

The Study of Prevention of the Dangers of the Torrents and Draining Rainwater of Uqdah in Hail Region, Saudi Arabia

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ABSTRACT

Fell on the city of Hail, heavy rain caused a huge loss of money, property and lives and claimed the lives of many families have not been counted and in the absence of a discharge of torrents and projects to ward off dangers. Also because it was not taken into account during the adoption of residential schemes over the past thirty years adult home valleys that penetrate the city of Hail path. The foregoing was necessary to study the work of warding off the dangers of flooding and the discharge of flood water, specifically interested in this research study ward off the dangers of flooding and storm water for the Uqdah in Hail region, Saudi Arabia. This is because the torrent of Uqdah valley of the dangers of flooding in the city of Hail. It is known that Uqdah watershed out of the Uqdah and enters the land custodian of the Two Holy Mosques to the people of Hail grant, but where to go after that, no one knows that it has nothing to clear the course in case of heavy rains(this is expected at any moment) . This research includes estimation of the rainwater quantities that falls on a Uqdah area and the expected behavior for rain water in the case of the design storm. To calculate the amount of flood water (Run off), it was to determine the correct value of the coefficient of flood water surplus (Runoff Coefficient) and so in a way practical and theoretical. As well as been identified rainfall concentration time (Tc) by preparing IDF curves are prepared for times of iterative (5,10,20,25,100)years. As well as the run off (torrents)have been identified quantities of water on a Uqdah area using two different methods. The rain distribution and account alheitogerav representative account for the intensity of the rain storm design and hedrogerav unit of the actions of the storm design hedrogerav dispose of total output at the assembly point. Accordingly, the incoming discharge or run off(torrent) from the storm design estimated and size of storage lakes existing and proposed. Also the size behaviors from the storm design and size of storage in case of availability of storage space about 500 thousand m³. It was also to determine the value of overseas disposition of the lakes in the direction of Uqdah and the direction of King Khalid Road in case of availability of storage space about 500 thousand m³ . Then, storage capacity have been identified that are stored in the existing lakes and Lake Uqdah (Aja lake) and the roposed Lakes. As well as the open channel designed to carry the water from the area Uqdah and then pour the water in the underground reinforced concrete box culvert and cutting the City-Hail road and pass below it, to collect and storage of flood water (torrents) to the proposed lakes, so as to be used in agriculture and drinking purposes and so in addition to that is the protection of a Uqdah area of torrents risk to life and property.

KEYWORDS:Torrents, Intensity of rain, Storm design, Rainfall concentration time, Run off coefficient, Hedrogerav, Storage capacity, Reinforced concrete box culvert, and Open channel.

1. INTRODUCTION AND LITERATURE REVIEW

This includes research at the amount of rain water or run off (torrents) that was recorded meteorological station Hail and topographic data and expected behaviors of rainfall amounts in case of storm design. It is worth mentioning that it has been the annual rain data is collected from the reality of the Presidency of Meteorology and Environment data. It was also estimate the storm design time to return (to occur) during the period of 50 years and to use this storm is likely assembled water flows account through the watershed and palmkharc taking into consideration the possibility of a leak of some rain water to seep into the soil as well as the preparation of hydrological study Uqdah area. In the city of Hail it was not taken into account during the adoption of residential schemes over the past thirty years adult home valleys that penetrate the city of Hail path. 15 in the first spring of the year 1362 H corresponding to April 21, 1943 of torrential rain on the Hail area rains lasted for a few days caused a huge loss of money, property and lives and claimed the lives of many families have not been counted and called this year a year algrqh. In 1296 H, corresponding to 1879 Hail fell on the rain for several days, during which many houses and shops fell and claimed the lives of many and create named this year, with the destructive. On Sunday, the first 15 spring 1362 H corresponding to March 1943 of torrential rain claimed the lives of families and human beings were countless number as well as the loss of homes and property and that the public is still called the year algrqh. In 1345 H, corresponding to 1936, torrential rains on the Hail, one elderly said that in that year, Adayra valley flow which runs through the city of Hail, 100 kilometers length of 48 times in the season an average of once a week during the six months. Rainfall amounts recorded in Hail and flood the most important dates in the Hail area 118 mm in 1967; 80 in 1981 mm; 95 mm 1998. What if repeated like this, especially

after the rain that shut down all the tracks municipal. Alnakrah district sinking in 1418 H, Kmachih district sank in 1405 H, and was directed by its residents by boats. Alsuivelh district that surrounds it Adayra valley of four points and still threatened though it fully sank in 1405 H, the population was not able to get out of it only by helicopter and landed during heavy rain the water level reached 39 mm. Hail flash floods area has seen a massive mid-eighties and also the calendar year 1418 H, corresponding to 1998 and caused material and human losses. And the people are still afraid of recurrence of such incidents in the absence of a discharge of floods and torrents, and projects to ward off dangers and the spring season of 1982 is the most torrents disasters in the country; 1982, 1983, 1992, 1993, 1994, 1995, 1997, 1998.

As already mentioned about the floods arising from falling on the city of Hail dangers, it was necessary to conduct a study to ward off the dangers of flooding and the discharge of flood water to the city of Hail. Specifically interested in this research study ward off the dangers of flooding and storm water for the city of Hail contract because the torrent valley held of the most serious floods in the city of Hail. Specifically interested in this research study to prevent the dangers of flooding and storm water for the Uqdah district in Hail Region because the torrent valley held of the most serious floods in the city of Hail. It is known that Uqdah watershed out of the Uqdah and enters the land of the King to the people of Hail grant (formerly Land Guard). But where to go after that, no one knows that it has nothing to clear the course in case of heavy rain (and this is expected at any moment). Uqdah mountains overflowed with water and the watershed flow strongly (120 mm), and by the geographic region rule, torrent must be descended from Uqdah to the east and find even Adayra valley but the problem is that boxed neighborhoods where to go. If it enter Alnakrah district or Alshfa district or destroy the dam, which on its course before 30 years and goes back to the original course through Sababa district and Salahuddin. And the above mentioned before the disaster was necessary to conduct a study to ward off the dangers of flooding and the discharge of flood water in Uqdah area. In order to calculate amounts of rain that falls on the Uqdah area by identifying the value of the intensity of rainfall, and run off coefficient and to determine the Uqdah area, which falls in the rainy space and can therefore precipitation that falls on a Uqdah area calculation.

