Downtown Transportation Strategy

Introduction

The transportation system in the Downtown area has been historically planned to support an activity center that has been primarily an employment district. Past policy direction has been to concentrate density in a core area and to locate parking around the core to accommodate the movement of downtown workers. Although Downtown is a regional destination, it is increasingly becoming a residential neighborhood. As development intensifies in the riverfront, North Loop, east Downtown, Elliot Park and Loring Park, the role of the transportation system in providing connectivity and accessibility in the Downtown area is changing.

Downtown is essentially landlocked by the freeway ring and the river. The capacity of the freeway access points and the routes that cross the freeway and the river limit the ability of the street system to continue to function in its historic role. The City and the Metropolitan Council project significant growth in downtown over the next twenty-five years including a 50 percent growth in residential population and an additional 40,000 jobs. This translates into an additional 150,000 trips per day in the downtown area. As growth continues in Downtown, an increasing amount of commute travel in and out of Downtown will have to occur on transit. Perhaps more importantly, there will be a significant increase in walking, biking and transit for circulation around downtown and for connections between the commercial core and residential neighborhoods in and near downtown. The management of parking in Downtown, both in terms of location and pricing, will also need to reflect these changes in population and employment. Future development will decrease the amount of surface parking lots n downtown and parking management strategies will be one of several tools that will need to be used to support a modal shift to transit. Parking strategies will be addressed in a separate section of the Action Plan.

The strategy for transportation in the Downtown area is organized to bridge the destination component of downtown and the ability to move to/from and around Downtown. Modal priority is the basis on which the strategy is built. In this context, a layered analysis of the transit alternatives for the downtown, needs for freeway connectivity, the need for improved pedestrian and bicycle systems in downtown was used to identify which streets need to be modified to support pedestrian activity, which streets need to emphasize movement of transit and/or bikes, and which streets are critical for moving traffic in and out and around Downtown.

The following sections of this report describe the transportation strategy by mode and summarize the general effects of the proposed system in terms of overall change and effects on traffic operations. Alternatives for transit operations in downtown are described in a separate report. Recommended street cross sections for activity center streets are provided (and will be incorporated into the companion Corridor Design Guidelines). Recommendations for traffic control to maintain building access on transit streets are provided. The effects of the proposed changes on air quality at hot spot locations identified in the State Implementation Plan are addressed. Longer term recommendations for changes in freeway access are also provided.

Modal Components

Transit

The Downtown transit network is built around the concept of transit spines that concentrate service through Downtown. While several alternatives have been presented for the transit spines, the transportation strategy presented in this document uses Alternative B for the transit spines (Figure 1). The transit layer would have the following components:

- Double-width contraflow transit lanes would be provided on Marquette and 2nd Avenues South between Washington Avenue and 11th and 12th Streets
- Nicollet Avenue would be used for a limited number of local transit routes configured to provide an intra-downtown circulation function along Nicollet Mall with a significantly improved pedestrian connection between Nicollet Mall and the Convention Center.
- 8th Street would be converted to a two-way street with a single with-flow transit lane(and a single general traffic lane) in each direction
- LRT and one lane of traffic would remain on 5th Street
- A contra-flow transit lane would be provided on 4th Street until the Central Corridor LRT replaces that service
- Hennepin Avenue would not have dedicated bus lanes, but would function as one of the transit spines with transit operating in the general traffic lanes
- Short segments of transit lanes would also be provided to connect freeway bus lanes to the downtown transit spines.

One-Way Streets and Freeway Access

A one-way street network provides connections into the Downtown Core from the regional freeway system (Figure 2). The movement patterns associated with the higher intensity core of Downtown are better served by a network of one-way streets that allow more flexibility in operation. The one-way network would provide circulation couplets through the Downtown Core with the following characteristics:

- 3rd and 4th Streets would function as a couplet that provides access to I-94 on the west side of Downtown and to I-35W on the east side. This latter connectivity would only be possible if the freeway access is modified on the east side of Downtown to provide direct ramps to 3rd and 4th Streets or a stronger distributor function that would disperse I-35W traffic similar to the way that the Third Avenue Distributor does on the west side. Prior to such a change in freeway access, these streets would continue to connect to Washington Avenue through the U of M campus.
- 6th and 7th Streets would function as a couplet that connects to I-94 on the east side of Downtown and to I-394 on the west side. Modifications to the existing 5th Street ramp on the east side would be necessary to reorient 5th Street traffic to 7th Street. Prior to such modifications, the strategy incorporates 10th Avenue South as a one-way link from 5th to 7th Streets. Reorientation of the access to I-394 to make the on-ramp south of 10th Street

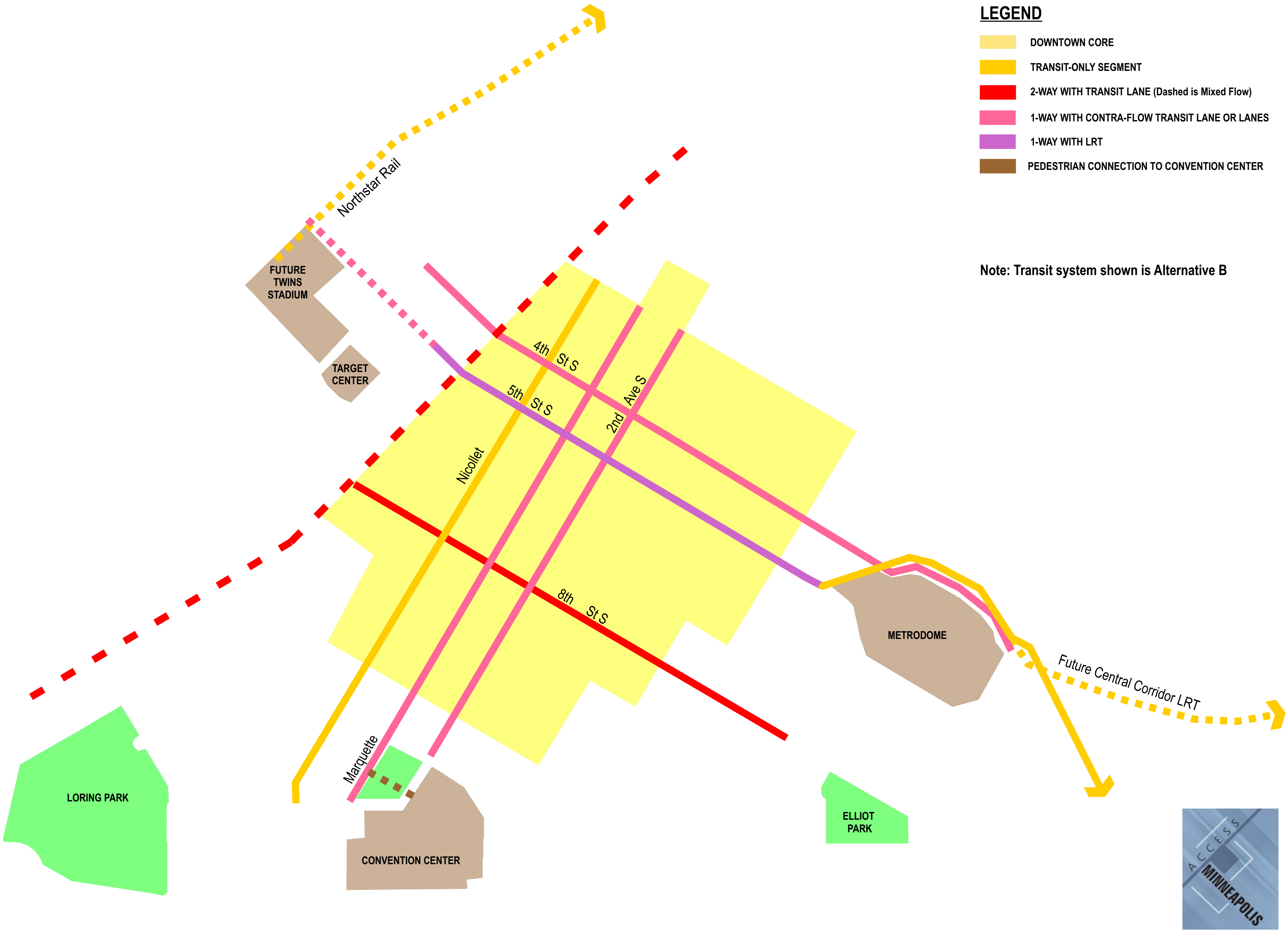

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Figure 1. Transit Network

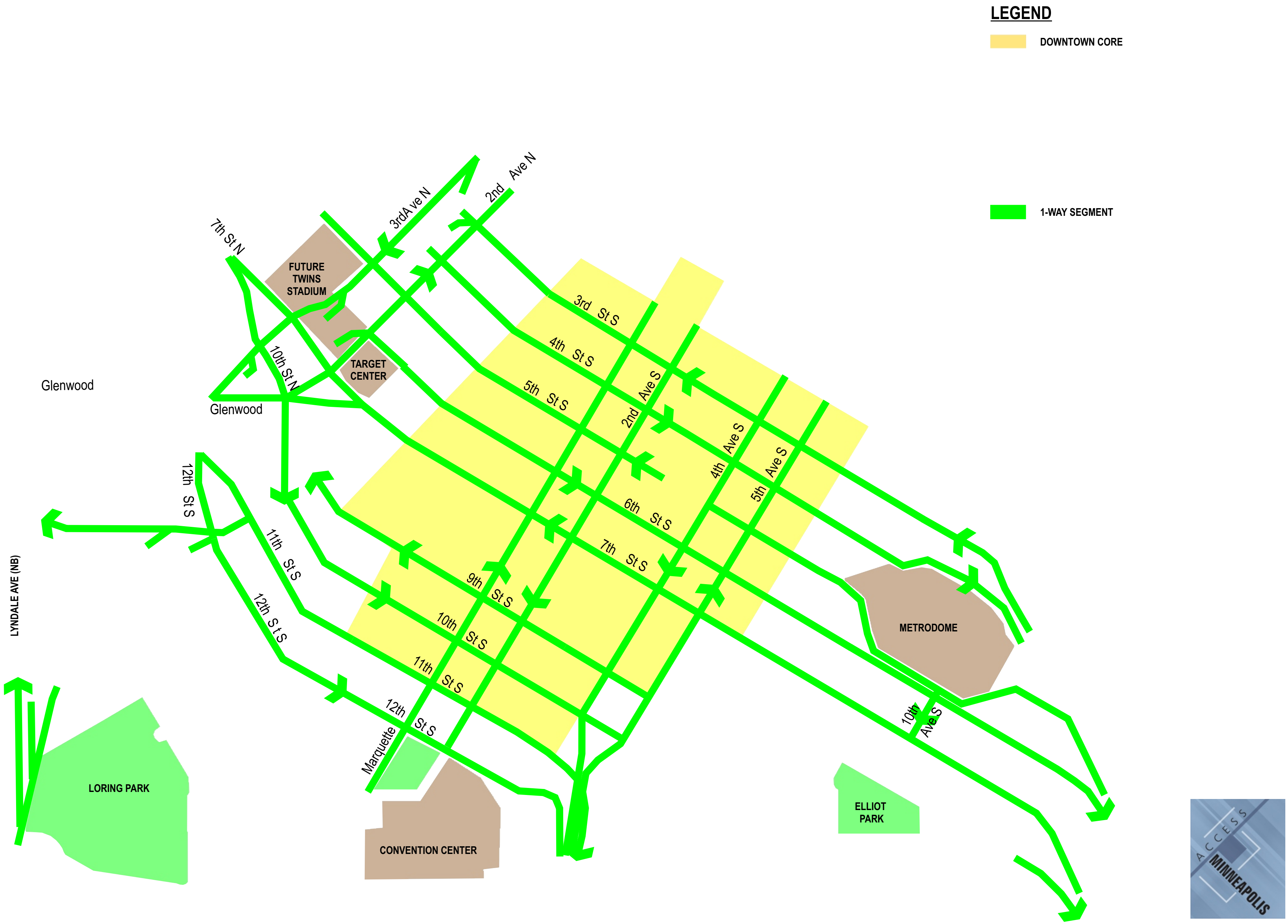

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Figure 2. One-Way Streets

accessible to all traffic rather than only carpools would provide for better distribution of traffic exiting the Downtown (see further discussion under Freeway Access). TH 55 access at 7th and 8th would be retained.

- 9th and 10th Streets would continue to serve the I-35/TH 65 ramps on the south side of Downtown and would transition to two-way operation east of 5th Avenue South.
- 11th and 12th Streets would serve the I-35/TH 65 and I-394 ramps on the south and west sides of Downtown respectively
- 2nd and 3rd Avenues North would continue to serve the I-394 corridor and the Third Avenue Distributor. Similarly, sections of 7th, 10th, 11th and Glenwood remain one-way.
- 4th and 5th Avenues South would connect to the I-35/TH 65 ramps on the south side of Downtown and would be one-way to 3rd Street.
- Marquette and 2nd Avenues South and 4th Street would serve one-way auto traffic on the contra-flow transit spines.

