

Road Diet Handbook - Overview

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ABSTRACT

Under the William Barclay Parsons Fellowship program, Jennifer Rosales developed a comprehensive handbook on “road diets,” called *Road Diet Handbook: Setting Trends for Livable Streets*. The handbook assesses livability benefits which have not been previously evaluated including improved mobility for all modes of transportation and enhanced street character and provides an overall best practice for the implementation of road diets. The handbook advances the state-of-the-practice and provides a practical and valuable tool for practitioners.

A “road diet” entails converting a four-lane undivided roadway to a two-lane roadway plus a two-way left turn lane by removing a travel lane in each direction. The remaining roadway width can be converted to bike lanes, on-street parking or sidewalks. In cities throughout the world, roadways have been put on “road diets,” and these improvements have generated benefits to all modes of transportation including transit, bicyclists, pedestrians and motorists. These benefits include reduced vehicle speeds, improved mobility and access, reduced collisions and injuries, and improved livability and quality of life.

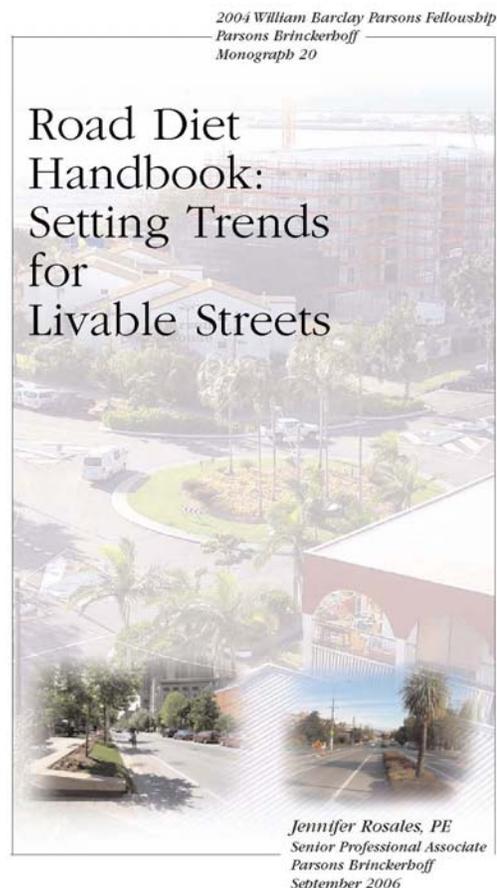
This paper will summarize the findings from research that the author conducted for the *Road Diet Handbook: Setting Trends for Livable Streets*. The handbook is intended to become a practitioner’s comprehensive guide for decision-making on applicability of road diets. It takes a practitioner through planning, analysis, design, and implementation of road diet projects. It includes guidelines for identifying and evaluating potential road diet sites, design concepts such as typical cross-sections, and lessons learned from experiences. This paper will provide a summary and highlights from the handbook.

INTRODUCTION

Increased traffic volumes on four-lane undivided roadways degrade service and safety. In cities throughout the world, the livability of neighborhoods is being improved by putting roadways on “road diets.” A road diet entails removing travel lanes from a roadway and utilizing the space for other uses and travel modes. Improvements have generated benefits to users of all modes of transportation, including transit riders, bicyclists, pedestrians and motorists.

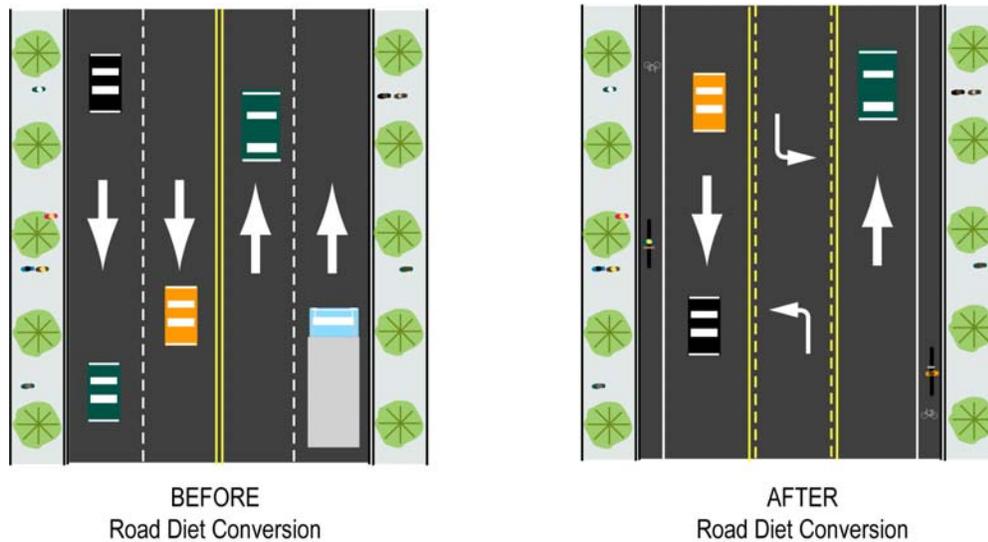
The focus of the handbook is the road diet conversion of four-lane undivided roadways to two-lane roadways plus a two-way left turn lane by removing a travel lane in each direction. The remaining

Exhibit 1: Road Diet Handbook Cover



roadway width can be converted to bike lanes, on-street parking, landscaping, and/or sidewalks. The resulting benefits include reduced vehicle speeds; improved mobility and access; reduced collisions and injuries; and improved livability and quality of life.

Exhibit 2: Representative Road Diet



This handbook is intended to be used as a comprehensive guide for planners, engineers, and designers to help them to make decisions on the applicability of road diets. Therefore, it contains information on planning, analysis, design, and implementation, including:

- Results from previous research efforts
- Identification of significant gaps in the field
- Analyses of safety and traffic operations
- Livability considerations
- Case study evaluations
- Lessons learned from experience
- Guidelines for identifying and evaluating potential road diet sites and design concepts such as typical cross-sections
- Overall guidelines for implementation.

This handbook also evaluates the livability impacts of road diet projects, addressing such issues as comfort and safety for pedestrians, bicycles, and transit users; increased landscaping and beautification opportunities; and improved quality of life and street character.

