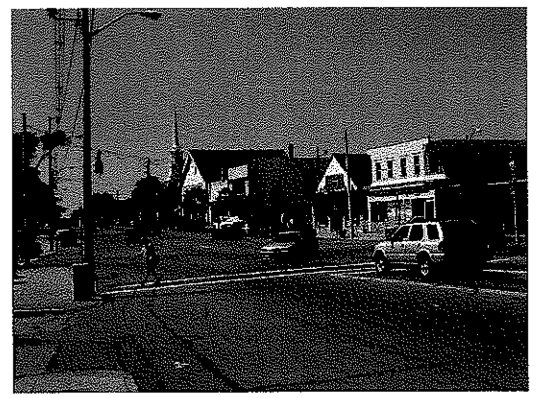
Draft Final
Downtown Hyannis Traffic Circulation Study

Volume I of II

Prepared for:

Town of Barnstable



December, 2001

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To: One Way Two Way, Hyannis Advisory Committee Group
FroM: Jacqueline Etsten, Principal Planner
Cc: Joellen Daley Assistant Town Manager
Date: December 3, 2001

RE: Advisory Committee Meeting, December 20, 2001 at 10.30 AM, Selectmans' Conference Room, Second Floor, Town Hall

The draft report from Transportation Engineers, Vollmer Associates, with their findings on the study of One way or Two Way direction of traffic flow on Main Street and South Street will be mailed to members of the Group during the week of December 10. The Group will meet December 20 to develop comments for the Town Manager.

A Study of the One-Way to Two-Way Streets Conversion in Downtown Edmonton

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A Paper for Presentation at the 2001 Annual Conference of the
Canadian Institute of Transportation Engineers

Calgary, Alberta, May 2001

1.0 Introduction & Background

This paper reviews the original objectives of the Downtown Edmonton two-way to one-way streets conversion plan to determine whether the original objectives were met and to determine the effects of the conversion on the Downtown.

Edmonton, Alberta's capital city, has a metropolitan population of 650,000 residents while the Edmonton regional population is over 900,000. The city's Downtown is home to nearly 7,000 residents, 2,200 business developments, and 55,000 workers. The cities main arts centres reside in the downtown making it a major tourist attraction. The average annual weekday auto trips into and out of the Downtown cordon total over 230,000 while the average annual weekday transit ridership into and out of the cordon is over 96,000.

1.1 One-Way Street System in Downtown Edmonton

In 1972, a one-way street system was implemented in the City of Edmonton Downtown as part of a project plan to improve traffic flow. One-way traffic has the effect of improving the capacity of a pair of arterial streets by 20 to 50 percent because turn delays are minimized [1]. One-way movement also facilitates coordinated signal control and usually reduces traffic collisions. However, the one-way street system can adversely affect emergency response capabilities and may reduce the level of business for some types of commercial activities such as those with a large amount of customer pickup or drop off business. [1]

In August 1998, as part of the Capital City Downtown Plan initiatives, some of the roadways were converted back from one-way to two-way. Sections of the roadways were not converted to two-way due to concerns of severe impact on transit operations, pedestrian safety and access impacts. The main purpose of the conversion was to:

i) improve the pedestrian environment,
ii) improve access to businesses coupled with increasing on-street parking,
iii) improve traffic circulation through the downtown,
iv) encourage residential and commercial development.

1.2 Downtown Edmonton Two-Way Street Conversion

The City of Edmonton downtown transportation system objective, as stated in the April 1997 Capital City Downtown Plan is as follows:

> "To provide a safe, balanced, integrated transportation system in the Downtown that serves the needs of existing and future development and is based on the role of each mode of transportation – pedestrian, public transit, private vehicle, bicycle, and other alternative modes."

In support of this objective, Policy 6.7 specified the staged conversion of one-way streets to two-way streets. The policy goals were as follows:

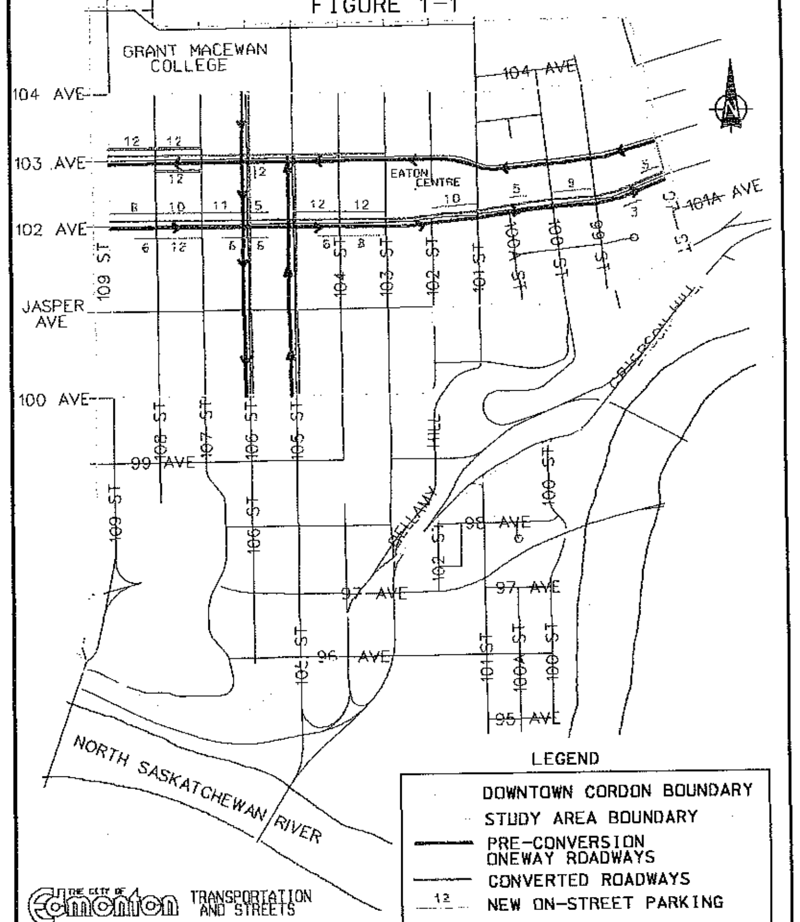
"Policy 6.7 –...to improve the pedestrian environment, to reduce traffic speed, to support the future residential development, to improve access to businesses and to simplify transportation circulation."

With regards to improving access to businesses, an additional objective of increased on-street parking in the Warehouse District and the Commercial/Cultural Core was initiated.

On August 28th and 29th 1998 the Downtown Two-Way Street Conversion project was implemented. Figure 1-1 also provides an overview of the study area and affected roadways.

DOWNTOWN EDMONTON TWO-WAY CONVERSION STUDY AREA

FIGURE 1-1



Data used for the analysis included traffic volume counts, travel speeds, motor vehicle collision counts, and pedestrian collision counts. A comparison of conditions was made pre- and post-conversion with particular emphasis placed on the immediately *affected roadways* (high-lighted in red in Figure 1-1) versus the *unaffected roadways* (i.e. in the remaining portion of the study area). For the purposes of this study the boundaries have been defined as 104 Avenue to the north, 97 Street to the east, 100 Avenue to the south, and 109 Street to the west.

3.0 Objectives of Two-Way Conversion

3.1 Improve Pedestrian Environment

Improving the pedestrian environment contributes directly to the vitality of the downtown. It increases attractiveness of the downtown as a centre for culture, living, and business. The conversion from two-way to one-way streets was seen as a vehicle to promote pedestrian movement in the downtown and make it a more attractive form of transportation.

3.2 Improve Traffic Circulation

Traffic circulation on a two-way street network is simpler than the one-way system, in that it eliminates the need to circle the block to reach an upstream destination. The two-way street system reduces confusion for visitors and simplifies travel for residents of the downtown.

3.3 Improve Access to Businesses

The two-way street network improves access to downtown businesses in the following ways:

i. Access is provided from any direction without the need to approach from the upstream direction of a one-way street.
ii. Drop-off and lay-by bays are on the right allowing passengers to disembark onto the sidewalk instead of the travel lane.

The two-way conversion improvements coupled with an increase in on-street parking further facilitates business access and encourages patronage.

3.4 Encourage Residential and Commercial Development

By improving business access, commercial and residential development becomes increasingly attractive as patrons and residents are able to derive the benefits outlined in section 3.3. In addition, residential developments will benefit from the decline in traffic noise arising from reduced travel speeds due to a two-way street configuration.

4.0 Evaluation Criteria

Several evaluation criteria have been identified in order to measure the success of the two-way conversion based on the four main objectives. Table 4-1 lists the objectives and their corresponding evaluation criteria.

Table 4-1: Objectives and Measures of Success for the Two-Way Conversion

Objective	Evaluation Criteria
Improve Pedestrian Environment	❖ Vehicles Speeds ❖ Pedestrian Collisions ❖ Pedestrian Clearance (Walk) Times
Improve Traffic Circulation	❖ Impact on Traffic Operations ❖ Distribution of Traffic Volume ❖ Vehicular collisions
Improve Access to Businesses	❖ Quantity of On-street Parking ❖ Business Patronage ❖ Residential and Commercial Development
Encourage Residential & Commercial Develop.	❖ Traffic Circulation ❖ Parking availability ❖ Residential and Commercial Development

4.1 Pedestrian Environment

The perception of a quality pedestrian environment is influenced by the traffic speed adjacent to the sidewalk. By converting the two-way streets to one-way it was anticipated that traffic speeds would be reduced thereby improving the pedestrian environment.
Using travel times and travel speeds captured before and after the conversion, a comparison was made to determine whether or not the average speed of vehicles in fact decreased.

A reduction in travel speed is also directly related to the reduction of the number of vehicle collisions and their severity. The speed differential between vehicles, cyclists, and pedestrians is reduced, thus improving the overall safety of the street network. Counts of pedestrian-vehicle collisions along with the costs associated with the collisions were used to determine the safety implications of the conversion.

Finally, pedestrian counts and clearance/walk times can be used to evaluate whether or not the conversion has had a positive effect and has in fact encouraged walking in the Downtown.

4.2 Access to Business

A major indicator of the success of the conversion is the feedback from the businesses that were directly impacted by the change. In addition, an increase in the amount of on-street parking facilitates near shops and businesses would encourage patronage of the Downtown businesses.

4.3 Traffic Circulation

Traffic volume counts and level of service measurements taken before and after the conversion will indicate whether or not there has been a change in traffic congestion on the converted streets. Also, the volume counts will be used to determine whether or not the distribution of traffic among the Downtown core streets has improved.

The impact on the operation of buses in the downtown resulting from the conversion will be derived from the Level of Service analysis performed on the various intersection movements. The volume to capacity ratio will be used as the main indicator.

Counts of vehicle collisions along with the severity of the collisions will be used to determine the safety implications of the conversion.

4.4 Residential and Commercial Development

One of the main criteria used to determine the success of this objective is whether or not traffic circulation has indeed improved due to the conversion. Improving the traffic circulation would make the Downtown more attractive to developers of commercial and residential initiatives, as it would be easier for patrons and residents to maneuver around the area. In analyzing the success of this criterion, consideration will be given to the fact that only two years have past since the conversion project was completed and as such, time may not have allowed quantifiable changes to have taken place. Another influential factor is the availability of existing parking spaces and the possibility for future parking developments for the potential patrons and residents.

5.0 RESULTS

5.1 Pedestrian Environment

Vehicle Speeds

Vehicle travel speed data collected on a typical weekday with dry roadway conditions in April 1998 (pre-conversion) and October 1998 (post-conversion) was used in this analysis. Three time periods were considered:

- AM Peak Period (07:00 – 08:30)
- Off-Peak Period (09:30 – 15:00)
- PM Peak Period (16:00 – 17:30)

The affected streets involved in the analysis included 102 Avenue, 103 Avenue, 105 Street, and 106 Street. Table 5-1 indicates the change in travel speeds before and after the two-way conversion on the streets.

Table 5-1: Change in Average Travel Speed on Converted Roadways

AM Peak Average Travel Speeds (km/h)								
	102 Ave		103 Ave		105 St		106 St	
	EB	WB	EB	WB	NB	SB	NB	SB
Pre-Conversion	24.8	-	-	39.9	26.3	-	-	28.6
Post-Conversion	21.6	21.0	20.1	29.6	24.6	18.9	19.4	19.7
Change in Speed	**-3.2**	**-**	**-**	**-10.3**	**-1.7**	**-**	**-**	**-8.9**

Off-Peak Average Travel Speeds (km/h)								
	102 Ave		103 Ave		105 St		106 St	
	EB	WB	EB	WB	NB	SB	NB	SB
Pre-Conversion	30.1	-	-	25.3	29.1	-	-	22.7
Post-Conversion	25.2	29.6	21.1	23.7	26.8	21.2	27.1	20.5
Change in Speed	**-4.9**	**-**	**-**	**-1.6**	**-2.3**	**-**	**-**	**-2.2**

PM Peak Average Travel Speeds (km/h)								
	102 Ave		103 Ave		105 St		106 St	
	EB	WB	EB	WB	NB	SB	NB	SB
Pre-Conversion	31.3	-	-	40.6	22.4	-	-	20.8
Post-Conversion	22.7	24.2	25.9	30.2	18.1	19.2	17.5	16.4
Change in Speed	**-8.6**	**-**	**-**	**-10.4**	**-4.3**	**-**	**-**	**-4.4**

All streets involved in the two-way conversion saw the desired decrease in travel speed as well as a corresponding increase in travel time. A decrease in speed ranging from 2 km/h to 10 km/h would translate into an increase in travel time ranging from 4 to 90 seconds across a 2 km stretch of road.

