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# Evaluation and Improvement of Traffic Flow on Main Intersections in Tafila City Using Synchro

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***Abstract:***
*Traffic congestion causes negative impacts on various aspects of the society and economy. This study evaluates the traffic congestion at road intersections located in Tafila city, Jordan. Traffic and geometric data were collected through a direct field survey at study area. The data were used to simulate the current situation for the selected road intersections using Synchro 10 software. Synchro was used to analyze operational performance for current situation and suggested improvements. After that, a number of improvements were proposed and examined to identify the most reliable improvement for solving traffic congestion at study intersections. The results showed that the absence of traffic control and parking problems were among the greatest causes of delays at the intersections in the city. Therefore, the study recommends that the intersections be controlled using roundabout or traffic light and vehicle parking be strictly prohibited at intersections to reduce traffic congestions and delays.*

***Key Word****: Traffic Congestions, Intersection; Synchro, Signalized, Improvements.*

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## I. Introduction

One of the most significant urban transportation problems is traffic congestion. Traffic congestion refers to the way in which the movement of vehicles is delayed by one another due to the limited road capacity. In other words, it occurs when the existing road networks are unable to meet the demand for them. Nowadays, almost all cities in developed and developing countries suffer from traffic congestion. In addition, Traffic congestions and traffic accidents have a negative impact on the development of urban areas [1].

Several studies have shown that traffic congestion has unfavorable impacts on the society and economy [2-9]. Lomax et al (1997) indicated that an ideal traffic congestion measure would have (1) clarity and simplicity, (2) descriptive and predictive ability (i.e. ability to describe existing conditions, predict change and be forecast), (3) statistical analysis capability (i.e. ability to apply statistical techniques to provide a reasonable portrayal of congestion and reproducibility of result with a minimum of data collection requirements), and (4) general applicability (i.e. applicability to various modes, facilities, time periods and scales of application). Wen and Yang [6] developed an automatic and dynamic traffic light control system to solve the road congestion problem. The authors simulated a specific congested road, the Chung San North road in Taipei, Taiwan, to discuss whether the road simulation model could solve the congestion problem.

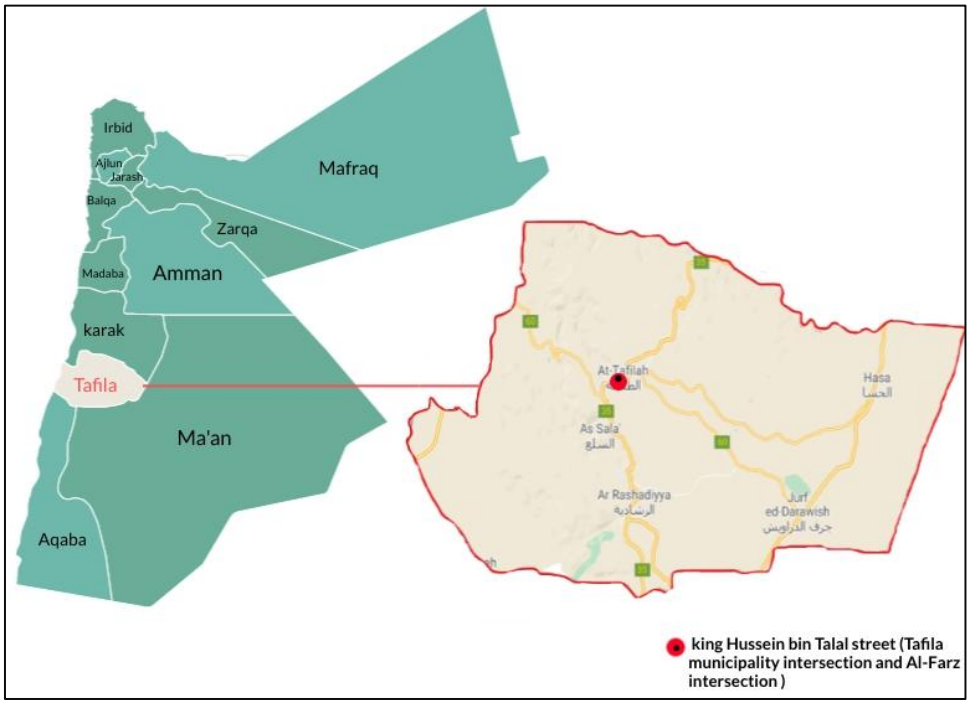
Synchro program is a macroscopic traffic optimization and simulation tool [10], which is chosen in this work. Udomsilp, et al. [11] used Synchro to generate optimal cycle lengths of the intersections along Sathorn road, Bangkok, to reduce the delay at intersections. A comparative analysis was performed between the actual signal timing as operated by traffic police from real data collection and optimal cycle lengths to see the improvement of travel times in different situations. The results showed clearly the significant improvements in each road intersection. In general, the main objective of Synchro is to improve the efficiency of road networks by simulating the current and future situations after treatment implementations [11-13]. Synchro is developed on the basis of the American road pattern which is similar to the Jordanian road pattern, right-hand traffic.

