TERMS OF REFERENCE

Bulk Water Supply Master Plan and Water Harvesting Master Plan in the West Bank

1. Context

1. Background

The status of the water sector in Palestine, as it exists today, is a direct outcome of the terms and conditions determined by the Oslo II Interim Agreement of 1995 and the occupation and closures imposed on the Palestinian territory by Israel. Palestinians suffer from restricted access to their entitled share, in accordance with international water law, of the trans-boundary water resources. This manifests itself with low per capita water availability, inadequate water service in terms of access, reliability and water quality, and major seasonal water shortages particularly acute in rural areas. The sewerage sector has fared no better with chronic underinvestment leading to partial coverage, very low rate of wastewater treatment, and widespread environmental damage.

The PWA was created in 1995 through a Presidential decree in order to regulate the water sector, improve and sustain water resources, planning and service delivery provision. It was assessed that the institutions and institutional framework created since 1995 to manage water resources and water uses, including the provision of water and wastewater service are insufficient for their purpose and consequently do not meet the needs of the Palestinian people in Palestine. The lack of clear institutional mandates had contributed to a situation of ineffective governance and weak capacity in the Palestinian water sector, which combined with occupation-related restricting factors, impaired the development of adequate policies and strategies for water resources management, infrastructure development and service provision. The institutional fragility of the water sector in Palestine was generally acknowledged, as reflected in a number of reports. In November 2008 a Norwegian funded infrastructure audit of the water sector in Palestine[1] (the Audit) requested by PWA concluded that there is an urgent need for a "strategic-level study of the institutional needs in the water and wastewater sub-sectors in Palestine", and that the study should take account of all previous work on institutional issues, but not be constrained by any earlier conclusions. It goes on to conclude that "the existing water sector program [in the West Bank and Gaza] does not sufficiently address the needs of the Palestinian population and that a major refocusing effort is required." It notes "policy and strategy development in the water sector has been inadequate" and goes on to say that "ongoing projects have been developed in a largely donor-driven fashion." Based on these Audit recommendations, and in line with the Program of the 13th Government to accelerate the establishment of a viable Palestinian State, the Palestinian National Authority has endorsed the Action Plan for Reform and asked the PWA to lead in the implementation of a multi-year Water Sector Reform.

Water Sector Reform

On Dec 14th 2009 the Cabinet of Ministers of the Palestinian National Authority endorsed an "Action Plan for Reform" (from here on referred to as "the Action Plan") towards the definition and implementation of a comprehensive program of institutional and legislative reform in the Palestinian water sector ("the Sector Reform"). As the central body in the sector, the Palestinian Water Authority (PWA) has the mandate to lead the reform process. The overall reform included the reorganization of the water sector and the institutions within, capacity building, and the developing of strategies and policies.

The reform objectives have been defined, and slightly adjusted in the Sector Reform Plan as follows, with regards to:

1. Institutions; the Sector Reform will establish strong (capable) and sustainable institutions within a legal framework that clearly defines their roles, responsibilities and the interface (relationship) between them.

2. Infrastructure needs; the Sector Reform will improve water supply and sanitation strategies, policies, investment programs, project designs, and the implementation of projects, in an effort to substantially accelerate infrastructure development.

3. Service provision; the Sector Reform aims to accelerate equitable access to a quality service, while providing improved efficiency and cost-recovery of effectively regulated water operators.

4. Water resources management; the Sector Reform will help to build the institutional knowledge, policies, and monitoring and enforcement capacities, as part of an effort to achieve a more sustainable water resources management strategy.

5. Water consumers; the Sector Reform will aim at improving water demand management and public health awareness in line with the development of water conservation, environmental and public health policies.

New Water Law

The President of State of Palestine issued a decree endorsing the new Water Law on 14 June 2014. The issuance of the new law establishes for a new phase for the water and wastewater sector, its governance and management, as the law states that the Water Authority will be under the responsibility of the Cabinet which goes in line with the basic law for having the authorities under the Cabinet umbrella. In addition the law splits policy from regulatory functions, which was previously carried out by PWA since its establishment. The new water law grants the establishment of Water Sector Regulatory Council. The Water Sector Regulatory Council has been established by the Cabinet and has a Board of Directors derived from the public sector, private sector and civil society. Its mandate makes it responsible for water prices and monitoring the performance of Water and Wastewater Service Providers. It will issue licenses for operators to establish the infrastructure needed to supply, desalinate and treat water and set the framework for quality assurance of services and manage consumer complaints. It will set the foundations to represent service providers in Regional Water Utilities and in addition, monitor the performance of Bulk Service Providers and ensure that their services are compliant with the accepted standards.

The Water Law includes directives to transform the West Bank Water Department into a National Water Company which will be owned by the State of Palestine. For this reason the Law states PWA need to develop a temporary Bylaw to facilitate this transitional period (transfer the West Bank Water Department into a company) and provide a mechanism to transfer the assets to the National Company. The Law also states that the company legal status will not change except by a Law. The National Water Company is responsible for supplying Bulk Water and any tasks as assigned by the Water Authority. The National Water Company will have Board of Directors formed by the Cabinet based on recommendations from the Head of the Palestinian Water Authority.

The new law gives PWA the mandate, supported by a bylaw endorsed by the Cabinet, for establishment of Regional Water Utilities and Water User Associations.

The Law includes articles protecting water resources and defined protection zones. In addition, to monitoring water resources and provides the head of PWA the mandate to provide judicial policy. It also contains articles which allows for sanctions for the infringement of Water resources.

Current and future organization of Water Sector

The current organization and relationships between the main administrative bodies involved in the sector are briefly presented in Figure 1. The "National Water Company" has not been fully established yet. It is supposed to integrate the current West Bank Water Department (WBWD) in charge of managing and operating the bulk water supply system in the West Bank.

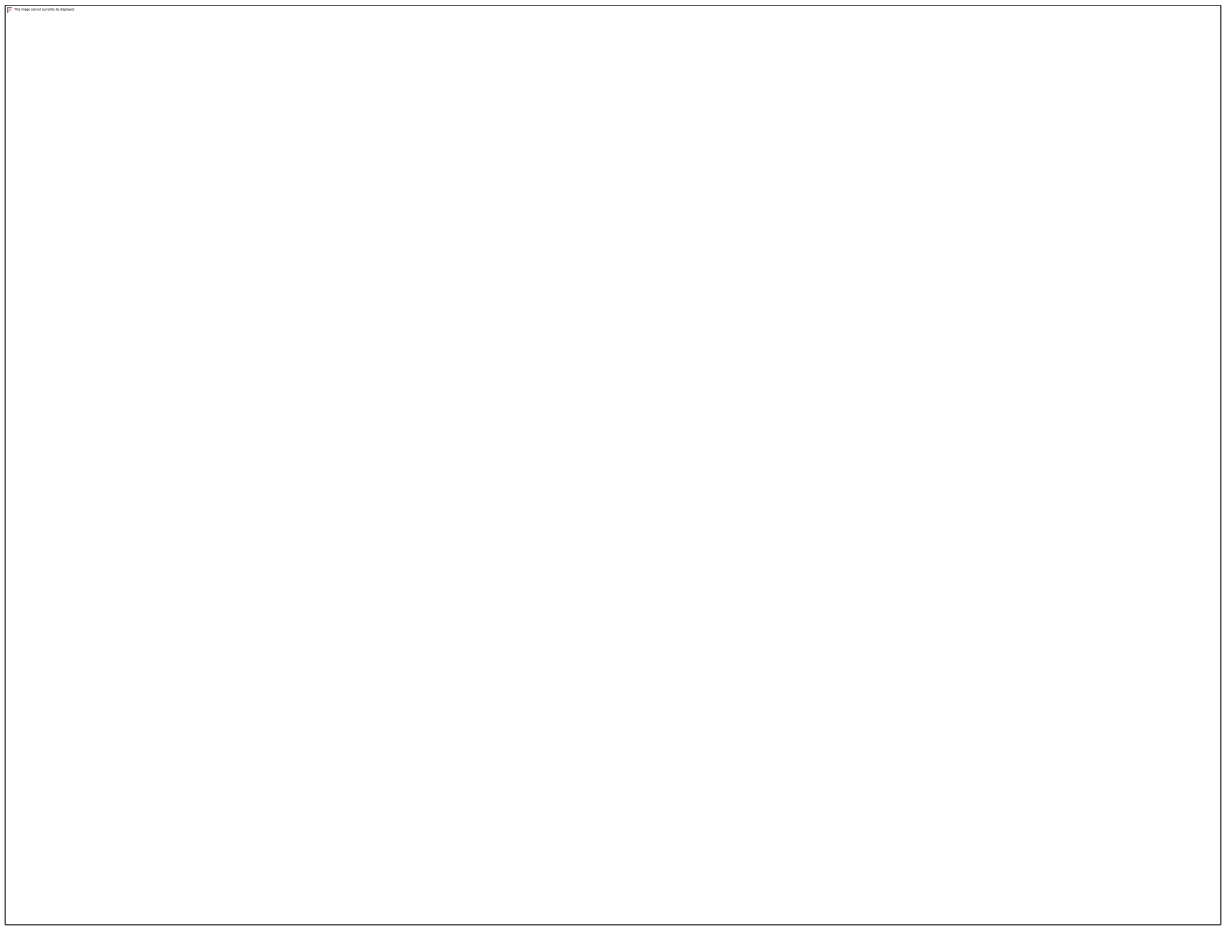


Figure 1 Water sector framework (source: PWA, cited in [WSRC, 2017])

The reorganization of the water service providers is also part of the Water Sector Reform. It was especially addressed in a study aiming at proposing a roadmap for the creation of Regional Water Utilities (RWU). The latest report of this study [FCG, 2018] recommended a stepwise approach to reduce the number of service providers from almost 300 in 2018 down to 3 RWUs in the West Bank and 1 in Gaza in 2032 (Figure 2).

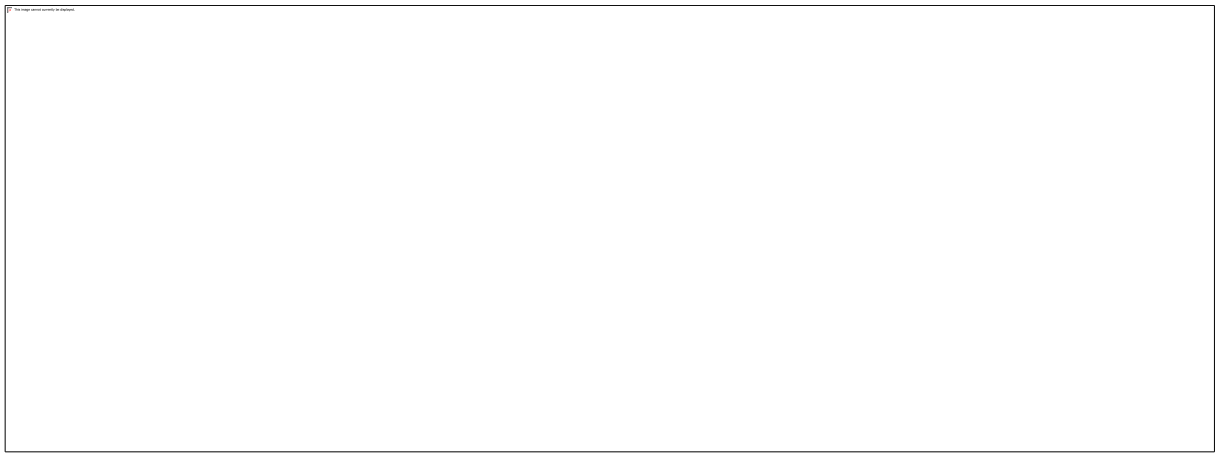


Figure 2 Proposed reorganization of the water service providers in the West Bank as per [FCG, 2018]

Bulk Water Supply Department

The current water supply to the West Bank mainly comes from groundwater and springs (60 %) and the water purchased from Israel (40 %) as presented in Table 1. As of today, the distribution of bulk water to Palestinian communities cannot be satisfactorily controlled by the Palestinians themselves due to the entangled Palestinian and Israeli water networks within the West Bank (Figure 3).

Water source	Volume (MCM) (available)	Volume utilized for bulk System (MCM)
Groundwater and Springs	122	602
Purchased water from Israel	73	683

Table 1 Volumes of various water sources in 2018 for the West Bank [PWA, 2018]

2 Part of the Ground water is used for agriculture use (62 MCM)

3 Part of purchased water is used for agriculture in Kardala and Bardala

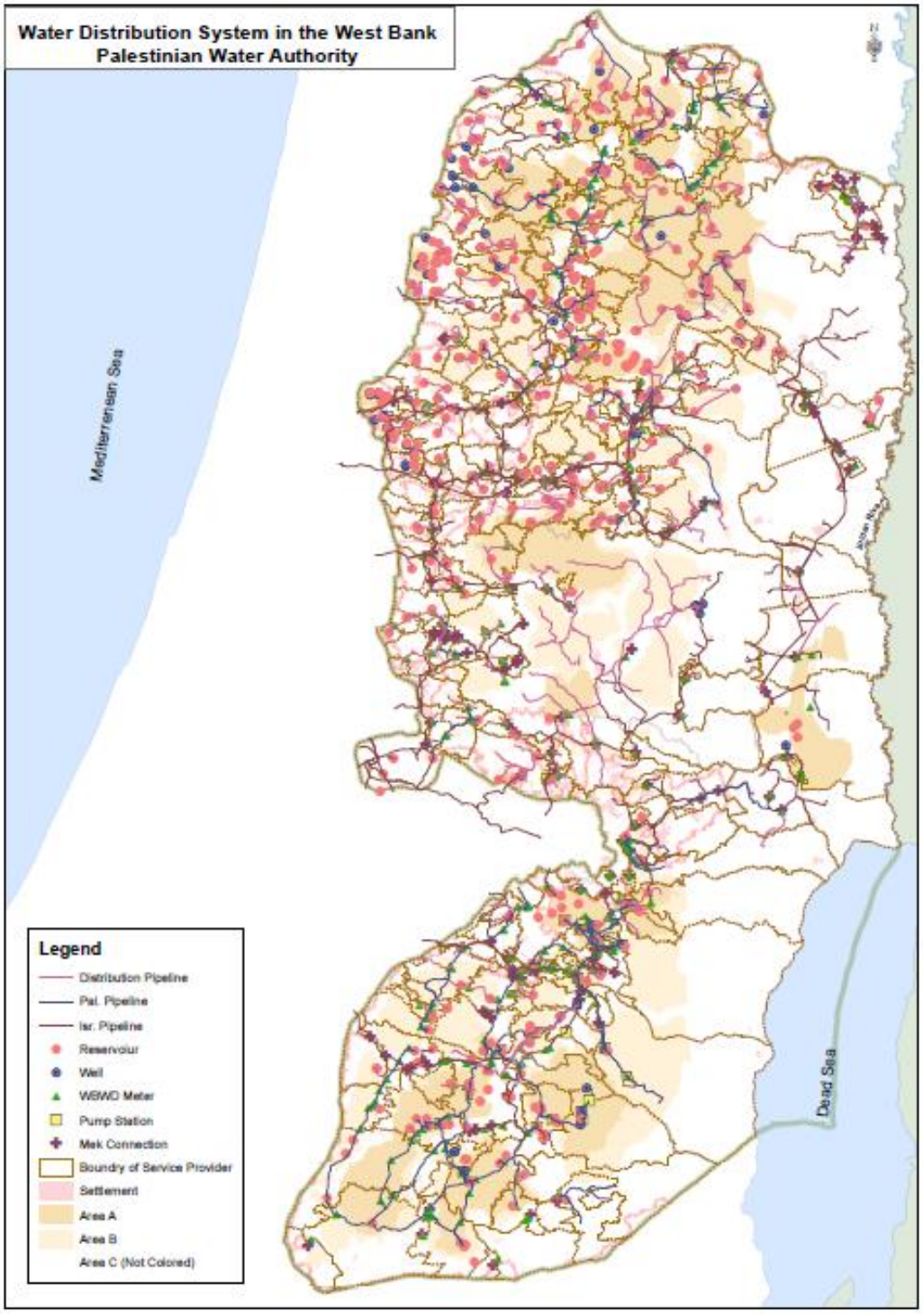


Figure 3 Water distribution system in the West Bank (PWA data)

In the West Bank, bulk water provision is the responsibility of the West Bank Water Department (WBWD). It manages wells and purchases water from Israel, and distributes and sells bulk water to service providers.

The WBWD purchases water from the Israeli side (Mekorot) through 175 connection points (for a water quantity of around 73 MCM/year) which adds to the water abstracted from 10 wells owned by the PWA and few private wells. The amount of water abstracted and purchased from private wells is around 55 MCM/year.

Currently, the WBWD is distributing water through 600 km of pipelines with diameters ranging from 2" to 36" supplying water to 199 service providers (in additional to individual connection) through 500 water meters which represents (87%) of the total service providers.

This situation creates the following issues PWA would like to address through this assignment:

1. Direct connections of Palestinian service providers to the Mekorot system (i.e. the bulk water distribution network managed by the Israelis) are out of reach of PWA in terms of operation and management as of today due to infrastructure layout. Consequently, PWA cannot ensure a fair distribution of the water volume allocated by Mekorot among the Palestinian communities nor can it control the flow towards certain communities.

2. The billing system applied by Mekorot does not take into account the true losses of its own network (which in some routes reach up to 60 % in some areas due to its poor condition and due to the fact that Mekorot does not allow WBWD to fix any loss on all routes owned by them), that add to the consumption of Palestinian communities (Figure 4). With no control over the direct connections to the Mekorot system, PWA cannot precisely monitor the consumption of each service provider nor argue with Mekorot against any doubtful bill.

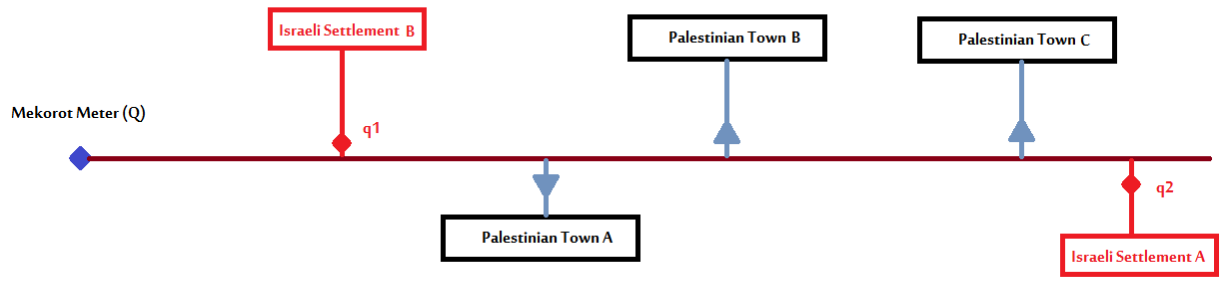


Figure 4 The water quantity paid by the PWA to Mekorot for Palestinian service providers A, B and C is Q – 104% (q1 +q2), therefore including almost all water losses along the Mekorot network (losses of only 4% are accounted for by the Israelis, based on their own consumption).

