Pedestrian Safety, Mobility & Context Improvement Study

State Routes 70/20
Marysville, CA

July 2008

Prepared By

Local Government Commission
Community Partners llc
Moore Iacofano Goltsman
Designing Streets for Pedestrians
Clairvoyant Graphics
Livable Streets

Pedestrian Safety, Mobility & Context Improvement Study:

State Routes 70/20 in Marysville, CA

July 2008

Acknowledgements

Marysville City Staff
Dave Lamon, City Services Director
Gary Price, Community Development Coordinator
Angela Spain, Planning Technician

Marysville City Council
Mayor Bill Harris
Vice Mayor Christina Billeci
Councilmember Jim Kitchen
Councilmember Michael Selvidge
Councilmember Benjamin Wirtschafter

Design Team

Local Government Commission
Paul Zykofsky, Director of Transportation and Land Use Programs
Anthony Leonard, Project Manager
1303 J Street, Suite 250
Sacramento, Ca 95814
916-448-1198

Community Partners LLC
Sue Newberry
218 Carville Circle
Carson City, NV 89703
775-841-6820

Moore Iacofano Goltsman
Mukul Malhotra, Urban Designer/Project Manager
Julia Abiassi, Urban Designer/Project Associate
800 Hearst Avenue
Berkeley, CA 94710
510-845-7549

Designing Streets for Pedestrians & Bicyclists LLC
Michael Ronkin
1602 Center St NE
Salem OR 97301
541-914-1401

Clairvoyant Graphics
Marcel Schmaedick
3043 NE 57th Ave
Portland, OR 97213
503-706-8788

Livable Streets, Inc.
Michael Moule, President
1413 S. Howard Ave., Suite 206
Tampa, FL 33606
813-254-7708

Funding provided through a California Department of Transportation (Caltrans) Community-Based Transportation Planning Grant and the City of Marysville.

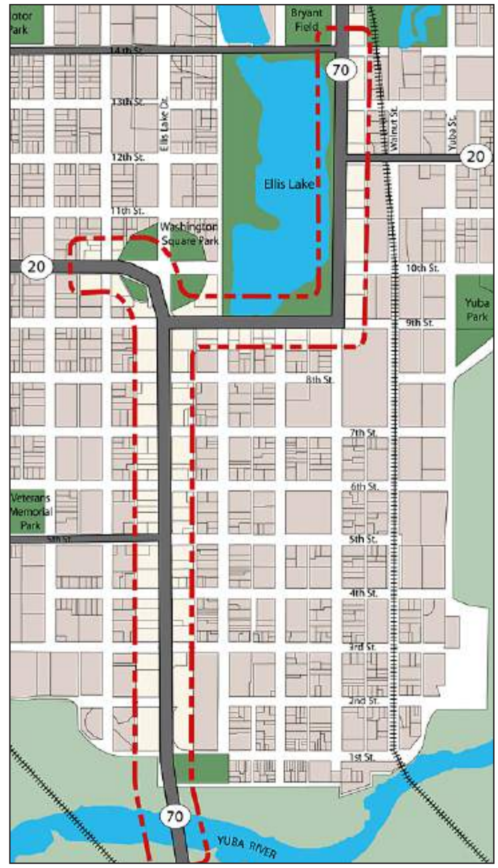
Table of Contents

Introduction

Project Purpose

The project's purpose is to prepare recommendations to improve pedestrian connections and walkability across and along State Route 70 and State Route 20 (SR70/20). As these highways pass through the City of Marysville, they become the major downtown arterials. Tens of thousands of cars and trucks travel through the city each day. The large trucks and heavy traffic volumes discourage walking and bicycling along these corridors. Furthermore, these corridors have little or no landscaping or accessibility compliant with the Americans with Disabilities Act (ADA). Some sidewalks are broken or uplifted. As a result, potential pedestrian and bicycle access between the historic downtown, parks, and other neighborhoods is severely restricted.

The project will produce a vision plan and detailed recommendations to help Marysville achieve its Smart Growth goals, including improved walking, bicycling, and transit facilities.



Highways 70/20 include E Street to 10th, 10th west of E to the City border, 9th between E and B, and B Street north of 9th. The highway wraps around the downtown area of Marysville and runs along the popular park around Ellis Lake.

Background

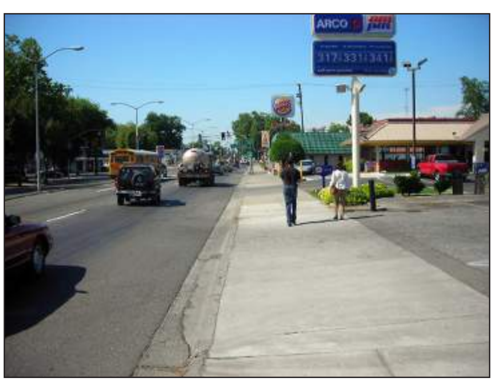
Marysville has about 12,500 residents and is the Yuba County seat. It is located at the confluence of the Feather and Yuba Rivers, 40 miles north of Sacramento. Highways 70 and 20 intersect in Marysville, making it a crossroads for vehicles destined for Chico, Grass Valley, Central Valley, and the Sierra Nevada, as well as many northern cities located near Interstate 5. Highways 70 and 20 are high volume roadways that provide access for through and local trips.

Some City neighborhoods attract pedestrian and bicycle users, but the state highways act as barriers between neighborhoods for walkers and cyclists. The southwest quadrant shown on the study map includes a hospital, elementary school, park, and residences. The southeast quadrant includes the historic downtown, parks, residences, library, post office, private school, churches, office buildings, and civic buildings.

Previous planning efforts have recommended improving connectivity and enhancing the appearance of major street development. The Downtown Economic Development Strategic Plan was to guide public and private investment toward building a thriving downtown commercial district in Marysville. The plan stresses providing pedestrian links between neighborhoods and

The recreational trail on this levee in Marysville has few connections with downtown or other destinations.

E and 9th Streets, Marysville. State highways 70 and 20 merge at this intersection.



The study area's commercial development was largely car-oriented, like in the photo above. Numerous wide driveways increase pedestrian risk.

corridors, both downtown and throughout the city. The General Plan promotes pedestrian convenience and requires landscaping and trees along major streets and highways.

The need for a highway bypass has been discussed over the years. Caltrans has no plans for a bypass, but the Metropolitan Transportation Plan, first tier, includes the first phase of a Marysville bypass project. That project is not expected to provide a complete bypass in the foreseeable future.

The Yuba-Sutter Bikeway Master Plan, December 1995, is incorporated into the Sacramento Area Council of Governments (SACOG) Regional Bicycle, Pedestrian, and Trails Master Plan dated May, 2007. SACOG vision statements express the need for a regional network of multi-use paths and lanes that connect jurisdictions. This network would provide walking and bicycling access to all destinations. Specific goals include providing bicycle and pedestrian connections within, through, and between each city and town in the six-county region. These include all public transit systems, park and ride lots, and activity centers such as universities, hospitals, and commercial centers. The SACOG plan includes a list of projects, none of which are located in Marysville.

Existing Conditions

The primary purpose of state highways is enabling inter-regional travel between counties and cities throughout the state. The same state highways also often serve as the backbone of local circulation systems, as in Marysville.

In Marysville, Highways 70 and 20 are surface streets with two to six through travel lanes varying in width. Entering Marysville from the south Highway 70 becomes E Street, turns east onto 9th Street and then north on B Street. Highway 20 enters the City from the west on 10th Street, shifts south one block to 9th, north on B Street and east on 12th Street. On-street parking is allowed in some segments of E Street between 3rd and 9th Streets. Some street segments within the study area have raised medians or curbing between signalized intersections that prevents left-turn movements.

Most businesses along the two highways are car-oriented, with multiple driveways, drive-through windows between sidewalks and buildings, and surface parking in front of buildings. Historic buildings along E Street are located near the back of sidewalks.

Many of the buildings in the study area are accessible from alleys in the back of the premises.

Sidewalks are on both sides of the street in most of the study area. The walkway on the north side of 9th Street and the west side of B Street is a narrow path near Ellis Lake. Sidewalk width and buffers between sidewalks and moving traffic vary. Some street segments have mature landscaping along the roadway edges. Portions of 10th Street have a landscaped median.

Fire hydrants are located on one side of the street. Emergency services do not currently have a system to preempt signals when crossing E Street, a common route for responding to calls.

At signal-controlled intersections, pedestrian crosswalks are marked inconsistently. Some intersections have all legs marked. Other intersections have some legs marked, while some signal-controlled intersections in the study area have no markings. Crosswalks are not marked on any uncontrolled intersections. Participants reported that the highways were difficult to cross. During field observations, some pedestrians who tired of waiting for a walk signal to cross E Street proceeded against the light during gaps in traffic.

Some intersections provide curb ramps for people who use wheelchairs, strollers, or other personal assistance devices. Many curb ramps and driveway crossings appear to exceed the maximum slope allowed. Truncated domes specified by the Americans with Disabilities Act (ADA), Public Rights-of-Way requirements are missing from most curb ramps.

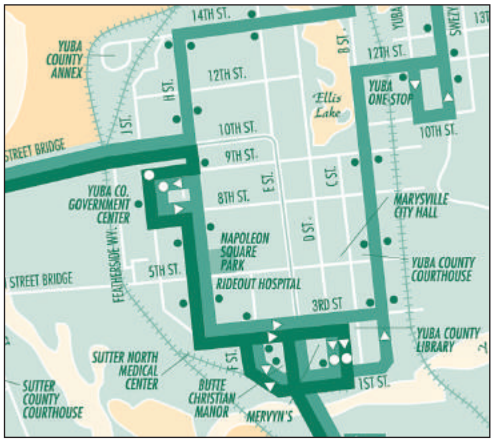
There is no bikeway system in Marysville. Bike lanes are marked on some side streets and there are some shared-use trails, but they are not easy to find. The facilities are disconnected and do not create a complete network. Some bicyclists use sidewalks, which creates conflicts with pedestrians. Other cyclists share travel lanes with vehicles.

Yuba-Sutter Transit provides service to Marysville. Transit routes almost completely avoid the state highways. Buses loop the downtown and link to Yuba City, outlying areas, and Sacramento. Transit routes cross E Street, but do not travel on E Street. One route does travel along B Street next to Ellis Lake, but only a few blocks. Crash data for January 2002 to December 2006 provided by the Marysville Police Department shows that most collisions

Crosswalk marking is inconsistent, as shown in the photo above. Crossing E Street here is legal, though the crosswalk is not marked, while the shorter 4th Street crossing has a marked crosswalk.

Marysville lacks a bikeway system. Major routes, like the one above, lack marked bike lanes.

Yuba Sutter Regional Transit buses serve downtown Marysville frequently.



Yuba Sutter Regional Transit provides frequent service connecting downtown Marysville (above) with Yuba City, outlying districts, and Sacramento. Buses have bike racks as shown below.

on Highway 70/20 were property damage only or resulted in minor injuries. Crashes were highest at the intersection of E and 5^{th}. The Police Department reported that two fatalities in 2006 were bicyclists. During focus groups, participants reported that crashes were reduced when cameras that take photos of vehicles running lights were installed at G, 3^{rd}, and 5^{th} Streets.. They also reported that even minor "fender bender" collisions created substantial delays at intersections.

Process

A multi-day design effort, or *charrette*, was conducted from May 30 to June 6, 2007. Staff, community leaders, and residents participated in a series of events designed to identify concerns, priorities, and potential solutions. The events began with a series of focus group meetings. Groups included City, SACOG, and Caltrans staff, emergency services providers, community leaders, schools, and downtown business people. The facilitator encouraged each group to share their knowledge, concerns, and ideas about the study area. Highlights of the focus groups appear in the Appendix.

A Community Workshop was held in Marysville at the Historic Packard Library on Thursday, May 31, 2007. Participants shared ideas and viewed a slide presentation highlighting study area issues. On Saturday, participants walked with the Consultant Team along E, 9^{th}, and B Streets. The group observed traffic and pedestrian patterns in the field, discussed concerns, and considered some ideas for resolving problems. After the field review, participants viewed a presentation illustrating concepts for addressing issues within the study areas. Participants then gathered at tables to develop suggestions for improvements and present their results to the entire audience.

A series of focus groups held at the beginning of the charrette helped identify concerns and ideas. In the photos above, participants provide input.

Some community concerns were beyond the scope of this project, but the improvement plan developed during the next four days reflected most of the input. On Wednesday, June 6, 2007, consultants presented slides of the plan's key points at a Closing Workshop. Notes from the public processes appear in the Appendix.

Photos at the top show participants at the opening workshop. Middle photos show participants working with aerial maps to plan improvements. Photos at the bottom show participants conducting field audit.

Marysville has many assets. These include an historic downtown, as shown in the two top photos. Marysville's natural environment includes two rivers (third photo above), Ellis Lake (at bottom), and neighborhood parks.

Recommendations

Guiding principles
Overall project recommendations
Site-specific recommendations

Guiding Principles

The public process in this and previous planning efforts suggested a strategy based on three guiding principles: building on Marysville's assets; corridor beautification; and providing safe connections for all users (pedestrians, cyclists, and motorists).

1) Assets: Build on Marysville's existing assets

Marysville has many assets that provide a foundation for the future and this plan. These include a historic downtown, a desirable natural environment, a grid for a street network, and numerous revitalization opportunities. The historic downtown includes a variety of restaurants, retail businesses, historic points of interest, and civic functions. The large variety of diverse destinations makes the historic downtown an attractive walking destination.

Marysville is closely connected to the natural environment by the Feather and Yuba Rivers, which define two edges of the city. Riverfront Park provides open space and trails along the Feather River. Marysville has several city parks and open spaces in its central district, including Veteran's, Motor and Yuba. Ellis Lake dominates the center of the city, with its parkland and adjacent Bryant Field. The state highways form two sides of the Ellis Lake park.

Marysville's traditional street grid with short blocks helps distribute motorists and allow pedestrians to reach many destinations. The grid pattern allows easy access to tourists who wish to leave or enter and provides multiple opportunities to attract visitors from the heavily traveled highways. It is an asset to be treasured and preserved. See the discussion of "Connectivity" on page 9 for some additional benefits of a grid system.

The state highway rights-of-way are spacious. This offers the flexibility to redistribute space within the existing cross sections to better balance the needs of pedestrians, cyclists, and motorists. In general, unnecessarily wide lanes promote higher speeds, especially when traffic is light. Slower speeds give drivers more time to react to pedestrians and cyclists. If a vehicle does hit a pedestrian or cyclist, lower speeds reduce the impact. Lower speeds means lowered risk of a fatal crash. Eliminating underused lanes and narrowing the remaining ones reduces the crossing distance for pedestrians and cyclists. Shorter crossings improve real and perceived safety for these users.

Marysville offers numerous revitalization opportunities. For example, many historic buildings line E Street. Currently vacant properties could be preserved and restored to maintain the neighborhood's character. The Downtown Economic Development Strategic Plan identified two sites, the State Theater and Marysville Hotel, as "Catalytic Opportunities." Charrette participants also expressed a desire to preserve historic buildings and encourage their use for pedestrian-compatible commerce. Many alleys provide access to downtown properties, allowing parking and loading in the rear. Numerous side streets provide additional on-street parking. Another potential revitalization site is the vacant lot on B Street near 14th Street. Development here could help connect to Ellis Lake and the rest of Marysville.

2) Beautify: Add more street trees and landscaping

Charrette participants strongly endorsed beautification of the corridors, especially provision of street trees. Marysville already has some trees and landscaping, but participants believed that more plantings would be a simple, effective way to beautify the

Photos above show an alley and State Theater. Marysville has mature trees and street landscaping on some streets, as shown below. Charrette participants envisioned similar beautification of the state highways.

US 395, Carson City, NV, shown on the left, has about the same amount of traffic as E Street north of 3rd Street. It features landscaped edges and raised center medians. Note the maintenance worker in this photo. Maintenance requirements vary depending on the type of landscaping selected.

corridors. Caltrans recognizes the benefits of street landscaping, as described in its publication *Main Streets: Flexibility in Design and Operations:*

> Street landscaping makes downtowns more livable, beautiful, and unique to the town. Quality landscaping along the roadway, close to the highway or in medians can increase driver awareness of the immediate environment and may alter driver behavior, resulting in slower speeds and a safer main street. A row of trees may calm traffic by making the road appear narrower. Street trees add an attractive canopy over the main street and may increase comfort for pedestrians. They create comfortable spaces and soften lighting. They cool streets in the summer, and provide a windbreak in the winter. Trees also create distinctive identity and seasonal interest.

Research suggests that sidewalk trees create street environments that are well-defined, comfortable, safe, and inviting to pedestrians. Closely planted trees at the sidewalk edge create a "transparent fence" that helps protects pedestrians, psychologically and physically, from traffic on the street. (Jacobs et al 2002). Closely planted deciduous street trees also play a major role in contributing to the year round physical comfort of pedestrians. They provide shade on hot, sunny days, and some protection from rain. Recent public health research suggests that environmental factors can increase or decrease physical activity. Pedestrians and cyclists are more likely to travel when and where they feel safest and most comfortable.[1, 2, 3] Policies limiting or restricting the location of street trees also limits the perceived and actual pedestrian safety and comfort. Except for certain situations, use of street trees should not be restricted.[4]

Beautification of public spaces is a simple way to enhance the overall image of the community. Sidewalks, streets, squares, and parks are public spaces that can encourage walking and other forms of physical activity. Research suggests that a beautified environment provides psychological health benefits to residents and visitors. http://www.uctc.net/papers/768.pdf.

"Street landscaping makes downtowns more livable, beautiful, and unique to the town. Quality landscaping along the roadway, close to the highway or in medians can increase driver awareness of the immediate environment and may alter driver behavior, resulting in slower speeds and a safer main street." Caltrans, "Main Streets: Flexibility in Design and Operations." The photos above demonstrate these principles.

The photo below shows a recent beautification effort on Marysville's D Street.

3) Connections: Provide safe connections for all users — motorized and non-motorized

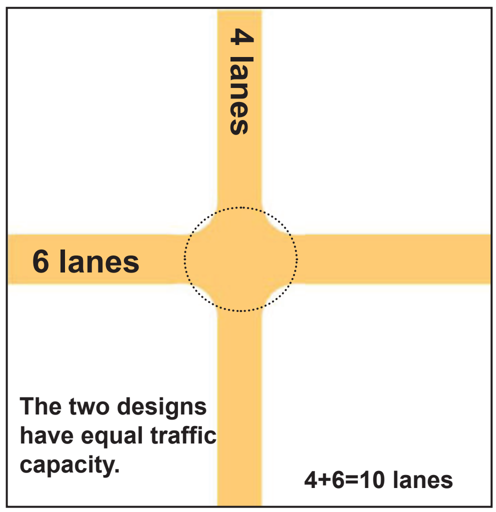
All users of a street share common travel goals. For example, all users want the most comfortable, convenient, and direct route. They also want easy access to destinations and want to avoid delays. Good, safe connections mean balancing the sometimes conflicting interests of motorists, pedestrians, and cyclists. Balancing these needs was one criterion used to evaluate potential design treatments. Recommendations in this report consider the needs of all potential users.

The directness of a route determines its level of connectivity. Motorists prefer direct connections that do not require going out of their way. Direct connections for other users have not been a priority. For example, at some intersections pedestrians are barred from crossing at one or more quadrants. This forces pedestrians to go out of their way to cross the street and can expose them to three times the number of conflicts. An intersection like this provides low pedestrian connectivity.

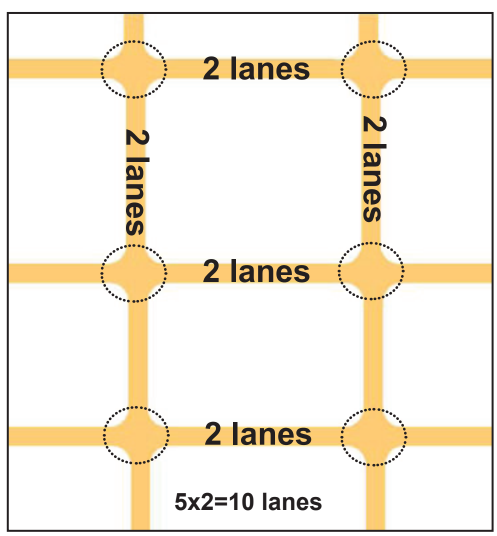
Connectivity

Walkability depends on connectivity to make this mode an appealing and useful choice. Connectivity gives greater options for vehicle movements as well. The two diagrams on the right each have the same traffic capacity: four total lanes north and south, six lanes east and west. All intersections in the diagrams are signalized. In the upper diagram, all lanes intersect at a single point, requiring longer wait times to accommodate all vehicle and pedestrian movements. Pedestrians need more time to cross all four or six lanes.

The lower diagram shows a grid system like Marysville's. Six smaller intersections distribute an equal amount of traffic over a wider area. Because users have numerous choices for turning instead of just one, wait times at each intersection are much shorter. Pedestrians can choose when and where to cross and have shorter crossing distances.



One single intersection must handle all through traffic volume, turning movements, and pedestrian crossings.



Six intersections distribute traffic and pedestrian volume, turning movements and crossings, making signal wait time and crossings shorter. In this situation, signals may not be needed at all intersections, due to the lower volumes at each.

Overall Study Area Recommendations

Throughout the study area, the corridor requires improvements in four major areas: street markings; pedestrian countdown clocks at signalized intersections; signal timing; and accessibility for users of all abilities.

Provide high-visibility crosswalk markings at all signal-controlled intersections.

Marysville should mark crosswalks on every leg of all signalized intersections, except at 9th and E Street, where crossing E Street to the south is prohibited. Markings should use stop bars and high visibility ladder-style markings. The ladder-style marking illustrated in the image below is more visible to both drivers and pedestrians with low vision. Using a staggered pattern reduces wear by placing markings between tire tracks.

Except as noted, all legs of signalized intersections should be available for pedestrian crossings. When one crossing leg is closed, some pedestrians must cross three legs of the intersection to reach their destination. This increases their exposure to traffic and risk of crash. When closing one crossing leg to pedestrians cannot be avoided, careful compliance with Americans with Disabilities (ADA) guidance will help visually impaired pedestrians recognize the closure.

Above, left: Pedestrian view of existing E Street crossing. All signalized intersections should have high-contrast "ladder-style" crosswalks, like those shown in the photo simulation to the right.


The motorist's view of the same intersection and simulated crosswalk markings. High-contrast markings alert drivers to watch out for pedestrians. Ladder-style markings are spaced so that vehicle tires travel between crossbars, instead of over them. This reduces wear and maintenance of crosswalk markings.

Install pedestrian countdown signals at all signalized intersections

Some intersections in Marysville already have pedestrian countdown signals. At these signals, a standard WALK symbol is displayed during the walk interval, which is the period of time during which pedestrians may enter the crosswalk. When the WALK interval closes, it is followed by a clearance interval, during which time pedestrians can complete their crossing, but may not enter the crosswalk. At a countdown signal, the number of seconds remaining in the clearance interval is displayed. Preliminary research shows most pedestrians understand the countdown display more clearly than signals which do not display the remaining seconds. Some pedestrians still start to cross during the clearance phase, but fewer pedestrians start crossing late in the clearance phase. The results are that pedestrians are out of the crosswalk by the steady "don't walk" phase. Despite fears that drivers would cue from the countdown signal and accelerate to beat the light, preliminary research indicates that this is not happening.


Pedestrian countdown signals.

Signal timing changes

Minor street pedestrian signals should be set to rest in WALK when the main street signals are resting in green. This allows pedestrians to proceed without pausing to push the button, as long as an adequate WALK interval remains. Some engineers hold a belief that requiring pedestrians to push a button before crossing the street makes them more "aware" of their crossing and thereby increases their safety. This is a reasonable assumption in theory. But the reality is that when many pedestrians walk along a major street, they simply don't bother pushing the button to cross the minor streets. They observe and cross with the adjacent green interval. Making signalized intersections more convenient for pedestrians results in better pedestrian behavior and encourages the appropriate use of pedestrian signals. WALK signals that are automatic, shorter wait times before the signal turns to WALK, and conveniently-placed pushbuttons (when truly needed) are three primary features that make signalized intersections more convenient for pedestrians.

High-contrast, ladder-style crosswalk markings are much more visible to motorists, as shown above. The top photo is the existing intersection, while the bottom is a simulation.

The WALK interval, which is the period during which pedestrians may enter the crosswalk, should be at least seven seconds long at all traffic signals. The current minimum in the Manual on Uniform Traffic Control Devices (MUTCD) is 4 seconds. Caltrans timing varies from 4 to 7 seconds. The clearance interval, which is the amount of time allowed for pedestrians to complete their crossing after entering the crosswalk, should be calculated based on a walking speed of 3.5 ft per second, curb to curb. Caltrans and the current edition of the MUTCD calculates clearance intervals based on a walking speed of 4 ft per second. These changes to increase the minimum time for pedestrians to enter the crosswalk and reach the opposite curb may become requirements in the 2009 MUTCD.

All pedestrian crossings of major streets should incorporate Leading Pedestrian Intervals (LPIs). Leading Pedestrian Intervals give pedestrians a two to five second head start over motorists. LPIs provide a brief, exclusive phase for pedestrians, allowing them to step into the crosswalk before turning drivers receive a green light. This increases visibility of pedestrians and reduces conflicts with turning vehicles.

Typically about 37% of pedestrian injury crashes and 20% of fatal pedestrian crashes occur at intersections. A study of LPIs at urban intersections showed they reduced conflicts between turning motorists and pedestrians. The high volume of turning movements from side streets onto E Street conflicts with pedestrians crossing E Street. Installing LPIs here can increase safety by reducing conflicts without slowing traffic.[5]

Within the study area, most of the traffic from minor streets turns right or left onto the major street. Most of the side streets have simple signal phase timing, without a protected left turn signal phase. Turning vehicles conflict with the concurrent pedestrians crossing the major street. Because the main streets are wide, they take longer to walk across. The estimated crossing time is called the Pedestrian Clearance Interval (PCI). On E Street, for example, the PCI is 22 seconds (at 3.5 feet per second). Together with the recommended 7 second walk interval, side streets have a pedestrian actuated 29 second cycle. Even during peak hours, the green time is more than long enough to serve the vehicle queue on the side street. Holding the side street traffic for two to five seconds with an LPI would not delay motorists on the major street, such as E Street.

Preemption for emergency service providers

Marysville should investigate the benefits of implementing an Emergency Vehicle Preemption (EVP) system. EVP systems allow drivers of fire and emergency medical response vehicles to change red lights to green. EVP can reduce driver confusion, reduce conflicts and crashes involving emergency vehicles, and improve emergency response times. EVP technologies include light-based, infrared-based, sound-based, and radio-based emitter/detector systems.[6] Impacts of preemption systems on traffic flow differ based on the frequency of calls, but could result in delays. In one study in Plano, TX, traffic during peak periods took 10 to 20 minutes to return to normal flow after a signal interruption.[7] The safety benefits must be weighed against the potential for increased traffic delay.

This well-designed downtown Marysville crosswalk illustrates how aesthetic treatments and the need for a smooth crossing can be compatible.

