

BICYCLE CIRCULATION PLAN FOR THE PRINCETON COMMUNITY

Prepared for the
Princeton Regional Planning Board

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Bicycle Circulation Plan for the Princeton Community

I. Introduction

A. *Introduction – the role bicycling can play in Princeton*

Bicycling is an important mode of transportation for many residents of Princeton Borough and Township: bicycling is also a popular recreational activity. Bicycling can provide children with the ability to travel within the community independent of their parents and cars. For adults bicycling can provide an alternative mode of commutation and offer an opportunity to exercise while completing local trips.

For everyone bicycling provides an opportunity to reduce the community's reliance on automobiles. Not all trips can be made by bicycle, but many can. Most motor vehicle travel consists of trips shorter than five miles, a distance that can be easily negotiated on a bicycle. Many residents drive their cars for trips less than a mile in length. For longer distances, bicycles can be used to access bus or rail services, and NJ Transit now allows bicyclists to travel with their bicycles on many train and bus routes. Instead of polluting the air and clogging community streets, residents can leave their cars at home, get some exercise and reach their destinations with little if any lost time.

The amount of bicycling that does occur in Princeton is substantially less than the amount that could occur. Many residents lack the confidence needed to bicycle on Township roads and Borough streets. Parents are reluctant to let their children bicycle to schools or parks or into town because of the perceived threat of vehicle conflicts. Narrow roadways and moderately high traffic volumes provide little margin for error, either for the bicyclist or the motorist. Bicyclists face problems finding appropriate places to secure their bicycles when they reach their destinations except within the university. P' SHOPPING CENTER

The Princeton Community Bicycle Circulation Plan addresses these issues and proposes a program of improvements, policies, development regulations and investments that can be used to encourage bicycling activity.

B. *Plan Preparation*

The preparation of the Princeton Community Bicycle Circulation Plan was funded in part by a Green Links grant provided by the Regional Planning Partnership. As part of that grant, a Geographical Information System (GIS) mapping database was developed by a consultant to assist in the analysis of geographical issues affecting bicycling in the community.

Since the Princeton community last systematically addressed issues affecting bicycling, extensive national research and policy development has occurred, including the publication of design guidelines by the American Association of State Highway and Transportation Officials (AASHTO) and design and planning guidelines by the New Jersey Department of Transportation.

This plan was prepared over a four year period. During the first year the consultant met several times with an advisory committee consisting of professional staff of the Borough, the Township and the Regional Planning Board and representatives from the Borough's bicycle advisory committee, the Township's Sidewalk and Bikeway Advisory Committee and the Regional Planning Board. (The two municipal bicycle committees have since merged to create a regional advisory committee.)

A preliminary draft plan was prepared in June 1999; in July 1999 the Regional Planning Board conducted a public meeting to discuss the preliminary recommendations. At this meeting, various members of the Princeton community expressed concern regarding the potential impact that bicycle improvements could have on other community values, including the historic character of regional roadways and the availability of on-street parking.

Based on these comments, the Circulation Subcommittee of the Planning Board held a series of work sessions with the consultant to clarify the role that bicycling should play in the Princeton Community, to identify goals that could be established regarding the role bicycling should play in Princeton, and to refine the plan so that it would better reflect community values.

The current plan represents the product of this community discussion. The plan provides the Princeton Community with approaches it can follow to encourage bicycling by all of its members, from children to occasional adult riders to expert riders. The plan will be used as a resource during the development of a revised Circulation Element of the Community Master Plan and during the preparation of revised development regulations for the borough and township. As these documents are developed, the Circulation Subcommittee and the Regional Planning Board will have to consider how the recommendations of this bicycle plan should be balanced with recommendations and opinions of other interested parties in the Princeton Community.

C. *Bicycling initiatives undertaken during the development of this plan*

During the four years that the plan was being prepared, a number of events affecting bicycling occurred within the community. These included:

1. *Route 206 bicycle and pedestrian compatibility study*

The New Jersey Department of Transportation (NJDOT) prepared and presented a set of concepts for how Route 206 could better accommodate the mobility needs of bicyclists and pedestrians. The community review of these concepts, including proposals for minor widening of segments with restricted width, resulted in extensive community debate, focusing attention on how competing values should influence the design of the community's roadways.