Two-Way Streets

The areas of Downtown outside the Core and on the edges of Downtown are guided toward a moderate intensity development pattern that is more mixed-use in or residential nature. Such areas are more appropriately served by a network of two-way streets that provide for more balanced flow and potentially slower traffic speeds. Three streets in the Downtown Core would be two-way – 3rd Avenue South, which is currently two-way, would remain two-way, while Hennepin and 1st Avenue North would be converted to two-way to address activity patterns in the Warehouse and Entertainment Districts (Figure 3). The following streets would also be two-way:

- Hennepin Avenue would become a two-way street (two lanes in each direction) with transit in mixed flow.
- 1st Avenue North would become two-way with two travel lanes in each direction
- 8th Street, while a transit street, would also be a two-way street with one travel lane in each direction for mixed traffic and one lane in each direction for transit.
- 3rd Avenue South would remain as a divided two-way street.
- LaSalle Avenue south of Downtown would become a two-way street.
- Portland and Park Avenues would become two-way streets with two lanes of traffic in each direction north of Franklin. Recommendations regarding the directional flow of traffic on Portland and Park Avenues outside downtown will be developed as a part of the citywide transportation planning that is currently underway.
- 9th and 10th Streets east of 5th Avenue S. would become two-way streets.

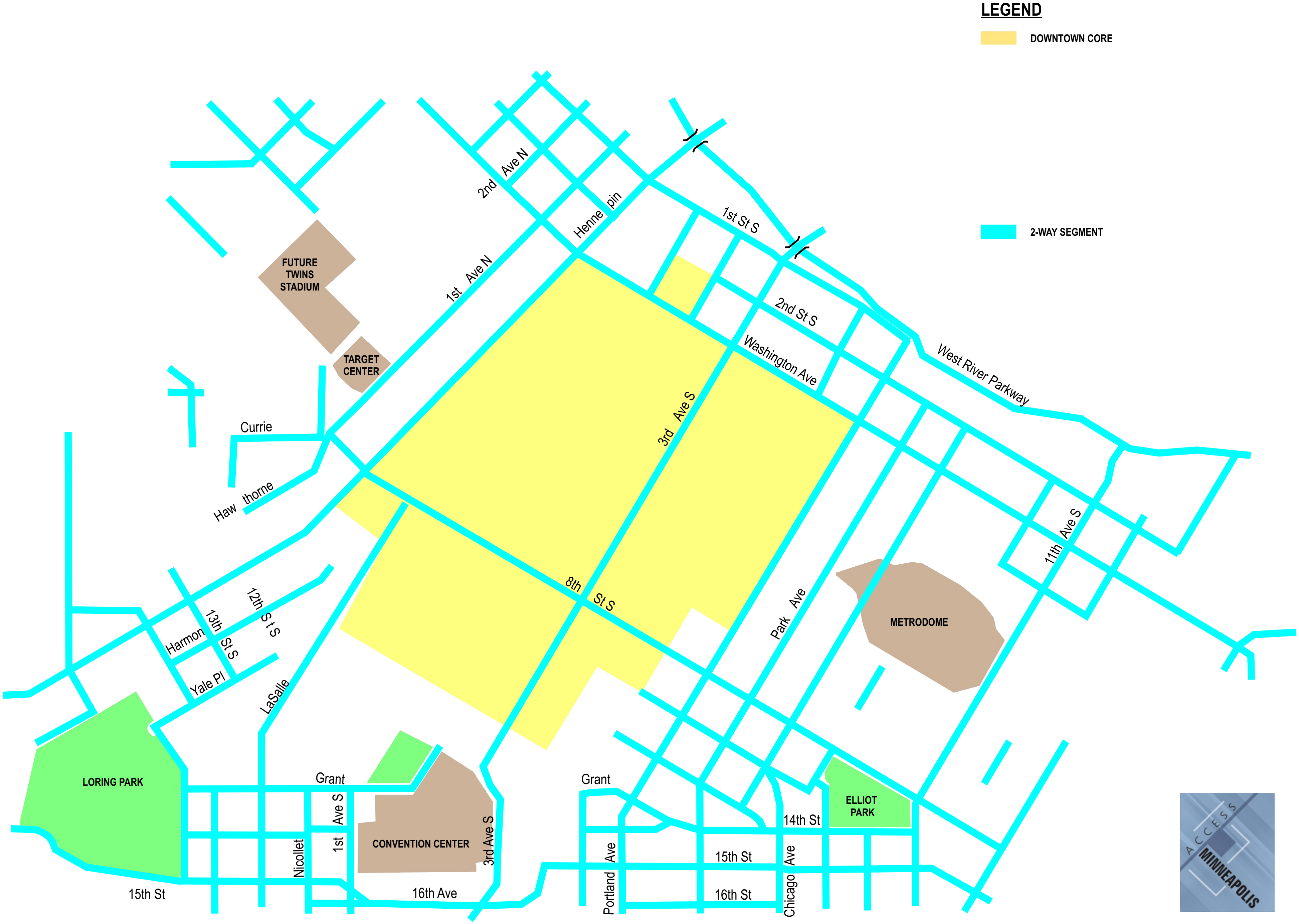

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Figure 3. Two-Way Streets

Auto Traffic Network

The combination of the transit, one-way and two-way layers illustrates the network that would carry auto, truck and bus traffic in the Downtown (Figure 4). The strategy focuses one-way streets and transit streets in the Downtown Core and provide for two-way circulation outside the core. Most streets would carry three or four lanes of traffic similar to today's network.

The strategy would introduce some two-lane streets into specific areas in Downtown. Looking at the strategy from the standpoint of changes from how streets operate today, the changes would focus on 1st Avenue North, Hennepin Avenue, LaSalle Avenue, Portland Avenue, Park Avenue and 8th Street. Marquette and 2nd Avenues South, while accommodating more transit, would continue to operate as a one-way couplet. The changes from the current system are illustrated in Figure 5.

Primary Pedestrian Network

A primary pedestrian network for downtown was defined in the Downtown East/North Loop Master Plan and that plan is reflected in the downtown transportation strategy. A network of streets with wider sidewalks, expanded pedestrian facilities and improved streetscaping is proposed on the following streets (Figure 6):

- Hennepin, Nicollet, 3rd Avenue, Portland, Chicago and 11th Avenue South in the north-south direction
- 1st Street North, 2nd Street South, 5th Street and 8th Street in the east-west direction.
- Depending upon the cross section used, sidewalk widths may increase on one side on Marquette and 2nd Avenue South and on both sides on 8th Street. This would provide increased space for passenger facilities on the transit streets.
- 5th and 7th Streets would link the pedestrian network to the new Twins Stadium site and the multi-modal (Northstar) station.
- The Loring Greenway is included as a primary pedestrian link
- West River Parkway and the Cedar Lake Trail are corridors with separated trails. A connection between downtown and the Cedar Lake Trail on the north side of downtown (in the vicinity of Washington Avenue) is needed.
- A significantly improved street level pedestrian connection between the Nicollet Mall and the Convention Center along 13th Street is added as part of the transit strategy. A vertical connection would also be provided between the street level and the existing skyway.

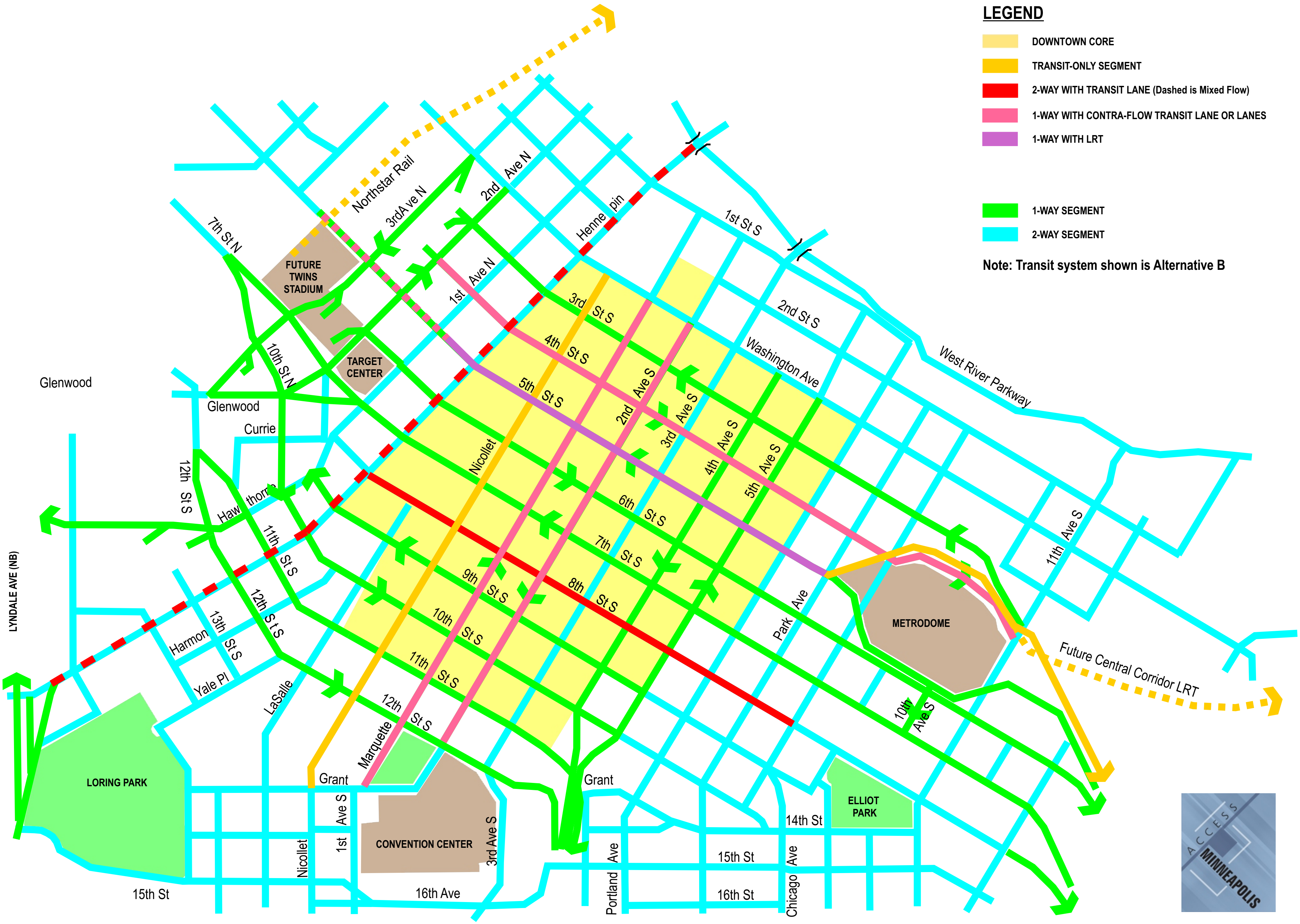

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Figure 4. Auto Traffic Network

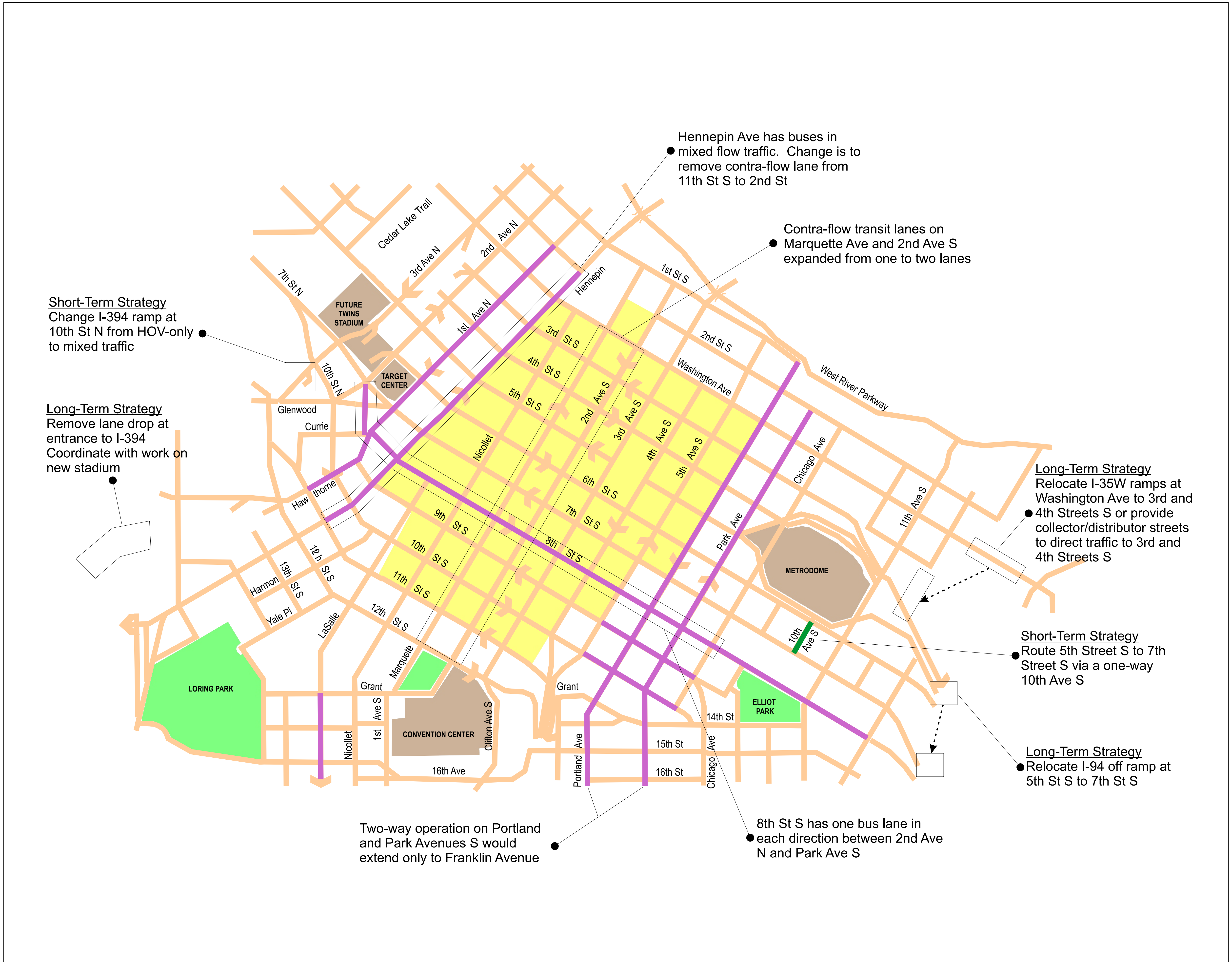

Figure 5. Changes in Auto Network

Ten-Year Transportation Action Plan

City of Minneapolis

Partner Agencies

Metropolitan Council/ Metro Transit
Hennepin County
Mn/DOT

Consultant Team
Meyer, Mohaddes Associates
Nelson/Nygaard Consulting Associates
Short Elliott Hendrickson, Inc.
Richardson, Richter & Associates

