EIBAS FA- Lot 1: Environment

Feasibility Study for North East Ramallah Villages Wastewater Collection and Treatment System

Feasibility Study Report / Draft revision 1

Annex 04: Environmental and Social Impact Assessment

Version Date: 17.09.2020

TA 2017177 PS FTF

This technical assistance operation is financed by FEMIP Trust Fund/CAMENA

A project implemented by ENVIROPLAN S.A and its consortium partners

European Investment Bank

Department for International Development

UKaid from the British people

ENVIROPLAN S.A. Consultants & Engineers

ENVIROPLAN S.A. and its consortium Partners

23 Perikleous Str.
15344 Gerakas/Athens - Greece
Tel: +30 210 6105127 / 8
Fax: +30 210 6105138
Email: fl@enviroplan.gr

Project: **Framework Agreement To Support EIB Advisory Services (EIBAS) Activities Inside And Outside EU-28 – LOT 1: Environment**
"Feasibility Study For North East Ramallah Villages Wastewater Collection And Treatment System"

Reference No: TA 2017177 PS FTF

Document title: Annex 04: Environmental and Social Impact Assessment
Feasibility Study Report

Status: Draft revision 1

Date: 17th September 2020

Client: European Investment Bank (EIB)

Prepared by: Mr. Markus Froemmer – Key Expert No 1 (Team Leader)

Review & Approved by: Mr. Thomas BUTH- Technical Director
Mr. Theofanis Lolos, Framework Manager

Visibility:
"The conception and execution of this TA operation is supported and supervised by the MeHSIP programme. The MeHSIP programme is financed under the FEMIP Support Fund and managed by EIB. This Fund utilises non-repayable aid granted by the European Commission in support of EIB investment activities in the eastern and southern Mediterranean countries, assisting Promoters during different stages on the project cycle".

"The study / technical assistance operation is financed under the FEMIP Trust Fund. This Fund, which was established in 2004 and has been financed – to date – by 16 EU Member States and the European Commission, is intended to promote private sector development and bolster socioeconomic infrastructure in the Mediterranean region by financing project preparation and implementation, capacity building and risk capital support.
CAMENA is a Climate Action 'envelope' managed by the European Investment Bank within the FEMIP Trust Fund. Its purpose is to assist EU Southern Neighbourhood Countries to fight climate change by providing grants targeted at specific climate initiatives.
The CAMENA envelope was created on the initiative and support from the Department for International Development UK (DFID), who contributed an amount of GBP 15m for a 4-year period (2015-2018). CAMENA also welcomes contributions from other interested donors.

Table of Contents

Tables

Figures

Appendices

Executive Summary

The North-East (NE) Ramallah project area is a small, mostly rural villages immediately north and north east of Ramallah City. Jerusalem Water Undertaking (JWU) will be responsible for the provision of water and wastewater servicing and stormwater management under Palestinian Government and Palestinian Water Authority (PWA) policy.

The current feasibility study builds upon the recommendations of the Master Servicing Plan for a new wastewater collection and treatment in the area. The purpose of the NE Ramallah project is to provide an environmentally sensitive and sustainable framework for the provision of sanitation services for both existing and future development within the project area.

The intent of the NE Ramallah environmental and social impact assessment (ESIA) is to address public, donor, and government requirements and concerns and to ensure all feasible alternatives and opportunities are fairly assessed and reviewed in a public forum before being finalized and carried forward for implementation.

Currently, no municipal wastewater collection or treatment infrastructure exists within NE Ramallah with the exception of collection system partially covers Al-Jalazoun Refugee Camp and part of Jefna Village. Existing area is serviced mostly by private on-site septic systems. A number of wastewater collection and treatment alternatives for NE Ramallah were developed as part of the feasibility study. Decision of the preferred solution will depend on technical, financial and the outcome of this study.

The environmental and social impact assessment (ESIA) report focuses on three alternatives identified as potential systems to serve the project area (one centralized, and two decentralized) and locations for the new WWTP/s.

The general area for the centralized NE Ramallah WWTP was identified based on the proximity to a discharging water body (Wadi AlBalat), as well as allowing for the potential direction of flows to the new WWTP from future development in the future, and by gravity. The Wadi AlBalat site has farthest distance separation from existing or future residential areas.

The areas for the decentralized WWTPs were chosen based on necessary distance separation between residential and other sensitive land uses but will complicate any future residential development, receiving water courses, and the availability of land based on communications with local municipalities (i.e., Yabroud, Mazra Alsharqeya, Dora and Silwad).

Figure 1 identifies the three potential sanitation schemes with proposed sites for centralized WWTP and decentralized WWTPs.

The current ESIA process where the level of investigation, consultation and documentation are sufficient to fulfill the requirements of the TOR.

Consultation

Key stakeholders and the public were notified of project feasibility study and environmental and social impact assessment (ESIA) and were invited to attend five Public Open House as part of the ESIA. The communities contacted as part of the ESIA process. Consultation with the Environment Quality Authority (EQA), and Jerusalem Water Undertaking (JWU), as well as consultation with land owners was undertaken.

Alternative Solutions – Wastewater System

The following wastewater collection and treatment alternatives for NE Ramallah were developed to address the sanitation improvement as part of the feasibility study:

Alternative 1: Centralized System for Collection and Treatment of Wastewater; One (1) centralized WWTP at site next Wadi Albalat (lowest elevation for the project area).

Alternative 2: Decentralized System for Collection and Treatment of Wastewater (Six (6) WWTPs and Two (2) Lift Stations);

Alternative 3: Decentralized System for Collection and Treatment of Wastewater (Three (3) WWTPs and Two (2) Lift Stations).

Preferred Solution

Based on the evaluation of site criteria and guidance from the EQA, JWU and municipal/ village councils, the Wadi AlBalat site and centralized system was confirmed as the preferred alternative. Alternative one (1) involves the construction of a centralized wastewater treatment plant owned and operated by JWU within the NE Ramallah area to service both existing villages and future development. The proposed location of the centralized WWTP meets the public and EQA requirements. Provided that appropriate mitigation and compensation measures are implemented with regard to natural environment and minimum distance separation guidelines, and applicable permitting and approvals are received, Wadi AlBalat site could be chosen for the centralized NE Ramallah WWTP.

Carbon Footprint and Air Emissions

Direct and indirect greenhouse gases (GHG) and an air quality impact assessment was completed for the estimated emissions from the proposed centralized WWTP, which found that the emissions will not negatively affect the ambient air quality relative to the EQA Ambient Air Quality Criteria. The emissions from the future plant are largely related to the volume of wastewater and biosolids treated.

The approach used for this air emissions consisted of dispersion modelling using "Aermod". Aermod is a sophisticated software package accepted by the EQA. All odorous compounds were estimated using Toxchem, and Green House Gases (GHG) were estimated using emission factors and assessed using the model and the resulting air concentrations were compared to the local standards and guideline values.

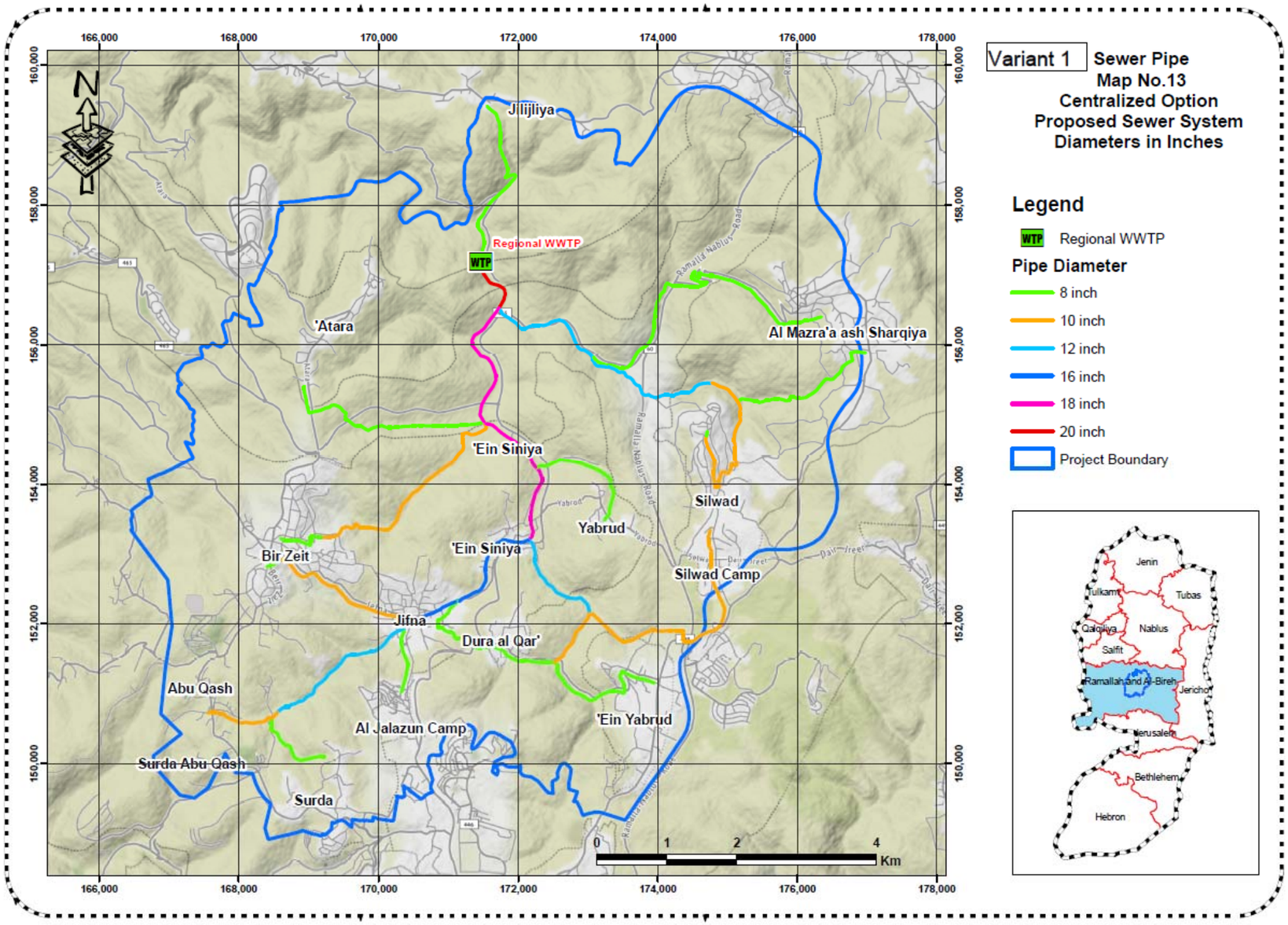
Results from the dispersion modelling indicate that potential emissions from the proposed WWTP are expected to meet all the EQA and local regulatory requirements. The impact of the emissions from the proposed plant on the ambient air quality is insignificant; the majority of the emissions result in ambient air concentrations that are expected to be less than of Palestinian standards.

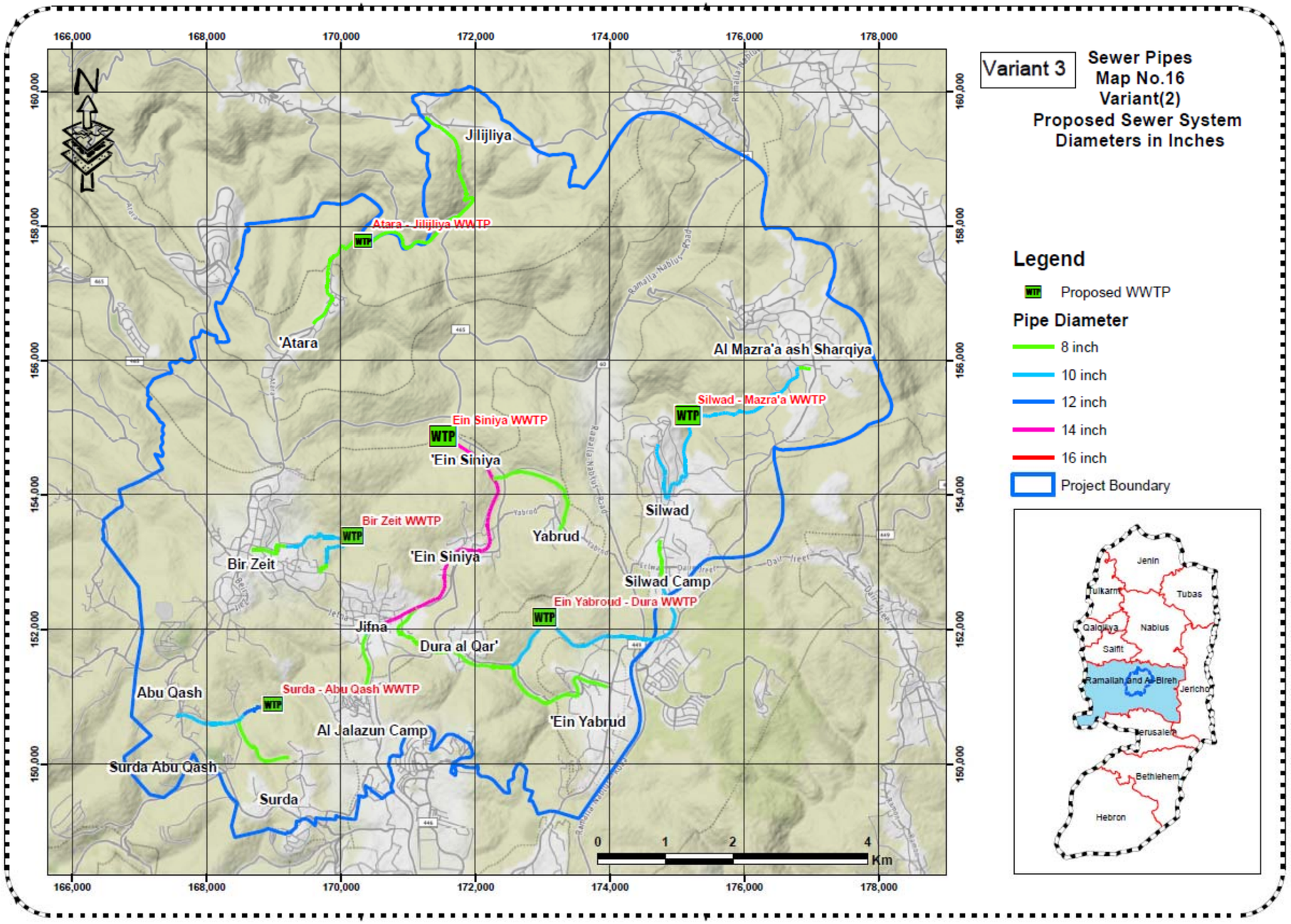
Although the proposed project is not expected to cause or promote population growth or any associated secondary air quality impacts, population growth in the project area is expected to occur at an annual

rate of about 2.4 percent through the year 2050. Despite the expected population growth, it appears likely that the overall good cumulative air quality of the project area would be maintained.

Similar to the criteria pollutants, it is anticipated that an increase in the GHG would occur associated with the WWTP project. The predicted emission of CH_4 from the proposed WWTP is about 247 kg CH_4/day. Given its global effects, such a typical infrastructure development project in a rural area would unlikely cause any meaningful global warming effects.

Figure 1: Three potential sanitation schemes with proposed sites for centralized WWTP and decentralized WWTPs.





