

BMBF IWRM R&D Programme

Funding No.: FKZ 02WM1080

SMART 2 – IWRM

Work package 3.1

Decentralised wastewater treatment and reuse:

Deliverable No. 303

**Report on the Construction of Modified Septic Tanks
and Treatment Wetlands**

Authors and Institution

NAW&CO

September 2012

Funded by



**Federal Ministry
of Education
and Research**

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DELIVERABLE 303 – 305: CONSTRUCTION OF THE TREATMENT SYSTEMS

This report presents a description of the construction of the Modified Septic Tanks and Treatment wetlands done in the framework of the SMART II Project.

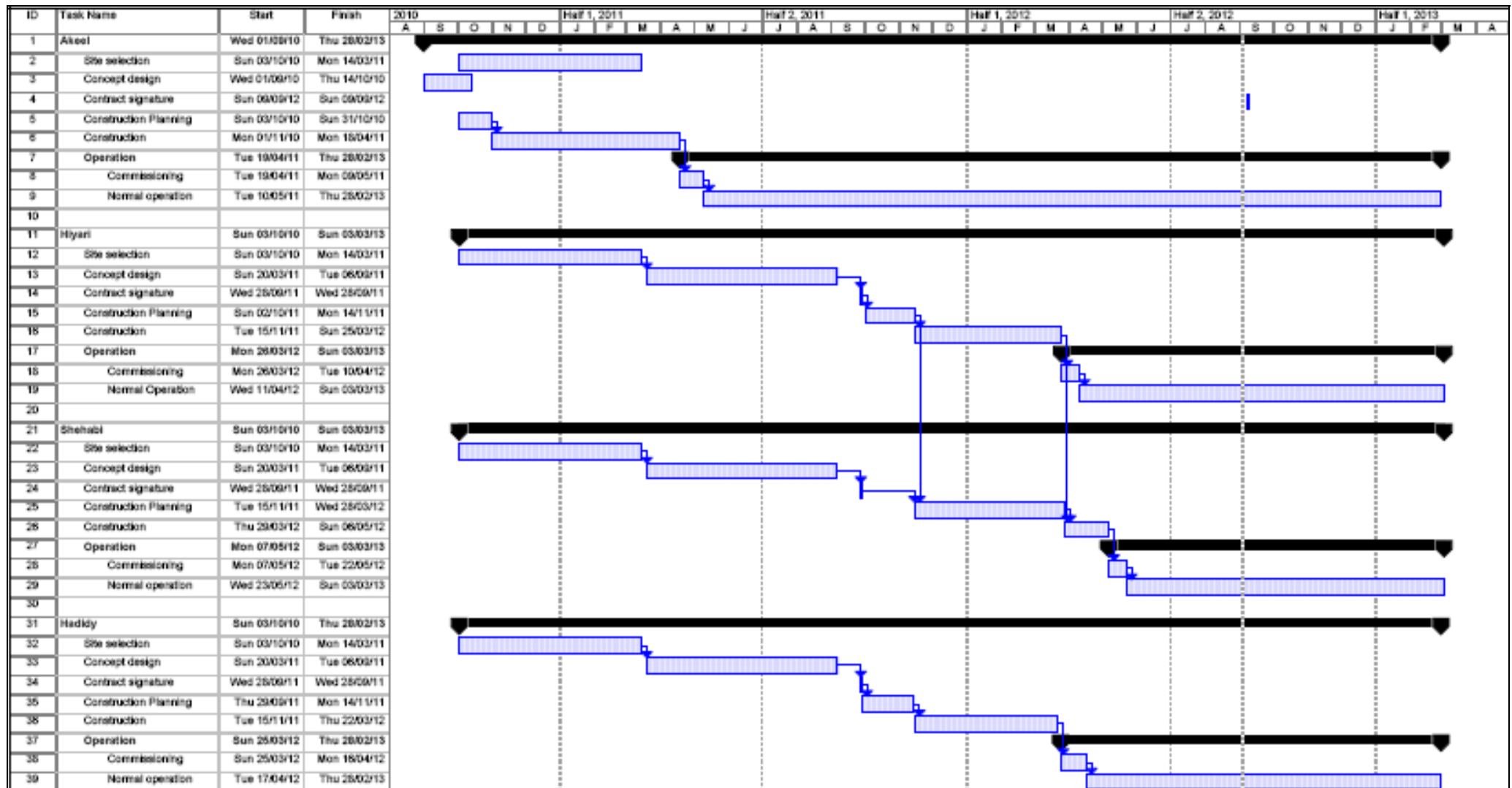
The constructions were being realised by the company NAW&Co from Amman, Jordan.

The report discusses the main steps and requirements of the construction. Photos and technical drawings were added to illustrate the different phases and elements of the work realised. Potential onsite difficulties and modifications are also presented.

When possible, the commissioning and operation of the systems are also described.

Table 1 on the following page shows the Grant's Chart of the WP 3.1 Project, including the site selection, the design, the construction, the commissioning and the operation phases.

Table 1: WP 3.1 Project's schedule.



1 CONSTRUCTION OF THE MODIFIED SEPTIC TANK

1.1 MODIFIED SEPTIC TANK – MR GHALIB HIYARI

1.1.1 PRESENTATION OF THE CONSTRUCTION PROCESS

1) Planning / time frame.

As shown in Table 1, the construction started on the 15th of November 2011 and was finished on the 25th of March 2012 (about 4 month). The construction was regularly stopped during winter (from December till the end of March) because of bad weather condition (rain and snow) that prevented access to the site. This extended the construction time by about 2.5 month.

The main construction stages are presented below and are briefly discussed:

- Excavation of the tanks and collectors:

The top soil layers were removed easily but once deeper it took some efforts to dig in the bed rock. Two sewer lines servicing the holding tank had to be diverted in order to proceed with the construction. These lines had to be connected to the Modified Septic Tank during the construction but were not put in operation until the work was finished. The main electric power cable feeding the house was also passing within the excavation area, it was necessary to replace and reroute the cable from the electric pole to the house main distribution board (Electric KWH Meter). For this work it was required to contact the Jordan Electric Power Company so they could bring in their team to connect the new cable to their electric power pole.

- Installation of the formwork (concrete blocks) and reinforcing steel:

Considering the fact that the wastewater treatment system had to be installed in a very tight corner, directly adjacent to the parameter wall, to the trees, to the existing septic tank and to the entrance road, it was not possible to provide a comfortable working space for the construction and for the formwork. Once the Excavation completed, concrete blocks were installed as external formworks. Planks were used as internal formwork. The concrete reinforcement was done using reinforcing steel bars.

- Pouring of the concrete:

This operation was done in 3 stages. First the floor concrete slab, then the external and internal walls and finally the roof concrete slab with the openings/block-outs for manholes and covers.

- Curing time:

Curing time took a couple of days for the walls but about two weeks for the roof in order to ensure the strength of the structure.

- Site work:

Upon removal of the internal formwork, it was necessary to finalize the connections to the sewer lines then redo the tilling of the garage floor (stone chips), install the cast iron and galvanized manhole access covers and finally reinstate the construction area.

- Installation of the pumps, blowers and other electrical work:

The power cables for the air blowers and the irrigation pumps have been connected to the main power distribution board in the building. A control box was installed nearby the treatment system to facilitate operation and maintenance.

- Installation of the pipework and irrigation fields:

Again, due to extreme weather conditions, resulting in a muddy and inaccessible site, this part of the work took much longer than originally anticipated. The layout of the site obliged to cross the access road. After the installation and testing of the irrigation lines, the trenches were filled back with the previously excavated soil.

- Garden reinstallation:

In order to give the site back in good condition, efforts were made to clean the site and to reconfigure the garden as it was before the construction.

2) Labour requirements:

Table 2: Labour requirement for the construction of Mr Hiyari's treatment system.

Type of labour	Number
Construction worker	5
Electrician	1
Plumber	1
Supervisor	1

3) Construction difficulties:

As mentioned before, the weather conditions (rain and snow) rendered the access to the site and the construction of the system difficult (mud and puddles).

In the irrigation field, the mud prevented the workers to dig or access the trench and install the pipes as quickly as originally planned.

The excavation work for the tank also uncovered the main power cable connecting the house. These cables had to be replaced and re-routed around the construction site.

1.1.2 COMMISSIONING

The wastewater was first diverted from the existing collection tank into the modified septic tank on the 25th of March 2012. Due to the sizing of the system (expected population of 20 PE and a peak flow of about 25 PE) it took about 6 days to fill the modified septic tank.

The modified septic tank required about 3-4 month to build up its microbiology and show satisfying treatment performances.

A monitoring program is going to be started in autumn 2012 for all the systems.

1.1.3 BILL OF QUANTITIES (BOQ)

Table 3: Bill Of Quantities for the construction of Mr Hiyari's treatment system.