After calculating the value of the intensity of rain water fall (mm / hr.) and calculate the exact value of the coefficient of the running water of the study area by theoretical and practical manner in the hydrology laboratory, Department of Civil Engineering, Faculty of Engineering, Hail University. Accordingly, the amount of flood water has been calculated on a Uqdah area and It was the design of an open concrete channel along the 7 kilometers parallel to the series Aga Mountains and the land of the Supreme Commission for Hail Region, carry flood water for the area in Uqdah and pouring the torrents in underground reinforced concrete box culvert, and cutting through the City - Hail road and pass below and to transfer the collection and storage of flood water for the Uqdah to the proposed Lakes next to the Hail airport in order to be used in agriculture and drinking purposes and so in addition to that is the protection of a Uqdah area of liquidity risk to life and property.

2. AIMS OF THE RESEARCH PROJECT

2.1. Compilation of annual rainfall data from the reality of General Presidency of Meteorology and Environment data and study the topographic characteristics of the area assembly (Watershed).

2.2. Study to determine the correct value of the intensity of rain water the expected fall of the study area (Uqdah area) (Intensity of Rain, mm / hr.), in order to determine the total amount of rain monthly and annual mm of reality Hail meteorological station records.

2.3. Study to determine the correct value of the coefficient of surplus running water (Run off Coefficient), and that the work of theoretical study on the study area on the ground and stand on the properties and type of soil on nature, and therefore can determine the correct value of the coefficient of excess rain water to the region. As well as the water is determined surplus plants running in a practical, given the importance of this parameter in determining the amount of flood water for the Uqdah region.

2.4. It has been compiling the required information from the station meteorologist Hail and from the preparation of studies and projects study the risk of floods in Hail city and its villages and discharges rain water projects in Hail city report. Consequently, it has been prepared the IDF curves for returned times of iterative 5,10,20,25,50,100 years and determine the concentration time of the floods. This factor is also used in determining the amount of flood water Uqdah area.

2.5. After the completion of the previous studies were identified ongoing flood water quantities on a Uqdah area using two methods hydrograph method and rotational method.

2.6. It has been identified peak value of the total discharges at the lakes assembly point.

2.7. It has been identified the volume of water resulting from the total discharges.

2.8. It has been identified storage capacity that is stored in Uqdah lakes, Age lakes and the proposed lakes.

2.9. The water collection on the track of Uqdah up to forty road, after determining the volume of rainwater resulting from the total discharges (total run off) to the region. Open Channel designed to carry water from the area and parallel to the land of the Supreme Commission for Hail Region, then pour water in the proposed lakes which is located south of Hail Airport.

2.10. Structural and hydraulic design of underground reinforced concrete box culvert and cutting the City - Hail road and pass below and to transfer the collection and storage of flood water for the Uqdah to the proposed Lakes next to the Hail airport.

2.11. Then thereby protect the Uqdah area of the risk of floods and torrents to drinking purposes, and so on.

3. ENVIRONMENT DESCRIPTION

3.1. Evaporation Rates

Evaporation region depends on two main factors, namely wind speed and temperature and evaporation affect the design of rain water lakes assembly and the evaporation of study area ranges from the sea (3-20) mm for the day, Figure (1) illustrates the evaporation rates of the reality of Hail weather station records.

3.2. Rain

Periods of rainfall is concentrated in an area of Hail during the month of November to March while almost zero rainfall during the month of June to September. It should be noted that the amount of rain falling and the rate of falling vary from year to year and through the stations Meteorological records (The most powerful rainstorms of varying periods), and some statistical methods of preparation of curves (IDF), which determine the intensity of rainfall at other times iterative different for different other times of concentration recorded. Of course, that the more repetition period increased intensity of rainfall and resulting in an increase in work required to collect rain water and thus costs, and Figures (2), (3) and (4) show the total amount of monthly and annual rain in mm of reality Hail weather station records, Hail Station (191 and 186). Figure 5 shows the average monthly rain during the period from 1970 to 2000, it has been preparing all Figures of reality Hail weather station records.

3.3. Temperature

The mean minimum temperature variation and great for the city of Hail by weather station data for the time period from 1970 to 2001, about 15° to 30° C. Temperatures drop in winter (December to March) while temperatures rise in the summer months (May to September), Figure 6 shows the average minimum and maximum temperature in Hail city. As well as the Table (1) the average maximum temperatures and Minor in Hail.

Table (1): Climate Data for the City of Hail in Saudi Arabia

	The Measurement Period	Jan	Feb	March	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Average of Maximum Temperature	1981-2000	30.5	31.0	32.8	35.4	37.6	38.5	38.5	38.1	38.2	36.8	34.4	31.7
Average of Minimum Temperature	1981-2000	21.1	22.1	23.8	27.7	27.5	29.3	29.3	29.3	28.2	25.9	24.1	22.1

3.4. Humidity

Region prevails generally dry climate variability and average moisture content of 20% minimum to a maximum of 50% and Figure (7) shows the average minimum moisture and Great registered ratios Meteorological Station Hail in the period between 1971 to 2000.

3.5. Wind

North winds prevail in the North Western part of the Kingdom of speeds up to 12 km /hr and wind play a main role in the movement of suspended sediment on the bottom or moving within the Red Sea. Influenced by climate in Saudi Arabia monsoon, which blows in the main two seasons, in the winter wind blowing North West. In the summer and the wind blowing south-western monsoon, this may occur as a result of the temperature difference between the land and sea water. The rain is almost non-existent in general within the Kingdom of Saudi Arabia, with the exception of periods of rain and storms over the mountains what caused the rush of water in the storm water drains toward roads and residential blocks.

4. DISCUSSION AND RESULTS

4.1. Study to determine the correct value of the expected intensity of rain fall of the study area (Intensity of Rain) (mm/hr)

How important account the density of rain fall in region to determine the quantities of rain water and floods and the resulting increase in the work required to collect rain water and thus costs. Studies have been the work of hydromervolloger to determine the accurate value intensity of rain water on the expected fall of the study area. Accordingly, the work has been thorough study to determine the exact and correct value for the density value rainfall(Intensity of Rain) and user account in amounts of rain water on the study area, It could be argued that the intensity of rainfall of more complex factors. It depends on the duration of the fall so it is expected to be high when the

rain period be short. It is therefore appropriate representation of rainfall in the form of curves such as those described in the Information Figure(8) IDF, linking of the rainfall with abundance periods periodically at 5,10, 20, 50 and 100 years. To obtain sufficient data on the extended rainy fall storms over the years, this is the basic data to calculate the intensity of rainfall curves for different other times iterative by using the method of distribution probability of Gumble as shown in Figure (9). So it was relying on the IDF curves of the preparation of studies and study design flood risk projects in Hail city and its villages and rainwater drainage projects in Hail city report.

