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STEADY FLOW ANALYSIS FOR SHATT AL- HILLA USING HEC-RAS PROGRAM

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ABSTRACT

Hec-Ras 5.0, 2016 program is an applied software package for simulation of river network in steady and unsteady flow regime. In this paper the model simulation with field survey for Shatt Al-Hilla is verify with different types of outputs resulted in both tabular and graphical, results were showed using different effective elements like discharge, velocity, elevation, Stations. In this paper, HEC - RAS program is applied to analysis Shatt Al Hilla for 51.100 km length of it for each 100 m long and herein illustration of the calculation results, results showed that at downstream max. water surface elevation for discharge 70 m^3/s is 4.19 m and hydraulic depth is 3.47 m while; for 170 m^3/s is 6.10 m and 5.21m which means that each 10 m^3/s discharge is raising water surface elevation about average 18 cm, which made the expectation of water surface elevation for each discharge ranged between (70 – 170) m^3/s is easy, water surface elevation in meter increase with the increase of discharge in Shatt Al- Hilla and the velocity of the river changes according to the cross section and can be noticed that the velocity increased when the river pass inside center of Al- Hilla city from the beginning of the specific researched area.

Key words: HEC-RAS Program, Shatt Al- Hilla, water.

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1. INTRODUCTION

Flow dynamics understanding in a river system is an essential step to the water needs agreement *(Traore Vieux Boukhaly, et. al., (2015))*. This representation documentations by the assessment essential factors of flow like water surface, Froude number, velocity of water flow… In this paper, we focus on the Shatt Al- Hilla within hilla city(K. N. Kadhim and Ahmed H).

When the various parameters at any point do not change with time, this flow is called Steady flow. unsteady (non-steady)is the flow in which changes with time do occur. In practice, steady flow is the exception rather than the rule, but many problems may be studied effectively by supposing that the flow is steady (K.N.Kadhim, 2018).

Hec-Ras 5.0, 2016 program is an applied software package for simulation of river network in steady and unsteady flow regime which is based on hydraulic routing. This program is commonly mentioned in hydraulic systems analysis. *(Gary W. Brunner, 2016 and Hassan &K.N.Kadhim, 2018).*

2. MATERIAL AND METHOD

2.1. The Case Study

The selected project is Shatt Al-Hilla , it's the main channel that branches from left side of Euphrates river just at the upstream of the new Hindiya Barrage. It's total length equal to (101 km), beginning from its head regulator, km (00.000), to Daghara head regulator, km (101.000), Hilla city is located at about (100 km) south of Baghdad city. Shatt Al-Hilla passes through the city, dividing it into two parts (See Figure (1)). Hilla city depends solely on it for maintaining all its water needs.

Figure 1 Site plan of Shatt Al-Hilla within Hilla city by google earth website

2.2. Methodology

HEC-RAS Software

HEC-RAS (where H refer to Hydrologic, E : Engineering, C : Center, R : River , A: Analysis and S: System) is numerical program for flow river hydraulic calculations. In this program three hydraulic components for flow analysis: Steady flow; unsteady flow; and sediment transport computations *(Ahmad Hakim Farooq et. al., (2016)).* One-dimensional flow characteristics calculations is usually used containing water surface profiles, energy grade line, depth of water, velocity, wetted perimeter for steady and unsteady river flow. These calculations are necessary in the analysis of various problems. In this paper, to perform flow parameters, the steady flow component was used of the Shatt Al Hilla to analyze this hydraulic system. The basic records wants for simulation are involved: geometric data, schematic of river, length of the reach, coefficient of Manning, contraction coefficient and expansion coefficient. *(Gary W. Brunner, 2016).*

2.3. Constraints which are used in HEC–RAS (5.0, 2016) software

Table 1 below shows The input parameters which were used in the program. Each constraint was either measured directly or calculated from hydrologic equations or was already patterned in the model.

Table 1 Input constraints which are used in HEC-RAS

Symbol	Description	Determination
n	Manning coefficient (Constant depends on type of channel and description)	(0.035) for straight, full no rifts or deep pool.
$Q_1(m^3/s)$	Minimum Discharge of water	70 (m^3/s) From "Iraqi Meteorological Office of Water Source, Babylon governorate"
$Q_2(m^3/s)$	Maximum Discharge of water	170 (m^3/s) From "Iraqi Meteorological Office of Water Source, Babylon governorate"
Cont.	Contraction coefficient of flow	0.1 for gradual transitions
Exp.	Expansion coefficient of flow	0.3 for gradual transitions

The cross section of Shatt Al-Hilla that is used in this paper at 51+100 Km from the barrage, the cross section geometry for the section has been considered as a trapezoidal shape (see Fig. (2)).