Interestingly, 104 Avenue (a peripheral arterial road) saw an increase in travel speeds during the AM and PM peak hours, which may indicate that the peripheral roadways had become more attractive in diverting Downtown through-traffic outside of the core. This was one of the goals of the Capital City Downtown Plan.

Pedestrian Collisions

Pedestrian collision data in the Downtown was analyzed using collisions statistics collected from police collision reports. Pre-conversion collision data was collected from September 1996 through to June 1998 and post-conversion data from September 1998 through to June 2000. The data was then separated by location according to whether the collision had taken place on the affected or unaffected roadways.

Table 5-2: Total Pedestrian Collisions in the Affected Area Pre- and Post-Conversion

Pedestrian Collisions	Pre Conversion	Post Conversion
Total Collisions in Downtown	59	36
Total Collisions on Affected Roadways	19	14
% of Collisions on Affected Roadways	32%	39%
Total Property Damage Cost in Entire Downtown	$ 9,950	$ 4,050
Total Property Damage Cost on Affected Roadways	$ 3,600	$ 1,300
% of Property Damage Costs on Affected Roadways	36%	32%

Table 5-2 shows that there were 5 less pedestrian collisions on the affected roadways after the conversion. However, relative to the total number of collisions in the Downtown there was a *7% increase*. The cost associated with the collisions also decreased and relative to the total damage costs, the affected roadways appear to have less costly collisions. It is interesting to note that the decrease in the total number of collisions in the Downtown can be attributed to a lower number of collisions along Jasper Ave.

Strong consideration should be given to the fact that it is always difficult to draw conclusions based on collision data due to their somewhat random nature.

Pedestrian Clearance Time

At the same time that the conversion of one-way streets was taking place, the opportunity was taken to perform a signal re-timing of the entire downtown system. As a result of the re-timing, more than half of the pedestrian signals within the affected area saw an increase in pedestrian clearance time. The average increase was 1.2 seconds and a maximum of 6 seconds.

Pedestrian Volumes

One of the statistics used as an indicator of pedestrian environment improvement is the change in pedestrian volumes. Unfortunately there was insufficient data to formulate a relationship between the change in pedestrian volumes and the downtown two-way streets conversion.

5.2 Access to Business

Quantity of On-street Parking

In addition to the two-way conversion, The Capital City Plan also contained a parking strategy aimed at increasing the vitality and commerce in the downtown. The strategy included recommendations for increasing the supply of on-street metered parking and promoting Downtown parking to Edmontonians.

In conjunction with the downtown two-way conversion in 1998, several on-street metered parking stalls were added as shown in Figure 1-1. According to the Capital City Downtown Plan, the key initiatives regarding parking included providing more on-street parking near shops and businesses in the Warehouse District and the Commercial/Cultural Core. 170 on-street metered parking stalls were added on 102 Ave and 103 Ave, which provide major service to the Warehouse and Commercial/Cultural Core.

Studies done after the installation of the parking meters shows that utilization is not as high as expected.

Business Patronage & Commerce

Positive feedback has been received from residents and businesses within the downtown. However, it is difficult at this stage to draw any specific conclusions with respect to business patronage.

5.3 Traffic Circulation

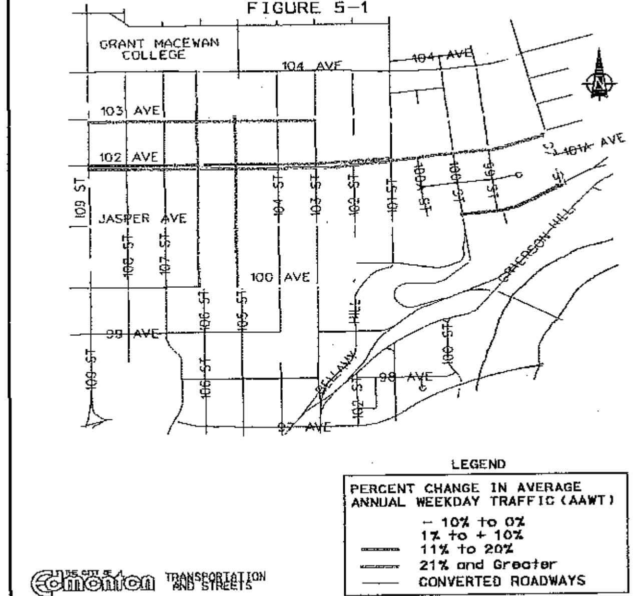
With the conversion to two-way operation, increased traffic circulation was noted on a number of roadways, particularly on those closest to the commercial core (notably 102 Avenue). The most significant decrease in traffic occurred along 103 Avenue in the westbound direction. It is noted that this route also experienced the most significant increase in traffic delays following the two-way conversion. Further evidence of the shift of traffic away from 103 Avenue can be found by comparing the 1998 and 2000 downtown cordon summaries, which show a 13% decrease in vehicles entering the downtown westbound along this route.

In both the initial assessments of the conversion, prior to implementation, and in the follow up, one of the key indicators of network performance and service level was the ratio of traffic volume to capacity (V/C) at individual intersections. While it was anticipated that intersection V/C would increase at many intersections due to the reduction in the number of through traffic lanes, it was also anticipated that the V/C levels at these intersections would remain within an acceptable range (generally less than 0.8). V/C ratios approaching 0.9, particularly in the interior of the downtown have a risk of creating long queues which can affect the operation of multiple intersections.

The before and after assessment confirmed that intersections along the roadways converted from one way to two way saw an increase in V/C, but the overall V/C remained less than 0.8. Figure 5-1 shows the percentage changes volume levels.

Assessment of the peripheral roadways around the Downtown shows that volumes have in fact increased indicating that there has been a shift in through-traffic away from the core and onto the peripheral roadways.

CHANGES IN AVERAGE ANNUAL WEEKDAY TRAFFIC VOLUMES
FIGURE 5-1



Impact on Transit

High occupancy vehicle lanes (HOV lanes) on 102 Avenue in the eastbound direction were not removed after the conversion. The operation of these lanes did no deteriorate at all and in some cases even saw an improvement in the level of service. HOV lanes in the westbound direction on 102 Avenue were removed, however there was not deterioration in service as a result; V/C ratios for movements in these lanes remained generally the same.

In addition, to the two-way conversion, a rationalization of streets with transit and length of transit zones also occurred with an objective of increasing on-street parking.

Vehicular collisions

Vehicle collision data collected from official police reports was used to determine whether the conversion had an adverse or positive affect on the number of collisions in the Downtown. Pre-conversion collision data was collected from September 1, 1996 through to June 30, 1998 while post-conversion data was taken from September 1, 1998 to June 2000.

The data collected indicates that the overall number of collisions in the Downtown decreased by 112 while the number of collisions in the affected area decreased by 84, which accounts for 75% of the total decrease in collisions (see Table 5-5).

In addition, when comparing the number of collisions which occurred in the month of September in 1997 and in 1998 (one month following the conversion) there is very little difference in the number of collisions, indicating that the conversion did not contribute to an increase in collisions.

Table 5-5: Vehicle Collisions in the Downtown Pre- and Post-Conversion

	Pre-Conversion		Post-Conversion	
	Month of September 1997	September 1997 to June 1998	Month of September 1998 (following conversion)	September 1998 to June 1999
Total Collisions in Downtown	54	1151	52	1039
Total Collisions on Affected Roadways	20	513	17	429
% of Collisions on Affected Roadways	37%	45%	33%	41%

Although the reduction of collisions on the affected roadways is an encouraging sign, we should reiterate that collisions are somewhat random nature and it is difficult to draw any strong conclusions based on this information.

6.0 OTHER TWO-WAY CONVERSION STUDIES

6.1 U.S.A Nation-Wide Study

A nationwide study conducted by The Hyannis Main Street Business Improvement District in the United States concluded that the majority of communities that have opted for converting their one-way streets to two-way in the downtown core have reported positive results, especially for business development [2].

In almost all of the 22 cities studied, the communities reported at least one of the following:

- Improved business
- Increased investment
- Better distribution of traffic
- A more pedestrian friendly environment

It should also be noted that none of the communities reported a negative effect due to the change. Some of the cities and their comments are shown in Table 6-1 below.

Table 6-1: Characteristics of Projects Converting Downtown Streets from One-Way to Two-Way Operation

City	Pop.	Year	Type of Conversion	Average ADT	Results
Anniston, AL	26,400	1997	Convert major downtown streets back to two-way.	10-15,000	Vacancy dropped, very positive for business development
Dubuque, IA	60,000	1998	Convert one-way loop around pedestrian mall to improve access, reduce confusion.	6,000	Very positive, better business access, customer friendly.
Gardner, MA	22,000	1993	Convert one-way loop around to two-way on three downtown streets.	40,000	Conversion immediately included bus development, reduced vacancy.
Green Bay, WI	97,000	1997	Convert main downtown gateways to two-way.	5,000	Improved business access.
Hickory, NC	36,000	1999	Converting paired one-way traffic system to two-way flow.	5,000	Good results, calmed traffic, improved bus access and development, new investment.
North Little Rock, AR	61,000	1999	Converting to two-way after 16 years.	13,000	Announced two-way flow attracted property investment and new businesses.
Lubbock, TX	200,000	1995	Convert two major downtown streets to two-way.	10,287	Requests for more streets to be converted to two-way.

Sources: The Urban Transportation Monitor, May 12, 2000 and ITE Journal, August 1998 [3].

7.0 SUMMARY OF FINDINGS

Analysis of the data before and after the two-way conversion show that in general there were no adverse affects on traffic operations or safety and that the original objectives were met.

The objectives for improving the pedestrian environment were largely achieved by lowering the traffic speeds in the desired areas as well as slightly increased pedestrian clearance times at the intersections. Pedestrian and vehicular collisions and their related costs both showed improvement following the conversion.

Improved business access was achieved through the instatement of a substantial amount of visible and accessible on-street parking in the cultural and commercial districts.

The two-way conversion also improved the traffic circulation in the downtown giving motorists more choice and the opportunity to make use of less congested roadways. A prime example of this is the shift in traffic away from 103 Avenue onto 102 Avenue between 1998 and 2000. This shift can be attributed to the reinstatement of the westbound movement on 102 Avenue. Also, traffic not destined for the Downtown core was directed to the major arterial streets on the periphery.

There was little deterioration of service on the converted streets with the exception of the through movements. However, this increase in the V/C ratio was due mainly to the reduction in the number of lanes to accommodate the new movements in the two-way street system.

Feedback from the public indicates that Edmontonians are generally pleased with the reinstatement of the two-way street configuration and the ease of movement that it brings. An encouraging sign is that there has been increased residential development following the conversion in the downtown although the role of the conversion relative to other measures implemented at the same time is not known.

In general, the conversion of one-way streets to two-way in downtown Edmonton has proven to be a positive initiative which has not had any adverse effects on traffic operations and has been met with satisfaction by both the public and business sectors.

REFERENCES

1. Transportation Planning for Your Community - Traffic Planning. National Transportation Library, U.S. Government Printing Office, Washington. D.C. 20402.

2. Brovitz, Ted. The Urban Transportation Monitor. "Converting Downtown Streets from One-Way to Two-Way Yields Positive Results". Issue: May 12, 2000.

3. Hart, Jeryl D. ITE Journal. "Converting Back to Two-Way Streets in Downtown Lubbock", August 1998.

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John C. Klimm, Town Manager
Joellen J. Daley, Assistant Town Manager

September 26, 2001

William Belden, Chairmain
Planning Board
38 Cove Island Road
Centerville, MA 02632

Dear Mr. Belden:

Please accept our invitation to serve on our One Way-Two Way Steering Committee. As you are aware, the Town has retained a consultant, Volmer Associates, to look at the feasibility of retaining Main Street as a one-way corridor, or making Main Street a two-way corridor. We would like to establish a committee to work with the consultant in this regard. Therefore, if you are interested in serving on the committee, or you would like to send a representative, please advise Jackie Etsten, our Principal Planner. Ms. Etsten will be coordinating the committee, and she can be reached at (508) 862-4676.

We look forward to receiving your response. We are hopeful to start working with the committee in mid-October.

