THE STATE OF ISRAEL

INVITATION FOR PRE-QUALIFICATION NO. 1903/2020

DESIGN, FINANCE, CONSTRUCTION, OPERATION AND MAINTENANCE OF A BIOLOGICAL PLANT FOR TREATMENT OF CONTAMINATED GROUNDWATER IN THE VICINITY OF THE RAMAT HASHARON IMI

AN INVITATION FOR PRE-QUALIFICATION NO.

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PRE-QUALIFICATION - Annexes A [1 – 6]

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A	**1**	General Description of the Project.
	2	The Site.
	3	Water Quality Reference DATA.
	4	Groundwater Remediation Plan and Hydrological Model.
	5	Pilot Scale Demonstration Plant information.
	6	Groundwater Supply for Voluntary Preliminary Tests and Analysis by Eligible Participants.

Annex A1 - General Description of the Project

1. **General**

The Project is intended on being implemented within the framework of a Public Private Partnership (PPP) for the design, finance, construction, operation and maintenance of a Contaminated Groundwater Biological Treatment Plant (the "**Plant**"). For further information see the Invitation for Pre-Qualification.

2. **Groundwater Contamination in the Vicinity of the IMI Ramat Ha'Sharon**

The IMI's operation has caused, over the years, severe groundwater contamination. The contamination is composed of a unique mixture of pollutants and includes, *inter alia*, high concentrations of Perchlorate, Chlorate, explosive components (such as hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)), heavy metals (such as Chromate), Nitrate and VOC's.

The WA has performed an ongoing site investigation of the IMI Compound including several groundwater monitoring cycles. The water quality data collected as part of this investigation is provided hereto in **Annex A3** (Water Quality Reference DATA).

The Perchlorate, Chlorate and Nitrate concentrations in the groundwater are in hundreds of thousands of micrograms per liter range with maximal concentrations of up to 850,000 µg/l, 600,000 µg/l and 200,000 µg/l, respectively. The explosives and heavy metals concentrations in the groundwater are in the thousands of micrograms per liter range, with maximal concentrations of up to 5,000 µg/l Cr^{+6} 6,000 µg/l RDX and 50 µg/l HMX.

The Project's main objective is to stop the expansion of the contaminated groundwater plume and reduce its volume by pumping groundwater at the contaminated sources, treat the pumped groundwater via biological methods and dispose the treated groundwater to the Yarkon river.

It should be noted that the contamination plume in the aquifer is one of the most severe groundwater contaminations in Israel, *inter alia,* with respect to the plume's contaminants composition, variety, concentrations and dispersion radius. The contamination plume covers an area of approximately 24 square kilometers and has led, so far, to the closing of 18 drinking water wells in the vicinity of Ramat Ha'Sharon and north Tel-Aviv. The plume's further expansion will contaminate additional groundwater volumes in the aquifer which may prevent the use of additional drinking water wells in the vicinity of Herzliya and Tel-Aviv.

3. **Ramat Ha'Sharon Groundwater Remediation Plan**

A remediation plan for contaminated groundwater has been prepared by the WA to apply on the Ramat Ha'Sharon IMI Compound and it's vicinity. The remediation plan includes extraction of contaminated groundwater and their treatment in order to stop the expansion of the plume, prevent contamination of other freshwater volumes, and reduce the contaminants concentrations. The remediation plan's implementation is aimed to allow the use of groundwater for diverse uses and the preservation of the aquifer as a sustainable natural water storage resource.

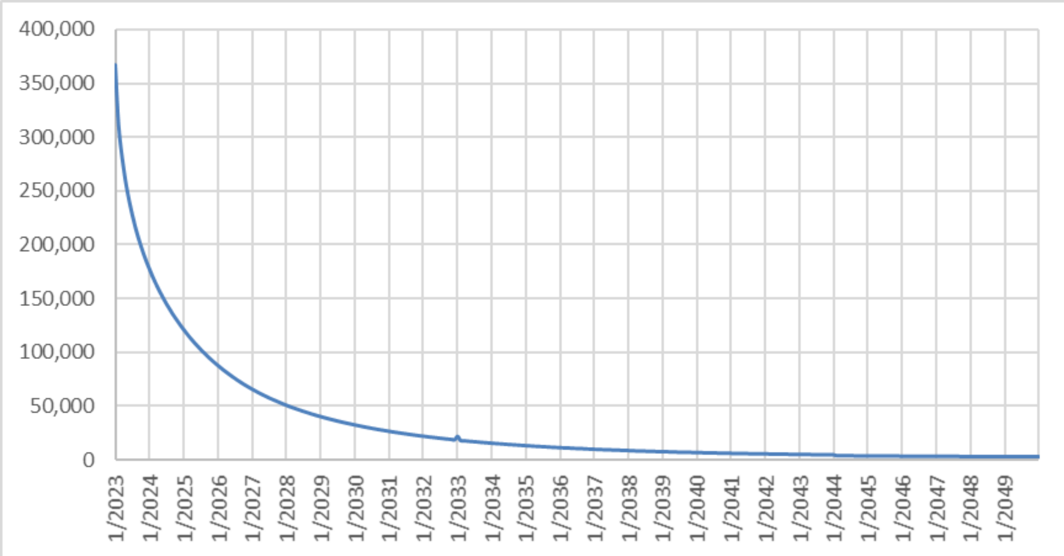
For the preparation of the remediation plan, the WA has set a flow and transport model and calibrated it to examine various remediation scenarios. Each scenario was of different flow-rate and different production wells' dispersion.

After examination of the various scenarios, it was identified that the most effective remedial scenario *vis-a-vis* - removal of Perchlorate and optimal reduction of the plume's radius - should include the construction of six designated production wells. It was further considered that these production wells should be drilled at the main contamination sources within the IMI Compound with a total maximum production capacity of 650 m^3/hr for approximately 25 years.

The pumped groundwater should be Ex-Situ treated to reduce the contaminants' concentration and channeled the treated groundwater to the Yarkon River within the framework of the Yarkon Redemption project (denoted in Hebrew: "**גאולת הירקון**").

According to the model's forecast - pumping the contaminated groundwater will reduce substantially the Perchlorate concentrations in the plant's inlet stream (a mixture of the water from the six production wells) during the first five years to values of approximately 30,000 micrograms per liter. Along the operation period, it is expected that the concentrations will continue to drop in a more moderate manner until reaching values of several thousands of micrograms per liter.

A graph presenting the estimated Perchlorate concentrations in the treatment plant's inlet during the operation years is provided below.



Annex A4 (Groundwater Remediation Plan Overview) provides the estimated Perchlorate concentrations at the plant's inlet during the operation period.

4. **Pilot Scale Demonstration Plant**

Towards the preparation and publication of this Pre-Qualification Process, the WA has conducted an international public tender for the design, construction, operation and maintenance of a pilot scale demonstration plant facility for treatment of contaminated groundwater within the IMI Compound ("**Demonstration Plant**"). The Demonstration Plant operation was based on biological treatment and supporting physicochemical treatment.

Information relating to the Demonstration Plant is provided under **Annex A5** (Pilot Scale Demonstration Plant information).

5. **Scope of Works – General Overview**

The Project's intended scope includes*, inter alia,* the components described in brief below:

a. Drilling of 6 designated production wells at the main contamination sources within the IMI Compound, with a maximum total production capacity of 650 m3/hr. The exact production capacity of each production well (including changes thereof during the operation period) shall be determined in the Tender Process Documents.
b. At grade pipelines between the production wells and the designated terminal point to be determined in the Tender Process Documents.
c. Underground connecting pipeline from the designated terminal point to a designated location in the Plant's Site, as shall be determined in the Tender Process Documents. Where needed, including with regard to crossings of roads such as roads 4 and 5.
d. The design and construction of the Plant which shall include, *inter alia*, a biological treatment system, physico-chemical treatment units and any other needed units required in order to reach and maintain the water quality criteria and volumes to be determined in the Tender Process Documents. The Plant shall also include all auxiliary, operation and maintenance supporting systems for treating any internal streams such as biological treatment sludge, backwash streams, cleaning solutions and treated water that is not compatible with the determined water quality criteria.
e. Treated water discharge pipeline conveying the treated water to the final discharge destination that shall be determined in the Tender Process Documents.

Note: the aforementioned provides only an preliminary and unexhaustive description of the Project's elements. As such the exact scope will be determined and elaborated in the Tender Process Documents.

Annex A2 - The Site

1. **General**

The treated water shall be channeled from the Plant to the discharge point located adjacent to the Yarkon River. Channeling the treated water from the Plant onwards to the discharge point shall be executed within the framework of the Yarkon Redemption project (denoted in Hebrew: "**פרויקט גאולת הירקון**") (which shall be advanced separately to the Project). The exact location of the discharge point will be indicated in the Tender Process Documents after it is determined.

The Plant shall be constructed in the south-eastern quadrant of the Morasha Junction (east of Route no. 4 and south of Route no. 5). It is estimated that the size of the area which shall be designated for the construction of the Plant will be approximately 15 dunams / 3.7 Acres (within the aforesaid quadrant). Exact details regarding the Plant's size and location, connecting pipelines, terminal point, Plant's Site and Infrastructure Corridor will be determined and indicated within the Tender Process Documents.

Figure 1: Site superposition – Aerial Photo

Figure 2: Morasha Junction quadrant (in which the Plant's Site will be located) – Aerial Photo

Figure 3: Production Sites – Aerial Photo

2. Statutory Overview

2.1. Planning Zones

- The area in which the Plant will be constructed is within the boundaries of the local planning zone of the Ramat Hasharon Municipality which is under the jurisdiction of the Tel-Aviv District Planning and Zoning Committee.
- The IMI Compound, in which the Production Wells are located, is within the boundaries of the local planning zones of Hod Hasharon, Herzliya and Ramat Hasharon, under the jurisdiction of the Joint Regional Committee of the Central and Tel Aviv Districts having authority over 1/מש– Taas (IMI) Hasharon plan (denoted in Hebrew: מתחם "**קדמת השרון**").

2.2. Obtainment of Permits

2.2.1. Permits for the Plant

Permit for the construction of the Plant will be applied for per TMM Plan 5/2 ("תמ"מ 2/5" "Partial Regional Outline Plan for the Yarkon River Region" (denoted in Hebrew: "תכנית מתאר מחוזית חלקית למרחב נחל הירקון") which was approved on October 30, 2007.

The aforesaid permit application will be submitted by the Concessionaire to the Ramat Hasharon Licensing Authority and will be required to comply with all the stipulations set forth in the TMM 5/2.

The area in which the quadrant is included is defined in the TMM 5/2 for "Special Agricultural Land" use. The TMM further stipulates that obtainment of building permits for construction of infrastructure facilities designated for rehabilitation of the Yarkon River is possible in any of the land uses (denoted in Hebrew: "בכל ייעודי הקרקע"), at the local committee's discretion and subject to the accumulative conditions set forth under Article 6.5.2 of the TMM.