To determine how specific road diet strategies affect livability, case studies of six sites (Vancouver, Washington (two sites); Clear Lake, Iowa; Athens, Georgia; Toronto, Ontario, Canada; and Dunedin, New Zealand) were analyzed. At each site:

- A public opinion survey was administered along comparable four-lane undivided and three-lane streets either before or after road diet strategies were implemented.
- Roadway and business activity data was collected both before and after the roadway was converted to further evaluate the livability, safety, and operational effects of road diets. The data collected included traffic volumes, vehicle speed and flow characteristics, collision rates and types, congestion, delay and queuing, cross-section design, existence of multimodal facilities, pedestrian crossings, and retail sales activity.

This research represents a state-of-the-practice analysis and provides a snapshot of the current state-of-the-art in the implementation of roadway diets. Ultimately, however, each road diet project is unique to its context, and its designers should strive to make the built, social and natural environment “better than before.”

HANDBOOK ORGANIZATION

This monograph is divided into four chapters. Information is intended to provide guidance on planning, analysis, design and implementation of road diets. It is also intended to provide information on the effects of road diets, including safety, operational and livability benefits. Applicable local ordinances, design requirements, and codes must be consulted for impacts to the planning and design process. A description of each of the chapters follows:

Chapter 1 Introduction

Chapter 2 Previous Studies

This chapter summarizes the existing road diet research and literature, including studies of safety and operational impacts of road diets. It includes citations of other literature that can be related to road diets, such as pedestrian crossing safety studies. Gaps in the previous research are identified and summarized.

Chapter 3 Case Studies

This chapter includes case study examples of road diet projects that have been implemented at locations around the world. Six sites in the United States and internationally were chosen for the survey and data collection. For each case study, traffic, safety and survey data are analyzed to evaluate factors related to the livability of these streets before and after the road diet was implemented. The methods used to collect and analyze the survey data are described, and lessons learned are summarized.

Chapter 4 Practice Guidelines

This chapter will help practitioners identify and evaluate potential road diet candidate sites, by taking them through the processes of planning, analysis, design and implementation of road diets. It includes general recommendations for the planning, analysis, design, and implementation of road diets that take into account the project context and site-specific conditions that need to be considered. This chapter includes:

- Guidelines for identifying and evaluating potential road diet sites
- General considerations including roadway characteristics and safety, operational and livability benefits
- An evaluation checklist
- Typical cross-sections for design concepts
- Implementation strategies

PREVIOUS STUDIES

This chapter summarizes previous research on road diets and includes safety and operational data from these studies. Related research that supports road diets has been included in the literature review. An example of such research is *Safety Effects of Marked versus Unmarked Crosswalks*, Federal Highway Administration (FHWA) and University of North Carolina, which shows that collision rates are significantly higher on multi-lane undivided roadways.¹

Safety and operational studies under a variety of traffic volumes and roadway conditions are needed to quantify the conditions for which road diets are appropriate². This chapter also identifies gaps in the previous research results as well as the significant gap in non-safety benefits, including livability benefits, which have not been examined in past research. This chapter includes past studies on several types of road diet projects.

This chapter is organized in the following sections and addresses:

- Economic Effects and Walkability
- Safety
- Operations
- Road Diet Project Types and Examples
- Lessons Learned
- Research Gaps

CASE STUDIES

This chapter, which illustrates the application of the road diet at six case study locations, includes evaluations of factors related to the livability of the streets at each location. The road diet case studies are diverse geographically and with respect to their surroundings, scale, character, function, and form.

Six case studies were chosen for the survey and data collection. The case study sites are in Dunedin, New Zealand; Toronto, Canada; Athens, Georgia; Clear Lake, Iowa; and two in Vancouver, Washington. They represent a wide range of project contexts from an urban street in Toronto, Canada to a rural street in Iowa with varying project lengths, designs, and magnitude. Exhibit 3 shows the locations of the road diet case studies.

Exhibit 3: Location of Road Diet Case Studies



Residents and businesses in the vicinity of each case study were surveyed to examine how a road diet affects the livability of an area. The public opinion survey, which was modeled from surveys conducted by Donald Appleyard in *Livable Streets*³, solicited information from people living and working adjacent to the streets with factors directly related to its livability. The survey included questions on:

- Household/business characteristics
- Perceptions on the street's traffic, safety, activities (street life) and friendliness
- Recommended improvements
- Reactions to the road diet

The surveys evaluated the livability impacts of road diet projects, addressing such issues as:

- Comfort and safety for pedestrians, bicyclists, and transit users
- Increased landscaping and beautification opportunities
- Improved quality of life and street character

The results of the survey were intended to be used as an indication of livability factors for each case study. The local agencies for the case studies were contacted for participation, and provided data for the project.

Exhibit 4: Case Studies

Case Study	Location	Street Class	ADT	Posted Speed	Primary Adjacent Land Use	Date of Conversion / Time Since Conversion	Project Length	Road Diet Project Elements	Estimated Project Cost
Grand Boulevard - 4 lane undivided roadway	Vancouver, Washington	Principal Arterial	12,000	30 mph / 25 mph	Commercial, Residential, Industrial	Not converted - waiting for funding	1.5 miles (2.4 km)	To be re-striped to two lanes, two-way center turn lane, bike lanes	\$50,000 (2003 US)
Fourth Plain Boulevard	Vancouver, Washington	Principal Arterial	17,000	30 mph	Residential with commercial	2002 / 2 years	1 mile	Conversion to two lanes, two-way center turn lane, bike lanes, ADA ramps, underground utility work	\$1.26 million (2002 US)
Baxter Street	Athens-Clarke County, Georgia	Arterial	20,000	35 mph	Commercial with residential & university	1999 / 5 years	1.9 miles	Conversion to two lanes, two-way center turn lane, bike lanes, signal modifications	\$190,000 (2000 US)
US 18	Clear Lake, Iowa	State Highway	12,000	45 mph	Commercial with residential	2003 / 1 year	1.1 miles	Interim project - re-striping to two lanes, two-way center turn lane, shoulders, temporary signal	\$105,000 (2003 US)
St. George Street	Toronto, Ontario, Canada	Minor Arterial	7,400	25 mph (40 km/hr)	University	1993 & 1996 / 11 & 8 years	0.65 miles (1.04 km)	1993 - lanes reduced to two lanes and bike lanes added with median, 1996 - lanes narrowed, new curbs, added landscaping, widened sidewalks	\$ 4 million (1996 Canadian)
Kaikorai Valley Road	Dunedin, New Zealand	Arterial	10,000	30 mph / 45 mph (50 & 70 km/hr)	Commercial with residential	2003 / 1 year	1.5 miles (2.4 km)	Conversion to two lanes with on-street parking, added cycle lanes, and improved median landscaping, turn lanes, pedestrian crossings	\$180,000 (2003 New Zealand)