According to the specifications, the design curve over (5 years) used for residential areas and curve (10 years) used for commercial areas, and the Curve (20 years) can be used for flood-prone areas it may result in damage to property. Accordingly, and in the study area were used curve (20 years) to determine the density of water intensity of rain is expected to fall of the study area. Based on the above, of extensive studies to determine the intensity of rain water on the expected fall of the study area and that at a concentration time ($T_c = 66$ min), from IDF curves as in Figure (8). Using the curve (20 years) and thus possible to determine the exact value of the intensity of rain fall. Table (2) shows the maximum daily rain storm during the period of measurements available (1970-2003) Station Meteorologist Hail in Saudi Arabia.

Table (2): shows the maximum daily rain storm during the period of measurements available (1970-2003) Station Meteorologist Hail in Saudi Arabia.

No	Year	Intensity of rains (mm/day)
1	1970	7.2
2	1971	13.5
3	1972	29.3
4	1973	23
5	1974	24.4
6	1975	-----
7	1976	-----
8	1977	15.2
9	1978	14.5
10	1979	49.8
11	1980	18
12	1981	79.6
13	1982	77.7
14	1983	22.2
15	1984	59.9
16	1985	34.9
17	1986	18.8
18	1987	25.4
19	1988	25.7
20	1989	36.7
21	1990	19.1
22	1991	21.1
23	1992	13.9
24	1993	27.2
25	1994	13.4
26	1995	19.9
27	1996	13.9
28	1997	25.2
29	1998	47.5
30	1999	26.9
31	2000	27.6
32	2001	18.3
33	2002	29.7
34	2003	8.7

4.2. Study to determine the correct value of the coefficient of excess rain water flow coefficient (Run off Coefficient)(C_{avg})

When rain falls on the ground, part of this water seeps into the ground and the other part evaporates. The remaining is a flood water (Run off) goes to the rain water drainage system and the amount of rain depends on the permeability surface on which it drops rain. Run off coefficient also known as the ratio between up to rain water drainage system and the amount of rainfall. How important is the flow coefficient of the surface water (Run off Coefficient) in the account amounts of rain water and the resulting increased work required to collect rain water. And therefore costs have been the work of an exhaustive study to determine this parameter carefully as shown afterwards.

The study of the nature of the Uqdah area by the difficult terrain were identified area that fall by the floods. And a preview of the study area was found that the rocky soil half (Semi Impervious Area). It is a series mountainous hills of the internal cracks these mountains form a group and valleys surrounded by these mountain ranges consisting and valleys. These valleys of the first type soil aggregate mixture of fine, medium and coarse aggregate. The rain water falling on the mountains and then descend to the valleys and formation a small lakes are surrounded by these mountains, and thus collects water from the sloping mountain ranges in these valleys and with the passage of time, the water of these valleys interspersed within these soils into the ground water and the other part evaporates.

And thus it is screened Uqdah area after determining the area that fall by the floods. It observed different properties and specifications of the soil that are falling by the rain water in the area to take place and this has been the division of the region (ten regions), depending on the differences in soil characteristics and specifications, samples were taken from each region to set the running water surplus coefficient in each region (Run off Coefficient) and soil that were examined by the rain falls in the study area and found that the region is made up of two types of soil as follows: -

4.2.1. Determine the running water surplus coefficient (Runoff Coefficient) for the first type of soil (C_1)

Aggregate soil consisting of a mixture of soft and medium coarse rubble and soil, a high porosity and permeability. After examining the region, it is found that this type of soil represents about 40% of the total area of the study area. It is determined the value of the runoff coefficient in the Hydrology Laboratory, College of Engineering. The transfer of these soils to the lab was set the value of runoff coefficient for these aggregate soils by a device (Hydrology System) as shown in Figure (10). Samples were transported from the soil of the site for the laboratory and the weight of the sample (500 kg), a device capacity set running water coefficient (Hydrology System). So, run off coefficient for this type of soil (C_1) = 30%.

4.2.2. Determine the running water surplus coefficient (Runoff Coefficient) for the second type of soil (C_2)

Inspect the study area found that this rocky soil (Semi - Impervious Area). After studying the contour lines of the area and found to be a mountainous area and not a slope in one direction. From the above after extensive study to set the runoff coefficient of these soils, which represent 60% of the total area of the region. And thus it can determine the value of the flow coefficient (C_2) for this area of these soils. Then, the coefficient of run off for these soils $C_2 = 0.85 \%$,

The total area of the study area were estimated (A_t) = 20000000 m².

So, the area of soil aggregates (A_1) = 40% x 20000000 = 8000000 m².

The area of rocky soil (A_2) = 12000000 m².

And therefore can calculate the coefficient of running water medium (C_{avg}) for the region

$$C_{avg} = (C_1 A_1 + C_2 A_2) / (A_1 + A_2) = 0.65$$

And therefore, the running water average coefficient (C_{avg}) = 0.65 = 65%.

4.3. Determine the total maximum discharges and total maximum volume at the assembly point storm design

The metrological and hydrological study by creating a base of data can be relied upon to choose the appropriate methods for data analysis. The accuracy and sensitivity and their compatibility with the region under study test. And it includes the required database field detective compiling and reviewing the mitorologia, hydrological data and cadastral maps in addition to the survey of previous studies on the region. Through the analysis of these data is determined by the storm distinctive design of the study area and the discharges of the rains generated by this storm during the period of occurrence.

The hydrological parameters and criteria needed to assess the degree of seriousness of the floods and design works rains on the extreme rainstorms and not on the recorded average annual or monthly. The data was used for measurements in the statistical analysis and probabilistic distribution of rain in the study area for different times of iterative. The probability distribution method used (Gumbel) to estimate the maximum daily rain storm different times of iterative of Hail Region, as shown in Figure (8) IDF-curve, Figure (9) and Table (3).

Table (3): maximum depth of rain daily times of different iterative

The frequency of time (in years)	5	10	20	25	50	100
Rain depth (mm)	52	64	69	72	75	78

Where it is chosen design storm frequency (Frequency) when the design on several factors, including: -

1. The amount of the risk to human life.
2. The amount of possible losses installations.
3. The amount of the flood threat, such as tourism or commercial and service activities and economic losses.