Incorporate Americans with Disabilities Act (ADA) recommendations

All improvements in the study area should provide access to users of all abilities, as described in the 2005 Revised Draft Guidelines for Accessible Public Rights-of-Way. This is the most recent guideline issued by the U. S. Access Board. The current draft revision of this guideline offers excellent information and recommendations for providing equal access to people with disabilities. Marysville should rely on the recommendations in this draft until they are superseded. The following accessible design features should be incorporated throughout the study area:

- Smooth surface on all walkways and crossings
- Five foot minimum unobstructed walkway.
- Pedestrian push buttons with audible and vibratory signals located per guidelines.
- Each corner needs two curb ramps, each aligned with its respective cross walk. A four foot level landing area is called for at the top of each curb ramp.
- Warnings detectable to the visually impaired at curb ramps, landings, and blended transitions. For example, truncated domes on curb ramps signal the edge of the crossing.

This sidewalk next to Ellis Lake is separated from traffic, making it a more pleasant walk. Better connections to the street and way-finding signs would enhance this asset.

The sidewalk in the top photo is not wide enough to pass comfortably. The next photo shows a sidewalk wide enough to accommodate passing and groups.

Ellis Lake is an important city asset. Along State Routes 70/20 the park trail is the only sidewalk provided on the Ellis Lake side. It serves both recreational walkers and destination-oriented people who are walking for transportation. Connections between the street and walkway at the lake should be as direct as possible. The walking route should be obvious to visitors who may not be familiar with the area, keeping in mind that people who are blind or have impaired vision need audible or tactile information to help them find their way.[8]

Sidewalks and sidewalk zones

Sidewalks can be organized by zones to accommodate a wide range of uses while minimizing potentially hazardous obstacles or obstructions. In addition to providing a clear travel route for pedestrians of all abilities, sidewalks are expected to provide zones for amenities like transit stops, landscaping, and bike racks.

Starting at the street, the first zone is the curb zone, as shown on the next page. Flat-faced curbs are best to define the edge of the vehicle boundary. Next to the curb is a furniture zone, or buffer zone, that separates the walkway from the roadway. Fire hydrants, benches, transit stops, trees, bike racks, signs, poles, newspaper racks, public phones, and other street elements are usually in this zone. The furniture zone on major streets should be at least five to six feet wide.[4] Next to the buffer zone is the pedestrian zone, an accessible pathway at least 5-feet wide that is free of obstacles, protruding objects, and vertical obstructions. This area should have a smooth surface for safe and comfortable use by individuals with personal assistance devices, such as walkers, wheelchairs, or strollers. Marysville may have to adopt local ordinances to protect the pedestrian zone from signs, other temporary street fixtures, sidewalk cafes, etc.

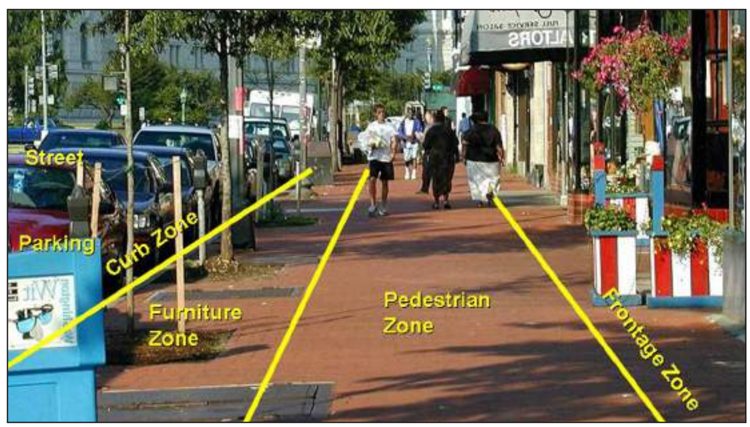
Between the pedestrian zone and any buildings adjacent to the sidewalk is the frontage zone. It marks the edge of the public right-of-way. Sidewalk users generally avoid the frontage zone if they can. For one reason, some ground floor doors open out, and people may exit buildings at any time. Most people don't feel comfortable walking or rolling very close to buildings, fences, or other structures at the edge of the right-of-way.

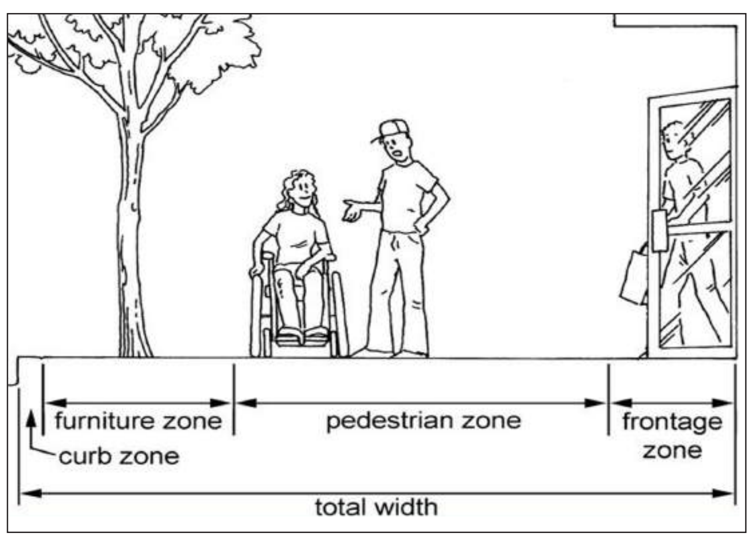
Bikeways

Many bicyclists were observed riding on sidewalks in Marysville, which is unsafe and prohibited in the City, but is an indicator of the need for safe bicycle routes. Bicyclists riding on sidewalks are twice as likely to be involved in a vehicle-bike crash as those riding on a designated bikeway. This is due to the conflicts at intersections and driveways, where motorists may not be expecting a bicyclist. Riding facing oncoming traffic, whether on a sidewalk or in the street, also increases the likelihood of a conflict.

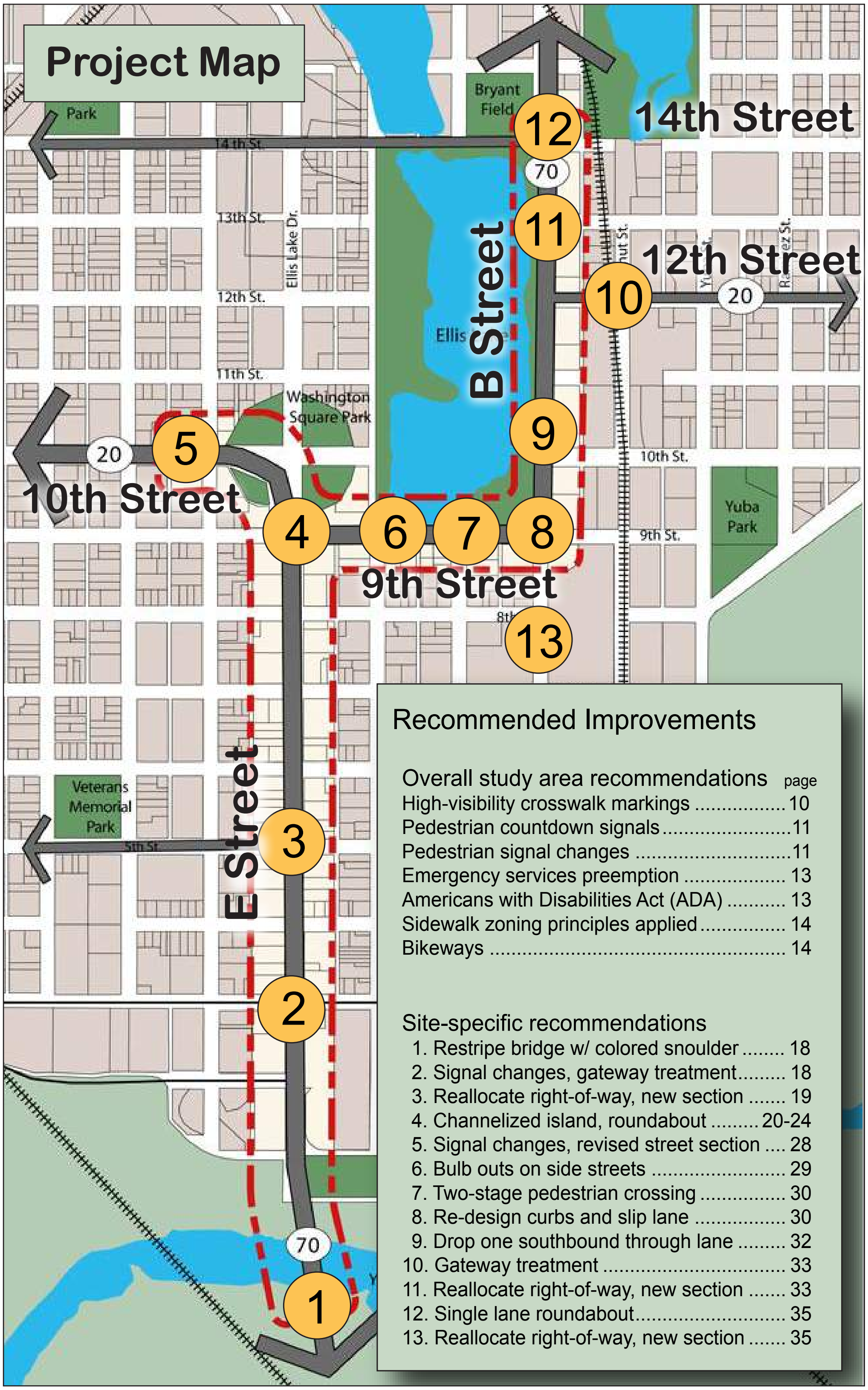
A detailed Master Plan should be developed to create a network of bikeways in Marysville. The Yuba County Bicycle and Trails Plan includes a planned bikeway around the outskirts of Marysville, but this loop does not provide a network that serves all types of bicyclists within the City.

Bikeways include both on-street and off-street facilities. Many bicyclists prefer to ride in the street and follow the same rules followed by motorists because they are not delayed by waiting at pedestrian crossing areas. Others prefer to use off-road shared use trails because they are uncomfortable on the street. Both types of facilities are important. A systematic approach to identifying locations for on-street and off-street facilities is recommended. These facilities should be linked together to create continuous routes throughout the community that serve bicyclists in much the same way motorists are served by street networks. Constraints such as railroad crossings or narrow bridges and tunnels should be addressed. The master plan should also consider other elements that influence bicycling. For example, well designed bike racks located in safe, secure locations where bikes can be "watched over" are a necessary part of a system. Another example is angled parking. Many communities choose not to stripe bike lanes on streets with angled parking. Some California communities, including San Francisco, sign streets where bicycle lanes cannot be provided with the message, "Bicyclists may use full lane." These and other issues require a planning process that focuses on bicyclist needs.





The photo above and sketch below demonstrate the concept of sidewalk zones.


Project Map
14th Street
12th Street
10th Street
9th Street
B Street
E Street
Bryant Field
Washington Square Park
Veterans Memorial Park
Yuba Park
14th St.
13th St.
12th St.
11th St.
10th St.
9th St.
5th St.
Ellis Lake Dr.
70
20
1
2
3
4
5
6
7
8
9
10
11
12
13
Recommended Improvements
Overall study area recommendations page
High-visibility crosswalk markings 10
Pedestrian countdown signals........................11
Pedestrian signal changes 11
Emergency services preemption 13
Americans with Disabilities Act (ADA) 13
Sidewalk zoning principles applied................ 14
Bikeways 14
Site-specific recommendations
1. Restripe bridge w/ colored snoulder........ 18
2. Signal changes, gateway treatment......... 18
3. Reallocate right-of-way, new section 19
4. Channelized island, roundabout 20-24
5. Signal changes, revised street section 28
6. Bulb outs on side streets 29
7. Two-stage pedestrian crossing 30
8. Re-design curbs and slip lane 30
9. Drop one southbound through lane 32
10. Gateway treatment 33
11. Reallocate right-of-way, new section 33
12. Single lane roundabout........................... 35
13. Reallocate right-of-way, new section 35

Site-Specific Recommendations

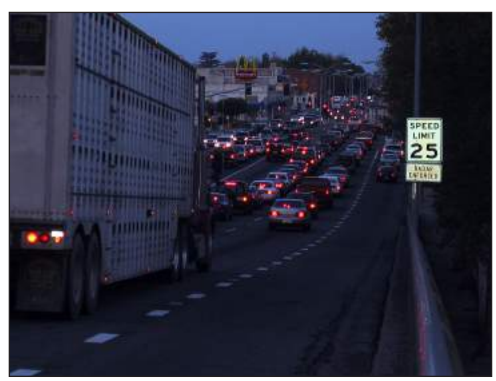
E Street (State Route 70)

E Street is one of Marysville's major north-south thoroughfares for vehicular traffic. From the city's southern boundary to 9th Street, it is designated State Route 70. Over the Yuba River, south of Marysville, the route is a limited access, high speed roadway. According to Caltrans (2006), E Street carried 49,500 vehicles per day, traveling both directions, near the Yuba River bridge. As it enters the city, the street gives direct access to adjacent commercial properties. E Street also connects to minor streets that lead to nearby commercial and residential districts. Some traffic turns on to side streets as E Street continues north. Near 9th Street, the average daily vehicle count is only 32,000. (Caltrans, 2006) Since this portion of E Street is a state highway, it naturally carries a lot of truck traffic. Most trucks do not turn onto side streets. Due to fairly tight corner radii, any turning trucks have to reduce speed considerably.

1. Restripe bridge w/ colored shoulder
2. Signal changes, gateway treatment
3. Reallocate right-of-way, new section

The state highway section of E Street has three key intersections: 3rd, 5th, and 9th Streets. Signal cycles at these intersections range from 80 seconds to 120 seconds. Signals are programmed with five different cycles, each one ten seconds longer. These traffic signal cycles are designed to vary with the actual traffic volume, not by certain times of the day. Wire loops embedded in the roadway detect volume and queue length at intersections. When traffic volume increases and more vehicles queue for each intersection, signal cycles are lengthened. Northbound and southbound traffic signal cycles are the same. Signal programming does not favor peak traffic in only one direction. Northbound traffic can back up at the intersection of 9th and E Street during peak hours. Because southbound traffic moves during two of the signal cycles, traffic in this direction keeps flowing even during peak hours.

Pedestrians trying to cross E Street face some serious challenges. Due to longer signal cycles during high traffic periods, pedestrians may have to wait up to 2 minutes to cross E Street. While intersections with the highest pedestrian traffic have crosswalks, smaller intersections do not. Pedestrian WALK intervals occur simultaneously with the permissive green for side street traffic, creating a conflict between pedestrians and turning traffic.



The upper photo shows a practically deserted E Street looking north. The lower photo shows peak hour conditions. Northbound congestion will decrease somewhat after improvements at 5th Street.

1. Restripe bridge w/ colored shoulder

Pedestrian signals for crossing side streets along E Street rest in DON'T WALK during the green phase on E Street until a pedestrian pushes a button to get a WALK interval. If enough time remains in the signal cycle, the pedestrian receives an immediate walk interval. All left turns off E Street to the minor streets are dedicated only, which benefits pedestrians by removing conflicts with left turning traffic.

Overall recommendations discussed in the previous section apply to E Street as well. Additional specific recommendations apply to particular sites along E Street. These are listed below, starting from the south.

State Route 70 entrance to Marysville at Yuba River bridge

1 The bridge carrying E Street across the Yuba River has 70 feet of available right-of-way. This is enough room to provide 6 foot paved shoulders on both sides, which could help buffer pedestrians and bicyclists from motorized traffic. Solid colored or pigmented shoulders can help distinguish this buffer zone. In Europe, colored shoulders have helped calm traffic and protect pedestrians and cyclists for decades. U.S. cities, including Chino Hills, Petaluma, and Sunnyvale, CA, have also adopted this strategy. Caltrans used this treatment on SR 16 through Capay Valley. Studies show that colored shoulders make roads seem narrower to drivers, helping reduce speed. Studies also show that vehicles are more likely to stay out of colored shoulders than unmarked shoulders or even striped shoulders. Keeping adequate separation between motorists and cyclists decreases bicycle-vehicle conflicts.

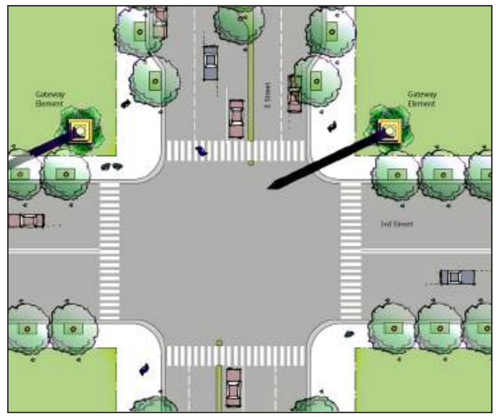
When roadway resurfacing includes colored shoulders, dyed asphalt is better than other materials because of installation ease, high durability, and low maintenance requirements. If the road is not scheduled for resurfacing in the near future, shoulders can be colored using thermoplastic/epoxy coatings or tennis court paint.

2. Signal changes, gateway treatment

E Street at 3rd Street

2 Northbound, the intersection of E and 3rd Streets includes double left turn lanes and a right turn pocket. At the time of the study, its signal timing was unusual because the cross street was only served every other cycle, without regard to time of day. Recent discussions with Caltrans engineers indicate that the signal timing has been changed to be consistent with other intersections on E Street. This is a significant improvement for pedestrians since it decreases the potential delay that pedestrians experience to cross E Street.

To enhance walkability at E and 3rd Streets, the crosswalk on the south leg should be opened. Crosswalks are marked on the other three legs of the intersection, but the crosswalk on the south side of the intersection is currently signed as closed. Considering that the Mervyn's Department store is a fairly high pedestrian-generating use, a crosswalk on this leg is important. Closing this leg of the intersection to pedestrians is not necessary or useful. Users who want to cross E Street on the south side of 3rd Street must travel around three sides of the intersection. When crossing these three legs of the intersections, pedestrians experience many conflicts with turning vehicles, including all of the turning movements that they would conflict with if crossing on the currently closed south leg of the intersection. Rather than crossing all three legs, pedestrians are very likely to simply cross the south leg anyway, thereby reducing overall pedestrian safety. This crosswalk is likely closed in order to improve vehicle capacity. Opening the crosswalk would only negatively impact vehicle capacity during cycles when pedestrians push the button to cross the street here. Pedestrian volumes are low enough that these crosswalks will only be used during a fraction of the signal cycles each day. If the crosswalk on the south side of the intersection remains closed, it needs an ADA-compliant barrier blocking the crosswalk instead of just a sign.



Proposed intersection improvements at E and 3rd Streets. Gateway features on the north side of the intersection would mark the entrance to downtown.

A gateway feature at 3rd Street is recommended, as shown at the right, serving to mark the southern entrance to the city. Gateways help signal to drivers to expect lower speeds, more turns, and pedestrians.

E and 5th Streets

3 During peak hours, the northbound left turn lane at 5th Street backs up into the through travel lanes. This causes additional traffic congestion, which can lead drivers to take dangerous risks. Caltrans plans to add an additional left turn lane.

3. Reallocate right-of-way, new section

E and 5th Streets, looking south towards the bridge.

4. Reallocate right-of-way, restripe, channelized island, roundabout.

E and 9th Street is a busy, large intersection. Note the dogleg crosswalk. Also notice how far pedestrians have to cross.

Proposed slow speed, right turn slip lanes at 9th and E Streets.

E Street at 9th Street

4 Highways 70 and 20 meet at this key intersection. Northbound, a lot of traffic turns right onto 9th Street, where the two highways merge for several blocks around Ellis Lake. Heavy eastbound traffic on Highway 20 must turn left onto 9th Street. Heavy southbound traffic on Highway 70 travels west on 9th Street and turns left onto E Street. The large number of vehicles turning at this intersection increases congestion and the risk of potential conflicts and crashes, both motorized and non-motorized. As at 3rd Street, there is a sign prohibiting pedestrians from crossing E Street on the south side of the intersection. The E Street crossing on the north side of the intersection includes an angled section. This intersection allows motorists to proceed straight through during two of the signal phases. Turning traffic only has one signal phase.

The heavy turning traffic reduces the capacity of the E Street and 9th Street intersection, since turning vehicles take longer. Charrette participants reported large trucks frequently back up on 9th Street, waiting to turn at E Street. They can block D Street, forcing motorists trying to enter 9th Street to wait through additional signal cycles.

Also, whether motorists continue on their original state highway or turn on to the intersecting one, they must turn up to four times while traveling through Marysville. The capacity of E Street is greatest at the southern end, where higher speeds are feasible in the freeway transition area on the bridge. North of 3rd Street, speeds are much lower and signalized intersections further slow motorists. Speeds decrease and congestion increases approaching 9th Street. After passing this intersection, congestion decreases again. The number of vehicles that can pass through the E and 9th Streets intersection limits the traffic capacity of the entire SR70/20 corridor.

Caltrans has discussed expanding E Street to six lanes to alleviate congestion. While further detailed analyses may be necessary, the preliminary analysis reveals that unless the capacity of this intersection is increased, additional lanes on E Street will not make a substantial difference in traffic flow. The added lanes will, however, reduce accessibility for non-motorized users. Additional lanes contribute to longer crossing distances, higher speeds, and higher traffic volume, all of which increase risk to non-motorized users. As the population ages, more people will rely on devices such as motorized wheelchairs and electric

The roundabout in the illustration is under construction in Reno, NV. Note how single and dual lanes are combined with right-turn slip lanes.

This family is running to get across all the lanes in time.

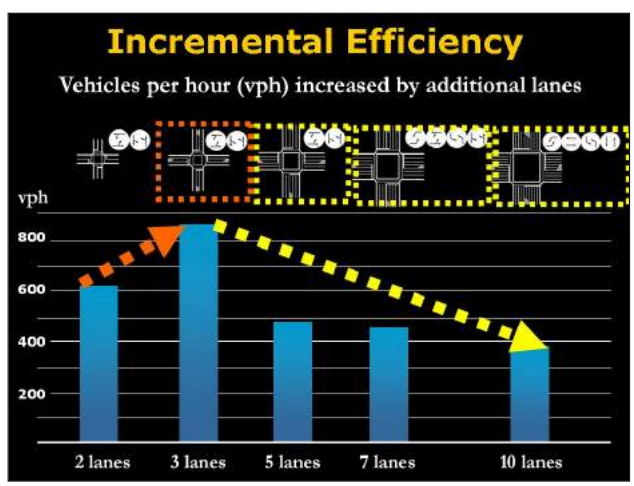
scooters to retain their mobility and independence. Other non-motorized users include children riding their bikes or scooters, young mothers with strollers, joggers, shoppers, and tourists exploring the downtown on foot.

The illustration at the bottom of page 20 shows improvements to the crosswalks at 9th and E Streets. A right-turn slow speed slip lane on the northeast corner helps align the crosswalk. (see page 24) Surface Transportation Assistance Act (STAA) turning templates will need to be used when designing the slip lane, as per the Caltrans Highway Design Manual. Without major changes, congestion and signal timing at this intersection prevent the opening of the southern leg for pedestrian crossings.

Increasing the traffic capacity at this intersection will require a new design. Such improvements will likely require land use changes on adjoining properties. Since any substantial improvement in intersection capacity will require additional right-of-way, a roundabout should be one of the alternatives considered to improve operations at E and 9th Streets.

A preliminary analysis shows that a roundabout with two lanes north and south of E Street and a single entry lane with a slip lane on 9th Street would provide a better level of service for traffic than a signalized intersection. It would also allow full access to all legs of the intersection. The analysis compares the roundabout to a signalized intersection with 12 entry lanes, 50 percent more lanes than the roundabout. The results forecast longer vehicle queues at the signalized intersection than at the roundabout. It may be necessary to re-time signals near the roundabout to prevent queues from backing up into the roundabout during peak traffic periods. See the appendix for the analysis.

The illustration above shows how the capacity of each additional lane diminishes as more lanes are added due to constraints at signalized intersections. As shown, per lane capacity is greatest when a single turn lane is added to a street with one lane in each direction. The capacity per lane drops substantially as more lanes are added. See the Appendix for details. In the case of E Street, capacity is constrained at the intersection of E Street and 9th Street. Unless additional lanes on E Street will continue through the intersection, so the benefit is limited. Adding lanes increases pedestrian crossing distances and exposure to traffic. The Institute of Transportation Engineers (ITE) Journal (2003), illustrates this concept. See details in the Appendix.



Roundabouts

Roundabouts are un-signalized intersections in which traffic circulates counterclockwise around a raised center island. In the proper setting, well-designed roundabouts have far fewer crashes than signalized intersections. Roundabouts have 76% fewer injury crashes and 30-40% fewer pedestrian crashes than signalized intersections. The most severe intersection crashes, often caused by red light running, are eliminated at roundabouts.

Well-designed roundabouts also increase roadway capacity to reduce delays, without adding more lanes. As a result, roundabouts reduce vehicles' speed differentials within the intersection, while reducing congestion. Elimination of stop and go driving by the roundabout lowers vehicle emissions and noise. Vehicles in the roundabout have the right-of-way over entering traffic. Drivers of cars, pickups, vans, SUVs, and motorcycles slow down as they approach the intersection, yielding to any pedestrians in the crosswalk. The yielding driver looks left, waiting if necessary for a gap in the traffic flow before merging into the roundabout. Once inside the roundabout, drivers signal and turn right at their exit.

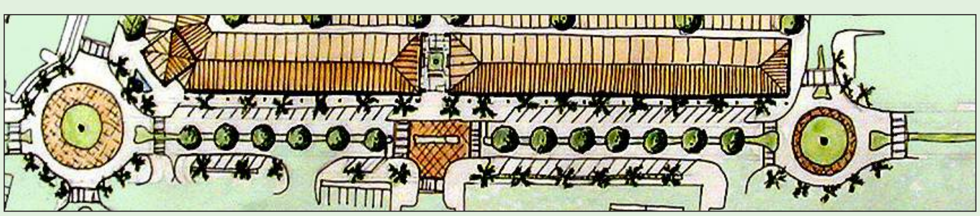
Pedestrians cross roundabouts at designated crosswalks. There are no signals for pedestrians. They cross one direction of traffic, wait in the refuge island to be sure a driver is going to yield, then complete their crossing. People with visual impairments rely on sound to determine when it is safe to cross. At roundabouts it may be difficult for them to determine when traffic has stopped to wait for them. Experienced bicyclists can proceed through the roundabout in a traffic lane, following the same rules as other vehicles. Cyclists may also use sidewalks and pedestrian crossings.

Large trucks and long fire engines drive over the low curb on the truck apron in the middle to make the tightest turns. The truck apron surrounding the center island uses contrasting paving and slopes slightly up toward the middle. Normal vehicles stay off the truck apron.

Roundabout size is dependent upon the volume and type of traffic that will pass through the intersection. Roundabouts can be designed to accommodate the largest trucks.

Roundabouts can increase intersection capacity 30-50%. They reduce delays, reduce pollution, save fuel, reduce the need for storage lanes, and improve traffic flow at intersections with frequent left turns. Roundabouts save signal maintenance and power costs. Cost comparisons between roundabouts and signalized intersections show that roundabouts can cost less over their life-times. The service life of a roundabout is 25 years, versus the 10-year service life of signal equipment.

While roundabouts are safer and offer beautification opportunities, they are not the right choice in every circumstance. Roundabouts often require more right-of-way than a signalized intersection. At 9^{th} and E Street, the roundabout central island diameter would be approximately 120 feet, with a circulating width of about 34 feet. A total of approximately 218 feet would be needed when sidewalks, buffers, and curb area are added. A right-of-way study was not conducted, but space required for the roundabout would most likely be triangular sections on all four corners. More detailed analysis is needed to know precise measurements and additional right-of-way requirements.