Fourth Plain Boulevard, Vancouver, Washington

Fourth Plain Boulevard is designated as a principal arterial, and serves a variety of transportation users, including truck traffic through west Vancouver. Fourth Plain connects Interstate 5 to West Vancouver neighborhoods, recreation, and industry, including the Port of Vancouver. Before the road diet project was implemented on Fourth Plain Boulevard, this facility was designated a state truck route. When Fourth Plain Boulevard was converted, a parallel facility, Mill Plain Boulevard, was converted to a truck route bypass. This new bypass contributed to the success of the project by removing some truck traffic from Fourth Plain Boulevard.

Exhibit 5: Fourth Plain Boulevard Lane Configuration – Before and After⁴



5 “Before” Road Diet



“After” Road Diet

The purpose of the road diet conversion project on Fourth Plain Boulevard was to:

- Cost-effectively enhance the environment for all street users while minimizing operational or spillover effects
- Develop a safe and efficient transportation system
- Reduce the crash frequency and number along the corridor
- Improve pedestrian and bicycle mobility
- Establish a balance between vehicle operations, port freight access and neighborhood livability

Livability Survey

In April 2004, an on-line web survey was used to solicit public input on livability. Most of the respondents are pleased with the results of the road diet project on Fourth Plain Boulevard and have noticed improvements to traffic, safety, and livability. The handbook provides survey findings for each case study.

Retail sales analysis found that the commercial area on, adjacent and near the Fourth Plain Boulevard road diet project performed better than comparable areas in the City.⁵ This growth occurred after the implementation of the road diet project and during a recession that affected all portions of the City. When comparing gross receipts before and after the road diet project, the commercial area in the Fourth Plain project area had a positive increase of 3.1 percent compared to negative declines of -9.8 percent to -25 percent in two other comparable community commercial zones in the City.

Lessons Learned

- Safety improvements resulted from the implementation of the road diet with a significant reduction in crashes.
- The traffic operations along Fourth Plain Boulevard continued to operate adequately without queuing issues with improved operations for bicyclists and pedestrians.
- From the livability survey, the majority of the respondents concluded that the road diet has improved traffic issues.
- The livability survey suggests that the implementation of a road diet creates a street environment that is calmer and safer, although respondents don't treat the street as a residential street (for example, not letting their children play in the street).

Baxter Street, Athens-Clarke County, Georgia

Baxter Street is located in Athens, Georgia and classified as an arterial and connects the University of Georgia on the east to a major shopping center on the west. Baxter Street runs parallel to State Highway 78 and serves a variety of transportation uses.

The road diet project started as a safety demonstration project when Baxter Street needed resurfacing. The purpose of the project was to:

- Reduce the crash frequency along the corridor (especially rear-end and sideswipe)
- Increase travel flow by separating through vehicles from left-turning vehicles
- Designate an area within the roadway for bicycle travel
- Further separate vehicles from the sidewalk edge

Baxter Street has a 40-foot (12 m) right-of-way. The “before” and “after” dimensions are as follows:

- Before the road diet, the facility consisted of four 10-foot-wide lanes (3 m)
- After the road diet, the facility consisted of two 14-foot-wide (4.2 m) lanes to be shared between vehicles and bicycles, and one 12-foot-wide (3.6 m) two-way left turn lane.

Exhibit 6: Baxter Street – After Road Diet
(Courtesy of David Clark)



In the initial design, Baxter Street was considered too narrow for full bike lanes, so the 14-foot travel lanes were striped with a dashed line to create an 11-foot travel lane and 3-foot shared vehicle/bike lane. In 2003, the 3-foot shared areas were striped as bicycle use only lanes.⁶

Livability Survey

An online web survey was chosen for this case study to solicit public input to the livability survey. The majority of respondents indicated that the street width is “just right” and that the number of travel lanes is “just right.” Most also indicated that the street is “safe,” “very safe,” or “comfortable.” This response indicates that the road diet project resulted in a positive change. The handbook provides complete survey findings for each case study.

Lessons Learned

After the implementation of the Baxter Street road diet, Athens-Clarke County staff recommended the following for road diet projects:⁷

- Add bus pull out bays, so buses don't block through traffic
- Include access management plans with appropriate spacing and/or eliminate driveways to reduce conflict points
- Improve grates across catch basins to improve bike operations (e.g., improve stormwater collection systems to remove water from curb lanes where bikes travel)
- Repair sidewalks and driveways in poor condition
- Improve landscaping to “soften” the corridor
- Coordinate with other corridor improvements

US 18, Clear Lake, Iowa

U.S. 18 is a state highway in Iowa and the primary east-west route through the City of Clear Lake. Railroad tracks run parallel to U.S. 18 on the south side. U.S. 18 serves traffic traveling in, through, and out of Clear Lake, and serves a variety of transportation uses in Clear Lake, including freight movement. U.S. 18 provides access to the downtown business and tourist area.

The U.S. 18 road diet project consisted of simply re-striping the highway with the road conversion, installing one traffic signal, and upgrading an existing traffic signal. A second phase of the project will include the installation of right turn lanes at key intersections along the corridor. Before the conversion, U.S. 18 was a four-lane undivided roadway. It was converted to two lanes plus a two-way left turn lane and painted shoulders. The purpose of this project was primarily to improve safety along the corridor.

Livability Survey

A door-to-door survey method was used for the US 18 case study to solicit public input to the livability survey. The respondents indicated that they would like more lanes to travel faster and to relieve some congestion during the peak hour. However, these respondents also think that speeding remains a problem at times. The respondents would like to see more police enforcement to slow speeds and keep motorists from using the center turn lane as a passing lane. The handbook provides the survey findings for each case study.