Tanks' Construction Works

Item Description	Unit	Qty.
Sulfate Resisting Reinforced Concrete	m ³	18
Reinforcing Steel	Ton	1.8
Water Stop	Lm	23
Block walls	m ²	40

Item Description	Unit	Qty.
Excavation	m ³	40
Screed	m ²	2.5
Backfilling	m ³	---

Site General Requirements

Item Description	Unit	Qty.
Walk Ways	m ²	25

Sewer Lines & Accessories

Item Description	Unit	Qty.
SEWER LINES	Lm	15
Sewer Manholes	No.	3
M/H C.I. Cover	No.	9

Item Description	Unit	Qty.
M/H Galv. Steel Covers	No.	2
Dia. 110 mm Valve	No.	---

Subsurface Irrigation System

Item Description	Unit	Qty.
Drip Irrigation Lines	Lm	115
Irrigation Mains	Lm	160
Floutes	No.	---
Indexing Valves	No.	1
Flushing Valves	No.	10
Valve Box	No.	10

Item Description	Unit	Qty.
Manhole C.I. Covers	No.	---
Manhole PVC Cover	No.	1
Pump	No.	1
ST. ST. WIER	No.	---
Splitter Box	No.	---
Irrigation Tanks	No.	1

Mechanical Works

Item Description	Unit	Qty.
Air Blower	No.	1
Air Blower Housing	No.	1

Item Description	Unit	Qty.
Air Lines and Accessories	LS	1
Fixed Bed-Packing Media & Accessories	LS	1

Electrical Works

Item Description	Unit	Qty.
ELECTRIC Power Main Cable size 4×16mm ²	Lm	50
ELECTRIC Power Main Cable 4×2.5mm ²	Lm	45

Item Description	Unit	Qty.
ELECTRIC Board	No.	1
ELECTRIC Manholes	No.	1

1.1.4 CONSTRUCTION PHOTOS

Below are the photos taken during the construction to illustrate the main steps of the work realised.



Figure 1: Excavation pit for the Modified Septic Tank



Figure 2: Concrete form and reinforcing steel of the Modified Septic Tank



Figure 3: Installation of the manholes and covers.



Figure 4: Mr Hiyari's Modified Septic Tank after the end of the construction.



Figure 5: Excavation of the irrigation trenches at Mr Hiyari's house



Figure 6: Installation of the irrigation lines in the garden.



Figure 7: Mr Hiyari's garden after the installation of the irrigation lines.

1.1.5 AS BUILT DRAWINGS

Below are presented the as-built drawings of the Modified Septic Tank installed at Mr Hiyari's house.

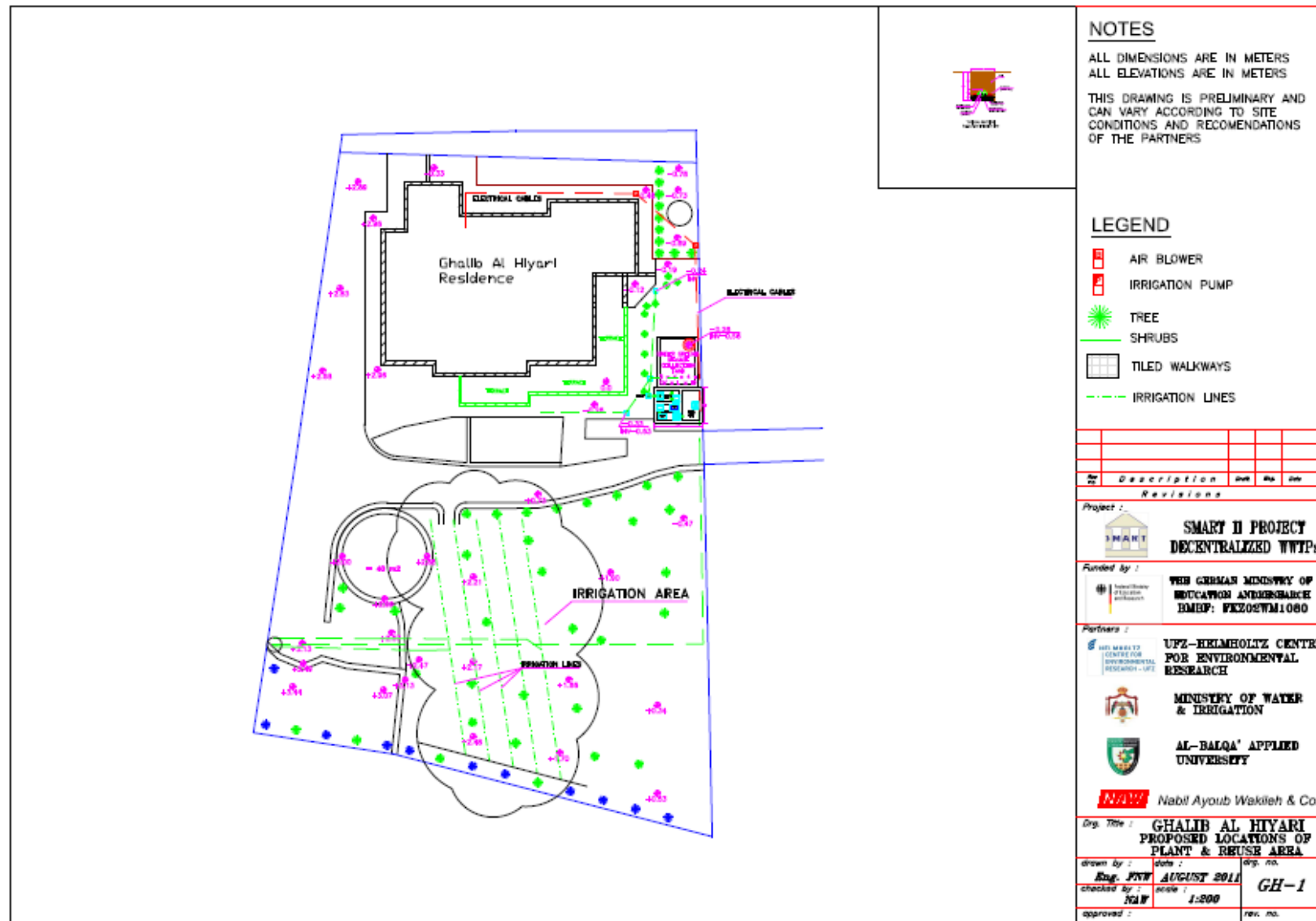


Figure 8: Mr Hiyari's site layout after construction.

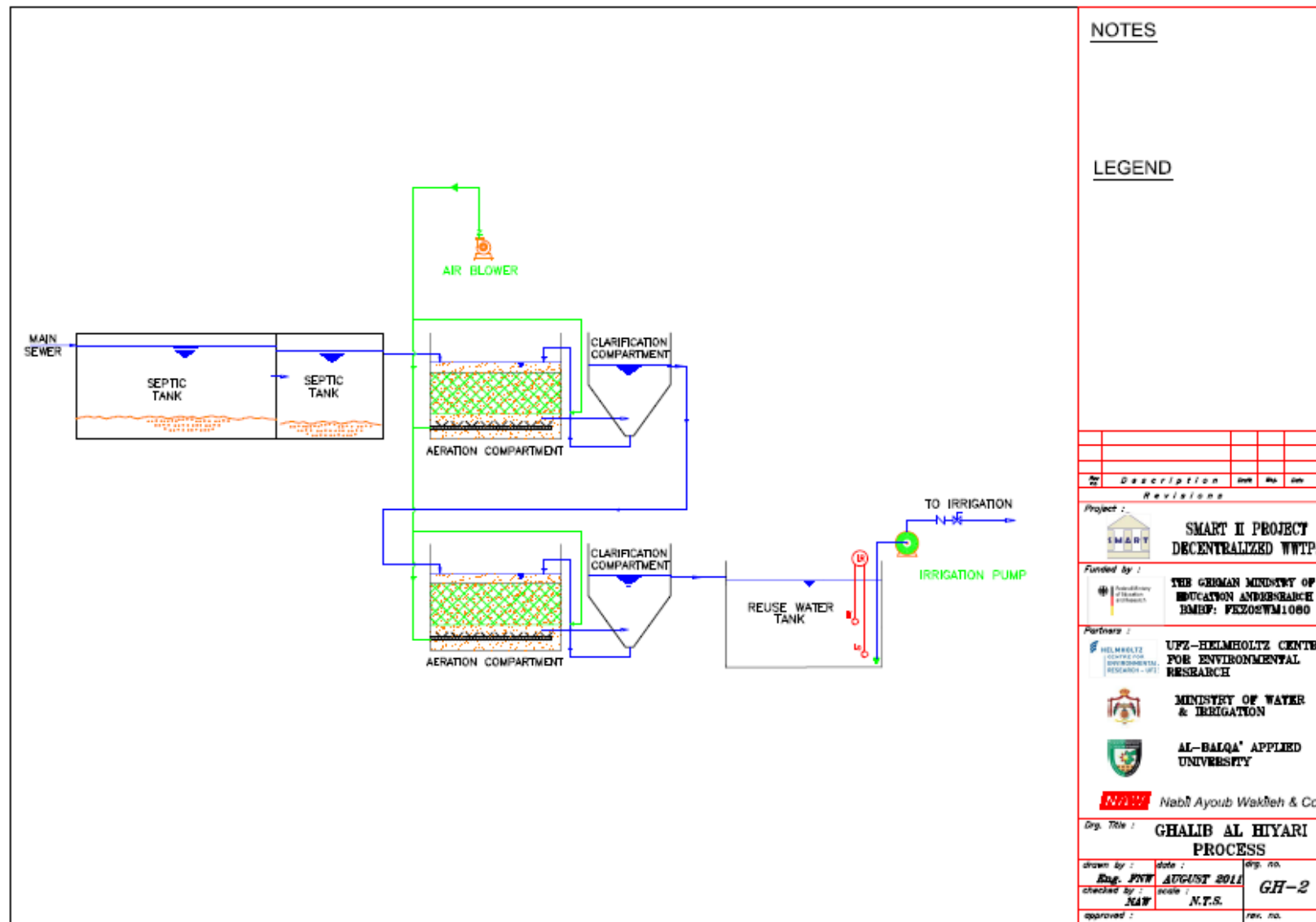


Figure 9: Modified Septic Tank As-Built process diagram.