This sketch illustrates how roundabouts are often used in pairs. Note how in this drawing the building is located near the sidewalk and parking is behind the building.

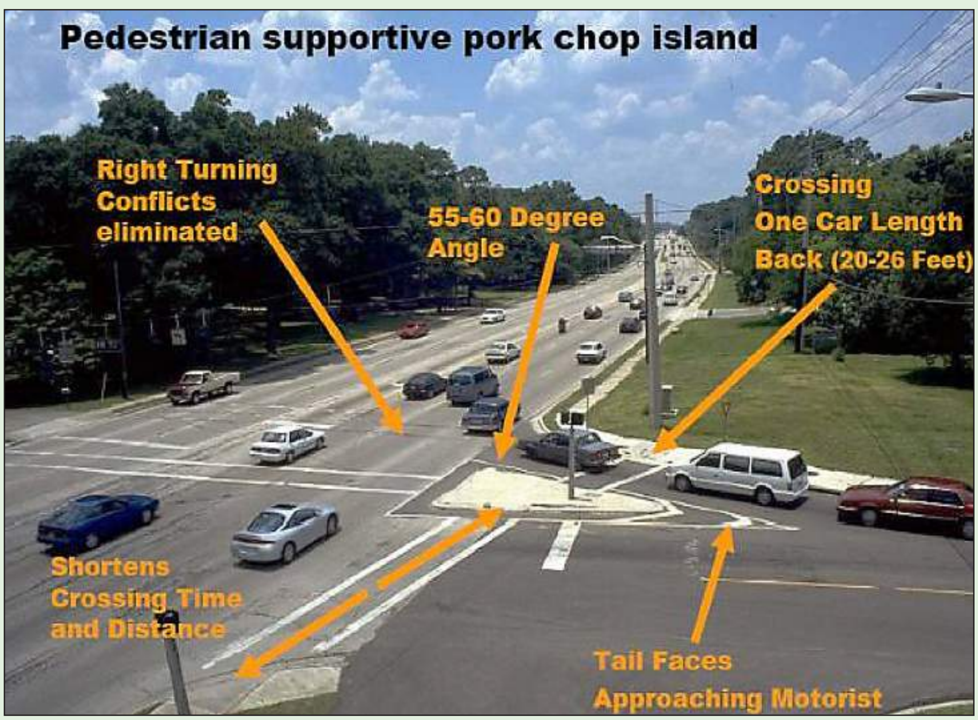
Right-Turn Slip Lane Design

A right-turn slip lane is a vehicle lane dedicated to right turning motorists. They are not usually controlled by a signal unless there are two right turn lanes. When they are not controlled by signals, motorists pull forward and wait for a gap to enter the traffic stream. On many arterial street intersections, pedestrians have difficulty crossing due to right-turn movements and wide crossing distances. The addition of well-designed right-turn slip lanes provide pedestrian crossing islands within the intersection and a right-turn lane that optimizes the right-turning motorist's view of the pedestrian and of vehicles to his or her left.

Pedestrians are able to cross the unsignalized right-turn lane and wait on the refuge island, or "pork chop island," for their walk signal. Since the traffic signal is timed based on a shorter crossing, the pedestrian crossing time has a much smaller influence on the timing of the signal.

The problem for pedestrians is that many slip lanes are designed for unimpeded vehicular movement. The design of corner islands, lane width, and curb radii of right-turn slip lanes should discourage high-speed turns, while accommodating large trucks and buses. The triangular "pork chop" corner island that results should have the "tail" pointing to approaching traffic.

This design has an additional advantage for the pedestrian; the crosswalk is located in an area where the driver is still looking ahead. Older designs place the crosswalk too far forward, where the driver is already looking left for a break in the traffic.



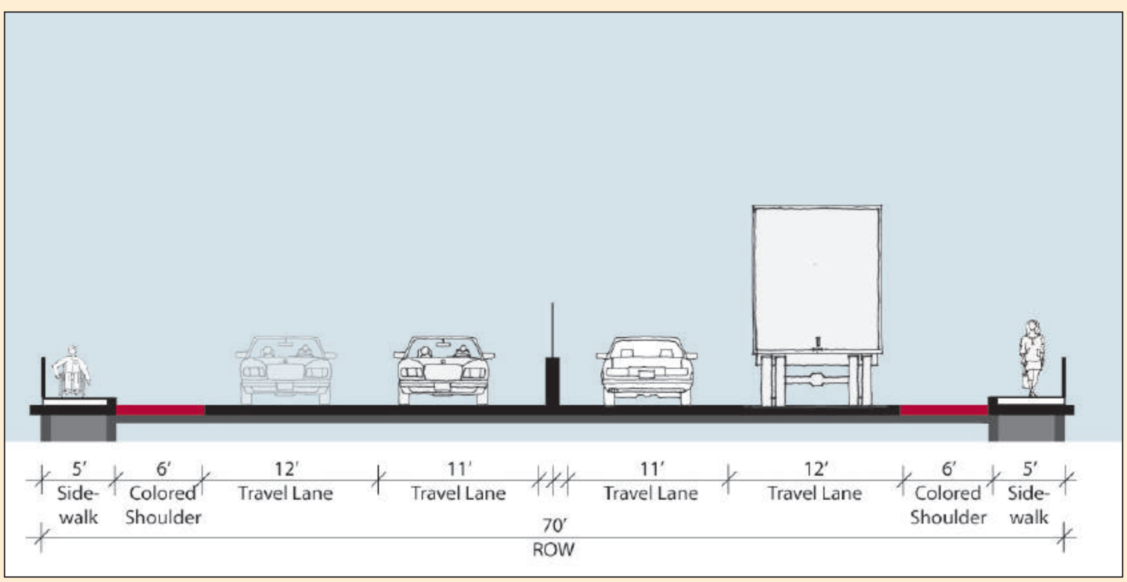
E Street Sections

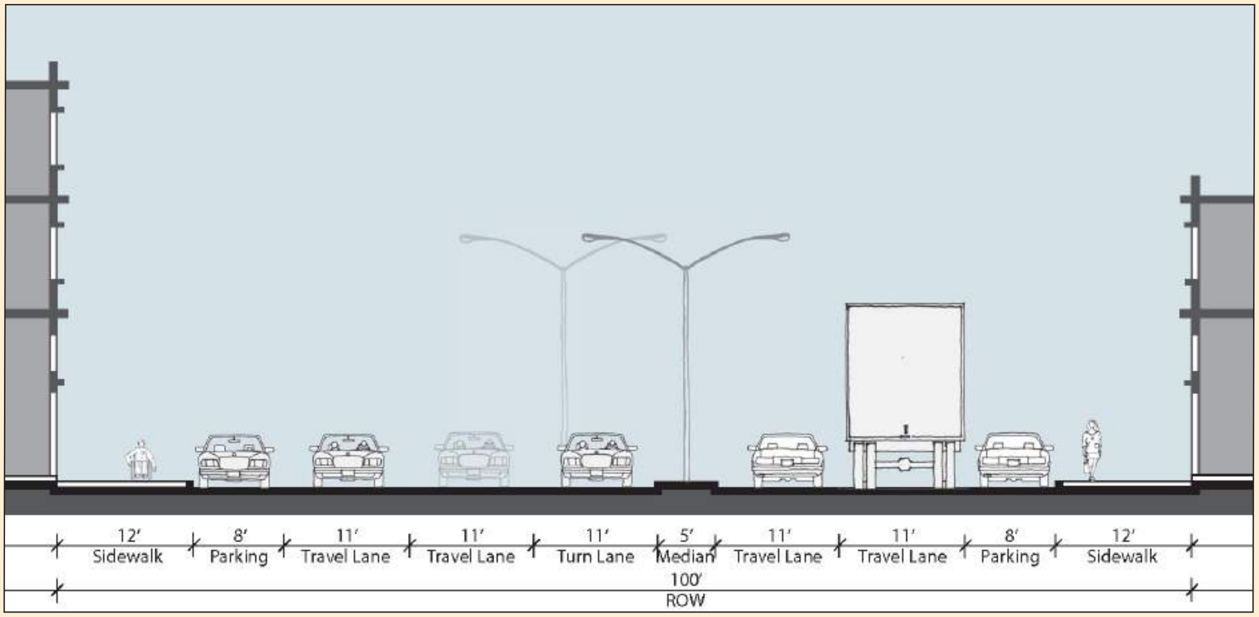
The right-of-way for all streets can be divided into sections, starting at the center line and proceeding to the edge of the right-of-way. At a minimum, streets have one or more travel lanes for vehicles and possibly, sidewalks. Other features found in the street cross section could include a raised median, right or left turn lanes, bicycle lanes, parking spaces, curbs, and sidewalks.

Many potential alternate street sections were studied during the charrette. Participants emphasized incorporating features that build on Marysville's assets and enhance its historic character. Participants also urged beautification of E Street by providing more landscaping. These considerations, along with other suggestions, have been incorporated in recommendations whenever possible and practical.

E Street sections vary. New sections proposed by charrette participants are shown in this section. The illustrations show how existing right-of-way could be reallocated. Starting at the south on the bridge, the proposed street section is shown first. This inside travel lane is reduced to 11 feet while the outside travel lane is 12 feet. This leaves enough room for a six foot colored shoulder, as shown below.

On the right are photos of the existing bridge conditions (left) and simulated colored lane (right). The proposed E Street section on the bridge is below.





The existing E Street section is shown above.

Between the bridge and 3rd Street, the E Street section would remain mostly unchanged, though lane widths could require adjustment to transition between higher and lower speed segments. The existing right of way between the bridge and 3rd Street is not adequate for wider sidewalks or other improvements recommended north of 3rd.

The recommended cross section for E Street north of 3rd Street reflects input from charrette participants, as well as current best practices. The proposed section better balances the needs of motorists with the needs of other users, including pedestrians and bicyclists. People who work, shop, or live on E Street, as well as motorists, would benefit from beautification efforts such as additional landscaping.

The recommended plan reduces the amount of uniform dark asphalt on E Street. Brick pavers on the edges of sidewalks would strengthen connections to the historic brick downtown. Smooth pavers, stamped asphalt, and/or colorizing would demarcate parking bays and buffer zones. Adding these design details will rebalance the character of E Street. The makeover will invite people downtown, to shop, dine, walk, cycle, work, or visit.

When black asphalt is used only for travel and turn lanes, the perceived width of the street narrows considerably. Distinguishing travel lanes from other zones helps separate traffic traveling at different speeds, which increases safety. Right-of-way zones designated for other uses, such as parking and buffer zones, are accentuated by using textured and colored surfaces. Such design details would improve both the function and beauty of E Street, while harmonizing with Marysville's existing character.

The upper photo shows the existing E Street condition. The middle photo simulates stamped, ADA acessible pavers, accented curbs, stamped, colorized parking bays, and other recommended features. The bottom simulation suggests how the streets could develop.

The proposed E Street section adds zones to the existing street section, without changing total right-of-way width. Starting in the center of E Street, the plan calls for a left turn lane, then two 11-foot travel lanes in each direction. Next to the travel lanes on both sides is a two foot buffer zone and parking spaces next to the curb. Small groups of parking spaces would be separated by eight foot curb extensions. The curb extensions help visually narrow the street and calm traffic.

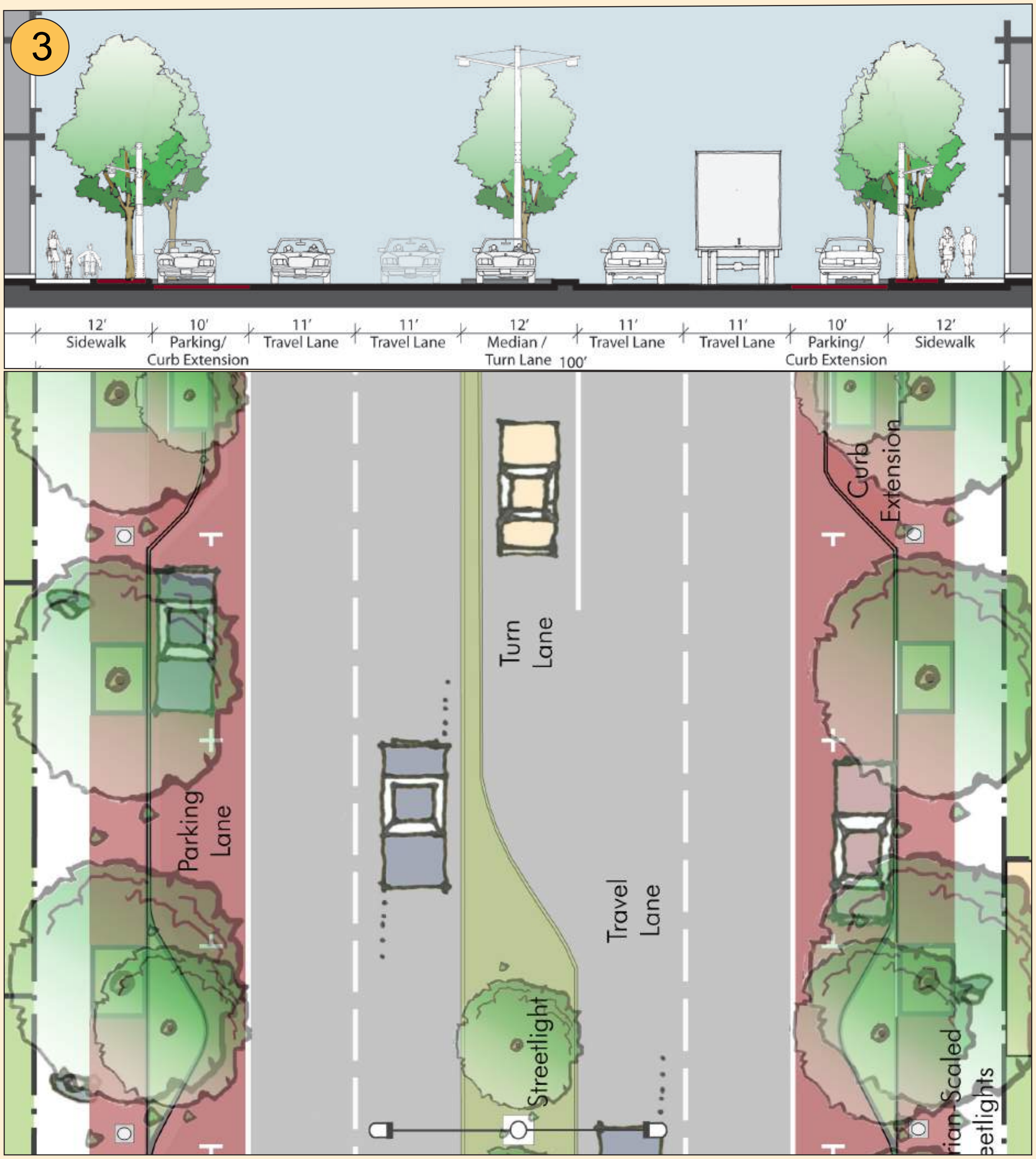
AASHTO guidance also discusses the benefits of narrower lanes on streets with speeds under 45 mph and "interrupted-flow operating conditions." On E Street the signalized intersections cause "interrupted-flow conditions." Benefits include shortened pedestrian crossing times.

Existing lane widths in the study area vary from 11 to 12 feet. Though AASHTO allows ten foot lanes, they were not recommended in the study area because of substantial truck traffic on this street. The plan's proposed section makes eleven feet the standard for all travel and turn lanes on E Street.

Travel Lane Widths

According to Caltrans' *Main Streets: Flexibility in Design and Operations*, (2005), 12 foot lanes are standard on state highways outside downtown areas, where exceptions can be made. The American Association of State Highway and Transportation Officials' (AASHTO) *Geometric Design of Highways and Streets* advises urban arterials should have 10-12 foot lanes. Lane widths of less than 12 feet may be appropriate on main street highways.

Proposed E Street section is shown below, at street level and from overhead. Note that trees in the median are only feasible where left turn lanes do not require the entire block. Trees cannot be planted adjacent to the left turn pocket and should be planted a minimum of 2 ft. behind the curb. Refer to Section 500 of the Caltrans Encroachment Permits Manual. This section only appies to E Street north of 5th Street due to the future addition of a second northbound left turn lane onto 5th Street.



5. Signal changes, revised street section.

10th Street at the curve north of E Street. Note the vehicle in the right turn lane. The right "trap lane" drops before the bridge. During field observations, few vehicles turned right from the lane. Most merged into through traffic lanes to cross the bridge. This movement is sometimes erratic. Conflicts are created as drivers attempt to pass as many cars on the right as they can before entering the traffic stream.

10th Street (State Route 20)

5 10th Street has 6 lanes and a wide raised median. Annual Average Daily Traffic (AADT) is 36,000, comparable to E Street traffic volume. The highway divides residential and commercial areas. Some children must walk across 10th Street to attend Covillaud Elementary School.

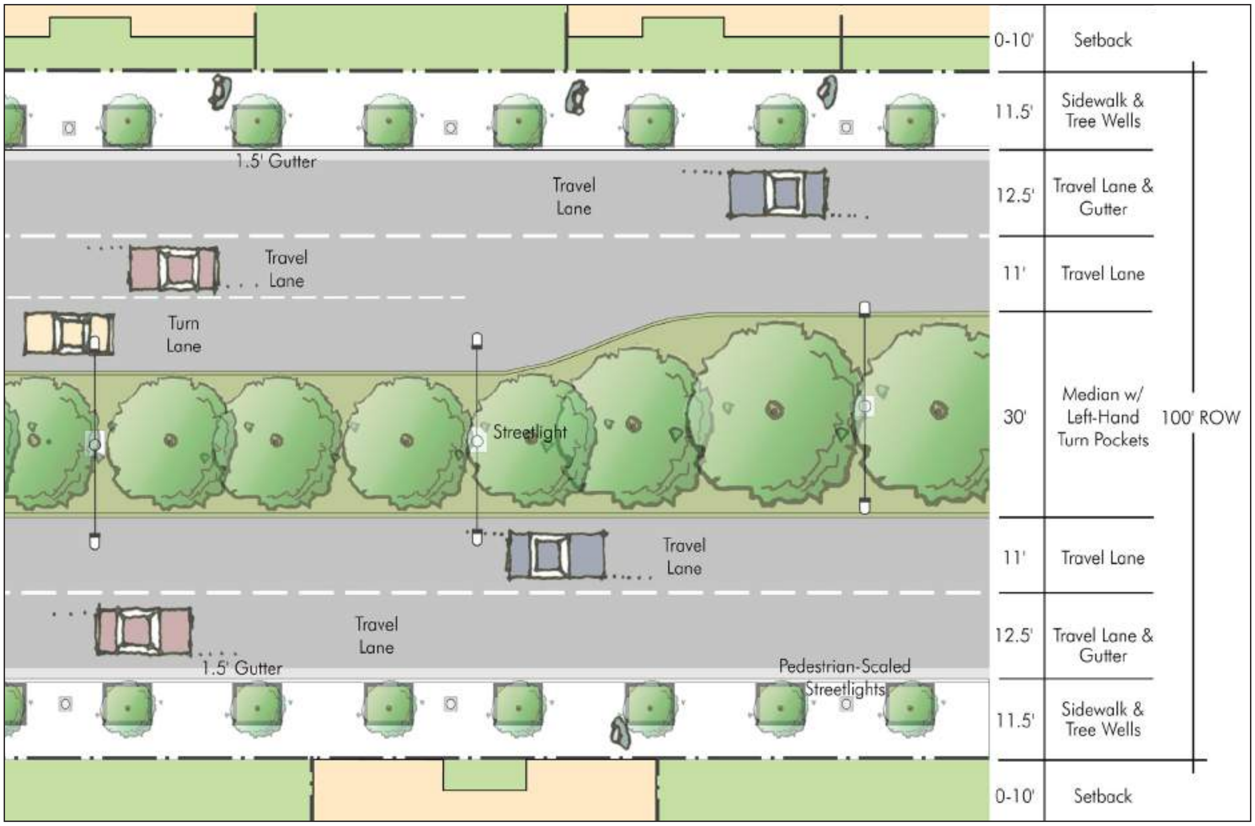
Caltrans has studied West 10th Street and proposed some spot improvements. In its *Project Study Report/Project Report, Marysville Operational Improvements,* Caltrans recommends

1. Remove outside westbound lane, which is not being used as intended.
2. Remove raised medians between F and H Streets. Instead, provide left turn lanes eastbound and westbound at G Street, and eastbound at F Street.
3. Prohibit westbound left turns at F Street (turning south on F Street)
4. Convert signals from 3-phase operation to 5-phase operation with permissive green movements northbound and southbound.
5. Retain left turn prohibition at H Street.
6. Remove on/off ramps and traffic island at I Street and convert the westbound "trap" lane into a lane that merges before the bridge structure.

This proposal increases capacity by eliminating the existing split phase timing, allowing more green time to move east and west bound traffic. Additional capacity is gained from the signal improvements. Caltrans should definitely move forward with the recommended signal upgrades. However, losing the landscaped medians would make the street less pedestrian-friendly. The capacity improvements provide an opportunity for options that preserve landscaping space while minimizing pedestrian exposure to traffic.

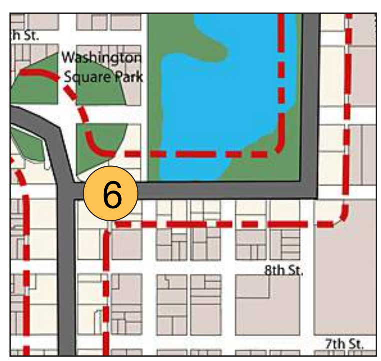
During the charrette, a more pedestrian-friendly street design emerged that deserves consideration. The alternate design calls for converting the leftmost through lanes at F and G Streets to left-turn-only lanes, and possibly one left-turn lane at H Street. The left-turn lane would extend back from each intersection for most of a block, but would be tapered out (by widening the median) at the beginning of each block. This design requires using protected left-turn-only phasing. Permissive left turns would be unsafe. A queue of oncoming left-turning vehicles can block the view of through travel lanes. Protected phasing also reduces risk to pedestrians and other users crossing the street. After the capacity of this design has been verified, further planning could lead to a longer-term project. Rebuilding the entire road could include widening sidewalks and/or buffer areas along the sidewalks with rows of trees.

The plan view below shows the street section recommended for west 10th near E Street. Design exceptions will be needed for this section:
1) Plan recommends 11 ft. Lane Width; Design Standard is 12 ft.
2) Plan recommends 1.5 ft. Shoulder/Gutter Width; Design Standard is 4 ft.



East 9th Street (State Routes 70/20)

6 D Street is an important gateway into the downtown area. The images on the next page illustrate how adding curb extensions on D Street would shorten the crossing distance for pedestrians, and make them more visible to motorists. The bulb-outs also enhance the intersection by replacing asphalt with sidewalks and landscaping. To maintain the right turn lanes on the approaches to 9th Street, bulbouts on the northwest and southeast corners were not recommended. The bulb-out on the northwest corner also would have conflicted with an existing driveway that is unusually close to the intersection.



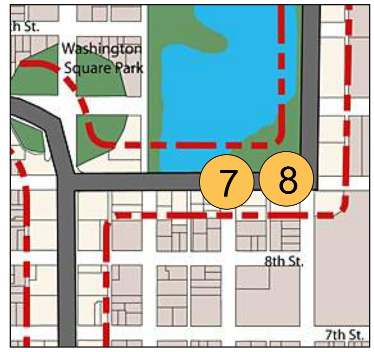
6. Bulbouts on side streets.

Access management of driveways can benefit non-motorized users. This can be done over time, as land uses change. Limiting the width and number of driveways along the street lowers risk to all users. Pedestrians reduce their risk by lowering their exposure to vehicles exiting and entering driveways. Access management lowers motorists' risk by reducing the number of vehicles entering and exiting the roadway.

The upper photo shows the existing 9th and D Street intersection. The bottom photo simulates recommended improvements.

New commercial development on 9th Street provides additional pedestrian destinations. However, crossing to the new businesses can be a problem, as the pedestrian in the lower photo found.

9th and C Streets



7. Two-stage pedestrian crossing.
8. Re-design curb and slip lane.

7 Connectivity across 9th Street is poor for pedestrians and other users. South of 9th Street lie the downtown and civic center area. Ellis Lake and commercial areas are north of 9th Street. The pedestrian in the bottom, left image is crossing at the C Street intersection, which is a legal, though unmarked, crosswalk. Past improvements at this site included the island the pedestrian is standing on, but the intention was for pedestrians to cross at B or D Streets. New commercial development has changed the desire line for pedestrians, making it unrealistic to expect them to travel to B and D Streets to access businesses. Today many pedestrians cross at or near C Street, towards Ellis Lake and the commercial destinations that line 9th Street. This location is well suited for a two-stage pedestrian crossing because existing turn restrictions and the existing median allow adequate room. The north side of 9th Street needs a new sidewalk connection to give direct pedestrian access to destinations on that side, including the lake and commercial destinations.

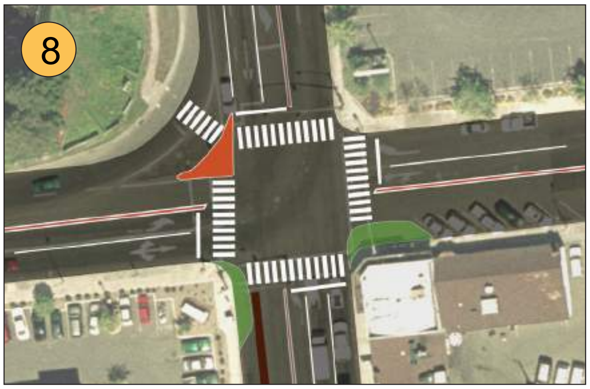
9th and B Streets

8 Most traffic at this intersection follows State Route 70 (north and south) State Route 20 (east and west). This requires turning at 9th and B Streets for most vehicles. New commercial development on the northwest corner hosts a variety of eateries and has become a neighborhood destination for all users. The north leg of the intersection is closed to pedestrians.

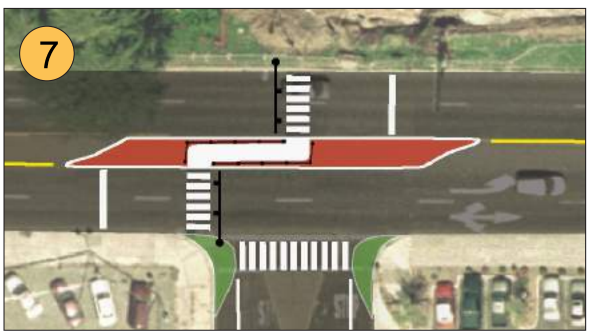
The right-turn slip lane and the curb line on the northwest corner

Looking north toward 9th Street on C Street. To reach retail destinations pedestrians must cross the state highway.

should be modified to slow right-turning traffic and encourage turning drivers to yield to pedestrians. (see slip lane information on page 24.) Since most traffic turns here, two southbound through lanes are not necessary. One southbound through lane should be dropped at this intersection. This would leave one right-turn lane, one through lane, and one left turn lane. All four legs of the intersection should be marked with crosswalks. Bulb-outs on the south side of the intersection would reduce pedestrian crossing distance and hold back parking at the southeast corner so drivers do not accidentally enter the crosswalk.