LEGEND
- DOWNTOWN CORE
- EXISTING STREET NETWORK
- STREETS PROPOSED TO BE CONVERTED FROM ONE-WAY TO TWO-WAY
- STREETS PROPOSED TO BE CONVERTED FROM TWO-WAY TO ONE-WAY

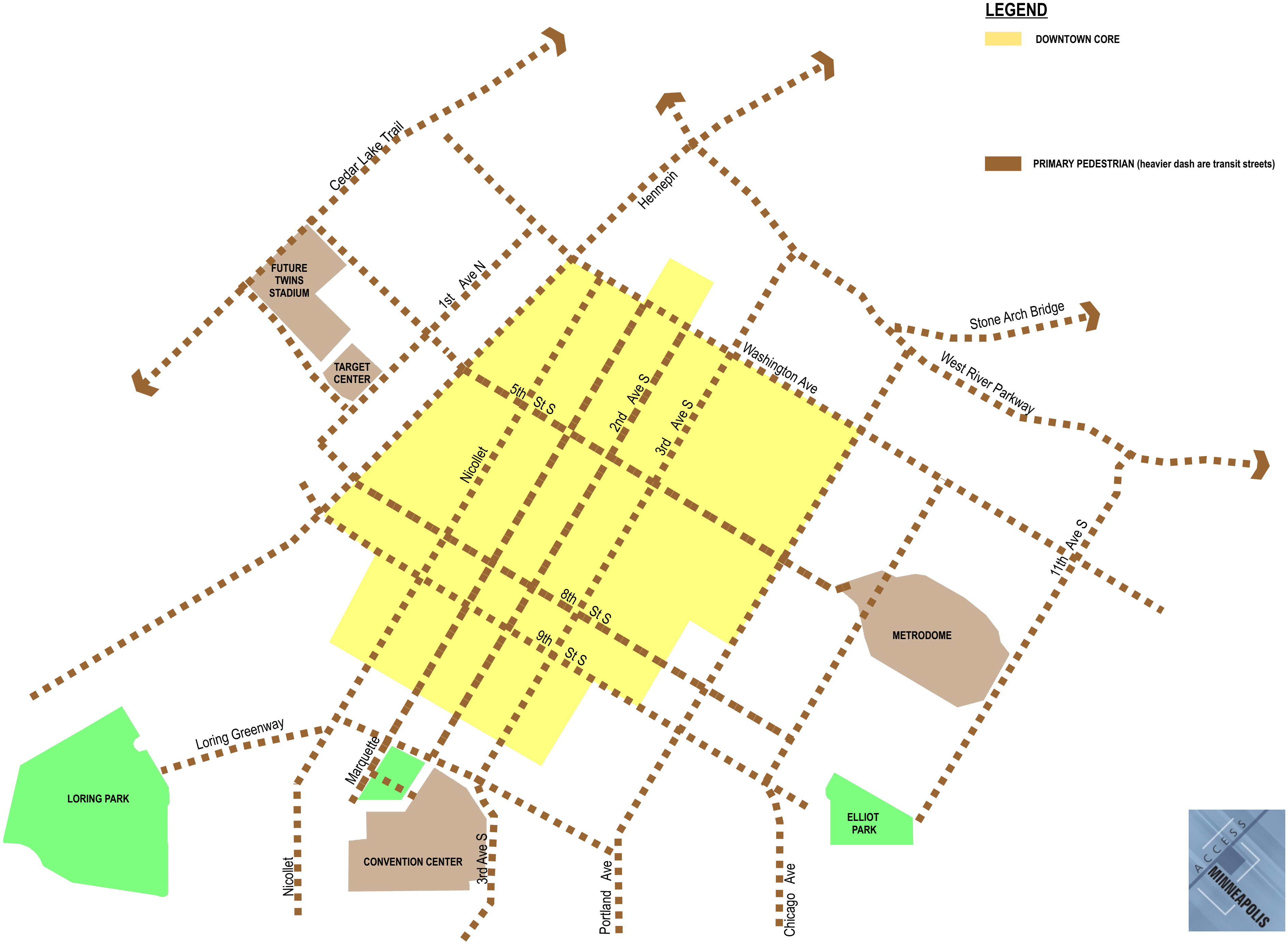

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Figure 6. Pedestrian Network

Bicycle Network

The bicycle network (Figure 7) builds from the following directions:

1. Connections into downtown (the Cedar Lake Trail West River Parkway, the trail adjacent to the Hiawatha LRT, Portland and 11th Avenues South)
2. Extensions of these connections through downtown (Portland Ave S, 3rd and 4th Streets, 11th Ave S, West River Parkway and the Cedar Lake Trail extension to West River Parkway)
3. A loop of streets with bicycle lanes around the downtown core (1st Avenue N/Hennepin, 2nd Street, Portland Avenue S, and 8th Street)
4. A north-south route across the downtown core (Marquette and 2nd Avenue South)
5. A route on 9th and 10th Streets that connects to the main routes accessing downtown and the north-south route across downtown.
6. A north neighborhoods connector on 2nd Street and a south neighborhoods connector from Elliot Park to Loring Park that generally follows 15th/16th Streets
7. Existing bicycle lanes not in the above would revert to shared streets and streets not included in the above would be treated as shared streets.

The combination of the transit, pedestrian and bicycle layers is shown in Figure 8. Figure 9 illustrates the combination of transit, one-way and two-way streets, pedestrian and bicycle layers.

Freeway Access

The strategy is designed to accommodate changes in freeway access and LRT extensions that will likely exceed the 10-year horizon of the plan. Changes in freeway access are needed to address the following:

- *A more-distributed system of access to/from I-35W on the east side of Downtown.* This could be achieved by changing the pattern of ramp access to use a reconnected 13th and 14th Avenues South as collector-distributor/frontage roads to distribute I-35W access to 3rd and 4th Streets directly. Alternatively, direct ramps might be provided at 3rd/4th Streets rather than at Washington Avenue. This concept would need to be coordinated with the Central Corridor LRT as the Central LRT alignment needs to connect with the Hiawatha LRT near the Metrodome.
- *Re-orientation of the I-94 off-ramp on the east side of Downtown to connect to 7th Street.* The Hiawatha LRT alignment on 5th Street has interrupted the 5th/6th Streets couplet of access to/from I-94 to the east. Re-orienting this couplet to 6th/7th Streets would provide better connectivity into and through Downtown.
- *Better utilize the available entry points to I-394 on the Third Avenue Distributor (TAD).* Traffic entering Downtown from the TAD uses four ramps to distribute over the Downtown street system. Traffic exiting the Downtown tends to concentrate on two of the entry points rather than distributing more evenly over the available on-ramps. This is a function of both

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Figure 7. Bicycle Network

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Figure 8. Non Auto Network

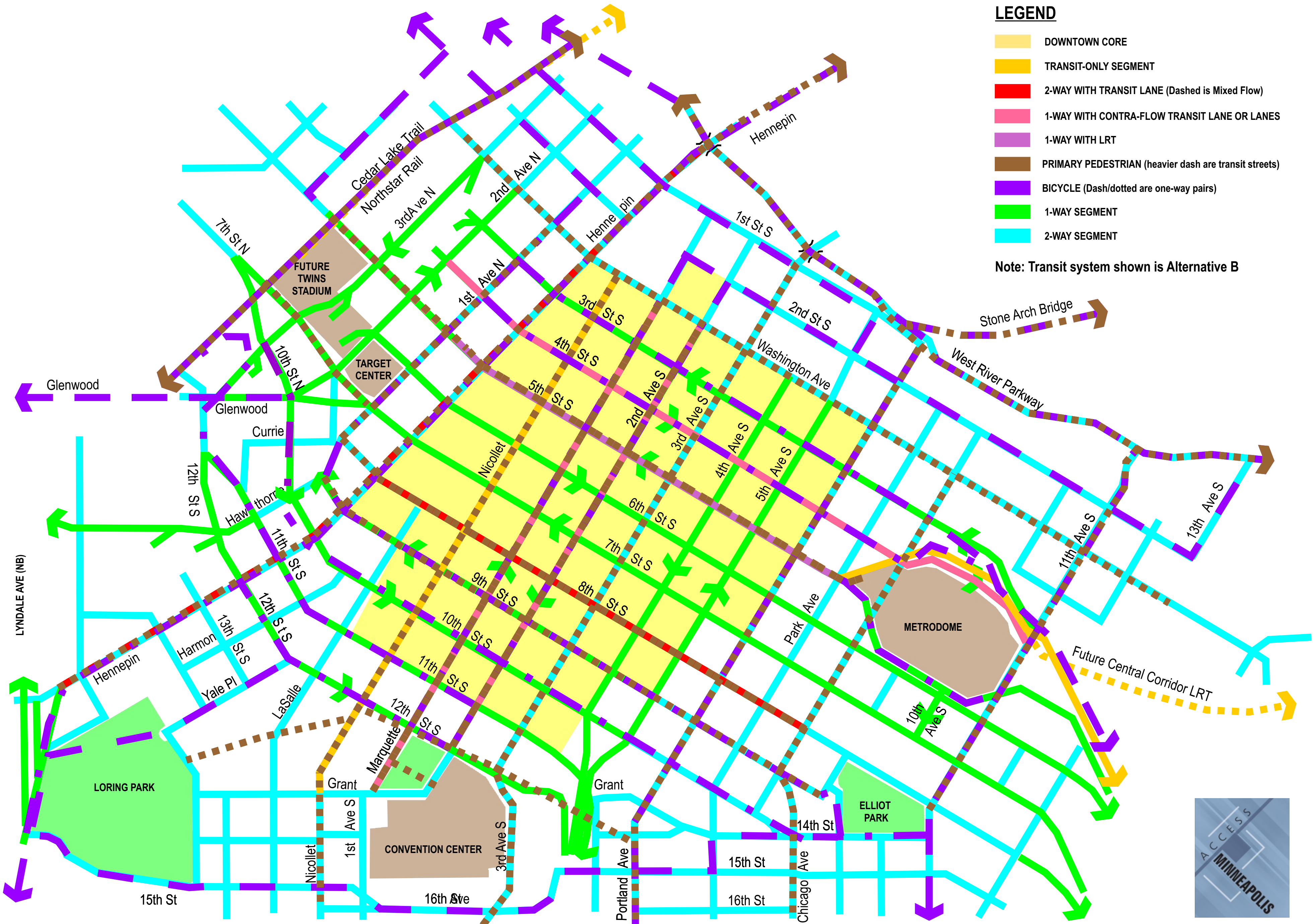

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Figure 9. Combination of all Layers

the placement of the ramps, the location of ramp meters, the designation of some of the ramps as HOV/motorcycle only, and the one-way circulation pattern of downtown streets. The de-emphasis of 5th Street as a cross-downtown connector when its role changed to LRT has reduced the utility of the 5th Street on-ramp to the TAD. The 10th Street ramp is HOV-only, which effectively funnels most traffic exiting Downtown to the 3rd Street and Hawthorne Avenue on-ramps.

The TAD has two lanes in each direction except where it connects to I-394. For westbound traffic leaving downtown, the two lanes are reduced to one prior to the merge onto I-394. This lane drop causes extensive queuing on the TAD during peak periods and affects the utilization of the on-ramps to the TAD from Downtown. Because the queue from the lane drop often backs up beyond the point where the Hawthorne on-ramp enters, traffic tends to use the Hawthorne on-ramp to avoid waiting in the longer lane-drop queue, which further imbalances traffic entering the TAD to exit Downtown. Ultimately, the lane drop needs to be resolved to provide more capacity for traffic exiting Downtown.

Resolving the lane drop will require bringing two lanes of the TAD onto I-394, which will require reconfiguring the lane patterns in the I-394 interchange with I-94. Because of the time to accomplish such a change, the following recommendations are made for the short and long term. Short-term, the HOV-only status of the 10th Street on-ramp should be changed to allow mixed traffic and combined with re-oriented one-way street access to provide for a more even distribution of traffic exiting Downtown. Long-term, the lane drop on the TAD should be removed to permit two lanes from the TAD to enter I-394. If the lane drop cannot be resolved, then an interim change would be to restrict the Hawthorne on-ramp to HOV-only status. This interim change would allow for a reduced weave/merge at the entrance to the HOT lane and would minimize delay to HOV and transit from what is experienced today. However, it would cause a major redistribution of non-HOV traffic to the other on-ramps to the TAD, which could exacerbate operation issues elsewhere in Downtown and is thus recommended only as a stop-gap measure if the TAD connection to I-394 cannot be modified.