Sincerely,

Joellen J. Daley
Assistant Town Manager

JJD:lmb

cc: John Klimm, Town Manager
Jackie Etsten, Principal Planner

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Executive Summary

This report is the culmination of efforts by the Town of Barnstable Planning and Engineering Departments and the Cape Cod Commission (CCC) to evaluate street circulation changes in downtown Hyannis, Massachusetts. Specifically, the conversion of Main Street from its current one-way circulation to provide for two-way travel along its length was reviewed in the context of safety, operations, economics and parking impacts. The Downtown Hyannis Traffic Circulation Study focused on the length of Main Street between Sherman Square (Intersection of Main/South/Stevens Streets) and Old Colony Road/Center Street. The transportation study area is comprised of two parallel corridors - Main Street and South Street - and the intersecting cross streets. Figure 1 shows the project study area.

This section provides an executive summary of the study methodology and findings for the Downtown Hyannis Traffic Circulation assessment. More detailed discussion and analysis for the transportation component can be found in later sections. As an independent component of this study, a parking management plan is under development and will be submitted under separate cover.

The goals of the transportation element of the study relate to three major issues: 1) pedestrian/bicycle safety and access, and 2) roadway capacity/traffic operations, and 3) quantify traffic with no origin or destination on Main Street. The project included an evaluation of the transportation impacts of converting Main Street back to two-way flow as related to these aspects.

The first objective of this study was to evaluate the pedestrian environment in terms of safety and accessibility. Specific attention was given to the interface between pedestrians, bicycles, and vehicles, and the number of pedestrian conflict points at each crossing, as well as traffic signal timing, which must allocate adequate time for crossings. A review of accident experience, particularly those accidents involving pedestrians, was undertaken. Field investigations to quantify the travel speeds on Main Street and South Street were also undertaken.

The second objective of this study was to examine the capacity and traffic operations of the existing one-way roadway system compared to that of a two-way roadway system in terms of operations, travel time, delay, and convenience. The goal of this analysis was to identify the transportation impacts of the proposed street conversions by providing a comparison between the one-way and two-way traffic alternatives.

The third objective of the study was to assess and quantify the percentage of traffic that has no origin or destination in the downtown area, and how those vehicle volumes might shift if the circulation pattern were changed. The CCC's regional traffic model was used to estimate the proportion of through and local traffic using the Main Street corridor. The traffic patterns from the model were supported by the results of a car-following study, which provided data regarding the origins and destinations of vehicles on Main Street and South Street.

Existing Conditions

The primary east-west roadway network serving downtown Hyannis consists of a one-way pair formed by Main Street and South Street. Old Colony Road, which is currently one-way northbound, provides a link from South Street to Main Street. Independent of this study, Old

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Project Study Area

Downtown Hyannis Traffic Circulation Study
Location: Barnstable, MA

Scale: Not to Scale

Legend

○ Project Intersection

Figure 1

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Colony Road will be converted to two-way flow. Other north-south cross streets in the study area include Barnstable Road/Ocean Street, High School Road, Sea Street, and Stevens Street. On a typical summer day, approximately 13,800 and 13,300 vehicles travel along Main Street and South Street, respectively. Relatively long delays and queues at major intersections resulting from a combination of heavy vehicular traffic, numerous parking and loading maneuvers, and intense pedestrian activity characterize traffic operations in the study area.

Evaluation Criteria
The evaluation criteria used in this analysis consist of five criteria developed in conjunction with the Town staff and the CCC. The criteria are safety, roadway capacity/traffic operations, parking impact, economic impact, and cost.

Changes in Circulation in Other Communities
In addition to performing qualitative and quantitative analysis of the downtown Hyannis street network, research of other communities that have performed conversions of their one-way street networks to two-way circulation was conducted. In general, positive feedback and results were noted, although most communities had not conducted post implementation studies. Many of the communities included in the various reports and studies were cities of considerably greater size and population than Barnstable, even when considering the dramatic influx of seasonal residents and visitors during the summer season. Traffic volumes and the cross section available for two-way travel also varied. All of the communities had a companion revitalization plan, making it difficult to establish the isolated effect of the two-way conversion on economic indicators.

Alternatives Considered
Two scenarios were evaluated. The first alternative looked at the existing roadway network, modified to include traffic calming measures along the length of Main Street and two-way traffic flow on Old Colony Road. It is presumed that if traffic calming measures are applied Main Street, they will also need to be applied to South Street in order to prevent increases in vehicle speeds and enhance pedestrian safety.

The second alternative considered converting Main Street and South Street to two-way traffic flow. Main Street would provide a single travel lane in each direction between Old Colony Road and Sherman Square, providing a continuous two-way function through Barnstable. Left-turn pockets would be located at major intersections along Main Street. South Street would provide a single travel lane in each direction along its length between Sherman Square and Lewis Bay Road as well. Old Colony Road will be reconfigured to allow two-way circulation independent of this project.

Findings
The findings of the study indicate the following:

Safety
Based on the travel speeds developed by the traffic simulation model, and information reported from other empirical studies, travel speeds are expected to decrease under either the traffic calming or two-way conversion alternative. Reductions in travel speeds are one of the primary effects achieved through traffic calming. Under the two-way conversion, the decrease is primarily a function of reduced capacity and delays introduced by turning movements and parking maneuvers.

A qualitative comparison of impacts to emergency response times under the two-way conversion indicates that there are advantages and disadvantages to both the current one-way network and the two-way conversion. Travel times are shorter under the Alternative One, even with the lowered speeds resulting from traffic calming measures. Travel times can be expected to increase along Main Street and South Street under a two-way system. However, multiple (redundant) routing options for emergency travel will be available under a two-way traffic circulation system that are not available in a one-way system.

Roadway Capacity/Traffic Operations

Both circulation alternatives were evaluated using the peak summer traffic volumes. The capacity of the two-way conversion as compared to the existing one-way pair shows comparable levels of service at intersections, with two notable exceptions. The intersection of South Street and Old Colony Road/Ocean Street will suffer due to the addition of another approach to service in an already-complex phasing plan under Alternative Two under peak summer conditions. The South Street approaches will have long queues approaching the intersection. At the intersection of Main Street and High School Road, the Main Street westbound through movement and both High School Road approaches will experience extremely long delays under peak summer conditions. Operationally, the two alternatives are similar along the primary roadways evaluated; additional impacts on roadways outside the study area may be incurred under the two-way alternative as drivers divert to South Street.

Parking Impacts

Both alternatives under consideration will reduce the number of on-street parking spaces on Main Street. Alternative One will reduce the number of on-street parking spaces by approximately 56. If Alternative Two is constructed, approximately 89 on-street parking spaces will be lost.

Economic Impacts

Based on previous studies commissioned to examine the economic impacts of the conversion to two-way travel, positive economic results were reported. Because of concurrent implementation of other economic incentives such as redevelopment and revitalization programs, it is difficult to draw a direct correlation between the conversion to two-way travel and improvement of economic indicators.

Cost

Alternative One will cost approximately $3.125 million to construct. The addition of decorative pavement treatments to Alternative One will result in an estimated construction cost of $6.125 million. Alternative Two will cost approximately $3.825 million to construct. The estimated cost of Alternative Two does not include any costs associated with land acquisitions that may be necessary to implement geometric changes. Land acquisitions may be necessary at three intersections in order to implement geometric changes.

Introduction

The Town of Barnstable retained Vollmer Associates LLP to evaluate the impacts associated with traffic circulation changes being considered for downtown Hyannis. The Town's Parking Management Plan for Main Street and Hyannis Harbor areas was also updated as a separate but related component of this contract. Specifically, retention of the existing one-way travel pattern with traffic calming measures or the potential for two-way traffic flow along Main Street were the two scenarios considered. These scenarios were formulated by economic and safety factors: interest on behalf of the commercial businesses in seeing a return of two-way flow as a means of promoting a more inviting downtown environment, and concern over recent increases in pedestrian accidents attributed to high traffic volumes and travel speeds.

The viability of the commercial, shopping, and public activities along Main Street, as well as positive resolution of critical quality-of-life issues that have generated concerns among the commercial and residential community are important factors in the consideration of travel options for Main Street. At the same time, businesses, community organizations, and residents are concerned with and need to understand the implications of changing or retaining the directionality of Main Street and South Street. Any option may further exacerbate critical quality-of-life issues associated with safety, traffic congestion, and parking. The impacts on these issues, and local economics, must be fully identified and addressed.

The study is intended to provide technical support through which the Town of Barnstable and various formal and informal community groups will discuss and reach consensus on transportation improvement and parking plans. This study provides the technical data for comparing the two street circulation alternatives.

The process involved three major activities:

- Evaluate the existing conditions of the streets in downtown Hyannis, including:
  - Pedestrian safety
  - Emergency response
  - Traffic congestion and roadway capacity
  - Parking
- Develop and evaluate transportation improvements for Main and South Streets identified by the Town. These alternatives considered include such transportation elements as:
  - Enhancing pedestrian/bicycle access and safety
  - Alleviating congestion on streets and at intersections
  - Addressing through traffic movement (peak season)
- Develop a parking policy that supports business activities and also respects a multi-modal transportation strategy (under separate cover).

The objective of the Town and the Advisory Team is to make an informed decision on proposed changes to the street circulation in downtown Hyannis. Stakeholder interests reflected different perspectives on the advantages and disadvantages associated with any changes, or conversely, no changes to the street system. Through the public process, a forum for discussion and listening was provided.

Existing Conditions

Main Street
Main Street is the heart of downtown Hyannis. Between Old Colony Road and Stevens Street, there are many shops and restaurants. The posted speed limit on Main Street is 25 mph. During field investigations, the average travel speed on Main Street was found to be approximately 20 - 30 mph, based on car following. Main Street has two lanes configured for one-way operation westbound. There are parking lanes delineated with pavement markings on both sides of the street. There are sidewalks on both sides of the street and several mid-block crosswalks.

Main Street and Old Colony Road/Center Street
The intersection of Main Street and Old Colony Road/Center Street is a four-legged intersection, controlled by a pre-timed traffic signal. The signal operates in a three-phase scheme. East of Old Colony Road, Main Street is configured for two-way operation. West of Old Colony Road, Main Street is configured for one-way operation westbound. Old Colony Road is configured for one-way operation northbound. The Main Street westbound approach has two through lanes. The Main Street westbound approach also has a right-turn lane that is not controlled by the signal. The Old Colony Road northbound approach has one exclusive left-turn lane, one through lane and one exclusive right-turn lane. The Center Street southbound approach has one general lane for left and right-turn movements. Parking is not allowed on Old Colony Road or Center Street. There is on-street parking on the south side of the Main Street eastern approach and on both sides of the Main Street western approach. There are crosswalks across the Main Street east, Old Colony Road south and Center Street north approaches. The west approach of Main Street has no crosswalk. No pedestrian signal heads are provided.

Main Street and Barnstable Road/Ocean Street
The intersection of Main Street and Barnstable Road/Ocean Street is a four-legged intersection that is controlled by a pre-timed, three-phase traffic signal, including an exclusive pedestrian phase. The Main Street westbound approach has two general lanes and is configured for one-way operation. Ocean Street is one-way southbound and provides one travel lane for vehicles departing the intersection. The southbound approach on Barnstable Road, a two-way street, has one through lane and one-exclusive right-turn lane. There is no parking on either street in the vicinity of the intersection. There are crosswalks and pedestrian signal heads provided on all four approaches to the intersection. The exclusive pedestrian phase is activated by pushbutton only.

Main Street and High School Road
The intersection of Main Street and High School Road is a four-legged intersection controlled by a three-phase pre-timed traffic signal, including an exclusive pedestrian phase. The Main Street westbound approach has two general lanes configured for one-way operation. The High School Road northbound approach has one general lane for left and through movements. The High School Road southbound approach consists of one through lane and one exclusive right-turn lane. There is no parking in the immediate vicinity of the intersection. Crosswalks are provided on all legs of the intersection. Pedestrian signal heads are provided for both Main Street approaches and on the High School Road southbound approach. The exclusive pedestrian phase is activated by pushbutton only.

Main Street and Sea Street
The intersection of Main Street and Sea Street is a four-legged intersection controlled by a two-phase, pre-timed traffic signal. The Main Street westbound approach has two general lanes and is configured for one-way operation. Each Sea Street approach provides one general lane. There is no parking allowed on Sea Street, and there are no parking spaces provided on Main Street near this intersection. Crosswalks are provided across all legs of the intersection, but there are no pedestrian signal heads.