When a direct threat to human life or limited the possible risks for the destruction of a few facilities such as buildings with only one round, the design will be by choosing an acceptable frequency of storms causing torrents. In most of these cases, most of designs based on the frequency of 25 years and in the case of increased risk to life is up to 50 and 100 years.

The rain time (Rainfall duration) and the severity of its occurrence (Rainfall Intensity) of the most important design characteristics of the storm affecting the runoff. In many facilities, especially for small valleys that the duration of this storm be equal to the time of compilation Valley (Time of concentration), so given the worst possible behavior of the valley. The heitogerav Representative to the intensity of the rain storm design, which affect the peak value of the disposal of the disposition of the torrent hydrograph. It must be followed the worst either the variety or the time of the storm distributed or the time distributions for the storms of rain recorded for the area. In the small business protection or small dams, the distribution schedule of storm or storm heitogerav usually assumed to be a regular (Uniform). In our study of the Hail region it has been the distribution of rain on the way (SCS, 1986) and which has established multiple distributions depending on the storm 24 hours time to represent the worst possible storms in different climatic zones. In a similar climate of the study area, the appropriate distribution is the distribution II (USGS), which was estimated volume of rainfall, accordingly, in this study, as shown in Figure (11). Based on this distribution has been concluded the heitogerav representative to the intensity of the rain to storm the design as shown in Figure (12).

Distribution has been mentioned on the application of the study area using morphological data and the mitrologih to rainstorms with a frequency of 50 times a year. where was obtained hydrograph dispose of total output at the assembly points, as shown in Figures (13 and 14).Table (4) Representative unit hydrograph shows the discharges of the storm design.

Table (4): Representative unit hydrograph shows the discharges of the storm design.

$$\Delta t = 5 \text{ min} \quad , \quad t_p = 43 \text{ min}$$

$\Delta t(\text{min})$	t/t_p	$Q = (\text{cfs})$	$Q = (\text{m}^3/\text{s})$
0	0	0	0.00
5	0.117	82.95	2.35
10	0.234	258.47	7.32
15	0.351	497.18	14.08
20	0.468	828.97	23.47
25	0.585	1249.96	35.39
30	0.703	1628.88	46.11
35	0.820	1880.92	53.25
40	0.937	2000.34	56.63
45	1.054	1987.15	56.26
50	1.171	1942.71	55.00
55	1.288	1733.72	49.08
60	1.405	1554.31	44.00
65	1.522	1348.37	38.17
70	1.639	1068.61	30.25
75	1.756	735.79	20.83
80	1.874	566.20	16.03
85	1.991	507.09	14.36
90	2.108	405.90	11.49
95	2.225	331.24	9.38
100	2.342	306.75	8.68
105	2.459	255.55	7.23
110	2.576	220.93	6.25
115	2.693	183.85	5.20

120	2.810	149.95	4.25
125	2.927	119.47	3.38
130	3.044	95.96	2.72
135	3.162	76.17	2.16
140	3.279	60.56	1.71
145	3.396	45.63	1.29
150	3.513	0.00	0.00

Table (5): Values of curve number for different regions.

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type and Hydrologic Condition	Average percent Impervious Areas	A	B	C	D
Fully developed urban areas (Vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, ect)					
Poor condition (grass cover less than 50%)		68	79	86	89
Fair condition (grass cover less 50 to 75%)		49	69	79	84
Good condition (grass cover greater than 50%)		39	61	74	80
Impervious areas					
Paved parking lots, roofs, driveways, ect. (excluding right-of-way)		98	98	98	98
Streets and Roads					
Paved; curves and storm sewers(excluding right-of-way)		98	98	98	98
Paved; open ditches(including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas					
Natural desert landscaping (previous areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1-to 2-in sand or gravel mulch and basin borders)		96	96	96	96
Urban districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93

Table (6): Total Discharges and Total Volume at assembly points of the storm

t (min)	Q = (cfs)	Q = (m ³ /s)	Total Volume (m ³)
0	0.00	0.00	0
5	0.00	0.00	0
10	0.00	0.00	0
15	0.00	0.00	0
20	0.00	0.00	0
25	0.00	0.00	0
30	0.00	0.00	0

35	0.00	0.00	0
40	11.27	0.32	96
45	28.17	0.80	239
50	57.08	1.62	485
55	101.81	2.88	865
60	162.58	4.60	1381
65	236.94	6.71	2012
70	322.45	9.13	2739
75	417.62	11.82	3547
80	525.08	14.86	4459
85	646.83	18.31	5494
90	884.41	25.04	7511
95	1265.03	35.81	10744
100	1757.49	49.75	14926
105	2382.83	67.46	20237
110	3129.86	88.61	26582
115	3833.21	108.52	32555
120	4353.08	123.24	36971
125	4651.43	131.68	39505
130	4723.11	133.71	40113
135	4677.55	132.42	39726
140	4392.25	124.34	37303
145	4070.30	115.23	34569
150	3688.74	104.43	31328
155	3194.49	90.44	27131
160	2618.16	74.12	22236
165	2216.45	62.75	18824
170	1969.04	55.74	16723
175	1699.89	48.12	14437
180	1458.69	41.30	12389
185	1283.26	36.33	10899
190	1094.43	30.98	9295
195	930.87	26.35	7906
200	775.86	21.96	6589
205	637.21	18.04	5412
210	514.57	14.57	4370
215	411.99	11.66	3499
220	327.83	9.28	2784
225	262.72	7.44	2231
230	205.95	5.83	1749
235	120.35	3.41	1022
240	86.94	2.46	738
245	66.70	1.89	566
250	50.62	1.43	430
255	38.30	1.08	325
260	28.35	0.80	241
265	20.52	0.58	174
270	14.49	0.41	123
275	9.82	0.28	83

280	6.29	0.18	53
285	3.50	0.10	30
290	1.51	0.04	13
295	0.00	0.00	0
300	0.00	0.00	0
			563663

4.4. Hydraulic Analysis

The program was used (FLOW MASTER) for the hydraulic design section of the proposed open channel. Taking into account the appropriate slope to reduce the amount of cut and fill whenever possible, according to the topographical nature of the river bed.