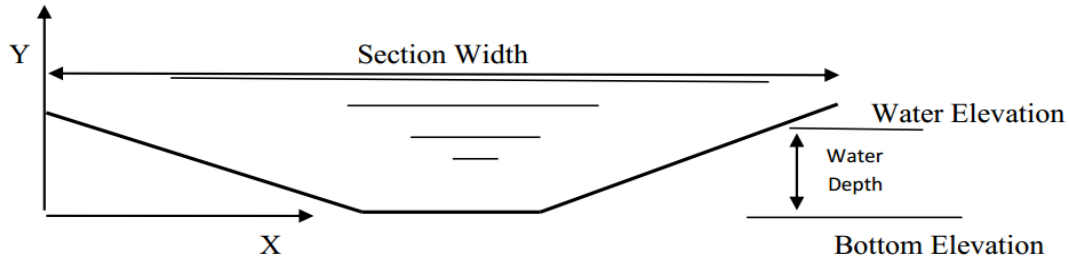


Figure 2 the cross section of Shatt Al_Hilla

3. SIMULATION USING HEC-RAS MODEL

For this paper, steady flow simulation was developed for 51.100 km length for each 100 m in Shatt Al Hilla using HEC-RAS [Version 5.0,(2016)] Figure (3) shows the main window of the HEC-RAS program.

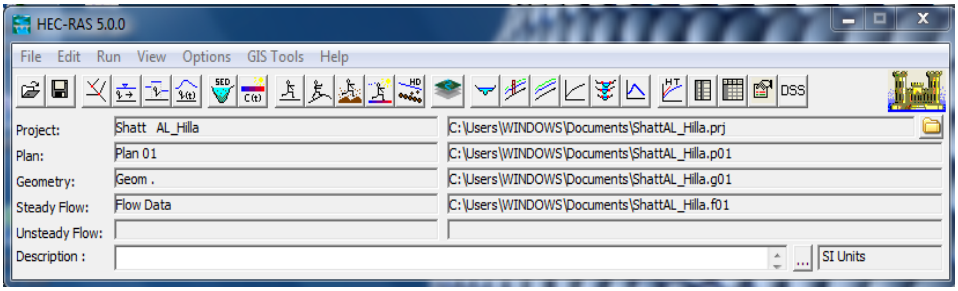


Figure 3 Chief menu of HEC-RAS program

Two essential files are required for making a simulation: (The geometric file and flow file) *(Khassaf Saleh I. and Shakir Saleh I., (2013))*

The following sections are presented the input records essential for running a steady HEC-RAS software.

3.1. Geometric File

To progress HEC-RAS program, the first step for generating a HEC-RAS geometric file. which involves of founding how the different river reaches are linked; data of cross section; length of the river reach; energy loss coefficients); stream junction information. Records were entered to the program via the menu of cross section geometrical records (see Figure (4)).

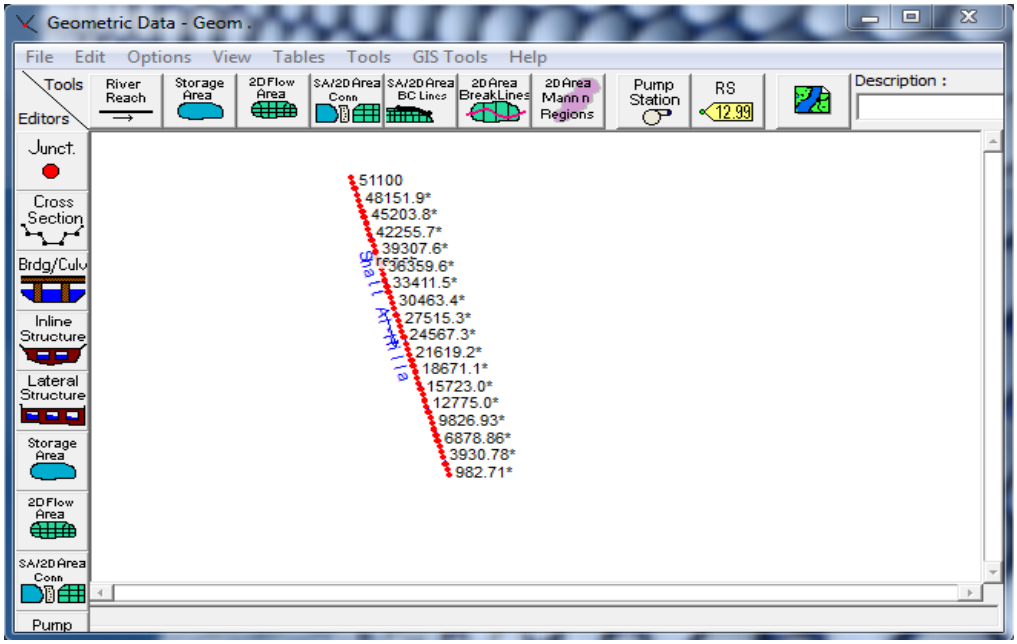
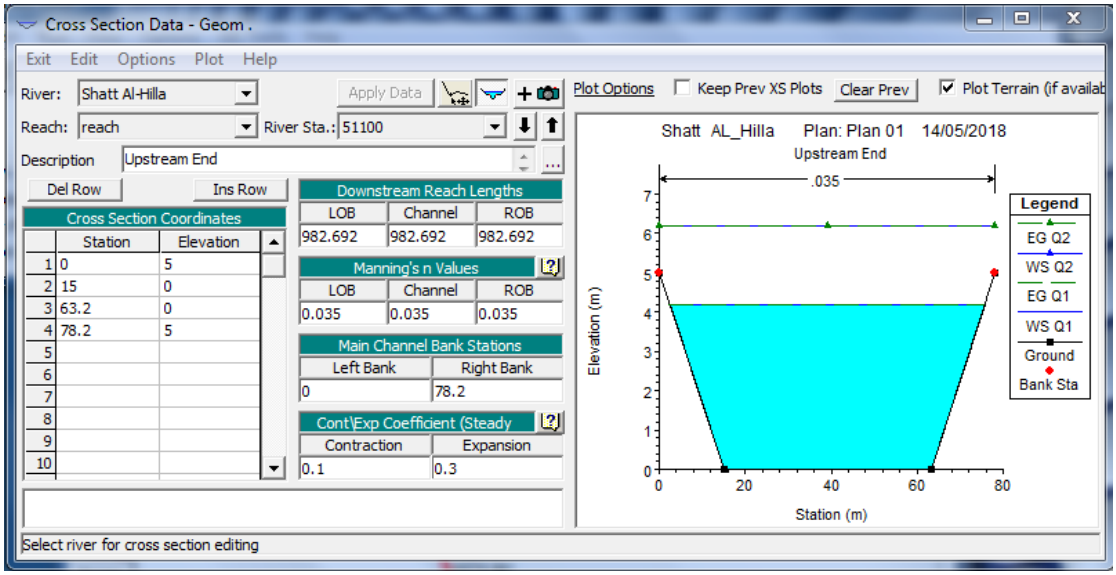