3. In addition to the above-mentioned issues, there is a need to complement the current "Red Sea – Dead Sea" project on the Palestinian side. In July 2017 a "commercial agreement" was prepared – it has not been signed yet - between Israel and Palestine that would increase the water supply to Palestine by 23 MCM to the West Bank and 10 MCM to the Gaza Strip. Consequently, PWA needs to be prepared to transfer and distribute this additional water quantity as well as other future additional purchased quantities. This water would be supplied to the West Bank through new connection

points with the Mekorot network. In the future (by 2032) PWA is willing to reduce the current high number of those connection points to several main ones which are under discussion with the Israeli side. All details regarding the current and future connection points (location, characteristics, planned supply quantities, etc.)are available at PWA.

Available Water Resource

Although current potential water resources in West Bank, comes mainly from groundwater and springs (122 MCM in 2018) , in addition to the water purchased from Israel (73 MCM in 2018), wadies runoff and treated wastewater are considered important conventional and nonconventional water resources that needs to be utilized

Water source	Volume (in MCM)
Estimated wadi runoff	165
Treated wastewater	24

Table 2 Volumes of Average Water from Wadi Runoff and Treated Wastewater in West Bank [PWA, 2019]

Wells and springs are located in three main basins in the West Bank: the Eastern Basin, the North-Eastern Basin and the Western Basin. Each of these basins contains several aquifers which are renewable. The water coming from wells and springs is used for both domestic and agricultural purposes although around 5 % only of the cultivated land is irrigated due to water scarcity (should more water be available this value would increase).

Faced with changing climate and rising intensity of climate extremes, surface storage may be an option to allow for direct use for irrigation or other purposes to be defined. Rainwater may be stored and infiltrated into the aquifers either to sustain the yield of the aquifer or to allow for the creation of additional wells. Intentional groundwater replenishment known as Managed Aquifer Recharge (MAR) is an increasingly important water management strategy to maintain, enhance and secure stressed groundwater systems and to protect and improve groundwater quality. The scarcity of water resources in semiarid regions such as the West Bank is usually accompanied by brief periods of quite intense precipitation. In such regions, the use of runoff water for aquifer recharge can contribute to both flooding prevention and effective management of water resources.

To date, no comprehensive or conclusive study has been conducted to assess the potential quantities and qualities that may feasibly be captured by harvesting rainwater4and reusing

4Stormwater is any water running off a land surface before it reaches a natural water body. It occurs when the rate of precipitation is greater than it can infiltrate, or soak, into the soil. Rainwater harvesting offers a small-scale best management practice to reduce storm water runoff and the problems associated with it. By harvesting the rainfall and storing it, the water can be slowly released back into the soil, either through irrigation or direct application. The water then moves into groundwater table, providing a steady supply of water to local streams and rivers.

treated wastewater. However, the availability of hydrological 5, geological and topographic data is sufficient to prepare a large-scale water harvesting Master Plan. Therefore, it is important to define the main conceptual guidelines applicable to the local context in terms of water harvesting and the best locations and the main characteristics of individual water harvesting projects to be developed in priority in a future investment phase

1. Definition of the Project

The project aims at supporting the Palestinian Water Authority (PWA) in (1) developing Bulk Water Master Plan and preliminary design of regional clusters, and (2) developing Water harvesting Master Plan for West Bank. The study will consider the updated Water Sector Policy and Strategy.

Developing Bulk Water Master Plan shall contribute to improvement in the bulk water management and distribution through:

1. Consideration of non – conventional water sources (I.e treated wastewater and harvested water) that will allow PWA to reallocate some fresh water currently used in agricultural sector towards domestic use.
2. A better control of the supplied bulk water quantities.
3. An improved planning and distribution of limited water resources in an appropriate manner. This will improve the relationship between the WBWD and the service providers as the WBWD can set agreements with service providers on quantities to be provided on monthly basis and have the service providers' commitment to pay for the provided quantities.
4. Improving the management of water at bulk level will certainly improve the management of water at local level as the service provider will distribute the quantities in an efficient manner
5. The reduction of direct individual connections of service providers of the West Bank to the bulk water network of the Israeli Mekorot company.
6. The generalization of the connection of service providers of the West Bank to the bulk water system managed by PWA.
7. The necessary adaptations of the existing bulk water system managed by PWA to allow for the connection of all Palestinian water service providers and to cope with the future additional water quantities from the "Red Sea – Dead Sea" project, from an increase of

5 Available hydrological data at PWA includes water level, water abstraction for wells , spring discharge, pumping test for some wells , hydrogeological and structural maps, water quality data, rainfall data, measurement for storm water flooding in some wadies)

purchase quantities as well as from increased quantities supplied through the development of natural water resources (connection points, regional reservoirs, transfer pipelines, etc.).

8. Figure below illustrate existing situation of Mekorot and PWA bulk water networks, and the anticipated future situation in order to reach affair and sustainable distribution of water among the Palestinian communities of the West Bank.

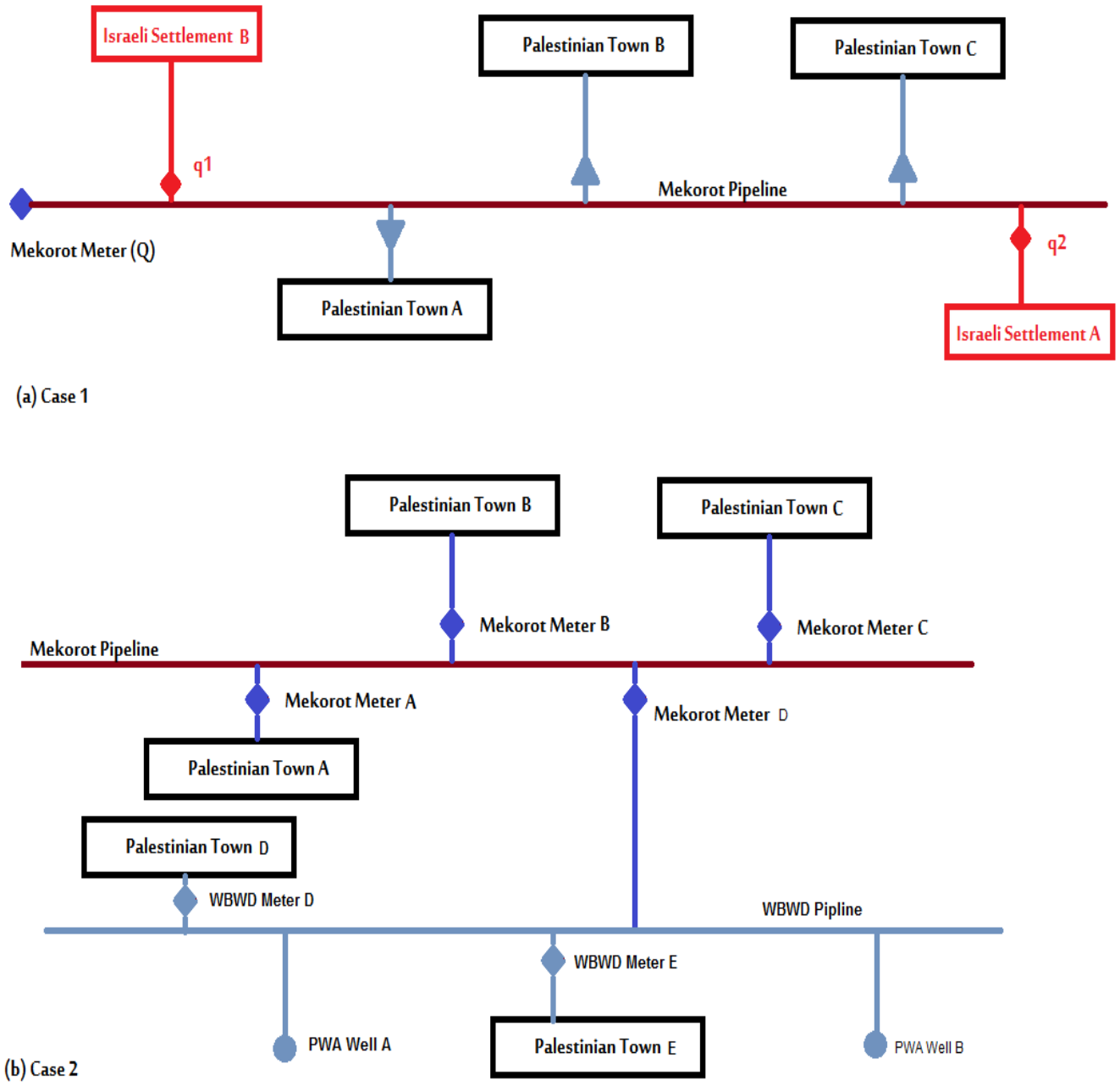
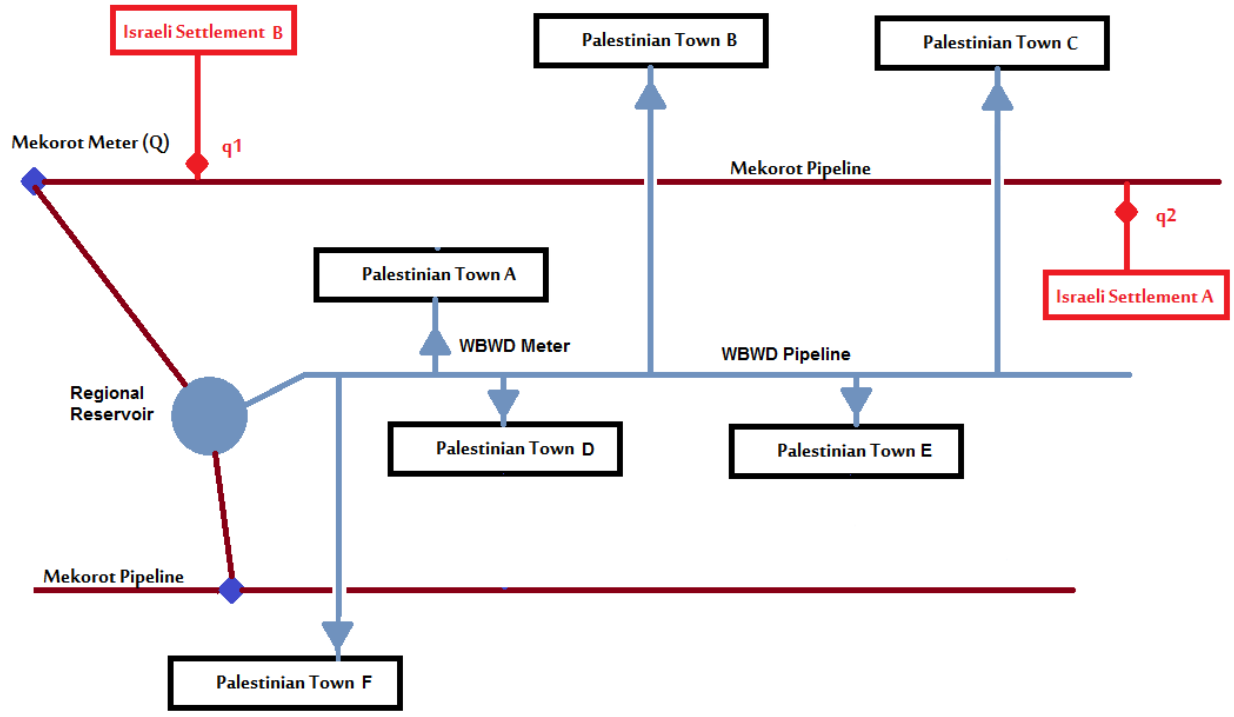


Figure 5 Existing situations of the Mekorot and PWA bulk water networks


Israeli Settlement B
Palestinian Town B
Palestinian Town C
Mekorot Meter (Q)
q1
Mekorot Pipeline
q2
Palestinian Town A
Israeli Settlement A
WBWD Meter
WBWD Pipeline
Regional Reservoir
Palestinian Town D
Palestinian Town E
Mekorot Pipeline
Palestinian Town F

Case A

Case B

Figure 6 Planned future situations of the Mekorot and PWA bulk water networks

The Consultancy Service includes various activities to be performed by the Consultant which cover various phases from the literature and data review to the preparation of preliminary design documents for a selection of priority projects to be implemented in the short-term.

Water Harvesting Master Plan will support PWA in considering non-conventional water sources (i.e. treated wastewater and harvested water) that will allow reallocating some fresh water currently used in the agricultural sector towards domestic use.

PWA is willing to more efficiently utilize the rainwater through developing water harvesting systems. The Project aims at supporting and prioritizing the development of PWA plan for water harvesting, including rainwater and treated wastewater. It includes various activities to be performed by the Consultant which cover all phases of the preparation of a water harvesting Master Plan from the literature and data review to the preparation of Master plan and selection of priority projects to be implemented in the short-term. The Project also includes the assessment of all technical, environmental, social, legal, institutional and financial aspects related to the proposed Master Plan.

1. Area of the project

For the Bulk Water Master Plan; the area of the Project is the whole West Bank. The landlocked territory stretches over an area of 2,183 square miles. Current estimates show that the population is approximately 3,284,787 as of 2017 according to the PCBS. Despite its small surface area, there is a considerable variation in elevation with the lowest elevation of a little more than 400 m below sea level (the Dead Sea) and the highest point of just over 1,000 m (tall Asur), close to the geographical center of the West Bank

For the water harvesting Master Plan; the area is the whole West Bank. The Gaza Strip is therefore not included. A map of the Project Area is displayed in Figure . The area of the Project includes all zones (A, B and C) but the priority projects can only be developed in zones A and B. The possibilities to build dams in the Project Area shall be investigated. In addition, the Consultant shall be well aware that the Project is targeting the Palestinian people. For instance, any proposed MAR project shall focus on artificial recharge of the upstream parts of the aquifers and thus benefits globally to the Palestinian wells.

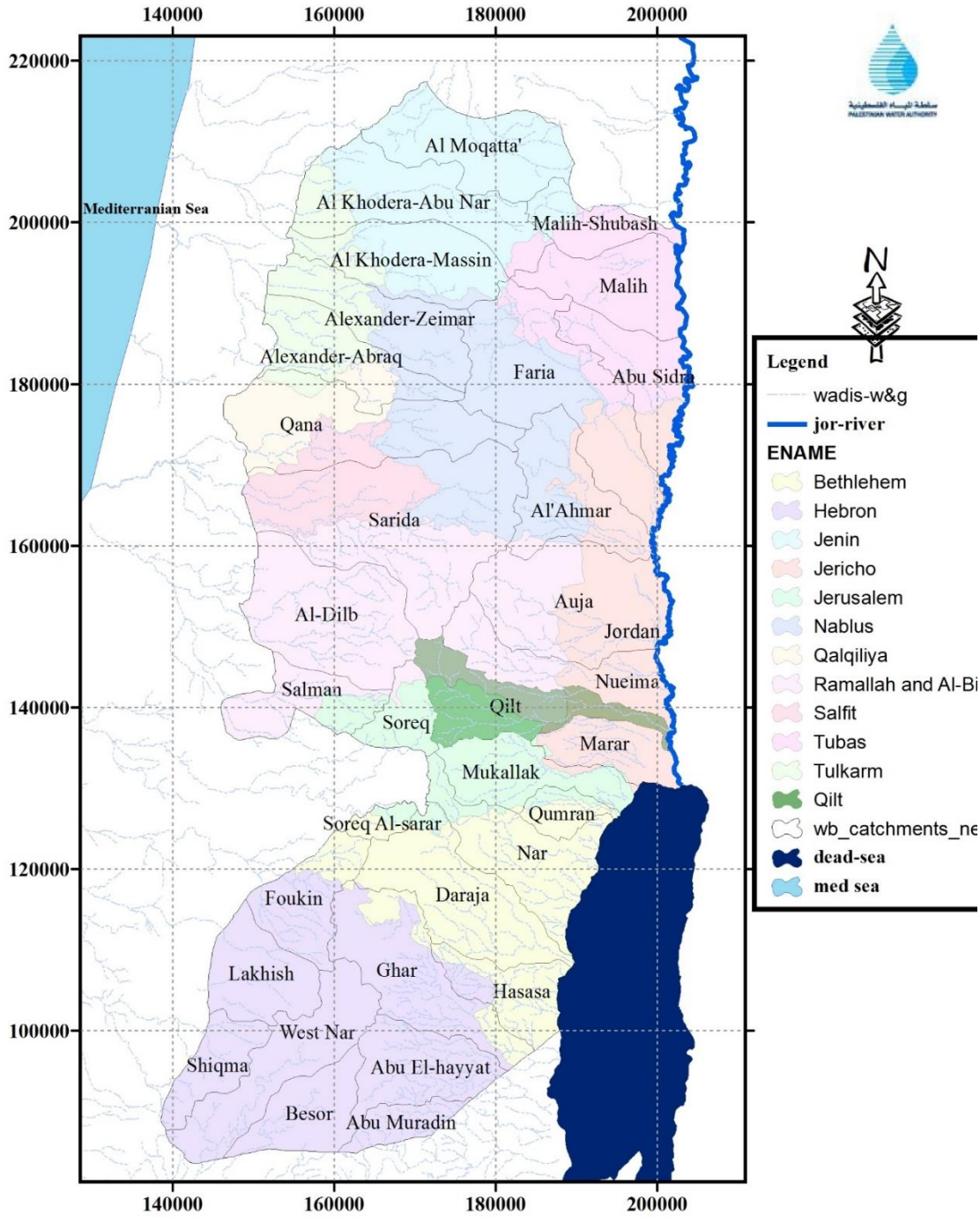


Figure 7 Map of the Project Area (i.e. West Bank) displaying the main hydrological features

2. Relevant studies and available data

The references presented in "**Error! Reference source not found.**" will help the Consultant understanding the local context while providing him with the previous studies that he should consider as the starting point for developing the activities included in the Project (the list is not exhaustive).