Design of Rectangular Open Channel :

- Worksheet → Rectangular Channel
- Flow Sheet → Rectangular Channel
- Method → Manning Formula
- Manning Coefficient = 0.036
- Slope = 1.0 mm/m
- Discharge = 30.2 m³/sec
- Flow area = 28.5 m²
- Wetted Parameter = 22.8 m
- Top Width = 20.0 m
- Critical Depth = 0.62 m
- Critical Slope = 15.3 mm/m
- Froude Number = 0.29 < 1.0 → Subcritical Flow
- Flow Type = Subcritical Flow
- Water Depth = 1.45 m
- Bottom Width = 20.0 m

5. CONCLUSIONS

5.1. The peak value of the total discharges at the assembly point by lakes up to 139 cubic meter per second of the storm with the frequency of time 50 years.

5.2. Volume of rain water resulting from the total discharges of the overall area up to 565 000 cubic meters of the design storm with the frequency of time 50 years.

5.3. There is a storage capacity of up to 903 000 cubic meters are stored by 403 000 cubic meters in the Uqdah existing lakes and 403 000 cubic meters in Aga lake (Sababa) and 102 000 cubic meters in the proposed lakes.

5.4. In the event of a design storm and lakes empty, all the discharges of the design storm is stored in lakes and an excess of up to 337 000 cubic meters. There is no disposal in the proposed channel southward along the land of the Supreme Commission for Hail Development and the proposed culvert in the direction of King Khaled Road, as shown in Figure (15).

5.5. In the event of a storm and design Lakes half full or in the case of non- possibility of the implementation of channel flying to Aga lake(Sababa). The discharges of the design storm is stored in Uqdah existing lakes of 403 000 cubic meters and 102 000 cubic meters in the proposed Lakes. While the estimated discharge of the proposed canal south along the land of the Supreme Commission for Hail Development and the proposed culvert in the direction of King Khaled Road at about 41 cubic meter per second (144,000 cubic meter per hour), as shown in Figures (16 and 17).

5.6. The distribution is estimated discharge about 41 cubic meter per second to act by three-quarters of the discharge of 31 cubic meter per second (108 000 cubic meter per hour) of the proposed channel south Align the land of the Supreme Commission for Hail Development. While a quarter of the estimated discharge of about 11 cubic meter per second (36,000 cubic meter per hour). Where it is set up the exit weir of the proposed lake the same level. While the length of the exit weir in the proposed channel southward along the land of the Supreme Commission for Hail Development equal of three times the length of the exit weir in the proposed culvert in the direction of King Khaled Road.

5.7. It has been designed an open channel to carry water from Uqdah region and parallel to the land of the Supreme Commission for Hail Development, then pour the water in the underground reinforced concrete culvert, which starts from the end of the land of the High Commission for the Development of Hail, until the proposed lakes next to Hail Airport.

5.8. Also, it has been designed the underground reinforced concrete culvert and cutting through the City - Hail Road and passes below it, to transfer the Flood water from Uqdah region through the open channel to collect and store it in the proposed lakes next Hail Airport, So as to be used in agriculture and drinking purposes, etc. In addition, the Uqdah region is protected from liquidity risk to life and property.

6. ACKNOWLEDGMENTS

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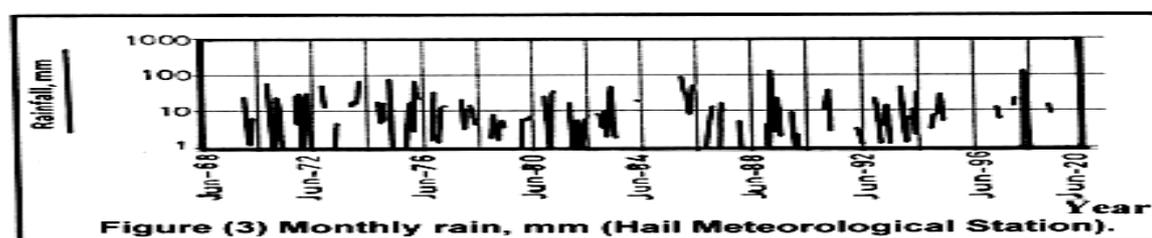
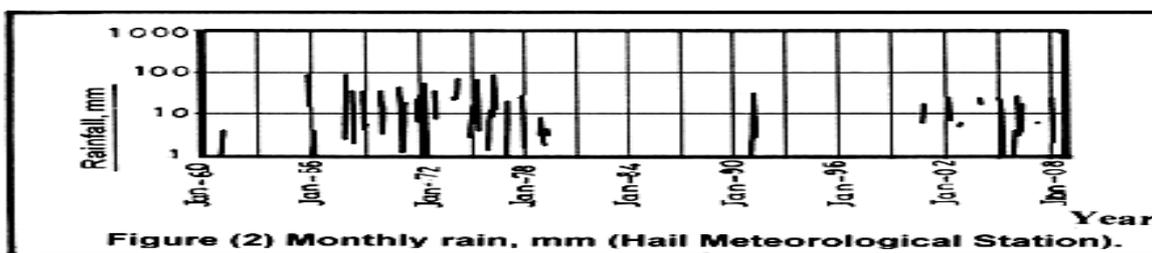
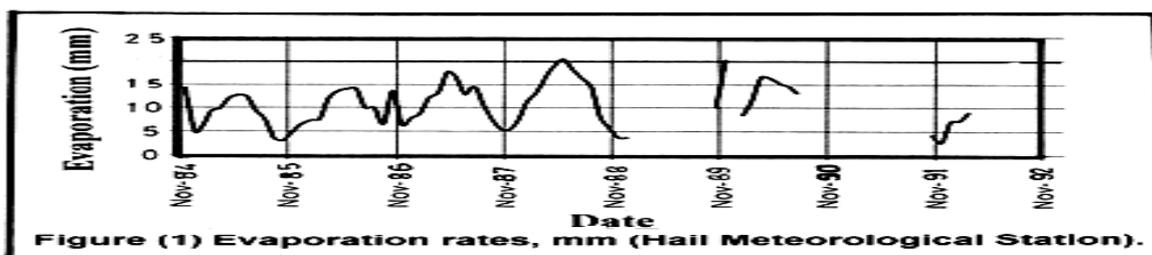
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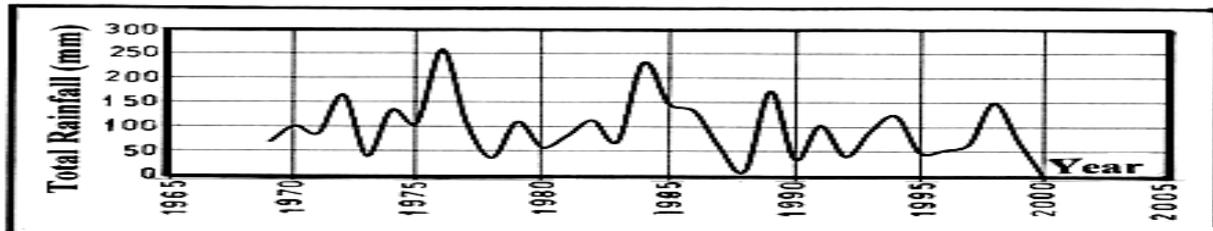


Figure (4) Total annual rainfall, mm (Hail Meteorological Station).