Figure 4 Input menu of cross section data for Shatt Al- Hilla

3.2. Geometry of the Cross Section

Boundary geometry is definite in terms of cross sections,. it is labeled by the stations and their elevations records from left to the right, Figure (5) shows some of cross sections.



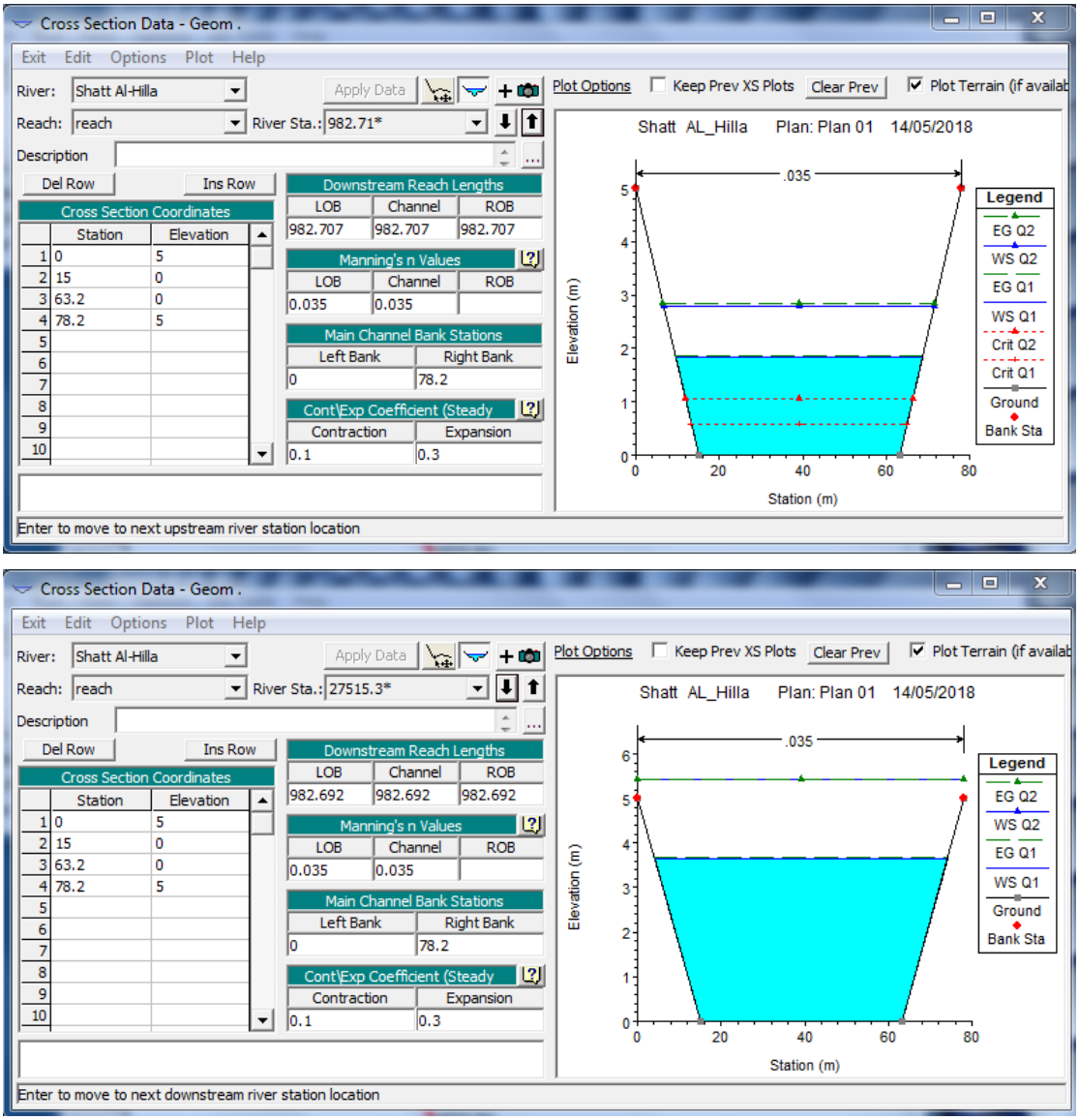


Figure 5 Different Cross sections

3.3. Steady Flow Data

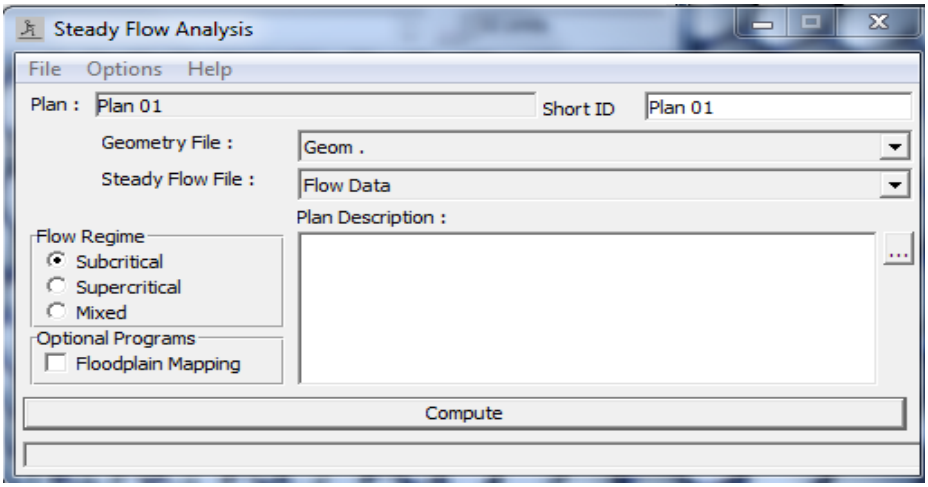


Figure 6 Steady flow analysis for Shatt Al-Hilla

HEC-RAS is capable for performance profile of water surface calculation for steady flow in normal or constraxted channels, subcritical, supercritical and mixed flow regime water surface profile can