

## **Water Resources Projects in Iraq: Irrigation Projects on Euphrates**

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### **Abstract**

Euphrates River is distinguished with long existing irrigation projects, which had been developed in the 20<sup>th</sup> century after centuries of deterioration. One of the major projects a long Euphrates inside Iraq is Great Abu Ghraib Project, which is the largest reclaimed area. Also, Great Musayab Project, Kifl-Shinafiyah Project and Shinafiyah-Nasiriya Project are other major projects. The most important for which Hindiyah Barrage had been built is Hilla Branch that supply many projects on both sides of this branch. Euphrates irrigation projects need a lot of investments to develop the status of the projects and confront the continuous decrease in water quality of the river.

**Keywords:** Great Abu Ghraib Project, Great Musayab Project, Hilla Branch, Shatt Al-Daghara, Kifl-Shinafiyah.

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## 1. Introduction

In this paper, the irrigation projects status along Euphrates River were presented. Irrigation projects on Euphrates are more related to the history of Mesopotamia, Hilla Branch and Shatt Al-Daghara is the place where the early civilization started in Babylon, Nuffar, Sumer and other spots. For the early of 20<sup>th</sup> century, Hindiyah Barrage is the first project that implemented to supply projects with irrigation requirements. Later, after commissioning of Development Board, Great Musayab Project is the first projects that had been reclaimed in the 20<sup>th</sup> century in the 1950s. Finally, during the stage of large advance in reclamation projects implementation in 1970s and 1980s, projects of Great Abu Ghraib, Hilla-Kifl, Hill Branch, Shatt Al-Daghara, Kifl-Shinafiyah and others have a lot of development with different levels.

## 2. Upper Euphrates, Fallujah and Jurf Al-Sakhar Projects

Some of small and medium sized projects are mainly distributed along Euphrates River in Anbar governorate and north of Babil Governorate. This area, despite its breadth, length of Euphrates reach and population density, is relatively small. One of the reasons is the unsuitability of soil in some areas, as well as the lack of gravity irrigation and the reliance on pumping mainly. The projects referred to are:

### 2.1 Haditha Dam Reservoir Projects

These projects have been implemented to compensate those affected by the flooding of Haditha Dam reservoir. These projects are irrigated through earth canals or sprinklers and do not represent projects reclaimed by all means. It feed through floating stations set up on Haditha Dam reservoir or Euphrates River.

The implementation was between 1992 and 1996. It can be summarized as follows:

- a. Anah site: land of this site is located in the right of the reservoir of Haditha Dam near the new city of Anah. The net area of the project is 1000 dunams, pumped from a floating station of which the discharge is  $0.125\text{m}^3/\text{s}$ . The water is passed through iron pipes of 600mm in diameter and 800 meters long.
- b. Al-Khor site: land of this site is located in the left of the reservoir of Haditha Dam near Rawa. The net area of the project is 1600 dunams, pumped from a floating station of which the discharge is  $0.6\text{m}^3/\text{s}$ . The water is passed through iron pipes of 600mm in diameter and 2500 meters long.
- c. Kusur Al-Ayman site: land of this site is located in the right of the reservoir of Haditha Dam, northeastern Anah city. The net area of the project is 800 dunams, pumped from a floating station of which the discharge is  $0.2\text{m}^3/\text{s}$ . The water is passed through iron pipes of 800mm in diameter and 800 meters long.
- d. Sagrah site: land of this site is located in the right of the reservoir of Haditha Dam, near Ma'adheid Village. The net area of the project is 1300 dunams,

pumped from a floating station of which the discharge is  $0.25\text{m}^3/\text{s}$ . The water is passed through iron pipes of 600 mm in diameter and 1400 meters long.

- e. Sakran site: land of this site is located to the left of Euphrates River, downstream Haditha Dam. Water is lifted by a pumping station of discharge  $0.5\text{m}^3/\text{s}$  through pipeline of 800mm diameter and 10km long to the storage reservoir in Sakran Village, where the storage reservoir capacity is 15000 cubic meter. Net area of the project is 1800 dunams, it is irrigated by sprinklers, and the feeding canals of the projects have a total length of 2.5km.

## 2.2 Ramadi Irrigation Project

Ramadi project is located on both sides of Euphrates River from Abu Tayban area northwest of Ramadi to Fallujah. The project, which is divided into six sectors, is based on full pumping and it is partly implemented. The project was studied by Rawafid Company in 1965 and completed in 1970. Works were initiated and the stages were opened between 1980 and 1985.

It is irrigated through several pumping stations, which are:

1. Al-Tarabasha Irrigation Station: It comprises two metric pumping units and three units of discharge  $0.75\text{m}^3/\text{s}$ .
2. The first station of Beziez Al-Tarabsha: it has two half-metric pumping units.
3. The second station of Beziez Al-Tarabsha: it has two quarter-metric pumping units.
4. Albu-Ali Al-Jassim Irrigation Station: It comprises two metric pumping units and three units of discharge  $1.17\text{m}^3/\text{s}$ , as well as two half-metric pumping units.

The details of the project sectors are as follows:

- a. Sector 1: Located on the right of Euphrates, upstream of Ramadi Barrage, land of the sector irrigated by the main station on Euphrates River, Abu Tayban station which includes 7 metric pumping units, in addition to Zweigher station, which includes two metric pumping units Beziez Zweigher station that includes two half-metric pumping units . This sector has been fully reclaimed through a network of canals and drains for 15.6 thousand dunams. The lined canals have a total length of 85.7 km, while the drains except field drains have a total length of 34.34 km. Drainage water is flowing into Euphrates River through the  $1.3\text{m}^3/\text{s}$  drainage station, which includes two metric pumping units and two pumping units with discharge of  $0.45\text{m}^3/\text{s}$ .
- b. Sector 2: Downstream sector 1, and is followed by the third sector. This sector is partially reclaimed and irrigated through Qutniyah pumping station which has 5 metric pumping units. The total area of the project is 15,000 dunams, including lined canals with lengths of 40.5km. Drains in this sector

has a total length of 9.9km. Drainage water is flowing into Euphrates River through Zangura Drainage station, which includes a metric pumping unit and a pumping unit with discharge of  $0.4\text{m}^3/\text{s}$ .

- c. Sector 3: It is downstream sector 2, it is irrigated through the Zangura Irrigation pumping station, which has 5 metric pumping units, also there is Toy pumping station with two metric pumping units. The total area of the project is 12,000 dunams, where the land of this sector has been fully reclaimed and constructed with 42.9km of lined canals and 11km of drains. Drainage water discharge into Euphrates River through Toy Drainage station that includes a metric pumping unit and another unit with discharge of  $0.45\text{m}^3/\text{s}$ .
- d. Sector 4: Opposite the previous sectors, the territory of this sector is located on the left side of Euphrates River, which is upstream of Ramadi Barrage. The total land area of the sector is 45,000 dunams and is fully reclaimed, total length of lined canals is 42.9km and a total length of drains except field drains is 72.3km. Drainage water discharged to Euphrates River through Abu-Eitha Drainage Station, which has six metric pumping units.
- e. Sector 5: This sector is located downstream of sector 4, and up to Tharthar-Euphrates Canal. This sector is irrigated through Abu-Thiab pumping station, which has 4 pumping units with  $1.17\text{m}^3/\text{s}$  discharge, and 3 metric pumping units, as well as Abu-Eitha irrigation pumping station, which has two metric pumping units. This sector is partially reclaimed with an area of 55,000 dunams and includes 162.7km long drains. The territory of this sector is drained to Tharthar-Euphrates canal through Siriyah Drainage station, which contains eight metric pumping units. The main drain of the fifth sector, which is connected with that of the fourth stage, has been connected through siphon passing down Tharthar-Euphrates arm with Saqlawiyah main drain, where the later discharging to MOD. Pumping stations are therefore used for emergency purposes only.
- f. Sector 6: The territory of this sector lies on the right of Euphrates River near the city of Ramadi; the total area is 114 thousand dunams. It is currently watering through a number of private pumps. Drains has implemented with a total length of 38.6km, which drains water to Euphrates River through Madheq pumping station, it has six metric pumping units. The sector is partially exploited and its canals are irregularly made.

### 2.3 Fallujah-Ameriya Irrigation Project

The projects is partially-reclaimed project, where the land of the project is located on the right of Euphrates River, the first sector of the project extends from the city of Khalidiya and to the city of Ameriyat Al-Fallujah, and the second sector, which is relatively small, locate to the south of the city Ameriyat Al-Fallujah. The net area of the project is estimated at 55,000 dunams, drainage network were excavated for the first sectors, this sector discharging drainage to Euphrates River through

(Ameriya/Fallujah 1) station that includes 5 pumping units with discharge of  $1.75\text{m}^3/\text{s}$  and 4 metric pumping units. The irrigation system is an old earth canal irrigated with private pumps.

