Tacoma Residential Streets

Complete Streets

Design Guidelines

City of Tacoma

November 17, 2009

Tacoma Residential Streets
Complete Streets
Design Guidelines

City of Tacoma

November 17, 2009

Acknowledgements

This report and guidelines are the work of an interdepartmental/interagency team, with input from numerous community stakeholders. AHBL, Inc. prepared the guidelines and analysis, in close consultation with the team, between January and May 2009. Extensive public comments were received on the public review draft, resulting in changes reflected in the final version. The objective of this project is to provide the City Council with well-developed and staff-supported draft guidelines, along with ample analysis of feasibility and implementation issues, to support a Complete Streets approach for Tacoma's residential streets. Thanks are due to all participants and to the City Council for their direction.

City Council Resolution Number 37916 adopted November 17, 2009:

"A RESOLUTION relating to the City's street design; endorsing the creation and ongoing development of Tacoma's Complete Streets Design Guidelines; and directing the City Manager to implement the Mixed-Use Centers Complete Streets Design Guidelines and the Residential Complete Streets Design Guidelines."

Complete Streets Team and Community Participants:

Community Partners:
Pierce Transit
Puget Sound Energy
Tacoma-Pierce County Health Department
Community Stakeholders Focus Group

City Participants:
City Council Environment and Public Works Committee
Planning Commission
Tacoma Area Commission on Disabilities
City Manager's Office
Community and Economic Development Department
Public Works Department
Tacoma Public Utilities
Tacoma Fire Department
Tacoma Police Department

Consultant: AHBL, Inc.

Table of Contents

Chapter 1: Background & Existing Conditions

Chapter 2: Design Guidance & Typologies

Chapter 3: Supporting Research & Analysis

Figures

Chapter 1
Background & Existing Conditions

1.1 Background

The purpose of this document is to provide specific guidance for the implementation of a Complete Streets approach on local streets within Tacoma's residential neighborhoods. This work is a component of Complete Streets Design Guidelines that are being developed for the entire City, which was initiated with guidelines for Tacoma's Mixed-use Centers. Further work will be done in the near future to develop Complete Streets design guidelines for the arterial streets that connect neighborhoods and Mixed-use Centers, as well as for streets in industrial areas. These guidelines are intended to inform and build upon the efforts of Tacoma's Public Works Department to update its Design Manual, as well as support various City initiatives and goals, including the Clean and Safe Initiative, the Mobility Master Plan effort, and Tacoma's Climate Action Plan.

Applying Complete Streets principles to Tacoma's residential streets will provide benefits to the City's neighborhoods by safely and comfortably accommodating walking, bicycling, wheelchairs and other mobility enhancement devices, automobiles, service vehicles, and in some cases transit, while also improving neighborhood livability and aesthetics. In addition to these functions, Complete Streets may also help to improve environmental quality and manage stormwater run-off through the integration of natural drainage systems and other low impact development stormwater techniques.

Complete Streets is a national movement that has been gaining substantial momentum. Cities, counties, and states across the country have been adopting Complete Streets policies and moving forward with implementation in order to improve peoples' transportation choices, reduce greenhouse gas emissions, encourage physical activity, and improve overall quality of life. In Tacoma, residential streets offer numerous opportunities for Complete Street implementation. Cities such as Seattle, WA, Portland, OR, and Berkeley, CA have implemented a number of projects on residential streets that have served to improve pedestrian and bicycle mobility, manage stormwater, and generally improve neighborhood livability. These design guidelines for complete residential streets in Tacoma incorporate many of the concepts and lessons learned from these other cities.

Through the process of developing these Guidelines and through other adopted policies, Tacoma has made Complete Streets our own. While Complete Streets is a national movement, each community overlays the concept

Poor drainage along S Junett S.t, an oilmat street.

A poorly defined street edge and detoriated pavement on S Monroe St.

with its own priorities and values, crafting its own Complete Streets definition. In Tacoma, a Complete Street is a street that safely, comfortably and appropriately accommodates all users and travel modes, fosters livability, neighborhood identity and character and, whenever feasible, incorporates features that reduce environmental impacts.

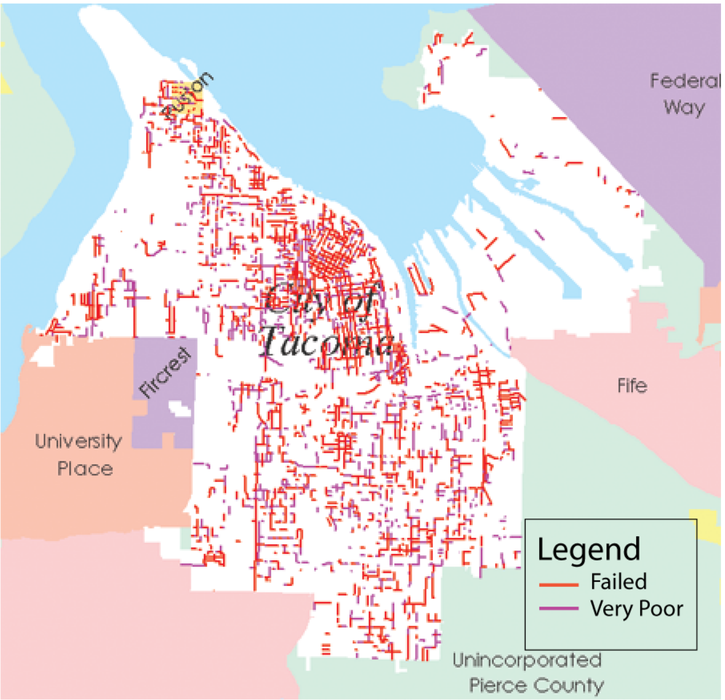
1.2 Existing Conditions of Residential Streets

The City of Tacoma has an extensive grid network, along with curvilinear streets in some areas, of local residential streets primarily serving lower-density single-family residences, and in some areas, medium-density multi-family and townhouse development. A significant number of Tacoma's residential streets have a pavement condition rating below 40, which means that they are considered to be in "failed" or "very poor" condition. According to City standards, any street with a rating below 40 is a priority for replacement (see Figure 1.1). A large portion of these residential streets are oilmat streets built to a "temporary" standard of 2" chip seal without curb and gutter systems (see Figure 1.2). In some cases, sidewalks are not present or are only present on one side of the street. Many of these oilmat streets, which are now 30-50 years old, have deteriorated pavement, a broken and untidy pavement edge, and poor drainage. Furthermore, lack of curbs and a poorly defined roadway edge results in vehicles parked within what would typically be the planting strip, often obstructing sidewalks and cluttering the general appearance of the neighborhood. Many streets also lack curb ramps.

Many residential streets in Tacoma have 60 foot rights-of-way; however, there are a number of streets with 70 and 80 foot rights-of-way. The typical roadway width ranges from 28 to 32 feet (the City's standard for new residential streets is a 28 foot roadway section), however there are a significant number of older streets with narrower widths, e.g. 24 feet, and some streets with widths as wide as 36 feet. Most existing residential streets have 5 foot sidewalks on at least one side of the street and a 4 to 10 foot planting strip area on either side of the street. In addition, there is often a two to four foot setback between the sidewalk and adjacent properties. In most cases, planting strips contain street trees, which vary widely in age, size, and species. Utilities (both above ground and underground) are often placed within the planting strip area and/or within alleys. The majority of Tacoma's residential neighborhoods have alley systems that provide access to residential parking located behind residences and also serve as service corridors.

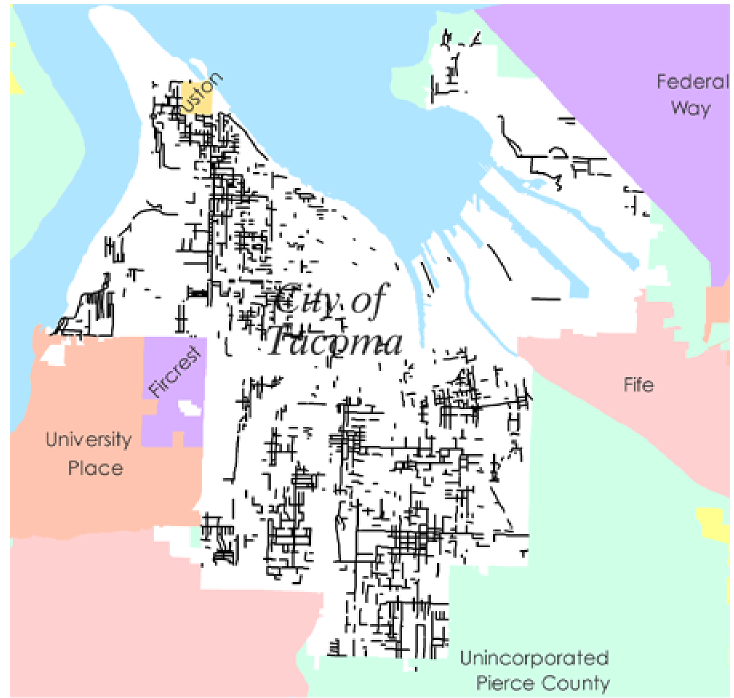
The vast majority of Tacoma's stormwater is collected in storm drains where it enters the stormwater system and ultimately discharges into Puget Sound. Development and redevelopment projects, including road projects, that meet certain thresholds have been required to install stormwater treatment and flow control facilities. However, many existing streets and facilities were installed prior to the requirements for stormwater treatment and flow control or did not individually meet the thresholds to require stormwater treatment or flow control. These locations are good candidates for retrofit projects. Of the existing stormwater treatment and flow control facilities in Tacoma only a handful are Low Impact Development (LID) facilities.

Figure 1.1: Tacoma Streets with Poor Pavement Condition



From govMe March 2009

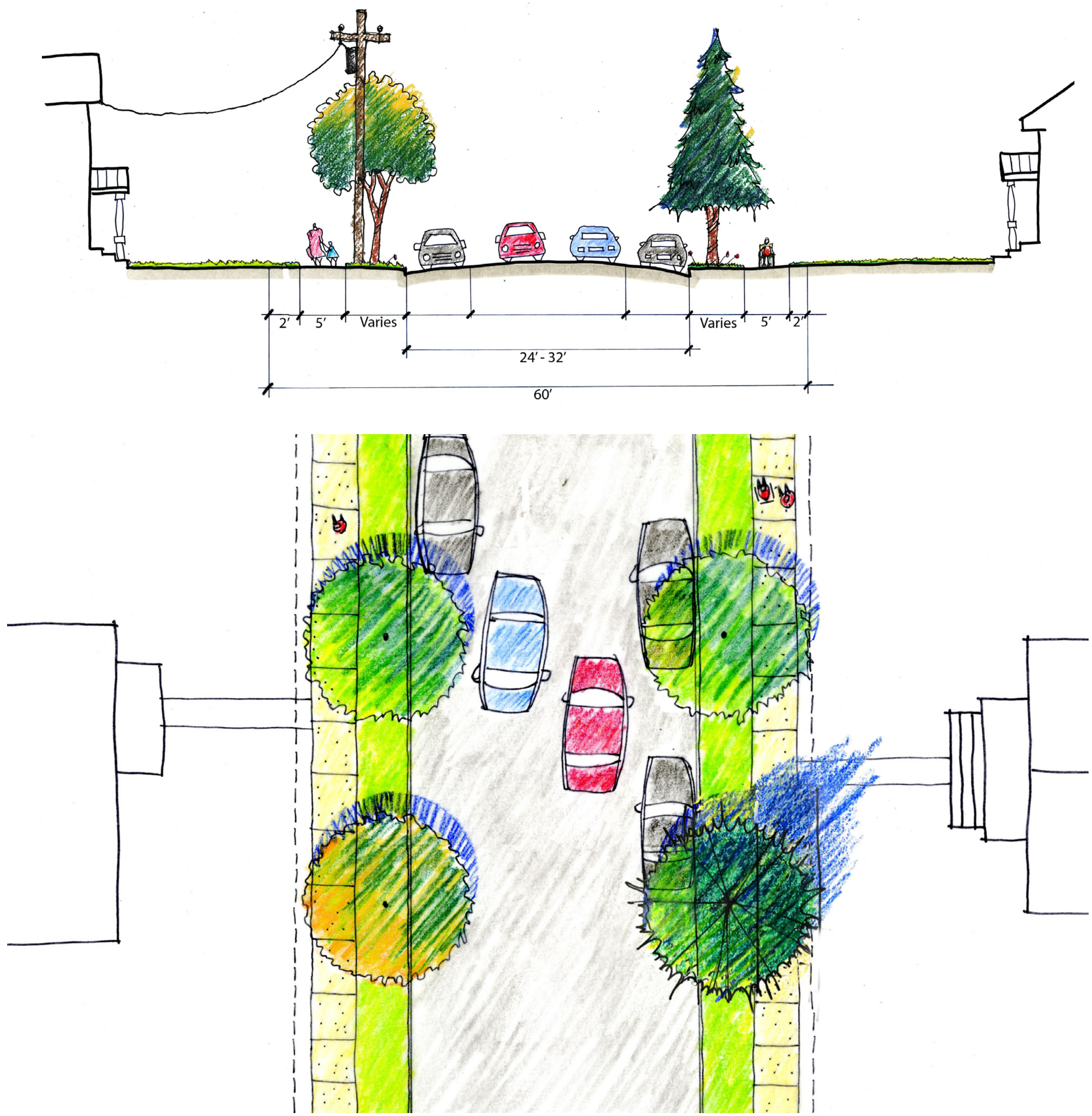
Figure 1.2: Tacoma Streets with Oilmat Surface



From govMe March 2009

(This page intentionally left blank)

Figure 1.3: Typical Existing Residential Street Section




RESIDENTIAL
STREET
20
M.P.H.