be calculayed. This paper, subcritical flow performed for steady flow analysis foe Shatt Al-Hilla as shown in Fig. 6

Fig. (7) show the steady flow data menua for Shatt Al-Hilla with two discharge values (Q1, Q2 which are minimum and maximum discharge) with length equal to 100 m for each reach.

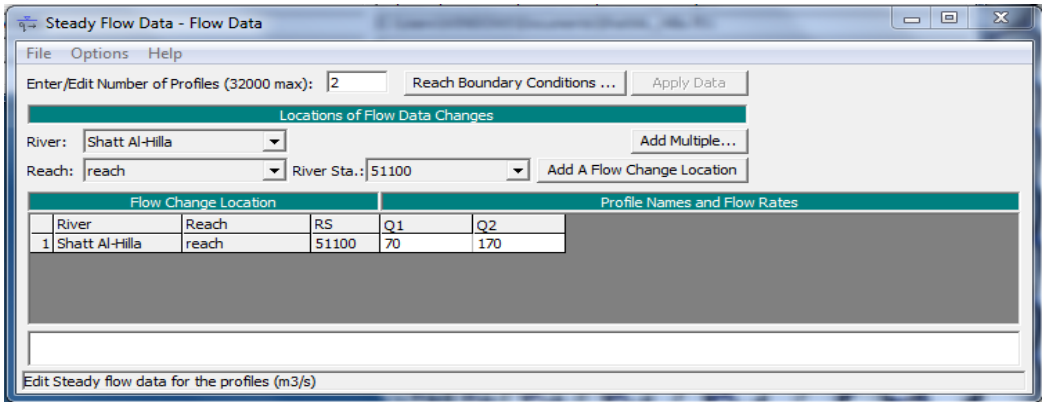


Figure 7 Steady flow data menua for Shatt Al-Hilla

4. RESULTS AND DISCUSSION

In this paper, after completed inserting steady flow data in the suitable places and clicked on "Run" button in the steady flow analysis, the program completed simulating the steady flow data and showed the result in View/ Steady flow Output (see figure 8).

