



Streets for Living

Planning and Best Practices in Street Design

What Are Living Streets?



Living streets are streets designed to be shared safely by pedestrians, bicycles and low speed motor vehicles.

Similar to pedestrian plazas, living streets are characterized by a lack of curb separation between the sidewalk and the street right-of-way. They therefore reclaim street space for pedestrians, bicyclists, children, community and commercial activity, while enhancing ecological performance by increasing the proportion of permeable surfaces and vegetation. Living streets may also reduce infrastructure costs through the use of a single stormwater drainage system instead of two stormwater systems on either side of the road.

In contrast to pedestrian plazas, living streets have the advantage of allowing low-speed access by all modes of transportation, which therefore improves local access and vitality, enhances the versatility of the street space, and increases the supply of vehicle parking in the area. Vehicle speeds of around 10 mph are maintained through self-enforcing measures such as narrow travel lanes, landscaping, tree planting, street furniture, cut-in parking spaces and other traffic calming features. The shared use of the street by children, pedestrians, bicycles, vehicles and residents is also indicated on signs that can be placed at each entrance to the living street.

How Are They Different From Conventional Streets?

Living streets require a more multidisciplinary design approach than conventional streets.

Conventional streets are designed to segregate different functions to different parts of the street. For example:

- High speed vehicular movement and vehicle parking occur along paved traffic lanes;
- Bicycle movements occur along bicycle paths if they exist or are more commonly mixed in with high speed traffic;
- Utilities are generally on or underneath the nature strips or sidewalks, with light poles and power lines sometimes cutting into the space available for pedestrians and wheelchairs;
- Percolation and landscaping occur along narrow nature strips with most of the runoff draining straight into stormwater pipes via concrete gutters; and
- Pedestrian movements, community interaction and children's play is relegated the remaining sidewalk space and people's private front yards.

Conventional streets are designed by professionals from various fields who operate in disconnected "silos" of expertise such as traffic engineering, road pavement design, sidewalk design and landscaping. The neighborhood streets resulting from this design process optimize vehicle circulation at the expense of the health and safety of children, pedestrians, cyclists, the local community and the environment.



In 2003, vehicle crashes involving pedestrians resulted in 4,759 pedestrian deaths, including 390 children under 15 years of age. In the same year, approximately 70,000 pedestrians were injured in motor vehicle accidents, including 17,000 children under 15 years of age.

National Center for Statistics and Analysis / NHTSA

In contrast, living street designs combine planning, engineering, design and ecological considerations to create a space that can be safely shared by all users.

Living streets have no separate sidewalks or curbs and gutters, but rather provide a shared space that is safe and accessible for pedestrians, wheelchairs, cyclists and low-speed vehicles. They also allow for integrated percolation and drainage through centerline drainage, landscaping and the use of porous paving materials.

Traffic calming measures have become standard practice in many US cities since the 1970s. These measures usually aim to reduce traffic speeds without necessarily requiring the full closure of a street. Individual strategies that contribute to traffic calming include vertical deflections such as speed humps and raised intersections; horizontal deflections such as chicanes and roundabouts; road narrowings such as chokers; and closures such as diagonal diverters or bollards.

In 1999, the Institute of Transportation Engineers published a synthesis of traffic calming experience in the United States, which is available on the web at: <http://www.ite.org/traffic/tcdevices.htm>



Where Have They Been Implemented?

To keep traffic speeds low enough to make it safe for pedestrians and children, traffic calming measures are designed to cover the entire street cross-section. These measures include the use of special paving materials, tree plantings, the arrangement of vehicle parking, vertical shifts such as raised intersections, road narrowings at entrance points and variations in the horizontal alignment of the street.

In order to balance different street functions and modes within the space available, living streets require a more holistic and multidisciplinary design approach than that of conventional streets. Collaboration with the community and different professionals is essential to successful design and implementation of living streets.

Many communities around the world have successfully implemented living streets. In Germany, the Netherlands, Sweden, Denmark and Australia, these streets are referred to as woonerven (singular: woonerf), while in the United Kingdom they are known as home zones.

Best practice examples of recent living street designs are provided on the following pages.

CASE STUDY 1

NORTHMOOR HOME ZONE: Planning multicultural communities in Manchester, United Kingdom

Northmoor is a compact, urban neighborhood of 1400 homes, most of which are townhouses. It has a high proportion of families with young children. In the late 1990s Northmoor was experiencing heavy, fast through-traffic and socioeconomic decline. By 1999 community members and the City decided to establish a “home zone” in Northmoor, consisting of green streets, pavement changes and traffic calming strategies. The implementation of the Northmoor home zone has reduced traffic speeds, improved safety and made the neighborhood more attractive.

The Strategy

The Northmoor Home Zone was implemented through a collaborative process involving the local housing association, which has a history of experience in local community participation.

After extensive community consultation and input, a home zone management group was established in 1999. This group represented local residents and businesses, the neighborhood housing association, the transportation authority, emergency services and the City. Monthly forums were held, newsletters circulated and a survey conducted. Through this process it became clear that residents were concerned about the poor pedestrian facilities, fast-moving traffic, lack of green space, insufficient play space and poor lighting.

A number of designs were developed with the aim of changing driver behavior while encouraging street-based activity. They include:



Photo: Debonair Photography

- Gateway signs, a shared street surface and unique pavement to signal that drivers should expect to encounter pedestrians, particularly children playing.
- Chicanes, alternating street parking bays and bollards to maintain the signal and slow vehicular speeds.
- Trees, planters and public art to protect pedestrians, slow cars and make the streets more attractive.
- Play spaces and gardens to encourage activity and provide amenity in the safer streets.