Lessons Learned

The project was implemented primarily to improve safety, and an assessment of crash statistics indicates that safety has improved. However, many respondents believe that the road is less safe following the initial phase of the road diet implementation. There may be a number of reasons for this perception including the unclear lane striping, misuse of the center turn lane, and several complementary improvements still to be added to the project, including improved signal timing and right turn lanes. Depending on the level of community acceptance of the project, a public involvement/education effort may be beneficial to show the resulting safety benefits of the project.

The cost of a road diet project can be minimal by simply re-striping a roadway, and it can be completed as an interim solution or as a pilot project for a short length of time, such as 6 months. By implementing a road diet as a pilot project study, the effects on safety and operations can be measured before deciding whether to keep it permanently and/or whether to fund enhanced design features and a more permanent solution. When evaluating a temporary solution, it is important to note that it may not provide all of the benefits of a permanent solution.

On U.S. 18, the transition areas from the four-lane to two-lane section with two-way left turn lane is confusing for drivers, and the survey respondents indicated that better lane markings are needed. A lesson learned for a pilot project or re-striping project is to ensure that the lane markings are clear and that the old lane markings are not still visible. Both the road diet pilot project and interim solution can be enhanced by adding landscaping, signal timing improvements, sidewalk connectivity, improved pedestrian crossings, and other enhanced design features.

St. George Street, Toronto, Ontario, Canada

St. George Street, a multimodal street through the St. George campus of the University of Toronto, was put on a road diet in the 1990s. St. George Street is classified as a minor arterial road by the City of Toronto and serves vehicles, delivery trucks, bicyclists, pedestrians and even skateboarders. An extremely high number of pedestrians use St. George Street, and continuous sidewalks on both sides of the street are provided in the pedestrian zones.

St. George Street road diet project was completed in 1996, about 8 years before this study. The project was incrementally enhanced beginning in 1993, with the most significant construction occurring in 1996. Prior to 1993, the street operated as a four-lane road during peak hours and as a two-lane road with on-street parking permitted during non-peak hours. In 1993, the number of lanes on St. George Street was reduced to two by permitting parking during all hours. Bicycle lanes, a narrow painted median, and turn lanes were provided at key intersections as part of the lane reduction project. The road diet project also narrowed the pavement width and reconstructed the curbs along St. George Street in 1996. Before the road diet project, the pavement width was wide considering the street function and surroundings. As part of the road diet project, the pavement width was narrowed from 46 feet (14 meters) to a varying width of 31 to 40 feet (9.5 to 12.2 meters). The sidewalk area was widened to increase the pedestrian zone.

The narrowing of the pavement and widening of the sidewalk has significantly enhanced pedestrian crossing areas. The majority of the pedestrian crossings occur at uncontrolled mid-block locations that correspond to campus pedestrian routes. To delineate the mid-block crossing areas, alternative roadway pavement materials were used to highlight these crossing areas.

Curbs extensions at specific locations in coordination with on-street parking have reduced vehicle travel speeds. By narrowing the pedestrian crossing areas, pedestrians have been encouraged to cross at specific locations with shorter crossing distances. Landscaping has been added to provide a buffer and enhanced urban environment to the road diet project. Exhibit 7 provides photographs of St. George Street.

Exhibit 7: St. George Street – After Road Diet



Livability Survey

A web survey was used to solicit public input on the livability of the street. The survey respondents indicated satisfaction with the street width and number of lanes, but some respondents indicate a desire to remove all cars. The survey respondents recognized the benefits that the road diet project has produced, including slower speeds and improved safety, but still desire further improvements such as more crosswalks and more greenery. The respondents desire additional aesthetic enhancements such as greenery and replacement of concrete planters, cobblestones and pavers. The handbook provides complete survey findings for each case study.

Lessons Learned

A road diet project through an urban University setting has both perceived benefits by users of all transportation modes and actual measured safety and operational benefits as well. An urban, university environment is an ideal location to consider a road diet project because of the high number of pedestrians and bicyclists that benefit from projects of this type.

Kaikorai Valley Road, Dunedin, New Zealand

Kaikorai Valley Road is located in Dunedin, New Zealand, which is an eastern coastal City in New Zealand. Kaikorai Valley Road is classified as a Regional Arterial road which is defined by the Dunedin City District Plan as one that serves as a link of strategic importance between or within regions, and between districts. Kaikorai Valley Road serves as an alternate route into and out of the Dunedin central business district from the south. Kaikorai Valley Road serves a variety of transportation uses, and parking is provided on both sides of the road.

The road diet project on Kaikorai Valley Road was completed in 2003, about one year before this study. The length of the road diet project is 2.4 kilometers (1.5 miles), on the northern end of Section 2 of Kaikorai Valley Road. The road diet project entailed reducing Kaikorai Valley Road (section 2) from a four-lane roadway with on-street parallel parking to a two-lane roadway with on-street parking and cycle (bicycle) lanes. The project included:

- Planting the existing median with low growing shrubs
- Improving pedestrian crossings by converting a crossing to a pedestrian crossing point, constructing disabled crossing ramps and installing floodlighting.
- Upgrading an existing pedestrian crossing by installing floodlighting.
- Extending the length of turn pockets to accommodate queuing vehicles without impeding the flow of through traffic.

Exhibit 8: Kaikorai Valley Road – After Road Diet *(Courtesy of Ron Minnema, City of Dunedin, NZ)*



Livability Survey

A door-to-door survey method was used for the Kaikorai Valley Road project to solicit public input to the livability survey. The respondents had mixed perceptions regarding the results of the project, but still almost half recommended this project to other streets in the City. The handbook provides complete survey findings for each case study.

Lessons Learned

The following summarizes the lessons learned for the Kaikorai Valley Road Case Study:

- Safety improvements for all transportation modes resulted from the implementation of the road diet with a significant reduction in traffic speeds and crashes.
- The traffic operations continued to operate adequately with no traffic diversion impacts.
- From the livability survey, the majority of the respondents on Kaikorai Valley Road concluded that the road diet has resulted in positive transportation improvements.