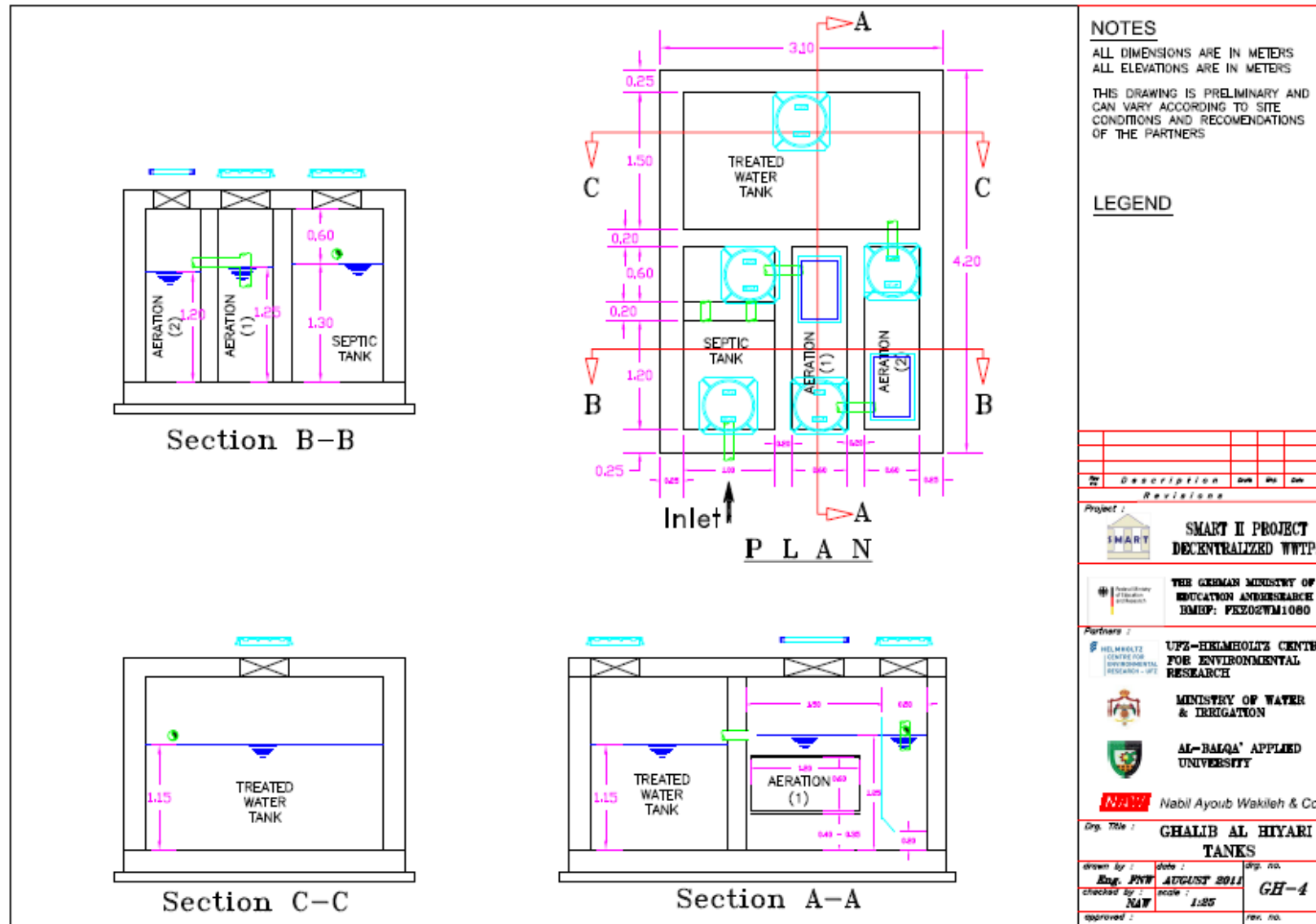


Figure 10: Modified Septic Tank As-Built technical drawings.

1.2 MODIFIED SEPTIC TANK – MR MOHAMAD MAHER AL SHEHABI

1.2.1 PRESENTATION OF THE CONSTRUCTION PROCESS

1) Planning / time frame.

As shown in Table 1, the construction started on the 29th of March 2012 and was finished on the 6th of May 2012 (about 5 weeks). The construction was stopped a few times because of bad weather condition. This extended the construction time by about 1 week.

The main construction stages are presented below and are briefly discussed:

- Excavation of the tanks and collectors:

The top soil layers were removed easily but once deeper it took some efforts to dig in the bed rock. The sewer line servicing the septic tank was conserved but the following cesspit was bypassed to reach the Modified Septic Tank. A connection to the cesspit was kept to be used as a backup solution. The main electric power cable feeding the house was also passing within the excavation area. It was necessary to protect the cable through all the construction period. Finally upon completion of the construction work, a new sleeve/conduit was installed to protect the cable.

- Installation of the form (concrete blocks) and reinforcing steel:

As the wastewater treatment system had to be installed in a very tight corner directly adjacent to the Parameter wall, to the trees, to the existing septic tank and to the entrance road, it was not possible to provide a comfortable working space for the construction and for installing the formwork. Once the excavation completed, concrete blocks were installed as external formwork in order to limit the space requirements and thus the excavation work. Planks were used as internal forms. The concrete reinforcement was done using reinforcing steel bars.

- Pouring of the concrete:

This operation was done in 3 stages. First the floor concrete slab, then the external and internal walls and finally the roof concrete slab with the openings / block-outs for the manholes and covers.

- Curing time:

Curing time took a couple of days for the walls but about two weeks for the roof in order to ensure the strength of the structure.

- Site work

Upon removal of the internal formwork, it was necessary to finalize the connections to the sewer lines then redo the tilling of the garage floor (stone chips), install the cast iron and galvanized manhole access covers and finally reinstate the construction area.

- Installation of the pumps, blowers and other electrical work:

The power cables for the air blowers and the irrigation pumps have been connected to the main power distribution board in the building. A control box was installed nearby the treatment system to facilitate operation and maintenance.

- Installation of the pipework and irrigation fields:

After the installation and testing of the irrigation lines, the trenches were filled back with the previously excavated soil.

- Garden reinstallation:

It was necessary to run the irrigation lines under the existing tiled walkways and then reinstate these walkways back to original condition. Moreover the garden was nicely planted and the irrigation lines were running between plants and trees. Works were thus executed very carefully in order to prevent damage to the existing vegetation. This work was realised without any complaint from the house owner. In order to give the site back in good condition, efforts were made to clean the site and to reconfigure the garden as it was before the construction.

2) Labour requirements:

Table 4: Labour requirement for the construction of Mr Shehabi's treatment system.

Type of labour	Number
Construction worker	5
Electrician	1
Plumber	1
Supervisor	1

3) Construction difficulties:

As mentioned before, the bad weather conditions (rain) rendered the construction of the system difficult by muddying the site and weakening the excavation hole. In the main excavation pit, a wall collapsed during the night of the 2nd of April, before the concrete form and the reinforcements could be installed. This accident did not endanger the workers but delayed the work by a few days.

The main electrical power cable passing through the construction site, it was necessary to work carefully around to prevent any damage. Protection had to be installed to enhance the safety of the site.

In the irrigation field, the mud prevented the workers to dig or access the trench and install the pipes as quick as originally planned.

The existing garden was very well maintained and great care had to be given to the installation of the irrigation lines to avoid damage to the vegetation.

1.2.2 COMMISSIONING

The wastewater was first diverted from the existing cesspit into the modified septic tank on the 6th of May 2012. Due to the sizing of the system (expected population of 16 PE and a peak flow of about 20 PE) it took about 6 days to fill the modified septic tank.

The Modified Septic Tanks requires about 3-4 month to build up its microbiology and show satisfying treatment performances.

A monitoring program will be started in autumn 2012 for all the systems.

1.2.3 BILL OF QUANTITIES (BOQ)

Table 5: Bill Of Quantities for the construction of Mr Shehabi's treatment system.