The main objective of this study is to evaluate and improve traffic flow on road intersections along King Hussein road. To achieve this, the main two intersections along King Hussein road are evaluated including Al-Farz intersection and Tafila municipality intersection using Synchro simulation software. The selected intersections have high traffic volumes, random traffic movements, and are not governed by traffic control devices. Therefore, these conditions lead to heavy traffic congestions in all intersection entrances, cause accidents, and high traffic delays. A number proposed improvements to reduce traffic congestions are evaluated.

The results of the evaluation included the most appropriate option that has significant potential to put into practice.

## II. Study Area and Data Collection

The study area selected as Tafila city, which is located 180 km southwest of Amman, the Jordanian capital. Figure 1 shows the map of the selected study area. The population of the city is approximately 109,000 people according to a study published by the Department of Statistics, Jordan [14]. Traffic congestion in Tafila becomes a very serious issue especially in the few last years. King Hussein road is one of the main roads in the city, which witnesses heavy traffic congestion. This road is not has any traffic controls and it suffers from frequent queues, delays, and time wastage that face road users, especially during rush hours.




**igure 1:** Map of the selected intersections, Tafila city, Jordan

The road has two main intersections including, Al-Farz intersection (4-legs) and Tafila municipality intersection (3-legs) as shown in Figure 2. These two intersections located in the central business district (CBD) of the city and suffer from high traffic congestions. The distance between the centers of these two intersections is about 317 meters.


**Figure 2:** Aerial image of the selected intersections, (A) Al-Farz intersection and (B) Tafila municipality intersection.

Traffic data was collected from study area and include; traffic volume and peak hour volume (i.e. one-hour time interval where the highest traffic density occurs). Traffic data collected on a working day from 7.00 AM to 9.00 AM and 3.00 PM to 5.00 PM. The data including number of cars, buses, and trucks that entering the selected intersections were collected manually by site visiting. Road geometric data such as lane width, shoulder width, slop, and lateral obstructions were collected from site visits and Google Earth Pro.

## III. Data Analysis and results

In this section, Synchro software 10 was used to evaluate the operational performance for each intersection during the existing conditions and for suggested scenarios. This software is compatible with Highway Capacity Manual (HCM) 6th Edition, 2000 and 2010 for the roundabout, signalized intersections, and un-signalized intersections [15]. Five scenarios were evaluated including:

1. Current conditions at both intersections (AL-Farz intersection and Tafila municipality intersection).
2. Adding traffic light at both intersections.
3. Adding a roundabout at both intersections.
4. Adding a traffic light at the Tafila municipality intersection and adding a roundabout at the AL-Farz intersection.
5. Adding a traffic light at the AL-Farz intersection and adding a roundabout at the Tafila municipality intersection.