Chapter 2
Design Guidance & Complete Street Typologies

2.1 Guidelines for Residential Complete Streets

These guidelines are intended to provide a broad vision for local streets within Tacoma's residential neighborhoods while also providing recommendations and direction for the incorporation of Complete Streets principles and practices in the updating of the City's Public Works Design Manual and other guidance documents, and in the replacement or retrofit of many of Tacoma's residential streets. These guidelines are not intended to address all factors and unique circumstances that may determine the most appropriate design nor replace well-established engineering principles.

2.1.1 Applying These Guidelines

The City Council has directed that these Guidelines be implemented through the City's design and review of proposed street improvements (as well as through corresponding code, standard and process changes). The following points provide a framework for City staff, and the public, to understand how and when to put the Guidelines into practice.

- The Guidelines' stated objectives and intent are the key considerations:

These Guidelines outline the City's default approaches, providing a starting point for project design. They must be tailored to the specific objectives of the project, taking into account professional judgment, community input, City Council direction and other factors. If other approaches are identified that better meet the Complete Streets objectives and intent, they should be implemented. If a decision is made to depart from the Guidelines, however, project designers must "show their work"—demonstrating why the alternative approach was chosen and how it is more effective for meeting Complete Streets objectives. Over time, this will result in innovations that should be incorporated into the Guidelines.

- When the Guidelines are to apply:

Generally, new and substantially rebuilt streets or street sections, whether built by the City or as part of private development, are to follow the applicable Guidelines (refer to thresholds in City code and procedures for when improvements are required). Maintenance and minor alterations to the right-of-way do not require full implementation as Complete Streets. However, such actions must not make conditions worse (depart further from Guidelines), and should incorporate incremental improvements as practicable.

Residential Streets should support walking and biking for health, recreation, and as viable transportation modes.

- Which typologies and sections of the Guidelines to apply:

The Guidelines contain direction organized by subject, as well as by typology. Both are applicable, as appropriate to the project scope and objectives. The discussion of each typology provides general direction for when that typology may be appropriate. Project designers are to document the process and reasoning behind the design choices made.

- The Guidelines set a baseline:

The Guidelines outline the essential features and characteristics of that typology, as well as optional features and considerations. Such optional features may be added when appropriate, when desired by the community and when resources are available.

- Balancing Complete Streets objectives:

These Guidelines provide a range of feasible, cost-effective approaches to achieving Complete Streets objectives. In practice, a specific design may more strongly emphasize some Complete Streets objectives while providing baseline treatments for others. Project decisions will continue to be made through the combination of expert and community input, City Council direction, available resources, site conditions and other factors. Opportunities to reduce environmental impacts should be routinely considered, along with other project objectives. Broadly speaking, the City will seek to cost-effectively maximize the benefits to the public, to distribute street improvements equitably and to serve all members of the community.

- How the Guidelines relate to other standards and regulations:

The Guidelines are to be used in conjunction with applicable sources of professional guidance, federal and state laws, and City policies, code and standards. Tacoma's land use regulations pertaining to abutting property in some cases would affect street designs, particularly in the sidewalk and amenity zones. Implementation of the Guidelines will include changes to pertinent code and standard sections. Additional work in the future will address issues related to but outside the public right-of-way, such as driveways and parking standards and regulations.

2.2 Goals for Residential Streets

Complete Streets approaches typically focus on safely and comfortably accommodating all modes of transportation. The City of Tacoma has expanded its definition of Complete Streets to include the fostering of sense of place in the public realm and reducing environmental impacts. Residential streets, due to their low traffic volumes and relatively wide rights-of-way, offer many opportunities for redefining the form and function of the street, fostering a sense of place for residential neighborhoods and improving environmental performance. Goals for residential Complete Streets include:

- Consider all users and transportation modes in the planning, design, building, and operating of residential streets
- Support walking and biking for health, recreation, and as viable transportation modes
- Improve neighborhood aesthetics and livability
- Provide safe and comfortable access for people with disabilities

- Create safe and people-friendly street environments through traffic calming
- Support the City's efforts to reduce environmental impacts through the integration of natural drainage systems, reduction of impervious surfaces and planting of street trees
- Allow for design flexibility to better respond to different street functions and neighborhood contexts
- Support multiple City policy priorities: Tacoma's Transportation Strategies, Climate Action Plan, Clean and Safe Initiative, Stormwater Management Program, Local Improvement District program, Mobility Master Plan effort, Urban Forestry Policy and Program, ADA Transition Plan, Green Streets policies, and others.

2.3 Residential Complete Street Design Considerations and Features

This section describes the various user needs that should be addressed, as well as design features that may be incorporated into residential streets in order to make them more complete in terms of mobility, ecological function, and neighborhood livability. Many of these features may be combined depending on the goals, constraints, and neighborhood context of the street. Other considerations such as the accommodation of larger vehicles are also discussed. A checklist of Complete Street features has been developed and will be maintained by a cross-functional team within the City. This checklist contains all of the features described in this document and is intended to be applied during the design phase of road construction projects in order to ensure that Complete Streets principles are being appropriately applied.

2.3.1 Pedestrians and Persons with Disabilities

Complete Streets provide a safe, comfortable, and convenient environment for pedestrians and persons with the full range of disabilities. Public Rights-of-Way Accessibility Guidelines (PROWAG) and Americans with Disabilities Act (ADA) standards, as updated, should routinely be incorporated. In addition, the following guidelines should be incorporated into design, maintenance and operation of local residential streets (additional guidance is provided for each typology):

- Complete Streets should in almost all cases have sidewalks on both sides (the rare exceptions could include pilot green street approaches and streets where topography makes providing sidewalks on both sides impracticable). Residential streets should have sidewalks that are a minimum five feet wide in order to accommodate wheelchairs or two people walking abreast.
- A minimum five feet of walkway clearance should be provided from utility features and other obstructions, unless it is determined that less than five feet is acceptable based on site specific conditions.
- Directional curb ramps should be installed at all crossing points to improve accessibility and walkability. Curb ramps should have a maximum grade of 8.3% to accommodate people with disabilities.
- Curb extensions at intersections should be considered in certain situations in order to shorten crossing distances and increase pedestrian visibility. Criteria for

Pedestrian-scaled lighting should be incorporated appropriate to the use of the street

Street trees provide shade, a sense of enclosure, and visual interest, thus creating comfortable walking environments.

Curb ramps at every intersection provide safe and comfortable access for people with disabilities.

Persons with disabilities should be considered in all Complete Street design (PBIC).

Designated bicycle routes may receive special design treatments such as signage, painted roadway symbols, and traffic calming devices.

Residential Streets should be safe for bicyclists of all ages and abilities.

curb extensions may include roadway widths 32 feet or wider, traffic volumes that are higher than the typical residential street, and where there is not adequate space to accommodate a curb ramp with maximum grade of 8.3% (for people with disabilities).

- Intersections should typically have no more than 2% cross slope to the back of the crossing area. Exceptions may be necessary due to topography. Street crossings should be discouraged in steeply sloped areas (greater than 5%) and alternative crossings in less steeply sloped locations should be identified and clearly marked.
- When the sidewalk crosses driveways and alley approaches, maintain a maximum of 2% cross slope unless topography or other site specific conditions dictate a different approach for safety reasons.
- Utility plates within the sidewalk should be slip resistant and result in a minimum change in grade. Vertical protruding objects that act as barriers to pedestrian passage should be avoided.
- Crosswalks are not standard, but should be considered under certain situations such as the presence of schools and other major facilities. When used, they should be designed to minimize vibration and to have slip resistant utility plates.
- Audio crossing warnings or similar devices should be used at arterial intersections, particularly where major facilities are present, to help people with visual disabilities.
- Detectable warnings should be incorporated into the walkway or accessible route where it crosses a public street or alley, or higher usage driveways.
- The selection of sidewalk surface treatments should take into consideration that some patterns and joints may cause vibrations that are uncomfortable for wheelchair users.
- Pedestrian-scaled lighting should be incorporated appropriate to the use of the street.
- Handrails and landings should be provided along steep grades.
- Adequate tread height and length is required for stairways.
- Benches should be provided for persons with disabilities to rest.
- Cul de sacs should be built, or retrofitted where practicable, with bicycle/pedestrian connectors that allow for greater non-motorized connectivity.
- Street trees should be planted on both sides of all streets in order to provide visual interest and comfort for pedestrians and other street users.
- The principles of Crime Prevention Through Environmental Design (CPTED) should be considered as part of street designs.

2.3.2 Bicycles

All Complete Residential Streets should also provide safe, comfortable, and convenient access for bicycles. Because residential streets typically have low traffic volumes and speeds, they are generally safe and comfortable for bicyclists, and do not require special pavement markings such as lane striping or sharrows. However, there are safety concerns for bicyclists on residential streets, including cars pulling in and out of driveways and on-street parking spaces, opening doors of parked cars, uncontrolled intersections, and intersections with arterial streets. Some of these concerns can be addressed through roadway design while others are entirely determined by the level of awareness of both bicyclists and drivers. Residential streets that are designated as bicycle routes or bike boulevards will receive special design treatments to raise awareness of the presence of bicycles and address other safety concerns, particularly, intersections. Many of these treatments are discussed under Section 2.2.3 of the Mixed-use Center Complete Streets Design Guidelines. In addition, the Tacoma Mobility Master Plan will provide further guidance and strategies for accommodating bicycles on all streets within the City.

2.3.3 Accommodating Emergency, Transit and Service Vehicles

Some Complete Street elements such as the traffic calming and low impact development stormwater approaches discussed below could result in delay of emergency response and encumber other large service vehicles if not designed properly. Generally speaking, however, it has been found that the incremental risk to residents from fire truck delays are usually much smaller than the increase in road safety resulting from traffic calming accident reductions.[1]

The following are some general guidelines from the Victoria Transport Policy Institute for minimizing potential problems that may arise with emergency and service vehicles in traffic-calmed neighborhoods

1 Litman, Todd. *Traffic Calming Benefits, Costs and Equity Impacts*. Victoria Transport Policy Institute, 1999.

- Establish extra large no-parking zones adjacent to fire hydrants to help fire trucks maneuver.
- Limit the use of skinny streets to low- and medium-density residential neighborhoods.
- Limit the use of skinny streets to streets that are part of an interconnected network of streets (i.e., connected on both sides to other public streets, no cul de sacs).
- Avoid skinny streets on primary emergency vehicle routes.
- Prohibit parking within 50 feet of an intersection (to allow fire trucks to make the turn).
- Purchase smaller fire and garbage trucks for use in traffic calmed areas[2].

On streets that currently have transit service, or are likely to in the future, a wider roadway width of 36 feet is appropriate. In addition, if the street is to have traffic calming and/or low impact development stormwater features such as rain gardens, some special considerations should be made in the design of these facilities. The following are guidelines for how to accommodate transit on streets with calming and/or rain garden facilities.

- Place bus stops a minimum of 60 feet from a mid-block curb extension rain garden to avoid blocking of travel lane when bus is stopped.
- If curb extensions are placed at an intersection where there is a bus stop, then they should be elongated to accommodate the bus stop.
- Curb extensions should be designed to accommodate bus turning movements.
- Where rain gardens or biofiltration swales have been

2 Ibid.

A wider roadway width is required for residential streets that are transit routes.

Emergency access is a major consideration in street design, but must be weighed with other important design and policy objectives. (photo by John Coastie)

Skinnier roadway widths reduce impervious surface and associated stormwater flows.

installed in the planting area, bus stops should be designed to keep riders out of these facilities and should incorporate permeable pavement.