Variant 3

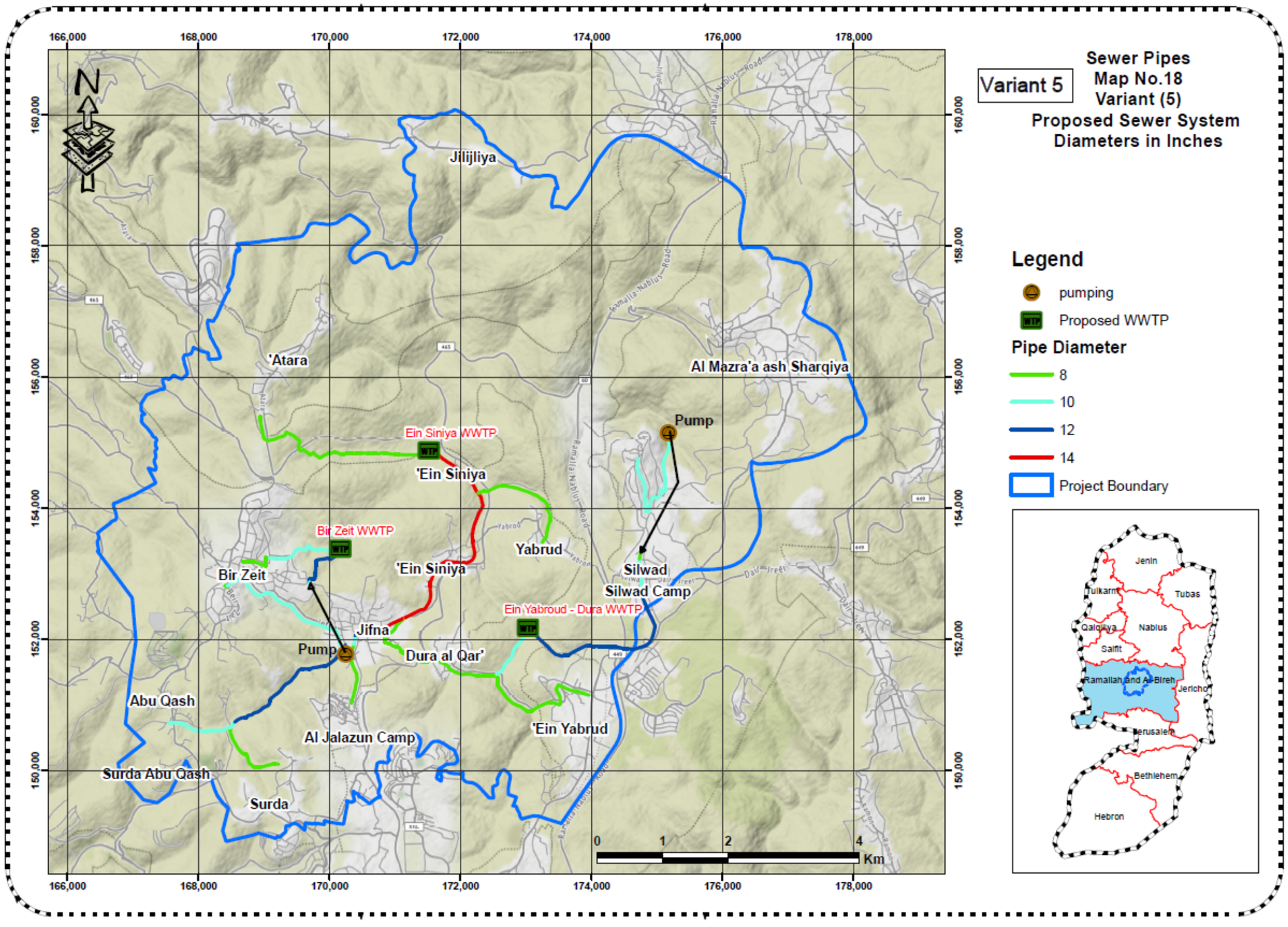
Sewer Pipes
Map No.16
Variant(2)
Proposed Sewer System
Diameters in Inches

Legend

- Proposed WWTP

Pipe Diameter

- 8 inch
- 10 inch
- 12 inch
- 14 inch
- 16 inch
- Project Boundary


Variant 5
Sewer Pipes
Map No.18
Variant (5)
Proposed Sewer System
Diameters in Inches
Legend
pumping
Proposed WWTP
Pipe Diameter
8
10
12
14
Project Boundary
Jilijliya
'Atara
Al Mazra'a ash Sharqiya
Pump
Ein Siniya WWTP
'Ein Siniya
Bir Zeit WWTP
Bir Zeit
Yabrud
Silwad
Silwad Camp
Ein Yabroud - Dura WWTP
Jifna
Pump
Dura al Qar'
Abu Qash
Al Jalazun Camp
'Ein Yabrud
Surda Abu Qash
Surda
Ramalla-Nablus-Road
0 1 2 4
Km
166,000
168,000
170,000
172,000
174,000
176,000
178,000
160,000
158,000
156,000
154,000
152,000
150,000
Jenin
Tulkarm
Tubas
Qalqilya
Nablus
Salfit
Ramallah and Al-Bireh
Jericho
Jerusalem
Bethlehem
Hebron

1 Environmental Legislative, Regulatory Framework and Guidelines

1.1 Introduction

This section introduces the legislative, regulatory and policy framework of Palestinian Authority (PA) pertaining to the NE Ramallah Sanitation Project. The project will be subjected to the following as described in the report:

- Rules of Palestinian Authority (PA)
- Policies, Laws, and Pertinent guidelines of the Environment Quality Authority (EQA)
- Palestinian Natural Resources Law
- Applicable Standards of other legislative authorities
- Palestinian National policies.

1.2 Environmental Regulations

The Palestinian Authority (PA) since its establishment in 1994 has worked hard to improve the Palestinian environment and strive towards sustainable development. The PA has established the institutions that could deal with the challenges of building a new state and worked hard to build the capacity of the different ministries and agencies along with building the capacity of the human resources. Laws and legislations were also developed and endorsed to organize and manage the various sectors such as environment, water, wastewater, land use planning, etc.

The PA stipulated the establishment of the Environment Quality Authority (EQA) as the environmental entity that would be responsible for mandating specifics of environmental regulations.

1.2.1 Environmental Law

The PA is acting actively in the field of infrastructure, and wastewater treatment plants in terms of legislation, policies and strategies, seeking funds, design and implementation of several projects. The wastewater reuse is regulated by the 1999 Environmental law (Article 29) and by one of the policies of Palestinian Water Authority PWA. The Environmental law states: "The Ministry of Environmental Affairs (MEnA)[1], in coordination with the competent agencies, shall set standards and norms for collecting, treating, reusing, or disposing wastewater and storm water in a sound manner, which comply with the preservation of the environment and public. The Palestinian Water Authority and EQA are responsible for technical and environmental approval of sewerage projects.

The objectives of this law Article (2) [2]are:

1. Protection of the environment against all forms and types of pollution;

[1] Ministry of Environmental Affairs (MEnA) is now renamed as Environment Quality Authority (EQA)
[2] Palestinian Environmental Law

2. Protection of Public health and welfare;
3. Insertion of the bases of environmental protection in social and economic development plans; and encouragement of sustainable development of vital resources in a manner that preserves the rights of future generations;
4. Protection of bio-diversity and environmentally sensitive areas, as well as improvement of environmentally harmed areas;
5. Encouragement of collection and publication of environment-related information to raise public awareness of environmental problems.

The law in Article (5) stressed on the flowing:

1. The right to every individual to live in a sound and clean environment and enjoy the best possible of health care and welfare.
2. Protection of the country's natural fortunes and economic resources, the preservation of its historical and cultural heritage without any harms or side effects that are likely to occur sooner or later as a result of the variant industrial, agricultural or constructional activities, with an impact on the quality of life and basic ecosystems such as air, water, soil; marine resources, animals and plants.

Another major issue stated in Article (6) of the Law is protection of Land Environment. The EQA shall devise the public policy for land uses taking into account the best use thereof and the protection of natural resources and areas with special natural characteristics as well as the conservation of the environment.

For management of Solid Waste, (Article (7)), the EQA shall set a comprehensive plan for solid waste management on the national level, including the ways and the designation of sites for solid waste disposal as well as the supervision to implement this plan by the local councils.

The Law in Article (10) elucidate on construction and transportation: "All agencies and individuals, in conducting any digging, construction; demolition, mining or transportation of debris and sands generated by such activities, shall commit themselves to take all necessary precautions for safe storage and transportation of such materials to prevent any environmental pollution".

For Hazardous Substance and Waste, the law in Article (11) states that EQA, in coordination with the specialized agencies, shall issue one or more lists of hazardous substances and wastes.

The Law is also clarifying on Hazardous material and waste in Article (12): "No person shall be authorized to manufacture, store, distribute, use; treat, or dispose any hazardous substance or waste whether it was solid, liquid, or gas, unless such a process is in compliance with the regulations, instructions and norms specified by The Ministry, in coordination with the specialized agencies". Also, it is forbidden to import any hazardous wastes to Palestine, it is forbidden to pass hazardous waste through the Palestinian territories or through the territorial water or free economic zone of Palestine, unless a special permit is obtained from EQA (Article (13)).

By law, the EQA shall specify standards to regulate the percentage of pollutants in the air which may cause harm or damage to public health, social welfare and the environment; and each facility, which will be established in Palestine, shall abide to these standards; every existing facility shall make necessary changes in a manner that makes it conform to these standards within a period, which does not exceed three years (Article (19)).

The Law also ensured the protection workers. Every facility owner shall provide all means to ensure the necessary protection for workers and the neighbors of the facility, in compliance with the conditions of occupational safety and health, against any leak or emission of pollutants in or out the working place (Article (20)). The emissions from machines and vehicles must adhere to Palestinian Standards in accordance with Article (22).

The Law prevents random collection, treatment or incineration of solid waste. Only authorized in the sites designated for this purpose in compliance with the conditions determined by EQA to ensure the protection of the environment (Article (23)).

To reduce environmental nuisance generated by different activities, EQA shall work on establishing standards, instructions and conditions to reduce environmental nuisance generated by different activities (Article (25)). Upon operation of any machine or equipment or upon utilization of alarm devices, loud speakers, or during any other activities, the noise shall not be allowed to exceed the permissible sound intensity and vibration levels (Article (26)).

To conserve Water Environment, the EQA in coordination with the specialized agencies, shall set standards and norms for collecting, treating, reusing, or disposing waste and storm water in a sound manner, along with the preservation of the environment and public health (Article (29)). No person or facility shall be allowed to discharge any solid or liquid or other substance unless such a process conforms to the conditions and standards that the specialized agencies determine (Article (30)).

To Protect the Natural, Historical and archaeological areas, EQA in coordination with specialized agencies, shall prescribe bases and standards for the protection of natural reserves and national parks, additionally tell about and supervise them, and establish, designate the national parks and supervise them (Article (40)).

The EQA shall specify the conditions are necessary to guarantee the preservation of bio-diversity in Palestine, and it is prohibited to hunt, shoot, or catch the birds, marine and wild animals, and the fish specified in the regulations of this law. Moreover, it is prohibited to possess, transport, walk with, sell or offer them neither dead nor alive, as well as it is forbidden to damage the nests or the eggs of these birds (Article (41) and Article (42)).

1.2.2 Ambient Air Quality

The applicable ambient air quality standards are given in ***Table 1***.

Table 1: Palestinian Ambient Air Quality Standards

Pollutant	Concentration in Ambient Air	
	Concentration (µg/m3)	Averaging period
PM10	150	24h
	70	1 year
SO2	250	24h
	60	1 year
NO2	400	1h
	100	1 year

Pb	0.5	1 year
CO	30,000	1h
	10,000	8h
Ozone	120	8h

1.2.3 Surface Water Quality Standards

The designated best use classification as prescribed by Palestine Standards Institution (PSI) for surface water is as given in ***Table 2***.

Table 2: Surface water guidelines

Parameters	Value
pH	6.5–8.5
TDS (mg/l)	1500
Mg2+(mg/l)	150
Ca2+(mg/l)	100
Na+(mg/l)	200
K+(mg/l)	12
HCO3−(mg/l)	200
Cl−(mg/l)	600
NO3−(mg/l)	70
SO4−(mg/l)	250

1.2.4 Ambient Noise Standards

Palestinian noise standards corresponding to areas of different activities are presented in ***Table 3***.

Table 3: Ambient Noise Standards

Category of Area	Maximum permissible noise (dBA) Day Time	Maximum permissible noise (dBA) Night Time
Rural, Schools, hospitals	40	30
Residential	50	40
Residential/ commercial	55	45
Commercial	65	50
Industrial	75	65

1.2.5 Noise Standards for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which in turn are being recommended by PA (***Table 4***).

Table 4: Standards for Occupational Noise Exposure

Total Time of Exposure per Day in Hours (Continuous or Short-term Exposure)	Sound Pressure Level in dB(A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115
Never	>115

1.3 Environmental Assessment Policy

1.3.1 Goals of the policy

Environmental Assessment policy shall be implemented to support the sustainable economic and social development of the Palestinian people through assisting in the following goals:

1. Ensuring an adequate standard of life in all its aspects, and not negatively affecting the basic needs, and the social, cultural and historical values of people as a result of development activities.
2. Preserving the capacity of the natural environment to clean and sustain itself.
3. Conserve biodiversity, landscapes and the sustainable sue of natural resources.
4. Avoiding irreversible environmental damage, and minimizing reversible environmental damage from development activities.

1.3.2 Principles underlying the policy

1. The application of this policy must be transparent, equitable and effectively administered in order to encourage environmentally sound development.
2. Environmental assessment must enhance development, by contributing to its environmental sustainability, not inhabit it.
3. Environmental assessment should begin as early as possible since it means for both planning and evaluating development activities through all stages including decommissioning.
4. Proponents of development activities should pay the cost of carrying out the environmental assessment studies. Preparation of studies and reports must be carries out by specialists qualified to carry the work.

5. Environmental assessment should specify measures for mitigating potential impacts, and for environmental monitoring and management, throughout the life of the development activity.
6. Environmental assessment should clearly identify who benefits from a project and who suffers the negative effects.
7. In the absence of Palestinian standards, appropriate standards will be considered in EA studies and in the measures and conditions included in the environmental approval of the projects.
8. Stakeholder consultation is an essential component of the EA policy.

1.3.3 Responsibility for implementation

In fulfilling its responsibility, the ministry (Environment Quality Authority (EQA)) shall:

1. Ensure that the goals and principles of the policy are and reflected in the implementation of the policy.
2. Establish and manage the required implementation procedures.
3. Provide advisory and technical guidance to individuals, organizations, agencies and proponents who are required to comply with or participate in implementing the policy.
4. Produce guidelines and best management practices for complying with policy.
5. Maintain a register for all activities currently being appraised under the policy.
6. Establish procedures for, and ensure, the monitoring and follow-up of conditions attached to activity environmental approvals under the policy.
7. Periodically evaluate the implementation of the policy and recommend adjustments or improvements to it.

1.3.4 Environmental assessment committee

An inter-agency environmental Assessment Committee consists of the following governmental agencies:

1. Environmental Quality Authority (EQA)(Chair)
2. Ministry of National Economy
3. Ministry of Local Government
4. Ministry of Transport
5. Ministry of Agriculture
6. Ministry of Health
7. Ministry of Tourism and Antiquities
8. Ministry of Planning
9. Palestinian Water Authority
10. Palestinian Energy Authority

Other agencies may be asked to join the committee as required to review the nature and location of individual projects.