Tanks' Construction Works

Item Description	Unit	Qty.
Sulfate Resisting Reinforced Concrete	m ³	12
Reinforcing Steel	Ton	1.2
Water Stop	Lm	15
Block walls	m ²	36

Item Description	Unit	Qty.
Excavation	m ³	40
Backfilling	m ³	10
Screed	m ²	2.5

Site General Requirements

Item Description	Unit	Qty.
Walk Ways	m ²	60

Sewer Lines & Accessories

Item Description	Unit	Qty.
SEWER LINES	Lm	12
M/H C.I. Cover	No.	3

Item Description	Unit	Qty.
M/H Galv. Steel Covers	No.	2

Subsurface Irrigation System

Item Description	Unit	Qty.
Drip Irrigation Lines	Lm	120
Irrigation Mains	Lm	80
Indexing Valves	No.	1
Flushing Valves	No.	7

Item Description	Unit	Qty.
Valve Box	No.	7
Manhole PVC Cover	No.	1
Pump	No.	1
Irrigation Tanks	No.	1

Mechanical Works

Item Description	Unit	Qty.
Air Blower	No.	1
Air Blower Housing	No.	1

Item Description	Unit	Qty.
Air Lines and Accessories	LS	1
Fixed Bed-Packing Media & Accessories	LS	1

Electrical Works

Item Description	Unit	Qty.
ELECTRIC Power Main Cable 4×2.5mm ²	Lm	20
ELECTRIC Board	No.	1

1.2.4 CONSTRUCTION PHOTOS

Below are the photos taken during the construction to illustrate the main steps of the work realised.



Figure 11: Excavation of the pit for the Modified Septic Tank.



Figure 12: Reparation of the wall collapse.



Figure 13: Concrete walls and reinforcing steel of the Modified Septic Tank.



Figure 14: Reinstalment of the tiles.



Figure 15: Mr Shehabi's Modified Septic Tank after the end of the construction.



Figure 16: Excavation of the irrigation trenches.



Figure 17: Installation of the irrigation lines in the front yard.



Figure 18: Installation of the irrigation lines in the back yard.



Figure 19 Mr Shehabi' garden after the installation of the irrigation lines.

1.2.5 AS BUILT DRAWINGS

Below are presented the as-built drawings of the Modified Septic Tank installed at Mr Shehabi's house.

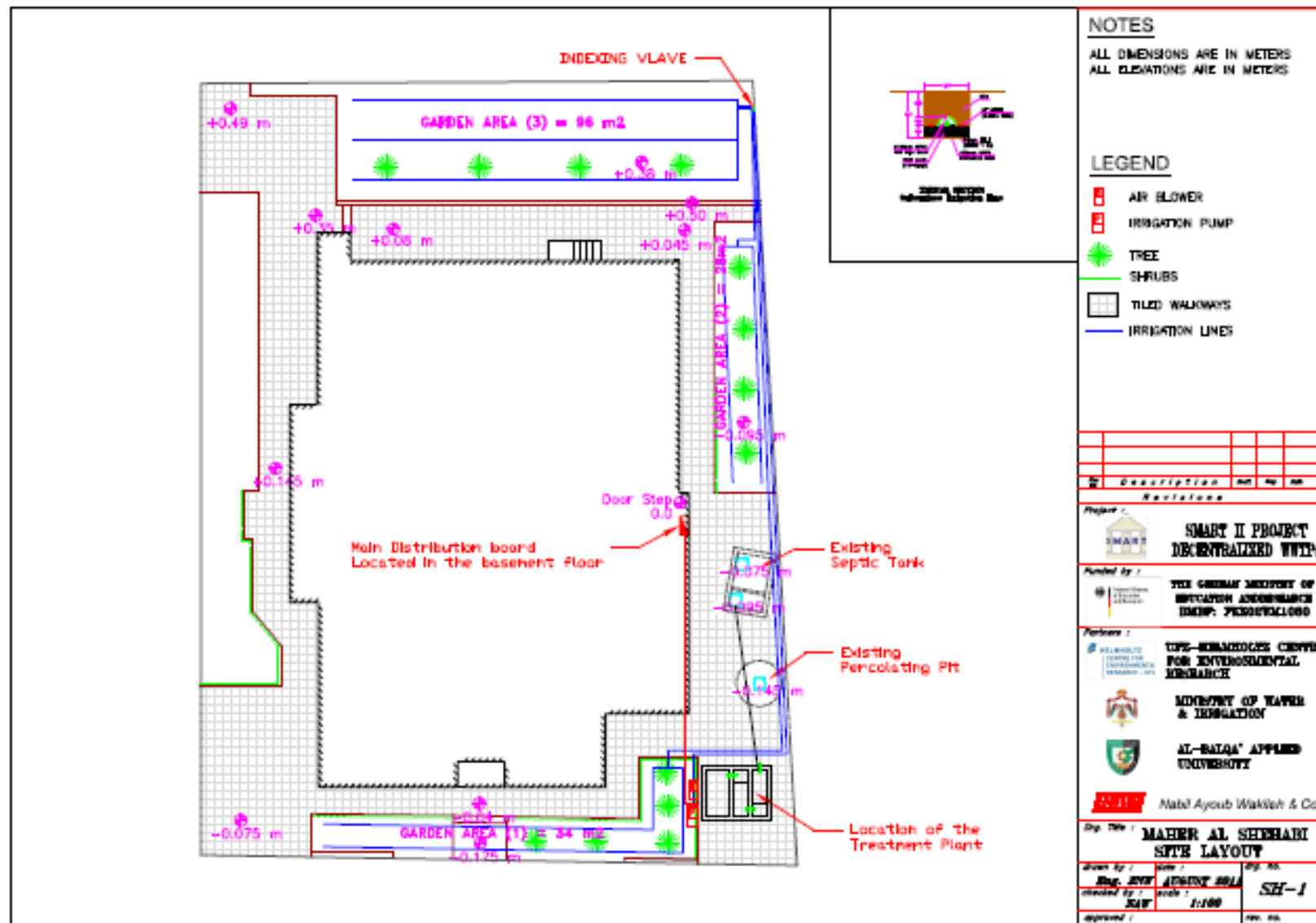


Figure 20: Mr Shehaby's site layout after construction

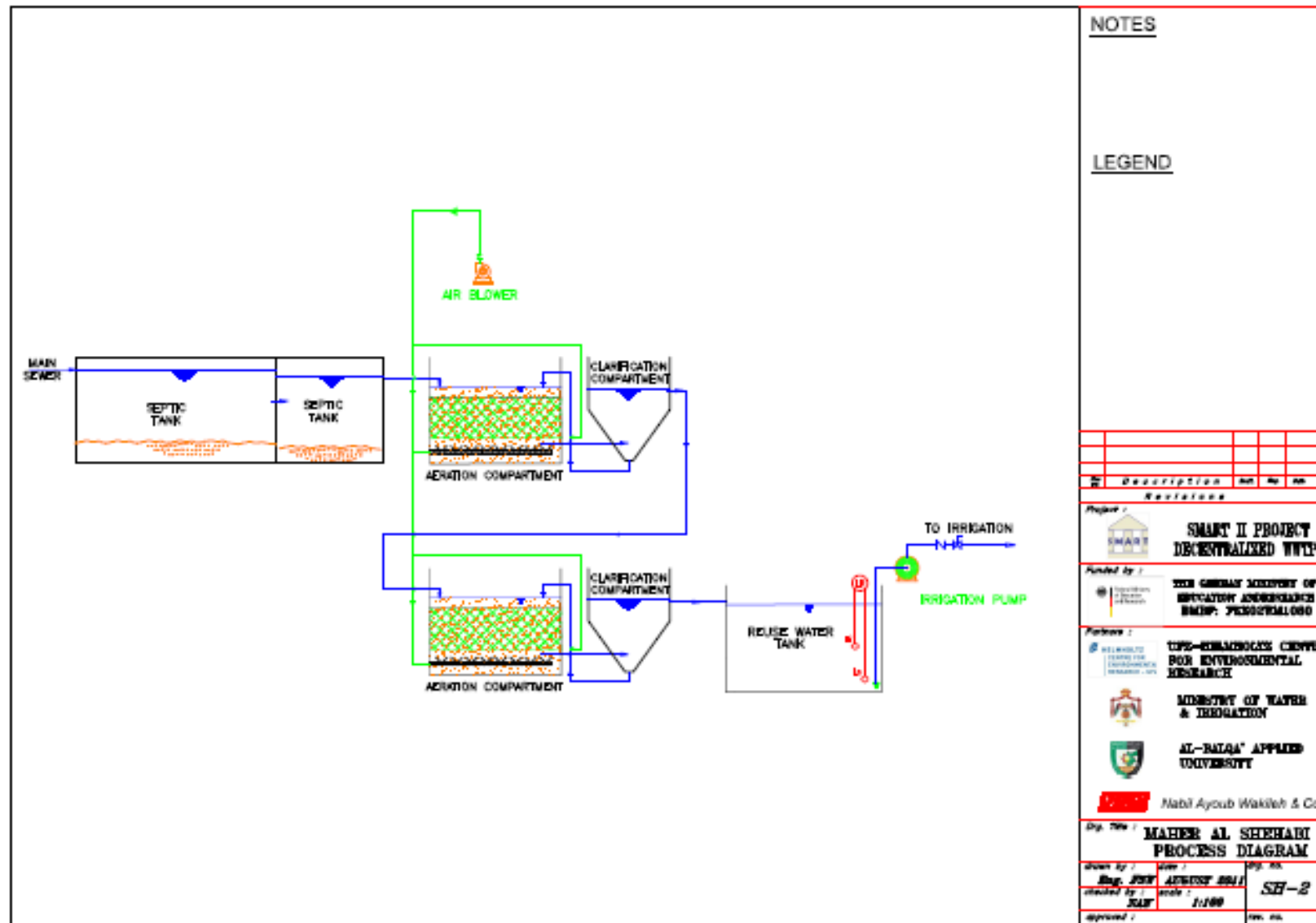


Figure 21: Modified Septic Tank process diagram.

