP	68
4-1-2	Advantages and Disadvantages of secondary and tertiary treatment	69
4-1-2-1	Secondary treatment	69
4-1-2-2	Tertiary treatment	69
4-2	Strategy 2: Conventional collection and treatment for centralized agricultural reuse	69
4-2-1	Quality of Alexandria effluent in relation to potential reuse options	70
4-2-2	Expected effluent quantities in Alexandria	70
4-2-3	Proposed effluent reuse options in Alexandria	70
4-2-3-1	Agricultural land proposed by ASDCO in west Noubaria region	71
4-2-3-2	The Omoum drain reversal scheme for effluent reuse recommended by WRc study ...	72
4-2-3-3	The Hammam extension reclamation area- Scenario proposed by the Ministry of water resources and irrigation	73
4-2-4	Other reuse options studied by WRc	74
4-2-4-1	Supplement the water supply in the Nasr canal by direct transfer of effluent from Alexandria	76
4-2-4-2	Supplement the water supply in the Nasr canal by transfer of effluent through the Omoum drain	76
4-2-4-3	Supplement the water supply in Bahig canal	77
4-2-5	Feasibility of effluent reuse in Alexandria region (Hamman extension)	77
4-2-5-1	Costs and benefits	78
4-2-5-2	Environmental assessment	79
4-2-5-3	Proposed cultivation	79
4-2-6	Irrigation water demand in Noubaria area	80
4-2-7	Suggested options for effluent reuse in case of tertiary treatment or highly disinfected secondary treated effluent for further study	80
4-3	Strategy 3: Mix of on-site sanitation and sewerage	81
4-3-1	On-site treatment and disposal	81
4-3-2	Off-site treatment and disposal	82
4-3-3	Scenarios for rural areas in Alexandria	83
4-3-3-1	Areas located in sandy soil land	83
4-3-3-2	Small areas in agricultural land	84
4-3-3-3	High density populated rural areas in Alexandria	84

4-4 Strategy 4: Direct Urban non-potable reuse	84
4-4-1 Public health risks	85
4-4-2 Reuse options for effluent from Alexandria WWTPs in irrigation	85
4-4-2-1 Effluent from ETP	86
4-4-2-2 Effluent from WTP	86
4-4-2-3 Effluents from small WWTPs	86
4-4-3 Reuse of grey water in Alexandria	88
4-4-4 Quality control of water, Inspection and supply	89
4-5 Strategy 5: Indirect urban potable/non-potable reuse by SAT and ARR	89
4-5-1 Use of SAT systems in West Alexandria	92
4-5-2 Use of SAT systems in East Alexandria	93
4-6 Strategy 6: Wetlands and aquaculture	93
4-6-1 Expected revenue of the IAP project	94
4-6-2 Proposed treatment alternatives by the Lake Maryout integrated management project	94
4-6-2-1 Alternative cost	96
4-6-2-2 Environmental Impacts of the suggested alternatives	96
4-7 Strategies evaluation	97
4-7-1 Strategy 1: Conventional collection and treatment for disposal	98
4-7-2 Strategy 2: Conventional collection and treatment for centralized agricultural reuse	98
4-7-3 Strategy 3: Mix of on-site sanitation and sewerage	98
4-7-4 Strategy 4: Direct Urban non-potable reuse	99
4-7-5 Strategy 5: Indirect urban potable/non-potable reuse by SAT and ARR	99
4-7-6 Strategy 6: Wetlands and aquaculture	99
Chapter 5 : Wastewater management and IUWM	101
Chapter 6 : Conclusions and recommendations	104
References	107
Annexes	111

List of Tables

Table 1-1	The Census population (2006) and its distribution in Alexandria.....	15
Table 1-2	Number of Served and Non-served population (2007).....	18
Table 1-3	Rural Areas and their existing population in Alexandria Governorate.....	19
Table 1-4	Water Quality Parameters.....	24
Table 1-5	Current and Future sludge production in Alexandria (m ³ /d).....	28
Table 1-6	New Wastewater treatment plant projects under construction.....	36
Table 1-7	Projects under execution for sewerage systems and their budget in Alexandria.....	36
Table 1-8	Comparison of Environmental Impacts of Wastewater Treatment Alternatives.....	41
Table 3-1	Population Prediction according to the as usual scenario.....	50
Table 3-2	Population Prediction according to the best case scenario.....	50
Table 3-3	Population Prediction according to the worst case scenario.....	50
Table 3-4	Existing and predicted water consumption in Alexandria.....	51
Table 3-5	Predicted wastewater production in Alexandria (m ³ /d) according to the as usual scenario.....	51
Table 3-6	Predicted Wastewater Production in Alexandria (m ³ /d) according to the best scenario.....	52
Table 3-7	Predicted Wastewater Production in Alexandria (m ³ /d) according to the worst case scenario.....	52
Table 3-8	Present Water Consumption - Alexandria Governorate.....	53
Table 3-9	Alexandria Wastewater Composition collected through pump stations...	54
Table 3-10	Alexandria Wastewater Composition entering the Wastewater Treatment plants.....	55
Table 3-11	Present Available Water Resources - Alexandria Governorate.....	56
Table 3-12	Future Water Needs (Year 2017) - Alexandria Governorate	56
Table 3-13	Maximum Standards Permitted for Reusing Treated Sanitary Effluent according to the Degree of Treatment (Decree 44/2000).....	59
Table 3-14	Maximum Standards of Metals Permitted for Reusing Treated Sanitary Effluent according to the Degree of Treatment (Decree 44/2000).....	60

Table 3-15	Egyptian Microbiological Quality Standards for Treated Effluent reuse in Agriculture (Decree 44/2000).....	61
Table 3-16	The characteristics of effluents produced from primary and secondary treatment plants in Alexandria.....	62
Table 4-1	Existing Self Cleaning Process in Lake Maryout.....	66
Table 4-2	Estimated costs for construction, operation and maintenance of conveying systems.....	78
Table 4-3	Comparative performance, requirements and construction costs of off-site sewage treatment systems.....	82
Table 4-4	Criteria of Treated Wastewater Allowed for Reuse in irrigation Purposes.....	87
Table 4-5	Classification of Plants and Crops allowed to be irrigated with treated wastewater.....	88
Table 4-6	The criteria after using wetland and maturation pond.....	96
Table 4-7	Scoring the Effect of the Strategies on the indicators.....	100

List of Figures

Figure 1-1	Location of Alexandria Governorate.....	12
Figure 1-2	Different Land uses within Alexandria Governorate.....	13
Figure 1-3	Municipality and Urban areas.....	13
Figure 1-4	Alexandria Districts and New Borg El-Arab City.....	14
Figure 1-5	The main districts of the urban area in Alexandria.....	15
Figure 1-6	Served Population in Alexandria.....	17
Figure 1-7	Main Pump Stations in Alexandria.....	20
Figure 1-8	Force main lines to pumping stations then to the ETP.....	21
Figure 1-9	West Wastewater treatment plant influent rate.....	21
Figure 1-10	Current and planned Wastewater treatment plants.....	22
Figure 1-11	Surface Water Canals in Alexandria.....	25
Figure 1-12	Direct Industrial Discharge into Lake Maryout.....	26
Figure 1-13	Industrial Discharge into the sewer network (ETP).....	27
Figure 1-14	Industrial Discharge into the sewer network (WTP).....	27
Figure 1-15	Composting Processes of Dewatered Sludge.....	29
Figure 1-16	Existing human health conditions, in the Main Basin of Lake Maryout...	41
Figure 3-1	Location of Alex West Housing compound receiving treated wastewater for irrigation.....	57
Figure 3-2	Location of proposed clubs which could use the treated effluent in irrigation of the green areas.....	58
Figure 3-3	Schematic representation of the saltwater intrusion.....	64
Figure 4-1	Locations of Wastewater disposal points in Lake Maryout.....	65
Figure 4-2	East Treatment Plant Lake Bypass.....	67
Figure 4-3	West Treatment Plant Lake Bypass.....	67
Figure 4-4	Sea Discharge Both ETP and ETP.....	68
Figure 4-5	Expected Effluent quantities in Alexandria (Master plan 2037).....	71
Figure 4-6	Map of Alexandria with locations of the WWTPs and the proposed effluent reuse area.....	72
Figure 4-7	Location of Hammam Extension land reclamation area	73

Figure 4-8	Proposed route of the effluent conveyance system and connections from the WWTPs in Alexandria.....	75
Figure 4-9	Schematic diagram of the existing Hammam extension canal and the proposed pumping stations.....	75
Figure 4-10	Schematic diagram of the sewerage system in Alexandria.....	81
Figure 4-11	Onsite sanitation through cesspool system.....	82
Figure 4-12	Schematic representation of Water Management.....	83
Figure 4-13	Schematic representation of Soil Aquifer Treatment (SAT).....	90
Figure 4-14	Schematic representation of Aquifers recharge and recovery (ARR)....	91
Figure 4-15	Aquifer storage and recovery system.....	92
Figure 4-16	Project Component of Alternative 8 using wetland and maturation pond.	95
Figure 4-17	Scheme of Alternative 8 using wetland and maturation pond.....	95

List of Annexes

Annex 1	Flows pumped from Middle (Wasat), East (Sharq), Montazah, West (Gharb), Gomrok (customs) and Amriya districts, and Borg El Arab City according to 2006 flows.....
Annex 2	Points of discharge, designed capacities, type of treatment and areas served.....
Annex 3	Irrigation and drainage canals in Alexandria.....
Annex 4	Composted Sludge Quality
Annex 5	Law 93/1962 establishes Standards for wastewater discharge into the sewer system.....
Annex 6	Planned upgrading of Wastewater treatment plants Up to year 2037.....
Annex 7	Priority pollutants in industrial discharge.....

Chapter 0

Introduction

SWITCH has been introduced to Alexandria to set the city to be among the leading cities in implementing Integrated Urban Water Management (IUWM). An IUWM long term plan will be developed. The IUWM plan will address current problems and issues of urban water management in Alexandria including lack of sanitation coverage, industrial pollution and challenges facing the supply of water to a city that is located at the end of the Nile River system, which is considered the main renewable water resource of Egypt that supplies more than 95% of its demand.

This activity would support the Governorate and other key institutions to develop a plan for integrated urban water management up till 2017, and possibly a vision of IUWM up till 2037, identifying scenarios, strategies and plans for more sustainable, less risk-prone and more equitable water management that supports city development.

The plan would be consistent with the National Water Resources Management Plan (which envisions the development of local plans) and existing sector plans in Alexandria (water and sanitation master plans are currently being developed to 2037).

A Vision for the Water Future of Alexandria is envisaged to include futuristic thinking of the water supply and sanitation sector in Alexandria. It will look at how Alexandria can meet a large part of its future water demand locally without depending mainly on Nile Waters as it will be difficult in the future to meet the growing demands with increasing demand in the upstream part of the Nile in Egypt. It will look at making use of rainfall harvesting and stormwater usage in Alexandria which receives little rain but can help in filling the demand gap, at using groundwater while managing potential problems of salt water intrusion, with Alexandria being a coastal city, at water demand management measures that could be considered to reduce water requirements. It doesn't leave out the wastewater treatment and reuse options, the enforcement of regulations to prevent industrial pollution of water bodies.

The main purpose of this study is to produce an integrated urban water resources plan that could be applicable till the year 2037. The five specific studies are as follows:

- 1) Storm water management
- 2) Groundwater management
- 3) Wastewater management and reuse**
- 4) System modeling and decision support
- 5) Water demand management

It is important to allow safe and economically responsible reuse of Alexandria treated wastewater in order to make the best use of existing resources and to protect the environment and human health. Wastewater reuse can reduce Lake Maryout deterioration, while minimizing the amount of wastewater discharged to the aqueous environment of the lake.

Therefore, it is important to establish “**New Strategies for Wastewater Management and Reuse in Alexandria in 2037**”. Tasks related to the new strategies were divided as follows:

Chapter 1: Description and assessment of current wastewater system:

Information on the Alexandria Governorate.

Chapter 2 : A Vision for a future wastewater system :

A description of a sustainable urban water system in Alexandria up to 2037. Including the objectives that should be met in order to reach sustainability.

Chapter 3 : Scenarios affecting the wastewater system

Wastewater composition depending on water consumption, priority pollutants, industrial discharges and the enforced effluent standards.

Chapter 4 : Potential strategies to achieve a sustainable urban wastewater

Describe strategies for Alexandria: 1) *Conventional collection and treatment for disposal*, 2) *Conventional collection and treatment for centralised agricultural reuse*, 3) *Mix of on-site sanitation and sewerage*, 4) *Direct Urban non-potable reuse*, 5) *Indirect urban potable/non-potable, Wetlands and aquaculture*.

Chapter 5 : Wastewater management and IUWM

Describe how various strategies would affect (or is affected by) the topics of the other studies (Water Demand Management, Groundwater management, Stormwater management, Modelling and Decision Support, Institutional mapping).

Chapter 6 : Conclusions and recommendations

Chapter 1

Description and assessment of current wastewater system

1-1 Land use (residential, commercial, industrial and agriculture areas; population per city section, population density).

The total surface area of Alexandria Governorate is about 2680 square kilometer. Surrounded from the East and South by El Behira Governorate and from the West by Matrouh Governorate as shown in Figure (1-1).

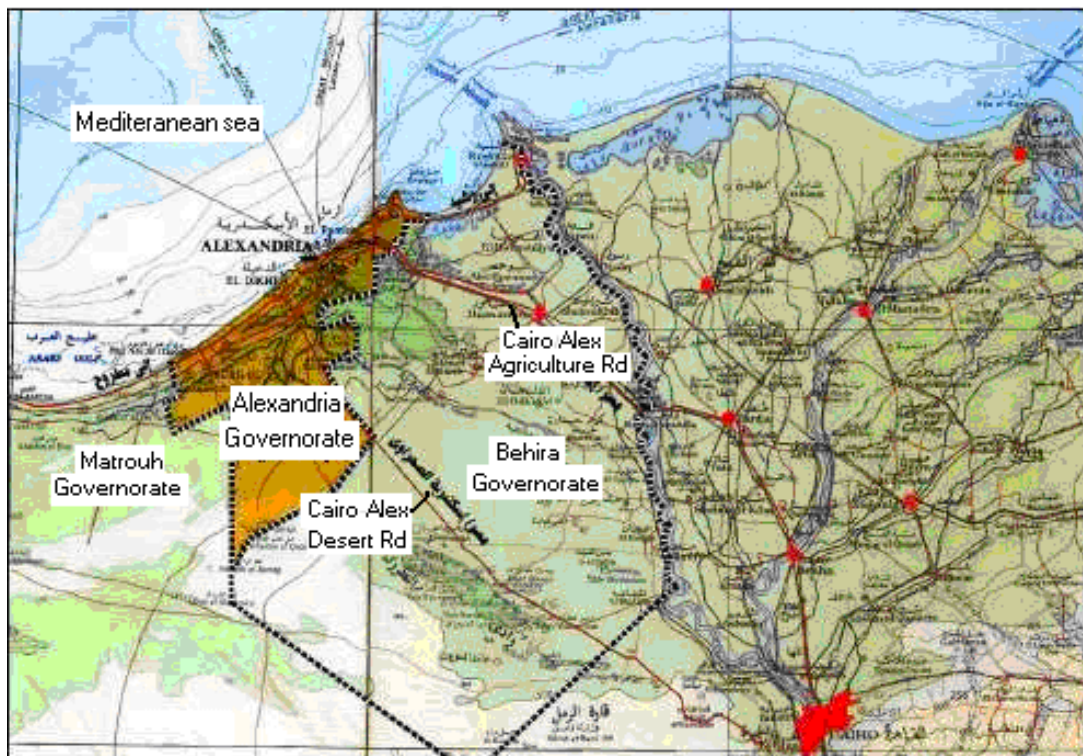


Figure (1-1) : Location of Alexandria Governorate.

Alexandria Governorate has different land uses such as:

- Desert areas which represents about 53% of the governorate area of about 1430 km² and mainly lies in the west and western south of Alexandria city, these areas include Amriya and Borg El-Arab which are new growing areas not highly populated.
- Agricultural uses of total area of about 730 km² represent about 27% of the total area of the governorate which mainly lies in the south and eastern south.
- Surface water area which represents about 8% of the total area of the governorate and includes lakes, canals, drains and fishery farms with total area of about 210 km². This distribution is presented in Figure (1-2).

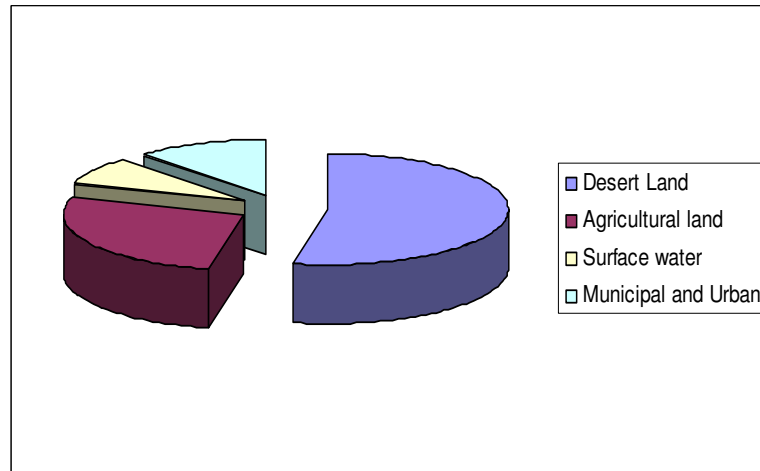


Figure (1-2) : Different Land uses within Alexandria Governorate.

- Municipality and Urban area which represents the rest part of the governorate area (about 12% and 310 km²) including the following uses as presented in Figure (1-3):
 1. Housing buildings of about 46 % ,
 2. Industrial buildings of about 19 % ,
 3. Roads, railway, and marine uses of about 29 %
 4. Public and recreation areas of about 3% and
 5. Military buildings of about 3 %

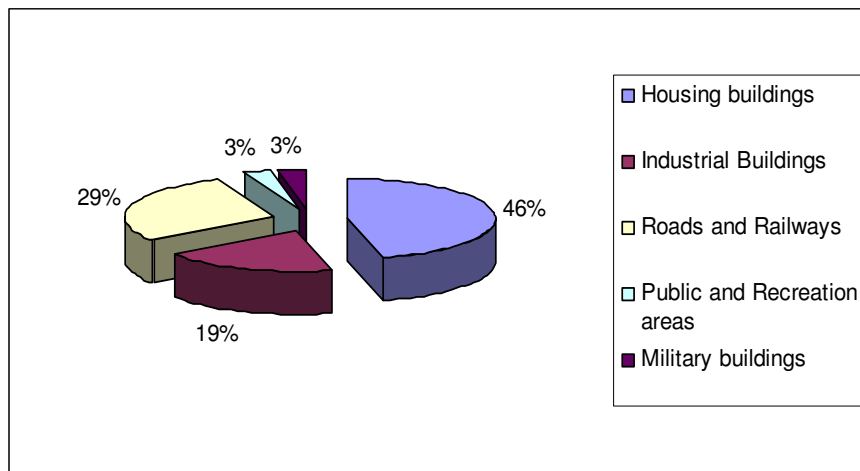


Figure (1-3) : Municipality and Urban areas.

Alexandria Governorate consists of three cities: Alexandria city, Borg El Arab City, and Centre & New Borg El Arab city with existing population of about **4,123,869** million persons

according to 2006 last census population. Figure (1-4) presents the location of Alexandria city districts and Borg El Arab City.

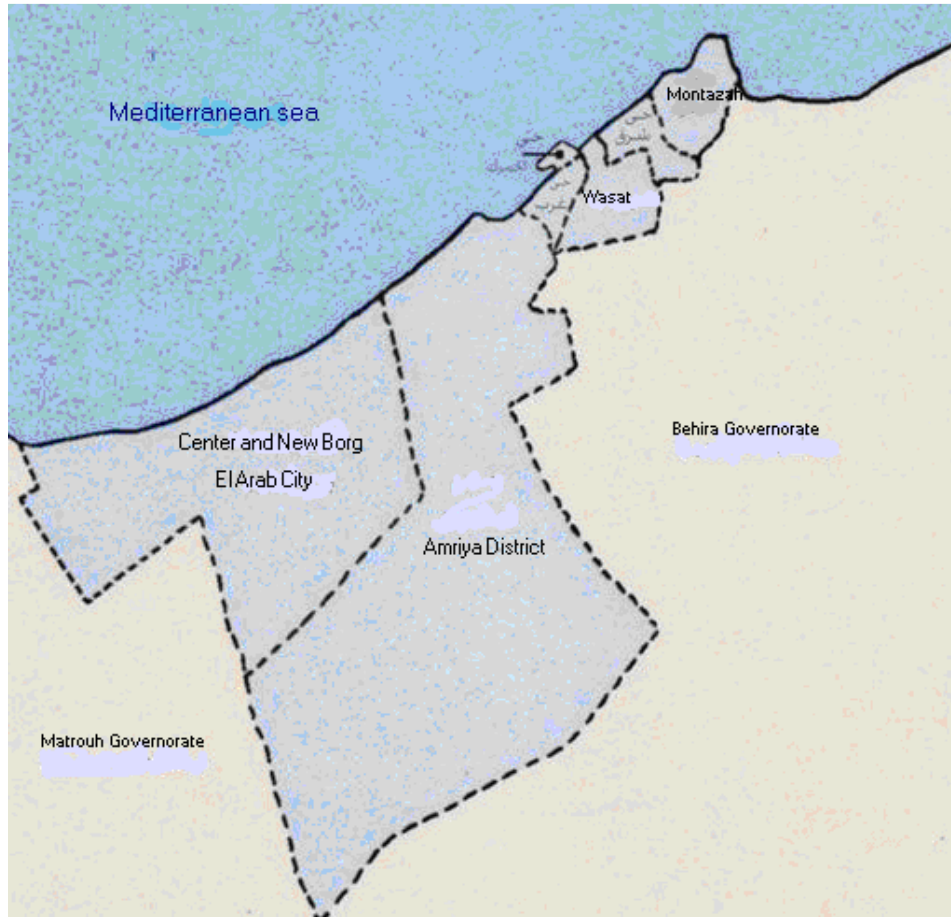


Figure (1-4) : Alexandria Districts and New Borg El-Arab City.

Borg El-Arab City is inhabited by 2238 capeta/feddan with a rate of increase of 2.77 % per year. According to 2037 predictions it is expected that new growing areas will increase by 24%.

The city of Alexandria is divided into seven districts as shown in Figure (1-5) and presented in Table (1-1), three local village units, and five sub-village units.

Montazah District, with total area of 81 km²; inhabited by 116 capeta per feddan, with a rate of increase of 1.37 % per year, 76.5% of the population is served by a sewer. According to 2037 flow predictions new growing areas will increase by 20%.

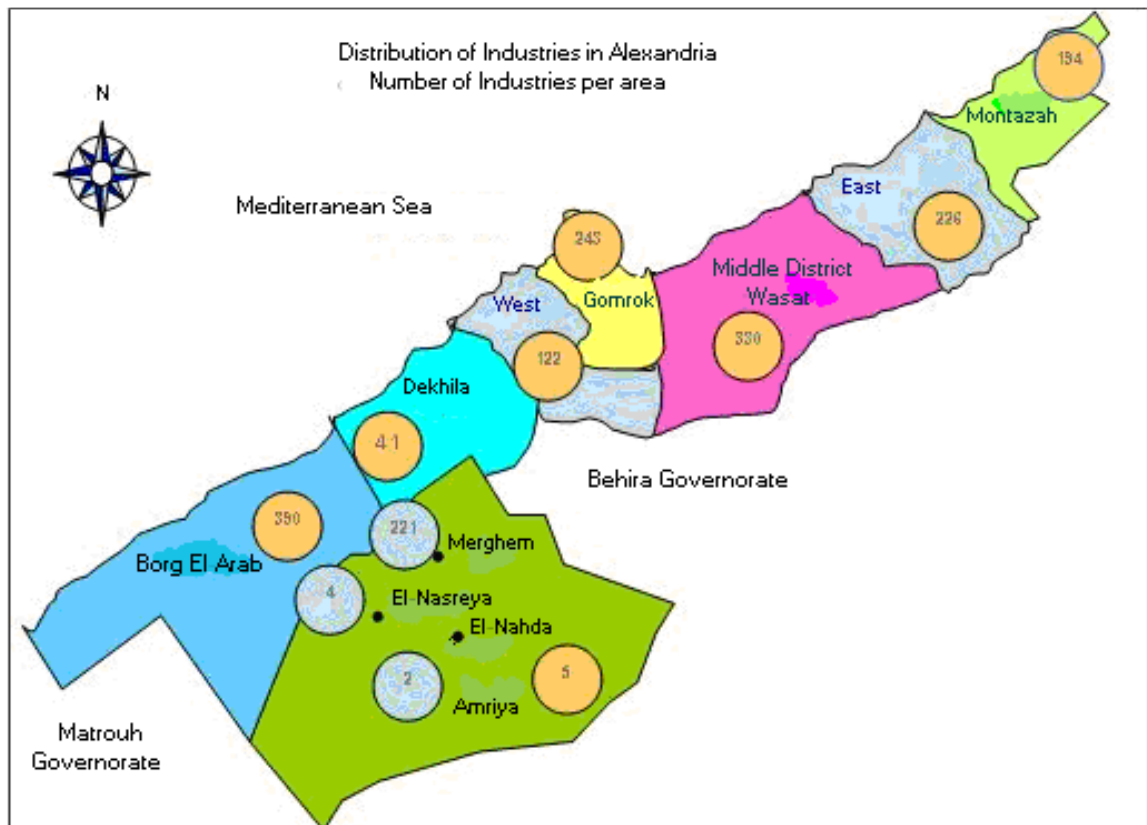


Figure (1-5): The main districts of the urban area in Alexandria

Table (1-1) : The Census population (2006) and its distribution in Alexandria.

District	Population	Rate of increase (%/year)	Total area (Feddan)	Building area (Feddan)	Density (Capeta/feddan)
Montazah	1,217,535	1.37	19300	8697	116
Eastern	1,003,965	1.26	11600	1697	578
Middle	613,925	0.94	8300	1711	337
Customs	196,402	1.17	642	642	305
Western	514,506	1.54	7100	1849	278
El-Amriya	697,450	2.23	515700	56558	9
Borg El Arab	81,977	2.77	75100	2238	25
Total	4,325,760	1.42	637742	73392	

1 Feddan = 0.42 hectare

Eastern District (sharq) with total area of 49 km²; inhabited by 578 capeta per feddan, with a rate of increase of 1.26 % per year, 81.7 % of the population is served by a sewer system pumping 736654.6 m³/d wastewater. According to 2037 predictions the saturated areas will increase by 9-13%.

Middle District (Wasat) with total area of 36 km²; inhabited by 337 capeta per feddan, with a rate of increase of 0.94 % per year, 91% of the population is served by a sewer system. It is expected that the saturated area will increase as Eastern district by 9-13%.

Western District (Gharb) with total area of 30 km²; inhabited by 278 capeta per feddan which is considered the lowest populated area with a rate of increase of 1.54 % per year, 73.9 % of the population is served by a sewer system. It is expected that the saturated area will increase by 9-13 % as Middle and Eastern districts.

Customs District (Gomrok) with total area of 4 km² which is considered the smallest area with the highest population density of 305 capeta per feddan with a rate of increase of 1.17 % per year; it is fully covered by a sewer system.

El-Amriya District, with total area of 2295 km² which represents the largest area inhabited by 9 capeta per feddan with a rate of increase of 2.23 % per year, 74.5 % of the populated is served by a sewer system. According to 2037 predictions new growing areas will increase by 14%.

1-2 Areas covered by a sewer system, type of sewer system, connection rate per area.

Alexandria extends about 32 km (20 miles) along the coast of the Mediterranean sea in north-central Egypt. The sewer system in Alexandria is mixed (domestic, storm water and industrial wastewater).

Data in Table (1-2) shows that up to 86% of the population is served by wastewater facilities, two primary treatment plants but to be upgraded to secondary and 16 secondary treatment plants. The rest (about 0.5 million) lives in 'rural' areas and relies on on-site sanitation. Current policy is to expand the sewer system to connect these areas. Figure (1-6) shows the served population in Alexandria. Served population means served by a sewer system connected to treatment plants. Un served population relies on septic tanks.

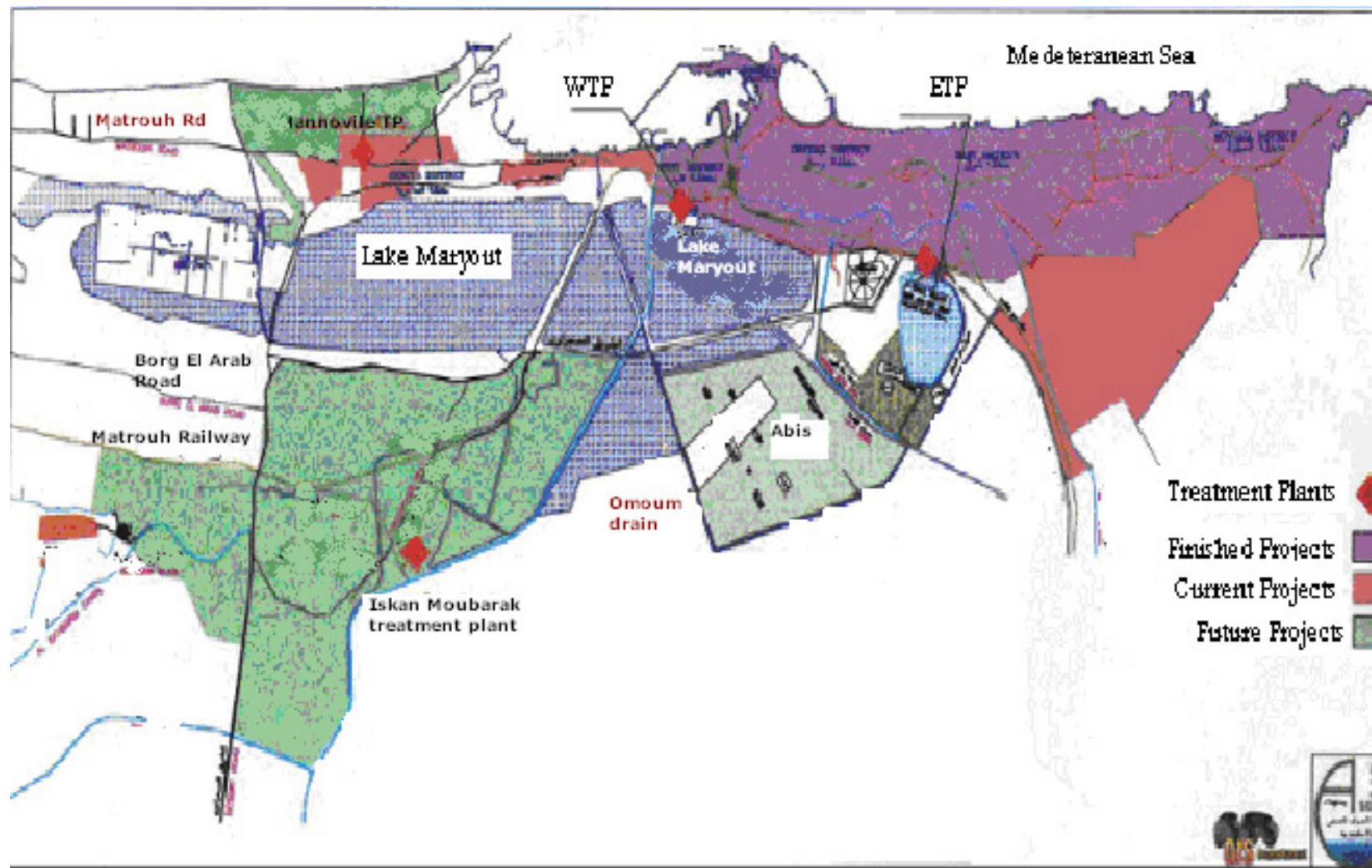


Figure (1-6) : Served Population in Alexandria.

Table (1-2) : Number of Served and Non-served population (2007).

District	Total Population/area	No. of Served population	No. of un-served population	% of served population
Montazah	1022344	782.093	240.251	76.5
East	989210	808.184	181.025	81.7
Middle	580010	527.809	52.201	91.0
Gomrok (Customs)	197103	197.103	0	100.0
West	518888	383.458	135.430	73.9
Amriya	553881	412.410	141.741	74.5
Borg El-Arab	591270	unknown	59.127	0
Total	4452706	3111057	552.563	85.9

(source: Central Agency for Public Mobilization And Statistics)

Total population according to 2007 estimates is 4,455,817.057 capeta 3,111,057 are served by a sewer system while 552.563 are unserved and depend on on- site sanitation. According to 2006 estimated the population was 4,325,760 as represented in table 1-1.

1-3 Areas and population relying on on-site sanitation forms. Type of on-site sanitation.

About 50 % of the population of the villages in the following table has no sewerage system and depends on on-site sanitation or similar systems. However, many of these rural areas have projects for executing sewerage systems ended with treatment plants as will be stated later. Generally in rural areas where there is no sewerage network, the raw sewage has on-site disposal or is evacuated and disposed off to the nearest agricultural drain or surface water bodies. This is considered a serious problem in rural areas, since most of the rural areas are suffering from it. Every house has to act on their own sanitation; unsealed latrine bits and cesspools facilities are rarely adopted. They depend on disposing their sewage using leaching pit adjacent to their houses or on direct discharge of raw sewage to drains using vacuum trucks.

However, most of the un-sewered rural areas in Alexandria have incomplete and unwell design of the on-site sanitation. Some of Alexandria rural areas have clay and gravel soil which is not suitable for on-site sanitation. Moreover, in many cases the septic tanks are not completely tighten and have many untreated wastewater percolating into the underground water. In addition the high water consumption and wastewater production are more than the capabilities of soil percolation which lead to run off of the untreated wastewater to the streets and to the nearest surface water resulting in polluting the surrounding environments. Table (1-3) presents the rural areas within Alexandria districts, villages and smaller units within the villages.

Table (1-3) : Rural Areas and their existing population in Alexandria Governorate

District	Main Village	No of Belongs**	Polulation
Montazah	Khorsheed- El-Mohagreen- El-Tabiah - El-kobaniah- El-Emerawy El-Kobra – Mohsen El-Kobra – El-Tawfiqiah – Hood 10	62	203820
Eastern	Abis 2 – Khoseed El-Kebliah	10	21650
Middle	Abis 7 – Abis 8 – Abis 10	26	36334
Amriya	Elmeseery – Deebah – Ahmed Oraby – El-Gazaer	41	151403
Borg El Arab	Bahig – Abo-Seer - Elghrobaniat	N A*	21805
Total			435012

* N A = Not Available

** Belongs : Means like small districts within the main village

1-4 Main sewer lines and pumping stations.

Alexandria has 10 Main Pump stations, ranging from 17,280 m³/day at Wadi El-Amar El-Gedida pumping station located West Alexandria to 850,000 m³/day from El Seiouf pump station located in the Montazah District representing one of the main source of wastewater to the East Treatment plant. Figure (1-7) shows the main pump stations in Alexandria.

Data in tables in Annex (1) represents the flows pumped from Middle (Wasat), East (Sharq), Montazah, West (Gharb), Gomrok (Customs) and Amriya districts, and Borg El Arab City according to 2006 flows.

Montazah (620,209.3 m³/d) and Sharq (East) district (736,654.6 m³/d) represents the highest wastewater pumped values, while the West district (Gharb) represents the lowest pumped values (4,318.66 m³/d).

According to 2037 flow predictions new growing areas in Borg El Arab, Amriya and Montazah are expected to increase by 24%, 14% and 20% respectively. While saturated areas in Wasat (Middle), Sharq (East) and Gharb (West) districts are expected to increase by 9-13 %.

Figure (1-8) shows that East of Alexandria has more main pump stations than west of the city as a result of topography changes. Pump stations in the East district pumps wastewater from smaller pump stations to the main pumping stations then to the East treatment plant.

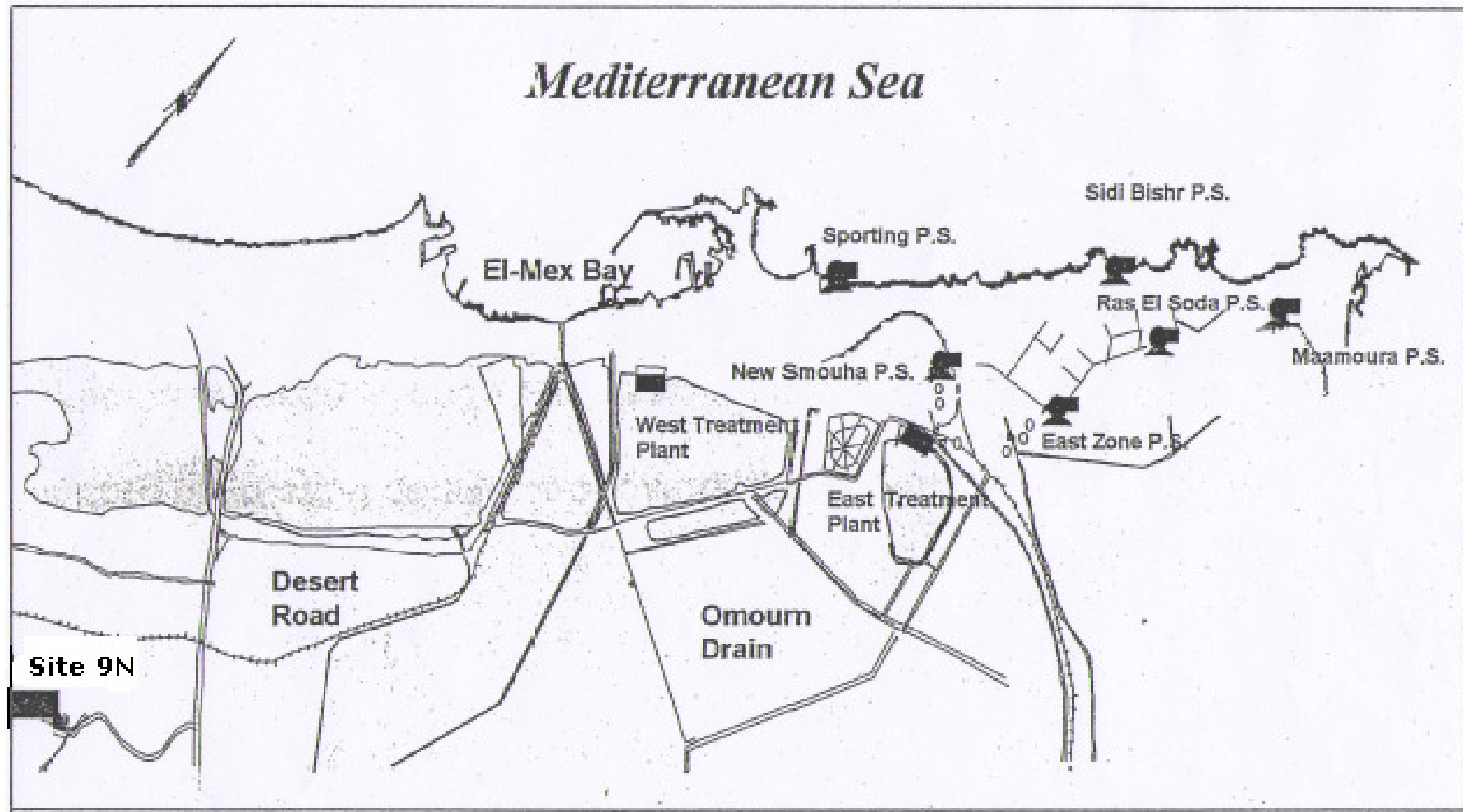


Figure (1-7) : Main Pump Stations in Alexandria.

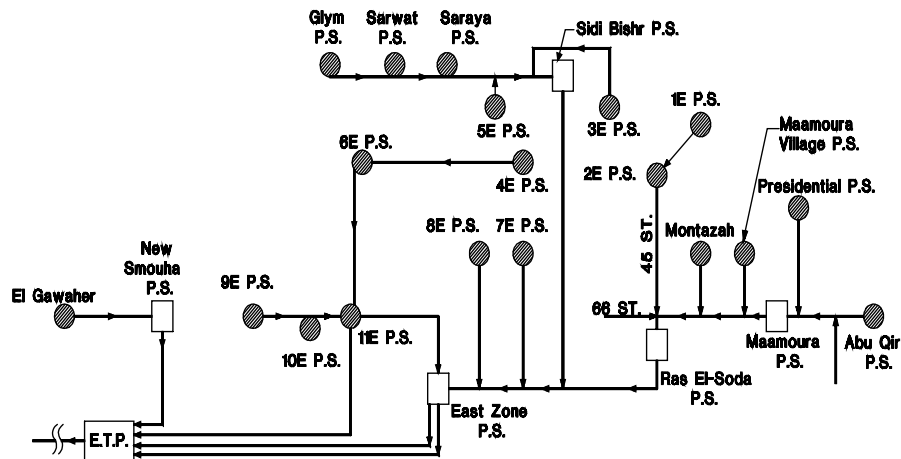


Figure (1-8) Force main lines to pumping stations then to the ETP.

In the west of the city pump stations are less where wastewater flows by gravity to the West Zone Collector. The Middle and West zone collectors are considered the two main sources of wastewater to the West Treatment Plant, as shown in figure (1-9).