The EA committee shall undertake the following responsibilities according to its own procedures:

1. Ensure adequate scoping of environmental assessment studies
2. Prepare and approve terms of reference for environmental assessment study
3. Review environmental assessment reports

4. Recommend environmental decisions to the minister
5. Assist the ministry to ensure compliance of the projects with environmental approvals conditions.

1.3.5 Environmental Approval

Without limiting its content, an Environmental Approval may state:

- Required measures to mitigate adverse environmental impacts or capture potential
- environmental benefits, including a compliance schedule
- Measures that the proponent must implement in order to comply with relevant standards and EIA requirements
- Monitoring and reporting duties of the proponent.
- The proponent of the project shall express the commitment to the standards and requirements for the protection of the environment and to apply all the required mitigation measures addressed in the EIA. He/ She shall express the legal commitment towards the EIA.

When the EQA review is complete, the EQA must attest that the EA document has been satisfactory carried out and:

i. Grant Environmental Approval with, if necessary, conditions to be included in subsequent permits, or
ii. Withheld Environmental Approval since the project has unacceptable environmental impact.

The proponent of the project shall express the commitment to the standards and requirements for the protection of the environment and to apply all the required mitigation measures addressed in the EA document. The developer shall express the legal commitment towards the EA.

The EIA for feasibility study is often not required by EQA.

1.3.6 Stakeholder Consultation

The Palestinian Environmental Assessment Policy (PEAP) refers to stakeholders as any person in his natural or legal capacity with an interest in or affected by a development activity. Consultation of stakeholders shall be fulfilled in two stages:

A. The Initial Environmental Evaluation (IEE) Report; where the policy stated that the stakeholder consultation is optional when undertaking an IEE. In consultation with the proponent and the EA Committee as required, the EQA determines whether stakeholder consultation is required and, if so, what the minimum requirements should be. It may be required during scoping and terms-of-reference preparation, and during conducting the IEE.
B. The Environmental Impact Assessment (EIA) Report; where the policy stated that the stakeholder consultation is mandatory when undertaking an EIA. In consultation with the proponent and the EA Committee, the EQA determines what the minimum requirements for stakeholder consultation should be. It may be required during scoping and terms-of-reference preparation, and during the conduct of the EIA. At the minimum, the proponent

must meet with the principal stakeholders to inform them about the proposed project and to solicit their views about it. More problematic projects should involve more extensive consultations. The methods and results of these consultations must be documented in the EIA Report.

1.3.7 Environment Quality Authority (EQA)

The Environment Quality Authority (EQA) was formed in 1998. The responsibilities of the EQA are as follows:

- Make recommendations for a National Environmental Policy
- Formulate and implement policies for environmental management
- Co-ordinate environmental functions
- Make recommendations for rationalizing government agencies with environmental functions
- Promote public awareness of the environment
- Formulate and implement environmental standards
- Monitor compliance with environmental standards
- Take appropriate action to prevent and control pollution for environmental conservation
- Establish links to local, regional and international institutions
- Perform other prescribed functions
- Undertake any action pertinent to the functions of the Authority.

As mandated in the Environmental Law, the EQA is charged with the responsibility of formulating rules for environmental management specifically in relation to sustainable development and pollution management in Palestinian Territories.

1.4 Wastewater Treatment Plants

The following guidelines are recommended for construction of wastewater treatment plants based on North and North-West region of the West Bank Master Plan (PWA).

1.4.1 Wastewater Treatment Plants Design Guidelines

The technical and design criteria for wastewater treatment plant design and operation are not yet available on either administrative level or on local level (service provider). The recommended technical and design criteria for WWTPs is presented in ***Table 5*** (PWA).

Table 5: Recommended technical and design criteria for wastewater treatment plants

Unit Process	Guidelines
Centralized or Decentralized WWTP	Topography, physical and geopolitical concerns (barriers), and land for reuse
Organic Loadings	Should be tested onsite per each Project, and use the following loads as guidelines **Parameter** — **Concentration (g/c/d)** **COD** — 110 **BOD** — 60 **TKN** — 11 **TP** — 1.8 **TSS** — 70 **Fats, oil, Grease** — 50
Materials	Metal: 314 Stainless steel for all metal parts; Concrete: Water Tight Concrete with water to cement ratio of 0.45 or less; Pumps: wastewater pumps should be solid handling.
Operators of WWTPs	Must be certified of running WWTPs (i.e., Civil or Environmental Engineering Background)
15 mm Manual Bar Screen Upstream of the Influent Pumping Station	Stainless Steel and size based on detailed design
Grease Interceptor	Size is based on Peak Flow per each Project
Influent Pumping Station	As per site, with at least one standby pump
Flow Meter	Size based on minimum and maximum flow per each site. Parshall Flume is recommended
Septic Receiving Tank	As per site, with at least one standby pump
Preliminary and Primary Treatments	Mandatory for any ongoing, planned and future WWTP project to assure the success of the subsequent secondary treatment
Open Inlet Chamber (no ceiling)	Sizing based on peak flow
Preliminary Treatment (removal of sand, grease, fat and oil)	Fine Screening
Grit and Sand Removal	360/ or 270 degrees Vortex Grit Tank
Grit Classifier	Stainless steel and sizing as per each project
Primary Treatment	To remove TSS (Rectangular or Circular). Average surface overflow rates (24.4 to 48.9 $m^3/m^2.d$)
Secondary Treatment for Carbon and Nitrogen Removal	Anoxic-aerobic cycling to enhance nitrogen and phosphorous removal; Solids Residence Time: Minimum 12 days; Hydraulic Residence Time: Minimum 10 hours; MLVSS: 2,800 to 4,000 mg/L
Blowers and Mixers Station	To achieve minimum dissolved oxygen of 2 mg/L in the aeration zones and mixing conditions in the anoxic zones

Secondary Clarifier	To separate sludge from water. Average surface overflow rates (24.4 to 48.9 $m^3/m^2.d$); Peak surface overflow rates (102 to 122 $m^3/m^2.d$)
Filtration	Gravity Filtration (Sand with crushed charcoal); Micro or Ultrafiltration.
Disinfection	UV or Chlorination
Irrigation Tank	As per site
Standby Generator	Recommended
Tap Water Supply	Mandatory
Standards	Technical Specification 34-2012
Effluent Utilization Rates	March-November
Irrigation Areas	Downstream/ and or pumping to elevated tanks
Crop Composition	Barley, alfalfa, Sudan grass and stone fruits such as almonds
Crop Modelling	FAO Crop Wat 8 for Windows Software or comparable program
Sludge Thickening	Gravity Circular thickener
Sludge Dewatering	Centrifugal (recommended) or Filter Press or Drying Beds
Energy Recovery	As per Terms of Reference and depending on the size of the plant.
Sludge Stabilization	Aerobic or anaerobic/ Composting
Sludge Disposal	Reuse and/ or for land application, or sanitary landfill

1.4.2 Wastewater Effluent Treatment Guidelines

The treatment guidelines present the effluent quality criteria for WWTPs. The guideline for the effluent are based on the *Reuse Scheme TS34-2012 Rules*. The secondary treatment is necessary to achieve the effluent criteria. It also gives the conditions for tertiary treatment and stipulates that the disinfection process is mandatory in all cases. PWA effluent requirements for current and future WWTPs are listed in ***Table 6*** , while effluents requirements as per JWC are listed in ***Table 7*** and ***Table 8*** (Schedule 1 & 2).

Table 6: Effluent Guidelines for the current & future WWTPs

Parameters	Curent Effluent Concentration (mg/L)	Future Effluent Concentration (mg/L)
Chemical Oxygen Demand (COD)	50	50
Biochemical Oxygen Demand (BOD)	20	20
Total Nitrogen	30	30
Total Phosphorous	30	30
pH	6-9	6-9
Total Suspended Solids (TSS)	30	30
Faecal Coliforms (cfu/100 ml)	200	200

Table 7: Schedule 1: Effluent-Disposal Options as per JWC[3]

End Use	Quality	Treatment Type	Suitable Crops
Irrigation in areas of high hydrological sensitivity	1*	Secondary treatment by activated sludge and tertiary treatment , including nutrient removal, additional filtration and disinfection	Unrestricted crops, including public parks, gardens and sports grounds
Irrigation in areas of medium/low hydrological sensitivity as detailed (in the attached map) (in map A)	2**	Secondary treatment by activated sludge and disinfection, or equivalent	Olives, peanuts, citrus fruit, vegetables for cooking, fruit for canning and trees
Irrigation of inedible crops	3***	Anaerobic ponds, oxidation ponds or aerated lagoons	Cotton, sugar beets, cereals, green and dry fodder, seeds.
Discharge into wadis/ streams/ rivers (incl. all their tributaries	4****	Secondary treatment by activated sludge and tertiary treatment, including nutrient removal, additional filtration and disinfection	Unrestricted crops, including public parks, gardens and sports grounds.

Table 8: Schedule 2-Effluent Quality Criteria as per JWC

	1**,4*****		2***,3****	
Pollutant	**Average**	**Maximum**	**Average**	**Maximum**
BODs (mg/l)	10	15	20	40
TSS (mg/l)	10	15	30	60
COD (mg/l)	70	100	100	150
Electrical conductivity (ds/m)	1.4 (1)		1.4	
pH	6.5 – 8.5 7-8.5 (4)		6.5-8.5	
Chloride (cl) (mg/l)	250 (1),400 (4)		250	
Boron (B) (mg/l)	0.4 (1)		0.4	
Sodium (Na) (mg/l)	150 (1), 200(4)		150	
SAR	5(1)		5	
Faecal coliform (MPN/100ml)	10 (1), 200 (4)	10 (1) 100 (3)	10	
Total nitrogen (N) (mg/l)	10(4),25 (1)	15 (4), 40(1)	25	40
Silver (Ag) (mg/l)	0.05		0.05	
Arsenic (As) (mg/l)	0.1		0.1	
Cadmium (Cd) (mg/l)	0.01 (1), 0.005 (4)		0.01	
Chromium (Cr) (mg/l)	0.1 (1), 0.05 (4)		0.1	
Cobalt (Co) (mg/l)	0.05 (1)		0.05	
Copper (Cu) (mg/l)	0.2 (1), 0.02 (4)		0.2	

[3] Joint Water Committee, Effluent discharged into rivers and wadis must comply with the above river quality requirements from Jan /2008.

Fluoride (F) (mg/l)	2.0 (1)		2.0	
Iron (Fe) (mg/l)	2 (1)		2	
Mercury (Hg) (mg/l)	0.002 (1) 0.005 (4)		0.002	
Lithium (Li) (mg/l)	2.5 (1)		2.5	
Manganese (Mn) (mg/l)	0.2 (1)		0.2	
Molybdenum (Mo) (mg/l)	0.01 (1)		0.01	
Nickel (Ni) (mg/l)	0.2 (1), 0.05 (4)		0.2	
Lead (Pb) (mg/l)	0.1 (1), 0.008 (4)		0.1	
Selenium (Se) (mg/l)	0.02 (1)		0.02	
Vanadium (V) (mg/l)	0.1		0.1	
Aluminium (Al) (mg/l)	5 (1)		5	
Zinc (Zn) (mg/l)	2(1), 0.2 (4)		2	

1.4.3 Septage and Biosolids Management

Septage collected from septic or septic tanks will be treated at the proposed WWTP.

A septage receiving station is proposed to receive incoming septage and treat it in the new WWTP. The design is addressed in the feasibility study report.

Biosolids will be produced at the proposed WWTP when stabilized solids are removed from the aerobic stabilization. The Biosolids can be thickened and disposed through one of the following methods:

- For agricultural purposes as nutrient sources.
- Dewatered and disposed at an appropriate landfill site.
- Dewatered and turned into pellets for farming.
- Dewatered, dried and incinerated to be used as an energy source at the WWTP.

Sludge drying beds are not proposed as part of the design of the NE Ramallah WWTP due to heavy rain events and an extra land.

2 Key Stakeholder and Public Consultations

Public consultation is an integral part of the environmental and social assessment process. It provides the opportunity for interested stakeholders to receive information from the project design team and, in turn, allows the proponents to gain input about public concerns. Public consultation can also provide an opportunity to actively involve stakeholders in the early stages of the project which, in turn, delivers a sense of transparency in the assessment, planning and detailed design process. Cooperation between the public, corporate and government sectors helps to determine and quantify the project impacts (both positive and negative), and to co-ordinate mitigation responses if needed.

For the NE Ramallah sanitation project, liaison was made between the project team and project key stakeholders in the form of a consultation meeting and separate introductory meetings for each authority. For this project, key stakeholders included Jerusalem Water Undertaking (JWU) (utility agency), government ministries and authorities, local village and municipal councils and private businesses. Opportunities for public participation with residents of the NE Ramallah Catchment Area were provided in the form of open-house public consultations meetings (held in the village/Municipal Halls).

2.1 Requirements of ESIA TOR

The TOR identifies the need for key stakeholder and the public to assist in the identification and mitigation of impacts while preventing environmentally unacceptable development, controversy, confrontation and delay. It requires that the key stakeholders and the public most relevant to the project be identified and contacted to make their input to the project.

With respect to liaison with members of the public, the consultation sessions were introduced and explained the project adequately as well as addressed all issues raised. Consultations were held at a date, time and venue most convenient to the participants and were advertised.

For the NE Ramallah sanitation project, the following activities assisted in communication with the public and stakeholders:

- One meeting and presentation where all stakeholders were invited.
- Meetings with individual stakeholder groups.
- Five open house public consultation meetings.

The following sections are a description of the events listed above.

2.2 Introductory Meetings with Key Stakeholders

The NE Ramallah sanitation Project was introduced to relevant stakeholders for the purpose of obtaining data pertinent to the treatment plant and collection system feasibility study. These agencies were also introduced to the project for the purpose of fulfilling the feasibility study TOR and facilitating coordination where proposed developments have the potential to conflict with the NE Ramallah sanitation Project. These meetings were with individual groups and occurred mainly in the preliminary design stages of the project.

The list of invitees was selected to include those groups who could be directly impacted by the proposed project. This list included regional villages and municipalities, and government ministries. The full list of invitees and attendees is located in Appendix A. Information including proposed locations, future developments, and project are critical to a successful wastewater project. This meeting also sought to determine the attitudes and expectations of stakeholders with respect to the project.

The presentation gave an overview of the project, and highlighted the importance of cooperation with stakeholders.

Table 9 lists the agencies that were contacted and the representatives present at the meetings with the consultant staff.

Table 9: Introductory Meetings held with Relevant Agencies

Agency	Representative(s)	Date
Palestinian Water Authority	Listed in Appendix A	7/8/2019
Ministry of Agriculture	Listed in Appendix A	7/8/2019
Ministry of Local Government	Listed in Appendix A	7/8/2019
Local Villages, AlJalazoun Refugee Camp and Municipalities of Project Area	Listed in Appendix A	7/8/2019
Ministry of Health	Listed in Appendix A	7/8/2019
The Consultant (Enviroplan and CEC)	Listed in Appendix A	7/8/2019
Jerusalem Water Undertaking	Eng. Nepal Najjar, Department of Sewerage	7/8/2019
Environment Quality Authority	Abdel Aziz AlRayan	7/8/2019

This communication not only provided venues for the consultant to explain the project, it allowed for feedback from all persons on how the project will affect themselves and the organizations they are representing.

2.3 Key Stakeholder Meeting

The Key Stakeholder meeting was held on August 07, 2019 to inform groups of the project, in order that cooperation could be obtained in gathering information relevant to the planning and design.