The current project is mainly focused on the development of Master Plans at national level. However; the consultant should utilize the results of other studies and Master Plans for water and wastewater, and consider its results as key input for the preparation of the Master plans. Important relevant studies to be considered for the Bulk Water Maser Plan are reflected in "Annex 1.1: References to Develop Bulk Water Master Plan". The following reports will help the Consultant understanding will provide the baseline in some areas during the preparation of the Master Plan (this list is not exhaustive):

1. Water And Sewerage Master Plan For The North And North-West Region Of The West Bank, 2015, funded by AfD and KfW. Specific Master Plan objectives includes the identification of most appropriate water and wastewater improvements at different scales during 2017-2032, support enabling investments targeted at the most deserving projects according to the priority hierarchy, transparently with recommendations based on assessment of needs and impacts, develop phased Investment Plan will be the basis for national and donor funding in the short (2017), medium (2022) and long term (2032), for water supply, wastewater collection, treatment and re-use.
2. The WRP Master Plan was completed in 2012 by a "Water master plan for the Southern West Bank" performed by MWH on behalf of USAID. This report - referred to as [MWH, 2012] – displays a water demand, production and gap analysis over the Bethlehem and Hebron governorates as well as recommendations to address the water availability issues.
3. An Environmental, Social, and Cultural Heritage Impact assessment was completed in 2013 to support the Hebron Governorate Wastewater Management Project, especially with regards to the HRWWTP project. The final report – referred to as [ESCHIA, 2013] - gives a comprehensive overview of the current issues on those subjects in the area.
4. The Water Master Plan for the South and North-East communities of the West Bank, specifically Area C (2017-2035) prepared by Action Against Hunger and GVC. The final report – referred to as [GVC, 2017] – presents the existing situation in those areas and gives a list of recommended investment measures for the 2035 horizon.
5. Water and wastewater Master Plan of Hebron Governorate, Palestine» that is currently being developed (ToR and Inception report produced in 2019 only) with the objective of undertaking the planning based on the policy, strategy document and envisaged strategic plan to achieve the requirements of the Palestinian Water Authority (PWA) in the field of water and wastewater in the Hebron Governorate and to enable investment support to be targeted at the most deserving projects in the priority hierarchy.
6. A Strategic Water Resources and Transmission Plan that was developed in 2014 to implement the national water strategy for public water supply for the West Bank including a stage development plan of the water resources showing their location and anticipated volumes, an effective plan to develop the inter-Governorate transmission infrastructure required to deliver those bulk resources to a location where they would become the responsibility of a regional service provider to deliver supply to its

customers, and a sufficiently detailed transmission plan that can be taken to outline design by others.

Important relevant studies to be considered for the Water Harvesting Maser Plan are reflected in “Annex 1.2: References to Develop Water Harvesting Master Plan”.

7. Objective

1. Overall objective

The main objective of the assignment is to assist PWA to (1) preparing planning documents (Master Plans) in order to fulfil better control of the distribution of bulk water towards the service providers (that would allow for a fair distribution, metered consumption, etc.), and improve the physical capacities of PWA water network to appropriately convey the additional water quantities that will be supplied by Mekorot and other local sources in the future and (2) enhancing the water resources available within the West Bank through rainwater harvesting and treated wastewater reuse in order to secure additional water quantities for domestic and agricultural uses at a lower cost, improve the quantity of groundwater in the Project Area, while preserving the groundwater quality, and enhance water and food security of the Project Area.

2. Specific Objectives

The specific objective of the project is to provide the PWA with:

1. Recommendations for the improvement of the bulk water distribution through the preparation of a bulk water Master Plan and the definition of priority projects to be implemented in the short term.
2. An updated overview of the hydrological and hydrogeological situation of the West Bank, a comprehensive water harvesting Master Plan and the definition of priority projects to be implemented in the short term. The sources of harvested water include rainwater (very small-scale facilities such as the collection of rainwater at the rooftop scale is not included) and treated wastewater mixing with surface water.

Therefore, the Project has been divided into the following activities:

Activity 0: Inception phase

Activity 1: Develop Bulk Water Master Plan and Preliminary Design of Regional Cluster for the West Bank Phase

Activity 2: Develop Water Harvesting Master Plan for the West Bank Phase

3. SCOPE OF WORKS

1. Activity 0 - Inception phase

During the inception phase, the Consultant shall:

4. Briefly review the existing data, available studies and planning documents related to updating the Water Sector Policy and Strategy, bulk and drinking water in the West Bank and water harvesting, including developed strategies, polices (see Annex 1 for reference document) .

5. Prepare a draft inception report that shall feature an adjusted work plan and methodology and shall provide an update to the TOR in specific relation to the planned tasks, fixed outputs, schedule, general organization of the Project, reporting and monitoring procedures, and an update on the financial and manpower resources. The Inception report shall reflect clearly how the current assignment builds on earlier data, studies, master Plans that were defined.

6. Organize an inception meeting with the Steering Committee to discuss the outcomes of the draft inception report.

7. Organize a stakeholder consultation workshop to discuss the outcomes of the draft inception report.

8. Prepare a final inception report and work plan based on comments obtained at the inception meeting.

1. Activity 1: Develop Bulk Water Master Plan and Preliminary Design of Regional Clusters in West Bank

1. Master Plan

Data collection and analysis

The Consultant shall collect and analyze all existing data required to develop the Master Plan. The list presented below is indicative only and the Consultant shall add any data as deemed relevant:

1. General background data (main administrative boundaries, zones A, B and C, land use, topography, etc.)
2. Outcomes of [FCG, 2018]
3. Organized statistical PWA data related to current water demand, water consumption, water bills of each water service provider or/and at each connection point, etc.
4. Anticipated water demand of each service provider and water supply at the existing and future connection points.
5. Existing and future institutional organization in terms of regional water utilities and local service providers.

The Consultant shall prepare a brief report summarizing the main findings of the data analysis, thus providing a clear, comprehensive and synthetic presentation of the existing situation and of the anticipated future situation in all fields relevant to the assignment, both in terms of physical characteristics (water network characteristics) and in terms of associated monitoring or management (Who does what, how, and when?).

The Consultant is not expected to perform specific field investigations (detailed survey) other than site visits (i.e. existing and potential connection points, local water sources, proposed location of regional reservoirs and other bulk water related works) to get a good understanding of the local context.

Identification and assessment of bulk water regional clusters

The Consultant shall define the best PWA bulk water network arrangements to fulfil the objectives of the Assignment. This task consists of the following activities:

1. Review of the work previously done by PWA. The definition of the RWUs shall be considered as final (no review is needed) while the clusters (which do not have any administrative meaning) can be redefined by the Consultant, especially through the assessment of their applicability based on a list of criteria to be defined by the Consultant and approved by PWA
2. Finalization of the appropriate regional clusters of the Project Area in accordance with the existing and/or future physical characteristics of the network and institutional organization (i.e. the best fit between the boundaries of the future Regional Water Utilities and the organization of the current and future bulk water regional clusters to be developed)
3. Definition of the relevant technical solutions to address the objectives of the Assignment within these regional clusters. These solutions are expected to include new infrastructures to be built at appropriate locations (such as water reservoirs, booster stations, transfer pipelines and associated relevant monitoring sensors), but also lighter adaptations (such as modifications of the current direct connections that would enable a better control from PWA/WBWD) when deemed feasible and more appropriate. All relevant and cost-efficient alternatives shall be investigated by the Consultant. The Consultant shall identify, assess and present the feasible alternatives in all previously identified regional subdivisions of the Project Area. The main technical and financial characteristics of these alternatives shall be presented to allow for a multi criteria analysis in addition to institutional, legal and political, and others that may be considered.

The expected output of this task is develop Mater Plan presenting the following elements:

1. Definition of meaningful regional subdivisions of the Project Area that would autonomous bulk water networks connected together through main pipes and supplied by PWA wells and a selection of connection points to the Mekorot network.
2. Results of hydraulic modeling at the scale of the regional subdivisions to justify the planned works.
3. Presentation of the works to be implemented for each previously identified bulk water regional cluster, including any relevant technical alternative. A summary table shall display the main characteristics of each alternative to be used by the Consultant as the

basis for a multi-criteria analysis. The Consultant shall also propose an evaluation grid to be approved by the Client in order to establish a priority ranking of the alternatives.

Recommended accompanying measures

The Consultant shall review the current organization of the bulk water sector in the Project Area, identify any weakness or risk that may jeopardize the sustainable monitoring, operation and maintenance of the proposed bulk water regional clusters and then make recommendations about any mitigation or improvement measures. This task shall notably consider the parallel development of RWUs, the way they will progressively be implemented and the future responsibilities and relationship with the service providers they will have

Phased investment plan

After discussion and approval of the concept note and the selection of the best alternatives by the Client, the Consultant shall prepare a phased investment plan aiming at implementing the recommendations of the bulk water Master Plan to be grouped as follows:

1. Phase 1 (short-term): the "top 5" priority regional clusters that can and should be implemented as soon as possible.
2. Phase 2 (medium to long-term): the other identified regional clusters with lower priority or higher uncertainties

All recommended accompanying measures (about the institutional organization, the monitoring and management system, etc.) shall also be integrated to the investment plan.

Priority investment shall be sorted out depending on their locations , categories (bulk water supply, Regional Reservoirs etc.), financial requirements (small or large CAPEX) and temporal priorities. The investment plan shall also show the interdependency of separate projects and the critical path.

The Consultant shall develop a pragmatic decision matrix which will help PWA and the other stakeholders involved to use the prioritization criteria also in a potentially changing environment. Examples for priority criteria are as follows (without ranking):

3. Political feasibility (location of infrastructure in zone A, B or C, authorizations to be obtained, etc.)
4. Administrative and institutional requirements or constraints (i.e. land purchase)
5. Environmental requirements and constraints
6. Pro-poor focus (to the extent that a scheme remains sustainable)
7. Gender related aspects and improving the role of women
8. Maximization of the direct impact (on the lives of the beneficiaries)
9. Specific investment cost or cost effectiveness
10. O&M cost

11. Direct health impact
12. Protection of ecologically critical areas
13. Operational aspects and indicators; if not readily available, appropriate indicators should be suggested

The Consultant shall coordinate with the Client on the development of a reduced list of criteria including their prioritization. The result would be priority lists for short-, medium- -term investments and tentative time schedules for the implementation of project measures.

Environmental and Social Management Framework

For the works to be implemented, the Consultant is required to employ a collaborative approach in ensuring that inputs are obtained from a wide cross section of stakeholders and from the authorities PWA, MOF, MOA, EQA, WSRC, service providers, users, and others. The consultant is expected to carry two consultations sessions, one for the scoping of the ESMF, and the second once a good draft is furnished. The consultant shall address all the issues raised by different stakeholders and affected parties in the final draft of the documents.

1. Specifically, the Consultant is required to develop an environmental and social instruments including ESMF and ESMPs which includes the following tasks and addresses the following factors:
2. Review relevant project related documentation so that the appropriate plans and social and environmental management instruments can be developed and elaborated upon, ensuring that the project development objectives are met;
3. Develop a stakeholder analysis and prepare stakeholder engagement plan (SEP) including roles and responsibilities and incorporating gender and special needs and, define specific activities so that women and special groups benefit from participation in project implementation; all in full coordination with PWA.
4. Carry an analysis of the PA relevant legal and policy framework and, identify gaps and gaps-filling measures between the Bank's ESF and the PA legal and policy framework.
5. Carry out field visits to the sites
6. Develop a screening procedure to identify potential environmental and social effects of specific activities, and to determine whether effects are relatively minor and can be summarily addressed and managed; or whether there are any potentially significant effects upon natural habitats, physical or cultural resources at particular project works sites, which would require further and separate analysis due to these complexities; and to ensure proper mitigation and possibly the preparation of a comprehensive EIA and or Resettlement Action Plan (RAP) where appropriate;
7. Create a checklist and suite of mitigation measures suitable for incorporation into project contract documents;
8. Identify both the positive impacts and environmental and social risks of the works to be implemented for each identified bulk water regional cluster and recommend effective measures to mitigate the risks through the development of an Environmental and Social Management Plan (ESMP) containing detailed descriptions of the mitigation measures,

suitable for incorporation into project contract documents. The ESMP includes a summary matrix of all project impacts, the proposed mitigation measures, a monitoring plan, and of an estimate of costs and a description of other inputs (such as training and institutional strengthening) needed to implement the plan.

9. Assess the potential environmental and social risks and environmental and social risk classification (ESRC) of proposed project activities. This will specifically include carrying out environmental and social analyses to ensure that the Master Plan complies with the World Bank's environmental and social management framework.

10. Identify the segments of the projects where permits or approvals will be required from the Israeli authorities such as the ones in area C and military zones.

In accordance to the Bank ESF, the consultant will specifically make analysis and recommendations on the applicability of the ten environmental and social standards (ESSs) to all specific activities within the Master Plan.

1. Preliminary design of priority regional cluster

Preliminary design

The Consultant shall prepare the preliminary design of each Phase 1 regional cluster. This task shall include the following documents:

11. Report about the identified sites and associated investigations (location, pictures, topography, geology, seismicity risks, etc.) for the structures to be built (storage tanks, pumping stations, main transfer pipes from the sources, main distribution pipes to the service providers, etc.)

12. Design report with hydraulic calculations and typical drawings of the proposed structures in their environment (plan and section views)

13. Environmental and Social Management Framework as described above

14. Cost estimates with the Preliminary design of priority cluster.

Work packages

In case it makes sense to group several works related to Phase 1 regional clusters (for instance in case they are of a very similar nature or they are located close to each other), the Consultant shall define appropriate work packages (civil works, equipment, supervision, etc.) that may cover more than one cluster.

Project summary documentation

The Consultant shall prepare a project summary documentation featuring the main characteristics of each Phase 1 regional cluster as a whole and the characteristics of each work package as previously defined so that PWA can share this information with any interested donor upon request for future development (detailed design and construction).

1. Activity 2: Develop Water Harvesting Master Plan for the West Bank Phase

1. Baseline

Data collection and analysis

The Consultant shall collect all existing data required to develop the Master Plan. The list presented below is indicative only and the Consultant shall add any data as deemed relevant:

1. General background data (main administrative boundaries, zones A, B and C, land use, topography, etc.)
2. Precipitation data
3. Geological data
4. Hydrogeological data
5. Hydrological data
6. Wastewater treatment systems (especially the quality and quantity of treated wastewater of existing and planned Wastewater Treatment Plants - WWTPs)
7. Relevant local standards and regulations

1. Master Plan

Evaluation of the global water harvesting potential

The Consultant shall evaluate the global potential of rainwater harvesting and treated wastewater reuse at the scale of the West Bank in terms of quantity and quality. This task shall be based on the results of the base line activity and the expertise of the Consultant.

Special attention should be paid to karstic aquifers since aquifers in the Project Area are mainly karstic: the geology of Central West Bank aquifer consists mainly of karstic and permeable limestones and dolomites interbedded with argillaceous beds; and the Eocene aquifer is also characterized by faults and karstifications. Specific methodologies to assess the recharge potential of karstic aquifers are presented for instance in [Daher, 2011] and [Rolf, 2017].

The Consultant is expected to prepare a map showing the surface water harvesting and recharge potential in the Project Area following the most appropriate methodology.

It is recalled here that the Master Plan shall not specifically address rainwater harvesting at the house level (that is mandatory in new buildings).

The Consultant shall perform this evaluation with the following priority ranking of potential future usages of harvested water:

1. Irrigation (direct agricultural use), and irrigation distribution system
2. Drinking water (direct domestic use)
3. Aquifer recharge
4. Recreational activities

Presentation of the most suitable water harvesting techniques

Several water harvesting techniques have been developed throughout the world but only few have shown satisfactory and sustainable performances due to many factors that can prevent complete success (faulty design, unplanned operation and maintenance, social unacceptance,

etc.). Therefore, even though there is no restriction regarding the types of techniques to be presented, the recommended water harvesting techniques shall be carefully selected in good accordance with the local context and following the lessons learned from previous unsuccessful experiences.

The nature of harvesting techniques may include the following:

1. Impervious structures (dams or ponds) to act as surface water storage for direct and almost immediate usage (agriculture or domestic) or to act as flow regulation tools for improving the riverbed infiltration through increase of the duration of the flow in ephemeral wadis. This should be considered as a first option when applicable.

2. Infiltration systems for artificial groundwater recharge in order either to maintain the aquifer water level thus making the past investments (abstraction wells) more durable or to allow for the creation of a new well field (the latter should be considered as a second option due to the expected difficulties to drill new wells in some areas)

Various types of harvesting techniques may then be described, such as infiltration basins (for rainwater or treated wastewater), flow control/retention structures to increase infiltration along the wadi beds, infiltration channels in upstream slopes to reduce runoff and increase the recharge, infiltration plains away from the wadi beds themselves, etc.

The Consultant is expected to take into account in this selection process - among other factors he shall detail - the scale of the water harvesting structure (from small earth ponds to relatively large storage or infiltration structures dealing with multi-million m^3 of stormwater or treated wastewater). The scale has not only an impact on the technical design of the structure but also addresses different environmental, social and management issues.

Identification and assessment of potential projects

The Consultant shall define, for each of the 33 main water catchments listed in Table and for all WWTPs in operation, under progress, and the planned at the date of the study, the optimum water harvesting project(s). This task consists in identifying the quality and quantity of water, the best site(s), the future usage(s) (for MAR projects this can be seen as global support of the water table or a local and immediate usage through pumping if deemed relevant) and the most appropriate harvesting technique(s) for each project, while estimating its environmental, social and economic impacts. The financial cost of each project shall also be roughly estimated at this stage to allow for a financial comparison.

Each project shall be presented individually in a one-page datasheet. A summary table (see example in Table 4) shall display the main characteristics of each project to be used by the Consultant as the basis for a multi-criteria analysis. He shall propose an evaluation grid to be approved by the Client in order to establish a priority ranking of the projects.

Criteria	Site location	Annual volume of harvested water	Quality of harvested water	Recommended technique	Usage	CAPEX (million USD)	…

		(MCM/y)				
Wadi X	Crossroad yyy-xxx	2	++	Impervious check dam	Direct irrigation	10
Wadi Y						
Wadi Z						
…						
WWTP A(b)	Alqarya	0.5	+	Infiltration basins	Groundwater recharge for maintaining the water level	1
WWTP A(a)	Alqarya	0.5	+++	Surface storage after tertiary treatment	Direct irrigation	3
WWTP B						
WWTP C						

Table 4 Example of summary table for the identification and comparison of water harvesting projects

This task shall be performed in close collaboration with local stakeholders that may already have thought about adequate water usages (the issue of high salinity wells around Jericho may be addressed by artificial recharge), local difficulties (such as the issue of land ownership) or opportunities (abandoned quarries could be used as storage or infiltration structures), or even some experience of faulty implementation. For instance, the social aspect was somehow underestimated in a recent project involving the construction of several stormwater infiltration basins around Jericho designed for farmers to maintain the level of the water table in their abstraction wells. Most of those basins have been sealed by the farmers soon after the completion of the project to be used as impervious storage ponds for direct use. Only two basins are used as infiltration basins as of today. Similarly, social obstacles are currently restraining the development of treated wastewater reuse for irrigation purposes. These issues shall be fully understood by the Consultant who shall propose adequate awareness campaign, step-by-step implementation or other measures to alleviate these obstacles. Gender aspects are to be considered.

Indeed, as far as land ownership is concerned and even though most of the land is privately-owned, land purchase is sometimes not an issue providing educational efforts are planned. For instance, in Beni Naim(Figure) the farmers offered the land to create the impervious storage dam because they anticipated direct benefits.