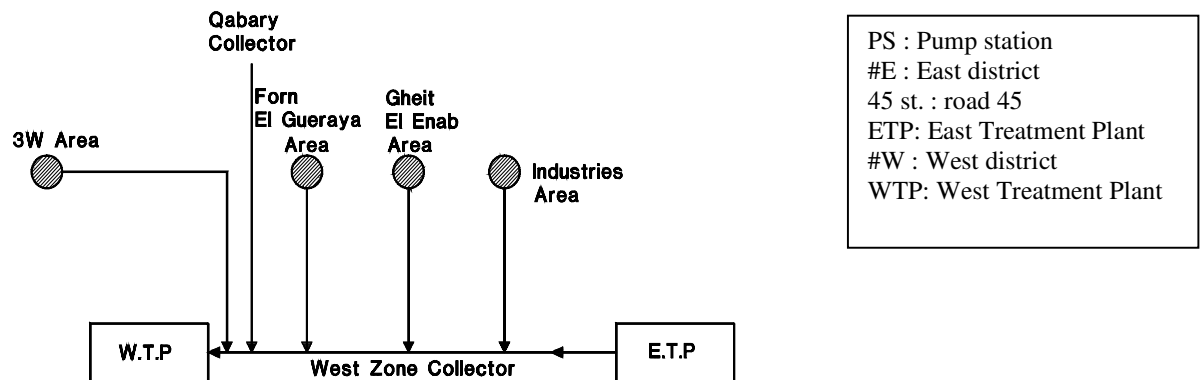


Figure (1-9) : West Wastewater treatment plant influent rate.

1-5 Location, capacity (current and planned), type of technology, points of discharge of all WWTPs.

Alexandria has 18 wastewater treatment plants, ranging from 3,000 m³/day to 607,000 m³/day. Total capacity is about 1.4 MCM/day, of which 1.3 MCM/day is concentrated in 4 large treatment plants. About 1 MCM/day is currently upgraded to secondary. 0.3 MCM is already secondary. Planned capacity increase is 0.55 MCM/day. As shown in Figure (1-10)

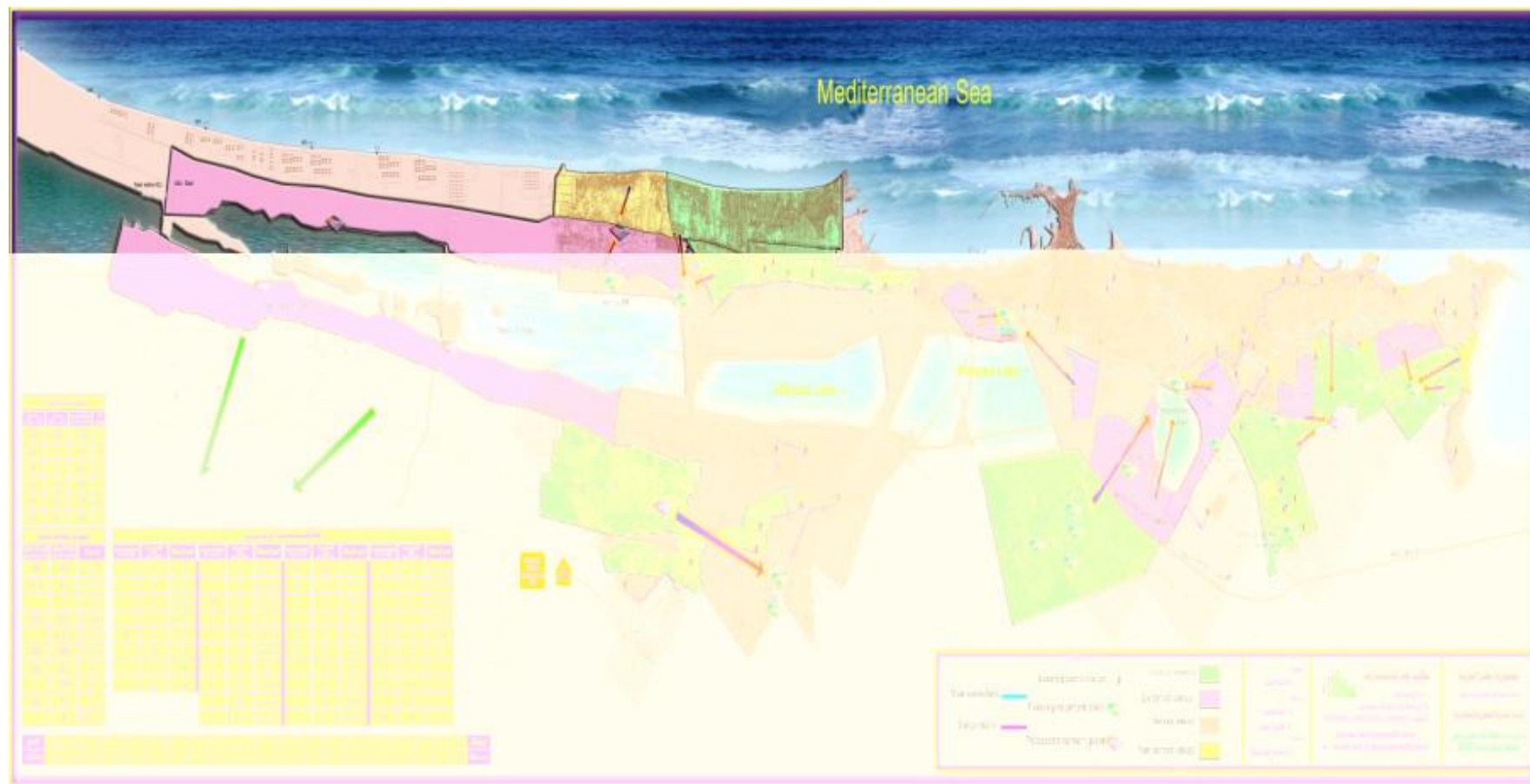


Figure (1-10) :Current and planned Wastewater treatment plants.

The East Treatment plant is currently a primary treatment plant under upgrading to secondary activated sludge treatment and discharges to Dayer El-Matar drain (Hydrodrome drain) to Lake Maryout through the Qalaa drain.

The Abis Villages 6 secondary treatment plants; The 10th Abis TP discharges to El Amlak drain, the 4th Nasriya TP to Dayer El Matar drain, Abis 1st and 2nd TPs to Masheya 2 Drain, Abis 3rd TP to Mansheya 3 drain and Abis 4th to Mansheya 4 drain.

The West Treatment plant (primary under upgrading to secondary Activated sludge treatment) discharges directly to Lake Maryout. The Km 26 secondary activated sludge treatment plant does not discharge its effluent but it is reused by Alex West Housing Compound adjacent to the treatment plant.

Khorshid & Zawayda TP and El Maamoura TP are secondary treatment plants and discharge to Amiaa Drain. Iskan Moubarak TP discharges to Amriya drain, El Hannover secondary treatment plant (Ard El-Hish) discharges near El-Dekhila Harbour. El Seiouf secondary treatment plant discharges to El Qalaa Drain. El Agamy Km 21 Treatment plant is still under construction and will discharge to West Noubariya drain. And El Amriya secondary treatment plant will discharge to Noubaria canal.

New Borg El-Arab secondary Aerated lagoon treatment plant discharges to its surrounding forest area which is considered reused. It is proposed to discharge the rest un-reused effluent to the West Noubaria Drain.

Points of discharge, designed capacities, type of treatment and areas served are shown in the Table in Annex (2).

1-6 Monitoring data (quality, quantity) for municipal WWTPs (influent and effluent) and surface water.

The removal of BOD and TSS in the treatment plants is as may be expected from the applied technology. It ranges for BOD from 30% in the primary treatment to 95% in the secondary treatment plants. TSS removal is ranging from 55% in primary to 95% in secondary plants. It can be concluded that operational performance of the treatment plants is good. Though some of the reported data shows anomalies, which raises concerns about data reliability.

Surface water quality

The final disposal point for the Alexandria wastewater treatment plants is Lake Maryout (then to the Mediterranean sea). The Lake currently plays the following roles:

- 1- To store water from the surrounding basin, Nile and its channels network and regulate underground and surface water system in the west delta. It is managed through El Mex pumping station.
- 2- To be the main depuration system of the industrial, agricultural and domestic waste waters from Alexandria and surroundings.
- 3- To facilitate drainage of the agriculture irrigation system.

- 4- To connect the Nile channels network with the sea through the Noubaria navigation channel and a system of locks (El Mex pumping station).
- 5- To produce fish and plants.
- 6- To provide a lagoon territory for human activities (urban development, industries, services, equipments, etc.)

The four first roles determine the quality and quantity of waters entering to the lake, and also the water quality outflow to the Mediterranean Sea. Both form part of the key parameters in order to understand the Lake Maryout Water ecosystem. The basic data of quality analysis is described in table (1-4) of water quality parameters. The table shows that the Main Basin is the most eutrophicated water body and Qalaa drain is the main source of pollution.

Table (1-4): Water Quality Parameters

WATER QUALITY PARAMETERS (EEAA 2004-2008)										
EEAA STATIONS	YEAR	YEARLY AVERAGES								
		DO (MG/L)	DO %	BOD	COD	NH3-N (MG/L)	NO2-N (MG/L)	NO3-N (MG/L)	TOTALN (MG/L)	PO4-P (MG/L)
MAIN BASIN 6000 IN FRONT OF KALAA DRAIN (1)	2004	3.8	43.7	38.0	110.0			3.6	3.6	
	2005	2.0	22.5	30.0	98.0	12.6	0.8	1.2	14.2	5.1
	2006	2.6	29.2	40.0	137.0	21.0		1.8	22.8	4.5
	2007					20.0	0.1	1.3	21.4	4.8
	2008	1.0			133.0	27.8		1.5	29.3	
	AVERAGE	2.4	31.8	36.0	119.5	20.3	0.4	1.9	18.2	4.8
MIDDLE OF 5000 (SOUTH BASIN) (2)	2004	7.2	83.5	2.0	11.8	0.3	0.2	4.0	4.3	0.5
	2005	6.7	76.9	1.0	29.3	0.3	0.2	2.2	2.7	0.8
	2006	7.4	82.5	4.3	34.8	0.6	0.1	1.9	2.1	0.4
	2007					0.1	0.3	1.0	1.2	0.7
	2008	9.2		2.0	55.0	0.4	0.0	2.9	3.3	
	AVERAGE	7.6	81.0	2.3	32.7	0.3	0.2	2.4	2.7	0.6
MIDDLE OF 2000 BASIN (WEST OF NUBARIA CANAL) (3)	2004	5.4	63.8	6.0	99.0	0.8	0.2	5.5	5.9	3.8
	2005	7.3	84.9	2.0	49.7	0.4	0.3	2.6	2.4	0.3
	2006	6.7	73.9	4.3	84.5	0.3	0.1	2.4	2.1	0.8
	2007					0.1	0.1	0.9	1.1	1.2
	2008	7.9		5.0	81.5	0.4	0.1	1.9	2.4	
	AVERAGE	6.8	74.2	4.3	78.7	0.4	0.2	2.7	2.8	1.6
MIDDLE OF MAIN BASIN	2004	4.5	52.3	21.0	97.0			1.2	1.2	
	2005	3.3	36.3	44.0	99.0	6.8	0.1	1.0	7.9	4.2
	2006	3.4	38.3	29.7	136.7	15.6	0.1	4.9	18.8	3.0
	2007					9.0	0.1	3.9	13.0	4.7
	2008	7.5			67.0	16.5		0.2	16.7	
	AVERAGE	4.7	42.3	31.6	99.9	12.0	0.1	2.2	11.5	4.0

Source: EEAA (2008) Dr. Hoda Moustafa, Alexandria Lake Maryut Integrated Management – ALAMIM Integrated Action Plan

The Main basin in front of the Qalaa Drain and in its middle are the most highly polluted areas within Lake Maryout having the highest BOD and COD values and the Lowest DO concentrations.

1-7 The irrigation and drainage canal network within the Governorate.

Treated effluent and untreated domestic and industrial wastewater is discharged into Lake Maryout, which also receives water from polluted drains. Water quality in the lake is poor, endangering livelihoods (fisherman) and the ecosystem. A pumping station pumps water from the lake into the Mediterranean.

The final disposal point of all the drains is in Lake Maryout and the Mediterranean sea. The main drains in Alexandria are El Qalaa drain which receives the effluent of ETP, West Noubaria and El Omoum drain which dispose into the Mediterranean through Lake Maryout. The Omoum Drain receives pollution loads from rural areas in Behira Governorate.

Most of the agricultural drains are serving all the agricultural areas located in Alexandria and most of them receive pollution loads from the surrounding rural villages and areas. Most of the water canals are used for agricultural irrigation, water treatment plants and navigation. The Main water canals are El Mahmoudia and Noubaria. Figure (1-11) shows the surface water canals in Alexandria and Annex (3) shows the Irrigation and drainage canals in Alexandria



Figure (1-11) : Surface Water Canals in Alexandria.

1-8 Points of Industrial Effluents Discharge (quality, quantity).

Industrial wastewater has a total flow of 308,000 m³/day of which 260,000 m³/day is discharged to sewer and receiving primary treatment (being upgraded to secondary). Only 5.62% of wastewater reaching the ETP is Industrial Waste (50,000 m³/d), while the west treatment plant receives only around 0.67% industrial waste. An amount of 48,000 m³/day of industrial wastewater is discharged into Lake Maryout without treatment.

Industrial effluent discharge may be either directly into the sewage system for all industries located in the sewer covered areas; or into adjacent drains such as Rakta Company; or directly into Maryout Lake; or directly into the sea (e.g Misr petrochemicals), Figures (1-12 to 1-14).



Figure (1-12) : Direct Industrial Discharge into Lake Maryout.

(Source: ALAMIM Final report of industrial activities integrated action plan)

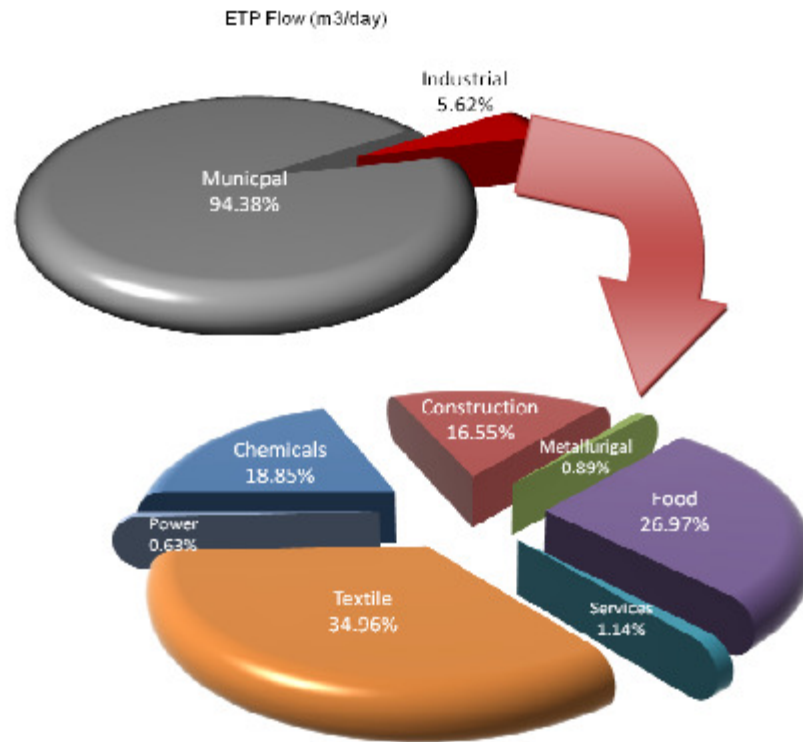


Figure (1-13) : Industrial Discharge into the sewer network (ETP).

(Source: ALAMIM Final report of industrial activities integrated action plan)

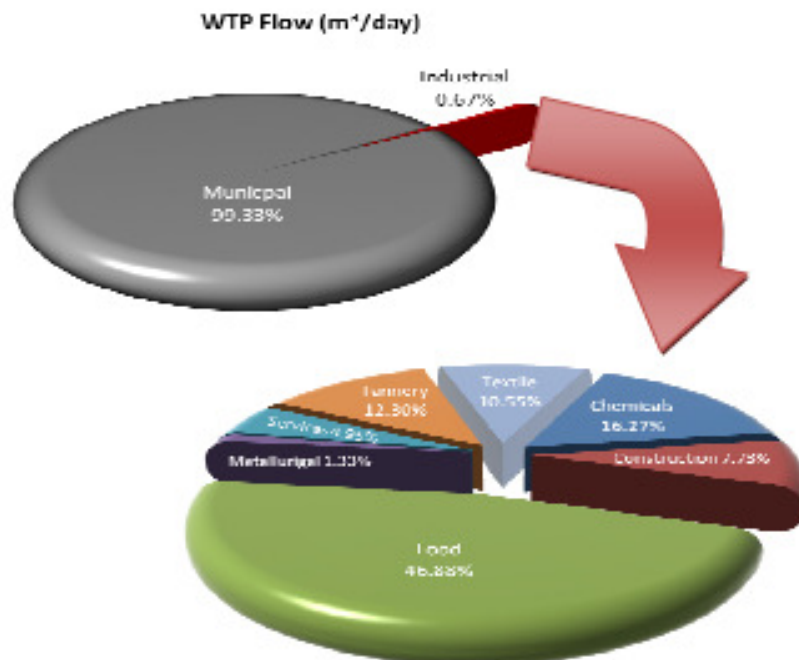


Figure (1-14) : Industrial Discharge into the sewer network (WTP).

(Source: ALAMIM Final report of industrial activities integrated action plan)

There are 6 main companies discharging into Lake Maryout, Two of these companies discharge its effluent directly into the Western Basin (3000 Thousand Feddan) which are El Amriya Petroleum Refinery company (10,000 m³/d) and Misr Petroleum company (35,000 m³/d). The other 4 companies discharge their effluents into lake Maryout through the navigation pond for Noubaria Canal these are Misr Amriya spinning and weaving, Petrochemicals company, Salt and Soda Company and Sidi Krir Petrochemicals. The total direct discharges are 48,155 m³/d.

1-9 Sludge Generation (location, quantity, quality), Processing and Disposal.

The sludge from both ETP and WTP is mechanically dewatered at the WTP. The liquid primary sludge is pumped from the ETP to the WTP where it is co-settled with sewage and the sludge is dewatered by the belt press to about 30% dry solids (ds). Sludge production is currently about 450 m³/d, equivalent to about 50,000 tones dry solids (tds per year). This will increase when the WWTPs are extended (currently under development) and secondary treatment is installed, reaching about 80,000 tds by 2015.

The generated amount of sludge from the East Treatment plant that resulted from clarifiers is about 3000-4000 m³/d, solid concentration 2-3 %, it is diluted to 1-2% then pumped through middle zone tunnel (12 km length, 5 m depth), to WTP, then dewatered by mechanical dewatering facility. The amounts of sludge production are shown in table (1-5).

Table (1-5) : Current and Future sludge production in Alexandria (m³/d)

Year	ETP/WTP	Amriya	Hannoville TP	Total
Current	450			450
2009	669	169/109	352	1,190/1,130
2010	724	169/109	364	1,257/ 1,197
2015	724	169/109	376	1,269 / 1,209
2020	759	169/109	388	1,316 / 1,256
2025	759	445/285	400	1,604 / 1,444

The amount of sludge generated from the West treatment plant is also about 3000-4000 m³/d with solid concentration of 3-5% , then to the mechanical dewatering facility, The produced sludge is 8704 Ton/month; Used polymer 6927 kg polymer/month; Polymer cost 182873 L.E/month.; Dewatering efficiency 27.9%.

The generated sludge from El-Hannoville TP and Iskan Moubarak TP is dewatered by centrifugation, with solid concentration of 25-30%, and then transported to 9N.

The Mex/Dekhila/Agamy WWTP is initially expected to produce 200 m³/d of 20% ds, increasing to 400 m³/d by 2025. This will be a conventional primary sedimentation and activated sludge plant. The total quantity of sludge that will be produced by Alexandria will be about 1,200 m³/d by 2015, equivalent to about 150,000 tds/y.

The produced composted sludge has an average of 34 % Organic matter, 3% Total Nitrogen, 175 mg/kg available phosphorus. The heavy metals contents of the compost are within the required limits of Egyptian regulations as presented in Annex 4.

Sludge Treatment and Disposal:

Site 9N is located 35 km west of Alexandria. The site receives sludge cake from the MDF and grit, scum, and screenings removed from the ETP and WTP. Grit, sand and screenings generated from the ETP and WTP are transported to site 9N by dump trucks. Currently, the total quantities transported of sludge are 83,212 m³/year, of sand is 7,973 m³/year and of screenings is 1,749 m³/year, and from Industrial solid waste 3338.85 m³/year according to values of year 2008/2009.

At Site 9N, a composting plant is established when the site was initially developed as a dedicated disposal area for the sludge. Consequently, land spreading of the sludge on the dedicated disposal area has ceased and all of the current production of raw sludge is now being composted using the turned windrow technique. Figure (1-15)

Mature compost is used as a bulking agent to improve the aeration of the composting process and is mixed on a 1:1 volume basis with the fresh dewatered raw sludge, delivered daily to Site 9N. Specialized windrow turners are used for mixing the materials and for process (temperature, moisture) control in the windrows. Some mixing and turning is also done by mechanical shovel. A 30-day period is allowed for the active composting phase in windrows, following which the compost is removed to a curing and stockpile area where it is allowed to mature for several weeks, but the compost may be stored for many months before sale and use.

Based on these assumptions, 1 m³ of dewatered sludge is converted into 0.4 m³ of matured compost. Therefore, at the current sludge production level, compost production is likely to be about 66,000 m³/y, rising to 184,000 m³/y by 2015, and 234,000 m³/y by 2025, based on the estimated increases in sludge production

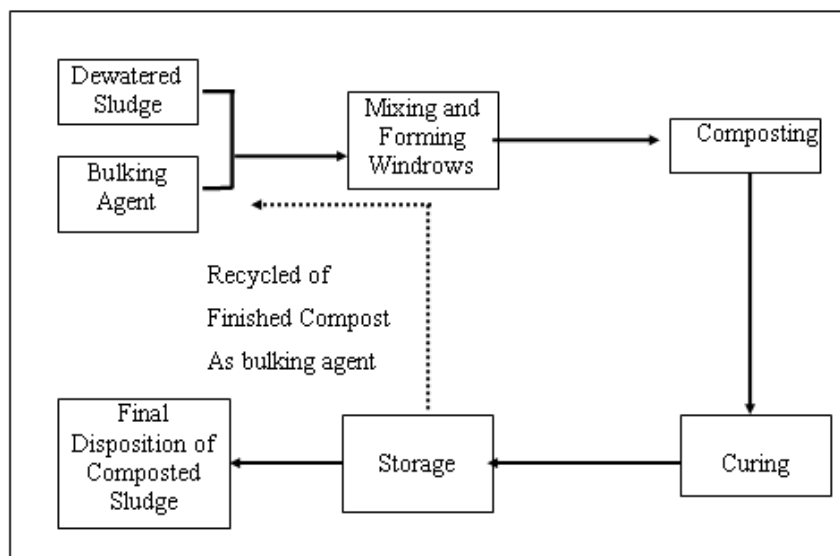


Figure (1-15) : Composting Processes of Dewatered Sludge.

1-10 Overview of the institutions involved in wastewater management in the city (mandate, operations)

1-10-1 Ministry of Water Resources and Irrigation.

The Ministry of Water Resources and Irrigation (MWRI) is the lead government body responsible for water resources management in the country. As such, it is charged with the regulation and distribution of water resources throughout Egypt as well as with the management of its quality.

The Ministry's most important responsibility is for management of the waters of the Nile River that flow through Egypt. MWRI also is responsible for management of water outside the Nile basin—principally the deep groundwater resources in the Western Desert. The current organizational structure of MWRI is given below:

MWRI has sole legal responsibility for water resources planning and management. With respect to water quality, it issues licenses to commercial, industrial, and tourist establishments for the discharge of liquid waste into inland waterways. According to Law 48/1982, industrial waste must receive treatment to the level of prescribed pollution standards before being discharged into inland water bodies, however this provision is often violated. MWRI is responsible for providing water of suitable quality to all users. To accomplish this goal, the Ministry must insure that appropriate measures are taken to protect water quality.

MWRI also handles surface water and groundwater quality monitoring through the National Water Research Center (NWRC), which operates under its authority. Within the NWRC, water monitoring activities are implemented by three bodies:

1. **Drainage Research Institute (DRI):** With respect to water quality, the DRI is responsible for monitoring the quantity and quality of drainage water in the Nile system. One of DRI's responsibilities is to provide MWRI with data on the availability of drainage water for reuse in irrigation, mainly for land reclamation projects. In this context, DRI has prepared guidelines for drainage water reuse.
2. **Nile Research Institute (NRI):** NRI is responsible for protecting and developing the Nile River in a sustainable manner by (1) monitoring water quality in the river channels; (2) assisting in the enforcement of pollution control laws affecting the Nile system; (3) evaluating and assessing impacts of new developments and interventions on water quality; and (4) operating and maintaining a database on water quality of the Nile. The monitoring network of the NRI has 34 stations along the Nile and 60 observation stations at key discharge sites.
3. **Research Institute for Ground Water (RIGW):** The RIGW carries out field investigations of groundwater throughout Egypt. Initially responsible mainly for groundwater development, RIGW now is charged with monitoring groundwater resources in order to assure their sustainable use by agricultural, domestic and industrial users. RIGW has approximately 500 wells for observing irrigation water abstraction and plans to install about 150 observation wells for drinking water.

1-10-2 Ministry of Agriculture and Land Reclamation (MALR).

The MALR is the most important government water management stakeholder outside of MWRI, since irrigation accounts for about 84 percent of the consumptive uses of water in Egypt (and agriculture accounts for about 20 percent of both GDP and total exports and about 34 percent of total employment). MALR is responsible for predicting cropping patterns and irrigation requirements used by MWRI to allocate water among the vast network of primary and secondary irrigation canals. This has become more critical with liberalization of the agricultural sector since market forces rather than government policy determines what is planted. MALR also participates with MWRI in the irrigation and drainage improvement projects with on-farm improvements such as laser land leveling and tiled drainage.

APRP Water Policy Program Economic Incentive 6 s for Water Management

Through its Soils, Water and Environmental Research Institute (SWERI), the MALR also is responsible for performing research on the sustainable development in the agricultural sector. In this capacity, SWERI has several responsibilities regarding water quality management: establishing policies for fertilizer use, classifying water resources and soils; and monitoring soil and water quality for agricultural uses. SWERI has a modern laboratory for physical, chemical and biological analysis of soil and water.

1-10-3 Ministry of State for Environmental Affairs (MOSEA).

After MWRI, MOSEA is the most important government body for the management of the country's water quality. Through the subsidiary Egyptian Environmental Affairs Agency (EEAA) and in coordination with the Ministry of Health and Population (see below), MOSEA is responsible for inspections regarding compliance with environmental and occupational health and safety regulations. Among the approximately 700 EEAA employees are 18 inspectors supplemented by a handful of additional inspectors in each of 8 local offices in the governorates, and they are charged with the oversight of compliance with all environmental and workplace standards. If inspectors find a problem, their options range from assessing a citation and levying a fine on the spot to granting a probationary period of 60-90 days to correct the problem before re-inspection. If the problem has not been corrected after the probationary period, a request is filed with the Ministry of Interior to write a citation. Governors and the State Minister for Environment can shut down severe polluters, however it is relatively easy for facilities to obtain a court order to reopen based on concerns over job loss and adverse economic impact (Khaled Fahmy, Monitoring, Verification and Evaluation Unit for EEAA, personal communication October 2001).

Facilities are chosen for inspection based on a master plan prepared by MOSEA but also in response to governors' requests and citizen complaints. There are approximately 23,000 industrial establishments in Egypt, however only about 400-500 are major polluters. In 2000, approximately 235 of these were inspected, but thousands of smaller establishments are inspected rarely, if at all (Fahmy).

In most new industrial cities (e.g., 10th of Ramadan, 6th of October, and Sadat City) industries already are generally meeting discharge standards, and compliance is improving elsewhere. Along the Nile, for example, all industries now at least have effluent discharge facilities (per. comm., Samia Galal Saad).

1-10-4 Ministry of Health and Population (MHP).

MHP has a central role in water quality management, particularly with respect to standard setting for: quality of potable water sources (the Nile and canals); drain waters that can be mixed with fresh water; industrial and sewage treatment plant discharge; and wastes discharged from river vessels.

In addition to developing standards, the ministry must sample and analyze all industrial, municipal, and wastewater treatment plant effluents. Two departments have the principal responsibility. The Environmental Health Department (EHD) under the Ministry is responsible for sampling intakes to drinking water treatment plants as well as discharges from wastewater treatment plants and industry. The Environmental Monitoring and Occupational Health Center (EMOHC) is responsible for environmental monitoring (air, water and soil).

APRP Water Policy Program Economic Incentive 7 s for Water Management

Since 1998, the EMOHC has monitored Nile River and main canal waters in cooperation with the Egyptian Environmental Affairs Agency.

1-10-5 Ministry of Industry and Mineral Wealth (MIMW).

MIMW is responsible for overseeing the licensing and operation of firms in Egypt. Within the Ministry, the General Organization for Industrialization (GOFI) supervises pollution control activities, as well as safety and health issues. GOFI does not perform any inspections or verify whether industries are in compliance with license requirements. The Environmental Management Department within the Ministry is in charge of providing advice to industrial firms regarding compliance with a 1982 ministerial decree that all industrial facilities must install and operate water pollution control equipment in conformance with Law 48. According to Law 93/1962 and its Amending Decree 9/1989, industrial wastewater must receive pretreatment before discharge to public sewer systems.

1-10-6 Ministry of Housing, New Communities and Public Utilities (MHNCPU).

MHNCPU is responsible for planning and developing water supplies and wastewater treatment facilities. MHNCPU and its affiliate agencies oversee construction of sewers and wastewater treatment facilities throughout Egypt. The regional wastewater authorities and other bodies affiliated with MHNCPU that are responsible for both water and wastewater treatment includes:

- The National Organization for Potable Water and Sanitary Drainage (NOPWASD).
- The General Organization for Sanitary Drainage in Cairo (GOSD).
- General Organization for Greater Cairo Water Supply (GOGCWS).
- The Alexandria Sanitary Drainage Company (ASDCO).
- The Alexandria Water General Authority (AWGA).
- The Suez Canal Authority; and
- A number of private companies for wastewater treatment in Damietta, Kafr El Sheikh and Beheira.

NOPWASD is responsible for the potable water and wastewater treatment systems outside of Cairo and Alexandria. These government organizations get their water from the Nile and from groundwater. In addition, groundwater-based systems are operated by various city councils. Water sources in industry vary according to the nature of the industrial activity. Food and pharmaceutical industries, for example, require clean water, so they either tap municipal supplies or make use of their own groundwater wells. Other industries may use Nile or canal water directly for cooling or washing purposes.

1-10-7 Ministry of Scientific Research.

The Ministry of Scientific Research is responsible for monitoring a small number of water and wastewater treatment plants in the Greater Cairo area and a handful of pumping stations. The primary purpose of these activities is to assure environmental protection from industrial wastes and the protection of potable water.

1-10-8 Ministry of Electricity and Energy.

The Ministry of Electricity and Energy is responsible for power generation and coordinates with MWRI to maximize hydropower generation without harming irrigation. Power generation and transportation are non-APRP Water Policy Program Economic Incentive 8 s for Water Management consumptive uses but their needs are factored into decisions on Lake Nasser water levels and releases at the HAD. The ministry also operates two thermal power plants that draw water from the Nile for cooling.

1-10-9 Ministry of Transportation and Ministry of Tourism.

These two Ministries are stakeholders interested in maintaining “in-stream flows” of the Nile River to provide sufficient depth for commercial and recreational navigation as well as for aesthetic purposes. The River Transport Authority of the Ministry of Transport manages navigation activities along the course of the Nile River below the Aswan Dam and on main canals in coordination with MWRI.

1-10-10 Ministry of Interior.

In coordination with technical agencies and the courts, the Ministry of Interior is charged with enforcing laws and with the collection of fines, including some relating to water extraction, pollution or other impacts.

1-11 Overviews of relevant legislations and policies.

MWRI derives its legal mandate as the lead governmental body for the water sector from Law 12/1984 on Water Management (primarily dealing with water for agriculture) and Law 48/1982 on Protection of the Nile River and its Waterways from Pollution. The Ministry of State for Environmental Affairs and its subsidiary body the EEAA also exert considerable influence over water quality management through authorities vested through Law 4/1994 on Environmental Protection. The principal laws governing water management include:

- **Water Quantity Resources Management.**

Law 12/1984 and its supplementary

Law 213/1994 provides the basic legal structure for water quantity issues. The basic law defines the use and management of the public and private sector irrigation and drainage network structures, including main canals, feeders, drains and tile drains. It also provides legal direction for the use and maintenance of public and private canals and specifies

arrangements for cost recovery in irrigation and drainage works. In addition to Nile surface water delivery, the law also regulates:

- Groundwater and drainage water;
- Protection against flooding;
- Navigation; and
- Coastal protection.

- **Nature Protection.**

Law 102/1983 delineates nature protection areas, forbids actions that lead to destruction of the natural environment, including marine and freshwater, and proscribes fines and penalties for violators. Under this Law, the Government can pursue damage assessments for harms to the environment.

- **Wastewater Discharges into the Sewerage System.**

Law 93/1962 establishes Standards for wastewater discharge into the sewer system. Annex (5).

- **Regulation of Water Resources and Treatment of Wastewater.**

Law 27/1978 regulates public sources of drinking water. It instructs and empowers the MHP to set standards for potable water.

APRP Water Policy Program Economic Incentive 9 s for Water Management

- **Protection of the River Nile and Its Waterways.**

Law 48/1982 regulates the discharge of waste and wastewater into the Nile and its waterways and sets standards for the quality of effluents. The law establishes the responsibilities of the MWRI and the MHP in monitoring the quality of effluents discharged into the Nile River (and its associated drainage system, lakes and groundwater) to ensure that water quality standards are met. Industrial establishments are required to obtain pollution discharge licenses. A bond is required with the license application and a fee of L.E. 0.1 (one piaster) per cubic meter of effluent is levied according to Article 82 of the implementing regulations. Under this Law, the MHP has the obligation to carry out periodic sampling and analysis of wastewater and waste discharge from establishments that are licensed to discharge to waterways. Annex (5).

- **Environmental Protection Law.**

Law 4/1994 delineates the roles and responsibilities of EEAA, including its financing through the Environmental Protection Fund. The Law authorizes use of incentives for managing the environment and supports the provisions of Law 48 regarding the management of water resources. Annex (5).

Institutional Constraints to Water Quantity Management

Other institutional constraints relate to the need for retooling of skills in key water management agencies—especially to reflect a better balance between engineering and socio-economics. Past attention of MWRI and other agencies involved with water management has centered on organizing the physical aspects of the water delivery system. Water professionals in Egypt now recognize that their strong engineering skills will not be

sufficient to deal with the emerging next generation of water management challenges that are the subject of this report—requiring much greater attention to social, economic and environmental dimensions of water management. The section which follows centers on one of these aspects, namely, growing concerns over pollution and water quality management in the country.

- ❖ Law 93/1962 regulates wastewater disposal and reuse.
- ❖ Decree No. 649/1962 of the Minister of Housing issues the executive regulations of Law 93/1962. It specifies regulatory standards for wastewater disposal. It was updated in 1989 by Decree No. 9/1989 in which a distinction was made between wastewater disposal on sandy soils and clay silt soils. Most prominent conditions included that wastewater treatment plants should be located more than three kilometres from the nearest residential area. Primary treatment was set as a minimum treatment level required before final discharge
- ❖ Reuse of effluent in the irrigation of vegetables, fruits or any other crops eaten uncooked is strictly prohibited. The same restriction is imposed on grazing of animals or milking cattle on the fields irrigated with wastewater. In 1995 an amendment was made by both the Ministry of Irrigation and the Ministry of Agriculture and approved by the Ministry of Health. It has been issued by the Minister of Housing decree No 44/2000 . This amendment determined the minimum degree required for wastewater treatment for the various reuse aspects.
- ❖ A code of practice for reuse is now prepared and published .

1-12 An overview of the various projects on wastewater management in the city (Alexandria City Development Strategy; Alexandria Development Project; etc.)

Most of the urban areas and about half of the rural areas in Alexandria have sewerage systems ended with treatment plants. In general, there are two main wastewater treatment plants (Eastern and Western treatment plants) which represents more than 95 % of the wastewater treatment capacity in Alexandria. The existing capacity of the Eastern Wastewater treatment plant is about 610,000 m³/d while the capacity of the Western wastewater treatment plant is about 470,000 m³/d.

There are also other two treatment plants with smaller capacities called, Hanoville Wastewater Treatment Plant with capacity of 30,000 m³/d and Moubarak Wastewater Treatment Plant with capacity of 15,000 m³/d. There is also other smallest wastewater treatment plant for some rural areas with total capacity of less than 5,000 m³/d. A Table showing times of expected upgrade dates is provided in Annex (6).

These existing wastewater treatment plants receive the collected wastewater through about 80 pump stations with various capacities ranged from large pump stations capacity of about 660,000 m³/day to small one of capacity about 1,000 m³/day. There is also a huge sewerage system that collects the wastewater from the served urban and rural areas. The total length of this sewerage system is about 750 km of various diameters ranged from 2750 mm to 200mm. In addition to the existing sewage systems in Alexandria, there are many projects under execution and design in different districts and rural areas. The new projects include treatment plants and sewerage systems.

The new wastewater treatment plants include six plants in addition to extension of the Eastern and western treatment plants. The new treatment plants projects will add capacity of about 500,000 m³/day to the existing capacities. Tables below show the new wastewater treatment plant projects. Some of these projects are nearly executed and under testing to be put in service.

There are also many projects to execute sewerage systems for many rural areas and some of the non-served urban areas on their boundaries and extensions. Tables (1-6),(1-7) show the projects location and the budget available for these projects. After execution of these projects most of the un-sewered rural areas (about 80%) will have sewerage system for collection of wastewater and pumping to treatment plants before disposal to the nearby drains. The total budget estimated for these projects was about 1.21 Milliard Egyptian pound. However, these budgets are usually not enough to finish all the projects and need to be increased by percentages ranged between 30 to 100 % for some projects which usually delay projects for many years.

Table (1-6) : The New Wastewater treatment plant projects under construction.

No.	Name	Capacity (m ³ /d)	Area Served
1	Hannoville - 2 Plant	30,000	El-Dekheelah – El-Max – Om Zeghboo Rd. – Part of El-Agamy
2	El-Zawaida Plant	15,000	Villages of Khorshed – El-zawaidah – El-Tawfiqiah – Shaker -
3	El-Seiouf West Plant	10,000	Villages of El-Syouf West – El-Bakatoush – Galal Ibrahim
4	El-Mallahah Plant	10,000	Villages of West El-Mallahah – Masood- El-Brins – Serkis – el-Tarouti
5	El-Agamy Plant	145,000	Bitash – El-Agamy - El-Agamy Beach
6	Old Amriya Plant	50,000	Old El-Aameriah – Merghem- Abdel-Kader Villages
7	Extension of ETP	200,000	
8	Extension of WTP	100,000	

Table (1-7) : Projects under execution for sewerage systems and their budget in Alexandria.

No.	Project Name	Budget (M L E)	Areas Served	Remarks
1	West Alexandria	170	El-Dekheelah – El-Max – Om Zeghioo Rd. – Part of El-Agamy	Include 3 pump stations
2	El-Agamy	450	Bitash – El-Agamy - El-Agamy Beach	Include 5 pump stations Stage 1 and 2 has finished
3	El-Mallahah	100	Villages of West El-Mallahah – Masood- El-Brins – Serkis – el-Tarouti and others	Include 9 pump stations
4	El-Seiouf West Plant	100	Villages of Khoursheed 1,2 ,3 – El-Bakatoush – El-Nemr – Galal Ibrahim – Karabig	Include 7 pump stations
5	Khorshed & Zawaida	150	Villages of Khoursheed – El-zawaidah – El-Tawfiqiah – Shaker -	Include 5 pump stations
6	King Maryout	240	King Maryout – Merghem- Abdel-Kader Villages	

1-13 Assessment of the wastewater system in terms of: public health, Environmental pollution, implementation of legislation and policies, Financing and Equity.

The mission of Alexandria Sanitary Drainage Company (ASDCO) is to protect public health and the environment by developing sustainable and effective wastewater management system for the city.

ASDCO collects and treats sewage from about five million persons, as well as businesses and industries. Eventually ASDCO is now an independent, autonomous, financially self-sustaining, and functional as a modern utility organization, and will support its operations and construction through tariffs, reduction of operation and maintenance (O&M) costs, and developing new income sources. Therefore, Alexandria Wastewater System will represent one of the largest public work investments in Alexandria. ASDCO's services are essential not only to protect public health and environment, but also considered as a significant socioeconomic assistant that stimulates and sustains social and economical development.