Capacity Analysis of Two-Way and One-Way Streets

Before making significant changes to the downtown street system, it is important to understand the impacts these changes, both positive and negative, may have on overall traffic operation in downtown. It is recognized that traffic volumes in downtown will continue to grow and there are limited options for improving traffic flow beyond a significant shift to other modes of transportation. In order to encourage this mode shift, it is important to accommodate these alternative modes of transportation. However, it is desirable to minimize any negative impact to automobile circulation and to avoid "unintended consequences". This is especially true for proposed changes from one-way to two-way operation on selected streets. This section of the report describes a series of traffic analyses that was done to determine where two-way streets would be feasible and to determine how proposed transit streets would be likely to function in the future.

As a precursor to the detailed analysis described below, the vehicular capacities were estimated for various cross sections for both one-way and two-way street systems. These cross sections were "generic" in the sense that they were not derived from any particular streets or intersections in downtown Minneapolis, but they were intended to act as a guide for evaluating alternative configurations for the downtown street network.

From turning movement counts collected in 2004 for another project at nearly 200 downtown intersections, it was determined that the average distribution of turning movements at a typical downtown intersection consisted of 12 percent left turns, 12 percent right turns, and 76 percent through traffic. From those turning movement counts, it was determined that these percentages remained stable throughout the day. It is realized that turn percentages can vary significantly from one intersection to another, but it was necessary to adopt a standard for the capacity determination of the generic cross sections.

Six different generic cross sections were analyzed, and capacity was determined on a couplet basis. Using a couplet, which consists of a pair of parallel adjacent streets, was necessary to balance the effects of one-way streets carrying traffic in opposite directions along parallel streets.

As shown in Figure 10, the six generic cross sections analyzed were:

1. Two-lane, one-way streets, with one street of the couplet carrying traffic in one direction (e.g., eastbound) and the other street of the couplet carrying traffic in the opposite directions (e.g., westbound).
2. Three-lane, one-way streets, again with adjacent one-way streets carrying flows in opposite directions as described for the previous cross-section.
3. Two-lane, two-way streets, with one lane in each direction on both streets of the couplet, carrying all left-turning, through, and right-turning traffic. In later discussions, this cross-section is referred to as "1+1".
4. Three-lane, two-way streets consisting of one lane in each direction carrying through and right-turning traffic and a center turn lane serving left-turning traffic in both directions. Depending on the location, the center turn lane could be a two-way left-turn lane for nearly its entire length to accommodate left turns both at the intersections and at mid-block locations. Alternatively, the center turn lane could be configured to accommodate

left turns only at the intersections, set up in a "back-to-back" fashion, where the turn lane is a left turn lane in one direction (e.g. eastbound) for a portion of the block and a left turn lane in the opposite direction (westbound) for the remainder of the block. This cross-section is referred to later as "1+1+1".

5. Three-lane, two-way streets consisting of two lanes in one direction – the left lane carrying through and left-turning traffic and the right lane carrying through and right-turning traffic – and one lane in the opposite direction. Because this cross-section is asymmetrical, it was assumed that one street of the couplet would have two lanes in direction A (e.g., eastbound), and the other street of the couplet would have two lane in direction B (westbound). This cross-section is referred to as "2+1".
6. Four-lane, two-way streets consisting of two lanes in each direction on both streets of the couplet. This cross-section is referred to as "2+2".

Obviously, different cross-sections require different street widths, and the space not used by moving traffic may serve a variety of purposes. The majority of the streets in downtown Minneapolis have 50- to 56-foot curb-to-curb street widths with an 80-foot total right-of-way. As shown in the figures, if on-street parking has the highest priority after moving traffic lanes, all but one of the generic cross-sections can accommodate on-street parking on both sides of the moving traffic lanes. That space can also be used for combinations of on-street parking/loading zones, bike lanes, exclusive transit lanes, and wider sidewalks. Relative to the effect of the configuration of the moving lanes, the use of that extra space has little influence on the overall capacity of a cross-section.

Figure 10. Generic Cross-Sections

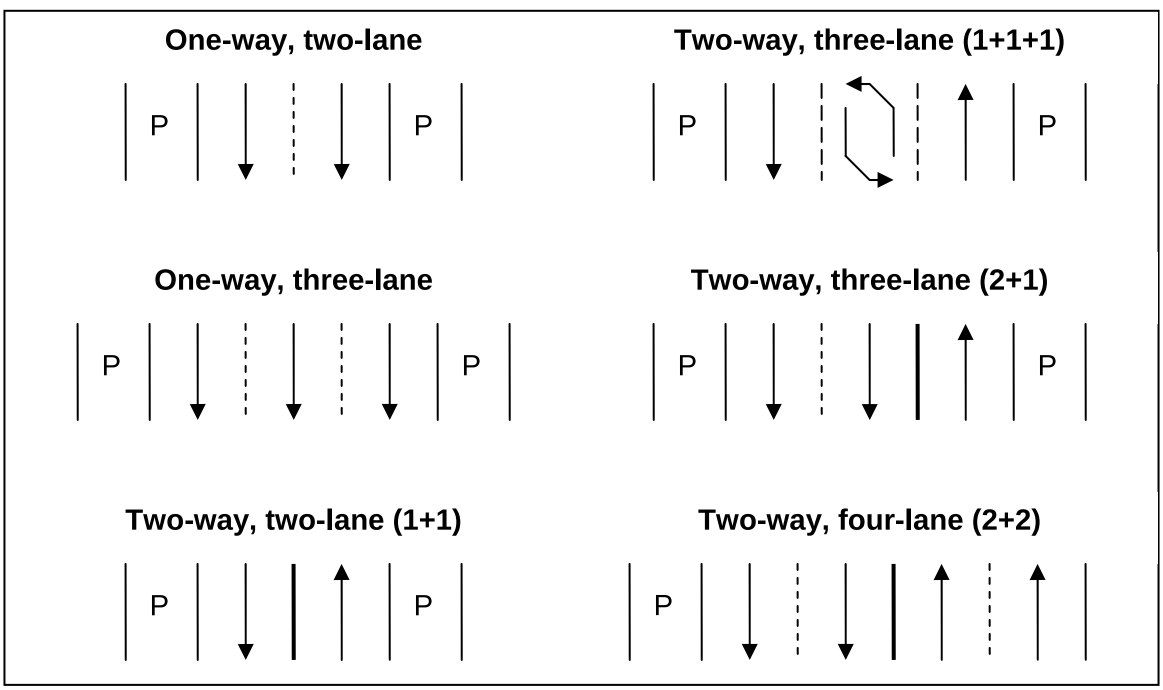


Table 1 shows the results of couplet capacity analysis for each of the generic cross-sections. It was recognized that directional splits of traffic demands may vary by intersection and by time-of-day. For example, a 70/30 split – 70 percent of all traffic on the couplet traveling in one (peak) direction, and 30 percent of all traffic on the couplet traveling in the opposite (non-peak) direction – is more typical of morning and afternoon peak periods and near major accesses (freeway, arterials) to downtown. On the other hand, a 50/50 split is more typical of midday and evening time periods and intersections closer to the central downtown core. Consequently, a range of directional splits was studied for each of the generic cross-sections to also measure their effect on capacity.

Table 1. Cross-section Capacity Analysis Results

Demand Split	Couplet Capacity (veh/hr)						% of traffic using 2-lane/1-lane approach	
	One-way		Two-way					
	2-lane	3-lane	1+1	1+1+1	2+1	2+2	Peak Dir	Off-peak Dir
50/50	2400	3500	2400	2800	2800	3300	68/32	68/32
55/45	2200	3200	2200	2800	2700	3200	67/33	68/32
60/40	2000	2900	2100	2500	2600	3000	65/35	68/32
65/35	1800	2700	2000	2300	2500	3000	65/35	69/31
70/30	1700	2500	1900	2200	2400	2900	65/35	68/32

LT phase required to achieve indicated capacity

As can be seen in the table, the two-lane cross-sections, whether one-way or two-way, demonstrated relatively low vehicular capacities. As expected, the capacities of all three-lane cross-sections were greater than each of the two-lane cross-sections. In the case of the one-way couplet, the increase was 45 to 50 percent, depending on the demand split. For the two-way couplets, the increases were more modest, ranging from 15 percent to 27 percent. Going to four moving lanes on the two-way couplet approached – and in some cases exceeded – the capacity of a one-way, three-lane couplet.

Due to the very labor-intensive nature of evaluating alternatives, and to keep as many options open as possible for future analysis, the Project Management Team selected three cross-sections as the base cross-sections in the initial capacity analysis tasks for the future downtown street system.

For one-way streets, a 3-lane cross-section was selected, since this cross-section was consistent with the majority of existing one-way streets in downtown.

For two-way streets, the two-lane cross-section was discarded due to its very limited capacity. The four-lane cross-section was retained for analysis because it had capacities similar to the capacity of a one-way, three-lane couplet.

For two-way, three-lane alternatives, the “1+1+1” option was retained for analysis because the general consensus was that this option would provide a more uniform – and less confusing – system for motorists because drivers would always know that the center lane was for left-turning vehicles. From a traffic forecasting perspective, this choice also provided an easier method for trip distribution, since all two-way streets would have the same approximate capacity in each direction.

Forecasting Methodology

For the base 2030 traffic demands, a uniform growth rate (26 percent or approximately one percent per year) based on the metropolitan area regional model was applied to all existing turning movements.

For all downtown street configurations in which at least one one-way street is converted to two-way and/or preferential treatment is provided for transit vehicles on the primary transit network (PTN), it was necessary to use a relatively labor-intensive iterative process in re-distributing turning movement demands to intersections. The metropolitan area regional model was used to identify increases on links (groups of streets) entering and leaving downtown in 2030. The link-by-link growth rates were used, in combination with existing turning movements, estimated capacities of the various roadway cross-sections (as described above), and knowledge of residential units, parking supply, and the quantity of commercial space on a block-by-block basis, to develop forecast growth rates for each of the turning movements at each of the intersections in the downtown street system.

Analysis Methodology

For each of the alternatives, capacity analysis was performed on an intersection-by-intersection basis by modeling the downtown traffic operations using the Synchro computerized traffic analysis package (version 6, Build 614), the most commonly used street network analytical tool in Minnesota and the U.S. With the exception of the analysis of existing conditions – the first analysis performed – the Synchro optimization features were used to develop optimized traffic signal timings. With Synchro, optimization consists of minimizing a combination of delays and stops to vehicles. Because the occupancies of those vehicles – in particular those in high-occupancy vehicles, such as buses – cannot be accounted for by Synchro, preferential signal timing was not provided for transit vehicles, i.e. all vehicles were treated equally, regardless of whether they were a single-occupant automobile or a fully-loaded bus.

Because it represents the worst operational conditions during a typical weekday, the afternoon peak hour was used as the time period for analysis. A morning peak hour analysis of a one-way system would yield significantly different results at some intersections because of the directionality of flows during the morning and afternoon peak periods and the roadways serving that directional flow. Generally speaking, if an intersection is congested in the p.m. peak hour, its partner intersection on the one-way pair would likely be congested in the a.m. peak hour. Traffic volumes in the a.m. are typically lower because they include primarily commuter traffic while the p.m. traffic volumes also include a significant amount of non-work trips. An analysis of the a.m. peak hour would likely not have produced a different answer to the larger question as to whether a conversion to two-way streets would or would not work overall from a system perspective.

The base Synchro model for this analysis was developed by SEH for a signal optimization project conducted for the City of Minneapolis in 2003 and 2004. That project consisted of two phases. In phase 1, new traffic signal timings were developed based on turning movement counts collected in 2003 at approximately 25 percent of the downtown intersections and on estimated turning movement counts at the remaining intersections provided in the <u>2000 Downtown Minneapolis Transportation Study</u>, a study conducted by another consultant. These signal timings were implemented in early 2004 in conjunction with the opening of the Hiawatha Light Rail Transit (LRT) line. For phase 2, turning movement counts were again collected, in 2004, this time at all downtown intersections, to account for current (at that time) demands, which included changes in traffic patterns and mode uses resulting from the implementation of LRT. Traffic signal timings were to be optimized using the new turning movement counts, pedestrian counts at selected locations, and bus occupancy data. Using a combination of Synchro and another traffic signal optimization tool, TRANSYT-7F, signal timings were to be developed which minimized delays and stops on a person basis, rather than on a vehicle basis, thereby providing priority for transit vehicles. Unfortunately, the City was unable to obtain sufficient funding to complete phase 2. Funding ran out just as the last turning movement counts were collected; consequently, the starting point for the Access Minneapolis project was a non-optimum combination of current (2004) turning movement counts and signal timing developed for a somewhat different set of turning movement counts and count estimates.

In all cases, traffic signal timing was assumed to be fixed along the LRT corridor – 5th Street from Hennepin Avenue to Park Avenue, and the intersection of Chicago Avenue and 4th Street South. This assumption was based on the requirement, imposed for the development of timing plans in conjunction with LRT, that signal timing modifications can be made at intersections adjacent to, but not in, the LRT corridor. A special signal timing plan was developed for LRT in 2004 which takes into account the unique characteristics of LRT service, such as vehicle acceleration and speed attributes, passenger loading and unloading times, LRT vehicle operator instruction, and exclusive LRT phases at several intersections.