Grand Boulevard, Vancouver, Washington

This case study differs from the other case studies in that the roadway was surveyed before the implementation of a road diet project. Grand Boulevard, an undivided four-lane arterial located in the City of Vancouver, Washington, is an example of an ideal road diet candidate. The City of Vancouver has been challenged by neighborhoods and special interest groups to re-assess the operational and capacity needs on many undivided four-lane corridors. The motivations behind these requests are varied, and often revolve around the perceived trade-off between transportation capacity and community livability.

Livability Survey

Overall, the survey respondents seemed as or more concerned with non-traffic issues such as aesthetics and crime. Perceptions of safety were correlated with perceptions of traffic speed, as respondents who felt the street is unsafe tended to say that traffic moves too fast. The handbook provides complete survey findings for each case study.

Recommendations

Grand Boulevard is an ideal facility for a road diet project, and the City of Vancouver plans to convert it to a two-lane with center left-turn lane facility as funding becomes available. The City of Vancouver plans to study Grand Boulevard after the road diet project is constructed to evaluate its effectiveness.

Recommendations for a road diet project on Grand Boulevard include the following:

- Re-stripe roadway from a four lane roadway to a two lane roadway with a center left-turn lane or median channelization (minimum 11 feet width for center turn lane).
- Provide a dedicated bike lane in both directions.
- Institute a speed monitoring and enforcement program to reduce vehicle speeds.
- Improve pedestrian facilities by adding curb ramps, crosswalks, lighting, and sidewalks where needed to provide connectivity, comfort and safety.
- Implement the road diet project with pavement overlay of street.

Case Studies Summary

Exhibit 9: Road Diet Impacts

Case Study	Safety Effects	Operational Effects	Livability Effects	Recommend Road Diet to Other Streets	Respondents suggested improvements
Grand Boulevard - 4 lane undivided roadway					Slow speeds, change street character, more police, widen sidewalks, better maintenance, add bike lanes, add street trees and planter strips
Fourth Plain Boulevard	Number of crashes decreased by 52 %, Traffic speeds decreased by 18 %, Pedestrian safety improvements	No queuing blocking access, increased pedestrian activity, improved bicycle conditions, no traffic diversion impacts	Redevelopment and renovation work at quicker pace, economic growth in adjacent and nearby businesses, easier to cross street, street feels safer	67% Yes, 21% Maybe, 12% No	Slow speeds, prohibit trucks, reduce traffic, improve pedestrian crossings, more street trees and curb side planters
Baxter Street	Overall number of crashes decreased by 53 %, crashes at unsignalized locations decreased by 60%, rear-end crashes reduced by 45%	No significant changes to traffic volumes, traffic diversion only about 4 %	Easier to cross street, slower speeds, several home and business improvements, perceived number of lanes and street width is "just right"	47% Yes, 33% Maybe, 20% No	Improve street maintenance, slow speeds, new street trees and curb side planters, more police
US 18	Number of crashes decreased by 65 %, Aggressive speeding reduced by 52%, vehicles over speed limit decreased by 32%	Adequate traffic operation, good mobility, more uniform traffic speeds closer to speed limit	Mixed perceptions on street, striping confusing, Phase 2 of project to address community concerns, livability benefits still to be realized	24% Yes, 28% Maybe, 49% No	widen street, add bike lanes, improve pedestrian crossings, slow speeds, more traffic signals
St. George Street	Number of crashes decreased by 40 %, improved safety for pedestrians and bicycles	No traffic volume changes, no traffic diversion impacts, adequate traffic operation, good mobility	Easier to cross street, slower speeds, street feels safer, perceived increase in pedestrians and bicyclists	81% Yes, 12% Maybe, 6% No	More pedestrian crossings, reduce traffic, more street trees and curb side planters, prohibit trucks, slow speeds
Kaikorai Valley Road	Number of crashes reduced by 10 %, aggressive speeding reduced by 76%, improved safety for pedestrians and bicyclists	No traffic volume changes, no traffic diversion impacts, adequate traffic operation, good mobility	Perceived number of lanes and street width is "just right," yards and buildings kept up, several home and business improvements	42% Yes, 31% Maybe, 27% No	Improve street maintenance, slow speeds, reduce traffic, more police, OK as is

Safety

Significant safety benefits resulted from the road diet projects. The overall number crashes were reduced by the road diet case study projects ranging from a 10 % to 65 % reduction. Also, traffic speeds were reduced at the case study locations as a result of the road diet projects. The safety impacts of the road diet case studies are summarized as follows.

On Fourth Plain Boulevard, Vancouver, Washington, the safety impacts resulting from the road diet project follow:⁸

- Number of reported collisions along Fourth Plain Boulevard decreased by 52 % after the road diet project was constructed.
- Pedestrian safety improved and there were no reported pedestrian collisions along Fourth Plain Boulevard after the road diet project compared to six reported pedestrian collisions for the three years prior to the road diet project.
- Traffic speeds along Fourth Plain Boulevard have decreased about 18 % after the road diet project was constructed from 29.4 miles per hour to 24.2 miles per hour.

On Baxter Street in Athens-Clarke County, Georgia, the road diet project resulted in the following safety impacts:⁹

- The reported number of crashes was reduced by 53 % from the implementation of the road diet project.
- The reported number of crashes at unsignalized locations was reduced by 60 %.

- The number of rear-end crashes were significantly reduced by 45 % since left turning vehicles have a center turn lane to use instead of stopping in the through lane.

On U.S. 18 in Clear Lake, Iowa, the safety impacts resulting from the road diet project follow:¹⁰

- Number of crashes per year was decreased by 65 % from 40 crashes per year “before” to 14 crashes per year “after” the project was implemented.
- Travel speeds have been reduced with before and after speed data showing a 52 % reduction in aggressive speeding. In addition, the number of vehicles driving over the speed limit was reduced by 32 % after the road diet project.

On St. George Street, Toronto, Canada, significant safety improvements were realized as a result of the road diet lane reduction and narrowing project which follow:¹¹

- The number of collisions was estimated to be reduced by about 40 % from the reduction of lanes on St. George Street, from about 33 collisions per year “before” the lane reduction to about 20 collisions per year “after” the lane reduction.
- By narrowing the pavement and lane widths on St. George Street, the number of collisions was further reduced to about 19 collisions per year for the six years following the pavement and lane width narrowing.