#### **2.4 Jurf Al-Sakhar Irrigation Project**

One of the projects exploited on the right of Euphrates River within Jurf Al-Sakhar sub-district in the north of Babylon. The project has a net area of 31,000 dunams, more than 5,000 dunams of which are orchards. The project feeds from a network of canals and pumps, project drainage made through a major drain, from which drainage water pumped into Euphrates River by Jurf Al-Sakhar pumping station, the station includes 6 metric pumping units and two half-metric pumping units [1, 2, 3].

### **3. Great Abu Ghraib Project**

It is one of the strategic projects in Mesopotamian plain, the land of the project is located the left of Euphrates River and starts from the left of Tharthar-Euphrates Canal to Great Musayab Project, the project is bordered from the north by Tharthar-Tigris Canal, and from the east the city of Baghdad and Tigris River. The project was one of the projects exploited before the development, as its territory was irrigated by Euphrates through the famous ancient canals: Saqlawiya, Abu Ghraib, Yusufiyah, Latifiyah and Eskandariah, head regulator controlling the flow from Euphrates River. After the founding of Supreme Agricultural Board, the idea of constructing of Euphrates Left Canal and Fallujah Barrage, proposed by William Willcocks in 1911, has been raised again. The Dutch company Nedeco has been entrusted for studying the project, and the company has carried out studies and designs since 1975 as well as general supervision of the implementation of the project since the beginning of implementation in 1979. Figure 1 shows a general outline of Great Abu Ghraib Project.

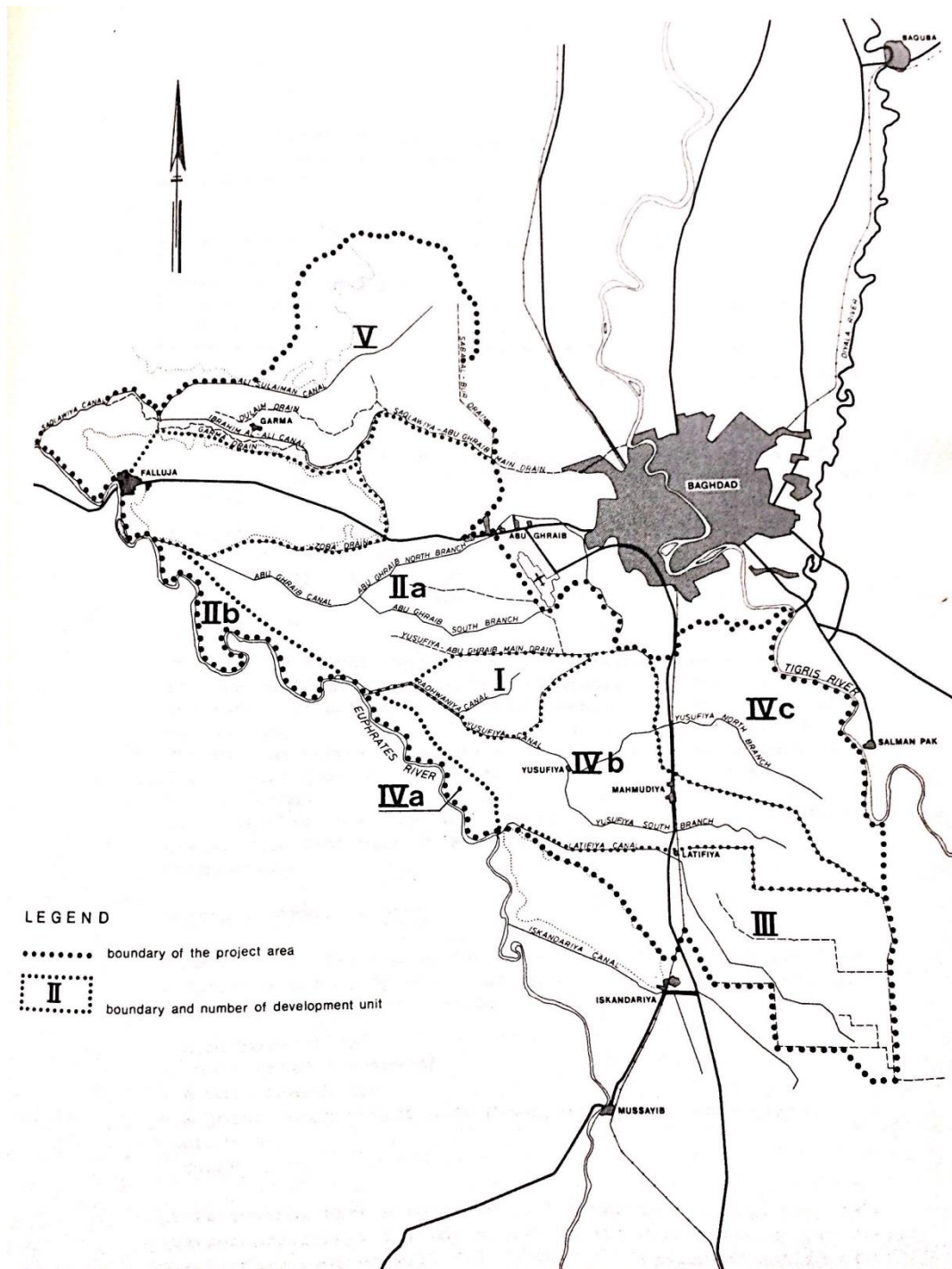


Figure 1: General outline of Great Abu Ghraib Project. (Source:[4]).

The total area of the project that was completed 572,000 dunams, and the project included dozens of pumping stations, which will be detailed later, as well as the following:

1. 1880km long paved road network and 10,000km of unpaved road network.
2. 1617km main, branch canals and distributary canals.
3. 11,000km water courses.
4. 2590km of drainage canals.
5. 16,000km of field drains.
6. 65 million cubic meters of earth works.
7. 82,260 irrigation structure of various sizes.
8. 4.7 million cubic meters of concrete for lining works.

The above quantities represent what is required for the overall development of the project, from which advanced stages have been implemented. Implementation has been initiated since the late 1970s by foreign companies, and development continued after 1991 only with Iraqi cadres, the progress declined after 2003 due to the security situation in the region, among from the companies that contributed to the implementation of the project in addition to the companies of the Ministry of Irrigation are:

- a. Bodemix Polish Company.
- b. Turkish Company ZDH.
- c. Akrocomplect.
- d. Azgo Patior Turkish Company.

In order to detail this large project, it comprises the following parts:

### **3.1 Fallujah Barrage**

Fallujah Barrage located at Euphrates River at a distance of 5 downstream the city of Fallujah. The barrage has 10 openings controlled by radial gates of dimensions 8.5m × 16m; the maximum discharge is 3600m<sup>3</sup>/s at the maximum operational level 44.79m a.s.l. There is fish ladder, and the navigational lock is not implemented, supposed to be implemented in the future. The barrage rise the water to the Combined Canal, that feeding Great Abu Ghraib Irrigation project, this canal is branched from the left side of Fallujah Barrage, where the water discharged through the head regulator which consists of 4 openings of dimensions 3.5m × 6m and has operational discharge of 104m<sup>3</sup>/s.

### **3.2 The Combined Canal**

The combined canal was created to the left of Euphrates River to draw water from upstream of Fallujah Barrage. It is a 52km long earth canal. The canals that branching from the combined canal are Abu Ghraib, Radwaniyah, Yusufiyah and Latifiyah. At the distance of 8km from the canal, Abu Ghraib main canal is branching, where the discharge of the canal is 28m<sup>3</sup>/s, the head regulator consists

of 3 openings in dimensions 2.5m×3m. At the distance of 30km, Radwaniyah main canal is branching, canal head regulator has two openings with dimensions 1.7m×2.5m and discharging 7.2m<sup>3</sup>/s. At the distance of 36km, Yusufiyah canal is branching, canal head regulator discharge is 24.4m<sup>3</sup>/s, consisting of two openings with dimensions 2.5m×3m, and at the same location there is a side escape on the right side to bypass the excess water to Euphrates River. Finally, at the distance of 52km which is the end of the canal, Latifiyah Canal is branching, canal head regulator has a discharge capacity of 23m<sup>3</sup>/s, consisting of 3 openings with dimensions 2.45m×3.25m. At the end also there is a side escape on the right side to bypass the excess water to Euphrates River.