2.3.4 Landscaping and Street Trees

Landscaping and street trees are important elements of Complete Streets and provide multiple benefits. Trees and landscaping help to soften the streetscape, making it a more comfortable place for people to walk, bike, and gather. Street trees, in particular, offer numerous benefits including stormwater interception and transpiration, providing shade and reducing the heat island effect, habitat, visual interest and aesthetics, establishing neighborhood identity and cohesiveness, and providing a traffic calming effect. Because of these multiple benefits, street trees should be incorporated into all residential streets. Planting designs should follow the Urban Forestry Policy and Program. A more specific discussion of how trees and other landscaping are to be incorporated into low impact development approaches can be found in Section 2.3.7 under the "Landscaping for Natural Stormwater Features" section.

2.3.5 Utilities

The Complete Streets concept is intended to create a safe and comfortable place for vehicles and pedestrians while improving neighborhood livability and aesthetics. A part of any neighborhood is the infrastructure and facilities that support the utilities necessary to make a neighborhood livable.

Utilities of all kinds need to be accommodated within the public right-of-way, whether in the roadway or the sidewalk and planting strip. The following points should be considered:

- Alleys provide an invaluable opportunity to open up the street for improvements. Whenever feasible, above ground utilities and municipal services should take place within alleys.
- Utility poles and other utility-related structures should typically be placed within the planting strip and a minimum of 5 ft. unobstructed sidewalk should be maintained.
- Utility vault covers and manhole covers should have non-slip surfaces; all features should meet ADA requirements.
- Utility structures such as switch boxes, poles, etc. should be visually integrated into the streetscape.

These Guidelines support the conversion of overhead power lines to an underground system to improve the aesthetics of residential areas. Overhead wires visually clutter the streetscape and typically detract from the overall aesthetic experience; therefore underground locations are preferable to overhead in most cases for electrical, telephone and communication wires.

While underground locations are clearly preferred, there are both policy and practical issues related to converting existing overhead to underground facilities. All new roadways within developments are installed underground in accordance with the current Tacoma Municipal Code. Currently, there are no set thresholds or triggers that initiate the conversion of an existing overhead system to an underground system. Existing overhead systems need to be carefully evaluated on a case by case basis in order to determine if conversion is a viable option that is in the best interest of the customers who are funding the conversion and the customers who will pay for the maintenance of the system over time.

The first factor that must be considered is right-of-way width. Under the ground there is competition for space. Sewer mains, water mains, storm water, natural gas, and planting strips (bio-retention swales, rain gardens, tree roots, etc), all compete for a limited amount of space. The preferred location for power facilities such as transformers and switch vaults is in easements on private property.

Where right-of-way space is available for underground utilities, the next factor to consider is the cost of the conversion. The cost to convert a power system varies extensively due to system requirements, property and right-of-way availability, restoration costs and the funding mechanisms implemented. The costs of conversions funded through the Local Improvement District process are shared between the customer and Tacoma Power at a percentage set in the current Tacoma Power Customer Service Policy.

Additional factors to consider when evaluating overhead to underground conversions are the reliability of the system and maintenance costs. Underground systems are less susceptible to environmental interruptions. In the Northwest wind storms can cause outages to overhead systems that do not affect the underground systems. Operationally, the cost of underground systems is higher than overhead and maintenance on the overhead system is far easier than underground systems.

As an alternative when undergrounding is not practicable, the length of poles can in some cases be heightened to further remove wires from the visual field of people on the street and within adjacent buildings. If space is available another alternative would be to relocate existing overhead utilities to alleys where the utilities are less visible.

Alleys

Alleys are a tremendous asset that supports the provision of Complete Streets features by redirecting utilities, services and vehicular access away from streets and thereby making room for Complete Streets features and fostering a more pedestrian-oriented and aesthetic streetscape. Tacoma benefits from a broadly extended regular street grid that incorporates alleys for access to the rear of lots. Where they exist, alleys should be the preferred location for vehicular access, utilities and services. Alleys should also be favorably considered in the development of new streets.

A 28 foot street with parking on both sides provides clearance for one vehicle in the drive lane, requiring queuing when there are two vehicles approaching one another.

Traffic circle

2.3.6 Traffic Calming

Traffic calming features are an integral component of Residential Complete Streets. By slowing vehicle speeds, and in some cases, diverting vehicles to arterial and collector streets, they create safer conditions for pedestrians, people with disabilities and bicyclists traveling within residential neighborhoods. The City of Tacoma has a well-intact grid street pattern in most areas, which tends to disperse traffic. However, in some cases, residential streets that connect major destinations such as schools, Mixed-use Centers or other commercial areas, highway access, etc., may experience higher volumes of traffic. These streets are good candidates for traffic calming devices. Traffic calming should be approached systemically and monitored closely for spillover effects, or the diversion of traffic from one residential street to another. Streets that are designated bicycle routes should be a higher priority for traffic calming devices. There are many types of traffic calming devices and approaches. Below is a discussion of traffic calming approaches that are recommended because they meet the following criteria:

- Proven effectiveness in slowing vehicles and/or reducing traffic volumes
- Can be designed to minimally encumber emergency and large vehicle access
- Can, in many cases, integrate landscaping, and thus be used as neighborhood beautification elements
- Can, in many cases, accommodate rain gardens, street trees, and potentially other features, that provide environmental benefits

Road Diets

Road diets typically reduce the number of travel lanes on a given roadway in order to reduce travel speeds and improve safety. A similar approach consists of reducing the width of existing travel lanes (lane diets). Road and lane diets can be an effective way to reduce traffic speeds because they encourage motorists to proceed more cautiously, especially if there is visual “friction” created by parked cars, street trees, bulb-outs or other features. The City should analyze street capacity citywide and identify opportunities to implement road and lane diets. Many streets in residential areas are likely to be found appropriate candidates for these techniques.

Skinny Streets

So called ”skinny streets” are streets that range from 20 feet to 28 feet. Skinny streets can be highly effective at calming traffic. Such streets are only appropriate for areas with net densities in the range of 5 to 15 dwelling units per acre. Some examples of cities that have built skinny streets include Madison, WI where the standard is 28 feet with parking on both sides of the street; Portland, OR where the standard street width is 24 feet with parking on both sides of the street and where 20 feet is allowed in areas with less than 9 dwelling units per acre and parking only on one side; and Novato, CA where the standard is 28 feet with parking on both sides. All of these examples accommodate two-way traffic. Tacoma is ahead in this respect, having for many years utilized 28 feet with parking on one or both sides as its standard for new residential streets.

Streets that are 24 to 28 feet wide and provide parking on both sides (leaving a 10- to 14 foot travel lane, respectively) are often referred to as queuing streets because they provide a single bi-directional lane when cars are parked on both sides. This is a typical situation in the City of Seattle and occurs on a number of streets in Tacoma. The narrow profile of the street, as well as the need to be on the lookout for oncoming traffic, forces reduced speeds, which in turn reduces vehicle collisions and increases pedestrian and bicycle safety. A study of the physical characteristics of streets found that a typical 36 ft-wide residential street had 1.21 collisions per mile per year, whereas a 24 ft-wide street had 0.32 collisions per mile per year.[3]

The City may choose to implement skinny street approaches on a pilot basis, and/or to develop additional guidelines pertaining to their use. In addition, when existing streets that currently have "skinny street" dimensions (less than 28 feet) are being retrofitted, those streets should typically be allowed to be rebuilt to their current width, if desired by the neighborhood and deemed acceptable by the Traffic Engineer.

Skinny streets also reduce overall impervious surface, which is discussed in greater detail in Section 2.3.6 below.

Traffic Circles

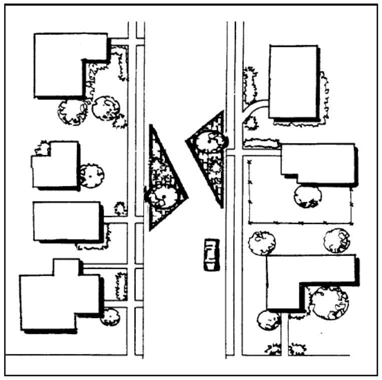
Traffic circles are typically raised islands, usually 10 to 25 feet in diameter placed in the center of an intersection, and may be landscaped or paved. Cutting into the pavement, rather than just installing traffic circles on the surface of existing pavement, should be the standard practice, in order to maximize stormwater benefits and tree and landscaping health. In some cases, traffic circles may be depressed to accommodate rain gardens (discussed in Section 2.3.6) if adequate safety devices such as curbing are incorporated. Numerous cities, including Tacoma, have utilized traffic circles to effectively reduce accidents, and in some cases, traffic volumes on residential streets. Typically, vehicles need to slow down to 15 mph in order to navigate a traffic circle. Traffic circles can be installed without having to redesign the intersection. These devices typically contain a yellow diamond hazard or some other type of signage, as well as reflectors around the base, that draws motorists and bicyclists' attention. In a study by Fehr & Peers, traffic circles were found to reduce the number of collisions by nearly 30%, and 73% if data from the City of Seattle is included.[4]

Chicanes

Chicanes are curb bulges or planters, usually occurring in two's or three's on alternating sides of the street. These devices effectively narrow and create shifts in the roadway, forcing motorists to slow down. Chicanes can also be placed opposite one another to create a choker, which results in a single bi-directional lane forcing cars to stop and queue if there is an oncoming car. Chicanes are good alternatives to speed humps because they cause less wear and tear on vehicles and are typically easily negotiable by large vehicles such as fire trucks. Chicanes require the removal of some on-street parking.

3 Swift, P. *Residential Street Typology and Injury Accident Frequency*. Longmont, CO: Swift and Associates, 1998.

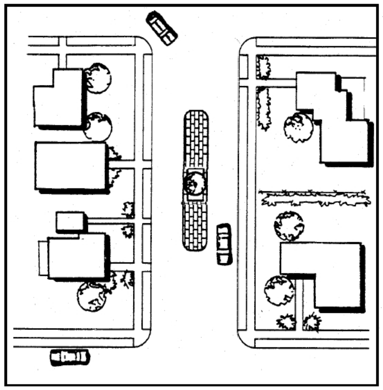
4 Effectiveness of Traffic Calming Measures. Fehr & Peers. 2008.



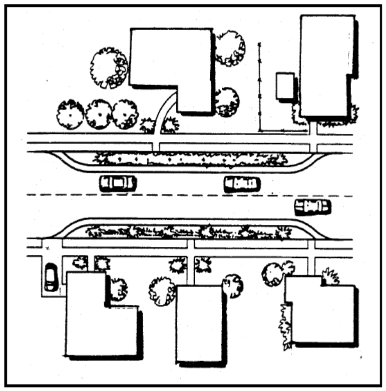
Chicanes and choker (Parametrix)

Chicane

Median with pedestrian cut-through.



Median (Parametrix)



Curb Extension (Parametrix)

Curb extension with rain gardens.

Curb Extensions/Bulb-outs

Curb extensions are horizontal treatments similar to chicanes, but more elongated. They effectively narrow the roadway, sometimes to one lane, inducing drivers to slow down and exercise more caution. Curb extensions usually occur at intersections, but can also occur mid-block. They can occur opposite one another, creating a choker-type situation, or in a staggered pattern. When installed at intersections, curb extensions have the added benefit of shortening the crossing distance between curbs and bringing pedestrians out from behind parked cars so that they can see and be seen more easily. As discussed further below in section 2.3.7, curb extensions also provide opportunities for incorporating sizable rain gardens into an existing or new street. Curb extensions require the removal of some on-street parking. Curb extensions should typically be limited to one foot less than the width of a typical parked car in order to avoid conflicts with bicycle movement.

Partial Street Closure

Partial street closures are usually accomplished by installing a curb extension or a short raised island at the intersection (diverter), blocking vehicle travel in one direction for a short distance on an otherwise 2-way street. This approach is very effective at locations with high traffic volumes or cut-through problems. In sampling 53 partial closures, Fehr & Peers found that they reduce traffic volumes 42% on average.[5] They also reduce vehicle speeds by pinching the roadway. Partial closures are able to maintain bicycle travel and also do not impede emergency vehicle access, but they can cause circuitous routes for residents. Also, if designed improperly, drivers may be able to circumvent the barrier.

5 Ibid.

Medians

Medians are islands located along the centerline of a street that narrows the travel lane at that location. They are often landscaped and can serve as a “gateway” to a neighborhood. Medians can also be designed to include a gap for pedestrians to safely walk through, if a crosswalk is provided. Medians are good for entrances to residential areas, wide streets, and to limit unsafe left turns. The maximum length of the median is dependent on emergency vehicle access. Median barriers may require the removal of some on-street parking.

Meandering/Curved Streets

Meandering or curved streets are similar to chicanes in creating shifts in the roadway. The continuous serpentine shape of the street is visually appealing and encourages vehicles to driver slower. This approach allows for larger “pocket” planting strips that can be used as a bioswale or rain garden. If designed properly, the radius of the curves do not impede emergency access. Meandering streets are good for new streets or full reconstruction streets with a wide right-of-way.