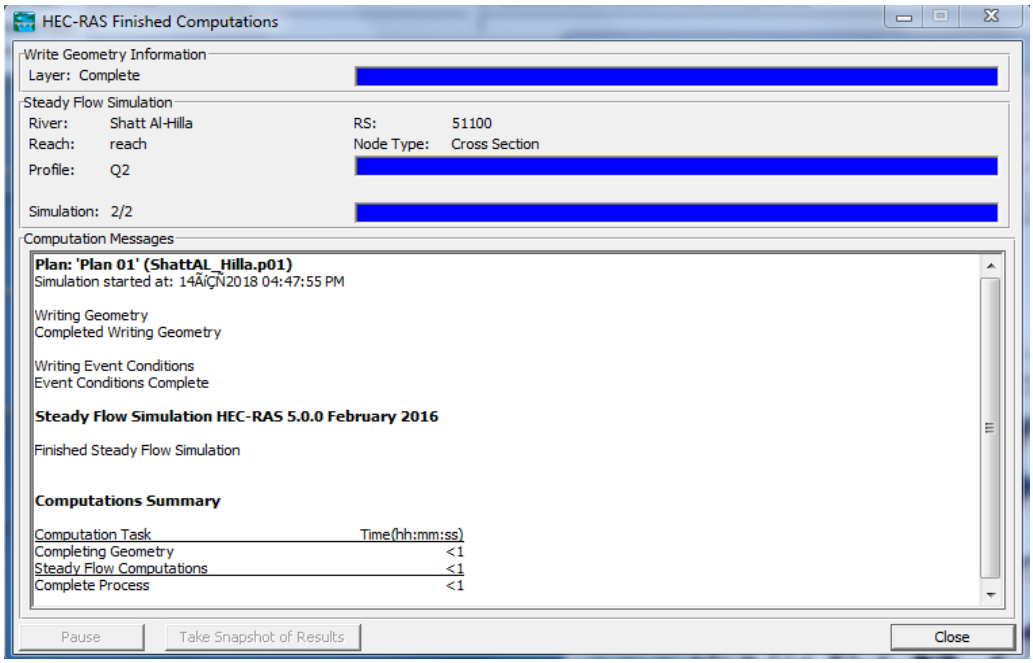


Figure 8 HEC-RAS Finished menua for Shatt Al-Hilla

So the HEC-RAS program results showed that the velocity of the river changes according to the cross section and can be noticed that the velocity increased when the river pass inside center of Al- Hilla city from the beginning of the specific researched area as shown in Figure (9).

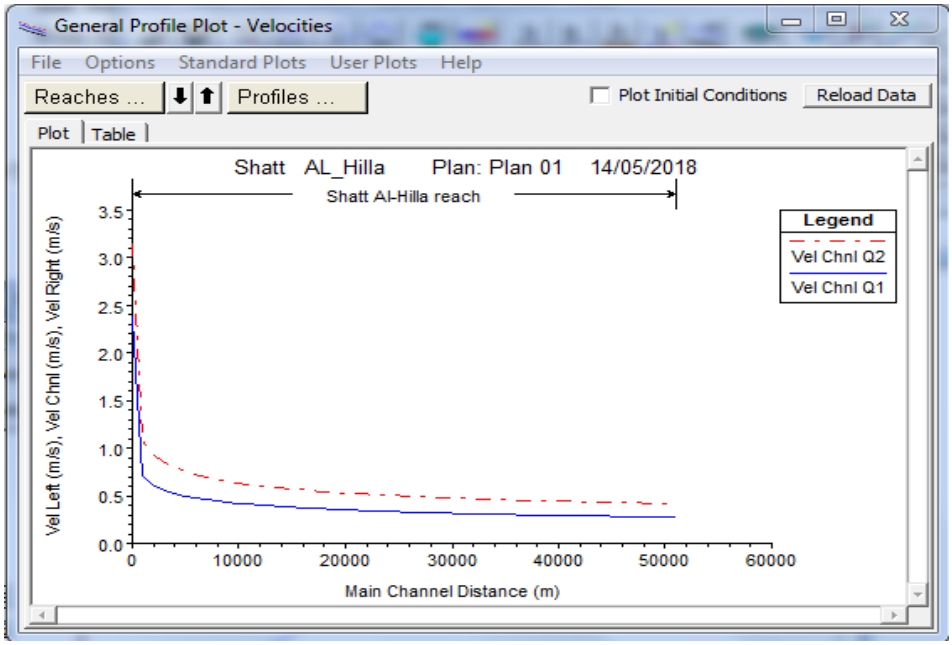


Figure 9 The relationship between velocity and its station

The water surface elevation in meter increase with the increase of discharge in Shatt Al-Hilla as shown in the rating curve

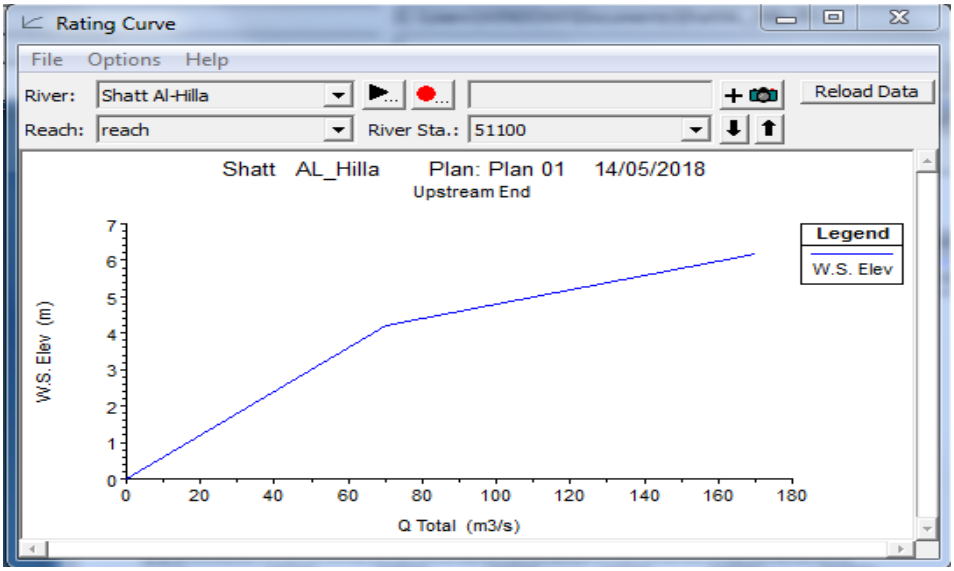


Figure 10 Rating curve plot.