The Consultant shall also consider the protection of the groundwater quality as an important factor to be part of the evaluation of potential rainwater harvesting projects. The artificial recharge of aquifers may lead to groundwater contamination by polluted rainwater or treated wastewater of low quality. All recommended projects shall comply with the relevant Palestinian standards complemented by any recognized international practice or regulation.

Recommendations about an appropriate management system

The Consultant shall review the current organization of the water sector in the Project area and then make recommendations about the modifications or improvements that may be required to enable the sustainable operation and maintenance of the various water harvesting schemes. Depending on their types, locations, end users, etc. they may be best managed by an appropriate existing institution (PWA, MoA, association of farmers, etc.) or by a new local, regional or national body to be created. The management procedures and the roles and responsibilities of all stakeholders involved in these projects shall be defined by the Consultant.

Preparation of a phased investment plan

The Consultant shall prepare a phased investment plan featuring the previously identified projects to be grouped as follows:

1. Phase 1 (short-term): the “top 5” most promising projects that can be implemented within 3 years.
2. Phase 2 (medium-term): the “top 10” most promising projects that can be implemented within 10 years.
3. Phase 3 (longer term): the other identified projects with lower priority or higher uncertainties due to the lack of sufficient or adequate data

All accompanying recommended measures (about the institutional organization, the management system, the regulatory framework, etc.) shall also be part integrated to the investment plan. He shall also include in Phase 1 all actions required to strengthen the relevant database for the development of water harvesting projects (hydrological data, WWTP data, etc.) that shall be implemented shortly in order to improve the definition of Phase 2 and Phase 3 projects.

Environmental and Social Management Framework

For the works to be implemented in Phase I (short term) , the Consultant is required to employ a collaborative approach in ensuring that inputs are obtained from a wide cross section of stakeholders and from the authorities , service providers, users, and others. The consultant is expected to carry two consultations sessions, one for the scoping of the ESMF, and the second once a good draft is furnished. The consultant shall address all the issues raised by different stakeholders and affected parties in the final draft of the documents.

4. Specifically, the Consultant is required to develop an environmental and social instruments including ESMF and ESMPs which includes the following tasks and addresses the following factors:

5. Review relevant project related documentation so that the appropriate plans and social and environmental management instruments can be developed and elaborated upon, ensuring that the project development objectives are met;

6. Develop a stakeholder analysis and prepare stakeholder engagement plan (SEP) including roles and responsibilities and incorporating gender and special needs and, define specific activities so that women and special groups benefit from participation in project implementation; all in full coordination with PWA.

7. Carry an analysis of the PA relevant legal and policy framework and, identify gaps and gaps-filling measures between the Bank's ESF and the PA legal and policy framework.

8. Carry out field visits to the sites

9. Develop a screening procedure to identify potential environmental and social effects of specific activities, and to determine whether effects are relatively minor and can be summarily addressed and managed; or whether there are any potentially significant effects upon natural habitats, physical or cultural resources at particular project works sites, which would require further and separate analysis due to these complexities; and to ensure proper mitigation and possibly the preparation of a comprehensive EIA and or Resettlement Action Plan (RAP) where appropriate;

10. Create a checklist and suite of mitigation measures suitable for incorporation into project contract documents;

11. Identify both the positive impacts and environmental and social risks of the works to be implemented for the short term (Phase I) projects and recommend effective measures to mitigate the risks through the development of an Environmental and Social Management Plan (ESMP) containing detailed descriptions of the mitigation measures, suitable for incorporation into project contract documents. The ESMP includes a summary matrix of all project impacts, the proposed mitigation measures, a monitoring plan, and of an estimate of costs and a description of other inputs (such as training and institutional strengthening) needed to implement the plan.

12. Assess the potential environmental and social risks and environmental and social risk classification (ESRC) of proposed project activities. This will specifically include carrying out environmental and social analyses to ensure that the Master Plan complies with the World Bank's environmental and social management framework.

13. Identify the segments of the projects where permits or approvals will be required from the Israeli authorities such as the ones in area C and military zones.

In accordance to the Bank ESF, the consultant will specifically make analysis and recommendations on the applicability of the environmental and social standards (ESSs) to all specific activities within the Water Harvesting Master Plan.

14. Deliverables

1. List of deliverables

The outputs expected from the Consultant are presented in Table below

Deliverable	Content	Due date (T is the date of commencement of the Services)
Monthly progress reports	The Consultants shall prepare a monthly progress report (1 or 2 pages) and a monthly progress meeting. The monthly report shall include progress for the previous month, planned progress for the next month and overall project progress versus planned progress, highlighting any reasons for delay and an agreed revised schedule. The monthly reports shall be presented via email as a pdf document to PWA and other stakeholders in advance of the monthly meeting. There shall not be final versions of monthly reports. Comments on the monthly reports or in the monthly meetings will be considered in the ongoing study phase. Minutes of meeting shall however be prepared and distributed to participants by the Consultant. PWA will be free to invite any relevant stakeholders such as representatives of various ministries or governmental agencies - as deemed relevant - to present general or specific outcomes of the Project and receive necessary feedbacks or approvals. Progress reports will present information in a sex disaggregated way, with regard to stakeholders met, data collected, etc.	Every month
Activity 0: Inception phase		
Inception Report	It shall provide a summary of the revised work plan developed by the consultant. It shall provide details in specific relation to the planned activities, outputs, schedule, and details of how the consultant intends to complete the services including a proposed timetable of meetings, and workshops, general organization of the project, and reporting. The report shall be discussed within a meeting at PWA, and finalized by the Consultant accordingly; The inception report shall also include the following components: 1. adjusted work plan and methodology 2. updated financial and manpower resources	T + 1 month

Activity 2: Develop Bulk Water Master Plan and Preliminary Design of Regional Cluster for the West Bank Phase		
Master Plan	The Activity report shall include the following chapters: 1. Data collection and analysis report 2. Concept note with regional subdivisions, technical solutions and associated multi-criteria analysis* 3. Recommended accompanying measures 4. Phased investment plan * A draft concept note shall be prepared and presented to the Client in a meeting to discuss the alternatives proposed by the Consultant and select the most appropriate one. The outcomes of this meeting shall be taken into account in the final version of R2 deliverable.	T + 6months
Preliminary design of Priority regional clusters	The Activity report shall include the following chapters: 1. Preliminary design of priority regional clusters 2. Work packages 3. Project summary documentation	T + 9months
ESMF	Draft ESMF including: (i) identification and screening of risks and the impact assessment of specific activities and an ESMP as described in the Scope of Work for the bulk water Management Master Plan according to World Bank ESF; (ii) recommendations of mitigation measures for adverse impacts; (iii) a summary of all findings from the stakeholder analysis and preparation of Stakeholder Engagement Plan (SEP) that is agreed by key stakeholders; (iv) occupational health and safety guidelines, and a set of special environmental clauses (SECs) for inclusion in Technical Specification and bidding document; (v) institutional framework for environmental management of the proposed projects to be implemented by PWA; (vi) Environmental and Social Capacity Building and training program for PWA and any other party that may be needed; (vii) ESMP cost implication and schedule; (viii) Contractors Obligations and responsibilities; (ix) Grievance Redress Mechanism (GRM). Final ESMF incorporating stakeholder feedback.	T + 10 months
Activity 3: Develop Water Harvesting Master Plan for the West Bank Phase		
Baseline	The Activity report shall include the following chapters: 1. Data collection and analysis 2. Conceptual model and groundwater balance of the main aquifers	T +6 months

	3. Critical review of [JICA, 2008] and [FORWARD, 1998] 4. Case studies	
Master Plan	The Activity report shall include the following sections and chapters: **Master Plan** : 5. Global harvesting potential (including a map) 6. Most suitable harvesting techniques 7. Potential projects (individual presentation and multi-criteria analysis) 8. Recommendations about an appropriate management system 9. Phased investment plan **ESMF:** Draft ESMF including: (i) identification and screening of risks and the impact assessment of specific activities and an ESMP as described in the Scope of Work for the water Harvesting Master Plan according to World Bank ESF; (ii) recommendations of mitigation measures for adverse impacts; (iii) a summary of all findings from the stakeholder analysis and preparation of Stakeholder Engagement Plan (SEP) that is agreed by key stakeholders; (iv) occupational health and safety guidelines, and a set of special environmental clauses (SECs) for inclusion in Technical Specification and bidding document; (v) institutional framework for environmental management of the proposed projects to be implemented by PWA; (vi) Environmental and Social Capacity Building and training program for PWA and any other party that may be needed; (vii) ESMP cost implication and schedule; (viii) Contractors Obligations and responsibilities; (ix) Grievance Redress Mechanism (GRM). Final ESMF incorporating stakeholder feedback.	T + 10 months

Table 5 List of deliverables

1. Requirements for deliverables

All documents shall be in English and as comprehensive as possible avoiding lengthy textbook sections

They should comply with the following requirements:

1. Compliance with the terms of reference

2. Clarity, soundness and relevance of their content

The reports will be submitted in three (3) hard, coloured copies; all reports shall be bound. Maps and drawings included in the reports must be easily readable. Three soft copies shall also be provided (in pdf, Word, Excel, MS-Project, Arc-GIS 10 - appropriate software versions to be coordinated with PWA - with linked shape files, suitable for PWA to work on). The consultant should provide PWA will all developed hydraulic models during the assignment and provide PWA the necessary training.

It is important that the deliverables presented by the Consultant be clear and transparent. As such the Consultant will ensure the following aspects are included in his final reports:

1. the source of all collected data shall be traceable
2. the methodology and assumptions used shall be fully described

1. Approval procedure of deliverables

Deliverables will be submitted to PWA for approval. PWA will review and organize comments from all relevant stakeholders within two weeks after reception. The Consultant shall integrate the requested modifications and comments within 2 weeks after receipt of PWA comments, unless otherwise indicated, prior to submitting the final version.

2. Workshops Details:

For each individual workshop, the consultant will:

1. With guidance from PWA, confirm the list of invited attendees from stakeholders register (expected number of attendees per each workshop not less than 60 participants)
2. Identify, arrange and confirm the venue including any necessary teleconferencing arrangements. Prepare and issue invitations to attendees upon PWA approval. The invitation shall encourage female participation.
3. Prepare and circulate an agenda with specific topics for discussion.
4. Facilitate the workshop with subject matter expert(s).
5. Prepare and present at each workshop, a summary of purpose and objectives. This introduction will provide an overview of the program and offer context to all participants.
6. Prepare the workshop meeting minutes for review and comment by PWA.
7. Distribute workshop minutes to all participants.

8. Staffing Requirements

The Consultant's team shall comprise at least the experts presented in **Error! Reference source not found.**le below.

The project manager and his team shall be experienced in the elaboration of master plans, feasibility studies, conceptual studies and preliminary design documents for hydraulic works

and unconventional water resources, ideally with some experience in the MENA region. The CVs submitted by the Consultant shall therefore reflect this requirement. In addition, a chief backstopping person as well as his deputy shall be nominated. This has to be understood as a tentative list of experts, however, the Consultant shall feel free to add extra and/or multi-skilled staff, as he deems necessary and appropriate to satisfactory reach the objectives of the Project based on his professional judgment.

The Consultant shall provide adequate, qualified and experienced staff for the good and timely execution of the study he has been assigned to. All such staff has to be approved by the Client and it is the right of the Client to withdraw at any time any approval for such staff if they are found to be unsuitable or otherwise not desirable, in which case the person or persons in question shall be replaced by others approved by PWA.

In addition to key staff, any supporting staff and any logistical support including rent transportation either for local and or international, cost of accommodation and any administrative cost, printing and producing all reports and documents as mentioned above shall be estimated by the Consultant and shall be included in the lump sum amount of the financial proposal.

The Team Leader is expected to be present in the West Bank& Gaza during 100 % of the project.

Expert #	Role	Estimated time input (man.month)	Qualification requirements
KE-1	Team leader and water expert for the Project	10	He/she should have qualifications in civil or environmental engineering and preferably have an advanced or second degree in a relevant specialization. He/she should have at least 15 years of international experience. Key specific experience requirements include: 1. Demonstrated leadership skills and at least 10 years of multi-disciplinary team leadership experience including master plan and feasibility studies preparation; 2. A minimum of 10 years' experience of projects involving water resources, water supply system planning and deigning of hydraulic works and institutional reorganization; 3. Broad experience in hydrology and hydrogeology, water supply, wastewater, infrastructure planning, engineering design,

Expert #	Role	Estimated time input (man.month)	Qualification requirements
			procurement, institutional development 4. Substantial relevant Middle Eastern country experience including preferably in Palestine. He/she shall be familiar with current best practice trends in water harvesting schemes in similar countries. He/she shall be able to communicate effectively with senior team members and government officials. He/she should have excellent English skills.
Allocated Experts for Activity 1 : Develop Bulk Water Master Plan and Preliminary Design of Regional Cluster in West Bank			
Key experts			
KE-2	Water supply expert	5	He/she should have qualifications in civil , water or environmental engineering and preferably have an advanced or second degree in a relevant specialization. He/she should have at least 15 years of international experience. Key specific experience requirements include: 1. A minimum of 10 years' experience of projects involving water supply system planning, design of hydraulic works and institutional reorganization. 2. Substantial relevant Middle Eastern country experience including preferably Palestine. He/she shall be able to communicate effectively with senior team members and government officials. He/she should have excellent English skills and a command of Arabic would be an advantage.

Expert #	Role	Estimated time input (man.month)	Qualification requirements
KE-3	Civil engineer	4	He/she should have at least 10 years of relevant professional experience in developing Water Master Plan. Key specific experience requirements include: 1. Substantial experience and knowledge about local standards, instructions, and legislations for civil works. 2. Past experience of similar projects, especially in preparing technical specifications for water storage tanks and pipes. He/she should have excellent English skills. A command of Arabic would be an advantage.
KE-4	Hydraulic engineer	2	He/she should have at least 10 years of relevant professional experience to the assignment. Key specific experience requirements include: 1. Substantial experience and knowledge about hydraulic modeling of water supply systems 2. Past experience of similar projects He/she should have excellent English skills. A command of Arabic would be an advantage.
KE-5	Environmental expert	1	He/she should have qualifications in environmental sciences or related discipline and should have at least 5 years of relevant experience in environmental assessment studies. Key specific experience requirements include: 1. Experience in relevant Palestinian laws and practice, as well as Palestinian and World Bank Environmental and Social Framework (ESF) and standards, 2. Experience in environmental and social impact assessments of water supply

Expert #	Role	Estimated time input (man.month)	Qualification requirements
			projects. He/she should have excellent English skills. A command of Arabic would be an advantage.
Non-Key experts			
NKE-1	Field surveyor	3	He/she should have at least 5 years of relevant professional experience. Key specific experience requirements include: 1. Substantial field experience in topography and geotechnical assessment works 2. Past experience of similar projects He/she should have excellent Arabic skills. A command of English would be an advantage.
NKE-2	Draughtsman	1	He/she should have at least 5 years of relevant professional experience. Key specific experience requirements include: 1. Past experience of similar projects (drawings of water works or other similar civil works) He/she should have excellent English skills.
Allocated Experts for Activity 2 : Develop Water Harvesting Maser Plan for the West Bank			
Key experts			
KE-6	Water resource expert	10	He/she should have qualifications in civil or environmental engineering and preferably have an advanced or second degree in a relevant specialization. He/she should have at least 15 years of international experience. Key specific experience requirements include: 2. A minimum of 10 years' experience of projects involving water resources planning ;

Expert #	Role	Estimated time input (man.month)	Qualification requirements
			3. Broad experience in hydrology and hydrogeology, water supply, infrastructure planning, engineering design, procurement 4. Substantial relevant Middle Eastern country experience including preferably in Palestine. He/she shall be familiar with current best practice trends in water harvesting schemes in similar countries. He/she shall be able to communicate effectively with senior team members and government officials. He/she should have excellent English skills.
KE-7	Hydrogeologist	4	He/she should have post graduate qualifications in hydrogeology and a background in international development projects. Key experience requirements include: 1. At least 15 years relevant experience; 2. Substantial experience in dams and artificial groundwater recharge projects, He/she shall be capable of contributing to a national level dialogue on water harvesting strategies. He/she shall be able to communicate effectively with senior team members and government officials. He/she should have excellent English skills and a command of Arabic would be an advantage. Karts
KE-8	Hydrologist	3	He/she should have qualifications in hydraulic engineering and preferably have an advanced or second degree in hydrology. He/she should have at

Expert #	Role	Estimated time input (man.month)	Qualification requirements
			least 10 years of experience in water resource development projects at the international level. Key specific experience requirements include: 1. Experience in water resource planning, rainfall-runoff modeling and design of water storage structure; 2. Substantial experience and knowledge about hydrological conditions in MENA countries, preferably in Palestine. He/she shall be familiar with current best practice trends in stormwater harvesting in similar countries. He/she should have excellent English skills and a command of Arabic would be an advantage.
KE-9	Wastewater reuse expert	1	He/she should have qualifications in wastewater treatment and/or agronomy. He/she should have at least 10 years of relevant experience. Key specific experience requirements include: 1. A minimum of 5 years' experience of wastewater reuse projects; 2. Substantial experience and knowledge about local standards, instructions, and legislations for reuse of treated wastewater in agriculture and groundwater recharge. He/she should be familiar with current best practice trends in treated wastewater reuse in similar countries. He/she should have excellent English skills. A command of Arabic would be an advantage.
KE-10	Environmental and Social expert	1	He/she should have qualifications in environmental sciences or related discipline and should have at least 5 years of relevant experience in environmental assessment studies. Key specific

Expert #	Role	Estimated time input (man.month)	Qualification requirements
			experience requirements include: 1. Experience in relevant Palestinian laws and practice, as well as Palestinian and World Bank ESF and standards, 2. Experience in environmental and social impact assessments of water and wastewater projects. 3. He/she should have excellent English skills. A command of Arabic would be an advantage.
KE-11	Dam expert	2	He/she should have at least 10 years of relevant professional experience. Key specific experience requirements include: 1. Substantial experience and knowledge about local standards, instructions, and legislations for civil works. 2. Past experience of similar projects, especially in preparing design and technical specifications for dams in various environments, especially the one found in the MENA region. He/she should have excellent English skills. A command of Arabic would be an advantage.
Non-Key experts			
NKE-3	Field surveyor	1	He/she should have at least 5 years of relevant professional experience. Key specific experience requirements include: 1. Substantial field experience in topography 2. Past experience of similar projects He/she should have excellent Arabic skills. A command of English would be an advantage.

Expert #	Role	Estimated time input (man.month)	Qualification requirements
NKE-4	Draughtsman	1	He/she should have at least 5 years of relevant professional experience. Key specific experience requirements include: 1. Past experience of similar projects (drawings of dams or other similar hydraulic works) He/she should have excellent English skills. A command of Arabic would be an advantage.