### 3.3 Saqlawiya Irrigation Project

Saqlawiya project feeds from Euphrates River, upstream Fallujah Barrage about 18 km away, back water curve of Fallujah Barrage ensures the sufficient levels of gravity water flow in the project. The net area of the project that irrigated from the Saqlawiya main canal is 113,000 dunams. Under project management, there are lands feed by pumping form Tharthar-Tigris Canal. These located north of the project and are estimated to be 32,000 dunams. Saqlawiya canal is fed by head regulator on the left of Euphrates, a modern regulator built in 2002 as an alternative to the old brick-built regulator. The regulator includes 3 openings of dimensions 2m×4.25m and passes a discharge of 26m<sup>3</sup>/s. After the head regulator to the right, Azragiah canal is branching, it runs paralleled to Euphrates River. At the hade of the canal is the SF-00 pumping station, which comprises 5 pumping units of discharge 0.8m<sup>3</sup>/s. At the middle of the canal is also Azaragiah station, which support canal discharges form Euphrates, it has a metric pumping unit. The 17 km-long Saqlawiya canal, branching at the end into two lined canal, the first is Ali Al-Sulaiman Canal, 52km long and 11m<sup>3</sup>/s discharge capacity, this canal irrigate area of 76.5 thousand dunams. The second canal is the 30km-long Ibrahim al-Ali canal with discharge of 7m<sup>3</sup>/s, the canal irrigate an area of 49.5 thousand dunams.

The Drainage network in Saqlawiya consists of the following:

- a. 79km main drain.
- b. Branch drains with length of 377km.
- c. 924km of collector drains.
- d. 1072km of field drains.

The main drain discharge is 24m<sup>3</sup>/s, flowing by gravity to MOD, the main drain is a carrier also for some sectors of Ramadi project as well. The project is partially reclaimed at 25%.

The pumping stations on Tharthar-Tigris canal are irrigating what is known as Garma Project, a project with an estimated area of 32,000 dunams.



The details of the stations are as follows:

- a. Mishihna pumping station includes 5 metric pumping units and a half-meter pumping unit.
- b. Banat Al-Hassan pumping station has 3 pumping units of discharge  $0.27\text{m}^3/\text{s}$ .
- c. Hamra pumping station has 3 metric pumping units.
- d. Issawia pumping station has 3 metric pumping units.
- e. Mishihna support pumping station with 3 metric pumping units.
- f. Shiha and Albo-Fahad pumping station includes a metric pumping unit.

### **3.4 Abu Ghraib Irrigation Project**

The project is irrigated from the combined canal. The main canal of project is 18km long lined canal; discharge is  $28\text{m}^3/\text{s}$ . At the end, the canal branched into three canals, the northern canal with discharge of  $7\text{m}^3/\text{s}$ , the eastern canal with discharge of  $8\text{m}^3/\text{s}$  and the southern canal with discharge of  $7\text{m}^3/\text{s}$ . The net area of the project is 170,000 dunams, of which 92,000 dunams had implemented with field drains. There are also lands irrigated from the combined canal through 5 pumping stations, 3 pumping stations have been managed by private farmer, and the stations under project management are:

- a. Fallujah 3 pumping station, has 3 pumping units, each  $0.345\text{m}^3/\text{s}$  of discharge capacity, and two metric pumping units and a half-metric pumping unit.
- b. Fallujah 5 pumping station, has 3 pumping units of  $1.07\text{m}^3/\text{s}$  discharge and two metric pumping units.

The project is drained to MOD through several drains and there is a pumping station at the northern section, which is Zubaa pumping station, it has 7 metric pumping units operating when in need.

### **3.5 Fallujah Irrigation Project**

The lands enclosed between the right of the Combined Canal and the left of Euphrates River, as well as land in the head of the Combined Canal. The project irrigated by private pumps. The net area is estimated at 72,000 dunams.

### **3.6 Radwaniyah Irrigation Project**

Radwaniyah project is located between Abu Ghraib and Yusufiyah projects, the project feed from the Combined Canal through a 9.5km main canal of discharge  $7.2\text{m}^3/\text{s}$ . The project is fully developed, where 29,000 dunams of the total area 49,000 dunams was fully reclaimed. The project drains also to MOD.

### **3.7 Yusufiyah Project**

It is one of the old projects which are irrigated from the ancient Yusufiyah Canal and extends its territory from Euphrates River to Tigris River; Yusufiyah Canal is

still in existence and works to supply the land with water. The project is bordered to the north by Abu Ghraib and Radwanayah projects and to the south by Latifiyah project. After the development of the area within the Great Abu Ghraib project, the lands of Yusufiyah were divided into two parts within the plan, the first partition from Euphrates to MOD which irrigated from the old and new Yusufiyah canal and was called Yusufiyah Project. While the lands after MOD up to Tigris River, is irrigated through the old Yusufiyah Canal, as well as pumping stations on Tigris River, this project is called Hour Rajab project.

In addition to the old Yusufiyah canal, the new Yusufiyah is branching from the Combined Canal with discharge of  $24.4\text{m}^3/\text{s}$ , it feeds some of new lined canals as well Shishbar canal with discharge of  $10.3\text{m}^3/\text{s}$  and Halan canal with discharge of  $2\text{m}^3/\text{s}$ . The net area of the Yusufiyah project is estimated at 122,000 dunams, of which 82,000 dunams were supplied by lined canals, also, a net area of 44,000 dunams has been reclaimed, other areas are under development. Drainage of the project is also connected to MOD.

### **3.8 Hour Rajab Project**

The land of the project is irrigated east of MOD and west of Tigris River from the old Yusufiyah Canal and pumping stations on Tigris as part of Hour Rajab project. The net area of the project is 95,000 dunams; the reclamation work was initiated in 1999 through the implementation of pumping stations and lining canals. The areas covered by the lining were 65,000 dunams.

Drainage network connected also with MOD. Irrigation pumping stations details as follows:

- a. First Yusufiyah irrigation station, on Tigris River has 7 metric pumping units.
- b. Second Yusufiyah irrigation station, on Tigris River has 6 metric pumping units.
- c. Al-Dora irrigation station, on Tigris River has 3 metric pumping units.
- d. Al-Rasheed/Manari irrigation station, on Tigris River has 4 metric pumping units.
- e. Hour Rajab station, on Tigris River has 5 metric pumping units and a half-meter pumping unit.
- f. Sikhraicha station, on Yusufiyah canal, it includes 3 metric pumping units.

### **3.9 Latifiyah Project**

Latifiyah project is located to the south of the Yusufiyah project and is bordered to the east by MOD and to the west and south by Eskandariah project. The project is mainly fed by the new lined Latifiyah Canal those branches from the end of the combined canal. Some of the lands are irrigated from the old Latifiyah Canal. The net area of the project is 103,000 dunams, new Latitiyah canal is 51km-long lined canal, and the old Latifiyah earth canal is 34km long. The area for which irrigation

and drainage networks have been implemented has reached 80,000 dunams.

### **3.10 Eskandariah Irrigation Project**

Eskandariah project is located at the end of Great Abu Ghraib grand project, although the preliminary design of the project included the connection of the combined canal to the head of the old Eskandariah Canal, but what is currently being fed the project from the Old Eskandariah Canal in addition to the new Eskandariah Canal new that branched from the new Latifiyah Canal at the 29km distance. Eskandariah new head regulator at the new Latifiyah canal includes two openings with dimensions 2.45m×3.25m and the discharge of the system 6.5m<sup>3</sup>/s. The land irrigated from this route is estimated at 20.6 thousand dunams. Eskandariah's old canal is partially lined is fed from Euphrates River and is 18 km long, the operation of the head regulator of this canal is partly influenced by Hindiyah Barrage, this regulator consists of a single opening of 2.5m×5.8m dimensions and a discharge of 8m<sup>3</sup>/s. Eskandariah's old canal provides an area of 15,750 dunams. While, the total of the project is 31,000 dunams. Some of the land inside the project is irrigated by pumping within Muwailha and Jafjafa canals.

The details of the stations are as follows:

- a. Muwailha pumping station: pumping water for the Muwailha canal with 5 metric pumping units and a half-meter pumping unit.
- b. JafJafa pumping station: pumping water for Jafjafa canal and consist 4 metric pumping units, two half-metric pumping units, and a quarter-metric pumping unit.
- c. T Abbas Aba'oub pumping station: the station has two metric pumping units.

The project is draining the water to MOD and to the northern Musayab drain. Within the drainage network, the Eskandariah MN-00 pumping station has 6 metric pumping units and a half-metric pumping unit [3, 2, 5, 6, 7, 8].

