

Pleasant Street Corridor Improvement Plan

Concord,
New Hampshire

Prepared for City of Concord
Concord, New Hampshire

Prepared by VHB/Vanasse Hangen Brustlin, Inc.
Bedford, New Hampshire

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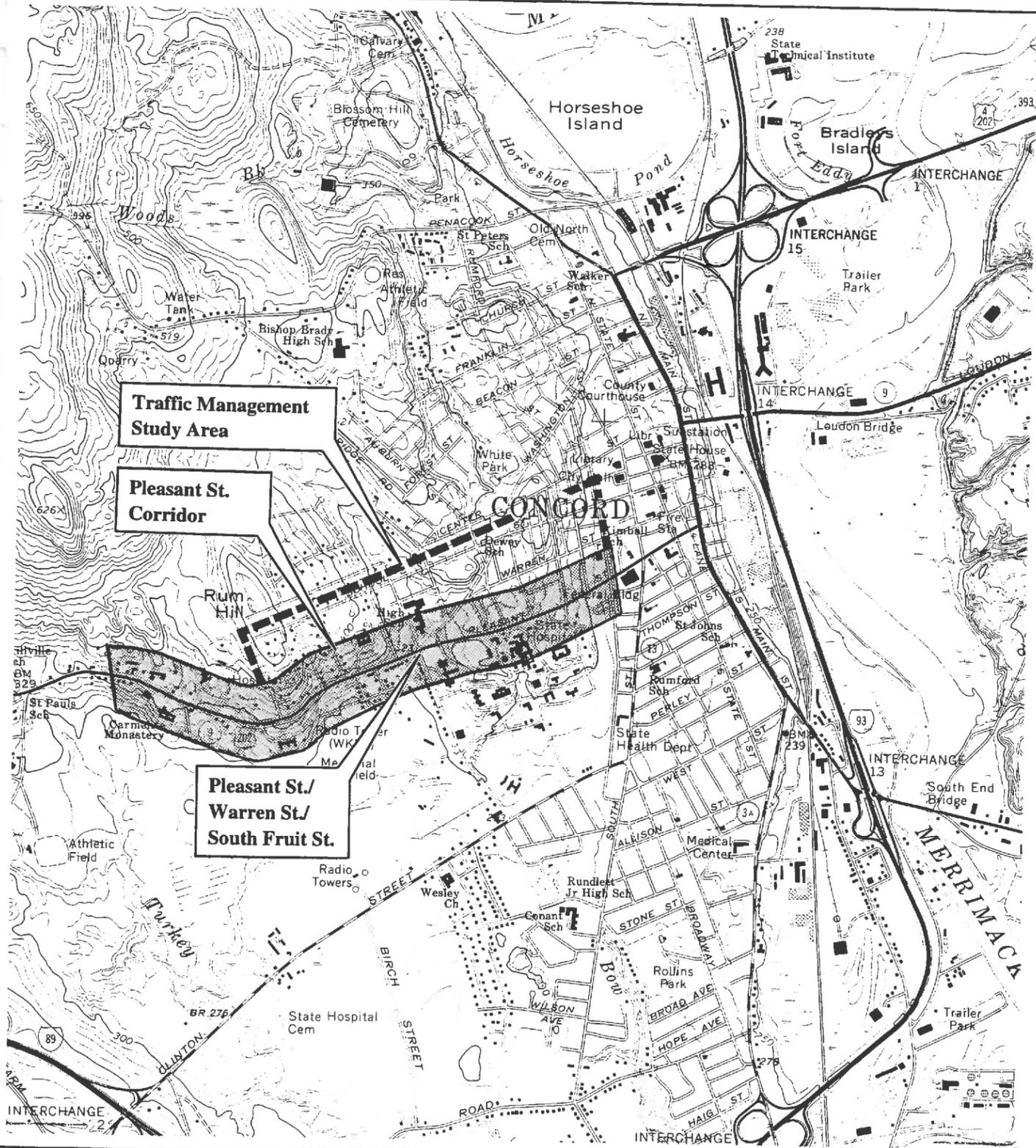
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Introduction

Vanasse Hangen Brustlin, Inc. (VHB) was retained by the City of Concord in cooperation with the Concord School District to conduct a transportation planning and traffic management study of the Pleasant Street Corridor. The findings of the recently updated City of Concord Master Plan identified a need to increase capacity along this corridor to meet existing and future traffic demands. The additional traffic generated by planned developments such as the Federal Courthouse, the expansion of the Concord Hospital Campus, the expansion of the Concord High School, and the redevelopment of the New Hampshire Hospital Campus, as well as other background growth identified in the City's Master Plan will not only increase the level of congestion along the corridor but will adversely impact the quality of life for residents of the nearby neighborhoods as traffic congestion continues to spill over onto local neighborhood streets.

The purpose of this study is to develop a conceptual improvement plan for a 1.4 mile section of the Pleasant Street Corridor extending from the Concord Hospital to South Spring Street, to evaluate and recommend a preferred improvement plan for the critical Pleasant Street/Warren Street/South Fruit Street intersection, and lastly to develop a traffic management plan aimed at protecting the nearby residential neighborhoods from the intrusion of continued traffic growth.

The project study area, which consists of the Pleasant Street Corridor extending easterly from the signalized Concord Hospital driveway to the signalized North Spring Street intersection, and the residential neighborhood located north of Pleasant Street bordered by Rum Hill Road to the west, School Street to the north, and North Spring Street to the east, is depicted graphically in Figure 1.



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Study Area

Figure 1

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Existing Conditions

The purpose of this section is to describe and summarize the findings of the existing conditions data collection inventory and to establish a base design hour volume condition. The data collection inventory includes: base plan development, physical roadway conditions, traffic volume counts, accident research, and general field observations.

Base Plan Development

In order to develop an up to date base plan of the Pleasant Street Corridor, 1" = 100' planimetric plans, 100 feet left and right of the Pleasant Street centerline were prepared from aerial photography flown in December 1992 by East Coast Mapping, Inc. for a portion of the corridor beginning at the westerly terminus of the study area in the vicinity of Concord Hospital and running easterly to the Minot Street intersection at Pleasant Street. 1" = 50' scale topographic plans with 2' contours were also prepared by East Coast Mapping for the Pleasant Street/Fruit Street /Warren Street intersection study area. East of Liberty Street along Pleasant Street, and the remaining corridor plans east of Fruit Street were developed using planimetric mapping information provided by the City as part of the NH State Hospital Complex Improvement Study. To depict the existing street system and properties connecting to the corridor, the City's Graphic Information System (GIS) Data Base was combined with the planimetric mapping.

Right-of-Way (ROW) and property line information was also included from the City's GIS system to identify the Street ROW and property ownership. A field review was completed to update the physical features along the Corridor.

Additional data was added to further update the base plan including areas of recent construction, development and/or proposed development. These areas include:

- New Signalized Intersection at Concord Hospital
- New Development at the Tuttle Street/Pleasant Street Intersection
- Day Care Center, Warren Street
- Concord High School Parking Facility
- Proposed Improvements to Concord High School
- Proposed Improvements to Centennial Home
- Proposed Improvements to the NH State Hospital Complex/Pleasant Street

Physical Roadway Conditions

Pleasant Street, within the study area, is a primary arterial roadway which runs in a general east-west direction providing connection to the downtown area. Throughout most of its length, the pavement width is approximately 36 to 38 feet providing two - 12 foot travel lanes and a 6-7 foot paved shoulder along each side of the roadway. There is a short section of the corridor east of Fruit Street and west of Liberty Street which is approximately 30 feet wide, and a short section of roadway east of the N.H. Hospital and west of Merrimack Street which is approximately 40 feet wide. Overall, the roadway's vertical and horizontal alignments are relatively level and straight with the exception of a 11° - 30' horizontal curve located in the vicinity of Rum Hill Road and a combination of 7.5 percent and 5 percent grades located east of South Fruit Street. Approach grades on each of the six intersecting streets between Rum Hill Road and Minot Street meet Pleasant Street at relatively steep 7 to 18 percent grades. East of Fruit Street, five (5) residential streets connect Pleasant Street with Warren Street, School Street, and Center Street to the north. On the south side, the N.H. State Hospital Complex abuts with Pleasant Street with five existing driveway curb cuts. The primary access to the Complex is located just east of Pine Street. Land use along the corridor is a mix of commercial-business, institutional and residential.

Right-of-way along the 1.4 mile section of Pleasant Street varies in general from 60 to 66 feet. Right-of-way along South Fruit Street and along Warren Street is approximately 66 feet and 60 feet, respectively. Right-of-way for local streets connecting to the corridor is approximately 50 feet in width. There is no formal control of access within the study area.

Traffic signal control is provided along Pleasant Street at the Concord Hospital, the Warren Street/South Fruit Street intersection, and at the North Spring Street intersection. A brief description of the lane usage at each of these key intersections is provided below.

Pleasant Street/Concord Hospital West Drive

The Concord Hospital West Drive (proposed Northwest By-Pass) intersects Pleasant Street to form a 4-way signalized intersection. The northbound leg of the intersection currently provides access to the intersection from a residential driveway. The Concord Hospital West Drive approach provides an exclusive left-turn lane and an exclusive right-turn lane. The Pleasant Street eastbound and westbound approaches each provide an exclusive left-turn lane and a shared through/right-turn lane. Travel lanes on all approaches to the intersection measure 12 feet in width.

Pleasant Street/Warren Street/South Fruit Street

Pleasant Street, Warren Street and North and South Fruit Streets meet to form a five-legged signalized intersection. North Fruit Street, which is 31 feet in width, is restricted to one-way flow in the northbound direction providing access to the High School and adjacent residential area. The South Fruit Street approach to the intersection is approximately 22 feet wide, providing an exclusive left-turn lane and a shared through/right-turn lane. The Warren Street 2-lane approach, which is approximately 20 feet in width, provides a similar exclusive left-turn lane and a shared through/right-turn lane. The Pleasant Street eastbound approach is approximately 26 feet wide with a shared left-turn/through lane and an exclusive right-turn lane, while the Pleasant Street westbound approach measures approximately 22 feet in width providing an exclusive left-turn lane and a shared through/right-turn lane.

Pleasant Street/North Spring Street/South Spring Street

North and South Spring Streets intersect Pleasant Street to form a 4-way signalized intersection. Lane usage at the intersection consists of a single 20 foot wide all purpose lane on both the Pleasant Street eastbound and Pleasant Street westbound approaches to the intersection. Similarly, North Spring Street and South Spring Street each consist of a single 13 foot wide all purpose lane.

Traffic Volumes

To determine the existing traffic volume demands and flow patterns within the study area, an extensive traffic volume count program was conducted at key locations during the month of September 1995. Weekday morning (7:00 - 9:00 AM) and weekday evening (4:00 - 6:00 PM) peak period manual turning movement counts were conducted at the following intersections:

- Pleasant Street/Rum Hill Road
- Pleasant Street/Kensington Road
- Pleasant Street/Warren Street/Fruit Street
- Pleasant Street/Liberty Street
- Pleasant Street/Pine Street
- Pleasant Street/N.H. State Hospital (PM only)
- Pleasant Street/Merrimack Street
- Pleasant Street/Rumford Street
- Warren Street/High School Parking Lot (AM only)
- Warren Street/ Liberty Street
- Warren Street/Pine Street
- School Street/Liberty Street
- School Street/ Pine Street
- School Street/ Rumford Street

To supplement the turning movement counts, 24-hour mechanical recorder counts were conducted at several key locations within the study area. A summary of the mechanical recorder count data is provided in Table 1.

In addition to the September 1995, traffic volume count program, the City Planning Department provided traffic volume data at numerous other study area locations. A complete summary of all the available traffic volume data is provided in the technical appendix to this report.

Table 1 Existing Traffic Volume Count Summary (September 1995)

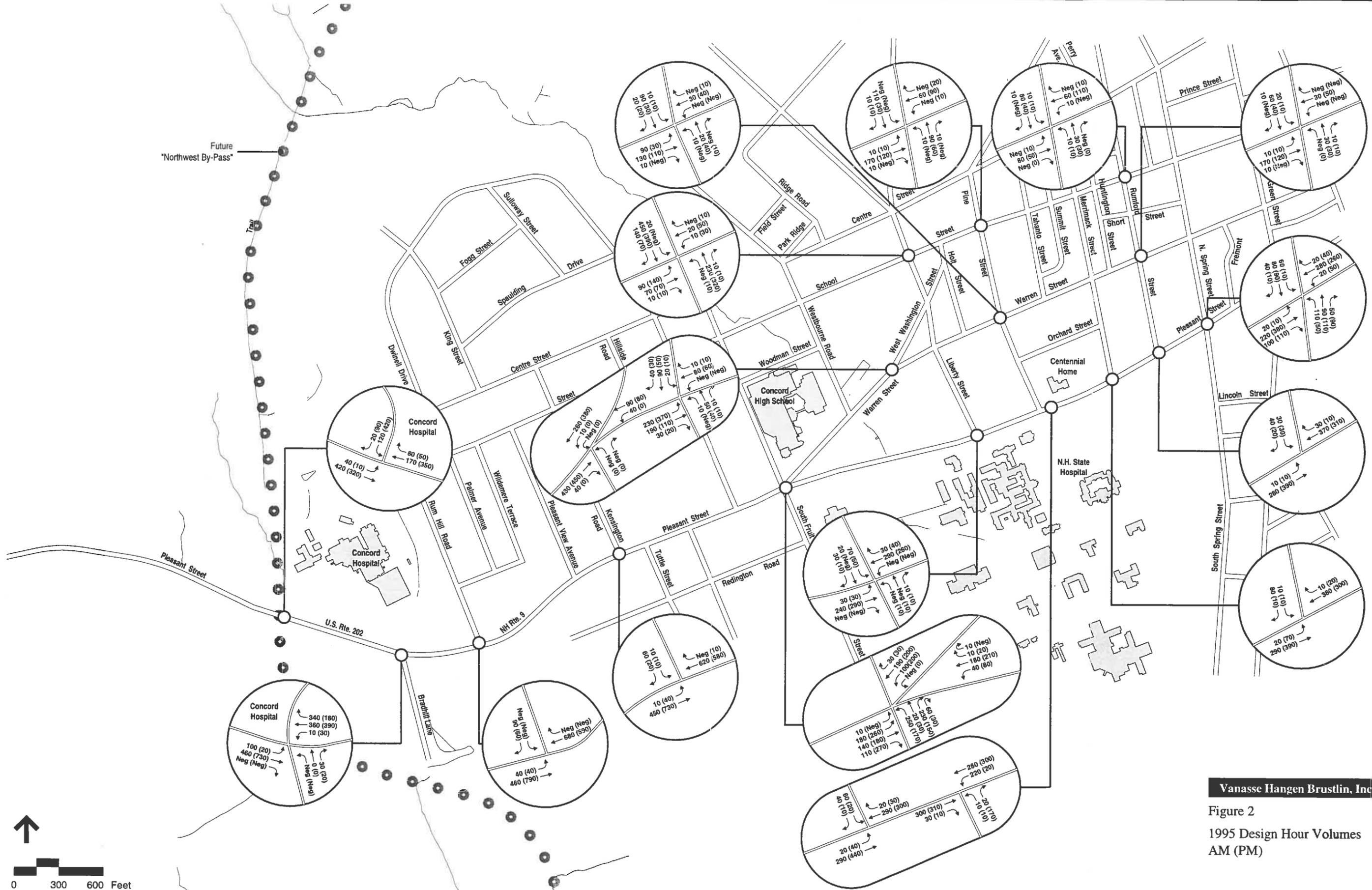
LOCATION	AWDT ¹	AM PEAK HOUR (vph)	PERCENT OF DAILY TRAFFIC	PM PEAK HOUR (vph)	PERCENT OF DAILY TRAFFIC
Pleasant Street					
West of South Fruit Street	14,200	1,000	7.0	1,300	9.2
Pleasant Street					
East of South Fruit Street	6,000	460	7.7	540	9.0
Pleasant Street					
West of North Spring Street	8,500	600	7.1	800	9.4
South Fruit Street					
South of Pleasant Street	9,800	820	8.4	900	9.2
Warren Street					
East of Rumford Street	2,200	190	8.6	220	10.0
School Street					
West of Liberty Street	3,300	320	9.7	310	9.4
School Street					
West of Westbourne Road	4,400	450	10.2	460	10.5
School Street					
West of North Spring Street	1,900	140	7.4	200	10.5
Rum Hill Road	1,300	100	7.7	130	10.0
Pleasant View Avenue	500	70	14.0	50	10.0
Kensington Street	700	80	11.4	60	8.6

¹ AWDT - Average Weekday Traffic

As shown in the table, the September 1995 Average Weekday Traffic (AWDT) along Pleasant Street ranges from a low of 6,000 vehicles per day (vpd) east of Fruit Street to a high of 14,200 vpd west of Fruit Street. South Fruit Street, south of Pleasant Street, recorded an AWDT of 9,800 vpd, while some of the neighborhood streets recorded AWDT's ranging from a low of 500 vpd along Pleasant View Avenue to a high of 4,400 vpd along School Street. The percentage of daily traffic occurring during the morning and evening peak hours range from 7.0 to 14.0 percent and 8.6 to 10.5 percent, respectively.

Based on an examination of historical traffic volume data collected by the New Hampshire Department of Transportation (NH DOT) at its permanent traffic recorder station located along NH 3A in nearby Bow, the monthly variation in average daily traffic revealed the peak traffic volume month to be June with the highest volumes recorded during the summer and fall. To evaluate the existing travel demands and to establish an appropriate design hour condition, the peak hour turning movement counts, conducted in September 1995, were adjusted (increased by 2 percent) to reflect a peak month design hour volume (DHV) condition for the base year of 1995.

The 1995 Design Hour Volume Network is shown in Figure 2.