The first step in traffic simulation modeling using Synchro is to construct the road network (i.e. segments and intersections) using the existing road conditions. In this step, all geometric and traffic data such as lane numbers, lane widths, road slops, traffic volumes were entered. Figure 3 shows the settings of geometric and traffic data in Synchro. The second step is to calibrate the model to ensure that the model provides realistic simulations for existing conditions. This step will be carried out before any change in the base conditions of the road features. In the third step, the road features will be changed according to the suggested solutions to evaluate the traffic operations before and after the suggested improvement. Figures 4-8 shown the five scenarios that evaluated.

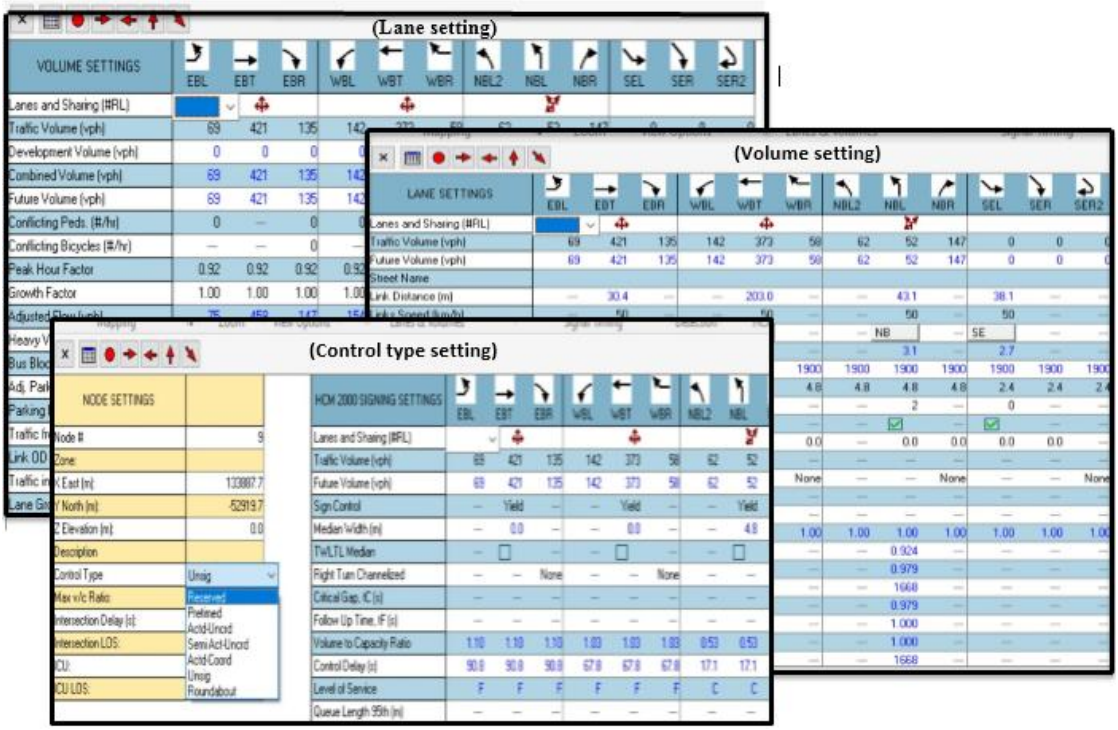



**Figure 3:** Lane setting, volume setting, and control type setting in Synchro 10 software.

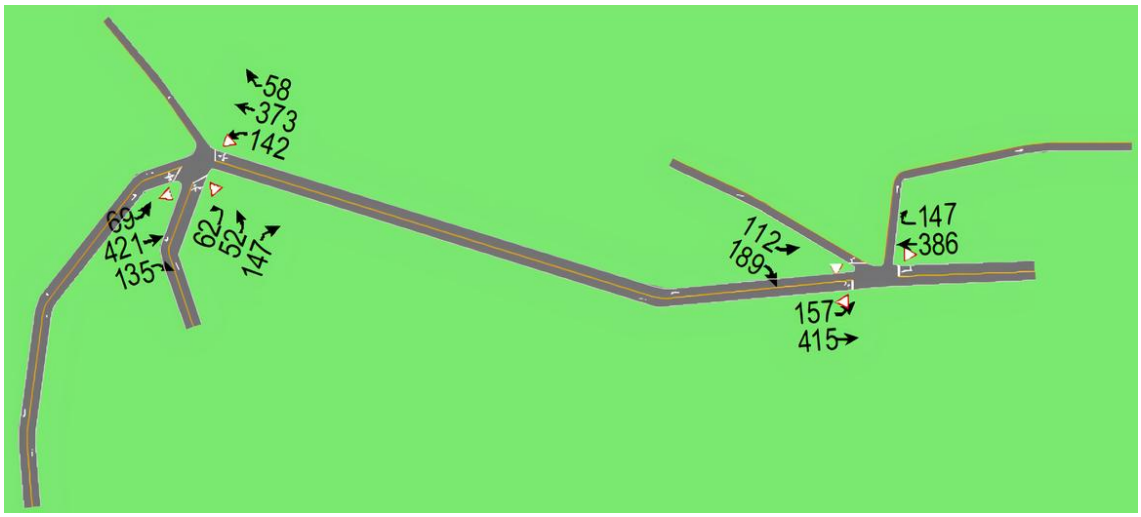