## **4. Great Musayab Project**

Great Musayab project is one of the old projects where its land was irrigated from the old Cotha Canal. After founding of Development Board, Musayab project was the first project to be reclaimed in Iraq, where the decision to implement the project was taken in 1952 and initiated in 1953, and the development work was completed in 1956. The work mainly consist the development of existing earth canals and excavating of drains at various levels. The net area after the development was 250,000 dunams; later, new area added which is Sumoud farm, whose land is located after the Southern Musayab Drain, with net area of 17,000 dunams.

The project feed by gravity from Euphrates River and the irrigation system includes the following details:

1. Musayab head regulator consists of 4 openings with dimensions 2.9m×5m, controlled by radial gates. The maximum discharge of the regulator is 60m<sup>3</sup>/s, and its normal discharge is 40m<sup>3</sup>/s.
2. The main canal which is 49.5km long.
3. Branch and secondary canals with total length of 151.5km.
4. 241 distributary canals, of a total length of 693km.

Drainage network consists of the following parts:

1. Northern Drain, the length is 47.5km and discharge is 15m<sup>3</sup>/s. Part of this drain became a reach of MOD.
2. Southern Drain, is 59.5km long and discharge is 29m<sup>3</sup>/s.
3. Branch and secondary drains, of total lengths 197km.
4. Collector drains of total length 638km.
5. Open field drains of total lengths 1796km.
6. Kish pumping station on the southern drain. This station serves Musayab project and Eskandariah-Mahawel project, consisting of three stations in the same location, which are:
  - a. New Kish pumping station has 5 pumping units, each 3,375m<sup>3</sup>/s.
  - b. Old Kish pumping station has 5 pumping units, each of discharge 1.6m<sup>3</sup>/s.
  - c. Kish horizontal pumping station has 3 metric pumping units.

Great Musayab project generally needs sophisticated rehabilitation work. All of its canals are earth and most of the canals design section and slopes were changed as a result of improper maintenance, a large number of brick-built structures have become out of work and bypass have been made around the structures [3, 9, 2, 5, 10].

## 5. Eskandariah-Mahawel Project

Eskandariah-Mahawel project is located between the borders of the Eskandariah project Great Musayab projects to the east and Euphrates River to the west, and is bordered to the south by Hilla Branch Babil Canal. The project is divided into three phases:

Phase 1: The land which is fed mainly from Hilla Branch upstream Babail Canal, the area is 125,000 dunams. The canals that feed the project are:

1. Mahawel Canal: The canal is branching from Hilla Branch at the distance of 8km, extends up to 20km, at the head there is a regulator with discharge of 10.7m<sup>3</sup>/s. The canal passes through the city Mahawel, also a pumping station with 13 metric pumping units has been installed near the head to support discharges.
2. Khatouniyah Canal: Branching at the 25km distance of the left of Hilla

- Branch, 5.4km long and discharge is  $1.4\text{m}^3/\text{s}$ .
3. Fandiyah Canal: Branching at the 25.5km distance from the left of Hilla Branch, 8km long and discharge is  $0.9\text{m}^3/\text{s}$ .
  4. Nile Canal: Branching at the 27km distance from the left of Hilla Branch, 17.88km long and  $3.5\text{m}^3/\text{s}$  discharge.
  5. The left side Babil Canal: the right side are within the boundaries of the Hilla-Hashimia project. The canal is branched at a distance of 27. km from the left of Hilla Branch, one of the largest branching streams of Hilla Branch, with length of 36km and a discharge of  $15\text{m}^3/\text{s}$ .

Phase 2: This phase is feed from Nasiriya Canal, a fully reclaimed phase also called the Nasiriya Project. The territory of this stage is located south of Musayab Canal, and the canal of Nasiriya is branched from the left of Euphrates River at a distance of 8km upstream of Hindiyah Barrage, head regulator has two openings with dimensions of  $1.8\text{m}\times 3\text{m}$  and discharge  $4.7\text{m}^3/\text{s}$ .

The irrigation system within the project consists of:

1. Nasiriya's main lined canal is 12.8km long.
2. Secondary canals with length of 24km.
3. 65.8km distributary canals.
4. 130.75km water courses.

All canals of the project are lined and cover the project area of 13,000 dunams. The project, as well as the first phase of the Eskandariah-Mahawel project, is being drained through drainage network. This network, which flows into the Southern Musayab Drain, where Kish pumping station contributes to discharge the drainage water, drainage network consists the following parts:

1. 22.5km main drains.
2. 103km branch drains.
3. 104km secondary drains.
4. 590km collector drains.
5. Drainage pumping station No.22, within the network of Nasiriya project, which includes 8 metric pumping units.

Phase 3: The land of this stage lies between the Eskandariah canal and Musayab canal and feeds through private pumps on the left of Euphrates. The area of this phase is 25.7 thousand dunams and a number of its land is currently being exploited as lakes for fish farming, which are also spread through other phases of the project [2, 5, 9, 11].

## 6. Husseinia and Bani Hassan Projects

After building of Hindiyah Barrage, the canals of Husseinia and Bani Hassan were dug, Husseinia Canal to deliver water to the city of Karbala and Bani Hassan Canal to irrigate the lands to the right of Euphrates downstream Hindiyah Barrage, as well as Karbala Drain from 1928 to 1931. The development of the project was studied at Development Board era by Nedeco for the period from 1954 to 1956. It was followed by studies from Iraqi entities, the most important of which are the design departments in the Ministry of Irrigation. The project is divided into two parts:

### 6.1 Husseinia Project

The project feeds mainly from the recently lined Husseinia Canal. The canal is 28km long and its maximum discharge is  $55\text{m}^3/\text{s}$ . This project feeds agricultural land, Karbala orchards and drinking needs for Karbala. The net area of the project is 112.5 thousand dunams, of which 56,000 dunams are orchards. From Husseinia Canal several canals were branched which are Al-Wand, Kamalyah, Al-Jadida, Abu Zara' and Hindiyah. At the end of the project, the 22km long Rushdiyah Canal is branched out.

The Drainage network covers an area of 96,000 dunams of the project and drains water to the main drain, which ends with pumping station which lifts water to Razzaza Lake, drainage water lifted through Razzaza pumping station, that consists of two pumping sets, the first is Razzaza vertical station consists of 5 pumping units of  $3.8\text{m}^3/\text{s}$  discharge capacity, and the second is Razzaza support station, it consists 12 metric pumping units.

One of the things that Karbala city experiencing is the rise in groundwater levels, so the drainage system plays an important role in controlling this problem. The city of Karbala is also had an official and informal urban expansion which reduce the area of the project day by day.

### 6.2 Bani Hassan Project

The project is located to the right of Euphrates River for the distance from Hindiyah Barrage to Kifl area. From the east, the project is bordered by Euphrates River and from the west by Karbala-Najaf road. The project is mainly fed from the newly-lined Bani Hassan Canal, where the canal is 68km long and its maximum discharge is  $45\text{m}^3/\text{s}$ . The net area of the project is 105.5 thousand dunams. Irrigation network is mainly earth canals connected to the main canal, Bani Hassan Canal, the total length of these canals is 149.3km and irrigated area is 82.5 thousand dunams. Drainage network consists of three sections implemented in the 1960s as follows:

- a. Northern section: Its land is drained by Imam Mansour drain, which reaches discharge of  $6\text{m}^3/\text{s}$ , and is linked to Husseinia drains.
- b. Central section: Its territory is drained to Euphrates River through Sichla Drainage station; it includes 3 pumping units with  $1.25\text{m}^3/\text{s}$  discharge capacity and 6 metric pumping units.

- c. Southern section: Its land is drained by Abu Fishaiga drain, which extends to the south of the project, and pumping drainage water to Euphrates River through Southern Husseinia pumping station, the station includes two pumping sets, the first set of 3 pumps of discharge  $1.8\text{m}^3/\text{s}$  and the second set of 3 half metric pumping units. There is also in southern section, what is so called Khurus pumping station, which lifts water from Khurus drain and has two metric pumping units [3, 2, 5, 12, 7].

## 7. Hilla-Kifl Project

It is one of the old projects that were fed from Kifl Canal, which modified later after building of Hindiyah Barrage. The project is located between Hindiyah Barrage and the city of Kifl, bordered to the west by Euphrates River and to the east by Hilla Branch and Hilla-Kifl road.