2. Guyot Walkway.

Led by parents, school children and other concerned citizens, the township has made numerous improvements to the Guyot pedestrian way between Jefferson Street and the Valley School property. These improvements, and the resulting increase in pedestrian activity along the path, have shown the important role that linkage trails can have in the community, especially for children.

3. Community Park South trail.

The township and the Recreation Committee have developed a plan for a multi-use trail through Community Park South. This trail will help to link the Guyot walkway with additional trails in the township west of Bayard Lane.

4. Designation of sidewalks as Bike Routes

The preliminary draft plan included a recommendation that sidewalks not be designated as bicycle routes. Since that report was released, the Borough has removed signs that designate sidewalks as bicycle routes. Such signage remains in place in the township.

5. freewheels™ of Princeton

In 1998 the Greater Mercer TMA introduced its **freewheels™** neighborhood yellow bike program for commuters, residents and visitors to the Princeton area. **freewheels™** is a federally-funded alternative mode of transportation for commuting around Princeton. The program allows people to hop on a free bike, travel to their area-destination, and then drop the bike off at a designated freewheels™ bike station.

The TMA has sustained the program over the past several years. However, because the yellow bicycles have continually disappeared rather than being returned to the designated bicycle parking stations, the TMA in 2002 decided not to continue providing replacement yellow bicycles for the program.

II. Issues in Developing a Bicycle Plan for the Princeton Community

A. *Types of Bicyclists*

There are many people who ride bicycles – children, young adults, working adults and retirees. Some use bicycles only for casual recreation, some adults and children rely on bicycles to commute to jobs or schools, some Princeton residents enjoy long and fast road rides for both aerobic exercise and a means of exploring central New Jersey, either with or without an intended destination. Some lower income persons may find that a bicycle is the only means of transportation that they can afford, while other persons who could afford a motor vehicle may elect not to own or drive a car.

There are differences in skills among riders, differences in strength, differences in experience and differences in judgment. Bicyclists also differ in their ability to ride with motor vehicles and their willingness to do so. Furthermore, some riders who may be able to ride on heavily traveled roads choose to avoid them. Conversely, some riders who willingly ride in traffic may not know how to safely use a bicycle on a traveled roadway.

These differences between bicycle riders present a recurring theme in this plan. Because individuals within the community have different needs, a variety of bicycling opportunities are needed.

1. Experienced Riders

Many adults and older children have learned to ride a bicycle with confidence, have the judgment to operate a bicycle in mixed traffic, and desire the same mobility using a bicycle that motorists take for granted. For trips under five miles, that is for most trips, these experienced riders will find a bicycle just as convenient as a car. For recreation, regional roadways provide experienced riders an infinite choice of routes to follow. And some of these longer trips can allow bicyclists to simultaneously get some exercise while accomplishing personal travel needs.

Modest accommodations – narrow shoulders or wide curb lanes – will allow these experienced bicyclists to safely ride with motor vehicle traffic on area collector and arterial roadways. However, these bicyclists will enjoy using more generous facilities such as off-road trails or bike lanes, if the facilities are conveniently located and provide the riders with the same quality of riding experience. These bicyclists will seek out routes with reduced motor vehicle traffic, when available, and they will try to avoid when possible highways with high volumes of motor vehicles or roadways that fail to accommodate bicyclists as a result of narrow widths and high traffic volumes.

Experienced bicyclists constitute a small proportion of all bicyclists: national surveys indicate that approximately 20% of bicyclists fall into this category. However, these same surveys indicate that experienced riders make over 80% of all bicycle trips.

The skills and confidence required to ride in mixed traffic or along relatively narrow shoulders can be learned. Less skilled riders can with encouragement and experience become more skilled riders. Communities that actively encourage and support bicycling will have more skilled riders.