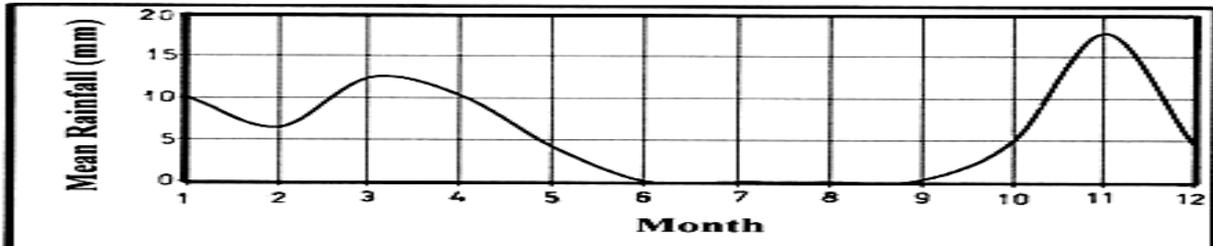


Figure (5) Average monthly rain, mm (Hail Meteorological Station).

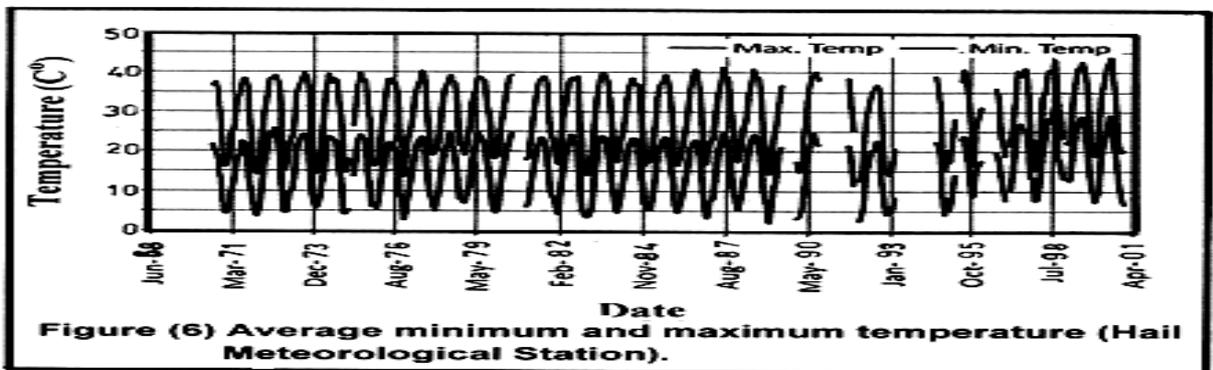


Figure (6) Average minimum and maximum temperature (Hail Meteorological Station).

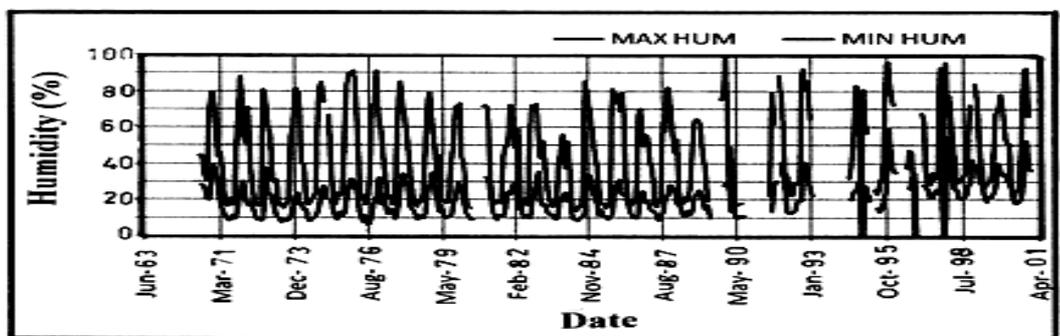


Figure (7) Averages of minimum and maximum degree of moisture ratio (Hail Meteorological Station).

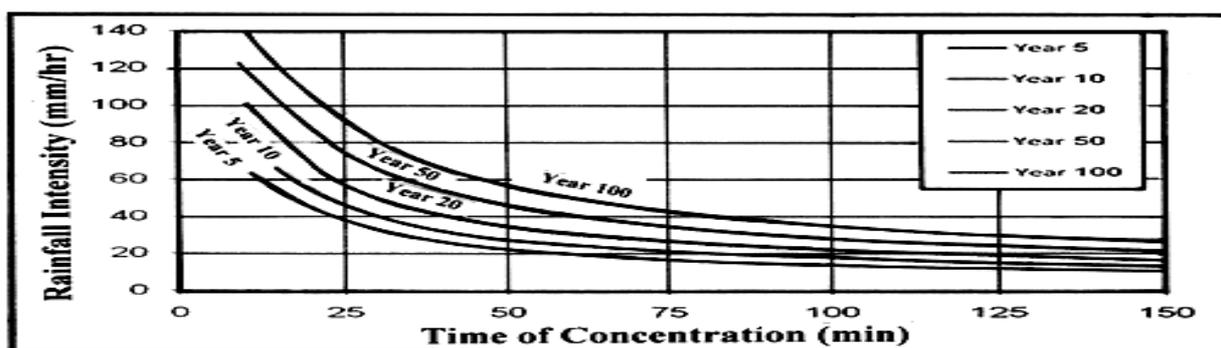


Figure (8) Curves of the IDF - Relationship between the depth of the rain and the time the frequency and duration of the fall.

