Improvement Of Traffic Capacity For Stadium Intersection In Al-Samawah City

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Abstract

Capacity and level of service are the control points of the analysis of intersections and must be fully considered to evaluate the overall operator of the intersection.

The objectives of the present study include the analysis, evaluation and improvement of the operation for Stadium Intersection in Samawah city and to present the best proposal to enhance the performance from the capacity point of view. To achieve these objectives, the estimated distribution of the traffic data in different directions that required for the traffic and geometrical analysis were gathered manually, while HCS traffic program is used for the requirements of traffic analysis process.

It has been concluded that the flyover between Al-Zwaid Street – Stadium Street (Proposal No.5) is the best proposal to improve the operation ability of Stadium Intersection.

Key Words: Traffic Capacity, Level of Service (LOS), HCS Application, Peak Hour Factor (PHF), Saturation Flow.

تحسين الاستيعابية المرورية لتقاطع الملعب في مدينة السماوة

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الخلاصة

إن مفهوم الطاقة الاستيعابية ومستوى الخدمة هما نقاط السيطرة لعمليات تحليل التقاطعات ويجب أن تؤخذ بعين الاعتبار عند تقييم التشغيل للتقاطع. أن هذه الدراسة تشتمل على ؛ التحليل ، التقييم و تحسين القدرة التشغيلية لتقاطع الملعب في مدينة السماوة وعرض أفضل المقترحات لتحسين الأداء من حيث الطاقة الاستيعابية .ولتحقيق هذه الأهداف فقد تم جمع المعلومات المرورية يدويا لمختلف الاتجاهات لأغراض التحليل المروري والهندسي بينما تم استخدام برنامج HCS لأغراض عمليات التحليل المروري.

لقد تم الاستنتاج بان اقتراح تنفيذ مجسر بمستوى واحد بين شارع الزويد وشارع الملعب هو أفضل البدائل لتحسين القابلية التشغيلية لتقاطع الملعب.

1. Introduction

The underlying objective of level of service analysis is to quantify a roadway's performance with regard to specified traffic volumes (i.e., its ability to efficiently handle a specified volume of traffic). This performance can be measured in terms of travel delay (as the roadway becomes increasingly congested) as well as other factors. The comparative performance of various roadway

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segments (which is determined from an analysis of traffic) is important because it can be used as a basis to allocate scarce roadway construction and improvement funds (Zegeer, 1986).

Capacity is simply defined as the highest traffic flow that a roadway is capable of supporting. For level of service analysis, a consistent and reasonably precise method of determining capacity must be developed within the definition. Because it can readily be shown that the capacity of a roadway section is a function of factors such as roadway type (e.g., freeway, multilane highway without full access control, or rural road), free-flow speed, number of lanes, and widths of lanes and shoulders(Khisty and Lall ,1998).

There have been tremendous increasing in road traffic flows since the decade of eighty's. The availability of vehicles to public in Iraq especially in the last three years has resulted in considerable improvements in personal mobility. The social benefits brought about by this increase in mobility and traffic movement are extensive and the gains in travel convenience to society are high.

This high unexpected annual increase after 2004 in Iraq resulted to a great extend to lower the roadway network efficiency ,safety ,speed ,capacity, and increase fuel consumption and have adverse effect on environment through noise and air pollution.

The local authorities and the traffic engineers are responsible to society and their decisions should reflect the goals and objectives of society, and require the implementation of a new traffic engineering projects Therefore, every effort is needed to ensure that the new transportation facilities should accommodate the anticipated high traffic volume by introducing free flow policies.

Intersections are an important part of highway network facilities as the performance parameter depend on their geometric design which facilitated the convenience ease and comfort of people traversing the intersection and enhance the efficient movement of vehicles.

2. Objective of Traffic Study

This study includes traffic data collection, forecasting future traffic volumes, analysis of existing and projected traffic volumes, and suggestions of the possible geometric solutions to maximize capacity and minimize the traffic delay.

3. Description of Site

Stadium Intersection (signalized intersection) is a four leg intersection type, located in the northern part of Al-Samawah city. Figure (1) shows a satellite image for Stadium Intersection and its approaches.

The high traffic volume at this intersection highly affects on the traffic flow especially through traffic .Stadium Intersection is located in an important commercial area ,for this reason, the percent of heavy vehicles is too high especially the approach of Baghdad-Samawah(North-South) Street.

4. Scope of the Study

1. Collection of Traffic data which includes the counting of traffic volume for each traffic stream with classification of vehicles,
2. Analyzing Traffic using computer software for existing and future traffic conditions to get the level of service,
3. Suggesting alternative geometric design proposals to improve the traffic performance across the intersection , and
4. Evaluation of the alternatives to choose the best one considering the traffic performance parameters, safety to road users, economic and environmental factors.

5. Data Collection and Analysis

5.1.Traffic Volume

Counting of traffic volumes classified by movements and vehicle composition was conducted manually for the four approaches in an average of seven days in good weather conditions starting 27 November, 2010. The traffic volume for the counting period was recorded for each 15 minutes to calculate the peak hour factor at each approach, the peak hour and traffic volume variation.

Tables (1) and (2) show the traffic volume at each approach and total volume across the intersection.

Figure1. Satellite image for stadium intersection in samawah city.

5.2. Peak Hour Volume

By considering the traffic volume account that previously presented in Table (1), an Excel program is used to determine the peak hour, which is found to be in Sunday between (8:00 - 9:00 a.m.) in 28th of November 2010. Figure (2a and 2b) show the peak hour in addition to the variation of flow every 15 min during the time of survey. From the traffic account, the following conclusions were drawn:-

a. The total traffic volume during the peak hour for all approaches is (3725) pc/h. This peak hour is found to be between (8:00 - 9:00 a.m),
b. It was found that the approach of Baghdad-Samawah has the highest volume of traffic while the approach of Stadium- Alzwaid has the lowest volume during the hours of the counting, and
c. For peak hour volume, the distribution of traffic volume in Stadium Intersection is as shown in Figure (3) which shows the total volume during the peak hour for passenger car.

5.3. Peak Hour Factor (PHF)

The peak hour factor is defined as the ratio of total hourly volume to the maximum 15- min rate of flow within the hour.

$$PHF = (\text{Hourly Volume}/\text{Peak rate of flow (within hour)})$$
$$PHF = (\text{Hourly Volume}/4 * V_{15\ min.}) \quad (1)$$

Where:

PHF= Peak-hour factor

$V_{15min.}$= Volume during the peak 15 min of the peak hour, on veh/15min

The peak hour factor is calculated for each direction in Stadium Intersection by using the data mentioned in Table (1).

Table1. Traffic Volume at Stadium Intersection from 7:00 a.m to 5:00 p.m for all Approaches

Pc =passenger car, Hv= heavy vehicles, L=Left Movement, R= Right Movement ,TH= Through Movement.