Note: the aforesaid provides a partial translation of the conditions set forth under the TMM. The binding conditions shall be the ones included in the TMM. The TMM 5/2 plan documents and appendixes are available (in Hebrew) online: http://www.mavat.moin.gov.il/MavatPS/Forms/SV4.aspx?tid=4&et=1&mp_id=6vCdEltSxBU%2f1xZwtAEqU9ie%2bwVjINVVjbRHQTcaiIQqGihWdAfNDIDsfuqwHnEXM2uugR1tBDn%2f0al21u6qLNL5JipxxPTp. It is the Participants full and sole responsibility to thoroughly study the provisions, conditions and constrains set forth in the TMM.

2.2.2. Permits for the Production Wells and the Infrastructure Corridor

Licensing of pipelines channeling water to and from the Plant shall be made per the national outline plan for building permits for water lines and facilities – NOP/34/b/6 (תמא/34/ב/6) which was approved on July 18, 2017. This plan allows the obtaining of building permits for system water lines of diameters up to 64 inches.

Licensing procedures for the Production Wells and connecting pipelines within the IMI Compound shall be subject to and executed in accordance with the procedures of the Law and subject to obtainment of the approval from all relevant authorities required for execution of works in security premises.

Note: the aforesaid provides a partial description only. Accordingly, the binding conditions shall be the ones included in the plan. The NOP/34/b/6 plan documents and appendixes are available (in Hebrew) online: https://www.gov.il/he/Departments/Guides/tama_34?chapterIndex=5. It is the Participants full and sole responsibility to thoroughly study the provisions, conditions and constrains set forth in the TMM.

2.3. Additional Plans applying to the Plant's Site and the Infrastructure Corridor

(a) RS/210/A (רש/210/א) – Statutory Zoning Plan - local outline plan.

(b) צל/רש/מורשה plan is a policy plan and, accordingly, does not have an obligatory statutory status. Without derogating from the above, this plan was approved by the District Committee on 2014. The aforesaid 15 dunams / 3.7 Acres for the construction of the Plant, mentioned in section 1 above, are included within the Polygon (see Figure 2) designated for the construction of infrastructure facilities including, inter alia, a waste treatment plant according the policy plan. The exact location of the Plant within the Polygon will be reflected in the Tender Process Documents.

Note: The Tender Committee reserves its right to instruct the Project is advanced via a statutory framework different to the one briefly described in this **Annex A2**. The final location the Pumping Wells, Infrastructure Corridor, pipelines, terminal point and Plant Site (may eventually may be located in a location outside the aforementioned quadrant) will also be determined within the Tender Process Documents.

<u>Annex A3 – Water Quality Reference DATA</u>

1. **Preface**

   The objective of this Annex is to provide Participants with background DATA of the water quality monitored by the WA in monitoring and production wells located in the IMI compound and adjacent surroundings as of 2010 and until 2020.

   The DATA is provided in the attached Excel file titled: "**Annex A3 – Water Quality Reference DATA**" in the Website.

   Note: By participating in this Pre-Qualification Process, Participants acknowledge and agree that the information included in this **Annex A3** is intended for descriptive purposes and is provided as reference only, and hence shall have no binding effect and shall not impose any responsibility or liability on the Tender Committee, its consultants and anyone acting on their behalf or on the Participant. The Tender Committee may update or modify the information provided within this **Annex A3** within the framework of the Tender Process Documents.

2. Maps

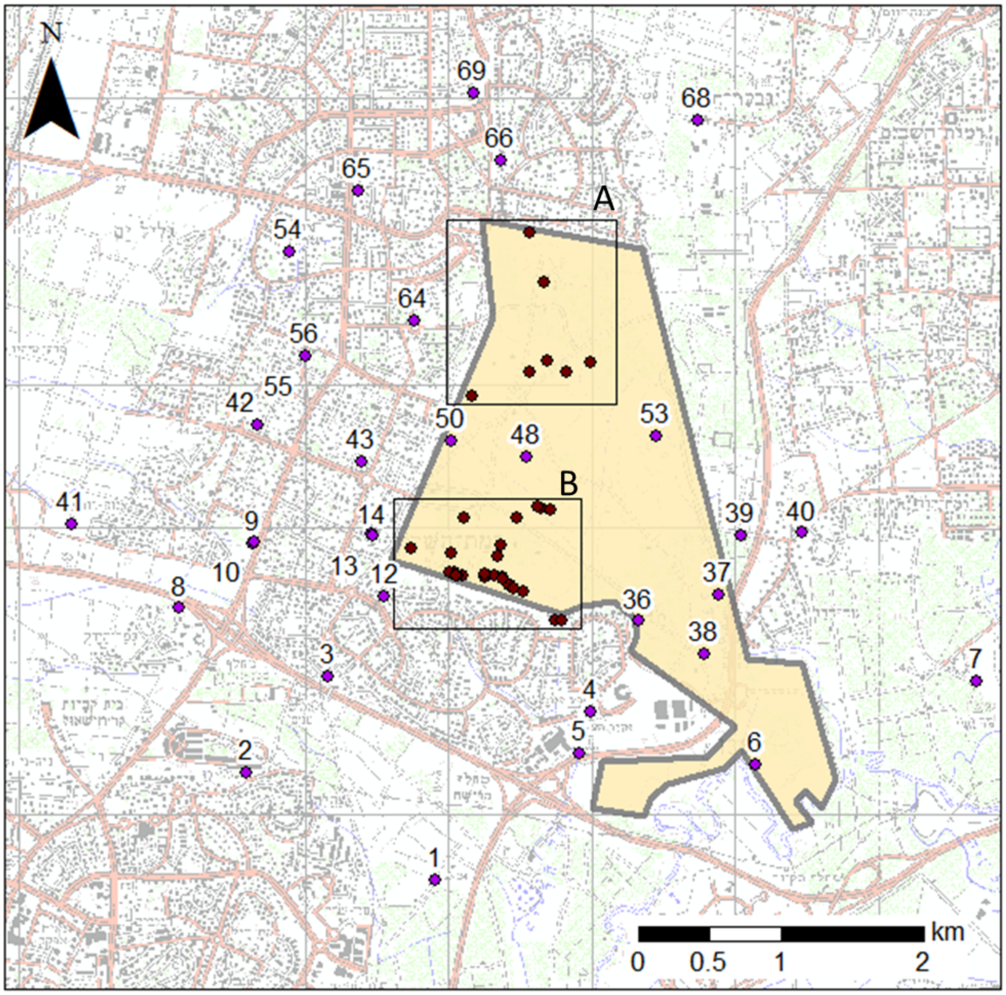
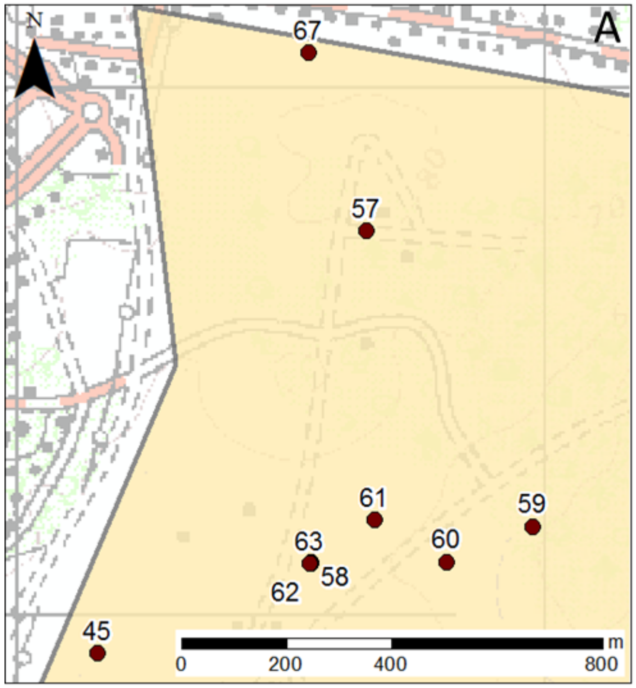
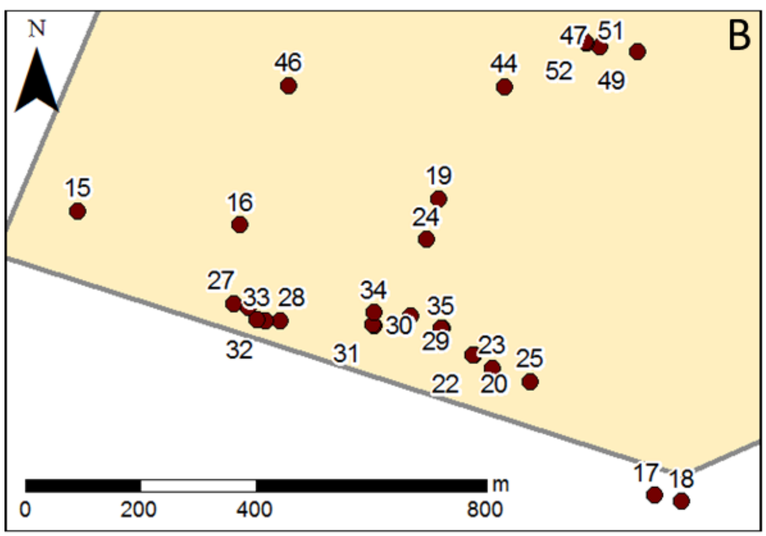


Figure 4: Monitoring and production wells in the IMI Compound and it's surroundings



<u>Figure 5</u>: Zoom in of Part A of map (above)



<u>Figure 6</u>: Zoom in of Part B of map (above)

Annex A4 – Groundwater Remediation Plan and Hydrological Model

1. Model setup

Within the framework of the remediation plan's preparation, a hydrological flow and transport model was set and calibrated. For this purpose, the GMS (Groundwater Modeling Systems) platform, which uses the MODFLOW and the MT3DMS modeling programs, was used.
The flow model area was extended beyond the contaminated area, so that the influence of the boundary conditions on the contamination plume would be minimal (Figure 7).