2. Casual and Less Experienced Riders

Sharing a roadway with substantially larger, faster and more powerful trucks, cars and motorcycles is not for everyone. Parents may be reluctant to expose their children to such roadways. Adults, especially adults with only limited bicycling experience, will feel uncomfortable riding next to traffic. And even experienced riders, when given a choice, will select a less traveled roadway provided that it accommodates their mobility needs.

People gaining experience riding a bicycle, or who ride bicycles only infrequently, will usually choose to use less traveled streets and roads and will welcome opportunities where they can ride on trails, bicycle paths or bicycle lanes that promise a greater separation from motor vehicle traffic.

Providing this group of bicyclists with riding opportunities can encourage the use of bicycling and can increase the number of persons who have developed the skills required to use bicycles as a means of transportation. Providing safe bicycling routes to schools and other youth oriented places can allow older children to travel independently within the community. Multi-use paths constructed in accordance with AASHTO standards can provide both skilled and novice riders with enjoyable and convenient alternatives to streets, and will promote the use of bicycle travel.

3. Younger Children and all Persons Learning to Ride

People learning to ride bicycles need to learn in a forgiving environment. Falls may occur as one learns to balance a bicycle. A novice rider has much to think about; contending with motor vehicle traffic adds an unneeded level of difficulty and stress.

Of particular concern are young children. Most children under the age of ten lack the judgment needed to ride bicycles on streets safely. They need strict rules regarding where they may ride their bicycle, and their riding should be monitored.

Local sidewalks, driveways and empty parking lots may be appropriate places for beginning cyclists to practice. However, parents should be aware that drivers may not anticipate a child riding a bicycle on a sidewalk. Every child needs to be taught about the responsibility to watch for traffic. Since drivers may not be able to see a child on a bicycle within a sidewalk, children must be taught to stop for cars when riding on sidewalks.

4. In-Line Skating, Scooters and Other Uses

Bicycles are just one type of human powered transportation. Skateboards, scooters and in-line skates are all popular mechanical means for facilitating human powered transportation. Many of the facilities provided to assist bicyclists will also serve these other modes. Bicyclists need to learn how to share and respect the needs of these other users. Although this report is entitled a bicycle circulation plan, the program of improvements suggested will benefit these other users.

Other machine-powered modes of transportation are now available and may also be used on facilities constructed to accommodate bicycles. These include motorized wheelchairs and powered scooters.

B. Safety of Bicycling

Many citizens, policy makers and parents are concerned about the perceived risk of riding bicycles on public streets in traffic. Some argue that bicyclists should ride out of traffic by using sidewalks, others that narrow off-road paths should be constructed to provide bicyclists with alternatives to riding on streets. Contrary to the expectation of persons who do not regularly bicycle, numerous studies have shown that accidents between motor vehicles and bicycles are least likely to occur if a bicyclist treats his or her bicycle as a vehicle and adheres to the "rules of the road".

A summary of national research on bicycle crashes was prepared during the development of this report and is presented as an Appendix 1. Key findings of that paper are as follows:

- Over 75 % of crashes between bicycles and motor vehicles are associated with turning or crossing maneuvers; over half of all crashes are at intersections. A bicyclist riding in the wrong direction on a roadway or sidewalk is much more likely to be involved in these types of turning or crossing crashes. Such a bicyclist is not within the driver's area of surveillance and is therefore more likely to be struck. For this reason two-way bicycle paths adjacent to streets are especially hazardous.
- Making roads compatible with bicycle use can help reduce the risk of accidents with vehicles on highways. The type of accident most feared by inexperienced bicyclists, and by policy makers with little bicycling experience, is a crash with a passing motor vehicle. However, these accidents represent only 8.6% of all crashes between motor vehicles and bicycles and less than 1% of all bicycling accidents. Although only a very small percentage of total bicycle accidents, an accident with an overtaking motor vehicle is more likely to result in serious injury or death. These accidents, when they do occur, are most likely to occur on higher speed rural roadways having insufficient roadway width. Making roadways compatible with bicycle use can reduce the already low risk of these accidents occurring. Roads can be made compatible with bicycle use either by controlling the speed of motor vehicles or by providing adequate pavement widths on higher speed roadways.
- Almost 90% of bicycle accidents are caused by falls that do not involve motor vehicles. Providing bicyclists with smooth riding surfaces, adequate riding width and good sight distance can help reduce the risk of falls. Since less experienced riders are especially likely to experience falls, safe and forgiving places for persons to learn to ride can help reduce the risk of severe injuries resulting from falls.
- Almost 60% of bicyclists involved in crashes with motor vehicles were under the age of 20. In over 50% of bicycle/automobile crashes the bicyclist was fully or partially at fault. Riders under the age of 20 were much more likely to be at fault than were riders over that age. This data indicates the importance of developing and maintaining effective cycling education programs in the schools to educate children on how to safely ride a bicycle, and on the responsibilities of riding a bicycle, especially in traffic.

C. *Respecting Community Values*

The land occupied by streets, roads and highways has many competing purposes. In addition to providing needed mobility, roadways provide access to property, they create the corridors through which we travel and therefore see and learn about our community, they provide the front yards for our homes and businesses, thereby becoming part of our greater estate. We meet and learn about our neighbors on our streets; the landscaping and views along the street provide a shared public environment that helps to define the community. Because the arterial roadway network in Princeton has been in place for centuries, roadway environments also have great historic importance, and their current appearance has evolved as transportation and settlement patterns have changed.

Because of the many different roles streets and roads play in the community, there are competing interests regarding how streets should be used. Frequently a balance has to be struck between different uses of this public environment. Since adequate roadway width is a key element in determining whether a roadway is compatible with bicycle use, an important function of the bicycle circulation plan should be to define how the special needs of bicycle users should relate to the needs of other users of the public environment.

D. *Encouraging Alternatives to Motor Vehicle Travel*

No one anticipates that motor vehicle use will disappear, or that the central role motor vehicles play in moving goods and people will be substantially diminished. But we can reduce the number of motor vehicle trips that we make and the frequency with which we choose to drive. Bicycles are only one of many alternatives to the motor vehicle. Encouraging greater use of these alternatives can help reduce the public's reliance on motor vehicles and improve the quality of community life. A community that befriends bicycles and encourages bicycle use can help itself become less dependent on motor vehicles.

III. Bicycle Goals for the Princeton Community

The Circulation Subcommittee of the Regional Planning Board developed the following goals for bicycling in Princeton to assist it in the preparation of this plan. The goals will also be useful in assessing the implementation of the plan and the extent to which the community has become a more accommodating community for bicycling.

A. *Assure that Princeton is a community where people will feel comfortable choosing to ride a bicycle*

Streets and roads in Princeton should accommodate bicycle use wherever possible. If, because of restrictions of right-of-way and competing street needs, bicycles cannot be accommodated on some roadway segments, then effective methods of mitigating the impact to bicyclists should be developed. For bicycling to be an effective alternative to motor vehicle travel, the Princeton community should assure that bicycle users are offered the same mobility and accessibility within the community that is currently provided to users of motor vehicles.

B. *Encourage more bicycling, and help reduce the number of motor vehicle trips*

Where appropriate, roadways, paths, bicycle racks and other improvements should be provided to encourage more people to choose to bicycle, and to encourage people who do bicycle to bicycle more frequently. In particular, people should feel that it is reasonable to consider bicycling when making short trips (less than five miles) that might otherwise be made by auto.

Motorists, pedestrians, other bicyclists and residents should learn to recognize that riding a bicycle is a reasonable travel choice for many trips, and should be one of the preferred methods of making short trips in the community.

C. *Enhance the mobility and autonomy of children*

Children should be provided with streets and paths that will allow them to ride within neighborhoods, between neighborhoods, to schools and parks and into town. Riding opportunities should be perceived to be safe so that parents can have the confidence needed to allow their children to use their bicycles for community travel.