Key stakeholders meetings was held on November 03/2019 and summarized in Table 10.

Table 10: Concerns raised by key stakeholders on November 03, 2019 Meeting

Concern Raised by Key Stakeholder	Agency/ Authority
Representative of Jerusalem Water Undertaking Eng. Nepal Najjar was in favor of the project and expressed her concerns related to the decentralized wastewater treatment plants. She argued that JWU prefer one centralized treatment plant for the project area due to: -One treatment plant is consistent with JWU strategy that approved on July 2019, -The project area will be served by gravity without the need for pumping stations which often generate odors with high operational and maintenance costs. -The JWU management and operational capacity. It is more feasible to manage one WWTP than, for example, two WWTPs.	Jerusalem Water Undertaking
Representative of Environment Quality Authority Eng. Yaser Abu Shanab welcomed the project and state the following recommendations: -Construction of Wastewater treatment plant requires an environmental approval from 10 authorities -It is easier for the Palestinian Authority to apply for one Israeli Permit than 5 permits. -Each wastewater treatment plant requires separate EIA report. -For EQA, it is easier to monitor fewer wastewater treatment plants due to lack of staff. Higher number of WWTPs requires more employees. -EQA have difficult experience with several decentralized systems. In general, EQA in favor of centralized systems for the project area.	Environment Quality Authority

2.4 Public Consultations

These meetings were conducted to provide an opportunity for members of the public to learn more about the proposed project and to provide an opportunity for them to express their comments. In keeping with the TOR, five public consultations were held within the study area. From the interest of the public, comments received, and attendance numbers, it was determined that additional public consultations would not be necessary.

From these meetings, information was gathered that supplemented the feasibility study of the project. Negative impacts were attempted to be minimized to the extent possible. The meetings are listed in Table 11.

Table 11: Schedule for Public Consultations

Date	Meeting Location	Attending Villages/ key Person	Number of participants
02-11-2019	Silwad	Silwad	17
04-11-2019	Birzeit	Birzeit, Surda - Abu Qash, Atara	46
05-11-2019	Ein Siniya	Ein Siniya, Jifna, Dura Al Qara	21
06-11-2019	Ein Jabrud	Ein Jabrud, Jabrud	15
15-12-2019	Mazra'a Ash Sharqiya	Mazra'a Ash Sharqiya	20

2.4.1 Public Consultation # 1

The first public consultation was held on Saturday November 2th 2019 at Silwad Municipality at 10:00 am. Advertising was conducted through the Municipality to contact businesses and the public in the project area. Letter invitations were delivered to key stakeholders, members of government, utilities, and non- governmental organizations.

All scoping sessions followed the same agenda:

- Welcoming words by the Mayor, head of the village Council
- Short overview and background of the project given by the Consultant
- Introduction of the experts of the Consultant that attend the session
- A formal PowerPoint presentation of the project included:
    1. The current situation of wastewater collection and discharge;
    2. Discussion of the project background
    3. Introduction of three of the 6 developed variants (variant 1, 3, 5 as numbered in the conceptual design report) encompassing the collection and diversion system and a corresponding number of waste water treatment plants.
    4. Discussion of the questionnaire to collect information about the residents' constraints and opinion about the presented variants and possible effluent use for irrigation purposes

5. Next steps to complete the ESIA
6. Summary of the presented variants, their pros and cons
7. Open discussion

Time was allocated for answering questions, and receiving comments on the proposed project. Key questions and comments raised, and responses have been included in Table 12.

Information on the public consultation including a copy of the presentation and a list of attendance are all located in **Appendix B**.

Seventeen people attended the consultation, not including the consultant staff.

Table 12: Key Questions and Answers from November 2th , 2019 Meeting

Concern or Question Raised by the Participants	Answer by the Consultant
The majority of the participants prefer the central solution as it can be implemented with the lowest investment and operation costs	
The farmers who cultivate the land complain about the difficult access to the land as they have to cross the sewage stream in the open channel	
If land that is owned by residents of Silwad will be used to build a WWTP The municipality should get any kind of bonus / benefit from the project	The operator of the system will charge fees to cover operation and maintenance

2.4.2 Public Consultation # 2

The second public consultation was held on Tuesday November 4th 2019 at Birzeit secondary school at 10:00 am and covers participants from Birzeit, Surda - Abu Qash, and Atara. Letter invitations were delivered to key stakeholders, members of government, utilities, and non-governmental organizations.

A formal PowerPoint presentation included:

1. The current situation of wastewater collection and discharge;
2. Discussion of the project background
3. Introduction of three of the 6 developed variants (variant 1, 3, 5 as numbered in the conceptual design report) encompassing the collection and diversion system and a corresponding number of waste water treatment plants.
4. Discussion of the questionnaire to collect information about the residents' constraints and opinion about the presented variants and possible effluent use for irrigation purposes
5. Next steps to complete the ESIA
6. Summary of the presented variants, their pros and cons
7. Open discussion.

Time was allocated for answering questions, and receiving comments on the proposed project. Key questions and comments raised, and responses have been included in **Table 13**. Information on the public consultation are located in **Appendix C**.

Table 13: Key Questions and Answers from November 4th , 2019 Meeting

Concern or Question Raised by Key Stakeholder	Answer by the Consultant
Wadi Sarida is rich on springs. Does the construction / operation of a WWTP constitute any hazard to the ground water quality?	The WWTP effluent will have no negative impact on the ground water quality
Birzeit Mayor explains that the Municipality has already selected a site of 6 donums for the construction of a common WWTP in Wadi Ballat. The owner of the site is willing to sell it to the "Common Service Council" of the 10 villages. The land has not yet been purchased. The next steps of land acquisition depend on the recommendation of the Consultant and the developed and recommended sanitation	

concept / variant. If more land will be necessary to build the WWTP the Council will purchase the required neighbouring parcels	
Birzeit Mayor: the Municipality does not have the capacity to operate its own WWTP. From this point of view the implementation of a centralised solution and construction of regional common WWTP seems to be the better solution	The Consultant explains that construction of the trunk lines and WWTPs will be funded by international institutions. The design and construction of the local sewer networks and pipelines remains in the responsibility of the villages.
A resident raises the idea that all local institutions, banks and local industries should contribute a higher share to finance the implementation of the internal sewerages	
a resident asks for information about the proposed technology of sewage treatment	The Consultant explains that the treatment shall comprise mechanical, biological (continuous activated sludge) and disinfection steps
Will the approval by Israeli Authorities be necessary for the implementation of the sanitation concepts	The variants have been developed with the sites of the WWTPs located in area B. Some sections of the trunk lines (main trunk line to the central WWTP) will be laid in area C. Because of the favourable impact of the project on the environment the Consultant expects that the Israeli Administration will not oppose its implementation
A resident asks for an overview of the pros and cons of all variants. He explains that he lacks information to evaluate the variants and to decide on which to option to go	The Consultant expadises the implementation of the project. He lists negative and positive aspects of central and decentral solutions (see the summarising tables in the presentation). A step by step implementation
Prof Mahmoud of the Birzeit University emphasises one advantage of decentral solution to be the availability of treated WW in several places in the catchment area and not only at one point downstream a single WWTP. Treated WW is already used in villages and municipalities for the irrigation of green field in the towns	The Consultant explains that he has developed central and decentral solutions for the sanitation system in the project area. The evaluation is on-going and no decision about the preferred solution has so far been taken
With respect to the appointed future operator of the WWTP(s), namely JWU Prof Mahmoud points out that JWU will be ready to take over this task. The capacity building within JWU is	The construction of the WWTP Ein Jariot, the central solution for Ramallah Municipality has not yet started. For the case that an operator for a WWTTP in the project area will be required before JWU will be ready

on- going and will finish with the start of the operation of the WWTP Ein Jariot.	to take over a temporary solution has to be found. It might be necessary to tender the construction of a WWTP in the project boundary with an extended operation period. JWU prefers less WWTPs to operate in the future to be consistent with JWU Strategy and management capacity.
The summary of construction costs that was shown in the presentation indicates that indicates that the cost of the central variant correspond to about half of the total costs of the decentralized solution	Centralized solution is cheaper than any other variants. A construction of the WWTP in phases is possible. Corresponding to the increase of collected sewage volume and pollution load the capacity of a central WWTP has be increased in (several) construction phases up to the maximum load. All parcels at the site that are necessary for the constructions of the WWTP for the maximum load should be purchased at the beginning of the implementation to make sure that the plant can be built at the end
Is the financing of the implementation of the whole project secured by funds of the EIB	The EIB will decide later on about the question of funding depending on the result of the feasibility study
The decentralized WWTPs will have to be built in proximity to the villages. This bears the risk that the costs for the purchase of the land will be important	Lands and the proximity of the decentralized WWTPs to the residential areas will be concluded during ESIA.
Will the effluent of the WWTPs have to be pumped to be used for irrigation? What can the effluent be used for?	Answering the Palestinian guidelines the effluent can be used above all for the irrigation of trees (olives), peanuts, citrus fruit, vegetables for cooking, fruits for canning and in areas of medium, low hydrologic sensibility. Because of high pumping costs the Consultant considers that reuse will only be feasible in areas downstream the WWTPs.
Will the construction of the trunk lines be covered by the project?	The implementation of the trunk line will be part of the project

Mayor of Atara: since 2005 several studies for the sanitation system in Birzeit and Atara have been elaborated. Without a result however. The towns are still without a sewerage system. Will it be useful that the towns start to implement the internal collection system before a decision about the regional solution has been taken?	The internal networks shall be implemented in parallel with the regional system to be able to divert the sewage to the trunk lines and thus to a WWTP. The internal networks shall be ready simultaneously with the trunk lines. The residents will not be allowed to connect to the internal networks unless the trunk lines have been laid.
A resident of a town west of Birzeit complains that his village is not included in the project	Due to the topography of the village, westerns slopes will be served by the regional WWTP West of Birzeit. Some areas of Birzeit require pumping to be connected to a WWTP in the project boundary. This complies with the on-going Feasibility Study for the Ramallah North East Villages
The Mayor of Birzeit states that the Municipality will soon start to build a part of the internal network	
A school member asks about the benefits of the implementation of the project for the neighbourhood of the school	The project and public consultation raise the public awareness of the problem of safe WW disposal The effluent can be used for the irrigation of green land in the area. Irrigation of fruits for direct consumption is however prohibited

2.4.3 Public Consultation # 3

The third public consultation was held on November 5th 2019 at Ein Siniya Village Hall at 10:00 am and covers participants from Ein Siniya, Jifna, and Dura Al Qara.

A formal PowerPoint presentation included:

1. The current situation of wastewater collection and discharge;
2. Discussion of the project background
3. Introduction of three of the 6 developed variants (variant 1, 3, 5 as numbered in the conceptual design report) encompassing the collection and diversion system and a corresponding number of waste water treatment plants.
4. Discussion of the questionnaire to collect information about the residents' constraints and opinion about the presented variants and possible effluent use for irrigation purposes
5. Next steps to complete the ESIA
6. Summary of the presented variants, their pros and cons
7. Open discussion.

Time was allocated for answering questions, and receiving comments on the proposed project. Key questions and comments raised, and responses have been included in **Table 14**. Information on the public consultation are located in **Appendix D**.

Table 14: Key Questions and Answers November 5th , 2019 Meeting

Concern or Question Raised by Key Stakeholder	Answer by the Consultant
A resident concluded from the presentation that a central WWTP would have more advantages than decentral WWTPs	
He asked for information about the financing of the sewer lines and trunk lines	The internal sewerage remains in the responsibility of the villages. The trunk lines will be financed by the project
The Head of the village Council explains: in the year 2006 a fund for the design of the network was available, The study cost US $ 20,000.-. It proposed to build a WWTP at Ein Siniya. Undeer the pre condition that the Israeli villages Ofra and Beit Il would be connected to the WWTP the Israeli administration approved the location of the WWTP. At that time the small decentral WWTP (BAR[4] with a sedimentation basin) at Ein Siniya was still in operation	
Is an approval by the Israeli necessary for the implementation of this on-going study	The proposed sites of the central WWTP and the decentral WWTPs are located in area B. As the Israeli and Palestinians have been suffering already long time under the current situation the Consultant does not expect that the Israeli will veto its implementation, this opinion is supported by the Head of the village Council. He has heard that the Israeli will support the village implementing the project
Will the Israeli again insist that Ofra and Beit Il will be connected to the WWTP if Silwad is included in the project? Has anything ben agreed in this case?	According to the Consultant's experience there must be an agreement between the financing institution and the Israeli administration as the EIB would not allow working in Palestine without approval by Israel. There is the agreement between PWA and the Israeli administration that the Palestinians are allowed working in area B without prior approval by the JWC. As the works are projected to be located in area B no objection by Israel is expected.

[4] BAR …. Baffled Anaerobic Reactor

Concern or Question Raised by Key Stakeholder	Answer by the Consultant
How long will it take to implement the central solution?	The experience of other projects with centralised solutions (see the long time it took until the construction of the WWTP Salfeet started) shows that these projects are long term projects. No quick implementation will be feasible
A resident underlines that a quick improvement of the situation at the hot spot is necessary	
Another participant favours a central solution. According to his understanding the decentral solutions have more disadvantages. The residents of Ein Siniya reserve the right to approve / disapprove the construction of a WWTP on their property. As buffer zones have to be established between the WWPTs and the residential areas it seems to be difficult to find the required number of sites answering the requirement. It will be easier to look for one site only.	
The 16" pipeline from the Refugee Camp Al Jalazun is frequently blocked in winter time. This pipe has been laid only 4 years ago. It is laid in a depth of 9 to 10 m below ground	This problem is noted and will be considered during the detail design of all trunk lines in the project area
Engineer of Jifna asks about the estimated time to implement of the decentralised solution	The Consultant assesses the implementation time of the decentral solution with 3 to 6 years. A quick solution of the hot spot might be feasible through the installation of pre-fabricated containerised WWTPs
Head of village Council of Jifna: prefers to be a bit more patient allowing the construction of a WWTP to solve the hot spot problem with a long term solution (WWTP)	
Head of school: a quick solution is necessary as the pupils are affected by thousands of flies and the bad smell coming from the open channel.	
The rehabilitation of the steel trunk line and the wadi are necessary	
The harmful hot spot solution has to be solved as soon as possible	
Before the construction of the 16" trunk line the sewage flew in an open channel through Jifna. The trunk line did not solve the problem but shifted it only from Jifna to Ein Siniya	
Another participant underlined the urgency to find a quick and long lasting solution for the collection,	

Concern or Question Raised by Key Stakeholder	Answer by the Consultant
treatment and diversion of the WW. Because of the shorter implementation time he favours a decentral solution for the hot spot	
The decentral solution for the hot spot should be built in Wadi Ballat and not at Ein Siniya.	The project could be implemented with several phases. The capacity of the WWTP could be increased in phases. Start to accept and treat the WW of the 4 villages / localities that are already connected to the trunk line. Then increase the capacity corresponding to the extension of the sanitation system. The Israeli will probably not object lying the extension of the trunk line from Ein Siniya to the site in Wadi Ballat in parcels in area C
Is there already a confirmation from the EIB to finance the implementation of the project?	There is still no confirmation but the intention from EIB to finance also the implementation, not only the study. The funding will depend on an agreement between PWA and EIB.

2.4.4 Public Consultation # 4

The fourth public consultation was held on November 6th 2019 at Ein Yabroud Village Hall at 10:00 am and covers participants from Ein Yabroud and Yabroud.