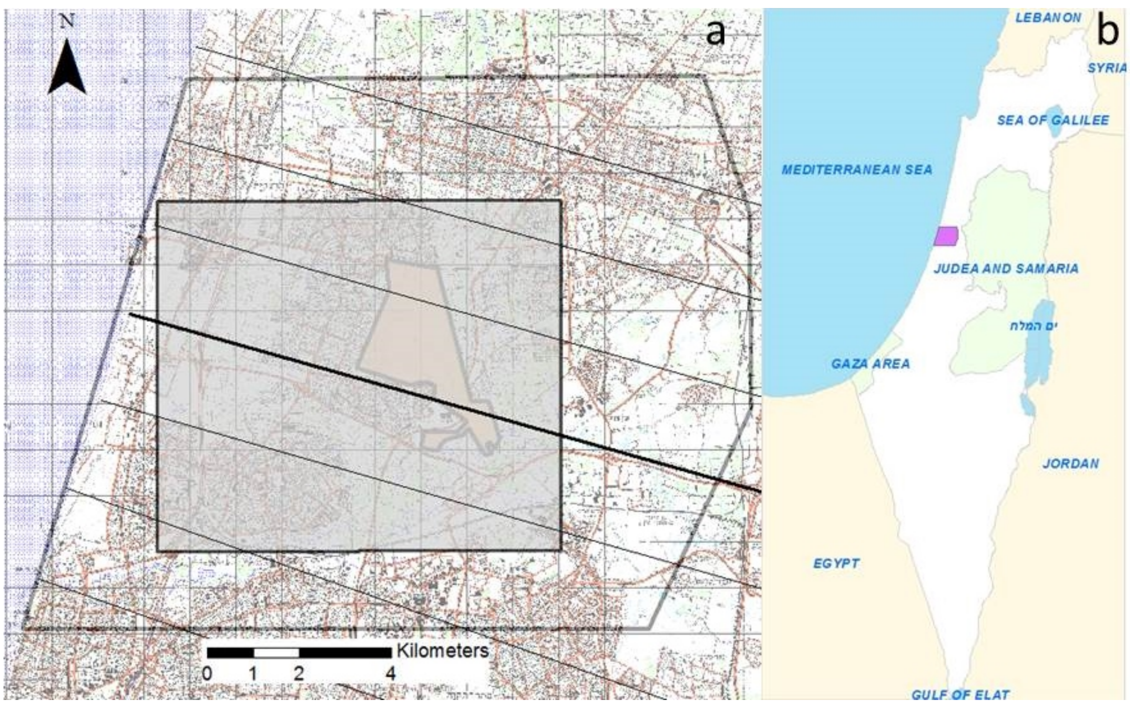
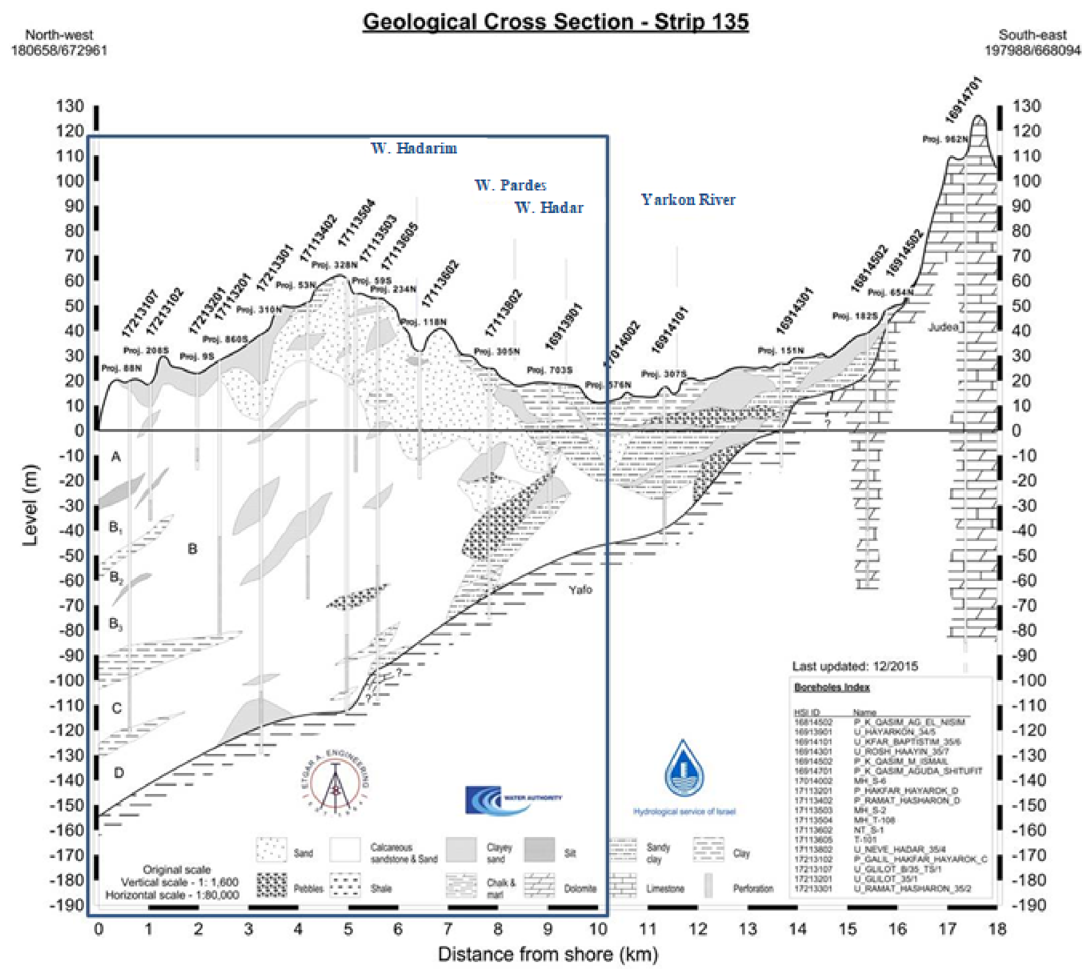


Figure 7: The model area. The flow model area is delineated as boundary line in map a, and as a violet polygon on the Israel map (b).

Figure 7 note: The transport model area is shown as the semi-transparent area and the IMI Compound is colored yellowish. The black lines show the location of the seven cross-sections, from which the lithology of the model was derived. The thick line locates the cross-section presented in **Figure 8**.

The eastern boundary of the model was determined at the outskirts of the coastal aquifer and could therefore be set as a non-flux boundary (Neumann-type). Since the natural gradient in the area of the model is directed west towards the sea, the northern and the southern boundaries are perpendicular to the main flow direction and were therefore also set as non-flux boundary. The western boundary is the seashore and was therefore set as a constant hydraulic head (i.e H=0 m).

In the vertical axis, the model covered the saturated zone from the water table down to the Yafo formation (aquiclude), which constitutes the basis of the coastal aquifer. The Yafo formation starts at 160 m below sea level at the western boundary of the model (the seashore) and elevates continuously westwards until 50 m below sea level at the eastern boundary of the model (**Figure 8**).



<u>Figure 8</u>: Cross-section no. 135.

Figure 8 note: The blue rectangle delineates the vertical model area throughout the thick line shown in **Figure 7**. This cross-section is updated at 2015 on basis of the cross-section from 1974 used for the model settings.

The model grid contained 143,510 cells; 10 vertical layers and 113*127 cells at each layer. The size of the horizontal cells faces vary from 25*25 m at the core of the Perchlorate contamination to 250*250 m at the outskirts of the flow model. The thickness of the vertical layers varies with the thickness of the aquifer (see **Figure 9**) between 4 and 16 m.

The coastal aquifer consists of Pliocene-Pleistocene predominantly calcareous sandstone sequence, with intercalations of clay, silt and loam of various origins, which divide the western part of the aquifer into sub-aquifers (denoted with letters A-D in **Figure 8**) and act as local aquitards throughout the whole aquifer.

For the hydrological model the area was divided into five different geological units: sandstone, sand, sandy loam, loam and clay (see **Figure 9**). The spatial location of these units was derived from seven cross-sections prepared by E. Shaknai [Eker, 1999]. The middle cross-section is presented in **Figure 8** and the locations of the different cross-section are indicated in **Figure 7**.

The horizontal model area was divided into recharge zones of three types: agricultural, urban and industrial and the average annual recharge was calibrated together with the hydraulic parameters (horizontal and vertical hydraulic conductivity, specific storage and specific yield) of the five geological units, using well data and monitored water heads (at 16 monitoring wells) for the years 1975-2000. In 2015, the average annual recharge was recalibrated using monthly well data (from 107 production wells) and monitored water heads (at 28 monitoring wells) for the years 2005-2014.

For the future scenarios, averaged continuous abstraction rates were estimated using the well records for the years 2010-2015. Due to the contamination only 43 production wells are still operating within the model area.

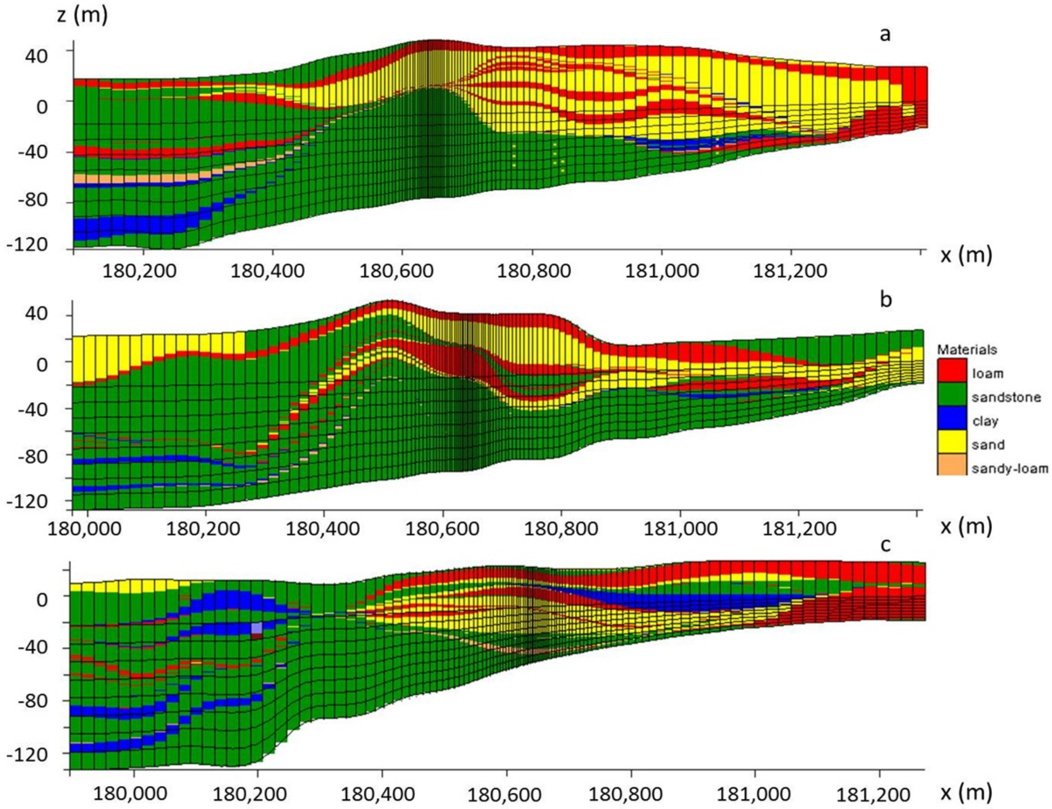


Figure 9: Model grid cross-sections, with colors according to soil material.