Programs should be offered to teach children how to safely ride on community streets, how to protect the rights of other street users, especially pedestrians, and how to protect and maintain their bicycles.

D. *Increase the awareness of all members of the public regarding the rights and responsibilities of bicyclists*

Bicycles in New Jersey are vehicles, and bicyclists have a right to use all of the streets and roads in Princeton. Information should be provided to drivers regarding the rights of bicyclists, and regarding proper ways of sharing the road with bicyclists. Police should warn or issue tickets when motorists fail to properly respect the rights of bicyclists to travel on streets and roads.

Likewise bicyclists have responsibilities to ride their bicycles in accordance with vehicle regulations. Riding on the wrong side of the road, failing to anticipate or respect pedestrians, traveling through red lights or not yielding the right-of-way at intersections are all violations and should be subject to warnings or summons.

E. *Make destinations bicycle friendly*

If bicycles are to be used for personal travel, then the destinations that could attract bicyclists need to be bicycle friendly. Good bicycle storage devices should be both available and located where they will be used. Destinations in the Princeton Community that could attract bicyclists would include schools, parks and recreation areas, downtown and other shopping areas, the library, employment centers, the university and transit centers including the Dinky station and Palmer Square.

F. *Promote the public's health*

The American Medical Association and the Centers for Disease Control have determined that encouraging bicycling, walking and other forms of human powered transportation is essential for protecting and improving the public's health. According to the CDC our nation is experiencing an epidemic of obesity; a chief cause of this epidemic has been the way our communities have evolved around motor vehicles. The CDC believes that communities must work to encourage physical activity in the routine behavior of Americans.

The AMA and CDC are particularly concerned about obesity among America's children. School buses and family cars are used too frequently by children, and children do not ride bicycles or walk as frequently or as long as they did in the past. A community that encourages bicycling will create a more active and healthy community.

IV. Tools for Accommodating and Encouraging Bicycling

A wide range of engineering, educational and enforcement tools are available to improve bicycling within the Princeton community to accomplish the above goals. These are briefly discussed below. Appendix 2 presents a more detailed discussion.

A. Accommodating and Encouraging Bicycling on Roadways

Engineering guidelines for roadways that accommodate bicycling have been developed and published by the American Association of State Highway and Transportation Officials (AASHTO)¹ (last revised 1999) and the New Jersey Department of Transportation² (1996). Central to these two publications is a philosophy that all roads should be designed to at least accommodate bicycle use. More rigorous standards however are required for those roadways that public agencies will designate as bikeways in order to encourage greater use by bicyclists.

1. Roads that Accommodate Bicyclists – Bicycle Compatibility

A road or street that accommodates bicycle use provides sufficient width to allow a moderately skilled bicyclist to comfortably and safely use the roadway. Almost all bicyclists will find local streets and roads with very low travel volumes acceptable places to ride. However, with increased motor vehicle volumes and increased motor vehicle speeds additional roadway width becomes needed to provide adequate separation between the motorist and the bicyclist.

Table One from the NJDOT Guide, reproduced on the next page, depicts how roadway speed, roadway environment and roadway geometry combine to determine whether a roadway can accommodate bicyclists.

2. Roads that Encourage Bicycling

Most bicyclists would prefer to ride in an environment where conflicts with motor vehicles, and perceived threats of motor vehicles, are limited. Less skilled bicyclists, and more timid bicyclists, are easily discouraged from riding in environments where the speed or volume of motor vehicle traffic is perceived to be dangerous.

As a result, to encourage bicycling it is desirable to identify streets and roads on which riders will feel less threatened by motor vehicles and to designate these as bike routes. Even skilled bicyclists will choose these routes if they offer similar riding opportunities in terms of convenience and directness.

Table Two above presents conditions required to designate a road as one that encourages bicycling.