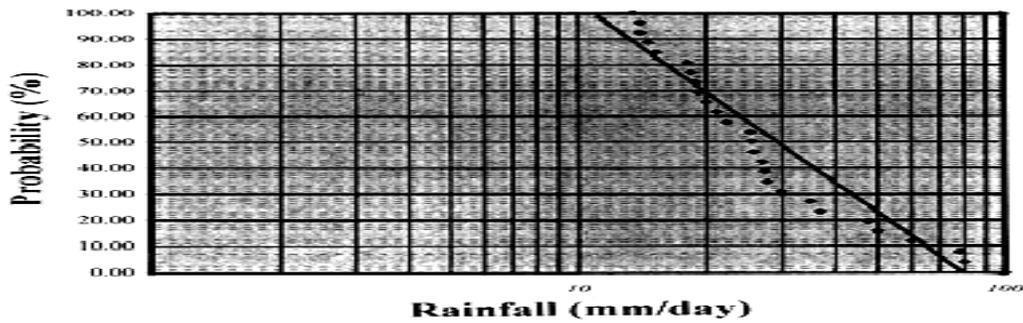


Figure (9) Maximum depth daily rain iterative different times using the method of distribution of the probability Gamble.

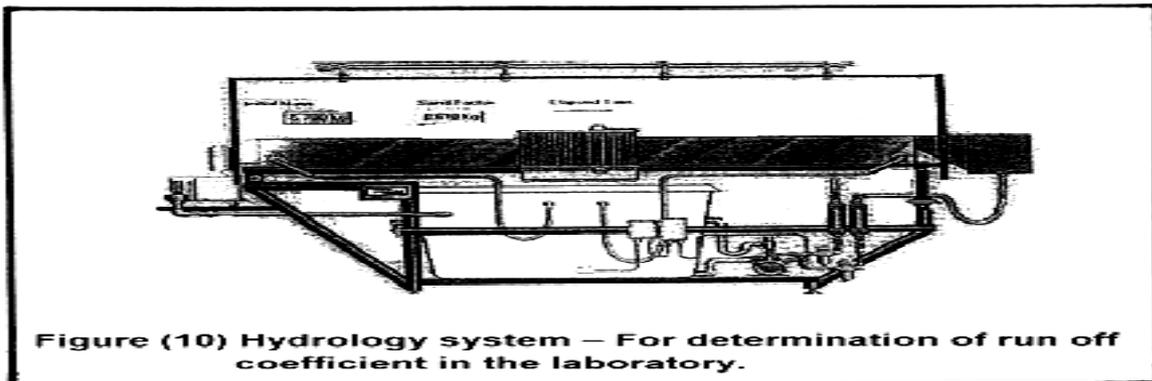


Figure (10) Hydrology system – For determination of run off coefficient in the laboratory.

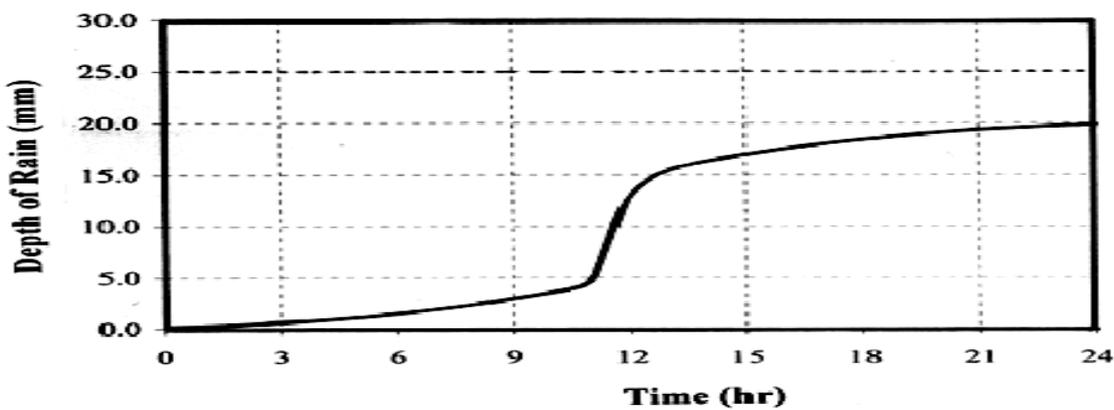


Figure (11) Rain distribution based on the method of SCS type (II).

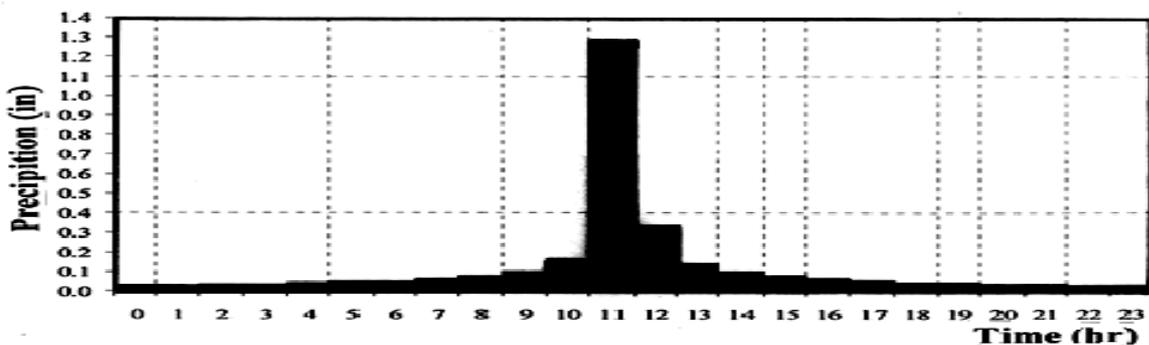


Figure (12) Alheitogerav representative to the intensity of the rain storm design.

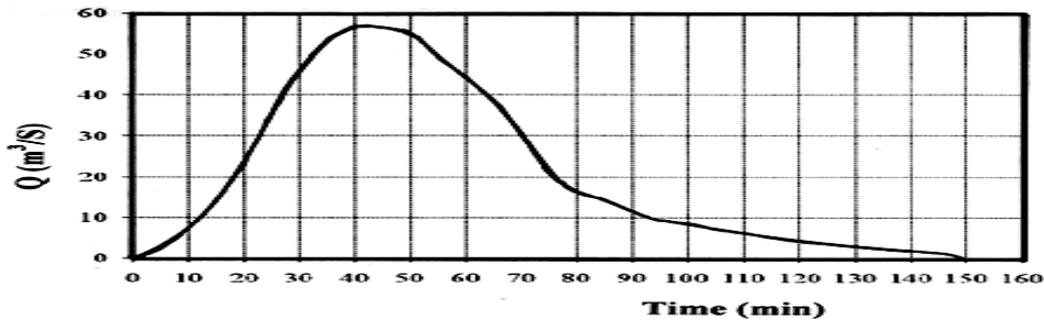


Figure (13) Hydrograph unit representative of the actions of the storm.