<u>Figure 9 note</u>: Cross-section a is located along y=675,000 m, cross-section b along y=671,000 m and cross-section c along y=668,000 m (location shown in **Figure 10**). The top boundary of the grid is the ground level, but only the saturated layer was modeled.

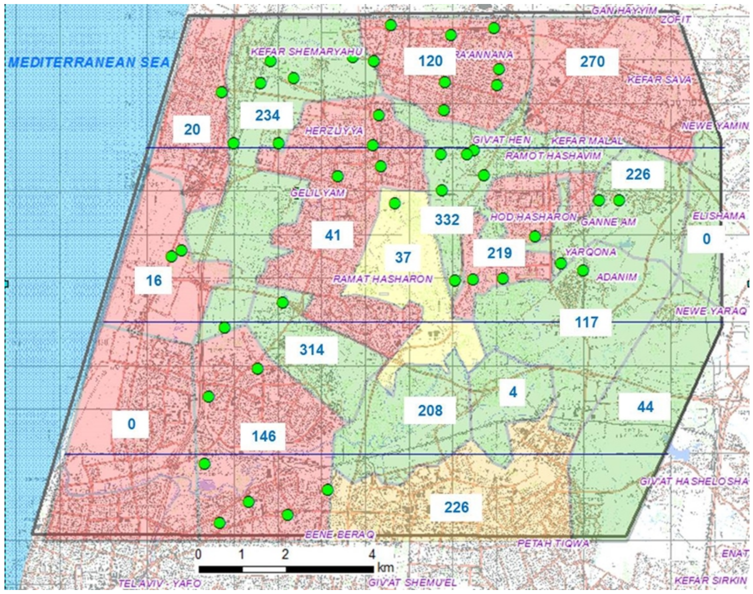


Figure 10: Recharge areas and active production wells.

Figure 10 note: Urban areas are colored red, rural areas are colored green and industrial areas are colored yellow. The numbers denote the calibrated recharge to each recharge polygon (mm/yr). Active production wells are shown as green dots.

2. Contaminants

The IMI Compound and its' adjacent surroundings were intensively monitored since 2004, using above 120 monitoring and production wells. The main contaminants found within this area were Perchlorate, Chlorate, RDX and HMX (explosives), Chromium, TCE and Nitrate. Since Perchlorate and Chlorate are highly water soluble and inert, and since Perchlorate was used intensively at the Malbin site, these contaminants produced the most widespread contamination plume, reaching up to 5 km downstream from the source. The large flow and transport model were mainly intended to manage and remediate the large and dynamic plume of these contaminants. A record of the different contaminants’ concentrations monitored at the IMI Compound and its adjacent surroundings, since 2010 can be found in **Annex 3** (Water Quality Reference DATA).

Based on the historical survey conducted and analysis of the monitoring records over time, five different sources were assumed from which the contaminants are infiltrated from the vadose zone into the upper part of the aquifer (**Figure 11**).

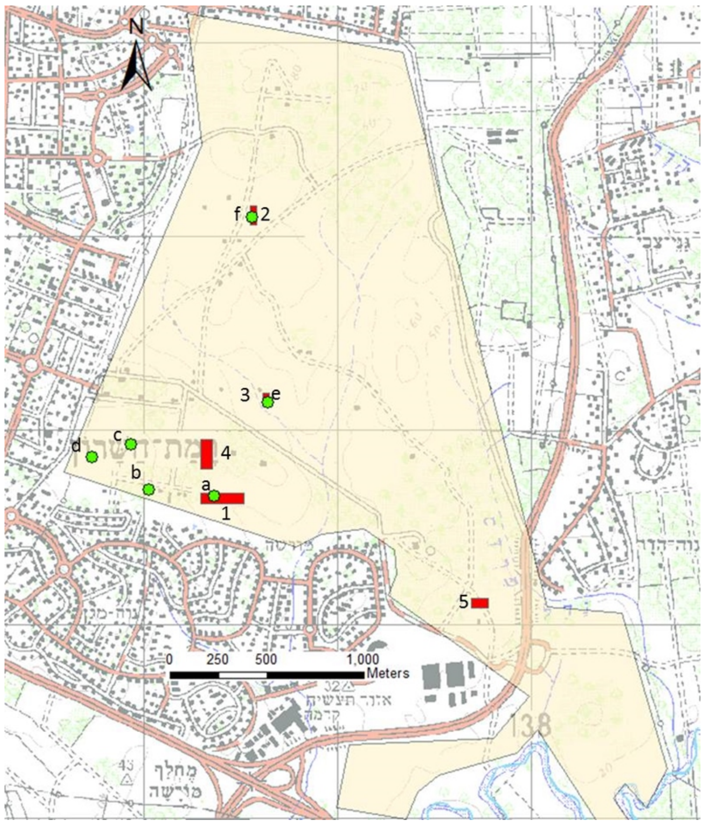


Figure 11: Modelled contamination sources (red polygons) and the designated 6 Production Wells (green dots).

The contamination sources in the above **Figure 11** are numbered accordingly:

- The main source for Perchlorate and Chlorate is at the Malbin percolation ponds (source no. 1 in **Figure 11**). RDX, Nitrate and Chloride are also considered to infiltrate to the aquifer at this area.
- In the northern-west part of the IMI Compound (and also westwards of the site) Chromium and TCE were found in high concentrations. Their source is noted as source no. 2 in **Figure 11**. Perchlorate and Chlorate also infiltrate at source no. 2, but with significantly lower concentrations than at source no. 1.
- The main source for RDX is noted as source no. 3.

- At two additional locations RDX and Perchlorate were observed. RDX was found at source no. 4 and Perchlorate at source no. 5. The monitored contaminants concentrations (i.e. significantly higher concentrations than the background, which frequent deviations from a linear trend), suggests that infiltration takes place. It should be noted that these two sources (no. 4 and no. 5) are of secondary importance, and therefore not addressed in the remediation scenarios.

All contaminants at the area are supposedly being infiltrated down to the groundwater from the vadose zone with the infiltration of surface water. Lacking comprehensive data in order to properly model the infiltration of the contaminants, thus their infiltration concentrations were kept constant and calibrated against the measured concentrations at the shallow monitoring wells at the infiltration sources (**Figure 11**).

3. Scenarios

In order to determine the optimal remediation scenario, more than 20 different scenarios were run using the flow and transport model. The selected remediation scenario has since been adjusted and tuned regularly over the years, as a result of additional data, statutory constraints and additional considerations, in order to determine the Remediation Plan.

The Remediation Plan is based on hydraulic containment of the contaminants at the main contamination core, which originates at the Malbin ponds, using four of the Production Wells located at the source and downstream (Production Wells a-d at **Figure 11**). The remaining two Production Wells are located at sources no. 2 and no. 3 (Production Wells e-f at **Figure 11**).

Table 1: Production Wells' flowrates according the Remediation Plan (for well locations see Figure 11)

Production wells	Q (m^3/hour)	Q (Mm^3/year)	Preliminary Starting Date	Assumed duration (years)
a and b	75 each	0.66 each	01/01/2023	25
c and d	200 each	1.8 each	01/01/2023	25
e and f	50 each	0.44 each	01/01/2023	10

The Remediation Plan further includes production of groundwater from the periphery of the contamination plume using local production wells in Tel-Aviv and Herzliya. The treatment of these groundwater is not included in the scope of this Project.

The following table provides the water balance (of the model domain) for the "As-Is" scenario (business as usual) and the Remediation Plan.

Table 2: Water balance at the two scenarios

	"As-Is" scenario (Mm^3/year)	**Remediation Plan (Mm^3/year)**
Recharge	22.7	22.7
Local production wells (not treated)	-13.7	-13.7
Outflow to the sea	-0.5	-0.2
Designated Production Wells	0	(-4.9) - (-5.8)
Local production wells (treated)	0	-3

At both the "As-Is" scenario (business as usual) and the Remediation Plan the water inflows (recharge) and outflows were kept constant, neglecting the seasonal variability.

a. The flow model

As seen at **Figure 11**, the natural flow gradient is from east to west, towards the sea. Since the extensive groundwater productions are located in Herzliya[1] (northwest part of the model domain), the groundwater flows north-west rather than westwards. At the south-west part of the model domain, the flow direction is slightly south-west, towards the active production wells of Tel Aviv.

The flow velocities according the model are approximately 1.1-1.4 cm/day or about 5 m/yr.

[1] following the shutdown of the local production wells in Ramat Hasharon and north Tel Aviv.