The Results

Northmoor home zone was implemented in three phases. Phase I was implemented in the two years following the first public survey. It was completed for less than \$1.1 million (£720, 000 in 2001) and was implemented on a rolling basis to minimize disturbances. Phase 2 has also been completed and Phase 3 is currently underway.

Surveys of residents and studies of traffic flow, speed and parking were conducted before and after the home zone implementation. The surveys showed that:

Purcell Street – Before



Photo: TRL654

Purcell Street – After



Photo: TRL654

- Nearly 60% of the residents are in favor of the new home zone designs (25% are not in favor and 15% do not know).
- A majority believe that the neighborhood is now more attractive.
- 50% of residents state that road safety has improved.

The traffic data collections show significant improvements in the home zone:

- Mean daily vehicle flow has been reduced by 29%.
- PM peak vehicle flow has been reduced by 42%.
- Mean vehicle speed has dropped from 17 mph to 11 mph, a 33% reduction.
- 85th percentile speed has dropped from 22 mph to 15 mph, a 33% reduction.
- The proportion of vehicles exceeding 20 mph has dropped from 26% to 3%. Eighty-fifth percentile speed has dropped from 22 mph to 15 mph, a 33% reduction.
- The proportion of vehicles exceeding 20 mph has dropped from 26% to 3%.

Lessons and Considerations

The Northmoor home zone was in large part a success because of its community process. Northmoor provides some key considerations for implementing living streets in other neighborhoods:

- Outreach and experience in working with diverse local stakeholders is very beneficial to effective participation in multi-cultural communities and young people is of critical importance.
- Reaching out to existing community groups or populations increases exposure and serves those who cannot attend public meetings such as families with young children or seniors.
- A semi-autonomous advisory group can guide the project throughout the process and provide a unified voice for a diverse local community.

References

Transport 2000. Streets for People Briefing: Tips for Successful a Home Zone.

Webster, D., Tilly, A., Wheeler, A., Nicholls, D., & Buttress, S. (2006) Pilot Home Schemes: Summary of the Schemes. Prepared for Traffic Management Division, Department for Transport. TRL Report TRL654. Transport Research Laboratory.

<http://www.northmoorhomezone.org/>

CASE STUDY 2

MAGASINSGATAN GÅRDSGATA:

Creating a vibrant mixed-use district in Gothenburg, Sweden

A dull back alley of narrow sidewalks and parked cars in central Gothenburg was reconstructed into a living street or gårdsgata. Today, Magasinsgatan is a popular district with residential and office units located above a vibrant atmosphere of restaurants, shops and cafés fronting on and occupying the street.

The Strategy

In Gothenburg and many other Swedish cities, living streets are typically created through a partnership between the affected property owners and the City. At Magasinsgatan, the City covered half of the costs of implementing the living street, while property owners covered the other half. The typical cost for property owners was roughly \$700 per meter of street frontage.

At Magasinsgatan a number of physical changes were made to the street. Existing parking spaces were removed, new lighting was installed and asphalt was replaced with red brick. The raised sidewalks and the travel lane were also leveled into a woonerf or single-level shared surface. On both sides of the street, rectangular paving blocks improved access for persons with disabilities and strollers. The street surface was given a consistent grade and building entrances were made more consistent to ease pedestrian access.



Photo: Susanne Jansson

The Results

As a result of its reconstruction, Magasinsgatan has become a vibrant mixed-use district with housing and offices above a streetscape of restaurants, shops and cafés. Following its redesign as a living street Magasinsgatan has transformed from a dull central city back alley into a popular local destination. The project has been such a success that storefront rents along the street have dramatically increased.

Lessons and Considerations

A number of lessons can be gained from the living street implementation at Magasinsgatan:

- One of the key factors to the success of Magasinsgatan was the cooperation between property owners and the City of Gothenburg in both the design and financing of the project.
- Given the success of Magasinsgatan, planning strategies for dealing with rent increases were critical to maintaining existing businesses within the district.

References

Anders Ågren, Innerstaden Göteborg AB (2006) Drottninggatan som gårdsgata. En konsekvensanalys av omvandlingen från gata till gårdsgata av Drottninggatan i Göteborg (Drottninggatan as a living street. An impact analysis of the transformation from street to living street of Drottninggatan in Gothenburg).

Västrafik (2005) Magasinsgatan fick ett lyft som gårdsgata ... och nu kan Drottninggatan stå på tur (Magasinsgatan was recently improved ... and Drottninggatan is next). Pling, 19 December 2005.

SWECO VBB (2003) Magasinsgatan, ombyggnad till gårdsgata (Magasinsgatan, reconstruction to living street).

Magasinsgatan – Before



Photo: SWECO VBB

Magasinsgatan – After



Photo: SWECO VBB

CASE STUDY 3

RIVER PLACE AND JAKE'S RUN:

Zoning for shared courts in
Portland, Oregon

Similar to Living Streets, the City of Portland encourages shared courts and has defined the concept in its zoning code. In the US context, incorporation of shared street concepts into zoning codes can help alleviate regulatory obstacles to implementing living streets.

The Strategy

Portland and other Oregon cities have approved several residential projects using the shared court concept. These projects include River Place and Jake's Run, which are essentially residential pedestrian zones or community yards.