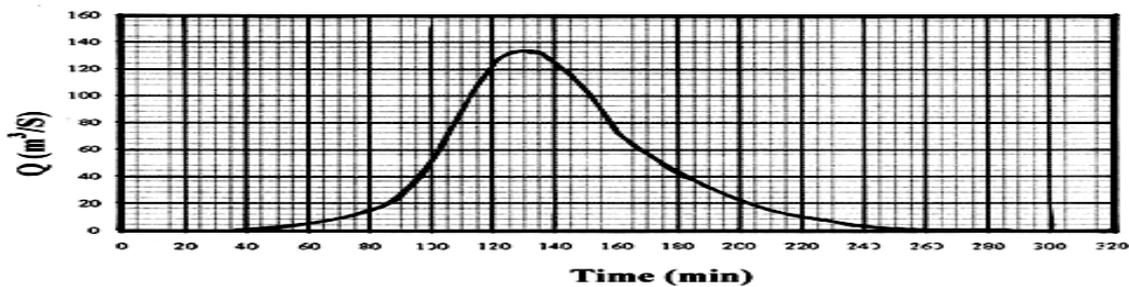


Figure (14) Hydrograph dispose of total output at the assembly point.

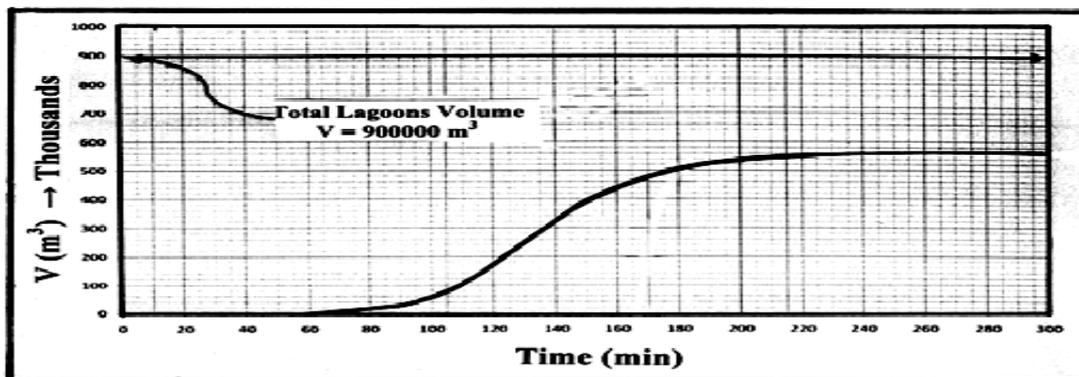


Figure (15) Relationship between the actions contained between the storm and the overall Design of the storage lakes existing and proposed.

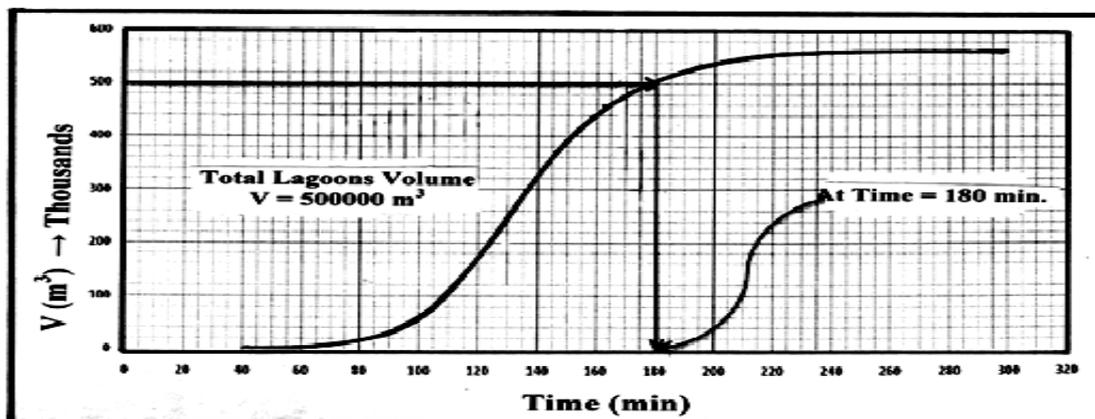


Figure (16) Relationship between the actions contained between the storm design and size of storage in case of availability of storage space 500 m³ only.

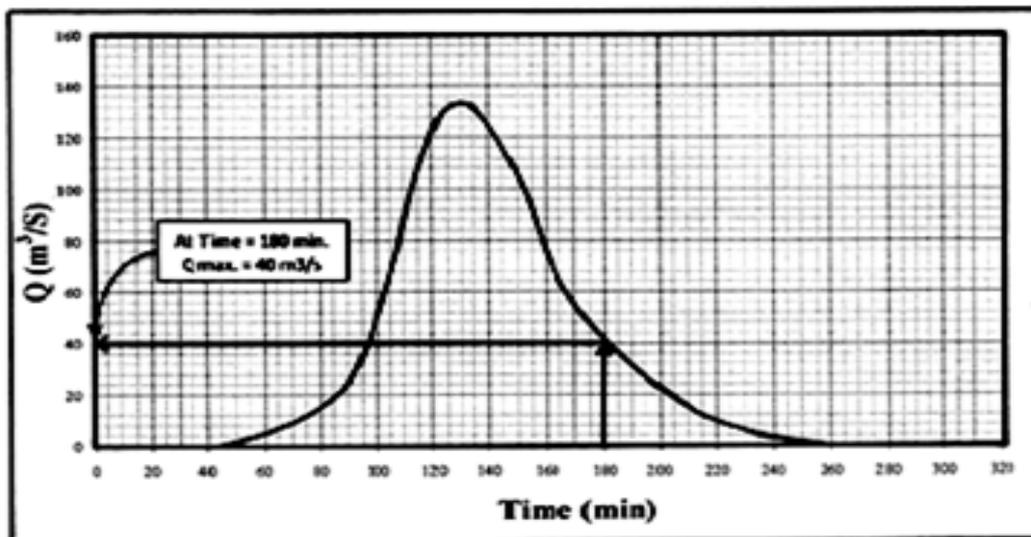


Figure (17) The Value of overseas disposition of the lakes in the direction of South Node and the direction of King Khalid road in case of availability of storage space 500 m³ only.