Above are the suggested intersection improvements for 9th and B Streets. The simulation below shows proposed crossing improvements at 9th and C Streets.

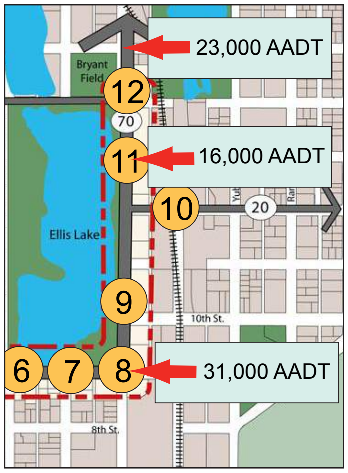


Two-stage pedestrian crossings

Two-stage crossings reduce pedestrian risk while minimizing interruptions in the traffic flow. Pedestrians push the button, wait for the “walk” interval (which is on their side of the street only); walk to the median island; push the next button, and cross during the “walk” interval. Ideally, pedestrians do not have to wait long for a “walk” interval. If wait times are long, pedestrians may cross during a gap in traffic and cars may be stopped when pedestrians are no longer present.

The offset in the island turns pedestrians towards oncoming traffic before proceeding across the second half of the street. This helps raise awareness of oncoming traffic. Pedestrian warrants in the Manual on Uniform Traffic Control Devices are expected to change in the near future, making it easier to meet warrants at locations like 9th and C Street.

The photo above shows a two-stage pedestrian crossing. After the first stage, crossing to the center island, pedestrians must walk to face traffic before completing the second stage. A signal, as shown above, is not required for two-stage pedestrian crossings.



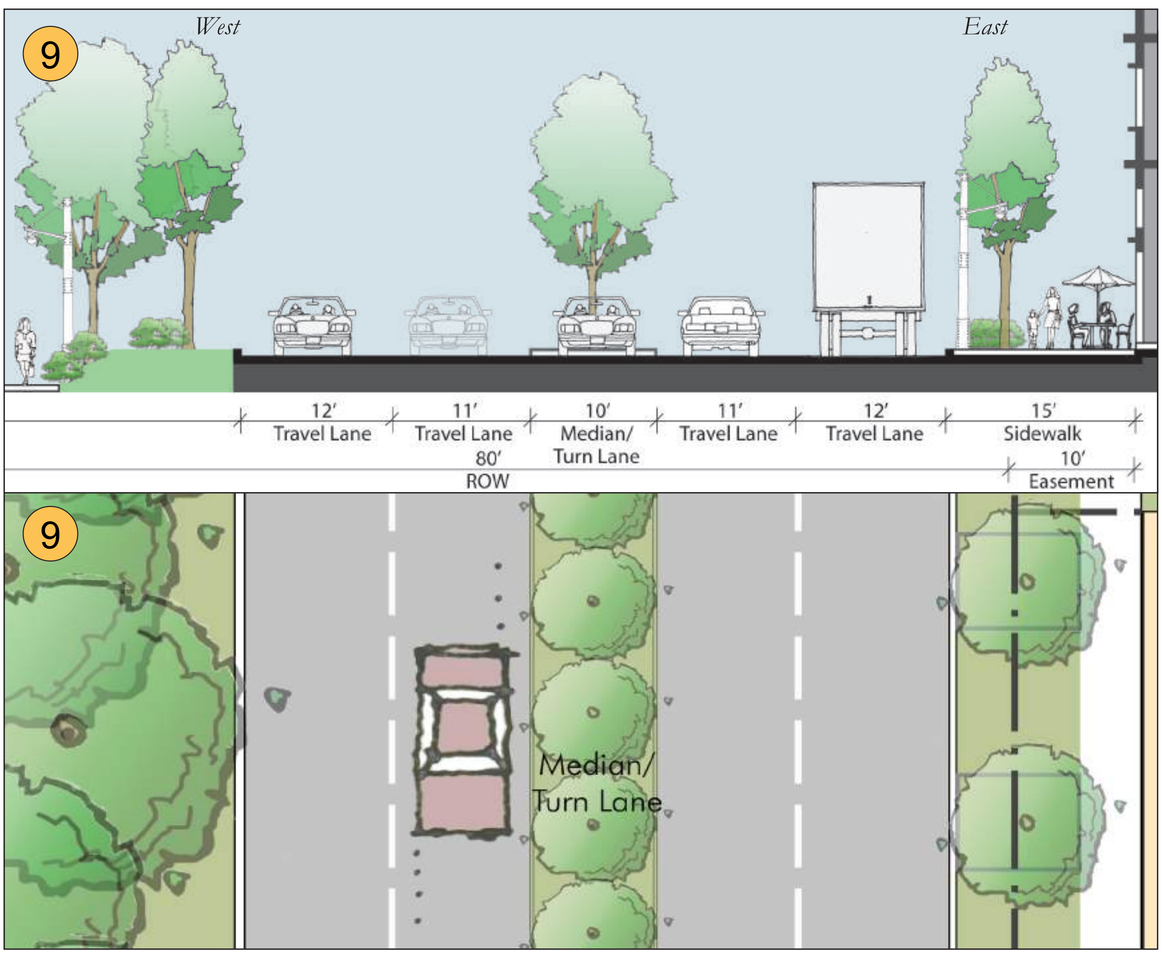
9. Drop one southbound through lane.

10. Gateway treatment.

11. Reallocate right-of-way, new section.

B Street (State Route 70/20)

9 B Street is designated as State Route 70/20 north of 9th Street. Traffic volume is substantially higher between 9th and 12th than in other segments of B Street. The recommended section for this segment has 4 travel lanes and a raised median, with turn pockets at selected locations between 10th and 12th Streets. The sidewalk zone on the east side of the street is 15 feet wide, with landscaping between the sidewalk and street to buffer pedestrians from the high volume of traffic. As shown in the section drawing below, accommodating a wider sidewalk on the east side of the street would require setting buildings back 10 feet and working with property owners to obtain a sidewalk easement. Trees in the buffer area and raised median will help achieve City beautification objectives and make the area more comfortable for pedestrians. The sidewalk on the west side of B Street is at lake level.



Top: Proposed B Street section between 9th-12th Streets. A median is only feasible between 10th and 12th Streets, north of the left-turn pocket. Bottom: Plan view of street.

North of 12th Street

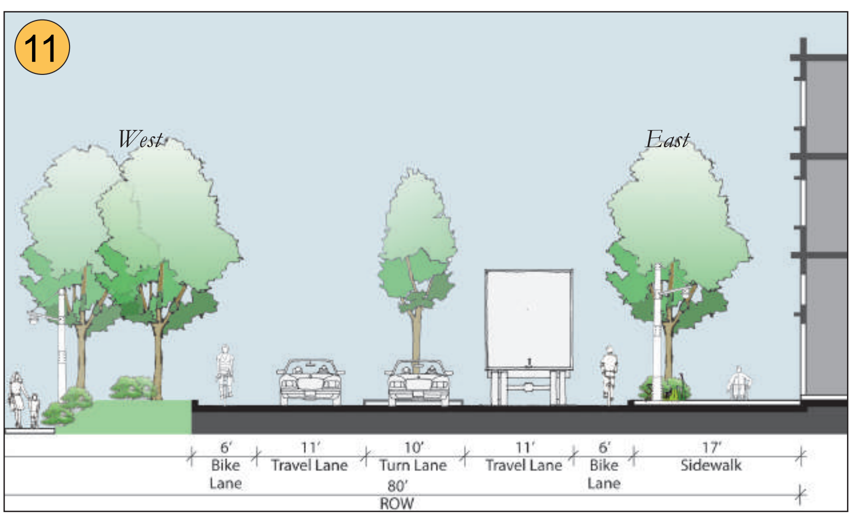
11 Between 12th and 14th Street, traffic volume on B drops substantially, then increases again on the two-lane segment north of 14th Street. There is a vacant parcel due for revitalization near the intersection of B and 14th Street.

Participants expressed a desire to strengthen connections to Ellis Lake as future development occurs. Numerous ideas for connecting the vacant parcel to the lake were considered. The cost to relocate B Street is prohibitive. Reallocating roadway space between 12th and 14th, however, would help the street environment complement the lake and better suit pedestrian-oriented business. Three options emerged from the discussions. However, the most feasible option of the three shows one 11 foot travel lane in each direction, a sidewalk with a landscaped buffer on the east side of the street, on-street bike lanes, and a raised median and left turn lanes where needed. The east side sidewalk is 11 feet wide and there is no sidewalk along the Lake Ellis side at street level. Bike lanes or delineated shoulders on both sides of the street keep traffic six feet further from the sidewalks.

This will still provide adequate capacity to carry current traffic volumes. A roundabout at the intersection of 14th Street is recommended to add traffic capacity, which would encourage revitalization of the intersection's southeast corner. The roundabout is discussed on pages 22 and 35. Reducing the number of lanes will increase connectivity to the lake. Pedestrians can cross easily and safely at the roundabout.

B Street parallels Ellis Lake. Pedestrian access to the lake is limited to the signalized crossings. There is no on-street parking near the lake.

The railroad bridge on Highway 20 just east of Ellis Lake is an ideal gateway sign location.



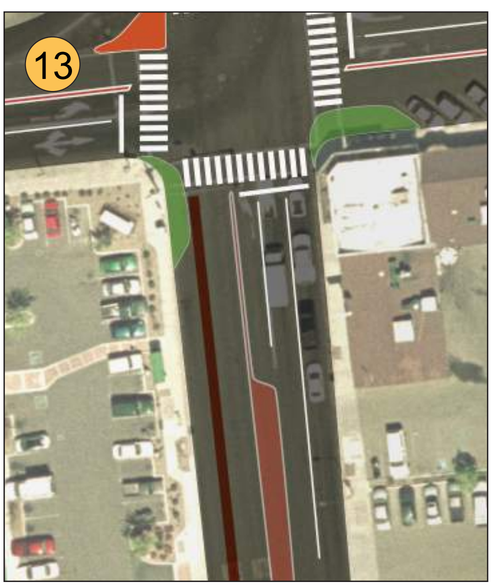
Proposed B Street section between 12th-14th Streets.

Bike lanes are shown in this section north of 12th Street. However, there is no room for bike lanes between 9th and 12th Street at this time. Until space is available in that segment, areas depicted as bike lanes should be delineated with an edge line, but should not be marked or signed as a bike lane. Whether marked as bike lanes or simply delineated as space not for driver use, this shoulder area creates a buffer between pedestrians and traffic and provides space for drivers to pull over for emergency vehicles. This area also provides space for officers to pull over errant motorists and for emergency parking if a vehicle is disabled.

As B Street develops, more pedestrian crossings may be needed. If the distance between intersection crossings is great, and people are crossing midblock, consideration should be given to installing a midblock crossing. Its location would be dependent upon land uses and proximity to other crossings. For example, if an ice-cream shop opened midway between 12th and 14th, pedestrians might cross frequently to the lake to enjoy their treat. A convenient crossing may be needed. A cut-through in the raised median similar to the one shown below allows pedestrians to cross one direction of travel at a time. This increases the number of gaps available for crossing and improves safety.

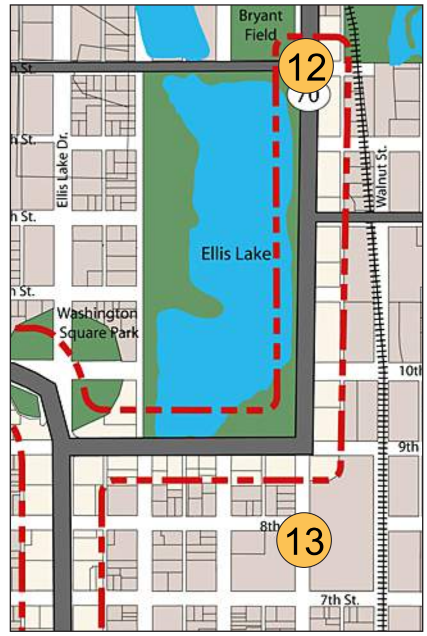
Example of a midblock crossing in Olympia, WA. Angling the crosswalk through the island forces pedestrians to look in the direction of oncoming traffic.

The photo above simulates an overhead view of the roundabout recommended for B and 14th Street. The drawing below provides a conceptual vision of a roundabout at this intersection.



B and 14th Street

12 A single-lane roundabout is recommended at B and 14th Streets to provide maximum capacity and smooth traffic flow through the intersection. See page 22 for more details on roundabouts.



12. Single-lane roundabout.
13. Rallocate right-of-way, new section.

B Street south of 9th

13 Although outside the formal study area, the consultant team observed the role that the southern portion of B Street plays in moving regional and local traffic. Traffic volumes drop substantially and the character of B Street changes south of 9th Street. There is a mix of uses in this segment, including commercial, Caltrans offices, the County Court House and residential. The street connects to the downtown grid and ultimately merges into 1st Street. First Street passes through the historic Chinese district and connects to E Street via a cloverleaf ramp on the west side near the end of the bridge. It is an attractive cut-through for drivers seeking less congested alternatives to highways 70/20, but it would be incompatible with the guiding principles of this plan to encourage through traffic to use this travel route. Therefore, one lane in each direction, turn pockets at intersections, on-street parking, and bike lanes should be considered for B Street south of 9th. However, due to the traffic movements, and to maintain the capacity of the intersection at 9th and B, the City may want to keep two northbound lanes, with turn pockets at intersections, between 6th and 9th Streets. See 4 to 3 Lane Conversions in the Appendix for additional information.

The simulation on the left shows improvements recommended for B Street south of 9th. To manage traffic speeds and cut through travel, this segment of B Street only needs one through lane in each direction.

Implementation

The plan recommends numerous improvements. This section lists improvements and the approximate implementation timeline.

Short-term projects could begin right away, with completion accomplished by the end of twenty-four months. Focusing first on these projects will benefit pedestrian safety and comfort while providing visible changes. For example, striping high-visibility crosswalks at all signalized intersections is a noticeable improvement. This affirms the message that Marysville is serious about becoming a more walkable community and responding to citizen input.

Some short-term recommendations, such as using the Sidewalk Zone System and the most recent ADA publications to guide development of new sidewalks, will require changes in procedures and/or standard drawings. Although it is feasible to draft and adopt the new requirements within a year, the results will not be visible until new projects are constructed. Changes such as these are important to include in short-term efforts so opportunities for improvements are not lost as redevelopment and ADA upgrades occur in Marysville.

Some short-term improvements, including signal timing changes, may require additional analysis before implementation. This process should begin as soon as possible.

Mid-term projects are those that could take 3 to 10 years to complete. Factors that influence the timeline include the need for collaboration with Caltrans, funding sources, and priorities. Some mid-term projects are less complex, and may merit a higher priority than those with more construction impacts. For example, it may be feasible to construct the right-slip-lane at E and 9th Streets more quickly than the signalized two-stage pedestrian crossing at 9th and C Streets. Since most of the recommended projects are on State right-of-way, Caltrans' input in selecting priorities is essential.

Long-term projects are those expected to take longer than 10 years to complete. In some cases, the long-term project timeline could be shortened if driven by development opportunities. For example, redevelopment is anticipated on the southwest corner of 9th and E Streets. That development may provide an opportunity for improving the intersection sooner than expected.

The Guiding Principles affect all implementation efforts. Community leaders should consider compatibility with the principles during the decision-making process. ***Principle 1, Taking Advantage of Marysville's Assets***, requires carefully considering projects to ensure they enhance existing assets. Many of the improvement can incorporate ***Principle 2, Beautify***, by adding landscaping and aesthetic features. ***Principle 3, Connections for All Users***, is equally important. Marysville must assess each project in the community to make sure it improves the current level of connectivity for nonmotorized users, as well as preserving existing connectivity for vehicles.

Implementation Schedule	1 - 24 months	3 - 10 years	10 years or more
Overall Recommendations			
High visibility crosswalk markings	x		
Pedestrian countdown signals		x	
Pedestrian signal changes	x		
Preemption for emergency service providers			x
Sidewalks: Guidance/standards for Zone System and ADA	x		
Bikeway master plan		x	
E Street			
Restripe bridge w/colored shoulder		x	
Signal timing changes	x		
Open or barricade crosswalk, south leg of E & 3rd	x		
Gateway at 3rd		x	
Additional left turn lane at E & 5th	x		
Slip lane w/island at E & 9th		x	
Roundabout or additional lanes at E & 9th			x
Restripe travel, turn, and parking lanes	x		
Construct and landscape medians		x	
Rebuild sidewalks w/brick paver edges		x	
Rebuild parking lanes with bulb outs and textured material		x	
10th Street			
Signal improvements as proposed by Caltrans		x	
Convert leftmost lanes to turn lanes		x	
Sidewalk and landscaping improvements			x
9th Street			
at D Street, side street curb extensions		x	
at C Street, two-stage pedestrian crossing, signalized		x	
at B Street, geometric changes per illustration		x	
B Street			
Restripe between 9th and 12th; drop one southbound thru lane	x		
Between 9th and 12th, widen sidewalks and add landscaping as easements are granted		x	x
Restripe north of 12th	x		
Colorize bike lanes when a continuous route can be provided			x
Roundabout at 14th			x
If needed, add midblock pedestrian crossing with island			x
South of 9th Street, restripe to one through lane each direction, bike lanes and center two-way left turn	x		

Pedestrian Infrastructure

MTC Pedestrian and Bicycle Toolkit. http://www.mtc.ca.gov/planning/bicyclespedestrians/index.htr

● High
⊖ Medium
(Low

Item	Description	Qty.	Unit	Low Unit $	High Unit $	Effective-ness	Notes & Assumptions[1,2]
Crossings							
1.0	Audible Pedestrian Crossing Cues at Intersection		LS	$10,400	$10,400	⊖	Per intersection. Assumes one at each corner of intersection (8 per intersection or $10,400 per intersection)
1.1	Automatic Pedestrian Detection		EA	$500	$1,000	⊖	A surface treatement that senses the weight of pedestrian
1.2	Bulbout (LF curb, sf Concrete, wheelchair access, demo)		EA	$15,000.00	$25,000.00	●	Costs increases with infrastructure implications. Based on lump sum cost for 6' wide bulbout extension, and 20' length
1.3	Crosswalk Countdowns		LS	$2,400	$6,400	●	Per intersection (assumes 8 signals). Cost is $300 - $800 for one countdown signal
1.4	Crosswalk: Lighted Flashing (In Pavement Flashers)		LS	$100,000	$120,000	⊖	Lights adhered to pavement in crosswalk. Per interesection.
1.5	Crosswalk: Raised above grade		EA	$5,000	$5,000	⊖	
1.6	Crosswalk: Striping (Standard and High Visibility)		LF	$3	$6	⊖	Low end: standard and zebra stripping; High end: high visibility floursescent
1.7	Pedestrian Push Button Treatments		EA	$1,300	$1,300	⊖	
1.8	Pedestrian Refuge Island		EA	$8,000	$15,000	⊖	Assumes curb and median approximately 6' wide
1.9	Signage (Standard vs. High Visibility)		EA	$300	$400	●	Assumes new post is needed in sidewalk and installation
1.10	Signalized Interesections		LS	$125,000	$250,000	●	Per intersection. Estimate depends on size of street, type of signal and complexity of intersection
1.11	Wheelchair Ramps (w/ warning surface half domes)		EA	$2,600	$3,000	●	Includes demolition costs and repaving asphalt at cuts
1.12	Yield Lines (Advanced Limit Lines or Back Lines)		LS	$200	$500	●	Per intersection
Enforcement							
1.13	Radar Speed Display Sign		EA	$13,000	$16,000	●	
1.14	Rat Box		LS	$400	$400	⊖	Per intersection. Rat box indicates when signal has changed. Requires 4 per intersection(or $100 each)
1.15	Traffic Cameras		LS	$75,000	$125,000	●	Infrared cameras that photograph autos running redlights. Per intersection.
Materials							
1.16	Asphaltic Concrete		SF	$9	$9	(	Roadway asphalt
1.17	Concrete Paving Sidewalk (scored)		SF	$8	$10	●	Square foot cost of concrete for interior of sidewalk only
Sidewalks and Lighting							
1.18	Concrete Curb and Gutter Installation		LF	$30	$40	●	
1.19	Concrete Curb and Gutter Remove and Replace		LF	$60	$60	●	
1.20	Concrete Sidewalks Removal and Replacement		SF	$20	$20	●	Crosswalk includes concrete treatment
1.21	Pedestrian-Level Street Lights		EA	$3,000	$5,000	●	
1.22	Standard Street Light (Cobra Head)		EA	$10,000	$10,000	(	
1.23	Widened Sidewalks		LF	$80	$80	●	Includes demolition cost for curb removal, replacement and concrete for 3 SF of sidewalk

Pedestrian Infrastructure

MTC Pedestrian and Bicycle Toolkit. http://www.mtc.ca.gov/planning/bicyclespedestrians/index.htr

● High
⊖ Medium
(Low

Item	Description	Qty.	Unit	Low Unit $	High Unit $	Effective-ness	Notes & Assumptions[1,2]
Traffic Calming							
1.24	Chicanes		LS	$15,000	$35,000	●	A significantly bermed median between two lanes of traffic
1.25	Speedbumps		EA	$3,000	$4,500	●	
1.26	Stop Signs		EA	$300	$300	⊖	Including new post and cost of installation
1.27	Traffic Calming Circles		EA	$8,000	$12,000	●	Small circle barrier in typical intersection and landscaped
Pedestrian Amenities							
2.0	24" Box Trees		EA	$1,820	$1,820	●	Includes irrigation, trenching and water barrier
2.1	60 Day Maintenance		LS	$3,000	$4,000	⊖	Estimate based on square footage of landscape area and tree maintenance of costs over 1/2 mile of road
2.2	Bench (6' Wide)		EA	$1,500	$3,000	⊖	
2.3	Bike Racks		EA	$600	$1,200	⊖	Includes installation
2.4	Bollards		EA	$500	$750	⊖	
2.5	Bus Shelter		EA	$5,000	$10,000	●	
2.6	Bus Concrete Pad		EA	$6,500	$6,500	(	
2.7	Crosswalk: Permeable Paving- Brick		SF	$13	$13	(	Includes demo of existing asphaltic concrete and aggregate base
2.8	Crosswalk: Scored Concrete		SF	$8	$12	(	Includes demo of existing asphaltic concrete and aggregate base
2.9	Crosswalk: Stamped Colored Concrete		SF	$10	$15	(	Includes demo of existing asphaltic concrete and aggregate base
2.10	Gateway Features		EA	$12,000	$24,000	●	
2.11	Grade Separated Crossing (Pedestrian Bridge)		EA	$500,000	$4,000,000	(	Costs increases with size and approach of crossing
2.12	Information Kiosks		EA	$1,500	$3,000	⊖	
2.13	Landscaped Median		LF	$200	$400	⊖	
2.14	Newsracks		EA	$4,000	$6,000	(	Includes a bank of 4-6 newspaper racks.
2.15	Orange Safety Flags at Corner Intersections		EA	$100	$100	(	Per set for one side of street; 8 sets required for complete set.
2.16	Planting at Bulb-outs		SF	$9	$9	⊖	
2.17	Seat Wall		LF	$185	$225	(	
2.18	Street Pole Banners		EA	$400	$600	⊖	Assumes standard street light pole already installed cost includes brackets and 2 banners.
2.19	Trash Cans		EA	$800	$1,500	(	
2.20	Tree Grates includes frame (4'x4')		EA	$680	$750	⊖	
2.21	Tree Guards (Powder Coated)		EA	$325	$670	(	
2.22	Tree Well		EA	$500	$500	●	Includes saw cut of 5' x5' hole, 2.5 cy amended soil, and concrete demo and hauling
2.23	Water Fountain		EA	$15,000	$50,000	(	Assumes water source is already available at site.

References

1. Giles-Corti, B., Donovan, R.J. (2003) Increasing Walking: Relative Influences of Individual, Social Environmental, and Physical Environmental Correlates of Walking, American Journal of Public Health, 93(9), 1583-1589.

2. Frank, Lawrence, and Peter Engelke. 2001. The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health. Journal of Planning Literature 16, 2: 202-18

3. Humpel N, Owen N, Leslie. 2002. Environmental factors associated with adults' participation in physical activity: a review. Am J Prev Med, 22:188-99

4. Jacobs et al, 2002

5. Field Evaluation of a Leading Pedestrian Interval Signal Phase at Three Urban Intersections. Van Houten, Retting, and Farmer. Transportation Research Board.

6. Traffic Signal Preemption for Emergency Vehicles. US Department of Transportation. Publication FHWA-JPO-05-010.

7. Intelligent Transportation Systems, U.S. Department of Transportation, Benefits of EVP, http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/14097_files/section_6.htm

8. Draft Public Rights-of-Way. http://www.access-board.gov/prowac/index.htm

9. Guide for the Planning, Design, and Operation of Pedestrian Facilities. American Association of State Highway and Transportation Officials (AASHTO). July, 2004.

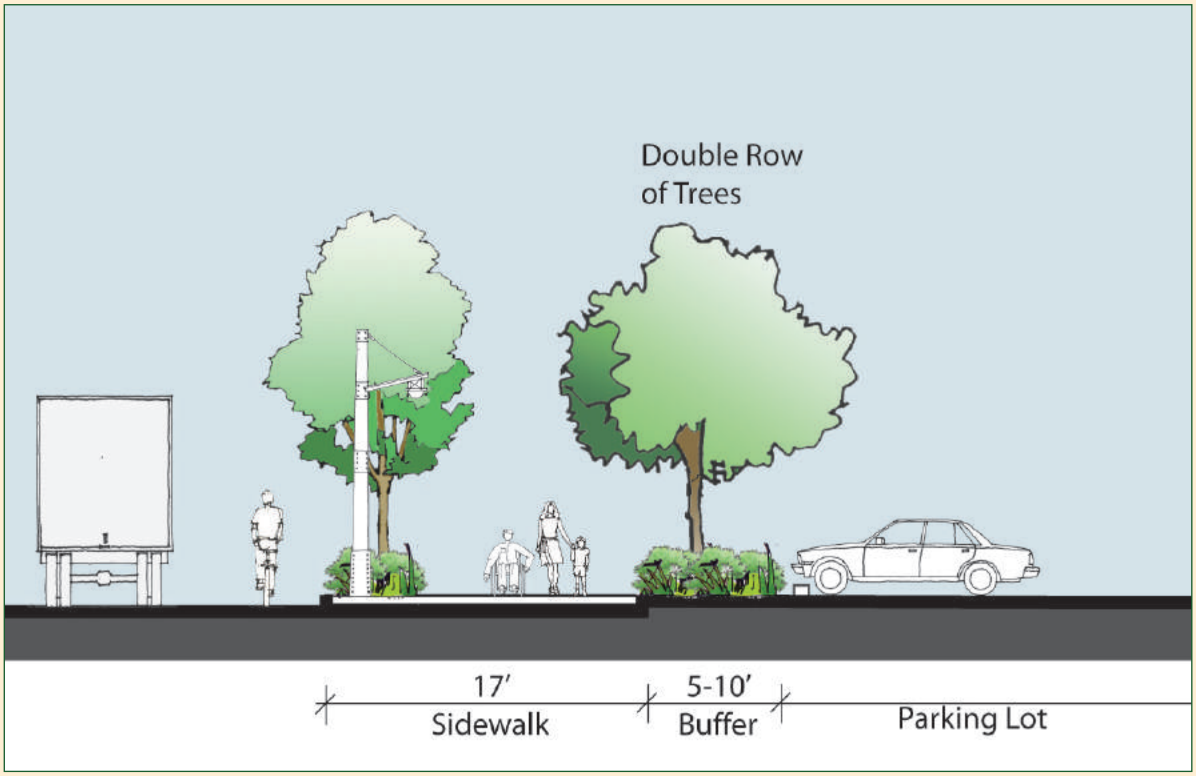
Design Guidelines

B Street Design Guidelines

Orientation and Layout

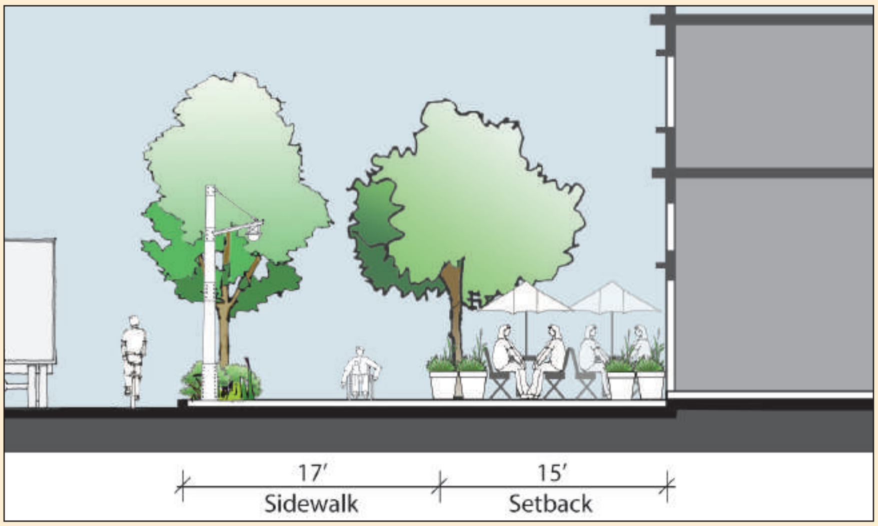
- Allow parking along the sides and rear of lots, accessed by side streets and rear alleys.
- Where parking abuts the right-of-way, create landscaped buffers between the sidewalk and parking lots to minimize the impacts on the pedestrian environment.
- Minimize the presence of curb-cuts and driveways along B Street by encouraging vehicular access to buildings from side streets.