Time	From Baghdad						From Al-Samawah					
	L		TH		R		L		TH		R	
	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv
7:00-7:15	4	1	153	77	2	5	18	18	66	61	8	5
7:15-7:30	6	5	182	60	18	12	32	18	84	64	10	12
7:30-7:45	9	1	205	73	10	6	26	15	165	98	12	3
7:45-8:00	21	2	204	53	37	9	42	16	174	78	16	1
8:00-8:15	25	15	203	44	45	11	40	13	189	114	8	3
8:15-8:30	16	7	210	47	41	5	24	9	182	91	5	2
8:30-8:45	23	3	119	64	13	3	26	3	201	124	5	1
8:45-9:00	17	5	150	69	14	5	17	3	136	76	6	1
9:00-9:15	21	14	156	74	15	7	28	8	170	111	11	4
9:15-9:30	20	6	180	62	15	5	18	11	129	80	12	2
9:30-9:45	15	1	167	53	10	5	20	4	117	75	15	2
9:45-10:00	20	5	152	65	9	2	18	10	138	56	5	4
10:00-10:15	20	4	136	44	10	1	23	9	144	49	8	3
10:15-10:30	6	1	157	66	5	5	22	7	123	46	14	4
10:30-10:45	6	1	113	65	20	5	24	3	157	56	11	3
10:45-11:00	10	10	120	70	10	8	21	5	161	65	15	3
11:00-11:15	15	7	95	66	10	1	27	6	171	43	11	1
11:15-11:30	6	1	96	24	10	1	17	5	182	43	5	1
11:30-11:45	8	3	94	43	14	4	20	6	173	61	18	10
11:45-12:00	11	6	90	43	10	1	20	3	189	78	35	5
12:00 -12:15	5	10	98	92	5	3	23	6	188	43	22	6
12:15-12:30	7	8	96	123	9	8	25	7	201	46	19	5
12:30-12:45	10	6	90	107	20	1	17	8	196	29	16	4
12:45-1:00	11	8	109	93	15	4	15	7	161	34	21	8
1:00-1:15	17	10	120	91	20	19	30	8	110	23	24	8
1:15-1:30	23	16	136	75	20	12	18	8	72	34	13	4
1:30-1:45	30	10	100	74	25	18	15	9	82	36	18	8
1:45-2:00	48	27	205	83	40	2	25	0	63	63	13	7
2:00-2:15	40	21	189	51	25	15	37	7	110	32	12	6
2:15-2:30	31	11	125	70	30	6	20	5	89	26	12	5
2:30-2:45	30	11	108	63	25	6	35	11	23	18	36	8
2:45-3:00	40	11	100	60	30	1	19	4	40	12	25	6

3:00 -3:15	32	7	87	44	25	11	25	6	56	34	18	0
3:15-3:30	15	6	76	77	20	2	21	6	32	20	9	3
3:30-3:45	20	1	61	45	15	12	26	4	46	19	18	4
3:45-4:00	22	1	73	43	15	2	33	4	51	20	12	3
4:00 -4:15	10	3	103	44	25	13	28	4	22	23	25	10
4:15-4:30	20	2	101	74	20	2	16	9	30	44	16	4
4:30-4:45	33	7	96	62	9	7	25	8	57	52	21	2
4:45- 5:00	16	3	65	81	14	4	31	4	65	50	14	4

Table1. Traffic Volume at Stadium Intersection from 7:00 a.m to 5:00 p.m for all Approaches.

Time	From Stadium						From Alzwaid					
	L		TH		R		L		TH		R	
	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv	Pc	Hv
7:00-7:15	31	6	5	7	18	6	31	15	7	6	2	8
7:15-7:30	27	4	2	1	20	14	50	15	5	8	3	8
7:30-7:45	23	9	1	5	17	11	65	31	6	7	3	5
7:45-8:00	17	13	0	2	35	12	45	11	0	4	1	2
8:00-8:15	29	3	4	3	21	8	65	9	8	6	0	1
8:15-8:30	20	3	0	0	22	6	30	6	5	5	4	3
8:30-8:45	14	2	1	1	18	10	36	3	8	8	2	5
8:45-9:00	22	3	4	3	13	6	35	3	2	5	5	1
9:00-9:15	9	3	8	4	10	9	35	3	6	3	2	3
9:15-9:30	12	0	5	3	17	1	24	4	10	5	3	5
9:30-9:45	19	6	6	3	23	7	30	5	6	8	1	4
9:45-10:00	18	5	4	3	13	7	25	4	7	8	3	3
10:00-10:15	17	5	1	3	18	5	50	3	2	3	2	2
10:15-10:30	9	3	0	1	20	5	25	3	7	2	5	1
10:30-10:45	17	4	1	2	26	5	19	4	2	7	1	6
10:45-11:00	19	3	0	2	18	1	13	2	6	5	1	4
11:00-11:15	18	1	2	3	65	55	27	3	7	5	2	3
11:15-11:30	13	1	3	0	13	6	18	2	4	3	2	2
11:30-11:45	13	5	2	5	13	7	21	7	5	1	0	4
11:45-12:00	38	7	2	4	18	7	11	5	2	2	2	3
12:00 -12:15	17	5	4	7	14	10	17	4	5	2	0	5
12:15-12:30	9	5	3	8	22	10	42	3	6	4	2	2
12:30-12:45	17	1	0	9	25	10	37	6	6	1	0	3
12:45-1:00	19	5	13	9	19	10	25	16	4	2	1	1
1:00-1:15	18	2	6	9	15	7	40	19	1	4	1	3
1:15-1:30	13	2	7	5	15	4	26	11	5	3	5	2
1:30-1:45	13	0	5	4	22	6	25	7	7	2	2	1
1:45-2:00	38	7	3	3	30	12	30	7	4	0	2	2
2:00-2:15	17	15	8	12	25	10	31	6	2	3	4	3
2:15-2:30	21	7	7	2	30	15	22	5	1	0	3	3
2:30-2:45	22	9	6	5	42	14	15	2	3	3	6	2
2:45-3:00	20	11	7	5	47	20	35	5	5	2	2	1
3:00 -3:15	34	11	13	7	30	19	30	8	5	3	10	6
3:15-3:30	16	13	3	8	14	11	28	6	10	7	5	3
3:30-3:45	16	13	5	6	12	3	28	6	0	7	3	2

3:45-4:00	16	12	5	6	17	9	40	8	3	2	5	1
4:00 -4:15	21	8	7	5	10	4	25	14	3	2	1	4
4:15-4:30	18	6	2	9	14	5	31	10	4	2	3	2
4:30-4:45	13	4	3	8	12	3	22	13	3	5	2	0
4:45- 5:00	16	2	2	7	15	4	40	9	2	1	4	3

Pc =passenger car, Hv= heavy vehicles, L=Left Movement, R= Right Movement ,TH= Through Movement.

Table 2.Total Traffic Volume at Stadium Intersection for each (15) min.

Time	Pc	Hv	Total =(P_C+2 × H_V)
7:00-7:15 a.m	345	215	775
7:15-7:30	439	221	881
7:30-7:45	542	264	1070
7:45-8:00	592	203	998
8:00-8:15	637	230	1097
8:15-8:30	559	184	927
8:30-8:45	466	227	920
8:45-9:00	421	180	781
9:00-9:15	471	243	957
9:15-9:30	445	184	813
9:30-9:45	429	173	775
9:45-10:00	412	172	756
10:00-10:15	431	131	693
10:15-10:30	393	144	681
10:30-10:45	397	161	719
10:45-11:00	394	178	750
11:00-11:15	450	194	838
11:15-11:30	369	89	547
11:30-11:45	381	156	693
11:45-12:00	428	164	756
12:00 -12:15 p.m	398	193	784
12:15-12:30	441	229	899
12:30-12:45	434	185	804
12:45-1:00	413	197	807
1:00-1:15	402	203	808
1:15-1:30	353	176	705
1:30-1:45	344	175	694
1:45-2:00	501	213	927
2:00-2:15	500	181	862
2:15-2:30	391	155	701
2:30-2:45	351	152	655
2:45-3:00	376	138	652
3:00 -3:15	355	156	667
3:15-3:30	256	162	580
3:30-3:45	252	122	496
3:45-4:00	282	111	504
4:00 -4:15	285	134	553
4:15-4:30	289	169	627
4:30- 4:45	278	171	620
4:45-5:00	266	172	610

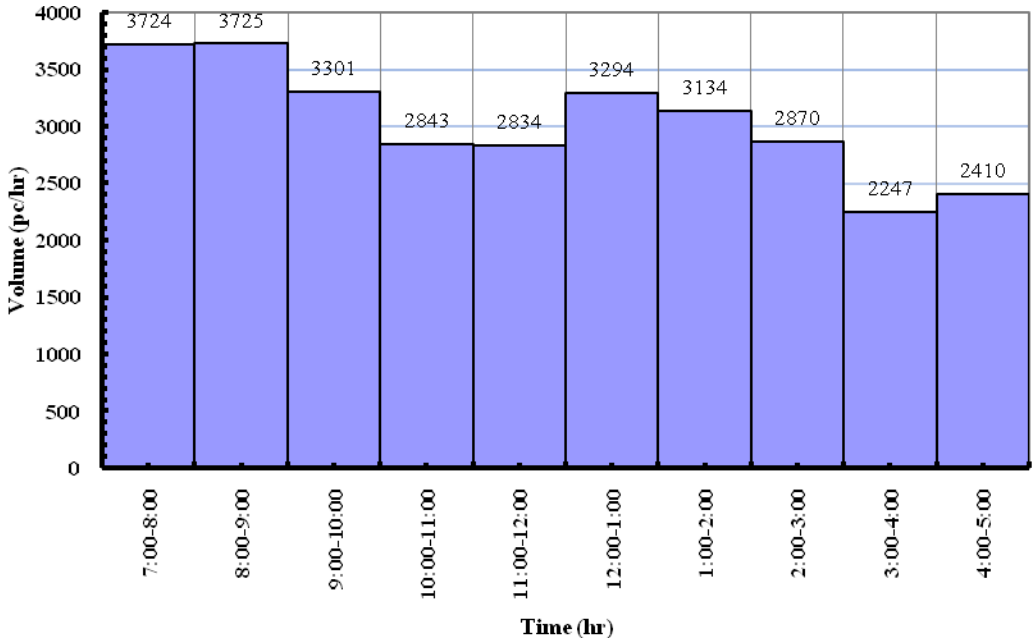

Figure2a. Distribution of traffic volume from 7:00 a.m to 5:00 p.m at stadium intersection.