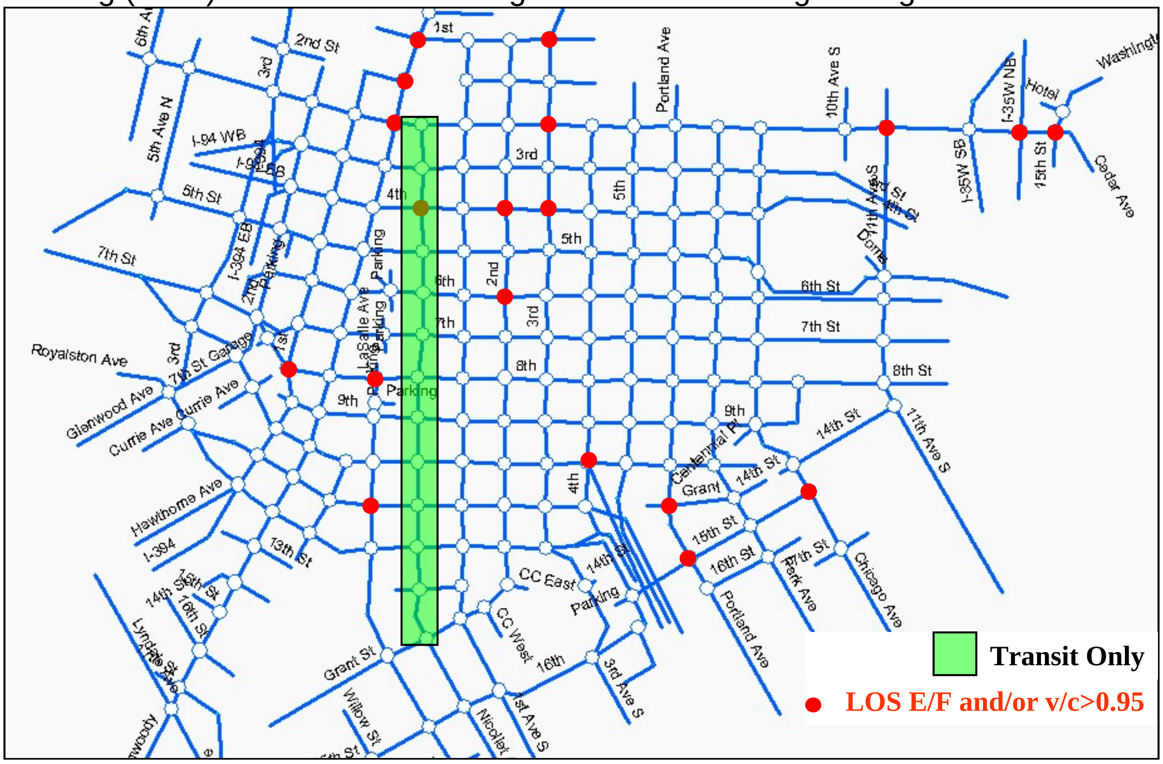
For each alternative analyzed, potential problem intersections were identified by examining the estimated performance of all of the movements at each intersection. The Highway Capacity Manual (HCM) reporting feature within Synchro was used to derive estimated performance for each vehicle movement. An intersection was defined as potentially problematic either if the average delay for a movement exceeded 55 seconds per vehicle or if the volume-to-capacity (v/c) ratio for a movement exceed 0.95. (The delay value of 55 seconds per vehicle corresponds to the low threshold for level of service E in the latest revision of the 2000 Highway Capacity Manual.) The practice of evaluating intersection performance based on both HCM level of service and v/c ratio is detailed in Transportation Research Record 1112 and reflects the inability, in some cases, of the HCM's delay-based levels of service to adequately identify potential problems in near- or over-capacity situations.

Summary of Alternatives and Capacity Analysis Results

Capacity analysis was performed for a variety of downtown street alternatives, each alternative consisting of a set of lane configurations and uses for each downtown street. Initial analyses of the existing street system, both currently and estimated in 2030, and of a large-scale conversion of one-way streets to two-way streets were performed. Based on these results, a hybrid, in which some streets are left as one-way and some – but not all – are converted to two-way operation was developed with input from the PMT. Further analysis was performed, and two additional hybrids, each developed based on the capacity analysis results from its hybrid predecessor, were also analyzed. Following is a summary of the characteristics of each alternative and the results of the traffic analysis.

Analysis 1 was simply a network-wide capacity analysis of existing (2004) counts with existing timing, using the existing downtown street configuration and existing transit facilities. The results for this analysis are presented graphically in Figure 11.

Figure 11. Results – Analysis 1
Existing (2004) Demands and Configuration with Existing Timing



Analysis 2 was identical to Analysis 1, except that the Synchro optimization features were used to improve signal timing for existing demands. The reduction in the numbers and the locations of intersections which would be expected to experience problems indicate those intersections at which operation would be expected to improve if current signal timing was optimized. Results for this analysis are presented in Figure 12.

For Analysis 3 the existing demands were re-distributed to a network in which most existing one-way streets were converted to two-way streets. In this case, the streets converted to two-way operation were modeled as having two lanes in each direction – the option "2+2" described earlier. In addition, it was assumed in this analysis that the contra-flow transit lanes currently on Marquette Avenue (southbound) and 2nd Avenue South (northbound) would be consolidated on Marquette Avenue, which would become a transit-only facility, with two transit lanes in each direction. 2nd Avenue South was assumed to be converted to be a four-lane, two-way facility carrying general (non-transit) vehicular traffic. Results from this analysis, presented in Figure 13, reveal that number of intersections expected to experience problems are approximately the same as for the current roadway configurations.

ADMINISTRATIVE DRAFT

Figure 12. Results – Analysis 2
Existing 2004 Demands and Configuration with Optimized Timing

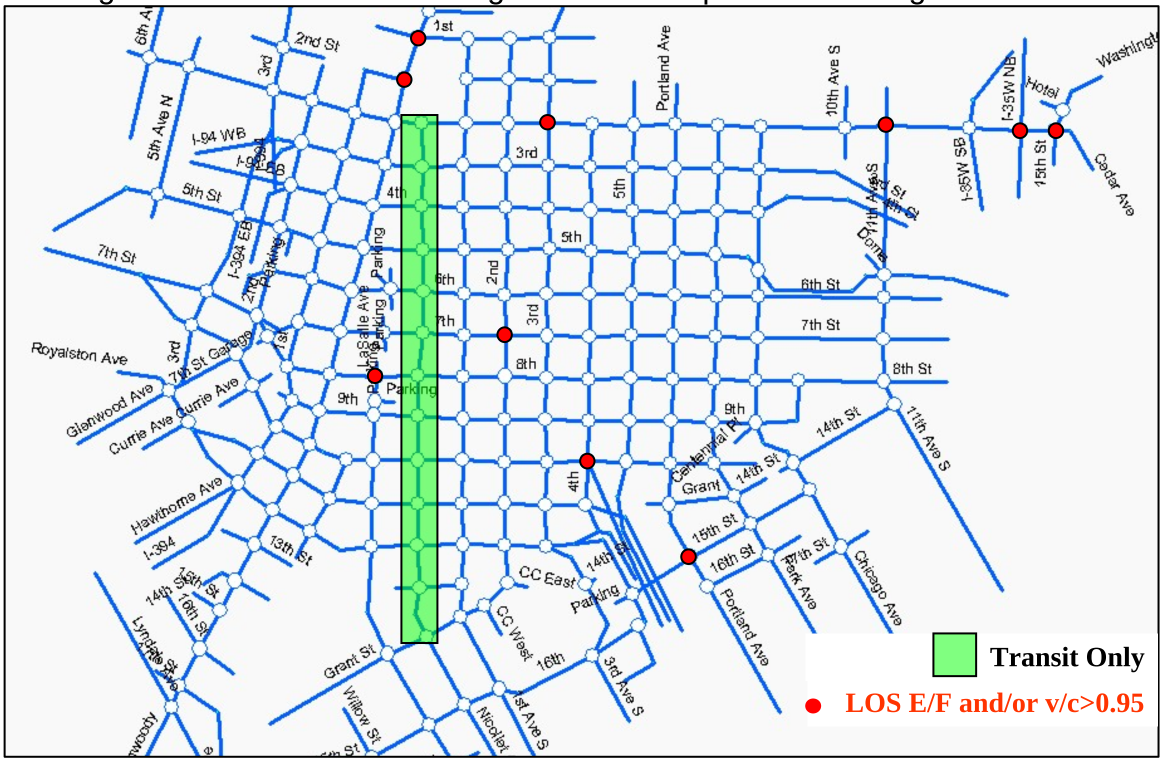
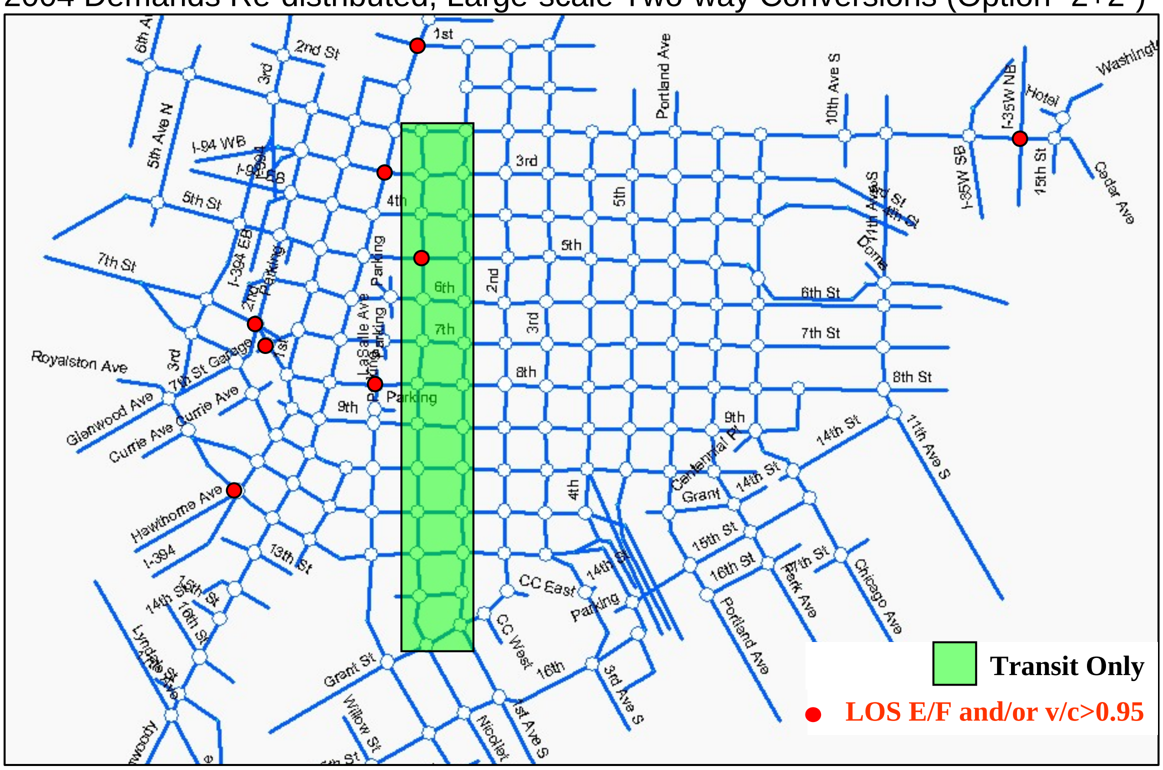


Figure 13. Results – Analysis 3
2004 Demands Re-distributed, Large-scale Two-way Conversions (Option “2+2”)



For Analysis 4, the assumptions were the same as for Analysis 3, except that the two-way roadway cross-sections would consist of one lane in each direction with a center left-turn lane – option "1+1+1" described earlier. In viewing the results, presented in Figure 14, it is clear that the reduction in capacities associated with the "1+1+1" cross-section would result in widespread capacity problems throughout the downtown network.

Analysis 5 consisted of evaluating the current downtown roadway configuration with forecast demands for 2030. As discussed earlier, to reduce the cost and attain quick results, the demands for this analysis were derived simply by using a uniform 26 percent increase in all turning movements. Figure 15 shows the results of this analysis.

Analysis 6 used 2030 forecast demands and assumed network-wide conversion of one-way streets to two-way using the "2+2" cross-section for the two-way streets. In addition, this analysis introduced the Primary Transit Network (PTN) into the system. As configured in the downtown area, the PTN included buses in mixed flow on Hennepin Avenue, buses in an exclusive with-flow transit lane on both 4th Street and 8th Street, and buses on Marquette Avenue in two exclusive transit lanes in each direction. The results from this analysis are shown in Figure 16. In that figure, it is clear that the street operation would be considerably worse than for the existing set of one-way streets.

Analysis 7 used 2030 forecast demands and assumed network-wide conversion of one-way streets to two-way using the "1+1+1" cross-section for the two-way streets. The results from this analysis are shown in Figure 17. These results indicate that well over half of the downtown intersections would be expected to experience capacity problems with this configuration.

After viewing these results, because of the significant capacity problems anticipated, the PMT consensus was to abandon the "1+1+1" cross-section from further study in favor of the "2+2" cross-section.