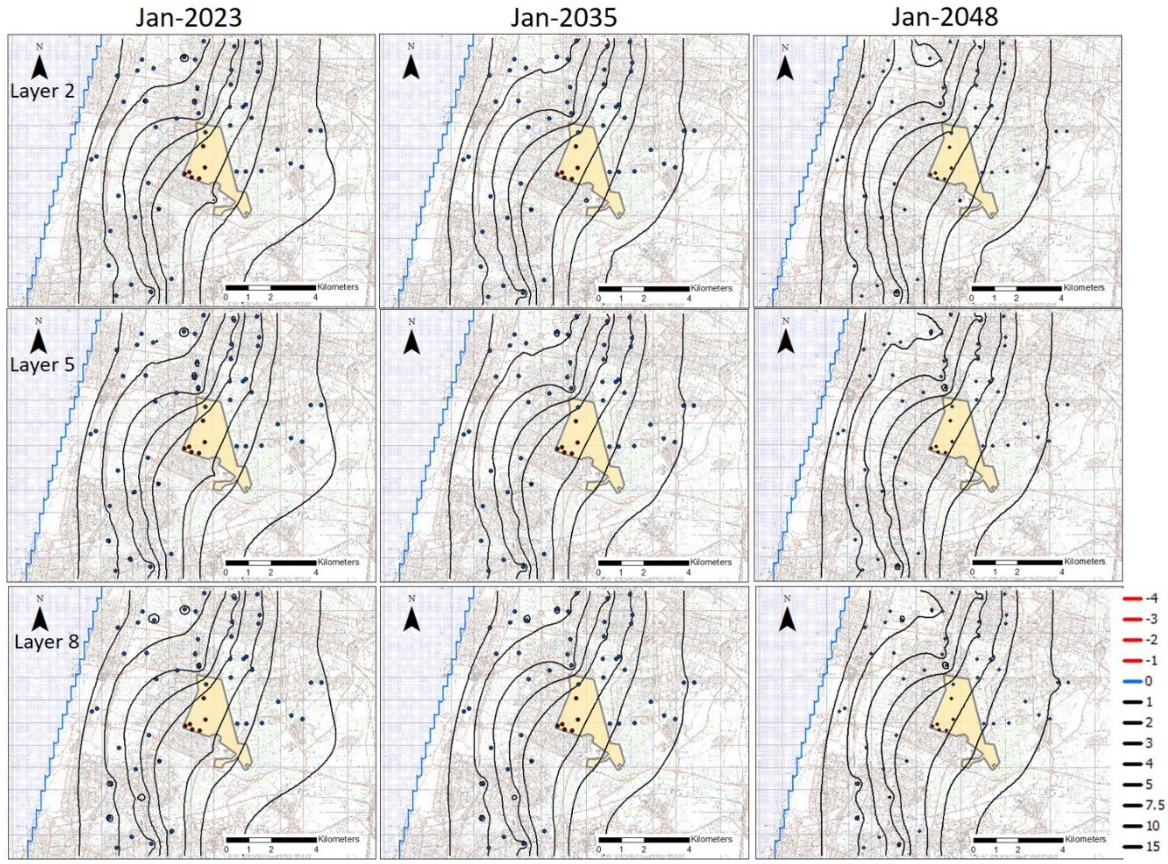
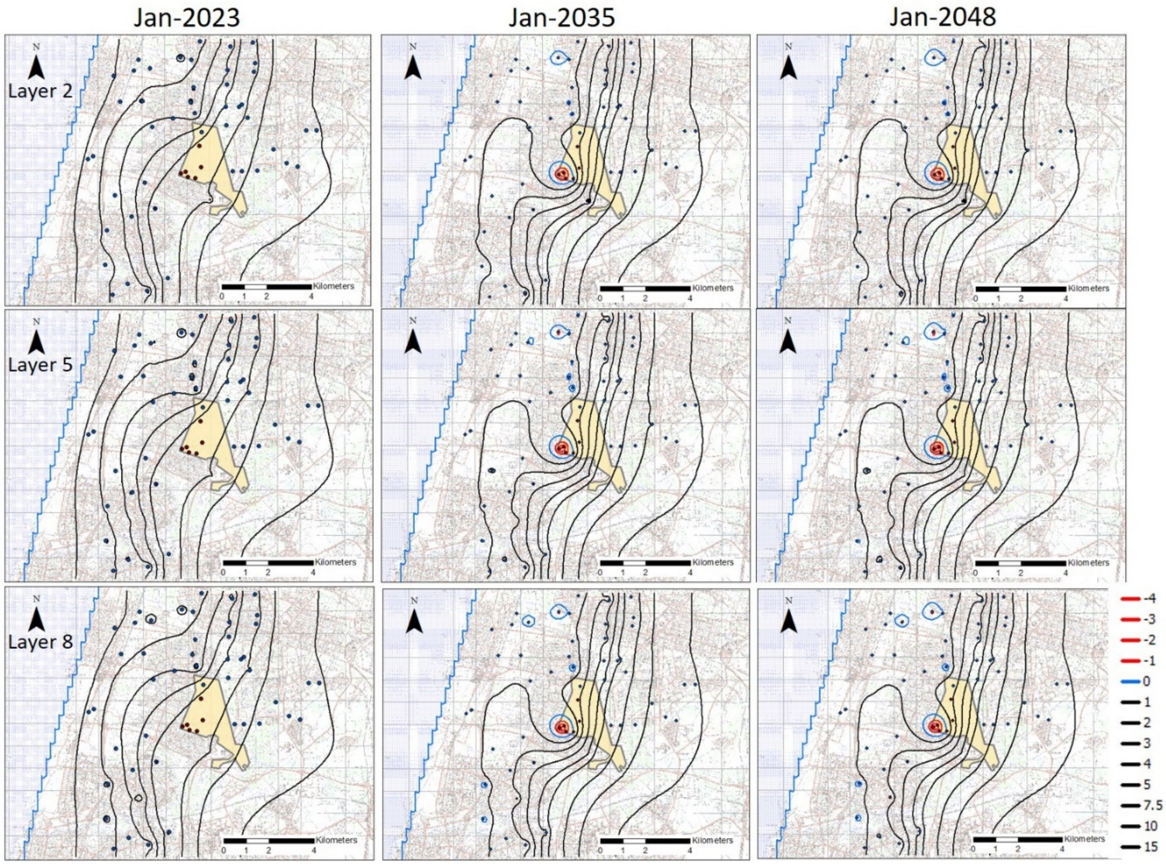


Figure 12: Head contours for the "As-Is" scenario.

Figure 12 note: as provided above, the model domain was divided into 8 vertical layers. The blue dots represent active production wells. The red dots represent the intended location designated for the remediation Production Wells.

According to the remediation scenario (**Figure 13** below), the intended remediation Production Wells induced sharp flow gradients, and thus higher flow velocities, towards them. The water head drawdown, at the containment conus at the Malbin area, is estimated to be approximately 10 meters, (reaching water heads of 4 meter below sea level).



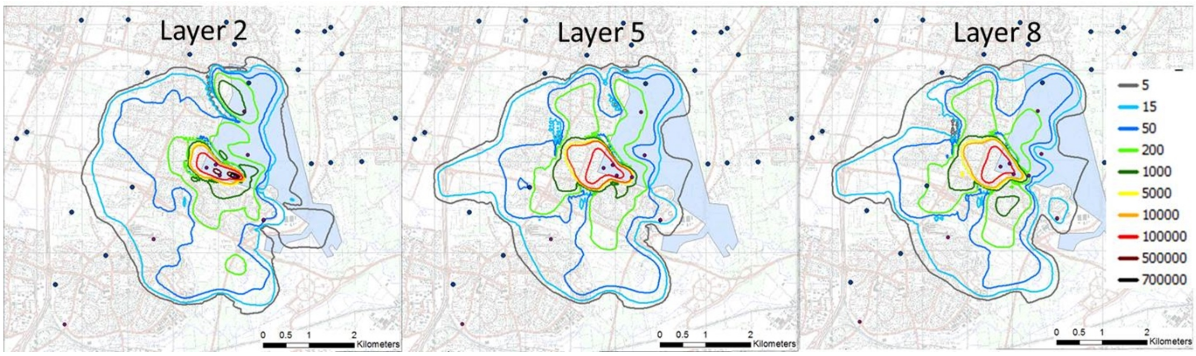
<u>Figure 13</u>: Head contours for the Remediation scenario.

b. The Perchlorate transport model

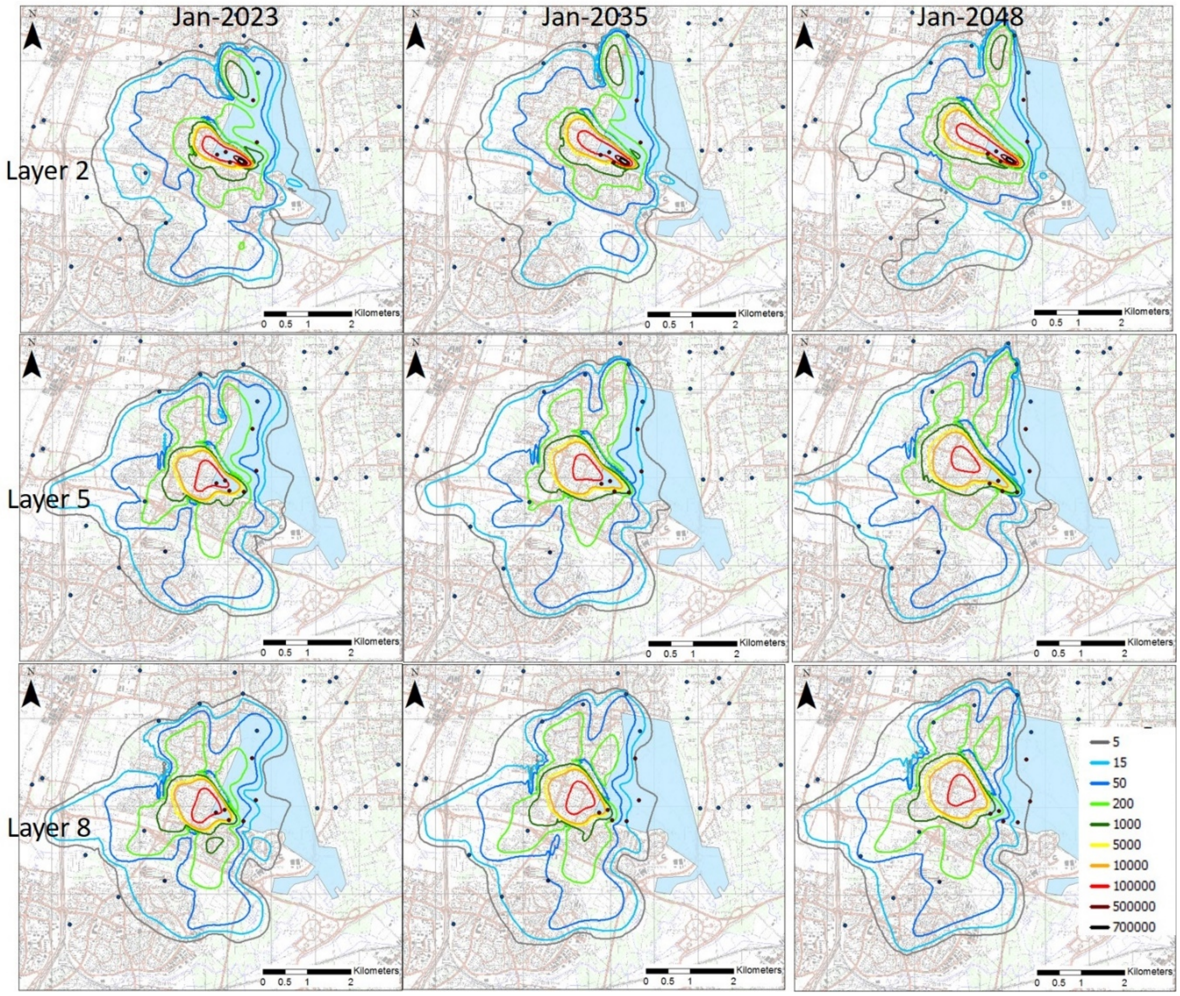
Due to its large spread, Perchlorate is considered the main trace contaminant for the contamination plume (see section 21 above) and is monitored since 2004 via all monitoring and production wells included in the model domain. As such the transport model almost exclusively addresses Perchlorate.

The Chlorate spread is similar in nature to the Perchlorate spread. The Chlorate concentrations are monitored since 2015. Given the limited period of time of Chlorate monitoring the existing records are insufficient for setting a transport model and as such Chlorate forecasted concentrations are determined based on the Perchlorate/Chlorate ratios.

The initial Perchlorate concentrations (for year 2015) were calibrated using the monitoring records dating back to 2005 and the calibrated flow model for the period of 2005-2015. The Perchlorate transport model calibration results for 1.1.2015 served as the initial 3D Perchlorate plume for the scenarios commencing from the aforesaid date.



<u>Figure 14</u>: Perchlorate concentrations (ppb) contour map for 1/1/2015.



<u>Figure 15</u>: Perchlorate concentrations (ppb) contours maps for the "As-Is" scenario.