Based on its experience in gaining approval for shared courts, the City of Portland took the idea further by incorporating these streets into its zoning code. The zoning code highlights a number of features of shared courts, auto courtyards and shared streets. Key features include pavement surfaces that suggest pedestrian priority while also accommodating vehicle access and parking. Other features include benches, planters, speed bumps and signage aimed at slowing traffic to 5–10 mph. Paving blocks, bricks or ornamental pavers are also critical to distinguish the zone from the conventional street and driveways.

Jake's Run, Portland



Photo: City of Portland

The Results

By encouraging the use of shared courts on narrow residential streets with little or no through traffic, Portland has experienced a number of benefits:

- Lower traffic speeds and less curb cuts result in safer public spaces for pedestrians and children.
- Increased access for persons of disability in places where sidewalks have historically been too narrow.
- More efficient use of limited land by combining numerous modes of travel into one space.
- Pervious paving materials and additional planting spaces reduce storm water impact.

Lessons and Considerations

Portland's shared courts provide a number of lessons for overcoming legal obstacles to implementing living streets in the US context:

- Codifying shared courts in municipal zoning ordinances can help to boost awareness and the perceived legitimacy of these streets within the local planning context.

- Development of a new street class can also learn from previous developments and facilitate implementation of similar strategies in future projects.
- The Portland shared street code restricts shared courts to a maximum of 16 parking spots. This ensures that the court does not end up looking like a parking lot, but instead balances parking needs with space for landscaping, recreation and access.

References

City of Portland (2005) Shared Court. Portland Zoning Code, Chapter 33. 910 Definitions.

City of Portland (2006) “Shared Court” Housing — Concept Summary.

Ryan, A. (2006) Code Changes in Portland pave the way for court-yard oriented development. Daily Journal of Commerce, May 15, 2006.

Examples of Portland Surfacing Treatments



Photo: City of Portland



Photo: City of Portland

River Place, Portland



Photo: City of Portland

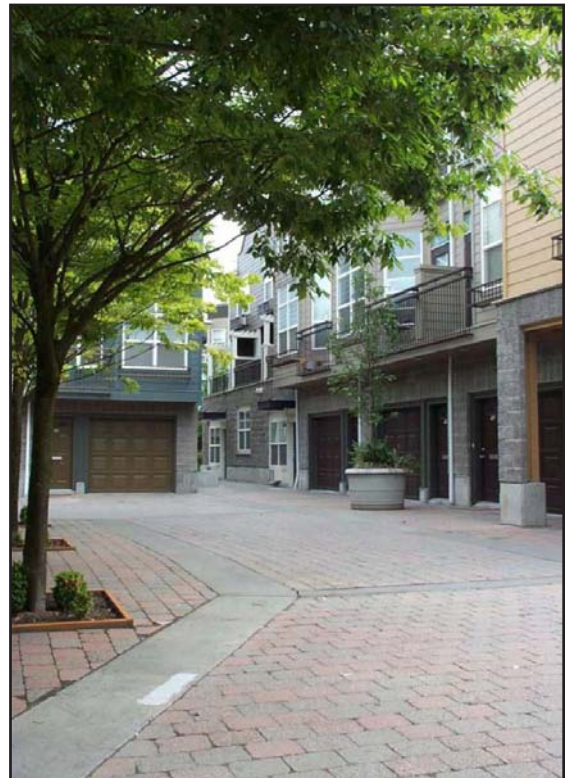


Photo: City of Portland

CASE STUDY 4

TERRY AVENUE:

Addressing accessibility regulations in Seattle, Washington

A recently adopted project focusing on the shared street concept is the redesign of Terry Avenue North in Seattle's rapidly developing South Lake Union District.

The Strategy

Terry Avenue is currently a non-arterial, slow-moving street with low traffic volumes, abandoned rail tracks and brick roadway surface in an industrial zone near downtown Seattle. The street has a wider than average right-of-way (varying from 71 to 76 feet) and runs parallel to Westlake Avenue North. Westlake Avenue has high traffic volumes and ambitions of being a commercial center for the area, while Terry Avenue is intended to serve as a local hub for the surrounding community, giving identity and character to the neighborhood by offering pedestrian amenities, art and public open space.

The original design of Terry Avenue incorporated the principles of shared and curbsless streets. However, this design was challenged in the planning process by accessibility regulations that require a distinct separation between pedestrian zones and areas where vehicles are allowed. To accommodate this concern, pedestrians have been integrated with the street by providing curbs but maintaining continuity in paving materials between the street and adjacent pedestrian areas.

The Results

The resulting concept plan maximizes pedestrian space while allowing for slow-moving vehicle traffic.

Terry Avenue – Looking North Before Redesign



Photo: Seattle DOT

According to Seattle's Design Guidelines:

“Recent Federal regulations require that where pedestrians move into a vehicular zone without a traditional sized curb or other defining element, a 36 inch wide warning strip with truncated domes is required. There must be 70% color contrast between the warning strip and the paving material running parallel and adjacent to the strip... This condition is required at all intersections and may be used along the length of the east pedestrian zone. Another alternative is to provide a 2 inch curb at the transition point from pedestrian to vehicle zones. On Terry Avenue, the curb would need to have a 70% color contrast with the adjacent paving materials. Designs should provide a clear path along the building line and across intersections for blind and sight-impaired pedestrians.”

Pedestrians may also be separated from areas where vehicles are allowed by a 2” or 4” curb, by a row of truncated domes per ADA specifications or by a separator such as a planting area. The Design Guidelines also contain specific intersection specifications. Since the street will not be a “true” shared street, these are not described.