A formal PowerPoint presentation included:

1. The current situation of wastewater collection and discharge;
2. Discussion of the project background
3. Introduction of three of the 6 developed variants (variant 1, 3, 5 as numbered in the conceptual design report) encompassing the collection and diversion system and a corresponding number of waste water treatment plants.
4. Discussion of the questionnaire to collect information about the residents' constraints and opinion about the presented variants and possible effluent use for irrigation purposes
5. Next steps to complete the ESIA
6. Summary of the presented variants, their pros and cons
7. Open discussion.

Time was allocated for answering questions, and receiving comments on the proposed project. Key questions and comments raised, and responses have been included in **Table 15**. Information on the public consultation are located in **Appendix E**.

Table 15: Key Questions and Answers from November 6th, 2019 Meeting

Questions / statements of the participants	Answer of the Consultant
The Head of Ein Yabrud Village Council explains that a couple of years ago (2006) the internal sewerage, a trunk line to a WWTP and a WWTP have already be projected. After the submission of the project there was however no fund to finance the implementation of the project	
Question of a participant: Will the construction of the internal sewers be financed by the project?	The project covers the construction of the trunk lines to the WWTP(s) and of the WWTP(s). House connections and internal sewerage remain in the responsibility of the Village Councils
Because of the lower construction and operation costs some participants favour the central solution	
Connection fees will be collected after the implementation of the project to cover the operation and service costs. Who will profit from the collected money if there is any surplus?	Usually WW projects are hardly cost covering and many plants have to be subsidised by the government to cover the costs. The collection rate might be too small to cover the costs.
Ein Jabrud is surrounded by plots that are classified as area C (settlement, route 60). Village extension is only possible to the West. At this area we have projected to build the WWTP. Consequently the plant will be located in close proximity of residential area. This issue might hinder the implementation of s decentral solution and favours the centralisation of the sanitation system	
Is money / funding already secured for the implementation of the project? This question should be solved before implementing the project	EIB finances the elaboration of the feasibility study. Only after the study has been finalised the EIB will evaluate if it will fund its implementation.
There are reservations about the building of WWTPs on the outskirts of villages as this might hinder the extension of the villages and increase of population. Therefore centralisation with only one WWTP in Wadi Ballat is favourable.	
The engineer of the village council says that another internal meeting will be held to discuss the question of centralisation / decentralisation. The date of that meeting has not yet been fixed.	
A resident utters that a WWTP should only be built in large distance to build up area of not less than d = 2 km	According to the standards WWTPs may be built in a distance of about d = 500 m to residential area. A buffer zone between the plant and houses / dedicated housing area has to respected

Questions / statements of the participants	Answer of the Consultant
A resident of Jabrud states that It would not be suitable to lay the trunk line under the asphalted road. It should be built in the Wadi	The allocation of the trunk lines will be determined during detail design
Residents are afraid that there will be bad odours arising from a WWTP	Bad odours develop under anaerobic conditions. Sections where such conditions are most likely to develop (pre-treatment, screening) shall be covered or installed I houses and the polluted air be sucked and treated in a bio-filter.
Is it possible to assess the costs of the construction of the internal sewerage? In Ein Jabrud there are about 4,000 residents These costs of construction of the network could be financed by the residents	Cost assessment: Sewers length = 12 km, specific costs 105 US $ / m => 315 US $ / person

2.4.5 Public Consultation # 5

The fifth public consultation was held on December 15, 2019 at Mazra'a Asharqiya Municipal Hall at 10:00 am and covers participants from Mazra'a Asharqiya.

A formal PowerPoint presentation included:

1. The current situation of wastewater collection and discharge;
2. Discussion of the project background
3. Introduction of three of the 6 developed variants (variant 1, 3, 5 as numbered in the conceptual design report) encompassing the collection and diversion system and a corresponding number of waste water treatment plants.
4. Discussion of the questionnaire to collect information about the residents' constraints and opinion about the presented variants and possible effluent use for irrigation purposes
5. Next steps to complete the ESIA
6. Summary of the presented variants, their pros and cons
7. Open discussion.

Time was allocated for answering questions, and receiving comments on the proposed project. Key questions and comments raised, and responses have been included in **Table 16**. Information on the public consultation are located in **Appendix F**.

Table 16: Key Questions and Answers from December 15, 2019 Meeting

Questions / statements of the participants	Answer of the Consultant
Participants asked if the fund are available for the implementation of the project.	After completion of the feasibility study, EIB and other donors may finance the implementation of trunk lines and WWTP.

Questions / statements of the participants	Answer of the Consultant
One participant favour one treatment plant for the municipality but without the responsibility of operation and maintenance.	The municipality can build decentralized WWTP and would be their responsibility to operate the plant. The PA and PWA appointed JWU to be responsible for wastewater collection and treatment in Ramallah Area. JWU strategy is one centralized WWTP for NE Ramallah Catchment Area.
The Municipality designed the internal collection system several years ago. Will the project finance the household and internal networks?	The consultant is aware of the sanitation study. The construction of the internal lines and household connections are outside the project scope.
One participant argued that JWU may assign high fees for collection and treatment.	JWU will assign fees to cover operation and maintenance in coordination with PWA. JWU is a non-profit organization.
Majority of participants agreed on building the wastewater treatment plant in Area C rather than in area A or B due to future expansion of residential areas in Area A & B.	The site of the proposed WWTP will be far from existing and future residential areas.
One participant stated that the municipality catchment area has two reaches: one drain toward the north-west and the second drain to the east side of the municipality. Can the municipality be served without pumping stations?	Yes. About 60% of the municipality wastewater will drain by gravity to Wadi AlBalat to the Centralized WWTP (Scenario 1). The remaining will drain to east and can be served by centralized WWTP of Kherbit Abu Falah and Turmus Aya Municipality.

2.5 Questionnaires Feedback

A soft copy of the responses of the completed questionnaires is presented in Appendix G. A summary of the responses is listed below:

- All responses endorse the sanitation project;
- Majority agreed on one centralized WWTP;
- Majority agreed on the location of the WWTP at the isolated site at Wadi Albalalt
- Majority agreed on the role of JWU for operating and maintain the sanitation system
- Majority of the public are willing to pay for household connection of costs (2000 ILS/ household).
- Minority of the public in Bir Zeit refuse to pay for Connection.
- Minority of the public in Bir Zeit refuse to the role of JWU and reject the centralized solution.
- Majority agreed on the reuse of the treated wastewater for irrigation of almonds, olives, and landscape.
- The majority of the public are lean toward reuse than recharge to the aquifer.

2.6 Conclusion

The perceived notions and attitudes of the public towards the project are generally positive. The residents and stakeholders realize that the project would be beneficial to the environment and their main concerns were about:

- Implementation of the Project
- Centralized and decentralized system
- Location of the WWTP
- Effluent Quality
- Project schedule

The questions of the persons attending the liaison meetings were addressed in the sessions; however, the report seeks to address any issues that may not have been clarified. The consultation conducted to fulfil the TOR and also sought to identify the perceptions and attitudes of the residents. The findings of this public consultations are used to determine the impact of this project on the lives of the residents and business population within the project area.

3 Project Description

3.1 Objective

The objective of this section is to outline, and where possible, provide detailed information on the proposed project in accordance with the ESIA TOR. The project description addresses details of the collection and treatment of the wastewater, labor requirements, activities associated with pre-construction (i.e. enabling works), and construction phase activities. The project description also addresses those activities that will occur during the operational life of the treatment plant and collection system.

The feasibility study of the NE Ramallah Wastewater Project has the following objectives:

- Identify the most effective and optimal regional arrangement of the wastewater systems within the NE Ramallah and its environs from a technical, social, environmental, operational, and cost standpoint.
- Prepare preliminary designs documents for the proposed new trunk wastewater collection systems within the NE Ramallah and its environs, and for the construction of new wastewater treatment plant/s.
- The design horizon of the collection system and treatment facility to serve communities up to the design horizon of 2050, at minimum investment and operations costs.

3.2 Project Background

The NE Ramallah is the potential for future urban development, and the area lacks sanitation system. The NE Ramallah localities expected 2050 population is approximately 86,040. Only the Refugee Camp (Aljalazoun) and part of Jefna Village are serviced by a wastewater collection. Other environs use septic tanks and cesspits for wastewater management.

The collected wastewater from serviced areas and from septic tanks is discharged into the Ein Sinia Wadi without any treatment, causing odor impacts and health danger for the adjacent residential areas and for road commuters.

There are three scenarios that have been developed for serving this project area as follow:

- Scenario 1: One Central medium size WWTP at Wadi AlBalat.
- Scenario 2: Decentralized solution with 6 small WWTPs with two (2) pumping stations.
- Scenario 3: Decentralized solution with 3 small WWTPs and two (2) pumping Stations with different assignment of catchment areas than in Scenario 2.

Palestinian government through Palestinian Water Authority (PWA) intends to improve the wastewater sector in NE Ramallah and environs by expanding the sewered service area and treatment of the collected wastewater.

Jerusalem Water Undertaking (JWU) in consist with PWA strategy will be responsible for operating the entire systems in Ramallah and Jerusalem.

The end result of the project will be an integrated and centralized wastewater system that provides a cost-effective and sustainable wastewater collection and treatment for NE Ramallah and environs. The main benefits of the project include:

- Reduction in public health risk associated with untreated wastewater discharges into drains, wadis and other water courses.
- Improvement of water quality in the western aquifer that currently receive untreated wastewater discharges.
- Overall improvement to the surrounding environment through the proper collection, treatment and disposal of wastewater that is presently adversely affecting the environment.
- Potential for production of up to 8000 m^3/d of reclaimed water that is suitable for irrigation and other non-potable uses in the area.
- Overall improvement in the quality of life for the citizens of NE Ramallah and environs.

3.3 Project Boundaries

The project boundaries are roughly defined by the catchment area in the North-East of Ramallah. The project boundaries are indicated by the solid blue line in **Figure 2**.

There are four (4) major roads located within the project boundary include Road 60, 466, 465, and 4566 Road.

Springs located within the project boundary include the Ein Sinya, Ein Yabroud, and Ein Dora Alqare'a.

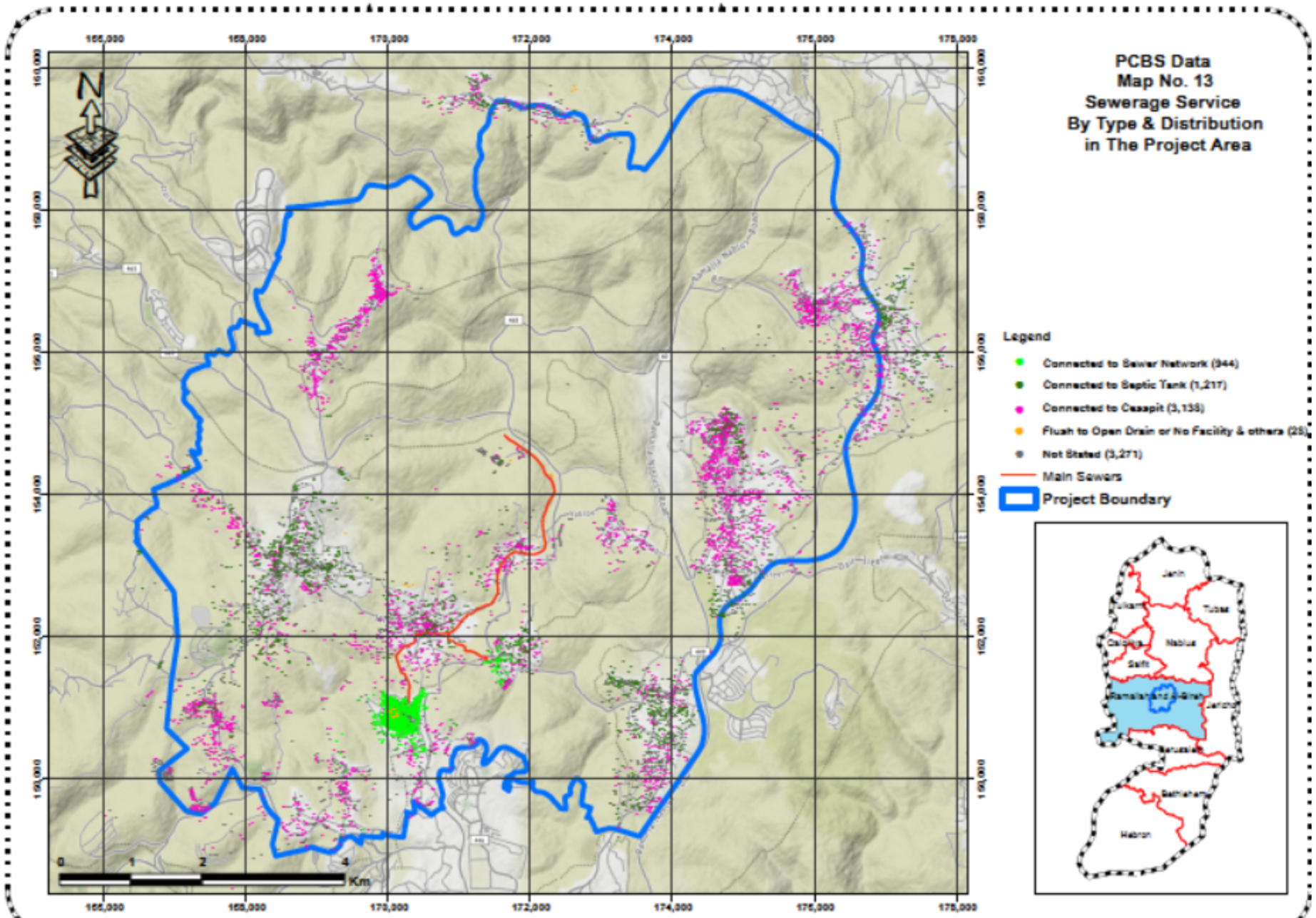


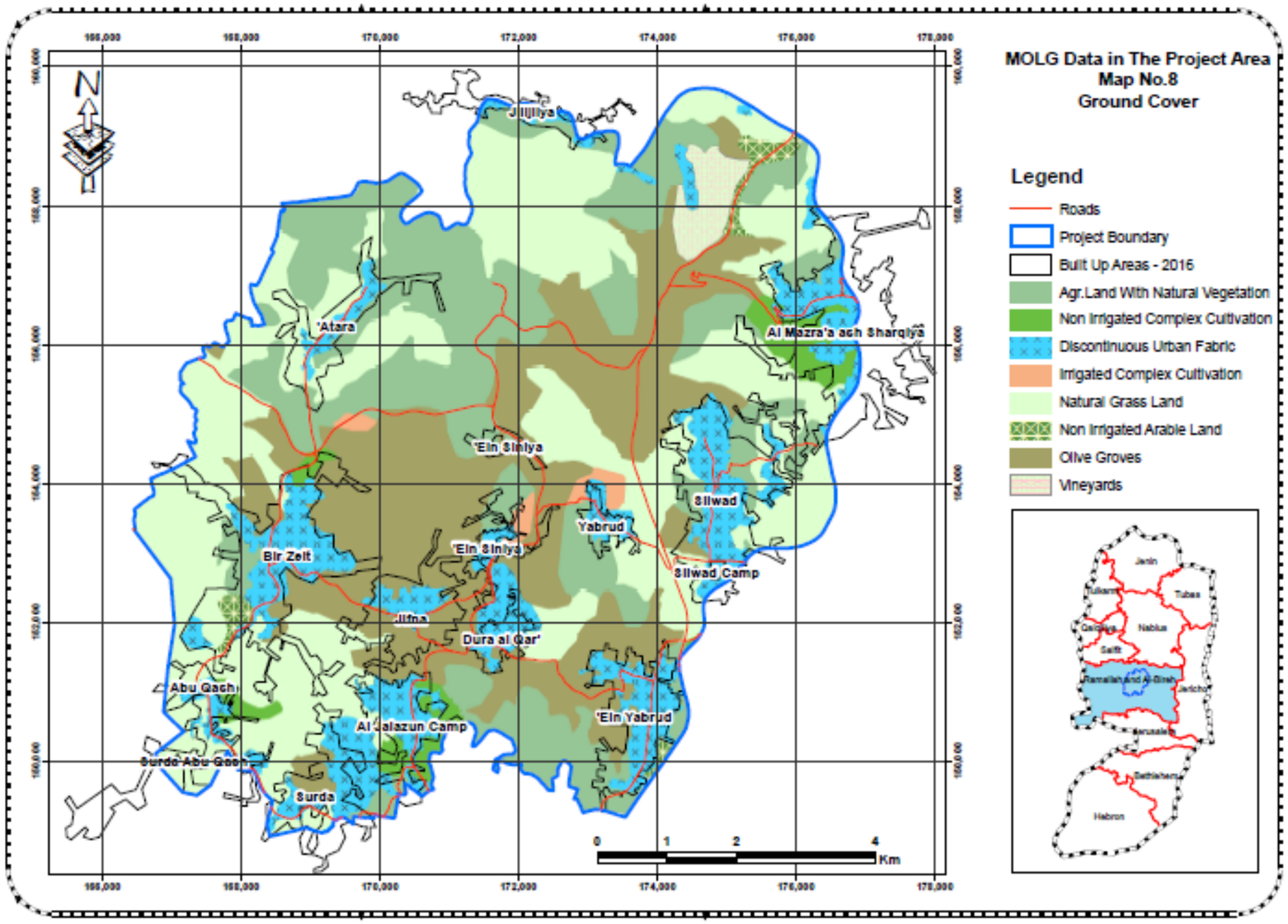
Figure 2: Project Boundaries , Wadi and Spring