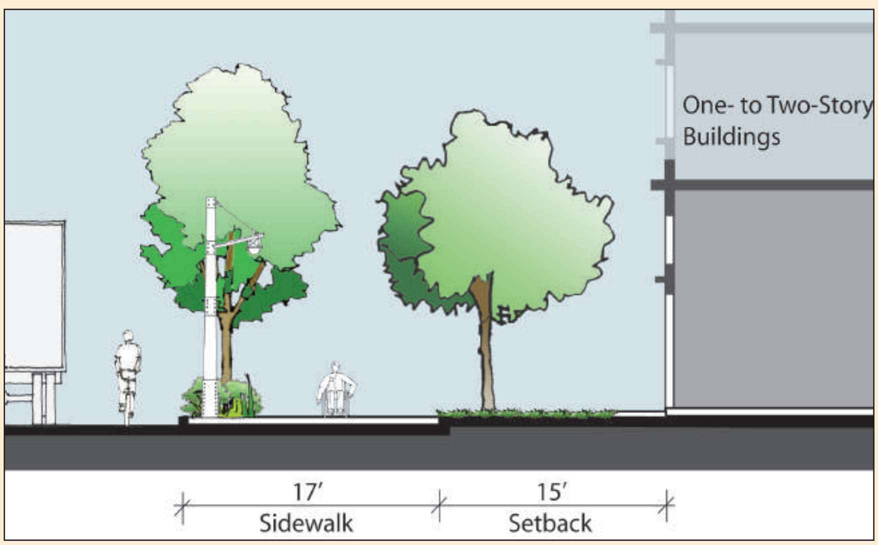
A buffer on both sides of the sidewalk enhances the pedestrian experience.



Massing and Setbacks

- Encourage the location of the majority of the building facades and commercial entrances to buildings along B Street.
- Provide building heights in keeping with the nature of B Street, such as one and two story buildings.
- Allow up to 15 feet wide front setbacks to provide additional room for outdoor seating, spill out uses from adjacent buildings, landscaping and other pedestrian amenities.





Public Realm Articulation

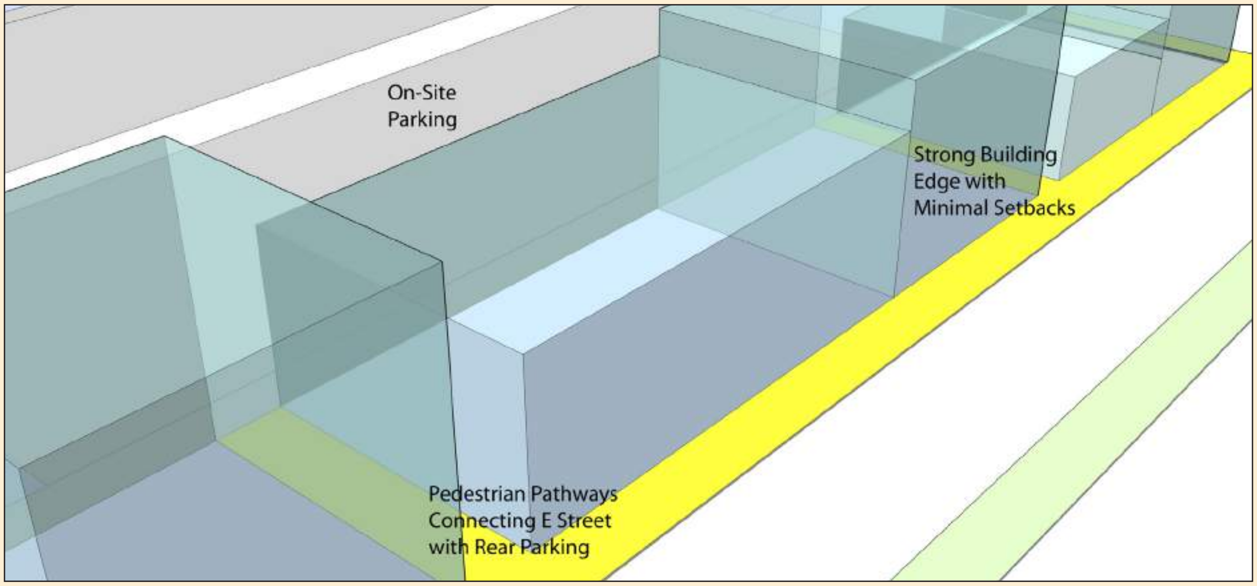
- Provide adequate shade along the east side of B Street with street trees lining the sidewalk.
- Where the sidewalk is widened through increased setbacks, ensure the sidewalk is shaded for pedestrians by providing additional landscaping and a second row of trees along the sidewalks.
- Encourage a boulevard feel along B Street with striking green canopies along both sides of the street to complement the lake.

E Street Design Guidelines

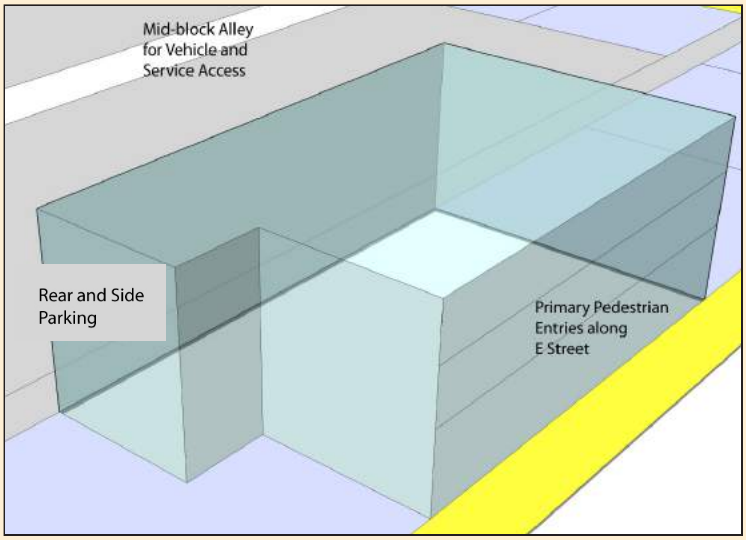
Design guidelines for buildings along E Street will increase the effectiveness of right-of-way improvements intended to improve safety, efficiency, and connectivity for all users. For the best outcome, street improvements must coincide with supportive building design guidelines.

Orientation and Layout

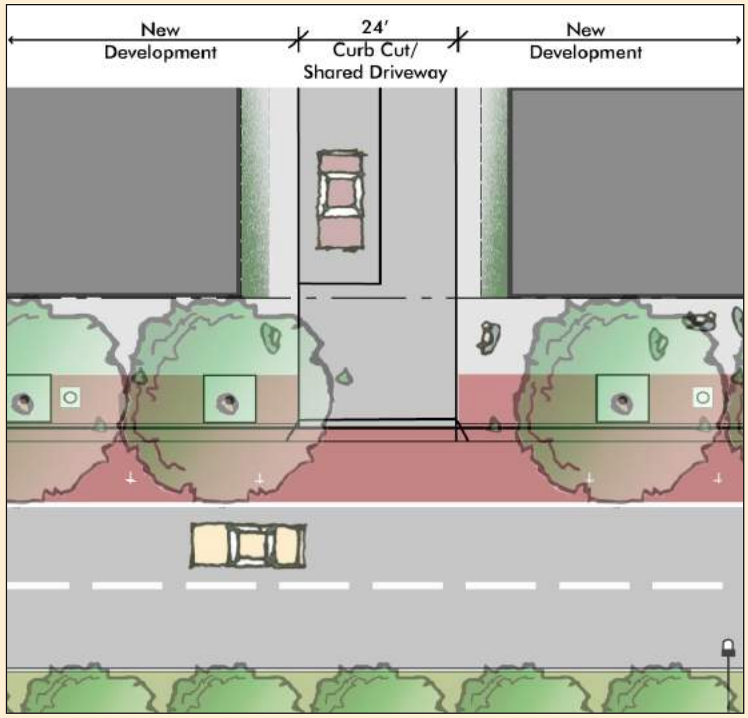
- Create a strong building edge along E Street to define the public realm, maximize visibility of commercial uses, provide “eyes on the street,” and limit turning movements at intersections. “Eyes on the street” refers to the concept that where people are out on the street, natural surveillance reduces criminal behavior.



- Locate parking in the rear of the lot, accessed by side roads and existing alleys. Incorporate pedestrian pathways between buildings to link rear parking lots with E Street and to provide convenient and secure access



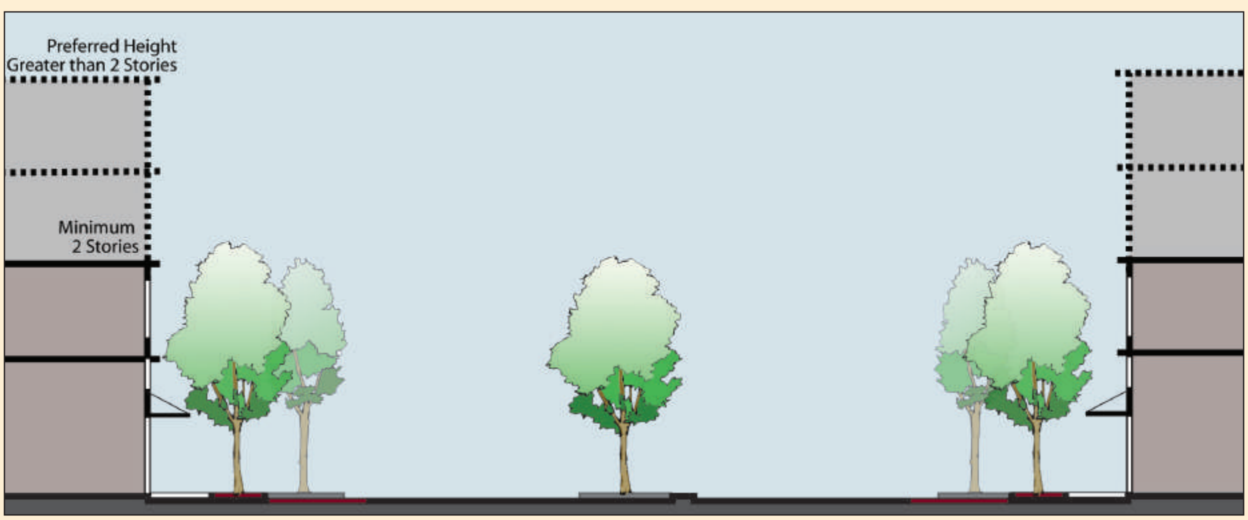
Parking behind and beside buildings is easily accessible from the street through alleys, plazas, and pocket parks.

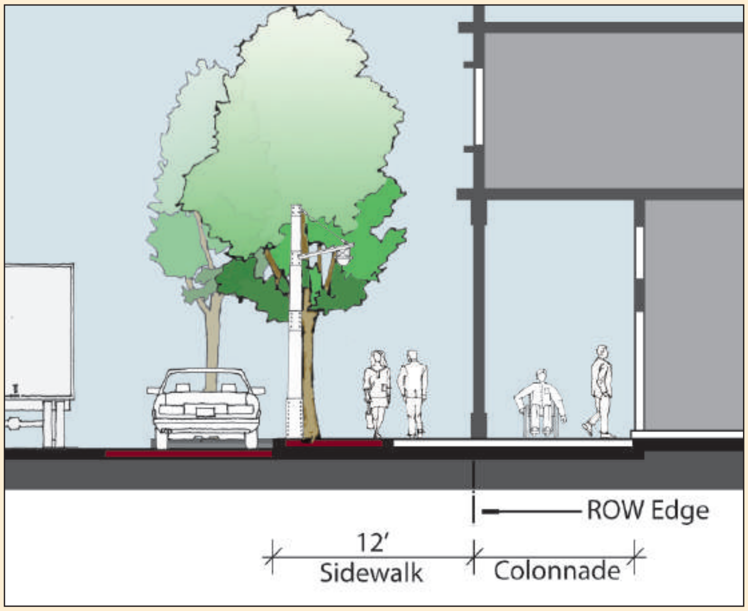


- Minimize the presence of curb cuts and driveways on E Street. Many businesses are served by multiple driveways. Traffic turning across sidewalks creates a conflict with pedestrians. Multiple turning movements also reduces through capacity for the street.
- Where possible, consolidate and narrow existing driveways to 24 feet in width to minimize conflict points between pedestrians and vehicles.
- Where driveway do exist, restrict movements to right-in and right-out only by continuing the raised median.
- Continue sidewalks across driveways. Do not design driveways like intersections.

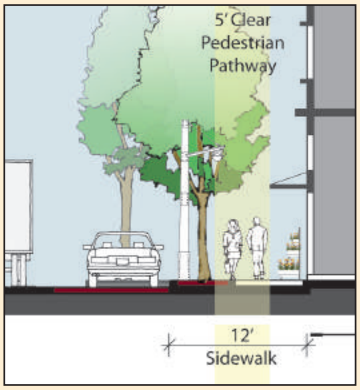
Massing and Setbacks

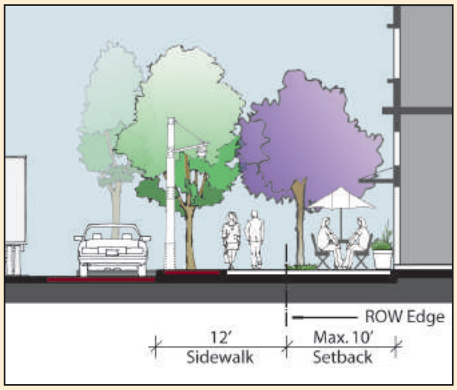
- Encourage building heights in keeping with the historic buildings along E Street, such as the State Theater and the Marysville Hotel.
- Ensure minimum building heights of two stories to provide some sense of enclosure along the street.
- Encourage heights of 15 to 20 feet floor-to-floor for commercial uses and 10 feet for residential floors
- Respect adjacent historic buildings in scale and massing.

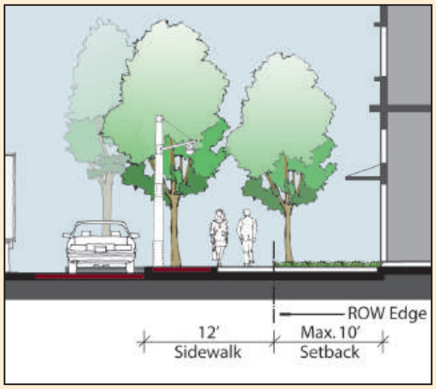


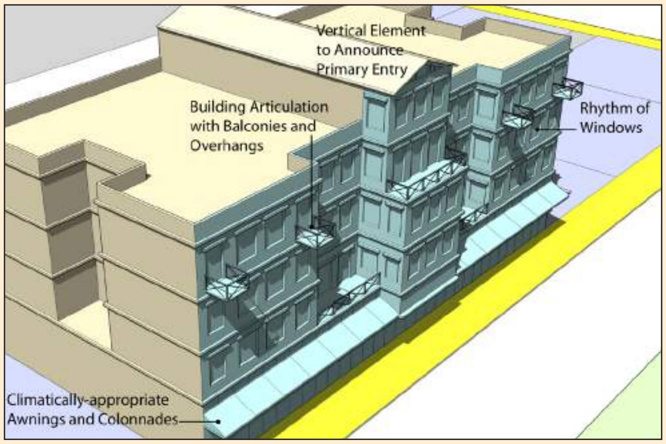


- Where possible, encourage the use of 10 to 15 feet wide colonnades along the ground floor of buildings as climatically-sensitive and appropriate means for extending and enhancing the pedestrian environment.
- Allow maximum 10 feet building setbacks to provide additional room for outdoor seating, spill out uses from adjacent buildings, landscaping, monuments, signs, and other pedestrian amenities.
- Allow buildings to be built to the right-of-way provided building spillout uses do not compromise minimum five feet wide clear pedestrian pathways along sidewalks.







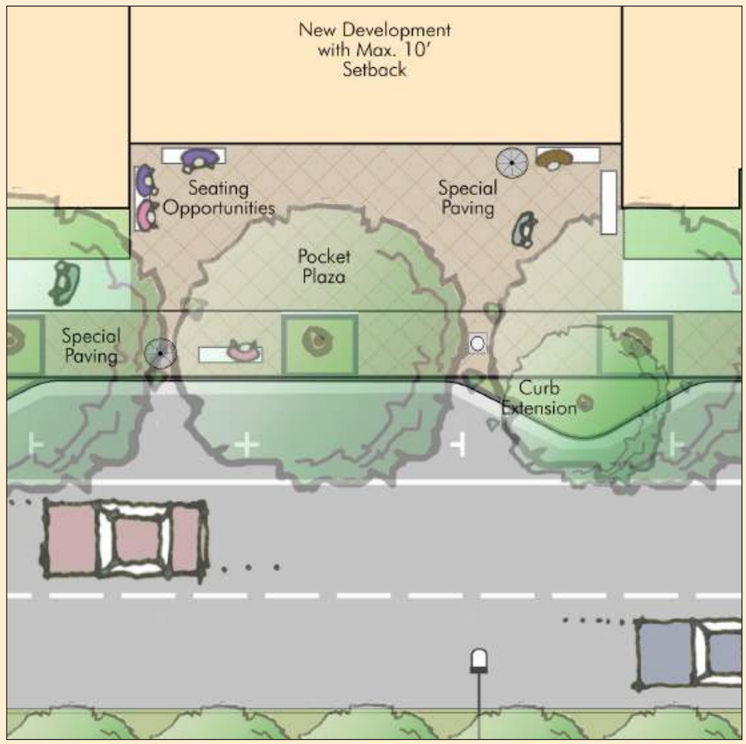


Building Articulation

- Locate most of the building façade along E Street.
- Maximize the number of primary pedestrian building entries along the façade facing E Street.
- Break the mass of larger and longer buildings with distinguishing architectural features, such as vertical elements and minor setbacks.
- Emphasize the primary entry of buildings with vertical elements.
- Articulate front façades with a rhythm of windows, both along the ground floor and upper floors.
- Ensure the ground floor is as transparent as possible to connect the pedestrians and building users.

- Minimize glare and heat gain caused by transparent glass by providing appropriate sun shade elements including awnings and deep overhangs. Integrate climatically sensitive building elements such as loggia, shaded walkways and colonnaded pathways into the overall architecture and façade of the buildings.
- Include pedestrian pathways between buildings connecting rear parking lots to E Street to improve accessibility and create a permeable built edge.
- Encourage the design of grand and distinctive buildings along E Street in keeping with its role as the gateway to Marysville.

Public Realm Articulation



- Celebrate key nodes along E Street like entryways of important community gathering buildings with pocket plazas through building setbacks and curb extensions. Distinguish nodes with special paving and seating opportunities.
- Use a contextually- and climatically-appropriate tree palette for street trees along E Street. Tree species such as London Plane are resilient in urban environments, easily maintained, and provide significant shade.
- Encourage the use of distinctive trees at curb extensions that do not block lines of sight. Ornamental trees, such as Eastern and Western Redbud, and Crepe Myrtle provide striking color contrast, attractive flowerings, and are smaller in size than full growth trees. See appendix for additional species information.
- Provide visual elements such as vertical historic markers within sidewalks to enhance the unique experience of E Street
- Create zones within the roadway public realm as described on pages 20-24.
- Select plants that will not encroach into the pedestrian zone or limit visibility when mature.

Building Use and Historic Preservation

- Encourage mixed use buildings along E Street with pedestrian friendly ground floor uses like cafés, restaurants, shops, and office and/or residential on upper floors.
- If uses are auto-oriented, design should be respectful of other buildings, with parking and other auto uses behind buildings
- Encourage the adaptive re-use of historic buildings along E Street to capitalize on existing assets along the corridor that contribute to the pedestrian environment and add to the richness of the City's fabric.

Appendix

Process Notes

Community Workshop

Thursday, May 31, 2007 6 – 8 pm

Visioning Exercise

Participants were asked to write on a 3 x 5 card how they would like highways 70/20 to be in twenty years. Their written comments were:

- Better economic development while still maintaining all the historic buildings and structures
- To be safer and more accessible for people with disabilities
- Marysville: Walkable community that serves as a regional destination where folks can safely enjoy and admire the area and be entertained with live/work situations
- Crosswalks with "chirping" signals for the blind. Bike paths, pedestrian paths. Safe paths of travel for people with disabilities and those who don't drive. Turn outs for bus stops.
- D Street as a pedestrian mall; "complete streets", connected system of bikeways within and without region; retain charm, history, and identity; Human scale; Bikeway over Yuba (Hwy 70); Mixed use
- More residential infill; downtown becoming a "destination," a self contained walkable community; Arts, entertainment, unique shops
- Pedestrian-oriented area with an eclectic mix of shops, dining and entertainment businesses; Drawn from the surrounding residential areas south and west of Marysville and the highway traffic.
- Pedestrian-friendly access to downtown areas; freedom from fear of vehicles; aesthetically pleasing; shaded walkways
- Small business mecca; lots of trees and history
- Well designed gateway into town; tree lined; slower traffic flow; people biking on the street safely – much more community-oriented – not car-oriented
- Yuba River parkway+eastern bypass; 3rd river crossing – south of Marysville; 4th river crossing – north of Marysville
- Vibrant, niche, commercial, business, and residential center devoid of gravel trucks
- 6 lanes on E Street or Maysville bypass and third bridge; more trees

The audience created a list of priorities, then "voted" on their top choices:

Trees	11
Crossings: 9th & D, E Street (all)	10
Pedestrian buffers	10
Fix sidewalks	9
Preserve historic buildings	8
Gateways: 3rd & E; 9th & D	8
Public Art	5
Wayfinding signs	5
Medians on E Street	5
Bike Lanes	5
Enhance Highway 20 Entry	5
Historic look for lighting	4
Highway 70 Tunnel: improve aesthetics	4

Saturday Design Workshop and Walk Audit

Saturday, June 2, 2007

Participants worked in groups to suggest improvements to the study area. The results are summarized below.

Group 1

Ninth Street

- Bulb outs at D Street to shorten side street crossing
- Wayfinding signs on bulb outs
- Clean up next to lake where slope is too steep
- Put in two green buffers on Carl's Junior side - one buffer between parking and sidewalk, and the other between the travel lane and the sidewalk
- On C and 9th, implement a two stage crosswalk. Add flashing warning lights.

E Street

- Keep 4 lanes; incorporate greenscape in center median and along pedestrian walk; put brick in furniture area; take away some parking to include some extra trees between parking bays.
- Define parking along E Street. Keeping parking allows us to incorporate the bump outs, which shorten ped crossings

Other

- Directional signs at key points
- Gateways over key city streets: 3rd, 5th, D both ends
- Signage as you come over the bridge
- Advance markings before crosswalks

They looked at B Street. At 18th near the train crossing there is a pedestrian crosswalk that needs improvement. It is used by the high school. Nearby charter school uses buildings for class; high school kids cross.

Group 2

Built scenario to get rid of on-street parking, 72' curb to curb, 2 lanes each way, continuous two-way or left-turn pocket; islands at intersection; that gained 14 feet on edges, so we looked at putting ; eliminated parking; added buffer tree wells with raised planter to separate from the roadway.

E Street

- Remove median lighting; move lighting to edges of streets; make it similar to the historic lighting that lights both the highway and pedestrian walkways
- Provide 14' pedestrian zone both sides, shoulders, 5 – twelve foot lanes
- Vegetation from 3rd to 9th
- Option 1 buffer: green edges with tree wells
- Option 2 buffer: Raised planers w/integrated benches, trees w/surface grate
- High visibility crosswalks
- Gateway – levee is an opportunity; the drop as you enter off the bridge creates an opportunity for a gateway
- Shoulders

Other

- Double right at 9th and B with signal
- Mid-block crossing refuge in wider intersections
- Playground on island where gazebo is.
- Off 20, visual cue about entering different environment
- Pigmented bike lanes
- Reroute westbound trucks on highway 20 to 14th and E Street

Closing Community Workshop

Wednesday, June 6, 2007

- I like the idea of using colored shoulders
- I like the idea of curb extensions
- An island at the intersection of 9th and E Streets could still be a problem for pedestrians
- For the 2-stage crossing recommended at 9th and C Streets, Check to make sure that's the right location. Make sure it is oriented properly for origins and destinations.
- Personally I don't like roundabouts, but they still work. How do we deal with things like drifters and street racers?
- At 9th and D Streets, for westbound cars will often block the crossing currently there. Also, the timing for pedestrians to cross is too short.
- Who will pay for the maintenance of any improvements?
- Look at one-way versus two-way streets.
- Is there a process for doing quick improvements? Especially with Caltrans?
- Did you look at re-routing trucks around Marysville?
- How about moving Route 20 north of Ellis Lake?
- How about using countdown signals?

Focus Groups

Highlights below include the facilitator question in italics, with bulleted responses from participants.