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Figure 2
1995 Design Hour Volumes
AM (PM)

Accident Research

Accident records provided by the NHDOT were researched for the four-year period of 1991 through 1994. The accident data revealed a total of 144 accidents reported within the study area for the four year period. A complete summary of the accident data is presented in Table 2. Examination of the data revealed the following trends.

- ▶ Of the total 144 accidents reported, 40 (28 percent) occurred at the Pleasant Street/Warren Street/South Fruit Street intersection. No other intersection recorded more than 9 (6 percent) accidents during the four-year period.
- ▶ Overall the number of accidents remained relatively constant with between 34 and 40 accidents reported throughout the study area each year.
- ▶ One hundred and thirty-seven (95 percent) of the total accidents occurred on a weekday with only seven accidents (5 percent) occurring on a Saturday or Sunday. In fact, 39 (98 percent) of the 40 accidents reported at the Pleasant Street/Warren Street/South Fruit Street intersection occurred on a weekday.
- ▶ Forty-seven (33 percent) of the total accidents involved some type of personal injury with the remaining 97 (67 percent) involving property damage only. No fatalities were reported.

TABLE 2 Accident Summary (1991-1994)

Category	7 HIGHEST ACCIDENT LOCATIONS							All Other Study Locations	Total Study Area
	Warren St/ Pleasant So. Fruit St	Pleasant St/ Minot St.	Warren St/ Liberty St.	Pleasant St/ Spring St.	Warren St. Rumford St	Pleasant St/ Pleasant View Drive	School St/ Merrimack St.		
Year									
1991	11	0	1	2	2	1	4	15	36
1992	5	3	6	1	2	3	0	20	40
1993	14	4	1	2	0	0	0	13	34
<u>1994</u>	<u>10</u>	<u>2</u>	<u>0</u>	<u>2</u>	<u>2</u>	<u>1</u>	<u>1</u>	<u>16</u>	<u>34</u>
Total	40	9	8	7	6	5	5	64	144
Season									
Winter (Dec.-Feb.)	12	1	3	3	3	2	2	16	42
Spring (Mar.-May)	9	5	2	0	0	1	1	16	34
Summer (June-Aug.)	6	0	1	1	2	1	1	14	26
<u>Fall (Sept.-Nov.)</u>	<u>13</u>	<u>3</u>	<u>2</u>	<u>3</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>18</u>	<u>42</u>
Total	40	9	8	7	6	5	5	64	144
Day of Week									
Mon.-Fri.	39	8	8	7	6	4	5	60	137
<u>Sat.-Sun.</u>	<u>1</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>4</u>	<u>7</u>
Total	40	9	8	7	6	5	5	64	144
Severity									
Property-Damage	25	8	5	5	2	4	2	46	97
Personal Injury	15	1	3	2	4	1	3	18	47
<u>Fatality</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	40	9	8	7	6	5	5	64	144
Type									
Angle	4	4	1	0	2	0	3	11	25
Rear-End	6	1	2	0	0	0	0	6	15
Head-On	1	0	0	0	0	0	0	0	1
Fixed Object	0	0	0	0	0	1	0	7	8
Bicyclist	2	0	0	0	0	0	0	3	5
Pedestrian	1	0	0	0	0	0	0	3	4
<u>Other/Unknown</u>	<u>26</u>	<u>4</u>	<u>5</u>	<u>7</u>	<u>4</u>	<u>4</u>	<u>2</u>	<u>34</u>	<u>86</u>
Total	40	9	8	7	6	5	5	64	144
Surface Condition									
Dry	27	7	5	5	5	4	3	49	105
Wet	12	2	2	1	0	1	1	12	31
Snow/Ice	1	0	1	0	0	0	1	2	5
<u>Other/Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>3</u>
Total	40	9	8	7	6	5	5	64	144
Weather									
Dry/Clear/Cloudy	30	8	7	5	4	4	3	53	114
Rain/Wet	5	1	0	1	1	1	1	8	18
Snow/Ice	2	0	1	0	0	0	1	2	6
<u>Other/Unknown</u>	<u>3</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>6</u>
Total	40	9	8	7	6	5	5	64	144

Field Observations

In addition to inventorying physical roadway conditions, conducting traffic volume counts, and researching accident records, it is important to conduct general field observations. The field observations consisted of both driving and walking the study area roadways in an effort to better understand and appreciate the issues and concerns of area residents. The following are some of the observations which were noted during the field inventory.

- The posted/legal speed limits for all roadways within the study area are 30 m.p.h.
- The horizontal alignment of Pleasant Street at Rum Hill Road limits the easterly sight distance for vehicles exiting Rum Hill Road creating an undesirable condition.
- The absence of sidewalks along many of the neighborhood streets west of the Concord High School can be problematic given the current volume of cut through traffic observed along these roadways.
- Student crossings at the Pleasant Street/Warren Street/Fruit Street intersection when the High School lets out at the end of the day impact the flow of traffic at the intersections for a short period of time (15 to 20 minutes). Students crossing Warren Street tend to cross in large groups with few using the pedestrian activated signal at the intersection or crosswalks provided.
- Vehicles parking along the north side of Pleasant Street from Minot Street to Kensington Street reduce available pavement for bicyclists and pedestrians. Students who frequently use this section to park (30-35 vehicles during school hours) walk along the roadway. This creates an undesirable condition especially during winter months when snow storage further reduces the available pavement.
- Due to poor sight distance (easterly) the Pleasant Street access to the High School parking is currently closed, requiring all traffic entering the facility to use Warren Street.
- The superelevation or cross slope of Pleasant Street in the vicinity of Rum Hill Road is greater than necessary for the 30 m.p.h. posted speed. During winter conditions vehicles traveling at low speeds tend to slide laterally across the slope.
- Utility poles along portions of Warren Street and Pleasant Street are located close to the edge of pavement creating obstacles for the motorists and headaches for winter maintenance operations.
- On street parking, with the exception of prohibitions at intersections, is allowed only at the following corridor locations:

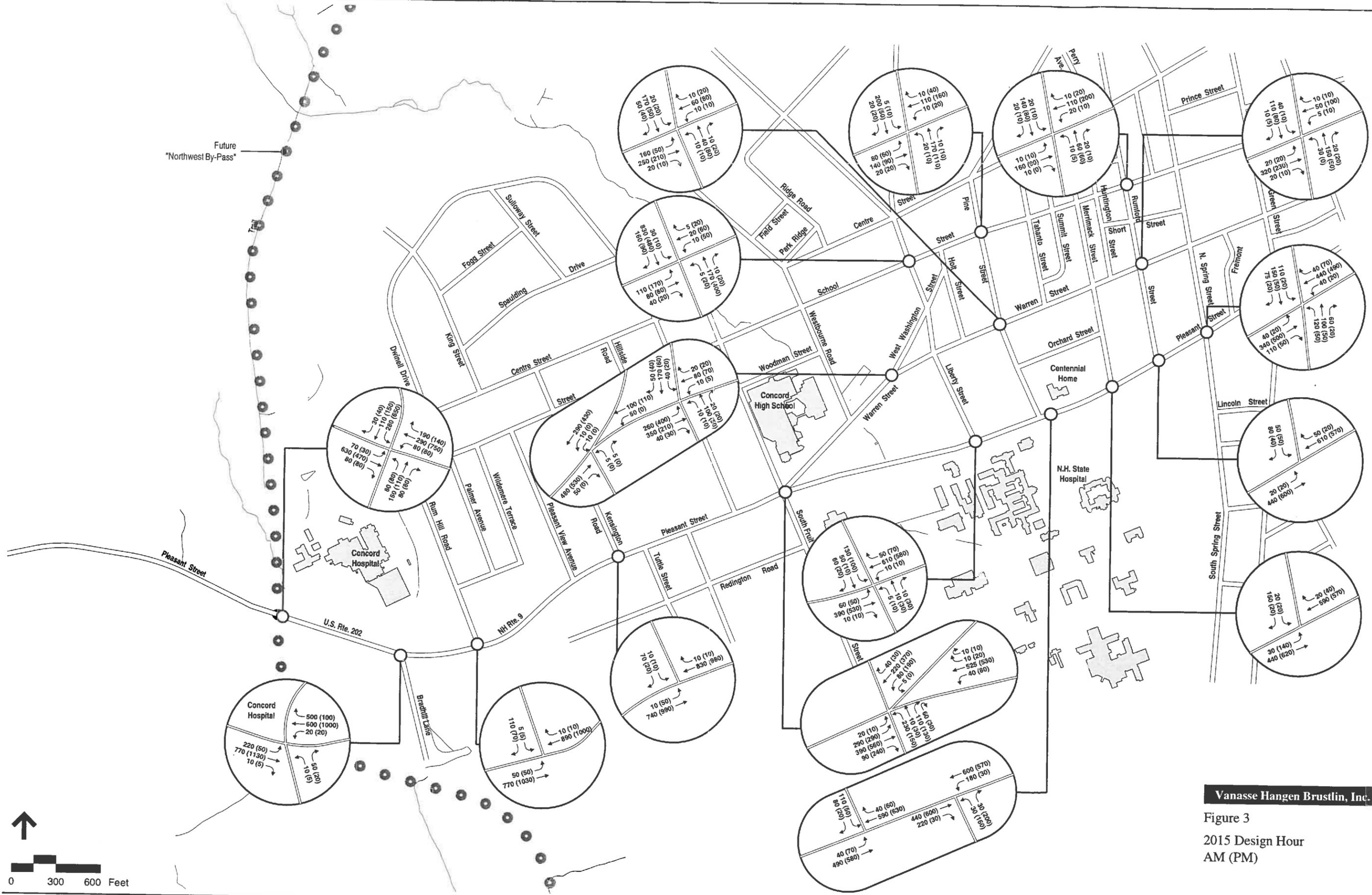
➤ Pleasant Street

North Side: 200 feet west of Pleasant View Avenue to Minot Street (all day)
In a Pinch restaurant (1 hour). Pine Street to Rumford Street (all day)
Rumford Street to North Spring Street (2 hour).

South Side: Beginning at Gale Street to Tuttle Street (no parking 7:00 am to
3:00 pm, Monday - Friday). Opposite Minot Street (2 hour). Merrimack Street
to Rumford Street (all day) Rumford Street to South Spring Street (2 hour).

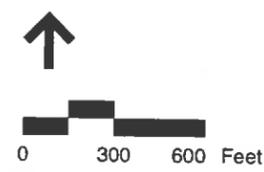
➤ Bus Stop Locations

- At the Professional Building (Minot Street) both sides Pleasant Street.
- State Hospital Entrance (Pine Street) both sides Pleasant Street.



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Figure 3
2015 Design Hour
AM (PM)



3

Future Conditions

To evaluate the impact of future travel demands within the study area, the 1995 design hour volumes were projected to a 20-year design horizon. A 20-year time frame is generally used for the purpose of long-range transportation planning. To project future traffic volumes, it is necessary to consider historical growth trends in the area, future planned land use, as well as planned transportation improvements.

One significant change to the existing transportation system, which must be considered to develop a future design condition, is the proposed Northwest Bypass. The Northwest Bypass will be a two-lane parkway that will connect Route 3 at Penacook Street in the north to Clinton Street in the south. The new roadway will intersect Pleasant Street adjacent to the Concord Hospital. Current plans call for the construction of the southern leg of the Bypass - from Pleasant Street to Clinton Street - by 1999 with the northern leg to be completed within the next 20 years. The 20-year design hour volumes evaluated for this study assume the construction of the Northwest Bypass.

The planned redevelopment of the New Hampshire State Hospital would necessitate the reconstruction and signalization of its primary access driveway onto Pleasant Street. Lane use at the intersection, which is located east of Pine Street opposite the Centennial Home would consist of an exclusive left-turn lane, a through lane, and an exclusive right-turn lane on the Pleasant Street eastbound approach and an exclusive left-turn lane and a shared through right-turn lane on the Pleasant Street westbound approach. The N.H. State Hospital approach would consist of a shared through/left-turn lane and an exclusive right-turn lane. The Centennial Home driveway would be reconstructed so as to align opposite the N.H. State Hospital driveway.

Working with the City Planning Department, the traffic volume projections developed for the City of Concord Master Plan were reviewed. Traffic volume projections were developed for such known planned development projects as the New Hampshire State Hospital (400,000 s.f. office space), the Federal Court House (102,000 s.f. office space), the expansion of the Concord High School (400 students), and the expansion of the Concord Hospital (120,000 s.f. medical office space).

As a result, average weekday traffic volumes along the Pleasant Street Corridor are projected to increase over the 20-year period from 5,200 vpd to 12,300 vpd east of Fruit Street and from 13,300 vpd to 21,500 vpd west of Fruit Street. Due to the diversionary effect of the Northwest Bypass, the currently heavily traveled Liberty Street to Warren Street corridor would experience substantially less increase with the volume of traffic on Warren Street, west of Liberty Street, increasing from 9,100 vpd to approximately 11,200 vpd.

The projected 20-year average weekday traffic volumes for the Pleasant Street Corridor are summarized in Table 3. The 2015 design hour volume network is shown in Figure 3.

Table 3 Projected Average Weekday Traffic Volumes

Location	1995 AWDT	2015 AWDT	Percent Increase
Pleasant Street West of Concord Hospital West Drive	7,700	14,500	88%
Pleasant Street East of Concord Hospital West Drive	11,400	21,700	90%
Pleasant Street West of Fruit Street	13,300	21,500	62%
South Fruit Street South of Pleasant Street	8,500	9,300	9%
Warren Street North of Pleasant Street	9,100	11,200	23%
Pleasant Street East of Fruit Street	5,200	12,300	137%
Pleasant Street East of Liberty Street	6,500	13,200	103%
Pleasant Street East of Merrimack Street	7,500	11,700	56%
Liberty Street South of Centre Street	8,900	11,200	26%
School Street West of Rumford Street	1,400	2,400	71%
Warren Street East of Rumford Street	1,900	3,800	100%

4

Deficiency Evaluation

Measuring traffic volumes within the study area indicates the importance of each street to the general roadway system in Concord, but gives little indication of the quality of traffic flow or the deficiencies throughout the roadway system that can affect the quality of life for residents of the community. This section of the report describes and discusses the traffic operational analyses, corridor design constraints, and neighborhood issues.

Level of Services Analysis

Level of service (LOS) is the term used to denote the different operating conditions which occur on a given roadway facility under various traffic volume loads. LOS is a qualitative measure of the effect of a number of factors including roadway geometrics, travel speed, travel delay, freedom to maneuver, and safety. Level of service provides an index to the operational qualities of a roadway segment or intersection. The evaluation criteria contained in the 1994 Highway Capacity Manual¹ were used to analyze the study area intersections. The criteria is described in the Appendix of this report.

Level of service is based on a grading system where LOS A is the best condition and LOS F is the worst condition. In general terms, intersection movements operating at LOS A or LOS B experience very little if any delay. Levels of service C and D are typically considered average delay conditions. LOS E and F suggest that motorists experience long delays. The level at service designation is reported differently for signalized and unsignalized intersections.

For signalized intersections, the analysis considers the operation of all traffic entering the intersection and the LOS designation is for the overall conditions at the intersection. The unsignalized intersection analysis criteria assumes that traffic maneuvers that have the right-of-way (in most cases the through traffic on the major street) are not affected by vehicles entering or exiting the main line traffic flow that must yield and wait for an appropriate gap to make a turn. Therefore, level of service results are not provided for the major street through

¹ Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, DC (1994).

traffic. Levels of service are calculated for turning maneuvers to and from the major street traffic flow, as well as vehicles crossing the major street traffic flow.

The results of the signalized intersection analyses indicated that two of the three intersections namely the Pleasant Street/North Spring Street and Pleasant Street/Concord Hospital West Drive currently operate at LOS B. However, the Pleasant/Warren Street/South Fruit Street intersection currently operates at a LOS F during both the morning and evening peak hours. By year 2015 the Pleasant Street/Concord Hospital intersection deteriorates to LOS E during the morning peak hour and LOS F during the evening peak hour. The proposed signalized intersection at the NH State Hospital is expected to operate at LOS B.

The results of the unsignalized intersection analyses indicate that under existing conditions the side street movements at 14 of the 15 intersections that were evaluated operated at level of service (LOS) C or better. Only the Liberty Street/School Street intersection operates at LOS D. By the year 2015, only five of the 15 intersections would continue to operate at LOS C or better with 8 intersections deteriorating to a LOS E or F condition.

The results of the signalized and unsignalized intersection analyses are summarized in Tables 4 and 5.