In the event no preventing actions are taken (i.e. - "As-Is" scenario), the Perchlorate plume is expected to continue spreading downstream towards Ramat Sharon and Herzliya. In addition, the south-west plume periphery will also continue spreading towards the active local production wells located in north Tel Aviv (**Figure 15**). In the event preventing actions will be taken per the Remediation Plan, most of the Perchlorate will be contained and extracted from the aquifer while only low concentrations will remain at the plume periphery (**Figure 16**).

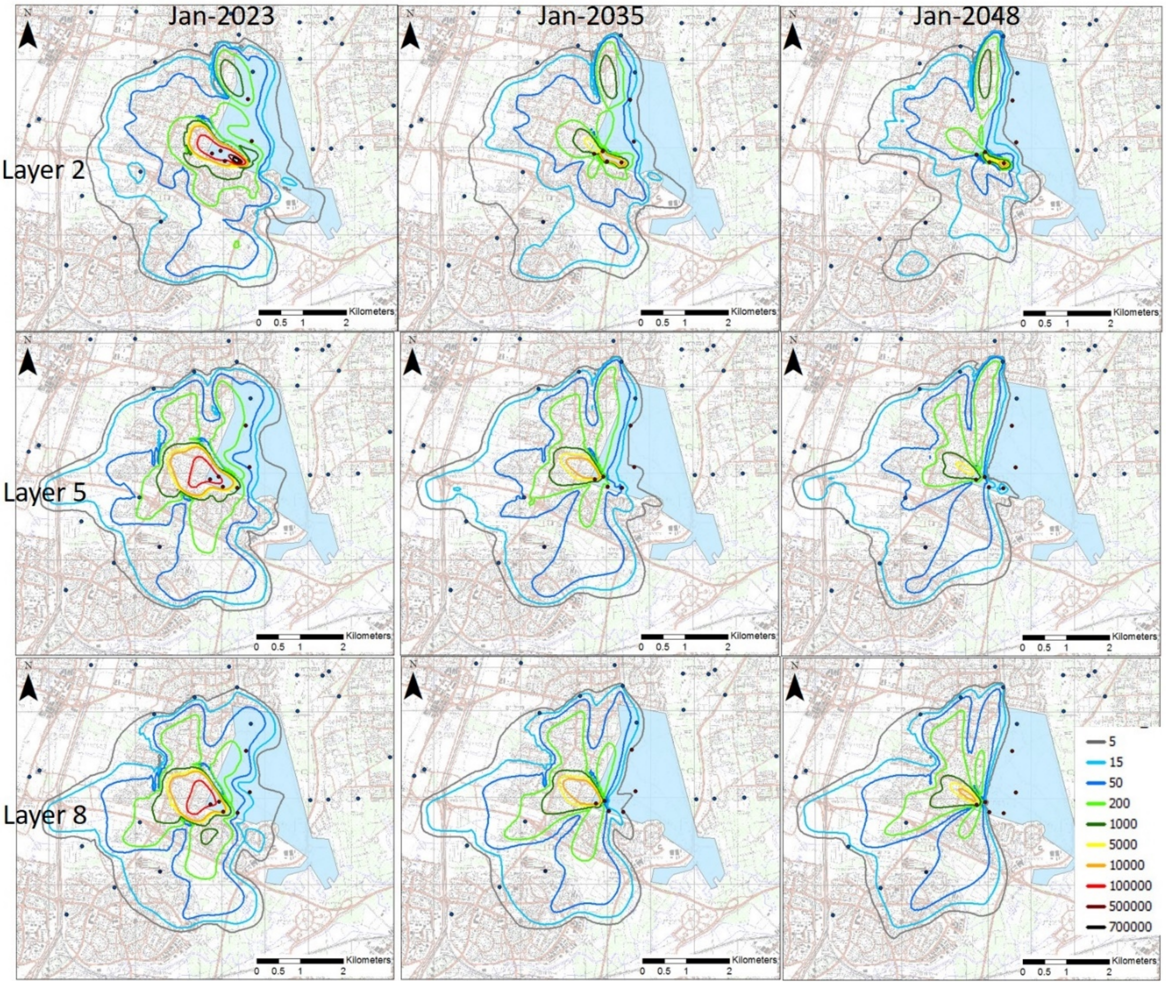


Figure 16: Perchlorate concentrations (ppb) contours maps for the Remediation Plan.

It should be noted that the remediation scenario was run with a constant flow-set (see Table 1). Eventually, the flows' dispersion between the Production Wells will be determined and occasionally verified or updated according to the remediation results. This will be done in order to optimize the containment and the removal of the contaminants while the total flow remains 650 m^3/hr for the first 10 year of operation which may be reduced down to 550 m^3/hr later on.

The estimated Perchlorate and Chlorate concentrations in the inlet flow to the Treatment Plant during the remediation period is presented in **Figure 17** and **Table 3** below. The Perchlorate mass balance is presented in

Table_4 below. The estimated Chromate, Nitrate, RDX and TCE concentrations in the Treatment Plant inlet is presented in **Figure 18**.

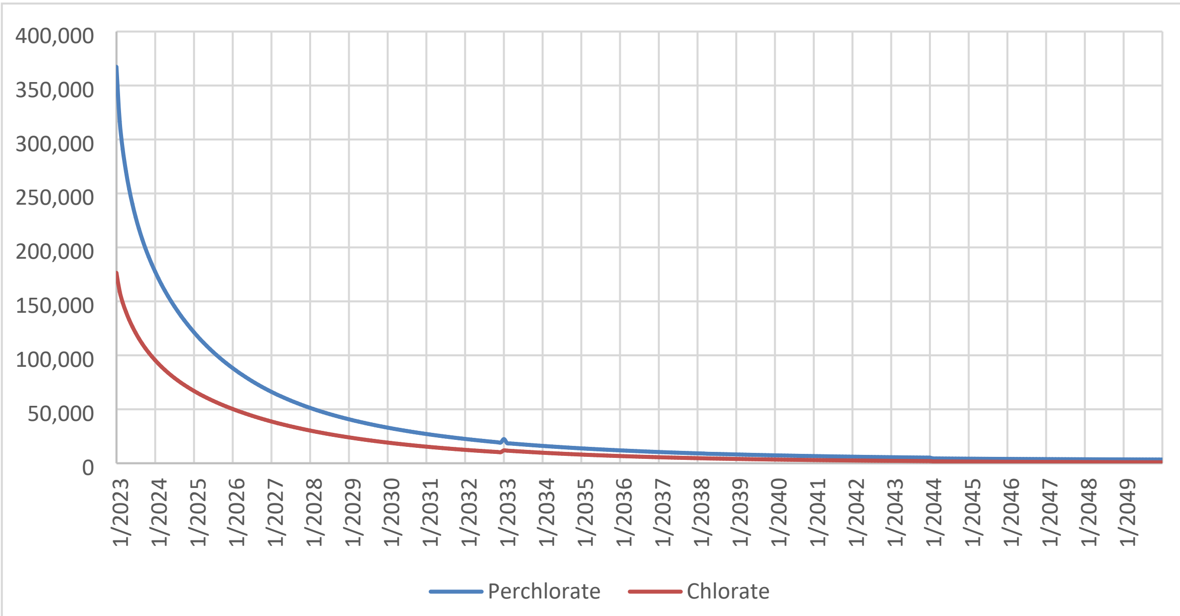


Figure 17: Estimated Perchlorate and Chlorate concentrations in the Treatment Plant inlet

Table 3: data table for Figure 17 above

Date	Perchlorate (ppb)	Chlorate (ppb)
1/1/2023	367,330	176,469
1/1/2024	177,554	95,492
1/1/2025	121,396	66,995
1/1/2026	88,161	50,274
1/1/2027	66,181	38,696
1/1/2028	51,250	30,280
1/1/2029	40,719	23,961
1/1/2030	32,979	19,129
1/1/2031	27,099	15,363
1/1/2032	22,530	12,411
1/1/2033	22,319	11,893
1/1/2034	16,070	9,752
1/1/2035	13,786	8,038

Date	Perchlorate (ppb)	Chlorate (ppb)
1/1/2036	11,930	6,677
1/1/2037	10,401	5,574
1/1/2038	9,167	4,701
1/1/2039	8,146	3,998
1/1/2040	7,322	3,427
1/1/2041	6,632	2,956
1/1/2042	6,062	2,568
1/1/2043	5,585	2,246
1/1/2044	5,183	1,975
1/1/2045	4,211	1,518
1/1/2046	4,004	1,354
1/1/2047	3,829	1,213
1/1/2048	3,679	1,092

Table 4: Perchlorate mass balance according the Remediation Plan

Date	Perchlorate in the model domain (ton)	Remaining Perchlorate out of the starting point (%)
01/01/2023	2,033	100%
01/01/2028	604	30%
01/01/2033	259	13%
01/01/2038	143	7%
01/01/2043	96	5%
01/01/2048	71	3%

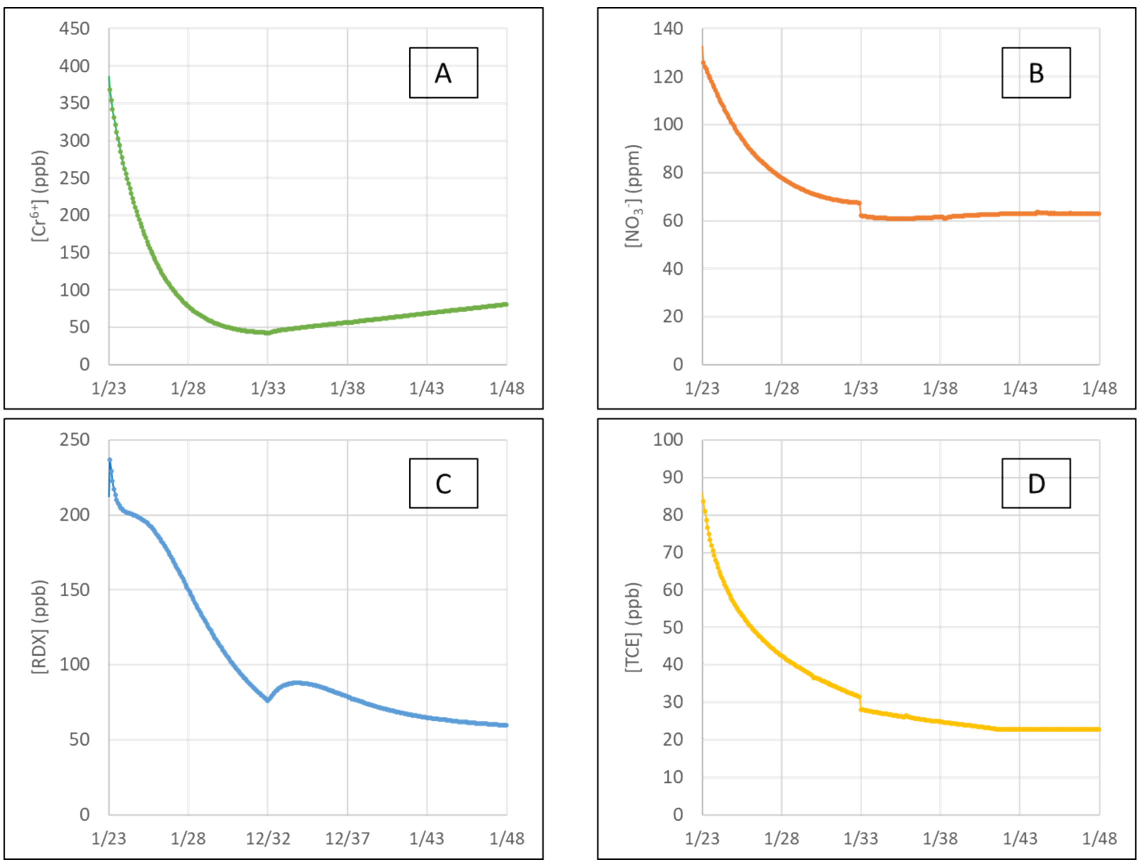


Figure 18: Estimated concentrations of Chromate (A), Nitrate (B), RDX (C) and TCE (D) in the Treatment Plant inlet