On Kaikorai Valley Road, Dunedin, New Zealand, safety benefits were also achieved from the road diet project which follows:^{12,13}

- The road diet project on Kaikorai Valley Road resulted in a 30 % crash reduction from 10 crashes per year “before” the road diet project to about 7 crashes per year “after” the road diet project was implemented.
- The traffic speeds along Kaikorai Valley Road were also reduced after the road diet project was implemented. Approximately 88 % of the speeds “before” the road diet project exceeded 50 kilometers per hour (30 mph) compared to approximately 69 % of the speeds “after” the road diet project exceeded 50 kilometers per hour.

Despite the diverse settings, in all five case study sites where the road diet was implemented, the number of crashes decreased and measured speeds decreased resulting in significant safety improvements.

Operations

As shown from the case studies, there were no significant changes to traffic volumes on the road dieted streets. In addition, no significant traffic diversion impacts were found as well. The road dieted streets continued to operate adequately without significant queuing and operational impacts. For several road diet projects, pedestrian and bicycle activities were measured and observed as a result of the road diet projects. Also, improved pedestrian and bicycle conditions resulted from the projects. The operational impacts of the road diet case studies are summarized in this section.

On Fourth Plain Boulevard, the traffic operational impacts after the road diet project implementation follow:¹⁴

- No significant negative impacts to the traffic operation including no reports of queuing vehicles interrupting adjacent business and residential access on Fourth Plain Boulevard.
- Bicyclists and pedestrian activity have increased. The bicycle operational safety along the corridor has improved, and the bicycle level of service has improved significantly since the road diet project was implemented.
- Other operational benefits such as the bicycle lane providing space for police enforcement and a refuge area for vehicles temporarily broken down.
- There was no significant traffic diversion as part of the Fourth Plain Boulevard road diet project.

On Baxter Street, the traffic operational impacts resulting from the road diet project follow:¹⁵

- No significant impacts to the traffic volumes on Baxter Street or on adjacent streets after the road diet conversion project.
- Traffic diversion experienced from the project to be about 4 % of the Baxter Street traffic to Broad Street, a parallel arterial street north of Baxter Street.

After the road diet project, the traffic operation along U.S. 18 remained acceptable with good mobility. The resultant operating speeds were more uniform and closer to the posted speed limit.¹⁶

On St. George Street in Toronto, Canada, the road diet project resulted in the following traffic operational impacts:¹⁷

- Adequate traffic operations continue along St. George Street.
- Increase in pedestrians and bicyclists
- Traffic volumes along St. George Street have remained relatively consistent before and after the narrowing of the travel lanes as part of the road diet project from 7,300 vehicles per day in 1994 to about 7,400 vehicles per day in 2003.
- No traffic diversion impacts.

On Kaikorai Valley Road in Dunedin, New Zealand, the traffic operations resulting from the road diet project follow:¹⁸

- Adequate traffic operations continue along Kaikorai Valley Road.
- Traffic volumes have not been impacted from the road diet project and remained relatively constant. In addition, the vehicle classification and % trucks remained relatively constant.
- The traffic volumes show a small amount of growth which indicates that traffic diversion was not experienced from the road diet project on Kaikorai Valley Road.

At all locations, impacts to overall traffic operations were negligible if not positive.

Lessons Learned

The following section summarizes the lessons learned from the road diet case studies:

- Consider road diet projects when multiple opportunities arise such as a pavement reconstruction project, presence of an adjacent parallel route, and jurisdictional roadway transfer.
- Consider community requests to evaluate and implement road diet projects. With technical evaluation and community involvement with stakeholder groups, road diet projects are more likely to be successful.
- A public education campaign that goes along with a road diet project needs to emphasize the notion that this is a safety enhancement project and that it may require trade-offs in capacity and speed. Increase public education regarding the use of the two-way left turn lane.
- Manage community expectations with clear communication and documentation. Identify project goals, performance measures, expectations and conduct follow-up evaluation.
- Coordinate road diet projects with concurrent pavement overlay projects, if possible. A road diet striping plan on new pavement results in less driver confusion.
- By implementing a road diet as a pilot project study, the effects on safety and operations can be measured before deciding whether to keep it permanently and/or whether to fund enhanced design features and a more permanent solution. A temporary solution may not provide all of the benefits that a permanent solution would provide.
- Add bus pull out bays when needed.
- Include access management plans with appropriate spacing and/or elimination of driveways to reduce conflict points.
- Improve storm water grates across catch basins to improve bike operations.
- Repair sidewalks, ramps, and driveways in poor condition.
- Improve landscaping to “soften” the corridor.

- Coordinate with other corridor improvements.
- Install a grass median or other median treatment.
- Increase police enforcement of speeds and the proper use of the center turn lane.

Both the road diet pilot project and interim solution can be enhanced by adding landscaping, signal timing improvements, sidewalk connectivity, improved pedestrian crossings, and other enhanced design features.

Safety, operational and livability benefits result for all modes of transportation from the implementation of road diet project as seen from the case studies in this handbook.

ROAD DIET GUIDELINES

Great streets rarely happen by accident; great streets require vision and knowledge to make them happen. Road diets, when implemented properly and in the appropriate context, can enhance the livability of a street and contribute to the traits that can make a street great. This chapter provides guidance to the practitioner regarding how to determine if a street is a good candidate for a road diet, and best practices for road diet implementation.

When determining the appropriateness of a road diet conversion project, the project context and site-specific conditions such as traffic flow characteristics, vehicle capacity, traffic operations, safety, environmental impacts (social, built, and natural), and livability need to be considered.

This chapter will help practitioners identify and evaluate potential road diet candidate sites by taking them through the processes of planning, analysis, design and implementation of road diets. It includes general recommendations for road diets that take into account the project context and site-specific conditions that need to be considered. This chapter includes:

- Guidelines for identifying and evaluating potential road diet sites
- Feasibility factors
- Design guidelines and considerations
- Typical cross-sections for design concepts
- “Greening” road diet options
- Other considerations

Identification and Evaluation of Potential Road Diet Candidates

A road diet project can improve walkability and community livability and economics. The road diet is an alternative to widening the cross-section of roadway and, when appropriate, it can have lower overall impacts than widening the roadway, be a more cost-effective option, and result in acceptable operations and improved safety.