TABLE 4 Signalized Intersection Analysis

Intersection	1995				2015			
	AM PEAK HOUR		PM PEAK HOUR		AM PEAK HOUR		PM PEAK HOUR	
	DELAY ¹	LOS ²	DELAY	LOS	DELAY	LOS	DELAY	LOS
Pleasant Street/Concord Hospital West Dr.	6	B	11	B	42	E	>60	F
Pleasant Street/Warren Street/Fruit St.	>60	F	>60	F	>60	F	>60	F
Pleasant Street/NH State Hospital	-	-	-	-	10	B	11	B
Pleasant Street/North Spring Street	8	B	8	B	17	C	6	B

¹ Delay - Average delay is seconds

² LOS - Level of Service

TABLE 5 Unsignalized Intersection Analysis

Intersection	1995				2015			
	AM PEAK HOUR		PM PEAK HOUR		AM PEAK HOUR		PM PEAK HOUR	
	DELAY ¹	LOS ²	DELAY	LOS	DELAY	LOS	DELAY	LOS
Pleasant Street/Concord Hospital East Drive								
Left from Pleasant Street EB	4	A	5	C	12	C	7	B
Left from Pleasant Street WB	6	B	4	A	5	B	8	B
Left/Right from Hillside	12	C	10	C	123	F	34	E
Pleasant Street/Rum Hill Road								
Left/Right from Rum Hill Road	9	B	9	B	16	C	22	D
Left from Pleasant Street	5	A	4	A	6	B	7	B
Pleasant Street/Kensington Street								
Left/Right from Kensington Street	9	B	14	C	16	C	52	F
Left from Pleasant Street	4	A	4	A	5	B	7	B
Pleasant Street/Liberty Street								
Left from Pleasant Street EB	3	A	3	A	5	A	5	A
Left from Pleasant Street WB	3	A	3	A	13	A	4	A
Left/Thru/Right from Twitchell	6	B	7	B	16	C	18	C
Left/Thru/Right from Liberty	11	C	10	B	972	F	140	F
Pleasant Street/Pine Street								
Left/Right from Pine Street	8	B	8	B	123	F	39	E
Left from Pleasant Street	3	A	3	A	5	A	5	B
Pleasant Street/NH Hospital Drive								
Left/Right from NH Hosp. Drive	8	B	6	B	26	D	*	F
Left from Pleasant Street	4	A	3	A	5	B	4	A
Pleasant Street/Merrimack Street								
Left/Right from Merrimack	6	B	9	B	13	C	38	E
Left from Pleasant	3	A	4	A	4	A	5	B
Pleasant Street/Rumford Street								
Left/Right Turn from Rumford Street	8	B	7	B	23	D	22	D
Left from Pleasant Street	3	A	3	A	5	A	4	A
Warren Street/West Washington Street								
Left/Right from High School Drive	9	B	-	-	11	C	-	-
Left/Thru/Right from W. Washington	5	A	5	A	5	B	5	B
Left from Warren into High School Drive	4	A	-	-	4	A	-	-
Warren Street/Liberty Street								
Left from Warren Street EB	3	A	3	A	3	A	4	A
Left from Warren Street WB	3	A	2	A	3	A	3	A
Left/Thru/Right from Liberty Street NB	10	B	11	C	28	D	28	D
Left/Thru/Right from Liberty Street SB	11	C	10	C	231	F	31	E
Warren Street/Pine Street								
Left from Warren Street EB	2	A	2	A	3	A	2	A
Left from Warren Street WB	3	A	2	A	3	A	3	A
Left/Thru/Right from Pine Street NB	6	B	5	A	11	C	7	B
Left/Thru/Right from Pine Street SB	6	B	4	A	16	C	6	B
Warren Street/Rumford Street								
Left from Warren Street EB	2	A	2	A	2	A	2	A
Left from Warren Street WB	3	A	2	A	3	A	3	A
Left/Thru/Right from Rumford NB	5	A	4	A	11	C	6	B
Left/Thru/Right from Rumford SB	5	B	5	A	13	C	7	B
School Street/Liberty Street								
Left/Thru/Right from School Street EB	23	D	23	D	≥1000 ³	F	≥1000	F
Left/Thru/Right from School Street WB	3	A	10	B	≥1000	F	≥1000	F
Left/Thru/Right from Liberty Street NB	7	B	12	C	≥1000	F	23	D
Left/Thru/Right from Liberty Street SB	-	-	30	D	≥1000	F	67	F
School Street/Pine Street								
Left/Thru/Right from School Street EB	5	B	2	A	11	C	4	A
Left/Thru/Right from School Street WB	2	A	3	A	5	A	5	B
Left/Thru/Right from Pine Street NB	3	A	2	A	8	B	4	A
Left/Thru/Right from Pine Street SB	3	A	2	A	8	B	4	A
School Street/Rumford Street								
Left/Thru/Right from School Street EB	2	A	2	A	5	A	2	A
Left/Thru/Right from School Street WB	2	A	3	A	4	A	5	A
Left/Thru/Right from Rumford Street NB	2	A	2	A	3	A	2	A
Left/Thru/Right from Rumford Street SB	3	A	2	A	6	B	3	A

¹Delay -Average Delay is Seconds

²LOS - Level of Service

³Calculated delay is excess of 1,000 seconds is considered meaningless.

Corridor Design Constraints

A review of the study area was undertaken to understand the corridor design constraints. Prior to the field review, a plan review was undertaken to note potential problem areas and areas to investigate further in the field.

Starting at the beginning of the project at station 10+00 just west of the signalized intersection adjacent to Concord Hospital and traveling easterly, the following constraints or design controls were identified.

Pleasant Street

Figure No. 10

- **Station 12+00 - 16+00± LT.** Retaining walls measuring 3-7 feet in height were constructed as part of the recent roadway improvements. The walls were constructed to minimize impacts to adjacent properties and to allow for an elevated parking area at Concord Orthopedics. (Figure No. 21)
- **Station 12+00 - 16+00± RT.** The Carmelite Monastery has well landscaped grounds located adjacent to Pleasant Street creating a sense of privacy to the area.
- **Station 17+00± RT.** The Tuttle property, identified as a historical property, which is listed on the National Register of Historic Places, has been under evaluation by the City as part of the "Northwest Bypass" project.
- **Station 18+00 - 19+50± RT.** Granite retaining wall approximately 160 feet in length and 4 to 5 feet in height located between the southerly Pleasant Street sidewalk and the parking area for the Hitchcock Clinic. (Figure No. 22)
- **Station 20+00 - 25+00± RT.** The parking facilities, driveways and buildings located on the south side of Pleasant Street (Hitchcock Clinic, Friends Program, etc.) are very close to the Pleasant Street edge of pavement.

Figure No. 11

- **Station 26+00 LT and RT.** Access to the Concord Hospital Campus (one way in only) on the north and the Hillside View Condominium Association via Bradhill Lane on the south create a four way intersection with Pleasant Street. Vertical modifications to Pleasant Street will be difficult due to the access approach grades.

Figure Nos. 11 and 12

- **Station 28+00 - 42+00± RT.** Granite walls/curbing, an iron fence (850 feet in length) and granite posts are located along the frontage of the Pleasant View facility (Figure No. 22). Steep topography (40% max.) falls away from Pleasant

Street behind the sidewalk beginning opposite Kensington Road to 300 feet west of Pleasant View Avenue.

- **Station 30+00 - 43+00± LT.** The steep topography and associated steep downgrades (8-12%) for the local streets (Rum Hill Road, Pleasant View Avenue, Kensington Road) approaching Pleasant Street any necessary widening of Pleasant Street would be obtained in a southerly direction. Widening to the north could only be obtained with a significant grade raise along Pleasant Street.
- **Station 31+00± LT.** Poor sight distance at Rum Hill Road looking easterly.
- **Station 39+00 - 42+00± LT.** Stone retaining wall (3-4 feet high).
- **Station 45+00 - 50+00± LT.** A granite retaining wall (dry joint) approximately 500 feet in length and 3 to 5 feet in height retains the Odd Fellows Home lawn area. (Figure No. 23)

Figures Nos. 12 and 13

- **Station 43+00 - 53+50± LT and RT.** This area is constrained by the close proximity of business and homes (10 to south, 2 north) to Pleasant Street. Gale Street and Tuttle Street (new retaining walls Figure No. 23) approach Pleasant Street with steep upgrades (15% and 18% respectively) from the south. Minot Street on the north approaches Pleasant Street with a steep down grade (7%) and is tightly constrained between the Professional Building and the granite wall previously noted at the Odd Fellows Home.

Figures No. 13 and 14

- **Station 56+00 - 61+00± LT.** Four business and homes are located adjacent to the north side of Pleasant Street including Cumberland Farms, "In a Pinch" and P&N Automotive.
- **Station 61+00 LT & RT.** A 3 feet high by 4 feet wide culvert is located at the bottom of the sag vertical curve. It is likely that a wetland permit will be required to provide any widening along Pleasant Street in this area.
- **Station 65+00 - 67+00± LT.** A granite retaining wall 2 to 6 feet in height and approximately 200 feet in length retain the yard area around a private home; the existing sidewalk runs along the base of the wall for its entire length. (Figure No. 24)
- **Station 67+00 - 83+00± LT & RT.** This section of Pleasant Street from Liberty Street to North Spring Street is intensely developed with a mixture (27) of homes and businesses including the NH State Hospital located to the south. Granite retaining walls are located between Liberty and Pine Street (360± feet) and Merrimack and Rumford Street (160± feet). The corridor is lined with well established trees, sidewalks are located continuously on the north and from the NH State Hospital easterly to the end of the project and beyond (Figures No. 24 and 25). The NH State Hospital entrance at station 73+50 is located opposite the proposed Centennial Home.

Warren Street

Figure No. 13

- Station 108+00 - 113+00+ LT. Concord High School is currently expanding and renovating its facility. Coordination will be necessary to integrate the schools planned improvements with any Warren Street improvement.
- Station 108+00 - 113+00+ RT. This area is constrained by the close proximity of businesses and homes (6) to the existing Warren Street curb line. Pedestrian access to School Parking Facility is located opposite Westbourne Road.

South Fruit Street

Figure No. 13

- Station 100+00 - 106+00+ LT & RT. South Fruit Street on the east is controlled by the NH State Hospital Complex. The Walker Building currently fronts along this section of South Fruit Street. Numerous residences front along the westerly side of South Fruit Street. Redington Road intersects South Fruit Street at Station 103+00 approximately 350 LF south of Pleasant Street.

Neighborhood Issues

Throughout the study process, a number of public informational meetings have been held to solicit input from the community. In fact, written comments and suggestions were solicited and received from several residents of the neighborhoods. Based on input received at the public informational meetings and through the written comments, it is clear that the residents of the neighborhoods are concerned with the continued traffic growth in the area and in particular with the growing intrusion of vehicular traffic within the residential neighborhoods. Any planned upgrade of the Pleasant Street Corridor will need to be implemented in conjunction with the implementation of actions specifically aimed at protecting the integrity of the neighborhoods.

A review of existing traffic volumes show Pleasant Street west of South Fruit Street carrying approximately 13,000 vpd with lower volumes ranging from 5,400 vpd to 7,400 vpd recorded east of the South Fruit Street intersection, while the Liberty Street to Warren Street corridor recorded daily volumes ranging from 8,000 vpd to 10,400 vpd. As described in a previous section, the critical Pleasant Street/Warren Street/South Fruit Street intersection currently operates at capacity during the peak hours of the day. As a result many neighborhood streets are already experiencing increased levels of traffic resulting from motorists attempting to avoid the congested intersection.

As an example, Rum Hill Road currently experiences cut-through traffic evidenced by the 1,100 vpd recorded along that roadway as well as the 2,300 vpd recorded along School Street, east of Kensington Road. The School Street to Rum Hill Road connection is becoming a popular cut-through route for motorists attempting to avoid the congestion at the Pleasant Street/Warren Street/South Fruit Street intersection.

East-west roadways such as School Street and Warren Street continue to be attractive routes for motorists traveling to and from the downtown area. North-south routes such as Rumford Street, Merrimack Street and Pine Street are also becoming attractive routes for motorists attempting to avoid the congestion along downtown streets such as Green Street or North State Street.

In addition to the neighborhood character issues, pedestrian access and safety, particularly in the vicinity of the high school, is a concern. Given the proximity of the high school to the congested Pleasant Street/ Warren Street/ Fruit Street intersection, the question of constructing a pedestrian overpass or tunnel at the intersection is often raised. The results of field observations indicate that most students fail to use the pedestrian actuated traffic signal and tend to cross Warren Street and Pleasant Street in groups. Given the students' current unwillingness to wait for the pedestrian signal, it is unlikely that an overpass pedestrian crossing would get much use, while providing a pedestrian tunnel would raise significant security issues. Also the cost of relocating utility lines to accommodate either an overhead crossing or a tunnel would be substantial. It is also important to recognize that an overpass or tunnel would provide crossing at one point whereas pedestrian crossings at the intersection occur in several directions. Therefore, given that the peak pedestrian activity of students occurs for a relatively short time period (approximately 20 minutes after school lets out) and pedestrian actuation is provided at the intersection, it is not recommended that the City provide either a pedestrian overpass or a pedestrian tunnel.

5

Improvement Plan

This section of the report presents an improvement plan aimed at addressing both the capacity deficiencies identified along Pleasant Street and the neighborhood protection issues. Specifically, this section describes the conceptual improvement plan developed for the Pleasant Street Corridor, discusses the evaluation process and the recommended preferred alternative improvement plan developed for the critical Pleasant Street/Warren Street/South Fruit Street intersection, and presents a traffic management plan aimed at protecting the residential neighborhoods from the intrusion of continued traffic growth.

Pleasant Street Corridor

The long term solution for the Pleasant Street Corridor involves widening the existing roadway to increase capacity for future travel demands and implementing an improved roadway cross section to enhance vehicular and pedestrian safety. This improvement coincides with the City's desire to reduce cut-through traffic in the adjacent neighborhoods by providing an improved Pleasant Street arterial which will collect and distribute traffic more effectively. Currently traffic utilizes the neighborhood streets to avoid congestion along Pleasant Street. The improvements as envisioned for Pleasant Street would include travel and turning lanes, sidewalk, bike lanes, and public transit pullouts along both sides of the roadway thereby enhancing opportunities for other modes of transportation and improving safety for those modes currently using the corridor.

Despite the fact that the flow of traffic throughout the Pleasant Street Corridor is primarily controlled by the operation of the major intersections, it is important to determine the basic lane requirements for each segment of roadway along the Corridor. To accomplish this, a criteria for determining the basic lane requirements for a given design hour volume has been established. A summary of the lane requirements for various volume levels is provided in Table 6.

Table 6 Lane Requirement Criteria for Roadway Segments

<u>Level of Service</u>	<u>Vehicles Per Hour Total of Both Directions</u>			
	<u>2 Lanes</u>	<u>3 Lanes</u>	<u>4 Lanes</u>	<u>5 Lanes</u>
A	100	125	1,750	2,025
B	300	375	2,960	3,400
C	650	825	4,120	4,750
D	1,150	1,450	4,900	5,625
E	2,050	2,575	6,200	7,125
F	>2,050	>2,575	>6,200	>7,125

Note: The criteria is presented for planning purposes only and should not be applied as a strict standard. Criteria was developed by VHB and is based on the analysis methods presented in Special Report 209, Highway Capacity Manual, Transportation Research Board, Washington, DC (1985).

As shown in the table, to provide a level of service D or better operation for a 2-lane roadway (one lane in each direction) the two-way design hour volume must be less than 1,150. The criteria for a 3-lane roadway (one lane in each direction with a center turn lane) is 1,450 vph with the criteria for a 4-lane and 5-lane section set at 4,900 vph and 5,625 vph, respectively. The two and four lane sections are used for segments of roadway where turning movements are minimal. The three and five lane sections, which provide a center turn lane, are used along segments where turning movements are more frequent.

Comparing the projected 20-year design hour volumes for the corridor with the criteria shown in Table 6 indicate that to provide a LOS D or better operation, the easternmost segment of the corridor between Rumford Street and North Spring Street requires only a 2-lane section with the design hour volume of approximately 1,100 vph. The segment extending westerly from Rumford Street to South Fruit Street with its design hour volume ranging from approximately 1,200 vph to 1,350 vph suggest the need for a 3-lane section. The western segment of the corridor extending from South Fruit Street to the Concord Hospital with its design hour volume ranging from approximately 2,000 vph to 2,150 vph suggest the need for a 4-lane section.

It should be noted that although Table 5 shows an increase in capacity of approximately 25 percent when expanding a 2-lane section to a 3-lane section and approximately 15 percent when expanding a 4-lane section to a 5-lane section, the decision to add a turn lane to either a 2-lane or a 4-lane section is generally based more on safety considerations than capacity considerations. For this reason, although it is clear that the segment of Pleasant Street adjacent to the Hospital would require a 5-lane section, due to the numerous turning movements in the vicinity of the Concord Hospital, the City needs to consider other factors to determine whether a 4 or 5-lane section is more appropriate for the segment between South Fruit Street and Rum Hill Road.

The City must weight the safety and convenience benefits of providing a turn lane onto such streets as Rum Hill Road, Pleasant View Avenue, Kensington Road and Minot Street with the adverse impacts that could result from potentially encouraging motorists to cut-through the neighborhood streets. The next section of the report discusses various traffic calming actions aimed at protecting the residential neighborhoods. It is important that the neighborhood protection actions and the Pleasant Street Corridor improvements complement each other.

It is also possible that the City may want to provide access onto one or more of these side streets from Pleasant Street while restricting movements onto others. However, it is important to recognize that restricting movements on to one street may result in simply moving the traffic onto another parallel street.

Having identified the number of lanes necessary to carry the future year 2015 traffic volumes, a roadway cross-section could be determined that would provide the necessary travel and turning lanes, shoulders, sidewalks, and locations of utilities along the corridor. Because the area along the corridor is highly developed with a mixture of residential, commercial and institutional properties located in close proximity to the existing roadway, the cross-section chosen would have to "fit" the corridor while minimizing impacts to those properties.

Figures 10 through 13 identify a five-lane curbed section proposed for the 0.9 mile westerly section of Pleasant Street from Concord Hospital to a point just east of South Fruit Street. This section consists of four 11 foot travel lanes, a 12 to 18 foot center turning lane and two 4 foot shoulders for a total roadway width of 64-70 feet. Seven foot sidewalks, which would incorporate a 2 foot utility strip, are proposed for both the north and south sides of Pleasant Street for a total right-of-way of 78 to 84 feet.

Figure 14 identifies a three-lane curbed section proposed for the easterly section of Pleasant Street beginning near Liberty Street and continuing approximately 1,400 feet through to Rumford Street. This section consists of two 11 foot travel lanes, a 12 to 18 foot center turning lane and two 4 foot shoulders for a total roadway width of 42 to 48 feet. Seven foot sidewalks are again proposed for the North and South sides of Pleasant Street for a total right-of-way of 56 to 62 feet.