Note: Currently the Water Authority is expanding and updating the flow and transport model. The updated and detailed results will be included in the Tender Process Documents. Please further refer to the "Note" provided in the end of **Annex A2** (the Site)

<u>Annex A5 - Pilot Scale Demonstration Plant information</u>

1. **Preface**

This document provides a general outline of the Pilot Scale Demonstration Plant ("**PSDP**"). The document is not intended (and should not be construed) to provide an exhaustive description of all information relating to the PSDP. This document should, therefore, be reviewed along with the PSDP's information included within a CD which shall be provided to Entities who pay the Participation Fee. Please note **Annex A5** includes all final submittals prepared and submitted to the WA. Annex A5 does not include drafts submitted by the PSDP's contractor and any comments given thereto by the WA or anyone on it's behalf or costs estimations relating to the Full-Scale Treatment Plant ("**FSTP**"). Accordingly, the information provided in this **Annex A5** consists of final submittals.

<u>**Note:**</u> all information provided herein or conclusions or assumptions that may derive therefrom are of reference information nature. As such it is explicitly provided the Tender Committee and anyone on its behalf including the WA shall bear no responsibility whatsoever (explicit or other) towards any entity whatsoever including the Participants, Members, Experience Providers or anyone on their behalf in any event of any use whatsoever of the information provided. As such any form of use of the information (all or part) is and shall always be at the sole responsibility of the aforesaid entities or anyone on their behalf.

2. **Background**

As a preparatory step towards the preparation of the FSTP the WA has published a public international RFP for the Design, Construction, Operation and Maintenance of a Pilot Scale Demonstration Plant Facility for the Treatment of Contaminated Groundwater within the vicinity of the Israeli Military Industries in Ramat-Hasharon.

The key objective of the above tender was to test and demonstrate feasibility of applicable technologies for the removal and treatment of groundwater contaminants to meet the required water quality values set by the WA. It was the WA's intention to nominate contractors who shall design and execute their on demonstrating plant, with the objective of facilitating a framework where more than a single technology can be demonstrated.

Three proposals were submitted. At the completion of the proposals review process, a contract was signed with the JV of Shikun & Binui Ltd and Envirogen Technologies Inc, who served as the contractor.

3. The Pilot Scale Demonstration Plant

The technology implemented in the PSDP by the contractor was Biological Fluidized Bed Reactor ("**FBR**") for the degradation of Perchlorate, Chlorate, Nitrate and RDX and reduction of Chromate. The PSDP's system included the following: (see Figure 1 (PFD) below)

a. Chemical addition prior to the primary FBR: Ethanol as the electron donor, Phosphoric acid + micronutrients, Sodium Hydroxide as pH adjustment.
b. Primary FBR containing sand media.
c. First stage separator.
d. Secondary FBR containing Granular Activated Carbon (GAC) media.
e. Sulfuric acid addition prior to the post-aeration.
f. Post-aeration.
g. DAF (Dissolved Air Flotation) with the addition of Alum Sulfate and a polymer.
h. Two granular media filters.
i. GAC filters.
j. Two trains of Ion Exchange (IX) columns.
k. Disinfection with a NaOCl solution.

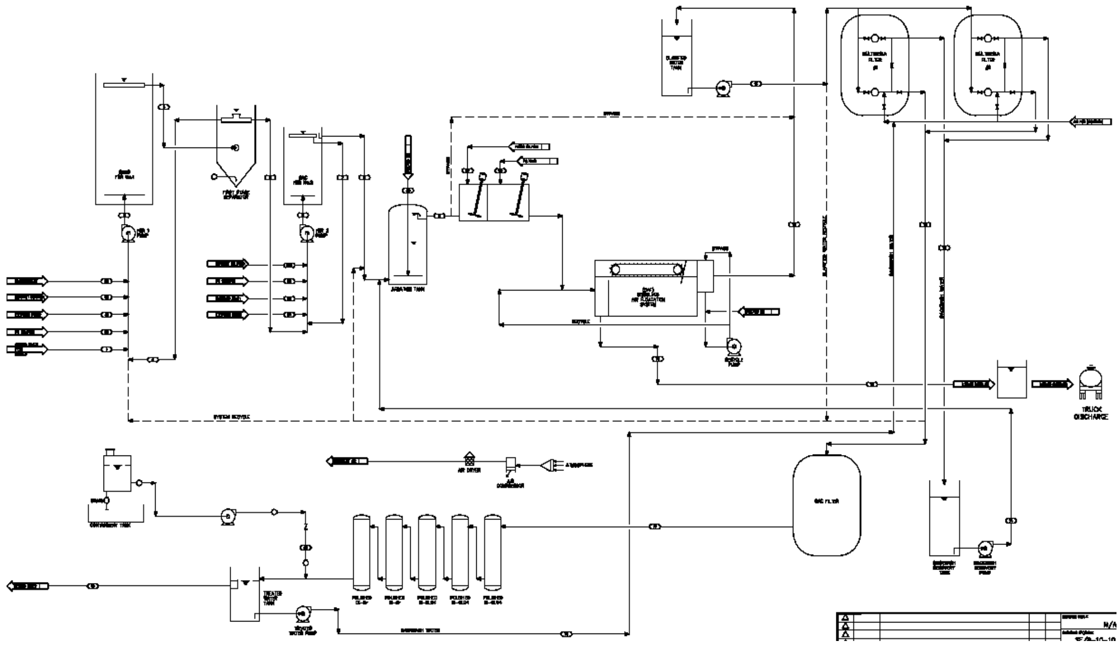


Figure 19: Process Flow Diagram

4. Design Data and Criteria

The PSDP was designed to treat an average hourly feed flow of 1 m^3/hr, and a peak hourly feed flow of up to 1.5 m^3/hr, of Ramat Ha'Sharon's groundwater to a quality detailed in **Table 1** below. The PSDP's treated water quality shall comply, at all times, with all Israeli Drinking Water Standards. Notwithstanding, the Chloride concentration of the treated water, which shall not exceed the Chloride concentration existing in the feed water by more than 150 mg/l.

Table 5: Guaranteed Water Quality Values

Parameter	Units	Value
Chloride	mg/l	<X[2]+150
Perchlorate	µg/l	<4
RDX	µg/l	<1
HMX	µg/l	<100
Cr	µg/l	<20
RDX derivatives (MNX, DNX, TNX)	µg/l	<1
Nitrate	mg/l	<45
Chlorate	µg/l	<4
Nitrite	mg/l	<3
TOC	mg/l	<2
Turbidity	NTU	<1
Coliforms	Coliform in 100 ml	<0
Total bacteria count	CFU in 1 ml	<1000

5. O&M Period – Objectives and Principle Observations

The PSDP met the required performance (regarding the water quality and chemicals and energy consumptions) during its operation. The following is a brief description of the 3 stages of operation and their main objectives and observations.

5.1. Stage 1 – Groundwater Treatment Stage (GTS)

5.1.1. Objective

The main objective of the GTS was to examine the technology's abilities to remove Perchlorate, Chlorate, RDX, HMX and Chromates from the contaminated groundwater. The applicable concentrations, in the PSDP's inlet, were the ones existing in the Perchlorate source in the aquifer at the time of treatment.

5.1.2. Observations

The GTS commenced on 24/08/14 and completed on 05/02/15.

[2] X shall mean the Chloride concentration existing in the inlet water (Ramat Ha'Sharon's groundwater).

a. Generally, the PSDP operated with an average feed flow of 1 m^3/hr. In total, the PSDP shut down for accumulated 179.6 hr, resulting with an availability of approx. 96%.

b. A total of 6 events of temporary electricity power shutdowns caused a stoppage of the feed flow to the PSDP. The shutdowns caused some adverse implications to the biomass (biomass flushing and a decrease in the FBR's bed level). It should be added in this context that the PSDP demonstrated a short few days recovery.

c. Removal of contaminants:

- Generally, the PSDP treated water met the guaranteed water quality (see
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- **Table 5** above).
- Perchlorate and Chlorate – the first FBR functioned efficiently, with few irregular events only and short recovery periods, with Perchlorate and Chlorate removal ratio of approx. 99.9%. Nevertheless, a few events were observed where the concentrations of Perchlorate and Chlorate (which as mentioned were removed by approximately 99.9% before the IX) were identified at the outlet of the IX.
- RDX – the first FBR functioned efficiently yet the second FBR and GAC were required in order to reduce the concentrations of RDX to below 1 µg/l per guaranteed water quality value.
- HMX – even though the HMX concentrations in the groundwater were 12 µg/l (a value significantly lower than the guaranteed water quality value (<100 µg/l)), the system reduced the HMX concentration to below 1 µg/l.

- Total Cr – the total Cr was the only contaminant which was reduced by all of the systems' process units including polishing by the IX (as opposed to the reduction of a contaminant by a single/few process units). In this context it is added that in a few events, in which the total Cr concentration at the outlet of the GAC minorly exceeded the guaranteed quality value, then the IX lowered the concentration below the guaranteed water quality value (<20 µg/l).
- TOC – generally, the TOC concentration in the treated water met the guaranteed quality value. Some events were observed where the TOC concentration in the treated water exceeded the guaranteed water quality value (<2 mg/l).

5.2. **Stage 2 – High RDX Concentration Stage (HRCS)**

5.2.1. **Objective**

The main objective of the HRCS was to examine the technology abilities of treating groundwater with high concentrations of RDX. Since the well water that were supplied to the PSDP's inlet contained lower RDX concentration than the maximal RDX concentration in the main contamination source RDX was dissolved in Acetone and added to the inlet water to reach minimal concentration of 500 µg/l RDX in the PSDP's inlet.