Table 2 List of experts

2. Time Frame of the Project

The Consultant shall commence his work after the signature of the Contract within the time period stipulated in the Contract. The PWA will make available to the Consultant all documents listed in **Error! Reference source not found.** before the date of Commencement of Services. The Consultant will liaise with the PWA and other institutions, form his team and take up the Project activities.

The Consultant shall carry out all tasks of the Project within an estimated total period of (10) months from the date of Commencement of Services. The Consultant is invited to carefully study if he will be able to follow the proposed time schedule as presented in figure below. In his proposal the Consultant can propose another time schedule as deemed appropriate with associated justification to considered by client

	Months									
Title	1	2	3	4	5	6	7	8	9	10
Inception phase										
Bulk Water Master Plan										
Data Collection and analysis										
Identification and assessment of bulk water reg. clusters										
Recommendation and accompayning measures										
preparation of phased investment										
preliminary design of priority regional clusters										
work packages										
Project Summary documintation										
ESMF										
Water Harvisting Master Plan										
Base line and Data Collection										
Evaluation of global harvisting potentials										
Presentation of the most suitable harvisting techniques										
Identification and assessment of porential projects										
Recommendation about appropriate management system										
Preparation of phases investment plan										
Reporting and Project Management										

Figure 8 Tentative time schedule for the completion of the Project

3. Project organization

1. Project executing agency and Management arrangement

The Project executing agency is the Palestinian Water Authority (PWA).

The Consultant will be technically responsible for the preparation and implementation of the assignment in full coordination with relevant PWA and WBWD staff to be nominated by PWA Head. For the Bulk Water Master Plan, the Consultant will be working closely with the Planning Directorate and WBWD. For the Water Harvesting Master Plan, the Consultant will be working closely with the Water Resource Directorate of the PWA.

2. Stakeholder participation

For the success of the Project it is important that all relevant stakeholders (governmental bodies including relevant Ministries such as the Ministry of Agriculture (MoA) , LGUS, service provider, WSRC, communities, water users' associations, NGOs, etc.) are involved in the progress of the Project and the decisions to be taken during the course of the Project. Therefore, throughout the Project, the team leader - and other experts if required - shall be available for meetings called by the PWA and for ad-hoc telephone or internet consultations on any matter concerning the Project.

The Consultant shall be ready to prepare a couple of formal presentations on the results of the Project at various stages. The audience for the presentation will be decided by the PWA and may include funding agencies.

3. Steering committee

A steering committee will be created to monitor the progress of the Project, assist in providing all the information and support necessary to facilitate the implementation of the different tasks of the projects, act as liaison team with all governance structure and other key stakeholders in order to support in having updated information for developing the Master Plans. It will be composed of representatives from:

1. The Palestinian Water Authority (PWA)
2. Other participants as deemed necessary.

The steering committee shall meet at least at both kick-off and final presentations and on quarterly basis of the Project. Its responsibility consists in assisting the PWA in leading the Project and in validating the deliverables.

3. Responsibilities of PWA

- PWA will coordinate and supervise the work of the Consultant and will oversee the activities on a day to day basis thus following the progress of the Project. PWA will review and provide comments on the Consultants' deliverables in a timely manner. PWA review does not alleviate the Consultant of his responsibilities for ensuring that his work is completed diligently and accurately.
- PWA will provide the Consultant with relevant available information and data and any other documents of general nature relevant to the assignment, the vast majority of which is available in English. The existing documents shall be made available by PWA before the start of the consulting activities on site.
- Comments by PWA shall be provided within 2 weeks of submission of deliverables.
- PWA will provide at its facilities in Ramallah meeting room for meetings (with needed facilities, and refreshments) upon prior notice. This will be provided free of any costs to the Consultant. The Consultant will work closely with the relevant PWA staff.
- PWA will provide meeting room for workshop outside PWA (with needed facilities, and refreshments) upon prior notice and agreement with PWA. This will be provided free of any costs to the Consultant.
- PWA will not provide office space, furniture or related services in its premises in the West Bank or Gaza.
- All of the above mentioned items will be provided by PWA, any other items needed must be provided by the consultant.

4. Responsibilities of the Consultant

The Consultant shall carry out his duties in a timely, diligent and professional manner according to the present TOR. As mentioned above, the Consultant is requested to review the TOR in his

proposal, but also during the inception phase to amend - if necessary - the tasks in order to come up with final deliverables fulfilling the intended purpose of the Project.

The Consultant shall cover all costs needed to accomplish the requested tasks indicated in the TOR and deliver quality outputs. This shall include the necessary office space and equipment, transportation, etc.

5. Backstopping and Quality Control

The home office of the Consultant shall maintain continuous support to the team working in the Project area. Before submitting any report, the home office is obliged to carefully review the respective document to assure the required quality. The Project shall be the basis for future project funding decisions in the Project area.

The corresponding cost shall be included in the financial proposal of the Consultant.

6. Contracts Type and Payments Schedule

The contract is lump Sum. The payments schedule (Reference to section 4 of the ToR) is:

Payment No	Outputs Delivered and acceptable to PWA
First payment: 10% of the contract price	upon the submission and completion of Activity 0: Inception phase (output # 1)
Second payment: 55% of the contract price	upon the submission and completion of Activity 1: Develop Bulk Water Master Plan and Preliminary Design of Regional Cluster for the West Bank Phase acceptable to PWA (output # 2)
Third payment: 35% of the contract price	upon the submission and completion of Activity 2: Develop Water Harvesting Master Plan for the West Bank, and final report acceptable to PWA (Output #3)

Table 7 The payments schedule

7. Beneficiary Country and Contracting Authority

The Contracting Authority and Executing Agency for the Project will be the PWA through the Project Management and Support Unit (PMUS)

8. Qualification of the Firm

1. Evidence of Firm capability and relevant experience in the execution of Consultancy Assignment of a similar nature, including the nature and value of the relevant contracts, as well as works in hand and contractually committed.
2. The evidence shall include successful experience in the execution of at least two (2) Consultancy Services of a similar nature and size and complexity during the last five (5) years.
3. Have been in business for at least the past 15 years in strategic development field, planning and design.
4. Availability of appropriate skills among staff and/or the ability to mobilize a diversified team of experts with appropriate knowledge and skills.

Annex1: References

Annex 1.1: References to Develop Bulk Water Master Plan

The following studies and data sets are especially relevant

Roadmap for the creation of Regional Water Utilities

This study is now completed. The final Phase 4 report is available [FCG, 2018]. It features the main steps towards the creation of three large Regional Water Utilities by the end of 2032 following the clustering procedure depicted in Figure 2.

PWA data and studies

The Consultant will have free access to any relevant dataset from the concerned Palestinian public bodies, especially PWA. The comprehensive web-based GIS managed by PWA that covers the whole Project Area (Figure) will be made available to the Consultant. The Consultant will receive full GIS features (shapefile format) of the existing water network including pipelines, reservoirs, booster stations, purchased connection points, boundaries of water service

providers and location of domestic wells. Other baseline features will also be made available if needed (such as political classification, elevation contour lines, etc.).

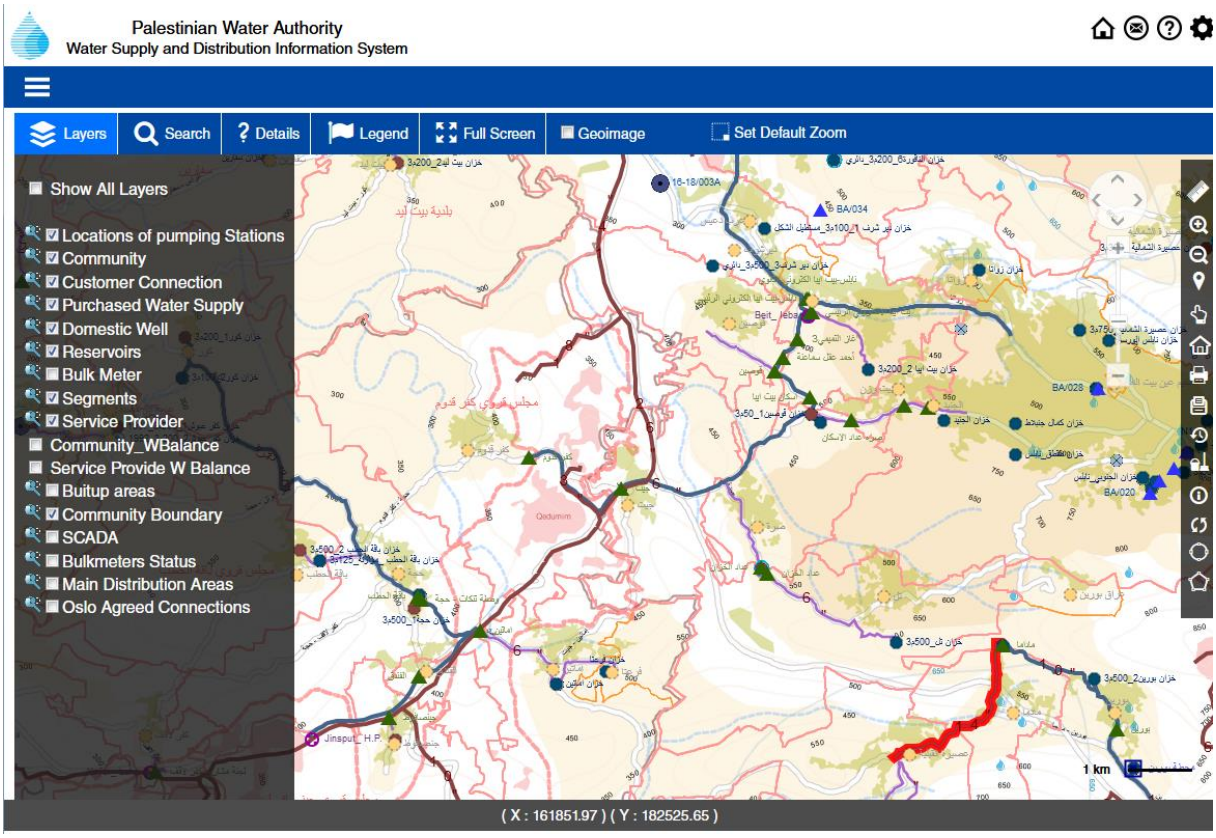


Figure 9 Screenshot of the GIS of PWA featuring all water related datasets

In addition, the statistical data computed by PWA will be made available. They include:

1. Water demand per service provider
2. Average water supply per connection point (to Mekorot system) in addition to the current and proposed new locations.
3. Average water production per local source point (well)

Recently, PWA divided the West Bank into 9 water management distribution clusters (Figure 10). Each of them is characterized in terms of bulk water infrastructures, detailed water supply quantities (including local sources, RSDS quantities, current and additional purchased quantities), location of the main Mekorot connection points, water demand, etc. until 2032 (Figure 11). The datasheet of each cluster will be provided by PWA to the Consultant at the start of the study.

There is no direct relation between the above-mentioned clusters and the RWUs. Clusters have been defined based on infrastructures, topography and geographical characteristics while RWUs are administrative bodies. Each RWU will be supplied through defined connection points. These connections could be located in one or another cluster.

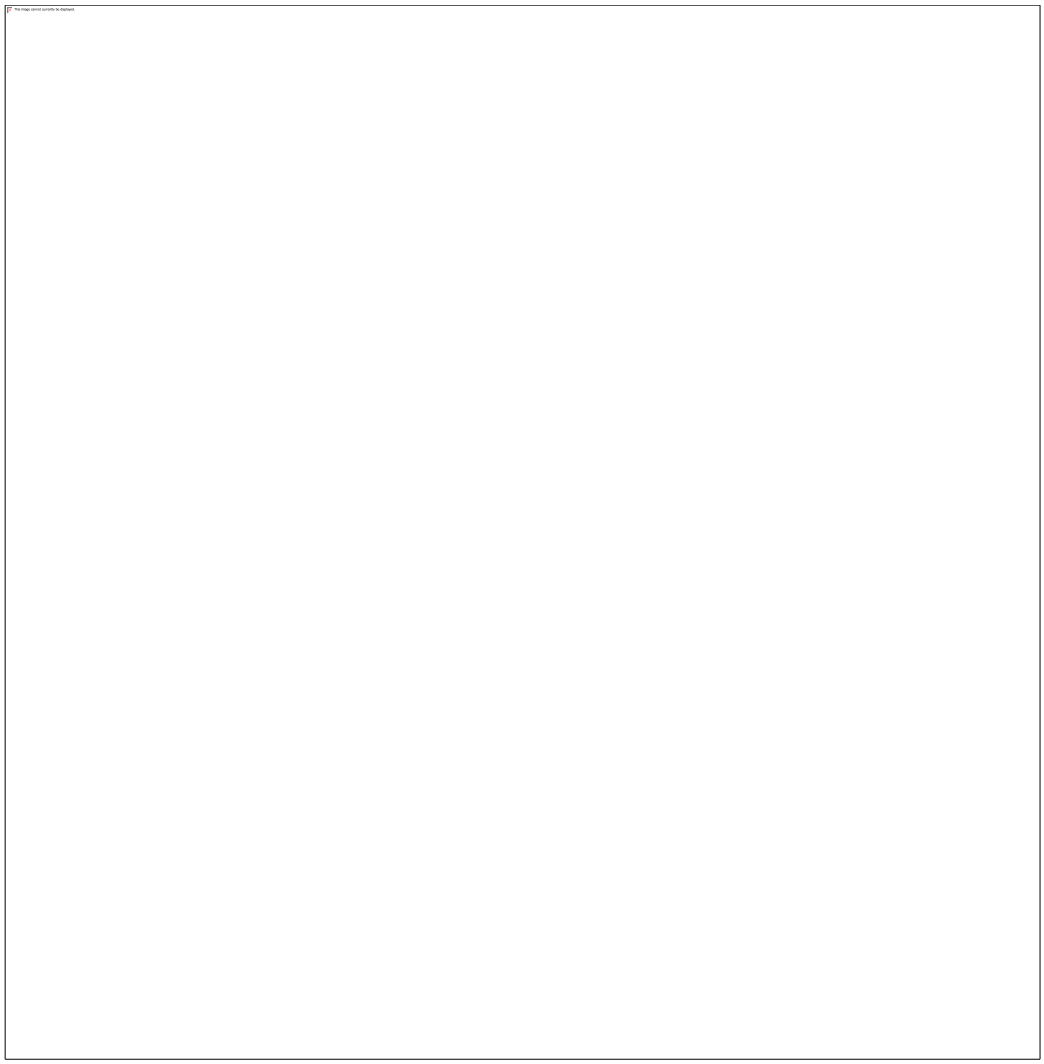


Figure 10 Water Management Clusters within the West Bank and Gaza

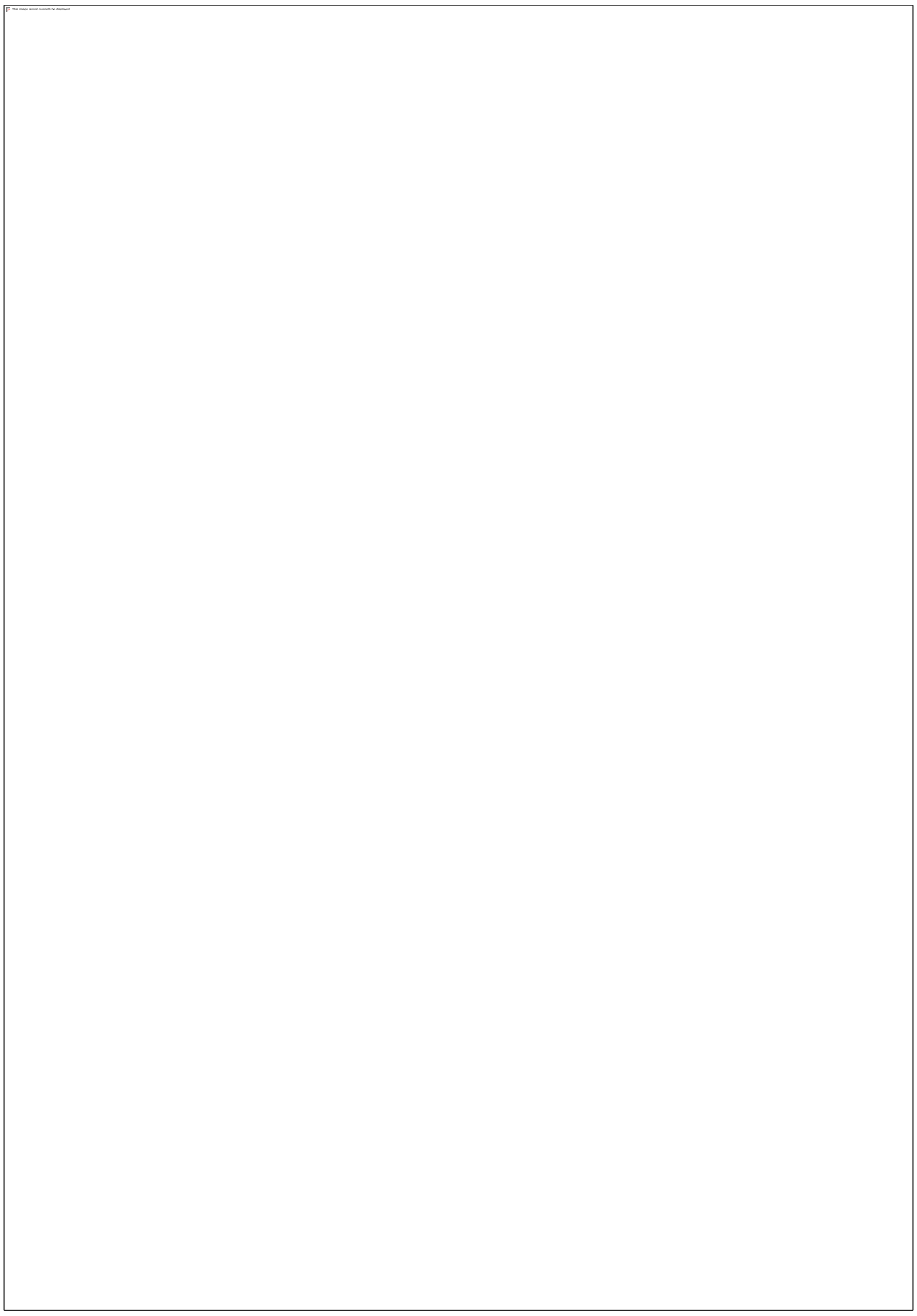


Figure 11 Example of Water Management Clusters with current and projected supply and demands quantities

Any previous studies deemed relevant (internal or external to PWA) will also be made available, including the previous developed master plans such as the one for the North-Northeast West Bank, the one for the South and others. Moreover, the recent PWA analysis of what is the current situation and what could be the future situation in a few governorates with regards to the bulk water network arrangement (Figure and 13). An example of the implementation of such reorganization project can be found with the design and construction (completed in 2015) of Halhoul reservoir, located north of Hebron city. This reservoir receives around 40,000

m3/day from two main sources (Dir ShaarMekorot connection point and several PWA wells located in Bethlehem Governorate). It now supplies most of the water service providers within Hebron Governorate through weekly distribution plans developed by WBWD.