Terry Avenue – Looking South Before Redesign



Photo: Seattle DOT

Lessons and Considerations

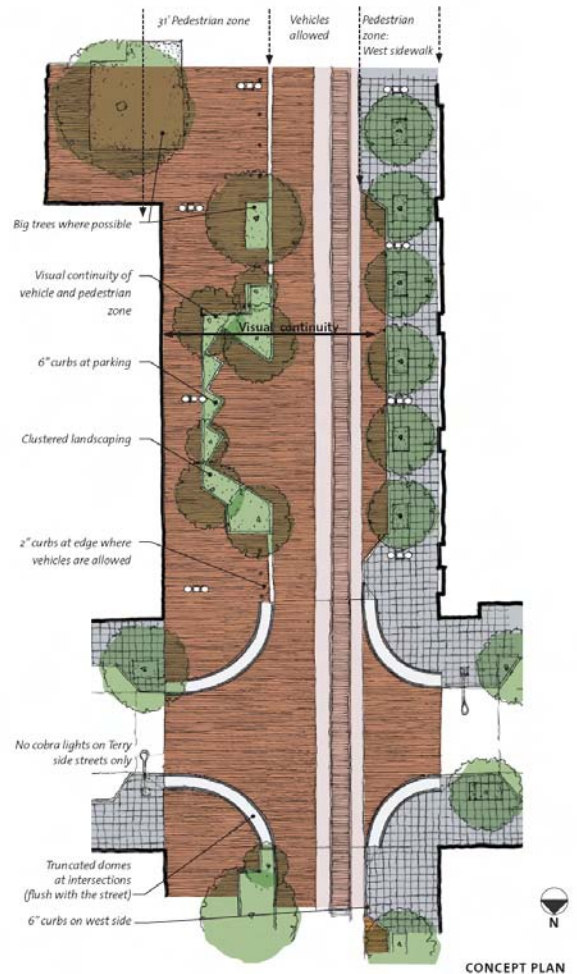
The experiences from Terry Avenue provide a number of lessons in relation to planning shared streets in the US legal environment:

- Local and federal regulations regarding accessibility and fire access need to be adequately addressed and discussed in the street design and/or codification process.
- Innovative approaches to pavement design, landscaping and street designation may help to alleviate regulatory concerns while achieving the goals of shared use, traffic speed reduction and environmental improvement.

References

Seattle Department of Transportation (2005) Terry Avenue North Street Design Guidelines.

Terry Avenue Concept Plan



CONCEPT PLAN

Credit: Seattle DOT

CASE STUDY 5

FULTON GROVE:

Private development of a residential shared street in San Francisco, California

In the United States, shared residential streets are most commonly found in the context of private residential developments such as Fulton Grove in San Francisco. Similar shared residential streets are also found in private multi-family developments in more suburban locations.

The Strategy

Fulton Grove Townhouses was built as a private development in the beginning of the 1990s. In this development, townhouses face each other along a private drive that is lined with trees along either side creating a new mid-block lane similar to those in older parts of the City.

Access at both ends of this street is through large apertures in new buildings that span the lane. This gateway treatment, as well as the use of textured paving along the street, creates the sense that vehicles are driving into an inside space with pedestrian priority. The lane provides vehicular access to each of the twenty-two 3-story townhouses.

The Results

The design for Fulton Grove was acknowledged in the 1993 Western Home Awards, a cooperative program of the AIA and 'Sunset' magazine.

The design has been a success in creating a slow traffic environment within the development, as well as a shared space for both pedestrians and vehicles. According to the architect, Solomon E.T.C., there have been no concerns regarding fire access or accessibility in relation to this development.



Photo: Solomon E.T.C.

Lessons and Considerations

The Fulton Grove development provides a number of lessons for shared street design:

- The stress-free planning of Fulton Grove suggests that regulatory issues such as fire codes and accessibility need not be an obstacle to the planning and development of shared streets in California.
- Gateway treatments such as paving changes and entrance designs are essential to creating a low speed environment within the shared street.

References

Interview with Solomon E.T.C.

Entering Fulton Grove



Photo: Solomon, E.T.C.

Fulton Grove Alley



Photo: Solomon, E.T.C.

Bollards Protect Alley Trees



Photo: Solomon, E.T.C.

CASE STUDY 6

MORICE TOWN HOME ZONE:

Improving safety in Plymouth, United Kingdom

Morice Town is a residential neighborhood in Plymouth, United Kingdom, comprised of 12 streets and 400 residences in mainly single-family homes and 3-4 story multi-family buildings. After years of disinvestment, several living streets were designed in parallel with other health, safety and social initiatives. Implementation of the home zone has been associated with improving safety, slower traffic, greater community empowerment and reduced crime.

The Strategy

In 1999, the Plymouth City Council proposed to create a Home Zone in Morice Town as part of a larger Health Impact Assessment of the neighborhood. Though stakeholders were initially suspicious, community relations and support increased after communication with the residents and businesses via public meetings, questionnaire surveys, a community advisory group and newsletters. In February 2000, a “Planning for Real” design charrette was conducted with children and other community members, followed by a design workshop in July 2000. Work began on the site in March 2002 and construction was complete by April 2003.

A living street concept was used to increase residents’ awareness of community space while helping it to be pedestrian-friendly, safe and clean. The design changes included:

- Gateway treatments and home zone signing at all entry points.
- Single-level shared surface on most project streets.



Photo: Department for Transport

- Extensive planting and landscaping on several other streets.
- Removal of all normal signing and street striping to redefine the shared street area.
- Different surface colors and textures to indicate how the streets were to be used. Grey pavement with a thermal-imprint pattern was used to indicate shared surfaces and through routes; yellow pavement was for pedestrian, community and play areas; bright red areas for keep-clear turning areas for buses and larger vehicles, and dark red for parking bays within shared surface areas.