Horizontal alignment designs were prepared for a 40 m.p.h. design speed utilizing AASHTO design guidelines. Vertical alignments were not developed as part of this conceptual study, however it is assumed that AASHTO guidelines for 40 m.p.h. vertical geometry would also be used if the project moves forward into final design. When evaluating the horizontal geometry, however, consideration was given to the general topography along the corridor based on field observation and general familiarity with the area. Utilizing the various controls and constraints previously identified, the horizontal alignment was established to minimize impacts to abutting properties while maintaining existing or improved connections to the local streets and driveways along the corridor.

Beginning at the westerly end of the project area, approximately 650 feet west of the signalized intersection at Concord Hospital, (Figure 10), the existing two-lane section of Pleasant Street shifts southerly and transitions to a full five lane section requiring the reconstruction of the existing signalized intersection at Concord Hospital. Raised median islands on all four approaches are recommended to protect the quality of flow through the intersection. Additional widening on the north would provide for an exclusive right-turn lane into the Hospital Complex. The improvements proposed are intended to be compatible with the proposed Northwest Bypass project. The proposed plan for the Bypass and/or this corridor project would require the acquisition of the Tuttle property located on the south side of Pleasant Street. A retaining wall approximately 160 feet in length and 6 feet high would be necessary to minimize the impacts to the Hitchcock Parking lot adjacent to Pleasant Street.

Beyond the Concord Hospital intersection, the alignment shifts northerly to reduce impacts to the properties located along the south side of Pleasant Street while maintaining reasonable access connections to the most easterly Concord Hospital drive on the north and to the Pleasant View Drive and Bradhill Lane on the south. Formal protected painted left-turn turning lanes are provided at these access locations.

Continuing easterly, the alignment again shifts southerly essentially holding the existing approach locations for Rum Hill Road, Pleasant View Avenue and Kensington Road with Pleasant Street. Widening to the north in this area is not practical due to the steep downgrades from the local roadways. Impacts to the Pleasant View property will require significant slope and grading easements in addition to right-of-way acquisition. The iron fence and granite posts delineating the property frontage will require relocation. The five-lane section in this area provides for a center turning lane to allow access to Pleasant View Avenue and Kensington Road as well as private drives connecting to Pleasant Street. Rum Hill Road, which currently provides full access at Pleasant Street, would be designed to allow only westbound vehicles to enter the street. Appropriate signing would notify Rum Hill Road traffic at the Rum Hill Road/Kent Street intersection that "no outlet" is available to Pleasant Street. Again, the City must balance the safety and convenience benefits of providing a center turn lane and restricting movements at Rum Hill Road with the goals and objectives of the neighborhood protection actions.

East of Kensington Road the alignment again transitions to the north as it approaches the Warren Street/South Fruit Street/Pleasant Street intersection in order to minimize impacts to homes and businesses which are located very close to the existing roadway. Widening in this area will require the regrading of the lawn and landscaped areas on both sides of Pleasant Street.

At Tuttle Street, the widening will require the acquisition of the Odd Fellows' Building on the south side of Pleasant Street, the closing of Tuttle Street and construction of a turn-around at the end of Tuttle Street. A retaining wall is necessary on the south side of Pleasant Street at Tuttle Street to minimize impacts to a

new private parking area. Replacement parking maybe available on the acquired Odd Fellows' property adjacent to the proposed turn-around. An optional reconstruction of Tuttle Street was evaluated which would realign Tuttle Street from Redington Road opposite Kensington Road at Pleasant Street. This option would cost approximately \$125,000 to construct and require the acquisition of two additional homes. On the north side of Pleasant Street the existing granite retaining wall (530 feet) would require replacement. It maybe possible to utilize a tiered wall effect and relocate the existing wall to form the upper tier. Minot Street on the north would require reconstruction for approximately 500 feet to provide an improved approach to Pleasant Street. The existing drive to the Odd Fellows Home from Minot Street would be relocated away from Pleasant Street and reconstructed for approximately 250 feet. A protected left-turn lane (painted) would allow traffic to access Minot Street and the Professional Building.

At the five-legged intersection of North Fruit Street/South Fruit Street/Warren Street and Pleasant Street the proposed improvements are intended not only to improve capacity but also to improve intersection safety and operational characteristics. The intersection would be reconstructed to develop a 4-way intersection with South Fruit Street and Warren Street intersecting Pleasant Street opposite each other. North Fruit Street would remain a one-way street in its existing location but would be out of the confluence of the intersection where westbound Pleasant Street traffic would be prohibited from entering. The reconstruction would provide for a channelized intersection with exclusive left, thru and right turn lanes along Warren Street and South Fruit Street and protected left-turn lanes in addition to two through lanes in each direction along Pleasant Street. Approximately 550 LF feet of South Fruit Street and 600 feet along Warren Street would be reconstructed. A new signal system would be constructed with exclusive pedestrian phasing at this location. It may be possible to reduce pedestrian conflicts during the period when school is dismissed by providing an all-red phase throughout the intersection. Formal bus turnouts are proposed just east of the intersection on both sides of Pleasant Street to replace the informal locations currently west of the intersection.

The intersection realignment would encroach on the N.H. State Hospital property and require the acquisition of the Cumberland Farms property. Parking for the business at the southwest corner of Pleasant Street and Fruit Street will be impacted by the construction and opportunities for replacement parking at this location may be available in the abandoned section of South Fruit Street.

East of the South Fruit Street intersection in the vicinity of the "In a Pinch" restaurant the five-lane section transitions to a three-lane section at Liberty Street. The alignment shifts southerly onto State of N.H. (State Hospital) property avoiding impacts to business and homes on the north side. Access to the Concord High School parking facility (currently closed) can be opened to traffic by improving sight distance for existing vehicles looking easterly. A grade raise along Pleasant Street in the area can be achieved with only minor grading impacts to provide improved sight distance. Closing the Warren Street parking lot access may be a consideration to help

reduce traffic and conflicts in the vicinity of the West Washington Street and Warren Street intersection, and cut through traffic if the Pleasant Street access is opened.

East of Liberty Street the three-lane section generally holds the existing curb line on the north side of Pleasant Street with all necessary widening occurring along the N.H. State Hospital frontage. Proposed improvement plans for the State Hospital Complex were reviewed to be sure that the Pleasant Street widening in this area would not create adverse impacts. A signalized intersection is recommended at the entrance to the State Hospital opposite the proposed re-development of the Centennial Home. Raised median islands are recommended to protect the signalized intersection operation. Formal transit bus turnouts are provided just east of the intersection on both sides of Pleasant Street.

The recommended corridor improvement plan as described does not provide on-street parking. An alternative plan was developed that would maintain much of the on-street parking between Liberty Street and North Spring Street. However with many of the building structures along this segment of Pleasant Street located close to the roadway, developing a plan to maintain the on-street parking would require the removal of much of the streetscape and mature trees, and require the reconstruction of the small front yard retaining walls located along the north side of the roadway. Although the City should consider the impact of losing on-street parking spaces along this segment of the corridor, to minimize impacts to the adjacent properties and minimize project costs the recommended plan eliminates on-street parking between Liberty Street and North Spring Street.

Construction cost estimates have been prepared based on major roadway items, full depth reconstruction sidewalks, curbing, retaining walls and traffic signals as well as percentage factors for drainage and miscellaneous items. Construction costs do include engineering contingencies but do not include costs associated with utility relocations, utility upgrades or heavy landscaping. All construction costs are estimated in 1996 dollars. Right of Way costs were based on an assessed \$/sq. ft. ROW impact only, and do not include additional costs for grading, slope, drainage or temporary construction easements. The cost of constructing the recommended Pleasant Street corridor improvement plan, including the cost of realigning the Pleasant Street/ Warren Street/ South Fruit Street intersection is estimated at \$4,800,000.

Pleasant Street/Warren Street/South Fruit Street

As with the Pleasant Street Corridor improvements discussed previously, the horizontal alignment designs were prepared for a 40 m.p.h. design speed utilizing AASHTO design guidelines. Vertical alignments were not developed as part of this intersection study, however, it is assumed that AASHTO guidelines would be used.

In developing the geometry for the North Fruit Street/South Fruit Street/Warren Street and Pleasant Street intersection improvements consideration was given (to the greatest practicable extent) in utilizing the conceptual corridor alignments for the entire corridor discussed in the preceding section. Using identical geometrics for the intersection and corridor improvement plans will allow for the phased construction of the Pleasant Street Corridor east and west of the intersection while minimizing the amount of intersection improvements reconstructed.

The intersection improvements begin just east of Tuttle Street (Figure 19), the existing two lane section of Pleasant Street transitions to a full five lane section in the vicinity of the Professional Building and carried through the improved intersection area. At the intersection of North Fruit Street/South Fruit Street/Warren Street and Pleasant Street proposed improvements (Figure 20) are intended not only to improve capacity but also to improve intersection safety and operational characteristics. The intersection would be reconstructed to develop a 4-way intersection with South Fruit Street and Warren Street intersecting Pleasant Street opposite each other. North Fruit Street would remain a one-way street in its existing location but would be out of the confluence of the intersection where westbound Pleasant Street traffic would be prohibited from entering. The reconstruction would provide for a channelized intersection with exclusive left, thru and right turn lanes along Warren and South Fruit Street and protected left-turn lanes in addition to two through lanes in each direction along Pleasant Street. Approximately 550 LF feet of South Fruit Street, 600 feet along Warren Street and 2,250 LF along Pleasant Street would be reconstructed. A new signal system would be constructed with exclusive pedestrian phasing at this location. It may be possible to reduce pedestrian conflicts during the period when school is dismissed by providing an all-red phase throughout the intersection. Formal bus turnouts are proposed just east of the intersection on both sides of Pleasant Street to replace the informal locations currently west of the intersection.

The evaluation and development of a recommended improvement plan for the Pleasant Street/ Warren Street/ South Fruit Street intersection included an evaluation of vehicular and pedestrian circulation surrounding the high school. As part of the study, comments and suggestions were provided to the City relative to preliminary layout plans for the expansion of the high school. Some of the suggestions included the following:

- The need to provide a sidewalk along all four sides (Warren Street, Westbourne Road, Woodman Street, and North Fruit Street) of the campus.
- Provide pedestrian access from high school courtyard to Warren Street/ Westbourne Road intersection.
- Design criteria for the bus stop area on Westbourne Road including a 50' stall length, 12' lane width and 5 to 1 tapers.

No street system circulation changes were recommended, although as described previously the recommended realignment of the Pleasant Street/ Warren Street/ South Fruit Street intersection takes North Fruit Street out of the intersection.

On the north side of Pleasant Street the existing granite retaining wall (530 feet) would require replacement. It maybe possible to utilize a tiered wall effect and relocate the existing wall to form the upper tier. Minot Street on the north would require reconstruction for approximately 500 feet to provide an improved approach to Pleasant Street. The existing drive to the Odd Fellows Home from Minot Street would be relocated away from Pleasant Street and reconstructed for approximately 250 feet. A protected left-turn lane (painted) would allow traffic to access Minot Street and the Professional Building.

The intersection realignment would encroach on the N.H. State Hospital property and require the acquisition of the Cumberland Farms property. Parking for the business at the southwest corner of Pleasant Street and Fruit Street will be impacted by the construction and opportunities for replacement parking at this location may be available in the abandoned section of South Fruit Street.

East of the South Fruit Street intersection in the vicinity of the "In a Pinch" restaurant the five-lane section transitions to the existing two-lane section at Liberty Street. The alignment shifts southerly onto State of N.H. (State Hospital) property avoiding impacts to business and homes on the north side. Access to the Concord High School parking facility (currently closed) could be opened to traffic by improving sight distance for existing vehicles looking easterly. A grade raise along Pleasant Street in the area can be achieved with only minor grading impacts to provide improved sight distance. Closing the Warren Street parking lot access may be a consideration to help reduce traffic and conflicts in the vicinity of West Washington Street and Warren Street intersection, and cut through traffic if the Pleasant Street access is opened.

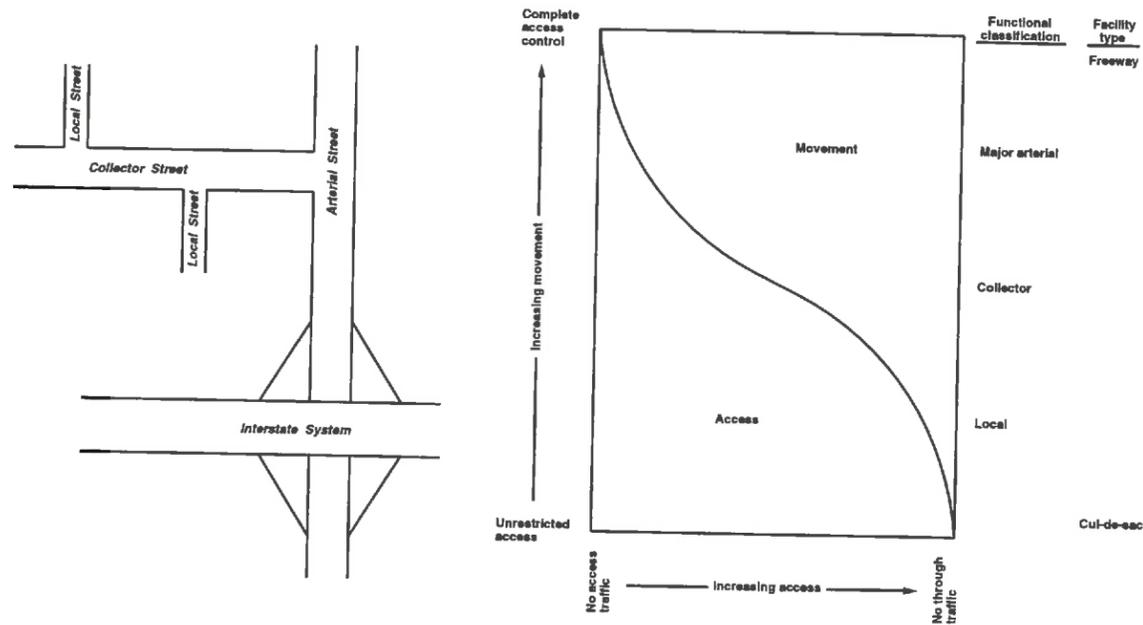
A construction cost estimate has been prepared based on major roadway items, full depth reconstruction sidewalks, curbing, retaining walls and traffic signals as well as percentage factors for drainage and miscellaneous items. The construction costs include engineering contingencies but do not include costs associated with utility relocations, utility upgrades or heavy landscaping. All construction costs are estimated in 1996 dollars. Right of Way costs were based on an assessed \$/sq. ft. ROW impact only, and do not include additional costs for grading, slope, drainage or temporary construction easements. The R.O.W. costs were based on the full corridor buildout along the impacted properties to reduce the settlement offers to a single negotiation. The cost of constructing the recommended Pleasant Street/ Warren Street/ South Fruit Street intersection improvement plan is estimated at \$2,000,000.

Neighborhood Protection

To address the cause of the neighborhood traffic flow problems, it is first necessary to understand the functional distinctions among various types of roadways. As shown in Figure 4, the typical functional circulation system is made up of a hierarchy of roadway types. This hierarchy includes local streets, collector streets, and arterial

roadways. Each type of roadway provides various levels of access and traffic movement. Arterial roadways are designed to process high volumes of traffic while access is often limited. On the other hand, local roadways accommodate low volumes of traffic with a primary function of providing access. A collector roadway, as the name suggests, collects traffic from local streets and distributes it to the arterial system. Therefore, for a roadway system to operate effectively local streets should only intersect collector streets or other local streets. Collector streets should intersect local streets and arterials, while arterial streets should intersect collector streets or other arterials. The graph shows the relationship between access and movement for different functional classifications.

Figure 4
Functional Circulation System



The existing roadway system within the study area does not display the characteristics of the typical functional circulation system. Local residential streets, such as a Rum Hill Road, intersect arterial roadways such as Pleasant Street. Roadways such as School Street and Warren Street, which bisect the neighborhoods, display similar characteristics and have the same general appearance as higher classified roadways such as Centre Street and Pleasant Street.

Currently motorists choose the most direct and often times quicker route to travel from one point to another regardless as to whether the particular route traverses a residential neighborhood. To protect the residential neighborhoods it is necessary to better manage the flow of traffic within the study area.

One way of managing the flow of traffic within the study area more effectively is through the implementation of traffic calming techniques. The concept of traffic calming stems from the idea that roadways are shared by many users, including pedestrians and bicyclists, and that roadways can be designed to enhance community character and quality of life rather than simply designing roadways with the goal of processing motor vehicles. Traffic calming involves the implementation of physical modifications to roadways in an effort to reduce vehicle speeds and to decrease the dominance of vehicular traffic.

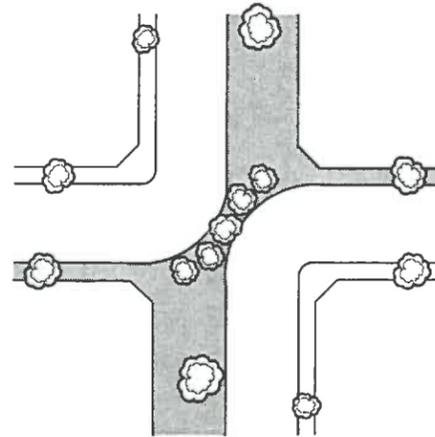
Traffic calming actions are most effective when introduced along local residential streets that are part of an overall street system that includes nearby collector and arterial roadways. The reason for this is that traffic calming actions encourage the diversion of through traffic away from local neighborhood streets and onto higher functionally classified roadways. Therefore, it would be inappropriate and ineffective to introduce traffic calming actions along a primary collector roadway such as Centre Street. (Public input from residents of Centre Street question why traffic calming is not recommended for Centre Street.) The key to traffic calming is to change the psychological feel of the street system so that local neighborhood streets have the look and feel of local neighborhood streets, and collector roadways and arterial roadways have the look and feel of arterial roads, implementing traffic calming actions along collector roadways and arterials would defeat the purpose of the traffic calming actions as traffic from the collector streets would be diverted back onto the local street system.