Sherman Square (Main Street/South Street and Stevens Street/Potter Avenue)
Sherman Square is a five-legged intersection with an island in the middle. The intersection is unsignalized with stop control provided on Potter Avenue and Stevens Street. The Main Street eastbound approach provides one general-purpose lane. The Main Street westbound approach is a two-lane approach configured for one-way operation. On the east side of the intersection, a U-turn lane from Main Street to South Street is provided. After the U-turn, traffic is required to merge from two lanes to one lane. Both the Potter Avenue northbound approach and the Stevens Street southbound approach provide one general-purpose lane. There are two parking spaces along the north side of Main Street between the U-turn and Stevens Street. Four spaces are provided along the south side of South Street between the U-turn and Potter Avenue. More parking is available along the south side of Main Street beyond Potter Avenue. Crosswalks are provided on Main Street and South Street at the U-turn, and a crosswalk is also provided on Stevens Street.

South Street and Sea Street
The South Street and Sea Street intersection is a four-legged intersection controlled by a three-phased traffic signal, including an exclusive pedestrian phase. The South Street eastbound approach provides two general-purpose lanes and is configured for one-way operation. The Sea Street northbound and southbound approaches each provide one general lane. Parking is prohibited on all approaches of the intersection. One crosswalk is provided across the South Street east approach of the intersection. The pedestrian phase to cross South Street is activated by pushbutton only.

South Street and High School Road
The South Street and High School Road intersection is an unsignalized four-legged intersection. The South Street eastbound approach is uncontrolled. It is configured for one-way operation. The High School Road northbound and southbound approaches each provide a single general lane and are stop controlled. Parking is prohibited on both South Street and High School Road, however during church services vehicles frequently park along the South Street westbound approach and the High School Road northbound approach. Crosswalks are provided on all legs of the intersection.

South Street and Ocean Street/Old Colony Road
The South Street and Ocean Street/Old Colony Road intersection is a six-legged intersection controlled by a four-phase traffic signal including an exclusive pedestrian phase. The South Street eastbound approach provides a two-lane approach, configured for one-way operation. One lane provides left and through movements while the other provides through and right movements. Right turn movements onto Old Colony Road are channelized and are not controlled by the traffic signal. The Old Colony Road northbound approach provides one lane for through and right movements. Right turn movements onto Ocean Street are channelized and are not

controlled by the traffic signal. The Ocean Street northbound approach also provides one approach lane for through and right movements. Left turn movements onto Old Colony Road are channelized prior to the intersection and are not controlled by the traffic signal. The Ocean Street southbound approach provides two lanes. The left lane is an exclusive left turn lane. The right lane allows through movements to Ocean Street and Old Colony Road. At the intersection, a U-turn lane is provided for access to Old Colony Road northbound. The U-turn is not controlled by the traffic signal; however, a minimal vehicle queue (1-2 vehicles) can prevent access to the U-turn due to the proximity of the U-turn to the intersection. On-street parking is prohibited near the intersection on all of the approaches. Crosswalks and pedestrian signal heads are provided on each approach. The exclusive pedestrian phase is activated by pushbutton only.

Traffic Volumes

To quantify existing traffic volumes and travel patterns, 72-hour Automatic Traffic Recorder (ATR) counts and intersection peak hour turning movement counts were conducted in August 2001. The turning movement counts were conducted from 4:00 – 6:00 PM at seven (7) of the eight (8) study area intersections. Recent count information available from other studies was used at the intersection of Main Street, Old Colony Road, and Center Street. The turning movement counts included both vehicles and pedestrians. The raw count data is included in Appendix A of this report.

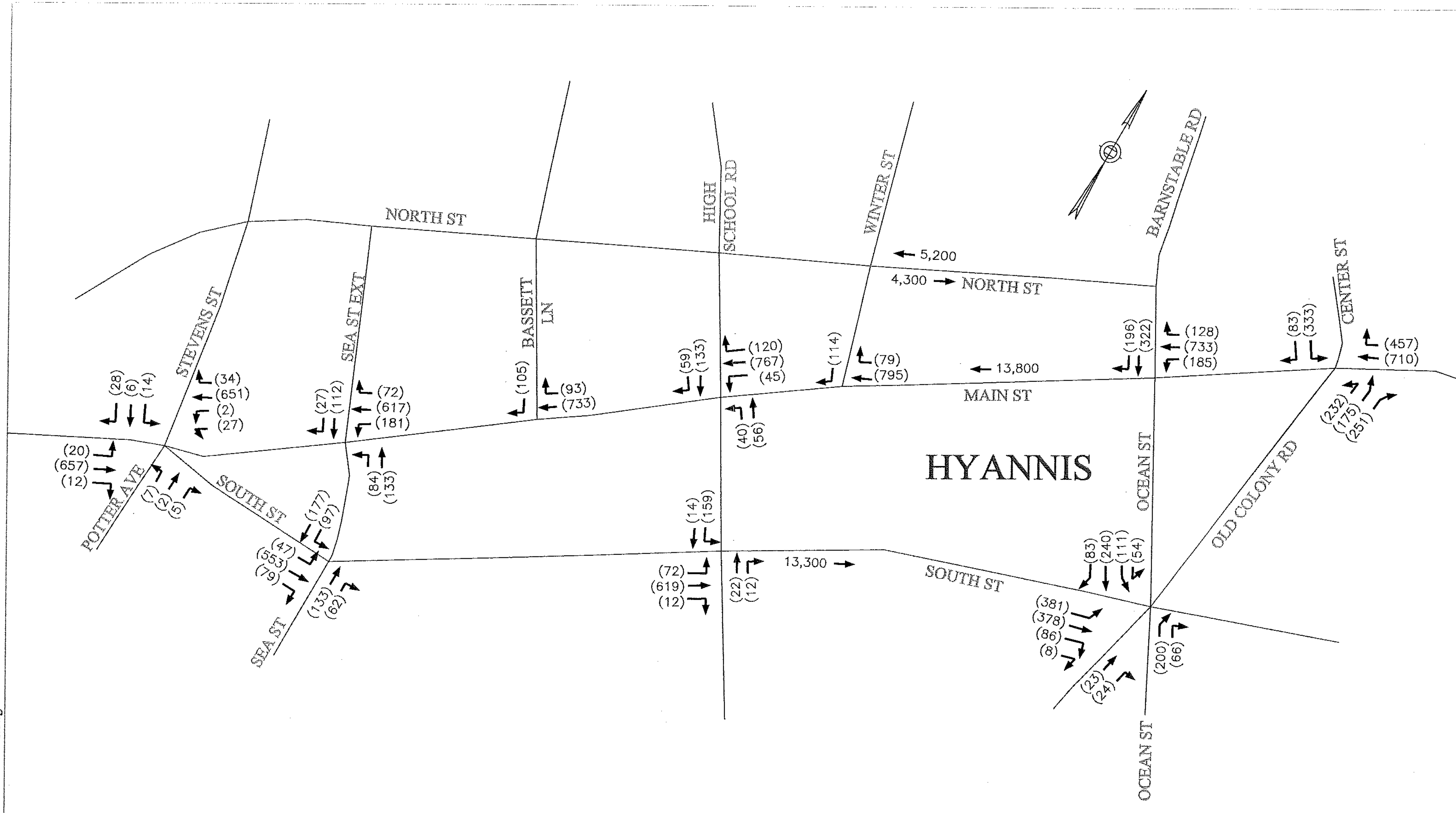
Figure 2 shows the existing summer peak hour traffic volumes and summer daily traffic volumes in the study area. The peak hour volumes shown in Figure 2 are the system peak hour volumes. Inspection of both the turning movement counts and the ATR counts determined that the system peak hour occurs between 4:00 – 5:00 PM. The individual peak hour varies from intersection to intersection. Main Street carries a peak summer daily traffic volume of 13,800 vehicles per day (vpd). South Street carries a peak summer daily traffic volume of 13,300 vpd.

Accident History

In order to assess the safety of the intersections within the project area, accident data was collected from both MassHighway and the Town of Barnstable Police Department. Detailed MassHighway and Barnstable Police Department accident data and crash rate worksheets are provided in Appendix B.

MassHighway Data

MassHighway provided accident data for the most recent four years (1997-2000). According to MassHighway data, there were a total of seventy-two (72) accidents at the eight project intersections. Of the seventy-two (72) accidents that occurred at the project intersections over the four-year period, none involved fatalities. The number of accidents at each location by year is summarized in Table 1. With the exception of the High School Road at South Street intersection, all of the intersections have a crash rate that is lower than the District 5 average. For signalized intersections the average crash rate in District 5 is 0.89 accidents per million entering vehicles (MEV) and 0.67 accidents per MEV for unsignalized intersections.



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Existing Summer Traffic Volumes

Downtown Hyannis Traffic Circulation Study
Location: Barnstable, MA

Not to Scale

Figure 2

2001215\dwg\traffic\peak-ex-volumes.dwg

Table 1 – MassHighway Accident Summary

Location	1997	1998	1999	2000	Total	Actual Crash Rate	MHD Average Rate
Main Street & Old Colony Road/ Center Street	1	0	2	0	3	0.11	0.89
Main Street & Barnstable Road/ Ocean Street	3	4	2	3	12	0.62	0.89
Main Street & High School Road	1	2	2	2	7	0.46	0.89
Main Street & Sea Street	1	1	1	3	6	0.39	0.89
Sherman Square	2	2	2	1	7	0.39	0.89
South Street & Sea Street	0	2	0	3	5	0.35	0.89
South Street & High School Road	2	6	4	4	16	1.41	0.67
South Street & Ocean Street/ Old Colony Road	3	9	3	1	16	0.78	0.89
Grand Total	**13**	**26**	**16**	**17**	**72**	**NA**	**NA**

There were three accidents at the intersection of *Main Street and Old Colony Road/Center Street* during the four-year period. Two of the three accidents occurred during the peak hour (7-9 AM, 4-6 PM). Only one (1) accident occurred during inclement weather. Two of the three accidents were rear-end collisions while the other was an angle collision. Injuries were reported in only one of the three accidents while the other two resulted in property damage only. For this location, the four-year crash rate is approximately 0.11 accidents per MEV. The District 5 average crash rate for a signalized intersection is 0.89 accidents per MEV for a signalized intersection. The Town of Barnstable is planning on converting Old Colony Road to a two-way street. The number of accidents may be reduced through the improvements made during that project.

Twelve (12) accidents were reported at the intersection of *Main Street and Barnstable Road/Ocean Street* during the four-year study period. Only two (2) accidents occurred during the peak hour. Ten (10) of the accidents occurred during clear weather while the other two (2) accidents were reported as weather condition unknown. Four (4) of the accidents were angle collisions while three (3) were rear-end collisions. One (1) accident, involved a collision with a parked car, while four (4) accidents were of unknown type. Half of the accidents resulted in injury while the other half resulted in property damage only. For this location, the four-year crash rate is approximately 0.62 accidents per MEV. The District 5 average crash rate for a signalized intersection is 0.89 accidents per MEV. Increased clearance times may help to prevent angle and rear-end collisions.

At the intersection of *Main Street and High School Road*, there were seven (7) accidents in four years. Peak-hour accidents accounted for three (3) accidents. Two (2) accidents occurred during rainy conditions. Two (2) accidents were angle collisions, while four (4) accidents were rear-end collisions. One accident involved a parked vehicle. A total of six (6) accidents resulted in property damage only, while only one accident resulted in personal injury. For this location, the four-year crash rate is approximately 0.46 accidents per MEV, which is below the District 5 average crash rate of 0.89 accidents per MEV for a signalized intersection. Improvements to the timing at this location may reduce rear-end collisions.

Six (6) accidents occurred at the intersection of *Main Street and Sea Street,* in the four-year study period. There were only two (2) peak-hour accidents. One (1) accident occurred during rain conditions. Angle collisions occurred in four (4) accidents, and there was one (1) rear-end collision and one (1) of unknown type. Half of the accidents resulted in personal injury while the other half resulted in property damage only. For this location the four-year crash rate is approximately 0.39 accidents per MEV. The District 5 average crash rate for a signalized intersection is 0.89 accidents per MEV. Alterations to the signal timing including protected turn phases may help reduce the number of angle and rear-end accidents at this location.

In the four-year study period, there were seven (7) accidents at *Sherman Square (Main Street/South Street and Stevens Street).* Only one (1) of the accidents occurred during the peak hours. Two (2) of the accidents occurred during inclement weather conditions. Five (5) of the accidents were angle collisions while the other two (2) were rear-end collisions. Injuries were reported in four (4) of the seven accidents, and the other three (3) resulted in property damage only. For this location, the four-year crash rate is approximately 0.39 accidents per MEV. The District 5 average crash rate for an unsignalized intersection is 0.67 accidents per MEV.

Only five (5) accidents were reported at the intersection of *South Street and Sea Street* during the four-year study period. One (1) accident occurred during the peak hours. One (1) accident was an angle collision, two (2) were rear-end collisions, one (1) involved a bicycle, and one (1) was of unknown type. Two (2) of the accidents resulted in personal injury, while three (3) resulted in property damage only. For this location, the four-year crash rate is approximately 0.35 accidents per MEV. The District 5 average crash rate for a signalized intersection is 0.89 accidents per MEV. Several of the accidents at this location may be the result of driver error and/or inclement weather conditions, factors which are not correctable. Sight distance may also have proved a factor in accidents at this intersection.