2.3.7 *Low Impact Development Approaches*

Complete Streets can address environmental quality while also enhancing neighborhood aesthetics and calming traffic using a range of approaches, including natural drainage systems such as bioretention swales and rain gardens, reducing impervious surfaces, and incorporation of street trees and other vegetation. The opportunity to reduce environmental impacts by incorporating green features and techniques should be routinely considered for every street design project. Specifically, the following approaches should be considered, as appropriate to project objectives and parameters, along with other techniques as identified.

Street trees are standard for all residential streets in Tacoma because they perform multiple functions, including stormwater interception and transpiration, reducing the heat island effect, providing habitat, inducing traffic calming, and providing a comfortable walking environment. A discussion of street trees and landscaping is included under Section 2.3.4.

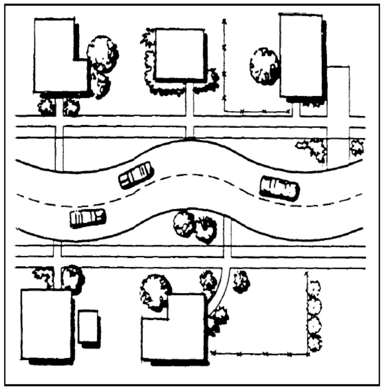
Some green features, such as rain gardens, may only be seen on a select number of streets due to various conditions and constraints, including soils, topography, and existing infrastructure. The City of Tacoma Surface Water Management Manual provides guidance on which surface and stormwater management features are typically acceptable in Tacoma.

Reducing Impervious Surfaces

In urban areas, the easiest and least costly way to approach low impact development is to reduce the amount of impervious surfaces. Often there is ample opportunity to accomplish this by narrowing the pavement area of existing roadways when rebuilding a street, or designing new roadways to a narrower standard, i.e., 28 feet or less. The narrowing of residential streets can often occur while also accommodating the minimum functional needs of the roadway such as parking, emergency or large vehicle access, and safe bicycle access. Narrowing the roadway also provides more room within the right-of-way for sidewalks, landscaping, and other Complete Street features.

Cities across the U.S. and Canada have reevaluated their street design standards and adopted narrower street standards. In Portland, OR, the city created a Skinny Street program, which has reduced minimum residential street widths by as much as 12 feet to 20 to 26 feet depending on parking needs.[6] Tacoma has existing residential roadways that range from 24 to 36 feet, with the majority of streets falling between 28 and 32 feet. Twenty-eight feet is the standard the City of Tacoma uses for new residential streets. Narrowing a roadway from 32 feet to 28 feet reduces the amount of impervious surface by about 12.5%, or about 1,200 sq. ft on a 300 ft-long block.

6 Southworth, M. "Walkable Suburbs? An Evaluation of Neotraditional Communities at the Urban Edge." *Journal of the American Planning Association* 63, no.1 (1997):28-44.



Meandering roadway (Parametrix)

Meandering roadway.


Sidewalk constructed of pervious concrete.


Rain garden within a curb extension.


A bioretention swale built along Visscher St in Tacoma.

Permeable Pavement

Permeable pavement can also be used to reduce the amount of stormwater runoff. Permeable pavement may be used for sidewalks, and potentially parking lanes, on residential streets. There are several types of permeable pavement that would be appropriate for these applications, including pervious concrete, porous asphalt, and pavers. It is important to consider the infiltration capabilities of underlying soil and slope when installing permeable pavement. The installation of permeable pavement for pollution generating surfaces, i.e., parking or travel lanes, that fall within the South Tacoma Groundwater Protection District (STGWPD) require special consideration. Permeable pavement is typically not allowed within the STGWPD, however the City's Environmental Services Division may allow it under special conditions.

After installation of permeable pavement, it is important to educate residents about the pavement, how it functions, and the importance of keeping fine-grained material such as soil, mulch, etc., off of the pavement. Some periodic maintenance such as sweeping and suctioning may be required to keep the pavement functioning properly. A fair amount of research has been done on how these materials perform over time under various maintenance schedules. Appendix 7 of the Low Impact Development Technical Guidance Manual for Puget Sound provides a good summary of this research.

Naturalistic Flow Control and Water Quality Features

The City of Tacoma Surface Water Management Manual contains guidance for selecting and designing many types of flow control and water quality features. These facilities can effectively treat and/or provide flow control for surface water when properly designed and constructed. Naturalistic facilities include biofiltration swales, infiltration facilities, stormwater treatment wetlands, vegetated filter strips, dispersion practices and rain gardens, to name a few. Some of these types of facilities are better suited for use along streets where available width is typically limited. Biofiltration swales can be placed along the roadways, rain gardens may be designed in an elongated swale form and infiltration trenches can be long and narrow. Each facility needs to be designed to best fit the existing conditions and provide the stormwater benefit needed. There are a variety of ways to allow flow to enter these facilities including curb cuts, low profile or flattened curbs or from pipes.

Bioretention Facilities

Rain gardens are bioretention facilities consisting of planted depressions with a layer of specialized soil mix that are designed to allow stormwater runoff from streets, sidewalks, driveways, yards, and roofs to infiltrate through the specially designed soil mix to provide water quality treatment. In locations where infiltration is possible, rain gardens may also provide onsite retention of stormwater. Rain gardens are designed to maximize soil-water contact and to treat runoff by filtering out sediments using vegetation and a soil mix. Rain gardens may function as treatment alone or as treatment and retention facilities. Flow attenuation is typically achieved in rain gardens even when the design is specific to water quality treatment. Rain gardens are very adaptable and may be installed at a number of locations throughout the roadway cross-section including within the planting strip area or curb extension placed within the parking lane of a street. Proper sizing of the rain garden is important in order to achieve the required treatment. The City of Tacoma's Surface Water Management Manual contains guidance for proper sizing and installation of rain gardens. Below is some general guidance for each type of facility:

Rain Garden in Planting Strip Area

- Rain gardens may typically be accommodated within a planting strip area that is 7 to 8 feet wide, however the width required for proper treatment and/or retention of stormwater is site specific. For safety of street users, it is important to maintain gentle slopes and avoid excessive depths in the rain garden design.
- Can vary in length and width depending on desired level of stormwater retention.
- Can be integrated with driveways using culverts, trench, span bridge or a proprietary subsurface structural system.
- Pedestrian access from the street to sidewalk should be considered in the design phase of all rain garden facilities.

Rain Garden in Curb Extensions

- Can be integrated with existing curb, gutter and drainage systems or new construction
- Extend 6.5 to 7 feet into parking lane, including 6 inch curb. Whereas this width may not be optimal, it is necessary in order to provide clearance in the roadway and avoid conflicts with vehicles and bicycles.
- 10 feet curb radius to provide more gradual transition from parking lane to travel lane
- Can be placed mid-block or at intersections (see guidance for transit streets in section 2.3.3).
- Can vary in length depending on desired level of stormwater treatment/retention
- Overflow accommodated through curb notch at downhill end of facility. Overflow typically flows into existing street drainage inlet.
- Requires removal of on-street parking, typically one space for every 20 feet of length.
- May be installed between driveways where there is inadequate space for parking, i.e., less than 20 feet; however, per unit costs may be high relative to functional benefits.
- Also function as traffic calming by narrowing the roadway and creating a queuing situation.
- Pedestrian access from the street to sidewalk should be considered in the design phase of all rain garden facilities.

Traffic Circle Rain Gardens

Rain gardens may also be placed within traffic circles at intersections. Such a facility would require the intersection to be constructed so that runoff would flow towards the center rather than towards the perimeter as is typical. Construction of this type of facility would be costly unless the entire street is being reconstructed. These rain gardens

Street trees provide multiple benefits including stormwater interception and uptake, reducing the heat island effect, habitat, and enhancing the walking environment.

Landscaping is an important component of rain garden and swale construction.

Appendix 3 of the Low Impact Development Technical Guidance Manual for Puget Sound contains specific guidance plant species that are appropriate for natural drainage features.

The Salishan housing development contains many low impact development features, including this raingarden within a street median.

would be designed in a similar way to a rain garden placed in a planting strip or curb extension, and in most cases would require the installation of a storm drain within the rain garden to capture overflow and prevent flooding of the intersection. An additional consideration may be the size of the traffic circle relative to the intersection (residential traffic circles tend to be small). Research conducted for the development of these guidelines found no examples of traffic circle rain gardens.

Cul de Sacs

Cul de sacs may be designed to reduce impervious surface, and in some cases, infiltrate stormwater if designed with a landscaped rain garden island. Currently, the City of Tacoma's standard for cul de sacs includes a minimum curb radius of 45 feet. To reduce impervious surface and provide space for green features, the default approach for cul de sacs should incorporate, where feasible, a landscaped island placed in the center of each cul de sac. Such an island could be designed as a depression to accept stormwater runoff. An island can take various shapes and be placed to allow for a wider driving lane in the rear, making turning easier for larger vehicles. A flat apron curb can be used to allow runoff to flow into the island, if depressed.

Rain Garden Medians

Rain garden medians installed in a roadway with an inverse crown may serve to attenuate or infiltrate stormwater flows from the entire right-of-way. An example of such a facility can be found in the Salishan development, a new housing development in east Tacoma. Opportunities for such a treatment may be limited in existing neighborhoods where right-of-way widths may not be adequate and other concerns such as maintaining on-street parking are paramount. An eighty-foot right-of-way may be able to accommodate a rain garden median while maintaining on-street parking and other complete street elements, as well as adequate turning radius for emergency vehicles.

Landscaping for Natural Stormwater Features

Where natural stormwater features are incorporated into the right-of-way, there are special considerations to be made regarding landscaping and street trees to ensure that these facilities function properly and that street trees can thrive. Flow control and bioretention facilities tend to be moist for a large portion of the year, but may also experience extended periods of dry conditions during the summer months. Therefore, they require plant species that are tolerant of these conditions. Where appropriate, native species should be used within natural stormwater facilities because they are better adapted and more tolerant of the local climate and soil conditions, and provide better habitat and foraging opportunities for wildlife. Where there are existing healthy street trees, rain gardens should not be installed unless the trees health can be assured through proper design of the facility. Where street trees do not exist or are in poor health, and rain gardens are being considered, the design should accommodate street trees to the extent possible. Trees should be planted on raised berms or between rain garden facilities in order to avoid excessive contact with standing water. For specific guidance on landscaping for natural drainage features, Tacoma's

Surface Water Management Manual (Volume 6, Section 2.2.3.1) and the Low Impact Development Technical Guidance Manual for Puget Sound, Appendix 3 may be referenced. In addition, section 2.4.3 of the Tacoma Mixed-use Centers Complete Streets Design Guidelines offers some considerations for street trees and landscaping that may also be applicable to residential streets.

2.3.8 Signage

Signage is an essential component of complete streets for providing wayfinding, as well as visual cues that indicate how the street is to be used by each mode. A number of sign standards are applicable within the City, including the American Association of State Highway and Transportation Officials (AASHTO), City standards, and Business District standards. Additional standards for signage related to bicycles and pedestrians may also be developed through the current Mobility Master Plan effort. These standards should be incorporated as appropriate.

2.3.9 Undeveloped Rights-of-Way

The City's default requirement for new development occurring adjacent to an undeveloped right-of-way is for the developer to build a full street and sidewalk(s). However, in some cases this may not be necessary and/or desirable to the neighborhood. The need for street improvements should be assessed by the Traffic Engineer, in consultation with other departments and the neighborhood. If there is not a clear traffic circulation, safety or other need for a full street, the Engineer may determine that a partial (skinny) street section is appropriate, that only a pedestrian/bicycle pathway or low-impact trail is appropriate, or that no improvements are necessary. Typically, an improved bicycle and pedestrian connection should still be provided. However, no improvements would typically be required when critical areas and/or habitat functions will unnecessarily be impacted, where topography is inappropriate and/or when there is no logical connection to be made.

Distinct and identifiable signage that provides wayfinding visual safety cues is an important component of Complete Streets. (PBIC)

Curb extension with rain garden.

Rain gardens help to manage stormwater flows and provide water quality benefits.

2.4 Typologies for Complete Street Implementation

This section outlines three general approaches, or typologies, for reconstructing existing or developing new residential streets within the City of Tacoma. These typologies are intended to provide guidance for addressing the various objectives the City may have when reconstructing or building a residential street. Determining the most appropriate typology for a particular residential street project depends on these objectives as well as specific site conditions.

2.4.1 Standard Residential Street with Green Stormwater Features Typology

Complete Streets provides an excellent opportunity to fulfill an important element of the City's Surface Water Management Program by retrofitting structural stormwater controls in the public storm system to reduce flows and improve water quality of stormwater discharging to our waterways. Natural drainage systems and low impact development features can be added to a Complete Streets design in order to manage stormwater effectively.