5.2.2. **Observations**

The HRCS commenced on 05/02/15 and completed on 29/03/15.

a. Generally, the PSDP operated with an average feed flow of 1 m^3/hr. In total, the PSDP shut down for accumulated 45 hr, resulting with an availability of approx. 96%.
b. The PSDP shut down for accumulated 28.3 hours due to reoccurring "high high aeration tank level" alerts. Additionally, there were events that has caused system shut down due to low air pressure, calibration, malfunction of the air blowers, etc.
c. Removal of contaminants:
   - Generally, the PSDP treated water met the guaranteed water quality (see

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- **<u>Table 5</u>** above), save for the TOC values (see the details below).
- Perchlorate and Chlorate – the first FBR functioned efficiently regarding the Perchlorate removal. However, since the RDX addition to the PSDP's inlet was added in one stage and without acclimation of the biomass, its viability was effected and during the first week of HRCS only partial removal of the Perchlorate was reached at the first FBR. The Perchlorate concentration at the PSDP's outlet met the guaranteed water quality value at all time. The Chlorate was removed to ND concentrations in the outlet of the first FBR.
- RDX – during the HRCS, the PSDP received RDX enriched groundwater. Due to the high loads of RDX, the RDX concentrations in the first FBR outlet were higher than the guaranteed water quality value, which led to the necessity of the second FBR and GAC filters for meeting the guaranteed water quality value (<1 µg/l). Additionally, the RDX derivatives MNX, DNX, TNX were all ND in the PSDP's effluent.
- HMX – the HMX concentration in the groundwater was lower than the guaranteed water quality value (<100 µg/l) to begin with. Nevertheless, the two FBRs reduced the HMX concentration, and in the GAC outlet the HMX concentration was below 1 µg/l at all time.
- Total Cr – the total Cr was below the treated water quality value at the GAC outlet at all time.

- TOC – due to the addition of Acetone to the PSDP's inlet water (was added in order to dissolve the RDX), the WA has agreed to temporary allow elevated values of TOC concentration in the treated water of up to 4 mg/l (compared to the guaranteed water quality value of <2 mg/l). although the TOC concentration in the treated water decreased compared to the inlet concentration, the average TOC concentration in the treated water was above the temporary approved concentration of <4 mg/l.

5.3. **Stage 3 – Dilution Stage (DS)**

5.3.1. **Objective**

the main objective of the DS was to examine the technology abilities to remove low concentrations of Perchlorate as a result of an anticipated decrease in Perchlorate concentrations as a function of time. The PSDP's inlet water for this stage was the well water diluted with net water by a factor of 40.

5.3.2. **Observations**

The DS commenced on 29/03/15 and completed on 11/06/15.

a. Generally, the PSDP operated with an average feed flow of 1 m^3/hr. In total, the PSDP shut down for accumulated 34 hr, which makes an availability of approx. 98%.
b. Two irregular events caused a system shut down. In total, the PSDP shut down for accumulated 15.5 hours due to chemical dosing pumps' power supply malfunction, and accumulated 8.7 hours due to power stoppage. In spite of the damage to the FBR's biomass the system demonstrated a short recovery time.
c. Removal of contaminants:

- Generally, the PSDP treated water met the guaranteed water quality (see
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- **<u>Table 5</u>** above).
- Perchlorate and Chlorate – due to the dilution of the groundwater, the Perchlorate and Chlorate concentrations in the PSDP inlet water were approx. 10,500 µg/l and 5,000 µg/l, respectively, significantly lower values. The first FBR functioned efficiently with Perchlorate and Chlorate removal rates of approx. 100%.
- RDX and HMX – due to the dilution of the groundwater, the RDX and HMX concentrations were below the guaranteed water quality value to begin with. Hence, the contractor was given an approval to stop the laboratory analyzing of these parameters in the treated water during this stage.
- Total Cr – the total Cr in the treated water was below the guaranteed water quality value already at the DAF outlet.
- TOC – the TOC in the treated water was below the guaranteed water quality value at all times.

<u>Notes:</u>

3. In respect to the PSDP's project milestones detailed description, details can be found in Section 7 (Project Milestones) of **Volume 2** (Contract).
4. In addition, Participants are encouraged to review all PSDP's Contract Documents.
5. The above provides a general description of the PSDP's O&M stages. As such, it is recommended Participants review this **Annex A5** not only in conjunction with the PSDP's Contract Documents but also in conjunction with the reference information attached to this **Annex A5**. Reference is made to the tote under Section 1 above.

Annex A6 – Groundwater Supply for Voluntary Preliminary Tests and Analysis by Eligible Participants

1. Eligible Participants may conduct preliminary tests and analysis for the purpose of preparation of their Proposals. In this framework the Eligible Participant shall be provided with groundwater from the contamination source which previously served as the source of contaminated groundwater used during the Pilot Scale Demonstration Plant ("**PSDP**") as described in **Annex A5** (Pilot Scale Demonstration Plant Information).
2. The groundwater supply system ("**GSS**") will be installed within the IMI Compound. The groundwater to be provided to the Eligible Participants shall be discharged from the center of the Perchlorate contamination plume (Malbin 1 "נת מלבין 1" and Malbin 2 "נת מלבין 2" as can be seen in **Attachment 1** to this **Annex A6**) which includes, in addition, high concentration of Chlorate, Nitrates explosive compounds (RDX and HMX) and chromates. See **Annex A3** (Water Quality reference DATA) for review of referenced information regarding the concentration of each of the aforesaid contaminants.
3. Each Eligible Participant shall be provided with up to 42 cubic meters of groundwater during a calendar week, for a period of up to 8 months. This volume shall be provided once a week on a set day (Sunday – Thursday, 7:00-16:00) within a set timeframe which shall be determined for each Eligible Participant by the Tender Committee. It is explicitly provided the Eligible Participant shall be expected to enter the IMI Compound for the purpose of collecting groundwater as long as the IMI Systems allows it including during national holidays or a day which the IMI Systems is not operating but entrance is made possible. Accordingly, alternative days for entering the IMI Compound shall be granted only upon the request of the Eligible Participant at circumstances under which entrance was not made possible by the IMI Systems.
4. The final period of time to be allocated for the performance of the Voluntary Preliminary Tests and Analysis will be determined by the Tender Committee in view*, inter alia,* of the number of Eligible Participants who have shown interest in exercising this voluntary process, duration and volumes requested by each.

5. The electricity for the GSS shall be supplied by IMI Systems and a backup generator is planned on being deployed. However, the Tender Committee and IMI Systems will not bare any responsibility for planned or unplanned electrical shutdowns.
6. Each Eligible Participant shall be fully responsible for any activity associated with the execution of the preliminary tests, including: groundwater collection from the GSS and its transportation, the location where the tests will be performed by the Eligible Participant or on its behalf, test systems and facilities, manner of tests' performance, and timely obtainment of any approval or license associated with any of the foregoing or additional step or measure associated with the execution of the tests.
7. Each Eligible Participant shall act in accordance with the requirements set forth under all Laws and Regulation, and instructions of any Relevant Authority including with respect to handling, transporting and evacuating to licensed dumping sites (compatible with the substance evacuated).
8. The Eligible Participant will be responsible to obtain the pipe connector compatible between the GSS and the Eligible Participant's water tanker.
9. In addition to the groundwater to be provided to the interested Eligible Participants – the option to perform independent groundwater sampling of the WA wells present at the IMI Compound shall be afforded to the interested Eligible Participants subject to the obtainment of IMI Systems' consent and compliance with any term that may be determined by IMI Systems. In the event the Eligible Participant wishes to exercise the option provided under this Section 9, it shall act in accordance with the requirements set forth under all Laws and instructions of any relevant authority including with respect to handling, transporting and evacuating to licensed dumping sites (compatible with the substance evacuated). The groundwater sampling of the WA wells shall be coordinated in advance with IMI Systems and WA and the duration of the sampling shall not exceed a period of 2 days.

10. Security Clearance – for the purpose of groundwater collection from the GSS each Eligible Participant shall appoint a permanent driver who shall be required to obtain security clearance from IMI Systems. In order to ensure continuous availability, it is advisable for the Eligible Participant to request the appointment of an additional driver (so in the event needed one can replace the other). The fee IMI Systems shall charge for each security clearance is 500 NIS. Confirmation of security clearance and conditions associated therewith are at the IMI Systems sole discretion.
11. The Eligible Participant, in respect of the activity under this Annex A6, undertakes to arrange and maintain suitable insurances (according to the matter: workers compensation, Employer's Liability Insurance, Third-Party Liability Insurance, Automobile insurances) with reasonable conditions. As long as subcontractors are being employed by the Eligible Participant, the Eligible Participant must demand that they arrange insurances as required under this clause or, alternatively, the Eligible Participant shall include coverage for their activities in his insurances.
    - The Eligible Participant shall ensure that all his insurances relating to his activity under this Annex A6 shall include the State, GOI ,the Inter-Ministerial Tender Committee comprised of: (i) the Ministry of Finance, (ii) the Ministry of Energy , (iii) the WA and (iv) Inbal Insurance Company Ltd, IMI Systems (Israel Military Industries (IMI)) and Netzer HaSharon. as additional insureds in respect of their liability for the acts and/or omissions of the Eligible Participant and anyone on its behalf subject to Cross Liability Clause.
    - In addition, The Eligible Participant shall ensure that all of the mentioned insurances shall include a waiver of subrogation clause in favor of the State, GoI ,the Inter-Ministerial Tender Committee comprised of: (i) the Ministry of Finance, (ii) the Ministry of Energy , (iii) the WA and (iv) Inbal Insurance Company Ltd, IMI Systems (Israel Military Industries (IMI)) and Netzer HaSharon and all of their managers and/or employees (the waiver of subrogation shall not apply in favor of a person who maliciously caused the damage). The Eligible Participant's insurances shall be primary to any insurance carried out by the entities mentioned above.

- The Eligible Participant shall be solely responsible to its insurer for the payment of the insurance premiums in respect all policies and for fulfilling all the obligations imposed on the insured under the terms and Conditions of the policies.

  WA reserves the right to receive from the Eligible Participant a certificate of insurance or copies of the insurance policies, by demand. The Eligible Participant's insurances shall be primary to any insurance carried out by the entities mentioned above.

12. Coordination and Approval of Groundwater Collection – the Tender Committee shall provide the Eligible Participants with a form in with each Eligible Participant shall be requested to fill and complete details relating to the framework for groundwater collection (which will also include the requested period of time during which groundwater shall be collected and the amount thereof). The form's contents shall, *inter alia*, reflect the principals and stipulations provided in this **Annex A6** (Groundwater Supply for Voluntary Preliminary Tests and Analysis by Eligible Participants). Additional provisions regarding the manner by which groundwater collection shall be executed by each Eligible Participant (including order of execution, approved quantity to be collected and period allocated for each Eligible Participant for groundwater collection and WA Wells sampling) shall be issued to the Eligible Participant.

Attachment 1 – the GSS location within the IMI Compound

It can be seen in the picture below:

a. The groundwater wells Malbin 1 and Malbin 2.

b. The GSS surrounding fence.