Figure 14. Results – Analysis 4
2004 Demands Re-distributed, Large-scale Two-way Conversions (Option “1+1+1”)

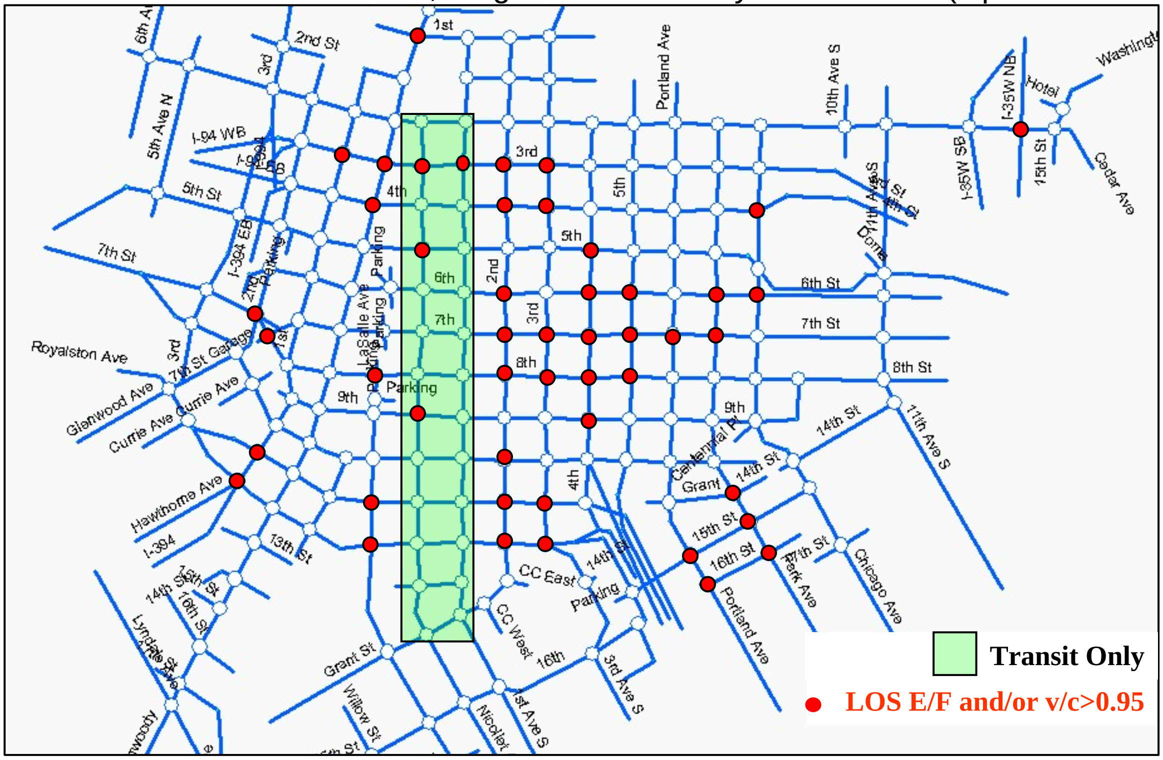


Figure 15. Results – Analysis 5
2030 Demands, Existing Configuration

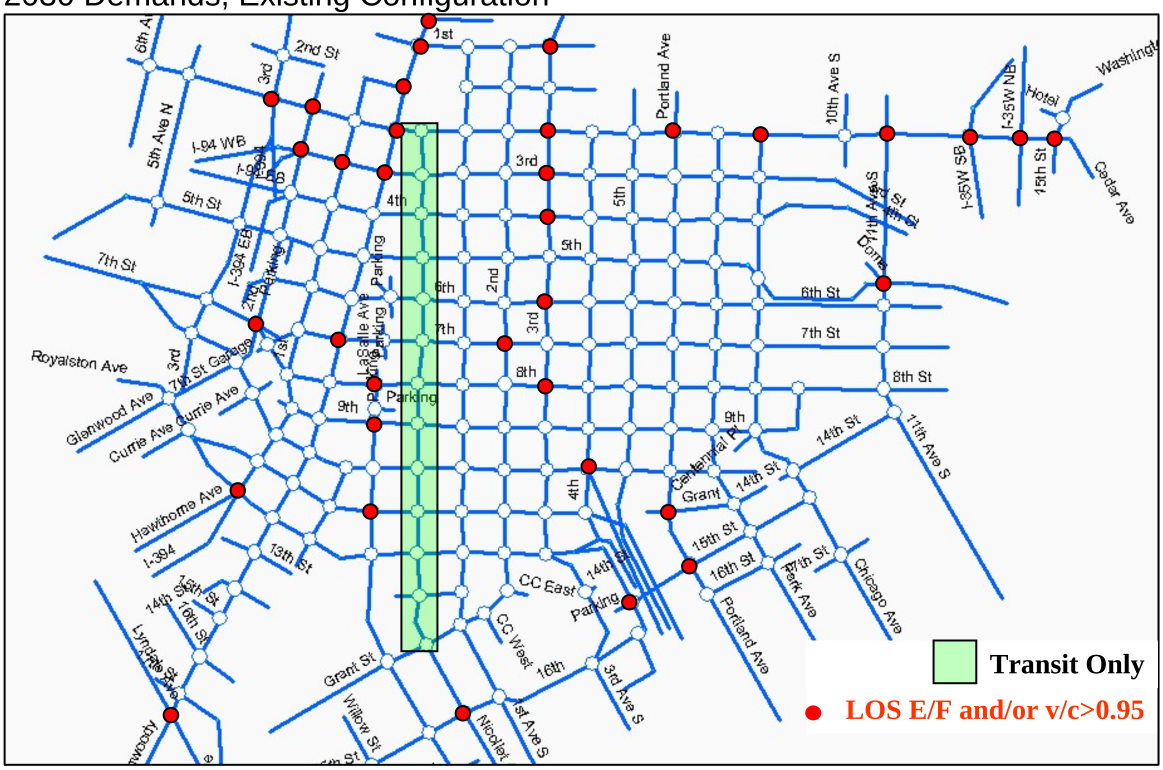


Figure 16. Results – Analysis 6
2030 Demands, Large-scale Two-way Conversions (Option "2+2")

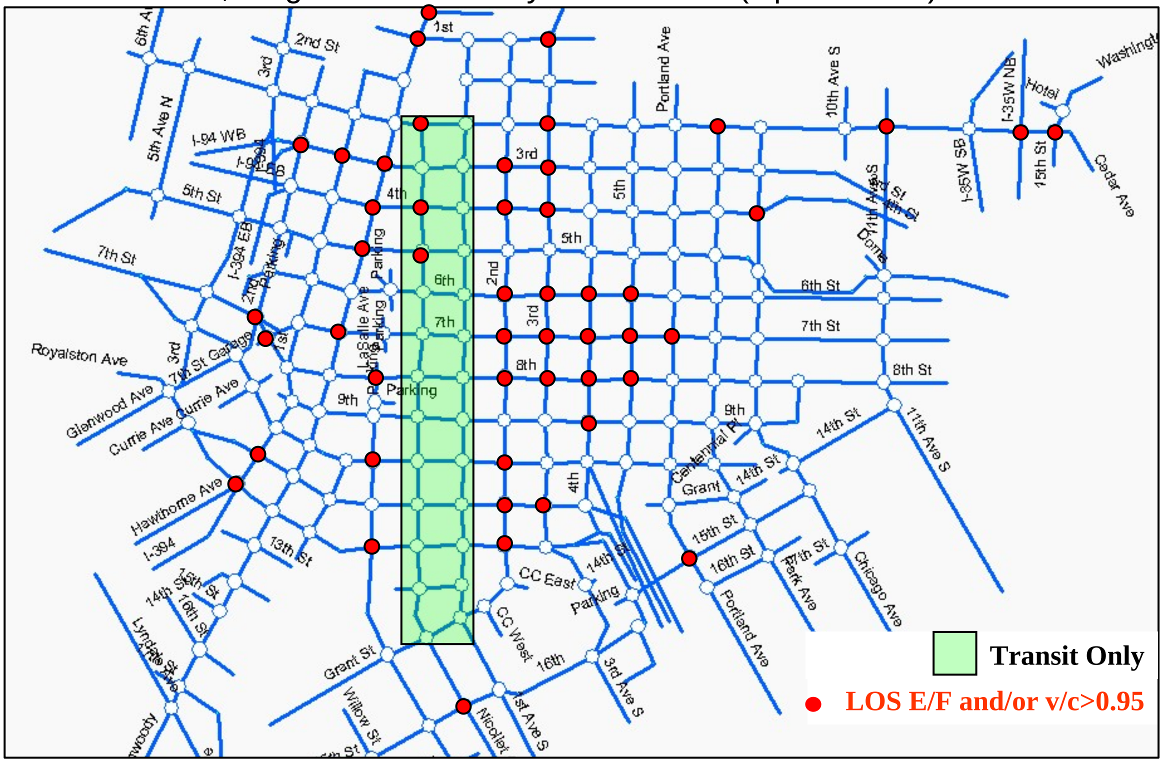
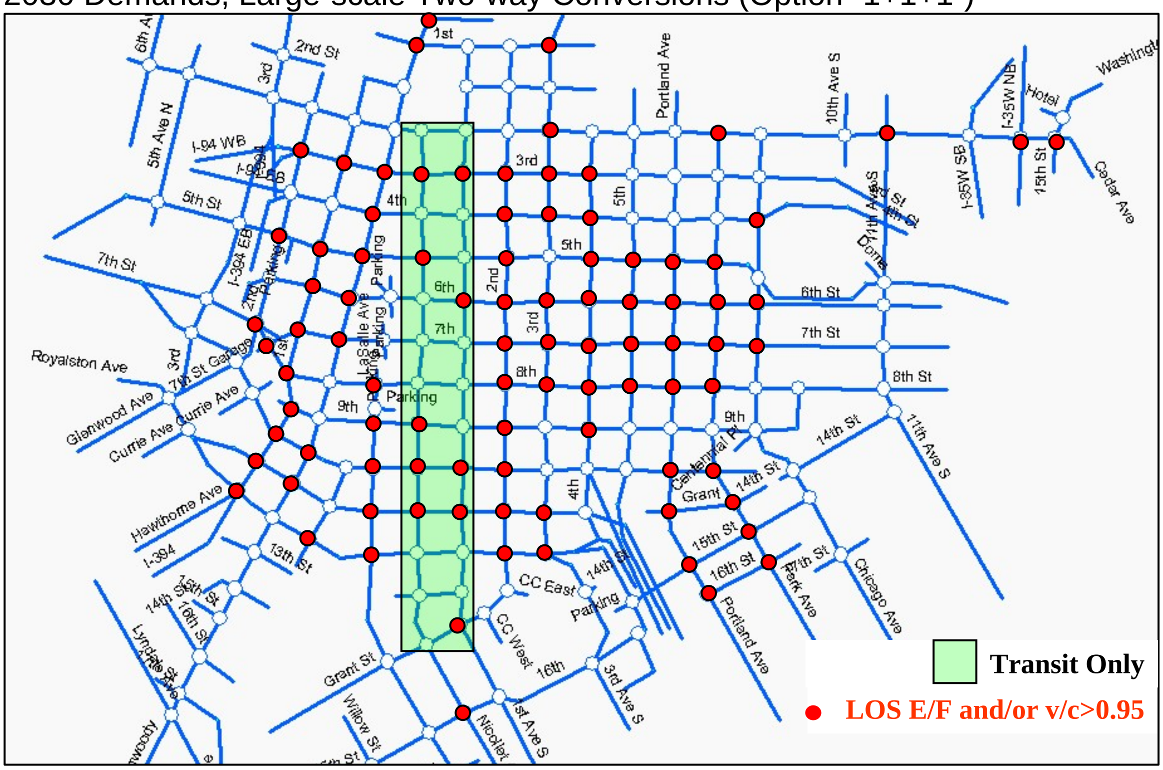


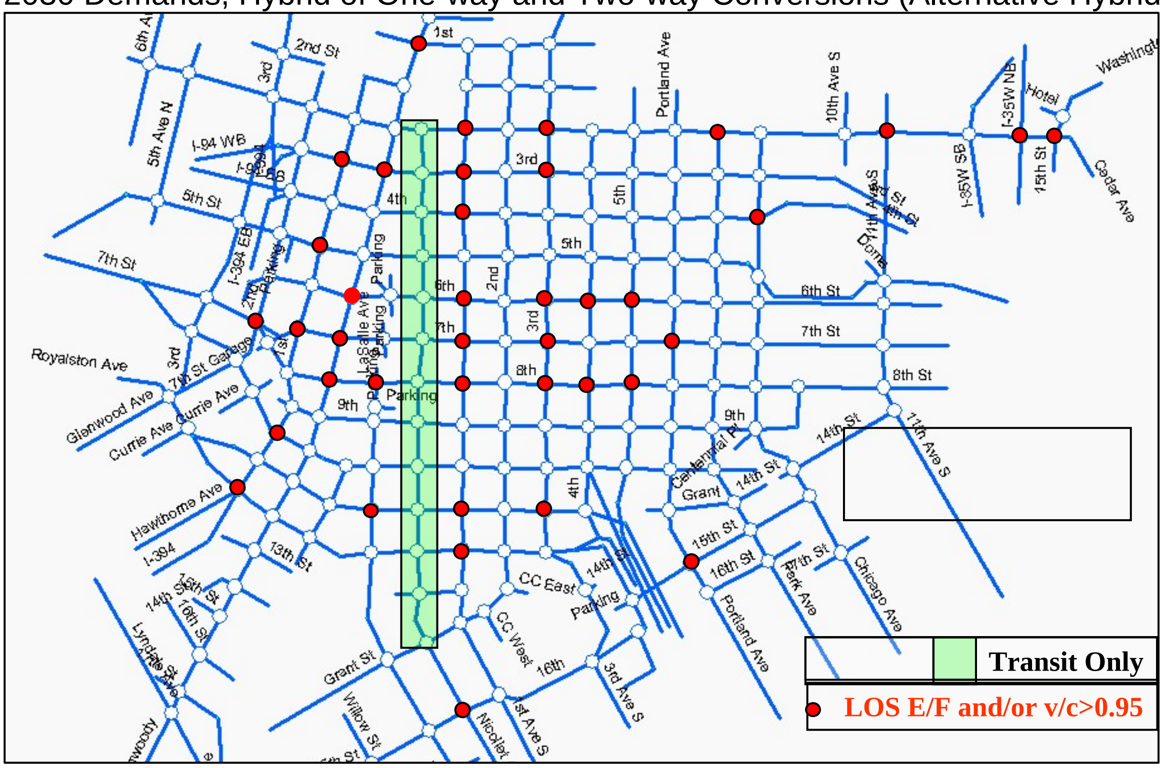
Figure 17. Results – Analysis 7
2030 Demands, Large-scale Two-way Conversions (Option "1+1+1")



In addition to eliminating the three-lane, two-way cross-section from further consideration, the PMT realized that the conversion of one-way to two-way streets would need to be scaled back to provide adequate vehicular capacity in 2030. Consequently, a hybrid of one-way and two-way streets was adopted. This hybrid, labeled "Hybrid A", recognized that accesses to the freeways – specifically I-35W to the south and I-94/I-394 to the west – would require one-way operations for several blocks, due to the high volumes delivered to and from those freeways. For this reason, both 4th Avenue South and 5th Avenue South were returned to one-way operation from 6th Street to 10th Street. Also, both 3rd Street and 4th Street were returned to one-way operation from 2nd Avenue North to 3rd Avenue South. In developing this hybrid, the PMT also recognized there were issues related to making Marquette Avenue a two-way, transit-only street. As a result, for all hybrid analyses, both Marquette Avenue and 2nd Avenue South were assumed to operate much as they do today, carrying general traffic in one direction and transit in contra-flow lanes in the opposite direction. Due to transit needs – increasing demands, the potential to implement stops every other block – the difference between current and future operations is that the contra-flow transit lanes on each street would require two lanes rather than the current single lane. The number of mixed-flow traffic lanes would remain the same as today but on-street parking would be removed during the peak periods.