Alexandria has the best sewerage service in the country, with about 87% of the buildings connected. 2910 kilometers of pipelines, 116 km tunnels, 157.5 km force mains, seven major pumping stations, two state-of-the-art primary treatment plants East and West of the city, sixteen secondary treatment plants and a sludge dewatering and disposal facility. It is reported that 90 % of the urban population are connected to public sewers but in rural areas only less than 5% of the population are connected to sewers. (GIS Department – ASDCO)

The sewerage system of Alexandria consists of three different catchment areas . The west (Km 26 treatment plant, Iskan Moubarak TP, El-Hanoville TP, and New Borg El-Arab TP and their collection system and pumping stations), central (East and West Treatment plant) and the East zone (Khorshed & Zawaida TP, El-Seiout TP, El-Maamora TP and 10th Village Abis TP).

Due to the flat surface along the coastal strip and its topographical situation with relatively low slopes of the sewers , the integration of several pumping stations is required , allowing flow to the wastewater treatment plants. Currently, there are 96 pumping stations in service. Figures (1-9,1-10) previously shown show the location of pumping stations in the sewered part of Alexandria.

Alexandria Wastewater treatment facilities now serve more than 5 million people. Most of the city wastewater is primary treated at the East and West treatment plants .Therefore, it is important to evaluate the current efficiencies of the two main primary treatment plants.

Primary effluent from the ETP is collected in the main discharge channel, which discharge into Dayer elMatar drain (the hydrodrome drain). The hydrodrome drain connects to the Qalaa drain, where flows are pumped through the Qalaa pumping station ending at the main basin of lake Maryout . The capacity of the main discharge channel is in excess of 1,200,000 m³/d , which is approximately the same as the 1,058,000 m³/d peak hourly flow as projected for the target year 2030 by M&E in 1996. The hydraulic capacity of the Qalaa drain system, however, is lower than the projected plant effluent and agricultural drainage flows.

Note: The Qalaa drain include : Primary treated effluent, agricultural drainage and raw wastewater from Abis villages

The evaluation of the East treatment plant has revealed that the plant is operating at its design average hydraulic capacity 607,000 m³/d. The ETP influent BOD (170 mg/L) and TSS (225 mg/L) values are lower than that of the designed values (200 mg/L) and (275 mg/L) respectively. The removal percentages of TSS (56.2%) and BOD (26%) of the plant are higher than those of the designed removal percentages (50%, 25%).

However, TSS (111 mg/L), BOD (126 mg/L), COD (325mg/L) and G&O (20.1 mg/L) of the effluent are not in compliance with the article 66 of the law 48 for the year 1982 which controls the discharge into surface water (50 mg/L, 60 mg/L, 80 mg/L and 10 mg/L respectively).

The west treatment plant TSS of influent (890 mg/L) and BOD (465 mg/L) are lower than that of the designed values (1093 mg/L and 791 mg/L respectively). The removal percentages of TSS (81%) and BOD (63.2%) of the planned are higher than those of the designed removal percentages (71% and 25% respectively) under the normal operation of Mechanical Dewatering Facility (MDF.)

The removal percentages of TSS and BOD under the normal operation conditions of MDF (81% and 63.2% respectively) are higher than those of the typical removal values of plain sedimentation of primary treatment (50% and 30% respectively). This may be attributed to the ETP returning liquid sludge, which acts as a coagulant aid, when mixed with the WTP influent and to the filtrate from the filter press at the mechanical dewatering facilities, which is collected and pumped back to be mixed with the WTP influent. MDF deficiencies affect the WTP performance due the returned liquid sludge into the plant inlet.

Under the primary treatment conditions mentioned above the ability to reach the effluent standards, stipulated by the Egyptian standards and international conventions and the ability to re-use the treated effluent in agriculture cannot be reached.

Upgrading the level of primary wastewater treatment, is a need, considering the requirements of law 48 for year 1982 which controls discharge into surface water and improving Lake Maryout conditions.

1-13-1 Assessment of the current Mechanical Dewatering Facility (MDF) conditions:

- 1- Hydrogen sulfide problems, which resulted from the septic conditions of sludge at the equalization tanks and different location of sludge dewatering operations, thus affecting life time of the MDF components.
- 2- Produced quantities of dewatered sludge (30%) of the designed value.
- 3- Reduction in sludge dewatering production results in accumulation of the sludge in the end effluent channel of the WTP, affecting primary treatment operation efficiency.

ASDCO's committee (no. 931 dated 30/11/2008) recommended the following to improve MDF performance:

- 1- Starting rehabilitation of current belt press components.
- 2- Keep the safe level of H_2S concentration.
- 3- Repairing and operating the blowers to ensure continuous mixing of liquid sludge in Equalization tanks, homogenizing SS concentration and prevents septic conditions.
- 4- Operating the MDF hydrogen sulfide control unit.
- 5- Rehabilitation of the computer systems.

It is a must to increase the efficiency of mechanical dewatering operations to guarantee dewatering all sludge produced from primary treatment plants.

Control of odor emissions from the current wastewater treatment plants by taking appropriate operating measures is not implemented to mitigate any noncompliance.

1-13-2 Assessment of Sludge/Solids Disposal Facility (9N)

Composting significantly reduces the volume of sludge. During the composting process, there is a substantial loss of water during composting (reducing from 70% to 10% moisture content) but the density of the product will become less than that of the sludge because of its open texture (reducing from 1 to 0.7 m³/t). The amount of dry solids will also be reduced through the mineralization of organic matter (20% loss assumed). The volume of the compost will be increased by using manure added to facilitate the composting process, but this is in effect internal relying within Site 9N and so does not influence the net volume of compost produced for marketing.

The assessment indicated that the thermophilic composting temperatures of 55 – 65° C are evolved during composting. The temperature of the compost is stable within this range for up to two months and is relatively insensitive to the frequency of turning. The compost windrows do not require many turnings to maintain efficient processing, which is desirable for moisture retention since high moisture loss is likely to limit microbiological activity.

1-13-3 Assessment of the wastewater system in terms of Public Health:

The current sewerage system has succeeded in eliminating sewage pounding in residential streets, controlling/eliminating raw sewage discharges to the beaches, providing an environmentally acceptable minimum level of treatment (primary), and disposal for the collected quantities.

The upgrading of wastewater treatment facilities will have a strong positive effect on the overall environment and the public health conditions. There will be improvement of water quality in the drains and the main basin of Lake Maryout and reduction in the odours emitted from the lake and Qalaa drain. As a result, economic benefits will occur in terms of increased water volume of good quality.

There will be considerable benefits to the fishermen and communities surrounding Lake Maryout by improving health conditions and their livelihood as the quality and quantity of the fish caught will potentially increase. The upgrade will reduce the amount of organic matter from the effluent and therefore will contribute to the cleaning of the lake. Additionally, reducing the odours coming from the Lake and from the Qalaa drain will increase the demand and cost of the land for future urban development. Besides, improving people's quality of life, this is also likely to have positive impacts on investment and tourism development in the area.

Treated effluent should be of acceptable quality so that it can be safely discharged into drainage canals and the Mediterranean. This means that the effluent quality should meet the standards for discharge into water bodies and the Egyptian guidelines for agriculture reuse and comply with the requirements of the Barcelona Convention and its protocols (*The protocol for pollution from Land-Based Sources requires from Egypt to take all appropriate measures to prevent, abate, combat and eliminate to the fullest possible extent pollution of the Mediterranean Sea Area caused by discharges from rivers, coastal establishments or outfalls, or emanating from any other land-based sources and activities within their territories, giving priority to the phasing out of inputs of substances that are toxic, persistent and liable to bio-accumulate*).

One of the major parameter of concern is the level of nematodes eggs which should be less than 1 egg per liter for water used in irrigation. The other major concern is the concentration level of nutrients such as ammonia, nitrate and phosphate which could result in algal growth in the receiving water bodies. The level of heavy metals is also of concern and could have adverse impacts on agriculture and water bodies.

The existing human health conditions, in the Main Basin of Lake Maryout are degraded as shown in Figure (1-16). The primary reason for the degraded health conditions is the discharge of non-disinfected wastewater into the basin via the Qalaa drain and WTP. Pathogens, as indicated by coliform numbers, are above levels specified in Government of Egypt regulations at both the ETP and WTP.

Analysis of water quality in Lake Maryout shows values range from 0.0 to 6.9 mg/L dissolved oxygen. The lowest values are found in the main basin and in the Qalaa and Moheet drains in particular. This is mainly because those drains carry heavy organic loads of the untreated sewage water in addition to the numerous adjacent animal farms directly discharging their untreated effluent to these drains. Also because of the increase of wastewater collected and the newly constructed networks in some areas that was integrated with the present network. Higher discharges from WTP & ETP of ASDCO were also reported upon their recent expansion schemes.

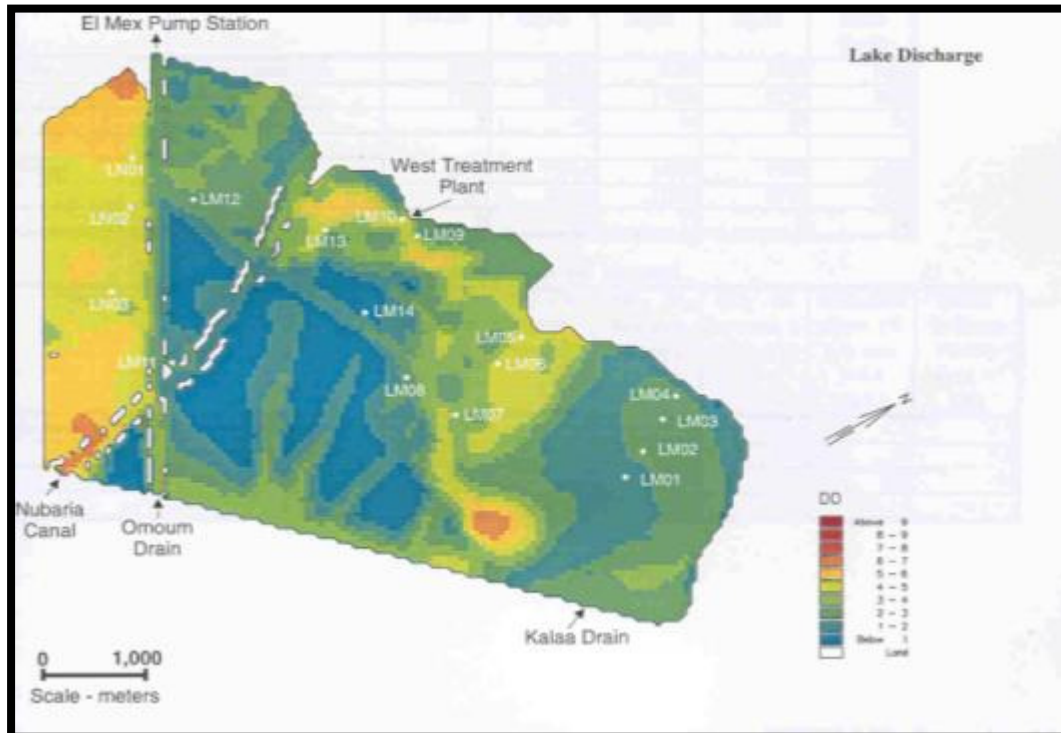


Figure (1-16) : The existing human health conditions, in the Main Basin of Lake Maryout.

The following table shows the Environmental impact of different treatment methods.

Table (1-8): Comparison of Environmental Impacts of Wastewater Treatment Alternatives

Parameter	current primary	small secondary	proposed tertiary
Impact on health	Negative-High	Negative-Medium	Very low
Discharge of effluent in water bodies	Negative-High	Negative-Medium	Very Low
Reuse of effluent in agriculture	Positive-Low	Positive-Medium	Positive-High
Amount of sludge produced	Negative-Medium	Negative-Medium	Negative - High
Reuse of sludge in agriculture (amount)	Positive-Medium	Positive-Medium	Positive-High
Reuse of sludge in agriculture (quality)	Positive-high	Positive-high	Positive-medium
Impact on soil	Low	Low	Low
Odour generation	Negative-High	Negative-Medium	Low
Noise generation	Low	Low	Low

On the other hand, rural sanitation coverage remains incredibly low at around 50%. The low coverage, in combination with a sub-optimal treatment, results in serious problems of water pollution and degradation of health conditions because the majority of villages and rural areas discharge their raw domestic wastewater directly into the waterways. The discharges are increasing year after year due to the population growth as well as the rapid implementation of

water supply networks in many villages without the parallel construction of sewage systems. Delays in achieving sufficient sanitation services are due to financial constraints.

1-13-4 Assessment of the wastewater system in terms of financing and equity:

A major challenge that faces Alexandria sanitary company is to close the gap between the limited financial resources available and competing users' escalating demand for sanitation, unless the Government implements policies to manage shortages of financial resources. This requires developing appropriate pricing and financing rules along with an institutional framework that encourages sustainable usage practices supply.

The operation & maintenance costs can be recovered in the company through the following:

- 1- The company revenues represented in {a-tariff b-scavenging fees, connections to the network fees, sample analysis...}
- 2- The holding company subsidiaries of production cost.
- 3- Other revenues as penalties fees.

The total revenue of the company during the period from 1/7/2008 to 30/6/2009 has reached (115,774,206 L.E) which represents tariff income which is 84,571,632 L.E. and income of different activities 31,202,547 L.E., while the total expenditure reaches (265,935,418 L.E) which represents the cost of O&M of the sewer system 156,257,048 L.E, and depreciation and other costs 84,230,875 L.E. The difference between the income and cost of O&M has been covered through out the holding company production subsidy (55 M L.E), therefore the company is covering 32 % of the total cost, and 54% of the operation and maintenance costs. The average tariff charged in the USA was higher than those charged in Egypt by 95% while the tariff charged across the developing countries exceeded the Egyptian tariff^{by} 66%.

As for the loans , the Executive Authority of Drinking Water and Sanitation will be the party who access to credit and repayment, which cover all new projects and complete the existing projects as well as rehabilitation and renewing projects that are under the supervision of the company and its funding through out the executive authority which obtain the loans from the national investment bank to execute the new projects , complete the existing projects as well as the coverage of all procurement assets of cars and equipments .

Significant investments in sanitation infrastructure from the national budget and from donor support. By comprehensive or integrated approach became apparent because of the inadequacy of government funds for sustaining new investments and O&M at current levels of engagement.

Alexandria Sanitary Drainage Company is an affiliated company for the holding company for water and wastewater which is established in 2004, subjected to the law 203. This means that Alexandria company should offer the sanitation services for the people with suitable revenue cost , but due to the low tariff which is about 35 % to 50 % of the water tariff (which is about 25% now of the O&M water cost).

So the major challenge that faces Alexandria Sanitary Drainage company is to close the gap between the limited revenues with the O&M cost of the sanitation service. The revenues of the company are represented in :-

- Direct revenues from the tariff .
- Indirect revenues from fees and penalties.

According to the financial statements of the company in the last year it shows that the revenue from O&M is covering only 32% of the total cost and 54 % of the O&M cost until the tariff resetting by the regulatory agency for water and wastewater which is established by the presidential decree 136 in 2004, the government will pay a subsidiary for the difference between cost and revenue in Alex. Company.

In the same time, till now the government is committed to offer the essential finance resources for the capital investment of the water and wastewater utilities in addition to loans and offers from the foreign donors and government.

Since the government policy has shifted to integrated water quality and quantity management, financing mechanisms must meet multiple objectives, including revenue generation, economic efficiency, and equity. In general, these three objectives are best met by charging the polluter (whether an individual household, an industry, or a municipality) the cost of mitigating the pollution-the so-called polluter pays principle. Such a principle should result in a level of charges that encourages the polluter to minimize the waste stream and/or provides sufficient revenue to treat the waste. However, the charges set must take into account both willingness and ability to pay. Furthermore, in almost no cases in either the industrialized or developing world have direct user charges actually been high enough to cover all capital and operating costs of wastewater systems.

1-13-5 Assessment of the wastewater system in terms of implementation of legislation and polices:

Law 93/1962 explains the responsibilities and authorities given to Alexandria Wastewater Company for Sanitary Drainage to license and limit the discharges to public sewers. One of the main challenges facing Alexandria Wastewater system is the urgent need to modify this Law in relation to Low level of enforcement for the implementation of the included regulations.

Two main legislations are in command of the reservation of water and environment in Egypt. The first is the **Law No. 48 for the year 1982** on the protection of the River Nile and its watercourses from pollution. The law and its executive regulation set standards for effluent discharge to the Nile and its water sources. This law is concerned with the control on the wastewater treated effluent arising from the company's wastewater treatment plants and assuring that the effluent is according to the permitted standards through the Ministry of Irrigation and Ministry of Public Health.

The second major legislation is the **Law No. 4 for the year 1994** on Environmental Protection. Implementation of Legislations is as mentioned in (Overview of legislations and polices). It controls the final outfalls to the Mediterranean Sea from different inland sources in Alexandria. However, there is an urgent need to continuous action on the above laws in different items affecting different activities of Alexandria Wastewater Company to solve or minimize different related complaints from concerned authorities in Environmental, Irrigation and Health Ministries to be aware of all issues.

With respect to industries, existing national legislation provides for control of industrial discharges, EEAA is mandated with the enforcement of the limits for industrial discharges and has secured so far a modest record in terms of enforcement of the laws and regulations against polluters by issuing warnings, imposing fines and eventually bringing them to courts.

Chapter 2

A Vision for a future wastewater system

2-1 Introduction:

For the past decade, Alexandria has enjoyed a very dynamic executive leadership that emphasizes the importance of long-term participatory strategic planning, under the framework of Alexandria City Development Strategy (2004-2007), partnership building with the city's vibrant private sector and civil society organizations, and enabling private sector participation in service delivery and housing supply.

2-2 Challenges:

Alexandria Governorate faces the challenge of creating more jobs to meet a rapidly increasing demand. The estimated number of jobs that needs to be created each year at minimum is 40,000 jobs to absorb new entrants in the labor market; 51% of the population is under the age of 20, whereas population is expected to reach 4.95 million inhabitants by 2021. A relatively low official rate of unemployment, 7.1% in 2004, compared with a national average of 10.3%, can thus be misleading if the great need for job creation is not considered. In addition, Alexandria experiences a large influx of workers commuting daily from adjacent Beheira and Matrouh Governorates, which have higher unemployment rates.

The second challenge manifests itself in the existence of 30 squatter settlements where one-third of the population (1.2 million) lives with limited access to infrastructure and municipal service and high rate of unemployment, 15-20%. The last challenge is the extensive pollution of Lake Maryout due to the discharge of untreated and primary treated sewage and industrial waste. Lack of strategy, resources and institutional capacity in the Governorate to efficiently manage the Lake and its surrounding land as a valuable development element has resulted in its transformation from a key asset to a major liability.

2-3 Alexandria City Development Strategy:

Such endowments and challenges formed the backdrop of the Alexandria City Development Strategy (CDS), which was initiated in 2004 with support from the Cities Alliance Program, World Bank, GTZ, UN-Habitat, AUDI, CIDA and IFC. The process consisted of formulating a long-term vision and action plan for sustainable development, constructed through a broad-based participation of key public, private and civil society stakeholders.

The emerging long-term vision is: “Alexandria takes advantage of its competitive endowments, better manages its local assets, removes constraints to private sector led growth, while ensuring the socio-economic integration of the poor”

In 1999, ASDCO senior managers developed a strategic plan which included a clear mission and vision of the future. The mission was established as safeguarding the public health and environment of the citizens of Alexandria. ASDCO does this by collecting, treating and safely disposing wastewater.

Heightened public interest, led by the Governorate, has resulted in significant improvement to many facets of the Alexandria environment. This new interest in community improvements requires that ASDCO examine its mission and vision to ensure that these statements reflect the need to revitalize Alexandria.

2-4 ASDCO Mission , Vision and Strategic goals:

ASDCO staff have reviewed the adopted mission and vision and found that it may be appropriate to update these fundamental operating principles. The purpose of this update is to expand the benefits to include the increased economic benefits associated with water resources free of sanitary pollution, and the increased public safety related to the appropriate control of storm waters. The Vision Statements was:

- ASDCO management and staff will be responsive to the needs of the citizenry of Alexandria.
- Public health will be protected by the effective sustainable collection, treatment and disposal of wastewater.
- Public and infrastructure safety will be ensured by the effective control of storm waters.
- Public waterways will be protected by treated wastewater of better quality.
- The environment of the citizens of Alexandria will be protected by the appropriate disposal/reuse of wastewater and storm waters and by the implementation of environmentally approved construction and operating procedures.
- Economic growth will be fostered by the existence of quality water resources in the seas, bays, lakes and waterways of Alexandria.
- ASDCO will be a financially self-sustaining, capable, empowered and independent company.
- The mission work of ASDCO will be conducted by a well-trained, motivated professional experienced staff.

The mission of ASDCO is fulfilled when all of the following goals or conditions are met:

- The customers of Alexandria appreciate the service provided by ASDCO and provide the political and financial support to fully fund the activities of the company.
- All customers, current and future, are serviced by sewage and waste control systems consistent with an approved sewerage facilities master plan.
- Collection of sewage and other waste is defined and controlled by approved rules and regulations for discharge of waste into the sewerage system.
- A facility upgrade and rehabilitation program is implemented in accordance with a facility upgrade and rehabilitation master plan.
- All activities of ASDCO are completed efficiently and effectively in compliance with existing (future) regulations and standards.
- Adequate funds are generated by ASDCO to finance all of the critical activities of the company.

- Using treated wastewater for irrigation will reduce the degradation of the environment. Furthermore, it could have many beneficial results for the ASDCO and should be considered an important part of any management policy.
- Facilitate adoption of new technology and management systems
- Ensure that the wastewater system is managed efficiently and effectively.
- Ensure that the costs of building, maintaining and operating the wastewater system are shared equitably.
- Ensure that customers served by regulated public wastewater systems are receiving *safe and reliable service*.
- Provide financial assistance to public wastewater systems for facility improvements *and protection*

To fulfill its mission and vision, ASDCO has identified the following three strategic goals:

- Financial strategic goal: To achieve, without delay, full cost recovery of operations and maintenance expenses and ultimately total cost recovery.
- Managerial Strategic goal: To operate with the degree of autonomy necessary to fulfill the ASDCO mission and vision.
- Service Delivery Strategic goal: To secure adequate financial resources to implement master plans that provide for full sanitary services to meet the current and future needs of Alexandria.

2-5 Vision for future water and wastewater systems 2037:

'A proud water city where available water resources are managed in an integrated manner, with the participation of all citizens, and are used effectively for development within a framework of environmental sustainability.

All citizens have access to high quality (meeting national norms), reliable, sustainable, and affordable water and sanitation services and benefit from a clean and healthy environment

Developed by the Alexandria Learning Alliance in July 2007, Source : Learning Alliance Briefing Note 9, Visioning (draft) Prepared by Charles Batchelor and John Butterworth

Therefore, to match future water vision, the future wastewater system vision is:-

*"Envision a future for the citizens of **Alexandria** where the quality of life is enhanced by the quality of the environment.*

In partnership with communities and businesses, we will assess, sustain, preserve, and enhance the quality of the environment while recognizing the need for maintaining the economic vitality of the city".

In order to achieve Alexandria strategic vision for 2037, the future vision for the wastewater system will be fulfilled through:

2-5-1 Effective wastewater system Establishment:

- ◆ Continuous upgrading and improving the wastewater system according to the current Alexandria Master Plan.
- ◆ Using on-site sanitation systems in sub-urban and far rural non-served areas around Alexandria to decrease costs of construction, operation and maintenance. And reusing its effluent in irrigating wood trees, flowers and green areas, instead of disposing in agricultural drains and creating a code for residential facilities to ensure separating grey water from black water to decrease treatment costs through using low-cost technologies in treating liquid waste from those areas.
- ◆ Wastewater system should be protected from the intrusion of saline water and increasing its levels, by isolating sewer lines, manholes and pump stations to minimize the effect of rise in sea water level, to ensure decreasing dissolved solids levels in wastewater system. Thus, to minimize the effect on the final quality of wastewater effluent that will be reused to overcome decreased River Nile water level, and deficiency in rainwater amounts. The reused effluent will be used completely in agriculture and un-edible industries within the city of Alexandria.
- ◆ Improving Wastewater System Management skeleton to ensure sustainable effective services, to reduce the environmental impacts resulting from increasing amounts of wastewater resulting from extension in tourist, commercial and industrial activities at west Alexandria and from new industrial zones in Amriya, Om Zeghio, Merghem and El-Nahda. All Alexandria will be covered by a wastewater sewer system. Thus, extending the wastewater systems in Alexandria and surroundings through Continuous improving Quality control and management of the operated sewerage systems..

2-5-2 Ensuring and improving aquatic environment of Lake Maryout as one of the major priorities for improving future Alexandria wastewater system as well as providing a new water resource through:

- ◆ Increasing the treatment level to tertiary treatment throughout the city's treatment plants. Thus, increasing the efficiency of self purification of all water bodies that receive treated wastewater from wastewater treatment plants.
- ◆ Establishing a suitable storm water collecting system, to be reused with a minimum cost, and collected into water bodies that can be self purified.
- ◆ Complete reuse of secondary effluent in irrigating forest trees to overcome the shortage in pure water supply in El-Hammam area through the National plan for irrigation as the option suggested by the WRC study, this is a corner stone to ensure improving aquatic environment of Lake Maryout.
- ◆ Establishing an emergency system for disposal of secondary treated effluent in case of storms and accidents to minimize different impacts.
- ◆ Adopting the large scale reuse range of Alexandria wastewater treated effluent in surrounding arid areas outside Alexandria, especially from small treatment plants.

2-5-3 Achieving full cost recovery of operation and maintenance expenses and ultimately total cost recovery of future wastewater system through:

- ◆ Ensuring an adequate tariff for wastewater treatment system service, to ensure adequate budget for operation and maintenance of the wastewater system.
- ◆ Adopting decentralization systems in Management, collection, treatment and reuse systems, to overcome poor availability of financial resources
- ◆ Decreasing the O&M costs of treating sludge which will be produced from future wastewater treatment systems, through producing electricity from sludge using anaerobic digestion; this will lead to decrease in using electricity from the main national facilities and producing partially treated sludge before drying. This will lead to decrease in hydrogen sulphide levels thus avoiding its impact on mechanical dewatering facilities and the environment, and decreasing mal odors at site 9N. Also, agricultural wastes can be used in producing safe sludge compost by mixing with sludge, leading to improving the organic content and assuring continuous decrease in heavy metals levels as much as possible.

2-5-4 Sustain, preserve, and enhance the quality of the wastewater system through:

- ◆ Public environmental awareness to ensure that all Alexandria and Borg El-Arab residences use the sewer system properly.
- ◆ Increasing levels of cooperation with all local and international granting authorities to fund solutions to environmental problems relating to primary treated effluent, and raw sewage from rural areas disposing into drains leading to Lake Maryout.
- ◆ Necessary arrangements with all concerned authorities to reuse treated wastewater to save raw water for economic and tourist developments.
- ◆ Progressive reduction of industrial contaminants entering the sewer system should remain a long- term objective of environmental and regulatory authorities in Alexandria to increase the sustainability of improving the wastewater system.
- ◆ Continuing upgrading and improving Industrial Waste Management Program to minimize the problems identified with the discharge of industrial wastes into the wastewater system. Thus, reach the level that all industrial, commercial and tourist facilities treat their liquid waste according to Law 93 year 1962 and its regulation 44 year 2000, and pay the cost of receiving and treating their organic load which is higher than the permitted levels in domestic wastes especially in new industrial areas in Borg El Arab – Om zeghio – Merghem – El Nahda – Amriya and inside Alexandria.
- ◆ Constructing industrial complexes and collecting each type of industry together to minimize the cost of constructing new treatment plants also to minimize operation and maintenance costs. This will create a new market for the waste of each industry to reach zero exhaust system.

Chapter 3

Scenarios affecting the Wastewater System

3-1 Population Growth, City Expansion and Wastewater Flow:

Study of the population and its future prediction are very important issues for prediction of consumption water supply in any community and for prediction of the wastewater produced from this community. For prediction of future population for any community, the previous censuses should be available. As shown previously in table (1-1) of Alexandria population and its rate of increase, the last census in 2006 was 4,325,760 capita with average rate of increase in the whole governorate of about 1.42 %. These population increases in summer by about 40% due to traveling many people from other governorates to Alexandria beaches in summer. From table 3-1, it is noticed that the rate of population increases in every district were not equal but they vary from districts of high rate of population increase of 2.77% for Borg El-Arab (which is a new city accepting more population) to low rate of about 0.94 % for the middle district (which is an old district reached near to saturation).

There are many scenarios for prediction of Alexandria population which could be^{1 2}:

1. **The As Usual Scenario:** The rate of population increase will be the same as in the previous period,
2. **The Best Case Scenario:** The existing population are near to saturation and the rate of increase will be less than the previous period with a gradual decrease of this rate and transferring many people to other governorates and new communities,
3. **The Worst Case Scenario:** The rate of population increase will be more than the previous period with increasing the level of living and transferring many people to Alexandria governorate.

The next tables (Tables 3-1, 3-2, 3-3) will predict the population in Alexandria at the target year (2037) according the above three scenarios with increasing the population in summer by 40%.

For calculation of the wastewater production in different districts in Alexandria, the existing daily per capita water consumption should be known and predicted for future. According to the Egyptian Code of Practices for Water supply, the future water consumption usually increases by a rate of about 10% the population rate of increase. The table (3-4) shows the existing per capita water consumption in Alexandria and predicts it in the future according to the normal increase rate of population.

¹ Reference: "Master plan of wastewater facilities of Alexandria Governorate up to 2037" prepared by Misr Consult for Alexandria of Sanitary Drainage Company, Alexandria, Egypt. 2008.

² Reference "Master plan of Alexandria City up to 2017" prepared by Communities Planning Authority , Cairo, Egypt. 2001.

Table (3-1): Population Prediction according to the as usual scenario.

District	2006	R%	2009	2017	2027	2037
Montazah	1,217,535	1.37	1,267,139	1,409,520	1,610,202	1,839,456
Eastern	1,003,965	1.26	1,039,002	1,148,470	1,301,664	1,475,292
Middle	613,925	0.94	630,276	679,261	745,882	819,036
Customs	196,402	1.17	202,654	222,417	249,854	280,675
Western	514,506	1.54	536,261	606,001	706,065	822,652
Amriya	697,450	2.23	746,470	894,701	1,122,044	1,407,154
Borg El Arab	81,977	2.77	89,970	128,188	222,072	464,074
Sub-Total	4,325,760	1.42	4,511,771	5,088,559	5,957,783	7,108,340
Summer Increase (40%)	1,730,304		1,804,708	2,035,424	2,383,113	2,843,336
Total Population in Summer	6,056,064		6,316,480	7,123,983	8,340,896	9,951,675

Table (3-2): Population Prediction according to the best case scenario.

District	2006	R%	2009	R%	2017	R%	2027	R%	2037
Montazah	1,217,535	1.37	1,267,139	1.25	1,399,537	1.15	1,569,073	1.00	1,733,233
Eastern	1,003,965	1.26	1,039,002	1.10	1,134,032	1.00	1,252,677	0.85	1,363,321
Middle	613,925	0.94	630,276	0.85	674,431	0.75	726,755	0.65	775,401
Customs	196,402	1.17	202,654	1.00	219,445	0.90	240,015	0.75	258,635
Western	514,506	1.54	536,261	1.30	594,636	1.20	669,972	1.00	740,066
Amriya	697,450	2.23	746,470	2.00	874,609	1.75	1,040,299	1.15	1,166,318
Borg El Arab	81,977	2.77	89,970	4.50	127,947	6.00	229,134	3.50	323,216
Sub-Total	4,325,760	1.42	4,511,771	1.35	5,024,638	1.32	5,727,925	1.05	6,360,190
Summer Increase (40 %)	1,730,304		1,804,708		2,009,855		2,291,170		2,544,076
Total Population in Summer	6,056,064		6,316,480		7,034,494		8,019,095		8,904,266

Table (3-3) Population Prediction according to the worst case scenario.

District	2006	R%	2009	R%	2017	R%	2027	R%	2037
Montazah	1,217,535	1.37	1,345,994	1.50	1,516,252	1.75	1,803,498	2.10	2,220,102
Eastern	1,003,965	1.26	1,039,002	1.30	1,152,104	1.55	1,343,665	1.75	1,598,215
Middle	613,925	0.94	630,276	1.00	682,498	1.25	772,773	1.60	905,710
Customs	196,402	1.17	202,654	1.25	223,828	1.50	259,762	1.85	312,022
Western	514,506	1.54	536,261	1.45	601,717	1.70	712,200	2.00	868,167
Amriya	697,450	2.23	746,470	2.45	905,959	2.70	1,182,532	3.00	1,589,224
Borg El Arab	81,977	2.77	89,970	5.00	132,927	7.00	261,488	9.00	619,037
Sub-Total	4,325,760	1.42	4,511,771	1.61	5,126,456	1.97	6,230,259	2.51	7,982,413
Summer Increase (40 %)	1,730,304		1,804,708		2,050,582		2,492,104		3,192,965
Total Population in Summer	6,056,064		6,316,480		7,177,038		8,722,363		11,175,378

Table (3-4): Existing and predicted water consumption in Alexandria.

District	Existing water consumption L/capita/day	R% of WC	Future water consumption L/capita/day			
			2009	2017	2027	2037
Montazah	280	0.18	287	293	299	317
Eastern	281	0.14	278	284	290	307
Middle	252	0.07	259	264	270	285
Customs	328	0.13	335	341	346	363
Western	176	0.17	183	189	195	212
Amriya	524 *	0.28	533	541	548	572
Borg El Arab	2355 *	--	2250	2000	1750	1500

* The water consumption of Amriya and Borg El Arab is huge because of the existence of many factories with high consumption of industrial water processes. For Borg El-Arab, the water consumption will decrease because the population increases rate will be more than the industrial increases rate.

The produced wastewater is estimated by the reduction of the water consumption by about 10% due to the evaporation and losses in the distribution system. The tables 3-5, 3-6, 3-7 shows the prediction of wastewater production in Alexandria according to the above three scenarios for population with respect to the daily per capita water consumption.

Table (3-5): Predicted Wastewater Production in Alexandria (m³/d) according to the as usual scenario.

District	2006	2009	2017	2027	2037
Montazah	306,819	327,302	371,690	433,305	542,797
Eastern	244,867	259,958	293,549	399,734	407,623
Middle	139,238	146,917	161,392	181,249	210,083
Customs	57,978	61,100	68,260	77,805	91,697
Western	81,498	88,322	103,081	123,914	156,962
Amriya	328,917	358,082	435,630	553,392	724,403
Borg El Arab	173,750	182,189	230,738	349,763	626,500
Sub-Total	1,333,067	1,423,871	1,664,341	2,059,163	2,742,064
Summer Increase	466,574	498,355	573,724	683,291	838,671
Total in Summer	1,799,641	1,922,226	2,246,860	2,779,871	3,701,786

Table (3-6): Predicted Wastewater Production in Alexandria (m³/d) according to the best scenario.

District	2006	2009	2017	2027	2037
Montazah	306,819	327,302	369,058	422,238	494,491
Eastern	244,867	259,958	289,859	326,949	376,686
Middle	139,238	146,917	160,245	176,601	198,890
Customs	57,978	61,100	67,348	74,741	84,496
Western	81,498	88,322	101,148	117,580	141,205
Amriya	328,917	358,082	425,847	513,075	600,421
Borg El Arab	173,750	182,189	230,305	360,886	436,342
Sub-Total	1,333,067	1,423,871	1,643,808	1,992,070	2,332,530
Summer Increase	466,574	498,355	573,724	683,291	838,671
Total in Summer	1,799,641	1,922,226	2,219,141	2,689,294	3,148,916

Table (3-7): Predicted Wastewater Production in Alexandria (m³/d) according to the worst case scenarios

District	2006	2009	2017	2027	2037
Montazah	306,819	347,670	399,836	485,321	633,395
Eastern	244,867	259,958	294,478	350,697	441,587
Middle	139,238	146,917	162,162	187,784	232,315
Customs	57,978	61,100	68,693	80,890	101,938
Western	81,498	88,322	102,352	124,991	165,646
Amriya	328,917	358,082	441,111	583,225	818,133
Borg El Arab	173,750	182,189	239,269	411,844	835,700
Sub-Total	1,333,067	1,444,239	1,707,900	2,224,751	3,228,713
Summer Increase	466,574	505,484	573,724	683,291	838,671
Total in Summer	1,799,641	1,949,723	2,305,665	3,003,414	4,358,762

3-2 Wastewater Composition, Industrial Discharges and the Enforced Effluent Standards

3-2-1 Priority pollutants and industrial discharge:

The current total water consumption in different sectors is shown in table 3-8, it shows that the agricultural sector consumes about 60% of water, industrial sector consumes 9%, while domestic sector consumes around 33% of the total water consumption. It is thought that the numbers mentioned in the table is the Ministry of irrigation estimated Alexandria share in excess of (raw water) before entering the water treatment plants for the domestic use to guarantee that the treatment plants have continuous water source. The table presents Alexandria water share not the actual consumption.

Table (3-8): Present Water Consumption - Alexandria Governorate

Water Use	Water Consumption (M m³/day)	
	Period of Max. Water needs	Period of Min. Water needs
Agricultural	7.50	4.10
Domestic	4.20	3.20
Industry and Power Stations	1.20	1.20
Total	12.90	8.5

Priority pollutants in industrial discharge are shown in the tables in Annex 7. These tables show that hazardous waste is produced mainly from the tannery factories located in El Mex area. However, most industries producing the high organic load are located inside Alexandria. Especially, industries in Moharram Bey industrial complex, which is responsible for the high organic load in the West Wastewater Treatment plant. The other industries have no impact on the influent characteristics in the rest of the treatment plants due to the diluting rate and low industrial density. The analysis of the ETP influent shows that the textile, food and chemical industrial sectors represent the highest discharge into the sewerage system.

3-2-2 Wastewater composition

The Wastewater composition in the East district (Sharq) is mainly domestic and there is a little contribution of industrial pollution due to the high dilution rate from domestic activities in this region. As shown in the following tables 3-9 and 3-10.

However, the Middle district (Wasat) shows impact of industrial pollution due to existence of industrial activities in Smouha area, as shown in the analysis of Influent wastewater to 14 may pump station. Also industrial impact is obvious at the Industrial complex pump station. While, wastewater composition of West district is almost domestic, most of the industries in this region are not connected to the sewer system.

In general, expected changes in wastewater composition of Alexandria city according to the different three scenarios is not significant as the predicted changes in water quantities varies between 1.5 – 3%, and the corresponding changes in composition by dilution (decrease under the Best case scenario) or concentration (increase under the worst case scenario) will not have significant impact on wastewater composition.

The enforced effluent standards for industrial discharges are according to the Law 93 year 1962 and its executive regulation 44 year 2000.

Table (3-9): Alexandria Wastewater Composition collected through pump stations.