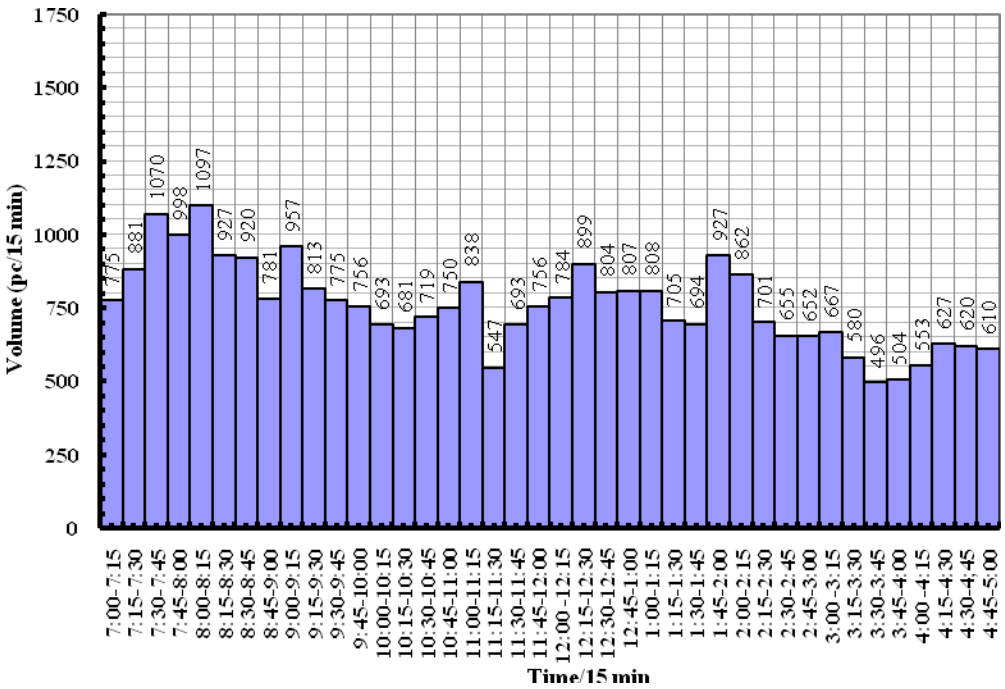

Figure 2b. Total of traffic volume every 15 min for all approaches at stadium intersection.

5.4. Saturation Flow

Saturation flow represents one of the main parameter in which has a major affect in the capacity of intersection (TRB, 1985). The saturation flow rate is the flow in vehicles per hour that can be accommodated by the lane group assuming that the green phase were displayed 100 percent of the time. The existing saturation flow is calculated by using HCS Software. Table (3) shows the

calculated saturation flow at the stop line for all approaches in Stadium Intersection by using HCS Software.

Table 3.Saturation flow at Stadium Intersection

Approach	Movement	Saturation flow vphg
From Baghdad Street	L	1231
	TH	2146
From Samawah street	L	1096
	TH	2137
From Stadium Street	L	1259
	TH	1326
From Alzwaid Street	L	1269
	TH	1336

6. Existing Geometric Design

To evaluate the level of service at Stadium Intersection, it is very important to specify the number of lanes and width of each approach. The existing geometric layout for Stadium Intersection and its approaches are shown in Figure (3).

7. Existing LOS at Stadium Intersection

The Highway Capacity Software (HCS) is adopted to analyze traffic conditions and achieved the existing capacity, volume to capacity ratio and calculation of estimated delay for each traffic movement at each approach.

After specifying the peak hour which represents the design hour volume, it is very important to estimate the level of service (LOS) at Stadium Intersection with existing geometric design and traffic flow.

To estimate the LOS For existing condition, the average delay at Stadium Intersection must be calculated because the average delay represents the main parameter for LOS estimation.

According to Highway Capacity Manual, the (LOS) of signalized intersections can be classifies into six types depending on the value of average delay as shown in Table (4).

Table 4.Level of Service Definitions Based on Delay (HCM method)

Level of service (LOS)	Control delay per vehicle in sec.
A	$d \leq 10$
B	$10 < d \leq 20$
C	$20 < d \leq 35$
D	$35 < d \leq 55$
E	$55 < d \leq 80$
F	$80 < d$

By using HCS program, the average delay for existing geometric at Stadium Intersection is (290.3) sec/veh and according to the Highway Capacity Manual(HCM 2000), Stadium Intersection will operate in LOS (F). Tables (5) and (6) show the average delay and LOS's and some of Stadium Intersection properties for all approaches connected with this Intersection.