3.4 Land Use and Population

Land use within the catchment is mainly residential, along with commercial, one industrial building (Aluminum Coating) and institutional uses. Commercial land use is primarily along main roads in the catchment. Aluminum factory land uses is primarily located upstream of the proposed centralized Treatment Plant in Wadi AlBalat. Institutional land uses include schools, and health clinics are found throughout the catchment. There is no single Hospital in the Project Area.

A land use category map was developed, and the results illustrate that about 20% of the project area is currently developed by human activities (Figure 3).

Figure 3: Map of NE Ramallah and Environs Showing Land Use



The projected population was determined by Palestinian 2017 Census and forecasting to the project design life of 2050. These numbers were verified from the Palestinian Central Bureau of Statistics (PCBS), and other sources.

Table 17: Summary of Population Projections

Population Projection	2035	2050
2017 Census, PE	61000	86040

3.5 Existing Sewered Areas

The NE Ramallah subcatchment is approximately 8 km^2 and only the Refugee camp and part of Jefna Village served by a scattered wastewater collection, without any treatment or disposal system owned and operated by UNRWA and Local village council. The largest areas of the NE Ramallah subcatchment are not served by sewer system.

3.6 NE Ramallah Development Sewerage System

Most of the wastewater that will be generated from the NE Ramallah will be is collected by gravity sewer systems for treatment (Senario-1). For Scenario 2 and 3, several lift stations will pump wastewater from low lying areas to gravity pipelines.

3.7 Estimated Wastewater Volume and Strength

The consultant conducted a wastewater sampling program at the Ein Sinia Wadi during 2019. The results of the wastewater analyses are inconsistent. The consultant adopted European Standards for estimating the future loads and are presented in Table 18. Septage loads are presented in **Table 19**.

Table 18: Assumed Raw Wastewater Loads (2019)

Population equivalent	pe	60,698	86,039
Average dry weather flow	m^3/d	5,818	8,185
	m^3/hr	242	341
	l/s	67.3	94.7
Wet weather flow	m^3/d	7,404	10,434
	m^3/hr	309	435
	l/s	85.7	120.8
Peak flow	m^3/hr	678	917
	l/s	188.3	254.6
COD inlet	kg/d	7,298	10,344

	mg/l	*1254*	*1264*
BOD inlet	kg/d	3,642	5,162
	mg/l	*626*	*631*
SS inlet	kg/d	4,288	6,008
	mg/l	*737*	*734*
TN inlet	kg/d	667	950
	mg/l	*115*	*116*
TP inlet	kg/d	133	215
	mg/l	*23*	*26*

Table 19: Typical Septage Concentrations

Parameter	**Suggested Design Value (mg/L)** [5]
BOD5	7,000
COD	15,000
TSS	15,000
TKN	700
NH3-N	150
TP	250

3.8 Design Effluent Criteria

The design effluent criteria are based on treating the wastewater to meet regulations governing reclaimed water. This will provide effluent water that can be used for agricultural and industrial uses instead of discharging this valuable resource to the Wadi. Until such time as users of the reclaimed water are identified, the treated effluent from the proposed WWTP/s will be discharged to the Wadi AlBalat.

Water reuse practices have been adopted in many countries because of increasing demand for water and decreasing supply of traditional sources of water. As part of the NE Ramallah WWTP design, the option of effluent reuse for non-potable applications has been adopted.

[5] US EPA Handbook: Septage Treatment and Disposal (October 1984)

4 Analysis of Alternatives

The objective of an analysis of alternatives is to describe reasonable alternatives to any project beginning with an assessment of the project siting options, through to an analysis of the social, environmental, technical and design consideration and ending with an assessment of a no action alternative. For this project, the overriding project goal is to treat the pollution generated from the discharge of untreated wastewater from AlJalazoun Camp and Jefna in NE Ramallah Catchment area and to serve the remaining communities by sanitation system (collection and treatment).

The goal of the project is to be realized through the following key project objectives:

- Collection of all point sources of wastewater from homes, commercial, and institutional entities in the NE Ramallah catchment area to a centralized sewer collection and treatment system/ or to a decentralized sewer collection and treatment system.
- Establishment of an interconnected network of new lateral sewers, trunk sewers and lift stations that will serve as an integrated wastewater collection system.
- Construction of the NE Ramallah WWTP/s to have the capacity to effectively handle all of the wastewater treatment needs of the catchment area while using modern secondary and tertiary treatment technology to consistently produce an effluent quality that meets the standards for discharge to wadi, and for reuse in agricultural or industrial end-uses.

As part of the environmental analysis, reasonable and feasible alternative solutions to the project are identified. The magnitude of the net positive and negative effects of each alternative solution are identified and evaluated. Based on this evaluation, a preliminary preferred alternative is selected and confirmed based on public, key stakeholders and community consultation.

4.1 Environmental Components

The environmental components outlined below represent a broad definition of the environment as described in the Environmental Law.

Table 20: Environmental Component Definitions

Environmental Component	Description
Natural Environment	Component having regard for protecting significant natural and physical elements of the environment (i.e., air, land, water and biota) including natural heritage and environmental features and functions.
Social / Cultural	Component that evaluates potential effects on residents, neighborhoods, businesses, community character, social cohesion, community features, and historical/archaeological and heritage components.
Technical	Component that considers technical suitability and other engineering aspects of the servicing options.
Economic / Financial	Component that addresses the potential effect on servicing costs.

A qualitative evaluation was used to consider the suitability of alterative servicing strategies for wastewater and to identify significant advantages and disadvantages with respect to a specific set of evaluation criteria identified for each environment component.

4.2 Wastewater Servicing Alternatives

The process of identifying and evaluating alternative solutions included the following activities:

- Development of a long list of potential alternatives, and screening of those to a short list;
- Compilation of a broad inventory of the natural, social and economic environment in the study area;
- Identification of impacts of the short-listed alternative solutions on the environment, and development of mitigating measures;
- Evaluation of the short listed alternative solutions;
- Consultation with key stakeholders and the public regarding the problem and the alternative solutions; and
- Selection of the preferred alternative.

After the problem opportunity statement was established and justification for the project was determined, alternative solutions to address the problem/opportunity were generated. The following wastewater collection and treatment alternatives (Alternative of do nothing was excluded) were developed for NE Ramallah to address the problem opportunity statement:

Alternative 1: Centralized System for Collection and Treatment of Wastewater;

Alternative 2: Decentralized System for Collection and Treatment of Wastewater (Six (6) WWTPs and Two (2) Lift Stations);

Alternative 3: Decentralized System for Collection and Treatment of Wastewater (Three (3) WWTPs and Two (2) Lift Stations).

4.3 Evaluation of Wastewater Servicing Alternatives

As part of the environmental assessment process, defining the framework and criteria for evaluating the alternative solutions for each servicing component was undertaken and all reasonableand feasible solutions that could be implemented to address the problem and/or deficiency were identified. The wastewater servicing strategies identified above were compared using a qualitative evaluation process. This process determined the suitability and classified the significant advantages and disadvantages of each alternative with respect to the specific evaluation criteria. The decision matrix that was developed to document the potential impacts associated with each alternative and to assist in the selection of the preferred alternative as part of the feasibility study is presented in Table 21.

Table 21: Wastewater Collection and Treatment Alternatives

Alternatives	Potential Impacts on Natural Environment	Potential Impact Due to Proximity to Residential Development, Cultural / Heritage or Other Features	Potential Economic Impacts Based on Both Capital Costs and Operations and Maintenance Requirements		Land Requirements	Complexity of Operations Due to Location, Proximity to Existing Infrastructure and Residential s	WWTP Site location and buffer zone by EQA	Access Roads and EIA Permission	Ability to Meet Official Plan and Policy Statement Requirements	Ability to Meet Future residential Expansion	Other	Preferred Alternative ○ ◔ ◑ ◕ ●
	Natural	Social	Economic		Land	Technical						
			Capital	Annual O&M								
Alternative 1: Centralized	Significant natural environment impacts due to length of sanitary sewer.	No impacts to archaeological/cultural heritage resources anticipated.	€22.2 M	€1.1 M	One site is required. No lift stations	Unlikely due to gravity system and lowest elevation in the entire catchment	Site for WWTP is large than the recommended 500 m from residential land uses.	One Access road and One EA Permission	Yes	Yes	Does meet the preferred alternative for JWU servicing and the Public	
	○	●	◕	◕	◕	●	●	◕	●	●	●	◕
Alternative 2: Decentralized with 6 WWTPS and 2 Lift Stations	Significant natural environment impacts due to length of sanitary sewer.	No impacts to archaeological/cultural heritage resources anticipated.	€32.5 M	€1.8 M	Additional land/easement may be required. Site is required for pumping station.	Likely requirements for a pumping station and forcemain. Does not account for potential future industrial flows.	Site for WWTP is less than the recommended 500 m from residential land uses.	6 Access Roads and 6 EA Permissions	NO	NO	Does not meet the preferred alternative for JWU servicing and the Public	
	◔	●	◔	◔	◔	◔	◔	○	○	○	○	◔
Alternative 3: with 3 WWTPS and 2 Lift Stations	Significant natural environment impacts due to length of sanitary sewer.	No impacts to archaeological/cultural heritage resources anticipated.	€25.2M	€1.3 M	Additional land/easement may be required. Site is required for pumping station.	Likely requirements for a pumping station and forcemain. Does not account for potential future industrial flows.	Site for WWTP is less than the recommended 500 m from residential land uses.	3 Access Roads and 3 EA Permissions	NO	NO	Does not meet the preferred alternative for JWU servicing and the Public	
	◔	●	◔	◔	◔	◔	◔	◔	○	○	○	

4.4 Preliminary Preferred Alternative

The best location for the NE Ramallah WWTP would be at the lowest elevation in the catchment so wastewater can be conveyed to the plant site by gravity and minimize the need for expensive pumping. In this case, locating the WWTP anywhere near Wadi AlBalat would meet this criterion.

Available sites along the Gulf are limited because the area within the San Fernando Project boundaries is highly limited. The Wadi AlBalat site has sufficient land area to build the new WWTP. The Wadi AlBalat site has a number of major advantages in the catchment. These advantages are:

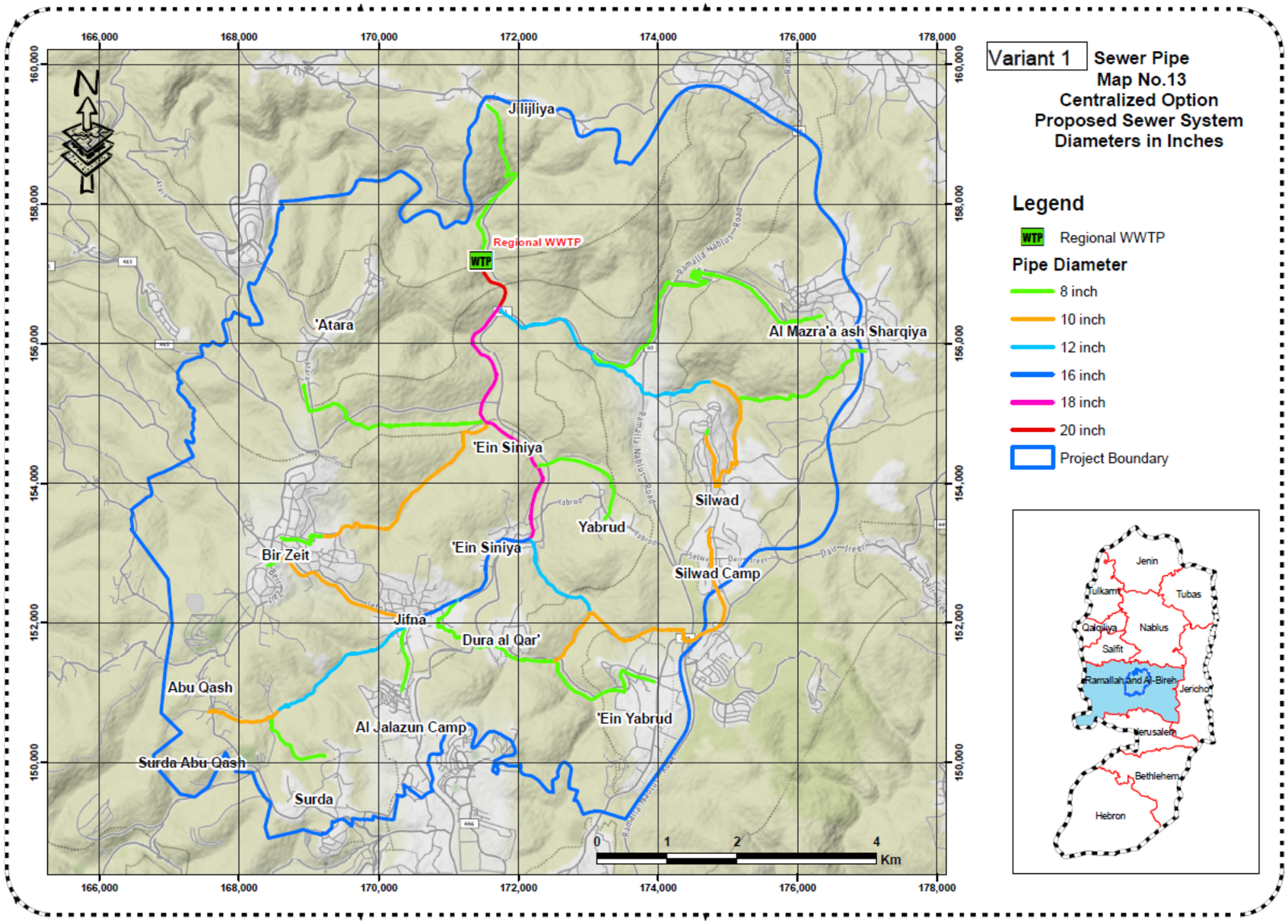
- Major trunk lines serving San Fernando Proper terminate at this site.
- Location is adjacent to the Wadi AlBalat Stream resulting in a short outfall.
- Land owners (From Silwad) are already willing to sell the land for construction of WWTP.