HEC-RAS results showed that at downstream max. water surface elevation for discharge 70 m^3/s is 4.19 m and hydraulic depth is 3.47 m while; for 170 m^3/s is 6.17 m and 5.21m which means that each 10 m^3/s discharge is raising water surface elevation about average 18 cm, as shown in figures (11 and 12); which made the expectation of water surface elevation for each discharge ranged between (70 – 170) m^3/s is easy.

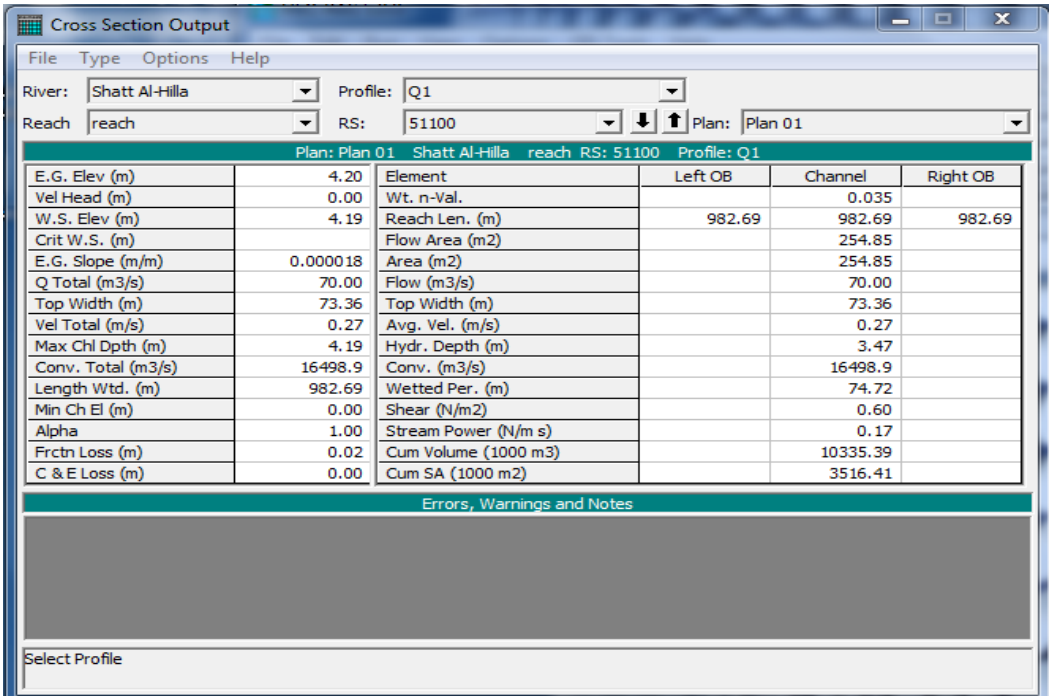


Figure 11 Cross section output for minimum discharge.