This typology should be considered the default for residential streets; meaning it should be considered first, and its elements should be implemented whenever appropriate, feasible, cost-effective and desired by the neighborhood. Street design efforts should begin with this typology, after which the design could move either toward more green features (the Green Streets Typology) or fewer (the Standard Residential Street Typology). This typology is intended to provide design guidance for both new streets and streets that are being reconstructed or retrofitted.

Figure 2.1 shows a section and plan view of this typology. In addition to the general guidance for Complete Residential Streets provided in section 2.3, the elements of this typology, which are outlined below, should generally be applied in situations where the following objectives are to be met:

Objective

- Improve pavement conditions of streets being reconstructed;
- Establish or retrofit the street edge to improve drainage;
- Incorporate green features such as rain gardens and permeable pavement to manage a portion of stormwater runoff;
- Enhance the pedestrian environment and safely accommodate people with disabilities;
- Provide safe and comfortable access for bicycles;
- Incorporate street trees wherever healthy tree growth can be accommodated;
- Create an orderly appearance and improve neighborhood aesthetics; and
- Increase property values.

Elements

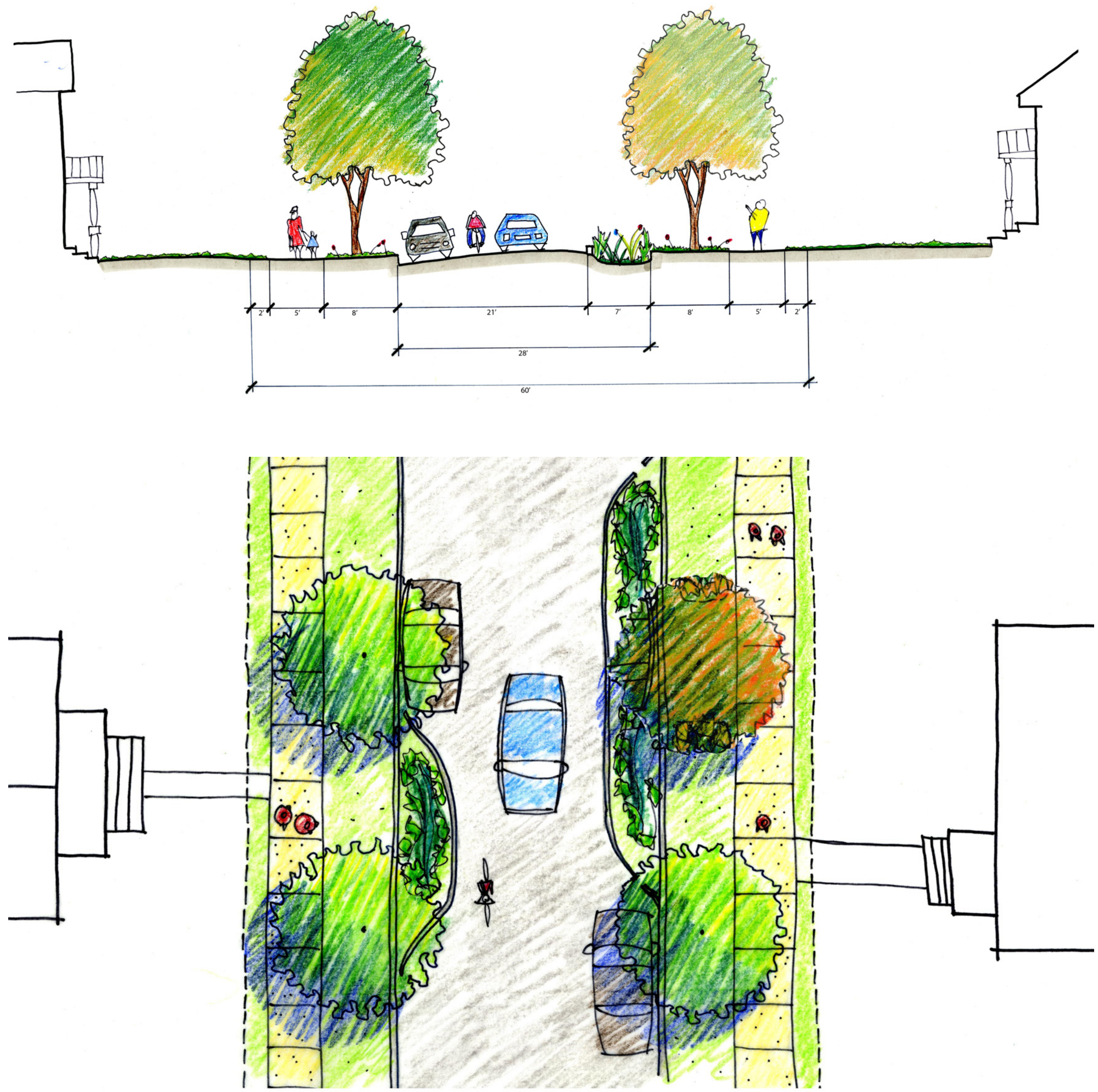
- Curb extensions with rain gardens
  - On one or both sides of street depending on stormwater management goals, parking demand, and traffic calming goals

- Size of facility depends on stormwater volumes
- Facilities should be sited a minimum 60 feet away from bus stops if a transit route
- Should not cause conflicts with bicycle movement

- Roadway width
  - 28 feet is the preferred width to reduce impervious surface. This width provides adequate drive clearance (14 feet) when parking is provided on both sides of street and requires oncoming cars to queue, providing a traffic calming function.
  - Street widths of less than 28 feet are acceptable when reconstructing streets that have been previously built to a narrower dimension, where other site specific conditions dictate, or where there is a goal to further reduce impervious surfaces.
  - Roadway widths of 29 -32 ft. may be appropriate under these circumstances:
    - Where there is an existing or potential transit route
    - Where street serves higher density development such as multi-family buildings or a large number of townhouses
    - Where the majority of residences have driveways loading onto the street
    - Where an existing curb and gutter system is not being replaced
    - Where there are site specific considerations such as topography, site distances, or the presence of utilities that deems narrowing the street as unsafe or too costly
- Vertical curb and gutter system
- On-street Parking
  - Both sides of street preferred to provide adequate guest parking and traffic calming
  - One side of street where the objective is to reduce roadway widths and impervious surfaces, or where there are constrained conditions or drive clearance outweighs parking demand
- Sidewalks
  - Maintain existing sidewalks
  - Where no sidewalks exist or sidewalks are in poor condition, install 5 feet sidewalks on both sides of street
  - Use permeable pavement where practicable
- Planting strips between roadway and sidewalk
  - Preferred width of 8 feet, minimum width of 6 ft for healthy tree growth
- Utilities typically in alley, planting strip or between sidewalk and property
- Street trees on both sides of streets
  - Refer to City's Urban Forestry Policy

Sidewalk constructed of pervious concrete.

Figure 2.1: Standard Residential Street with Green Stormwater Features



Drawings are for illustrative purposes only.

2.4.2 *Standard Residential Street Typology*

The Standard Residential Street typology is intended to provide design guidance for both new streets and streets that are being reconstructed or retrofitted. Figure 2.2 shows a section and plan view of this typology. In addition to the general guidance for Complete Residential Streets provided in section 2.3, the elements of this typology, which are outlined below, should generally be applied in situations where it is not practicable, cost-effective, desired by the neighborhood and/or is judged inappropriate for site specific or functional reasons to incorporate green stormwater features, and the following objectives are to be met:

Objective

- Improve pavement conditions of streets being reconstructed;
- Establish a street edge and improve drainage with curb & gutter system;
- Enhance the pedestrian environment and safely accommodate people with disabilities;
- Provide safe and comfortable access for bicycles;
- Incorporate street trees wherever healthy tree growth can be accommodated;
- Create an orderly appearance and improve neighborhood aesthetics; and
- Increase property values.

Elements

- Roadway width
  - 28 feet is the preferred width for both new and reconstructed residential streets. This width reduces impervious surface and capital costs while providing adequate drive clearance (14 feet) when parking is provided on both sides of street. This width also requires oncoming cars to queue, providing a traffic calming effect.
  - Street widths of less than 28 feet are acceptable when reconstructing streets that have been previously built to a narrower dimension or where other site specific conditions dictate.
  - Roadway widths of 29 -32 ft. may be appropriate under these circumstances:
    - Where there is an existing or potential transit route
    - Where the street serves higher density development such as multi-family buildings or a large number of townhouses
    - Where the majority of residences have driveways loading onto the street
    - Where an existing curb and gutter system is not being replaced
    - Where there are site specific considerations such as topography, site distances, or the presence of utilities that deems narrowing the street as unsafe or too costly
  - Roadway widths of 32 to 36 feet may be appropriate under special circumstances, including:
    - For higher volume transit streets
    - For designated primary emergency vehicle routes

Planting strips that are a minimum 6 feet in width accommodate healthy tree growth and provide opportunities for additional landscaping.

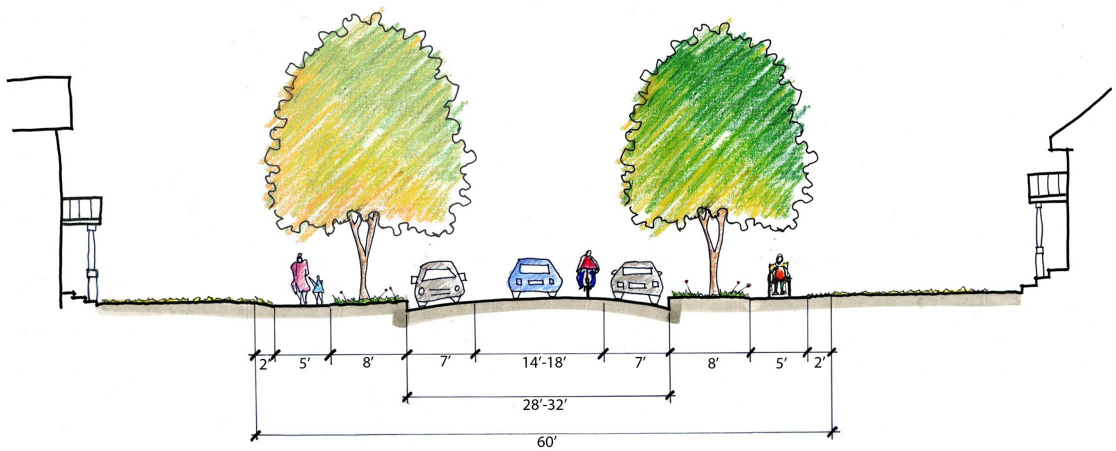
Residential streets with multi-family housing may need to have wider widths in order to better accommodate a larger number of vehicles.

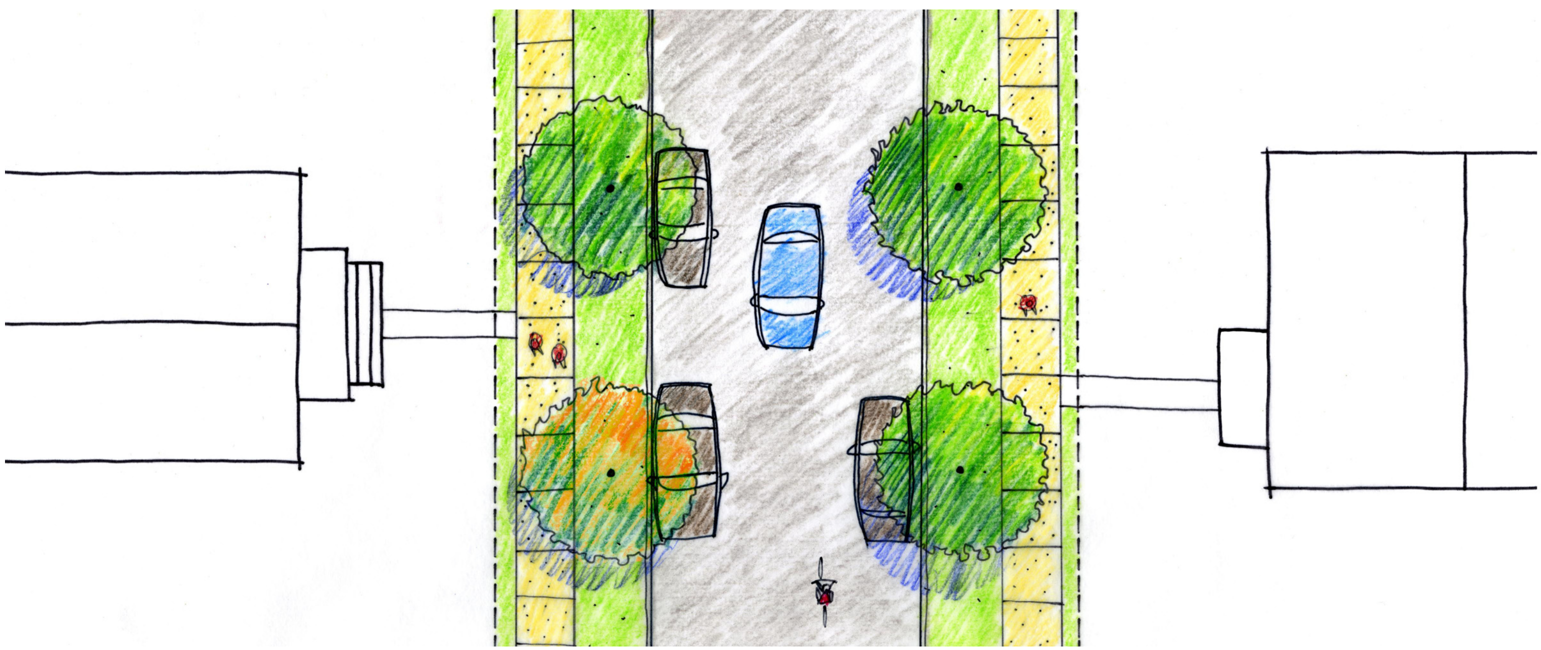
- Where there are community facilities such as schools, parks, or community centers that generate high volumes of traffic

Note: Streets built to these widths should include traffic calming measures to control speeds that are anticipated with a wider roadway. Such measures should be compatible with transit and emergency vehicles.