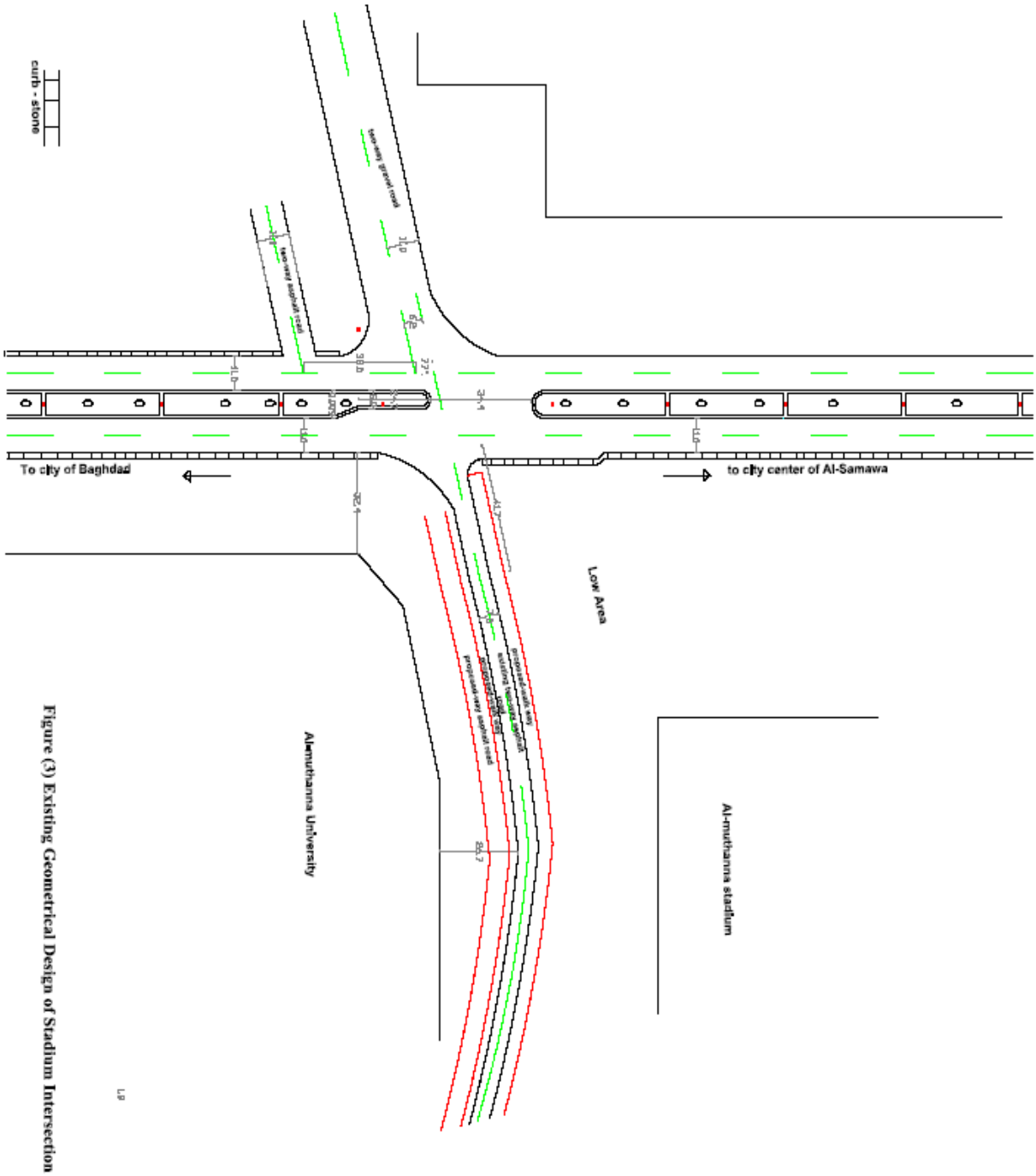

Figure (3) Existing Geometrical Design of Stadium Intersection

Figure 3. Existing geometric design of stadium intersection

Table 5.Existing LOS at stadium intersection.

Approach	Approach delay sec/veh	Level of service(LOS)
From Baghdad Street	178.3	F
From Samawah street	328.4	F
From Stadium Street	173.4	F
From Alzwaid Street	613.5	F
Intersection Average delay	290.3	F

Table 6.Properties of existing geometry for stadium intersection.

Approach	Movement	Vol.	% Hv	PHF	No. of Lane	Cycle length	
						G	Y
From Baghdad Street	L	111	52	0.79	1	42	4
	TH	906	52	0.79	2		
From Samawah street	L	135	32	0.87	1	42	4
	TH	1113	32	0.87	2		
From Stadium Street	L	96	29	0.79	1	10	4
	TH	16	29	0.79	1		
From Alzwaid Street	L	187	28	0.71	1	10	4
	TH	47	28	0.71	1		
Total						120	

8. Design of Proposals for Stadium Intersection

The following proposals can be suggested:

8.1. Proposal NO.1:

This proposal contains improvement of intersection by adding some parameter to enhance LOS of this proposal .These Parameters are:

1. Adding another left lane to for both approaches of Baghdad-Samawah Street ,and
2. Changing phasing time for the intersection.

The expected traffic volume for peak hour at intersection will be as shown in Figure (4) .the new geometric for Stadium Intersection need to enhance the number of lanes to increase the capacity of the intersection in addition to use traffic lights.

The expected average delay at the at-grade level will be (133.2) sec/veh, which means the intersection, will remain in LOS (F). Tables (7) and (8) show the average delay and LOS's and some of Stadium Intersection properties for all approaches connected with this Intersection at Base year.

Table 7.Level of service stadium intersection by adopting proposal NO.1 on the base year

Approach	Approach delay sec/veh	Level of service(LOS)
From Baghdad Street	62.6	E
From Samawah street	171.6	F
From Stadium Street	61.0	E
From Alzwaid Street	273.2	F
Intersection Average delay	133.2	F

Table 8.Properties of stadium intersection after proposal No.1 in base year.

Approach	Movement	Vol.	% Hv	PHF	No. of Lane	Cycle length	
						G	Y
From Baghdad Street	TH	906	52	0.79	1	*41	*4
	L	111	52	0.79	1	13	4
From Samawah street	L	135	32	0.87	1		
	TH	1113	32	0.87	1	*41	*4
From Stadium Street	TH	16	29	0.79	2	**10	**4
	L	96	29	0.79	1	12	4
From Alzwaid Street	L	187	28	0.71	1		
	TH	47	28	0.71	2	**10	**4
Total						92	

Note: - *Phase 1 **Phase 2

8.2. Proposal No. 2

This proposal contains improvement of proposal No.1 by adding some parameter to enhance LOS of this proposal includes the execution of flyover along Stadium-Alzwaid Street approaches. For this proposal the expected traffic volume at ground level in Stadium Intersection will be as shown in Figure (5). The expected traffic volume, which will be use the proposed flyover, will be as follow:

- About 16 veh /h along Stadium-Alzwaid Street (from Stadium to Alzwaid) in peak hour.
- About 47 veh/h Alzwaid- Stadium Street (from Alzwaid to Stadium) in peak hour.

For this proposal, the same number of lanes will be adopted as shown in Figure (4). This proposal includes traffic light at ground level.

For the base year, the results of analysis show that the average delay is (70.9) sec/veh, and the intersection will operate at LOS (E). Tables (9) and (10) show the average delay and LOS's and some of Stadium Intersection properties for all approaches connected with this Intersection at Base Year.

Table 9.Level of service stadium intersection by adopting proposal NO.2 on the base year

Approach	Approach delay sec/veh	Level of service(LOS)
From Baghdad Street	26.2	C
From Samawah street	85.8	F
From Stadium Street	45.4	D
From Alzwaid Street	219.9	F
Intersection Average delay	70.9	E

Table 10.Properties of stadium intersection after proposal No.2 in base year

Approach	Movement	Vol.	% Hv	PHF	No. of Lane	Cycle length	
						G	Y
From Baghdad Street	TH	906	52	0.79	2	*13	4
	L	111	52	0.79	2	41	
From Samawah street	L	135	32	0.87	2		4
	TH	1113	32	0.87	2	*13	
From Stadium Street	L	96	29	0.79	1	12	4
From Alzwaid Street	L	187	28	0.71	1		
Total						78	