Thursday, May 31, 2007

Regional Agencies
City Hall, Covillaud Room
10:00 – 11:30 am

Attendees:

- Greg Chew, SACOG
- Keith Martin, Yuba-Sutter Transit
- Jackie Slade,Yuba-Sutter Economic Development Corp.
- John Fleming, Yuba County Economic Development
- Kevin Malley, Yuba County Planning Department

The meeting opened with an overview of the downtown strategic plan that was developed with the help of citizen input two years ago. The downtown is a jewel with great fabric and many amenities. The plan identified ways to revitalize downtown. It looked at the residential market to revitalize area. It identified six catalytic sites; one has already happened, Vicks-Worley. Working on retail but with residential leading. Levees, trail systems, specialty retail.

What issues are most important to address?

- Improving E Street, which is a barrier between residential neighborhoods and downtown.
- Would like to see more green, walkable space. City planned as center of region 150 years ago. Now outskirts are larger than the City and have taken over. How do you keep outskirts connected to Marysville? Lot of traffic from Hwy 20. There have been dreams of a bypass for many years.
- Traffic issues are more than just congestion. Newspaper has ranked Marysville as one of the worst from a traffic standpoint. Now identified as #6 statewide. There are more issues than just traffic movement. Pedestrian, signage and other issues; Marysville ranks as one of 10 worst for traffic issues. Traffic incidents.
- Red light cameras are considered for safety issues. Adding 3 cameras. People staying away from them. Not clear if cameras are doing what you want to help control traffic.
- Issues include the time it takes to get through intersection with delays due to fender benders, crashes, etc.
- If we want to create pedestrian-friendly environment need to look at why Marysville is ranked so high for bad traffic.
- Most traffic just trying to get through town, from Linda to Yuba City. As traffic gets worse you start seeing drivers cut through side streets.
- Do you make it easier for cars to get through or do you keep it a place for people to stop? Eliminate left lanes.
- Traffic congestion is relative. Folks from other areas don't consider it an issue. Locals stay away from downtown, concerned over parking. From a transit perspective the delays are a problem. Most of riders are folks without cars. Lot of non-home work trips.
- 14th is a very busy route but it is the way folks cut through to neighborhoods to west. Folks choose routes based on how many stop signs, etc.

- Now we cram as many people through Marysville as possible and capture some of that traffic in the downtown. That's self-defeating. Might be better to create a more desirable downtown that locals would use. Looking at a Marysville bypass that would relieve truck traffic coming from aggregate, 20, 65 & 70. It would create more free traffic easterly and north/south, avoiding congestion in Marysville. Difficulty with this scenario is it will take 10 years before that could happen. From an economic development standpoint if we want to preserve historic atmosphere downtown, we need to get as much of truck traffic out of the flow of traffic through downtown as possible. Explore ways to make this section a non-truck traffic area.
- There are no alternative routes. Looking at a bypass, maybe not as extensive as originally considered. Would need Caltrans to provide alternate route. County road to east. Are going through project study report for that. It's as real as development in south end of Yuba County because that's how they would be paid. With current development in South County even with bypass there will be more volume through Marysville than today after the bypass is complete.
- Suggest fewer pedestrian crossing locations with more visibility. Right now so many places for folks to cross have made it more of a challenge. More ped friendly crossings.
- E Street and 9th captured about 40% of sales tax revenue for downtown. Auto-oriented, marginal uses, but still brings in significant dollars.
- Proposed bypass is a 4 mile route with 6 intersections, max. Question is whether trucks will choose that option.
- Truck traffic is coming from one direction and cars from another, and all end up on E Street. At 9th & E, trucks continue to go on red lights, which is very tough for peds. Multiple crossings might be an issue. Population of Marysville is only 13,000. That's not enough peple to make downtown work.
- Lot of potential for residential in downtown. Especially east of C Street.
- New development on 9th Street. Café, strip development. Seems to be busy. Hard to find parking space. Only Starbucks in town. Same developer looking at development at 10th and E. Plaza of old Marysville that has become state highway.
- Impact fees, 12,000 for traffic. Caltrans has washed its hands of the bypass. Are selling right of way if bypass is too far out into the future. Widening of 5th Street Bridge might relieve some of the through-traffic.
- Caltrans proposed several years ago that Marysville close every other intersection to cars, not peds. Lots of fatalities. Right now no reason to walk on E Street.
- Residential project on NW of lake blocks views to lake. The new Waterfront Plaza project turns back on lake. Desperation to get development.
- Walgreens another example where there is not a single tree in parking lot.
- Some Chinatown buildings have a lot of potential.
- D Street might be key area.
- Where to focus crossings of pedestrians.
- Hotel project at 5th. 3rd is other key east/west intersection.
- Move Highway 70 east of lake and then open up lake to development.
- First phase of bypass is in 1st tier of Metropolitan Transportation Plan project. Second phase of bypass is in second tier.
- If we turn our back on E Street, then what do you do with great buildings? A parking garage can support other development on E St. SACOG has given $2 million for garage. Would be done as condos with retail on ground floor. Short term stay apartments as well. Senior housing, market rate condos.
- Character of E Street vs. D Street. D is the main street and E is more of the state highway.
- D Street used to be E Street. Wanted both to be main street. Bridge got washed out and shifted it over. E was always stepchild. Always had auto-oriented uses. Ford dealer used to be there. Tire stores. Furniture. Absentee landlords. Very small parcels, very deep, narrow lots.
- Was street always that way? Used to have grassy median. Used to be only two lanes. Had diagonal parking.
- Site of Sutter memorial museum, Chamber of Commerce. Union Lumber.
- Hard to visualize how to make it more walkable.
- Big problem: trucks. 9th Street, trucks shift over.

Friday, June 1, 2007

Business Improvement District Continental Breakfast
The Brick Coffee House Café
7:30 – 9 :00 am

Attendees:

- James and Kara David, Amicus Books
- Ethel and Bill Padgett, Candy Box
- Nancy Duplantis, Posh Décor
- Julie Shackleford, Gold Country Bank

Michael Ronkin opened the meeting by explaining this project focuses on the impact of highway 70 and 20, and how they can become more walkable. He explained this is an opportunity to energize E Street to become a part of the downtown. There are also ways to bring the traffic in, which is so important to the business community. Making it easier to get around without a car.

Mukul provided an overview of the development of the strategic downtown plan. The conclusions included recommended heritage tourism, residential development and strategies to revitalize the downtown. Part of the process helped identify strategic sites, including the theaters. Some improvements have already begun.

What is working for you downtown?

- Storefronts are starting to fill, creating foot traffic. There is nothing to entice you to turn off E Street, so nearby businesses are important. The bank would like to assist with the funding. We have alliance group that does that type of funding. We have 40 people in the building who need to park.
- We agree. Stores fill and so does the parking. Get some business from Caltrans personnel who are walking around during lunch. We need more foot traffic.
- Nancy pointed out new residents benefit her home décor business.
- What works for us is the book store draws people. We need the arts center to draw people. We need more of that. We have had an established business since 1964.
- I agree. Also, the positive businesses nearby let us build on each other. Word of mouth is starting to happen. A new brochure with a map that pinpoints the businesses and points of interest. It is a beautiful place to walk. Parking needs to be addressed.
- City has a parking study, which says there is more of a management issue.
- The marketing plan done two years ago is working for us. Our purpose is to build recognition for literary arts and the possibility of expressing yourself in writing. We were invited here, loved the building, we saw the possibilities. We started projects like the downtown Chautauqua. We started downtown walking tours, which has helped bring people's consciousness to the history of the city, which builds pride. We are walkers; we would like to ride a bike, but it is too dangerous to ride a bike. Crossing E Street to the bank is harrowing. We see the power of building a walking plan in the downtown. When you connect walkability to the downtown marketing plan it is very powerful.
- Although downtown is a commercial district, we see it as the central district. It holds the character of the city. Our business is more of building community than anything else. We create events so people in the community can be included.

What is your anchor? Does Mervyn's anchor downtown?

- People go to Mervyns, then leave downtown. It doesn't draw people into downtown.
- Posh Décor helped create a flow; there is no one anchor.

We are looking primarily at how we can improve walking conditions up and down E Street.
What do you see as the major negatives that need to be addressed?

- It is difficult to find the downtown. There are no directional signs. If you are walking it is hard to find.
- You left out a major portion of new development. Chinatown is rebuilding. It is a tiny little hotspot. People aren't aware of it happening, but people in San Francisco and LA are becoming more and more aware of the revitalization that is going on there.
- Getting across E Street is a problem. If you've been to Spokane, they have walkovers. Perhaps there could be occasional walkovers, say from the lake. Along D Street, starting at 9th, the sidewalks are atrocious. You have to know those sidewalks to walk there. In terms of bicycling, forget it. It is very dangerous in the downtown area. People use the sidewalks; that has become a safety issue. (conflicts with pedestrians)
- The hospital is planning an expansion. It generates walking traffic.
- Towns I've visited had directional signs that show walking routes. I find even in cities like San Francisco there is not enough parking, so traffic is going around and around, so it is dangerous to walk. You have to have a place for people to park. We have brochures that show stores, but we don't have a walking route that will help them feel safer. Just for the people who work here.
- One of the biggest problems in downtown is it shuts down at 6 o'clock.
- Mini strip too hard to get into.
- No lighting downtown. We walk people leaving our business to their cars in the evening. D street is fine; it is the side street.
- There isn't anything to draw anyone's attention. There is no beautification on E Street. It looks like a ghost town. Except by Bank of America it is void of green. Some buildings are eyesores.
- I believe E Street is what is hurting downtown Marysville. Driving through, I would not be tempted to venture off the E Street. It must feel inviting.

What kind of businesses do you think would work on E Street?

- We need more retail specialty shops.
- The beautification is what it takes to get the people there.
- You have to think about the parking issue.
- The loudness of the noise, the smell of the diesel fuel, I have trouble imagining any business that would attract people. It is hard to imagine. Part of the issue is not just walkability, but what the traffic does. A friend rides his bike from Yuba City to Yuba College. He cites the diesel fumes as the biggest danger.
- I could see a travel agent there. That would bring people. Might be able to have a small café. Maybe some kind of a computer store. Actual destinations, not random.
- We're about community. You want to catch someone's attention so people want to go further. Spokane uses public art to draw people into the city. When we travel what we see on the main street is what determines whether or not we get off.

Some cities adopt a theme. What is the first thing people see now? What theme would work?

- The arches. People have talked about putting more arches on E Street. We want people coming in to see there is no other place like Marysville. The arches seem to be a positive attraction.
- Plants or trees, water.
- Bricks. I think of it as a brick city.

- Brick art.
- Brick podium with lights on top. Brick is amazing. We have it indoors. Marysville was once called the brick city. Using brick in flower boxes or whatever. Brick as a line to follow on a walking tour.
- Bricks in sidewalk, bricks in crosswalks.
- C and 2nd, there is a big brick intersection.
- There is no calm when you come over any of the bridges.
- On D Street they have the poles with flags.

Where do your customers come from?

- Chico, San Francisco, Oroville.

Where are your competitors?

- Yuba City. People act like they have to swim across the bridge.
- They come to us for the personal one-on-one service. We know everyone who walks in the bank.
- We are trying to build a concept of the Brick City, but the developers come in and do horrible designs that don't blend into our concept. We would like to see those businesses "brick it up." We would like to incorporate the existing businesses, even if they just add a large brick flower bed.
- Michael explained the idea of form based code.
- We are reactive now. We don't have design guidelines and don't have the funds to develop them now. Form based can be very expensive.
- We can't buy into worrying about internal competition; every new business helps us.
- The concept we are hearing is they want to bring in people with sliding scale rents. These don't help us. We need people who can afford to live in downtown and enjoy the comfort of urban life. I don't understand the concept of low income housing downtown.
- We need a mix of housing, not just low income.

What would entice businesses to move into downtown Marysville?

- Downtown, retail. On edges, doctor offices and services like travel agents.
- A Whole Foods would be good.
- We are looking at marketing B Street property across from the lake. What do we want there? B Street markets to a different clientele.
- We have a high end market in the foothills.
- Every time we put a big business across the lake we ruin the opportunities.
- I would do a gorgeous hotel; beautiful restaurants. The view at the lake is cars and trucks. The beauty it was intended to bring is being etched away with the kind of commercial that is there.
- Smaller scale grocers. Trader Joes.
- There was a pivotal thing that destroyed hope in downtown. The day the RentaCenter went in with the huge signs we walked away.
- If we had a vision of what we would like our city to look like it would help.
- We have a school in our downtown; it is not very walkable.
- There is a massive residential buildup occurring south of town in county area. Plumas Lake, Earl Road, McGowan Road. Nearby residents are asking us to stay open later.

Emergency Responders
City Hall, Covillaud Room
10:00 – 11:00 am

Attendees:

- Jack Beecham, Police Chef
- Joe Hernandez, City Fire Chief
- Aaron Ward, Director, Office of Emergency Services, Yuba County

What issues do you see from your perspective?

- Red light running was worse before the red light cameras were installed. Driving habits have been influenced. They have been a significant help.
- We get gridlock on a regular basis and use the side streets instead.
- Any corridor changes that restrict access across the street are a problem because the hydrants are on one side of the street. So a median design is a problem because we can't drive around and put hose down. Hydrants on both sides would mitigate that problem.
- Yuba City has an Opticom system; Marysville providers weren't able to be part of that grant. They have a switch to operate signals at B and 10th, but it doesn't work well. They would like to be able to have priority at intersections to be able to preempt when crossing E.
- If you add medians, we cannot pass in the middle. Traffic can't pull off to the right, so we can't go down that road. Access is number one concern.
- Cameras are at G, 3rd, 5th. They have slowed people down.
- They also use 14th; wide enough and less congestion.
- Emergency providers have issues during construction.
- Truck traffic is going down side streets including residential.
- A pothole on 10th Street bridge caused one lane to close. It gridlocked the town. I waited 15 minutes.
- We had 180,000 cars a day in 2003. A bypass would solve the problem, but the city might dry up. Most vehicles are going through. We had an OTS grant that funded traffic enforcement; we dropped crashes substantially.
- The problems are deeper than that…this is a poor county. When the grants run out you cut back. I may have to cut traffic officers this year, which is likely to result in increased injury accidents. Whatever could be done in engineering to help would be good.

What kind of injuries are occurring?

- Bicyclists, auto occupants. Both fatalities last year were bicyclists.
- On Highway 70 heading toward Butte I've noticed a reduction in crashes. I attribute it to the halo affect from the red like camera. Highway 70 north of town is very dangerous.
- Truck traffic is a huge issue. There is no place for them to stop, so they just pass through. We've had a couple of cases where we've had major accidents and everything gridlocks. There's been talk of another bridge, and a bypass, for thirty years. I don't see that happening. You are dealing with a depressed area here. If they do anything here it is a result of grants or outside help. But there are developers interested now because of the growth. Schools Focus Group
- Michelle Healy, Senior facilities planner for School District provided information about Covillaud School, which is located near the downtown area. The District has a master plan and is currently renovating buildings. Covillaud is getting a new two story addition.
- Covillaud School; not sure about travel to school or after school programs.
- School does not have facilities used by the community.

- Many parents transport their kids to and from school. There is a lot of chaos when parents drop off and pick up their children. 2:30 release; 8:00 or so start time.
- All of downtown is very business oriented. Very few residences.
- Enrollment is increasing, although more slowly at Covillaud than other schools.
- If you cross the river to Yuba City, there is commercial growth, which generates more tax revenue than property tax. Tax base isn't there to support it [increased enforcement]. We lose the OTS positions in September, plus another two positions will be lost.
- Fire responders are located on 9th near B.
- Caltrans interested in red light program.
- The blocking of the intersections is another problem. We've stepped up enforcement of those, but one judge throws those tickets out. Enforcement seems to make it drop off, but it comes back.
- Emergency service's concern is to support fire and police department needs. Our issues are consistent with those already mentioned. In an evacuation situation (flooding) highway 20, Simpson Lane, and Highway 70 are the only ways to get out of Marysville. Doing that while bringing people in is our concern. Maintain intersection access for purposes of moving people out of here as quickly as possible.
- We have a transient population near the river.
- The lake purpose is flood drainage runoff; occasionally city buys water so they can run new water into the lake; then the water is clear. Only 10 feet deep; not a desirable place to recreate.

Have you considered walking as part of your evacuation plan?

- Yes, we have considered walking to transit locations as part of the plan.
- The size of the incident makes a difference. Very few incidents where everyone has to be evacuated at the same time. We have levels of evacuation.

Schools
City Hall, Covillaud Room
3:00 –4:00 pm

Attendee:

- Michal Healy, MJUSD, Senior Facilities Planner

- Covillaud School, which is located near the downtown area. The District has a master plan and is currently renovating buildings. Covillaud is getting a new two story addition; not sure about travel to school or after school programs.
- School does not have facilities used by the community.
- Many parents transport their kids to and from school. There is a lot of chaos when parents drop off and pick up their children. 2:30 release; 8:00 or so start time.
- All of downtown is very business oriented. Very few residences.
- Enrollment is increasing, although more slowly at Covillaud than other schools.

Street tree palette

Botanical Name	***Common Name***

TREES

Canopy Trees

Platanus acerifolia	London Plane 'Yarwood'
Quercus lobata	Valley Oak
Quercus wislizenii	Interior Live Oak
Pinus attenuata	Knobcone Pine

Secondary Trees

Acer freemanii	Maple 'Autumn Blaze'
Liriodendron tulipifera	Tulip Tree
Platanus racemosa	California Sycamore
Ulmus wilsoniana	Prospector Elm
Zelkova serrata	Sawleaf Zelkova

Ornamental Trees

Cercis canandensis	Eastern Redbud
Cercis occidentalis	Western Redbud
Lagerstoemia indica	Crepe Myrtle
Malus (various disease resistant species, 15' dia max)	Crabapple
Prunus dulcis	Almond Tree

The above tree list is provided to suggest the scale and character that might be appropriate for planting along State Routes 70/20 in Marysville, and should not be considered an exhaustive list. They are trees typically considered for street settings and the environment found in Marysville. However, final selection should be made by a landscape architect and arborist after careful consideration of soils, drainage, specific location, and other design factors and by consulting Section 500 of the Manual for Encroachment Permits on California State Highways, Caltrans.

Effectiveness of Additional Lanes at Signalized Intersections

IN THIS FEATURE, THE AUTHORS EXPLORE WHETHER INCREASING THE NUMBER OF LANES AT SIGNALIZED INTERSECTIONS COULD BE A SUSTAINABLE APPROACH TO SATISFY TRAFFIC DEMAND ONLY IF LARGER INTERSECTIONS HAD ECONOMIES OF SCALE, OR AT LEAST DID NOT HAVE DISECONOMIES OF SCALE.

BY KORNEL MUCSI AND ATA M. KHAN

INTRODUCTION

Approaches to combat urban traffic congestion span from demand management to physical expansion of road capacity. Attempts to shift a part of peak travel from car to high-quality public transit and to times when roads are relatively less crowded sometimes have been successful.[1,2] Also, intelligent transportation systems (ITS) have the promise to optimize the operation of transportation systems and delay the building of additional lanes.[3]

However, the most common attempt to alleviate traffic congestion at intersections is to provide more road space to vehicles.[4] Since very little or no research exists on the optimum size of intersections, they are often made as large as traffic demand projections require and/or the available right-of-way (ROW) allows. It is often assumed that this approach is both an effective and a sustainable way to provide for growing travel demand. From the technical perspective, increasing the number of lanes could be a sustainable approach to satisfy traffic demand only if the marginal capacity of additional lanes can match the marginal traffic demand increase.

This feature shows that the effectiveness of additional lanes decreases as the size of the intersection increases. Effectiveness is expressed in terms of marginal capacity increase of the additional lanes, vehicle delay and queue lengths.

Typical urban intersections usually are expanded a number of times during a 60- to 80-year span. Evaluating and comparing the operation of a particular intersection during this period is technically infeasible due to changes in the environment and the lack of appropriate historical data. In this feature, measures of effectiveness (MOEs) of a hypothetical intersection during a similar life span are evaluated and compared assuming common traffic engineering procedures are applied as traffic demand grows.

The authors appreciate that adding new traffic lanes is often the only feasible approach to reduce congestion in the short term. However, the objective of the feature is to demonstrate technical reasons why this approach is not sustainable in the long run.

REASONS FOR DIMINISHING MARGINAL CAPACITY BENEFITS

A number of factors affects the marginal capacity of additional lanes. Although all factors are described in traffic-engineering textbooks and routinely utilized in traffic-engineering calculations, the importance of their cumulative and long-term effect usually is not recognized. The importance of these factors depends on the particular intersection configuration, traffic characteristics and types of intersection users. Not all factors are always relevant; however, most intersection expansion projects are affected by some of them.

Lost time due to phase change: From the capacity perspective, every phase change generates some lost time. The total lost time in a cycle increases with the number of phases. Furthermore, additional lanes increase the size of the intersection and, consequently, the clearance intervals, which represent lost time.

Left-turn phasing: The treatment of left turns varies from jurisdiction to jurisdiction. In terms of approach capacity, permissive or protected plus permissive left turns are preferred. This practice is normally allowed as long as it provides safe operation. The implementation of double left turns, however, usually requires the introduction of protected-only left-turn phasing. The additional protected left-turn phase introduces another clearance interval that represents additional lost time and the protected-only phasing eliminates permissive left turns during gaps in the opposing flow.

Provision for pedestrians: At intersections with pedestrian activity, the provi-

Table 1. Default lane-utilization factors.

Movement	Number of lanes	Lane utilization factor
Through or shared	1	1.00
	2	0.95
	3	0.91
Exclusive left turn	1	1.00
	2	0.97

Source: Highway Capacity Manual 2000, *pages 10–26, Exhibit 10-23.*

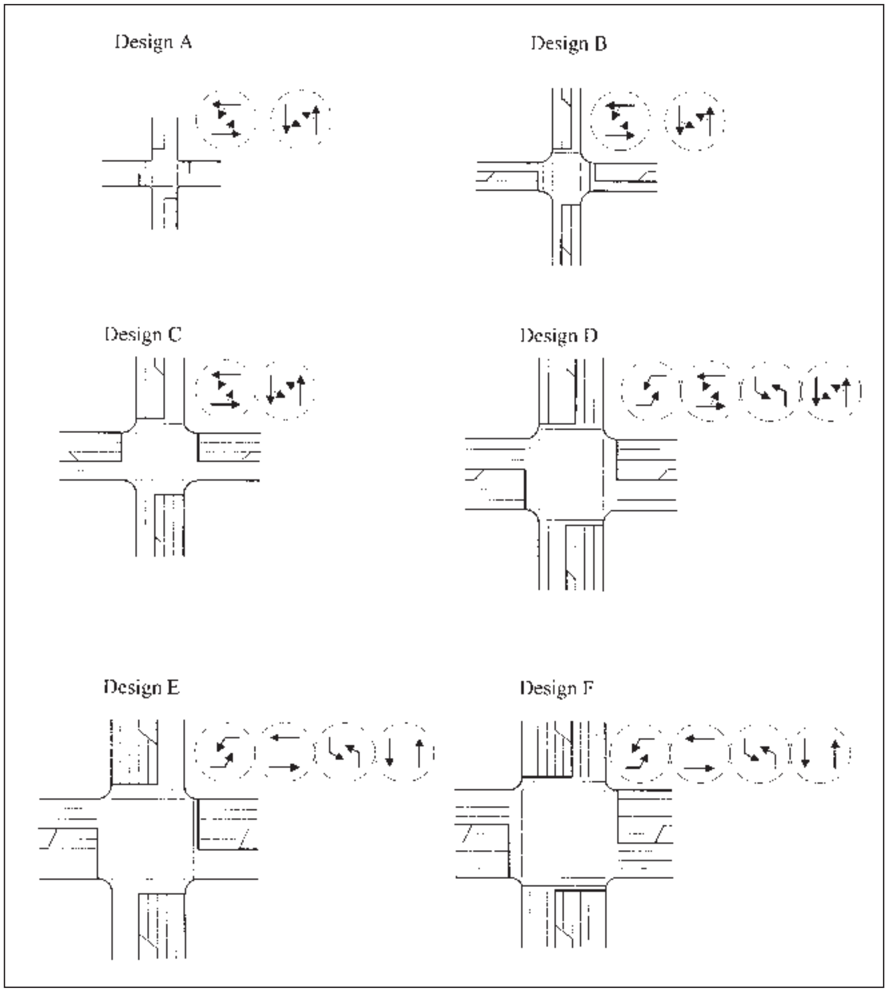


Figure 1. Intersection designs.

sion of adequate pedestrian timings may contribute to unutilized vehicular green times and lost vehicular capacity on the conflicting approach. Since the minimum (safe) pedestrian crossing time is directly related to the size of the intersection, under certain circumstances some pedestrian crossings may require more green time than what is needed for the concurrent vehicular movement. Consequently, splits (the allocation of green times between competing vehicular movements) cannot be optimized.

Lane utilization: Due to lane arrangements along an arterial and driver behavior, it is possible that the capacities of all lanes are not fully utilized. To account for this phenomenon, lane-utilization factors are often used in intersection analysis. In the absence of local data, the *Highway Capacity Manual* (HCM) suggests the use of default lane-utilization factors.[5] These are shown in Table 1.

Lane blockages and inadequate queue storage space: Larger intersections usually require longer signal cycles and, therefore, longer queuing space. If the required queuing space is unavailable, the potential capacity benefits of additional lanes will be reduced.

DESIGN AND ANALYSIS

The analysis of a signalized intersection has been carried out as the intersection goes through a series of expansions. As is common practice, intersection development is in the form of adding straight-through (ST) and left-turning (LT) lanes to accommodate growing traffic demand (Figure 1). This process resembles the most common approach to the urban traffic growth problem, particularly in locations on the fringes of the central business district and in suburban areas.

To keep the analysis relatively simple and straightforward, only some of the factors contributing to the diminishing capacity of the additional lanes were included in the analysis. These included the lane-utilization, left-turn arrangements and the lost time due to the increased number of signal phases. The selected factors may not be the most important in all cases. However, the objective of the provided analysis is not to quantify the exact reduction of lane capacity due to the relevant factors but to demonstrate the phenomenon of diminishing marginal benefits and its long-term consequences.

To ensure that results are not affected by uncontrolled circumstances, the following assumptions were made:

- There are no right turns, or no special provision is made for right turns;
- The left-turn bays are always of sufficient length to prevent queue blockage;
- The proportion of LT and ST movements remains constant; and
- The approach volumes are the same for all four approaches.