This scheme was financed by Local Transport Plan funding and Single Regeneration Budget funding. Additional funding was sought from the European Community and the Home Zones Challenge.

The Results

Construction of the Morice Town home zone was completed in April 2003 at a cost of \$11,000 (£5,530) per property. Attitudinal surveys, traffic surveys and parking surveys conducted both before and after the home zone implementation showed that:

- More than 75% of the residents are in favor of the home zone after it was installed, and less than 15% are not in favor.

Morice Town's Charlotte Street – Before



Photo: TRL654

Morice Town's Charlotte Street – After



Photo: TRL654

- A majority believe that the neighborhood is now more attractive and that traffic volumes and speeds have been reduced.
- More than 75% of residents state that road safety has improved.

The traffic data collections show significant improvements in the home zone as well:

- Mean daily vehicle flow has been reduced by 26%.
- PM peak vehicle flow has been reduced by 31%.
- Mean vehicle speed has dropped from 21 mph to 15 mph, a 30% reduction.
- 85th percentile speed has dropped from 27 mph to 19 mph, a 29% reduction.
- The proportion of vehicles exceeding 20 mph has dropped from 56% to 10%.

In addition, since implementation of the home zone crime rates have fallen dramatically. Crime statistics from Plymouth City Council show a 90 percent reduction in the number of recorded crimes and a 48 percent drop in the number of people who reported being crime victims before and after the implementation. In particular, violent crime was dropped by 62 percent, vehicle crimes dropped by 96%, and criminal damage, domestic burglary and other theft fell by 100%.

Lessons and Considerations

Morice Town achieved a high level of community participation and a dramatic reversal of public opinion in favor of the home zone process.

- In relation to this project, a Health Impact Assessment helped to contextualize physical design among larger issues of community health. Dramatic reductions in crime following implementation of the project also tend to support this idea.
- The success of the Morice Town home zone could be attributed to the use of a semi-autonomous Advisory Panel and city project manager who helped to see the project through from start to finish.

References

IHIE (2005) Morice Town Home Zone, Plymouth, Devon. Institute of Highway Incorporated Engineers.

Transport 2000. Streets for People Briefing: Tips for Successful a Home Zone.

Webster, D., Tilly, A., Wheeler, A., Nicholls, D., & Buttress, S. (2006) Pilot Home Schemes: Summary of the Schemes. Prepared for Traffic Management Division, Department for Transport. TRL Report TRL654. Transport Research Laboratory.

Home Zones: improving the quality of life in residential streets. Renewal.net

CASE STUDY 7

FIVE ROADS HOME ZONE:

Addressing parking and amenity in Ealing, United Kingdom

This home zone just west of the Ealing town center comprises five roads on a grid of 400 households. Before implementation of the home zone, most of the households lived in semi-detached units with on-street parking. The quality of life had deteriorated in the neighborhood in terms of noise, air pollution, visual intrusion and safety because of increasing traffic in their streets.

The Strategy

In October 1998, residents of the London Borough of Ealing established the 'Five Roads Forum' and began writing to the Borough Council to request the planning of a home zone in their neighborhood. By early 1999 the council approved a preliminary design proposal as well as consultations for further design of the project. As part of this consultation, a project board was established, comprising residents, public officials and other advisors. Landscape architects were later appointed to design the project in conjunction with engineering consultants and the community.

As part of this process, the Forum arranged several design charrettes in the street, photographing activities, student surveys, newsletters and open-air design exhibitions throughout the entire process. A number of design features and traffic control measures were incorporated with the aim of reducing through traffic volumes and traffic speeds. These features include:

- Gateway features and contrasting surfacing materials.



Photo: Five Roads Forum

- Bulb-outs, street trees and landscape plantings.
- Street lighting, refurbished sidewalks and a road closure to through-traffic.
- Angled parking bays marked on alternate sides to create a chicane effect.
- Controlled Parking Zone (CPZ) to prioritize parking for residents, limit all-day parking for employees in nearby Ealing town center, increase parking turnover in retail areas, and limit drivers "cruising" for parking.

The home zone was completed in April 2004 at a total cost of \$2,000 (£1,014) per property.

The Results

Attitudinal surveys, collection of traffic flow and speed data, parking surveys and other data collection have been conducted both before and after the home zone implementation. Nearly 75% of the residents were in favor of the home zone after it was installed, and less than 10% were not in favor. A majority believed that the neighborhood is now more attractive and that traffic volumes and speeds have been reduced, and almost 70% stated that road safety has improved. The traffic data collections show significant improvements in the home zone:

Five Roads – Before



Photo: TRL654

Five Roads – After



Photo: TRL654

- Mean daily vehicle flow has been reduced by 52%.
- PM peak vehicle flow has been reduced by 58%.
- Mean vehicle speed has dropped from 19 mph to 16 mph, an 18% reduction.
- 85th percentile speed has dropped from 25 mph to 20 mph, a 17% reduction.
- The proportion of vehicles exceeding 20 mph has dropped from 43% to 17%.

Lessons and Considerations

According to a member of the five roads forum, the community-initiated process of creating a home zone built a shared sense of ownership and awareness of neighborhood design, safety and well-being. Some lessons from the Five Roads Home Zone process include:

- The project and community could have benefited more from a consistent project manager.
- A long consultation period gave people the opportunity to contemplate desired outcomes and accept unconventional ideas.
- Simple parking policies implemented two years before finalizing construction helped achieve

many of the area's traffic reduction and safety goals.