Recent research has recommended that road diet conversion should be evaluated in terms of safety and operation effects, especially vehicle speeds, congestion, traffic volume and traffic flow. Road diet conversions should be made on a case-by-case basis considering traffic flow, vehicle capacity, and safety goals.¹⁹ Each potential road diet implementation should identify, compare and analyze all feasible alternative improvements that meet the project goals and objectives.

Feasibility Factors

Several feasibility factors were identified in research conducted by Knapp to evaluate the feasibility of road diets:²⁰

- Roadway Function and Environment
- Overall Traffic Volume and Level of Service
- Turning Volumes and Patterns

- Frequent-Stop and Slow-Moving Vehicles (Agriculture, Buses, Mail, Buggies)
- Weaving, Speed, and Queues
- Crash Types and Patterns
- Pedestrian and Bicycle Activity
- Right-of-Way Availability, Cost, and Acquisition Impacts
- Presence of Parallel Routes
- Other Contextual Considerations

Road Diet Design Solutions

This section in the handbook provides a tool box for design of road diet projects, including optional enhancements such as landscaped medians, improvements to pedestrian crossings and facilities, street trees and curbside planters, improved transit user facilities, and green street options. For cost-effectiveness and natural resource conservation, road diet projects can be designed and constructed by simply re-striping the roadway and re-using the existing pavement width and curbs.

A context-sensitive solutions approach is recommended for potential road diet projects. From *Thinking beyond the Pavement*, Maryland State Highway Administration Workshop, 1998 – “*Context sensitive design asks first about the purpose and need of the transportation project, and then equally addresses safety, mobility, and the preservation of scenic, aesthetic, historic, environmental, and other community values. Context sensitive design involves a collaborative, interdisciplinary approach in which citizens are part of a design team.*”

It is important to recognize that every project is unique. Design solutions for road diet project alternatives need to:

- Provide a safe and efficient transportation corridor for vehicles, buses, bicycles and pedestrians.
- Balance the needs of the transportation system with the interests of the surrounding community and the environment
- Create a transportation facility that is an asset to the community

Road diet project objectives could include:

- Improved safety and operations
- Enhanced neighborhood character
- Improved access to businesses, transit, parks, etc.
- Preserved and improved environmental conditions throughout project limits by reducing pavement area and treating water run-off

Design Concepts

Street design is a key element of smart growth development and directly affects quality of life. Designers are encouraged to integrate streets closely with planned land use. From Metro’s (regional government agency for Portland Metro, Oregon, U.S.) document, *Creating Livable Streets*²¹:

“A livable regional street should provide those environmental conditions that support independence and freedom of choice; provide orientation, safety and comfort; encourage a sense of community yet provide sufficient privacy; foster a sense of neighborly ownership and responsibility; avoid disturbing nuisances; and enhance the economic value of adjacent property.”

The road diet design concepts presented in this chapter are focused on the conversion of a four-lane undivided roadway to a two-lane roadway. A center turn lane is recommended when driveways are present, and a landscaped center median in areas where driveways are uncommon or absent. The remaining roadway width can be converted to bike lanes, on-street parking, landscaping, sidewalks, and/or turned back to the property owners.

A Policy on the Geometric Design of Highways and Streets (Green Book) published by the American Association of State Highway and Transportation Officials (AASHTO) provides geometric design criteria for roadways. As noted in the Foreword (2004), “*The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions. It is not intended to be a detailed design manual that could supercede the need for the application of sound principles by the knowledgeable design professional. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations.*”²²

The road diet design concepts presented in the handbook complement the AASHTO guidelines.

Traveled Way

The handbook provides general design parameters for major urban arterial and collector thoroughfares with varying contexts. General guidance on dimensions and cross-section elements criteria, including lane widths, is included for urban streets with two to four through lanes.

Travel lane and turn lane widths can vary depending on the project context, land use, modal use, and speed from a minimum of 10 feet to 14 feet (3 m to 4.3 m).

Suggested Left-Turn Treatments for Road Diet Streets

Based on previous research, the handbook provides guidance on the selection of left-turn treatments for specific conversion alternatives and factors.

Transitions

When the number of travel lanes is reduced and/or width of the street is changed, a smooth transition needs to occur. The principles for designing effective transitions include:²³

- Properly design, stripe, and sign geometric transitions using established guidance (Manual on Uniform Traffic Control Devices (MUTCD), AASHTO).
- Transitions should occur on a tangent roadway section and avoid areas with horizontal and vertical sight distance constraints.
- Entire transition length should be visible to the driver.
- When roadways widen or lanes are added, a transition taper of 10:1 is sufficient.
- Transitions to left or right turn lanes typically require a shorter taper. AASHTO recommends 100 feet (30.5 m) for single turn lanes.

It should be noted that choosing the transition locations for road diet projects needs special attention and thorough evaluation. Major driveways and intersections should be avoided along a transition. Intersection and roundabout locations can be ideal beginning transition locations to drop lanes.

Bicycle Facilities

Bicycle travel is an important element of multimodal, livable streets. Bike lanes are practical and often essential for road diet projects. They not only improve the bicycling environment, but also provide a buffer to pedestrians. In addition, bike lanes allow space for vehicles to temporarily store while emergency vehicles pass, they add to turning radii, and they improve sight lines. Important sources for bicycle facility design and treatments are the *AASHTO Guide for the Development of Bicycle Facilities*²⁴, *ITE Innovative Bicycle Treatments*²⁵, and the *MUTCD*²⁶.

General considerations for bicycle facilities are:

- Smooth surfaces are needed for safety and comfort of bicyclists.
- Regular maintenance and street sweeping are required and pavement should be free of large cracks and potholes.
- Curb inlets for drainage or bicycle-safe inlet grates should be provided.

Recommended lane widths for bicycle lanes and typical lane marking for bicycle lanes are presented in the handbook.

On-Street Parking

On-street parking provides a buffer to pedestrians from traffic and is found to decrease traffic speeds. In addition, on-street parking meets the needs of adjacent land uses and stimulates street activity. On-street parking should be implemented based on project context, traffic volume and speed, adjacent land uses, and local parking management plans and policies.