Figure 12 Current and anticipated situations in Jenin, Tubas and Nablus governorates with regards to bulk water network arrangement

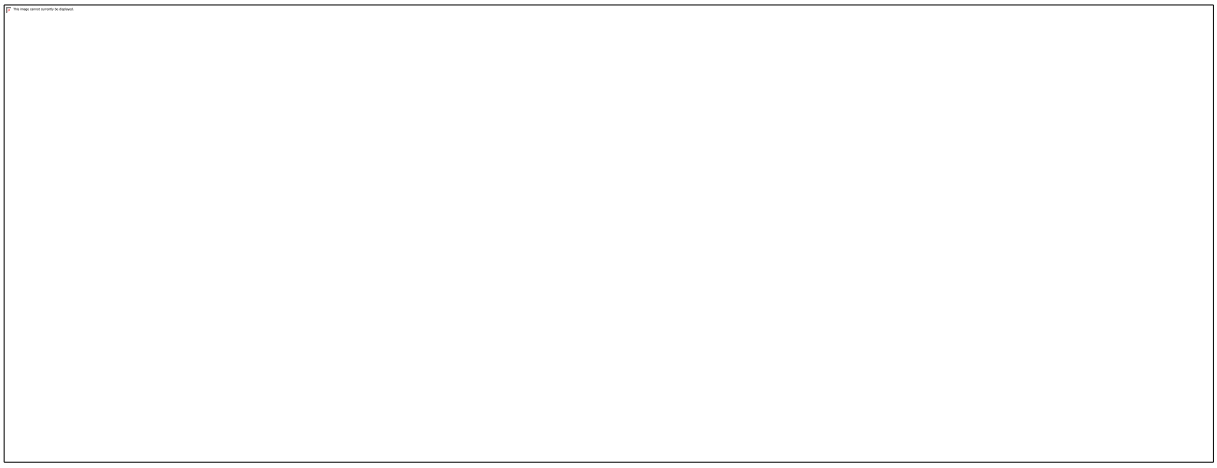


Figure 13 Current and anticipated situations in Ramallah and Salfit governorates with regards to bulk water network arrangement

On-going studies

Studies about the Abood and North Jenin areas are on-going (USAID-AFD funded projects). Their recommendations and design shall be considered and possibly integrated by the Consultant in the Project.

Other important references includes:

1. [PWA, 2017] Status report of water resources in the occupied state of Palestine – 2017, PWA, (publishing pending)
2. [Nour, 2018] Raya Nour & Mohammad Al-Saidi (2018) Regulation reform process and perception in the Palestinian water sector, Water International, 43:7, 908-925, DOI:

10.1080/02508060.2018.1490863 (available online at https://doi.org/10.1080/02508060.2018.1490863)

3. [FCG, 2018] Roadmap for the creation of Regional Water Utilities in the frame of the Water Sector Reform in Palestine, Final Phase 4 Completion Report, June 2018, FCG Sweden in association with FCG International, Office of the European Union Representative in Palestine (EUREP)
4. Water Sector Policy & strategy 2012 – 2032
5. General Policy for Water Demand Management Concepts and Principles
6. Water Sector Strategic Plan and action plan
7. Trans-boundary Water Resources Strategy and Action Plan
8. Water resources and transport Strategy
9. Northern West Bank Master Plan, 2015, funded by AfD and KfW
10. Water and Wastewater Master Plan for Ramallah and Al Bireh, 2018, by KfW
11. INB 4 Progrom funded by USIAD and implemented through Black & Vetch
12. Hebron Governorate - Water and Wastewater Master Plan ToR and produced documents in 2019 funded by World Bank (WB), the European Union (EU) and the French Development Agency (AFD)
13. wastewater Master Plan (USAID, 2001)
14. The WRP Master Plan was completed in 2012 by a "Water master plan for the Southern West Bank" performed by MWH on behalf of USAID. This report - referred to as [MWH, 2012] – displays a water demand, production and gap analysis over the Bethlehem and Hebron governorates as well as recommendations to address the water availability issues.
15. The Water Master Plan for the South and North-East communities of the West Bank, specifically Area C (2017-2035) prepared by Action Against Hunger and GVC. The final report – referred to as [GVC, 2017] – presents the existing situation in those areas and gives a list of recommended investment measures for the 2035 horizon.

Annex 1.2 References to develop Water Harvesting Master Plan

The following studies and data sets are especially relevant

SUSMAQ project

The aim of the SUSMAQ (Sustainable Management of the West Bank and Gaza Aquifers) project was to increase understanding of the sustainable yield of the West Bank and Gaza aquifers under a range of future economic, demographic and land use scenarios, and evaluate alternative groundwater management options. The project was interdisciplinary, bringing together hydrogeologists and groundwater modelers with economists and policy experts. In this way, hydrogeological understanding could inform, and be informed by, insights from the social sciences. The results of the study provided support to decision making at all levels in relation to the sustainable yield of the West Bank and Gaza aquifers.

The SUSMAQ project has involved a major multidisciplinary effort, with contributions from a wide and varied set of people. The project was led by Newcastle University, working with the Palestinian Water Authority (PWA) as the main project beneficiary and other UK project partners. The project ran from November 1999 to October 2004 followed by an embedment phase from November 2004 to December 2005, and was funded by the United Kingdom's Department for International Development (DFID).

All reports prepared in the course of the SUSMAQ project are presented online at http://hwe.org.ps/Projects/PublicationReports.aspx. The full reports will be made available by PWA upon request to the Consultant.

In addition to these reports, a number of relevant documents directly derives from the SUSMAQ project such as the hydrogeological map of the West Bank [PWA, 2004] and the report about "Recharge modelling for the West Bank aquifers" published by the British Geological Survey in 2005 [BGS, 2005]. The latter document provides a description of the aquifer recharge mechanisms at stake in the West Bank (Figure) as well as the results of modelling activities focusing on wadi Natuf and expanded to the whole West Bank (Figure)

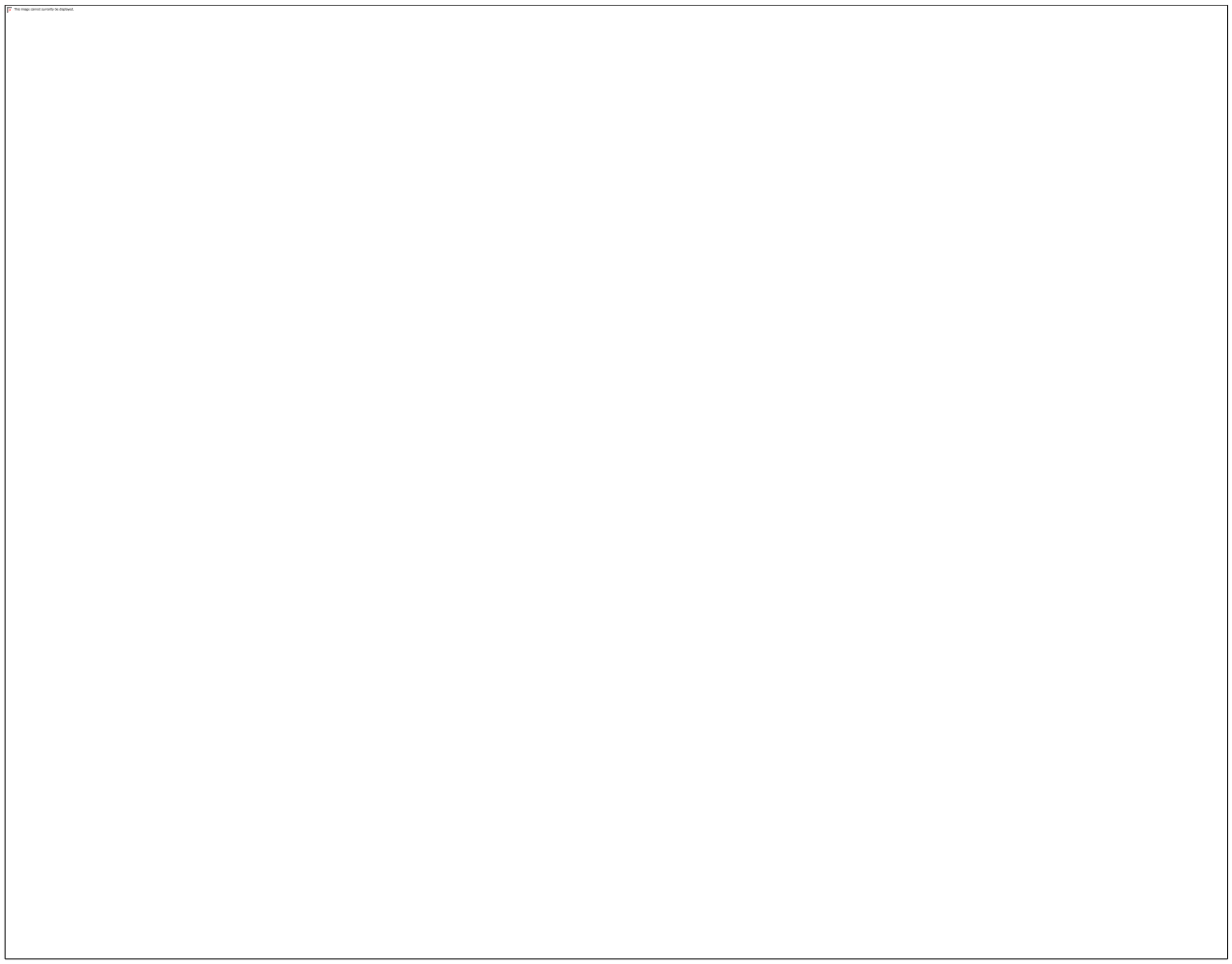


Figure14 Summary of recharge processes operating in the West bank [BGS, 2005] - SMD stands for Soil Moisture Deficit

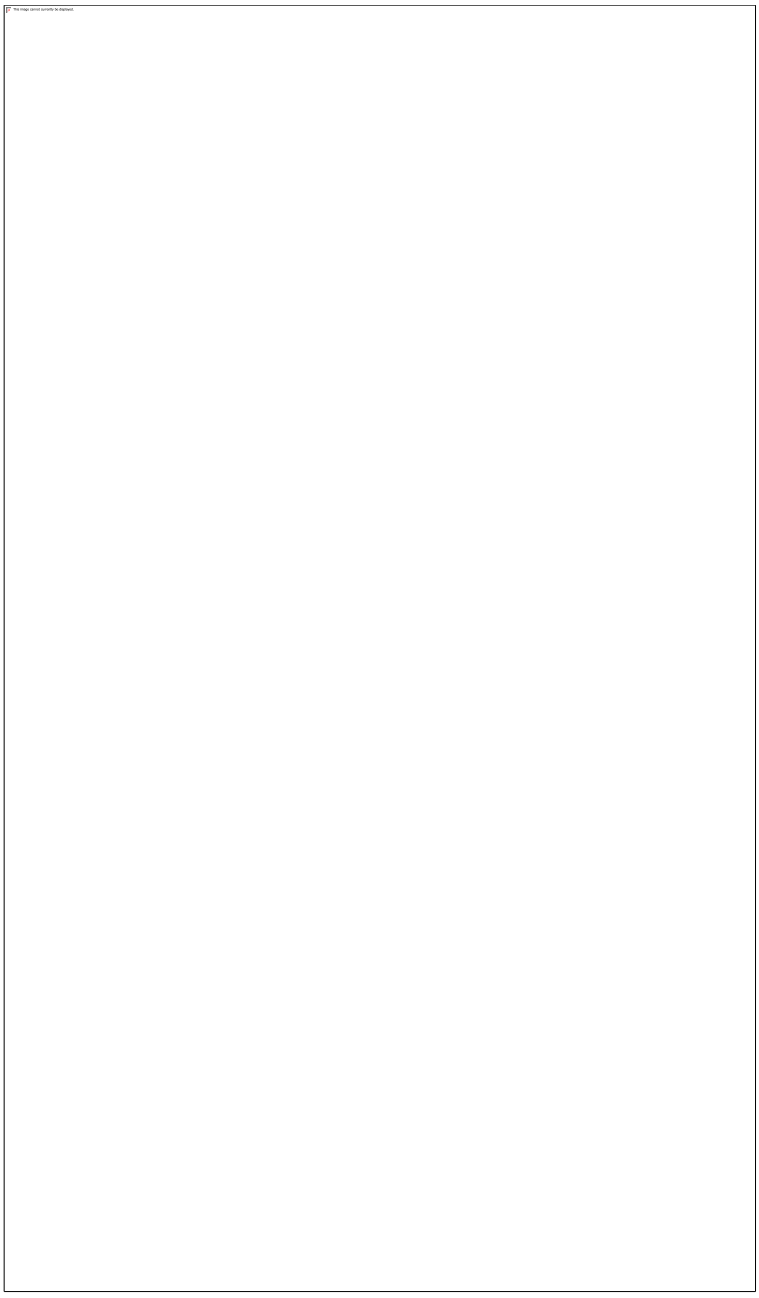


Figure15 Spatial distribution of recharge resulting from the application of the SMD method, including urban zones and irrigation [BGS, 2005]

JICA feasibility study

Among the previous studies, the "Feasibility study on water resources development and management in the Jordan River rift valley" performed by JICA in 2008 is especially relevant for the Project since it addresses the same objectives of the Project in terms of rainwater harvesting at a smaller geographical scale (water catchments along the Jordan Valley only, see Figure) than the Project Area, while addressing other subjects such as improvement of spring conveyance systems and rehabilitation of agricultural wells, which are out of the scope of the Project.

FORWARD study

The FORWARD study was prepared in September 1998 for the United States Agency for International Development under Contract #HNE-C-00-96-90027 to investigate the potential for Stormwater Harvesting in the Eastern Surface Catchment of the West Bank.

PWA data

In addition to previous studies addressing a specific subject, the Consultant will have free access to any relevant dataset (meteorological data, land use, etc.) from the concerned Palestinian public bodies, especially PWA.

A comprehensive GIS managed by PWA covers the whole Project Area. It will be made available to the Consultant. An example of dataset extracted from this GIS is pictured in Figure .

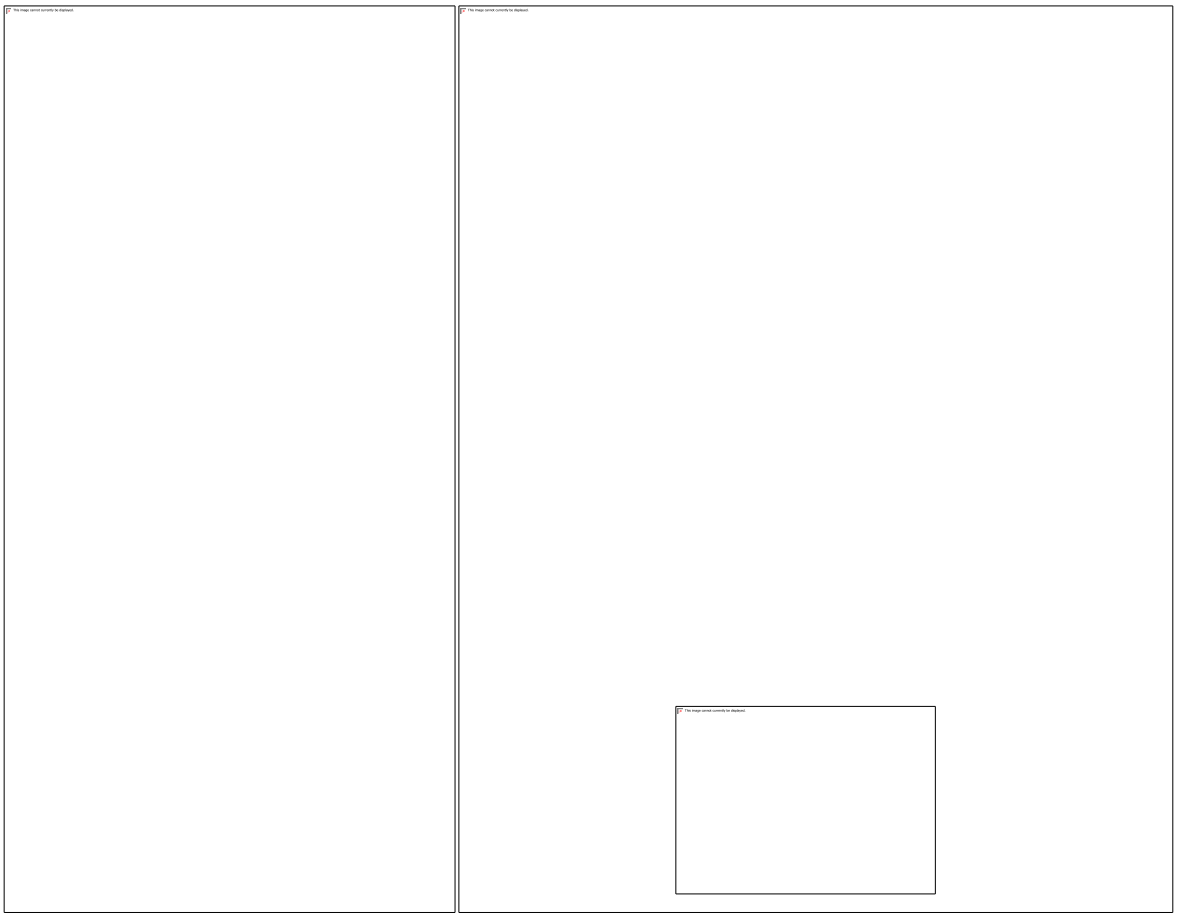


Figure 16 Map of the West Bank featuring relevant data sets extracted from [GIS, 2018]

Besides, PWA did already some work about the potentialities of stormwater harvesting that are presented together with general water related data in [PWA, 2013b]. For instance, PWA estimated the runoff generated by each of the 33 main wadis of the West Bank (Table) and the volumes of stormwater that could be harvested from the “priority” wadis (Table).