Provided that appropriate mitigation and compensation measures are implemented with regard to natural environment and minimum distance separation guidelines, and applicable permitting and approvals are received, centralized system and Wadi AlBalat site could be chosen for the new NE Ramallah centralized WWTP. ***Figure 4*** illustrates possible treatment plant configurations for the selected site.

4.4.1 Consultation

Based on lower costs associated with land and buffer zone required for the centralized WWTP , as well as the elevation of the site making pumping stations unnecessary, key stakeholders (JWU and EQA) and the public confirmed that the Wadi AlBalat Site was their preferred location.

Figure 4: Location and Possible Configuration of Centralized WWTP



5 Greenhouse Gases (GHG), Odours and Air Quality Analysis

5.1 Introduction

This section provides an overview of the project elements and tools that are common to the greenhouse gases (GHG), odor and air quality impact analyses.

5.2 Potential Releases of Odour at NE WWTP

The presence of odorous substances in wastewater does not necessarily mean that they will contribute to odour problems because the conditions under which they are transformed from liquid to gas are complicated. The factors which affect the amount of odorous gases released to atmosphere are [6] :

- The solubility of the dissolved gases,
- Concentration of compounds in the gas and liquid phases,
- Overall volumetric mass-transfer coefficient which is related to the mass transfer coefficient and the interfacial area - the rate of release at points of turbulence is very much greater than from quiescent surfaces,
- Temperature - solubility decreases and the rate of transfer increases with increasing temperature,
- pH - low pH values favor the emission of H_2S, thiols and volatile fatty acids, while high pH values favor the emission of ammonia and reduced nitrogenous compounds.

Examples of locations where there may be significant potential for release of odours are discharge point of rising main sewers, primary tank weirs, free drops of sludge into open holding tanks or over weirs, mechanical sludge thickening and dewatering plant, discharge points of septage sludges and discharge point of sludge liquors[7].

5.3 NE Ramallah Wastewater Treatment Plant

The NE Ramallah WWTP is likely to consist of an inlet works prior to aeration in an activated sludge aeration basin. Following secondary sedimentation, sludge may be thickened using a thickening tank and then dewatered in an enclosed building prior to disposal offsite.

The proposed treatment plant proposed for either the centralized WWTP or decentralized WWTPs has most of the same major process units that contribute air emissions. These include:

- Influent pump station,
- Septage Receiving Station,

[6] Water Environment Federation, 1995. "Odour Control in Wastewater Treatment Plants"
[7] IWA, 2001, "Odours In Wastewater Treatment - Measurement, Modelling and Control"

- o Flow Balancing Tank,
- o Headworks (screening and degritting),
- o Primary sedimentation basins,
- o Aeration basins,
- o Secondary basins,
- o Disinfection for reuse,
- o Thickener basin
- o Aerobic digestion tank,
- o Sludge dewatering,
- o Laboratory fume hood, and
- o Diesel-fired standby internal combustion engine generator.

The design flow rate capacity of the proposed centralized wastewater treatment plant is 8,185 m^3/day (design period of year 2050). The proposed WWTP is based on continuous activated sludge. Process flow diagram of the proposed unit processes is presented in **Figure 5**

5.3.1 Sewer Network

In rising main sewers, respiration of wastewater and slimes rapidly depletes any dissolved oxygen and nitrates. Thus, sulphate reduction and fermentation may take place within the body of wastewater and on the slimes in the submerged sewer walls leading to odour releases at the discharge points. Design to minimize odours should minimize the length of pumped sewers and ensure odours cannot escape outside the sewerage system. Design velocities of at least 1 m/s in conjunction with the short length of the rising main sewer in NE Ramallah will ensure that solids and grit accumulation in the sewer is reduced and that odour formation will not be a significant issue[8] .

5.3.2 Inlet Works

Raw wastewater inlet channels can be a source of odour problems. Odours can be released from the discharge points, channels, screenings and grit removal. Screenings and grit will be odorous during storage and transfer, particularly if not washed after separation. Designs to minimize odours should avoid accumulation of grit and minimize height of discharge points.

5.3.3 Influent Pumping and Septage Receiving Stations

Influent pumping and septage receiving stations can be a major source of odour problems. Designs to minimize odours should avoid accumulation of grit, provide mixing for septage station and minimize the hydraulic residence time.

[8] Water Environment Federation, 1995. "Odour Control in Wastewater Treatment Plants"

5.3.4 Flow Balancing Tank

The flow balancing tank will be used for stormwater flows and thus will not be in operation continually. Provided that the flow balancing tank is clean after discharge of influent, odour emissions should not be significant.

5.3.5 Aeration

Odours are removed from wastewater by adsorption of anaerobic compounds onto sludge floe and through biochemical oxidation. However, the aeration system will also strip odours from the mixed liquor with the off-gases having a characteristic musty odour. Greater stripping of odour is likely with a mechanically aerated plant than a fine bubble diffused air plant. Designs to minimize odours should:

- Ensure adequate aeration and mixing - An adequate concentration of DO must be maintained especially at the point of fresh wastewater entry. Poor mixing can result in organic solids deposition in corners and along edges of the tank.

5.3.6 Secondary Sedimentation Tank

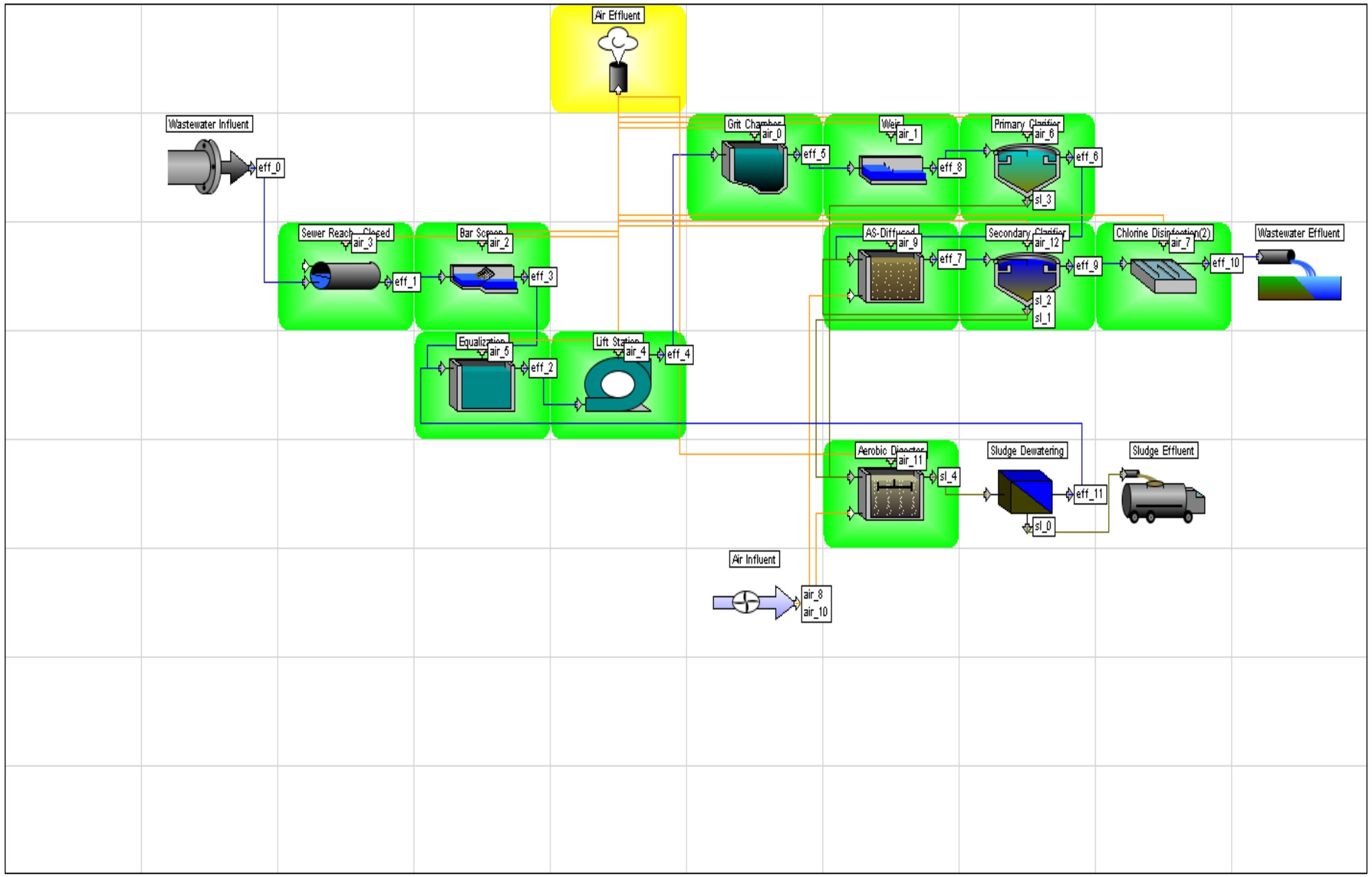
The secondary sedimentation tank is generally low in odour due to the low BOD load in the influent. However, odours can develop faster than primary sedimentation tanks due to the more biologically active, settled mixed liquor. Housekeeping to prevent accumulation of scum on water surface, sludge accumulation on walls and organic matter on effluent weir troughs will minimize odour formation. Withdrawal rates should provide for residence times not exceeding 1.5 - 2 hours to avoid septic conditions in the settled sludge [9].

5.3.7 Sludge Thickening & Dewatering

The amount of hydrogen sulphide and fermentation products generated will increase significantly with time of storage during sludge thickening. Depletion of residual DO occur very rapidly because the number of micro-organisms in the sludge is several orders of magnitude higher than in wastewater whilst the availability of substrate per unit volume is much greater. The strength of sludge liquors will also increase with time. In order to reduce odour release, the dewatering unit will be contained within an enclosed building with the dewatered sludge transferred to a cover skip.

[9] Water Environment Federation, 1995. "Odour Control in Wastewater Treatment Plants"

Figure 5: Process flow diagram and Potential Emissions of the Proposed NE Ramallah WWTP



5.4 Mass Emission

Two models were used in the air quality impacts analysis: a model to develop mass emissions, and a model to simulate offsite impacts from the treatment plant emissions.

5.5 Emissions Estimations

This section of the report presents the detailed approach to the estimation of emissions from each unit process within the proposed WWTP. There are many different sources of air emissions and many different sources of information required to develop a comprehensive emissions inventory. The following sub-sections present the methodology and calculation approaches used for each. The carbon footprint analyses were performed using literature emission factors.

5.5.1 Greenhouse Gases

Direct GHG emissions include emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) that can be biologically produced during wastewater and sewage sludge treatment.

Indirect GHG emissions occur at WWTP mainly by the consumption of electricity, fossil fuel for transportation and by the use of chemicals.

The greenhouse gas emitted from proposed WWTP depend upon the treatment technology. The paragraphs below detail the emissions sources of a particular GHG from the proposed wastewater treatment plant.

- Carbon Dioxide (CO_2)

CO_2 production is attributed to two main factors: treatment processes and electricity consumption. During anaerobic process the BOD5 of wastewater is either incorporated into biomass or it is converted to CO_2 and CH_4. A fraction of biomass is further converted to CO_2 and CH_4 via endogenous respiration. Other emission sources of carbon dioxide are sludge digesters and from digester gas combustion. In the aerobic process CO_2 is produced through the breakdown of organic matter in the activated sludge process and some through the primary clarifiers.

- Methane (CH_4)

Wastewater as well as its solid train components can produce CH_4 if it degrades anaerobically. The extent of CH_4 production depends primarily on the quantity of degradable organic material in the wastewater, the temperature, and the type of treatment system. With increases in temperature, the rate of CH_4 production increases. This is especially important in uncontrolled systems and in warm climates.

- Nitrous Oxide (N_2O)

N_2O is associated with the degradation of nitrogen components in the wastewater, e.g., urea, nitrate and protein. Domestic wastewater includes human sewage mixed with other household wastewater, which can include effluent from shower drains, sink drains, washing machines, etc.

The GHG emissions for the proposed plant were estimated based on the technology used for treatment of WW and the anticipated energy used in the plant during operation. The proposed wastewater treatment technology is a single stage activated sludge with aerobic stabilization of the excess sludge. Analytical calculations regarding GHG emissions (direct and indirect) are presented in Annex 08 of Feasibility Report.

5.5.2 Predicted Impact of the Proposed Sanitation Development

Indicative plant specifications and layout have been assumed based on the specified design and based on similar plants and engineering calculations. Although based on the specified design with assumptions in regard to emission heights (assumed to be at 1.5m above ground elevation) and incorporating worst-case emission factors, the modelling will give an estimation of the likely impact of the facility in the surrounding environment.

5.5.3 Indicative Emission Rates

In the absence of specific plant and operational details, accurate emission rates cannot be derived. However, typical emission rates from a wide range of WWTPs are available in the literature and will give an order of magnitude estimate of likely levels at the proposed WWTP. A recent review of over one hundred measurements (Stuetz and Frechen, 2001 [10]) is shown in **Table 22**:

Table 22: Overview of specific odorant flow rates from WWTP sources.

WWTP Source	Specific odorant flow rate	
	From (ou/m²/hr)	To (ou/m².hr)
Inlet Pumping Stations	11,000	15,000
Aerated Grit Chamber	500	20,000
Screenings	1,000	5,000
Sand from Grit Chamber	1,000	6,500
Primary Clarifier: surface	500	4,000
Primary Clarifier: weir area	500	5,000
Aeration tank: Anaerobic/ Anoxic part	850	3,000
Aeration tank: Aerobic part	300	1,700
Final secondary clarifier	150	500
Primary sludge thickener	12,000	35,000
Stabilized Sludge holding tank	1500	5,000
Stabilized Sludge dewatered	600	16,000

The range of emission factors above assumes normal conditions at a well operated plant without major industrial influent. However, values outside of this range will occur where poor site management and overloading leads to septic conditions. In addition, some emission sources are particularly difficult to measure accurately. Area source (sedimentation tanks, aeration basins etc.) emission factors are generally measured using wind tunnel systems by sweeping air across the surface at a sweep rate of approximately 1800 L/min. However, some literature studies have been sampled using isolation chambers (flux hoods) which have a

[10] IWA, 2001, "Odours In Wastewater Treatment - Measurement, Modelling and Control"

significantly lower sweep rate (5 - 24 L/min). Comparisons between total odour emission rates using both sampling apparatuses show under-predictions of isolation chambers of up to 300 times in some cases[11]

5.5.4 Process Emissions

Emission sources for the model were based on the specified design supplied by design engineers. Odour emission rates used the highest of the range of values outlined for the specific odorant flow rate in **Table 22**. This is likely to significantly over-estimate the impact of the proposed facility in the surrounding environment. The details of the input parameters are given in **Table 23**.