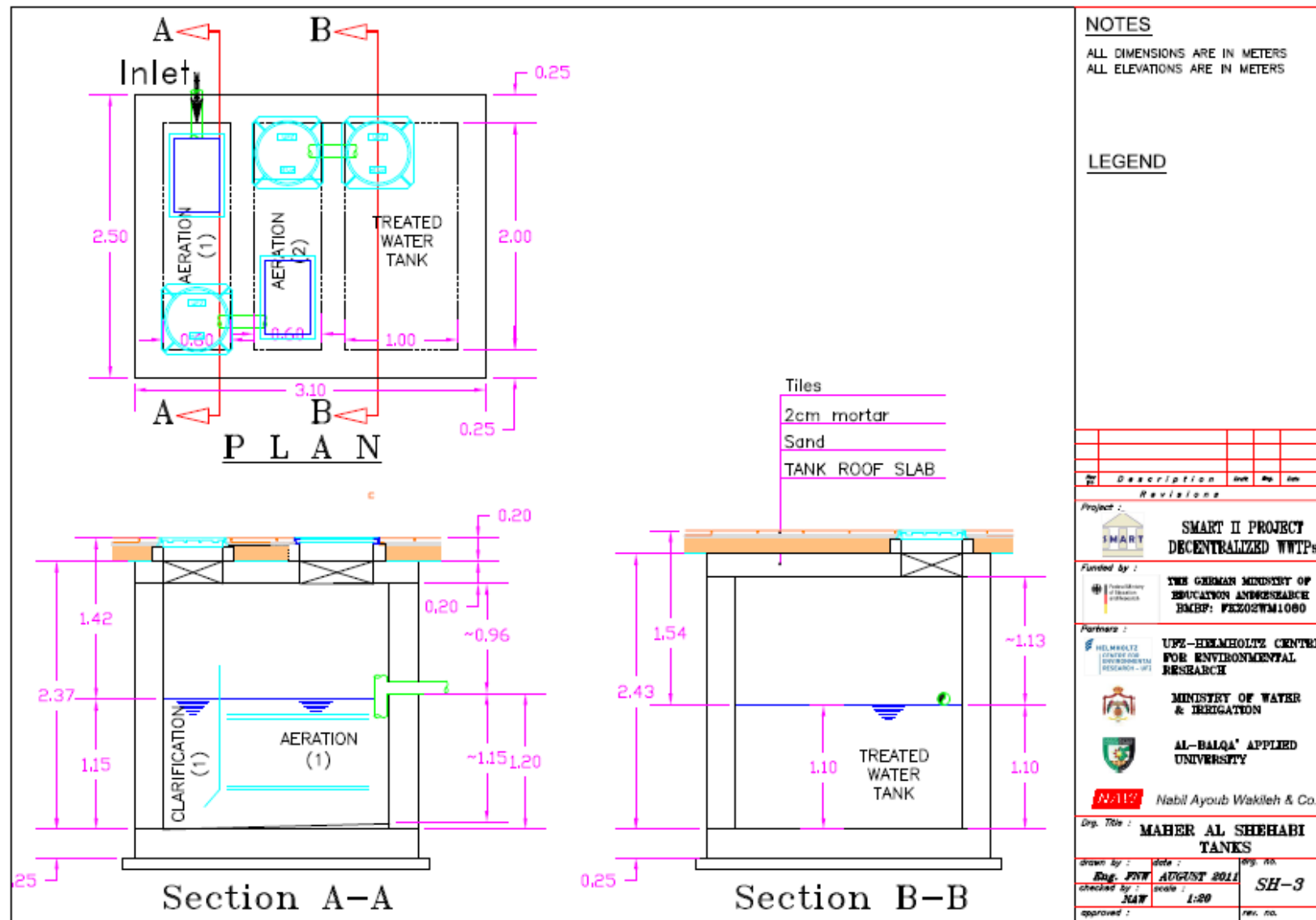


Figure 22: Modified Septic Tank As-Built technical drawings.

1.3 MODIFIED SEPTIC TANK – MR ISMAIL AKEEL

1.3.1 PRESENTATION OF THE CONSTRUCTION PROCESS

1) Modifications at the owner's request.

In order to optimise the reuse of treated effluent, subsurface drip irrigation had been envisioned. However, as the owner had already started to install his garden  at the same time that the building was constructed and in order to limit the construction time, the owner decided to install a sprinkler irrigation system. This required the installation of chlorine disinfection unit to avoid contamination risks for the household's inhabitants.

2) Planning / time frame.

As shown in Table 1, the construction started on the 11th of November 2010 and was finished on the 19th of April 2011 (about 5 weeks). The construction was stopped a few times because of bad weather condition that rendered the site inaccessible. This extended the construction time by about 1 week.

The main construction stages are presented below and are briefly discussed. It is important to mention that the construction of the treatment system happened at the same time as the construction of the building itself. This allowed a more flexible construction planning.

- Excavation of the tanks and collectors:

The top soil layers were removed easily but once deeper it took some efforts to dig in the bed rock. The sewer line servicing the building were connected directly to the Modified Septic Tank as the building was originally not used (no need to bypass a system in operation).

- Installation of the form (concrete blocks) and reinforcing steel:

Once the excavation completed, wooden planks were installed as forms for the different chambers. The concrete reinforcement was done using reinforcing steel bars.

- Pouring of the concrete:

This operation was done in 3 stages. First the floor concrete slab, then the external and internal walls and finally the roof concrete slab with the openings / block-outs for the manholes and covers.

- Curing period:

Curing time took a couple of days for the walls but about two weeks for the roof in order to ensure the strength of the structure.

- Installation of the pumps, blowers and other electrical work:

The power cables for the air blowers and the irrigation pumps have been connected to the main power distribution board in the building. A control box was installed nearby the treatment system to facilitate operation and maintenance.

- Installation of the pipework and irrigation system:

The installation of the irrigation system was quite fast as it consisted only in surface sprinklers. It required only the installation of some pipes and taps.

- Garden reinstallation:

In order to give the site back in good condition, efforts were made to clean the site. Lawn was also installed on top of the tanks to provide some landscape integration.

3) **Labour requirements:**

Table 6: Labour requirement for the construction of Mr Akeel's treatment system.

Type of labour	Number
Construction worker	4
Electrician	1
Plumber	1
Supervisor	1

4) **Construction difficulties:**

As mentioned before, the main difficulties consisted in the fact that the system was constructed at the same time than the building thus requiring coordination with the other construction workers and sometimes constraining the access to the site.

1.3.2 COMMISSIONING

The wastewater was first diverted from the existing cesspit into the modified septic tank on the 19th of November 2010. Due to the sizing of the system (population of 8 PE and a peak flow of about 12 PE) it took about 6 days to fill the modified septic tank.

The Modified Septic Tanks requires about 3-4 month to build up its microbiology and show satisfying treatment performances.

A monitoring program will be started in autumn 2012 for all the systems.

1.3.3 BILL OF QUANTITIES (BOQ)

Table 7: Bill Of Quantities for the construction of Mr Akeel's treatment system.

Tanks' Construction Works

Item Description	Unit	Qty.
Sulfate Resisting Reinforced Concrete	m ³	15
Reinforcing Steel	Ton	1.5
Water Stop	Lm	21

Item Description	Unit	Qty.
Excavation	m ³	60
Backfilling	m ³	30
Screed	m ²	8

Sewer Lines & Accessories

Item Description	Unit	Qty.
SEWER LINES	Lm	5
Sewer Manholes	No.	2
M/H C.I. Cover	No.	6

Mechanical Works

Item Description	Unit	Qty.
Air Lines and Accessories	LS	1
Air Blower	No.	1

Item Description	Unit	Qty.
Fixed Bed-Packing Media & Accessories	LS	1
Air Blower Housing	No.	1

Electrical Works

Item Description	Unit	Qty.
ELECTRIC Power Main Cable 4×2.5mm ²	LM	20

Item Description	Unit	Qty.
ELECTRIC Board	No.	1

1.3.4 CONSTRUCTION PHOTOS

Below are the photos taken during the construction to illustrate the main steps of the work realised.



Figure 23: Installation of the reinforcement steel for the Modified Septic Tank.



Figure 24: The Modified Septic Tank at the end of the construction.



Figure 25: The Modified Septic Tank in Mr Akeel's garden.

1.3.5 AS BUILT DRAWINGS

Below are presented the as-built drawings of the Modified Septic Tank installed at Mr Akeel's house.