The areas to the south of Hindiyah Barrage are generally distinguished by rising groundwater levels. Due to the spread of salinity, Tewerej Drainage network for parts of project land was implemented in 1954. Nedeco carried out a study and designs for the drains of Hilla-Kifl, also the 55.5km-long Hilla-Kifl main drain was completed in 1959 to serve the land in the project. The project was later studied by Swiss consultants and completed the study in 1984. Reclamation work was initiated in 1982, works were begun by Romanian companies, where the reclamation of the northern and central sectors was carried out. After 2006, at various intervals, the reclamation of the southern sector was initiated, as well as the lining of Kifl Canal, which is still on going. The net area of the project is 152,000 dunams.

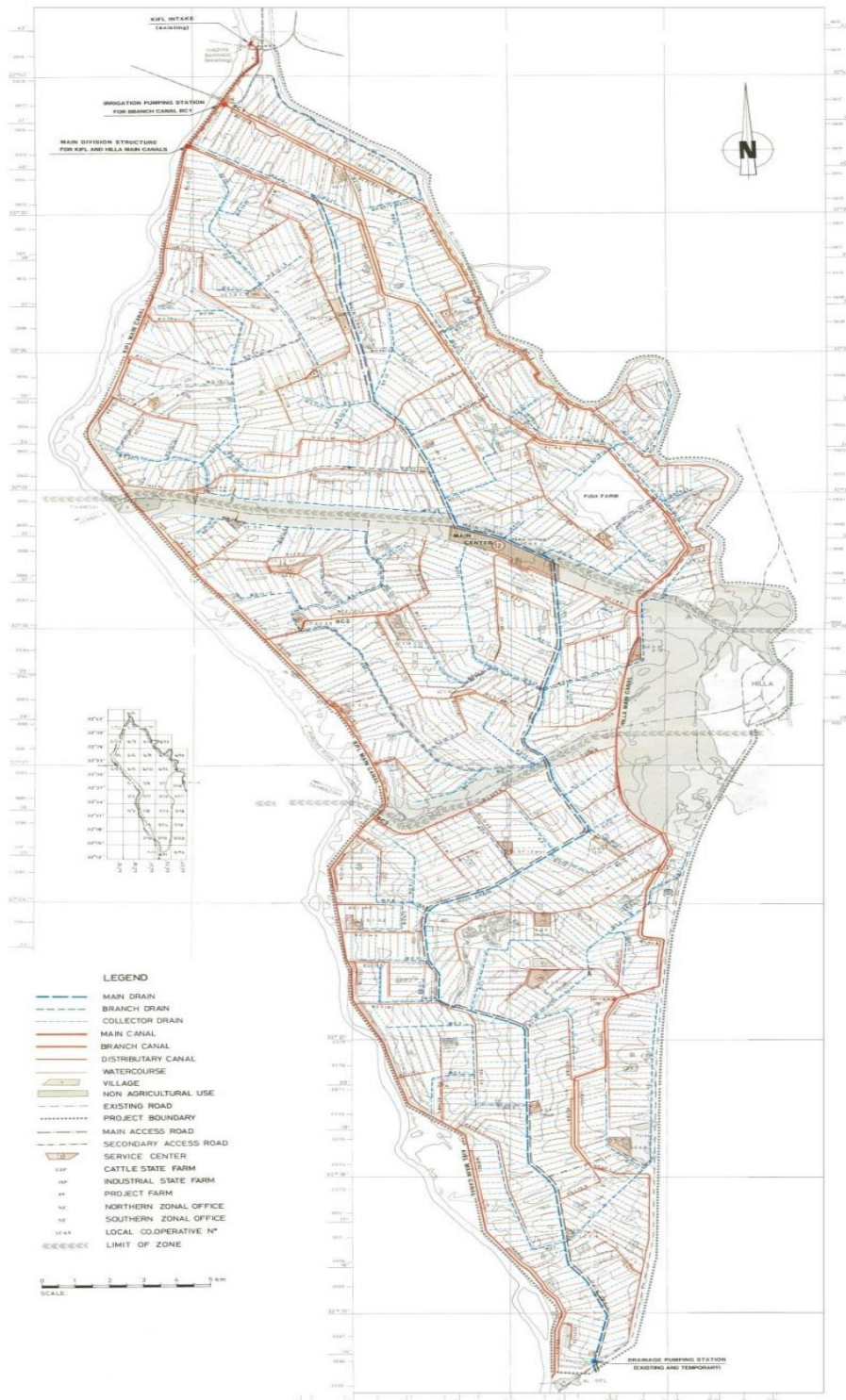
The irrigation system is fed by three canals branching from Kifl Canal, which are:

1. Pumping canal: A 17.74km lined canal supplied with water through a pumping station built near Kifl Canal with 6 metric pumping units and 3 half-metric pumping units. The path of this canal is adjacent to Hilla Branch.
2. Hilla Canal: A 51km lined canal with discharge of  $14.2\text{ m}^3/\text{s}$ . This canal passes from the center of the project and its route is adjacent to Hilla city and the eastern edge of the project.
3. The Kifl Canal: the extension of the old Kifl, as the upstream reach of it is 6.9km long and is considered a main canal that supplies the Pumping and Hilla canals, and then the path of the old canal is the current canal of Kifl, which has been partially lined. The canal is 50.25km long and discharge capacity is  $18.5\text{m}^3/\text{s}$ . The canal runs along Euphrates River and ends at the city of Kifl, a supporting pumping station called the Abu Jamus has been installed with two metric pumping units to raise water from Euphrates River to the canal.

There are more canals in the irrigation network, branch, secondary and distributary canals with total length of 291km, and water courses with total length of 2507km. The Drainage network discharge to Eastern Shamia drain, and the main Hilla-Kifl drain is the backbone of the project to drain the lands, it is connected by branch drains with total length of 24km and collector drains with total length of 1150km, while the field drains are estimated within the areas covered by the reclamation is 6696km [2, 5, 13, 9, 14].

Figure 2 shows a map of Hilla-Kifl Irrigation Project.





**Figure 2: Hilla-Kifl Irrigation Project map. (Source:[14]).**

## 8. Hilla Branch Projects

Hilla Branch and its extension of Shatt Al- Diwaniyah are one of the ancient routes of Euphrates River; also, it is the most important branch that feed from Euphrates River to irrigate the territory of Babylon, Qadisiyah and Muthana governorates, in addition to provide drinking needs for cities on its course. Hilla-Diwaniyah area was studied by Nedeco from 1958 to 1960 for the first time, dividing the project into four sectors; Nedeco again submitted a study on the drainage network in the region in 1972. Then a study was presented also by Nedeco in 1986, which included 9 sectors, 3 right of Hilla Branch and three each for right and left of Shatt Al-Daghara. Hilla Branch projects consist of the following:

### 8.1 Hilla Branch

Hilla Branch according to the irrigation management extends from Hindiyyah Barrage to the head of Shatt Al-Diwaniyah, for a length of 101km. The maximum discharge of this reach is  $245\text{m}^3/\text{s}$ . It was planned to expand the capacity to pass a  $300\text{m}^3/\text{s}$ .

Along Hilla Branch are the following regulators:

- a. Doora Regulator: South of Hilla city at a distance of 51.1km. The regulator consists of 6 openings with dimensions  $6\text{m}\times 9\text{m}$ , the maximum discharge is  $249\text{m}^3/\text{s}$ . To the right of the regulator is a  $6\text{m}\times 90\text{m}$ -dimension navigation lock, the regulator was opened in 1981.
- b. Al-Tayas Regulator: South of Midhatiyah city at a distance of 76km. The regulator consists of 5 openings with dimensions  $6\text{m}\times 9\text{m}$ , the maximum discharge is  $206\text{m}^3/\text{s}$ . To the right of the regulator is a  $6\text{m}\times 90\text{m}$ -dimension navigation lock, the regulator was opened in 1982.
- c. Shatt Al-Diwaniyah head regulator: this regulator together with head regulator of Shatt Al-Daghara were opened in 1928, a new regulators have been re-built as an alternative to the old ones. New Shatt Al-Diwaniyah head regulator was opened in 2010 and consists of 4 openings with dimensions  $3.75\text{m}\times 6\text{m}$ , it is controlled by radial gates to pass a maximum discharge of  $96\text{m}^3/\text{s}$ .
- d. Shatt Al-Daghara head regulator: The new regulator of Shatt Al-Daghara was opened in 1980 and is located upstream of Shatt Al-Diwaniyah head regulator, consisting of 3 openings with dimensions  $4\text{m}\times 6\text{m}$ , the regulator controlled by radial gates to pass a maximum discharge of  $96\text{m}^3/\text{s}$ , while the normal discharge is  $55\text{m}^3/\text{s}$ .