- Vertical curb and gutter system
- On-street Parking
  - Both sides of street preferred to provide adequate guest parking and traffic calming
  - One side of street in constrained situations or where road narrowing and/or drive clearance outweighs parking demand
- Sidewalks
  - Maintain existing sidewalks
  - Where no sidewalks exist or sidewalks are in poor condition, install 5 feet sidewalks on both sides of street
- Planting strips between roadway and sidewalk
  - Preferred width of 8 feet, minimum width of 6 feet for healthy tree growth
- Utilities typically in alley, in planting strip, or between sidewalk and property
- Street trees on both sides of streets
  - Refer to City's Urban Forestry Policy
- Streets that are designated bicycle routes should be a higher priority for traffic calming devices

Figure 2.2: Standard Residential Street





Drawings are for illustrative purposes only.

Rain garden landscaping can enhance neighborhood aesthetics while providing water quality benefits.

2.4.3 Green Street Typology

The City of Tacoma envisions a network of Green Streets throughout the City. These streets would be visually and functionally distinctive, and may include features in addition to what might be seen on a Standard Street, or a street with some green storm water features, such as enhanced landscaping, open spaces, and green features such as rain gardens, bioretention swales, and permeable pavement.

Green streets are intended to:

- Improve drainage and manage the flow and quantity of stormwater runoff from streets, sidewalks and adjacent properties (where feasible) onsite, i.e., within the street right-of-way, or as close to its source as possible;
- Provide water quality benefits and replenish groundwater (if infiltration is possible);
- Create attractive streetscapes that enhance neighborhood livability and walkability;
- Serve as distinctive connectors between neighborhoods, parks, schools, habitat areas, and Mixed-use Centers;
- Contribute to broader City goals related to promotion of non-motorized transportation, climate action, urban forestry, and reducing impacts on streams and the Puget Sound.

The design considerations and features discussed in Section 2.3 should be considered in addition to the Green Street Typology elements discussed below.

Green Street Selection Criteria

The elements of the Green Street typology are likely to be applied only in select situations based on a number of contextual and design-related factors. The selection criteria listed below may help to determine which streets would be appropriate candidates for Green Street treatments, however in no way are these criteria intended to prescribe when and where low impact development features are built.

a. Presence of Alleys – focusing on streets where there are alleys and few driveways may help to avoid complicated design for rain garden construction and associated costs

b. Utilities –Maintaining adequate coverage (minimum 30”) of water pipes to prevent freezing may be an issue where significant re-grading of right-of-way is necessary to achieve stormwater flow or accommodate rain gardens. Rain gardens may not be possible where there are underground utilities, particularly water mains, due to pipe coverage concerns and costs associated with relocating of pipes. Focusing on streets where underground utilities such as water mains are in need of replacement provides an opportunity to relocate these utilities in order to better accommodate rain gardens.

c. Mature trees – avoid placing rain gardens where there are viable existing mature trees. Mature trees have large root systems and excavation may not be possible within the root zone without causing serious harm to the tree; curb extension rain gardens may be a better option when mature trees are present.

d. Longitudinal slope of street is less than 5% for placement of rain gardens.

e. Degree to which soils and sites allow infiltration

   i. Area with glacial till or shallow groundwater will limit infiltration options.

   ii. Sites on or adjacent to steep slopes will have limited infiltration options per Volume 3, Chapter 2 of the Tacoma Surface Water Management Manual.

   iii. Infiltration of pollution generating impervious surfaces within the South Tacoma Groundwater Protection District shall be allowed only with written permission, at the discretion of Tacoma Environmental Services and the Tacoma-Pierce County Health Department

f. Neighborhood receptiveness, stewardship potential. Receptive and engaged residents will facilitate implementation and may lower long-term maintenance costs.

g. Width of Right-of-Way – although a typical 60 feet right-of-way could accommodate most Green Street features, wider rights-of-way present additional opportunities to manage larger quantities of stormwater and provide additional open space and landscaping.

h. Streets with no curb and gutter –these streets often have drainage issues that need addressing

i. Drainage – streets that have poor drainage or do not currently have underground drainage systems may be good candidates. Opportunities should be sought to avoid having to install piped storm systems where none currently exist. Where infiltration is limited and detention is the goal, natural drainage systems can be designed to tie into storm systems that may exist several blocks away.

j. Supports additional policy priorities of City, which may include:

   i. Minimizing direct and indirect stormwater discharge to fish habitat or wetland area

   ii. Open space deficiency (wider rights-of-way, i.e., greater than 60 feet would offer more opportunity for open space)

   iii. Non-motorized connector, i.e., between parks, schools, commercial areas and other activity areas

   iv. Traffic calming

   v. Clean & Safe Initiative

   vi. Neighborhood beautification

Natural drainage systems require periodic maintenance, a major consideration in the design and installation of these facilities.

Flattened curbs allow for sheet flow of stormwater into roadside natural drainage facilities while providing an edge to the roadway.

There are additional factors that would need to be considered before the installation of low impact development techniques. All specific design considerations should be consistent with standards and approaches defined within Tacoma's Surface Water Management Manual. Below is a general list of additional factors that may inform the design of low impact development features:

- Cost-effectiveness when compared to conventional stormwater approaches,
- Traffic volumes and associated pollutant loads,
- Parking demand,
- Pedestrian access from the street to the sidewalk area,
- Desires of residents,
- Driveway crossings,
- Crime Prevention Through Environmental Design (CPTED) principles,
- Tree planting and landscaping goals, and
- An appropriate maintenance program is in place.

Green Street Elements

This typology is intended to provide design guidance for both new streets and streets that are being reconstructed or retrofitted. Figures 2.3 and 2.4 shows a section and plan view of this typology. In addition to the general guidance for Complete Residential Streets provided in section 2.3, the elements of this typology, which are outlined below, should generally be applied in situations where the following objectives are to be met:

- Roadway width
  - 28 feet or less is preferred as a means to reduce impervious surfaces and stormwater runoff.
  - Consider narrower roadways (less than 28 feet) and reduced on-street parking in areas with low parking demand and traffic volumes. A minimum width of 20 feet should be considered in situations where on-street parking is provided only on one side of the street. Narrower widths may be considered on a case-by-case basis when there is no on-street parking and the goal is further reduce impervious surfaces, calm traffic, and integrate additional natural drainage features.
- Curb
  - Flattened – usually a 2 feet wide drivable concrete strip that allows water to sheet flow over it into an adjacent rain garden (e.g. SEA Streets).
  - Pre-cast perforated curb – allows water to flow through inlets into adjacent rain garden. Prevents vehicles from driving or parking in rain garden facility.
  - Pre-fabricated curb inserts – appropriate for situations where existing curb is being retrofitted to allow water to flow into a rain garden. Inserts can be installed to create a half-inch lip that allows settling out of sediment that can later be removed by street cleaning equipment.
  - Invisible curb with lip – retains the road surface while allowing water to flow into an adjacent rain garden. A shallow half-inch lip allows settling out of sediment that can later be removed by street cleaning equipment.

- Sidewalks
  - Maintain existing sidewalks
  - Where no sidewalks exist or sidewalks are in poor condition, install 5 foot sidewalks on both sides of street. Sidewalk on only one side of the street may be considered if adequate safe and comfortable access can be provided for pedestrians and persons with disabilities, and where it may be necessary to maximize stormwater management goals.
  - Use permeable pavement where possible
- Rain gardens
  - Within 8-12 foot planting area or
  - Within curb extensions
  - A paved area for transit stops should be provided between the edge of street and sidewalk, if installed along a transit route
- Layered landscaping, including groundcover, shrubs and trees
- Roadway grading
  - "Full warp" cross-section (continuous 2% cross-slope) is preferred in narrower rights-of-way (60 feet or less) that have low traffic volumes for the following reasons:
    - Directs stormwater to rain garden facility on one side of street, requiring less total space for LID facility, leaving room for other complete street features
    - Reduces costs associated with design, construction and maintenance of facility
  - Crowned cross-section may be more applicable where:
    - Right-of-way width is greater than 60 feet
    - Roadway width greater than 28 feet is required for functional need of street, i.e., higher traffic volumes, transit street, etc.
    - Where greater detention volumes are needed and there is adequate room in the right-of-way to provide them
- Parking on one or both sides of street, or clustered angled parking in special situations where the roadway has been narrowed to further natural stormwater management goals. Amount of existing parking is not necessarily maintained after retrofit.
- Utilities typically in alley or between sidewalk and property, under unit-paver sidewalks, or within planting strip if rain garden/swale design can provide adequate pipe coverage

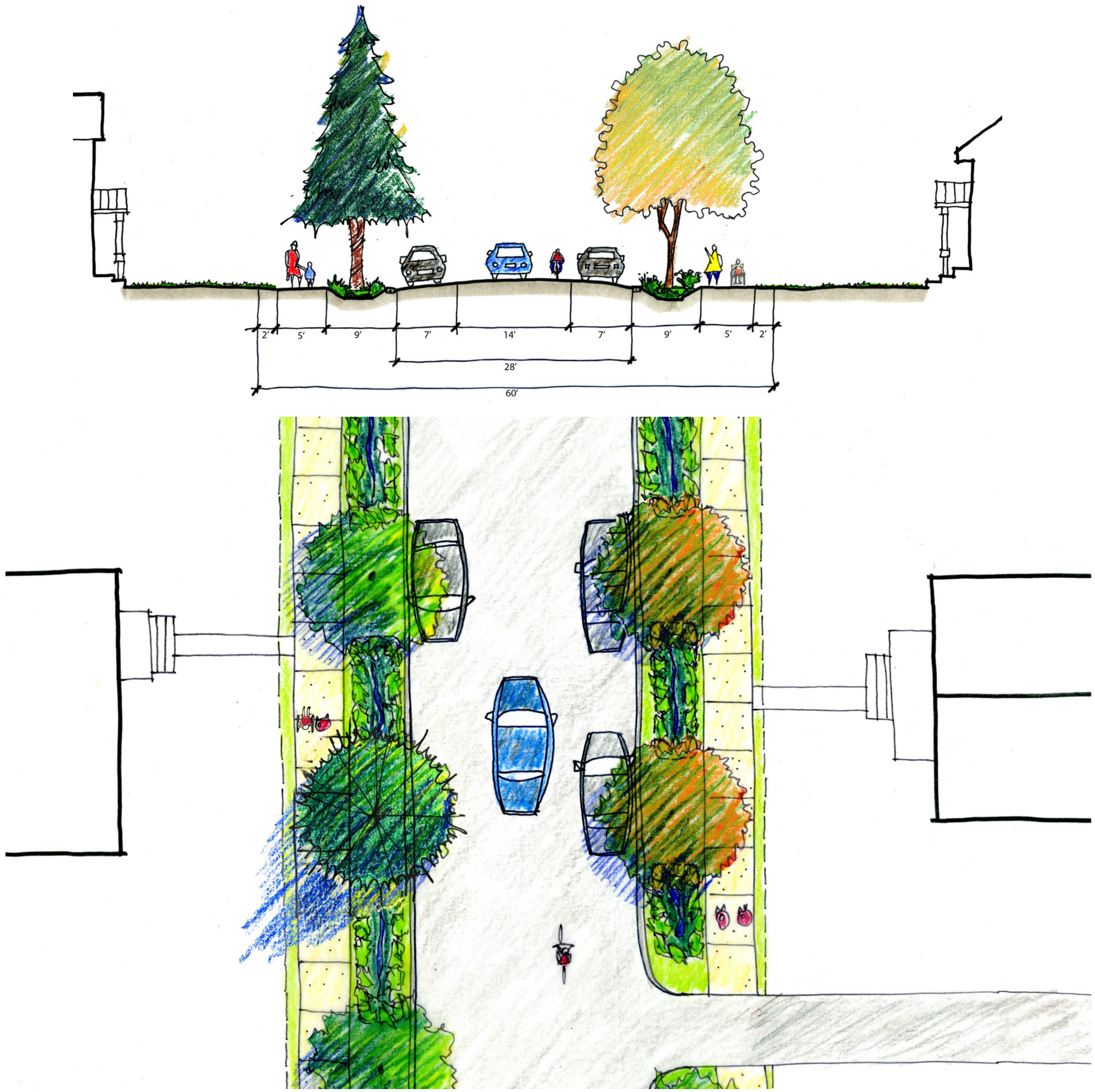
In certain situations where the objective is to reduce roadway width to the fullest extent possible to meet stormwater management goals, parking may be provided in clusters adjacent to the roadway.