References

Five Roads Forum website www.fiveroadsforum.org.

Transport 2000. *Streets for People Briefing: Tips for Successful a Home Zone*.

Webster, D., Tilly, A., Wheeler, A., Nicholls, D., & Buttress, S. (2006) *Pilot Home Schemes: Summary of the Schemes*. Prepared for Traffic Management Division, Department for Transport. TRL Report TRL654. Transport Research Laboratory.

How Can Streets Become More Sustainable?



Streets can become more sustainable simply by implementing street amenities designed to improve stormwater management. Although rain is a rare occurrence in the Santa Monica area, the stormwater runoff produced during rainfall events has negative impacts which can be mitigated in a sustainable way with proper stormwater Best Management Practices (BMPs). A distributed system of BMPs, such as the ones presented in this document, can help restore the natural hydrologic regime to urban areas, improve water quality, and add aesthetic value to the neighborhood by providing landscaping, visually appealing pavement design, and other street amenities. The end result of BMP street improvements is a more sustainable and attractive urban environment.

Stormwater runoff can be a problem for a variety of reasons. In urban areas, the high proportion of impervious surfaces does not allow rainfall to infiltrate into the soil like vegetated areas do. Instead, this excess water becomes stormwater runoff. As this runoff flows over pavements, rooftops and other urban infrastructure, it accumulates pollutants such as oil, chemicals, metals, nutrients and bacteria. These pollutants are then washed to the ocean or other waterways while the groundwater is denied its natural replenishment. Increased runoff can also produce flooding hazards as drainage systems are overwhelmed by higher peak flows. Stormwater BMPs presented in the following pages aid in alleviating problems caused by urban runoff.

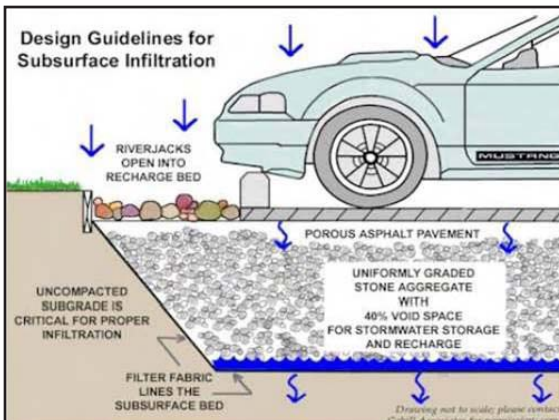
1. Permeable Pavement

Definition

Pervious pavement consists of permeable or perforated paving materials or pavers with spaces that allow transmission of water to aggregate base and subsoils. Runoff is temporarily stored in the base before infiltration into the subsoils and/or slow release to storm drain system. Common types of pervious pavement include plastic rings planted with grass, stone or concrete blocks with pore spaces backfilled with gravel or sand, porous asphalt, and porous concrete.

Design Considerations

- Maintenance.
- Infiltration rate of the native soil is a key element in design.
- Design with respect to traffic loading and design speed.
- Pedestrian ADA accessibility.



Pennsylvania Stormwater Best Management Practices Manual



Photo: Calhoun Street Foundation

Benefits

- Can incorporate aesthetically-pleasing textures and patterns
- Reduces runoff rates and volumes
- Proven durability (increased lifespan over asphalt)
- Recharges groundwater and sustains base flow
- Filters sediments and pollutants
- Can reduce detention needs
- Acts as a storage pond (35% void storage)
- Effective runoff reduction in urban settings

Applications

- Suitable for new developments in commercial, ultra-urban, and industrial areas for walkways, parking lots, play grounds, and alleys
- Can be retro-fitted to existing infrastructure
- Limited use on roadways and highways
- Not appropriate for sensitive or high groundwater areas
- Not appropriate for industrial sites

2. Rain Gardens

Definition

Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site retention and treatment of stormwater runoff. Surface runoff is directed into shallow, landscaped depressions designed to incorporate many natural pollutant removal mechanisms. The plants take up pollutants; the soil medium filters out pollutants and allows storage and infiltration of stormwater runoff; and the depression provides additional temporary storage.

Design Considerations

- Requires some maintenance to ensure long-term functionality.
- Requires semi-wet tolerant native plantings.
- Site-specific design.
- Best suited for areas with well-drained soil (detained water should drain within 24 hours).
- Amendment of topsoil may be required.
- Optional infiltration trench may be required.



Photo: Sherwood Design Engineers



Photo: Portland Stormwater Management Manual

Benefits

- Added aesthetic amenity to site and potential for wildlife habitat
- Low-cost tool for stormwater mitigation
- Volumes provide retention and infiltration, thereby reducing total runoff volume
- On-site groundwater recharge
- Combines street landscaping with stormwater treatment
- Reduces amount of sediment and nutrients transported by runoff to nearby waterways
- Water quality filtration; the soil matrix adsorbs pollutants and plants take up pollutants

Applications

- Can be used in bulb-outs, traffic circles, and stormwater parks
- Can be retrofitted into developed sites and existing greenspace
- Suitable for most development situations
- Can be integrated into a site with a high degree of flexibility

3. Sidewalk Planting Areas

Definition

Sidewalk planters and flush right-of way (ROW) parkway greenways involve removing pavement and simply planting landscaping in its place. It is an easy way to add green space to excessively wide sidewalk areas. While planters do provide minimal infiltration, detention, and pollutant filtration, their main function is to reduce impervious area and add to the aesthetics of a neighborhood. They also create a nice buffer between pedestrians on the sidewalk and cars on the road.