Note: - *Phase 1

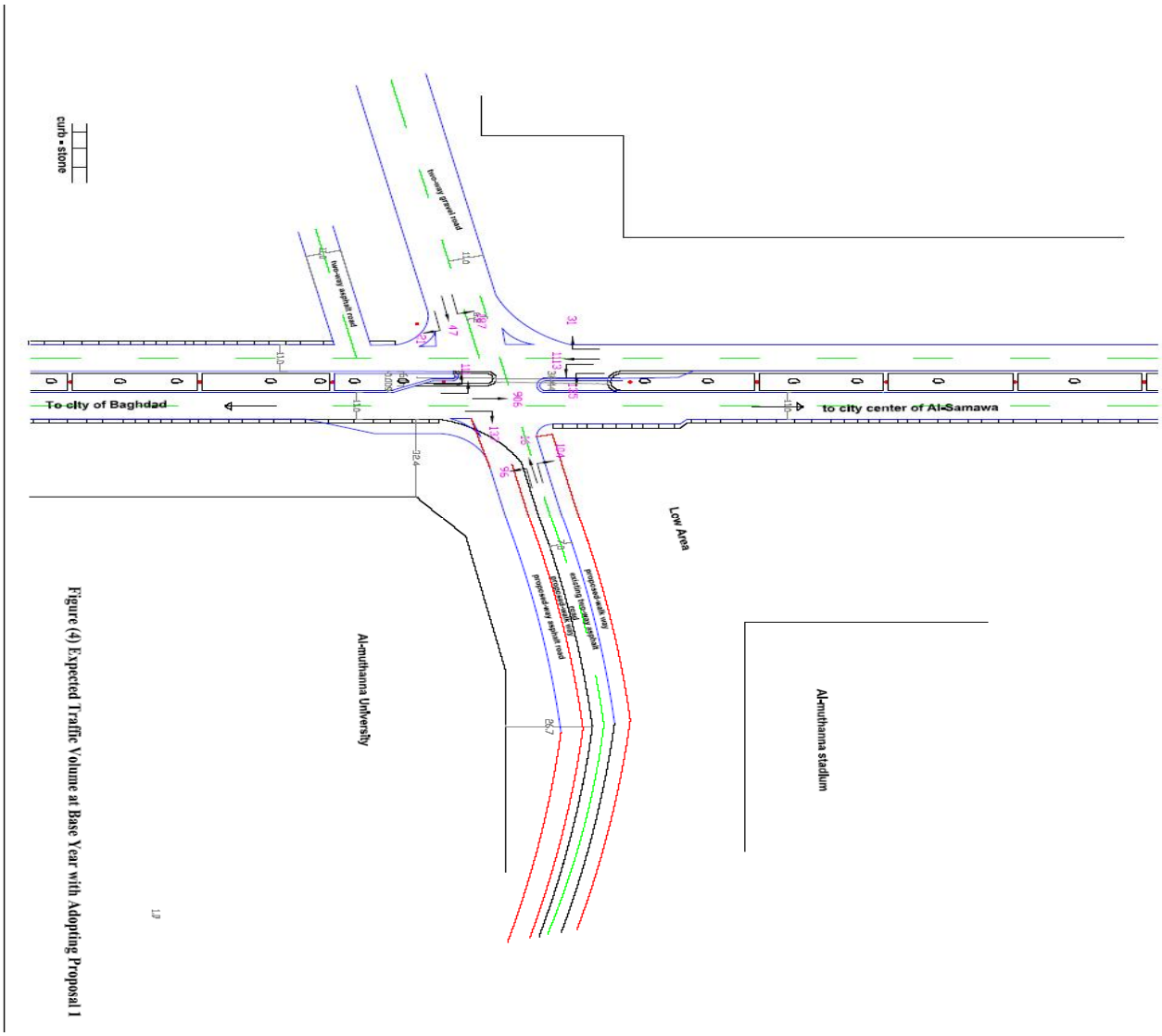

Figure (4) Expected Traffic Volume at Base Year with Adopting Proposal 1

Figure 4.Expected traffic volume at base year with adopting proposal NO.1.

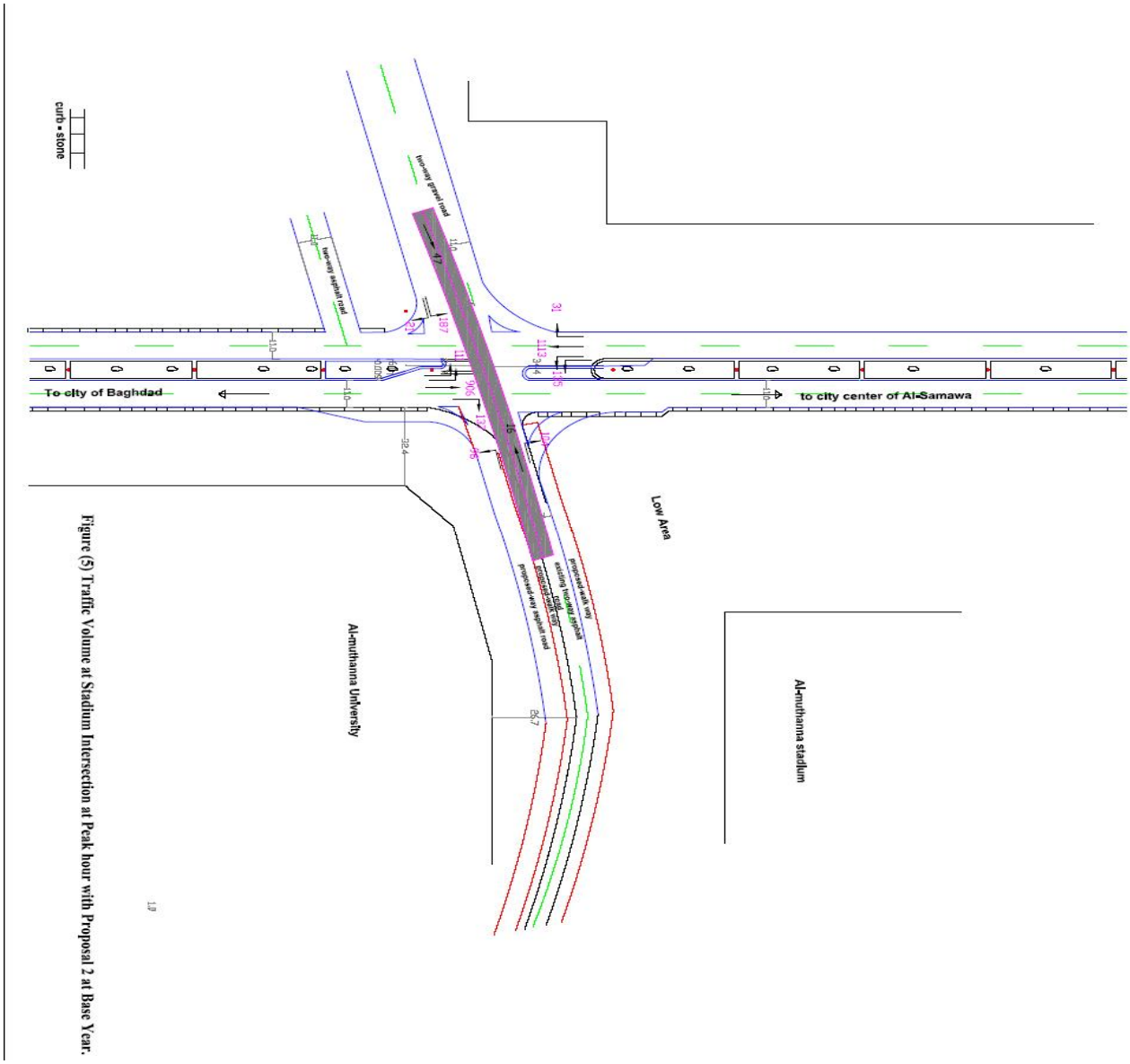

Figure 5. Traffic volume at stadium intersection at peak hour with proposal No. 2 at base year

8.3. Proposal No. 3

This proposal includes the execution of flyover along Baghdad-Samawah Street, the expected number of vehicles which will use the proposed flyover will be as follow:-

- About 1063 veh /h along Baghdad – Samawah Street (from Samawah to Baghdad) in peak hour.
- About 856 veh /h Baghdad – Samawah Street (from Baghdad to Samawah) in peak hour.

For the base year, the results of analysis show that the average delay is (25.2) sec/veh, and the intersection will operate at LOS (C). Tables (11) and (12) show the average delay and LOS's and some of Stadium Intersection properties for all approaches connected with this Intersection at Base

Year. For this proposal the expected traffic volume at ground level in Stadium Intersection will be as shown in Figure (6).

Table 11.Level of service stadium intersection by adopting proposal NO.3 on the base year

Approach	Approach delay sec/veh	Level of service(LOS)
From Baghdad Street	26.7	C
From Samawah street	28.3	C
From Stadium Street	19.9	B
From Alzwaid Street	24.2	C
Intersection Average delay	25.2	C

Table 12.Properties of stadium intersection after proposal NO.3 in base year

Approach	Movement	Vol.	% Hv	PHF	No. of Lane	Cycle length	
						G	Y
From Baghdad Street	TH	50	52	0.79	1	*10	*4
	L	111	52	0.79	1	15	4
From Samawah street	L	135	32	0.87	1		
	TH	50	32	0.87	1	*10	*4
From Stadium Street	TH	16	29	0.79	2	**5	**4
	L	96	29	0.79	1	23	4
From Alzwaid Street	L	187	28	0.71	1		
	TH	47	28	0.71	2	**5	**4
Total						69	

Note: *Phase 1 ** Phase 2

For target year (after 20 years with 3% annual increasing rate), the expected traffic volume will be as shown in Figure (7). The average delay will be (38.7) sec/veh and the intersection will operate at LOS (D), this delay and LOS are accepted according to international specification. Tables (13) and (14) show the average delay and LOS's and some of Stadium Intersection properties for all approaches connected with this Intersection at target Year.