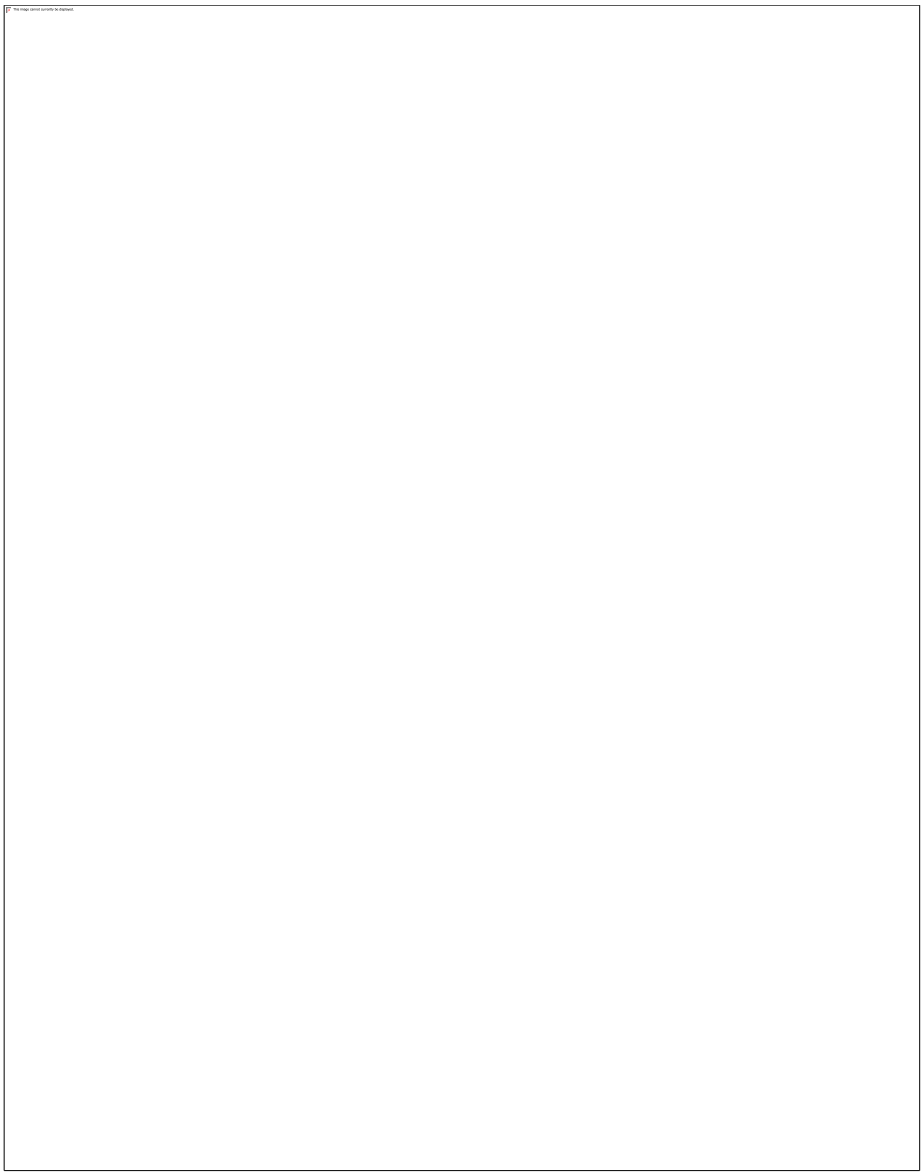


Table 8 Estimated discharge of the wadis in the West Bank, 2011/2012 season [PWA, 2013b]

Table 9 Estimated available resource from various wadis in the West Bank [PWA, 2013a]

The following references were used in these TOR :

1. [PWA, 2004] Hydrogeological map of the West Bank, scale 1:250000, PWA, 2004
2. SUSMAQ reports available online at http://hwe.org.ps/Projects/PublicationReports.aspx
3. [BGS, 2005] Recharge modelling for the West Bank aquifers, British Geological Survey, 2005
4. [FORWARD, 1998] The Potential for Stormwater Harvesting in the Eastern Surface Catchment of the West Bank, USAID, 1998
5. [JICA, 2008] Feasibility study on water resources development and management in the Jordan River rift valley – final report, JICA, December 2008

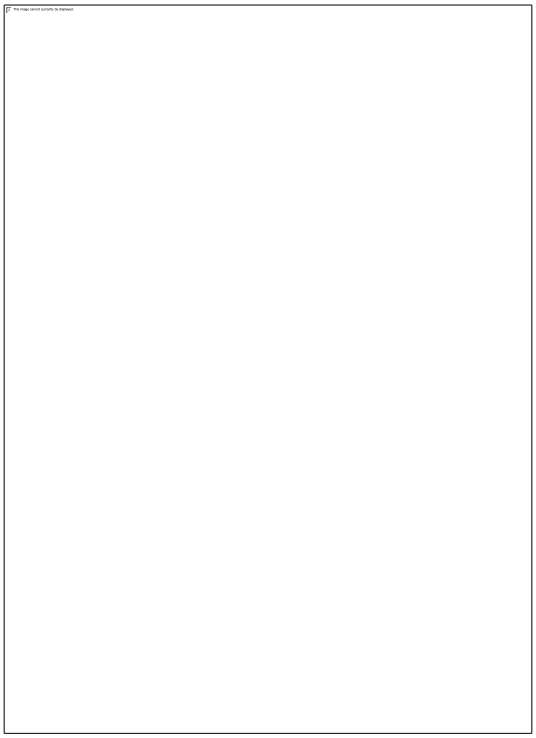
Volume I - Main report (http://open_jicareport.jica.go.jp/833/833/833_317_11919172.html)

Volume II - Annexes A (http://open_jicareport.jica.go.jp/833/833/833_317_11919180.html)

Volume III - Annexes B (http://open_jicareport.jica.go.jp/833/833/833_317_11919198.html

Volume IV - Annexes C (http://open_jicareport.jica.go.jp/833/833/833_317_11919206.html)

The table of content of [JICA, 2008] is presented below, for information:



1. [PHG, 2010] Marj Sanour watershed development plan, PHG, IUCN, August 2010
2. [Daher, 2011] Daher W, Pistre S, Kneppers A, Bakalowicz M, Najem W (2011) Karst and artificial recharge: theoretical and practical problems—a preliminary approach to artificial recharge assessment. J Hydrol 408(3):189–202
3. [PWA, 2013a] National Water Strategy for Palestine. Towards building a Palestinian State from water perspective. Draft copy. Palestinian Water Authority, June 2013.

4. [PWA, 2013b] Status report of water resources in the occupied state of Palestine – 2012, PWA, October 2013

5. [PHG, 2014] Groundwater Artificial Recharge - The Marj Sanour watershed, S. Whishahi, PHG, Regional Knowledge Network on Systemic Approaches to Water Resources Management

6. [SWIM, 2015] Activity 1.3.4.4 – guidelines for developing national regulation for managed aquifer recharge in three swim countries; final report on draft guideline for managed aquifer recharge with - in particular - treated wastewater in Palestine; Sustainable Water Integrated Management (SWIM) - Support Mechanism; Project funded by the European Union

7. [AE, 2016] Three technical reports on the design of stormwater storage structures for three West Bank catchments (Beit Al Roush, Beni Naim and Arrabeh), Arab Engineers, 2016 (in Arabic only)

8. [Aliewi, 2016] The Palestinian-Israeli management of shared groundwater aquifers. Status, realities and lessons learned, Amjad Aliewi, 2006

9. [PWA, 2017] Status report of water resources in the occupied state of Palestine – 2017, PWA, (publishing pending)

10. [WSRC, 2017] Bridge to Sustainability, Water and Wastewater Service Providers in Palestine, Facts and Prospects, 2015 Report, Water Sector Regulatory Council, June 2017 (available online at http://wsrc.ps/publications)

11. [Rolf, 2017] Lukas Rolf, 2017. Assessing the Site Suitability of Managed Aquifer Recharge (MAR) Projects in Karst Aquifers in Lebanon, A Multi Criteria Analysis, Master's Thesis, Utrecht University, Netherland, June 2017

12. [GIS, 2018] Various data extracted from the GIS of PWA including the location and characteristics of groundwater wells and WWTPs, the DEM (5 m contour lines) of the West Bank, as well as the location of all wadis. These data are available as GIS shapefiles.

13. Geological maps of Israel (covering the West Bank; scale 1:50,000) from the Geological Survey of Israel are available online at http://www.gsi.gov.il/eng/?CategoryID=253

All available original files cited in the previous reports will be transferred to the preferred bidder before the signature of the Contract upon request.

Annex 2- Hydrogeology of the West Bank

This annex is extracted from the annex 1 of [SWIM, 2015].

In the West Bank three hydrogeological aquifer basins are distinguished, the north-eastern basin, the western basin and the eastern basin (Figure). The Western and North Eastern aquifer basins flow to Israel where it constitutes one of the main groundwater resources. The majority of Palestinian water supply in the West Bank comes from these aquifer basins either by wells or springs. The total renewable groundwater resources are estimated as 578-814 Mm3/year. In the West Bank, groundwater resources are contained in deep (karstic) limestone and dolomite aquifers. Most wells are 200-800 m deep and the water table lies between 100 and 450 m below the surface. Shallow alluvial aquifers are found mainly in the Jordan Valley along the outlets of major wadis. These fans are recharged after large floods.

At present some 87 MCM/year or 14 % of the renewable groundwater resources is abstracted by the Palestinians from the upper aquifer (Figure). This is insufficient to meet the West Bank's 2.65 million inhabitants demand for water.

The larger part of the abstraction from the aquifer basins is abstracted by Israel from the deeper aquifers. In fact, there is overexploitation, which is particularly marked in the southern part of the Eastern aquifer, where nearby Palestinian wells are significantly affected. In some places, the drawdown has been more 70 m in just ten years in southern part of the West Bank and this is considered as great threatening to the groundwater system in this area [PWA, 2013].

Aquifer-Basin	Area within West Bank (Km^2)	Average rainfall (mm) 2010/2011	Recharge Volume 2010 /2011 (MCM)	Long-term Average Recharge (MCM)
Western Aquifer	1,767	407	311	318-430
Northeastern Aquifer	981	433	134	135-187
Eastern Aquifer	2,896	281	153	125-197
West Bank Total	5,644	347	598	578-814
Coastal Aquifer	365	225	33	55-60
Palestine Total	6,009		631	633-874

Table 10 Aquifer basin characteristics [PWA, 2013]

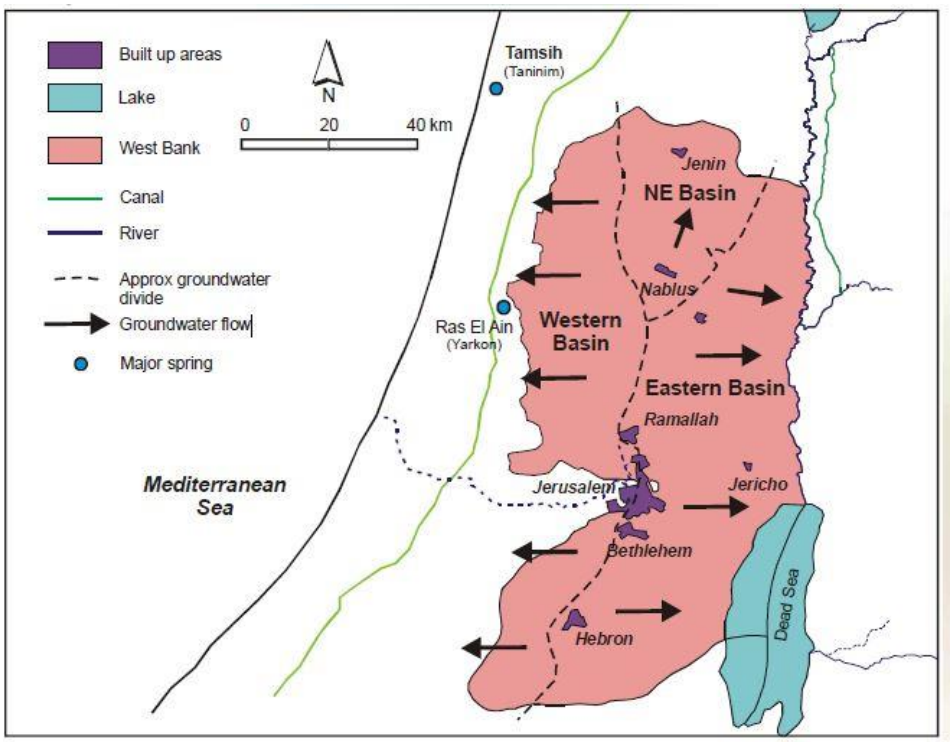


Figure 17 The West Bank aquifers [Aliewi, 2006]

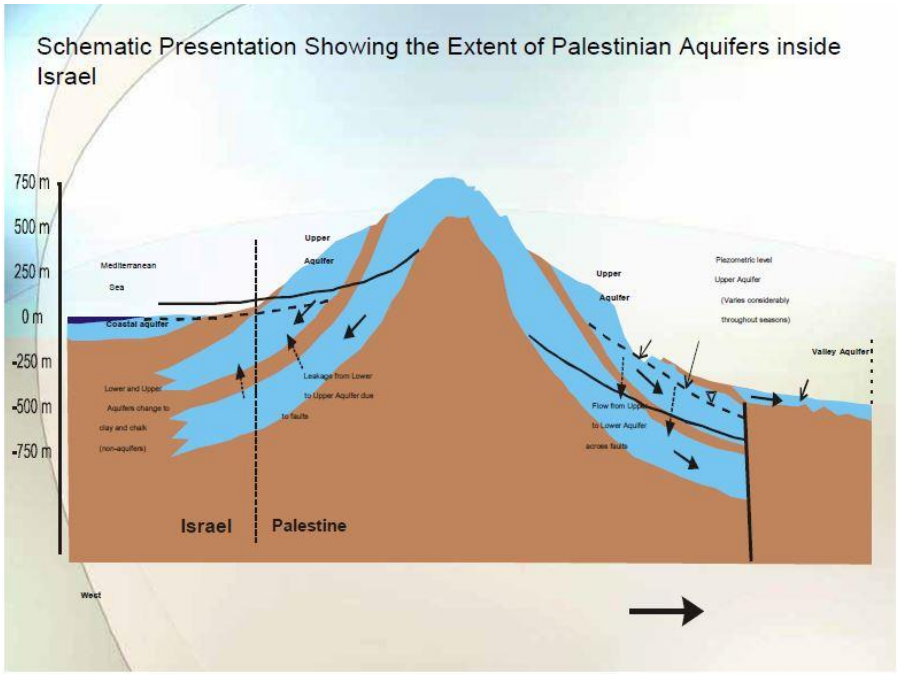


Figure18 Hydrogeological cross-section of the West Bank [Aliewi, 2006]

Groundwater quality in the West Bank

The combination of poor wastewater facilities, uncontrolled intensive chemical fertilizers use for agriculture, Israeli wastewater settlement and aquifer vulnerability (karstic aquifers) are causing nitrate contamination. This is illustrated in Figure 19.

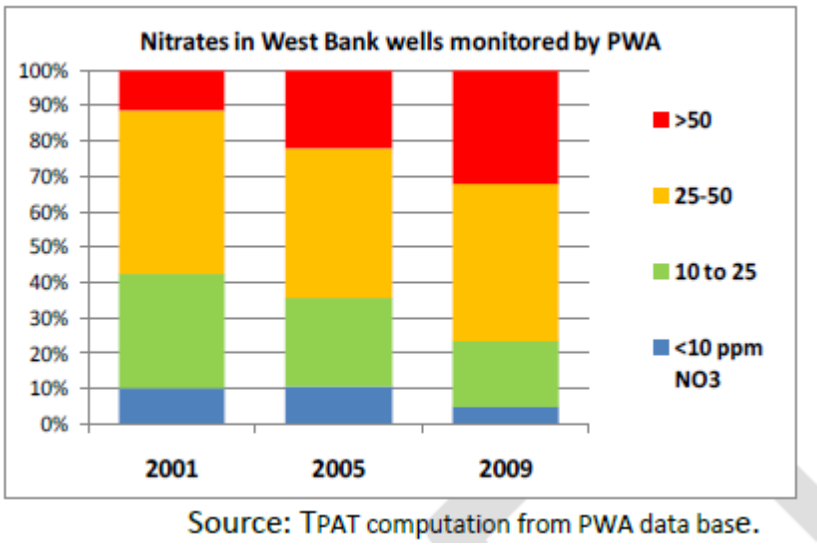


Figure 19 Nitrate concentrations in wells in the West Bank [PWA, 2013]

Chloride concentrations in the shallow aquifer are generally low (50 – 70 mg/L). Locally concentrations may rise up to 2,200 mg/L in areas influenced by salt domes, hypersaline brines and/or inflows from Dead Sea water. In the deeper aquifers, chloride concentrations are found ranging from 20 – 150 mg/L [PWA, 2004].

Annex 3 - Runoff data

Since November 2010, a monitoring program has been implemented to assess the runoff of four of the main wadis in the West Bank (i.e. Wadi Qilt, Wadi Nueima, Wadi Auja and Wadi Samia – tributary to Wadi Auja; all of them are tributaries to the Jordan River) as presented in Figure 20 and Table . The characteristics of the flow measuring stations are displayed in Table 12. In addition to these stations, partial flumes were constructed on Faria and Badan wadis and some measurements will be made available.

Runoff generation at the catchment scale is believed to be strongly influenced by the strong climatic gradient within the area from the mountain range in the west towards the Jordan Valley in the East. Short rainfall events with very high intensity (thunderstorms) as typical for the beginning of the winter season and spring time can cause runoff events at the wadis Auja, Nueimah and Qilt with high peak discharge but typically short duration (few hours) and overall little runoff volume. Runoff is generated typically due to rainfall intensities exceeding infiltration rates. Long lasting rainfall events within the strongest rainfall months of the winter season can cause high peak flows with high overall runoff volumes. These events are mainly caused from saturated areas after event rainfall exceeded certain thresholds.

The results of the monitoring program are displayed in Figure 21and Table 3. The data recorded from October 2015 are not yet available in a soft format. Therefore, the available monitoring data cover a period of approximately 5 years only.