Design Considerations

- ADA requirements for path/sidewalk width.
- Typical sidewalk planter strips are created with a 12" to 36" (18" ideal) wide parking walkway along the curb. Utilities, signage, valves, and other small vaults can be located in this zone.
- This is a simple way to green the existing sidewalk streetscape and reduce stormwater runoff.
- Requires some maintenance.



Photo: Portland Stormwater Management Manual



Photo: Sherwood Design Engineers

Benefits

- Added aesthetic amenity to site and potential for wildlife habitat
- Low maintenance
- Easy to build and design
- Combines street landscaping with stormwater treatment
- Provide infiltration
- Entrusts community ownership

Applications

- Landscaping can be located along sidewalk strips, planted medians, parking-lane planters, bulbouts, etc. in any street type
- Suitable for most development situations
- Applicable in very high density residential neighborhoods
- Easy integration into existing developed lots
- Can be integrated into a site with a high degree of flexibility

4. Open or Flush Curbed Swales

Definition

Street swales are long, narrow landscaped depressions used to collect and convey stormwater runoff. The main difference between a swale and a rain garden is that swales convey stormwater in the longitudinal down gradient direction. They allow pollutants to settle and filter out as water infiltrates into the ground or flows slowly through the facility from one bay to the next.

Design Considerations

- Requires some maintenance to ensure long-term functionality.
- Requires semi-wet tolerant native plantings.
- Site-specific design.
- Sized to convey design runoff rate (typically 10-year storm).
- Requires minimum detention time to provide adequate water quality treatment.
- Slopes and depth should be kept as mild as possible to avoid safety risks, improve aesthetics, and prevent erosion within the facility.



Photo: Portland Stormwater Management Manual



Photo: Sherwood Design Engineers

Benefits

- Added aesthetic amenity to site and potential for wildlife habitat
- Provides conveyance and water quality benefits in one stormwater feature
- Combines street landscaping with stormwater treatment
- Filters pollutants, through both soil particles (which trap pollutants) and plant material (which take up pollutants)
- Reduces amount of polluted runoff to nearby waterways
- Provides retention and infiltration thereby reducing total runoff volume

Applications

- Can be used in moderate density residential homes or wide sidewalk planting strips
- Very useful in retrofit projects and can be integrated easily into developed sites, existing parks and other greenspace

5. Building Downspout Planters

Definition

Roof downspout systems are intended only for infiltration and conveyance of runoff from roof downspout drains. Infiltration planters are structural, landscaped reservoirs used to collect, filter, and infiltrate stormwater runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil and infiltrates into the ground. Flow-through planters are identical to infiltration planters, except that water is discharged through an outflow device instead of being infiltrated into the ground.

Design Considerations

- Building planters should be structurally separate from the adjacent sidewalk.
- Some maintenance (weeding, replacement of rock, loosening of soil).
- Planter walls shall be made of stone, concrete, brick, wood, or other durable natural material.
- Downspout systems generally discharge to the sub-surface via infiltration trenches filled with drain rock or may discharge via surface dispersion.



Liberty Center Parking Garage (650) NE Holladay

Photo: Portland Stormwater Management Manual



Buckman Terrace Apartments (303 NE 16th Ave.)

Photo: Portland Stormwater Management Manual

Benefits

- Added aesthetic amenity to site and potential for wildlife habitat
- Combines street landscaping with stormwater treatment
- Provides both filtration of pollutants through both soil particles and uptake of pollutants by plants/plant
- Reduces amount of polluted runoff to nearby waterways
- Provides retention and infiltration thereby reducing total runoff volume

Applications

- Flow-through planters are extremely versatile and can be used next to foundation walls, adjacent to property lines, or on slopes.
- Suitable for new developments, and also can be retro-fitted to existing parks and greenspace

6. Inline Storage / Structural Vaults

Definition

Detention tanks, vaults, and pipes provide underground storage of stormwater as part of a runoff flow control system. Structural detention facilities are designed to fill with stormwater during large storm events and slowly release it over a number of hours. They may be used to handle general site runoff, or they may be dedicated to the runoff from impervious surfaces, such as roofs and parking lots.

Design Considerations

- Avoid potentially corrosive chemical or electrochemical soil conditions.
- Must accommodate or avoid heavy ground and surface loadings.
- Limited maintenance accessibility.
- When used for detention storage, either a surface sediment containment pond should be placed upstream of the tank or vault, or the tank/vault should be oversized to allow for the temporary accumulation of sediment.
- Anti-floatation provisions in areas with high groundwater table.
- Detention vaults may be designed to empty completely between storms (dry vaults), or they may be designed to maintain a permanent water pool (wet vaults).
- Expensive to install or retrofit.

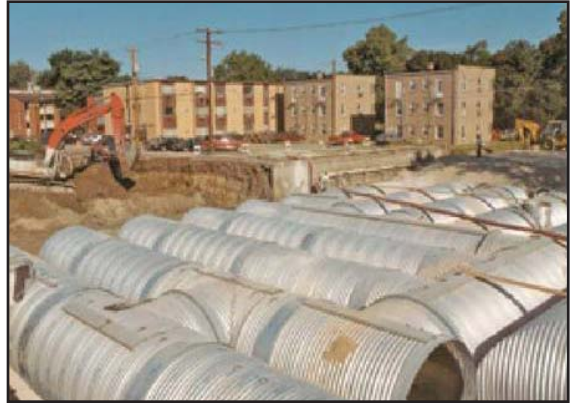


Photo: NY State Stormwater Management Design Manual

Benefits

- Reduces peak runoff flow rate
- Provides flood control
- Occupies less surface area than other detention and settling techniques
- Few aesthetic concerns since vaults are normally underground
- Wet vaults provide some contaminant removal through sedimentation in the permanent pool