	Pollutant	Unit	Levels	Average Influent Composition			
				15 May P.S.	Abis P.S.	El Seiouf PS	Mogamaa Elmasanee PS
	Temperature	°C	43	19.00	19.00	19.00	20.75
	pH		6 - 9.5	7.53	7.63	7.30	7.10
	Settleable solids After 10 minutes After 30 minutes	mm/L	80 150	1.5 2.03	4.7 8.4	0.7 1.3	4.0 6.4
	Total Solids	mg/L	800	1182	4855	1349	4460
	Total suspended solids	mg/L	1274	274	2652	270	1217
	Total volatile solids	mg/L	2000	329	3315	385	793
	Volatile suspended solids	mg/L	197	184	524	219	3668
	Total dissolved solids	mg/L	2000	908	2204	1079	409
	BOD	mg/L		211	305	231	1565
	COD	mg/L		549	1004	650	5
	Sulphides	mg/L		3.20	2.90	4.40	56.00
	Oil & Grease	mg/L		39.33	196	38	4
	Phosphates	mg/L		4.42	4.493	4.317	1.658
	Nitrates	mg/L		0.91	0.561	0.925	20.75
Heavy Metals	Cu	mg/L		0.15	0.480	0.052	0.309
	Ni	mg/L		0.07	0.034	0.016	0.057
	Zn	mg/L		0.13	4.509	0.121	0.232
	Cr	mg/L		0.01	0.020	0.021	0.015
	Cd	mg/L		0.00	0.287	0.011	0.023
	Ar	mg/L		0.03	0.030	0.030	0.030
	Total Heavy Metals			0.389	5.137	0.250	0.665
Metals	Al			0.29	0.230	0.278	0.306
	Ar			0.01	0.054	0.009	0.010
	Ba			0.27	0.934	0.330	0.440
	Co			0.00	0.005	0.006	0.006
	Fe			0.34	0.306	0.228	4.038
	Mn			0.10	1.895	0.232	1.015
	Pb			0.01	0.005	0.014	0.005
	An			0.03	0.030	0.030	0.030
	Se			0.03	0.030	0.030	0.030
	St			0.92	1.476	0.761	0.881
	Vanadium			0.02	0.038	0.010	0.044
	Total Metals			2.42	9.864	2.179	7.471
Microbiology	Possible Total coliform	cell/100 cm ³		22 x 10 ¹¹	23 x 10 ¹¹	11 x 10 ¹¹	13 x 10 ¹⁰
	Possible Total Fecal coliform	cell/100 cm ³		14 x 10 ¹¹	12 x 10 ¹¹	10 x 10 ¹¹	14 x 10 ⁸
	Total coliform	cell/100 cm ³		42 x 10 ⁶	81 x 10 ⁶	35 x 10 ⁶	50 x 10 ⁶
	Total Fecal coliform	cell/100 cm ³		18 x 10 ⁶	42 x 10 ⁶	10 x 10 ⁶	1 x 10 ⁶
	Salmonella			+ ve	+ ve	+ ve	+ ve

Table (3-10): Alexandria Wastewater Composition entering the Wastewater Treatment plants

	Pollutant	Unit	Levels	ETP	WTP	Hanoville TP	Iskan Mobarak TP
				Average	Average	Average	Average
	Temperature	°C	43	20.17	19.67	20.00	19.33
	pH		6 - 9.5	7.53	7.40	7.23	7.10
	Settleable solids	mm/L					
	After 10 minutes		80	1.30	3.13	3.00	1.97
	After 30 minutes		150	2.10	4.27	4.93	2.73
	Total Solids	mg/L	800	1428	2116	1507	1142.6
	Total suspended solids	mg/L	1274	432	634	517	308.00
	Total volatile solids	mg/L	2000	214	903	363	570.67
	Volatile suspended solids	mg/L	197	1196	1482		
	Total dissolved solids	mg/L	2000	172	1482	990	625.00
	BOD	mg/L		397	341	197	173.67
	COD	mg/L		3.27	995	386	377.67
	Sulphides	mg/L		36.00	5.60	4.00	2.93
	Oil & Grease	mg/L		7.22	95.67	32.50	28.50
	Phosphates	mg/L		1.33	7.01	5.21	5.70
	Nitrates	mg/L		20.17	1.46	0.58	0.57
Heavy Metals	Cu	mg/L		0.08	0.07	0.02	0.13
	Ni	mg/L		0.01	0.03	0.03	0.12
	Zn	mg/L		0.12	0.10	0.07	0.08
	Cr	mg/L		0.01	0.30	0.01	0.00
	Cd	mg/L		0.01	0.00	0.00	0.00
	Ar	mg/L		0.03	0.03	0.03	0.03
	Total Heavy Metals			0.26	0.52	0.15	0.37
Metals	Al			0.72	0.76	0.09	0.14
	Ar			0.15	0.14	0.17	0.16
	Ba			0.24	0.25	0.06	0.42
	Co			0.01	0.09	0.00	0.00
	Fe			0.21	0.21	0.41	0.48
	Mn			0.11	0.07	0.52	0.37
	Pb			0.05	0.01	0.01	0.01
	An			0.03	0.05	0.03	0.03
	Se			0.03	0.05	0.03	0.03
	St			0.78	1.44	2.70	0.49
	Vanadium			0.02	0.01	0.09	0.01
	Total Metals			2.60	3.59	4.28	2.51
Microbiology	Possible Total coliform	cell/100 cm ³		40 x 10 ¹¹	57x 10 ¹¹	11x 10 ¹¹	21x 10 ⁷
	Possible Total Fecal coliform	cell/100 cm ³		10 x 10 ¹¹	49 x 10 ¹¹	55 x 10 ¹⁰	16 x 10 ⁷
	Total coliform	cell/100 cm ³		41 x 10 ⁶	49 x 10 ⁶	32 x 10 ⁶	57x10 ⁶
	Total Fecal coliform	cell/100 cm ³		15 x 10 ⁶	19 x 10 ⁶	43 x 10 ⁶	68x10 ⁵
	Salmonella			+ ve	+ ve	+ ve	+ ve

3-3 Demand for Effluent (industrial, urban and agricultural reuse; location, required qualities and potential quantities)

3-3-1 Alexandria water challenges:

Water resources and future water needs in different sectors are shown in tables 3-11 and 3-12, they show the amounts of water used by different sectors.

Table (3-11): Present Available Water Resources - Alexandria Governorate

Water Resource	Water Resources (M m³/day)	
	Period of Max. Water needs	Period of Min. Water needs
Nile (Main canals)	10.40	6.90
Drainage Water Reuse	1.10	0.90
Ground Water	0.00	0.00
Rain Water	0.00	0.20
Wastewater Reuse	0.50	0.50
Total	12.00	8.50

Table (3-12): Future Water Needs (Year 2017) - Alexandria Governorate

Water Resource	Water Needs (M m³/day)	
	Period of Max. Water needs	Period of Min. Water needs
Agricultural	8.00	4.40
Domestic Water	5.70	4.20
Industry and Power Station	1.40	1.40
Total	15.10	10.00

The above tables show that Alexandria city will face water scarcity problems and will face the following challenges:

- Water Demand Increase (population, economic, industrial and social activities).
- Semi-arid zone (little rain fall 150-200 mm/year).
- Limited groundwater Potential (Fresh, 3 million m³/year).
- Down stream main irrigation system.
- Water quality degradation.
- Climate Change.

3-3-2 Effluent Demand

3-3-2-1 Industrial Demand:

According to our survey no industries are willing to consider using treated effluent from Alexandria wastewater treatment plants in any industrial activities, due to the concern about the safety of using this effluent and the risk of loosing their market. Given the fact that, other sources of clean water are available in affordable prices.

However, some industries reuse their own treated effluent within their property. As an example Rakta Paper company: (*reference: wastewater treatment and recycling in Industrial facilities report prepared by Environmental affairs*)

- 1- Recycling effluent from paper machines (white liquor), which is considered about 10% of the total used water (6000 m³/day).
- 2- Primary treatment of 11,500 m³/day of Rice ash washing water, reusing 4000 m³/day.

3-3-2-2 Urban demand:

From our survey, only urban areas located outside Alexandria especially in arid zones can use treated effluent in irrigating green yards (this is mainly due to the shortage of water resources all over the year).

Example: ASDCO contract with Alex West Housing compound to receive treated wastewater from the km 26 wastewater secondary treatment plant (4000 m³/d) to be reused in irrigating the green areas all around the compound. Figure 3-1 shows the location of Alex West compound along the km 26 on Mehwar El Taameer Road.



Figure (3-1): Location of Alex West Housing compound receiving treated wastewater for irrigation.

It could be possible also to use the treated effluent from the ETP after upgrading the degree of treatment to secondary treatment inside Alexandria in some clubs within the city as located in the following map taken by Google Earth.



Figure (3-2): Location of proposed clubs which could use the treated effluent in irrigation of the green areas.

The quality of the treated wastewater required for reuse in irrigation is according to the standards of effluent reuse mentioned In Law 93 year 1962 and its regulation 44 year 2000. (Mentioned in details in chapter 1).

3-3-2-3 Agricultural demand:

The previous table 3-8, show that the current needs for all purposes at Alexandria (in accordance to the as usual scenario), are fulfilled from the available resources. But the table 3-12 "*Future water needs 2017*" shows that the required demand will increase by approximately 3 million m³ which should be provided from non-regular resources like reuse of wastewater with an amount of 0.5 million m³ which will be used only in arid desert areas west Alexandria which suffers from severe lack of water resources.

This situation could change under the worst case scenario due to the decrease in Alexandria's share of water resources. Thus, it would be worth to reuse all treated wastewater in irrigation within Alexandria with rates covering the expected decrease in water quantities from different water resources. Fortunately, the main wastewater treatment plants are adjacent to the agricultural areas inside Alexandria in Abis area and in Amriya, they have the advantage to reuse the treated effluent without the need for additional construction to transfer water.

3-3-3 Required Qualities:

The required qualities of wastewater to be reused in agriculture varies according to the type of treatment (Primary, secondary or tertiary) and for each there are certain crops that should be irrigated according to the parameters mentioned in the following tables (3-13 to 3-15).

Table (3-13): Maximum Standards Permitted for Reusing Treated Sanitary Effluent according to the Degree of Treatment (Decree 44/2000)

Ser.	Parameters	Unit	First Group Preliminary Treated Water	Second Group Secondary Treated Water	Third Group Advanced Treated Water
1	B.O.Ds	ppm	300	40	20
2	C.O.D. Dichoromate	ppm	600	80	40
3	T.S.S.	ppm	350	40	20
4	Oils and Grease	ppm	undetermined	10	5
5	Number of Enteric Nematode Cells or eggs	Number/liter	5	1	1
6	Number of Fecal Coliform Cells	For every 200/ml	undetermined	1000	100
7	Maximum Concentration of Total Dissolved Salts (according to plant endurance degree)	ppm	up to 2500	up to 2000	up to 2000
8	Rate if sodium Adsorption (permeability according to type of soil & plant)	9	25	20	20
9	Chlorides Concentration	ppm	up to 350	300	300
10	Boron Concentration	ppm	up to 5	up to 3	up to 3

Table (3-14): Maximum Standards of Metals Permitted for Reusing Treated Sanitary Effluent according to the Degree of Treatment (Decree 44/2000).

Degree of Treatment/ Standards Metal	Unit	First Group Preliminary	Second Group Secondary	Third Group Advanced
Cadmium	ppm	0.06	0.01	0.01
Lead	ppm	10	5	5
Copper	ppm	Undetermined	0.2	0.2
Nickel	ppm	0.5	0.2	0.2
Zinc	ppm	Undetermined	2	2
Arsenic	ppm	Undetermined	Undetermined	0.1
Chrome	ppm	Undetermined	Undetermined	0.1
Molybdenum (green fodder only)	ppm	Undetermined	0.2	0.2
Manganese	ppm	0.2	0.2	0.2
Iron	ppm	Undetermined	5	5
Cobalt	ppm	Undetermined	0.05	0.05

Table (3-15): Egyptian Microbiological Quality Standards for Treated Effluent reuse in Agriculture (Decree 44/2000).

Category	Re-use Conditions	Faecal coliforms (geometric mean no./100 mlc)	Intestinal nematodes (arithmetic mean no. of eggs/liters)	Exposed Group	Wastewater treatment expected to achieve required microbiological quality
A "Unrestricted"	Irrigation of crops likely to be eaten uncooked, sports fields, public parks	<1000 d	<1	Workers , consumers and public	A series of stabilization ponds designed to achieve the microbiological quality indicated, or similar treatment
B	Irrigation of cereal crops, industrial crops, fodder crops , pasture and treese	<1000	<1	Workers	Retention in stabilization ponds for 8 - 10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	Not applicable	Not applicable	None	Pretreatment as required by the irrigation technology ,but not less than primary sedimentation

3-3-4 Quality of treated Effluent:

The characteristics of the primary effluent produced from the ETP & WTP and the secondary effluent produced from the Iskan Moubarak and Hanoville secondary treatment plants in Alexandria are shown in table 3-16 compared with the permitted levels for reuse of primary and secondary treated effluent.

Table (3-16): The characteristics of effluents produced from primary and secondary treatment plants in Alexandria.

Pollutant		Characteristics of Secondary treated Effluent		Characteristics of Primary treated Effluent		Reuse Levels for secondary treatment	Reuse Levels for primary treatment
		Iskan Mobarak TP	Hannovile TP	WTP	ETP		
Generals	Temperature °C	19.50	20.00	19.83	20.00		
	pH	7.53	7.47	7.33	7.57		
	Settleable solids mm/L						
	After 10 minutes	0.00	0.00	0.37	0.67		
	After 30 minutes	0.00	0.00	1.37	2.67		
	Total Solids mg/L	541.67	892	1533	1251		
	Total suspended solids mg/L	114.33	69	521	302	40	350
	Total volatile solids mg/L	8.67	8	92	110		
	Total dissolved solids mg/L	527.00	884	1441	1135	Up to 2000	Up to 2500
	BOD mg/L	24.67	14	175	126	40	300
	COD mg/L	46.00	27	273	280	80	600
	Sulphides mg/L	0.00	0.00	0.53	1.60		
	Oil & Grease mg/L	0.00	0.00	13.00	15.00	10	undetermined
	Phosphates mg/L	4.65	4.06	6.01	6.60		
	Nitrates mg/L	0.21	0.17	0.66	0.52		
Heavy Metals	Cu mg/L	0.06	0.01	0.07	0.04	0.2	undetermined
	Ni mg/L	0.02	0.02	0.03	0.02	0.2	
	Zn mg/L	0.02	0.01	0.08	0.02	2	
	Cr mg/L	0.09	0.00	0.33	0.01		
	Cd mg/L	0.04	0.00	0.00	0.00	0.01	0.06
	Ar mg/L	0.03	0.03	0.03	0.03		
	Total Heavy Metals	0.26	0.08	0.54	0.12		
Metals	Al mg/L	0.32	0.18	0.64	0.61		
	Ar mg/L	0.01	0.01	0.01	0.16	undetermined	
	Ba mg/L	0.15	0.11	0.30	0.25		
	Co mg/L	0.01	0.01	0.00	0.01	0.05	undetermined
	Fe mg/L	0.17	0.10	0.27	0.46	5	undetermined
	Mn mg/L	0.04	0.02	0.28	0.37	0.2	0.2
	Pb mg/L	0.01	0.04	0.01	0.00	5	10
	An mg/L	0.03	0.03	0.03	0.03		
	Se mg/L	0.03	0.03	0.03	0.03		
	St mg/L	0.42	1.94	1.40	0.92		
	Vanadium mg/L	0.02	0.02	0.01	0.02		
	Total Metals	1.45	2.56	3.54	2.99		
Microbiology	Possible Total coliform cell/100 cm ³	48x 10 ³	180	58x 10 ⁸	76x 10 ⁸		
	Possible Total Fecal coliform cell/100 cm ³	32 x 10 ³	180	32 x 10 ⁸	49 x 10 ⁸		
	Total coliform cell/100 cm ³	12x 10 ³	123	34 x 10 ⁶	33 x 10 ⁶		
	Total Fecal coliform cell/100 cm ³	12 x 10 ²	6	19 x 10 ⁶	11 x 10 ⁶		
	Salmonella	- ve	-ve	+ ve	+ ve		

The figures in the table show that currently the reuse of treated wastewater in agriculture is not possible as the characteristics are far beyond the permitted levels.

The quality of treated effluent from all treatment plants are not complying with the regulations of reuse due to the increase in the number of fecal coliforms.

For the safe reuse of treated effluent it is necessary to upgrade the existing secondary treatment plants to tertiary treatment to be able to reuse this treated water in irrigating land around the treatment plants.

3-4 Intrusion of saline water into the sewer system

Saline water intrusion is the invasion of fresh surface water or groundwater by saltwater that contains more than 1000 mg/L of dissolved solids. Since groundwater systems in coastal areas are in contact with saline water, one of the major problems is the saltwater intrusion. The withdrawal of fresh ground water for water supply and other uses can cause the saline water that underlies the coastal aquifers to intrude into the fresher parts of the aquifers. Seepage of groundwater into the sewerage systems constructed under the water table level is representing a kind of groundwater withdrawals and result in saline water intrusion.

Another reason for saline water intrusion is the rise of the sea level due the climate changes and increasing temperature around the world and especially in the northern and southern poles of the earth and melting of the snow there.

Some studies indicate that the water level in the Mediterranean Sea has already started increasing with about 5 to 20 cm through the last century. It is expected in these studies that the Mediterranean Sea water level will increase by about 50 to 100 cm through the next century. According to the prediction of these studies, Alexandria will be one of the first cities on the Mediterranean area that will be affected by the increase of the sea water level and therefore will suffer of high saltwater intrusion.

Saltwater intrusion refers to the replacement of fresh water in coastal aquifers by saltwater due to the motion of a saltwater body into the freshwater aquifer (As shown in Figure 3-3). Saltwater intrusion reduces the available fresh groundwater resources in coastal aquifers. Moreover, intrusion of saline water could result in scaling of water and precipitate forms salts on surfaces in contact with water as the result of a physical or chemical change. At present, many coastal aquifers in the world, especially shallow ones, experience an intensive saltwater intrusion caused by both natural and human-induced processes.

In Alexandria, most of the main sewers and collectors of sewage are below the groundwater table and close to the coastal area which could easily infiltrate the fresh water during seepage to the sewers resulting in increasing salt water intrusion in the aquifer.

Quantitative understanding of the patterns of movement and mixing between freshwater and saltwater, as well as the factors that influence these processes, are necessary to manage the coastal groundwater resources. It is imperative to understand these processes when planning salinity management strategies. Hence, the studies on saltwater intrusion have become necessary in designing and planning of groundwater systems in coastal areas. Saline-water intrusion could be monitored by installing a number of observation wells for determining the amount of freshwater available for development in this area.

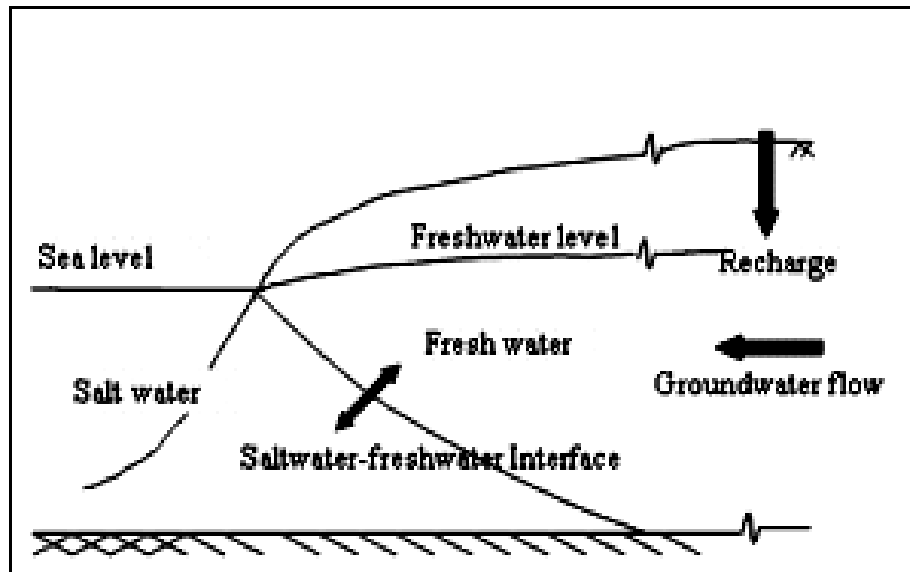


Figure (3-3): Schematic representation of the saltwater intrusion.

In nature, the freshwater/saltwater interface (as shown in the above figure) seldom remains stationary. Large scale recharge into the aquifer, as well as withdrawals from it, result in the movement of the freshwater/saltwater interface from one position to another. The movement will advance or retreat, depending on whether the freshwater flow through the aquifer is decreased or increased. The saltwater intrusion of coastal aquifers will accelerate due to the reduction of groundwater recharge and increasing of different kinds of withdraws. This could mean a reduction of fresh groundwater resources in coastal aquifers.

In Alexandria, groundwater recharge is the major source of freshwater across most aquifers; particularly it lies in arid and/or semi-arid regions. There is very little research on the potential effects of groundwater recharge on saltwater intrusion and factors affecting the saltwater intrusion. Moreover, most of the surface areas in urban and rural areas in Alexandria are developed for many buildings asphalt paved that have storm water collection and directed to the sewerage systems. These storm water collection systems reduce the entrance of the precipitation rain to the groundwater and aquifers and increase reasons for saltwater intrusion.

Chapter 4

Potential strategies to achieve a sustainable urban wastewater system

There are many strategies that could be used to predict and to achieve a sustainable urban wastewater system in Alexandria. The next subtitles will discuss what could be achieved.

4-1 Strategy 1: Conventional Collection and Treatment for Disposal.

The general degradation of the Lake Maryout system contributes to the very bad sanitary conditions in the Lake. As a consequence, the condition of the accumulation of toxic component in the food web requires definition. One of the main solutions that were evolved to improve sanitary conditions in the Lake is to bypass the ETP and WTP wastewater from the lake through El Omoum drain upstream of the main basin or discharge both ETP and WTP discharges directly to the sea. The following figure shoes the points of discharge of different industries directly into the Lake and also the points of discharge of the ETP and WTP.

(Source: Lake Maryout integrated management Study- integrated action plan 2009)

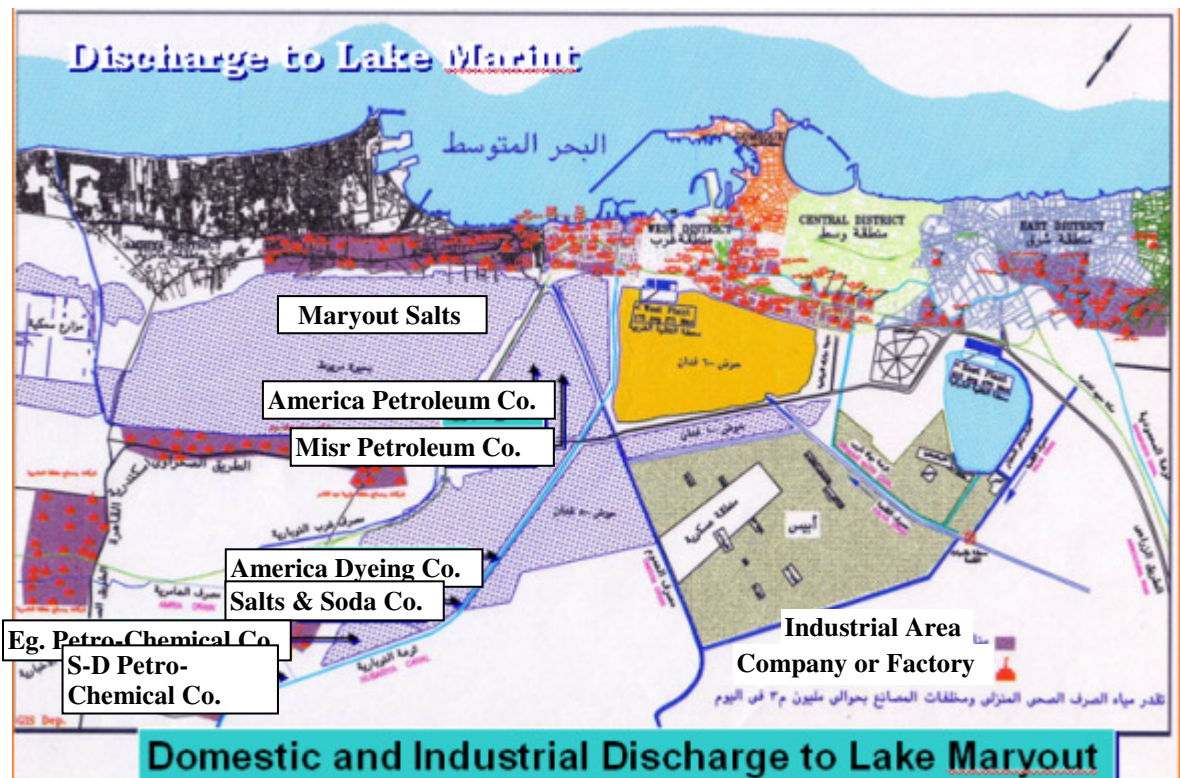


Figure (4-1): Locations of Wastewater disposal points in Lake Maryout.

Table (4-1): Existing Self Cleaning Process in Lake Maryout.

Source of Water		Discharge 1000 m ³ /day	TSS Ton/day	COD Ton/day	BOD Ton/day
Inflows	WTP	410	67	117	44
	ETP	607	55	177	59
	Omoum drain	4200	155	84	277
	200,000 m ³ untreated commercial water	200	41	82	27
	Total		319	459	408
Outflows	El-Mex Pumping station	7994	208	224	176
	Self Purification		111	235	232

The figures in table 4-1 show that the pollution load of the Omoum drain is more than that of the WTP and ETP together. The pollution load in the Omoum drain is coming from three sources 1) The wastewater coming from rural villages located along the drain in Alexandria and Behira Governorates; 2) The lateral drains connected to Omoum drain containing raw wastewater of these villages; 3) The agricultural organic compounds drainage from Alexandria and Behira Governorates. Table 4-1 also reflects the cleaning capacity of the Lake reducing around 40% to 50% of the pollutants of the main inputs.

Note: According to the Egyptian Master Plan, each village polluting the Omoum drain and its laterals will have its own treatment plant.

4-1-1 Disposal Options:

4-1-1-1 Lake Bypass- East Treatment Plant:

There are several alternative conveyance routes. All three of the potential bypass routes terminate at the Omoum drain. Two of the routes terminate at the Omoum drain upstream of the main Basin, either via the Abis drain or the Maryout drain (as shown in figure 4-2). The third route terminates at the WTP and is mixed with WTP effluent and conveyed to the Omoum drain in the immediate vicinity of El-Mex. Therefore, these alternatives will be evaluated as bypasses that enter the Omoum Drain upstream of the Main Basin and bypasses that enter the Omoum Drain downstream of the Main Basin.

These alternatives impact Lake Maryout in two general ways. The first is that the flow through Qalaa drain is significantly reduced creating a change in the hydrology of the main basin. The second is that at a point downstream of the effluent discharge into the Omoum Drain, some of the Omoum Drain flows into several portions of Lake Maryout. Downstream of the Moheet Maryout Drain, the Omoum drain leaks into the southwest basin. The amount and extent of leakage into the southwest basin is unknown (However, it has been reported to be around 200,000 – 500,000 m³/d).

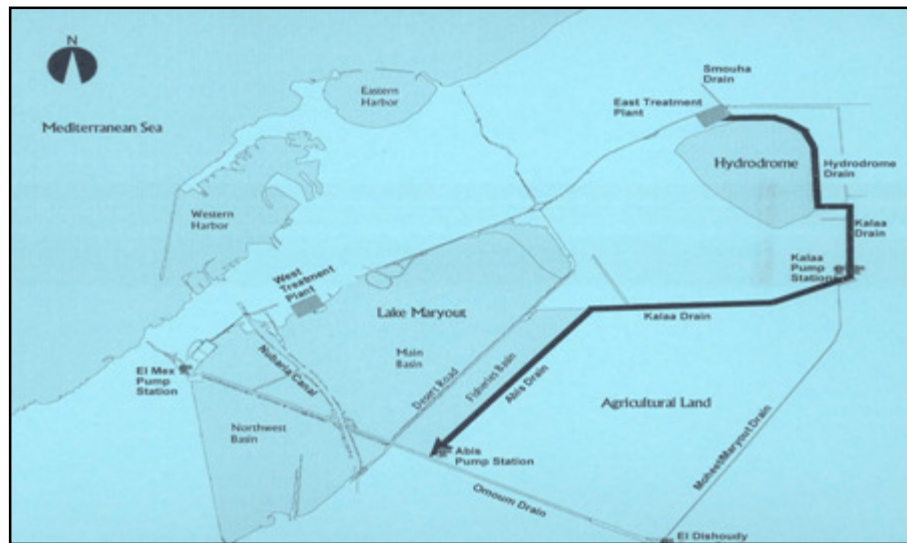


Figure (4-2): East Treatment Plant Lake Bypass

Downstream of the Abis Drain, a significant portion of the Omoum drain flows into the southwest portion of the Main Basin. This flow into the Main Basin is large but the extent the flow penetrates into the basin is unknown. The affected environment for the bypass alternatives depends on the alternative being considered and includes the following areas: Qalaa Drain, Abis Drain, Moheet Maryout Drain, Omoum Drain, the Mex Bay, the Main Basin, and the Southwest Basin.

(Source: Technical Report- Volume 1 – USAID project No. 263-0100, 1996)

4-1-1-2 Lake Bypass - West Treatment Plant:

The Lake bypass alternative envisages the WTP transporting its flows to the Omoum drain. The route of this alternative is shown in Figure 4-3.

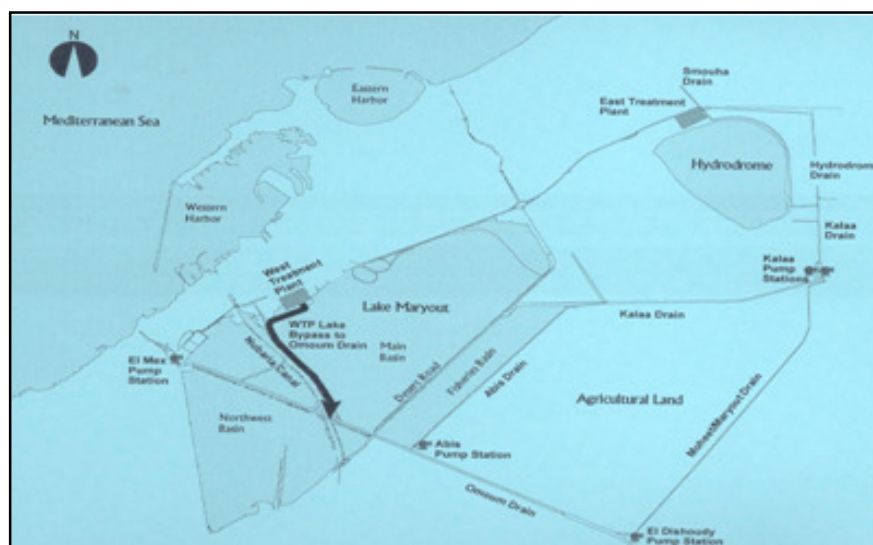


Figure (4-3): West Treatment Plant Lake Bypass

(Source: Technical Report- Volume 1 – USAID project No. 263-0100, 1996)

4-1-1-3 Sea Discharge Both ETP and ETP:

The proposal is to combine the effluent from the two treatment plants, convey it 10 km off-shore and discharge through a deep sea outfall. Three alignments were initially considered for the deep-sea outfall route. The alignment that runs of Suez canal road, near Anfoushy, was chosen as the most feasible. Site reconnaissance has indicated that along the selected alignment, between 8 to 12 km, off-shore the waters are 50 to 60 meters deep and the bottom is fairly irregular. Patches of sandy areas are interspersed with irregular rocky outcrops (as shown in the following figure).

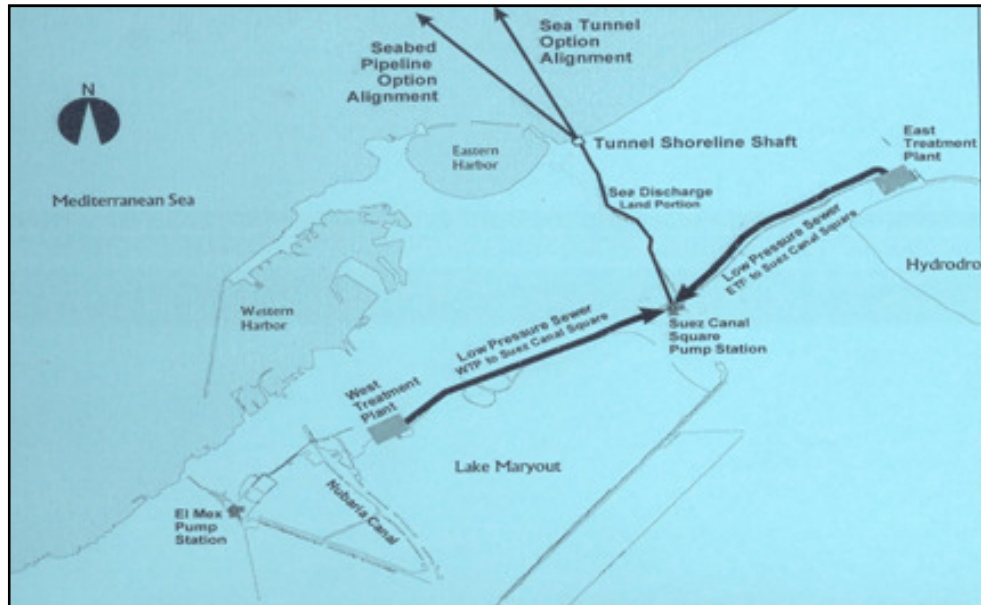


Figure (4-4): Sea Discharge Both ETP and ETP.

Significant impacts caused by the deep sea outfall will depend upon the nature of the effluent plume generated and the diffuser design. The impacts will vary with the plume direction and rate of pumping, alterations caused by physical (wind, current, etc.) and chemical parameters (salinity, temperature, etc.), seasonal variations in the behavior of the plume, frequency of the plume migrating shore wards, etc.

The deep sea area off the Qait Bey outfall was studied in 1977 under the Alexandria Wastewater facilities development program. The goal of this study was to determine the feasibility of using sea outfall for the large-scale disposal of sewage from Alexandria City. The study concluded that as sea outfall with an initial dilution of 150:1 (seawater: sewage) and a secondary or far-field dilution of 1,000:1 (seawater: sewage) would be necessary to meet established water quality standards. For the Kait Bey outfall, the study recommended a length of 8 km, terminating in a water depth of 40 m with a 450 m long multiport diffuser.

The data collected during the 1978 investigation was reanalyzed in 1983 based on year 2030 flow projections for the entire city. The reanalysis showed that projected wastewater flow for the year 2030 could be discharged through a single outfall off Qait Bey without violating proposed water quality standards which were more stringent than any existing standards for the Mediterranean sea.

Computer modeling indicated that the predominantly along-shore currents would keep the effluent plume largely off-shore and that the plume would return to shore only about 10% of the total time. Initial dilution to meet the proposed standards for most parameters at the boundary of the zone of initial dilution could be achieved as near as 6 km from Qait Bey, however the 10% of the time when the plume would reach the shoreline, coliform standards could be met only with an outfall length of at least 8 km.

(Source: Technical Report- Volume 1 – USAID project No. 263-0100, 1996)

4-1-2 Advantages and disadvantages of secondary and tertiary treatment:

4-1-2-1 Secondary treatment: Is designed to substantially degrade the biological content of the sewage. The majority of the municipal plants treat the settled sewage liquor using aerobic biological processes. However, nutrients cannot be removed by this treatment and require further tertiary treatment. Secondary discharged effluent into Lake Maryout will affect the lake's aquatic environment through increasing the rate of eutrophication. Eutrophicated water will create continuous deterioration and environmental problems and will affect the fishing activities and change the nature of different components of the lake.

4-1-2-2 Tertiary treatment: Is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "*effluent polishing*".

Tertiary and/or advanced wastewater treatment is employed when specific wastewater constituents which cannot be removed by secondary treatment must be removed. Therefore, tertiary treatment through maturation ponds which are proposed to be constructed in lake Maryout as discussed in "*the Lake Maryout Integrated Management Project*" is an effective tool to guarantee the sustainability of good aquatic environment in different basins of the lake and create a good environment for fishery industry.

As a conclusion, Secondary treated effluent could be used in irrigation of certain crops in arid areas outside Alexandria to benefit from its high nutrient content with low cost. On the other hand, tertiary treatment is more expensive but can be used for a wide range of reuse options inside Alexandria instead of sea/lake discharge. Tertiary effluent is one of the main solutions for water resource deficiency under the worst case scenario.

4-2 Strategy 2: Conventional Collection and Treatment for Centralized Agricultural Reuse:

The principle objectives of the study is to allow safe and economically responsible reuse of treated effluent from the city of Alexandria in order to make the best use of the existing resources and to protect the environment. The system proposed must be robust, reduce or eliminate risk, and simplify control.

Agriculture in the region, with the exception of limited rain-fed agriculture along the northern coast, relies upon water supplied through the Noubaria canal, which receives a fixed quantity of water from the River Nile. Irrigation water is distributed in the Noubaria area via the Nasr Canal in the south, and the Maryout/Bahig canal in the north. Both canals converge on the Hamman project to the west, although in the Nasr/Hammam canal, water does not flow its full length.

The provision of sewage treatment in Alexandria has resulted in the production of substantial quantities of effluent. In an arid country as Egypt, this material should be regarded as a valuable resource for agricultural irrigation and soil fertilization, particularly as water resources are strictly limited and there is an urgent need for continued horizontal expansion of agriculture into the desert areas as the population expands. However, effluent needs to be treated and managed appropriately to avoid potentially adverse impacts on the environment and human health. The use of effluent must also be practicable and economic, to ensure operational substantially.

The Alexandria effluent and sludge reuse study has been commissioned to establish the appropriate approaches to be adopted by ASDCO to secure efficient and beneficial disposal of effluent and sludge.

4-2-1 Quality of Alexandria Effluent in relation to potential reuse options:

Secondary treatment is now under construction in the East and West Treatment Plants. The primary effluent is currently discharged to Lake Maryout. The available data indicate that the concentrations of potentially toxic elements are well below the commonly adopted international limits to protect crop production and quality. There are also 16 new secondary treatment plants in service (as presented in chapter 1 of this document), their secondary treated effluent should to be reused on-site.

Effluent provides supplementary fertilization to crops, and calculations show that the addition of nitrogen at normal irrigation rates will not supply a surplus of nitrogen, which may otherwise be lost to groundwater. Therefore, potential impacts on groundwater would be minimal. Valuation of salinity and solidity resulting from the reuse of the effluent in the soils in the Noubaria area indicates that no problems are likely to develop, although chloride sensitive crops, such as banana and citrus, may not be advised.

Agriculture represents the largest potential outlet for the effluent. However, forestry, amenity (e.g. the proposed Alexandria green belt), industrial uses, and even aquaculture are potential alternatives. The quality requirements of these options vary according to use and the potential human and environmental exposures.

4-2-2 Expected effluent quantities in Alexandria:

The quantity of effluent is expected to reach around 2.33 million m³/day by year 2037, as shown in figure 4-5, and this requires the development of a reuse scheme.

4-2-3 Proposed effluent reuse options in Alexandria:

All the proposed scenarios have the benefit of recycling effluent in an overall environmentally friendly way, providing water in a water scarce situation, providing a considerable quantity of plant nutrients at no cost to the farmer, thus increasing crop production, farm incomes and improving the local community. The schemes also support the stated policy of Government to recycle treated sewage effluent to the maximum extent possible.

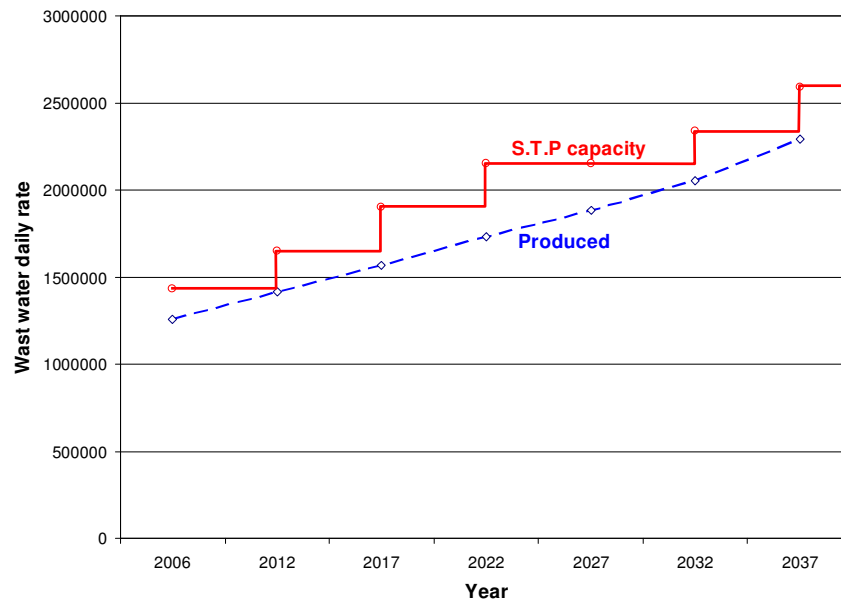


Figure (4-5): Expected Effluent quantities in Alexandria (Master plan 2037).

4-2-3-1 Agricultural land proposed by ASDCO in West Noubaria region: *(Rejected by WRc)*

The site, or sites, recommended for consideration for reuse of a suitable treated effluent have been selected on the basis that the effluent is polished to an appropriate standard acceptable for irrigation. The west Noubaria area is critically short of sufficient water to meet the present demands for crop production and any planned extensions to the existing cultivated lands will exacerbate an already serious water-short situation.

In considering the possibility of reuse of the effluent that will be generated from Alexandria, ASDCO suggested a poorly defined area of uncultivated desert land, comprising about 28,000 hectare (70,000 feddan) gross, situated to the south of the Nasr Canal, as the preferred reuse area as shown in the following figure. Most of the suitable land along the Nasr Canal has already been distributed and cultivated and the land provisionally selected on the irrigated margin is of poor quality.

The land designed for consideration lies outside the land reclamation programme currently contemplated by GARPAD. The altitude varies from around 40 m near the irrigated margin to over 100 m on the ridge trending approximately east to west, implying considerable pumping costs. Soil maps indicate a predominance of stony or gravelly soils, mostly shallow to a hard calcareous crust overlying poorly drained grey clay with an extremely restricted potential for irrigation. The land is classified as Class 6- unsuitable for cultivation.

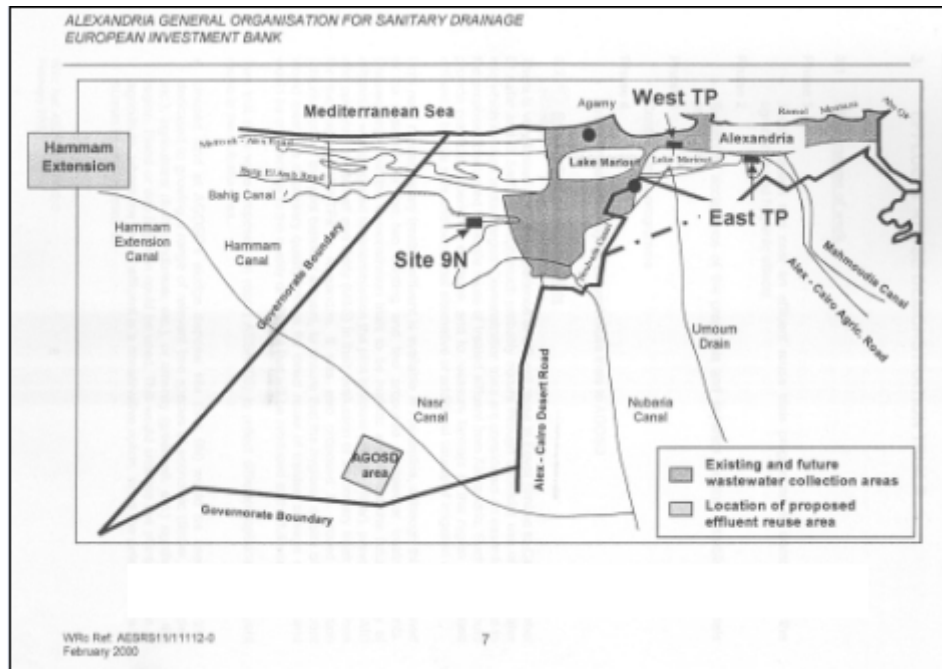


Figure (4-6): Map of Alexandria with locations of the WWTPs and the proposed effluent reuse area.