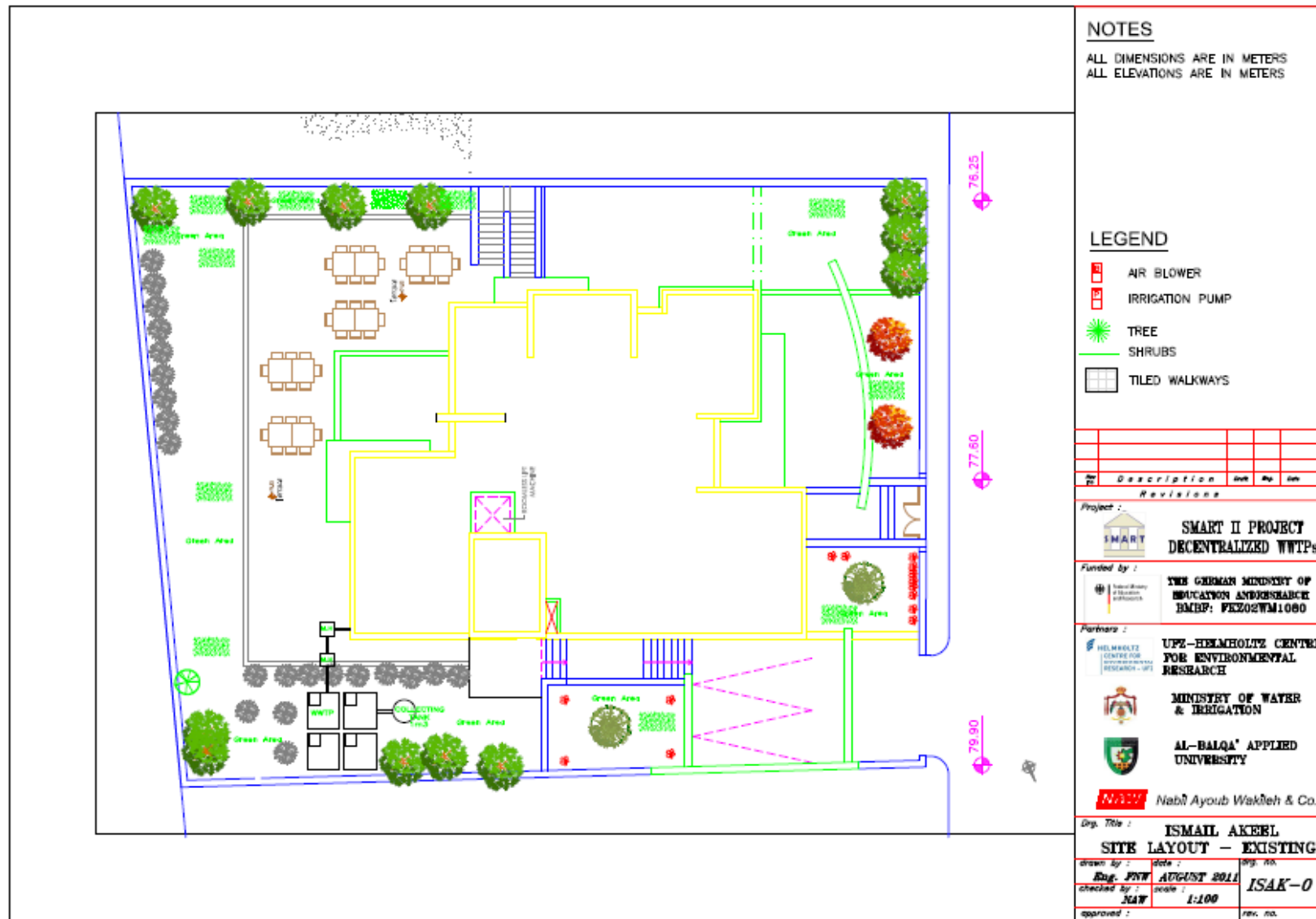


Figure 26: Mr Akeel's site layout after construction.

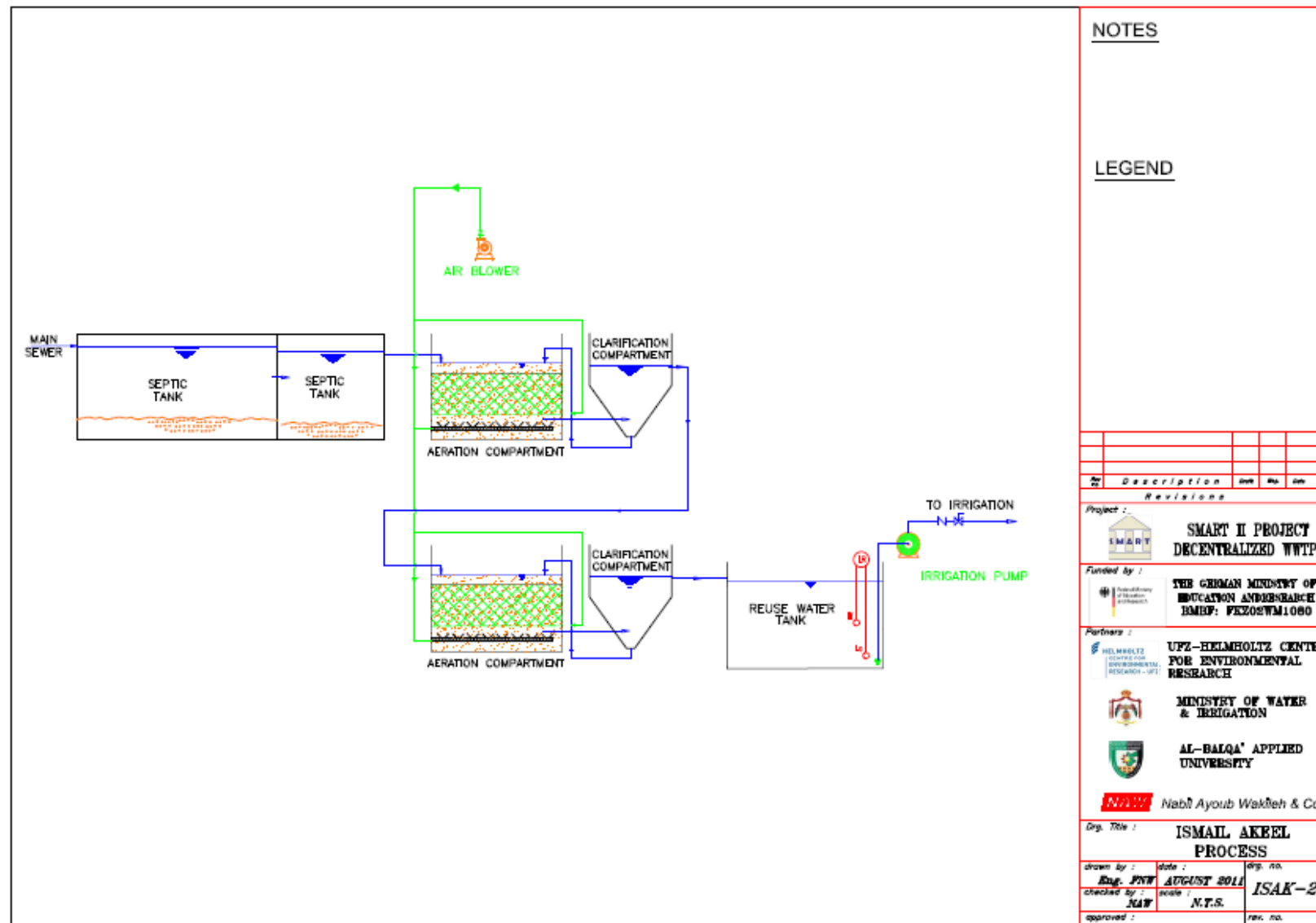


Figure 27: Modified Septic Tank process diagram.