¹ *Guide for the Development of Bicycle Facilities*, AASHTO, 1999

² *Bicycle Compatible Roadways and Bikeways Planning and Design Guidelines*, NJDOT, April 1996

Table 1

NJDOT Bicycle Compatible
 Roadway Pavement Widths

Condition I
 AADT 1200* - 2000

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
<30	12' shared lane	11' shared lane	10' shared lane
31-40	14' shared lane	14' shared lane	12' shared lane
41-50	15' shared lane	15' shared lane	3' shoulder
>50	NA	4' shoulder	4' shoulder

For volumes less than 1200 a shared lane is acceptable.

Condition II
 AADT 2000-10,000

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
<30	14' shared lane	12' shared lane	12' shared lane
31-40	14' shared lane	14' shared lane	3' shoulder
41-50	15' shared lane	15' shared lane	4' shoulder
>50	NA	6' shoulder	6' shoulder

Condition III
 AADT over 10,000 or Trucks over 5%

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
<30	14' shared lane	14' shared lane	14' shared lane
31-40	14' shared lane	4' shoulder	4' shoulder
41-50	15' shared lane	6' shoulder	6' shoulder
>50	NA	6' shoulder	6' shoulder

NOTE: NJDOT minimum shoulder width of 2.4 meters (8 feet) should be provided wherever possible on roadways having an AADT greater than 10,000 vehicles.

Table 2

NJDOT Bikeway Designation and
 Roadway Pavement Width

Condition I
 AADT 1200* - 2000

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
<30	14' shared lane	14' shared lane	10' shared lane
31-40	5' Bike Lane	5' Bike Lane	4' shoulder
41-50	6' Bike Lane	5' Bike Lane	6' shoulder
>50	N/A	6' Bike Lane	6' shoulder

For volumes less than 1200 AADT a shared lane is acceptable.

Condition II
 AADT 2000 - 10,000

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
30	14' shared lane	14' shared lane	4' shoulder
31-40	5' Bike Lane	5' Bike Lane	6' shoulder
40-50	6' Bike Lane	6' Bike Lane	6' shoulder
>50	N/A	6' Bike Lane	8' shoulder

Condition III
 AADT Over 10,000

SPEED (mph)	URBAN W/PARKING	URBAN W/O PARKING	RURAL
<30	5' Bike Lane	5' Bike Lane	4' shoulder
31-40	6' Bike Lane	5' Bike Lane	6' shoulder
41-50	6' Bike Lane	6' Bike Lane	6' shoulder
>50	N/A	6' Bike Lane	8' shoulder

3. Methods of Improving Roadways for Bicycling

The NJDOT and AASHTO bicycle design guidelines for roadways, both those for accommodating bicycling and those for encouraging bicycling, reflect four roadway attributes – roadway width, roadway markings, motor vehicle volumes and motor vehicle speeds. Roads that fail to achieve desired characteristics for bicycling can be modified in a variety of ways including widening, restriping, slowing vehicles or diverting vehicles.

Furthermore, a variety of these techniques can be employed to accomplish a particular desired outcome. For example, a 26' roadway that currently has 12' travel lanes and 1' shoulders can be modified to provide 4' bicycle lanes by narrowing the travel lanes to 10' and widening the roadway to 28'.

Similarly, an existing 28' wide road with a 45 mph operating speed can be made appropriate for marking with bicycle lanes if traffic calming measures are implemented to effectively slow roadway traffic to below 40 mph.

Appendix 2 provides a more detailed discussion of roadway standards appropriate for accommodating bicyclists and standards appropriate if a road is to be designated as a bikeway.

B. *Develop Off-Road Opportunities*

Streets and roads provide a substantial network for using bicycles. However, many less skilled bicyclists feel threatened when riding with motor vehicle traffic. Novice riders, and children under the age of ten who lack the judgment required to ride in traffic, require areas for riding where they can learn how to safely operate a bicycle.

Providing off-road riding opportunities will encourage greater bicycling activity, especially if the trails can be located where they also serve bicycle trip origins and destinations. Even isolated trails however will attract some novice bicyclists, including families that want to provide their children with a learning opportunity.