The analysis (Analysis 8) results of the initial hybrid configuration (Hybrid A) are shown in Figure 18.

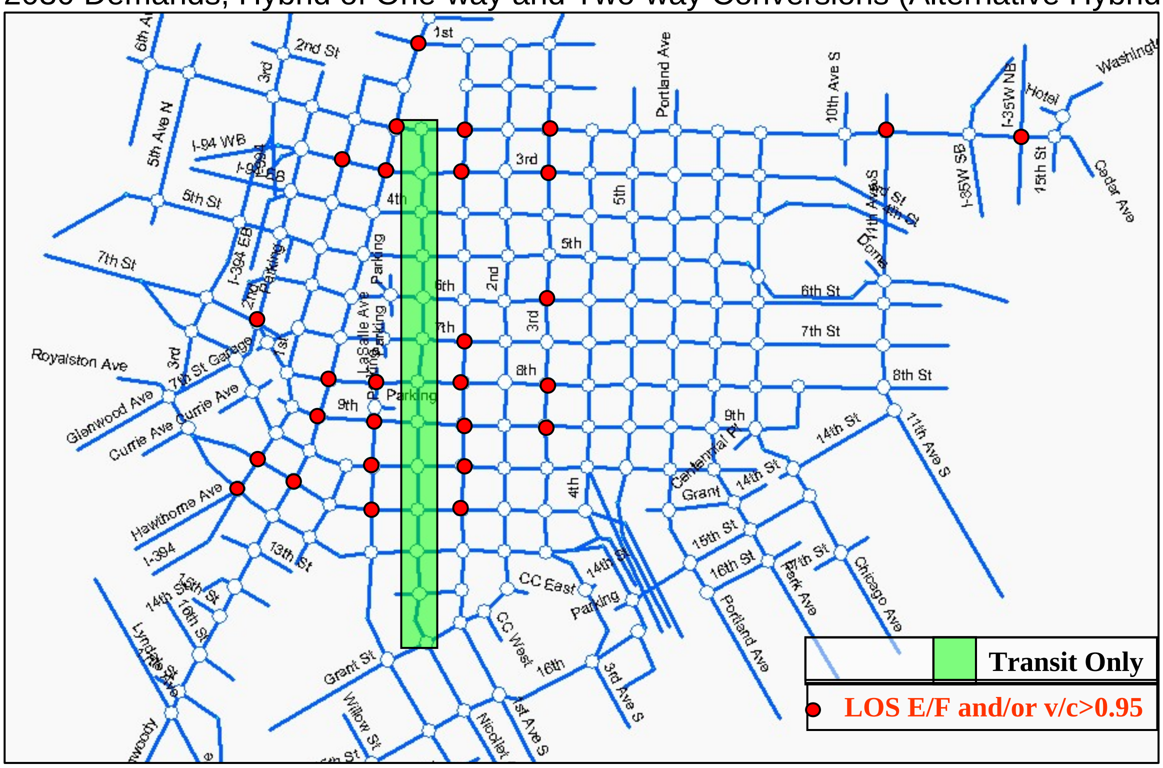
Figure 18. Results – Analysis 8
2030 Demands, Hybrid of One-way and Two-way Conversions (Alternative Hybrid A)



Hybrid B was developed when the results from Analysis 8 revealed that there were significant anticipated capacity problems remaining. Those problems were concentrated primarily in the central core area – on 6th, 7th, and 8th Streets and on Hennepin Avenue, Marquette Avenue and 3rd Avenue South. Because 8th Street is identified as a key component of the PTN, the cross-section on 8th Street was left as it was in Hybrid A. Also, based on feedback from City representatives, retaining Hennepin Avenue and 1st Avenue North as two-way streets in further analyses was also determined to be of extreme importance, even if that requirement forced other streets to remain one-way.

Based on this direction, both 6th Street and 7th Street were returned to one-way operation for their entire lengths, and one-way operations existing in Hybrid A were extended to the full length of the streets on 4th Avenue South, 5th Avenue South, 3rd Street, and 4th Street. In addition, both 11th Street and 12th Street were returned to one-way operation west of I-35W. When the preliminary results for Hybrid B proved to be not significantly better than those for Hybrid A, it was determined that the forecasting model set up to assign turning movements to each of the intersections was relatively insensitive to changes made from Hybrid A to Hybrid B. Therefore, a second trip re-distribution was conducted – manually – to arrive at a condition in which the intersections in the core area had relatively balanced operations (i.e., equilibrium). The results of the final analysis for this hybrid alternative are shown in Figure 19.

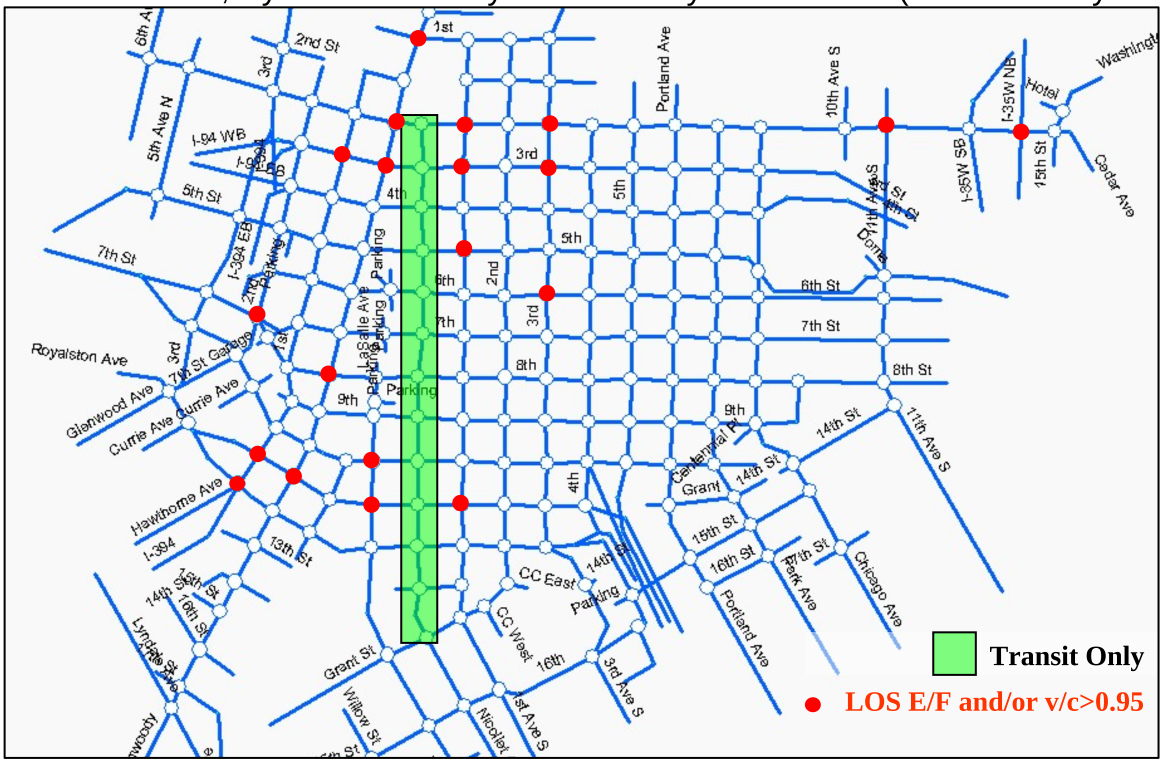
Figure 19. Results – Analysis 9
2030 Demands, Hybrid of One-way and Two-way Conversions (Alternative Hybrid B)



As shown in that figure, forecast capacity problems persisted in the southern portion of the core area. Therefore, 9th Street and 10th Street were returned to one-way operation west of 5th Avenue South and the system was analyzed again, as Hybrid C. As was found in the comparison of

Hybrid A and the preliminary analysis in Hybrid B, the preliminary analysis of Hybrid C proved to be nearly the same as for Hybrid B. Once again, a manual re-distribution of turning movements was performed to arrive at an equilibrium condition in the core area. The results of this final analysis are shown in Figure 20. It was determined that the operations of this alternative would be similar to those of the current downtown configuration in 2030.

Figure 20. Results – Analysis 10
2030 Demands, Hybrid of One-way and Two-way Conversions (Alternative Hybrid C)



Following is a summary of the cross-section changes represented in Hybrid C:

- Hennepin Avenue becomes a four-lane, two-way street carrying all traffic – general traffic and transit traffic – in both directions. Transit in both directions would be mixed with other traffic, i.e. no exclusive transit lanes.
- 1st Avenue North becomes a four-lane, two-way street for its entire length (including Hawthorne Avenue), requiring removal of on-street parking on at least one side, potentially both sides depending on other uses for this street. Significant geometric changes at the intersection of Hawthorne Avenue and 12th Street North would be required to transition to the I-394 entrances and exits. This transition is critical, to prevent traffic from diverting from Hawthorne/1st Avenue North to Hennepin Avenue.
- Marquette Ave and 2nd Avenue South become four-lane roadways, carrying general traffic in two lanes in one direction (northbound on Marquette, southbound on 2nd) and buses in two exclusive lanes in the contra-flow direction. It is proposed that the bike lanes be retained on 2nd and Marquette and, therefore, there would be no on-street parking on these streets. Curbside activities such as deliveries and passenger drop-off would be permitted during the non-peak periods.

- Portland Avenue and Park Avenue become four-lane two-way streets north of Franklin Avenue. If these streets remain one-way south of Franklin Avenue, logical transition locations between the one-way and two-way operations, which may be north of Franklin Avenue, will need to be determined.
- 8th Street becomes a four-lane, two-way street. The inside two lanes carry general traffic, one lane in each direction. The outside two lanes are exclusive with-flow transit lanes, necessary for proper functioning of the PTN.
- 9th Street and 10th Street South become two-lane, two-way streets east of 5th Avenue. As for other streets discussed above, transitions between the one-way and two-way segments will need to be identified.

Volume-To-Capacity Analysis Summary

As a means to consolidate and easily convey the system-wide results of the capacity analyses performed for the downtown portion of this project, the volume-to-capacity (v/c) ratios for the entire system are shown in a series of bar charts. V/c ratio was one of the two measures used in previous figures to identify locations at which capacity issues are likely to arise, both now and in the future. (The other measure was level of service, based on delay according to the 2000 Highway Capacity Manual.) . It should be noted that, at individual intersections, a particular movement or combination of movements could experience high delays, but have volumes well under capacity, as a result of low volumes, which in a signal optimization tend to receive less green (and more red) time, or non-progressive signal timing between intersections.

In Figure 21 are shown the distribution of v/c ratios across all intersections in the downtown area for four alternatives using 2004 demands. The first two alternatives, “Existing” and “Existing, Optimized Timing”, demonstrate that some intersections currently experiencing capacity problems, could improve their operation through signal timing optimization. The other two options show the expected operations if most of the one-way streets were converted to two-way operation, using either of two two-way cross-sections. This figure shows that the “2+2” two-way cross-section could provide approximately the same operation network-wide as the current street configurations.

Figure 22 shows essentially the same comparison, except that 2030 forecast volumes were used for the alternatives. This figure confirms that the “1+1+1” two-way cross-section would be expected to provide a significantly worse operation than either the current downtown configuration or the “2+2” two-way cross-section, with approximately 45 percent of the downtown intersections exceeding or very near capacity. The comparison of the existing configuration and the “2+2” alternative shows that there is a tendency as demands increase – as they are expected to do between now and 2030 – the operation of a two-way network will degrade at a faster rate than a primarily one-way network. It is likely that this is a consequence of the increasing conflicts occurring between left-turning vehicles and opposing through vehicles in a two-way system.