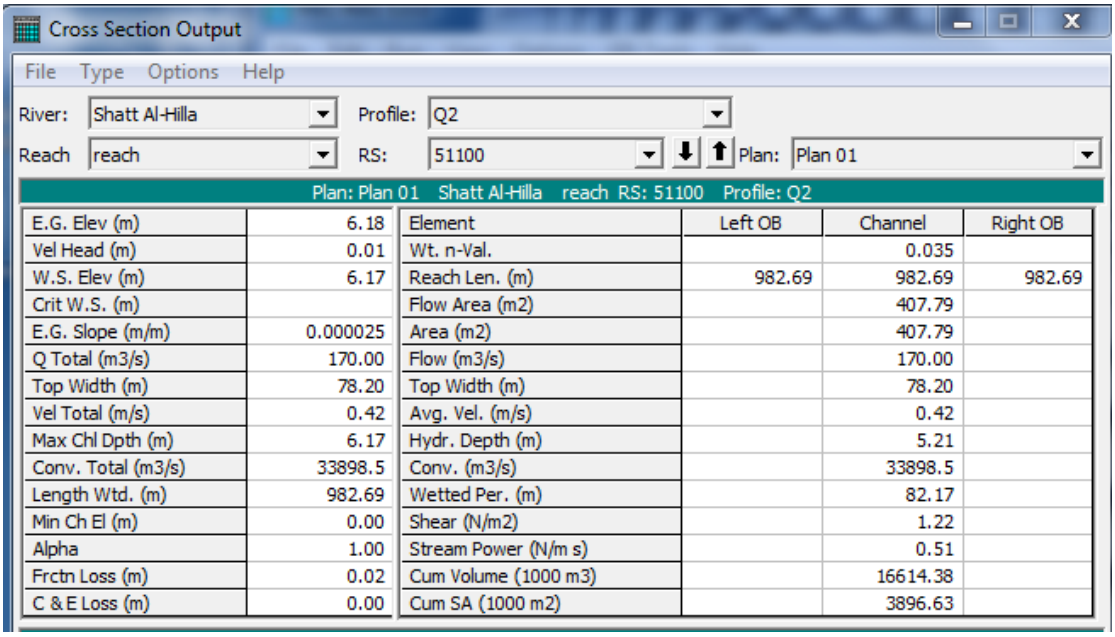
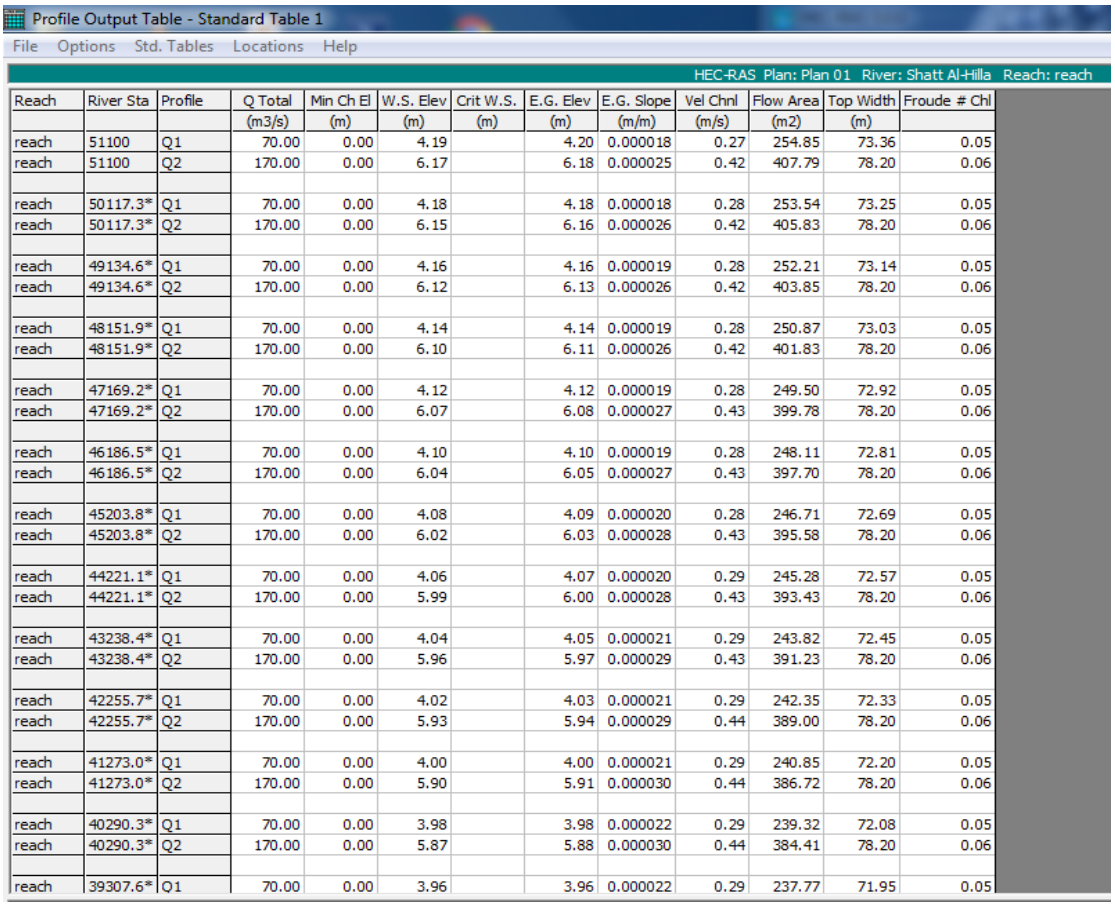


Figure 12 Cross section output for maximum discharge.

The fact of Shatt Al- Hilla is alluvial river, and the slow velocities ranged (0.71 – 0.27) m/s for discharge 70 m^3/s from upstream to downstream calculated by HEC-RAS, with low shear stress 0.60 N/m^2 and low Froude No. ranged (0.18 – 0.05) figure (13) assured that the river had risked of high cumulative of sedimentation loads. Even results for 170 m^3/s (at the same figures) are not so different from the first one were the velocities ranged (1.08 – 0.42) m/s which considered slow velocity too, low shear stress 1.22 N/m^2 and low Froude No. (0.22 – 0.06).

The difference between the height of water levels for the two chosen discharges, the cumulative volumes of water (10335.39 and 16614.38)*10^3 m^3, stream powers (0.17 – 0.51)

N/m s and the mentioned shear stress figure (13) referred to high probability of embankments erosion and may cause natural series of frequently shifting bends.



Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Plan 01 River: Shatt Al-Hilla Reach: reach