Appendix 2 includes a discussion of appropriate design standards for off-road bicycle routes based on standards developed by AASHTO and NJDOT. Key issues from the appendix are discussed below.

1. *Bicycling on Paths Adjacent to Roadways*

Sidewalks and paths adjacent to streets and roads are generally inappropriate for designation as a bikeway, as will be discussed later in this report. Bicycle paths can be constructed adjacent to roadways and still comply with NJDOT and AASHTO design guidelines. Two types of paths can be provided – bicycle tracks or shared paths that comply with off-road trail standards.

a. Bicycle tracks

Bicycle tracks are a design alternative to bicycle lanes and consist either of raised shoulders or separate bicycle only paths. Bicycle tracks operate as one-way paths and function as extensions of the roadway. They are not intended for use by pedestrians. As a result, separate paths or sidewalks must be provided for pedestrians.

Bicycle tracks require more right-of-way than bicycle lanes or bicycle compatible shoulders. Raised tracks or separated tracks also require additional maintenance. However because they are restricted to bicycle use and do not appear as an extension of the roadway, they may be more acceptable to members of the community who are opposed to wider roadways. Bicycle tracks have been used in Europe to encourage bicycle use.

b. Shared paths

Shared paths along roadways function as a cross between multi-use trails (see below) and sidewalks. Shared paths are located along street corridors but are designed in accordance with state guidelines for multi-use paths (see following section).

Intersections with streets and driveways that cross the path are separated from adjacent street intersections by a minimum of one car length, and preferably several car lengths, to permit the junction of the path with the intersecting street to operate independently of the intersection of the street with the parallel roadway. Adequate sight distance and pathway alignment must be provided to permit bicycles to be operated safely and to allow bicyclists to see pedestrians.

2. Multi-use Trails

Multi-use trails are preferred by many casual bicyclists and are very effective at encouraging bicycling. Communities that have developed extensive networks of multi-use trails frequently generate more bicycle travel, both on the trail network and on community streets and roads. Examples of such communities include Boulder CO, Washington DC and Ottawa Canada.

Multi-use trails attract experienced bicyclists, novice bicyclists, groups of riders, pedestrians, joggers, skaters and other users. As a result of the diversity of users, trails must be carefully designed if they are to function both safely and efficiently. Trails must have adequate width, especially given the likelihood that users will seek to travel abreast.

The Delaware & Raritan Canal's towpath is the most heavily used multi-use trail in the Princeton community.

3. Linkage Paths

Linkage paths are short multi-use trails that connect sections of roadways that would otherwise be isolated. They allow bicyclists and pedestrians to travel more direct routes when completing trips, frequently making the walk or bike trip more efficient than an automobile trip. A short linkage path can also allow a bicyclist to use low volume local streets to make longer trips using routes that cars cannot use.

The path between the Princeton Shopping Center and Grover Lane is one of the many linkage paths that have already been built within the Princeton community.

4. Bicycling in Parking Lots and Alleys

Circulation roads in parking lots and alleys behind buildings can extend the street network for bicyclists and shorten travel distances. However, careful consideration should be given to potential conflicts before these facilities are designated as bicycle routes. In particular, parking lots with high turnover rates can generate frequent conflicts. The owner of a parking lot must consent to the lot being designated as part of a bicycle route. Frequently it will be necessary to assign an easement to the municipality so that issues of liability can be addressed.

5. Bicycle Boulevards

Bicycle boulevards combine multi-use trails, linkage paths, local streets, alleys and other roadways that have limited motor vehicle use to create continuous bicycle routes that most cyclists will find safe, convenient and direct. Bicycle boulevards are most frequently created along routes parallel to major arterial streets, both to discourage through motor vehicle traffic and to provide bicyclists with an alternative to the arterial street. By constructing roadway diverters, or by closing short blocks to motor vehicle traffic, a parallel roadway can remain accessible to bicycle and pedestrian traffic, provide access to abutting properties yet discourage through motor vehicle movements.