Figure 21. Volume-to-capacity Ratios for Alternatives (2004)

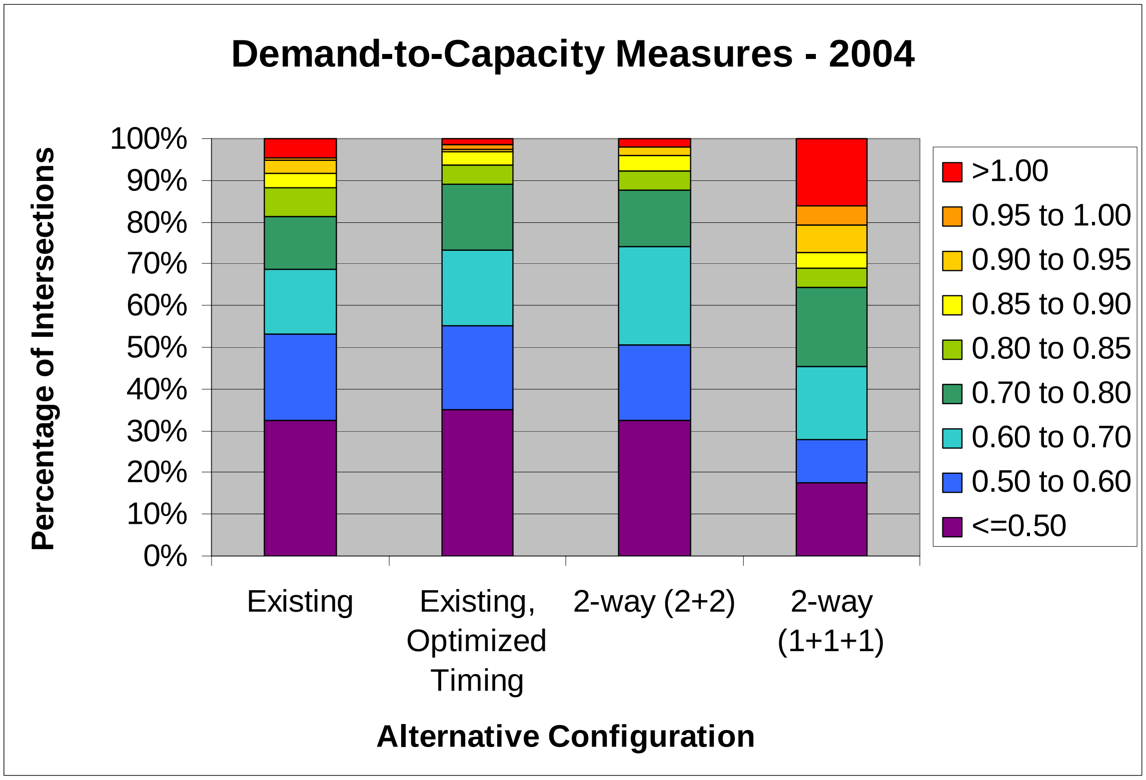
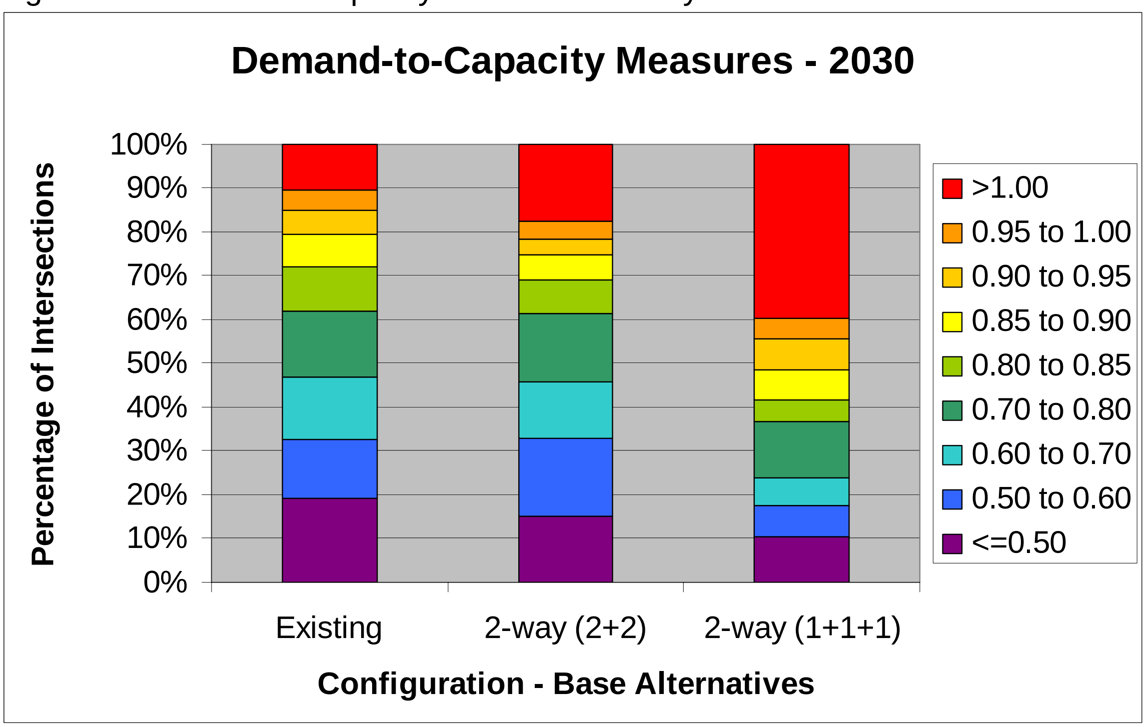


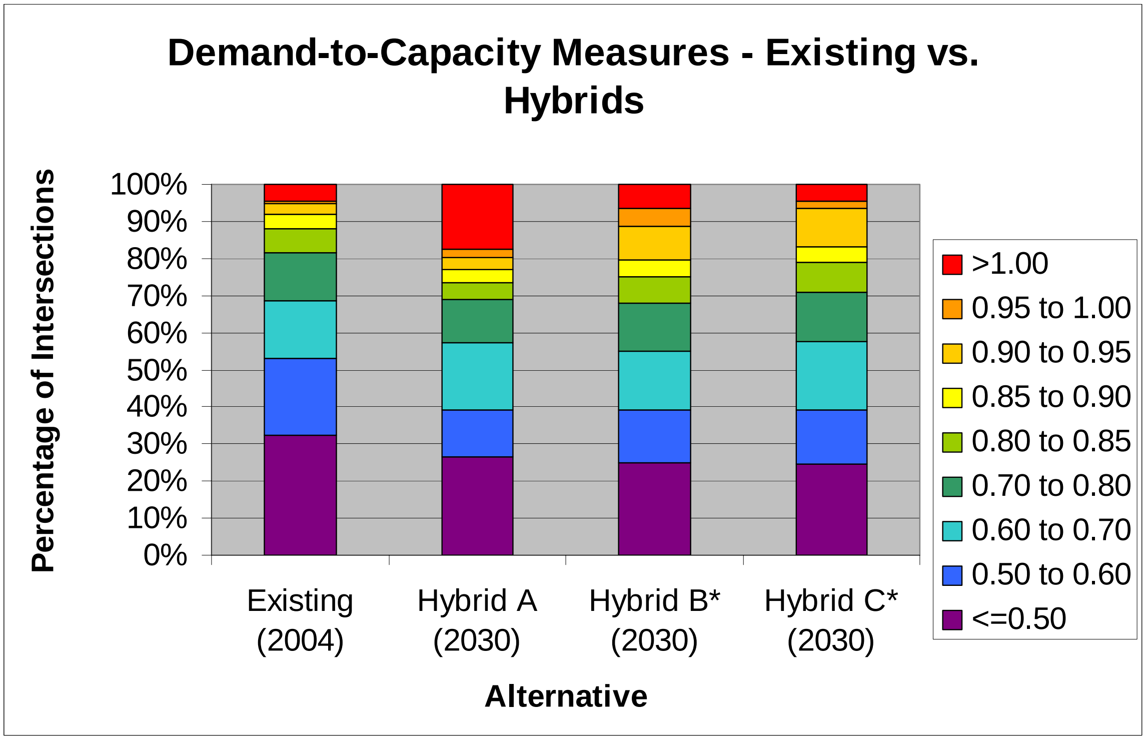
Figure 22. Volume-to-capacity Ratios for Primary 2030 Alternatives



Finally, Figure 23 provides a comparison between existing operations and the three hybrid alternatives, which convert some of the one-way streets to two-way operation. This comparison was provided so that a person familiar with current downtown operations and capacity issues would have a feeling for how the downtown operations would behave overall under the three hybrid scenarios. In fact, a goal of the succession of hybrid alternatives was to arrive at an alternative which would feel similar to today's traffic levels. From the figure below, it appears that the Hybrid C alternative approaches that goal.

There is one cautionary note, touched on in earlier capacity analysis discussions but which deserve repeating here. Operations for hybrid alternatives B and C, each denoted with an asterisk (*) in the figure, were evaluated in a two-step process, the second step of which involved very detailed manual manipulation of traffic distributions to arrive at a best-possible operational solution. None of the other alternatives were put through this rigorous exercise, in most cases because the extra effort would not have yielded a different overall conclusion as to whether or not an alternative would work. It is a certainty that if the same exercise had been performed for each of the other alternatives, including the 2030 analysis of the existing downtown street configurations, the results for those alternatives would have been better than shown in these figures.

Figure 23. Volume-to-capacity Ratios, Existing (2004) vs. Hybrids (2030)



Air Quality Effects

Discussion of State Implementation Plan issues with downtown hot spot locations.
[Hot spot analysis of 7th/Hennepin in process]

Effects on Parking Garage Access

Discussion of building access in relation to transit street operations

Diagrams of Marquette, 2nd, 8th showing building access

Description of traffic operations at garage access on Marquette with and without traffic control officers – video of Midwest Plaza operations

Simulation of Midwest Plaza access operations showing how double width transit lanes would operate

Downtown Street Cross Sections

The following table shows proposed cross section treatments for streets in the Downtown under the proposed strategy described above.

Downtown Streets
Proposed Lane Patterns

DRAFT 9/13/2006

One-way Streets with Three Lanes

3rd St, 4th St, 6th St, 7th St, 9th St, 10th St, 4th Ave S, 5th Ave S, 2nd Ave N, 3rd Ave N

	Walk	Park	Bus	Bike	Travel	Travel	Travel	Travel	Bike	Park	Walk	Nominal Width Travelway	Nominal Width R/W
One-way w/Prkg/1-way Bike	12	8			11	11	11		6	8	13	55	80
One-way w/Transit/1-way Bike	12		13	8	11	11	13				12	56	80
One-way w/Prkg/Pk Lane*	13	8			11	11	11			13	13	54	80

* Wide parking lane is striped for peak period use as a travel lane

Two-way Streets with Two Lanes

2nd St. S, 11th Ave S

	Walk	Park	Bike	Travel	Travel	Median/Turn	Travel	Travel	Bike	Park	Walk	Travelway	R/W
Two-way with Bike/Prkg	15	8	6		11		11		6	8	15	50	80

Two-way Streets with Four Lanes

1st Ave N, Park, Portland, Chicago, LaSalle

	Walk	Park	Bike	Travel	Travel	Median/Turn	Travel	Travel	Bike	Park	Walk	Travelway	R/W
Parking both sides	12	7		11	10		10	11		7	12	56	80
Bike both sides	12		6	11	11		11	11	6		12	56	80
Parking/Bike	12	7		11	10.5		10.5	11	6		12	56	80
Parking one side	12	8		11	11		11	13			14	54	80

Note: 10 ft lanes do not meet MSA/CSAH standards, variance/exception required

Hennepin

	Walk	Park	Bike	Travel	Travel	Left Turn	Travel	Travel	Bike	Park	Walk	Travelway	R/W
No Parking/bike	21			13	11	11	11	13			20	59	100
Bike one side	20			13	10	10	10	11	6		20	60	100

Note: 10 ft lanes do not meet MSA/CSAH standards, variance/exception required

3rd Ave S

	Walk	Park	Bike	Travel	Travel	Median/Turn	Travel	Travel	Bike	Park	Walk	Travelway	R/W
Median	10.5			13	11	11	11	13			10.5	59	80
Left Turn Lanes	10.5			13	12	9	12	13			10.5	59	80

Two way Streets with Six Lanes

Washington Ave

	Walk	Park	Travel	Travel	Travel	Median/Turn	Travel	Travel	Travel	Park	Walk	Travelway	R/W
Median or Left Turn Lanes	13.5		12	12	12	11	12	12	12		13.5	83	110

Transit Streets

With single with-flow transit lanes (8th St)

	Walk	Park	Bike	Bus	Travel	Left Turn	Travel	Bus	Bike	Park	Walk	Travelway	R/W
Hennepin to Nicollet	12			13	10		10	13			12	46	70
Nicollet to Marquette	11.5			11	10		10	11			11.5	42	65
<u>East of Marquette</u>													
Two-way with Prkg	12	7		11	10		10	11		7	12	56	80
Two-way with Left Turn Lanes	12			13	10	10	10	13			12	56	80

Section with parking could have curb extensions at transit stops

With two contra-flow transit lanes (2nd Ave S, Marquette)

	Walk	Park	Bike	Bus	Bus	Bike	Travel	Travel	Bike	Park	Walk	Travelway	R/W
One-way Bike Option	14			13	11	6	11	13			12	54	80
Two-way Bike Option	14			13	11	8	10	12			12	54	80
Parking one site Option	14			13	11		11	11		8	12	54	80

Either option would allow for wider walks on the transit side of the street or a wider transit or bike lane

Nicollet

	Walk	Park	Bike	Bus	Travel	Median/Turn	Travel	Bus	Bike	Park	Walk	Travelway	R/W
Two-way with Prkg	27			13				13			27	26	80