At the intersection of *South Street and High School Road*, there were sixteen (16) accidents in four years. Peak-hour accidents accounted for five (5) of the sixteen (16) accidents. Only two (2) of the accidents occurred in rainy conditions. Eleven (11) accidents were angle collisions, while two (2) accidents were rear-end collisions, one (1) was a head-on collision, and two (2) were of unknown type. Six (6) accidents resulted in personal injury, while ten (10) accidents resulted in property damage only. For this location, the four-year crash rate is approximately 1.41 accidents per MEV. The District 5 average crash rate for an unsignalized intersection is 0.67 accidents per MEV. Enforcement of the "No Parking" zone on the south side of South Street may prevent angle collisions by improving sight distance and permitting two lanes for through traffic on South Street at the intersection.

Sixteen (16) accidents occurred at the intersection of *South Street and Old Colony Road/Ocean Street,* in the four-year study period. There were only three (3) peak-hour accidents at this location. Two (2) of the accidents occurred during inclement weather conditions. Angle collisions accounted for seven (7) accidents, while there were five (5) rear-end collisions, two (2) of unknown type, and one (1) head-on collision. One (1) accident involved a parked vehicle. Six (6) of the accidents resulted in personal injury while ten (10) accidents resulted in property damage only. For this location, the four-year crash rate is approximately 0.78 accidents per MEV. The District 5 average crash rate for a signalized intersection is 0.89 accidents per MEV.

The intersection geometry is skewed, and longer clearance times may help reduce accidents, particularly angle collisions.

There were a total of seventy-three (73) accidents on Main Street at locations between intersections during the four-year study period. It should be noted that some of these accidents may have taken place in other villages of Barnstable. The MassHighway data did not indicate in which village of Barnstable each accident took place. Of these accidents, only one (1) accident involved a pedestrian. There were five (5) accidents involving collisions with parked vehicles, and five (5) more involved collisions with fixed objects. Nineteen (19) angle collisions and twenty (20) rear-end collisions occurred during the study period. There were twenty-one (21) accidents of unknown type. There were two (2) head-on collisions. The majority of the accidents took place during clear weather and daylight conditions. Twenty-nine (29), or forty (40) percent, of the seventy-three (73) accidents resulted in personal injury.

There were a total of twenty-five (25) accidents at locations between intersections on South Street during the study period. None of the accidents involved pedestrians. There were twelve (12) angle collisions and seven (7) rear-end collisions. There was one (1) fixed object collision, and five (5) accidents were of unknown type. Approximately one half of the accidents resulted in personal injury to the parties involved. The majority of the accidents took place in clear weather conditions on dry pavement.

Overall, there were no locations at which the data indicated an extreme safety issue. At the intersection of South Street and High School Road, the accident rate is above the MassHighway accident rate for District 5. However, it does not appear that the volumes at the intersection would meet the MUTCD warrant criteria for signalization. Enforcement of the parking restrictions at this location may reduce the incidence of accidents at this location.

Barnstable Police Department Data

The Barnstable Police Department provided accident data from 1997 through 1999, and from June 2000 through August 2001. Because the Barnstable Police Department has recently changed the computer system that is used to store the report database, much of the older years' data was unavailable. The Police Department made a special effort to provide accident information related to pedestrian and bicycle collisions.

During these time periods, there were a total of sixty-two (62) accidents at the eight (8) project intersections. The accidents are summarized by location in Table 2.

Table 2 – Barnstable Police Department Accident Summary

Location	1997	1998	1999	6/2000 – 12/2000	1/2001 – 8/2001	Total
Main Street & Old Colony Road/ Center Street	0	0	2	4	3	9
Main Street & Barnstable Road/ Ocean Street	0	1	0	5	2	8
Main Street & High School Road	0	0	0	3	5	8
Main Street & Sea Street	1	0	1	6	10	18
Sherman Square	0	0	0	2	1	3
South Street & Sea Street	0	0	0	4	4	8
South Street & High School Road	0	0	0	4	4	8
South Street & Ocean Street/ Old Colony Road	0	0	0	0	0	0
Grand Total	**1**	**1**	**3**	**28**	**29**	**62**

Along Main Street, both at intersections and at non-intersection locations, there were a total of thirteen (13) accidents that involved pedestrians. There were seven (7) accidents that involved bicycles on Main Street. On South Street, there was one (1) reported pedestrian accident and one (1) reported bicycle accident.

The incidence of accidents within the study area is relatively low at all locations. The intersection of Main Street and Sea Street has a high occurrence of angle collisions and rear-end collisions. Changes in the signal timing, including longer clearance times, may improve safety at this location.

Circulation Patterns

In order to quantify the amount of through traffic on Main Street that might be diverted if circulation patterns in downtown Hyannis were changed, two methods were employed. The CCC lent their expertise in modeling the existing travel patterns. The CCC provided traffic flows for the study area from their regional model. The traffic flows are based on the summer peak and do not represent average conditions when through volumes may differ. These link-to-link flows and critical link flows were used to determine the origins and destinations of vehicles on various links in the study area. Finally, the CCC re-ran their regional model to reflect two-way travel patterns on Main Street, South Street, and Old Colony Road.

The flows on the existing two-way links of Main Street between Park Square and Center Street/Old Colony Road were compared to determine the percent change in traffic flow. The percentages were averaged to determine what percentage of Main Street westbound traffic would divert to South Street from points east of Old Colony Road. The result was that during the summer peak, thirty-eight (38) percent of the through volume on Main Street westbound at Center Street/Old Colony Road was diverted to South Street at Ocean Street/Old Colony Road. An additional nine (9) percent of the Barnstable Road southbound right-turn volume shifts to South Street eastbound via Ocean Street southbound representing vehicles destined for Sea Street southbound.

To assign volumes to the Main Street eastbound direction, CCC's regional model was again consulted. The two-way model assigned approximately fifty-three (53) percent of the volume from Main Street west of Sherman Square to Main Street, and forty-seven (47) percent remained on South Street eastbound during the summer peak. The percentages were applied to the turning movement counts at each intersection, with adjustments to account for left and right turns.

To support the percentages derived from the CCC model, a car-following study was undertaken. A total of 235 vehicles were followed through the study area on October 19, 2001. The study was conducted between 8:00 AM – 5:00 PM. The origin of each vehicle and its final destination were recorded and tabulated. The percentage of traffic destined for points outside the study area, particularly Main Street west of Sherman Square, was calculated based on the total number of vehicles which originated from a given area.

The results indicate that twenty-three (23) percent of the vehicles followed from Center Street at Main Street were destined for points south and west of the study area. Thirty-nine (39) percent of the vehicles followed from Main Street westbound at Old Colony Road/Center Street were destined for points south and west. Seventeen (17) percent of the vehicles followed from Barnstable Road southbound were destined for points south and west of the study area. On South Street, fifty-two (52) percent of the vehicles that entered the study area at Sherman Square moved through the system to points north and east of the study area. Forty-three (43) percent of vehicles that entered the study area from Sea Street northbound at South Street had destinations north and east of the study area..

The results show that thirty-nine (39) percent of the traffic on Main Street at Old Colony Road/Center Street does not have a destination within the study area. This result correlates closely with the percentage of through traffic from the CCC model, which was calculated as thirty-eight (38) percent of traffic on Main Street. The car following study showed that fifty-two (52) percent of traffic on South Street had no destination within the study area, while the CCC model assigned fifty-three (53) percent of South Street eastbound traffic to Main Street eastbound. Again, the car following results correlate very closely with the CCC model results.

Traffic Operations

In order to assess the traffic operations at the intersections within the study area, capacity analysis was performed for each intersection. The capacity analysis methodology is based on the concepts and procedures in the 2000 *Highway Capacity Manual* (HCM). The primary result of capacity analysis is the assignment of Levels of Service (LOS) to traffic facilities under various traffic flow conditions. LOS is a qualitative measure that describes operational conditions and provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

There are six Levels of Service defined for each type of facility. They are given letter designations from A to F. LOS A represents the best operating condition and LOS F the worst. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, the LOS of a facility may vary greatly, depending on the time of day, day of week, or period of year. LOS for signalized and unsignalized intersections is calculated using the operational analysis methodology of the HCM.

The capacity analysis procedures for unsignalized intersections are provided for two-way stop controlled (TWSC) intersections and all-way stop controlled (AWSC) intersections. LOS for a

TWSC and AWSC intersections is based on average control delay and is defined for each minor street movement. Average control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. LOS is not defined for an intersection as a whole. The LOS criteria are provided in Table 3 for unsignalized intersections. TWSC and AWSC LOS criteria are the same.

LOS for signalized intersections is defined in terms of average control delay, which is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The LOS criteria for traffic signals are stated in terms of average control delay per vehicle. The average control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Average control delay under signalized control is a complex measure and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the volume-to-capacity ratio for the lane group in question. Table 3 also provides the LOS criteria of signalized intersections.

Table 3 – Level of Service Criteria

Level of Service	Unsignalized Intersection Criteria Average Control Delay (Seconds per Vehicle)	Signalized Intersection Criteria Average Control Delay (Seconds per Vehicle)
A	0 – 10	≤10
B	>10 – 15	>10 – 20
C	>15 – 25	>20 – 35
D	>25 – 35	>35 – 55
E	>35 – 50	>55 – 80
F	>50	>80

Capacity analysis was conducted at the eight (8) signalized and unsignalized intersections which comprise the study area to quantify the operational characteristics under the existing peak summer operating conditions. The capacity analysis was performed using Synchro 5 and HCS 2000, computer software programs that utilize the methodology of the 2000 HCM. The results of the capacity analysis are included in Table 4. Although the capacity analysis shows that all of the study area intersections are operating within acceptable ranges, the actual operations may be slightly worse due to constraints which cannot be input in the analysis, such as jaywalkers and double-parked vehicles.

Main Street and Old Colony Road/Center Street
The signalized intersection of Main Street and Old Colony Road/Center Street operates at LOS C during the summer PM peak hour under existing conditions. All lane groups operate at LOS D or better.

Main Street and Barnstable Road/Ocean Street
At the signalized intersection of Main Street and Barnstable Road/Ocean Street, all lane groups of the intersection operate at LOS C or better. The intersection operates at LOS B overall.

Main Street and High School Road
The intersection of Main Street and High School Road is signalized and operates at LOS B under existing conditions. All lane groups of the intersection operate at LOS B.

Table 4 - Capacity Analysis Summary, Existing Conditions
Downtown Hyannis Traffic Circulation Study - Barnstable, MA

Location	PM Peak Hour			
	Peak Summer Conditions			
	LOS	Delay (sec)	v/c	95% Queue
Signalized Intersection: Main Street and Center Street/Old Colony Road				
Main Street WB Thru	D	41.1	0.97	268#
Old Colony Road NB Left	C	23.7	0.75	198#
Old Colony Road NB Thru	B	11.8	0.28	86
Old Colony Road NB Right	A	1.9	0.38	37
Center Street SB Left/Right	C	22.8	0.87	271#
Intersection	C	20.8	-	-
Signalized Intersection: Main Street and Barnstable Road/Ocean Street				
Main Street WB Left/Thru/Right	B	13.9	0.86	267#
Barnstable Road SB Thru	C	25.8	0.77	234#
Barnstable Road SB Right	B	11.6	0.53	96
Intersection	B	16.1	-	-
Signalized Intersection: Main Street and High School Road				
Main Street WB Left/Thru/Right	B	17.5	0.89	279#
High School Road NB Left/Thru	B	15.8	0.26	60
High School Road SB Thru	B	16.3	0.34	79
High School Road SB Right	B	11.3	0.15	0
Intersection	B	17.0	-	-
Signalized Intersection: Main Street and Sea Street				
Main Street WB Left/Thru/Right	B	12.4	0.71	237
Sea Street NB Left/Thru	C	25.2	0.67	169
Sea Street SB Thru/Right	B	18.9	0.33	92
Intersection	B	15.7	-	-
Unsignalized Intersection: Sherman Square				
South Street EB Left/Thru/Right	A	9.4	0.03	2
Main Street WB Left/Thru/Right	A	9.1	0.00	0
Potter Avenue NB Left/Thru/Right	E	44.0	0.20	18
Stevens Street SB Left/Thru/Right	E	37.0	0.34	36
Signalized Intersection: South Street and Sea Street				
South Street EB Left/Thru/Right	B	15.0	0.58	149
Sea Street NB Thru/Right	A	8.2	0.28	73
Sea Street SB Thru/Right	B	11.9	0.46	132
Intersection	B	13.1	-	-
Unsignalized Intersection: South Street and High School Road				
South Street EB Left/Thru/Right	A	1.9	0.06	5
High School Road NB Thru/Right	C	20.6	0.17	15
High School Road SB Thru/Right	E	38.3	0.64	102
Signalized Intersection: South Street and Old Colony Road/Ocean Street				
South Street EB Left/Thru/Right	C	32.2	0.86	352#
Ocean Street NB Thru/Right	C	25.4	0.66	214
Old Colony Road NEB Thru/Right	C	29.6	0.17	55
Ocean Street SB U-turn/Left	B	19.9	0.35	122
Ocean Street SB Thru/Bear Right	C	27.3	0.68	276
Intersection	C	28.6	-	-

Notes:
95th percentile volume exceeds capacity, queue may be longer.