General considerations for on-street parking are:²⁷

- Parallel parking should be considered on urban arterials and collectors.
- Angled parking may be considered on low-speed and low-volume commercial collectors and main streets.
- On-street parking should not be considered on major streets with speeds greater than 35 miles per hour due to potential maneuvering conflicts.
- Consider the use of a curb lane for on-street parking during off-peak hours when traffic capacity needs to be balanced with on-street parking needs.
- Provide a minimum of 1.5-foot (0.46 m) offset between face of curb and edge of potential obstructions such as poles and trees.
- Parking should be prohibited within 20 feet (6.1 m) of fire hydrants or per local codes.
- Parking should be at least 20 feet to 50 feet (6.1 m to 15.2 m) from midblock crosswalks and at least 20 feet (6.1 m) from the curb return of intersections (30 feet (9.1 m) for signalized intersections). Curb extensions can be used to reduce this distance.

Pedestrian Realm

Streets have multiple uses and appropriate solutions should be selected to improve pedestrian safety and access. In addition, walkable streets promote healthy communities and safe neighborhoods. Sidewalks are important elements of street design. Key attributes of good sidewalk corridors are:²⁸

- Accessibility
- Adequate travel width
- Safety
- Continuity
- Landscaping
- Social space for people to interact
- Quality of place to strengthen the character of neighborhoods and business districts

When implementing a road diet conversion project, the following are key issues/actions to be addressed and/or undertaken:

- Identification of pedestrian crossing locations and exposure to potential hazards.
- Identification of missing sidewalks or pathways
- Identification of transit zones and stop locations and provision of adequate pedestrian access.
- Both pedestrian and bicycle facilities need to be designed to be compatible with and facilitate transit use.
- Design and maintenance of landscaping to provide good visibility between pedestrians and approaching vehicles.
- Provision of adequate lighting for pedestrian safety at night.
- Comfortable sidewalks for pedestrians, with a minimum width of 5 feet, and maintained routinely.

Other sources for effective design of pedestrian facilities include: ITE *Alternative Treatments for At-Grade Pedestrian Crossings*²⁹, *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations* for FHWA³⁰, *ITE Design and Safety of Pedestrian Facilities*³¹, and AASHTO's *Guide for Planning, Design*

and *Operation of Pedestrian Facilities*³². Pedestrian facilities need to be accessible to all users, and in the U.S. meet the requirements of the Americans with Disabilities Act (ADA), and an additional resource is the United States Access Board's *Draft Guidelines for Accessible Public Rights-of-Way*³³.

Guidelines for installing marked crosswalks and other needed pedestrian improvements at uncontrolled (unsignalized) locations are provided in the handbook. To reduce the effective street crossing distance for pedestrians, the following design options can be considered:

- Narrow the street width,
- Provide curb extensions, and/or
- Add raised pedestrian refuge islands at intersections.

Pedestrian refuge islands as raised medians can be added at intersections between center left turn lanes, if designed appropriately.

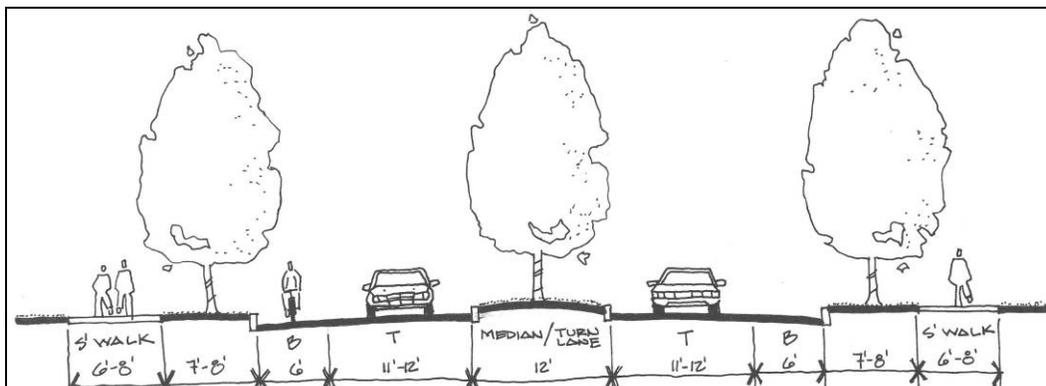
Typical Road Diet Cross-Sections (Two-Lane Streets)

Several road diet cross-sections are provided in the handbook for reference. The selection of cross-sectional elements is project-specific. The width of street, travel lanes, bike lanes, on-street parking, sidewalk, and landscape areas can be adjusted within the right-of-way. These decisions will likely be based on modal priorities, adjacent land uses and speeds, and should be made on a case-by-case basis, and may vary along a project corridor.

Exhibit 10: Curb Extension



Exhibit 11: Example Road Diet Cross-Section with Median/Turn Lane, Bike Lanes, Landscaping and Sidewalks



Streetscaping may be initiated by a community visioning or planning process that establishes guidelines for streetscape design. Implementation may involve special published guidelines, plans and funding for streetscape improvements on a particular street or in an area.

Streetscape improvements can also be incorporated into subdivision and roadway design standards, for example, by encouraging or requiring shorter blocks, wider sidewalks, bike lanes, narrower streets, landscaping, and other features that improve accessibility, walkability and aesthetics.

Traffic Calming Options

Traffic calming measures can be implemented as part of road diet projects. The ITE *Traffic Calming State of the Practice*³⁴ provides traffic calming options that can be considered. The handbook presents examples of traffic calming measures.

In addition to the above traffic calming examples, roundabouts can be used for intersection traffic control to both slow traffic speeds and keep traffic moving. The FHWA *Roundabouts: An Information Guide*³⁵ is an important resource to use when considering the implementation of a roundabout. Roundabouts have also been used to serve as transition points between three- or two-lane street segments and four-lane segments.

Green Streets

A green street meets the transportation need and applies environmental stewardship to improve the natural, built and social environments. A few examples of green street design solutions are provided in this chapter of the handbook as optional enhancements for the road diet application.

As identified in Metro's (regional government agency for Portland Metro, Oregon, U.S.) *Green Streets Handbook*³⁶, the appropriate green streets design solutions and/or combination of solutions depends on the desired functions (e.g., runoff reduction, detention, retention, conveyance and water quality mitigation) and site/watershed conditions.

Exhibit 12: Green Street with Bio-Filtering Stormwater Planter/Bio-Swale and Unit Pavers



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END NOTES

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