The following is a brief description of various types of traffic calming actions which, if implemented within the study area, would serve to define the neighborhoods and enhance the residential community character of the area. Examples of some of the various traffic calming devices are depicted in Figures 5, 6 and 7.

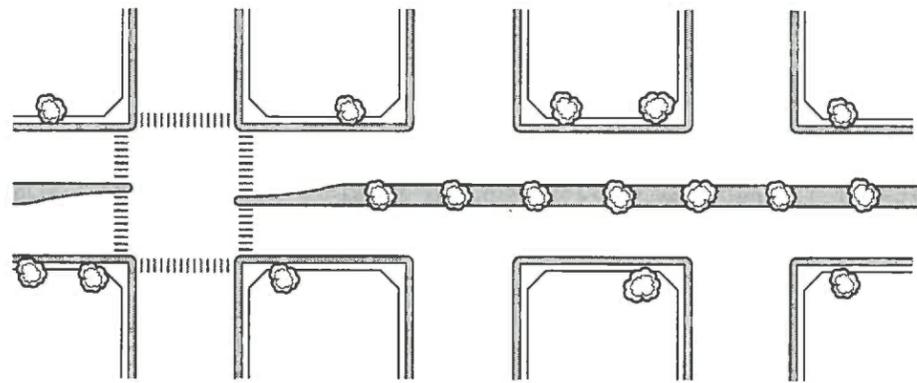
Gateway treatments serve to present a positive indication of a change in environment from an arterial roadway to a residential street. These treatments, which would be put in place at locations where motorists enter the defined residential neighborhood, would include modifying the pavement surface, adding landscaping, and reducing the available pavement area. The purpose of this treatment is to alert motorists that they are entering a traffic calming area.

Diagonal/Diverters are physical barriers placed diagonally across an intersection which effectively converts a four-way intersection into two unconnected streets. Its purpose is to make travel through a neighborhood street circuitous while not prohibiting it.

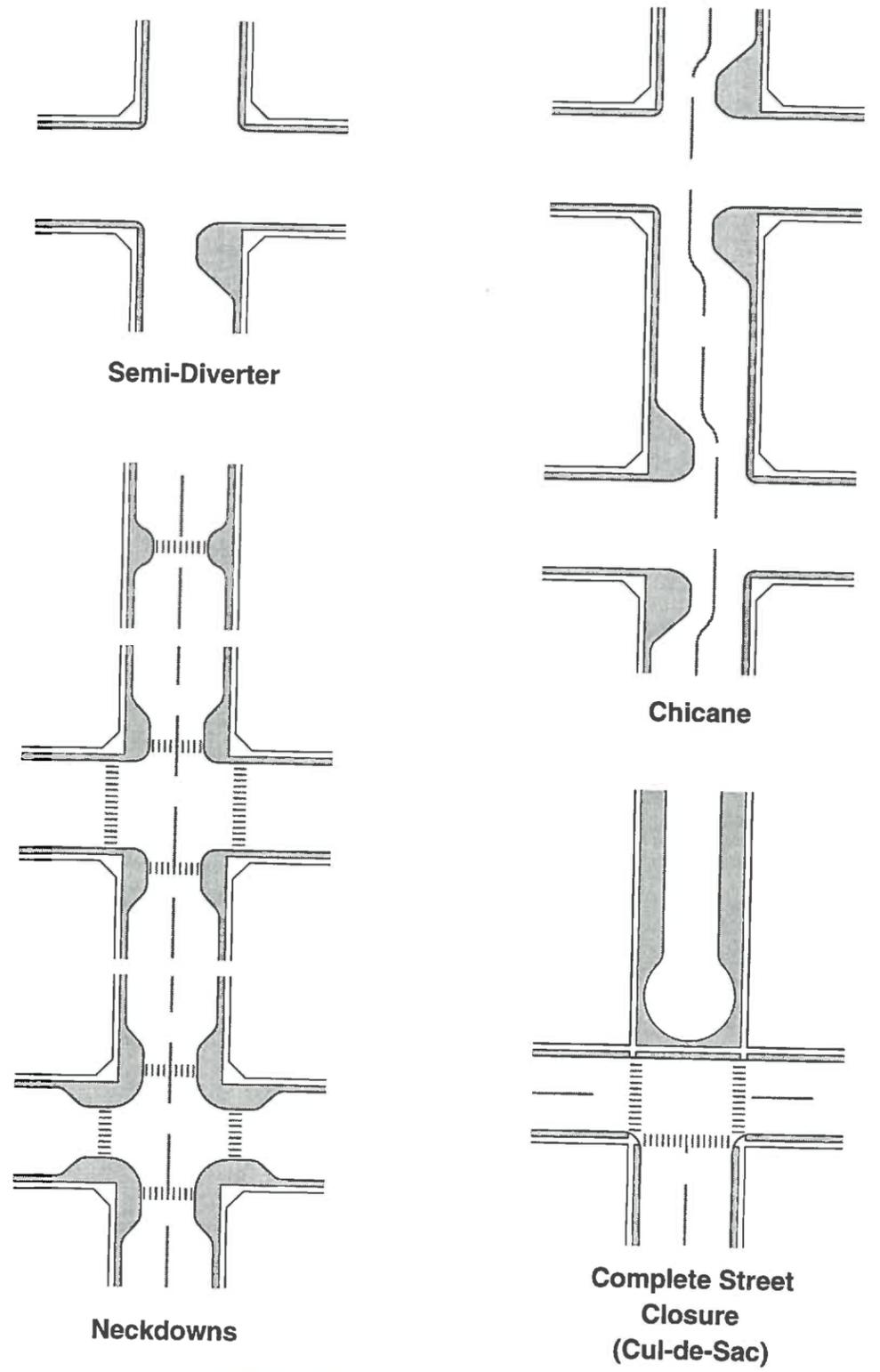
A semi-diverter is a barrier or a reduced pavement area placed at an intersection to prohibit travel in one direction. The semi-diverter does not restrict the entire length of the roadway to a one-way operation but simply prohibits motorists from entering the street at that location.



Diagonal Diverter



Median Barrier



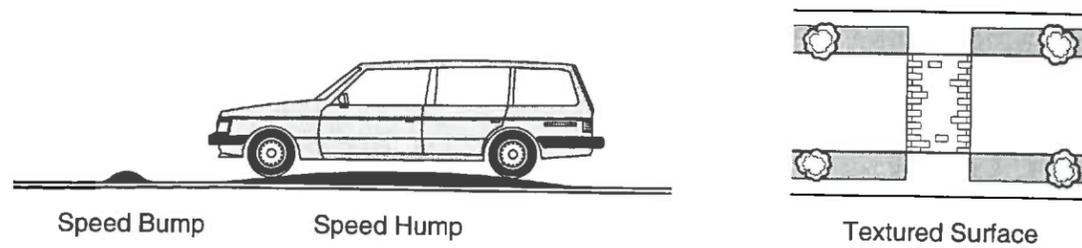
Semi-Diverter

Chicane

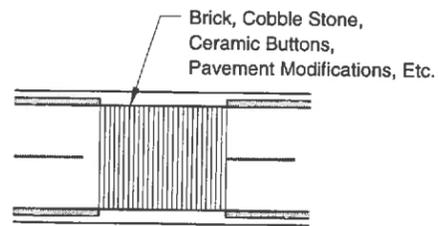
Neckdowns

**Complete Street
Closure
(Cul-de-Sac)**

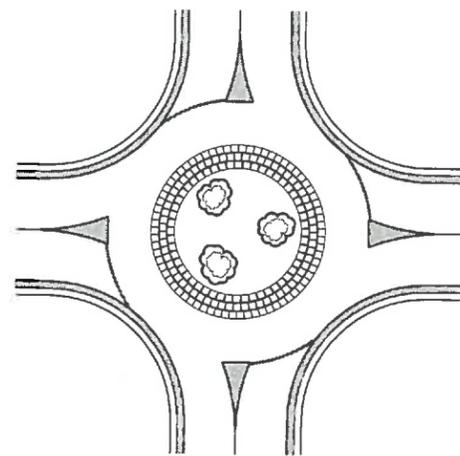
Vanasse Hangen Brustlin, Inc.



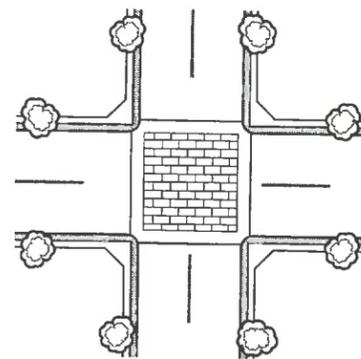
Speed Humps



**Raised Textured
Pedestrian Crossing**



Roundabout



Raised Intersection

Chicanes are a form of curb extension which alternate from one side of the street to the other. Generally chicanes are used to reduce travel speeds along lengthy street roadways.

Plantings, landscaping, and street furniture can be introduced throughout the area to once again enhance the residential community character and give the motorist the sense of traveling along a roadway where pedestrians and bicyclists would be expected. Often times community leaders and residents of the neighborhood will want to form a neighborhood beautification committee to work with City officials to layout and maintain these areas.

A **roundabout** is a form of intersection control that has been used extensively in Europe and Australia and has been introduced and becoming more popular in the United States in recent years. A roundabout is similar to a traffic circle, but with specific design features such as: yield control for vehicles entering the roundabout, a deflection angle to control speeds, and a small center diameter.

Speed humps unlike speed bumps can be an effective means of traffic calming by introducing a vertical acceleration factor to the moving vehicle. Speed humps typically measure 3 to 4 inches in height and are approximately 12 feet in length. The characteristics of speed humps differ substantially from speed bumps, commonly used in parking lots, which measure 3 to 6 inches in height and are generally no more than a couple of feet in length.

Pedestrian peninsulas at intersections and **chokers** at midblocks can be effective traffic calming devices as they serve to reduce the effective width of the travelway. These devices also provide ideal locations for pedestrian crossings.

The City has received a request to install a four-way stop sign at the Liberty Street/ Warren Street, Redington Road/ Tuttle Street, and Redington Road/ Gale Street intersections. Because these intersections are within the study area and because the installation of four-way stop signs might be considered by some as a form of traffic calming, the City's Traffic Operations Committee has asked that the study consider these requests.

The Manual on Uniform Traffic Control Devices² (MUTCD) provides specific criteria for installing a four-way stop sign. These include; 1) installation as a temporary measure at a locations where installation of a traffic signal is being arranged; 2) five or more reported accidents of a type susceptible of correction by a four-way stop; and 3) the total vehicle volume entering the intersection must average at least 500 vehicles per hour for any eight hours of an average day, and the combined vehicular and pedestrian volume from the minor street must average at least 200 units per hour for

▼
² Manual on Uniform Traffic Control Devices, U.S. Department of Transportation, 1988

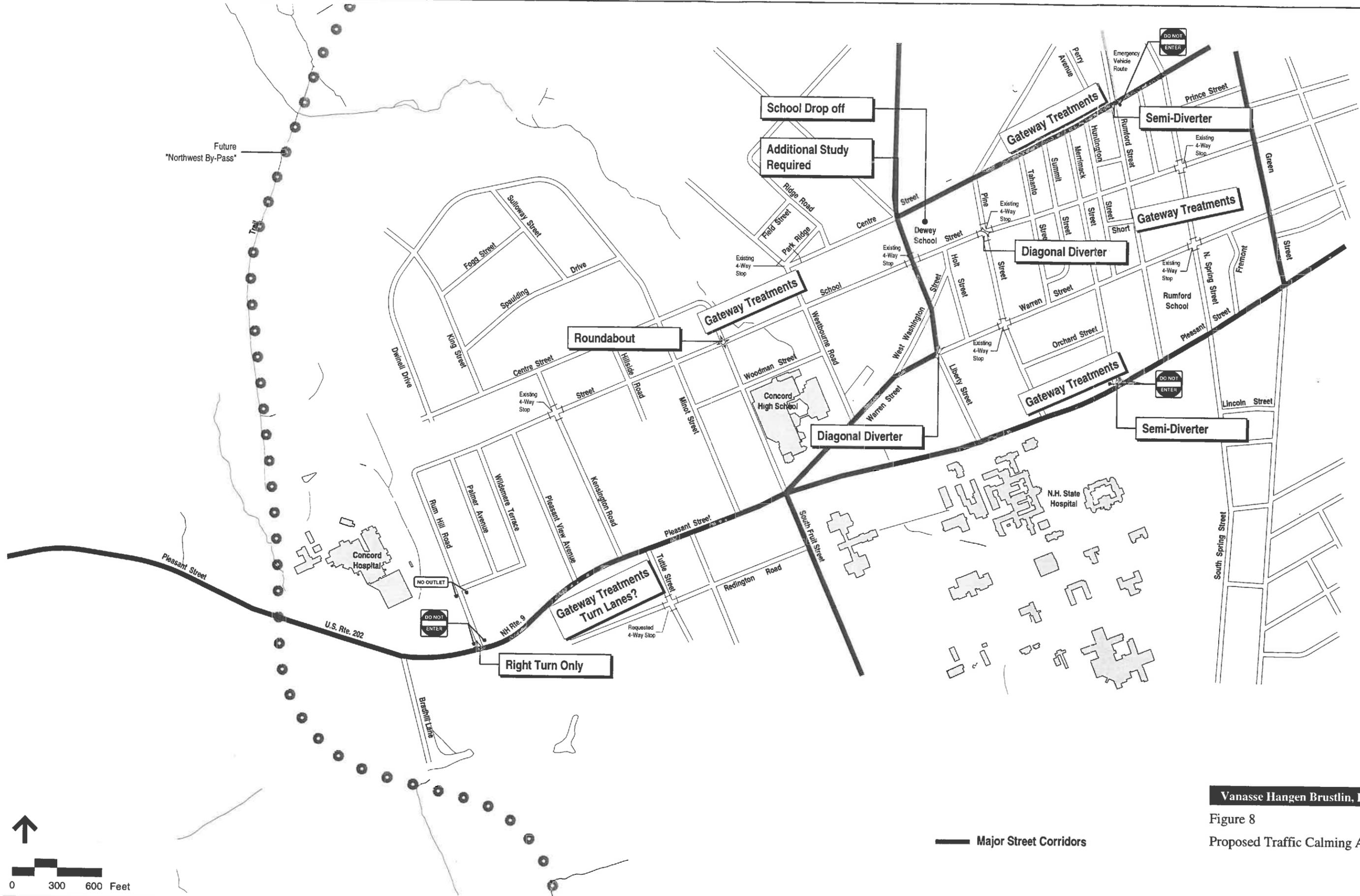
the same eight hours with an average delay to the minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour.

A review of warrant criteria revealed none of the three requested intersections meeting warrants. In fact, the MUTCD states that stop signs should not be used for speed control. Therefore, four-way stop signs are not recommended at the Liberty Street/ Warren Street, Redington Road/ Tuttle Street, and Redington Road/ Gale Street intersections.

As depicted in Figure 8 a number of specific traffic calming actions have been recommended for the study area. However, it is important to note that the primary purpose of the recommended actions is to change the psychological feel of the street system and that it is not necessarily critical that every action be implemented as recommended or at the location recommended. These actions are designed to be relatively low cost, easy to implement, and probably most important, easy to monitor and change if found to be not effective.

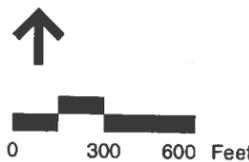
The recommended traffic calming actions are as follows:

- ▶ Provide gateway treatments at intersections where motorists tend to enter the neighborhood area. These locations would include: intersecting roadways with Pleasant Street, such as Pleasant View Avenue, Kensington Road, Minot Street, Liberty Street, Pine Street, Merrimack Street and Rumford Street; intersecting routes from Centre Street, such as Rumford Street, Huntington Street, Merrimack Street, Summit Street, Tahanto Street, and Pine Street; along School Street and Warren Street at North Spring Street; and along School Street between Westbourne Road and Fruit Street. These gateway treatments might involve such techniques as reducing the pavement width, modifying the pavement texture, or providing plantings and landscaping close to the roadway in an effort to provide motorists a sense that they are entering a residential neighborhood.
- ▶ Restrict turning movements at the Pleasant Street/Rum Hill Road intersection to right-turn entering movements onto Rum Hill Road only. No exiting movements from Rum Hill Road onto Pleasant Street would be permitted. This action will not only significantly reduce the cut through activity that currently uses Rum Hill Road, but would also address safety issues particularly the limited sight distance currently available at the intersection.
- ▶ Install diagonal diverters at the Warren Street/Liberty Street and School Street/Pine Street intersections. The Warren Street/ Liberty Street diagonal diverter is depicted graphically in Figure 9.
- ▶ Install semi-diverters at the Pleasant Street/Merrimack Street and Centre Street/Rumford Street intersections. The semi-diverters would effectively prohibit motorists from entering Merrimack Street from Pleasant Street and from entering Rumford Street from Centre Street.