### 8.2 Hilla-Hashimia Project

The lands on the left of Hilla Branch, from the right of Babil Canal to the left of Dhulmia Canal. No study about the project was made after that of Nedeco, until Euphrates Center for Studies and Design prepared a study of the integrated irrigation and drainage network in 1990. Drainage network up to collector drains

were implemented between 1993 and 1995. In addition to a pumping station, that was constructed in 1996. The irrigated area covered by the project's canals is 410,000 dunams, of which 240,000 dunams covered by drainage network. Irrigation Network consists of Babil Canal, which was mentioned earlier in Hilla-Eskandariah project and a number of canals which feed by gravity or private pumps, the most important of which are:

- a. Wardia Canal: Branching at the 36.9 km distance from Hilla Branch. Canal length is 8.1km long and the discharge is  $1.3\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1.25m x1.5m.
- b. Bermama Canal: Branching at the 57.4km distance from Hilla Branch. Canal length is 9km long and the discharge is  $1\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1mx1.3m.
- c. Meshaimish Canal: Branching at the 61.7km distance from Hilla Branch. Canal length is 8.1km long and the discharge is  $0.7\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1mx1.2m.
- d. Rubianah Canal: Branching at the 70.26km distance from Hilla Branch. Canal length is 5.5km long and the discharge is  $0.7\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1mx1.2m.
- e. Bashya Canal: Branching at the 74.7km distance from Hilla Branch. Canal length is 9km long and the discharge is  $0.7\text{m}^3/\text{s}$ .
- f. Kedis Canal: Branching at the 76.6 km distance from Hilla Branch. Canal length is 9km long and the discharge is  $0.7\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1.4mx0.8m.
- g. Khamisiah Canal: Branching at the 76.68km distance from Hilla Branch. Canal length is 25.45km long and the discharge is  $6\text{m}^3/\text{s}$ .
- h. Awadel Canal: Branching at the 76.95km distance from Hilla Branch. Canal length is 15.4km long and the discharge is  $2.7\text{m}^3/\text{s}$ . Canal head regulator consists two openings of dimension 1mx1.2m.
- i. Zebar Canal: Branching at the 81.12km distance from Hilla Branch. Canal length is 0.9km long and the discharge is  $0.81\text{m}^3/\text{s}$ .
- j. Um Al-Wared Canal: Branching at the 88.7km distance from Hilla Branch. Canal length is 30km long and the discharge is  $3.5\text{m}^3/\text{s}$ .
- k. Shomeli Canal: Branching at the 90.2km distance from Hilla Branch. Canal length is 35.5km long and the discharge is  $6.2\text{m}^3/\text{s}$ .
- l. Dhulmia Canal: Branching at the 95.84km distance from Hilla Branch. Canal length is 32km long and the discharge is  $7.1\text{m}^3/\text{s}$ . The land to the left of this canal is in the boundaries of Hilla- Hashmia hill project, while the land to the right, is within the boundaries of Hurriya-Daghara project.

Drainage network consists of the following:

- a. Main drain with total length of 93.3km.
- b. Branch and secondary drains with total length of 343km.
- c. collector drains with total length of 318km.
- d. Al-Shomeli drainage station, which pumps the water to MOD, where it has

3 pumping units of  $5.3\text{m}^3/\text{s}$  discharge per each. The length of the carrier canal from the station to MOD is 20km.

### 8.3 Hilla-Diwaniyah Project

Hilla-Diwaniyah project is no different from the Hilla-Hashimia project except that it feeds from the right side of Hilla Branch through other canals. Drainage network is connected to East Shamiya drain. The project is a part of the Hilla-Diwaniyah-Daghara project, which was submitted by Nedeco, this was divided into two projects, the first involving 3 sectors of the right of Hilla Branch, named after Hilla-Diwaniyah project, and the second includes the sectors of Shatt Al-Daghara. The net area Hilla-Diwaniyah project is 282,000 dunams. Development of the project was implemented by the Greek company Scapaneus, which was initiated in 1975, but the project is still a partially-reclaimed project.

The irrigation system in the project includes several canals, the most important of which are:

- a. Tajiah Canal: Branching at the 45.75km distance from Hilla Branch. Canal length is 8.77km long and the discharge is  $0.65\text{m}^3/\text{s}$ . Canal head regulator consists one opening of dimension 1.5mx0.6m.
- b. Qadisiyah Canal: Branching at the 47.6km distance from Hilla Branch. Canal length is 32.2km long and the discharge is  $8.1\text{m}^3/\text{s}$ . Canal head regulator consists two openings of dimension 1.2mx1.5m. Qadisiyah Canal supported by First Irwaiyah pumping station, which includes 3 pumping units, each discharging  $0.75\text{m}^3/\text{s}$ .
- c. Doora Canal: Branching at the 51.8km distance from Hilla Branch. Canal is partially lined and its length is 25km long, the discharge is  $3.6\text{m}^3/\text{s}$ . Canal head regulator consists two openings of dimension 1.2m x1.5m.
- d. Himeinia Canal: Branching at the 54.37km distance from Hilla Branch. Canal length is 8.5km long and the discharge is  $0.62\text{m}^3/\text{s}$ .
- e. Wesmi Canal: Branching at the 54.9km distance from Hilla Branch. Canal length is 4.2km long and the discharge is  $0.2\text{m}^3/\text{s}$ .
- f. Elaj Canal: Branching at the 56.47km distance from Hilla Branch. Canal length is 31.5km long and the discharge is  $6.8\text{m}^3/\text{s}$ . Canal head regulator consists two openings of dimension 1mx2m.
- g. Abu Qamchi Canal: Branching at the 60.2km distance from Hilla Branch. Canal length is 7.68km long and the discharge is  $0.58\text{m}^3/\text{s}$ .
- h. Amadiya Canal: Branching at the 61.97km distance from Hilla Branch. Canal length is 11.2km long and the discharge is  $1.1\text{m}^3/\text{s}$ .
- i. Jarboua'ya Canal: One of the large canals branching from the right of Hilla Branch, such as Qadisiyah and Haidari and Wardia Canal. This canal, branching at the 62.6km distance from Hilla Branch. Canal length is 29.35km long and the discharge is  $9.63\text{m}^3/\text{s}$ . Canal head regulator consists two opening of dimension 2mx1.5m. Canal is supported by Second Irwaiyah

pumping station, the station includes 3 pumping units of  $1.5\text{m}^3/\text{s}$  discharge capacity.

- j. Hashmia Canal: Branching at the 65km distance from Hilla Branch. Canal length is 13.13km long and the discharge is  $1\text{m}^3/\text{s}$ .
- k. Bazul Canal: Branching at the 85.75km distance from Hilla Branch. Canal length is 4.5km long and the discharge is  $0.71\text{m}^3/\text{s}$ .
- l. Ebaikher Canal: Branching at the 88.15km distance from Hilla Branch. Canal length is 5.8km long and the discharge is  $0.53\text{m}^3/\text{s}$ .
- m. Haidari Table: One of the large canals where it branches at the 90.35km distance from Hilla Branch, it also extends within the boundaries of Qadisiyah governorate and reaches the length of the Table to 28.27km and discharged  $7.42\text{m}^3/\text{s}$ . Canal head regulator has two openings with dimensions of  $2\text{m}\times 3.2\text{m}$ .

Drainage network in this project, which flows into Eastern Shamia Drain, consists of the following:

- a. 32.19km main drain.
- b. Branch drains with total length of 266km.
- c. Secondary drains with total length of 511.36km.
- d. Collector drains with total length of 832km [10, 2, 15, 12, 9, 11].

## 9. Hurriya-Daghara Project

It is one of the important and large projects that feed mainly from Shatt Al-Daghara, in addition to the right of Dhulmia Canal and Hurriya Canal which are branching from Hilla Branch and Sharifiya Canal, which is branched from the left of Shatt Al-Diwaniyah. This project covers 6 sectors of the Hilla-Diwaniyah-Dagarh project. Most of the project's land is exploited through old canals and there are reclaimed sectors, some of which are still in the process of being reclaimed. A new 23km of Shatt Al-Daghara was excavated in 1952, replacing the old route and being linked to the rest of the old route to the length of Shatt Al-Daghara to 65km. The net area of the project is approximately 643,000 dunams. One of the best sectors of the project in terms of completing the work of lining and reclamation is Sector 4, which includes Thuraima Canal and Right Jannabia Canal, where the Bulgarian company Akrocomplecet developed this sector, and carried out the full reclamation for an area of 65,000 dunams. The development of Sector 7 of the project was initiated in 2001 and is still under development. The irrigation system consists of canal described in Table 1 below, as well as right side of Dhulmia Canal.