Wadi	Qilt	

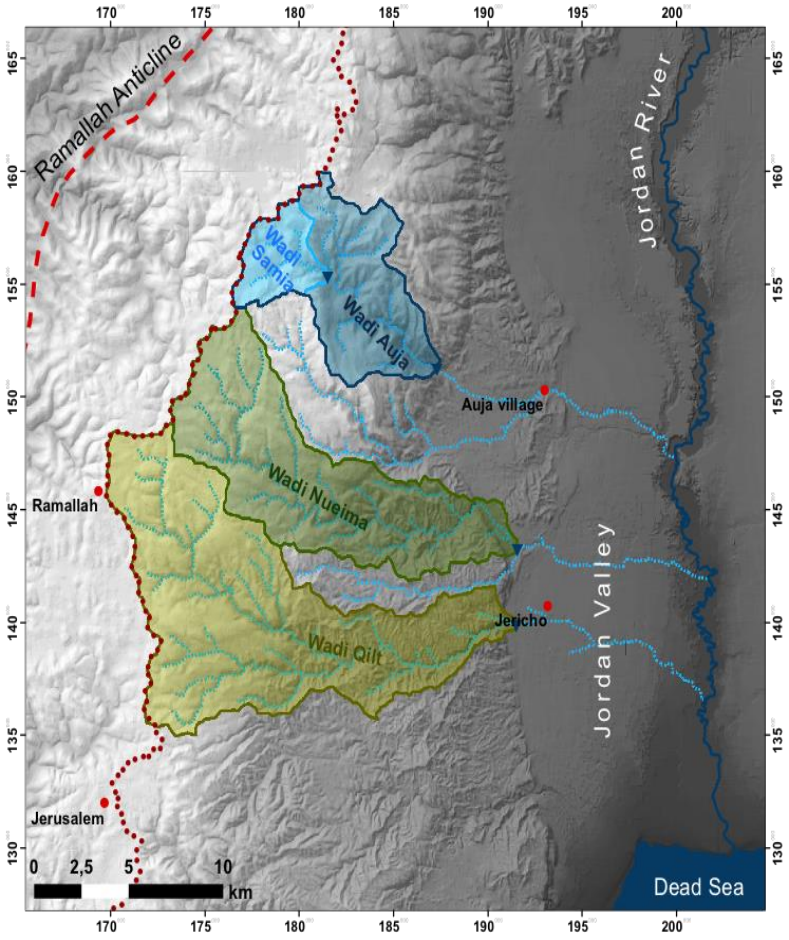


Figure 20 Map of the 4 catchments

	Wadi Qilt	Wadi Nueimah	Wadi Auja	Wadi Samia
Area (km2)	129.2	85.9	54.8	14.5
Observed runoff events	15	20	5	7
5min peak discharge (m3/s)	42.3	28.5	9.7	2.1
Max event runoff coefficient (%)	10.5	12.6	4.2	4.5
Total runoff coefficient (%)	2.4	2.7	0.7	1
Elevation (m)	496 (-240/911)	492 (-190/1010)	594 (-11/1010)	780 (434/1010)
Slope (°)	12.4 (0/62.1)	12.1 (0/62.5)	14.0 (0/49.1)	11.8 (0/46.8)

Table 11 Characteristics of the 4 catchments

Measuring station	Parshall flume	
Flow calculation	Formula for 30-foot Parshall flumes	
Wadi	Nueimah	
Measuring station	Road culvert	
Flow calculation	Manning-Strickler formula	
Wadi	Auja	
Measuring station	Broad crested weir	
Flow calculation	Relevant formula	
Wadi	Samia	
Measuring station	V-notch weir	
Flow calculatio	Relevan formula	

Table 12Characteristics of the flow measuring stations of the 4 wadis

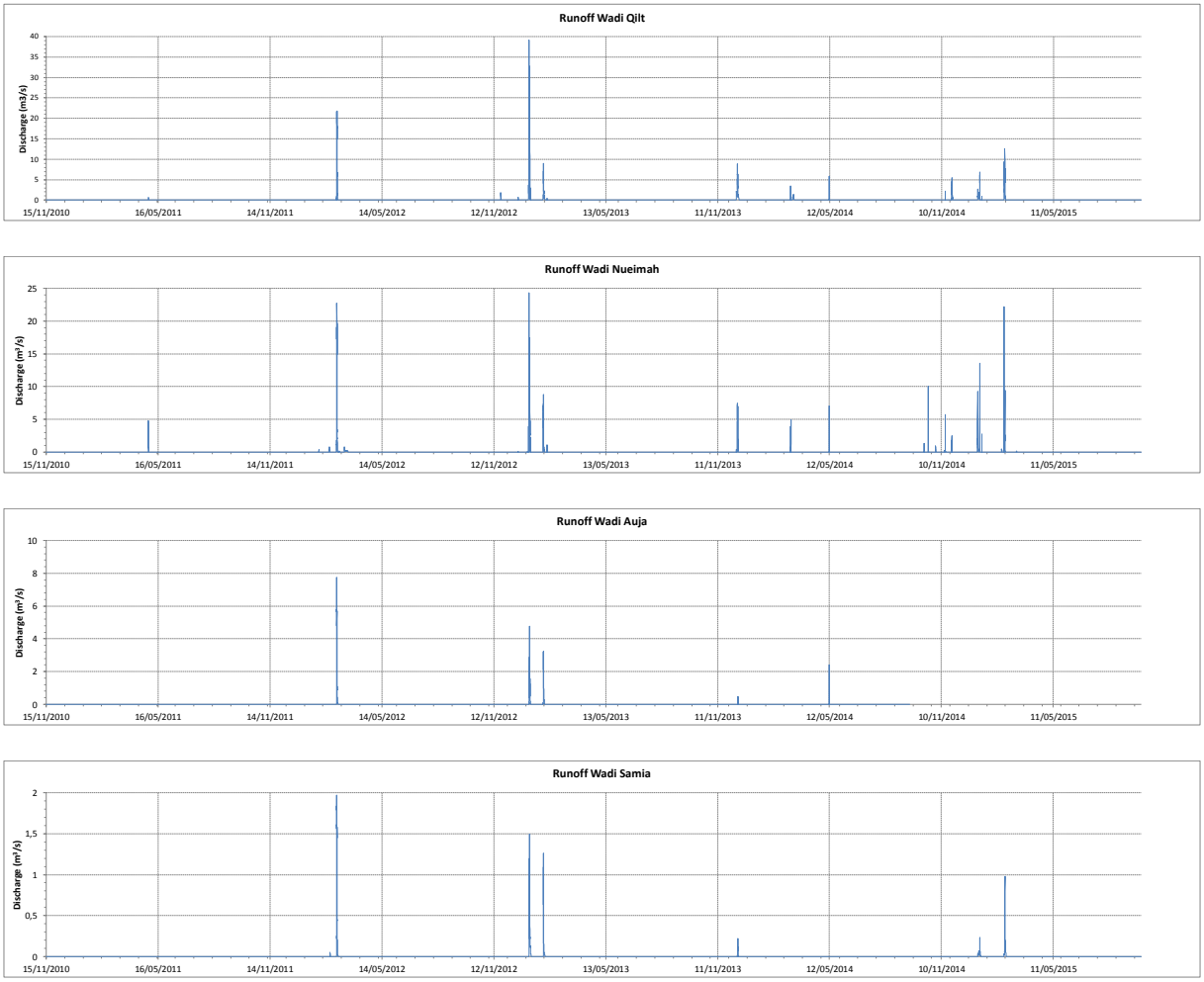


Figure 21 Runoff time series

Wadi	Qilt	Nueimah	Auja	Samia
Start of measurement period	15/11/2010	15/11/2010	15/11/2010	15/11/2010
End of measurement period	30/09/2015	30/09/2015	30/09/2015	30/09/2015
Days of measurement	1,781	1,781	1,404	1,781
Days with detected flow	40	54	11	24
Maximum hourly flow rate (m3/h)	140,832	87,408	27,864	7,092
Average daily flow rate (m3/d) - over the	3,356	2,458	568	207

total measurement period				
Average daily flow rate (m3/d) - during "flowing" days only	149,425	81,074	72,545	15,375
Maximum daily flow rate (m3/d)	1,111,000	860,000	272,000	90,000
Average yearly flow rate (m3/year)	1,195,400	875,600	159,600	73,800

Table 33 Summary of runoff measurements

Annex 4 - Water harvesting experiences in Palestine

4.1 General

Several projects related to water harvesting have recently been developed in Palestine. Among them are the following:

1. Marj Sanour artificial groundwater recharge of stormwater (see section 0)
2. Far'a artificial groundwater recharge of stormwater (see section 0)
3. Al Auja dam (financed by the MOA, PWA and Jordanian funds) is designed for storage only of stormwater and excess flow of Al Auja spring. It is of the earth-filled type equipped with an intake connected to an irrigation network. The main issue comes from the fact that a significant fraction of the stored water infiltrates, which was not the original purpose of this dam.
4. Infiltration basins for treated wastewater have been implemented in the NGEST plant (WWTP in Gaza strip) in order to recharge the aquifer used for agriculture purpose.
5. Three stormwater storage dams have been built in Beit Al Roush (impervious storage dam, construction completed), Beni Naim (impervious storage dam, construction completed) and Arrabeh (200,000 m2 pond, under construction) following the local requests of municipalities and/or farmers (see section 0). They are funded by the Islamic bank, implemented and managed by the MOA and designed for agriculture purpose only.
6. Check dams for flood control in Al Dyuk have been implemented by Jericho municipality.
7. Several WWTPs in the West Bank do have a treated wastewater reuse scheme (see section 0) even though this approach is not general as illustrated by the following examples:

1. Jericho WWTP: reuse for agricultural purposes
2. Jenin WWTP: reuse for agricultural purposes
3. Al Bireh WWTP: direct discharge into the wadi Al Auja since the plan to transfer the treated wastewater to Al Auja dam – about 6 km away – has not yet been implemented.
4. Ramallah WWTP: direct discharge to the wadi because the farmers refused to use the treated wastewater.

Additional information on the status of artificial recharge in Palestine in 2015 can be found in section 3.2 of [SWIM, 2015].

4.2 Marj Sanour

A groundwater recharge project has been developed in Marj Sanour for several years. This project is well described in [PHG, 2010] and [PHG, 2014]. It mainly consists in creating injection wells to reduce the lifetime of a stormwater lake that forms during the rainy season at the low point of an endorheic catchment therefore having a strong negative impact on farming activities in this highly productive area, while increasing the groundwater recharge. Four

injection wells have been completed in 2015 (Figure), 2 new wells are currently being drilled (completion expected before the end of 2018), a total of ten wells is projected in the medium-term depending on the availability of the funds (so far the project was financed by Dutch funds).

The injection wells are 100-120 m deep, while the water table is 40 to 50 m below the bottom of the wells, which provides additional soil filtration before the stormwater can reach the groundwater table. The top soil layer is made of 2 m of silty clay then clay (impervious).

Meanwhile, new abstraction wells for agriculture purposes have been built, which increases the over-pumping of the groundwater.

The surface area of the "marj" (i.e. plain) of Sanour is around 20 km^2. This closed watershed is supposedly unique in the West Bank, which does not allow for the duplication of this experience.

The flooding frequency and extent greatly varies from year to year depending on the precipitation patterns (Figure). In 1991 an estimated 30 million m^3 of stormwater was stored in the ephemeral lake, which had a lifetime of about 3 years (maximum depth of water: 4 m). Since the implementation of the injection wells, only 2 floods occurred because of a change in the precipitation patterns:

1. In 2015 the lake had a lifetime of 15 days only (the injection flow rate was estimated at 200 m3/h for each well)
2. In 2016 no lake was formed
3. In 2017 approximately 500 dunum were flooded, the lifetime of the lake was less than 1 month

In average, over the past 20 years, it can be estimated that about 1,500 dunum are flooded for a duration of 2 to 5 months per year.

There is no monitoring report available yet although an automated monitoring station that continuously measures relevant parameters (Cl, NO3, NO2, EC, pH, T, water level; every 15 min) has been installed.

Besides, small earth ponds for stormwater storage have been created in the plain to provide farmers with surface water (separate project from the injection wells, other funding).

Figure 22Pictures of a reinjection well taken in October 2018

31/12/2004

15/06/2010

14/01/2013

22/08/2013

27/02/2016

Figure 23 Aerial view of Marj Sanour at five different days (source: Google Earth).

Far'a

Following the recommendations of [JICA, 2008], a dam was built in 2014 on wadi Far'a thanks to Dutch funds in order to allow stormwater to infiltrate through limestone faults. The lessons learned have not been yet officially drawn. No monitoring report is available. However, the construction itself appear to be faulty because the dam structure is not well grounded on the bed rock, which leads to seepage. Besides, the wadi also drains wastewater from the upstream refugee camp, which accumulates as shown in the pictures of Figure 24.

Figure 24 Pictures of Far'a dam taken in October 2018

Location of storage dams in Beit Al Roush, Beni Naim and Arrabeh

The following figures are extracted from [AE, 2016]. They display the location of the three catchments were stormwater storage structures (impervious) have recently been implemented.

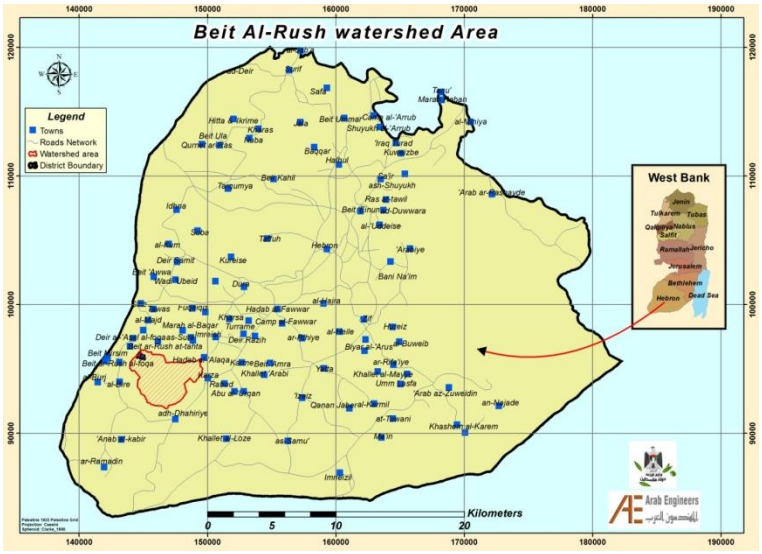


Figure 25 Location of Beit Al Roush watershed (Hebron governorate)

Figure 26Location of Beni Naim watershed (Hebron governorate)

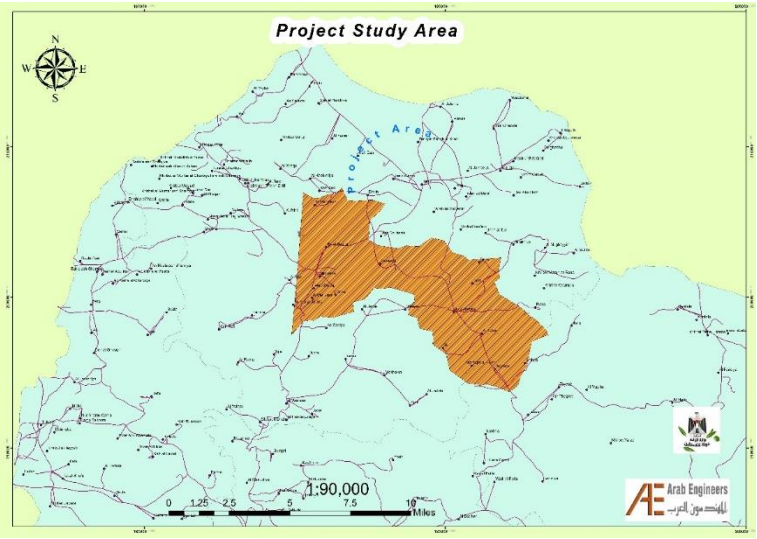


Figure 27Location of Arrabeh watershed (Jenin governorate)

Annex 5 – Current WWTPs in the West Bank

The attribute table of the WWTP layer available in [GIS, 2018] show around 20 WWTPs in operation within the West Bank. This table displays uncomplete data and sometimes contradictory information (see for instance columns “reuse” and “resuse”). The Consultant is then expected to search for the minimum information required to address the component of the Project related to treated wastewater reuse, such as design capacity, current load, treatment processes, quality and quantity of treated wastewater, etc. for each WWTP in operation or in procurement or construction phase

DISCRIPTIO	St	Technology	IN_PW	Capacity	Re_Criteri	Reuse	Resuse	N_Status
8. Nablus Beit Dajan WWTP	Operating-Major	Modified Activated Sludge	No	550 m3/d for 2022	Filtration Requered to Meet The Reuse Criteria	no	Yes	Operating
1.Nablus West WWTP	Operating-Major	Extended Aereation Activated Sludge	Yes	14000 m3/d for 2020	Filtration & Disinfection are Required to Meet The Reuse Criteria	yes	Yes	Operating
9. Nablus Sarra WWTP	Operating-Major	Constructed Wetland	No	280 m3/d for 2022	Filtration & Disinfection are Required to Meet The Reuse Criteria	no	Yes	Operating
13. Qalqiliya Hajja WWTP	Operating-Major	Constructed Wetland	No	180 m3/d for 2022	Filtration & Disinfection are Required to Meet The Reuse Criteria	no	Yes	Operating
11.Jenin Anza WWTP	Operating-Major	Modified Activated Sludge	No	350 m3/d for 2022	Filtration Requered to Meet The Reuse Criteria	no	Yes	Operating
16.Tubas Tayaseer WWTP	Construction-Major	Activated Sludge	No	3500 m3/d for 2032	Proposed Reuse Scheme (Tertiary Treatment Under Construction)	yes	No	Under Construction
2.Jenin WWTP	Operating-Major	Aerobic Ponds	No	10000 m3/d for 2030	Cannot Meet Effluent Criteria Due to Absence of Pretreatment, Primary Treatment& Nutrients Removal & Invalid Sequence of Tertiary Treatment	no		
12. Nablus Beit Hasan WWTP	Operating-Major	Constructed Wetland	No	80 m3/d for 2022	Filtration & Disinfection are Required to Meet The Reuse Criteria	no	No	Operating
14.Jenin Misilyya WWTP	Operating-Major	Constructed Wetland	No	700 m3/d for 2020	Cannot Meet Criteria	no	Yes	Operating
Zeita Wet Lands	Pilot	Constructed Wetland	No	100 m3/d for 2018	Cannot Meet Criteria	no	No	Pilot
20.Khirbet Sir WWTP	Operating-Minor	Constructed Wetland	No	40 m3/d	Cannot Meet Criteria	no	No	Pilot
21.Salfit Bediya	Pilot	Constructed Wetland	No	20 m3/d	Cannot Meet Criteria	no		
30. Jenin Industrial Estate WWTP	Procurment Phase						No	Industrial
Rehabilitation of old Jenin	Operating						No	Deleted
51.Ramallah Region Betunia - Ein Jariot WWTP	Hold Permitting						No	Planned
5. Ramallah Al-Tireh WWTP	Operating-Major						No	Operating
4. Ramallah Al Bireh WWTP	Operating-Major						No	Operating
3. Jericho WWTP	Operating-Major						No	Operating
28.Bethlehem Industrial Park WWTP (temporary)	Operating						No	Industrial
10. Ramallah Taybeh - Rammun WWTP	Operating-Major						No	Operating
7. Ramallah Rawabi WWTP	Operating-Major						No	Operating
15.Ramallah Al Rehan WWTP	Operating-Major						No	Operating
Birzeit University WWTP	Operating							Deleted
6. Hebron Sa'ir Arrub WWTP	Operating-Major							Operating

Table 14 Current WWTPs in the West Bank (extracted from the WWTP data of [GIS, 2018])