**Figure 4:** Network modeling for Scenario 1 using Synchro 10 Software.

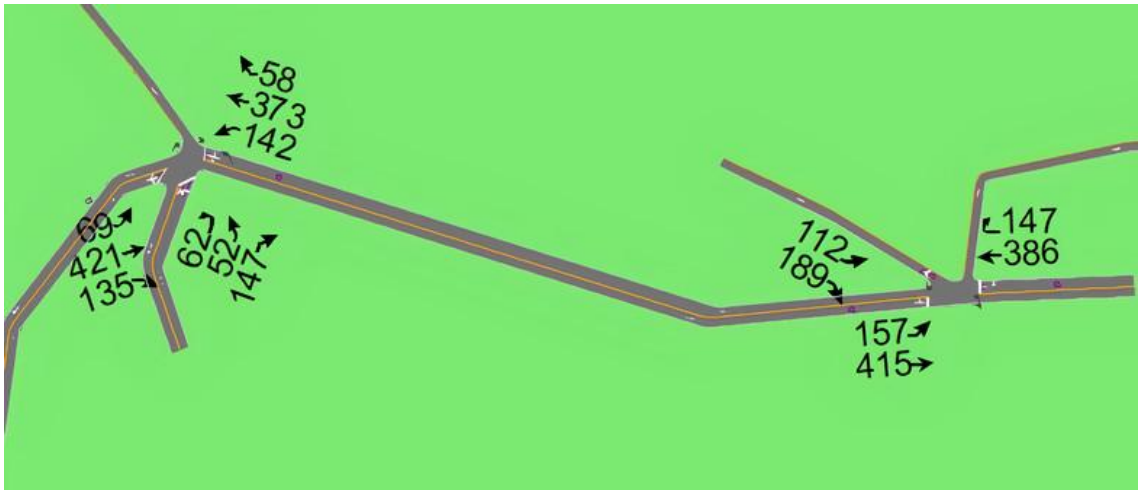



**Figure 5:** Network modeling for Scenario 2 using Synchro 10 Software.

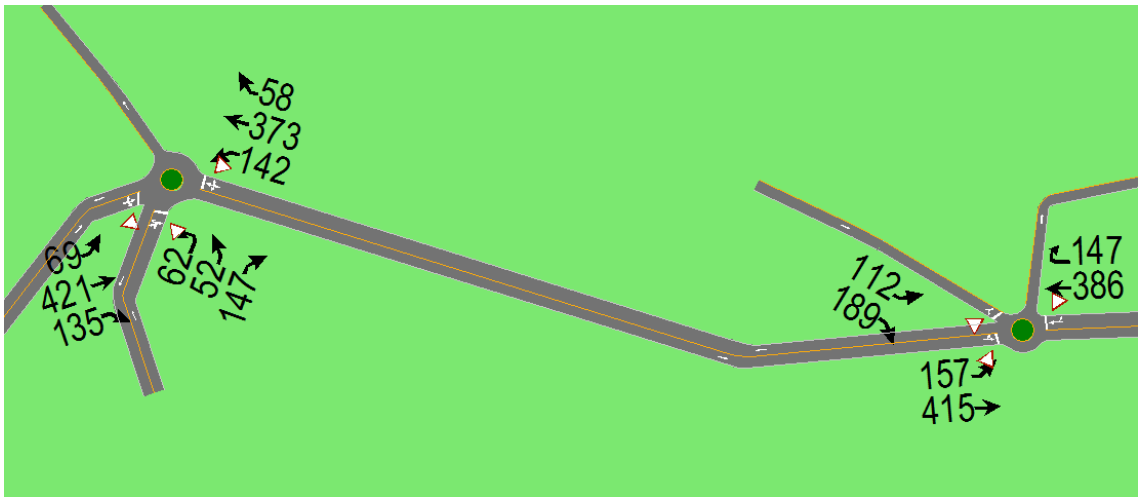



**Figure 6:** Network modeling for Scenario 3 using Synchro 10 Software.

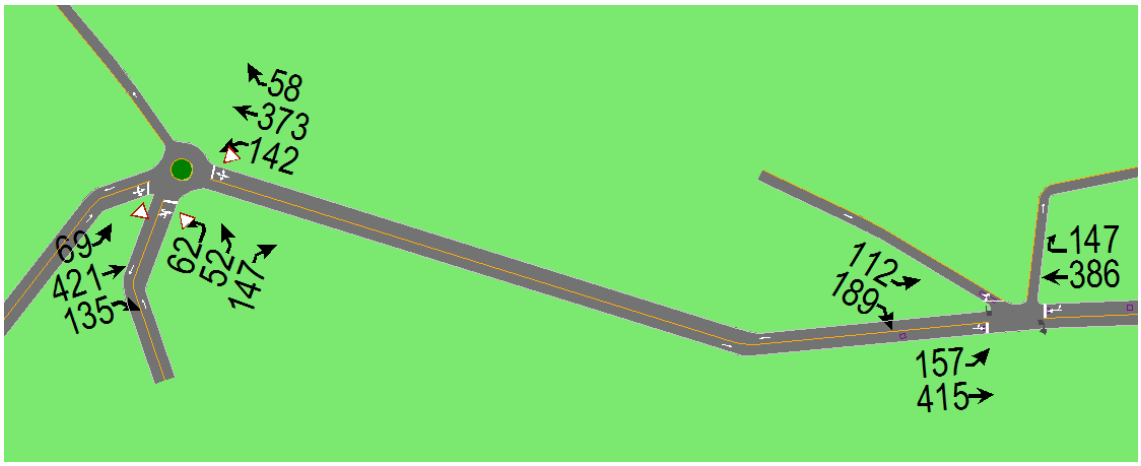



**Figure 7:** Network modeling for Scenario 4 using Synchro 10 Software.

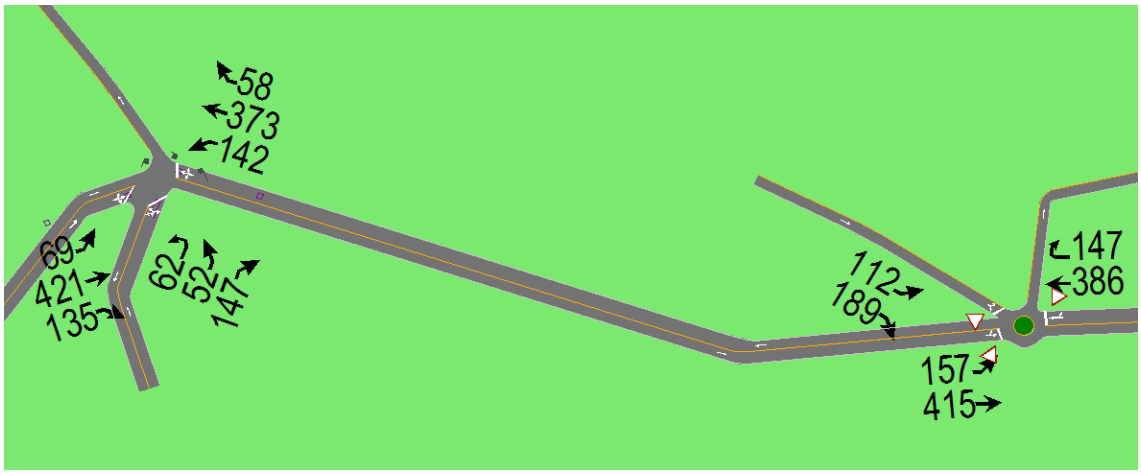



**Figure 8:** Network modeling for Scenario 5 using Synchro 10 Software.

## IV. Analysis Results

The level of service (LOS), average delay, volume to capacity (V/C) ratio, and average speed were adopted as key performance indictors in the evaluation process using Synchro 10. The operational performance was evaluated for each intersection using Synchro during the current conditions and for the future suggested improvements. Table 1 summarizes the evaluation results