Any development in this area would entail significant land preparation costs, such as deep ripping and removal of fragments of crust, installation of crust, installation of drip irrigation and extremely careful irrigation scheduling to minimize the loss of water. The clay layer is only slowly permeable and a perched water table would quickly develop, requiring the installation of subsurface drainage. The area is not suitable for the smallholder farmer or the traditional range of crops; the only possibility is some form of plantation agriculture, or trees. Subject to a clearer definition of this area and more detailed soils information, **development in this area is not recommended**. The WRC study rejected the ASDCO's option due to the high cost of transfer and the unsuitability of the land for agricultural development.

4-2-3-2 The Omoum Drain Reversal Scheme -Scenario for effluent reuse recommended by the WRC study: *(rejected by The Ministry of Water Resources and Irrigation)*

The study recommended discharging the treated effluent into the Omoum Reversal Scheme, which had the lowest cost and would contribute to solving the critical water shortage developing in the region as a whole, while respecting current legislation. However, this option was eventually rejected by the Ministry of Water Resources and Irrigation due to concerns over the protection of the potable water off-takes down-stream of where the Omoum drainage and effluent would be discharged.

The reversal scheme was devised to provide additional water (comprising surface run-off, treated effluent and drain water) with some dilution with Noubaria Canal water, About 1.1 billion m³ could be abstracted from the Omoum drain. The successful reclamation of all the planned areas (up to 2015) would require about 1.6 billion m³ shortfall of 0.5 billion. This shortfall could be met from the expected production of treated sewage effluent from Alexandria, hence the recommendation of this option by the study.

The Ministry of Water Resources and Irrigation and the Steering Committee members **rejected the Study's recommendation** due to the potable water off-takes downstream of

where the Omoum Reversal Scheme would discharge into the Noubaria canal. Despite the fact that the potable water extracted receives treatment, mixing treated effluent with raw potable water is currently considered unacceptable in Egypt.

4-2-3-3 The Hammam Extension reclamation area - Scenario proposed by the Ministry of Water Resources and Irrigation:

The Ministry of Water Resources and Irrigation recommended transferring the effluent to the Hammam extension reclamation area for dedicated irrigation. This area as shown in the following map lies to the west of Alexandria and is outside Alexandria Governorate. The Steering Committee and EIB have **accepted this recommendation** for further evaluation.

This site comprises about 60,000 feddans of potentially irrigable land commanded by the newly constructed Hammam Extension canal (length 57 km), but shortage of canal (Nile) water limits any irrigation development in this area. This land is located between the canal and the Alexandria/Al-Alamein railway. The area is a semi-desert, with sandy soils and very little cultivation that depends upon winter rainfall. Semi-nomadic Bedu graze flocks of sheep and goats on the sparse vegetation. The effluent water chemistry is generally acceptable for irrigation of the restricted range of crops selected according to the climatic and soil conditions the area and the requirements of Decree 44/2000.

Additional land may become available in the future when the World war two minefields are cleared south of the Hammam Extension Canal.

The immediate constraint to development in this area is the complete lack of water, both at the present and in the future. The water shortage in this region has been exacerbated by the recent intensive urban developments, principally for tourism, along the coastal strip between Alexandria and El-Alamein. There will be a great demand both for potable water and for the extensive landscaping in progress.



Figure (4-7): Location of Hammam Extension land reclamation area.

Effluent Conveyance System:

Plans exist for the construction of a pumping station at Km 49.5 on the Hamman Canal, designed to abstract 300,000 m³/d of water for domestic use. The Ministry of Water Resources and Irrigation consequently has determined that there will be sufficient water in the Nasr-Bahig Canal systems to serve the Hammam Extension canal which has already been constructed.

It is proposed that a dedicated effluent conveyance system will start at Abis Pump station where it will receive effluent from the West and East Treatment Plants by the lake bypass scheme proposed by Metcalf & Eddy consultant. An open canal will transfer the effluent along the south side of Lake Maryout to a point immediately west of the Noubaria Drain where this turns north to cross the lake (this is termed ASDCO disposal point).

The conveyance system (as shown in the following figures 4-8, 4-9) will comprise: a new pumping station at Abis at the ASDCO disposal point; a 16 km canal from Abis to the disposal point with feeder canals from the two planned WWTPs at Amriya and El Agamy, a 65 km long lined canal to El Royasat, a relift pumping station, a 5 km transfer pipe line, a 32 km lined canal running parallel with the Hammam Canal and a discharge control point at km 50 of the Hammam Canal. The Effluent will then be conveyed through the project area using the existing Hammam Extension Canal (57 km).

The first section would be under the responsibility of ASDCO. Treated Effluent from the East and West treatment Plants would be received at Abis Pumping station by the Lake bypass scheme, as proposed by M&E. Abis PS would require upgrading and a new canal (about 16 km long) to be constructed with siphons to cross the Noubaria Canal, Desert Road and the Noubaria drain.

The ASDCO effluent disposal point is immediately west of where the Noubaria drain turns north to cross Lake Maryout. Effluent from the planned WWTPs would be transferred to the canal; for the Agamy WWTP this is very close to the ASDCO disposal point, but for Amriya WWTP, alternative options can be considered (i.e discharge to the Noubaria Canal and lifting into the effluent canal, or consider the effluent as compensatory flow for navigation thus allowing more water to be extracted further upstream of the Noubaria Canal).

The second section would be under the responsibility of the Ministry of Irrigation. A new pumping station would be required at the ASDCO disposal point discharging into a 65 km length concrete lined canal to El Royasal, where a lift station would pump by pipeline 34 m lift to discharge into a new canal that would run parallel to the existing Hammam canal for 31.5 km, to discharge into the beginning of the Hammam extension canal. Three siphons would be required for this section as well as a number of bridge crossings.

4-2-4 Other Reuse options studied by WRc:

The other studied options proposed to contribute the effluent to the general irrigation water supply of the Noubaria region by direct or indirect discharge to the canal system.



Figure (4-8): Proposed route of the effluent conveyance system and connections from the WWTPs in Alexandria.

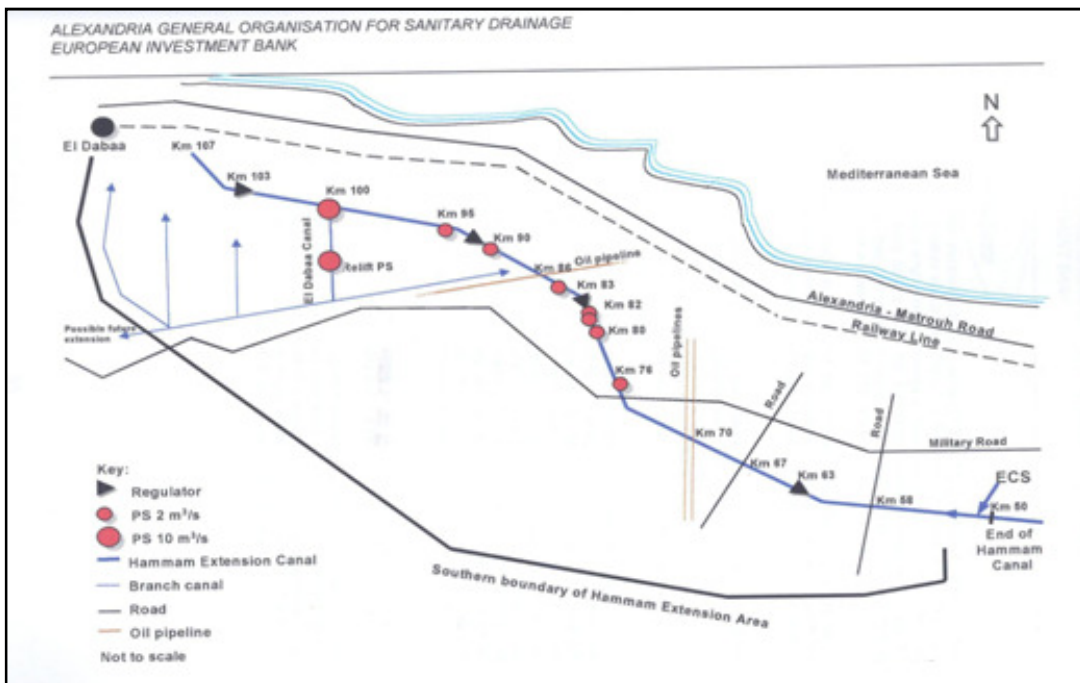


Figure (4-9): Schematic diagram of the existing Hamam extension canal and the proposed pumping stations

4-2-4-1 Supplement the water supply in the Nasr canal by direct transfer of effluent from Alexandria:

Involve the blending of effluent with canal or drain water, thus reducing the concentrations of potentially constituents in the irrigation water at very low levels.

Advantages:

Dilution of effluent with canal water. Discretionary Ministry of Water Resources and Irrigation (MPWWR) allocation of enhanced water supply to downstream irrigation projects.

Constraints:

Pump lift of 50 meters and a conveyance distance of 50 kilometers. Land required for sedimentation tanks. Infrastructure required for blending of canal and effluent water. Capacity of canals. Increased salt burden to scheme. Variability of canal water quality according to quantity of diversion of water from the Noubaria Canal. Effluent disposal during canal closure. Public health campaign. Possible exclusion of certain crops for cultivation. Regular monitoring of health of scheme population and produce. Agreement to discharge to the Nasr Canal. Expensive construction costs and high annual running costs.

The scenario **was rejected** on the basis that these contravened Law 48/1982, which does not permit the discharge of effluent to a canal.

4-2-4-2 Supplement the water supply in the Nasr Canal by transfer of effluent through the Omoum Drain.

Involve the blending of effluent with canal or drain water, thus reducing the concentrations of potentially constituents in the irrigation water at very low levels.

Advantages:

Supplement water supply within the proposed Omoum Drain Reversal scheme. Discretionary (MPWWR) allocation of water for irrigation from the Noubaria Canal (to Nasr or Bahig systems).

Constraints:

Pump lift of 10 meters and a conveyance distance of 20 kilometers. Land required for sedimentation tanks prior to discharge into Umoum drain. Quality of drain water after mixing. Variability of water quality throughout the year. Drain and canal capacity. Effluent disposal during canal closure. Agreement to discharge to drain. Public health campaign. Possible exclusion of certain crops. Possible monitoring of population health and crop produce depending upon total dilution of effluent and resultant pathogen levels. Moderate construction and annual running costs.

This Scenario was recommended by the WRc study based on the lowest overall cost for both infrastructure and annual operational costs, compliance with Egyptian Law 48/1982 especially that all treatment plants are about to be secondary and will produce high quality effluent, and provision of a substantial quantity of water to the Ministry of Water Resources and Irrigation for distribution (as supplements to the Omoum Drain may decline) according to their priorities, throughout the irrigated lands of north-western Egypt. It contributes to overall water balance in the region with increasing water shortage

4-2-4-3 Supplement the water supply in Bahig Canal:

Involve the blending of effluent with canal or drain water, thus reducing the concentrations of potentially constituents in the irrigation water at very low levels.

Advantages:

Effluent quality would improve following mixing with canal water. Increase in overall water quantity available for irrigation.

Constraints:

Pump lift of 30 meters and a conveyance distance of 20 kilometers. Land required for sedimentation tanks prior to discharge to the bahig canal. Quality of the canal water after mixing. Variability of water quality throughout the year. Canal capacity. Disposal of effluent during canal closure. Possible exclusion of certain crops. Possible monitoring of population health and crop procedure depending upon degree of dilution of effluent achieved. Agreement to discharge to Bahig canal. Moderate construction and annual running costs.

Is the technically the most feasible and had the lowest cost since the point of discharge for the effluent to the Bahig Canal would be the closest to sources of effluent.

Rejected on the basis that, these contravened Law 48/1982, which does not permit the discharge of effluent to a canal.

4-2-5 Feasibility of Effluent Reuse in Alexandria Region (Hammam Extension):

A route has been proposed and costs estimates prepared for a dedicated Effluent Conveyance System (ECS) to transfer the future treated sewage effluent from the East, West, and Agamy WWTP to effluent discharge points into the ECS located at the Omoum Drain and the West Noubaria Drain. The previously proposed Lake Bypass Scheme for the east Treatment Plant would be modified to avoid mixing the effluent with agricultural drain water (Qalaa Drain), which would comprise effluent quality for irrigation. Effluent from the WTP would be transferred to the Omoum Drain by the planned Lake Bypass Scheme. Costs associated with the Lake Bypass Scheme have been excluded from the costs of the effluent reuse scheme as these would be incurred regardless of the reuse scheme proceeding.

Effluent from the Amriya WWTP has been excluded from the scheme since it is considered more cost-effective to discharge the effluent to the Noubaria Navigation canal to assist with maintaining navigation, thus potentially releasing an equivalent volume of clean water further upstream for use through the Nasr/Hammam and Maryout/Bahig canal systems.

The initial section of the ECS would be an open canal running along the southern shore of lake Maryout from the Omoum Drain to the West Noubaria Drain, with pipe bridges and culverts to cross the various infrastructure crossing the lake. The main section of ECS would run on level ground from the West Noubaria Drain to Hammam, and then cross a low-lying ridge to discharge into the start of the existing Hamman Extension canal.

The conveyance system as planned would comprise: new pumping stations at the Omoum Drain and the West Noubaria Drain, with bypasses to these drains when irrigation demand is low or during maintenance of the ECS; a 44.5 km long lines canal to Hammam; a relift pumping station with 3.4 km pipeline to deliver the effluent to a 38.5 km lined canal running parallel with the Hamman canal; a further relift pumping station and 1.3 km pipeline discharging after a control structure at km 50 of the Hammam Canal, which is the start of the Hamman Extension canal.

The effluent would then be distributed through the project area using the Hammam Extension Canal, which at present commands about 30,000 feddans from seven planned offtakes. An additional planned canal (El Dabaa canal) would have to be constructed to irrigate a further 30,000 feddans, involving a further relift pump station, and increasing the net irrigable area to 60,000 feddans. This area is the optimum calculated to utilize the maximum volume of sewage effluent generated by the various wastewater treatment plants to meet peak summer irrigation demand.

4-2-5-1 Costs and Benefits:

The total capital costs of the scheme (based on year 2001 calculations when the WRc study was finalized) were estimated at US\$ 394 million, with annual operating and maintenance costs of US\$ 40 million. These are summarized in the Following table 4-2.

Table (4-2): Estimated costs for construction, operation and maintenance of conveying systems.

Item	Amount (US\$ million)
Capital costs	
Conveyance system (canals, pumping stations, structures, etc.)	210.8
Distribution systems within the Hammam Extension area	126.2
Detail design and construction supervision (assumes done locally)	5.3
Contingencies	51.3
Total	393.6
Operating and maintenance costs	
Pumping stations	4.5
Secondary and tertiary service units and trickle irrigation	35.7
Total	40.2

Development of the Hammam Extension Area was evaluated according to the direction of the Ministry of Water Resources and Irrigation for settlement by a mix of smallholder, medium size and large-scale farming enterprises. The crop mix envisaged varies according to the financial circumstances of the settler. Smallholder farmers would of necessity, grow grain and fodder with some fruit trees using a mix of flood and drip irrigation. Commercial tree species, suitable for industrial reuse, feature largely in the cropping system for the larger-scale farms and would utilize mainly drip irrigation systems.

Overall, the project would have an EIRR (Economic Internal rate of Return) of 7.6%. Despite the relatively high capital cost of the project and the high operating and maintenance costs necessitated by the need to lift pump the treated effluent water several times during its conveyance to the project area and the predominant use of expensive trickle irrigation systems, the economic performance is reasonable. The major contribution to the benefits is obtained from the industrial tree crops to produce high quality tropical hardwood and/or fuel or pulp. They make up over half of the predicted irrigated command area and produce over 70% of the benefits. **Without forestry, the scheme would be uneconomic.**

The returns from perennial fruit production, as envisaged in the model (grapes, figs, olives and pomegranate), while producing reasonable returns, do not produce sufficient to justify the project. Therefore, their inclusion in the land use of the scheme can only be regarded as secondary to the industrial tree crops to provide some income diversification and to smooth the cash flow for an investor through their annual income.

4-2-5-2 Environmental Assessment:

The proposed scheme was subjected to an initial environmental assessment. The scheme would have considerable social and socio-economic benefits by the resettlement of landless people from the overcrowded Delta lands and the urban fringes. More than 2000 farmers and their families would benefit from increased incomes, employment and enhanced land values.

The production of forage would have a positive impact upon the Bedouin livestock, resulting in a considerable expansion of the sheep population, many destined for export. The production of grains and wood would go some way to reduce imports of these commodities. Overall employment opportunities and incomes of settlers and nomads would improve. The removal of World War II land mines from the area would be necessary for land development and this would be a considerable benefit. Negative environmental impacts are generally minor and can be overcome by a variety of mitigatory measures. Two issues do require further attention- the future hydrological conditions within the project area and certain public health considerations.

The groundwater under the project area would be affected by percolation of excess irrigation water that would be somewhat saline. The underlying groundwater is also saline and not suitable for domestic or agricultural use. Therefore, the contamination of the underlying aquifers is not likely to be a problem. The problem that may arise is the unknown relationship between the underlying saline aquifer and the fresh water aquifer on the coast. A groundwater mound would establish following irrigation development and the resulting direction of flow, and interaction with this coastal aquifer, is not known.

Potential public health concerns arise from the presence of parasite eggs or ova in the effluent. Many parasites would be removed by the various treatment stages planned to produce a secondary and chlorinated effluent. Further settlement along the ECS and filtration before drip irrigation would additionally reduce levels to an acceptable degree.

Nevertheless, some exposure to parasites would be inevitable by canal maintenance workers and farmers using flood irrigation techniques. Whatever, an intensive public health campaign would be necessary.

4-2-5-3 Proposed cultivation:

The ideal crop choice would be trees for industrial use. A mono-culture system of this type is not suited to smallholder farmers but is ideally suited to a large scale private enterprise. The industrial tree crop approach has many advantages and would maximize water demand

throughout the year, instead of the fluctuating seasonal agricultural crop water demand inherent in the winter/summer crop rotation. Also the occasional downturn in effluent quality would have virtually no adverse impact on the plantation operations or the quality of produce.

Reference: WRc Alexandria Effluent and Sludge Reuse Study funded by EIB.

4-2-6 Irrigation Water Demand in Noubaria area:

Calculation of irrigation water demand (based on conservative water duty of 5,600 m³/fd) and availability indicates that the reclaimed land in the Noubaria area is short of water, to the extent of 200 million m³/y over the cropped area of 144,000 fd. This situation is expected to worsen as more land is brought under cultivation. The General Authority for Rehabilitation projects and Agriculture Development (GARPAD) intends to reclaim additional land along the Nasr and Bahig canals, of which 287,000 fd are within the Governorate and would require a minimum of 1.6 billion m³/y. Present total demand from all water sectors in the region is about 2 billion m³/y, and this will increase to 3.6 billion m³/y by 2015, assuming that all land scheduled for reclamation is provided with the required infrastructure.

To compensate at least in part for this, the Omoum Drain project was developed. This will result in the reversal of the drain flow at a point near the Truga pump station, and through a series of lift stations, the drain water will be transferred to the Noubaria Canal, south (upstream) of the off-take of the Nasr Canal. Two scenarios were developed initially the reclamation of 165,000 fd, implying a total demand of 924 million m³/y, half of which would be derived from the Omoum Drain, based on a drain/canal mixing ratio of 1:1. The second scenario considered the reclamation of 350,000 fd and supply of 1.1 billion m³/y from the drain. However, drainage water in the Omoum drain is predicted to decline as irrigation improvement programs are implemented.

The overall future shortfall in water supply by 2015 is estimated to be 1.6 billion m³/y, of which 1.1 billion m³/y could be derived from the Omoum. The balance required matches the expected production of treated effluent from Alexandria of 550 million m³/y.

4-2-7 Suggested Options for Effluent Reuse in case of tertiary treatment or highly disinfected secondary treated effluent for further study:

These options are based mainly on reuse within the boundaries of Alexandria agricultural zones. Through the following:

- 1- Mixing treated effluent from localized wastewater treatment plants with the adjacent receiving drain water. According to figure 4-10.
- 2- Using the mixture of effluent and drain water as an irrigation source, and include it in the plan of the Ministry of Irrigation to irrigate these areas.
- 3- Saved amounts of usual irrigation water as a result of reusing the mixture, can be used in other ways.

One of the advantages of this option is its applicability under current economic conditions. In addition to low conveyance costs. As an alternative in case of the worse case scenario.

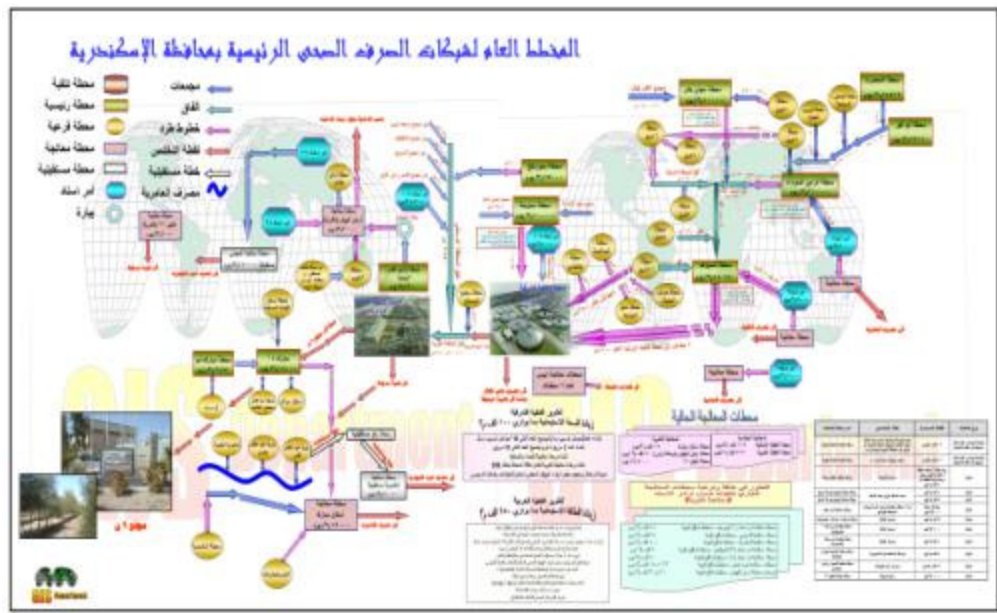


Figure (4-10): Schematic diagram of the sewerage system in Alexandria.

4-3 Strategy 3: Mix of on-site sanitation and sewerage

There are many wastewater treatment and disposal facilities. The type of selected system depends on the site characteristics encountered such as: soil profile, characteristics and permeability, soil depth over water table, and size of the available area. Generally, there are two different types for treatment and disposal.

4-3-1 On-site treatment and disposal:

Onsite wastewater management means all the treatment and disposal methods done within the same region without using complicated collection or treatment works. This will help in solving the wastewater problem onsite by lowering the cost of construction and O&M costs and decrease energy consumption with sludge of more suitable for soil conditioning. Therefore, it is believed that onsite sanitation is more suitable for small communities (Mattila et al. 2002).

Onsite sanitation systems present a sound method of household waste management in communities where the development density is low, land is available for system construction, and where soil and groundwater conditions permit system use. The onsite systems include sealed septic tank and percolating cesspools well (as shown in figure 4-11).

Septic tanks are usually designed to serve as a combined settling and skimming tank and as an unheated-unmixed anaerobic digester. Sludge of residential septic tanks is usually evacuated every 2 to 5 years without necessity of washing or leaving “seed” in the tank. Cesspools or Percolating Well is the place where the liquid effluent from the septic tank is distributed over such an area that will be all taken up by the soil. The most suitable soil characteristic is the deep medium permeable soil within the area with sandy or loamy textures and low groundwater table (US. EPA, 1992). Gravel and clay soil are not recommended for installing cesspools.

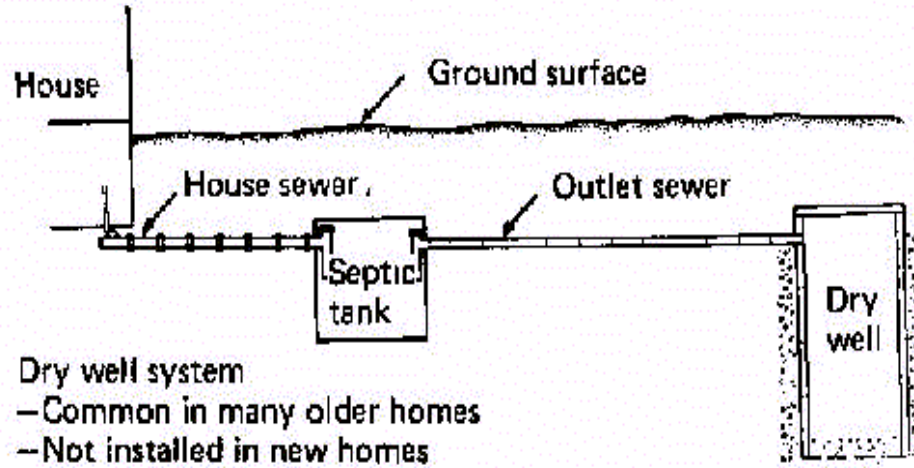


Figure (4-11): Onsite sanitation through cesspool system

4-3-2 Off-site treatment and disposal:

Should the circumstances not allow the use of onsite systems, especially for highly density populated rural areas in Alexandria; wastewater must be transported and managed for off-site system. There are many different sewage treatment technologies. Each one has its advantages and disadvantages in terms of: construction cost, operational costs, energy consumption, operational complexity, effluent quality (organic matter, pathogens, etc.), reliability, land requirements, and environmental impact.

There are different systems for the off-site treatment two main categories for the off-site treatment; conventional intensive energy and natural biological extensive systems. Table 4-3 shows the comparative performance, requirements and construction costs of the mentioned sewage treatment systems.

Table (4-3): Comparative performance, requirements and construction costs of off-site sewage treatment systems.

Treatment systems	Removal Efficiency %		Requirements		Construction Cost
	BOD	Pathogens	Land m ² /cap.	Power Watt/cap.	
Activated sludge or Trickling filter	85-95	60-90	0.2-0.4	1.0-2.75	High
Aerated Lagoon	80-90	70-95	0.5-0.75	0.2-0.6	Medium
Stabilization pond	75-90	99-99.9	1.5-3.5	0	Low
Constructed wetlands	85-95	More than 99	1-6	0	Low
High rate anaerobic reactor	90	60-90	0.1-0.2	Very low	Low

Full coverage of a large governorate, like Alexandria, with sewerage may be unaffordable. This strategy is therefore based on a mix of on-site sanitation and sewerage systems for covering whole Alexandria with sanitation systems. In some cases and areas in Alexandria, traditional wastewater management and treatment strategies have been shown to be inappropriate for the physical and economic characteristics especially for the rural areas communities. Even in developed communities the current large scale systems for collecting wastewater and treating it are not environmentally sustainable, because it is difficult to close the cycle of water and nutrients (G. Ho 2004). Therefore, it is preferable for this strategy to use the sewerage sanitation systems for the urban and semi-urban (high density populated rural areas).

Meanwhile, small communities and rural areas in Alexandria face a variety of problems that make the construction and operation of community-wide managed wastewater facilities a difficult undertaking. The principal problems are related to high per capita costs, high O&M costs, limited finances, and limited O&M budgets. The low population density means that longer sewers are needed to serve each household. The household cost of building sewerage systems in a community of 5,000 is twice the cost in a city of 100,000 (Bakir 2000).

Onsite sanitation of small size Alexandria rural areas should be developed within the following principles: 1) solutions should be tailored to the social, cultural, and economic circumstances, 2) wastewater should be managed within the integrated water resources management processes (as show in figure 4-12), and 3) wastewater should be managed as close as possible to its source and to where its beneficial reuse is located.

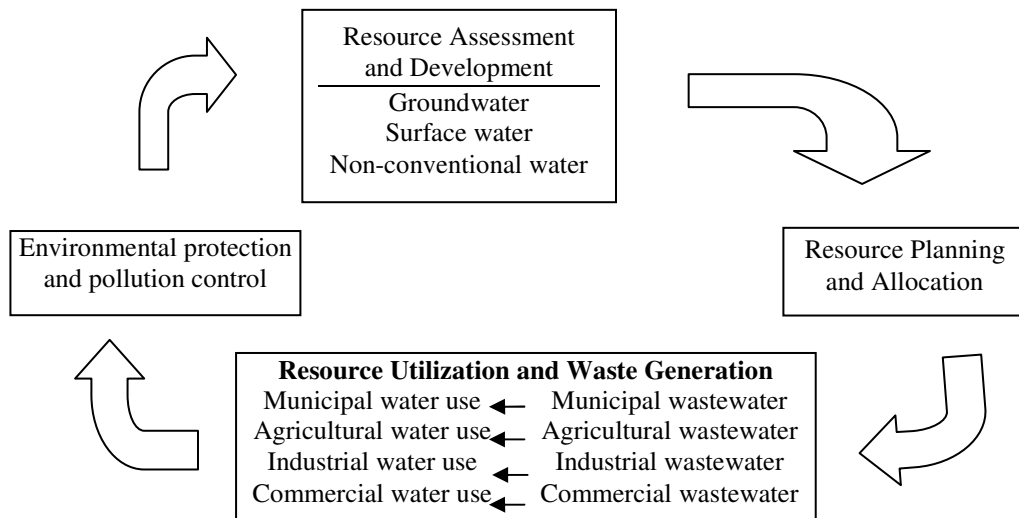


Figure (4-12): Schematic representation of Water Management.

4-3-3 Scenarios for Rural areas in Alexandria:

Many scenarios can be adapted to the concerned Alexandria rural areas according to the topography, soil texture, ground water table, land availability, population.

4-3-3-1 Areas located in sandy soil land:

The first scenario concerns the areas located in sandy soil land in the desert nature area (as Amriya and Agamy rural areas) where percolation and flow rates are considerable and

groundwater table is low. The typical sanitation system in such villages could be adopted to onsite sanitation containing septic tanks (each serves a group of houses) followed by deep cesspools to allow the primary treated wastewater to percolate into the soil. The proposed cesspool must be located more than 50 m from any well, surface water, or storm drains, 5 m from any property line, and 1.5 m between its bottom and the groundwater table.

4-3-3-2 Small areas in the agricultural land:

The second scenario concerns about the small villages in agricultural land and suffering from high levels of contaminated groundwater table. Septic tanks, serving a number of households, could be constructed in streets or public spaces, and then small pore sewer could be used to collect settled sewage for further treatment in an aerated lagoon. Otherwise, a conventional sewerage system is suggested to transport for treating in an UASB system. These systems relatively need small area, which has high economic values for agriculture, and low O&M costs and skills. This system could be optimum for Abis and El-Seiouf rural areas.

4-3-3-3 High density populated rural areas in Alexandria:

Third scenario concerns about the high density populated rural areas in Alexandria which can be considered as a small city where they have the same characteristics of the city, i.e. high population, high density, public services, etc. Conventional sewers are recommended to these areas for wide roads with assistant of small pore sewers for narrow roads. Sewage treatment for these areas could be divided to two systems; conventional intensive energy system (activated sludge or high trickling filters) for limited land area and nature extensive systems (oxidation ponds or constructed wetland) for available land area.

4-4 Strategy 4: Direct Urban non-potable reuse

The reuse of wastewater has become an attractive option for increasing water reserves and for sanitation sustainability. In addition to the value of the reclaimed water itself, the nutrients contributed to the soil and to the crops by use of such water cannot be overlooked, particularly with increasing costs of chemical fertilizers. Moreover, sludge could be used in a large scale in land reclamation and fertilization.

Other ways of using treated sewage can be suggested for fish farms. The treated sewage effluent could be disposed into ponds to feed fishes. However, in planning wastewater reuse, high priority must be given to the public health considerations. The required water quality for irrigation needs should be according to law 44, year 2000. For the maximum concentrations of trace elements in irrigation water, FAO (1986) Guideline is recommended.

As is the case with most water management practices, there are significant trade-offs associated with irrigation using urban sewage. From a river-basin perspective, wastewater irrigation is an important form of water and nutrient reuse; however, there are important water quality, environmental, and public health considerations

The most significant wastewater reuse takes place in arid and semi-arid regions where other sources of water are less available. Along with reuse of a valuable water resource, the appropriate use of the nutrients found in wastewater has been a primary objective of most wastewater reuse systems. Nutrient cycling has been the predominant objective of wastewater irrigation for centuries.

In China, wastewater reuse in agriculture is a traditional practice. However, as wastewater treatment capacity is increased, greater quantities of sludge are being generated with a new set of land application challenges (Wang 1997). Sewage used for irrigation in India over a 15-year period was reported to have improved the soil structure. At a separate site, wastewater irrigation over 15 years increased soil nutrients and organic carbon content without increasing heavy metals to toxic levels (Gupta, Norwal, and Antil 1998). Even in cases where wastewater is treated at the primary level (e.g., stabilization ponds) for subsequent discharge into the environment, the nutrients may be beneficially used. Several researchers have described the aqua cultural benefits of wastewater ponds.

4-4-1 Public Health Risks:

The public health risks associated with wastewater reuse include increased exposure to infectious diseases, trace organic compounds (Cooper 1991), and heavy metals. Wastewater contains the full spectrum of enteric pathogens endemic within a community. Many of these can survive for weeks when discharged on the land. Notwithstanding the presence of infective organisms, however, epidemiological studies have shown that the presence of pathogens does not necessarily increase human diseases. The establishment of the World Health Organization (WHO) guidelines on wastewater use in 1989 effectively ended the international debate (with some strident objections) on how stringent bacteriological standards need to be, to safeguard public health.

The potential for adverse health impacts of irrigation with wastewater has been reported in a number of articles, but usually there is no obvious indication of adverse health impacts in many areas of study. The successive reuse of the wastewater in particular basin suggests that the adverse effects may be smaller than in situations without reuse. The passage through field vegetation and/or the filtration that accompanies irrigation and subsequent runoff and drainage would be expected to reduce the level of parasites and other microorganisms, in addition to the observed changes in chemical concentrations.

In the planning and implementation of wastewater reclamation and reuse, the reuse application will usually govern the wastewater treatment needed and the degree of reliability required for the treatment processes and operations. Because wastewater reclamation entails the provision of a continuous supply of water with consistent water quality, the reliability of the existing or proposed treatment processes and operations must be evaluated in the planning stage.

The principal reuse categories considered are:

- (1) Agricultural and landscape irrigation,
- (2) Industrial applications,
- (3) Groundwater recharge,
- (4) Potable reuse.

Although the quantities of water involved in potable reuse and ground recharge are small, some of the technological advancements will be discussed in the next strategy.

4-4-2 Reuse options for Effluent form Alexandria WWTPs in Irrigation:

In Alexandria, effluent from wastewater treatment systems could be reused for urban landscaping, irrigation of many areas in each district. The direct reuse of treated wastewater into irrigation is preferable in the following cases:

- Irrigation of green areas in resorts and golf playgrounds and similar conditions.
- Green areas inside residence cordons in new cities.
- Irrigation of green belts all around the cities.
- Plantation of highways.
- Irrigation of desert lands to be reserved for agricultural investment and specially irrigated with treated wastewater.

4-4-2-1 Effluent form ETP :

The wastewater treated effluent from the existing East Wastewater treatment Plant-ETP (after implementation of the under-executing extension projects and adding secondary treatment units) will have a huge quantity of about 830,000 m³/day of water suitable for reuse in irrigation of green areas in the near districts and plantation of the highways entrance to Alexandria. The treated effluent from the ETP could be reused in irrigation of green and landscaping areas in many locations near to the plant such as: Smouha club, Sporting club, Lagoon, Acasia and Jardinia. Moreover, the effluent of this plant could be reused in plantation of the near highways such as: the end part of the Cairo/Alexandria agricultural Road, the northern part of Cairo/Alexandria desert road after Carrefour to the beach.

In addition, the eastern part of the coastal and the ring roads around Alexandria could be planted and irrigated by the reuse of the effluent of the ETP. There is need to have network pipelines to transfer the effluent to the location of reuse. The water in these network pipelines could be used for toilet flushing especially in the public buildings. It is preferable for the reused treated wastewater to be filtrated in filter beds in the treatment plants to insure quality of water for reuse.

4-4-2-2 Effluent form WTP :

The wastewater treated effluent from the existing West Wastewater Treatment Plant-WTP (after implementation of the under-executing extension projects and adding secondary treatment units) will have a big quantity of about 680,000 m³/day of water suitable for reuse in irrigation of green areas in El-Dekhila and Agamy districts which are near to the WWTP.

The treated effluent from the Western Plant could be reused in irrigation of green and landscaping areas in many locations near to the plant such as: the West Noubaria Housing area. Moreover, the effluent of this plant could be reused in plantation of the near highways such as: the western part of the coastal and the ring roads around Alexandria. The effluent of the WTP could be also reused for toilet flushing especially in the public buildings in the ways of its distribution after suitable filtration. Part of the effluent of the Western plant could be also pumped to the nearest desert area in Amriya and/or Borg El-Arab to irrigate green belts all around them and irrigate the reserved areas for agricultural investment and specially irrigated with treated wastewater.

4-4-2-3 Effluents form small WWTPs :

For El-Agamy Wastewater treatment plant and the new proposed plants near the western coastal beaches, the effluents could be reused in irrigation of green areas in resorts and golf

play grounds and similar conditions.

Both of Borg Al-Arab and Amriya WWTPs lie in a desert location and near to the West Egyptian Desert and therefore, the effluent of the existing and the new proposed wastewater treatment plants in this zone could be reused for many purposes such as: irrigation of green belts all around the zone, plantation of highways and irrigation of desert lands that can be reserved for agricultural investment and specially irrigated with treated wastewater.

El-Maamora, El-Seiouf, Abis and the zones around are already positioned near to agricultural areas, and therefore the effluent of the existing and the proposed wastewater treatment plants in these zones could be used for irrigation of the nearby agricultural areas after improving the quality of the effluent to be in the Class "A" and "B1" according the Egyptian guidelines for wastewater reuse.

The wastewater effluent must have a quality suitable for reuse in various purposes. According the Egyptian regulation, the treated wastewater is classified according to its treatment level into four (4) divisions in accordance with the efficiency of the wastewater treatment operation with respect to the physical, chemical and biological characteristics, as mentioned in table 4-4.

The different classes of the treated wastewater are:

- **Treated Wastewater - Class (A);** It is an advanced wastewater treatment which can be obtained by the development of the secondary treatment plants including the wastewater disinfection and other treatment steps and due to the expensive cost of this treatment , it is only used for special cases if necessary.
- **Treated Wastewater -Class (B);** is divided into B1, B2 which are secondary treatment classes suitable for the wastewater treatment plants (Class B1 is conforming with articles 66 and 67 of law 48 year 1982), (Class B2 as Class (B1) but bacteriological parameters are not determined).
- **Treated wastewater – Class (C):** is equivalent to treated wastewater resulting from primary treatment plants

Table (4-4): Criteria of Treated Wastewater Allowed for Reuse in irrigation Purposes.

Treatment Class		Class (A)	Class (B1)	Class (B2)	Class (C)
Requirements and Criteria					
Max. Limit for Physical and Chemical parameters for Treated Effluent	BOD ⁽¹⁾ mg/L	< 30	< 60	< 60	< 400
	Suspended Material mg/L	< 30	< 50	< 50	< 250
Max. Limit for Biological parameters for treated Effluent	Probable Number ⁽²⁾ for E-coli in 100 cm ³	< 1000	< 5000	N.A.	N.A.
	Number of Cells or Interstitial Nematodes Ovum number/liter	< 1	< 1	N.A.	N.A.

⁽¹⁾ After filtration

- (2) In case of impossible testing of Escherichia Coli Test, Fecal Coliforms Test can be carried out.

Plants and crops allowed to be irrigated with treated wastewater are classified into four (4) agricultural groups and each group subdivided into 13 subdivisions. This classification is compiled with the review of local conditions and suitable with the four groups. This classification is shown in the Table 4-5.

Table (4-5): Classification of Plants and Crops allowed to be irrigated with treated wastewater.