Although the above assumptions significantly oversimplify real-world traffic and geometric conditions at most locations, the nature of conclusions is not affected by the assumptions. The law of diminishing marginal benefits of additional lanes applies to all geometric and traffic conditions because the reasons for the diminishing benefits are always present, although the exact numerical values are certainly different. It is very likely that for traffic and geometric conditions, which are less ideal than the conditions defined in the assumptions (e.g., queue blockage due to short left-turn lanes, interference with right-turning vehicles,

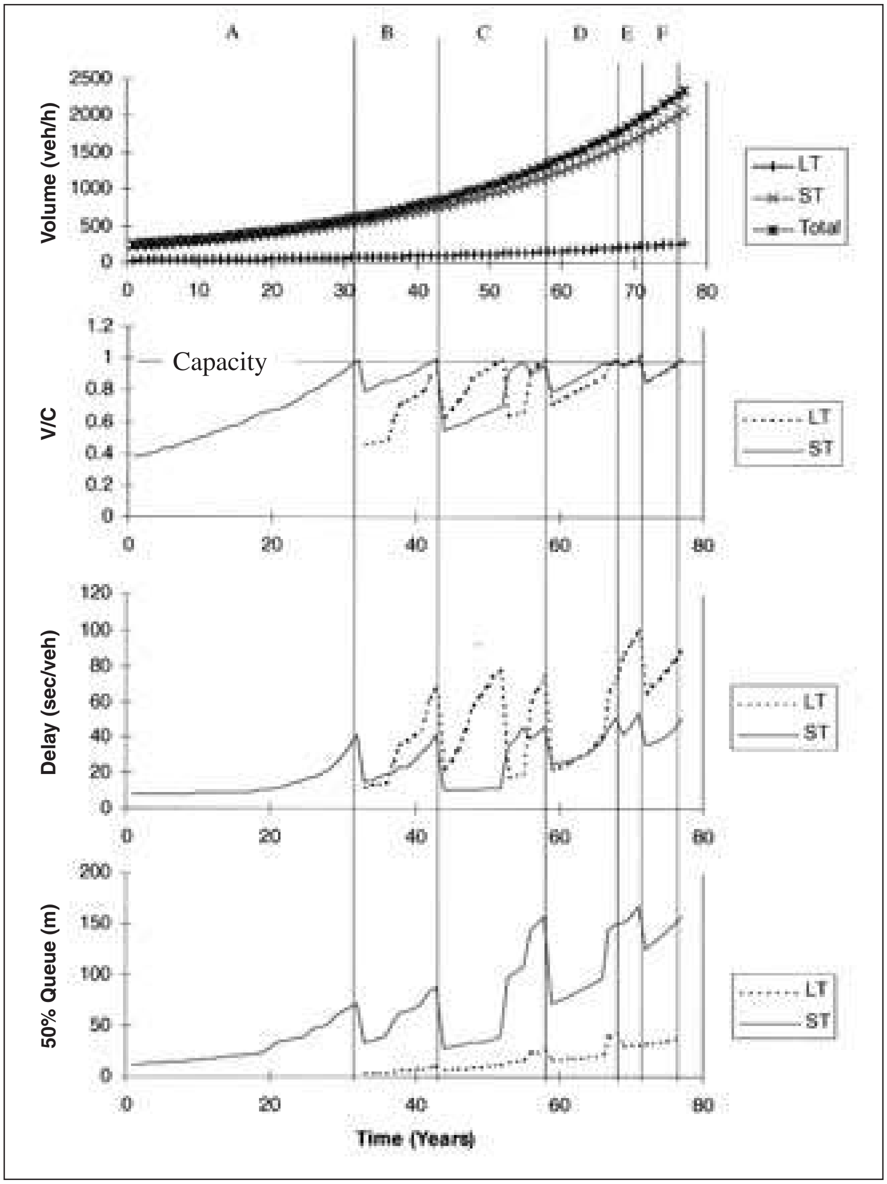


Figure 2. MOEs for the six stages of intersection capacity expansion.

different approach volumes), the rate of diminishing marginal benefits is even more dramatic (see Figure 1).

At the outset, the intersection has one shared LT and ST lane at all four approaches (Design A in Figure 1). Expansion of the intersection occurs when the volume/capacity (V/C) ratio of either the LT or the ST movement reaches its saturation. The expansion is in the form of adding one lane to each of the four approaches—either to the LT or the ST movements. Signal timing is modified to keep the V/C ratio of the ST and LT lanes in balance and identical at all four approaches.

The cycle length is optimized to provide minimum delay and queue lengths, but it is not increased beyond 120 seconds (sec.). Theoretically, longer cycle lengths provide more capacity because the proportion of lost time decreases and the proportion of green time increases. However, there is a practical limit to increasing the cycle length above 120 to 140 sec. due to the decreasing saturation flow rate during long phase times and due to long queues associated with longer cycle lengths.

To calculate the number of years before the intersection reaches capacity, a 3 percent annual traffic growth is assumed. However, a sensitivity analysis for other growth rates is also provided. Three MOEs, namely the V/C ratio, vehicular delay and average queue length, are calculated for each year. A widely used traffic signal optimization package, Synchro, marketed by Trafficware, was used for signal optimization and the calculation of factors shown in Figure 2.[6] However, any other software package with comparable features could be employed for these tasks.

Design A

As noted earlier, this is the starting point of the analysis and represents an intersection with one shared ST and LT lane per approach. It is assumed that traffic volumes in year one satisfy the minimum volume requirements for signalization.

The increase of traffic volumes and the corresponding MOEs, including the V/C ratio, vehicle delay and average queue length, are presented in Figure 2. Signals are operated in two phases (Figure 1), and there is no special provision for left turns; left turns are made during gaps in the opposing flow and during the clearance interval.

The cycle length starts at 40 sec. and increases to 60 sec. Higher cycle lengths do not provide more capacity because a significant proportion of LT is accommodated at the phase change interval and longer cycle lengths decrease the number of these opportunities.

The V/C ratio reaches one in approximately 32 years (Figure 2). While the V/C ratio is a good indication of the demand-supply balance, the vehicular delay shows that as the volume approaches capacity, vehicular delay increases exponentially.

As expected, the queue length increases with the increase of volume and cycle length.

Design B

When Design A reaches saturation, an LT lane is added to each of the four approaches. The additional ROW is approximately 4 meters (m). The two-phase signal control is retained because it provides the highest capacity for both the LT and the ST movements. Although a protected plus permissive LT phasing normally would improve the LT V/C ratio and delay, it also increases the V/C ratio and delay of the opposing ST movement. In this particular example, the gain to LTs is less than the loss to the ST movement.

Table 2. Comparison of intersection designs at traffic growth rate of 3 percent/year.

Design	Lifetime (years)	Additional lane	Additional ROW (m)
A	32	—	—
B	11	1 LT lane	4
C	15	1 ST lane	8
D	10	1 ST lane	8
E	3	1 LT lane	4
F	6	1 ST lane	8

The cycle length increases from 40 to 60 sec. The LT V/C ratio and delay change abruptly with the change of the cycle length. These effects can be noticed in Figure 2.

The lifetime of Design B is approximately 11 years. The loss of efficiency, expressed in delay per vehicle as volume increases, is evident. Vehicular delay at the beginning of the observation period for Design B (year 33) is not more than 15 sec. At the end of the period (year 43), it increases to approximately 68 and 42 sec. for the LT and ST movements, respectively (Figure 2).

Design C

This design evolved from Design B with the addition of a second ST lane. To keep average vehicular delay at a minimum, the LT operates as a permissive turn during the first nine years. However, due to insufficient opportunities for making left turns, a protected plus permissive left-turn phasing is introduced. This change significantly improves the LT V/C ratio and delay at the expense of the ST V/C ratio and delay. The introduction of the protected LT phase requires increasing the cycle length from 50 to 90 sec. This increase contributes to longer delay and queue length. In year 56, the cycle length is increased again to 120 sec. and the jump in delay and LT queue length is evident.

It takes approximately 15 years for Design C to become saturated. Although the lifetime of Design C is longer than the lifetime of Design B, in terms of the total road space requirement, Design B required only one additional lane because the two left turns are "back-to-back," while Design C required two additional lanes or approximately 8 m of additional road space (Table 2).

Table 3. The marginal capacity of additional lanes.

Additional lane	Designs compared	Additional ST + LT capacity per approach (veh/h)
1st LT	A to B	240
2nd LT	D to E	168
1st ST (base)	A (base)	625
2nd ST	B to C	483
3rd ST	C to D	463
4th ST	E to F	385

Design D

This design has one LT lane and 3 ST lanes (one more than Design C). The left-turn phasing is protected plus permissive. The cycle length starts from 85 sec. and increases to 120 sec. The cycle length increase provides additional capacity. However, this additional capacity is sufficient for only three more years. The cycle length increase causes a jump in delay and queue lengths. In terms of the marginal increase of the ROW requirement, both Design C and Design D needed 8 m of additional space. However, the lifetime of Design D is only 10 years compared to the 15 years of Design C (Table 2).

Design E

This design has an additional LT lane (two LTs per approach). It is assumed that double lefts require protected LT phasing due to safety reasons. In terms of signal operation, there is very little flexibility. The cycle length must be relatively long—120 sec.

The lifetime of the design is approximately three years compared to the 11 years of Design B that had the same marginal increase of ROW (Table 2).

Design F

This design has two LT lanes and one more ST lane than the previous design. Signal phasing is similar to the previous design. The lifetime of the design is six years. This is significantly less than the 10 and 15 years of Designs D and C that required the same marginal increase (8 m) of ROW (Table 2).

DISCUSSION OF RESULTS

By comparing the capacity of Designs A to F, it can be seen that the marginal capacity increase of additional lanes decreases as the size of the intersection increases. The single approach lane of Design A accommodates 625 vehicles per hour (veh/h). However, the second, third and fourth lanes add only 483, 463 and 385 veh/h, respectively. A similar trend could be observed for the LT movement as well (see Table 3). It is recognized that the total volume moved increases in absolute terms. However, it is clear that every new ST (or LT) lane provides less additional capacity than the previous ST (or LT) lane did.

While the marginal capacity of additional lanes decreases, the constant annual traffic growth results in more additional traffic each year in absolute terms. The combination of the increasing number of vehicles (in absolute terms) on the intersection approach and the decreasing marginal capacity of additional lanes results in a dramatic reduction in the uncongested lifetime of subsequent intersection designs. The 3 percent growth used in the calculations was chosen for illustration purposes. Developing areas, however, do experience traffic growth that is significantly more than 3 percent.

Sensitivity Analysis of Uncongested Lifetime

The above reported information corresponds to 3 percent per year growth in traffic. A sensitivity analysis was carried out to show the trend in the uncongested lifetime of intersection designs for traffic growth at 5 percent and 7 percent per year. The estimated lifetime values for the various growth factors are provided in Table 4. The results clearly show similar trends in the uncongested lifetime of intersection designs.

OTHER CONSIDERATIONS

In addition to decreasing marginal capacity, larger intersections function less efficiently. One measure of the loss of efficiency is the increased vehicular delay. The average delay of Design A at capacity is approximately 42 sec. per vehicle, which increases to 100 sec. and 52 sec. for the LT and ST movements, respectively, in Design F (Figure 2).

At low volumes, which could prevail for most parts of the day except the peak hours, large intersections with pedestrian activity and protected left-turn phasing could be even more inefficient (in terms of delay) compared to smaller intersections due to the restricted left-turn phasing, long pedestrian crossing times and the resulting relatively long minimum cycle lengths.

The cost of capacity expansion is an important consideration in decision-making. While the benefits of additional lanes diminish, the cost of additional lanes usually increases exponentially with increased intersection size due to space constraints in urban areas.

CONCLUSIONS

While roads are an essential part of every urban transportation network, limits to their capacity expansion do exist. As intersections grow, they become less effective in providing additional capacity. The loss of effectiveness is reflected in the reduced uncongested lifetime of larger intersections due to increasing marginal demand for capacity and the decreasing marginal capacity of additional lanes.

This does not mean that roads should not be built. However, expanding intersections above a certain size, especially in locations where traffic growth is high, may be an expensive, ineffective and short-lived solution to the traffic-congestion problem. The recognition of the fact that every new additional lane has less capacity than the previous additional lane should be a strong incentive for transportation professionals to seek other approaches to solve the traffic-congestion problem.

Table 4. Uncongested lifetime at various traffic-growth rates.

Design	Uncongested lifetime (years) for different annual growths		
	3%	5%	7%
A	32	19	14
B	11	7	5
C	15	9	7
D	10	6	4
E	3	2	1
F	6	4	3

ACKNOWLEDGMENTS

This feature is based on a research project carried out at Carleton University. The use of the City of Ottawa's software and financial support by the Natural Sciences and Engineering Research Council are acknowledged. The views are those of the authors. ■

References

1. Khan, A.M. "Reducing Traffic Density: The Experience of Hong Kong and Singapore." *Journal of Urban Technology.* Vol. 8, No. 1, April 2001, pp. 69–87.

2. Dunphy, R. *Moving Beyond Gridlock, Traffic and Development*. Washington, DC, USA: Urban Land Institute, 1997.

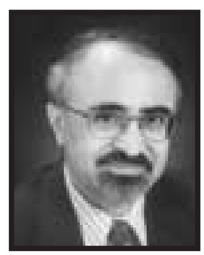
3. Smith, S. *Integrating Intelligent Transportation Systems Within the Transportation Planning Process, An Interim Hand Book*. Report FHWA-SA-98-048. Washington, DC, USA: Federal Highway Administration, 1998.

4. Lundberg, B.D., M.N. Gorman, R. Haden, S. Masters and V. Singh. "A New Approach for Programming Congestion Improvements." Proceedings of Conference: Traffic Congestion and Traffic Safety in the 21st Century: Challenges, Innovations, and Opportunities. Edited by R.F. Benekohal, American Society of Civil Engineers, New York, 1997, pp. 41–47.

5. Transportation Research Board. *Highway Capacity Manual 2000 (Metric Units).* Washington, DC, USA, 2000.

6. Trafficware. Synchro 5.0. Albany, CA, 2000.

KORNEL MUCSI, *P.Eng., is a traffic engineer with the City of Ottawa, Canada. He has a BSc degree in Transportation Engineering from the University of Novi Sad, Yugoslavia and masters' degrees in transportation planning/management and engineering from the University of Westminster, London, England and the University of Toronto, Canada. Mucsi is an associate member of ITE.*



ATA M. KHAN, *P.Eng., is a professor at and director of the Transportation Research Centre, Department of Civil and Environmental Engineering, Carleton University, Ottawa, Canada. Khan received his bachelor's and master's degrees from the American University of Beirut and his Ph.D. in civil engineering (transportation) from the University of Waterloo, Canada. Khan is a member of ITE.*

The Conversion of Four-Lane Undivided Urban Roadways to Three-Lane Facilities

Thomas M. Welch
Director, Office of Transportation Safety
Engineering Division
Iowa Department of Transportation
800 Lincoln Way
Ames, IA 50010
twelch@iadot.e-mail.com

ABSTRACT

In recent years, many traffic engineers have advocated converting four-lane undivided urban streets to three-lane two-way left-turn facilities. A number of these conversions have been successfully implemented. Accident rates have decreased while corridor and intersection levels of service remained acceptable. This conversion concept is yet another viable alternative "tool" to place in our urban safety/congestion toolbox.

BACKGROUND

Prior to the mid 1980s, it was common practice in Iowa to widen an existing two-lane urban roadway to a four-lane undivided facility if traffic volumes were in excess of 6,000 vehicles per day (vpd). Further, if a four-lane undivided roadway was experiencing an unacceptable accident rate, either a four-lane divided or five-lane two-way left-turn lane (TWLTL) facility was proposed to improve safety along the corridor. Each of these proposals was generally opposed by most property owners adjacent to the roadway because of the right-of-way impacts and/or the changes in access control.

At public hearings, project engineers would state that corridor safety would improve if the two-lane roadway were widened to a four lane undivided roadway. Graphics would be shown to illustrate that additional acceptable gaps in the traffic stream would result, and motorists could avoid rear-end collisions by changing lanes, etc. Those in opposition to the widening would argue that travel speeds would increase, pedestrians would have to cross a wider street, and noise would increase. In most cases, however, the four-lane undivided cross-section was selected as the preferred alternative because the only other alternative was generally to do nothing (i.e., the roadway remains a two-lane facility).

I conducted a 2-year before and after study on US-61 through Ft. Madison, Iowa (*1*) to assist in identifying the road-user benefits and noise impacts of widening an urban two-lane roadway to a four-lane undivided facility. US-61 was widened from two to four lanes in 1983 and had an average daily traffic volume between 10,000 and 14,000 vpd. Table 1 is a summary of the before and after data.

During this same time period, the Iowa Department of Transportation (DOT) authorized the re-stripping of several wide (40–42 feet) two-lane urban roadways to three-lane two-way left-turn lane facilities. The collision rates on the first seven conversions,

TABLE 1 Changes After Highway Widened from Two to Four Lanes (US-61 at Ft. Madison, Iowa)

Corridor Element	Change
• Traffic Volume	Increased 4 percent
• Corridor Travel Delay	Increased 4 percent
• Mid-block 85th% Speed	Increased 2.5 mph
• Traffic Traveling More Than 5 mph Over Speed Limit	Increased from 0.5 percent to 4.2 percent
• Accident Rate	Increased 14 percent
• Injury Rate	Increased 88 percent
• Total Value Loss	Increased 280 percent

which had Average Daily Traffic (ADT) volumes from 5,400 to 13,500 vpd, decreased an average of 40 percent (23 percent to 48 percent) (*2*). Because of the results in Ft. Madison and the success of our two-lane to three-lane conversions, I began a search to determine if anyone had converted a four-lane undivided urban roadway to a three-lane two-way left-turn facility. My search led me to Billings, Montana.

The City of Billings had restripped 17th Street West from a four-lane undivided roadway to a three-lane two-way left-turn lane facility in 1979. 17th Street West is 40 feet wide with an ADT range of 9,200–10,000 vpd and a posted speed limit of 35 mph. City Traffic Engineer Pierre Jomini, P.E., reported that the number of reported accidents decreased from 37 in the 20 months before to 14 in the 20 months after the conversion. He further stated that there was "no increase in traffic delay (*3*)."

I began to look for a candidate roadway to propose a four- to three-lane conversion. The Iowa DOT management staff had only recently accepted the concept of three-lane two-way left-turn lane facilities and was apprehensive about *decreasing* the number of traffic lanes on a state primary highway. However, I was able to convince the City of Storm Lake, Iowa, to convert a portion of existing US-71 after the DOT built a US-71 bypass and transferred jurisdiction of existing US-71 to the City of Storm Lake. Old US-71, Flindt Drive, is 40 feet wide and has an ADT of 8,500 vpd. The roadway was converted to a three-lane facility in 1996. Clyde Bartel, Iowa DOT Resident Engineer, reports that there has been a "very positive community reaction" to the conversion. The city is very pleased with the traffic operations and improvement in safety. At about the same time, a similar conversion was also made on Clay Street in Muscatine, Iowa. Ray Childs, City Engineer, reported "an immediate large reduction in accidents."

The Iowa DOT Office of Transportation Safety has recently begun to actively promote the conversion of other four-lane undivided urban roadways to three-lane two-way left-turn lane facilities when a concern about safety along the existing highway is expressed to the Iowa DOT. Several of these roadways under consideration are 48 feet wide and have traffic volumes in excess of 13,000 vpd. The recommendation to convert to a three-lane facility on these 48-foot-wide roadways is often met with apprehension by the local community and other engineers. As a result, additional inquiries were made around the country about the experience others have had with this concept. I found a number of states discouraged the construction of new four-lane undivided roadways and that those who had experience with the conversion concept had a very positive experience with it.

One example provided was an urban primary highway (US-12) in Helena, Montana. It is a 48-foot-wide, 35-mph roadway with an ADT of 18,000. The roadway did not have a high collision rate but it did have a high percentage of rear-end and sideswipe accidents. It is located in a commercial area with numerous commercial access points. Montana State Traffic Engineer Don Dusek proposed restripping the roadway to a three-lane facility. Both the city staff and other state staff engineers were apprehensive at first, but after observing the improvement in traffic operations and reduction in accidents they support the conversion. They also have received numerous complimentary remarks from city residents about the conversion. Don Dusek stated that the "number of accidents decreased, good traffic flow was maintained, and community residents prefer the three-lane facility over the former four-lane roadway." The roadway cross section was marked with 5-12-14-12-5 foot lanes which meets AASHTO standards to accommodate bikes along a roadway. However, they do not designate the five-foot lanes as a bike path.

In a study conducted for the Minnesota DOT, Howard Preston, BRW Inc., found that the highest urban corridor accident rates were found on four-lane undivided roadways. In fact, the collision rate on four-lane undivided roadways was 35% higher than on urban three-lane roadways (*4*). The study found three-lane roadways in Minnesota with ADTs as high as 20,000 vpd. Mr. Preston stated he would convert most four-lane undivided urban roadways with ADTs less than 20,000 vpd to three lane facilities "in a heart beat."

A good example of a change in community attitude toward the four- to three-lane conversion is the conversion of 21st Ave. East in Duluth, Minnesota. (ADT is 17,000 vpd.) Prior to the conversion many in the community opposed decreasing the number of traffic lanes. A *Duluth News-Tribune* article pleaded "Don't limit 21st Ave. East" and "it's not too late to keep [it] a four-lane street." However, after the conversion, a *Duluth News-Tribune* staff editorial (*5*) stated the following:

> Admit it, 21st East Works
>
> When Duluth officials announced they would convert busy 21st Avenue East between London Road and Woodland Avenue from four lanes to two, with a turn lane in the middle, some armchair analysts predicted it wouldn't work. The News-Tribune Opinion page was among them. Well, it works. About everyone agrees—from city traffic officials to neighbors—that the change has eased congestion and reduced drivers' speed making it safer for pedestrians, and it hasn't caused problems in winter. Traffic moves steadily up and down the hill even though the volume is up. Cutting available traffic lanes by 50 percent on the already heavily used stretch carrying vehicles between the I-35 exit at 21st Avenue East at London Road and the Hunters Park and Woodland neighborhoods did not seem like a good prospect when it was done last May. Initiated at the end of the academic year, many believed that, when the University of Minnesota–Duluth and St. Scholastica resumed classes in the fall, the thoroughfare wouldn't be able to handle the traffic. And winter . . . well, it would be a disaster, we doomsayers predicted. None of it happened. Now the city is planning to repaint the lanes and keep the pattern on 21st indefinitely—as well it should.

ADVANTAGES

Improved Safety

At first glance, it is difficult for most, including many transportation engineers and planners, to accept that, in urban corridors with less than 20,000 vpd, reducing the number of traffic lanes will improve traffic safety and maintain an acceptable level of service. The substantial reduction in accident rates is primarily the result of the reduction in conflict points and improved sight distance for turning and crossing traffic along the corridor. See Figures 1 and 2 for examples of reductions in traffic conflict points along a three-lane corridor. Figure 3 illustrates the improved intersection sight distance.

The three-lane facility is also much more user friendly to elderly drivers. Fewer decisions and judgments have to be made to enter or cross a three-lane facility. Iowa has the third highest percentage of elderly drivers in the country and is making an effort to better accommodate this growing segment of the population on its roadways.

Table 2 shows the 3-year before and after midblock and nonsignalized intersection crash information for a four-to-three-lane conversion project on Minnesota Trunk Highway 49 (Rice Street) in Ramsey County, Minnesota (Figure 4) (*6*). The ADT on Rice Street during the after period was 16,400 vpd. Table 3 reflects data from several street conversions in Seattle, Washington (*7*). It appears a 20 to 30% reduction in crashes would be a reasonable estimate of the potential safety improvement of a four-to-three-lane conversion.

Improved Pedestrian Safety

For pedestrians, the three-lane facility can on occasion provide a pedestrian refuge allowing pedestrians to focus on one lane of traffic at a time. If necessary, elderly and

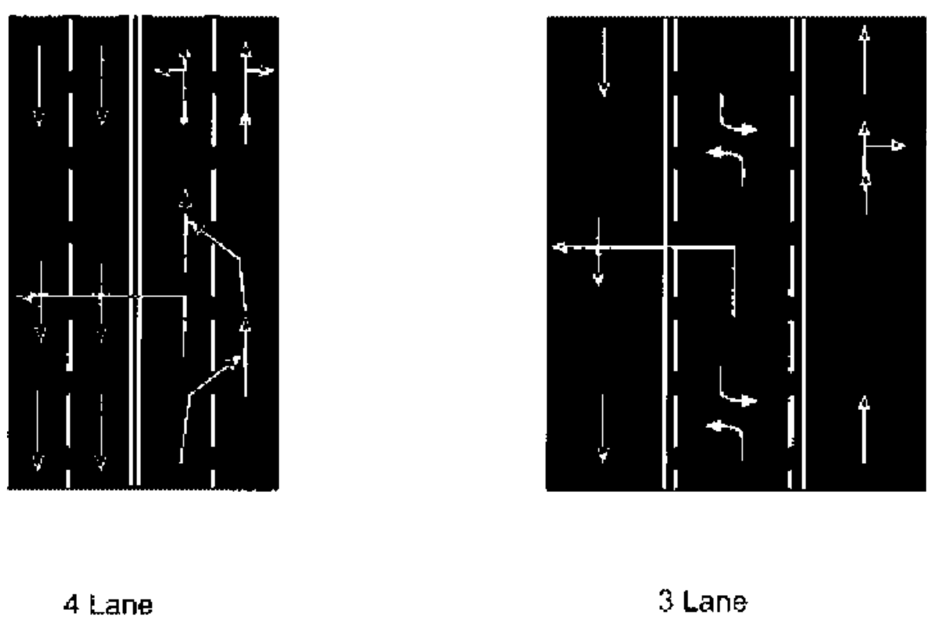


FIGURE 1 Midblock conflict points.

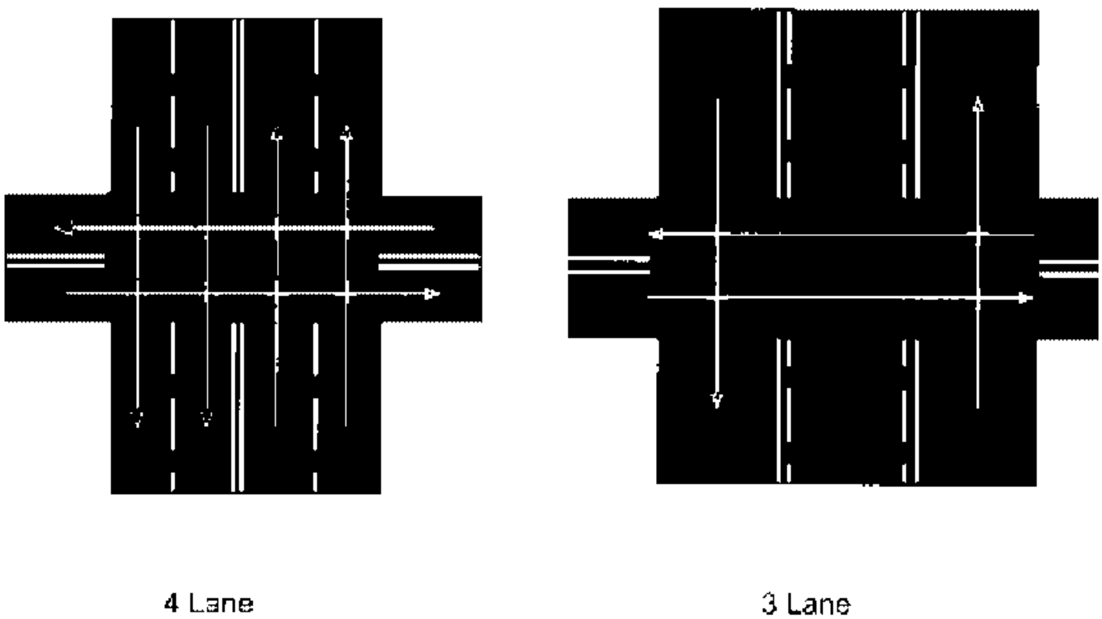


FIGURE 2 Cross-traffic conflict points.