Main Street and Sea Street
The intersection of Main Street and Sea Street operates at LOS B under its existing signalized conditions. All lane groups at the intersection operate at LOS C or better.

Sherman Square (Main Street/South Street and Stevens Street/Potter Avenue)
The intersection of Main Street/South Street and Stevens Street/Potter Avenue is unsignalized. The Potter Avenue northbound and Stevens Street southbound approaches operate at LOS E under the existing conditions. The South Street eastbound and Main Street westbound approaches operate at LOS A under the existing conditions.

South Street and Sea Street
The intersection of South Street and Sea Street is signalized and operates at LOS B under the existing conditions. All lane groups of the intersection operate at LOS B or better.

South Street and High School Road
The intersection of South Street and High School Road is unsignalized, controlled by STOP signs on the High School Road approaches. The High School Road northbound approach operates at LOS C under the existing conditions. The High School Road southbound approach operates at LOS E under the existing conditions. The South Street eastbound approach operates at LOS A.

South Street and Ocean Street/Old Colony Road
The intersection of South Street and Ocean Street/Old Colony Road is signalized and operates at LOS C under the existing conditions. All lane groups of the intersection operate at LOS C or better.

Criteria and Methods for Evaluating Circulation Alternatives

In order to evaluate the circulation alternatives, it is necessary to develop a set of criteria. Based on input from the Town and the CCC, five criteria were chosen: safety, roadway capacity, parking impacts, economic impact, and cost.

Safety

Safety is of primary importance in evaluating the circulation alternatives. Historic accident data was collected from both MassHighway and the Barnstable Police Department. Although this data can be analyzed to identify any trends or problem locations, it cannot be used to quantify safety. The safety of a location, whether intersection or street segment, must be evaluated qualitatively for all users of the roadway, including vehicles, pedestrians, and bicycles. Trends of the accident data can be used to identify potential deficiencies at a location. Deficiencies may be corrected with such measures as changes in signal timing and phasing, removing obstacles at intersections to improve sight distance, changing the type of control at an intersection, or installation of signing. For pedestrians and bicycles, safety can be assessed qualitatively using several factors. The length of a particular crossing is one means of evaluating pedestrian safety. The width of the traveled way increases the danger to pedestrians when crossing the street by virtue of the longer crossing distance.

Emergency access and response time is another safety issue that must be considered in the evaluation. In order to evaluate the emergency response times, the travel time along both Main Street and South Street from Old Colony Road to Sherman Square will be quantified using data extracted from the simulation runs for each alternative. The average travel time can be calculated using the street length and the average travel speed on each street. Once the base travel time is calculated, the intersection delays are added to account for delays caused by signl control. In addition to travel time, some vertical traffic calming measures such as raised intersections and speed humps may not be looked upon favorably by emergency personnel because they can cause discomfort to patients and difficulty for personnel in administering treatment.

Roadway Capacity

Roadway capacity can be evaluated quantitatively by several methods. One useful measure of roadway capacity is Level of Service (LOS). Level of service for signalized and unsignalized intersections is evaluated in terms of average control delay. Delay is a measure of driver discomfort, fuel efficiency, and many other factors. Another indicator of roadway capacity is queuing. Queuing has a direct correlation to LOS and delay. Other measures of effectiveness related to roadway capacity are travel speed and travel time on a link within the roadway network.

Parking Impacts

Parking impacts, both on-street and off-street, are another measure which should be considered. The number of on-street parking spaces can be counted directly for each circulation alternative. Loss of on-street parking spaces is considered a negative impact of a circulation alternative. Additionally, accessibility of off-street parking lots must be evaluated qualitatively by assessing available routes to off-street parking lots.

Economic Impact
For the purposes of this study, the economic impact of each alternative will be evaluated qualitatively. Based on previous studies commissioned to examine the economic impacts of the conversion to two-way travel, positive economic results were reported. However, because of concurrent implementation of other economic incentives such as redevelopment and revitalization programs, it is difficult to draw a direct correlation between the conversion to two-way travel and improvement of economic indicators.

Cost
A construction cost has been estimated for each of the two alternatives.

Circulation Changes in Other Communities

In addition to performing qualitative and quantitative analysis of the downtown Hyannis street network, research of other communities that have performed conversions of their one-way street networks to two-way circulation was conducted. Several sources were consulted in order to gather information. The *Institute of Transportation Engineers (ITE) Journal* had several articles relating to methods of assessment and results of studies by several communities. In 2000, the Hyannis Business Improvement District (BID) commissioned two studies addressing the conversion. Ted Brovitz, AICP, performed a canvassing of communities that had implemented or were considering such circulation changes. Several of these communities were contacted again to obtain additional information, and specifically to obtain feedback from an operations perspective. John Edwards, P.E., used traffic data and analysis developed by MS Transportation Systems in the Barnstable-Yarmouth Transportation Study to review several variations of converting the one-way streets to two-way. A list of sources that were consulted is included as a bibliography to this report.

Many of the communities included in the various reports and studies were cities of considerably greater size and population than Barnstable, even considering the dramatic influx of seasonal residents and visitors during the summer season. Most communities had some level of tourism, but the demand in terms of transportation infrastructure remained relatively stable throughout the year. Many of these cities had a more traditional grid street network, affording alternate routes to the roadways being converted. Most cities contacted had not conducted a post-implementation study to ascertain if the perceived or anticipated/expected benefits had in fact been realized. However, the City of Edmonton, Alberta, Canada did undertake such a study ("Downtown Two-Way Street Conversion") and excerpts from a paper presented at the 2001 Annual Conference of the Canadian Institute of Transportation Engineers are included in Appendix D. Note that the study commissioned by the BID is referenced in Section 6.0. The conversion was implemented in August 1998. Interestingly, the physical street layout of the street network appears similar to that of Main Street in Hyannis.

The goals and objectives for undertaking the conversions were almost identical to those of this study and sought to improve the pedestrian environment, improve access to businesses (coupled with increasing on-street parking), and improve traffic circulation. A fourth objective was to encourage residential and commercial development. Overall, the paper reflects positively on the conversion.

The findings of the Edmonton study indicate that the study objectives were achieved. The pedestrian environment improved because travel speeds were lowered (between 1 and 7 mph). However, an increase in travel time was also associated with the decreased speeds (4-90 seconds). Over a two-year period, pedestrian collisions declined approximately 26% on the affected streets, and to a greater degree in the downtown overall (almost 40%).

In conjunction with the circulation changes, the city was able to add 170 on-street metered spaces; post-implementation surveys indicate utilization of these spaces is not as high as originally anticipated. Qualitatively, the study indicated positive feedback from residents and businesses of the downtown, but no specific conclusions were drawn.

The objective of increased traffic circulation was measured by increase/decrease in traffic volumes and change to volume to capacity (v/c) ratios. This provides a mixed message, indicating that an increase in traffic volumes reflects an increase in circulation. The authors acknowledge this dichotomy by noting that the roadway with a decrease in traffic volumes also experienced the highest increase in delays. From this it may be inferred that drivers are avoiding this route or choosing a more direct route now that it is available. V/C ratios did increase along the converted roadways, but remained below 80% of capacity, indicating acceptable operations were maintained.

Other communities reporting a positive post-implementation experience of two-way conversions were Norfolk, VA, York, PA, and Albuquerque, NM. The City of Brockton, Massachusetts is moving ahead with plans for conversion of the existing one-way street systems in the downtown to two-way flow. Fitchburg, Massachusetts is currently evaluating the impacts of a two-way conversion identified as a component of the Fitchburg Urban Development and Revitalization Plan.

Alternative One: Traffic Calming

The traffic calming plan proposed by Art Traczyk would result in the installation of raised intersections and bulb-outs along Main Street. Raised intersections are used to force vehicles to slow down due to a change in the road elevation, like a speed bump. Bulb-outs are also used to slow down vehicles. Bulb-outs increase sidewalk area at crossing nodes and narrow the roadway such that there is only sufficient roadway width to provide one or two travel lanes. They improve sight lines by shifting parking away from a crossing. The downtown Hyannis traffic calming plan proposes bulb-outs that reduce the crossing width to two travel lanes. Raised intersections and bulb-outs are used in conjunction with pedestrian crossings because vehicles are forced to slow down to maintain a smooth ride, thus improving safety for pedestrians.

Along Main Street, the plan proposes eight (8) raised intersections, two (2) raised crosswalks, and numerous bulb-outs. Raised intersections, some extended to include several offset side streets, and crosswalks are proposed at the following locations:

- Main Street at the Town Common (crosswalk)
- Main Street and Barnstable Road
- Main Street between Winter Street and Pearl Street
- Main Street and High School Road
- Main Street between Bassett Lane and Pine Street
- Main Street between Bassett Lane and Sea Street (crosswalk)
- Main Street and Sea Street
- Sherman Square

A raised intersection prevents vehicles from gaining speed. It also visually emphasizes the crossing to both vehicles and pedestrians, encouraging pedestrians to cross at designated crossing points rather than jaywalk. The raised intersections and crosswalks force vehicles to slow their speeds and watch for pedestrians emerging from neighboring shops and restaurants. Most of the bulb-outs are proposed in conjunction with the raised intersections. Using the bulb-outs at the intersections allows a motorist in the near lane a better view of a pedestrian and prevents a pedestrian from being hidden from a driver's view by parked vehicles.

Similar traffic calming measures to those described for Main Street should be implemented on South Street. Because South Street has a narrower cross section than Main Street, bulb-outs may not be possible, and since parking is prohibited on South Street, they may not be necessary. Raised intersections at key locations such as Sea Street, High School Road, Pearl Street, and in front of Town Hall would force vehicles to drive more slowly, increasing safety for pedestrians.

In addition to the traffic calming measures, Alternative One includes the Town's plan to re-design Old Colony Road to allow two-way traffic flow. Alternative One also includes signal upgrades at all signalized intersections on Main Street. The signal upgrades will include the addition of exclusive pedestrian phases.

Alternative Two: Two-Way Circulation

Under Alternative Two, Main Street from Center Street/Old Colony Road to Sherman Square will be changed from a one-way westbound travel pattern to a two-way travel pattern. South Street from Lewis Bay Road to Sherman Square will also be changed to a two-way travel pattern. Throughout the study area, there are geometric and control-related improvements that will need to be implemented in order to accommodate two-way traffic flow. In addition to the alterations necessary at each of the intersections described below, it is recommended that exclusive left-turn lanes be provided at the intersections of Main Street and the Town Hall parking lot, Pearl Street, and Winter Street. The changes in the traffic circulation pattern may result in increased traffic volumes on other local streets, such as School Street and Pleasant Street.