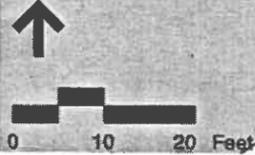
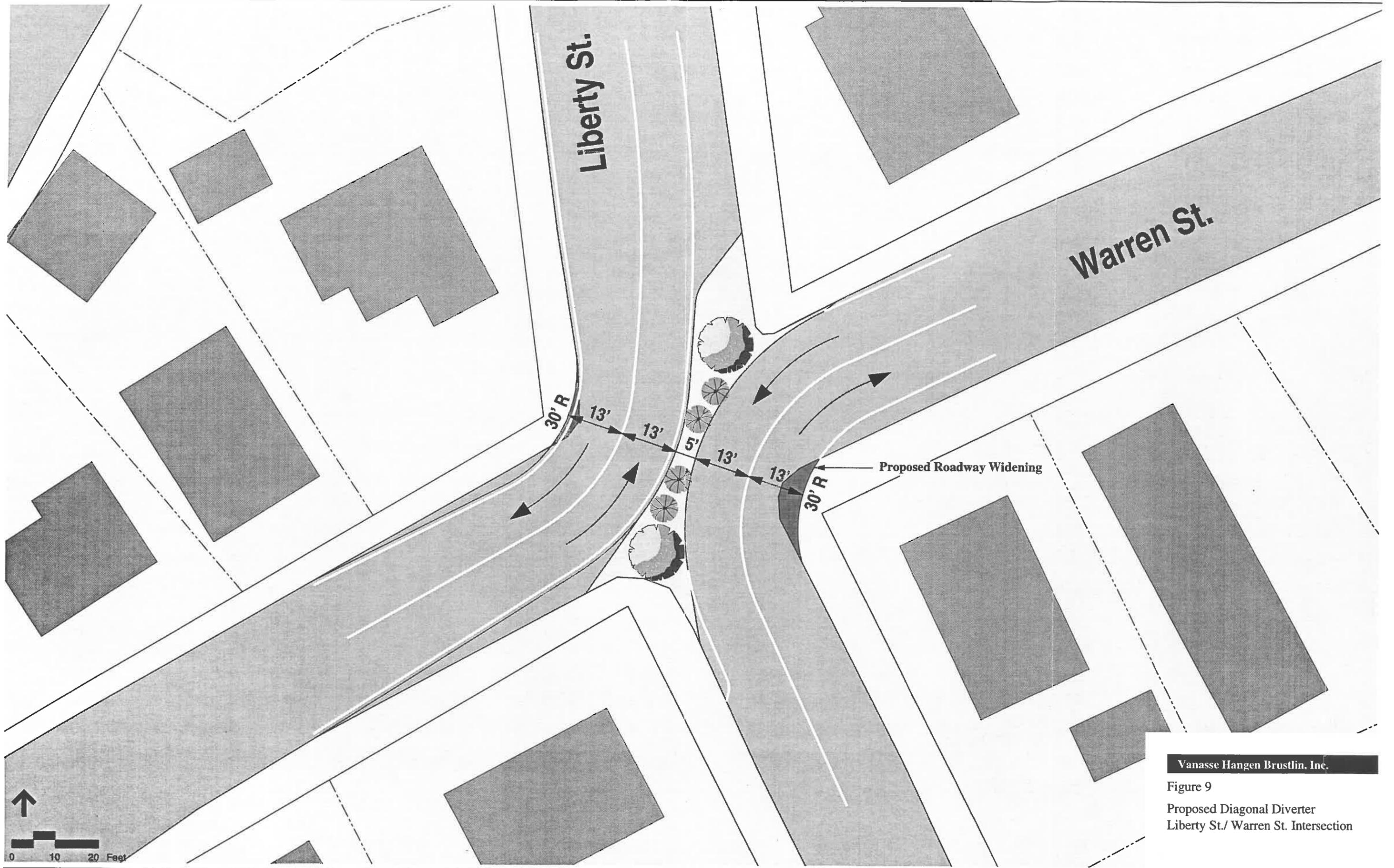


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Figure 8
Proposed Traffic Calming Actions



Major Street Corridors



Vanasse Hangen Brustlin, Inc.

Figure 9
Proposed Diagonal Diverter
Liberty St./ Warren St. Intersection

- Install a roundabout at the School Street/North Fruit Street intersection. This action would serve to reduce travel speeds along School Street and potentially discourage cut-through traffic.

In addition to the recommended traffic calming actions, it is recommended that additional study be conducted to address the deficiencies at the Centre Street/ Liberty Street/ Auburn Street/ High Street intersection and to address the specific needs of the Dewey School. The City should work with the school to possibly develop a drop-off area within the parking lot where parents could drop-off and pick-up students. In addition, pedestrian peninsulas and mid-block chokers could be used on Liberty Street in front of the school to delineate pedestrian crossing areas.

Again the traffic calming actions are designed to be relatively low cost and easy to implement and as a result, once installed can be monitored and if found to be ineffective removed or modified. It is particularly important to monitor the effectiveness of devices that physically restrict movements such as the diagonal diverters or semi-diverters. It is recommended that the diagonal diverters at Liberty Street/Warren Street and School Street/Pine Street intersections and the semi-diverters at the Pleasant Street/Merrimack Street and Centre Street/Rumford Street intersections be temporarily installed and monitored for a six month trial period.

To provide a fair test during the monitoring period, the diagonal diverters and semi-diverters should be constructed as close to the permanent design as possible. Fiscal constraints may limit the installation of some items such as the final landscaping. However, the temporary installation would require the necessary roadway widening, median and berm layout, and pavement markings.

The permanent installation of the diagonal diverters will require the City to go through the process of changing street names as once the roadway is physically divided by the diverters the street is essentially transformed to two separate streets.

It will be best not to implement and test all of the traffic calming measures at the same time because it will take some time for motorists to become accustomed to the traffic circulation changes. However, it is important to recognize that some actions complement each other and to be effective will need to be tested concurrently.

The cost of constructing the various traffic calming actions vary from \$5,000 to \$10,000 for gateway treatments such as a semi-diverter to as much as \$25,000 to \$35,000 each for diagonal diverters and roundabouts.

6

Conclusion

The purpose of this study is to develop a conceptual improvement plan for a 1.4 mile section of the Pleasant Street Corridor extending from the Concord Hospital to South Spring Street, to evaluate and recommend a preferred improvement plan for the critical Pleasant Street/Warren Street/South Fruit Street intersection, and to develop a traffic management plan aimed at protecting the nearby residential neighborhoods from the intrusion of continued traffic growth. The goal is to increase the vehicle carrying capacity of Pleasant Street while protecting the residential neighborhoods abutting the corridor.

The Pleasant Street Corridor improvement plan primarily consists of the widening of the exiting roadway to accommodate future travel demands, and the introduction of an improved roadway cross section to enhance vehicular and pedestrian safety. The neighborhood protection plan consists of the implementation of traffic calming techniques, which involve physical modifications to the neighborhood roadway system in an effort to reduce vehicle speeds and decrease the dominance of vehicular traffic.

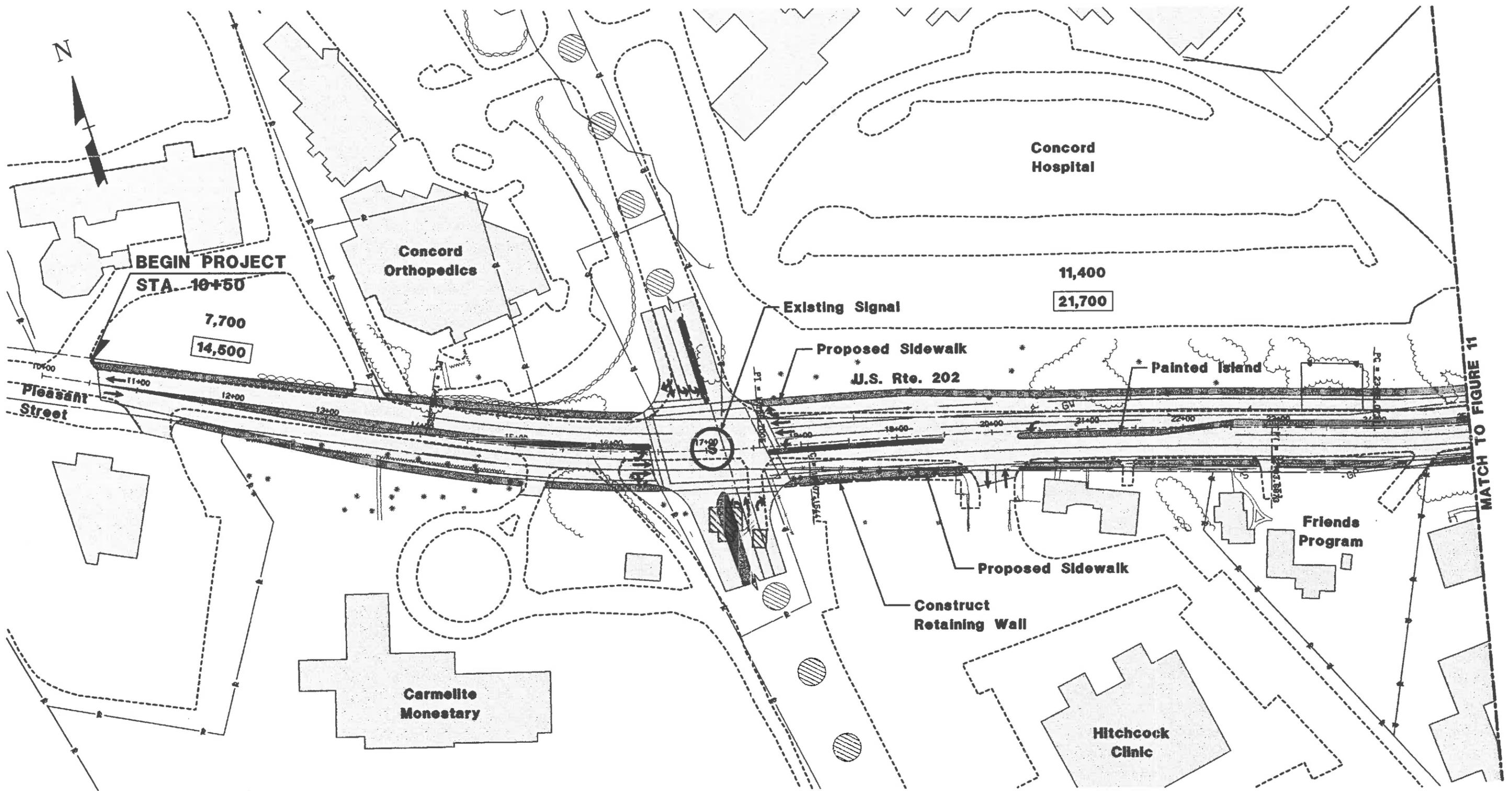
It is important to stress that the Pleasant Street widening and the neighborhood traffic calming actions comprise a comprehensive transportation plan for the study area and that the implementation of the traffic calming actions without the upgrade of Pleasant Street would prove ineffective.

The traffic calming actions are designed to be relatively low cost and easy to implement and as a result, once installed can be monitored and if found to be ineffective removed or modified. Recognizing that motorists may require a period of adjustment to become acclimated to the traffic calming actions, it is recommended that the diagonal diverters at Liberty Street/Warren Street and School Street/Pine Street intersections, and the semi-diverters at the Pleasant Street/Merrimack Street and Centre Street/Rumford Street intersections be temporarily installed and monitored for a six month trial period.

It is important to recognize that many of the traffic calming action complement each other and therefore to be effective will need to be installed and monitored concurrently. For example, the installation of the two recommended diagonal diverters must occur simultaneously because installing one without the other would result in diverting traffic from one parallel street to the other. The two semi-diverters

will also need to be installed concurrently, although not necessarily at the same time as the diagonal diverters. Other actions such as the roundabout and the gateway treatments can be installed independently.

Again, the reason for installing the traffic calming measures is to change the psychological feel of the street system so that the neighborhood streets have the look and feel of a neighborhood. Once the actions are in place, it will be important to maintain the neighborhood character. One way of accomplishing this will be to establish a neighborhood beautification committee made up of residents of the area who can work with the City officials to maintain landscaping and other streetscape improvements.

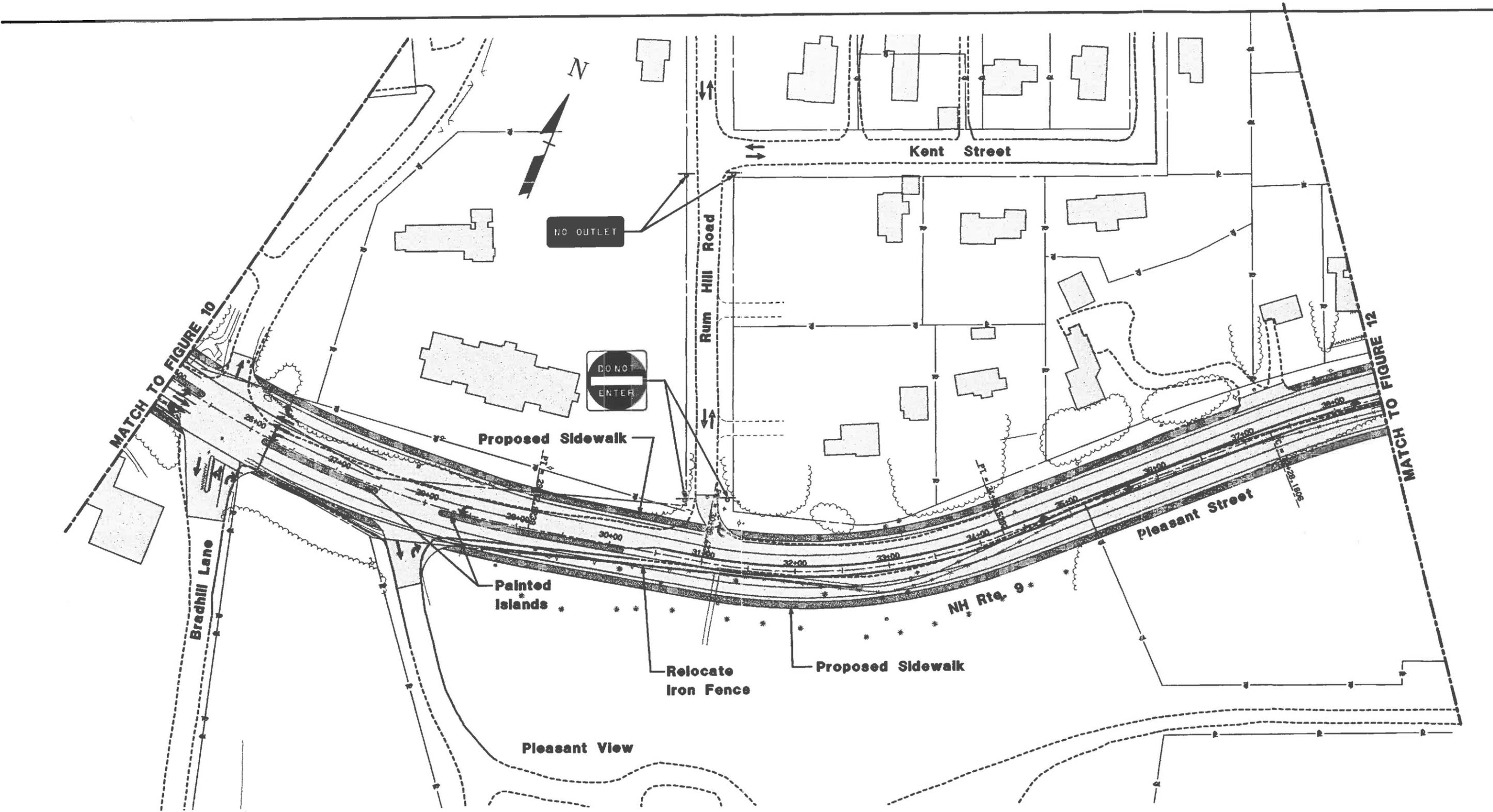


- | | | | |
|---------------|---------------------------|---|---------------------------|
| ----- | Exist. Pavement Areas | □ | Proposed Pavement |
| —▲— | Property Line | ▨ | Proposed Sidewalk |
| — | Right of Way Line | ■ | Proposed Island |
| 7,700 | 1995 ADT | ▨ | Proposed Northwest Bypass |
| 14,500 | 2015 ADT (W/ N.W. Bypass) | | |

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Figure 10

Pleasant Street Corridor
Transportation Improvements



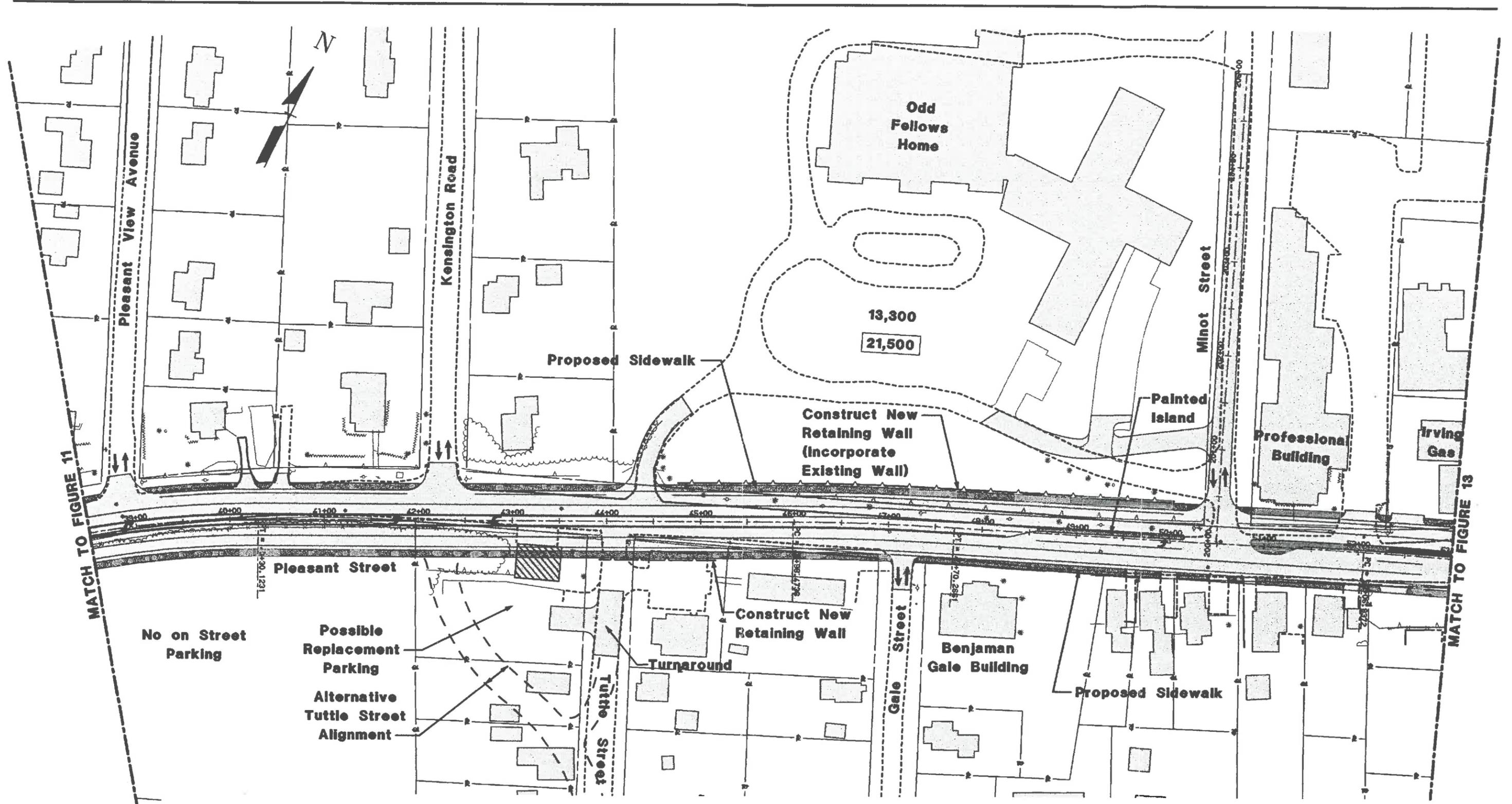
- | | | | |
|-------|---|---|-------------------|
| ----- | Exist. Pavement Areas | □ | Proposed Pavement |
| -▲- | Property Line | ■ | Proposed Sidewalk |
| --- | Right of Way Line | ■ | Proposed Island |
| | 7,700 1995 ADT | | |
| | 14,500 2015 ADT (W/ N.W. Bypass) | | |

Vanasse Hangen Brustlin, Inc.