Applications

- Suitable for ultra urban areas with limited space
- Vaults and tanks can be retrofitted to developed and redeveloping areas

7. Catch Basin Hoods and Water Quality Filters / Litter Guard

Definition

Catch basins, also known as storm drain inlets or curb inlets, are inlets to the storm drain system. Catch basins are used in combined sewer overflow (CSO) watersheds to capture suspended solids and settle coarse solids, and they act as pretreatment for ensuing treatment practices by capturing coarse sediment. Inserts designed to remove oil and grease, trash, debris, and sediment can improve the efficiency of catch basins. Some inserts are designed to drop directly into existing catch basins, while others may require retrofit construction. There are proprietary products on the market that allow for water quality filters to be installed at the stormwater inlets, or the proprietary product can replace the catch basin entirely.

Design Considerations

- Regular maintenance according to application and manufacturer's recommendations is essential for continued performance.
- The effectiveness of catch basins (their ability to remove sediments and other pollutants) depends on its design (e.g., the size of the sump) and on maintenance to regularly remove accumulated sediments from its sump.
- Most products are designed for an overflow in large storm events, which is necessary hydraulically and still allows for a "first flush" treatment.



Photo: Pennsylvania Stormwater Best Management Practices Manual



Photo: Pennsylvania Stormwater Best Management Practices Manual

Benefits

- Reduces large sediment, suspended solids, oil and grease, and other pollutants in runoff
- Provides pretreatment for ensuing water quality treatment BMPs; inadequate pretreatment is the main cause of failure for filtration BMPs
- Easy implementation

Applications

- Can provide "hotspot" control and reduce sediments loads to infiltration devices
- Used as pretreatment for and can be integrated with other BMPs
- Most useful in small drainage areas
- Catch basin inserts (CBIs) are designed either to hang from a drain-inlet frame or to be inserted well below the drain inlet in the sump area

8. Water Harvesting and Storage

Definition

Rainwater harvesting encompasses a wide variety of water storage techniques designed to “capture” for precipitation, hold it for a period of time, then reuse the water. Small-scale storage/reuse devices can be installed to supplement garden needs, or larger installation can feed “vertical storage” units that satisfy firefighting needs. Storage/reuse techniques are useful in urban areas where there is little physical space to manage storm water.

Design Considerations

- The reuse of stormwater for potable needs is not allowed without water treatment.
- The roof or site catchment area on which the rain falls determines the size of tanks.
- Screens may be used to filter debris and prevent it from entering the storage units.
- “First flush” runoff may be diverted away from storage in order to minimize sediment and pollutant entry.
- To minimize algae growth, storage elements should be protected from direct sunlight by positioning and landscaping.
- Account for probable lengthy permit process.

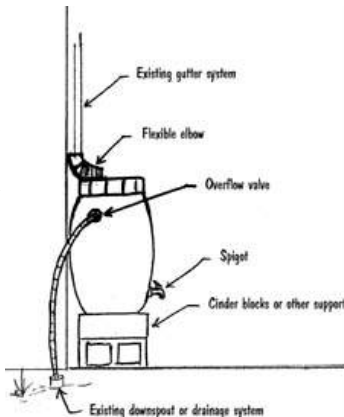


Photo: Seattle Rain Barrels



Photo: Left: Art – tec/Guy Marsden ; Right: Buster Simpson

Benefits

- Minimize potable water consumption for non-potable applications (i.e., irrigation, laundry and toilets)
- Peak flow reduction and control
- Larger devices may provide flood control
- Reduced annual runoff volume
- Contaminant removal through sedimentation
- Can be used to manage a portion of the flow and lessen the overall runoff
- Collected rainwater is good for irrigation of plants

Applications

- Captured water can be used for landscaped areas and gardens to meet irrigation needs, storage for firefighting needs, or for greywater reuse opportunities such as flushing toilets.
- Storage devices can be located in urban courtyards, sidewalks, building basement vaults, or city fire suppression tanks in the city intersections.

9. Landscaping and Soil Amendments

Definition

Landscaping and creating proper soil amendment are an important part of the successful design of a stormwater BMP. Soil amendment processes include restoring disturbed soils by aeration through mechanical loosening and/or adding a soil amendment, such as compost, for the purpose of reestablishing the soil's long-term capacity for infiltration and pollution removal.

Design Considerations

- It is critical that selected plant materials are appropriate for soil, hydrologic, and other facility and site conditions.
- Landscape design should minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Temporary irrigation system needed for the establishment period
- Plantings shall be designed to minimize the need for mowing, pruning, and irrigation.



Photo: Land + Living



Photo: City of Santa Monica, Environmental Programs Division

Benefits

- Landscaping as added site amenity and potential for wildlife habitat
- Native plantings reduce irrigation and fertilization requirements, as well as the use of fossil fuels and air pollution, relative to turf landscapes that require regular watering, mowing and maintenance.
- Reduces runoff volumes
- Increases permeability of compacted soils, thereby, increasing infiltration rates
- Increases organic content of soils
- Increases ability to remove nutrients

Applications

- Landscaping is often a component of other BMPs, such as detention and infiltration basins, filter strips, bioswales, and rainwater gardens
- On compacted soils, amendment may be necessary to increase organic content, improving success of establishment
- il amendment media can include compost, mulch, manures, sand, and manufactured microbial solutions.