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
reach	51100	Q1	70.00	0.00	4.19		4.20	0.000018	0.27	254.85	73.36	0.05
reach	51100	Q2	170.00	0.00	6.17		6.18	0.000025	0.42	407.79	78.20	0.06
reach	50117.3*	Q1	70.00	0.00	4.18		4.18	0.000018	0.28	253.54	73.25	0.05
reach	50117.3*	Q2	170.00	0.00	6.15		6.16	0.000026	0.42	405.83	78.20	0.06
reach	49134.6*	Q1	70.00	0.00	4.16		4.16	0.000019	0.28	252.21	73.14	0.05
reach	49134.6*	Q2	170.00	0.00	6.12		6.13	0.000026	0.42	403.85	78.20	0.06
reach	48151.9*	Q1	70.00	0.00	4.14		4.14	0.000019	0.28	250.87	73.03	0.05
reach	48151.9*	Q2	170.00	0.00	6.10		6.11	0.000026	0.42	401.83	78.20	0.06
reach	47169.2*	Q1	70.00	0.00	4.12		4.12	0.000019	0.28	249.50	72.92	0.05
reach	47169.2*	Q2	170.00	0.00	6.07		6.08	0.000027	0.43	399.78	78.20	0.06
reach	46186.5*	Q1	70.00	0.00	4.10		4.10	0.000019	0.28	248.11	72.81	0.05
reach	46186.5*	Q2	170.00	0.00	6.04		6.05	0.000027	0.43	397.70	78.20	0.06
reach	45203.8*	Q1	70.00	0.00	4.08		4.09	0.000020	0.28	246.71	72.69	0.05
reach	45203.8*	Q2	170.00	0.00	6.02		6.03	0.000028	0.43	395.58	78.20	0.06
reach	44221.1*	Q1	70.00	0.00	4.06		4.07	0.000020	0.29	245.28	72.57	0.05
reach	44221.1*	Q2	170.00	0.00	5.99		6.00	0.000028	0.43	393.43	78.20	0.06
reach	43238.4*	Q1	70.00	0.00	4.04		4.05	0.000021	0.29	243.82	72.45	0.05
reach	43238.4*	Q2	170.00	0.00	5.96		5.97	0.000029	0.43	391.23	78.20	0.06
reach	42255.7*	Q1	70.00	0.00	4.02		4.03	0.000021	0.29	242.35	72.33	0.05
reach	42255.7*	Q2	170.00	0.00	5.93		5.94	0.000029	0.44	389.00	78.20	0.06
reach	41273.0*	Q1	70.00	0.00	4.00		4.00	0.000021	0.29	240.85	72.20	0.05
reach	41273.0*	Q2	170.00	0.00	5.90		5.91	0.000030	0.44	386.72	78.20	0.06
reach	40290.3*	Q1	70.00	0.00	3.98		3.98	0.000022	0.29	239.32	72.08	0.05
reach	40290.3*	Q2	170.00	0.00	5.87		5.88	0.000030	0.44	384.41	78.20	0.06
reach	39307.6*	Q1	70.00	0.00	3.96		3.96	0.000022	0.29	237.77	71.95	0.05

Figure 13 Portion of profile output.

5. CONCLUSIONS

In this paper, HEC - RAS program is applied to analysis Shatt Al -Hilla for 51.100 km length of it for each 100 m long with min. and max. discharge equal to 70 and 170 m³/sec, the steady flow analysis is carried out successfully for Shatt Al-Hilla located along Hilla city for it's cross section and herein illustration of the calculation results:

- Shatt Al- Hilla is alluvial river, and the slow velocities ranged (0.71 – 0.27) m/s for discharge 70 m^3/s from upstream to downstream calculated by HEC-RAS, with low shear stress 0.60 N/m^2 and low Froude No. ranged (0.18 – 0.05) figure (13) assured that the river had risked of high cumulative of sedimentation loads. Even results for 170 m^3/s (at the same figures) are not so different from the first one were the velocities ranged (1.08 – 0.42) m/s which considered slow velocity too, low shear stress 1.22 N/m^2 and low Froude No. (0.22 – 0.06).
- High probability of embankments erosion and may cause natural series of frequently shifting bends.
- The velocity of the river changes according to the cross section and can be noticed that the velocity increased when the river pass inside center of Al- Hilla city from the beginning of the specific researched area

REFERENCES

[1] Traore Vieux Boukhaly, et. al., (2015), "STEADY FLOW SIMULATION IN ANAMBE RIVER BASIN USING HEC-RAS", International Journal of Development Research Vol. 5, Issue, 07, pp. 4968-4979, July

[2] Ahmad Hakim Farooq et. al., (2016) " One Dimensional Steady Flow Analysis Using HECRAS – A case of River Jhelum, Jammu and Kashmir", European Scientific Journal November 2016 edition vol.12, No.32 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431

[3] Khassaf Saleh I. and Shakir Saleh I., (2013) " Evaluation of The Local Scour Around Group Piers (Babil Bridge as Case ", International Journal of Innovative Research in Science, Engineering and Technology *(An ISO 3297: 2007 Certified Organization)* Vol. 2, Issue 12.

[4] Hassan and Kadhim Naief Kadhim (Development An Equations For Flow Over Weirs Using MNLR And CFD Simulation Approaches). (IJCIET), Volume 9, Issue 3, (Feb 2018)

[5] Kadhim Naief Kadhim (Estimating of Consumptive Use of Water in Babylon Governorate-Iraq By Using Different Methods). (IJCIET), Volume 9, Issue 2, (Feb 2018)

[6] Gary W. Brunner, (2016), " HEC-RAS River Analysis System", US Army Crops of Engineers, hydraulic reference manual, version 5

[7] Kadhim Naief Kadhim and Ahmed H. (Experimental Study Of Magnetization Effect On Ground Water Properties).Jordan Journal of Civil Engineering, Volume 12, No. 2, 2018.

[8] Iraqi Meteorological Office of Water Source, Babylon governorate