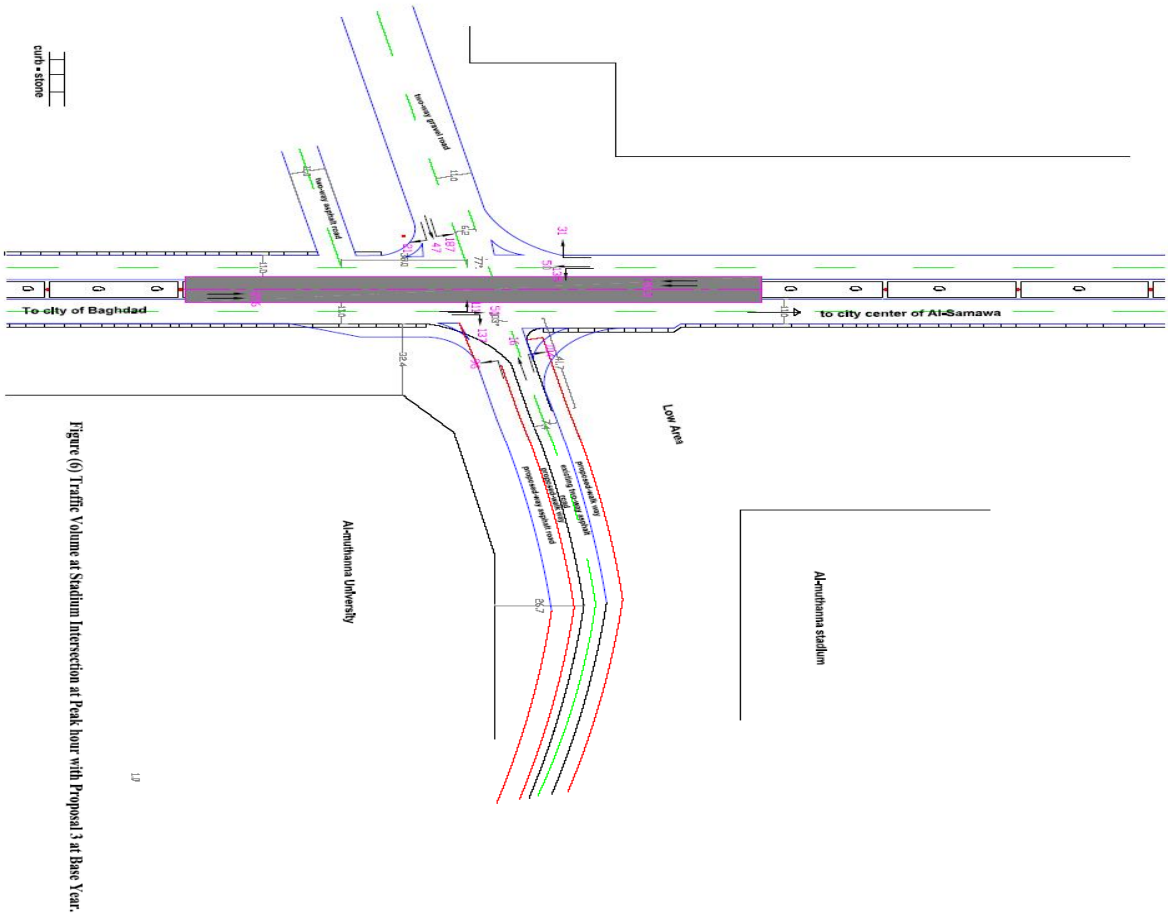

Figure 6. Traffic volume at stadium intersection at peak hour with proposal No. 3 at base year

Figure 7. Traffic volume at stadium intersection at peak hour with proposal No. 3 at target year

Table 13.Level of service at stadium intersection at target year (proposal NO.3)

Approach	Approach delay sec/veh	Level of service(LOS)
From Baghdad Street	34.7	C
From Samawah street	46.1	D
From Stadium Street	23.3	C
From Alzwaid Street	43.1	D
Intersection Average delay	38.7	D

Table 14.Properties of stadium intersection after proposal No.3 in target year

Approach	Movement	Vol.	% Hv	PHF	No. of Lane	Cycle length	
						G	Y
From Baghdad Street	TH	95	52	0.79	1	*10	*4
	L	210	52	0.79	1	15	4
From Samawah street	L	255	32	0.87	1		
	TH	95	32	0.87	1	*10	*4
From Stadium Street	TH	30	29	0.79	2	**5	**4
	L	185	29	0.79	1	23	4
From Alzwaid Street	L	353	28	0.71	1		
	TH	88	28	0.71	2	**5	**4
Total						69	

Note :- *Phase 1 **Phase 2

8.4. Proposal No. 4

Additional proposals will be used in order to cover all the proposals , the proposal contained includes the execution of flyover along Stadium-Alzwaid Street approaches and remove the current access point. This proposal also includes adding at least two U-turn in the study area.

For this proposal the expected traffic volume at ground level in Baghdad- Samawah Multilane will be as shown in Figure (8). The expected traffic volume, which will be use the proposed flyover, will be as follow:

- About 16 veh /h along Stadium-Alzwaid Street (from Stadium to Alzwaid) in peak hour.
- About 47 veh/h Alzwaid- Stadium Street (from Alzwaid to Stadium) in peak hour.

According to Highway Capacity Manual, the (LOS) of Multilane Highway can be classifies into six types depending on the value of Density as shown in Table (15).

Table 15.Level of service criteria for multilane highways definitions based on density (HCM method)

Level of service (LOS)	Maximum density (pc/mi/ln)
A	11
B	18
C	26
D	35
E	40
F	>40

For the base year, the results of analysis show that the Density is (26.0 and 29.5) (pc/mi/ln), and the multilane will operate at LOS (D). Table (16) show the average Density and LOS's and some of Baghdad – Samawah multilane properties for all approaches connected with this Intersection at Base Year.