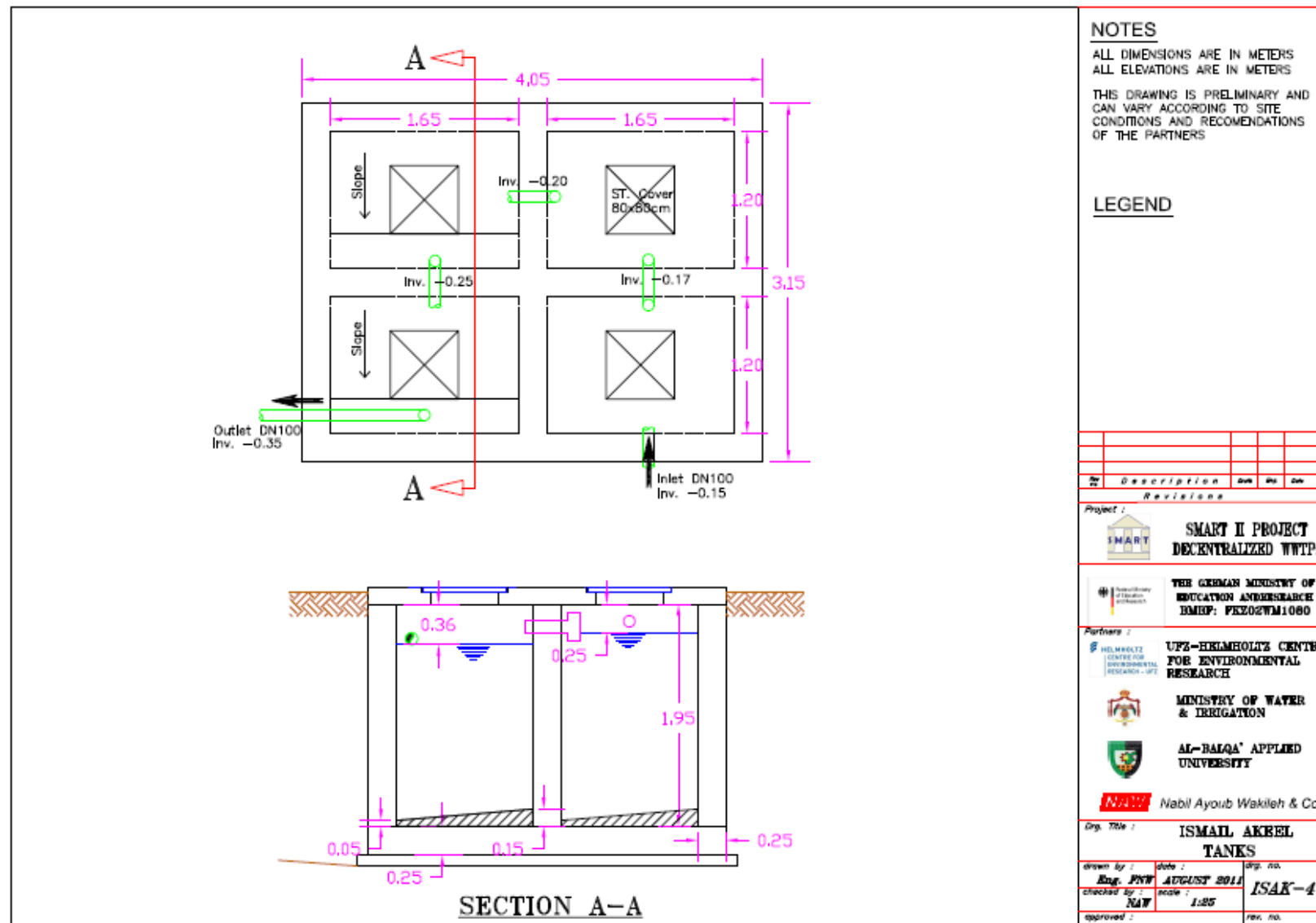


Figure 28: Modified Septic Tank As-Built technical drawings.

2 CONSTRUCTION OF THE SMALL SCALE TREATMENT WETLANDS

2.1 TREATMENT WETLAND – MR BASHIR EL HADIDY

2.1.1 PRESENTATION OF THE CONSTRUCTION PROCESS

1) Planning / time frame.

As shown in Table 1, the construction started on the 22th of November 2011 and was finished on the 25th of March 2012 (about 4 month). The construction was stopped regularly because bad weather condition that rendered the site inaccessible. This extended the construction time by about 2 month.

As this site was designed to function without electric power (gravity fed system, including the irrigation) it was necessary to import from outside Jordan some special irrigation dosing units (flouts). This required extra delay to account for the delivery time.

Some materials were also difficult to obtain (liner and filtration media for the wetland). The filter media was collected in the Jordan Valley and required preparation (cleaning). This delayed the construction by another few weeks.

The main construction stages are presented below and are quickly discussed:

- Excavation of the tanks (septic tank, flow splitting box and irrigation tanks) and collectors:

Access for mechanical equipment was only possible for the Septic Tank location. Due to the difficult terrain and presence of trees, it was not possible to reach the other components of the treatment system. Most of the excavation and construction works were done manually by labourers. The top soil layers were removed easily but once deeper it took some efforts to dig in the bed rock. The site was also presenting a slope and precautions had to be taken during the construction to avoid landslides. The sewer line servicing the existing cesspit was conserved as back up but bypassed to reach the septic tank. The presence of many trees at the site has limited the available working space, but the construction was carried out without the need to remove any of them.

- Installation of the forms and reinforcing steel:

Considering the fact that the treatment plant had to be installed directly adjacent to trees, it was not possible to provide comfortable working space for the construction and the formwork. Once the excavation completed, concrete blocks were installed as external forms in order to limit the space requirements and thus the excavation work. Planks were used as internal forms. The concrete reinforcement was made of reinforcing steel bars.

- Pouring of the concrete:

For each structure (septic tank and flow splitting box - irrigation tank), the operation was done in 3 times. First the bottom slab, then the external and internal walls and finally the top concrete slab with the manholes and covers. As mentioned above, Due to the site difficult topography and the presence of trees, it was not possible to reach most of the plant's components with mechanical equipment. The construction materials (stones, reinforcing steel, concrete, and filter media) were transported to the site manually by labourers.

- Curing time:

After pouring, the concrete has been left to dry for some time. It required a couple of days for a couple a days for the walls but about two weeks for the roof in order to ensure the strength of the structure.

- Excavation of the wetland:

Defining the wetland location was a complicated task as the slope of the site required some excavation and some filling. Where filling was required, stone and concrete retaining walls had to be built to ensure the strength of the structure.

- Installation of the liner and geotextile:

In wetlands, the sealing of the bed is a crucial operation in order to ensure that no partially or untreated wastewater infiltrated the ground. The sealing requires the installation of a liner but before that stones that may puncture the liner have to be removed and a small layer of sand applied. The liner is then installed with great attention paid to the sealing of the joints. Another layer of geotextile is added on top of the liner to prevent direct contact of the media with the liner and prevent direct exposure of the liner overboard to the sun. Installing liner and geotextile took about

- Collection and cleaning of the filter media:

Finding appropriate filter media for the wetland was a difficult task. The wadi stones that fitted the quality criteria have been found in the Jordan valley. However, once collected and brought onsite, they had to be washed to remove fines that could have settled at the bottom of the bed and clogged the pipework.

- Installation of the pipework and filter media:

Once the liner installed and the media cleaned, the inlet and outlet pipes were installed and the bed carefully filled with the filter media. Coarser media was used at the inlet and outlet zones to increase the hydraulic conductivity. Finer media was used at the centre of the bed to improve treatment performances.



- irrigation fields:

After the installation and testing of the irrigation lines, the trenches were filled back with the previously excavated soil.

- Garden reinstallation:

In order to give the site back in good condition, efforts were made to clean the site and to reconfigure the garden as it was before the construction. The owner installed new trees as soon as the work was finished to take profit of the new source of water.

2) Labour requirements.

Table 8: Labour requirement for the construction of Mr Hadidy's treatment system.

Type of labour	Number
Construction worker	7
Plumber	1
Supervisor	1

3) Construction difficulties:

As mentioned before, the weather conditions (rain and snow) rendered the access to the site and the construction of the system difficult (mud and puddles).

In the irrigation field, the mud prevented the workers to dig or access the trench and install the pipes as quickly as originally planned.

The site has a difficult topography and is planted with many trees. It was not possible to reach the location of most of the components of the system using mechanical equipment. Most of the construction work, from the transport of the construction materials till the pouring of the concrete was thus done manually by labourers.

2.1.2 COMMISSIONING

The wastewater was first diverted from the existing cesspit to the septic tank septic tank on the 25th of March 2012. Due to the sizing of the system (expected population of 14 PE and a peak flow of about 20 PE) it took about 6 days to fill the septic tank. Accordingly, it took about 15 days to fill the wetland. Under full occupancy, the septic tank retention time will be about 3 days (2 days at peak flow) and the treatment wetland retention time 7 days (about 5 days at peak flow).

The septic tanks require a minimum of 3-4 month to build up its microbiology and show satisfying treatment performances (retention and digestion of solids).

The treatment wetlands usually take also a minimum of 3-4 month to begin the development of its biofilm. However, after 6-8 month, treatment performances should still be increasing as the summer will help the development of the microorganisms.

A monitoring program will be started in autumn 2012 for all the systems.

2.1.3 BILL OF QUANTITIES (BOQ)

Table 9: Bill Of Quantities for Mr Hadidy's treatment system.

Tanks' Construction Works

Item Description	Unit	Qty.
Sulfate Resisting Reinforced Concrete	m ³	17
Reinforcing Steel	Ton	1.7
Water Stop	LM	30

Item Description	Unit	Qty.
Block walls	m ²	40
Excavation	m ³	90
Backfilling	m ³	15

Wetland

Item Description	Unit	Qty.
HDPE Liner (2 mm thick)	m ²	90
300 gr. Geo Textile	m ²	90
Aggregate 10-20 mm	m ³	17

Item Description	Unit	Qty.
Gravel 40-60 mm	m ³	9
Inlet & Outlet Perforated PVC Pipes	LS	1

Site General Requirements

Item Description	Unit	Qty.
Walk Ways	m ²	25

Item Description	Unit	Qty.
Grouted Stone Walls	Lm	30

Sewer Lines & Accessories

Item Description	Unit	Qty.
SEWER LINES	Lm	26
Sewer Manholes	No.	2

Item Description	Unit	Qty.
M/H C.I. Cover	No.	3
Dia. 110 mm Valve	No.	1

Subsurface Irrigation System

Item Description	Unit	Qty.
Drip Irrigation Lines	Lm	90
Irrigation Mains	Lm	50
Flouts	No.	3
Flushing Valves	No.	6
Valve Box	No.	6

Item Description	Unit	Qty.
Manhole C.I. Covers	No.	3
ST. ST. WIER	No.	1
Splitter Box	No.	1
Irrigation Tanks	No.	3

2.1.4 CONSTRUCTION PHOTOS

Below are the photos taken during the construction to illustrate the main steps of the work realised.