Table 23: Source Emission Details

Emission Source Reference	Estimated Cross-section area (m^2)	Odour Emission Rate (ou/s)
Inlet Pumping Stations	20	83
Screenings	15	21
Sand from Grit Chamber	15	27
Primary Clarifier: surface	110	122
Primary Clarifier: weir area	300	417
Aeration tank: Anaerobic/ Anoxic part	55	46
Aeration tank: Aerobic part	25	12
Final secondary clarifier	200	28
Primary sludge thickener	50	486
Stabilized Sludge holding tank	60	83
Stabilized Sludge dewatered	60	267

The air emissions (including odor compounds) from the proposed WWTP were estimated using TOXCHEM Software. For instance, Toxchem includes a large database of physical and chemical properties for VOCs that are present in wastewater during its treatment. The averaged emission flux ($g/m^2/day$) from the proposed WWTP for odorous compounds is about 6 $gm/m^2/day$ or about 120 kg/day, ammonia 1.6 g/day, and hydrogen sulfide emission is 310 g/day. (Appendix H: Toxchem output report - soft copy in Excel format).

[11] IWA, 2001, "Odours In Wastewater Treatment - Measurement, Modelling and Control"

6 Dispersion Modelling

The air emissions from the proposed collection and treatment were modelled using emission estimates based on concept design information as described in feasibility study. The modelling results are summarized in the form of tables and isopleths. Isopleths provide pollutant concentration contour plots. The isopleths and the maximum modelled concentration results were used to assess the potential for concerns at the receptor with the highest modelled concentration and to compare to the local standards.

Air dispersion models can be used to assess the likelihood of airborne contaminants from the wastewater treatment plant impacting a particular location. The use of these tools comes with a certain amount of uncertainty. Dispersion models mathematically predict the behavior of emitted plumes by accounting for: emission rates, physical characteristics of the release, geometry and location of the sources as related to receptor locations, terrain effects, meteorology, and atmospheric dispersion.

The American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC) was formed to introduce state-of-the-art modelling concepts into the United States Environmental Protection Agency's (US EPA's) air quality models. Through AERMIC, a modelling system, AERMOD, was introduced that incorporated air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources and both simple and complex terrain (US EPA, 2019[12]).

Given the likelihood that the highest modelled concentrations will occur in the near areas (within 1 km), it was decided that AERMOD was the preferred model for this assessment. AERMOD was also selected for this application because of its ability to account for:

- Directional and seasonal variations in land-use;
- Building induced plume downwash, which can affect the sources plume rise;
- Dispersion in a mixed urban/rural/ forested environment; and
- Terrain influences.

AERMOD also considers variable urban treatment as a function of city population and can selectively model sources as rural or urban. The proposed WWTP was modelled as Rural.

In addition, AERMET and AERMAP, AERMOD's meteorological and terrain pre-processors, were employed to process meteorological data and terrain data inputs for AERMOD. Modelling was conducted in accordance with the 2019 AERMOD implementation guide for Air Quality Dispersion Modelling, where applicable.

6.1 Boundaries

Boundaries for the air quality modelling assessment are categorized in two ways: spatial and temporal. The modelled concentrations from the proposed WWTP and comparison with air quality criteria are investigated within these defined boundaries.

[12] U.S. Environmental Protection Agency, AERMOD Implementation Guide, August, 2019

6.1.1 Spatial Boundary

The study area for this modelling assessment was based on a 3 km by 3 km domain surrounding the proposed centralized WWTP to assess where the emissions may impact. This is based on the conservative model approach. A survey of this area showed that there were not any sensitive receptors such as schools, hospitals, senior homes, community centers or public recreation areas within the spatial boundary. Nonetheless, local villages receptors were presented to the model to show predicted concentrations.

6.1.2 Temporal Boundary

Temporal boundaries for this assessment have been developed in consideration of continuous operations and emissions from the proposed WWTP. The maximum concentrations modelled are based on the WWTP operating 24 hours per day, seven days per week. The model assumed 365 days of operation to assess worst case emission scenarios.

For air emissions, the temporal boundary also includes several time averaging periods including 3-hour, 4-hour, 8-hour, 24-hour, and annual time periods. The potential effects on air quality are presented in accordance with the time periods outlined for the identified air quality criteria in Section 1.2.2.

Other temporal boundaries include the time period for which meteorological conditions were assessed. Meteorological data for two (2) years, 2017-2018, were considered for the modelling assessment.

6.2 Meteorology

Air quality is dependent on the rate of pollutant emissions into the atmosphere and the ability of the atmosphere to disperse the pollutant emissions. The dispersion of air pollutants is affected by local meteorological patterns. The wind direction controls the path that air pollutants follow from the point of emission to the receptors. In addition, wind speeds affect the time taken for pollutants to travel from source to receptor and the distance over which air pollutants travel. As a result, wind speeds also impact the dispersion of air pollutants. Therefore, it is important to assess local meteorological patterns to assess potential air quality effects.

AERMET, AERMOD's meteorological pre-processor requires hourly surface observations along with concurrent twice-daily upper air observations. As such, the dispersion modelling used two years (2017-2018) of meteorological data along with concurrent upper air data. 2017-2018 were chosen for the surface and upper air data as they were the most recent consecutive data set with acceptable quality and completeness. **Figure 6** shows a 2-year (2017-2018) wind rose for project area and

Figure 7 shows a frequency distribution of the wind over 7 wind speed class ranges (Raw Data was acquired from Meteoblue AG Basel, Schweiz/Switzerland).

Figure 6 shows that the winds are calm approximately 7.4 percent of the time over the two-year period. Calm is defined in this instance as when the winds are less than the starting threshold of the anemometer (0.5 m/s). It is not likely the 7.4 percent calm hours represented are truly calm for the entire hour; rather the winds are below the threshold of the anemometer at the time when the observation is taken.

AERMOD does not have the ability to model calm winds. As such, these events were not assessed as part of the dispersion modelling analysis. Conversely, AERMOD is conservative (over-predicts) during very low non-calm periods.

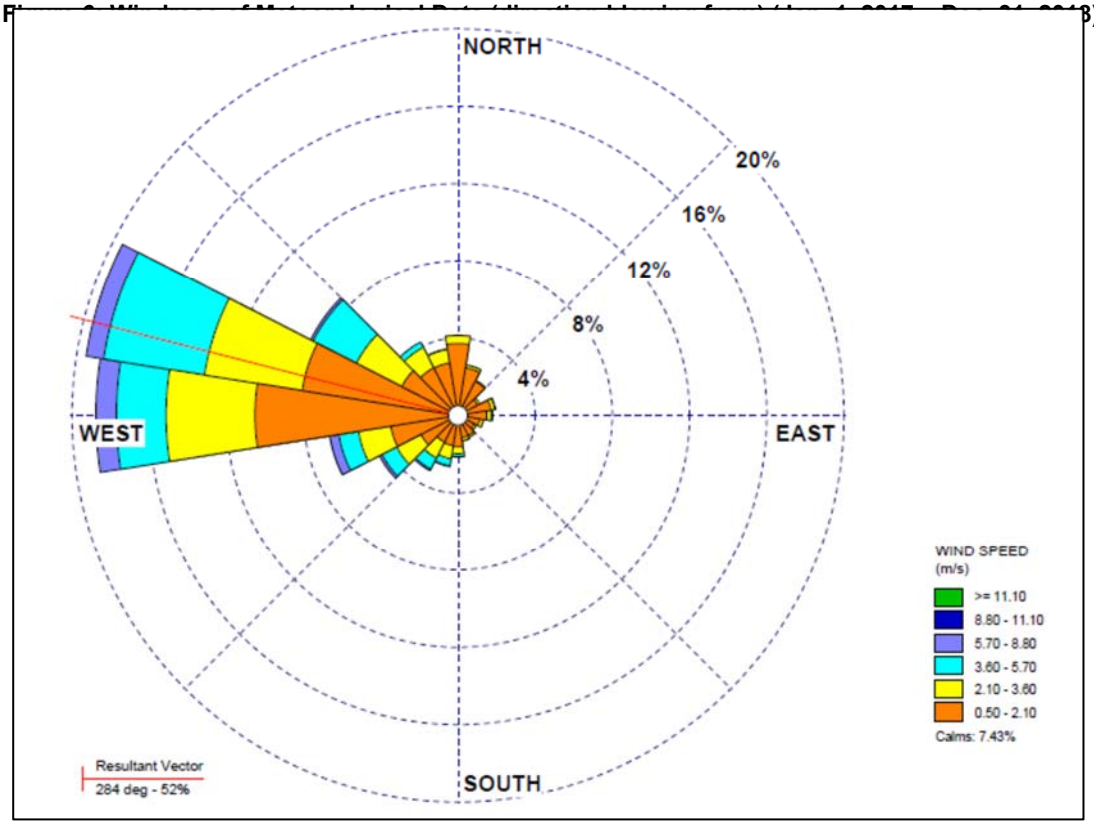
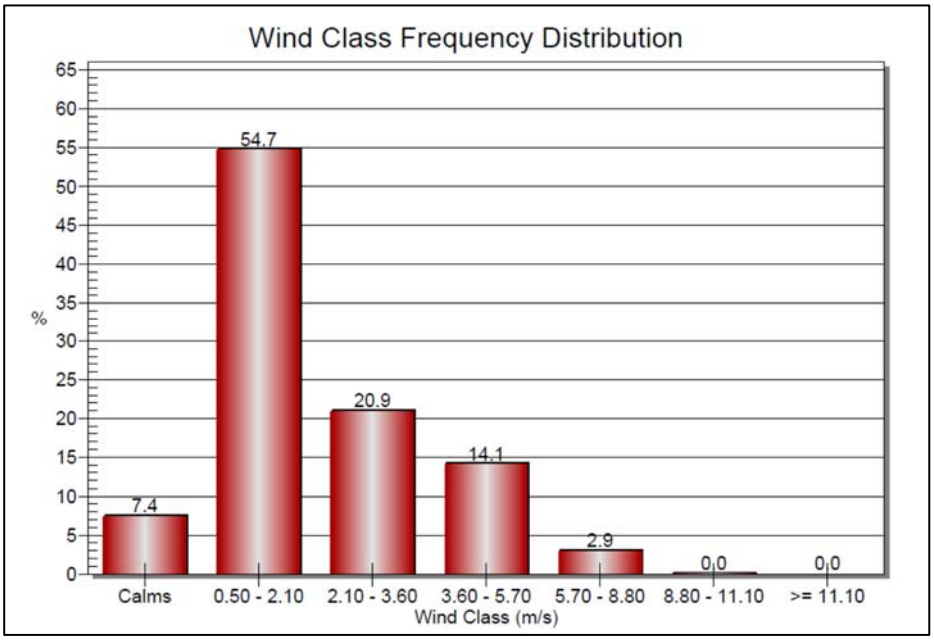


Figure 7: Wind Class Frequency Distribution of Meteorological Data (Jan. 1, 2017 – Dec. 31, 2018)



AERMET produces surface scalar parameters and vertical profiles of meteorological data as an input for AERMOD. In order to quantify the boundary layer parameters needed by AERMOD, AERMET also requires specification of site-specific land use characteristics including surface roughness (zo), albedo (r) and Bowen ratio (Bo). These site characteristics are used by AERMET, along with the meteorological data to help characterize the atmospheric boundary layer and dispersion. The boundary layer is quantified by AERMET in calculating parameters such as:

- Sensible heat flux;
- Surface friction velocity;
- Convective velocity scale;
- Vertical potential temperature gradient;
- Height of convectively-generated boundary layer;
- Height of mechanically-generated boundary layer; and
- Monin-obukhov length (m).

These boundary layer parameters are calculated on an hourly basis and are contained in AERMET's surface file. The surface file is read into AERMOD and these values are used to quantify the atmospheric dispersion.

The land use surface characteristics surrounding the proposed WWTP site were quantified for this project and were determined based on specific land use surface characteristics provided to AERMET.

6.3 Topography

Topographical features, such as valleys and mountainous terrain, can have an important effect on airflow and, therefore, the atmospheric dispersion. Examples of topographically induced circulations include mountain-valley circulations and flow around topographical boundaries. A valley in which a stream flows could introduce wind tunnelling.

The terrain in the immediate vicinity of the proposed is relatively hilly. The proposed site's elevation is approximately 550 m above sea level. Nevertheless, for this dispersion modelling assessment, terrain data was included.

6.4 Land-Use Characteristics

The project' stakeholders stipulate that the land use of the surrounding 5 km must be assessed to determine whether the dispersion coefficients should be based on rural or urban coefficients. In the model a rural coefficient was utilized to represent the surrounding area. In addition, in order to complete the meteorological preprocessing surface roughness, Albedo and Bowen ratio must be input. The land use characteristics were modelled for Cultivated Land.

6.5 Summary of Conservative Approach to Modelling

The modelling assessment used a conservative approach to provide worst-case scenario results. The key assumptions, attributes and methodologies leading to this conservative approach include:

- Emission rates were based on constant maximum production rates. In reality, production rates are expected to vary.
- Emission factors such as those from US EPA are generally inherently conservative.

Background ambient concentrations were not available and likely have ambient pollutant concentrations due to the untreated wastewater discharged to Wadi AlBalat.

The inherent nature of dispersion modelling involves assuming that that the proposed WWTP is operating at peak worst case conditions at the same time as worst case meteorological conditions. The probability of operating at peak conditions at the same time as worst case meteorological conditions is low.

7 Results

All of the maximum concentrations for all averaging periods (3-hour, 4-hour, 8-hour, 24-hour and annual average), for odor compounds (listed in Appendix H) , H2S and GHG, are predicted to occur within 400 meters of the proposed site boundary. The maximum concentrations are expected to occur during the night time, under stable conditions and very light winds.

Isopleths showing the distribution of predicted concentrations and the maximum predicted concentrations for the proposed Facility over the study area for all contaminants and averaging periods can be seen in Appendix I.

As seen in Isopleths concentrations at the adjacent villages show no exceedances for any of the contaminants.

7.1 Summary and Discussion

An air dispersion model was conducted to determine the proposed impacts of the NE Ramallah WWTP. Modelling results of the proposed facility predict that maximum concentrations of major pollutants are only limited to project site and below limits in adjacent villages. Concentrations at the nearest receptors (road 60) are well below the maximum allowable limits. For example, the odor compounds concentrations is below 20 $\mu g/m^3$ at Road 60 receptors.

A full representation of the distribution of predicted concentrations can be seen in the isopleth figures in Appendix I.

In summary, no significant impacts to ambient air quality from the operation of the proposed facility at Wadi AlBalat , especially given the reasonably isolated location of the Facility and the absence of sensitive receptors.

References

- G. Venkatesh*, Helge Brattebø , 2011 . Energy consumption, costs and environmental impacts for urban water cycle services: Case study of Oslo (Norway). 2011 Elsevier Ltd.

- IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

- IWA, 2001, "Odours In Wastewater Treatment - Measurement, Modelling and Control".

- US EPA 2013. AERSURFACE User's Guide. (EPA-454/B-08-001, January 2008, Revised January 2013). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

- US EPA 2009. AERMOD Implementation Guide (Revised). US EPA, Research Triangle Park, NC. March 19, 2009. Wardrop Engineering Inc., McCain Foods Limited Portage La Prairie Odour and Noise Emission Control Study.

- USEPA (1998) User's Guide to the AERMOD Meteorological Preprocessor (AERMET)