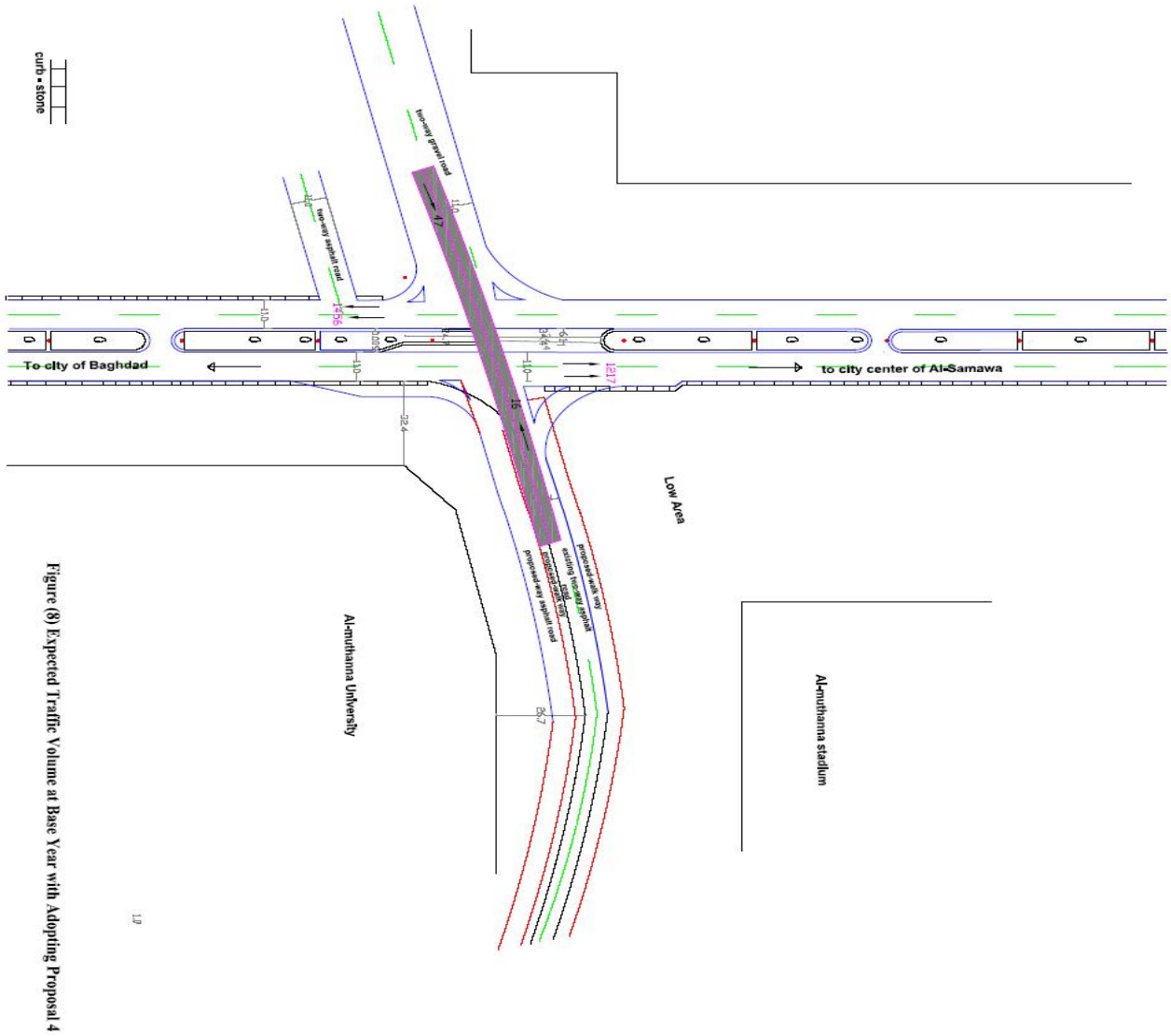

Figure 8. Expected traffic volume at base year with adopting proposal NO.4.

Table 16. Level of Service of baghdad- samawah multilane by adopting proposal NO.4 on the base year

Approach	Base year volume (vph)	Approach density (pc/mi/ln)	Level of service (LOS)	Target year volume (vph)	Approach density (pc/mi/ln)	Level of service (LOS)
From Baghdad – Samawah	1217	26.0	D	2300	------	F
From Samawah - Baghdad	1456	29.5	D	2752	------	F

The current situation is unacceptable to the multilane system because the area will see traffic jams after a few years because of growth in the country in the future.

8.5. Proposal No. 5

Additional proposals will be used in order to cover all the proposals, the proposal contained includes the execution of flyover along Stadium-Alzwaid Street approaches and remove the current access point. This proposal also includes adding at least four U-turn in the study area. This proposal also includes adding two loops one of them on stadium area and the other on Alzwaid area.

For this proposal the expected traffic volume at ground level in Baghdad- Samawah Multilane will be as shown in Figure (9). The expected traffic volume, which will be use the proposed flyover, will be as follow:

- About 16 veh /h along Stadium-Alzwaid Street (from Stadium to Alzwaid) in peak hour.
- About 47 veh/h Alzwaid- Stadium Street (from Alzwaid to Stadium) in peak hour.

According to Highway Capacity Manual, the (LOS) of Multilane Highway can be classifies into six types depending on the value of Density as shown in Table (15).

For the base year, the results of analysis show that the Density is (10.5 and 12.5) (pc/mi/ln), and the multilane will operate at LOS (A and B). Table (17) show the average Density and LOS's and some of Baghdad –Samawah multilane properties for all approaches connected with this Intersection at Base Year.

Table 17.Level of Service of baghdad- samawah multilane by adopting proposal NO.5 on the base Year

Approach	Volume vph	Approach Density (pc/mi/ln)	Level of service(LOS)
From Baghdad –Samawah	1217	10.5	A
From Samawah - Baghdad	1456	12.5	B

For target year (after 20 years with 3% annual increasing rate), the average density will be (19.8 and 23.7) (pc/mi/ln) and the multilane will operate at LOS (C), this delay and LOS are accepted according to international specification. Table (18) show the average Density and LOS's and some of Baghdad –Samawah multilane properties for all approaches connected with this Intersection at target Year.

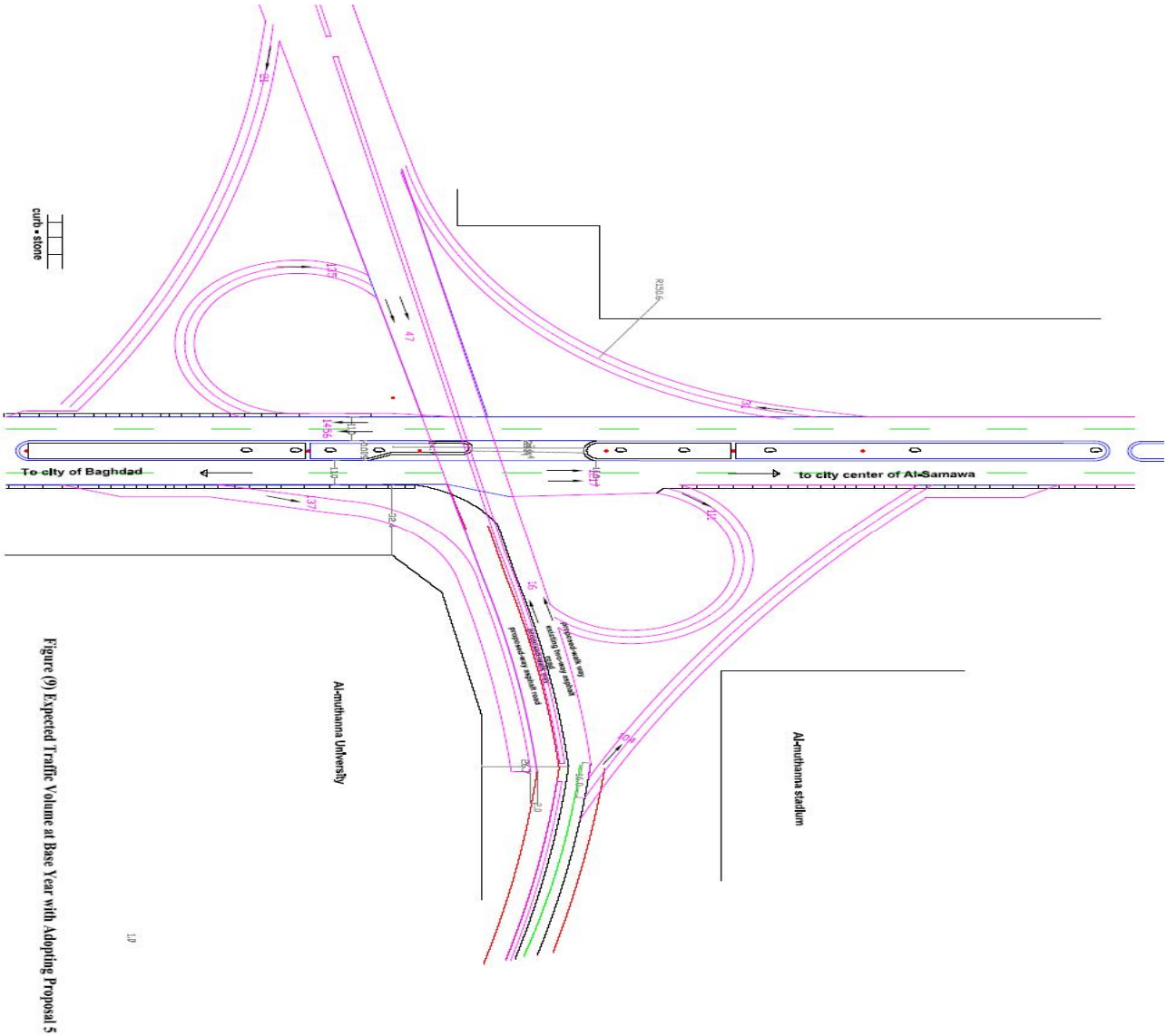

Figure 9. Expected traffic volume at base year with adopting proposal NO.5.

Table 18.Level of Service of baghdad- samawah multilane by adopting proposal NO.5 on the target Year

Approach	Volume vph	Approach Density (pc/mi/ln)	Level of service(LOS)
From Baghdad –Samawah	2300	19.8	C
From Samawah – Baghdad	2751	23.7	C

For this proposal the expected traffic volume at ground level (Baghdad- Samawah Multilane) at Target Year will be as shown in Figure (10).