Figure 11

Pleasant Street Corridor
Transportation Improvements



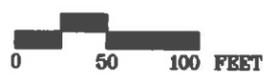


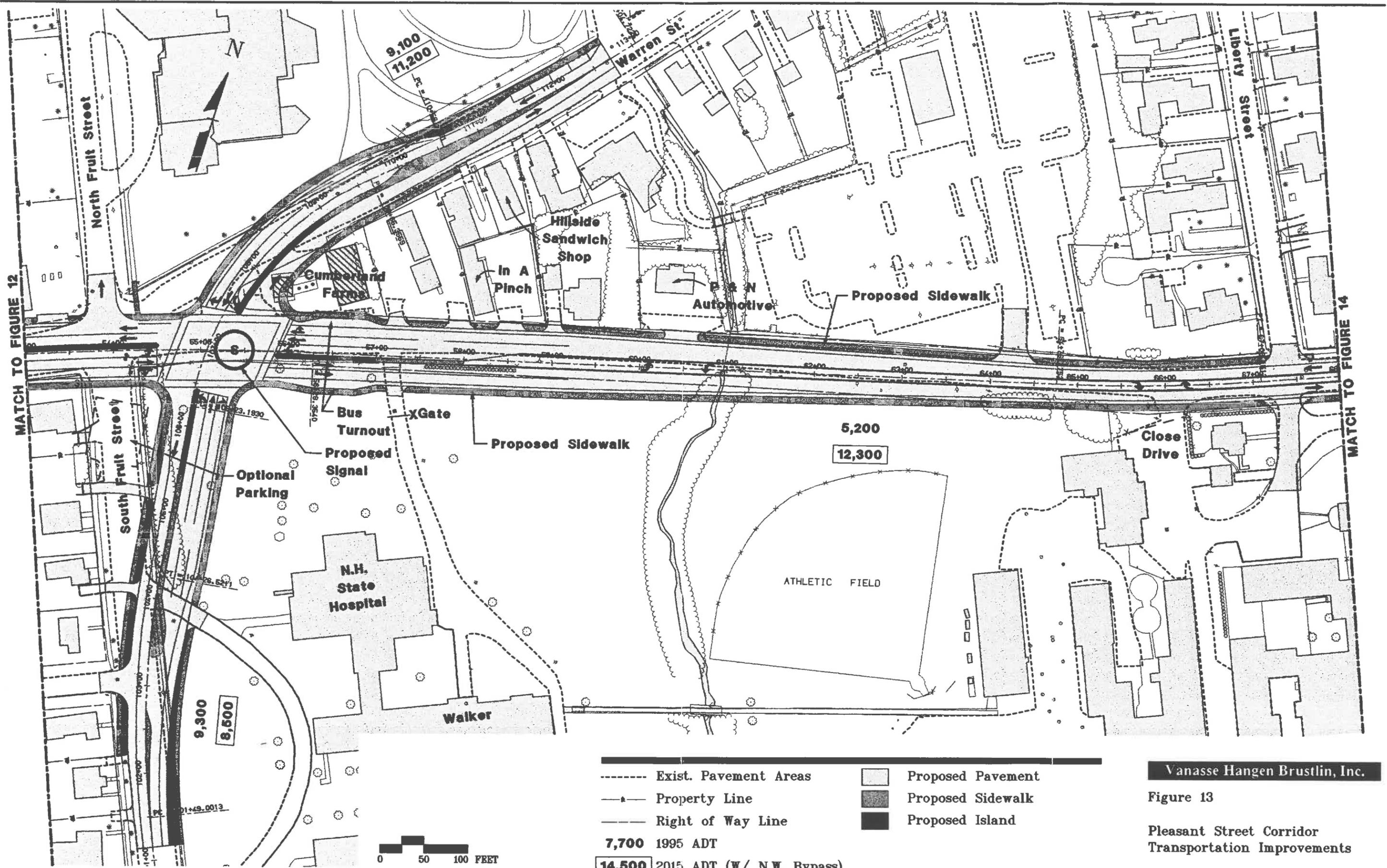
- | | | | |
|---------------|---------------------------|---|-------------------|
| ----- | Exist. Pavement Areas | □ | Proposed Pavement |
| —▲— | Property Line | ■ | Proposed Sidewalk |
| ——— | Right of Way Line | ■ | Proposed Island |
| 7,700 | 1995 ADT | | |
| 14,500 | 2015 ADT (W/ N.W. Bypass) | | |

Vanasse Hangen Brustlin, Inc.

Figure 12

Pleasant Street Corridor
Transportation Improvements

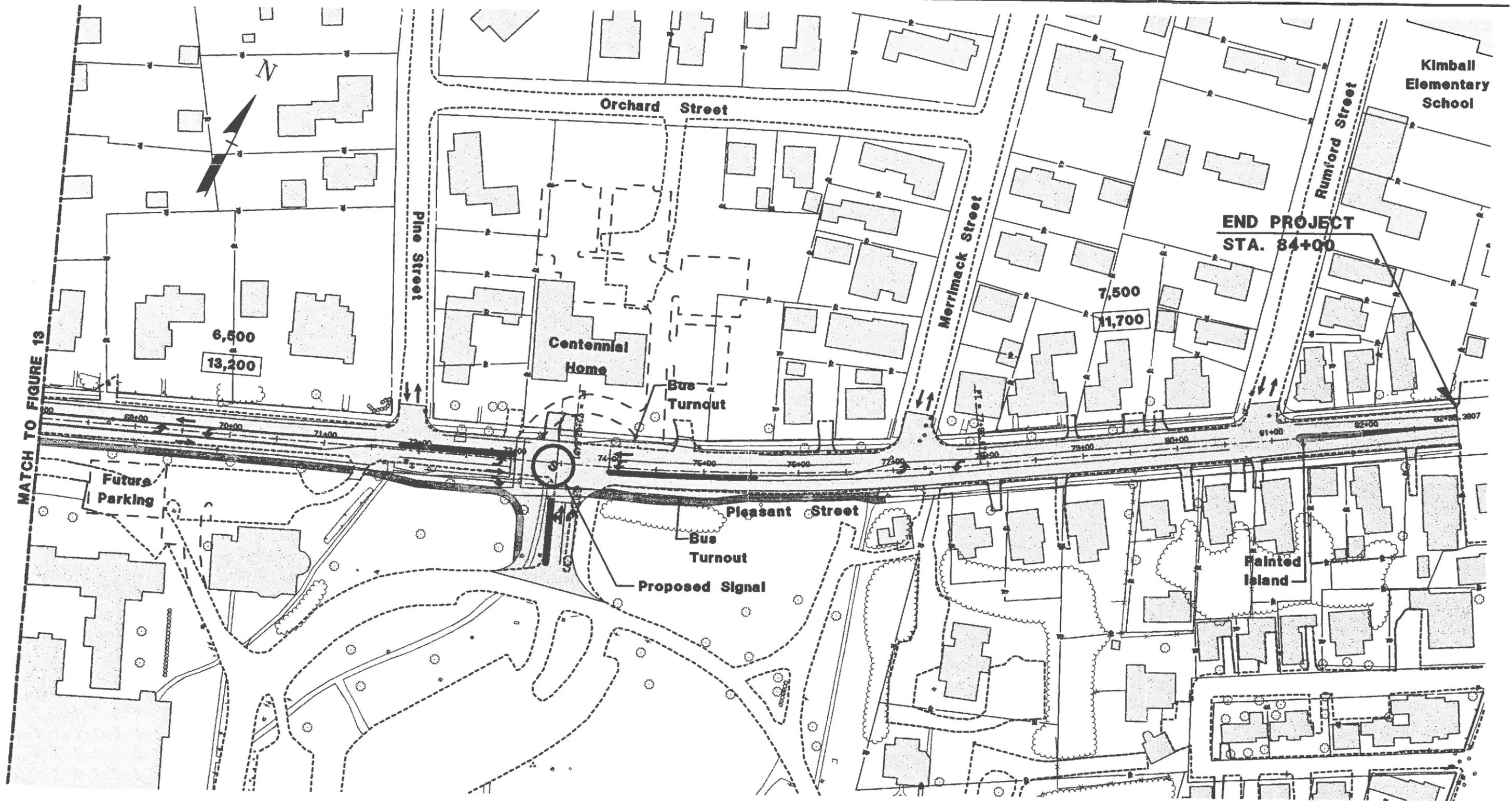




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Figure 13

Pleasant Street Corridor
Transportation Improvements



MATCH TO FIGURE 13

Kimball Elementary School

END PROJECT
STA. 84+00

6,500
13,200

7,500
11,700

Pleasant Street

Painted Island

Proposed Signal

- Exist. Pavement Areas
- Property Line
- Right of Way Line
- Proposed Pavement
- Proposed Sidewalk
- Proposed Island

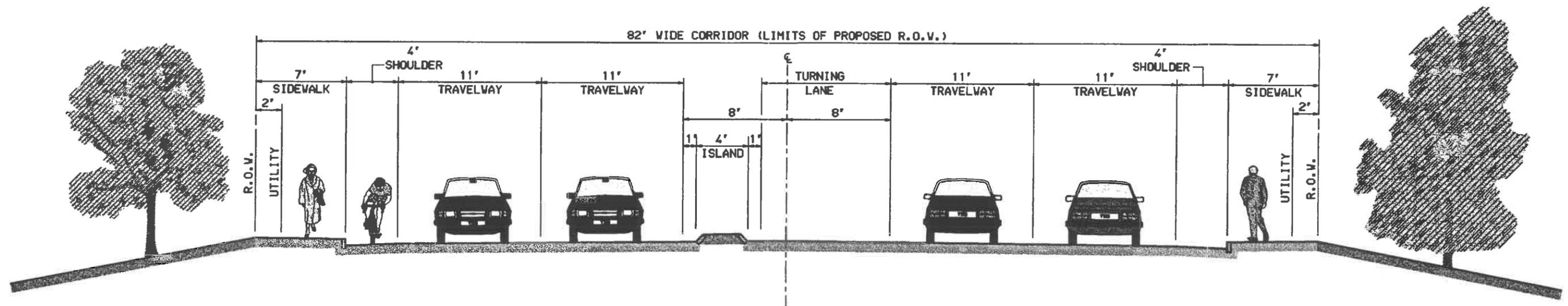
7,700 1995 ADT
14,500 2015 ADT (W/ N.W. Bypass)

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Figure 14

Pleasant Street Corridor
Transportation Improvements





TYPICAL SECTION OF IMPROVEMENT

STA. 14+00 - STA. 30+50
 (West of Concord Hospital West Drive to Rum Hill Road)

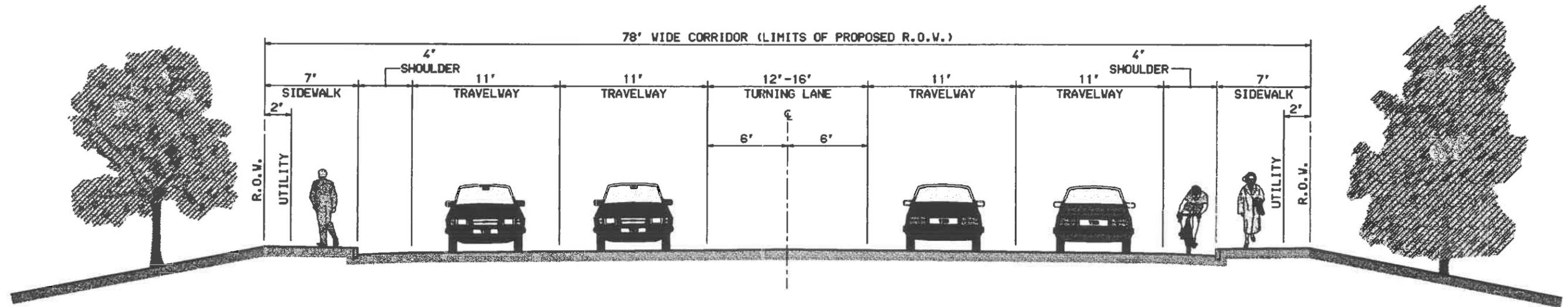
STA. 49+50 - STA. 61+50
 (Minot Street to East of Warren Street)

NOT TO SCALE

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Figure 15

Pleasant Street Corridor
 Typical Sections



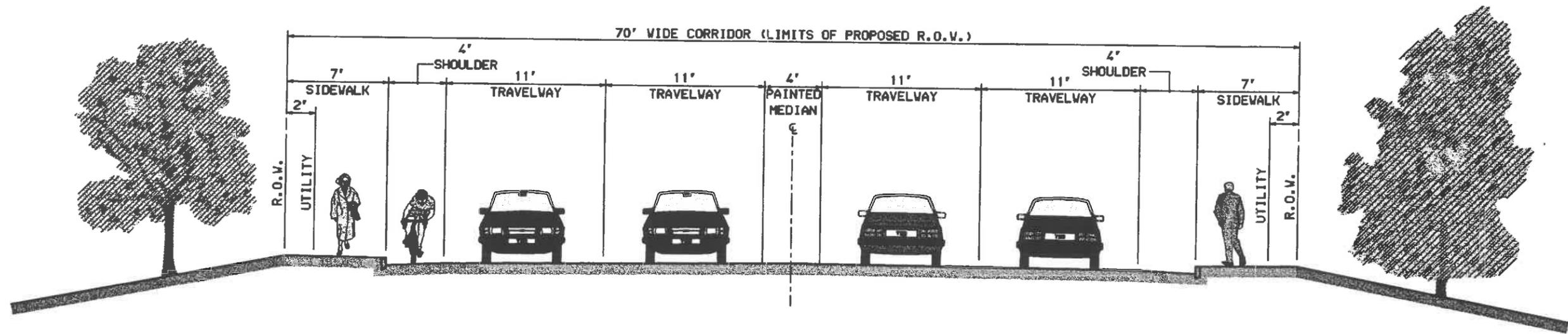
TYPICAL SECTION OF IMPROVEMENT

STA. 30+50 - STA. 49+50
 (Rum Hill Road to Minot Street)
 NOT TO SCALE

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Figure 16

Pleasant Street Corridor
 Typical Sections



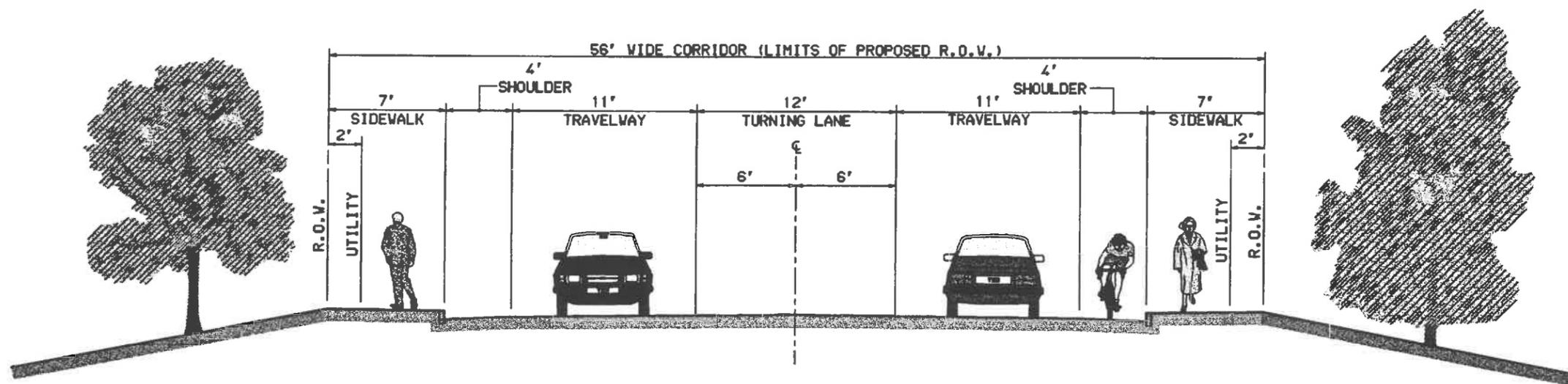
TYPICAL SECTION OF IMPROVEMENT (OPTIONAL)

STA. 30+50 - STA. 49+50
 (Rum Hill Road to Minot Street)
 NOT TO SCALE

Vanasse Hangen Brustlin, Inc.