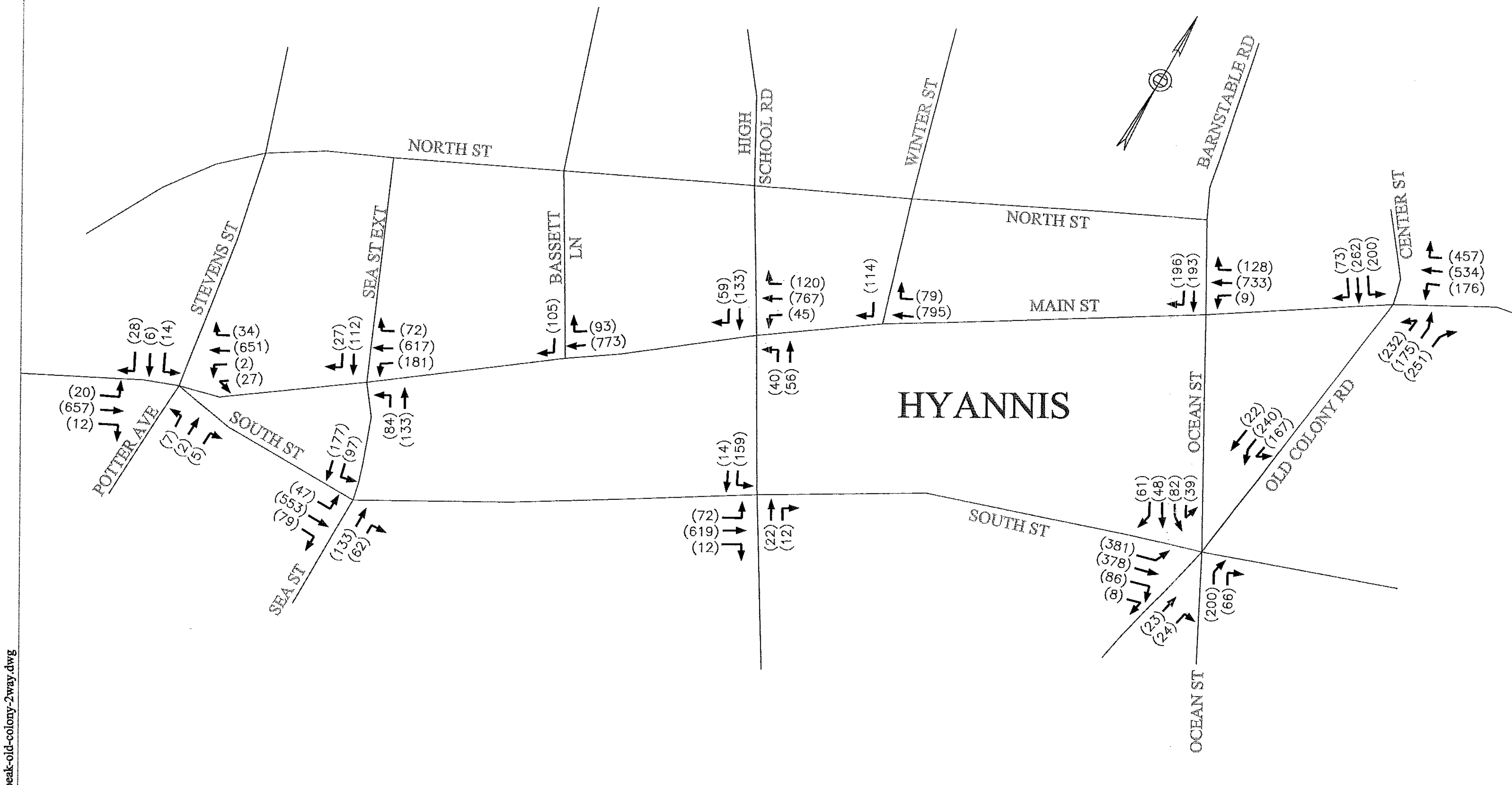
Main Street and Old Colony Road/Center Street
At the intersection of Main Street and Old Colony Road/Center Street, the Main Street eastbound approach should be configured to provide one exclusive left-turn lane and one through and right-turn lane. The Main Street eastbound left-turn lane should provide storage for a minimum of two vehicles, approximately 50 feet. The other three approaches should remain as proposed in the plans for the conversion of Old Colony Road to two-way traffic flow. The Main Street westbound approach will provide one exclusive left-turn lane, one through lane, and one exclusive right-turn lane, as will the Old Colony Road northbound approach. The Center Street southbound approach will provide one exclusive left-turn lane and one general lane.

The traffic signal should be configured as a four-phase fully actuated installation, including an advance phase for the Old Colony Road northbound and Center Street southbound left-turn movements and an exclusive pedestrian phase. The signal should be coordinated with the signal at Barnstable Road/Ocean Street.

Main Street and Barnstable Road/Ocean Street
At the intersection of Main Street and Barnstable Road/Ocean Street, the Main Street eastbound approach should provide a short, exclusive left-turn lane and one general lane. The Main Street westbound approach should provide one general lane and one exclusive right-turn lane. The Barnstable Road southbound approach will remain in its current configuration of one lane for left and through movements and one exclusive right-turn lane.

The traffic signal should operate as a three-phase fully actuated signal, including an exclusive pedestrian phase. One phase will be provided for Main Street traffic movements and one for Barnstable Road traffic movements. The signal should be coordinated with the signals at Old Colony Road/Center Street and High School Road.

Main Street and High School Road
The Main Street eastbound approach at the intersection of High School Road should be configured to provide one exclusive left-turn lane and one general lane. The Main Street westbound approach should provide one lane for left and through movements and one lane exclusively for right-turn movements. Each of the Main Street exclusive turn lanes should provide storage for a minimum of two vehicles, or approximately 50 feet. The High School Road northbound approach will provide one general lane, while the High School Road



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PM Peak Summer Traffic Volumes, Alternative One

Downtown Hyannis Traffic Circulation Study
Location: Barnstable, MA

Not to Scale

Figure 3

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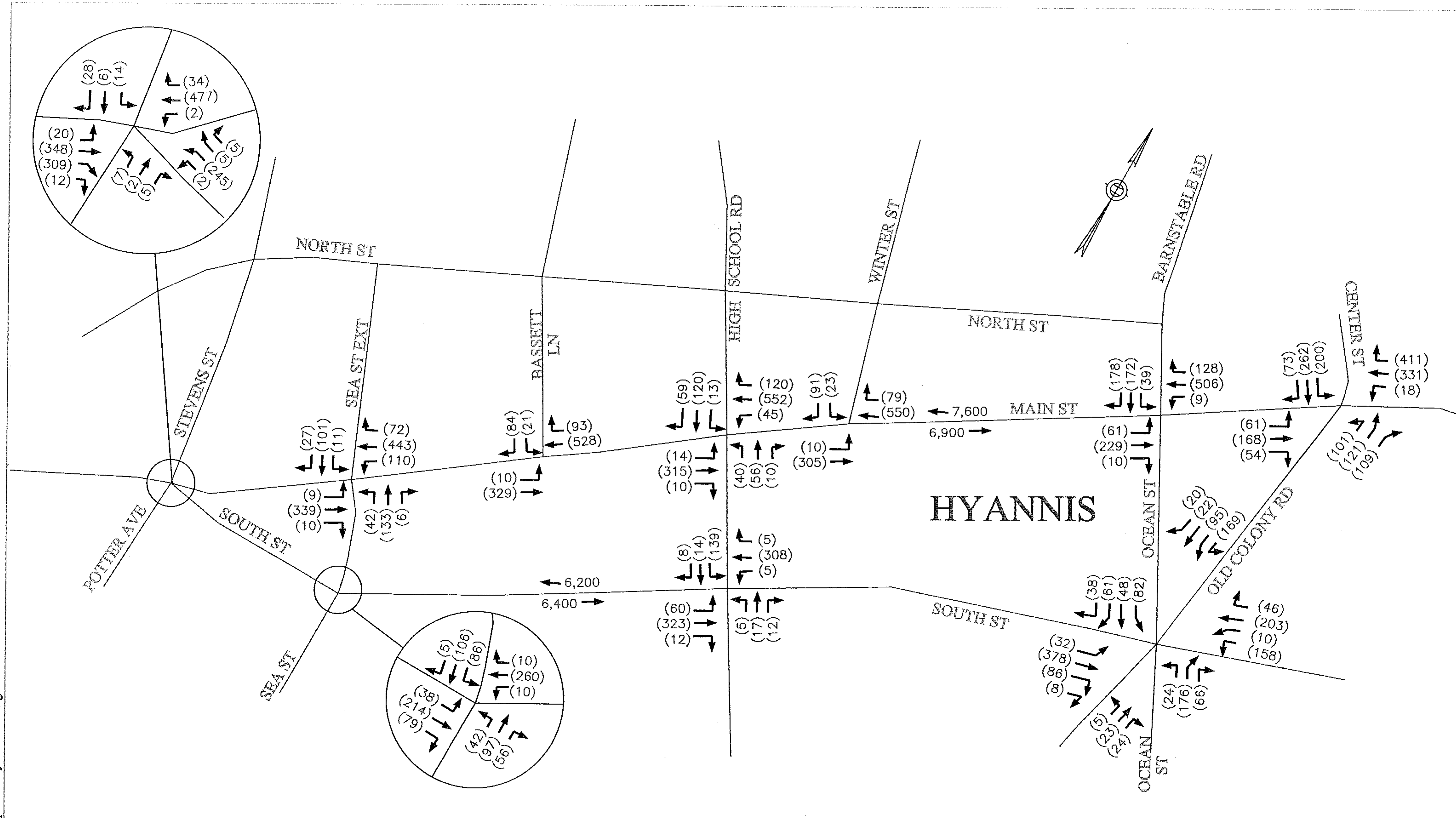

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PM Peak Summer Traffic Volumes, Alternative Two

Downtown Hyannis Traffic Circulation Study
Location: Barnstable, MA

Not to Scale

Figure 4

2001215\dwg\traffic\peak-2way-volumes.dwg summer traffic conditions if Alternative Two is implemented. This is a change of 49 seconds from existing peak summer conditions. An emergency vehicle will be able to traverse South Street westbound in approximately 2.8 minutes during peak summer traffic conditions. The travel time calculations and simulation output for both alternatives are included in Appendix D.

Traffic Operations

For Alternative One, the three (3) intersections where there are volume changes due to the circulation change on Old Colony Road were re-analyzed as were the other two (2) signalized intersections. For Alternative Two, all eight (8) project intersections were analyzed. The results of the capacity analysis for both alternatives are shown in Table 5. Figure 5 shows a comparison of the overall levels of service at each intersection.

Main Street and Old Colony Road/Center Street

Under Alternative One, the intersection will operate at LOS D. All lane groups of the intersection will operate at LOS E or better. The 95th percentile queue length on Main Street westbound is expected to be greater than 800 feet.

Under Alternative Two, the intersection will operate at LOS C. All lane groups of the intersection will operate at LOS D or better. The 95th percentile queue length on Main Street westbound is expected to be about 300 feet. The intersection is projected to improve the intersection operations and queues. However, if the section of South Street between Lewis Bay Road and Old Colony Road is not made two-way, there will be no shift of traffic to South Street, and the queue length and delays will be longer.

Main Street and Barnstable Road/Ocean Street

Under Alternative One, this intersection will operate at LOS C. All lane groups will operate at LOS D or better. The 95th percentile queues will extend more than 300 feet on the Main Street westbound approach.

Under Alternative Two, the intersection will operate at LOS C. All lane groups will operate at LOS D or better. The 95th percentile queue length on Main Street westbound is expected to be greater than 500 feet. The other lane groups will have no significant queues.

Main Street and High School Road

Under Alternative One, the signal at this intersection will be upgraded to a fully actuated signal. The timing plan should include an exclusive pedestrian phase. The intersection will operate at LOS D. The 95th percentile queue length on Main Street westbound will be extend approximately 400 feet per lane. The other approaches will have no significant queues.

Under Alternative Two, the intersection will operate at LOS E. The Main Street westbound through movement, High School Road northbound approach, and High School Road southbound left and through lane group will operate at LOS F. All other lane groups will operate at LOS A. The 95th percentile queue on Main Street westbound is expected to extend almost 600 feet. The queues on both High School Road approaches will extend almost 200 feet.

Main Street and Sea Street

Under Alternative One, this signal will be upgraded to include fully actuated control. The timing plan should include an exclusive pedestrian phase. The intersection will operate at LOS D. The

Table 5 - Capacity Analysis Summary, Alternatives One and Two, Peak Summer Conditions
Downtown Hyannis Traffic Circulation Study - Barnstable, MA