of the suggested improvements for selected intersections. As listed in Table 1, there is a clear difference in operating performance for the same intersections after improvements. It's obvious that the current condition (scenario 1) for both intersections operates at an unacceptable level of service. On the other hand, the LOS raised from (F) to (B and C) with an average delay of around 17 seconds after simulating the suggested improvements.

The best improvements based on LOS, average delay, V/C ratio, and average speed (Figure 9) were achieved after introducing scenarios 3 and 5. Scenario 3 includes adding a roundabout in each of the intersections, and scenario 5 includes adding a traffic light at the AL-Farz intersection and adding a roundabout at the Tafila municipality intersection. The applying of these improvements are conditional on several factors that must be taken into consideration, as the CBD area in Tafila city is a crowded area with buildings and it has a small road width. The dimensions of the roundabout must be chosen with great accuracy. Theoretically, we have chosen an outer diameter of the roundabout by 10 meters and an internal diameter of 4 meters for both intersections.

**Table 1:** Synchro analysis results of the selected intersections.

| Scenario Number | Intersection[1] | LOS | Delay (sec.) | (V/C) ratio | Speed (km/h) |
|---|---|---|---|---|---|
| **1** | A | F | 68.8 | 1.10 | Figure 9 |
| | B | F | 75.6 | 1.15 | Scenario 1 |
| **2** | A | B | 18.3 | 0.78 | Figure 9 |
| | B | C | 21.6 | 0.87 | Scenario 2 |
| **3** | A | C | 15.3 | 0.72 | Figure 9 |

| | | | | | |
|---|---|---|---|---|---|
| | B | B | 12.7 | 0.64 | Scenario 3 |
| **4** | A | C | 15.3 | 0.72 | Figure 9 |
| | B | C | 21.6 | 0.88 | Scenario 4 |
| **5** | A | B | 17.7 | 0.78 | Fig (9) |
| | B | B | 12.7 | 0.49 | Scenario 5 |

[1] (A) Al-Farz intersection and (B) Tafila municipality intersection.