9. Design of Flyover (Number of Lane)

HCM specification is used to calculate the number of lanes for the proposed flyover.

9.1. For Proposal NO. 3 on the Target Year

At Baghdad-Samawah Street from (Baghdad to Samawah).

$$N= [SF / (C_j \times \frac{v}{c} \times f_w \times f_{Hv} \times f_p)] \quad (2)$$

Where

N = Number of lanes in one direction.

SF = Service flow rate for LOS under ideal condition .

C_j = Capacity under ideal condition for freeway element of design speed.

f_w = Factor to adjust for the effect of restricted lane widths (and lour) lateral clearance.

f_{Hv} = Factor to adjust for the effect of heavy vehicle.

f_p = Factor to adjust for the effect of driven population.

Assume LOS(D)

[SF = 2009 pc/h, v/c = 0.80, f_{Hv} = 1.0, f_p = 1.0, $f_{w=}$ 0.93].

Where

f_w = 0.93 (use standard lane with 1 ft obstruction on both sides)

N = [2009 / (1900 *0.80* 0.93* 1.0* 1.0)] = 1.42 lanes

Use two lanes for each direction.

9.2. For Proposal NO. 5 on the Target Year

At Stadium-Alzwaid Street from (Stadium to Alzwaid Street).

Assume LOS(D)

[SF = 90 pc/h, v/c = 0.80, f_{Hv} = 1.0, f_p = 1.0, $f_{w=}$ 0.93].

Where

f_w = 0.93 (use standard lane with 1 ft obstruction on both sides)

N = [90 / (1900 *0.80* 0.93* 1.0* 1.0)] = 0.06 lanes

Use one lane for each direction.

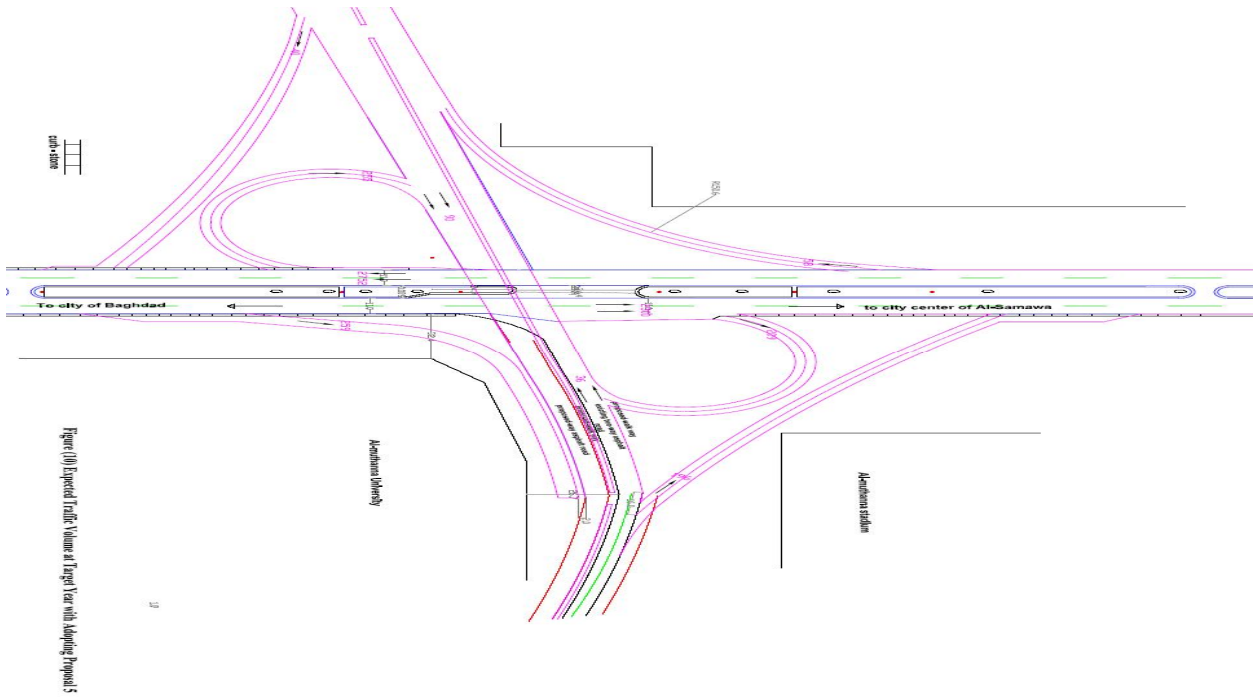

Figure (10) Expected Traffic Volume at Target Year with Adopting Proposal 5

Figure 10. Expected traffic volume at target year with adopting proposal NO.5

9.3. For proposal No. 6 on the Target Year (Loop Near Stadium)

At Stadium-Alzwaid Street from (Stadium to Alzwaid Street) loop near stadium

Assume LOS(D)

[SF = 209 pc/h, v/c = 0.80, f_{Hv} = 1.0, f_p = 1.0, $f_{w=}$ 0.93].

Where

f_w = 0.93 (use standard lane with 1 ft obstruction on both sides)

N = [209 / (1900 *0.80* 0.93* 1.0* 1.0)] = 0.147 lanes

Use one lane for each direction.

9.4. For Proposal No. 6 on the Target Year (Loop Near Department of Weather Forecasters)

At Stadium-Alzwaid Street from (Stadium to Alzwaid Street) loop near Weather forecasters

Assume LOS(D)

[SF = 225 pc/h, v/c = 0.80, f_{Hv} = 1.0, f_p = 1.0, $f_{w=}$ 0.93].

Where

f_w = 0.93 (use standard lane with 1 ft obstruction on both sides)

N = [225 / (1900 *0.80* 0.93* 1.0* 1.0)] = 0.18 lanes

Use one lane for each direction.

9.5. Conclusions and Recommendations

By considering the previous mentioned results, and throughout the presented five proposals, it is concluded that proposal No. (5) Reflects the best solution on the target year from the capacity and the performance operation point of view at Stadium Intersection in Samawah city. This proposal include construct flyover along Stadium to Alzwaid Street, this is mean that the Baghdad- Samawah multilane work in LOS (C) for target year. The results for base and target year are accepted according to the international traffic specification.

The selection of best proposal depends on two factors: first-class is service and the second is the appropriate choice with the reality of the situation. So we can say that all the remaining proposals (1, 2 and 4) are not scientifically because of not achieving the purpose of the study to reduce traffic congestion in the study area. About proposal no. 6 was accepted according to the Highway Capacity Manual in base and target year analysis, but it's contains too much owning land in study area, we can select proposal no.6 if the cost and owning land is not important, However, this option ensures continuity in the traffic without traffic lights.

The geometrical designer must select the best radius of curves on ramps to ensure safety and comfort for the driver during driving on ramps at appropriate speed.

About proposal no. 3 was accepted according to the Highway Capacity Manual in base and target year analysis, but it contains traffic signal in study area, we can select proposal no.3 if traffic signal is allowed, However, this option ensures continuity in the traffic without traffic jam. In the event that we wanted to develop the intersection for the period that are years after the target in case of Proposal No.3, it will be possible to improve the traffic conditions of the intersection of two ways , The first is the work of the change in cycle time light to fit with the new volumes sizes, while the second method are the use of new stage design, summed up by adding Flyover of the Stadium heading towards Baghdad and in the form of arch is designed in a timely manner helps to reduce the volumes of traffic.

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Nomenelature

PHF = Peak-hour factor
V15 = Volume during the peak 15 min of the peak hour, on veh/15min
LOS = Level of Serves
PHV = Peak Hourly Volume
HCS = Highway Capacity Software
HCM = Highway Capacity Manual
HV =Heavy Vehicle
G =Green Time
Y =Yellow Time
L =Left Turn
TH = Through Turn
R = Right Turn
N = number of lanes in one direction
SF = service flow LOS under prevailing and traffic condition for N lanes in one direction (vph)
Cj = Capacity under ideal condition for freeway element of design speed.
fw = Factor to adjust for the effect of restricted lane widths (and lour) lateral clearance.
fHv = Factor to adjust for the effect of heavy vehicle.
fp = Factor to adjust for the effect of driven population