Agricultural Group	Sub-group		Description
Group (A)	1-1	Plants and trees cultivated in green areas in resorts and hotels.	Grass, Gustine grass, ornamental palm trees, climbing plants, shrubs, wooden trees, shade trees
	1-2	Grass for golf playgrounds.	Playground grass in addition to the mentioned in 1-1
	1-3	Plants and trees cultivated in green areas inside cordon of residential areas in new cities.	Grass, Gustine grass, ornamental palm trees, climbing plants, shrubs, wooden trees, shade trees
Group (B1)	2-1	Fodder products.	In condition to be ripped and dried in sunrays before to consumed by animals.
	2-2	Fruit trees.	In condition to be produced and preservation in cans or processed as orange, lemon, mango, olive, dates palm, or nuts, coconuts.
	2-3	Cereals products.	Products processed by heating and drying before consumed as wheat, barley, and maize.
	2-4	Suitable trees for highways plantation and green belts around cities.	Dates palm and olive.
	2-5	Plant nurseries.	Nursery wood plants, ornamental plants or fruit trees.
	2-6	Roses and gathering flowers.	Roses, gladiolus, etc..
Group (B2)	3-1	Plants producing industrial oils.	Caster oil plant, etc..
	3-2	Fibers products.	Flax, jute, hemp, etc..

	3-3	Mulberry for the production of silk.	Local mulberry, Japanese mulberry.
Group (C)	4-1	Wooden trees.	All kinds of wooden trees.

4-4-3 Reuse of Grey Water in Alexandria:

The grey water in Alexandria, after some treatment, could be reused for various purposes such as: toilet flushing, irrigation, etc. However, to reuse the grey water, it should be collected in a separate piping system which is not cost effective or practical for all parts of Alexandria, especially in crowded streets. Therefore, the grey water could be reused locally within large public buildings and institutes such as: the sport clubs buildings, universities and educational buildings, hotels, resorts and recreation activities buildings, etc. A local separate grey water collection pipe system could be installed in each institute or building then directed to a small or compact treatment plant to remove suspended solids, fats, greases and/or other pollutants. After that, the treated grey water can be locally reused in toilet flushing and/or plants irrigation.

According to our knowledge, there is no Egyptian reuse standard for toilet flushing. However, it is preferred to have the Criteria for Treated Wastewater allowed for reuse in irrigation purposes according to class “B1” in the existing Egyptian regulation (Table 4-4).

4-4-4 Quality Control of Water, Inspection and Sampling:

This includes the control of water quality at the end of the treatment operation (effluent), and at the end of the transmission treated wastewater pipe to the site project to be sure that the treated wastewater for reuse is in conformity with the code requirements. The responsible authority prepares the control program for the operation and maintenance; also it is responsible for inspection by taking the required samples and testing at the expense of the competent authority for operation and maintenance.

Soil Condition; Following the soil property which is irrigated with treated wastewater to prevent increase of heavy and poisonous elements and minerals. It is necessary to get samples and should be identical to site soil and at least one sample every 10 feddans (4.2 hectares) at depth till 30 cm from ground surface.

Quality of Underground Water; Samples from underground water must be taken for testing at regular time intervals, testing must determine percentage of nitrate in addition to health measurements mentioned in the specifications.

Possibility of Crops Pollution; Samples of crops extracted from soils irrigated with treated wastewater must be tested to determine if polluted with excremental colonial bacteria and nematode according to the regulations.

Health Condition of Workers; It includes preliminary medical check-up procedures and periodical check-ups implemented by the Ministry of Health.

4-5 Strategy 5: Indirect urban potable/non-potable reuse by SAT and ARR

Effluent from centralized and/or decentralized treatment systems could be further treated by SAT (Soil Aquifer Treatment), recovered and reused for urban landscaping, toilet flushing and other non-potable reuse purposes or potable reuse.

Where soil and groundwater conditions are favorable for artificial recharge of groundwater through infiltration basins, a high degree of upgrading can be achieved by allowing partially-treated sewage effluent to infiltrate into the soil and move down to the groundwater. The unsaturated or "vadose" zone then acts as a natural filter and can remove essentially all suspended solids, biodegradable materials, bacteria, viruses, and other microorganisms. Significant reductions in nitrogen, phosphorus, and heavy metals concentrations can also be achieved.

After the sewage treated by passage through the unsaturated zone, has reached the groundwater it is usually allowed to flow some distance through the aquifer before it is collected. This additional movement through the aquifer can produce further purification (removal of microorganisms, precipitation of phosphates, adsorption of synthetic organics, etc.) of the sewage. Since the soil and aquifer are used as natural treatment systems, they are called soil-aquifer treatment systems or SAT systems, as shown in figure 4-13. Soil-aquifer treatment is, essentially, a low-technology, advanced wastewater treatment system. It also has an aesthetic advantage over conventionally treated sewage in that water recovered from a SAT system is not only clear and odour-free but it comes from a well, drain, or via natural drainage to a stream or low area, rather than from a sewer or sewage treatment plant. Thus, the water has lost its connotation of sewage and the public see it water more as coming out of the ground (groundwater) than as sewage effluent. This could be an important factor in the public acceptance of sewage reuse schemes.

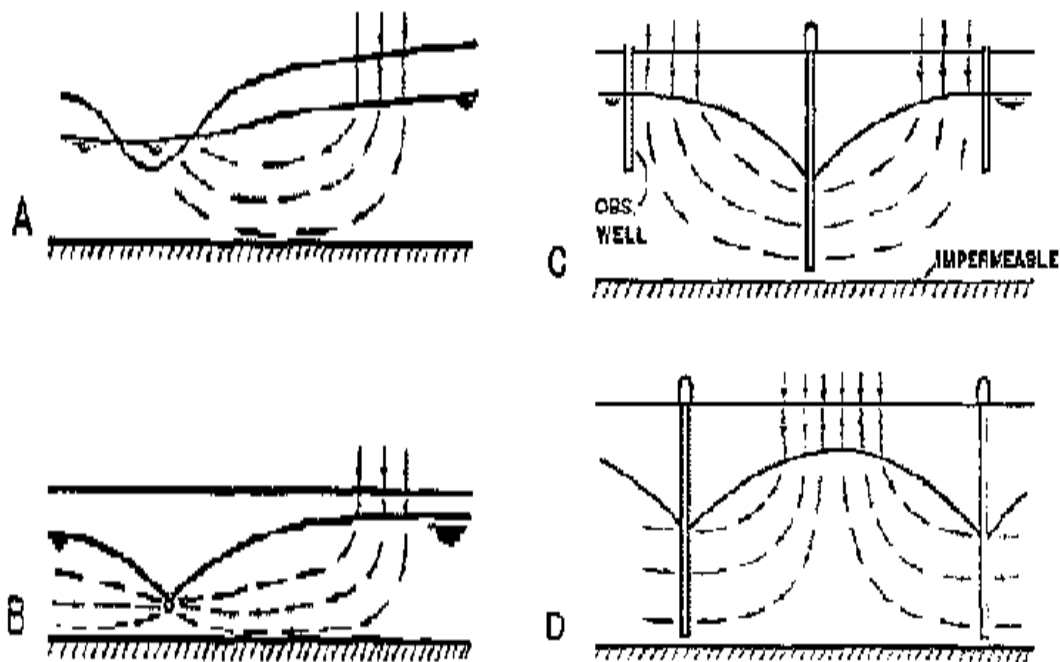
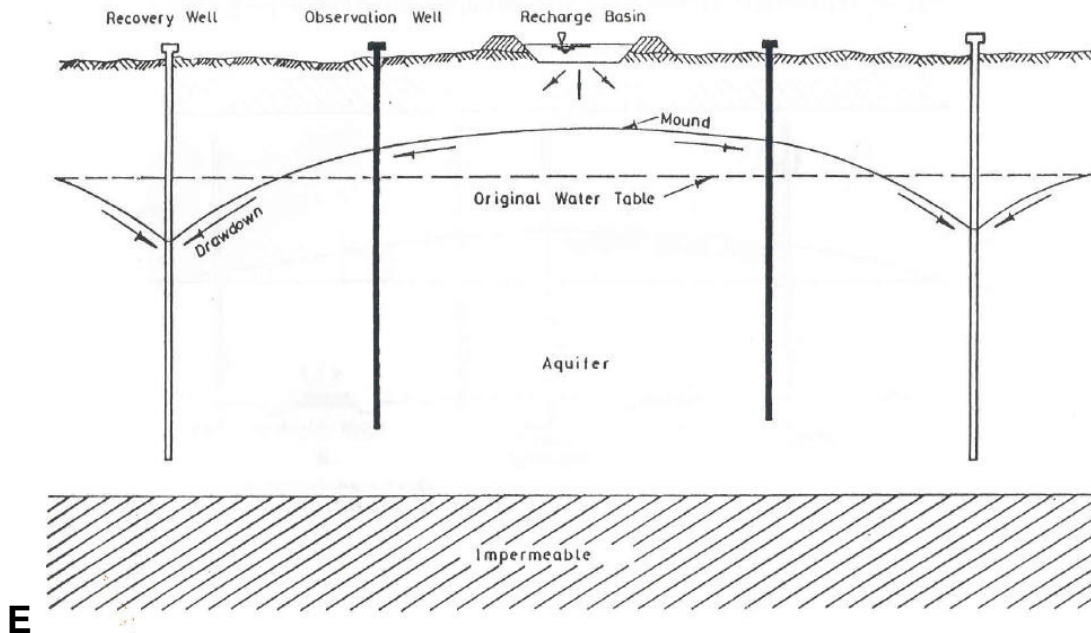


Figure (4-13) : Schematic representation of Soil Aquifer Treatment (SAT).

The simplest type of SAT systems is where the sewage effluent is applied to infiltration basins on high ground from where it moves down to the groundwater and eventually drains naturally through an aquifer. Systems C and D in above figure can be used both for seasonal underground storage of sewage water, allowing the groundwater mound to rise during periods of low irrigation water demand, and for pumping the groundwater mound down in periods of high irrigation water demands. In some SAT systems as F in figure 4-14, sewage could be

injected through wells to the aquifer (to reach to enough permeable soils to give high infiltration rates) where the top soil layers are not suitable for surface recharge, (figure 4-15).

The aquifer recharge and recovery concept is to inject water into the groundwater aquifer and recover a percentage of the injected water from a production well down gradient. The percentage of injected water not recovered from the aquifer is a net gain of a groundwater resource for the region. The both above recharged aquifers could be used for water recovery and reuse for many purposes according the efficiency of soil treatment for the received wastewater. According many literatures, the SAT systems have good efficiency for removal of most of the chemical and biological contamination from the wastewater. Therefore, the recovery water from these aquifers could be unrestrictedly reuse in most of the human and municipal activities such as: industrial activities, irrigation for plants and crops, animal consuming and others. Potential sites for SAT could increase groundwater availability for irrigation and also mitigate existing marine intrusion problem facing Alexandria aquifer. Moreover, the recovery water could be used for potable municipality water after some kind of treatments according its quality. Analysis of the recovery water should be done for monitoring its quality and its suitability for the different usages. For less quality aquifer recovery water, restricted usages of water could be included such as: urban landscaping, toilet flushing and other non-potable reuse purposes. With proper operation and maintenance and adequate monitoring, the SAT system should be considered an extremely attractive and reliable method for effluent reclamation and reuse in areas of Alexandria where suitable conditions exist for groundwater recharge via spreading basins.



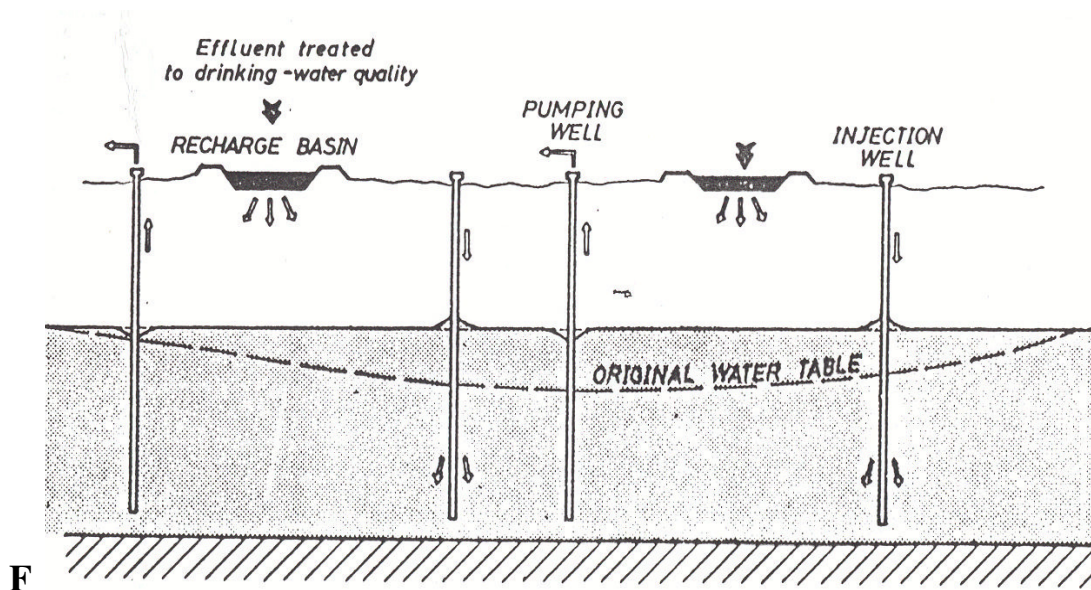


Figure (4-14): Schematic representation of Aquifers recharge and recovery (ARR).

Soil requirements; Infiltration basins or wells for SAT systems should be located in soils that are permeable enough to give high infiltration rates. This requirement is important where sewage flows are relatively large, where excessive basin areas should be avoided (due to land cost) and where evaporation losses from the basins should be minimized. Groundwater tables should be at least 1 m below the bottom of the infiltration basins during flooding. Above all, soil and aquifer materials should be granular.

According to this strategy, many parts of Alexandria could have further treatment of the partially treated wastewater effluent through the soil aquifers. However as stated above, different systems of the soil aquifers should be used according the soil characteristics of each district in Alexandria. Moreover the SAT systems could need a large land area (which is high expensive or not available in many districts in Alexandria) for surface recharge or big numbers of wells (which is highly expensive in execution for big quantities of wastewater) for underground recharge.

Annual infiltration amounts or "hydraulic loading rates" typically vary from 15 m/year to 100 m/year, depending on soil, climate, quality of sewage effluent, and frequency of basin cleaning. Therefore, the systems of SAT could be used for the small capacity wastewater treatment plans.

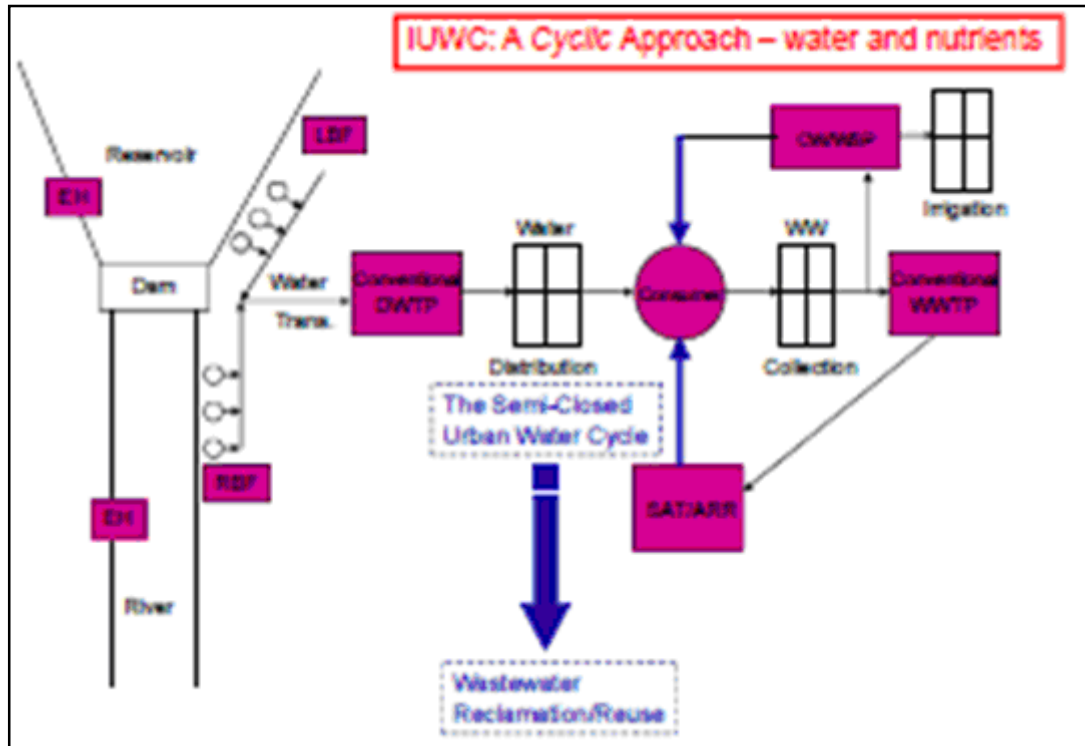


Figure (4-15): Aquifer storage and recovery system.

4-5-1 Use of SAT systems in West Alexandria:

In the western and/or south western districts (such as: Agamy, El-Dekhila and Amriya), the most of the top soil layers are sand, loamy sand, and/or sandy loam as a desert nature with relatively high permeability which is suitable to apply the recharge basin for SAT. Recharge basins could be used as a surface SAT. A number of surface basins could be executed near to the wastewater treatment plants.

To estimate area requirements for SAT, soil investigations should be done for every location for more description of the soil characteristics and the aquifer boundary in the location of executing surface basins for aquifer recharge. Rough estimation of permeability and infiltration of soil in these locations might be in range of 140 to 200 mm/day (50 m/year to 75 m/year). Therefore, the area estimated for SAT system in the future is about 100 hectare and the expected wastewater production in the district is around 160000 m³/d from Agamy and Dekhila.

4-5-2 Use of SAT systems in East Alexandria:

In the eastern districts (such as: Montazah, East, and Middle), most of the top soil layers are clay or silty clay for agriculture usages with low permeability which is not suitable to apply the recharge basin as for SAT. However, recharge wells could be used as a deep SAT systems. A number of wells could be executed near to the small wastewater treatment plants (with small capacities up to 30,000 or 40,000 m³/d).

The pre-treatment of sewage before that kind of SAT system should be high and the applied sewage should have low turbidity and contaminations. Soil investigations should also be done for every location for more description of the soil characteristics and the aquifer boundary in the location of executing wells for aquifer recharge.

It is recommended to carry out experimental works and out door pilot plants to evaluate the SAT systems and the quality of water after the systems and its suitability for recovery for different usages in different districts of Alexandria.

4-6 Strategy 6: Wetlands and aquaculture

Constructed wetlands are among the recently proven efficient technologies for wastewater treatment. Compared to conventional treatment systems, constructed wetlands are low cost, are easily operated and maintained, and have a strong potential for application in developing countries.

A Comprehensive Strategic Development Plan (CSDP) for the rehabilitation of Maryout zone, was started in 2005 and divided into short, medium, and long-term plans ending in 2013. It had three main Programs: Technical, Policy and Institutional Reforms and Socioeconomic. There were seven technical projects and all were integrated in one plan called the ***Immediate Action Plan (IAP)***. This plan provides a valid quick solution to the pressing problem of the lake main basin at a reasonable cost. The expected change in the lake environment after implementing the IAP would result in attracting investors and bring about a new look to Maryout zone as a promising development zone.

The IAP consists of the following projects:

1. Aeration/chemical treatment of primary treated sewage (East & West sanitary treatment plants).
2. Biological treatment of sanitary drainage wastewater at east and west primary treatment plants, Qalaa drain, and the lake main basin.
3. Civil Engineering works on Qalaa drain.
4. Dilution of Qalaa drain wastewater with a better quality agriculture drainage water from the Omoum drain (at a ratio of 1:1).
5. Aeration of the water body of the main basin and Qalaa drain (surface aeration using mobile units).
6. Water reeds reduction.
7. Industrial pollution control.

4-6-1 Expected revenues of the IAP project:

Expected revenues, after implementing the IAP, were estimated for only two resources:

- *Fish production* and selling enhanced primary treated wastewater. The value estimated for fish production from the main basin went from 2 million L.E./year (0.34 million US\$) in 2005 to 35 million L.E./year (6 million US\$) in 2008, and up to 105 million L.E./year (18.1 million US\$) in 2013.
- Selling enhanced primary treated wastewater created revenues estimated in year 2009 to be 10.8 million L.E./year (1.86 million US\$) and go up to 27 million L.E./year (4.7

million US\$) in year 2012. Of course, cost of the distribution network is not yet known.

Other revenue resources:

- **Land:** Any form of private-public sectors partnership regarding land utilization is a big revenue source. Assuming a release of about 300 feddans of land surrounding Maryout lake and approximately 3000 feddans in Maryout valley (Wadi Maryout), at a price of 100 L.E./m² (1 feddan = 4200m²) as a starting price, revenues could come up to 126 and 1260 million L/E (21.7 and 217.2 million US\$) respectively.
- **Tourism:** Investment plans in this zone should always look at utilizing the uniqueness of a combination hardly found elsewhere, i.e. geographic location and Lake Environment, archeological sites, Mediterranean front, closeness to city, 2 airports, the main harbor of Egypt. Revenues from tourism in Maryout zone are expected to be profoundly high.

Revenue estimates obviously indicated that spending on the IAP implementation pays off. This was a preliminary cost-benefit analysis and indicators showed real direct and indirect benefits, hopefully full feasibility studies will confirm such findings

"Source: . Executive Summary World Bank – CDS – Lake Maryout Rehabilitation Component"

4-6-2 Proposed treatment alternatives by the Lake Maryout integrated management Project:

From the eight studied alternatives through the **Alexandria Ground Pool Project**, alternative No. 8 was chosen to treat the effluent of East and West treatment plants in Alexandria. This alternative depends mainly on using wetlands and maturation ponds to raise the treatment level from primary to secondary and tertiary treatment as shown in the following figures (4-16,4-17).

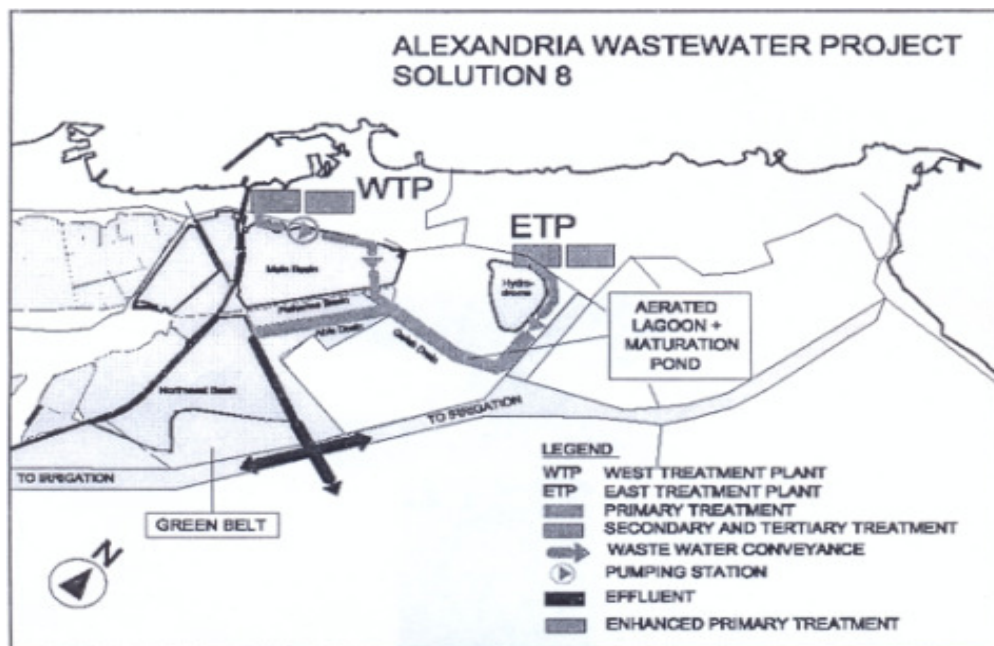


Figure (4-16): Project Component of Alternative 8 using wetland and maturation pond.

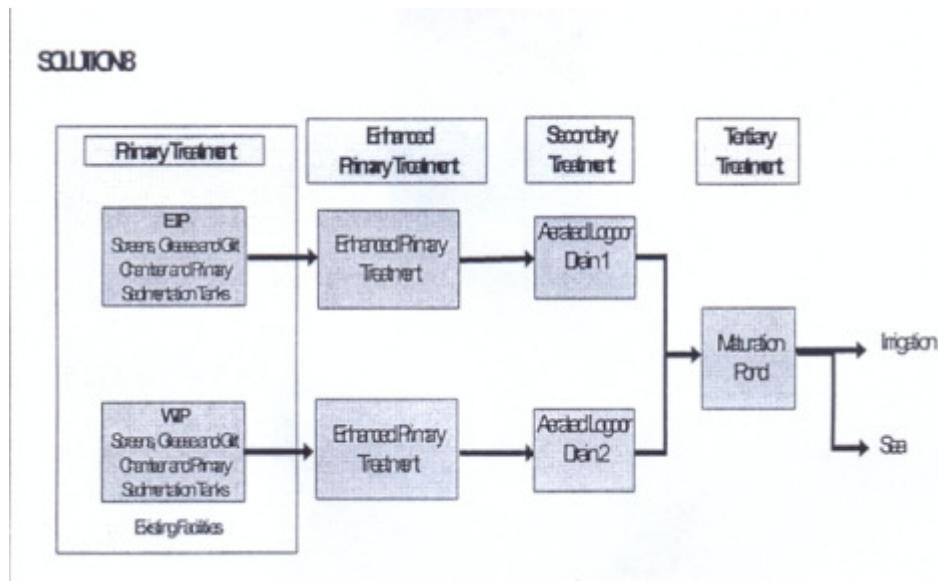


Figure (4-17): Scheme of Alternative 8 using wetland and maturation pond.

This alternative was suggested to achieve the following:

- 1- Enhancing primary treatment in ETP and WTP by using chemicals.
- 2- Using aeration ponds in polishing chemically precipitated effluent.
- 3- Using Maturation ponds to reduce fecal coliforms and BOD levels.

Construct a pump station to transfer discharges of East and West treatment plants to the south west of the lake to be used as storage for agricultural reuse, aquaculture or direct disposal into the sea. As shown in the above figure and map. Table (4-6) shows the criteria that should be reached by using this alternative.

Table (4-6): The criteria after using wetland and maturation pond.

Parameter	Level
BOD	< 30 ppm
COD	< 25 ppm
TSS	< 60 ppm
Total Coliform	< 1000/100 mL
Nematodes	< 1/1000 mL
Total Nitrogen	< 3 ppm

4-6-2-1 Alternative cost:

Total investment cost is 138 million\$, meanwhile the estimated investment cost for the American consultant 455 million\$ according to 2006 prices. The operation and maintenance cost is 31.5 piaster/m³. The energy consumption will increase by around 100% compared to the current project.

*(Source: Alexandria Growth Pole Project,
Project ID No. P094229- Enhanced wastewater treatment system in Alexandria)*

4-6-2-2 Environmental Impacts of the suggested alternative:

- 1- **Water Quality:** An increase in treatment level from primary to secondary and tertiary will significantly improve the overall water quality of the effluent. The most significant improvements will occur in water quality parameters such as TSS, BOD₅, COD, and O&G. There will be high reduction in nutrient and coliform levels associated with the removal of a higher proportion of the solids. The salinity of the main Basin will be decreased under this alternative as a result of increasing the discharge of treated effluent into the Main Basin.

As a result, water quality of the Qalaa Drain and disposal area of west treatment plant in the lake will improve, although it is likely to become anoxic before it enters the main basin. It is predicted that there will be a noticeable improvement in the water quality of the main basin in the vicinity of the Qalaa Drain and disposal area of west treatment plant in the lake. It is reasonable to conclude that water quality will significantly improve under this alternative.

- 2- **Fish Production:** Fish production in the main basin should be increased as a result of the anticipated improvement in water quality and availability of nutrients in suitable concentrations. Therefore, zooplanktons and phytoplanktons densities will increase. As the transition zone from poor water quality to acceptable water quality moves eastward towards the Qalaa Drain, a larger quality moves eastward towards the Qalaa Drain, a larger area of the Main Basin will be suitable for fish production.

The short term increase in the area suitable for fish production may be relatively small, but, the long term increase should be significant.

- 3- **General Ecology:** The general ecological community of Lake Maryout should be enhanced from an improvement in water quality. The main basin currently is the only basin of Lake Maryout that is not 100% vegetated, and an increase in the vegetated area is likely under this alternative. The overall ecological community would then become more similar to those of the other basins.
- 4- **Human Health:** Project induced human health impacts will be significantly reduced as a result of fecal coliforms reduction. The overall coliform level in the Qalaa Drain and the main basin will also be significantly reduced through dilution and some potential minor reductions of coliforms originating from other sources as a result of the chemical and natural treatment. It is likely that coliforms in the Kalaa Drain and the main basin will be below the Egyptian regulations requirements of 5,000 MPN/100 ml. Likewise; the coliform loading the eastern portion of the main basin will be significantly reduced. However, the coliform levels at El Mex will be reduced by this alternative because of other sources of coliform to El Mex.

4-7 Strategies Evaluation:

The evaluation of the above scenarios of strategies could be done with some constrains and guidance indicators. The strategies should be firstly evaluated to achieve the proposed vision for the future wastewater system in Alexandria which is:

“all citizens have access to high quality (meeting national norms), reliable, sustainable, and affordable water and sanitation services and benefit from a clean and healthy environment”.

Therefore many indicators should be taken into consideration for evaluating each proposed scenario of possible strategies for wastewater management and reuse in Alexandria in 2037 which could include:

- 1- Potential to achieve the vision
2. Public health effects
3. Environmental pollution
4. Energy consumption
- 5- Compatibility with legislation
6. Cost estimates

The indicators effects on the selected strategies are ranked with scores ranged from 1 (for very poor and negative effect), 2 (for moderate bad and negative effect), 3 (for fair and neutral effect), 4 (for middle positive effect) to 5 (for very good and positive effect). Table (4-7) will summarize the effect of the above indicators on each strategy.

4-7-1 Scenario of Strategy 1 “Conventional collection and treatment for disposal” :

It achieves the proposed vision with un-reasonably price due to its expensive operation and maintenance costs. It also has good effects on the public health and environmental pollution and all groups in society will fully benefit from the proposed strategy except that there may be re-growth of biological activities in the receiving water body of Lake Maryout/Mediterranean with bad impacts on fisheries there.

The estimated cost and the energy consumption of this strategy are very high especially for constructing complete sewerage systems, pump stations and treatment plants for all the scattered rural areas. The strategy is compatible with most of the existing legislations except with the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy.

For cost recovery and funding sustainability of this strategy, high priced services charge might be conducted on customers where there is no cost reduction through substitution of fresh water by effluents.

4-7-2 Scenario of Strategy 2 “Conventional collection and treatment for centralised agricultural reuse”:

It achieves the proposed vision with un-reasonably price due to its expensive operation and maintenance costs. It also has good effects on the public health and environmental pollution

and all groups in society will fully benefit from the proposed strategy except that there may be contamination of crops with re-growth of microbiological and chemical pollution, groundwater pollution and pollution of irrigated agricultural fields.

The estimated cost and the energy consumption of this strategy are very high especially for construction of complete sewerage system, pump stations and treatment plants for all scattered rural areas. The strategy is also compatible with most of the existing legislations and agrees with the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy with requiring more restrictions for heavy metals and polluted industrial wastewater disposal into sewage networks.

For cost recovery and funding sustainability of this strategy, moderate priced services charge might be conducted on customers where there is cost reduction through substitution of fresh water by effluents.

4-7-3 Scenario of Strategy 3 “Mix of on-site sanitation and sewerage” :

It achieves the proposed vision with reasonably price due to its inexpensive operation and maintenance costs. However, it might have bad effects on the public health and environmental pollution due to groundwater pollution (with improper on-site sanitation) which could be used for water supply and irrigation leading to health hazards and contamination of crops with re-growth of microbiological and chemical pollution, and pollution of irrigated agricultural fields. Improper usages and contacts of customers with on-site sanitation might also arise many health diseases hazards.

The estimated cost and the energy consumption of this strategy are reasonable especially for construction of on-site sanitation and treatment plants for all scattered rural areas. The strategy is also compatible with most of the existing legislations but don't agree with the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy with requiring more restrictions for heavy metals and polluted industrial wastewater disposal into sewage networks.

It is expected to have no cost reduction for this strategy through substitution of fresh water by effluents.

4-7-4 Scenario of Strategy 4 “Direct Urban non-potable reuse” :

It achieves the proposed vision with high price due to its expensive operation and maintenance costs for the required high treatment before reuse. It might also have bad effects on the public health and environmental pollution with improper treatment and reuse applications and irrigation leading to health hazards and contamination of crops with re-growth of microbiological and chemical pollution, and pollution of irrigated agricultural fields. Improper usages and contacts of customers with urban non-potable reuse might also arise many health diseases hazards.

The estimated cost and the energy consumption of this strategy are significantly high to achieve the requirements of reuse quality. The strategy is also compatible with most of the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy with requiring more restrictions for heavy metals and polluted industrial wastewater disposal into sewage networks.

It is expected for this strategy to have cost reduction through substitution of water for reuse.

4-7-5 Scenario of Strategy 5 “Indirect urban potable/non-potable reuse by SAT and ARR” :

It achieves the proposed vision with reasonably price because it needs less treatment processes for less quality treated effluent leading to inexpensive operation and maintenance costs. It also has good effects on the public health and environmental pollution and all groups in society will fully benefit from the proposed strategy except that there might be underground water pollution leading to re-growth of biological activities in the groundwater body in case of inefficient treated effluent. It might be also rise the groundwater level with their bad effect on the foundation and structure of the different constructions.

The estimated cost and the energy consumption of this strategy are moderate due to fewer constructions of treatment units and their capacity. The strategy is also compatible with most of the existing legislations especially with the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy.

For cost recovery and funding sustainability of this strategy, high priced services charge might be conducted on customers where there is no cost reduction through substitution of fresh water by effluents.

4-7-6 Scenario of Strategy 6 “Wetlands and aquaculture”

it achieves the proposed vision with low priced due to its inexpensive operation and maintenance costs for required pre-treatment before reuse. It might also have small bad effects on the public health and environmental pollution with improper treatment and reuse applications and irrigation leading to some health hazards and contamination of crops with re-growth microbiological and chemical pollution, and pollution of irrigated agricultural fields. Improper usages and contacts of costumers might also arise some health diseases hazards. The estimate cost and the energy consumption of this strategy are moderate to achieve the requirements of reuse quality. The strategy is also compatible with most of the existing National Water Resources Plan and the National Sustainable Agriculture Development Strategy with requiring more restrictions for heavy metals and polluted industrial wastewater disposal into sewage networks. It is expected for this strategy to have cost reduction through substitution of water for reuse.

Table 4-7: Scoring the Effect of the Strategies on the indicators.

Scenario x Indicators Strategy	A 1- Potential to achieve the vision	B 2. Public health effects	C 3. Environmental pollution	D 4. Energy consumption	E 5- Compatibility with legislation	F 6. Cost estimates	Total score
1: Conventional collection and treatment for disposal	4	4	4	2	3	1	22
2. Conventional collection and treatment for centralised agricultural reuse	5	3	3	2	4	1	18
3. Mix of on-site sanitation and sewerage	2	2	3	5	3	5	20
4. Direct Urban non-potable reuse	3	3	2	4	3	4	19
5. Indirect urban potable/non-potable reuse by SAT and ARR	4	4	3	3	4	3	21
6. Wetlands and aquaculture	3	3	3	4	3	4	20

Indicators effects on the selected strategy have ranked with scores ranged from 1 (for very poor and negative effect), 2 (for moderate bad and negative effect), 3 (for fair and neutral effect), 4 (for middle positive effect) to 5 (for very good and positive effect).

Chapter 5

Wastewater management and IUWM [3 pages] B

Describe how the various strategies would affect (or is affected by) the topics of the other studies (Water Demand Management, Groundwater management, Stormwater management, Modelling and Decision Support, Institutional mapping)

Chapter 6

Conclusions and recommendations

Alexandria's administration is structured as follows: the Governorate consists of three cities: Alexandria, Borg El Arab City and Centre and New Borg El Arab with an existing population of about **4,123,869** million persons according to 2006 census population. The city of Alexandria is divided into seven districts, three local village units, and five sub-village units. The main districts of the urban area are: Montazah District, Eastern District, Middle District, Western District, Customs District, Agamy district and Amriya District.

Currently the City of Alexandria receives its urban water from the Nile. Inhabited by more than 4 million people, the city of Alexandria resides on the Mediterranean coast, which makes it a summer destination, increasing its population in the summer to 6 million people, putting more pressure on the city's water demand. Although the city receives rainfall of about 200 mm/year, this storm water finds its way into sewage systems, drains into the Mediterranean Sea without use, or seeps into the coastal groundwater aquifer through the little-left infiltration areas of the city. Most of the city is covered with potable water supply networks, but many peri-urban and informal settlements lack sewage/sanitation coverage. Most of the city sewage is at least primary or secondary treated; however, potential uses of this treated wastewater are yet to be explored in line with the country's National Water Resources Plan.

About 50 % of the population of the villages have no sewerage system and depends on on-site sanitation or similar systems. However, many of these rural areas have projects for executing sewerage systems ended with treatment plants.

The recent sewerage system in Alexandria's urban areas has succeeded in eliminating sewage pounding in residential streets, controlling/eliminating raw sewage discharges to the beaches, providing an environmentally acceptable minimum level of treatment (primary), and disposal for the collected quantities..

Future production of sludge from East, West treatment plants and new treatment plants will become more than double the current amount produced. As a result, it is a must to increase the efficiency of mechanical dewatering operations to guarantee dewatering all sludge from primary treatment plants. Nevertheless, the sludge disposal site capacity has to expand to receive approximately 700 m³/d.

The existing human health conditions, in the Main Basin of Lake Maryout are degraded. The primary reason for the degraded health conditions is the discharge of non-disinfected wastewater into the basin via the Qalaa drain and WTP. Pathogens, as indicated by coliform numbers, are above levels specified in the Government of Egypt regulations at both the ETP and WTP.

It is important to allow safe and economically responsible reuse of Alexandria treated wastewater in order to make the best use of existing resources and to protect the environment and human health. Wastewater reuse can reduce Lake Maryout deterioration, while minimizing the amount of wastewater discharged to the aqueous environment of the lake.

To match the future water vision developed by the Alexandria Learning Alliance in July 2007, the future wastewater system vision is:- "*Envision a future for the citizens of **Alexandria** where*

the quality of life is enhanced by the quality of the environment. In partnership with communities and businesses, we will assess, sustain, preserve, and enhance the quality of the environment while recognizing the need for maintaining the economic vitality of the city".

The expected changes in wastewater composition of Alexandria city according to the different three proposed scenarios (Best case, worse case and as usual case) are not significant as the predicted changes in water quantities varies between 1.5 – 3%, and the corresponding changes in composition by dilution (decrease under the Best case scenario) or concentration (increase under the worst case scenario) will not have significant impact on wastewater composition.

According to our survey no industries are willing to consider using treated effluent from Alexandria wastewater treatment plants in any industrial activities, due to the concern about the safety of using this effluent and the risk of loosing their market. Given the fact that, other sources of clean water are available in affordable prices. From our survey also, only urban areas located outside Alexandria especially in arid zones can use treated effluent in irrigating green yards (this is mainly due to shortage of water resources allover the year). It is possible to use wastewater treated effluent from ETP after upgrading the degree of treatment to secondary treatment with complete disinfection inside Alexandria in some clubs.

This situation could change under the worst case scenario due to decrease in Alexandria's share of water resources. Thus, it would be worth to reuse all treated wastewater in irrigation within Alexandria with rates covering the expected decrease in water quantities from different water resources. Fortunately, Main wastewater treatment plants being near to the agricultural areas inside Alexandria in Abis and Amriya areas and have the advantage to be reused without need to additional construction to transfer the treated effluent. The required qualities of wastewater to be reused in agriculture varies according to the type of treatment (Primary, secondary or tertiary) and for each there are certain crops that should be irrigated according to the specified parameters.

According to reviewing the options and the current situation regarding environment and irrigation and economic conditions, the WRc study preferred the option mentioned in section 4-2-4-2 to Supplement the water supply in the Nasr Canal by transfer of effluent through the Omoum Drain for the following reasons :

- a. small head (<10 m), short distance (about 20 km).
- b. Complies with Law 48/1982 especially that all treatment plants are about to be secondary and will produce high quality effluent.
- c. Supplements the Omoum Drain as flows may decline.
- d. Contributes to overall water balance in the region with increasing water shortage.

One of the advantages of this option is its applicability under current economic conditions. In addition to low conveyance costs. As an alternative in case of the worse case scenario.

Beside the above reuse scenarios we suggest options for Effluent Reuse especially in case of tertiary treatment or highly disinfected secondary treated effluent for further study. These options are based mainly on reuse within the boundaries of Alexandria agricultural zones. Through the following:

1. Mixing treated effluent from localized wastewater treatment plants with the adjacent receiving drain water.

2. Using the mixture of effluent and drain water as an irrigation source, and include it in the plan of the Ministry of Irrigation to irrigate these areas.
3. Saved amounts of usual irrigation water as a result of reusing the mixture, can be used in other ways.