Stormwater flows may be reduced by using permeable pavement for sidewalks, driveways, and in some cases, within the roadway.

Other Elements to Consider

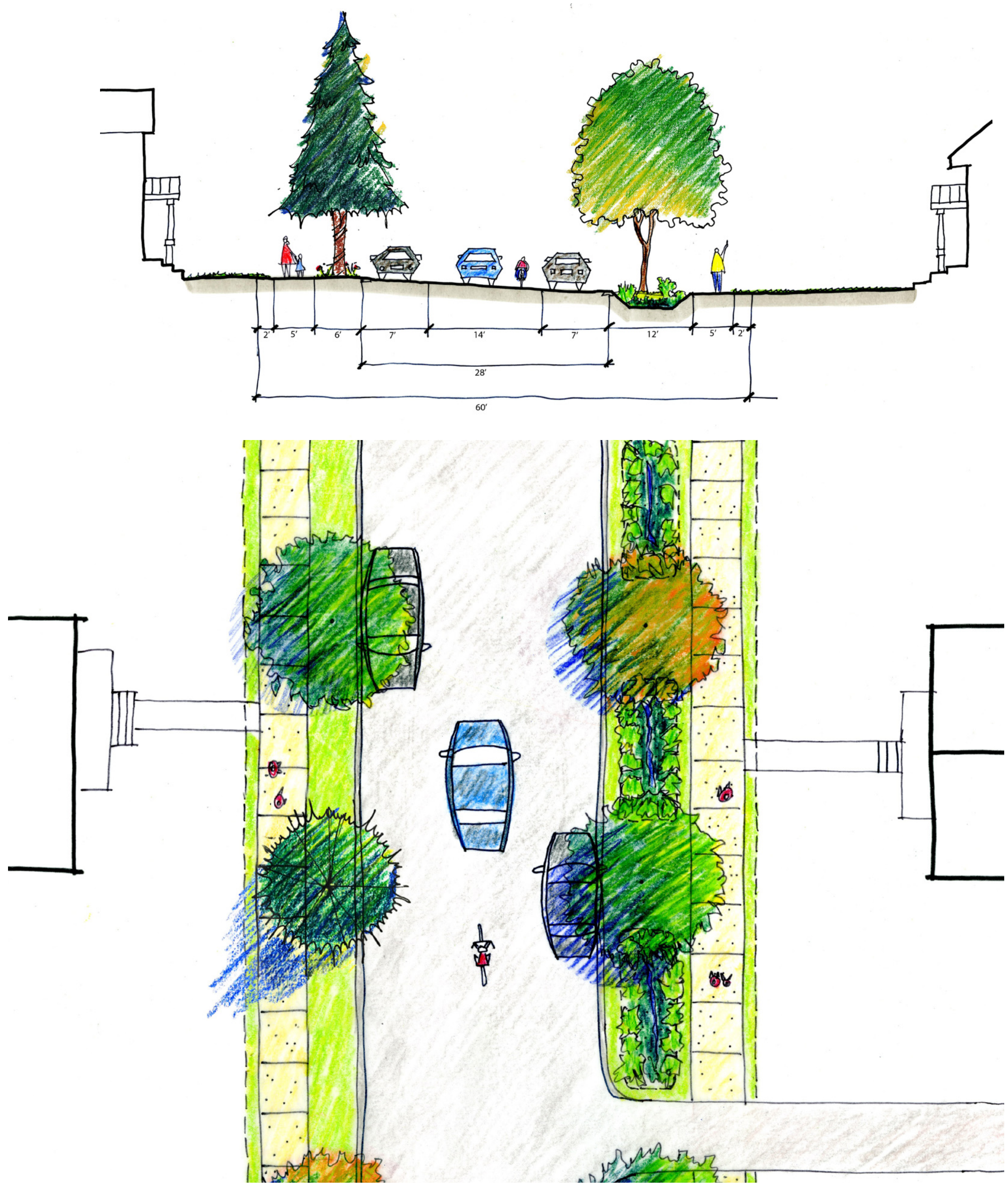
- Permeable pavement in parking lane or drive lane on low ADT roadways (not within the STGWPD)
- Driveways
  - Minimize number of driveway crossings
  - Reduce maximum width to 10 feet
  - Permit the use of common driveways that serve up to four dwelling units
  - Use permeable pavement for portion of driveway within right-of-way
  - Encourage permeable pavement or use of Hollywood strips for entire driveway
- Narrowed curvilinear roadway, e.g. SEA Streets (in Seattle)
  - Roadway widths of 16 to 20 feet
  - May have flattened curb to allow sheet flow and provide additional drive clearance
  - Allows for more variation in design of rain garden facilities
  - Has traffic calming effect
  - Parking may be best accommodated in clusters of angled stalls to maintain drive clearance and to keep vehicles out of rain garden facility
  - May be appropriate treatment for a bicycle boulevard (see Section 2.4.1 in the Tacoma Mixed-use Centers Complete Streets Design Guidelines)
  - Adds aesthetic interest and establishes a neighborhood identity

Figure 2.3: Green Street - Crowned Section



Drawings are for illustrative purposes only.

Figure 2.4: Green Street - Cross-Slope Section



Drawings are for illustrative purposes only.

(This page intentionally left blank)


N 29TH ST
City of Tacoma
Adopt-A-Spot
Girl Scouts
Troop 216
St Patrick School
Tacoma CARES
Program
Cleanup And Revitalization Efforts

Chapter 3
Supporting Research and Analysis

Research was conducted in order to provide information on the relative costs and benefits of select Complete Street features, including low impact development stormwater techniques and traffic calming. The findings presented in this chapter are not exhaustive, but do point to there being significant benefits to integrating the features discussed above into Complete Streets. While other Complete Street features mentioned throughout this document such as street trees, sidewalks, curb ramps, lighting, etc., are equally important, this section focuses on traffic calming and low impact development stormwater techniques because they are potentially the most costly to implement, but offer multiple benefits.

3.1 Low Impact Development

The strong interest in Low Impact Development (LID) is driven by the multiple benefits it provides. Not only can LID techniques address stormwater management issues, facilitate groundwater recharge, and reduce impacts to streams, but they also can be contributors to the urban forest, reduce the urban heat island effect, improve air quality, enhance neighborhood appearance, improve pedestrian safety, and provide a stronger sense of place. Some of these benefits may be quantified in terms of capital cost outlays and savings while other benefits such as aesthetics and sense of place are more difficult to quantify. Below is a more in-depth discussion of these various benefits.

3.1.1 Ecological Benefits

The ecological benefits of LID are the most obvious. LID can vastly improve water quality by reducing peak flows and associated downstream impacts, as well as facilitating onsite infiltration and treatment. By controlling the volume and velocity of stormwater runoff, LID techniques such as swales and permeable pavement can help to reduce erosion and sedimentation of creeks, remove sediments, and reduce the occurrence of combined sewer overflows. Bioretention facilities such as rain gardens control stormwater volumes, flows, help to recharge groundwater, and provide treatment by both removing sediments and facilitating cationic exchange between soil and pollutants. A study[1] of SEA Streets concluded the following:

- The natural drainage facilities prevented 99 percent of the wet season runoff from flowing directly into Pipers Creek between 2000 and 2003.

---

1 Richard R, Hormer, Heungkook Lim, Stephen J. Burges. *Hydrologic Monitoring of the Seattle Ultra-Urban Stormwater Management Projects: Summary of the 2000-2003 years.* UW Department of Civil and Environmental Engineering, October 2004

- A traditional drainage system that adheres to City of Seattle conventions would have discharged almost 100 times more runoff to Pipers Creek as the SEA Streets system.

- As time passes, it was found that the facilities prevented more runoff from flowing directly into Piper's Creek because as vegetation matures, more water is absorbed through the soil.

In addition to water quality benefits, LID may also provide numerous other ecological benefits. Vegetation that is integrated into LID systems provides habitat for birds and insects, particularly when it consists of native species. Vegetation can also provide air quality benefits by "scrubbing" out particulates. When trees are planted, they can significantly reduce the urban heat island effect by shading paved areas that tend to absorb heat energy.

3.1.2 Neighborhood Benefits

Low impact development strategies can have numerous neighborhood benefits when designed properly. These benefits include improving neighborhood aesthetics with enhanced landscaping and visually interesting features, incorporating more green space into the neighborhood, providing traffic calming, and potentially encouraging interaction among neighbors.

There are numerous case studies of LID projects that have documented such neighborhood benefits. SEA Streets in Seattle is an example where an LID retrofit of an existing street generally resulted in improved quality of life for residents through the installation of sidewalks, improved neighborhood aesthetics, traffic calming, and the creation of distinct neighborhood identity. Both the improved safety and comfort of the pedestrian environment, and the fact that many residents have taken an active role in maintaining the swales and vegetation, have generally resulted in increased interaction among neighbors.

In some cases, low impact development stormwater features have resulted in less flooding and reduced basement sewer backups. A number of projects in the City of Portland have improved drainage, resulting in the alleviation of flooding and reduction of damage to private property.

3.1.3 Property Values

There is a limited amount of research that has been done on the effects that low impact development techniques have on property values. However, what research has been done supports the view that incorporation of LID stormwater features may have a positive affect on property values.

A study conducted in Omaha, Nebraska looked at sample home sales between 2000 and 2006 to determine if LID subdivision designs had an impact on the sale prices of adjacent single-family homes. The study focused on characteristics that mimicked those found in LID subdivisions, i.e., enhanced vegetation, narrower streets, since no true LID subdivisions existed in the Omaha area. The study found that buyers were willing to pay a price premium of 2.74 percent for homes in subdivisions that contained LID characteristics.[2]

A study conducted by ECONorthwest for the City of Seattle looked at four neighborhoods in which the city had installed Natural Drainage Systems, which included bioswales and associated features. The study found that these systems increased property values in the affected neighborhoods by 3.5% - 5%.[3] The highest increase was found in the High Point neighborhood, which consisted of new homes rather than the retrofitting of streets in neighborhoods with existing homes. The authors of the study concluded that the increase in property values indicates that individuals value the amenities produced by LID projects, even though they did not attempt to isolate or identify exactly the amenities or characteristics to which people were responding. Some potential characteristics may include enhanced vegetation, narrower streets, visual variety, as well as less tangible characteristics such as an enhanced sense of community, unique neighborhood identity, and living in a more environmentally friendly area.

Other studies seem to also indicate that LID positively affects property values. LID on commercial sites was found to provide amenities for people living and working in the area, which complemented the site's economic vitality and improved its competitive advantage over similar establishments for customers and tenants.[4] A study done for the Department of Defense found that that the natural features and vegetative cover of LID can enhance an area's aesthetics and architectural interest, and increase adjacent property values.[5]

3.1.4 Implementation Costs

The costs associated with implementing LID should be discussed in terms of both initial capital costs, as well as cost savings associated with reduction of offsite impacts and potentially long-term maintenance and decommissioning. For example, many LID techniques reduce the quantity of concrete and other materials used in conventional approaches that tend to drive up project costs. In addition, many LID techniques are self-perpetuating, easily repairable, or can be left as natural areas at the end of their functional lifetime, while conventional facilities may require high costs to take out of commission and leave the area safe. In addition, since LID addresses stormwater at its source, it is likely to reduce major offsite costs in the form of maintaining or increasing storm sewer capacity or incurring environmental costs associated with combined sewer overflows.

2 Schultz, S.; Schmitz, N. (2008) *How Water Resources Limit and/or Promote Residential Housing Developments in Douglas County*. University of Nebraska, Omaha, Real Estate Research Center.
3 Ward, Bryce; MacMullen, Ed; and Reich, Sarah. (2008) *The Effect of Low-Impact-Development on Property Values*. ECONorthwest, Portland, Oregon.