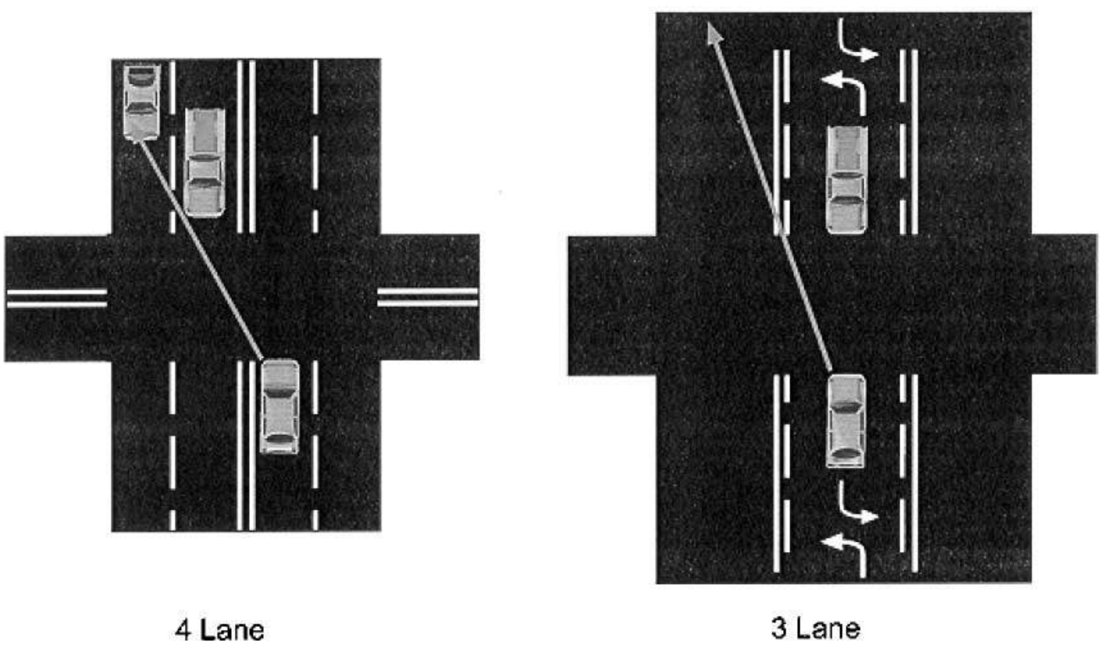


FIGURE 3 Intersection sight distance.

TABLE 2 Collisions Before and After Three-to-Four-Lane Conversion

Corridor Element	Change
• Traffic Volume	Increased 4 percent
• Corridor Travel Delay	Increased 4 percent
• Mid-block 85th% Speed	Increased 2.5 mph
• Traffic Traveling More than 5 mph Over Speed Limit	Increased from 0.5 percent to 4.2 percent
• Accident Rate	Increased 14 percent
• Injury Rate	Increased 88 percent
• Total Value Loss	Increased 280 percent

young pedestrians can stop in the two-way left turn lane, an option not available on four-lane undivided roadways. While the center lane is an active traffic lane, it would have a lower volume of traffic and slower vehicle speeds. Often this lane would be unoccupied by vehicles.

Traffic Calming

Another attribute of the three-lane facility is the traffic calming effect it has on the traffic flow. Aggressive motorists can not travel along three-lane corridors at excessive speeds making multiple lane changes. The three-lane concept also reduces the variability of travel speeds along the corridor, which helps reduce possible collisions. On a four-lane roadway crossing traffic must not only find a gap in four traffic lanes but must also make a judgment on the approach speed of four different vehicles. This is very difficult to do, particularly for elderly drivers and pedestrians.

Improved Emergency Response Time

Emergency vehicles often find it difficult to travel down four-lane urban roadways. Waiting for all the traffic to move over to the curb lane can cause delays to emergency vehicles. The center two-way left-turn lane can be used as a lower-conflict access route along the roadway corridor (Figure 5).

DISADVANTAGES

Increased Travel Delay

Increased travel delay along the corridor is the primary concern many have with converting a four-lane roadway to a three-lane facility. Many assume there will be a 50% reduction in corridor capacity because the number of “through lanes” is reduced by half.

Before

After

FIGURE 4 Four-to-three-lane conversion, Minnesota Trunk Highway 49 (Rice Street), Ramsey County, Minnesota.

TABLE 3 Changes in Traffic Volume and Collisions After Roadways Changed from Four Lanes to Two Lanes plus TWLTL (Seattle, Wash.)

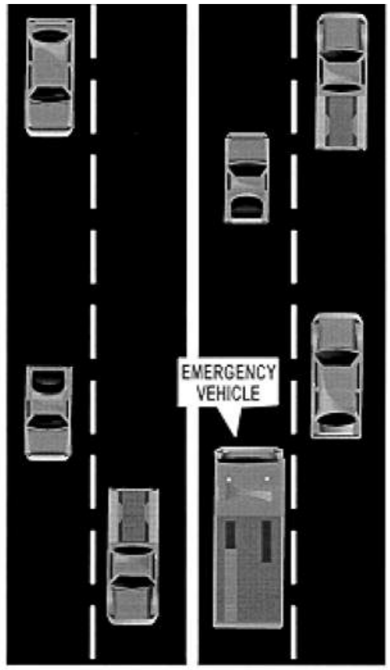
ROADWAY SECTION	DATE CHANGE	ADT (BEFORE)	ADT (AFTER)	CHANGE	COLLISION REDUCTION
Greenwood Ave. N, from N 80th St. to N 50th St.	April 1995	11872	12427	4 lanes to 2 lanes plus TWLTL plus bike lanes	24 to 10 58%
N 45th Street in Wallingford Area	December 1972	19421	20274	4 lanes to 2 lanes plus TWLTL	45 to 23 49%
8th Ave. NW in Ballard Area	January 1994	10549	11858	4 lanes to 2 lanes plus planted median with turn pockets as needed	18 to 7 61%
Martin Luther King Jr. Way, north of I-90	January 1994	12336	13161	4 lanes to 2 lanes plus TWLTL plus bike lanes	15 to 6 60%
Dexter Ave. N, East side of Queen Anne Area	June 1991	13606	14949	4 lanes to 2 lanes plus TWLTL plus bike lanes	19 to 16 59%
24th Ave. NW, from NW 85th St. to NW 65th St.	October 1995	9727	9754	4 lanes to 2 lanes plus TWLTL	14 to 10 28%
Madison St., from 7th Ave. to Broadway	July 1994	16969	18075	4 lanes to 2 lanes plus TWLTL	28 to 28 0%
W Government Way/Gilman Ave. W, from W Ruffner St. to 31st. Ave. W	June 1991	12916	14286	4 lanes to 2 lanes plus TWLTL plus bike lanes	6 to 6 0%
12th Ave., from Yesler Way to John St.	March 1995	11751	12557	4 lanes to 2 lanes plus TWLTL plus bike lanes	16 to 16 0%
				Total	185 to 122 34%

In reality the capacity of a three-lane facility is very near that of a four-lane undivided roadway. Envision a four-lane undivided roadway in a commercial area during the peak hour of the day. Drivers who want to travel through the corridor generally stay in the outside curb lane to avoid getting caught behind mid-block left-turning vehicles. During these peak hours the inside lanes are generally used by left-turning vehicles and very few through trips are made in those lanes. As such, only one lane in each direction is accommodating most of the through trips—which is similar to a three-lane facility.

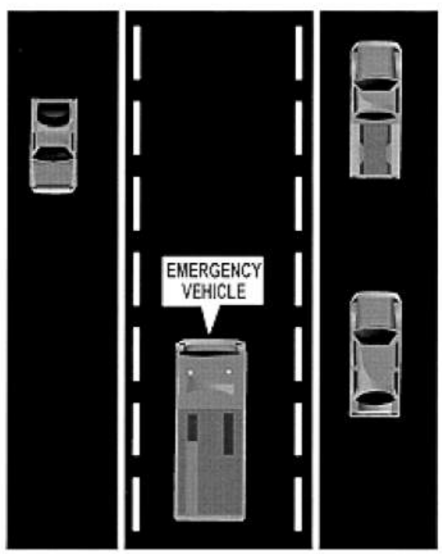
Further, the actual capacity of a corridor is controlled by the signalized intersections. These intersections generally have high volumes of left-turning traffic. As such, once again most of the through traffic is carried in one lane—the outside curb lane.

The following is an example corridor level of service analysis performed on a proposed high-volume roadway in Iowa. Table 4 is an arterial level of service analysis for a section of US-75 through the central business district of Sioux Center, Iowa (population 5,100) (*8*). The ADT on US-75 is 14,500 vpd with 9 percent trucks.

Table 5 is the intersection level of service analysis for the signalized intersection along a proposed conversion of US-65 in Iowa Falls, Iowa (population 5,500) (*9*). The 1996 ADT on US-65 was 8,700 vpd with 8 percent trucks and on Brooks Road the ADT was 1,600 vpd. This is an example of a typical intersection along a three-lane roadway corridor in Iowa.



(a)



(b)

FIGURE 5 Emergency vehicle access (a) on four-lane road; (b) on three-lane road.

As shown, while travel delay increases, an acceptable level of service would be maintained if these four-lane undivided roadways were converted to a three-lane two-way left-turn lane facility. Travel delay along these corridors could be further reduced if right-turn lanes were constructed at major intersections and high-volume commercial entrances. In addition larger turning radii at other driveways will help right-turn traffic exit the roadway quicker, reducing travel delay and the potential for rear-end accidents.

TABLE 4 Arterial Level of Service (LOS) Analysis for Proposed High Volume Roadway[1]

Cross Section	Total Corridor Travel Delay	Average Travel Speed	LOS
Four lane undivided	20.5 secs	16.0 mph	C
Three lane alternative	29.4 secs	14.3 mph	C
Five lane alternative	15.8 secs	17.1 mph	C

[1] U.S. Highway 75 corridor, 1st St. to N. 4th St., Sioux Center, Iowa.

TABLE 5 Intersection Level of Service (LOS) Analysis for Proposed Conversion of a Signalized Intersection[1]

Existing 4 lane undivided

	Lane Mvmts	v/c Ratio	g/C Ratio	Mvmt: Delay	LOS	Approach: Delay	Approach: LOS
EB	LTR	0.356	0.314	12.2	B	12.2	B
WB	LTR	0.379	0.314	12.4	B	12.4	B
NB	LTR	0.342	0.600	4.6	A	4.6	A
SB	LTR	0.293	0.600	4.4	A	4.6	A

Intersection Delay = 6.2 sec/veh   Intersection LOS = B

Proposed 3-lane with TWLT Lane

	Lane Mvmts	v/c Ratio	g/C Ratio	Mvmt: Delay	LOS	Approach: Delay	Approach: LOS
EB	LTR	0.356	0.134	12.2	B	12.2	B
WB	LTR	0.379	0.314	12.4	B	12.4	B
NB	L	0.234	0.600	4.3	A	5.1	B
	TR	0.457	0.600	5.2	B		
SB	L	0.139	0.600	4.0	A	5.0	A
	TR	0.438	0.600	5.1	B		

Intersection Delay = 6.7 sec/veh   Intersection LOS = B

L = Left, T = Through, R = Right.
[1] U.S. Highway 65 at Brooks Road, Iowa Falls, Iowa.

However, this is not recommended if large volumes of pedestrians are present on adjacent sidewalks.

Increased Delay at Driveways

Often when this concept is proposed through a residential area, residents will express concerns about increased difficulty in backing out of their driveways. Granted, conversion to a three-lane roadway will result in fewer gaps in the traffic stream and motorists will have to be more patient. However, backing onto a four-lane undivided highway and into a traffic lane is a high-risk traffic maneuver. The three-lane concept can enhance the safety of this traffic maneuver by allowing motorists to back across the traffic lane into the unoccupied center lane, and then proceed to enter the traffic lanes in either direction. The center lane also provides a low-risk escape lane for motorists who need to avoid a potential collision with a vehicle backing into the roadway.

Loss of Passing Opportunities

A concern often heard is from aggressive motorists who do not want to lose the opportunity to pass vehicles along the corridor. As previously discussed, that disadvantage provides a benefit to pedestrians and other motorists trying to enter or cross the roadway.

Some are of the opinion that aggressive drivers will use the center lane as a passing lane. While this does occur occasionally it has not been a problem in Iowa on three-lane facilities.

Also, in Iowa slow-moving agriculture vehicles commonly travel on these urban roadways to either grain elevators or implement dealers. There is concern that removing a through lane in each direction will result in motorists illegally passing these agriculture vehicles. This likely will happen just as it occurs on two-lane roadways through a community. While this potential conflict may occur several hundred times each year, this disadvantage must be put in the proper perspective. The safety advantages the three-lane facility provides are to the thousands of vehicles which try to cross and turn left onto or off of the highway each day.

ACCESS CONTROL

Opportunities for eliminating, consolidating and relocating driveways should be investigated during the study analysis. Particular attention should be made to ensure high-volume access points on opposite sides of the roadway are not offset in the wrong direction, which could result in “gridlock” in the center turn lane.

Turbulent traffic flow along the corridor can be reduced by constructing right-turn lanes at signalized intersections and constructing larger turning radii at high-volume commercial driveways.

FACTORS TO CONSIDER

A number of factors should be considered before this type of conversion is made. They include roadway function and access control; total traffic volume; turning volumes and 85 percent speed; accident type and patterns; pedestrian and bike activity; and right-of-way availability and cost. A qualitative discussion of each factor and the changes it may experience due to a conversion are being documented in a follow-up report to be presented at the 1999 Institute of Transportation Engineers Annual Conference (*10*).

CONCLUSIONS

Most of Iowa's four-lane undivided urban roadways are providing both an acceptable level of service and safety to the local community because of the relatively low volume of traffic they carry. However, when safety concerns are expressed about one of these corridors, we have another "tool" in our traffic safety tool box we can consider to address these concerns. This "tool" can be implemented quickly, at a very low cost and with less right-of-way, environmental impact (i.e., tree removal), and other controversy associated with improvement alternatives.

Along four-lane undivided corridors, where it is not acceptable to add more lanes or a median, the key question to answer during an evaluation of alternatives is: What is the primary need in the corridor under study? Is it to move high volumes of traffic as quickly as possible? Or is it to improve corridor safety for motorists and pedestrians, while providing an acceptable level of service to corridor traffic? The answers to these questions will determine if converting to a three-lane facility is a viable alternative to include in your study. There is a need to perform a comprehensive before and after study on this concept. However, the positive community reactions to the past conversions and the fact that none of the previous conversions has been converted back to a four-lane undivided roadway support placing this tool in your traffic safety "tool box."

REFERENCES

1. Welch, T. W. Iowa Department of Transportation, unpublished report, 1987.
2. Welch, T. W. Iowa Department of Transportation, unpublished report, 1986.
3. Jomini. City of Billings, Montana. City Traffic Division, unpublished report, 1981.
4. Preston, H. R. *Statistical Relationship Between Vehicular Crashes and Highway Access.* Report for Minnesota Department of Transportation, 1998, figure 1-1.
5. *Duluth News-Tribune*. Editorial, April 28, 1998.
6. Kastner, B. C. *T.H 49 (Rice Street) from Hoyt Avenue to Demont Avenue Before and After Crash Study.* SP 6214-66. Minnesota Department of Transportation, 1998.
7. Burden, D., and P. Lagerway. *Road Diets, Fixing the Big Roads.* Walkable Communities, Inc., March 1998.
8. Perington, M. A. US-75 Sioux Center, Iowa. Iowa Department of Transportation, Traffic Engineer Assistance Program report, June 1998.
9. Welch, T. W. Iowa Department of Transportation, US-65 Iowa Falls Traffic Safety Draft Report, November 1998.
10. Knapp, K. K., T. W. Welch, and J. Witmer. *Converting Four-lane Undivided Roadways to a Three-lane Cross-Section: Factors to Consider.* Iowa State University, Center for Transportation Research and Education 1999.

Alternate Street Design, P.A.
1516 Plainfield Avenue, Orange Park, Florida 32073-3925
904-269-1851, Fax 904-278-4996, Email: mjwallwork@comcast.net

November 6, 2007

Sue Newberry
Community Partners LLC
218 Carville Circle
Carson City NV 89703

RE: E Street and 9th Street Intersection, Marysville

Dear Sue:

As requested I have undertaken a series of capacity analyses for the above intersection to determine its expected operation if the intersection was controlled by a roundabout. Attached are the capacity analysis summary sheets that show the expected operation for a multi-lane roundabout at this intersection.

The proposed roundabout used in the analysis was a roundabout that uses two lanes north and south along E Street with a right turn lane on E street south and single entry lane on 9th Street west and a left /through and right turn slip lane on the east approach. The total number of entry lanes is eight.

The traffic volumes used in the analysis were the existing traffic volumes from a report prepared by KD Anderson Transportation Engineers report dated 3/14/2006.

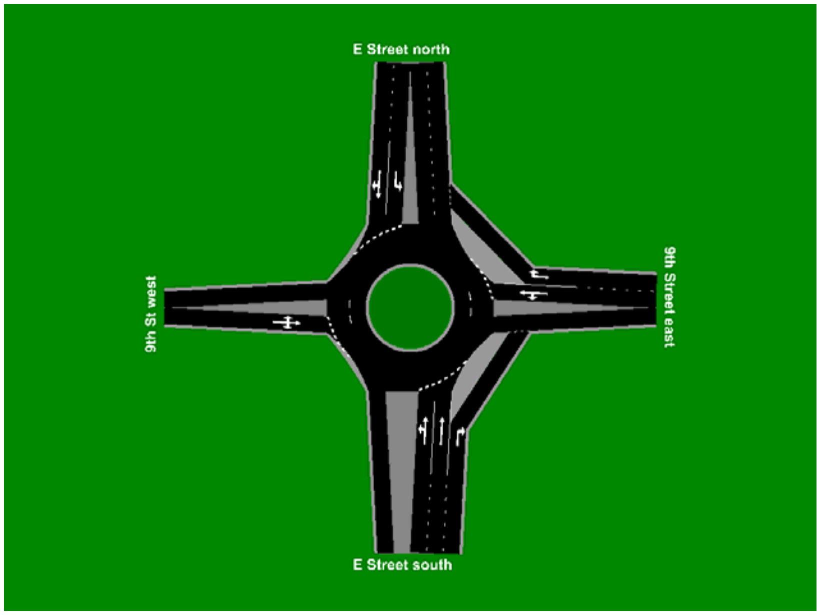
As a direct comparison the intersection was analyzed as a signalized intersection using the same capacity analysis program, SIDRA 3.1, using the proposed lane arrangement. The result showed that a signalized intersection is expected to have a poorer level-of-service than a roundabout even though several movements that restrict circulation and access to properties were banned under signal. Furthermore, the signalized intersection had 12 entry lanes, 50 percent more lanes than the roundabout. Even with the extra lanes and prohibited movements the 95th percentile queues at the signalized intersection are longer than the expected vehicle queues at the roundabout.

In summary, a two lane/one lane roundabout with eight entry lanes with no restricted vehicle movements provides better operation than the signalized intersection with 50 percent more lanes.

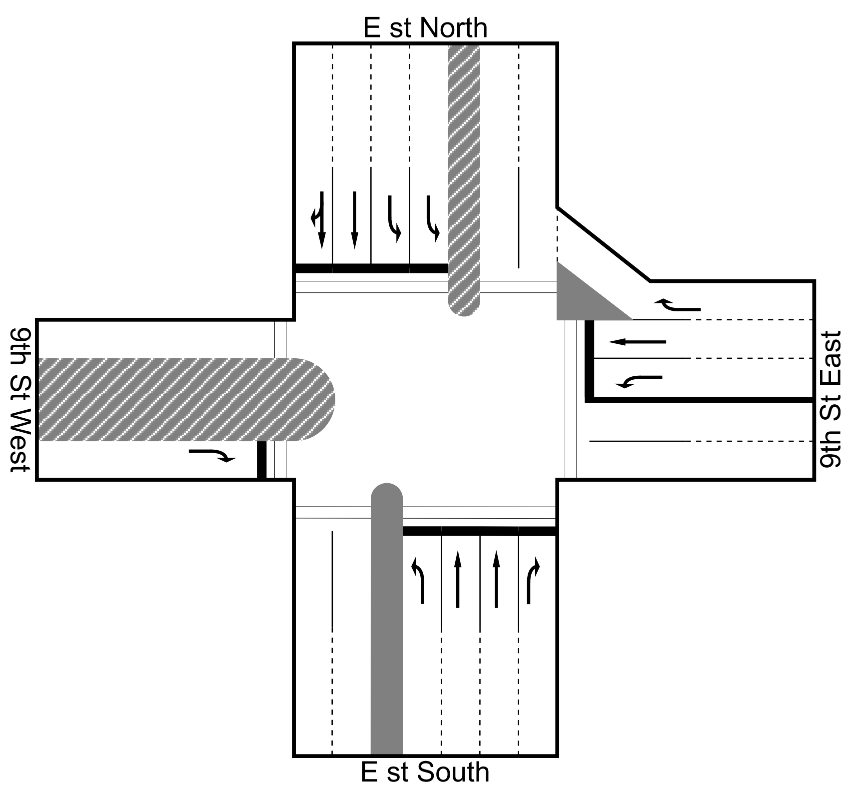
Sincerely,
Alternate Street Design, P.A.

Michael J. Wallwork, P.E.
President

Lane arrangement for the roundabout analysis



Lane arrangement for the traffic signal analysis



SIDRA INTERSECTION

Movement Summary

E and 9th

AM Peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
E st South										
3L	L	43	2.3	0.419	15.4	LOS B	103	0.80	0.82	27.9
8T	T	852	2.0	0.418	7.3	LOS A	115	0.79	0.63	30.9
8R	R	340	2.1	0.370	9.1	LOS A	89	0.77	0.75	30.4
Approach		**1236**	**2.0**	**0.418**	**8.1**	**LOS A**	**115**	**0.79**	**0.67**	**30.6**
9th St East										
1L	L	420	1.9	0.756	20.9	LOS C	194	0.89	1.11	25.6
6T	T	63	1.6	0.759	13.8	LOS B	194	0.89	1.08	28.5
6R	R	502	2.0	0.567	10.3	LOS B	129	0.82	0.90	30.2
Approach		**984**	**1.9**	**0.757**	**15.1**	**LOS B**	**194**	**0.85**	**1.00**	**27.8**
E st North										
7L	L	509	2.0	0.664	20.0	LOS C	221	0.93	1.02	26.0
4T	T	584	2.1	0.697	12.8	LOS B	255	0.95	1.01	29.1
4R	R	11	8.3	0.706	14.3	LOS B	255	0.95	1.02	28.2
Approach		**1105**	**2.1**	**0.697**	**16.2**	**LOS B**	**255**	**0.94**	**1.01**	**27.5**
9th St West										
5L	L	5	16.7	0.222	21.2	LOS C	35	0.82	0.95	25.5
2T	T	11	8.3	0.222	13.6	LOS B	35	0.82	0.89	28.7
2R	R	50	2.0	0.224	15.0	LOS B	35	0.82	0.86	27.8
Approach		**68**	**4.4**	**0.224**	**15.3**	**LOS B**	**35**	**0.82**	**0.87**	**27.7**
All Vehicles		**3393**	**2.1**	**0.759**	**12.9**	**LOS B**	**255**	**0.86**	**0.88**	**28.7**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue

SIDRA INTERSECTION

Movement Summary

E and 9th

PM Peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
E st South										
3L	L	45	2.2	0.703	22.7	LOS C	245	0.99	1.13	24.8
8T	T	980	2.0	0.705	14.5	LOS B	268	1.00	1.10	28.1
8R	R	482	2.1	0.609	12.4	LOS B	199	0.96	0.99	29.4
Approach		**1508**	**2.1**	**0.705**	**14.1**	**LOS B**	**268**	**0.99**	**1.06**	**28.4**
9th St East										
1L	L	364	1.9	0.997	47.9	LOS D	427	1.00	1.56	17.4
6T	T	77	2.6	1.000	40.8	LOS D	427	1.00	1.56	18.3
6R	R	617	1.9	0.325	5.8	LOS B#	16#	0.00	0.48	34.3
Approach		**1059**	**2.0**	**0.998**	**22.8**	**LOS C**	**427**	**0.42**	**0.93**	**24.3**
E st North										
7L	L	633	2.1	0.717	19.7	LOS B	273	0.96	1.01	26.1
4T	T	557	2.0	0.703	13.1	LOS B	254	0.95	1.01	29.0
4R	R	4	20.0	0.714	14.5	LOS B	254	0.95	1.05	28.1
Approach		**1194**	**2.1**	**0.717**	**16.6**	**LOS B**	**273**	**0.95**	**1.01**	**27.3**
9th St West										
5L	L	5	16.7	0.231	21.1	LOS C	36	0.83	0.95	25.6
2T	T	11	8.3	0.235	13.5	LOS B	36	0.83	0.90	28.7
2R	R	50	2.0	0.234	14.9	LOS B	36	0.83	0.87	27.9
Approach		**68**	**4.4**	**0.233**	**15.2**	**LOS B**	**36**	**0.83**	**0.88**	**27.8**
All Vehicles		**3829**	**2.1**	**1.000**	**17.3**	**LOS B**	**427**	**0.82**	**1.01**	**26.8**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue

SIDRA INTERSECTION

Movement Summary

E and 9th Signalized

PM Peak

Signalised - Pretimed **Cycle Time = 100 seconds**

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
E st South										
3L	L	45	2.2	0.117	41.5	LOS D	67	0.84	0.74	18.0
8T	T	980	2.0	0.850	47.4	LOS D	681	1.00	0.99	16.7
8R	R	482	2.1	0.466	14.0	LOS B	275	0.43	0.78	28.3
Approach		**1508**	**2.1**	**0.850**	**36.6**	**LOS D**	**681**	**0.81**	**0.91**	**19.3**
9th St East										
1L	L	364	1.9	0.587	38.6	LOS D	373	0.88	0.95	18.9
6T	T	77	2.6	0.151	28.4	LOS C	105	0.80	0.62	21.8
6R	R	617	1.9	0.407	9.5	LOS A	126	0.14	0.66	31.4
Approach		**1059**	**2.0**	**0.587**	**20.9**	**LOS C**	**373**	**0.44**	**0.76**	**24.9**
E st North										
7L	L	633	2.1	0.823	64.3	LOS E	467	1.00	0.96	13.9
4T	T	557	2.0	0.486	31.3	LOS C	334	0.87	0.74	20.9
4R	R	4	20.0	0.480	39.8	LOS D	332	0.87	0.83	18.4
Approach		**1194**	**2.1**	**0.823**	**48.8**	**LOS D**	**467**	**0.94**	**0.85**	**16.5**
9th St West										
2R	R	50	2.0	0.066	10.1	LOS B	17	0.19	0.71	30.8
Approach		**50**	**2.0**	**0.066**	**10.1**	**LOS B**	**17**	**0.19**	**0.71**	**30.8**
All Vehicles		**3811**	**2.0**	**0.850**	**35.7**	**LOS D**	**681**	**0.74**	**0.85**	**19.6**

Pedestrian Movements

Mov ID	Dem Flow (ped/h)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate
P1	54	41.4	LOS E	0	0.91	0.91
P3	5	30.4	LOS D	0	0.78	0.78
P5	5	38.7	LOS D	0	0.88	0.88
P7	5	25.9	LOS C	0	0.72	0.72
All Peds	**69**	**39.3**	**LOS D**	**0**	**0.88**	**0.88**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Signalized 9th and E PM
E:\Project files\Marysville\E and 9th.aap
Processed Nov 06, 2007 08:59:55AM

A0172, Alternate Street Design, Small Office
Produced by SIDRA Intersection 3.2.0.1455

www.sidrasolutions.com