Scenarios can be adopted to the concerned Alexandria rural areas according to the topography, soil texture, ground water table, land availability, population. First scenario is concerning the areas located in sandy soil land in the desert nature area (as Amriya and Agamy rural areas) where percolation and flow rates are considerable and groundwater tables are low. The typical sanitation system in such villages could be adopted to onsite sanitation containing septic tanks (each serves group of houses) followed by deep cesspools to allow the primary treated wastewater to percolate into the soil. Second scenario is concerning about the small villages in agricultural land and suffering from high level of contaminated ground water table. Septic tanks, serving a number of households, could be constructed in streets or public spaces, and then small pore sewer could be used to collect settled sewage for further treatment in an aerated lagoon. Otherwise, a conventional sewerage system is suggested to transport for treating in UASB systems. Sewage treatment for these areas could be divided into two systems; conventional intensive energy system (activated sludge or high trickling filters) for limited land area and nature extensive systems (oxidation ponds or constructed wetland) for available land area. .

Constructed wetlands are among the recently proven efficient technologies for wastewater treatment. Compared to conventional treatment systems, constructed wetlands are low cost, are easily operated and maintained, and have a strong potential for application in developing countries.

From the eight studied alternatives through the *Alexandria Ground Pool Project*, alternative No. 8 mentioned in section 4-6-2 was chosen to treat the effluent of the East and West treatment plants in Alexandria. This alternative depends mainly on using wetlands and maturation ponds to raise the treatment level from primary to secondary and tertiary treatment.

References

- Bakir, Hamed (2000). Sanitation and wastewater management for small communities in EMR countries. Sanitation and WWM Item # 01 November 2000.
- Abdul Alim F. (1997). Wastewater management in Egypt. Proc. of WHO/CEHA Multinational training course on low-cost technology for on-site wastewater treatment (Amman), Sep. 1997.
- FAO (1997). Irrigation in the Near East Region in Figures. Water Report 9 (Rome, FAO).
- Elmitwalli, T. A.; Elmashad, H.; Mels, A.; Zeeman, G. and Lettinga, G. (2003). Sustainable Treatment of Waste(water) in Rural Areas of Egypt. Water Sci. Tech., Vol. 48, No. 6, 2003.
- Abdel-Shafy, Hussein and Aly, Raouf (2002). Water Issue in Egypt: Resources, Pollution and Protection Endeavors. CEJOEM 2002, Vol.8. No.1.:3–21.
- Mattila, H.; E. Santala and J. Aho (2002). Consumer managed co-operative; a solution for progressing wastewater management in rural areas. Proc. of the 5th IWA Intl. Conf. on Small Water and Wastewater Treatment Systems, Istanbul, Turkey, 24-26 Sep. 2002.
- US Environmental Protection Agency (US, EPA) (1993), Design Manual: Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment.
- Elsheikh, A. Mahmoud (2005) Water supply and sanitation conditions reviewing and upgrading in Rural Egyptian area. Proc. of the 5th Intl. Conf. on Upgrading Rural Area., Cairo – Shebeen El-kom, Egypt, 26-29 Sep. 2005.
- W.M. Alley, T.E. Reilly, and O.L. Franke "2007" Sustainability of Ground-Water Resources. U.S. Geological Survey Circular 1186.
- Priyantha Ranjan (2007). Effect of climate change and land use change on saltwater intrusion. [http://www.eoearth.org/by/topic/climate change, land-use and land-cover change and water](http://www.eoearth.org/by/topic/climate%20change,%20land-use%20and%20land-cover%20change%20and%20water).
- D.H. Boggess, T. M. Missimer, and T.H. O'Donnell (2001) Saline Water Intrusion Related to Well Construction in Lee County, Florida. Water-Resources Investigations USGS Report 77-33
- Mohammed Amin Sharaf; Mohammed Tahir Hussein; Abdulaziz M. Al-Bassam. (2001) Upconing and Saline Water Intrusion and the Need for Water Conservation in the Lower Part of Wadi Fatimah, Western Saudi Arabia. International Journal of Water Resources Development, Volume 17, Issue 2 , pages 211 - 226
- G. Ho (2004). Small water and wastewater systems: pathways to sustainable development? Water Sci. Tech., Vol 48, No 11 pp 7–14.

- Gary Amy and Jörg Drewes (1998) Soil Aquifer Treatment (SAT) as a Natural and Sustainable Wastewater Reclamation/Reuse Technology: Fate of Wastewater Effluent Organic Matter (EfOM) and Trace Organic Compounds. UNESCO-IHE Institute for Water Education, Delft, The Netherlands
- FAO Corporate repository (2007) Aquifer recharge with wastewater, Soil-aquifer treatment (SAT) Originated by: Natural Resources Management and Environment Department
- Jerry Blain, Charles F. Webster (2008). Equus Beds Aquifer Recharge and Recovery Project. U.S. Department of the Interior Bureau of Reclamation, <http://www.usbr.gov/gp/otao/equus>.
- Emanuel Idelovitch (2003) SAT (Soil Aquifer Treatment) – The Long-Term Performance of the Dan Region Reclamation Project. The World Bank Water Week 2003
- COLORADO SPRINGS, COLORADO (2008) Final report of "Legal and Institutional Opportunities for Aquifer Recharge and Storage in Colorado, USA, An Interactive Forum, SEPTEMBER, 2007
- L. G. Wilson, G. L. Amy, C. P. Gerba, H. Gordon, B. Johnson and J. Miller. (1995) Water Quality Changes during Soil Aquifer Treatment of Tertiary Effluent. Water Environment Research, Vol. 67, No. 3 (May - Jun., 1995), pp. 371-376
- World Health Organization. 1989. Health guidelines for the use of wastewater in agriculture and aquaculture. Geneva:
- Eden, R. E. 1996. Wastewater reuse: Limitations and possibilities. Desalination 106(1/3):335–338.
- Farid, M. S. M.; S. Atta; M. Rashid; J. O. Munnink; and R. Platenburg. 1998. Impact of the reuse of domestic wastewater for irrigation on groundwater quality. In Water supply and sanitation for rural areas: Proceedings of the IAWPRC First Middle East Conference held in Cairo, Egypt, 23–25 February, 1997, 147–157.
- Hall, J. E.; and S. R. Smith. 1997. Cairo sludge disposal study. Water and Environmental Management 11(5):373–376.
- Wang, M. J. 1997. Land application of sewage sludge in China. The Science of the Total Environment 197(1/3):149–160.
- Christopher A. Scott J. Antonio Zarazúa, and Gilbert Levine, 2000. Urban-Wastewater Reuse for Crop Production in the Water-Short Guanajuato River Basin, Mexico. International Water Management Institute, Mexico
- Gupta, A. P.; R. P. Narwal; and R. S. Antil. 1998. Sewer water composition and its effect on soil properties. Bioresource Technology 65(1/2):171_173.
- Shuval, H. I. 1998. Investigation of typhoid fever and cholera transmission by raw wastewater irrigation, Santiago, Chile. Water Science and Technology 27(3/4):167_174.

Waste Water Treatment and Recycling in Industrial Facilities, By Chem. Ihab Al Sharkawy
EEAA (presentation)

Industrial wastewater in lake Maryout, presented by Chemist/Hoda Mostafa Ibrahim
(presentation.

Appropriate wastewater management in egypt existing situation and future perspectives
prepared by prof. dr. eng. fatma el-gohary

Monitoring Network and Information Provisions of Lake Maryut, M. El Raey, University of
Alexandria And CEDARE

Integrated National Water Resources Plan in Egypt, Alexandria Governorateby Dr. Hussein
El-Atfy Ministry of Water Resources and Irrigation

Re-use of Treated Wastewater in Agriculture, Mohamed Abd El-Naim, Agricultural Research
Center

Alexandria Effluent and Sludge Reuse Study – WRc.

Alexandria Governorate Environmental Assay-2007.

Alexandria Governorate Environmental Plan-2008.

Innovative Treatment technologies for Water, Wastewater, Sludge and other Contaminated
waters- National Research Center Cairo-Egypt (2007).

ASDCO's Site 9N reports.

ASDCO's GIS Department.

Quality monitoring of composting processes of wastewater sludge in Alexandria. El-Sebaie,
Olfat D (OD); Hussein, Ahmed H (AH); Abdel-Aty, Magda M (MM); Ramadan,
Mohamed H (MH); Helaly, Helaly A (HA). The Journal of the Egyptian Public Health
Association (J Egypt Public Health Assoc), published in Egypt.

Environmental Affairs Agency website.

ALAMIM «Alexandria LAke Mariuot Integrated Management » - Progress of Industrial
Activities' Assessment . 11-12 February 2009

Central Agency for Public Mobilization And Statistics

EEAA (2008) Dr. Hoda Moustafa, Alexandria Lake Maryut Integrated Management –
ALAMIM Integrated Action Plan.

Alexandria -September 2006 SMAP presentation – CEDARE

Alexandria Effluent and Sludge Reuse study-WRc.

Wastewater Treatment Plants Sector-ASDCO.

Sludge composting and disposal facility ASDCO (Site 9N) monthly reports.

Khaled Fahmy, Monitoring, Verification and Evaluation Unit for EEAA, personal communication October 2001).

Integrated Environmental and Social Impact Assessment (IESIA) Executive Summary June 21, 2007

Alexandria Integrated Coastal Zone Management Project (AICZMP) Environmental and Social Impact Assessment Executive Summary DRAFT FINAL Revision Date: October 20th, 2009

Cost-effectiveness and equity in Egypt's water sector Egypt Public Expenditure Review May 2005

Environmental Priorities at the Governorate of Alexandria

Actualizing the Right to Water: An Egyptian Perspective for an Action Plan.

ALAMIM Project – Final report of industrial activities integrated action plan – April 2009.

Annexes

Annex 1

Flows pumped from Middle (Wasat), East (Sharq), Montazah, West (Gharb), Gomrok (customs) and Amriya districts, and Borg El Arab City according to 2006 flows

Table (1a) : Sewerage systems and pumping stations in Middle District.

Table (1b) : Sewerage systems and pumping stations in East District.

Table (1c) : Sewerage systems and pumping stations in Montazah District.

Table (1d) : Sewerage systems and pumping stations in West District.

Table (1e) : Sewerage systems and pumping stations in Borg El Arab District.

Table (1f) : Sewerage systems and pumping stations in El Amriya district.

Table (1g) : Sewerage systems and pumping stations in Gomrok (Customs) district.

Table (1a) : Sewerage systems and pumping stations in Middle District.

Wasat (Middle district) pump station									
label	Total flow (m3/d)								
	max capacity	AVERAGE	Year 2006(max)	Year 2012(max)	Year 2017(max)	Year 2022(max)	Year 2027(max)	Year 2032(max)	Year 2037(max)
Ezzbet Halash	4800	2725.1	4290.4	4532.05	4763.09*	5002.11	5254.2	5524.7**	5803.7
Amr esnad 104	50000	11096	16511	17431	18307.9	19248.5**	20224	21233	22312**
Somoha Al gadedda	285000	86265	123526	127254	130564**	131959	133374	134806**	136257
Sporting	45000	25431	37091	37570.4	37890.2**	38209.9	38530	38849**	39169
abees 10	5600	3599.7	5588.4	5660.65*	5708.83	5757	5805.2**	5853.4	5901.5
Abees 1	3500	1440	2357	2387.45	2407.77	2428.09**	2448.4	2468.7	2489**

**

mech & elect & civil works

*

station rehabilitation

(source: ASDCO Master Plan 2009)

Table (1b) : Sewerage systems and pumping stations in East District.

Sharq (East district) pump stations									
	Total flow (m3/d)								
Label	max capacity	متوسط التصريف اليومي	year 2006(max)	Year 2012(max)	Year 2017(max)	Year 2022(max)	Year 2027(max)	Year 2032(max)	Year 2037(max)
Al Shareka Al Arabeya	25000	5051.8	7725.9	7826.11**	7892.64	7959.17	8025.7**	8092.2	8158.8
Ganayoti	26000	19293	28303*	28669.4	28913.4	29157.4**	29401	29645	29889**
El Saleheya	26000	12042	17878	18108.6	18262.8**	18416.9	18571	18725**	18879
Hagar Al Nawateya	43200	17027	25052	25375.6	25591.6**	25807.5	26024	26239**	26455
Hood Al Genena	21000	6000	9113.5	9231.34	9309.91**	9388.47	9467	9545.6**	9624.2
Seikinaa	2500	863.04	1468.5	1597.29**	1743.19	1890.81	2055**	2236	2434.1
El Khawaga Ibrahim	11000	5737.8	8730.3*	8843.22	8918.48	8993.74**	9069	9144.3	9219.5
Abees 2	7000	6503.4	9848.4*	9975.71	10060.6	10145.5**	10230	10315	10400**
abo soliman sub.	86400	29516	42538	43088.4**	43455.1	43821.8	44189**	44555	44922
al siouf al gaded	435000	414242	585997*	606040	617987	627335**	636977	646594	656136**
abo soliman & 11 sharq	311000	0							

(source: ASDCO Master Plan 2009)

Table (1c) : Sewerage systems and pumping stations in Montazah District.

Montazh pump stations								
Station	Total flow (m3/d)							
	Max capacity	average	2006(max)	2012(max)	2017(max)	2022(max)	2027(max)	2032(max)
SH-Korshid & Al Zawayda (1)	15000	1382.7	2269.6	2485.14	2693.51**	2933.42	3190.9	3480.7**
Al Ma'mora Al balad	50000	41926	60611*	62415.6	64037.9	65720.7**	67577	69546
Abo Keer Station	35000	28510	41491*	42027.3	42384.9	42742.6**	43100	43458
dobat abo keer	7000	4682.9	7184.4*	7865.34	8581.48	9357.4**	10206	11132
al abd	4500	3498.6	5438.8*	5509.1	5555.98	5602.87**	5649.8	5696.6
SH-Korshid & Al Zawayda (3)	55000	9986.4	14907	16344	17836.6**	19488	21288	23216**
SH-Korshid & Al Zawayda (4)	13000	3203.2	5001.2	5490.67	5974.63**	6512.66	7115.7	7736.7**
SH-Korshid & Al Zawayda (5)	5000	1572	2557.8	2800.41	3044.94**	3312.72	3614.3	3929.8**
SH-Korshid & Al Zawayda (2)	31000	1382.7	2269.6	2485.14	2693.51**	2933.42	3190.9	3480.7**
Al Ras Al Sooda	215000	91587	128411	154456	179645	205304.0*	227176	232130
(3) Sharq	30000	256.13	493.43	537.84**	580.517	628.373	681.46**	739.84
Al Ma'mora Station Al Seyahy	8000	2129.8	3399.9	3713.52**	4046.52	4414.13	4817**	5225
Scondry no. 2	12000	2962.2	4643.3	4703.34	4743.36	4783.39**	4823.4	4863.4
(4) Sharq	34000	23594	34464	34910*	35207.1	35504.2	35801**	36098
sydi beshr	150000	89044	127619	129307**	130449	131550	132663**	133764
(1) Sharq	35000	24794	36180*	36686.1	36985.8	37297.9**	37623	37935
(5) Sharq	55000	0	0	0	0	0	0	0
(6) Sharq	84700	70600	101383*	102694	103568	104442**	105316	106190
(2) Sharq	40000	28787	41885*	42426.6	42787.6	43148.7**	43510	43871
	**	mech & elect & civil maintenance works						
	*	station rehabilitation						

(source: ASDCO Master Plan 2009)

Table (1d) : Sewerage systems and pumping stations in West District.

Gharb (West area) pump stations								
Total flow (m³/d)								
max capacity	Average daily	Year 2006(max)	Year 2012 (max)	Year 2017(max)	Year 2022(max)	Year 2027(max)	Year 2032(max)	Year 2037(max)
13000	2113.1	3374.8	3418.43 ^{***}	3447.52	3476.61	3505.7 ^{***}	3534.8	3563.9
8600	530.82	943.86	1034.24 ^{***}	1088.25	1164.73	1289 ^{***}	1389.1	1420.7

Table (1e) : Sewerage systems and pumping stations in Borg El Arab District.

Borg al arab pump station									
Label	Total flow (m3/d)								
	max capacity	Average flow	Year 2006(max)	Year 2012(max)	Year 2017(max)	Year 2022(max)	Year 2027(max)	Year 2032(max)	Year 2037(max)
Abdel Kader Bahary	34600	4290.1	6606.9	7894.97	9402.69 ^{**}	11209.7	12290	12392 ^{**}	12494
Abdel Kader Qibly	34600	4315.9	6644.8	7942.17	9470.18 ^{**}	11302.9	13323	13434 ^{**}	13544
escan el nasria	20000	12579	18651	18892.4 ^{**}	19053.2	19214	19375 ^{**}	19536	19696
Mubarak no. 4b	24000	9769.1	14592	15044.9 ^{**}	15489.9	16001.2	16592 ^{**}	16790	16928
El Kilo 23.5	3000	948.65	1601.8	1904.79 ^{**}	2256.93	2676.71	3177.1 [*]	3266.1	3292.9
Monkhafed Al Takaleef	27900	18005	5860.6	5936.36	5986.88 ^{**}	6037.41	6087.9	6138.4 ^{**}	6189
Merghem	3500	3783.9	3813 [*]	3862.34	3895.21	3928.09 ^{**}	3961	3993.8	4026.7
Mubarak no. 4a	55000	2405.4	26749	27621.1 ^{**}	29669.1	31270	31984 ^{**}	33469	35154
	^{**}	mech & elect & civil works							
	[*]	station rehabilitation							

Table (1f) : Sewerage systems and pumping stations in El Amriya district.

Al amrya pump station									
	Total flow (m3/d)								
label	max capacity	Average flow	Year 2006(max)	Year 2012(max)	Year 2017(max)	Year 2022(max)	Year 2027(max)	Year 2032(max)	Year 2037(max)
Wadi Al Qamar	17280	10026	14964	15157.2	15286.2**	15415.2	15544	15673**	15802
Tala'at Mostafa	57600	13607	20134	20393.9	20567.4	20741**	20915	21088	21262**
Agamy no.2	57600	6862.6	10372	10506	10595.4	10684.8**	10774	10864	10953**
Agamy no3	57600	9003.5	13483	14000.5	14119.6	14238.8**	14358	14477	14596**
Agamy 1	57600	5469.6	8338	8445.78	8517.65	8589.53**	8661.4	8733.3	8805.2**
Al Heesh	55000	50757	73169*	74456.4	75090	75723.7**	76357	76991	77625**
	**	mech & elect & civil works							
	*	station rehabilitation							

(source: ASDCO Master Plan 2009)

Table (1g) : Sewerage systems and pumping stations in Gomrok (Customs) district.

El Gomrok (customs) pump station			
Label	Designed capacity (m3/day)	No. of units	Flow (L/sec)
Ras El Tin	2,160	2	25
El Sanan station	5,000	3	117
Old Qait Bey	144,000	6	834
New Qait Bey	83,000	3	600

Annex 2

Annex 2 : Points of discharge, designed capacities, type of treatment and areas served by Wastewater treatment plants

No	Wastewater TP	Point of discharge	Capacity (m ³ /d)		Type of Treatment	Areas served
			designed	average		
1	East treatment plant	Lake Maryout, dayer el matar drain.	607,000	450,000	Primary (going to secondary)	East of Alexandria through eight main pump stations (El maamora, Abo Kir, Elras elsoda, Sidi bishr, el seiouf, Sporting, Smouha)
2	West Treatment plant	Lake Maryout	462,000	350,000	Primary (going to secondary)	West Alexandria from (ETP & as shown in Map)
3	Iskan Moubarak	El Amriya drain	15,000		Secondary (3 units): Biogest (5000 m ³ /d), Zenon (4000 m ³ /d), A.B.J. (6000 m ³ /d)	Iskan Moubarak 4A, 4B, Iskan merghem, Iskam km 32.5, Iskan Abdel kader, Iskan Zobat el-saaka)
4	El Hannovile (Ard el-Hish) 1 st & 2 nd stage.	Near el Dekhila harbour	50000		Secondary	El-Mex, Dekhila, Ard elhish- Ard Midan, ElShamaadan, mothalath elagami, masaken talaat mostafa)
5	Abis Villages (6 TP)	Surrounding drain within area	3000 (each)		Secondary	
6	Amr Isnad 2 (khorshid)	Amriya drain	15000		Secondary	
7	Amr Isnad 3 (El-Seiouf)	El Kalaa drain	7000		Secondary	12 villages east Alexandria
8	Amr Isnad 4 (El-maamora)	Amriya drain	10000		Secondary	
9	El Amriya treatment plant	Noubariya canal	100000		Secondary (Activated sludge)	
10	El Agamy treatment plant, km 21	West Noubaria drain	200000		Secondary (Activated sludge)	El-agamy, Abou Yousef, shamal bitash, Hanooville
11	Km 26 treatment plant	Maryout Lake	4000		Secondary (activated sludge)	
12	New Borg El Arab TP	Forest	36000		Secondary (Aerated lagoon)	
13	El Noubaria	El Shagaa drain	6800		Secondary	

(Source: GIS Department-ASDCO)

Annex 3

Annex 3 Irrigation and drainage canals in Alexandria



Irrigation canals in Delta



Drainage Canals in delta

Annex 4

Annex 4 : Composted Sludge Quality

Parameter	Date	1/1/2008- 31/1/2008	1/2/2008/- 27/2/2008	1/3/2008- 8/4/2008	9/4/2008- 29/6/2008	1/7/2008- 28/9/2008	4/10/2008- 19/11/2008	18/12/2008- 31/1/2009	1/2/2009- 31/3/2009	Average
Conductivity .d Sm ⁻¹		2.74	2.50	2.35	3.13	3.87	1.61	4.17	3.5	2.98
pH		7.7	7.80	7.22	7.03	7.05	6.05	7.00	7.1	7.12
CaCO ₃ %		3.21	4.14	8.30	7.95	11.6	7.4	7.2	6.7	7.06
Organic Matter %		17.21	34.90	39.20	23.5	39.6	25.81	40.8	46.59	33.45
Total Nitrogen N %		1.02	2.45	2.38	2.28	2.88	2.73	3.8	3.66	3
Available phosphorus mg/kg		260	160	128	190	320	100	105	134	175
K mg/kg		-	770	650	780	720	530	-	920	728
Mn mg/kg		29.58	181	179	184	23.76	40.53	210	152.2	
Fe mg/kg		61.40	117	122	147	159.6	155.5	121.9	676	
Zn mg/kg		116.74	133	141	153	199.5	245.88	1640	782.4	
Cu mg/kg		4.82*	6.25*	28.5*	38*	8.640*	11.64*	307	207	
Ni mg/kg		0.76*	1.89*	19.2	18.6	2.560*		42	35.5	
Cd mg/kg		0.16*	0.28*	0.48*	.044*	0.168*	0.218*	2.7*	1.92*	
Pb mg/kg		14.24*	34.76*	62*	58*	21.30*	0.57*	206	235	
Cr mg/kg		0.174*	0.22*	0.27*	0.26*	0.584*	0.227*	134	133.7	

- **Available**

(Source: Site9N-ASDCO/ Faculty of Agriculture- Soil and water department)

Annex 5

Annex 5 : Egyptian Legal requirements for industrial wastewater.

Table (9) Egyptian Environmental Legal Requirements for Industrial Wastewater						
Parameter (mg/l unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
					Municipal	Industrial
BOD (5day,20 deg.)	60	<600	20	30		
COD	100	<1100	30	40	60	60
pH (Grease)	6-9	6-9.5	6-9	6-9	80	100
Oil & Grease	15	<100	5	5	6-9	6-9
Temperature (deg.)	10 C>avg. temp of receiving body	<43	35	35	10	10
Total Suspended Solids	60	<800	30	30	35	35
Settable Solids	—	<10	—	20	50	50
Total Dissolved Solids	2000	—	800	1200	—	—
Chlorine	—	<10	1	1	—	—

Annex 5 : Egyptian Legal requirements for industrial wastewater..... contd.

Parameter (mg/l unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
					Municipal	Industrial
PO ₄	5	30	1	1	—	10
Total phosphorus		25				
Fluoride	1	<1	0.5	0.5	—	0.5
Cadmium	0.05	0.2	0.01	0.01	—	—
Chromium	1		—	—	Total concentration for theses metals should be: 1 for all flow streams	
Chromium Hexavalent	—	0.5	0.05	0.05		
Copper	1.5	1.5		1		
Iron	1.5		1	1		
Lead	0.5	1	0.05	0.05		
Mercury	0.005	0.2	0.001	0.001	—	—

Annex 5 : Egyptian Legal requirements for industrial wastewater.....contd.

Parameter (mg/l unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
					Municipal	Industrial
Nickel	0.1	1	0.1	0.1	—	—
Silver	0.1	0.5	0.05	0.05	—	—
Zinc	5	≤10	1	1	—	—
Cyanide	0.1	≤0.1	—	—	—	0.1
Total heavy metals	—	Total metals should not exceed 5 mg/l	1	1	1	1

Annex 6

Annex 6

Planned upgrading of Wastewater treatment plants Up to year 2037

No.	Wastewater TP	Planned upgrading	
		1 st option	2 nd option
1	East treatment plant	Increasing capacity with about 350,000 m ³ /d in 2 stages, 1st at 2012, 2 nd at 2032	
2	West Treatment plant	Increasing capacity with about 200,000 m ³ /d. (under bidding)	
3	Iskan Moubarak	Increasing capacity with about 20,000 m ³ /d at 2 stages.	
4	El Hannovile (Ard el-Hish) 1 st & 2 nd stage.	Increasing capacity with about 60,000 m ³ /d in 2 stages.	Increasing capacity with about 30,000 m ³ /d, and diverting some flow of change order 28 to Agamy TP (not determined yet)
5	Amr Isnad 2 (khorshid)	Increasing capacity with about 17.5 thousand m ³ /d (extension July 2011)	
6	Amr Isnad 3 (El-Seiouf)	Increasing capacity with about 10,000 m ³ /d.	
7	Amr Isnad 4 (El-maamora)	Increasing capacity with about 30,000 m ³ /d, in 2 stages. (July 2011)	
8	El Amriya treatment plant	Increasing capacity with about 50,000 m ³ /d to receive flows from king mariout. (End of 2012)	Constructing TP with capacity 50,000 m ³ /d at King mariout, and 50,000 m ³ /d from king mariout to amriya TP.
9	El Agamy treatment plant, km 21	Increasing capacity with about 70,000 m ³ /d in 2 stages to receive flows of change order 124. (Middle 2010)	Increasing capacity with about 105,000 m ³ /d in 2 stages to receive flows of change order 124 and some of change order 28.
10	Km 26 treatment plant		
11	New Borg El Arab TP	Extension (under construction)	
12	El Noubaria	Under design and bidding	
13	ABIS 10 th treatment plant	Increasing capacity with about 15,000 m ³ /d. (within 3 years)	
14	ABIS 1 st treatment plant.	Increasing capacity with about 8,000 m ³ /d. (June 2010)	
15	ABIS 2 nd treatment plant.	Increasing capacity with about 8,000 m ³ /d. (June 2010)	
16	ABIS 3 rd treatment plant.	Increasing capacity with about 8,000 m ³ /d. (June 2010)	
17	ABIS 4 th treatment plant.	Increasing capacity with about 8,000 m ³ /d. (June 2010)	

Annex 7

Annex 7 : Priority pollutants in industrial discharge East and West wastewater Treatment Plants.

Company Name	Received WWTP	Industrial Sector	Flow (m ³ /month)	Flow (m ³ /year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Zahran	Eastern	Metallurgical	2472	29664	200	250	405.5	3.2	13	0.75	139	
Vesta For Textile	Eastern	Textile	3686	44232	960	1700	2647.5	3.2	179.5	5.55	1.93	COD-BOD-TSS-O&G
Western Delta Bus	Eastern	Petroleum	1500	18000	200	250	605	1.2	36.5	0.35	1.925	
Geverx	Eastern	Food	2160	25920	200	250	341.5	1.2	15	0.7	1.355	
General Authority for transportation	Eastern	Petroleum	1500	18000	440	980	1409.5	220.6	141	3.895	31.015	COD-BOD-O&G
Nile for Matches	Eastern	Chemicals	12500	150000	200	250	263	0.4	14.5	0.25	3.68	
Starch and Yeast	Eastern	Food	22170	266040	205	238	2712	2.8	526	3.81	5.2	
Extracted Oil	Eastern	Food	45959	551508	700	1200	454.5	2.2	8	0.1	21.79	COD-BOD-TSS-O&G
Nozha Dyeing shop	Eastern	Textile	3690	44280	250	345	79	4	4	0	3.86	
Nasr for Textile- STIA-unit 9	Eastern	Textile	10000	120000	330	350	885.5	2.4	17	0.3	0.725	
Nasr for Textile- -STIA-unit 1	Eastern	Textile	2159	25908	6500	3200	24259.5	18	262	65		COD-BOD-TSS-O&G
Ahram for Metals	Eastern	Metallurgical	1212	14544	380	550	973.5	3.6	17.5	9.6	4.311	
Primo Graph Printing house	Eastern	Chemicals	2400	28800	210	252	2700	1.8	111.5	3.9	1.045	
Swissa for chocolate	Eastern	Food	2882	34584	3520	1450	17623.5	8.6	334.5	3.775	8.79	COD-BOD-TSS-O&G
Mohamed Mahmoud Company	Eastern	Metallurgical	150	1800	250	360	625.5	1.6	38.5	1	5.13	
Ragab Abass Marble workshop	Eastern	Construction	120	1440	310	270	908	0.4	15	0.55	5.24	
Salama Marble workshop	Eastern	Construction	75	900	550	1976	2462	0.4	40	5.6	3.725	COD-TSS-O&G
Egyptian Co. for Marble and Granite	Eastern	Construction	120	1440	450	1100	1488	0.6	46	3.6	6.5	COD-TSS-O&G
Al-Amal for Marble and Granite	Eastern	Construction	150	1800	680	1700	2057	0.4	31.5	2.6	5.03	COD-BOD-TSS-O&G
El-Shark for Marble and Granite	Eastern	Construction	120	1440	360	610	1142.5	0.4	25	1.7	4.235	
Eastren Company- Elrasafa	Eastern	Chemicals	1700	20400	375	850	1560.5	9.4	54.5	9.05	1.92	COD-TSS-O&G
Elsayed Farag Marble workshop	Eastern	Construction	80	960	223	463	347	0.4	8	0.4	6.59	
El-Hoda Marble workshop	Eastern	Construction	80	960	500	1000	1042	0.4	41	0.9	3.09	COD-TSS-O&G
Nazar Marble workshop	Eastern	Construction	75	900	525	1500	1316.5	1	23	1.25	6.97	COD-TSS-O&G
Elmadena Elmonawra Marble	Eastern	Construction	75	900	540	1500	1953.5	3	36	5.8	7.265	COD-TSS-O&G

Company Name	Received WWTP	Industrial Sector	Flow (m³/month)	Flow (m³/year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
workshop												
Elmotaheda2000 Marble workshop	Eastern	Construction	80	960	332	240	1686	0.4	38	2.7	6.29	
Shrefe Abo Elkher Marble workshop	Eastern	Construction	80	960	530	2250	552	0.4	7.5	0.55	5.955	COD-TSS-O&G
El-Ashakaa Marble workshop	Eastern	Construction	80	960	210	450	2357.5	0.6	48	2.9	10.09	
Hassan Ali Marble workshop	Eastern	Construction	80	960	150	350	604.5	0.4	15.5	0.55	7.245	
Ahmed Mohamed Marble workshop	Eastern	Construction	80	960	230	3421	849	0.4	7.5	0.25	11.24	COD-TSS-O&G
Hamdy Elsayed Marble workshop	Eastern	Construction	75	900	650	1800	733	1	17	0.45	14.025	BOD-TSS
El-Shazly for Plastics	Eastern	Chemicals	200	2400	200	250	1042	1.2	33	2.2	14.1	
Art for Industrial Construction	Eastern	Construction	125255	1503060	255	375	151.5	1.6	12.5	0.1	8.96	
Karkour Dyeing shop	Eastern	Chemicals	2894	34728	200	250	649	0.4	51	2.4	5.86	
Alexandria for oil and Soap	Eastern	Food	2014	24168	190	240	266	2.6	9.5	0.8	3.965	
El-Nile for transportation	Eastern	Petroluem	3060	36720	600	2800	263.5	4.6	31	0.65	29.03	COD-BOD-TSS-O&G
Rasheda Ali for Textile	Eastern	Textile	13851	166212	900	2850	1813	357	105.5	13.4	29.29	COD-BOD-TSS-O&G
Moharm Press	Eastern	Chemicals	5552	66624	450	120	2228.5	3.2	225	28.25	28.41	COD-TSS-O&G
El-Nasar for Textile	Eastern	Textile	48710	584520	218	406	1463.5	4	82	52.2	30.38	
El-Nozha Dyeing shop	Eastern	Textile	5553	66636	250	345	395.5	1.5	31	2.45		
Eastren Company- Suez Canal	Eastern	Chemicals	3450	41400	800	920	3120.5	3.4	27	2.95	31.315	COD-BOD-TSS-O&G
El-Shimaa Marble workshop	Eastern	Construction	80	960	210	800	989	2.8	8	1	14.4	TSS
El-Ekhlal Marble workshop	Eastern	Construction	80	960	120	700	190	10	13.5	6.85	7.2962	
El-Torky Marble workshop	Eastern	Construction	75	900	250	625	552	1.6	13.5	0.55	6.145	
Elsafawemarawa Marble workshop	Eastern	Construction	80	960	1030	4500	2592.5	0.8	34	0.635	3.885	COD-BOD-TSS-O&G
Abanbko Marble workshop	Eastern	Construction	80	960	275	650	544	3.2	14.5	2	27.42	
El-malhey Marble workshop	Eastern	Construction	80	960	450	1500	954	1.4	45	0.2	16.53	TSS
Samy Hamed Marble workshop	Eastern	Construction	75	900	110	6500	228	2.2	12.5	1.1	9.055	TSS

Company Name	Received WWTP	Industrial Sector	Flow (m ³ /month)	Flow (m ³ /year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Mohamed Fayz Marble workshop	Eastern	Construction	75	900	180	640	509	0.8	8	0.6	11.855	TSS
Alaa Saied Marble workshop	Eastern	Construction	80	960	720	1450	5.5	1.2	12	4.2	12.3	BOD-TSS
Naglaa Hassan Marble workshop	Eastern	Construction	75	900	205	406	370.5	0.6	11	0.05	9.765	
Shawky Mohamed Marble workshop	Eastern	Construction	75	900	250	445	824.5	1.4	33.5	0.75	19.995	
Mohamed Ali Marble workshop	Eastern	Construction	75	900	118	8365	485	1	19	5.05	4.45	TSS
Zamzam Marble workshop	Eastern	Construction	75	900	136	6100	542	1	13	4.05	0.142	TSS
El-Islam Marble workshop	Eastern	Construction	80	960	118	1374	503.5	0.6	15	0.5	0.63	TSS
Elsayed Abdelghany Marble workshop	Eastern	Construction	140	1680	245	584	9451	5.2	326	9.2	3.19	
Alexandria for Metal Product	Eastern	Metallurgical	380	4560	420	800	1052	1	68	5.6	1.475	TSS
El-Oroba for Papers	Eastern	Chemicals	800	9600	431	611	1044.5	2.8	68.5	4.1	15.295	
Salt & Soda Co.	Eastern	Food	9295	111540	420	810	1257	1.2	78.5	6.5	1.39	COD-TSS-O&G
Angal Marble workshop	Eastern	Construction	156	1872	565	1010	1160	1.4	52	1.2	4.03	TSS
Mamdouh Ismael Marble workshop	Eastern	Construction	80	960	440	747	371	1.6	8	0.6	3.7	
El-Nahda for Textile	Eastern	Textile	8350	100200	330	643	1221	2.2	40	4.25	10.545	
Lozan for Garment	Eastern	Textile	2000	24000	450	745	1744.5	10.6	53	4.05	1.94	
Sesta for Garment	Eastern	Textile	2451	29412	460	660	1044.5	12	54.5	4.1	2.645	
Neaza Co.	Eastern	Chemicals	1670	20040	185	243	10	16	97	5.2	1.36	
Transportation and Engineering Co.	Eastern	Chemicals	81370	976440	900	1518	501	5	9	0.75	2.62	COD-BOD-TSS-O&G
Alexandria National for Cars (Mercedes)	Eastern	Petroleum	680	8160	750	2350	2772	11.8	134	5.1	3.8	COD-BOD-TSS-O&G
Elyonania Dyeing shop	Eastern	Textile	2344	28128	188	233	270	2.2	18	0.75	1.7	
Eldeek Elzahby Dyeing shop	Eastern	Textile	3176	38112	220	276	643.5		41.5	2.45	8.76	
El-Helb Printing house	Eastern	Chemicals	250	3000	320	350	1190	2.8	16	3.7	3.89	
Arabsco Co.	Eastern	Food	3112	37344	422	910	1379.5	10.4	95	18.15	1.75	TSS
Elbatekhy Marble workshop	Eastern	Construction	80	960	400	1400	1262	8.2	46	0.75	4.405	TSS

Company Name	Received WWTP	Industrial Sector	Flow (m ³ /month)	Flow (m ³ /year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Fardous Mohamed Marble workshop	Eastern	Construction	80	960	300	2100	1007.5	5.2	19	3.95	3.37	TSS
El-Nahda for Soap	Eastern	Chemicals	80	960	215	244	162	2.2	16	7	8	
Amr Khalaf Marble workshop	Eastern	Construction	80	960	320	1605	1042.5	0.8	20	1.8	5.54	TSS
El-Maazon Marble workshop	Eastern	Construction	80	960	350	1050	1164.5	8.2	41	3.3	3.415	TSS
Damanhour for Carpets	Eastern	Textile	189	2268	189	235	198.5	0.8	8.5	0.1	6.2245	
Kandel Dyeing shop	Eastern	Textile	925	11100	191	206	239.5	0.8	6	0.05	5.3445	
Krouna for chocolate	Eastern	Food	5234	62808	198	241	155	1.6	13	7.1	3.57	
Alexandria Marble workshop	Eastern	Construction	80	960	323	3000	967.5	8.6	50	2.1	7.755	TSS
Sinia Marble workshop	Eastern	Construction	80	960	196	218	768.5	4.2	43.5	0.9	6.98	
Mohamed Ahmed Marble workshop	Eastern	Construction	80	960	445	752	429.5	9.6	5.5	0.55	4.755	
North Flour Mills Manufacturing	Eastern	Metallurgical	1490	17880	340	814	1053.5	1.4	61.5	13.5	9.48	TSS
Mohamed Abdo Marble workshop	Eastern	Construction	75	900	210	236	955	1	27.5	7.2	4	
Ahmed Elsayed Marble workshop	Eastern	Construction	75	900	270	741	1202	0.4	66.5	7.95	3.42	
Kabaa Marble workshop	Eastern	Construction	75	900	245	1044	811.5	0.4	36	0.35	7.625	TSS
Essam Ali Marble workshop	Eastern	Construction	75	900	645	869	1366.5	0.4	32	5.2	0.56	BOD-TSS
Ibrahim Abass Marble workshop	Eastern	Construction	80	960	165	244	577	2	11	5.25	18.425	
Ali Kabary Marble workshop	Eastern	Construction	80	960	175	233	239.5	0.6	7.5	1.28	19.035	
Etmad Marble workshop	Eastern	Construction	80	960	183	236	1002	0.4	13.4	3.8	20.945	
Alaa Mansour Marble workshop	Eastern	Construction	80	960	330	782	911	0.4	0.8	0.5	14.583	
Bn laden Marble workshop	Eastern	Construction	80	960	320	1241	1095	0.8	25	1.3	7.44	TSS
Ali El-Khadeeb Marble workshop	Eastern	Construction	80	960	245	564	1095	0.6	15	2.2	10.7	
Ahmed Ali Marble workshop	Eastern	Construction	80	960	312	315	985	0.6	16	0.2	18.98	
Ali El-Tayb Marble workshop(1)	Eastern	Construction	80	960	305	306	1037	0.6	13	1.3	19.38	
Ali El-Tayb Marble workshop(2)	Eastern	Construction	80	960	650	1040	1989	0.4	127	5.2	20.66	BOD-TSS