Location	Alternative One				Alternative Two			
	Summer Conditions				Summer Conditions			
	LOS	Delay (sec)	v/c	95% Queue	LOS	Delay (sec)	v/c	95% Queue
Signalized Intersection: Main Street and Center Street/Old Colony Road								
Main Street EB Left	-	-	-	-	C	22.9	0.39	75
Main Street EB Thru/Right	-	-	-	-	B	19.1	0.48	181
Main Street WB Left	C	21.2	0.28	178	B	18.1	0.06	23
Main Street WB Thru	E	60.2	0.98	835#	C	25.9	0.63	319#
Main Street WB Right	B	17.6	0.71	414	A	1.1	0.51	40
Old Colony Road NB Left	E	75.2	0.97	402#	C	27.6	0.64	91#
Old Colony Road NB Thru	D	41.8	0.35	243	D	35.4	0.58	128
Old Colony Road NB Right	A	0.5	0.26	0	A	7.0	0.40	46
Center Street SB Left	C	26.3	0.62	219	C	22.7	0.62	154
Center Street SB Thru/Right	E	79.5	0.98	577#	D	51.0	0.91	363#
Intersection	D	42.7	-	-	C	23.3	-	-
Signalized Intersection: Main Street and Barnstable Road/Ocean Street								
Main Street EB Left	-	-	-	-	B	14.6	0.34	59
Main Street EB Thru/Right	-	-	-	-	B	12.4	0.37	144
Main Street WB Left/Thru	-	-	-	-	D	51.3	0.92	534#
Main Street WB Right	-	-	-	-	A	7.6	0.30	63
Main Street WB Left/Thru/Right	C	23.1	0.89	335#	-	-	-	-
Barnstable Road SB Left/Thru	-	-	-	-	D	39.4	0.79	227#
Barnstable Road SB Thru	D	37.6	0.78	200#	-	-	-	-
Barnstable Road SB Right	A	5.1	0.57	59	B	12.5	0.62	103
Intersection	C	22.5	-	-	C	31.4	-	-
Signalized Intersection: Main Street and High School Road								
Main Street EB Left	-	-	-	-	A	2.2	0.06	0m
Main Street EB Thru/Right	-	-	-	-	A	2.7	0.51	16m
Main Street WB Left/Thru/Right	D	42.8	0.98	391#	-	-	-	-
Main Street WB Left	-	-	-	-	A	7.9	0.17	28
Main Street WB Thru	-	-	-	-	F	97.7	1.14	580#
Main Street WB Right	-	-	-	-	A	4.6	0.33	38
High School Road NB Left/Thru	C	31.1	0.57	95	-	-	-	-
High School Road NB Left/Thru/Right	-	-	-	-	F	159.6	1.24	187#
High School Road SB Left/Thru	-	-	-	-	F	81.8	0.93	189#
High School Road SB Thru	C	32.6	0.69	125	-	-	-	-
High School Road SB Right	A	8.5	0.25	32	A	10.0	0.32	33
Intersection	D	39.0	-	-	E	61.7	-	-
Signalized Intersection: Main Street and Sea Street								
Main Street EB Left	-	-	-	-	B	11.9	0.05	5m
Main Street EB Thru/Right	-	-	-	-	B	11.2	0.50	169m
Main Street WB Left/Thru/Right	D	50.2	1.01	388#	-	-	-	-
Main Street WB Left	-	-	-	-	B	18.2	0.43	74m
Main Street WB Thru/Right	-	-	-	-	C	26.3	0.84	383#m
Sea Street NB Left/Thru	E	64.6	0.95	230#	-	-	-	-
Sea Street NB Left/Thru/Right	-	-	-	-	D	39.3	0.81	172
Sea Street SB Thru/Right	C	23.4	0.43	110	-	-	-	-
Sea Street SB Left/Thru/Right	-	-	-	-	C	28.7	0.52	126
Intersection	D	49.9	-	-	C	23.8	-	-
Unsignalized/Signalized Intersection: Sherman Square								
Main Street EB Left/Thru/Right	A	9.4	0.03	2	-	-	-	-
Main Street EB Left/Thru	-	-	-	-	C	22.6	0.57	384#
Main Street EB Bear Right/Right	-	-	-	-	B	13.8	0.42	261
Main Street WB Left/Thru/Right	A	9.1	0.00	0	-	-	-	-
Main Street WB Left	-	-	-	-	C	20.5	0.01	1m
Main Street WB Thru/Right	-	-	-	-	D	41.6	0.86	566#m
Potter Avenue NB Left/Thru/Right	E	44.0	0.20	18	C	30.0	0.24	19
South Street NWB Left/Thru/Right	-	-	-	-	D	46.5	0.86	288#
Stevens Street SB Left/Thru/Right	E	37.0	0.34	36	C	22.9	0.50	45
Intersection	-	-	-	-	C	31.3	-	-
Signalized Intersection: South Street and Sea Street								
South Street EB Left/Thru/Right	B	15.0	0.58	149	B	15.2	0.54	231#
South Street WB Left/Thru/Right	-	-	-	-	B	11.5	0.44	154
Sea Street NB Thru/Right	A	8.2	0.28	73	B	13.2	0.48	126#
Sea Street SB Thru/Right	B	11.9	0.46	132	C	22.6	0.61	179#
Intersection	B	13.1	-	-	B	15.3	-	-
Unsignalized Intersection: South Street and High School Road								
South Street EB Left/Thru/Right	A	1.9	0.06	5	A	1.9	0.06	5
South Street WB Left/Thru/Right	-	-	-	-	A	0.2	0.00	0
High School Road NB Thru/Right	C	20.6	0.17	15	C	18.7	0.17	15
High School Road SB Thru/Right	E	38.3	0.64	102	F	63.7	0.79	144
Signalized Intersection: South Street and Old Colony Road/Ocean Street								
South Street EB Left/Thru/Right	E	55.1	0.92	660	-	-	-	-
South Street EB Left	-	-	-	-	D	40.7	0.08	57
South Street EB Thru/Right	-	-	-	-	F	126.4	1.17	834#
South Street WB Left/Bear Left	-	-	-	-	F	101.0	0.96	361#
South Street WB Thru/Right	-	-	-	-	F	181.2	1.35	556#
Ocean Street NB Thru/Right	E	57.8	0.18	98	-	-	-	-
Ocean Street NB Left/Thru/Right	-	-	-	-	F	119.2	1.12	519#
Ocean Street SB U-turn/Left	D	52.6	0.55	274	F	174.6	1.25	241#
Ocean Street SB Thru/Bear Right	E	66.6	0.88	495#	-	-	-	-
Ocean Street SB Thru/Bear Right/Right	-	-	-	-	D	44.9	0.48	216
Old Colony Road NEB Thru/Right	E	59.9	0.90	457	E	58.1	0.42	101
Old Colony Road SWB Left	D	43.6	0.27	190	F	97.5	0.78	363#
Old Colony Road SWB Thru/Bear Right	D	43.6	0.25	174	-	-	-	-
Old Colony Road SWB Bear Left/Thru/Bear Right	-	-	-	-	F	108.1	1.01	316#
Intersection	E	55.7	-	-	F	117.6	-	-

Notes:
95th percentile volume exceeds capacity, queue may be longer.
m Volume shown for 95th percentile queue is metered by upstream signal.

Main Street westbound queue will extend over 350 feet. The Sea Street northbound queue approach will extend over 200 feet.

This intersection will operate at LOS C under the conditions of Alternative Two. All lane groups will operate at LOS D or better. The 95th percentile queue on Main Street westbound will extend almost 400 feet. The other approaches will experience queues between 100 – 150 feet in length.

Sherman Square (Main Street/South Street and Stevens Street/Potter Avenue)
There are no changes proposed for this location under Alternative One. Stevens Street and Potter Avenue will continue to operate at LOS E while the Main Street approaches will operate at LOS A.

Under Alternative Two, the signalized intersection will operate at LOS C. All lane groups will operate at LOS D or better. The Main Street eastbound lanes will experience queues between 250 – 400 feet in length. The Main Street westbound through lane will experience a queue greater than 550 feet. Potter Avenue and Stevens Street will experience no significant queuing.

South Street and Sea Street
There are no changes proposed to this location under Alternative One. The intersection will continue to operate at LOS B. Vehicles on the South Street eastbound and Sea Street southbound approaches will experience 95th percentile queues around 150 feet in length.

With the improvements proposed by Alternative Two, the intersection will operate at LOS B. All lane groups will operate at LOS C or better. The South Street eastbound approach will experience a 95th percentile queue of around 230 feet. The South Street westbound approach will experience queues approximately 150 feet in length. The Sea Street approaches will experience queues between 125 – 175 feet in length.

South Street and High School Road
No improvements are proposed at this location under Alternative One. The High School Road northbound approach will continue to operate at LOS C, and the High School Road southbound approach will continue to operate at LOS E. The South Street eastbound approach will continue to operate at LOS A. All approaches will experience very little queuing.

No changes are proposed in either geometry or control under Alternative Two. The High School Road northbound approach will operate at LOS C. The High School Road southbound approach will operate at LOS F. The South Street approaches will both operate at LOS A. The High School Road southbound will experience a queue length greater than the one shown in Table 5, due to spillback from the intersection of South Street and Old Colony Road.

South Street and Ocean Street/Old Colony Road
Under Alternative One, this intersection will operate at LOS E. All lane groups will operate at LOS E or better. The 95th percentile queue on the South Street eastbound approach will extend farther than 650 feet. The 95th percentile queues on the Ocean Street southbound approach and the Old Colony Road northeastbound approach will extend approximately 500 feet.

Under Alternative Two, the intersection will operate at LOS F. Many of the lane groups will also operate at LOS F. The 95th percentile queue on the South Street eastbound approach is projected to be around 850 feet. The queue could extend as far back as High School Road,

Cost

Alternative One has an estimated construction cost of $3.125 million. The estimated cost includes raised intersections on both Main Street and South Street, full-depth reconstruction of Main Street, new sidewalks and curbing on both Main Street and South Street, cold-planing and pavement overlay on South Street, and signal upgrades at all existing signalized locations within the study area. It also includes pavement markings, drainage and landscaping on both streets. It does not include decorative pavement treatments such as cobblestones, granite pavers or stamped concrete for the raised intersections. The inclusion of decorative pavement would raise the order-of-magnitude cost estimate to approximately $6.15 million.

Alternative Two has an estimated construction cost of $3.825 million, not including land acquisitions. The estimated cost includes full-depth reconstruction of Main Street, sidewalk and curbing on both Main Street and South Street, upgrading existing signals, installation of a new signal at Sherman Square, pavement markings, drainage, landscaping, and traffic calming measures. The breakdown of the order-of-magnitude cost estimates for both alternatives is included in Appendix E.

Findings

Five criteria were chosen to evaluate the effects during peak summer traffic conditions of two circulation alternatives on the downtown Hyannis street network: safety, traffic operations, parking impacts, economic impacts and cost. Based on the five evaluation criteria, each alternative has advantages and disadvantages. The results of the study are summarized in an evaluation matrix, given in Table 7.

Both alternatives improve safety for pedestrians. Both alternatives slow vehicle speeds, but in different ways. Alternative One increases pedestrian visibility to motorists and limits the points of unprotected conflicts between pedestrians and vehicles. Alternative Two slows travel speeds by increasing traffic congestion. Alternative One will result in increased emergency response times, approximately 34 – 40 seconds. Based on emergency response times, Alternative Two could double the time to traverse Main Street westbound, adding approximately 3.5 minutes.

Based on traffic operations and roadway capacity, each alternative yields similar levels of service with two notable exceptions. The intersection of Main Street and High School Road will operate at on overall acceptable LOS, but several lane groups will operate at LOS F. The intersection of South Street and Old Colony Road/Ocean Street will fail under Alternative Two. The queues on the South Street eastbound approach could extend as far as High School Road.

Impacts to parking will be incurred under both alternatives. The impacts of Alternative Two are higher than those of Alternative One. Alternative Two offers the advantage of additional routes to parking lots and on-street parking.

Alternative One will provide no positive or negative economic impacts since it effectively represents a similar case to the existing conditions. For Alternative Two, the economic impacts are difficult to measure, but research of other communities that have performed a conversion of streets from one-way operation to two-way operation indicate that the economic impacts were favorable. The qualitative economic indicators such as "walkability" and "quaintness" can also be applied to the traffic calming alternative. It should be noted that in most cases, the conversion was accompanied by other measures to boost economic vitality, so a direct correlation between the street network conversion and the economic impacts cannot necessarily be inferred directly.

Alternative One will have a cost of $3.125 million for traffic calming measures on both Main Street and South Street. If some optional treatments for raised intersections are implemented, the construction cost could rise to an estimated $6.15 million. Alternative Two has an estimated cost of $3.875 million, not including potential land acquisition costs. Land acquisitions will be required at the intersection of South Street and Old Colony Road/Ocean Street in order to accommodate a left-turn lane on the South Street westbound approach. Land acquisitions may also be necessary at the intersections of Main Street and Barnstable Road and Main Street and High School Road to accommodate turning lanes.

Table 7 - Evaluation Matrix
Downtown Hyannis Traffic Circulation Study - Barnstable, MA

Criterion	Existing Peak Summer Conditions	Alternative One	Alternative Two
Safety			
Emergency Access - Average Travel Time	min (sec)	*Change* min (sec)	*Change* min (sec)
Main Street Eastbound	-	-	3.5 (207)
Main Street Westbound	2.6 (155)	0.7 (40)	3.5 (213)
South Street Eastbound	2.1 (125)	0.6 (34)	0.8 (49)
South Street Westbound	-	-	2.8 (170)
Pedestrian Safety	-	improved	improved
Roadway Capacity/Traffic Operations			
Level of Service at Intersections	LOS (delay)	LOS (delay)	LOS (delay)
Main St/Old Colony Rd/Center St	C (20.8)	D (42.7)	C (23.3)
Main St/Barnstable Rd/Ocean St	B (16.1)	C (22.5)	C (31.4)
Main St/High School Rd	B (17.0)	D (39.0)	E (61.7)
Main St/Sea St	B (15.7)	D (49.9)	C (23.8)
Sherman Square	E (44.0)*	E (44.0)*	C (31.3)
South St/Sea St	B (13.1)	B (13.1)	B (15.3)
South St/High School Rd	E (38.3)*	E (38.3)*	F (63.7)*
South St/Old Colony Rd/Ocean St	C (28.6)	E (55.7)	F (117.6)
Parking Impacts	-	56 lost spaces	89 lost spaces
Economic Impact	-	neutral	mostly positive
Cost	-	$3.125 million	$3.825 million

* Overall LOS is not defined for unsignalized intersections. LOS and delay shown are for minor approach experiencing the longest delay.

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