Figure 17

Pleasant Street Corridor
 Typical Sections



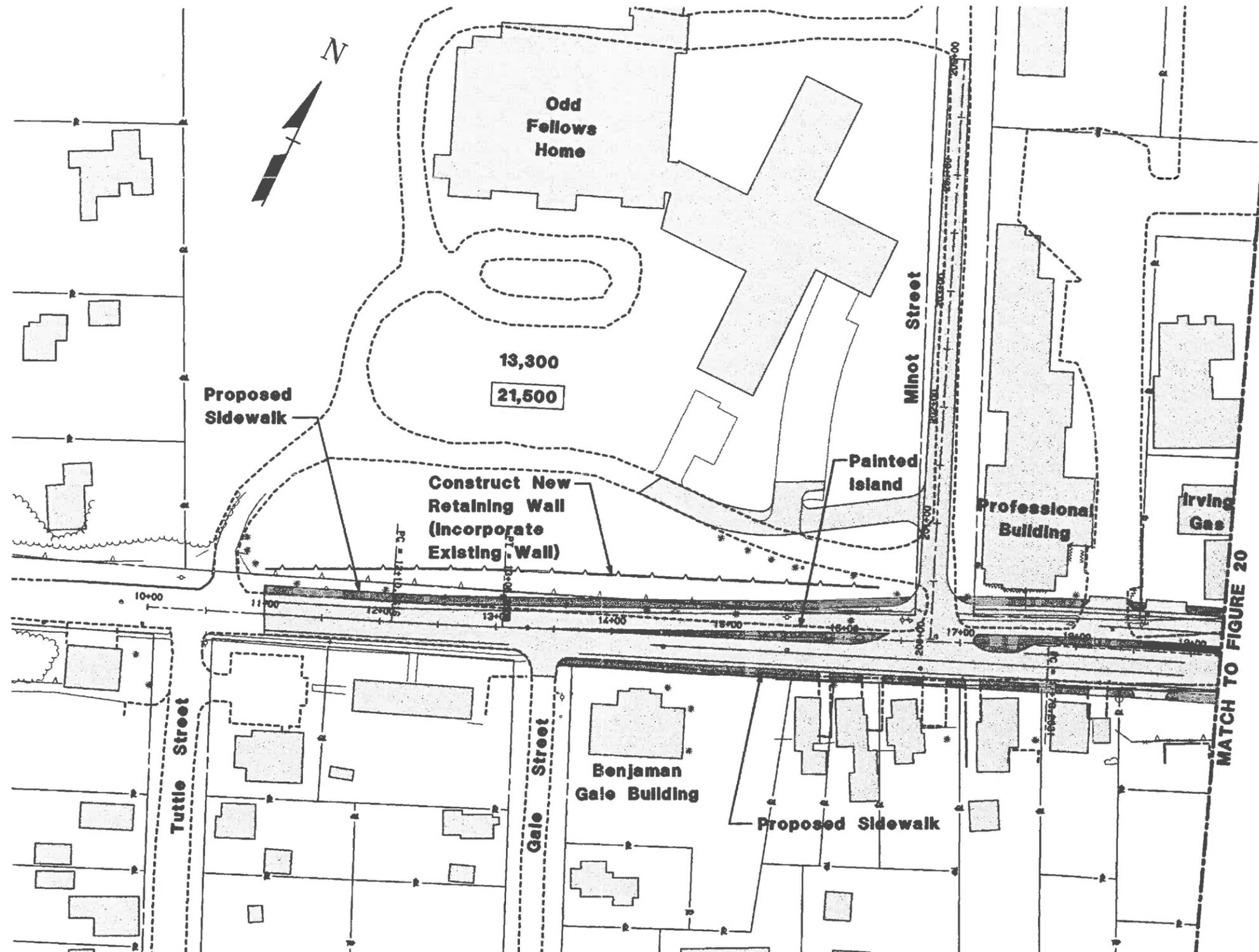
TYPICAL SECTION OF IMPROVEMENT

STA. 61+50 - STA. 80+50
 (East of Warren Street to Rumford Street)
 NOT TO SCALE

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Figure 18

Pleasant Street Corridor
 Typical Sections



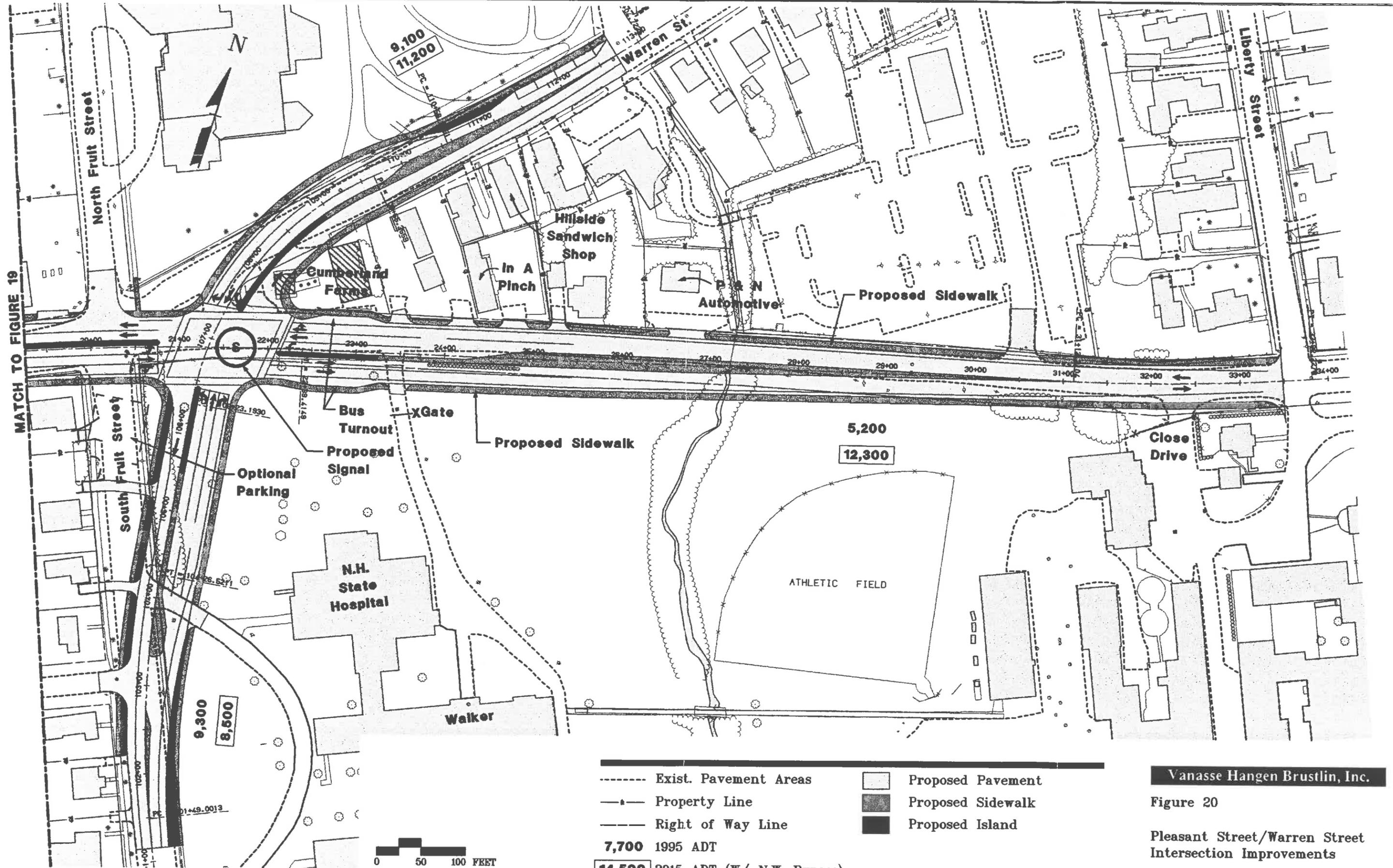
- | | | | |
|-------|---|---|-------------------|
| ----- | Exist. Pavement Areas | □ | Proposed Pavement |
| —•— | Property Line | ▨ | Proposed Sidewalk |
| — — — | Right of Way Line | ■ | Proposed Island |
| | 7,700 1995 ADT | | |
| | 14,500 2015 ADT (W/ N.W. Bypass) | | |

Vanasse Hangen Brustlin, Inc.

Figure 19

Pleasant Street/Warren Street Intersection Improvements

MATCH TO FIGURE 20



MATCH TO FIGURE 19

- Exist. Pavement Areas
- - - - - Property Line
- Right of Way Line
- 7,700 1995 ADT
- 14,500 2015 ADT (W/ N.W. Bypass)
- Proposed Pavement
- Proposed Sidewalk
- Proposed Island

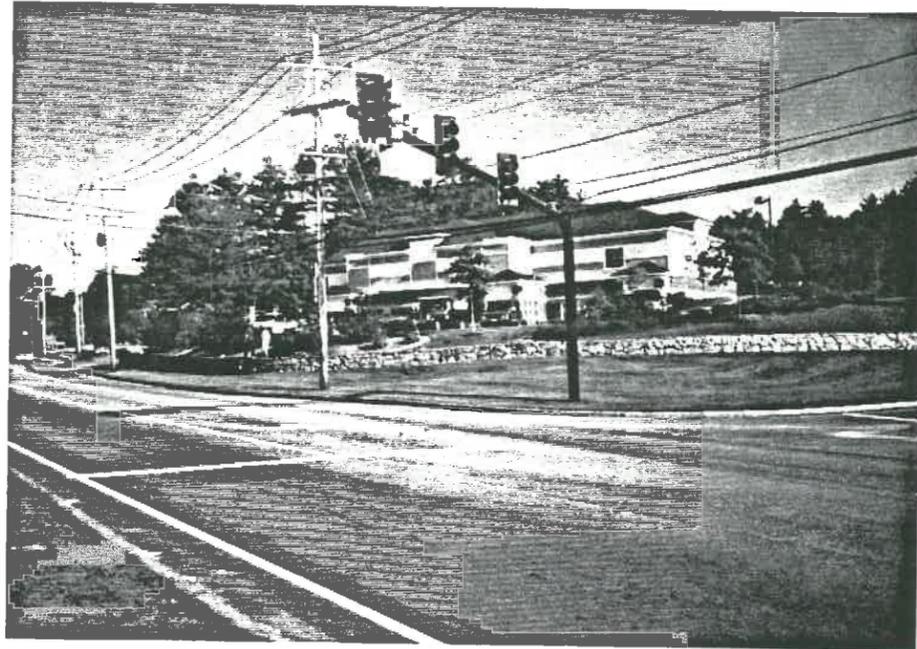
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Figure 20

Pleasant Street/Warren Street Intersection Improvements



Looking west Concord Orthopedics & Carmilite Monestary



Concord Orthopedics retaining wall
Station 14+00 - 16+00

Vanasse Hangen Brustlin, Inc.

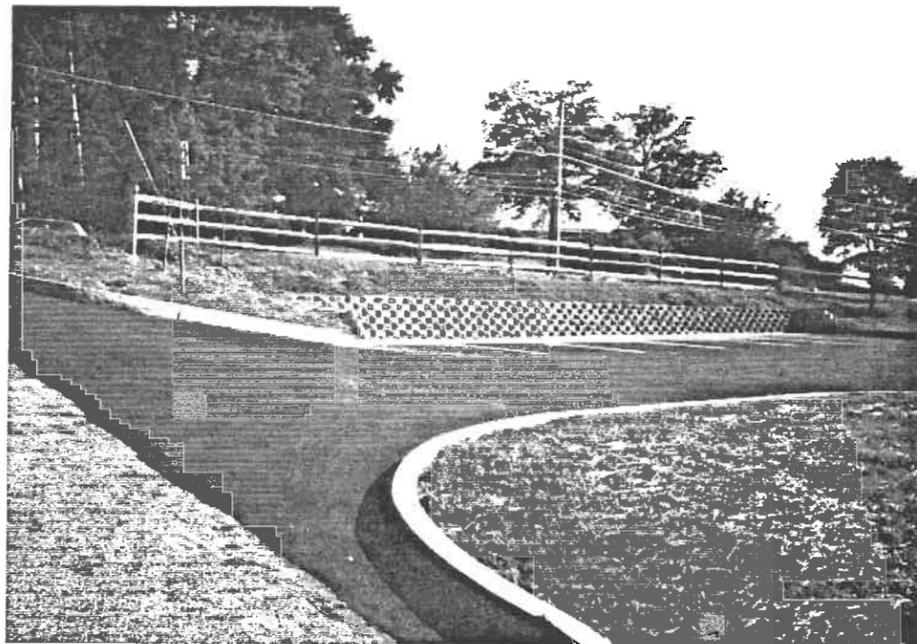


Retaining wall at Hitchcock Clinic
Station 18+00 - 19+00 Rt.

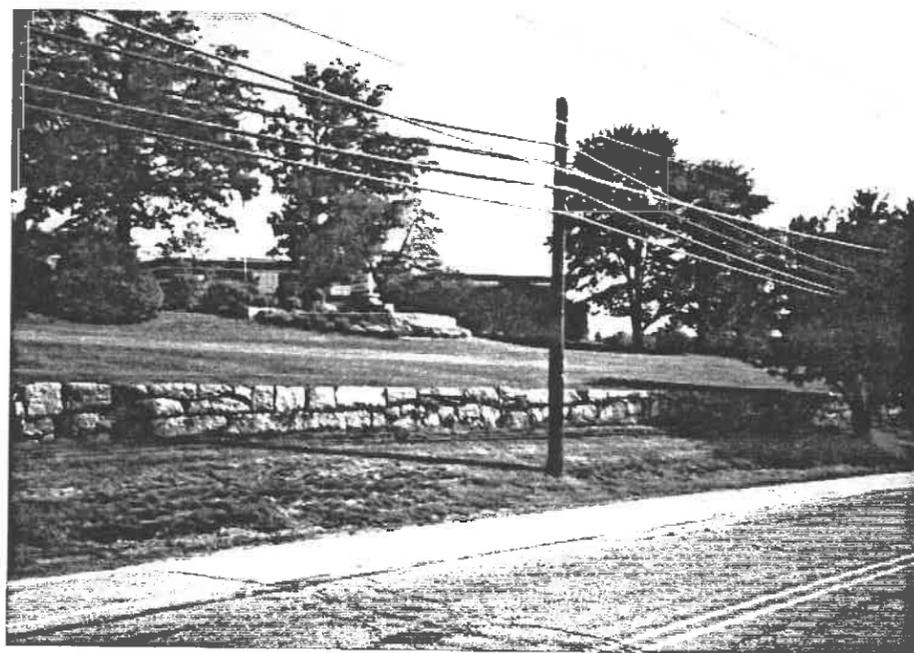


Ornamental iron fence outside Pleasant View
Station 30+00 Rt.+/-

Vanasse Hangen Brustlin, Inc.

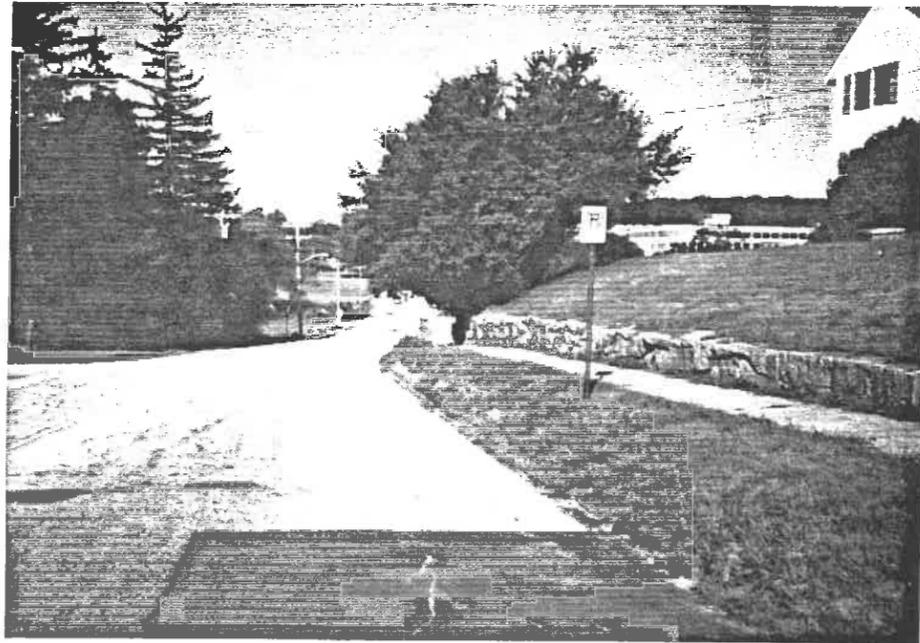


Retaining wall at Tuttle Street
Station 45+00 Rt.



Retaining wall at Odd Fellows Home
Station 46+00+/-

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Retaining wall no impact
Station 65+00 - 67+00 Lt.



Rene Street looking west
optional parking

Vanasse Hangen Brustlin, Inc.



Impact areas with optional parking
Station 72+00 Lt. looking east

Vanasse Hangen Brustlin, Inc.