Company Name	Received WWTP	Industrial Sector	Flow (m³/month)	Flow (m³/year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
El-Esraa Marble workshop	Eastern	Construction	75	900	281	1511	1821	0.4	123	9	22.2	TSS
Saied Hafez Marble workshop	Eastern	Construction	75	900	220	2655	3158	1.2	21	55.65	9.12	TSS
Hussien Ali Marble workshop	Eastern	Construction	75	900	165	224	363	0.8	4	0	7.66	
Kamel Mohamed Marble workshop	Eastern	Construction	283	3396	283	771	493	0.4	12	2.1	9.07	
Mohamed Mohamed Marble workshop	Eastern	Construction	80	960	485	3459	595	0.4	9	4.7	16.6	TSS
Mabrouka Marble workshop	Eastern	Construction	80	960	112	1056	747	0.4	11	5.4	8.5	TSS
El-Romany Marble workshop	Eastern	Construction	75	900	468	1006	343	0.4	12	3.2	9.73	TSS
Mohamed Abd-Elhady Marble workshop	Eastern	Construction	75	900	438	1085	432	0.4	8	4.5	12.29	TSS
Ibrahim Abd-Elaziz Marble workshop	Eastern	Construction	75	900	326	500	111	0.4	4	0	14.33	
Kamara for Blankets	Eastern	Textile	340	4080	198	244	884	0.4	22	0.1	13.96	
Nagy Rezk for Spinning & Weaving	Eastern	Textile	40304	483648	142	160	505	4	16	0.3	8.74	
Totex for Garment	Eastern	Textile	350	4200	240	547	1516	0.4	48	1.2	3.97	
Mohamadia for Construction	Eastern	Construction	140	1680	100	345	393	0.4	4	1	16.49	
Aid Salah Marble workshop	Eastern	Construction	80	960	125	831	940	1.6	12	15	16.8	TSS
Mohamed El-Sayed Marble workshop	Eastern	Construction	80	960	315	1484	980	2	8	13	16.01	TSS
Ashraf Hamedo Marble workshop	Eastern	Construction	80	960	122	532	414	1.6	14	0.4	27.7	
Ahmed Refay Marble workshop	Eastern	Construction	80	960	270	610	516	2	6	0.3	19.17	
Elsalam for Golden Products	Eastern	Metallurgical	410	4920	155	233	528.5	4.3	4	0.3	17.925	
Alexandria for Manufacturing	Western	Food	240	2880	210	237	390	2	38	1	2.75	
Elwatany for Flour of sesama	Western	Food	85	1020	148	213	235	0.8	8.5	14.2	1	
Antonio for Macaroni	Western	Food	3678	44136	295	270	518	1.4	10	1.1	1.5	
Elbadal Elromany Tannery3	Western	Chemicals	200	2400	975	3083	7460	30	123.5	2.15	0.9	COD-BOD-TSS-O&G
Awlad Elshafay Tannery 1	Western	Chemicals	180	2160	720	886	5439.5	46	131	1.78	0.9	COD-BOD-TSS-O&G

Company Name	Received WWTP	Industrial Sector	Flow (m³/month)	Flow (m³/year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Awlad Elshafay Tannery 2	Western	Chemicals	250	3000	1650	953	1193	9	101	0.88	0.9	COD-BOD-TSS-O&G
Emad Hanna Tannery	Western	Chemicals	200	2400	2940	1681	7333	42	126	0.75	0.5	COD-BOD-TSS-O&G
Elbadal Elromany Tannery 1	Western	Chemicals	180	2160	370	400	1473	9.6	76.5	0.65	0.5	
Elbadal Elromany Tannery 2	Western	Chemicals	200	2400	420	457	1291	4.2	27	0.5	2.6	
Mohamed Khames Tannery	Western	Chemicals	200	2400	950	844	1832	6	200	7.8	2.72	COD-BOD-TSS-O&G
Ibrahim El-Maghrby Tannery	Western	Chemicals	200	2400	673	723	803	2.2	54	14.16	3.3	COD-BOD-TSS-O&G
Mahmoud Kabary Tannery	Western	Chemicals	250	3000	1195	2000	6569	61.4	122	15.46	4.24	COD-BOD-TSS-O&G
Ahmed Shahin Tannery	Western	Chemicals	250	3000	1125	1831	4959	11.8	67.5	8.5	2.5	COD-BOD-TSS-O&G
Ekhwan AboSena Tannery	Western	Chemicals	240	2880	905	1093	972	9.4	39	3.1	5.6	COD-BOD-TSS-O&G
Amar Tannery	Western	Chemicals	240	2880	705	1107	1435	7.6	115	9.04	1.4	COD-BOD-TSS-O&G
Abd-Elwahab workshop for Thread	Western	Textile	200	2400	4240	4873	7380	10.2	217	13.5	1.7	COD-BOD-TSS-O&G
Ahmed Ahmed Shahin Tannery	Western	Chemicals	400	4800	8273	11409	14608	7.2	472	5.05	1.9	COD-BOD-TSS-O&G
Adel Mostafa Tannery	Western	Chemicals	200	2400	1612	2280	8529	67	435	15.1	3.15	COD-BOD-TSS-O&G
Feola Co.	Western	Chemicals	3240	38880	702	1105	1805	2.2	60.5	5.6	1.38	COD-BOD-TSS-O&G
Art for Decore	Western	Construction	140	1680	596	490	1705	3.4	64.5	5.4	3.6	
Elnesr for Soap	Western	Chemicals	200	2400	588	491	1046.5	5.4	147.5	14.35	5.475	
El-Eman Dyeing shop	Western	Textile	114	1368	332	450	1516	1.6	19.5	8.5	1.32	
Elthager Marble workshop	Western	Construction	120	1440	842	2021	613.5	0.4	13	4.6	1.7	COD-BOD-TSS
Al Sharbia for Dairy Product	Western	Food	5310	63720	428	193	2611	2	11.8	11.8	2.7	
Abd-Elaal El-Sayed Marble workshop	Western	Construction	120	1440	244	420	324.5	2.4	15	8	3.125	
Melatex Textile	Western	Textile	600	7200	696	937	2502	10.4	60	6.75	3.1	COD-BOD-TSS
El-Nile for Chemicals	Western	Textile	500	6000	112	68	516	5.2	18.5	8.45	3.55	
El-Nile for transportation	Western	Petroluem	1500	18000	314	169	379.5	2	24	7.15	1.1	
El-Nile for Trucks	Western	Petroluem	600	7200	1660	3824	2190.5	13.2	63.5	2.2	3.1	COD-BOD-TSS
Public Tranportation Authority Garage-Betash	Western	Petroluem	400	4800	264	242	636	1.4	48.9	2.85	4.25	

Company Name	Received WWTP	Industrial Sector	Flow (m³/month)	Flow (m³/year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Al-Alamia for Plastics	Western	Chemicals	2000	24000	146	302	1608.5	10.8	48.5	7.75	3.1	
Abo Elhoul for Wires	Western	Chemicals	140	1680	264	320	483	3.3	19	4.35	0.5	
El-Sharief Dyeing shop	Western	Textile	4500	54000	282	413	419.5	4	14.5	6.3	26.85	pH
Dahab for Biscuit	Western	Food	1100	13200	442	528	516.5	3.4	35.5	7.65	1.6	
Public Transportation Authority Garage- Elmnshya	Western	Petroluem	262	3144	262	181	644.5	5	41	2.9	0.7	
El-handsia for Cars manufacturing	Western	Petroluem	810	9720	580	1311	1201.5	3	35	7.75	3.5	COD-TSS
Millon for Garment	Western	Textile	500	6000	311	154	562	1.4	15	8.05	1.05	
El-Nasr Tannery	Western	Chemicals	1000	12000	76	157	281	3	13	5.85	1.4	
Alexandria for Oil and Soap 2	Western	Food	1810	21720	1420	2452	380	0.8	9.5	30.4	1.45	COD-BOD-TSS-O&G
Artef Cosmetics	Western	Chemicals	100	1200	1440	1694	1593	1.6	58	7.45	5.95	COD-BOD-TSS-O&G
Shamaadan for Food Industries	Western	Food	6000	72000	365	379	1685.5	8	32	7.75	3.3	
Alexandria for Oil and Soap - Bahry 1	Western	Food	4974	59688	84	89	154	1.8	9.5	10.95	2.05	
Alexandria for Oil and Soap - Bahry 2	Western	Food	335	4020	742	2822	3425.5	2.8	165	0.415	0.95	COD-BOD-TSS-O&G
Ahmed Ahmed Shahin (Elmesyo)Tannery	Western	Chemicals	200	2400	1491	2620	4035.5	36	168.5	5.9	2.75	COD-BOD-TSS-O&G
Kalash Tannery	Western	Chemicals	250	3000	342	147	618	3.4	13	7.7	1.65	
Mahmoud Ibrahim Tannery	Western	Chemicals	200	2400	2185	4759	8262	34	206	2.25	1.05	COD-BOD-TSS-O&G
Ahmed Bayoumy Tannery	Western	Chemicals	200	2400	107	267	1453	7.6	56.5	1.27	1.055	
Hanna Nassem Tannery	Western	Chemicals	200	2400	900	2656	6772.5	24	190.5	7.05	2.25	COD-BOD-TSS-O&G
El-Salam for Papers	Western	Chemicals	2800	33600	1020	2770	4210	1	449	2	1.13	COD-BOD-TSS-O&G
El-Nahda for confectionary	Western	Food	4000	48000	2917	5806	7494	2.8	209	4.85	1.54	COD-BOD-TSS-O&G
El-Shamy Tannery	Western	Chemicals	250	3000	1610	2523	3035	98.2	92.75	13.3	0.86	COD-BOD-TSS-O&G
Houda Tannery	Western	Chemicals	200	2400	480	841	1887	29.6	77.5	3.25	0.8	COD-TSS-O&G
Ghareeb Tannery	Western	Chemicals	250	3000	760	936	1656	7.8	22.5	1.05	1.55	COD-BOD-TSS-O&G
Abd-Reheem Ali Tannery	Western	Chemicals	250	3000	542	884	313	2.2	14	1.55	2.76	COD-TSS-O&G

Company Name	Received WWTP	Industrial Sector	Flow (m³/month)	Flow (m³/year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Mohamed Hassan for Soap	Western	Chemicals	314	3768	3380	2856	10036.5	15.8	422	4	1.85	COD-BOD-TSS-O&G
Misr Aluminium Stores	Western	Chemicals	160	1920	160	200	712.5	1	91.5	4.95	3.18	
El-Nile for Goods Transportation	Western	Petroluem	250	3000	440	855	3098	0.4	409.5	2.5	1.035	COD-TSS-O&G
Bata	Western	Chemicals	290	3480	280	226	237	0.8	46	5.45	2.3	
Abdo Farhat for Oils	Western	Food	350	4200	415	601	9009.5	6	51.5	1.05	3.04	
Gesr Mix for Concrete	Western	Construction	4200	50400	680	1068	1276	6.4	125	0.9	2.45	COD-BOD-TSS-O&G
Mohamed Atef El-Sayed Tannery 1	Western	Chemicals	200	2400	1805	3328	5089	10.4	111	6.87	0.925	COD-BOD-TSS-O&G
Efat Beshara Tannery	Western	Chemicals	200	2400	1220	2179	3412.5	102	43	1.05	1.395	COD-BOD-TSS-O&G
Farouk Kalash Tannery	Western	Chemicals	250	3000	1350	2843	671	2.2	10.5	1.54	1.175	COD-BOD-TSS-O&G
OmEl-Nour Tannery	Western	Chemicals	140	1680	1961	3115	7391.5	64	163	0.82	0.68	COD-BOD-TSS-O&G
Extracted Oil-Mahmoudia	Western	Food	630	7560	630	888	1293	0.8	74	11.6	0.96	COD-BOD-TSS-O&G
Zefelah Marble workshop	Western	Construction	120	1440	172	494	310	0.8	4	22	0.78	
Bacine for Paints	Western	Chemicals	400	4800	120	773	189	6.4	8	1	4.8	
Elnemr for Glue	Western	Chemicals	250	3000	950	793	0	0	0	0	0	COD-BOD
Gaber Shehata Tannery	Western	Chemicals	250	3000	1075	757	3452	9.4	101.5	13.69	0.91	COD-BOD
Elshemy Tannery	Western	Chemicals	250	3000	1525	1677	2915.5	30	91	17.5	2.55	COD-BOD-TSS
Attallah Co.	Eastern	Chemicals	250	3000	261	447	799.5	2.4	16	3.926	0.25	
Moharm Press-Bakous	Eastern	Chemicals	2600	31200	140	118	486.5	2.8	8.5	1.68	1.335	
Egyptian Copper 1	Eastern	Chemicals	20800	249600	750	828	1307.5	3	50.5	0.8615	0.9255	COD-BOD-TSS-O&G
Arabia for Spinning & Weaving	Eastern	Textile	10188	122256	280	259	538.5	1.4	21.5	1.0565	1.0955	
Starch and Yeast 1-Abo Soliman	Eastern	Food	28000	336000	525	615	846	0.4	28	9.286	2.554	
Senyoreta May- Egypt	Eastern	Food	2500	30000	727	1464	2554	2.7	91.5	3.512	7.235	COD-BOD-TSS-O&G
El-Helal for Knitwear	Eastern	Textile	27738	332856	227	345	1035	1.6	15.5	8.2325	2.625	
Waal Dyeing shop	Eastern	Textile	15000	180000	43	56	255	1.2	17	1.82	5.85	
El-Nasr for Textile-STIA	Eastern	Textile	1185	14220	2585	995	2825	6.8	587	2.3	1.735	COD-BOD-TSS-O&G
Kandy for Confectionary	Eastern	Food	253	3036	265	520	805	0.4	18	1.08	2.62	
African for Packing	Eastern	Chemicals	213	2556	192	175	652.5	2.4	33.5	1.175	4.175	

Company Name	Received WWTP	Industrial Sector	Flow (m ³ /month)	Flow (m ³ /year)	BOD (mg/l)	TSS (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)	Non-Compliance Reasons
Plastic & Electrical Co.	Eastern	Chemicals	1000	12000	415	450	1056	2.4	66	1.197	0.65	
San Govany	Eastern	Food	450	5400	415	562	1672	2.6	29	2.31	4.385	
Samer for Biscuit	Eastern	Food	885	10620	56	74	138	0.4	4	1.175	0.186	
San Peter for Confectionary	Eastern	Food	2500	30000	150	393	325.5	1.2	10	3.99	0.2495	
Sangam for Biscuit	Eastern	Food	1026	12312	63	148	621	0.4	18	2.135	0.3925	COD-TSS-O&G
Abo Keer slaughterhouse	Eastern	Food	3295	39540	655	807	2403.5	12.8	56	6.35	2.76	COD-BOD-TSS-O&G
Power Station - Elsyouf	Eastern	Power	5000	60000	265	417	816.5	3.8	41.5	0.72	1.65	
Alexandria for pharmaceutical	Eastern	Chemicals	9368	112416	200	273	507.5	3.6	18.5	2.65	2.285	
Makres for Glue	Eastern	Chemicals	2197	26364	1220	1629	2614.5	9.2	98.5	5.86	1.38	COD-BOD-TSS-O&G
El-Zahraa for Flour of sesama	Eastern	Food	1424	17088	121	215	479.5	0.8	15.5	2.39	0.69	
Onion Dehydration Co.	Eastern	Food	3200	38400	1025	427	1762.5	3.6	57	3.74	1.235	COD-BOD-TSS-O&G
Mohame Mahmoud for Metals	Eastern	Metallurical	250	3000	297	465	594.5	8	12	4.45	0.92	
Public Transportation Authority Garage-Sidi Beshr	Eastern	Petroluem	3000	36000	425	908	783	1.2	24.5	4.94	0.09	COD-BOD-TSS-O&G
Arabia for Spinning & Weaving- Unit 6	Eastern	Textile	42416	508992	268	650	588.5	1	19	3.27	2.34	
Meyamy Print House	Eastern	Textile	800	9600			1831.5	9.8	20	1.024	2.274	COD-TSS-O&G
Dairy Factory	Eastern	Food	1616	19392	665	821	1286.5	0.6	27.5	2.62	1.04	COD-BOD-TSS-O&G
Nefertiti Dyeing Shop	Eastern	Textile	31434	377208	144	74	727.5	0.4	8	6.5465	1.75	
Edfina	Eastern	Food	45700	548400	375	466	883	1.6	23	3.819	1.655	
Seclam	Eastern	Food	24899	298788	945	808	4021	0.4	106	11.852	1.66	COD-BOD-TSS-O&G
Bisco Misr	Eastern	Food	5000	60000	180	171	239	0.4	9	0.175	1.55	

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Nile for Matches	Chemicals	Eastern	12500	500	250	200	263	0.4	14.5	0.25	3.68
Primo Graph Printing house	Chemicals	Eastern	2400	96	252	210	2700	1.8	111.5	3.9	1.045
Eastren Company- Elrasafa	Chemicals	Eastern	1700	68	850	375	1560.5	9.4	54.5	9.05	1.92
El-Shazly for Plastics	Chemicals	Eastern	200	8	250	200	1042	1.2	33	2.2	14.1
Karkour Dyeing shop	Chemicals	Eastern	2894	115.76	250	200	649	0.4	51	2.4	5.86
Moharm Press	Chemicals	Eastern	5552	222.08	120	450	2228.5	3.2	225	28.25	28.41
Eastren Company- Suez Canal	Chemicals	Eastern	3450	138	920	800	3120.5	3.4	27	2.95	31.315
El-Oroba for Papers	Chemicals	Eastern	800	32	611	431	1044.5	2.8	68.5	4.1	15.295
Neaza Co.	Chemicals	Eastern	1670	66.8	243	185	10	16	97	5.2	1.36
Transportation and Engineering Co.	Chemicals	Eastern	81370	3254.8	1518	900	501	5	9	0.75	2.62
El-Helb Printing house	Chemicals	Eastern	250	10	350	320	1190	2.8	16	3.7	3.89
El-Nahda for Soap	Chemicals	Eastern	80	3.2	244	215	162	2.2	16	7	8
Attallah Co.	Chemicals	Eastern	250	10	447	261	799.5	2.4	16	3.926	0.25
Moharm Press-Bakous	Chemicals	Eastern	2600	104	118	140	486.5	2.8	8.5	1.68	1.335
Egyptian Copper 1	Chemicals	Eastern	20800	832	828	750	1307.5	3	50.5	0.8615	0.9255
African for Packing	Chemicals	Eastern	213	8.52	175	192	652.5	2.4	33.5	1.175	4.175
Plastic & Electrical Co.	Chemicals	Eastern	1000	40	450	415	1056	2.4	66	1.197	0.65
Alexandria for pharmaceutical	Chemicals	Eastern	9368	374.72	273	200	507.5	3.6	18.5	2.65	2.285
Makres for Glue	Chemicals	Eastern	2197	87.88	1629	1220	2614.5	9.2	98.5	5.86	1.38
Ragab Abass Marble workshop	Construction	Eastern	120	4.8	270	310	908	0.4	15	0.55	5.24
Salama Marble workshop	Construction	Eastern	75	3	1976	550	2462	0.4	40	5.6	3.725
Egyptian Co. for Marble and Granite	Construction	Eastern	120	4.8	1100	450	1488	0.6	46	3.6	6.5
Al-Amal for Marble and Granite	Construction	Eastern	150	6	1700	680	2057	0.4	31.5	2.6	5.03
El-Shark for Marble and Granite	Construction	Eastern	120	4.8	610	360	1142.5	0.4	25	1.7	4.235

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Elsayed Farag Marble workshop	Construction	Eastern	80	3.2	463	223	347	0.4	8	0.4	6.59
El-Hoda Marble workshop	Construction	Eastern	80	3.2	1000	500	1042	0.4	41	0.9	3.09
Nazar Marble workshop	Construction	Eastern	75	3	1500	525	1316.5	1	23	1.25	6.97
Elmadena Elmonawra Marble workshop	Construction	Eastern	75	3	1500	540	1953.5	3	36	5.8	7.265
Elmotaheda2000 Marble workshop	Construction	Eastern	80	3.2	240	332	1686	0.4	38	2.7	6.29
Shrefe Abo Elkher Marble workshop	Construction	Eastern	80	3.2	2250	530	552	0.4	7.5	0.55	5.955
El-Ashakaa Marble workshop	Construction	Eastern	80	3.2	450	210	2357.5	0.6	48	2.9	10.09
Hassan Ali Marble workshop	Construction	Eastern	80	3.2	350	150	604.5	0.4	15.5	0.55	7.245
Ahmed Mohamed Marble workshop	Construction	Eastern	80	3.2	3421	230	849	0.4	7.5	0.25	11.24
Hamdy Elsayed Marble workshop	Construction	Eastern	75	3	1800	650	733	1	17	0.45	14.025
Art for Industrial Construction	Construction	Eastern	125255	5010.2	375	255	151.5	1.6	12.5	0.1	8.96
El-Shimaa Marble workshop	Construction	Eastern	80	3.2	800	210	989	2.8	8	1	14.4
El-Ekhlal Marble workshop	Construction	Eastern	80	3.2	700	120	190	10	13.5	6.85	7.2962
El-Torky Marble workshop	Construction	Eastern	75	3	625	250	552	1.6	13.5	0.55	6.145
Elsafawemarawa Marble workshop	Construction	Eastern	80	3.2	4500	1030	2592.5	0.8	34	0.635	3.885
Abanbko Marble workshop	Construction	Eastern	80	3.2	650	275	544	3.2	14.5	2	27.42
El-malhey Marble workshop	Construction	Eastern	80	3.2	1500	450	954	1.4	45	0.2	16.53
Samy Hamed Marble workshop	Construction	Eastern	75	3	6500	110	228	2.2	12.5	1.1	9.055
Mohamed Fayz Marble workshop	Construction	Eastern	75	3	640	180	509	0.8	8	0.6	11.855
Alaa Saied Marble workshop	Construction	Eastern	80	3.2	1450	720	5.5	1.2	12	4.2	12.3
Naglaa Hassan Marble	Construction	Eastern	75	3	406	205	370.5	0.6	11	0.05	9.765

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
workshop											
Shawky Mohamed Marble workshop	Construction	Eastern	75	3	445	250	824.5	1.4	33.5	0.75	19.995
Mohamed Ali Marble workshop	Construction	Eastern	75	3	8365	118	485	1	19	5.05	4.45
Zamzam Marble workshop	Construction	Eastern	75	3	6100	136	542	1	13	4.05	0.142
El-Islam Marble workshop	Construction	Eastern	80	3.2	1374	118	503.5	0.6	15	0.5	0.63
Elsayed Abdelghany Marble workshop	Construction	Eastern	140	5.6	584	245	9451	5.2	326	9.2	3.19
Angal Marble workshop	Construction	Eastern	156	6.24	1010	565	1160	1.4	52	1.2	4.03
Mamdouh Ismael Marble workshop	Construction	Eastern	80	3.2	747	440	371	1.6	8	0.6	3.7
Elbatekhy Marble workshop	Construction	Eastern	80	3.2	1400	400	1262	8.2	46	0.75	4.405
Fardous Mohamed Marble workshop	Construction	Eastern	80	3.2	2100	300	1007.5	5.2	19	3.95	3.37
Amr Khalaf Marble workshop	Construction	Eastern	80	3.2	1605	320	1042.5	0.8	20	1.8	5.54
El-Maazon Marble workshop	Construction	Eastern	80	3.2	1050	350	1164.5	8.2	41	3.3	3.415
Alexandria Marble workshop	Construction	Eastern	80	3.2	3000	323	967.5	8.6	50	2.1	7.755
Sinia Marble workshop	Construction	Eastern	80	3.2	218	196	768.5	4.2	43.5	0.9	6.98
Mohamed Ahmed Marble workshop	Construction	Eastern	80	3.2	752	445	429.5	9.6	5.5	0.55	4.755
Mohamed Abdo Marble workshop	Construction	Eastern	75	3	236	210	955	1	27.5	7.2	4
Ahmed Elsayed Marble workshop	Construction	Eastern	75	3	741	270	1202	0.4	66.5	7.95	3.42
Kabaa Marble workshop	Construction	Eastern	75	3	1044	245	811.5	0.4	36	0.35	7.625
Essam Ali Marble workshop	Construction	Eastern	75	3	869	645	1366.5	0.4	32	5.2	0.56
Ibrahim Abass Marble workshop	Construction	Eastern	80	3.2	244	165	577	2	11	5.25	18.425
Ali Kabary Marble workshop	Construction	Eastern	80	3.2	233	175	239.5	0.6	7.5	1.28	19.035

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Etmad Marble workshop	Construction	Eastern	80	3.2	236	183	1002	0.4	13.4	3.8	20.945
Alaa Mansour Marble workshop	Construction	Eastern	80	3.2	782	330	911	0.4	0.8	0.5	14.583
Bn laden Marble workshop	Construction	Eastern	80	3.2	1241	320	1095	0.8	25	1.3	7.44
Ali El-Khadeeb Marble workshop	Construction	Eastern	80	3.2	564	245	1095	0.6	15	2.2	10.7
Ahmed Ali Marble workshop	Construction	Eastern	80	3.2	315	312	985	0.6	16	0.2	18.98
Ali El-Tayb Marble workshop(1)	Construction	Eastern	80	3.2	306	305	1037	0.6	13	1.3	19.38
Ali El-Tayb Marble workshop(2)	Construction	Eastern	80	3.2	1040	650	1989	0.4	127	5.2	20.66
El-Esraa Marble workshop	Construction	Eastern	75	3	1511	281	1821	0.4	123	9	22.2
Saied Hafez Marble workshop	Construction	Eastern	75	3	2655	220	3158	1.2	21	55.65	9.12
Hussien Ali Marble workshop	Construction	Eastern	75	3	224	165	363	0.8	4	0	7.66
Kamel Mohamed Marble workshop	Construction	Eastern	283	11.32	771	283	493	0.4	12	2.1	9.07
Mohamed Mohamed Marble workshop	Construction	Eastern	80	3.2	3459	485	595	0.4	9	4.7	16.6
Mabrouka Marble workshop	Construction	Eastern	80	3.2	1056	112	747	0.4	11	5.4	8.5
El-Romany Marble workshop	Construction	Eastern	75	3	1006	468	343	0.4	12	3.2	9.73
Mohamed Abd-Elhady Marble workshop	Construction	Eastern	75	3	1085	438	432	0.4	8	4.5	12.29
Ibrahim Abd-Elaziz Marble workshop	Construction	Eastern	75	3	500	326	111	0.4	4	0	14.33
Mohamadia for Construction	Construction	Eastern	140	5.6	345	100	393	0.4	4	1	16.49
Aid Salah Marble workshop	Construction	Eastern	80	3.2	831	125	940	1.6	12	15	16.8
Mohamed El-Sayed Marble workshop	Construction	Eastern	80	3.2	1484	315	980	2	8	13	16.01
Ashraf Hamedo Marble workshop	Construction	Eastern	80	3.2	532	122	414	1.6	14	0.4	27.7

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Ahmed Refay Marble workshop	Construction	Eastern	80	3.2	610	270	516	2	6	0.3	19.17
Geverx	Food	Eastern	2160	86.4	250	200	341.5	1.2	15	0.7	1.355
Starch and Yeast	Food	Eastern	22170	886.8	238	205	2712	2.8	526	3.81	5.2
Extracted Oil	Food	Eastern	45959	1838.36	1200	700	454.5	2.2	8	0.1	21.79
Swissa for chocolate	Food	Eastern	2882	115.28	1450	3520	17623.5	8.6	334.5	3.775	8.79
Alexandria for oil and Soap	Food	Eastern	2014	80.56	240	190	266	2.6	9.5	0.8	3.965
Salt & Soda Co.	Food	Eastern	9295	371.8	810	420	1257	1.2	78.5	6.5	1.39
Arabsco Co.	Food	Eastern	3112	124.48	910	422	1379.5	10.4	95	18.15	1.75
Krouna for chocolate	Food	Eastern	5234	209.36	241	198	155	1.6	13	7.1	3.57
Starch and Yeast 1-Abo Soliman	Food	Eastern	28000	1120	615	525	846	0.4	28	9.286	2.554
Senyoreta May- Egypt	Food	Eastern	2500	100	1464	727	2554	2.7	91.5	3.512	7.235
Kandy for Confectionary	Food	Eastern	253	10.12	520	265	805	0.4	18	1.08	2.62
San Govany	Food	Eastern	450	18	562	415	1672	2.6	29	2.31	4.385
Samer for Biscuit	Food	Eastern	885	35.4	74	56	138	0.4	4	1.175	0.186
San Peter for Confectionary	Food	Eastern	2500	100	393	150	325.5	1.2	10	3.99	0.2495
Sangam for Biscuit	Food	Eastern	1026	41.04	148	63	621	0.4	18	2.135	0.3925
Abo Keer slaughterhouse	Food	Eastern	3295	131.8	807	655	2403.5	12.8	56	6.35	2.76
El-Zahraa for Flour of sesama	Food	Eastern	1424	56.96	215	121	479.5	0.8	15.5	2.39	0.69
Onion Dehydration Co.	Food	Eastern	3200	128	427	1025	1762.5	3.6	57	3.74	1.235
Dairy Factory	Food	Eastern	1616	64.64	821	665	1286.5	0.6	27.5	2.62	1.04
Edfina	Food	Eastern	45700	1828	466	375	883	1.6	23	3.819	1.655
Seclam	Food	Eastern	24899	995.96	808	945	4021	0.4	106	11.852	1.66
Bisco Misr	Food	Eastern	5000	200	171	180	239	0.4	9	0.175	1.55
Zahran	Metallurigal	Eastern	2472	98.88	250	200	405.5	3.2	13	0.75	139
Ahram for Metals	Metallurigal	Eastern	1212	48.48	550	380	973.5	3.6	17.5	9.6	4.311
Mohamed Mahmoud	Metallurigal	Eastern	150	6	360	250	625.5	1.6	38.5	1	5.13

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Company											
Alexandria for Metal Product	Metallurigal	Eastern	380	15.2	800	420	1052	1	68	5.6	1.475
North Flour Mills Manufacturing	Metallurigal	Eastern	1490	59.6	814	340	1053.5	1.4	61.5	13.5	9.48
Elsalam for Golden Products	Metallurigal	Eastern	410	16.4	233	155	528.5	4.3	4	0.3	17.925
Mohame Mahmoud for Metals	Metallurigal	Eastern	250	10	465	297	594.5	8	12	4.45	0.92
Alexandria National for Cars (Mercedes)	Metallurigal	Eastern	680	27.2	2350	750	2772	11.8	134	5.1	3.8
Power Station - Elsyouf	Power	Eastern	5000	200	417	265	816.5	3.8	41.5	0.72	1.65
Western Delta Bus	Services	Eastern	1500	60	250	200	605	1.2	36.5	0.35	1.925
General Authority for transportation	Services	Eastern	1500	60	980	440	1409.5	220.6	141	3.895	31.015
El-Nile for transportation	Services	Eastern	3060	122.4	2800	600	263.5	4.6	31	0.65	29.03
Public Transportation Authority Garage-Sidi Beshr	Services	Eastern	3000	120	908	425	783	1.2	24.5	4.94	0.09
Vesta For Textile	Textile	Eastern	3686	147.44	1700	960	2647.5	3.2	179.5	5.55	1.93
Nozha Dyeing shop	Textile	Eastern	3690	147.6	345	250	79	4	4	0	3.86
Nasr for Textile- STIA-unit 9	Textile	Eastern	10000	400	350	330	885.5	2.4	17	0.3	0.725
Nasr for Textile- -STIA-unit 1	Textile	Eastern	2159	86.36	3200	6500	24259.5	18	262	65	
Rasheda Ali for Textile	Textile	Eastern	13851	554.04	2850	900	1813	357	105.5	13.4	29.29
El-Nasar for Textile	Textile	Eastern	48710	1948.4	406	218	1463.5	4	82	52.2	30.38
El-Nozha Dyeing shop	Textile	Eastern	5553	222.12	345	250	395.5	1.5	31	2.45	
El-Nahda for Textile	Textile	Eastern	8350	334	643	330	1221	2.2	40	4.25	10.545
Lozan for Garment	Textile	Eastern	2000	80	745	450	1744.5	10.6	53	4.05	1.94
Sesta for Garment	Textile	Eastern	2451	98.04	660	460	1044.5	12	54.5	4.1	2.645
Elyonania Dyeing shop	Textile	Eastern	2344	93.76	233	188	270	2.2	18	0.75	1.7
Eldeek Elzahby Dyeing shop	Textile	Eastern	3176	127.04	276	220	643.5		41.5	2.45	8.76
Damanhour for Carpets	Textile	Eastern	189	7.56	235	189	198.5	0.8	8.5	0.1	6.2245

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	S (mg/l)	O&G (mg/l)	TN (mg/l)	TP (mg/l)
Kandel Dyeing shop	Textile	Eastern	925	37	206	191	239.5	0.8	6	0.05	5.3445
Kamara for Blankets	Textile	Eastern	340	13.6	244	198	884	0.4	22	0.1	13.96
Nagy Rezk for Spinning & Weaving	Textile	Eastern	40304	1612.16	160	142	505	4	16	0.3	8.74
Totex for Garment	Textile	Eastern	350	14	547	240	1516	0.4	48	1.2	3.97
Arabia for Spinning & Weaving	Textile	Eastern	10188	407.52	259	280	538.5	1.4	21.5	1.0565	1.0955
El-Helal for Knitwear	Textile	Eastern	27738	1109.52	345	227	1035	1.6	15.5	8.2325	2.625
Waal Dyeing shop	Textile	Eastern	15000	600	56	43	255	1.2	17	1.82	5.85
El-Nasr for Textile-STIA	Textile	Eastern	1185	47.4	995	2585	2825	6.8	587	2.3	1.735
Arabia for Spinning & Weaving-Unit 6	Textile	Eastern	42416	1696.64	650	268	588.5	1	19	3.27	2.34
Meyamy Print House	Textile	Eastern	800	32			1831.5	9.8	20	1.024	2.274
Nefertiti Dyeing Shop	Textile	Eastern	31434	1257.36	74	144	727.5	0.4	8	6.5465	1.75
				31673.2	963.5763889	430.4652778	1343.0966	6.664583333	46.8944828	4.49371	8.900931

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	O&G(mg/l)	TN (mg/l)	TP (mg/l)
Feola Co.	Chemicals	Western	3240	129.6	1105	702	1805	2.2	60.5	5.6	1.38
Elnesr for Soap	Chemicals	Western	200	8	491	588	1046.5	5.4	147.5	14.35	5.475
Al-Alamia for Plastics	Chemicals	Western	2000	80	302	146	1608.5	10.8	48.5	7.75	3.1
Abo Elhoul for Wires	Chemicals	Western	140	5.6	320	264	483	3.3	19	4.35	0.5
Artef Cosmetics	Chemicals	Western	100	4	1694	1440	1593	1.6	58	7.45	5.95
El-Salam for Papers	Chemicals	Western	2800	112	2770	1020	4210	1	449	2	1.13
Mohamed Hassan for Soap	Chemicals	Western	314	12.56	2856	3380	10036.5	15.8	422	4	1.85
Misr Aluminium Stores	Chemicals	Western	160	6.4	200	160	712.5	1	91.5	4.95	3.18
Bata	Chemicals	Western	290	11.6	226	280	237	0.8	46	5.45	2.3
Bacine for Paints	Chemicals	Western	400	16	773	120	189	6.4	8	1	4.8
Elnemr for Glue	Chemicals	Western	250	10	793	950	0	0	0	0	0
Art for Decore	Construction	Western	140	5.6	490	596	1705	3.4	64.5	5.4	3.6
Elthager Marble workshop	Construction	Western	120	4.8	2021	842	613.5	0.4	13	4.6	1.7
Abd-Elaal El-Sayed Marble workshop	Construction	Western	120	4.8	420	244	324.5	2.4	15	8	3.125
Gesr Mix for Concrete	Construction	Western	4200	168	1068	680	1276	6.4	125	0.9	2.45
Zefelah Marble workshop	Construction	Western	120	4.8	494	172	310	0.8	4	22	0.78
Alexandria for Manufacturing	Food	Western	240	9.6	237	210	390	2	38	1	2.75
Elwatany for Flour of sesama	Food	Western	85	3.4	213	148	235	0.8	8.5	14.2	1
Antonio for Macaroni	Food	Western	3678	147.12	270	295	518	1.4	10	1.1	1.5
Al Sharbia for Dairy Product	Food	Western	5310	212.4	193	428	2611	2	11.8	11.8	2.7
Dahab for Biscuit	Food	Western	1100	44	528	442	516.5	3.4	35.5	7.65	1.6
Alexandria for Oil and Soap 2	Food	Western	1810	72.4	2452	1420	380	0.8	9.5	30.4	1.45
Shamaadan for Food Industries	Food	Western	6000	240	379	365	1685.5	8	32	7.75	3.3
Alexandria for Oil and Soap - Bahry 1	Food	Western	4974	198.96	89	84	154	1.8	9.5	10.95	2.05

Company Name	Industrial Sector	Received WWTP	Flow (m ³ /month)	Flow (m ³ /day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	O&G(mg/l)	TN (mg/l)	TP (mg/l)
Alexandria for Oil and Soap - Bahry 2	Food	Western	335	13.4	2822	742	3425.5	2.8	165	0.415	0.95
El-Nahda for confectionary	Food	Western	4000	160	5806	2917	7494	2.8	209	4.85	1.54
Abdo Farhat for Oils	Food	Western	350	14	601	415	9009.5	6	51.5	1.05	3.04
Extracted Oil-Mahmoudia	Food	Western	630	25.2	888	630	1293	0.8	74	11.6	0.96
El-handsia for Cars manufacturing	Metallurigal	Western	810	32.4	1311	580	1201.5	3	35	7.75	3.5
El-Nile for transportation	Services	Western	1500	60	169	314	379.5	2	24	7.15	1.1
El-Nile for Trucks	Services	Western	600	24	3824	1660	2190.5	13.2	63.5	2.2	3.1
Public Tranportation Authority Garage-Betash	Services	Western	400	16	242	264	636	1.4	48.9	2.85	4.25
Public Tranportation Authority Garage- Elmnshyia	Services	Western	262	10.48	181	262	644.5	5	41	2.9	0.7
El-Nile for Goods Transportation	Services	Western	250	10	855	440	3098	0.4	409.5	2.5	1.035
Elbadal Elromany Tannery3	Tannery	Western	200	8	3083	975	7460	30	123.5	2.15	0.9
Awlad Elshafay Tannery 1	Tannery	Western	180	7.2	886	720	5439.5	46	131	1.78	0.9
Awlad Elshafay Tannery 2	Tannery	Western	250	10	953	1650	1193	9	101	0.88	0.9
Emad Hanna Tannery	Tannery	Western	200	8	1681	2940	7333	42	126	0.75	0.5
Elbadal Elromany Tannery 1	Tannery	Western	180	7.2	400	370	1473	9.6	76.5	0.65	0.5
Elbadal Elromany Tannery 2	Tannery	Western	200	8	457	420	1291	4.2	27	0.5	2.6
Mohamed Khames Tannery	Tannery	Western	200	8	844	950	1832	6	200	7.8	2.72
Ibrahim El-Maghrby Tannery	Tannery	Western	200	8	723	673	803	2.2	54	14.16	3.3
Mahmoud Kabary Tannery	Tannery	Western	250	10	2000	1195	6569	61.4	122	15.46	4.24
Ahmed Shahin Tannery	Tannery	Western	250	10	1831	1125	4959	11.8	67.5	8.5	2.5
Ekhwan AboSena Tannery	Tannery	Western	240	9.6	1093	905	972	9.4	39	3.1	5.6
Amar Tannery	Tannery	Western	240	9.6	1107	705	1435	7.6	115	9.04	1.4
Ahmed Ahmed Shahin Tannery	Tannery	Western	400	16	11409	8273	14608	7.2	472	5.05	1.9

Company Name	Industrial Sector	Received WWTP	Flow (m³/month)	Flow (m³/day)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	O&G(mg/l)	TN (mg/l)	TP (mg/l)
Adel Mostafa Tannery	Tannery	Western	200	8	2280	1612	8529	67	435	15.1	3.15
El-Nasr Tannery	Tannery	Western	1000	40	157	76	281	3	13	5.85	1.4
Ahmed Ahmed Shahin (Elmesyo)Tannery	Tannery	Western	200	8	2620	1491	4035.5	36	168.5	5.9	2.75
Kalash Tannery	Tannery	Western	250	10	147	342	618	3.4	13	7.7	1.65
Mahmoud Ibrahim Tannery	Tannery	Western	200	8	4759	2185	8262	34	206	2.25	1.05
Ahmed Bayoumy Tannery	Tannery	Western	200	8	267	107	1453	7.6	56.5	1.27	1.055
Hanna Nassem Tannery	Tannery	Western	200	8	2656	900	6772.5	24	190.5	7.05	2.25
El-Shamy Tannery	Tannery	Western	250	10	2523	1610	3035	98.2	92.75	13.3	0.86
Houda Tannery	Tannery	Western	200	8	841	480	1887	29.6	77.5	3.25	0.8
Ghareeb Tannery	Tannery	Western	250	10	936	760	1656	7.8	22.5	1.05	1.55
Abd-Reheem Ali Tannery	Tannery	Western	250	10	884	542	313	2.2	14	1.55	2.76
Mohamed Atef El-Sayed Tannery 1	Tannery	Western	200	8	3328	1805	5089	10.4	111	6.87	0.925
Efat Beshara Tannery	Tannery	Western	200	8	2179	1220	3412.5	102	43	1.05	1.395
Farouk Kalash Tannery	Tannery	Western	250	10	2843	1350	671	2.2	10.5	1.54	1.175
OmEl-Nour Tannery	Tannery	Western	140	5.6	3115	1961	7391.5	64	163	0.82	0.68
Gaber Shehata Tannery	Tannery	Western	250	10	757	1075	3452	9.4	101.5	13.69	0.91
Elshehy Tannery	Tannery	Western	250	10	1677	1525	2915.5	30	91	17.5	2.55
Abd-Elwahab workshop for Thread	Textile	Western	200	8	4873	4240	7380	10.2	217	13.5	1.7
El-Eman Dyeing shop	Textile	Western	114	4.56	450	332	1516	1.6	19.5	8.5	1.32
Melatex Textile	Textile	Western	600	24	937	696	2502	10.4	60	6.75	3.1
El-Nile for Chemicals	Textile	Western	500	20	68	112	516	5.2	18.5	8.45	3.55
El-Sharief Dyeing shop	Textile	Western	4500	180	413	282	419.5	4	14.5	6.3	26.85
Millon for Garment	Textile	Western	500	20	154	311	562	1.4	15	8.05	1.05
total	70			2432.88	1463.057143	987.3571429	2714.9786	13.27571429	95.085	6.471786	2.432642857