**Table 1: Canals of Hurriya-Daghara Project. (Sources:[16][17]).**

Canal Name	Canal Type	Canal length (km)	Canal discharge (m <sup>3</sup> /s)	Branching Side	Kilometric distance of branching
<b>From Hilla Branch</b>					
Hurriya	Earth	6	7	Left	101
<b>From Shatt Al-Diwaniyah</b>					
Sharifiyah	Lined	15.6	2.86	Left	0.34
<b>From Hurriya Canal</b>					
North Hurriya	Earth	3	18.6	Tail	6
South Hurriya	Earth	2	24.3	Tail	6
<b>From Shatt Al-Daghara</b>					
Abu Sabkha	Lined	11.9	5.95	Right	10.9
Um Al-Sukhaila	Earth	4.4	0.4	Right	15
Um Henain	Lined	6.3	0.5	Right	16.15
Warshana	Earth	3.5	0.5	Right	18.14
Fawara	Lined	9.7	2	Right	19.19
Main Jo'an	Lined	15.2	8.5	Right	20.13
Tubar Shekheir	Earth	10.9	5.3	Left	27.32
Al-Fani	Earth	13.3	2	Left	28.3
New Jo'an	Earth	9	1.7	Right	30.3
Nuffar Canal	Earth	4.3	0.6	Left	31.7
Al-Kheir	Earth	14.5	3	Right	32.1
Nuffar River	Earth	14.4	2.8	Left	39.3
Main Juheish	Lined	27.6	4.5	Left	41
Thuraima	Lined	52	38.5	Right	42.39
Noniah	Lined	7	0.4	Left	43.1
Efach	Lined	17.5	2	Left	43.38
Aradat	Lined	4.2	0.6	Left	60.25
Kafarat	Earth	4.17	0.4	Left	61.5
Limfawiyah	Lined	3.8	0.3	Left	62.6
Right Jannabiya	Lined	30.6	8	Right	64
Left Jannabiya	Lined	27.1	6.4	Left	64.1
Shatt Al-Daharra Tails	Earth	24.48	1.9	Tail	65

Most of the project's land is irrigated by gravity, except for Abu Sabkha canal, some of the lands in the boundary of the canal irrigated by pumping, a pumping station on canal route of seven metric pumping units. The project covered by a large drainage network that collects and discharge drainage water to MOD. There are two main drains in the project, the first drain MD III to the left of Shatt al-Daghara, with a length of approximately 75km, and the second drain MD IV to the right of Shatt al-Daghara, with a length of approximately 53 km [10, 2, 5, 16, 17].

## **10. Shatt Al-Diwaniya Projects**

Few canals are branching form Satt Al-Diwaniya, starting from Shatt Al-Diwaniya head regulator till Ruamaitha project boundary, the lands of the project is not reclaimed yet, and many canals depends on private pumps.

After Hilla Branch, Shatt Al-Diwaniya continues for a distance of approximately 120km and discharge is  $60\text{m}^3/\text{s}$ . A cross regulator is located in Siniya sub district at the 34.5km distance Shatt Al-Diwaniya. Due to the high levels of groundwater in Diwaniya city and the implementation of a new head regulator for Shatt Al-Diwaniya and its increased discharge, and to secure water for cities located downstream, Shatt Al-Diwaniya Diversion Canal has been implemented. It is a 27.9 km long,  $45\text{m}^3/\text{s}$  discharge capacity lined canal, which passes two-thirds of the discharge and one-third of the discharge is left to run in Shatt Al-Diwaniya within its original course within the city of Diwaniya.

The canal begins from the right Siniya regulator and continues along the borders of the city of Diwaniya and flows into Shatt Al- Diwaniy at the distance of 62 kilometers.

Upstream Siniya regulator also, New Shafiya Canal is branching, a 30km long earth canal and discharge is  $15.7\text{m}^3/\text{s}$ , a new pumping station comprising 4 units has been implemented on Shatt Al-Diwaniya Diversion Canal, with the aim supporting discharges of New Shafiya for future reclamation. Also, Old Shafiya Canal, an earth canal that branches at a distance of 35.82km from Shatt Al- Diwaniya, the canal extends 7.8km long and its discharge  $1\text{m}^3/\text{s}$ .

The remaining distance within Diwaniya and Hamza districts from Shatt Al-Diwaniya is watered through earth canals and private pumping stations [5, 3, 17].

## 11. Rumaitha Irrigation Project

It is one of the old projects at the tails Hilla Branch, where it irrigates the land of the Rumaitha district. From 1940 to 1954, General Irrigation Directorate organized irrigation in the project and constructed canals and regulator. Project has two sections of a 144,000-dunam winter irrigation section and a summer irrigation area of 35.5 thousand dunams.

The irrigation system within the project consists of several canals, the most important of which are:

1. Al-Hechaimi Canal: The length of the canal is 20km and discharge of  $3.36\text{m}^3/\text{s}$ , canal head regulator has one opening with dimensions of  $1.5\text{m}\times 3\text{m}$ .
2. A'wja Canal: The length of the canal is 13.5km and discharged of  $2.21\text{m}^3/\text{s}$ , canal head regulator has one opening with dimensions of  $1.5\text{m}\times 3\text{m}$ .
3. Qazwini Canal: The length of the canal is 18km and discharge of  $2.27\text{m}^3/\text{s}$ , canal head regulator has one opening with dimensions of  $2.2\text{m}\times 3.75\text{m}$ .
4. Nu'mani Canal: The length of the canal is 6km and discharge of  $1.36\text{m}^3/\text{s}$ , now feed from Shatt Al-Rumaitha Support Canal.
5. A'rdhiat Canal: The length of the canal is 18km and discharge of  $18\text{m}^3/\text{s}$ .
6. Nejmei Canal: The length of the canal is 10km and discharge of  $1.6\text{m}^3/\text{s}$ , canal head regulator has one opening with dimensions of  $1.7\text{m}\times 3.1\text{m}$ .
7. Abu Sekhair Canal: The length of the canal is 4km and discharge of  $1.5\text{m}^3/\text{s}$ , canal head regulator has one opening with dimensions of  $1\text{m}\times 1.2\text{m}$ .

Further, there is the important Gat'aa Regulator on Shatt Al-Ruamaitha, which consists of 4 openings of dimensions  $2.2\text{m} \times 3.75\text{m}$  and passes a discharge of  $9.55\text{m}^3/\text{s}$ . The project was studied by Nespac Company from Pakistan and has drawn up plans for the necessary lining and reclamation work. In 1971, Dar Baghdad Company also prepared a study about the main project drains, consisting of main Rumaitha Drain of length 58km, the main Qazweini Drain with length of 38km and the Eastern Drain with length of 37.5km. Excavations of the main drains for the project were made, which was flowing into Euphrates River, now connected to Eastern Euphrates Drain. Due to of the scarcity of water that affected Iraq in 1999, and as Rumaitha lands in the tails Hilla Branch system. A new canal built to support Rumaitha with water, it is Shatt Al-Rumaitha Support, and it feed from the upstream of Khawarnaq Regulator near the city of Ghamas, which is part of the Kifl-Shinafiyah project. Canal was implemented within 3 months in 2000 and is a 64.5 km-long,  $15\text{m}^3/\text{s}$  discharge capacity lined canal [2, 5, 13, 7, 6].



## **12. Kifl-Shinafiyah project**

Kifl-Shinafiyah project is one of the old existing. The project begins from the branching of Euphrates River near Kifl city to Kufa and Shamiya Branches and ends when they meet near the city of Shinafiyah. The project is an important and socially complex. The project was initially studied by the U.S. company TAMS in 1958 to develop river navigation in the region. From 1975 to 1978, Selkhozpromexport Company conducted investigations and studies and submitted its report in 1980. The French company Sugrea then developed the designs of the regulator on Kufa and Shamiya Branches, although there are regulators at the end of Kufa Branch carried out during the 1930s and 1950s. The designs of the main drains were then developed by Nespac Company, namely Eastern Euphrates, Western Shamiya and the Najaf Sea Drains. The Indian consultant WAPCOS also prepared the designs of the irrigation and drainage networks for the Kifl-Shinafiyah project, the report was submitted in 1983, with net area of 664,000 dunams.