4 Bisco Werner, J.E., J. Raser, T.J. Chandler, and M. O'Gorman. 2001. *Trees Mean Business: A Study of the Economic Impacts of Trees and Forests in the Commercial Districts of New York City and New Jersey*. New York, NY: Trees New York and Trees New Jersey. September.
5 U.S. Department of Defense. 2004. *Unified Facilities Criteria - Design: Low Impact Development Manual*. Unified Facilities Criteria No. 3-210-10. U.S. Army Corps of Engineers, Naval Facilities Engineering Command, and Air Force Civil Engineering Support Agency. October 25. Retrieved May 4, 2007

Information comparing the costs of traditional drainage approaches to LID in a given context is limited. Seattle has estimated that the natural drainage system approaches it used in the SEA Streets project costs on average 10 to 20 percent less than traditional drainage systems. The first SEA Street project cost $325,000 per block (approximately 330 linear feet) whereas a traditional drainage approach would have cost closer to $425,000.

The City of Portland has included project costs in a number of its “green street” projects. Several case studies are summarized below:

Stormwater Curb Extensions

SE Ankeny Street - $11,946 to convert about 495 sq. feet of pavement to a vegetated system for stormwater management. The facility consists of one 30 feet and one 60 feet long curb extension and captures runoff from 7,300 sq. feet of paved surface, resulting in unit cost of $1.64 per sq. feet of impervious area managed.

NE Siskiyou Street - $17,000 to convert 590 sq. ft of pavement to a vegetated system for stormwater management. The facility consists of two 60 feet long curb extensions and captures runoff from approximately 9,300 sq. feet of paved surfaces, treating and infiltrating a large portion of this runoff. Unit cost equal $1.83 per sq. feet of impervious area managed.

Permeable Pavement

Pervious concrete has been documented as costing 1.5 to 2 times that of conventional concrete for transportation and installation.

Westmoreland Neighborhood - $412,000 to pave a four block area (28,000 sq. feet) with pervious pavers. Total catchment area is 60,984 (assumed to include 30 feet from each curb into residential lots fronting the project). The cost of the street construction using pervious pavers was approximately 1.8 times the cost of standard construction.

3.1.5 Maintenance and Resident Involvement

It is important to maintain LID facilities in order to ensure that they continue to function as designed and to prevent expensive repair of the facility and adjacent infrastructure. Maintenance may include watering to establish vegetation, removal of sediment and organic matter, weeding, mulching, pruning of vegetation, replacing dead plants and street cleaning. Each one of these maintenance requirements has associated costs. Effective measures to support and ensure quality maintenance of LID facilities include public education, incentives, and regulations. A maintenance schedule should be established for each facility, and it should include responsibilities and actions for both the city and residents. This means that adjacent property owners need to be made aware of the facility and how it functions, and be educated on what and what not to do in order to maintain its functionality.

The City of Seattle has seen some success in engaging residents in the maintenance and care of the natural drainage systems that it has installed in existing neighborhoods. Residents are required to maintain their street frontage, and therefore, it has been critical to educate residents about the function of natural drainage systems and what should and should not be done in order to maintain the functionality of the systems. According to an engineer involved in the design and implementation of natural drainage system projects, beginning with the original SEA Street back in 2000, resident participation in maintenance of the natural drainage systems can be attributed to their involvement in the project during the design phase. For landscaping adjacent to their properties, residents were able to choose from among a palette of plant types to suit their aesthetic preferences as well as the level of effort they are willing to put into maintaining the vegetation. Visual inspection of the projects in Seattle indicates that the natural drainage systems are for the most part well taken care of by residents.

On occasion, the City has had to respond to calls about mistreatment of the facilities, and has had to either take an enforcement action and/or dispatch a crew to restore the functionality of a natural drainage system. In addition, on streets where houses do not have a frontage (east-west streets), the City maintains all LID facilities. The City contracts with Conservation Corps to do most of the maintenance on LID facilities.

Additional maintenance costs cited by an engineer at Seattle Public Utilities include street sweeping, bottom soil replacement, and watering to establish plants, which is usually done for three years. Although the City anticipated having to replace the bottom soil of natural drainage systems every five years, they have not had to do this yet, even for its oldest facilities, which are going on nine years. Overall, the City of Seattle has been able to build upon the success of its original SEA Street project in terms of design, planting plans, and resident involvement, which has resulted in lower maintenance costs for subsequent projects.

Ideally, the level of resident interest and acceptance should be gauged before embarking on a major natural drainage system retrofit project. In Seattle, having a successful project for residents to see firsthand has achieved a high level of acceptance, and has led to numerous requests from residents for similar projects. As LID techniques become more common, and there are more and more good examples to point to, it will likely become easier to gain neighborhood acceptance of and involvement in these types of projects.

3.2 Traffic Calming

Traffic calming on residential streets may have multiple benefits, including improved road safety, increased safety, comfort and mobility for non-motorized travel, reduced environmental impacts, increased neighborhood interaction, and increased property values. There are numerous types of traffic calming measures that have been implemented in cities across the country and world, including Tacoma. These include traffic circles, chicanes, curb extensions, speed humps/tables, partial and full street closures, bike lanes, large tree canopies, and signage. There are numerous factors to consider when installing traffic calming infrastructure, including costs, impacts on traffic volumes and speeds, emergency vehicle access, maintenance, as well as effects on the overall street system and traffic mobility. These factors are discussed in more detail below.


Tacoma should consider developing a formalized process for installing traffic calming devices.

Currently, the City of Tacoma does not yet have a formalized process for implementing neighborhood traffic calming. Installation of traffic calming devices is based on resident complaints and meeting certain defined traffic engineering criteria. An example of a more formalized process is the City of Seattle's 5-step process for installing traffic circles, which could be adapted for any traffic calming measure. It includes:

Step 1 – Community Request. Support from residents of the affected area is required before constructing a traffic circle.

Step 2 – Preliminary Traffic Safety Analysis. The City evaluates the safety record of each location based on crash history. If the analysis supports installation of a traffic circle, then a neighborhood contact person will receive notification and a petition that includes a map of affected properties.

Step 3 – Petition Process. Signatures must be gathered from at least 60% of the households (owners and renters) and businesses (property or business owner) within one block of the proposed traffic circle.

Step 4 – Traffic Safety Analysis. After receiving a valid petition, the City will conduct a speed and volume study. The data collected is then used to prioritize the location for construction using the Point Criteria for Traffic Safety Analysis. Point criteria address accident history, traffic volumes (vehicles per day), and traffic speeds (85^{th} percentile speed). The higher each of these factors are, the more points the proposed project receives, and thus higher priority for implementation.

An optional community meeting may be held to discuss the project, including results of the traffic analysis, design concept, and procedures leading up to construction. Identification of a landscape volunteer is also discussed since that is an important component of a traffic circle project.

Step 5 – Design and Construction Overview. Traffic circles are designed according to the existing geometry of each intersection and sized to accommodate the passage of emergency vehicles. The Fire Department, transit and other agencies review locations and may conduct a field test to check for maneuverability.

After construction, the circle is monitored for a period of six months to one year. During this time, traffic speeds and volumes are measured to help determine the effectiveness of the circle. If a volunteer signs up to maintain plantings, soil and plants will be supplied; otherwise, the traffic circle will be covered in asphalt.

Such a process as described above could be applied to any traffic calming measure; however, some measures may have a larger impact, and thus would require wider neighborhood support.

3.2.1 Implementation Costs

There are both direct and indirect costs associated with the installation of traffic calming measures. Direct construction costs vary among the different types of traffic calming devices. For example, traffic circles may cost between $6,000 and $10,000 while a full street closure could cost up to $100,000 once all the necessary modifications are made to the adjacent street network. Other variables that may increase the cost of installing in-street devices include whether or not landscaping is integrated and if the device is being installed on a concrete street vs. asphalt. Typically, installation of devices such as traffic circles and chicanes on concrete costs more.

In addition to these direct project costs, there may also be indirect costs associated with liability claims, vehicle delay, traffic spillover, and emergency response delay. In regards to liability costs, a 1997 survey found that out of more than 1,500 total lawsuits brought against traffic engineers in 68 jurisdictions, only 6 involved traffic calming devices, and only two were successful.[6] Because traffic calming reduces vehicle speeds, and sometimes may increase distances required to drive to destinations, vehicle delay can be expected. This is an individual cost that could result in traffic spillover, thus impacting other streets and neighborhoods. Impacts related to traffic spillover will depend on whether the roads experiencing additional traffic are equally sensitive as the road where traffic calming devices have been installed. Ideally, any shift of traffic volumes should occur from low-volume residential streets to high-volume collector or arterial roads. Delays to emergency response can be minimized if they are considered in project planning and design. In general, it has been found that incremental risk to residents from fire truck delays are usually much smaller than increased road safety from traffic calming accident reductions.[7]

6 Ransford S. McCourt, *Survey of Safety Programs*, ITE Traffic Engineering Council (www.westernite.com/technical/signalsurvey/ntm), 1997.

7 Litman, Todd, *Traffic Calming Benefits, Costs and Equity Impacts*, Victoria Transportation Policy Institute, December 1999.

3.2.2 Neighborhood Benefits

Research generally shows that traffic calming results in more neighborhood benefits than it does costs because it tends to reduce the external costs imposed by motor vehicles (injuries, emissions, noise, etc.) and improving the balance between different uses of the public street. Neighborhood benefits include increased road safety, improved conditions for non-motorized modes, increased neighborhood interaction and crime prevention, increased property values, improved aesthetics, and potentially decreased noise and air pollution. It has been found that traffic calming has been an effective catalyst for stimulating walking and biking by designating safe, direct-access routes through neighborhood.

Decreasing vehicle speeds results both in a decreased number of vehicle-pedestrian collisions and reduced injury severity. Generally, injury severity increases with the square of vehicle speed. For example, the probability of pedestrians receiving fatal injuries when hit by a motor vehicle is 3.5% at 15 mph, 37% at 31 mph and 83% at 44 mph.[8] A study of 119 residential traffic circles in the city of Seattle between 1991 and 1994 found that reported accidents in those areas declined from 187 before installation to 11 after installation, and injuries declined from 153 to one.[9]

8 Rudolph Limpert, *Motor Vehicle Accident Reconstruction and Cause Analysis*, Fourth Edition, Michie Company, Charlottesville, 1994, p. 663

9 James Mundell, "Neighborhood Traffic Calming: Seattle's Traffic Circle Program," *Road Management & Engineering Journal*, January 1998.

Natural drainage systems require periodic maintenance, including mulching, replacement of bottom soil, and pruning of vegetation.

Educating residents about natural drainage systems and engaging them in the maintenance of these facilities is important for keeping the facilities functioning properly.

Reduced vehicle speeds and volumes that result from traffic calming tend to improve safety, comfort and convenience for pedestrians and bicyclists. This effect may have the added benefit of encouraging more walking and bicycling as alternative modes of transportation as well as for recreation and exercise. This also ties into increased neighborhood interaction and crime prevention as more people are out on the street due to improved conditions. This aspect of traffic calming is particularly important to the City of Tacoma's goals for complete streets and strengthening neighborhoods.

Traffic calming measures such as traffic circles, chicanes/chokers, or narrowing the roadway can provide opportunities for adding landscaping to the streetscape, and thus improving neighborhood aesthetics and general livability of the street environment. Such measures may also provide opportunities for implementing low impact development strategies as discussed in Section 2.3.7. Increased landscaping can also help to mitigate noise and air pollution. Some traffic calming measures could result in increased noise, i.e., textured road surfaces, and/or air pollution, i.e., measures that cause more frequent acceleration such as speed humps or tables.

3.2.3 Property Values

There have been numerous studies on how traffic calming measures affect property values. Increases in property values are often attributed to the benefits discussed above. Most homebuyers prefer homes on streets with lower traffic volumes and speeds. One study found that traffic restraints that reduced traffic volumes on residential streets by several hundred vehicles per day increased house values by an average of 18%.[10] A study in Baton Rouge, LA estimated that home prices increased by 1.05% for every reduction in traffic of 1,000 cars. It also found that homes on streets with exclusively local traffic, such as cul de sacs, were worth 8.8% more than other homes.[11] Traffic calming measures such as street closures, or partial closures would possibly have similar effects. Higher property values could also partly reflect the safety and environmental benefits experienced by residents as a result of traffic calming measures.

10 Gordon Bagby, "Effects of Traffic Flow on Residential Property Values," Journal of the American Planning Association, Vol. 46, No.1, January 1980, pp. 88-94.
11 Hughes, William, and C.F. Sirman (1992). "Traffic Externalities and Single-Family House Prices," *Journal of Regional Science* 32:4, pp. 487-500.