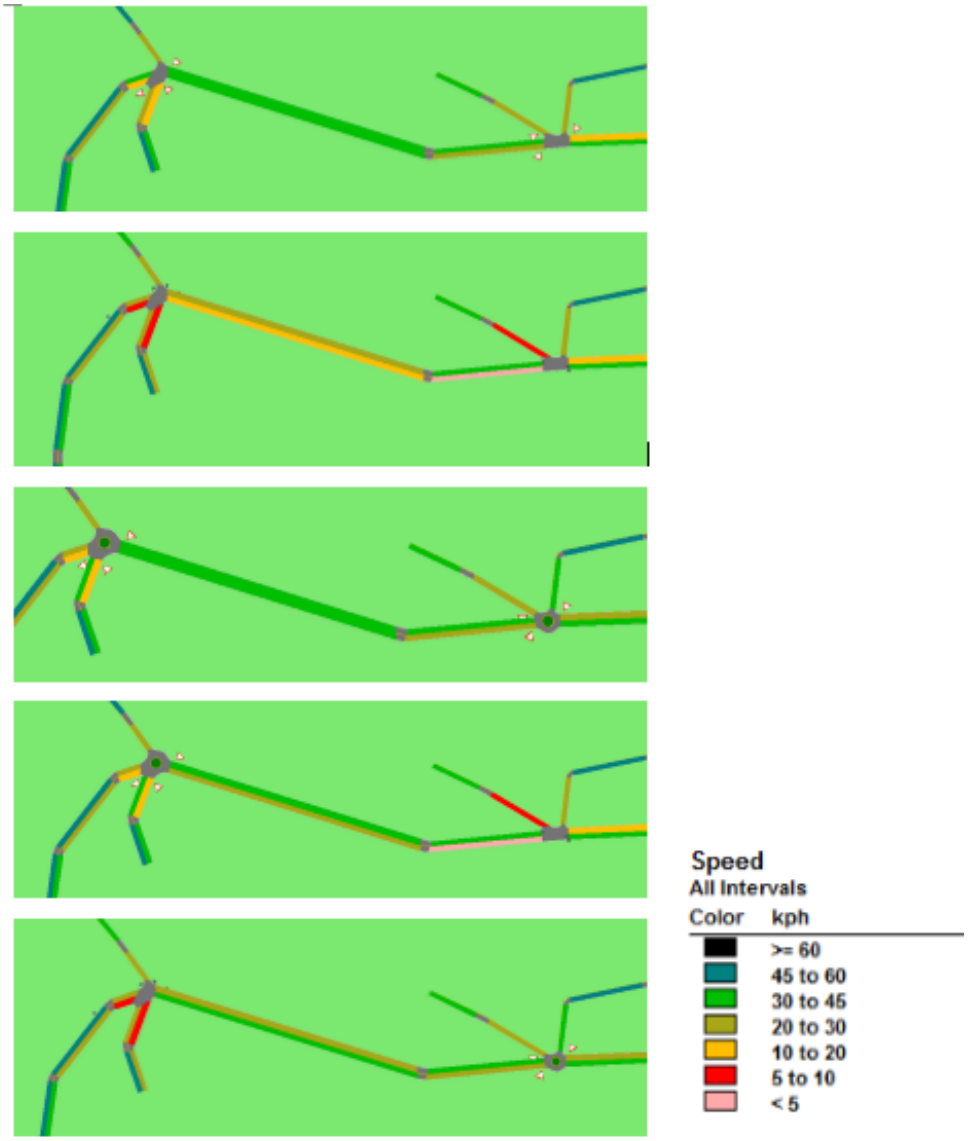



**Figure 9:** Average speed at selected intersections for the scenarios 1 to 5.

## V. Conclusions

As the population and number of vehicles increase, the traffic congestion problem becomes worse. Traffic problem should not be left until it deteriorates further in Tafila city. This study provides an evaluation of the current and proposed traffic conditions at road intersections in Tafila. The results of the analysis process with Synchro showed that traffic conditions were enhanced after applying suggested improvements. It is also important to point out that several scenarios were evaluated during the analysis process. The results showed clearly the significant improvements in each intersection. Two scenarios were found have the most effective on traffic conditions at study intersections. The first includes adding a roundabout at both of the intersections (scenario 3). The second includes adding a traffic light at the AL-Farz intersection and adding a roundabout at the Tafila municipality intersection (scenario 5).

To achieve the aim of the study, the following recommendations were made: improve public transportation services, improve driver behavior, provide parking areas to prevent vehicles from blocking intersection entrances, and traffic laws should be enforced.

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