One of the phenomena prevalent in this region is what is known as the phenomenon (Nagarat), which is a waterfall developed in the river due to the difference and as a result of the occurrence of the waterfall and the erosion of the point of its estuary the waterfall moves upstream, causing a decrease in the levels of rivers and affecting irrigation. The project comprises a number of major Barrages and regulators, and it has been considered that the navigation route on Kufa Branch as the largest branch and the route of the approved river navigation line. The Barrages in the project are Kuafa, Meshkhab and Abu Ashraa Barrages, while the main regulators are Abbasiyah, Shamiya, Khawarnaq and Al-Ya'aw Regulators.

Irrigation network in the project is mainly composed earthen canals which feeds Shamiya and Kufa Branches. Table 2 and Table 3 below illustrate the branching of the canals within Kifl-Shinafiyah project.

**Table 2: Canals branching from Kufa Branch. (Source:[18]).**

Canal name	Discharge (m <sup>3</sup> /s)	Length (km)	Irrigated area (thousands dunams)
Chahat	28	33.4	27.25
Sedeir	3.2	28	9.5
Abu Gedha'	4.2	18	9
Bedairiyah	8	26.5	24
Hashimiy	2.2	13	12.3
Shahriyah	4.2	4.2	15.2
Turra	4	4.2	2
Azzamiyah	4	3	1
Jala'awiy	2	4	1
Keshikheil	1	3	1.15
Bachay	1	2	0.5
Abu Dananer	3.2	5.8	1.8
A'rfy	3.2	4.1	1.45
Malha wal Daham	1	2.5	1.1
Mejehleiah	2	3.2	1.8
Debaineiah	15	9.1	6.19
Sewariah	16	8.1	1.29
Right Jannabia	9	9.3	7.35
Shallal	12	9.5	9.6
Sayed Alwan	1	2	0.4
Mawlani	1	2.7	1.45
A'yesh	1	9.2	0.96
Gat'at Al-Marashdah	1	2.6	0.63
Gat'at Al-Zurfan	1	2.5	1.26
Left Jannabia	10	6.1	7.15
Al-Leithawi	5	4.1	0.95
Al-Ehaimer	6	8.9	2.5
Abdullah Al-Majeed	3.5	2.7	0.45
Abu Al-Dejaej	1	3.3	0.75
Al-Rufai'	2	4.9	0.75
Bezaiz Shatt Al-Ghazali	3	7.8	0.95
Da'ariah	1	2.3	0.4
Um Al-Housh	1	2.5	0.45
Tubar Hamadi	12	9	13.5
Tubar Al-Jawasim	1.5	3	1.3
Shiblawi	6	6.9	8.5
Qadisiya	9	9.4	4

**Table 3: Canals branching from Shamiya Branch. (Source:[18]).**

<b>Canal name</b>	<b>Discharge (m<sup>3</sup>/s)</b>	<b>Length (km)</b>	<b>Irrigated area (thousands dunams)</b>
Haidari	9	16	12
Al-Adel	1.5	4	1.5
Wahabi	9	18	10
Abu Gharab	9	16	12
A'ryan	5	15.7	5
Fatha	9	15.7	5.5
Al-A'ma	9	7	5
Ayashy	1	1.6	1.5
Um Hayaia	9	9	10
Abu Khora	5	4.5	5
Abu Dawanech	1	3.5	1
Al-Zayde	7	6.9	3
Vartical Al-Masy	12	18	12
Mehanawiyah	12	21	2.5
Cheihan	2	12	5
A'gar	2	5.6	3.2
Ghudheib	1	9	2.75
Hadady	1	7	0.65
Mehdi Al-Asal	2	5	4.68
Najarmah	9	5	14.1
Gharbasha	1.5	9	2.35
Ghashaniyah	4	4	6.27
Daragha	3	4	4.73
Mu'abrah	2	14	2
Feidha	2	4	4.7
Tubar Al-Ibrahim	6	3.5	12
Hawi	2	10	4.6
Abu Halan	0.5	10	0.9
Dhahi Al-humood	1	4	1.35
Al-Negheil	1	11	2
Al-Nehas	1	6	3
Neghaisheiah	0.5	4	1

It is noticeable that no canal is branching from Kufa Branch until Manathra district. Among the canals referred to Sedeir Canal, which is the only one that feeds Najaf Sea region.

The reclamation for small sector in the project to the right of Shamiya Branch was initiated in 2008 and for a square of 12,000 dunams.

Drainage network is mainly Eastern and Eastern Shamiya Drains, which flows into Euphrates River.

Drainage network includes a number of pumps, which are:

1. Northern Kufa pumping station with two metric pumping units and a pumping unit of discharge  $0.75\text{m}^3/\text{s}$ .
2. Southern Kufa pumping station with two metric pumping units.
3. Kasrat Chahat pumping station which includes 3 metric pumping units.
4. Bakriya Drainage pumping station which includes a half-metric pumping unit.

Finally, it is worth to mention that in 1993 a support canal which called Qadisiya Canal were dug, started from the upstream of Abu Ashra Barrage and flow towards Atshan Branch to the south of Shinafiyah in order to support discharges in Atshan which is a branch of Euphrates [10, 2, 5, 13, 18, 8].

## **13. Lower Euphrates Projects**

These are projects that located on Euphrates downstream Shinafiyah city in Muthana and Dhi Qar governorates. These projects are mainly among large, unfinished future projects, namely, Shinafiyah-Nasiriya, Muthana and Souq al-Shoyukh. Lower Euphrates projects include:

### **13.1 Pumping Irrigation Projects in Muthana Governorate**

Small projects which are watered by pumping from Euphrates River within Muthana governorate, the pumping stations were established before 2003 as part of the farming campaigns. Its details are in Table 4 below.

**Table 4: Pumping irrigation projects in Muthana governorate. (Source:[2]).**

<b>Project/Station Name</b>	<b>Irrigated Area (thousand dunams)</b>	<b>Design Discharge (m<sup>3</sup>/s)</b>
Al-Khedhir	10	3
Tal Al-gut	10	4
Al-Tubba	20	3
Al-Bedeir	4	1
Al-Ghadeir	10	1
Siweir tails	20	3
Al-Kheir	5	1
Al-Kawthar	10	1

### **13.2 Muthana Irrigation Project**

One of the proposed projects in Muthana governorate, where its boundary lies between Shatt Al-Siweir and Euphrates River, was presented by Swiss consultants in 1981. Its net area at the time of development is 48,000 dunams. It is currently irrigated by canals and pumps, which is an irregular irrigation system, while the Drainage network was implemented after 2005 and includes a main drain and a number of branch and secondary drains in addition to a pumping station that raises the drainage water to Eastern Euphrates Drain, the station includes 3 pumping units, each of which discharges 1.35m<sup>3</sup>/s.

### **13.3 Euphrates Tail system**

When Euphrates at Souq Al-Shuyokh district, the river branched into a series of branches that feed agricultural canals in the area. The development of the area was studied by TAMS in 1952, and a number of barrages and regulators were built later. These are Ghlewen Regulator, Ekaikah Barrage, Garmat Hassan Regulator and Haffar Barrage [3, 2].

## **14. Al-Kheir Projects**

Although the status of these projects is not currently clear, they are considered cancelled projects. However, some of the land of these projects is still being exploited by farmers, and some are currently flooded. With the fact that some canals may be submerged or studied, the size of these projects, which amounted to nearly one million dunams, justify the importance to know about these projects. Al-Kheir projects were started to reclaim land from the marshes in 1996 and the work was extended until 2003. Among the projects are:

1. Hour Odeh project in Al-Salam sub district of Maysan governorate, with an area of 2,100 dunams.
2. Wawyah project in Majar district, with an area of 6,400 dunams.
3. Maleha project in Hammar Marsh to the right of Euphrates River, the area was 122,000 dunams.
4. Shafi project, to the right of Euphrates in Souq Al-Shoyukh district, the area was 122,000 dunam, this project is a sector form the planned Shatt Al-Arab Irrigation Project.
5. Right Euphrates in the district of Souq Al-Shoyuk, with an area of 40,000 dunams.
6. Um Nakhla project in Garamat Bani Sa'eid, the area was 80,000 dunams.
7. Many projects on Glory River.

There is currently no statistics or proven description of the status of these projects, and as of the year 2000, the cost of 27.6 billion IQD was spent [6].

## **15. Conclusion**

Several conclusions are noticeable about Irrigation exploitation status along Euphrates River inside Iraqi territories, which are:

1. Projects downstream Shinafiyah and Shatt Al-Diwaniyah Regulator Barrage has a less relatively development comparing to other lands upstream of these two stations.
2. Major development occurred in Abu Ghraib, Musayab and Hilla Branch projects. Other areas downstream need more interest for future.
3. Irrigation projects on Euphrates are long existing projects, mean that social and tribal aspects have influence on the development programs.

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