Figure 29: Excavation of the septic tank.



Figure 30: Concrete form and reinforcing steel of the septic tank.



Figure 31: The septic tank after completion.



Figure 32: construction of the retaining walls before the installation of the wetland.



Figure 33: Construction of the wetland.



Figure 34: Installation of the liner and geotextile in the wetland.



Figure 35: Preparation (cleaning) of the wetland's filter media.



Figure 36: The wetland after completion.



Figure 37: Concrete walls and reinforcing steel of the flow splitting box and irrigation tanks.



Figure 38: Interior of the flow splitting box.



Figure 39: Flow dosing device (flout) for the irrigation fields.



Figure 40: Mr Hadidy's wetland, flow splitting box and irrigation tank after completion.



Figure 41: Excavation of the irrigation lines.



Figure 42: Installation and water testing of the irrigation lines.



Figure 43: Mr Hadidy in his garden 4 month after completion of the wastewater treatment and reuse system.

2.1.5 AS BUILT DRAWINGS

Below are presented the as-built drawings of the treatment system installed at Mr Hadidy's house.

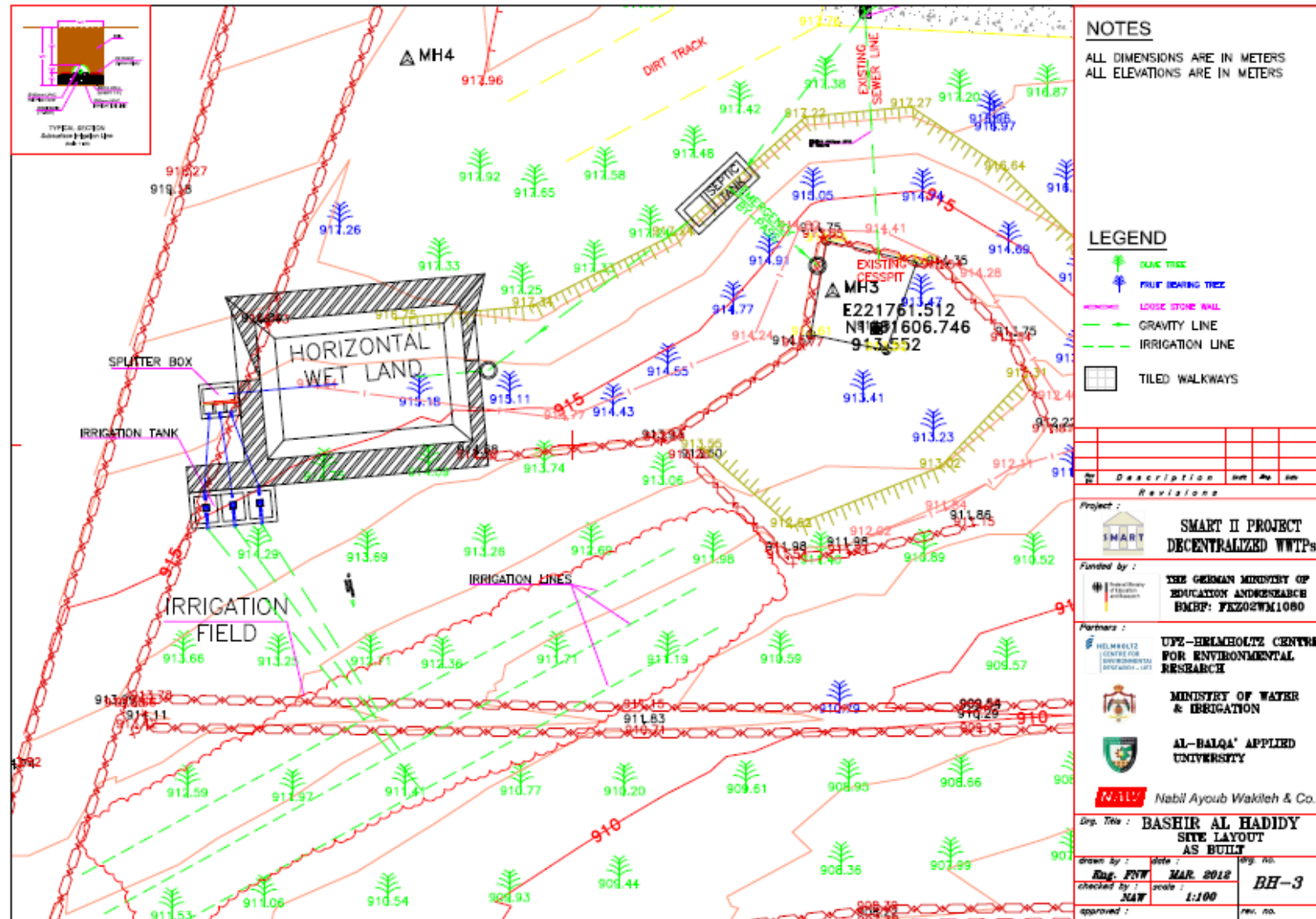


Figure 44: Mr Hadidy's site layout after construction.

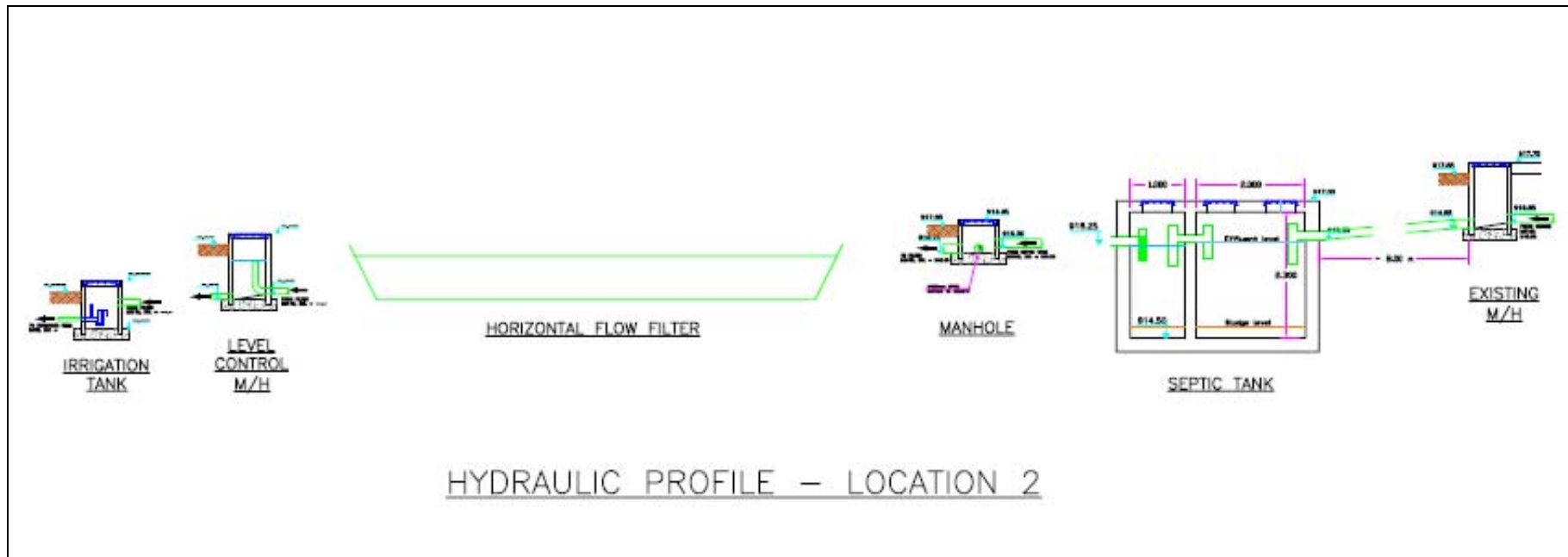


Figure 45: Treatment wetland process diagram.

2.2 TREATMENT WETLAND – ABU RUMMAN

Due to delays in the site selection and in the design process, the treatment wetland has not been built at the time when this report is being written. Further details will be given in the final report of the WP 3.1 of the SMART II project.

General information on the site can be found in the “Deliverable 301-302” report.

3 CONSTRUCTION OF THE COMMUNITY TREATMENT WETLAND

The site where the treatment wetland for a community will be installed has still not been identified. The main reason is the difficulty to fit the budget requirements to the selection criteria and especially to the sewer connection, to the space available and to the population connected.

Actually 3 sites are still being surveyed and discussed by the different partners.

The final site selected will be presented and the design discussed in the final report of the WP 3.1 of the SMART II Project. 