C. **Supporting Bicycle Use**

This section discusses additional tools that can be used to:

- Encourage bicycle use within the Princeton community
- Permit bicycles to be used as a convenient mode of transportation
- Promote safe use of bicycles in an environment that requires sharing roadways and paths with motor vehicles and pedestrians

1. **Bicycle parking**

If bicycling is to help reduce the public's reliance on motor vehicles for making trips, adequate facilities must be available to safely and securely park bicycles at locations that attract trips. Bicycle parking facilities, to be effective, should provide the following features:

- Support the bike frame at two locations
- Support the use of both cable or "U-type" locks
- Allow for locking the bike frame and at least one wheel
- Not require that the bike have a kickstand
- Not conflict with water bottle cages

Bicycle parking facilities must also be conveniently located and assure security by being reasonably visible. However, they should not interfere with the flow of pedestrians or motor vehicles.

Bicycle lockers should be provided at locations where a bicyclist will regularly park his or her bicycle for several hours or a day, for example at the Dinky station, employment sites or within the downtown. A bicycle locker provides room to store a bicycle helmet and other gear and provides a higher level of security compared to a bicycle rack.

Bicycle lockers usually are rented on a monthly or quarterly basis to assure that they remain actively used. Other options include coin operated lockers or attendant controlled lockers.

Another method of providing longer term bicycle parking is to create **bicycle parking areas within parking garages**. Most garages have dead areas where motor vehicles cannot park. These areas frequently can be designed to accommodate several bicycles and give bicyclists a weather protected area in which to park.

has this been done?

2. **Enforcement**

The Princeton community has been recognized for its aggressive protection of pedestrian rights and its enforcement of pedestrian responsibilities. By enforcing statutes governing pedestrian mobility, including the requirement of motorists to yield to pedestrians in crosswalks and of pedestrians to obey traffic signals and to walk on sidewalks, the Princeton police have made Princeton a much safer and more enjoyable place to walk.

Similar enforcement priority can be placed on bicycle use. Motorists should be required to use safe procedures when passing bicyclists or when following bicyclists. Police who observe motorists intimidating bicyclists should know that the motorists should be issued a summons.

Conversely, police in the borough and township should require bicyclists to operate in accordance with state statutes and regulations. Bicyclists observed riding on the wrong side of the street or improperly passing motor vehicles should be initially warned, and adult bicyclists should be cited. Similarly, bicyclists should be required to respect red lights, stop signs and other traffic control devices. Bicyclists should also be required to have mandated reflectors and lights on their bicycles if using them during the hours of darkness.

3. Education

Township and borough police currently educate children at community schools regarding safe bicycle practices. In addition, the police departments have conducted bike rodeos and other programs that promote safe bicycling by children.

Additional education is needed to instruct drivers how to safely share roadways with bicyclists. Both parents and children need to be instructed regarding safety issues associated with riding bicycles on sidewalks: that is the need to yield to pedestrians on the sidewalk and the need to yield to cars at driveways and street crossings.

If bicycling is to become an accepted mode of transportation within the community, operators of trip attractions need to learn that the community wants people to ride bicycles and that bicycle access should be both permitted and encouraged, at least to the same extent that motor vehicle use is permitted and encouraged.

4. Encouragement

All of the activities described above can help to encourage bicycling. However, changing people's attitude about the cultural acceptability of bicycling requires further encouragement. Bicycle to Work Day, **Critical Mass Friday night rides**, the Princeton Freewheelers recreational rides and similar events and programs are good methods of raising awareness regarding the viability of bicycling as a transportation mode. Participation in pilot programs such as the freewheels™ of Princeton yellow bicycles shows additional community support. Newspaper coverage of bicycling events and activities can be helpful.

However, the greatest need is for residents to be encouraged to believe that bicycling is a legitimate travel choice, both for themselves and their children.

V. Components of a Bicycle Improvement Plan

A. Provide Accessibility to Potential Bicycle Trip Attractions

1. Encourage bicycling to schools and parks

Schools and parks attract a large number of trips by children who live in Princeton. Providing routes that encourage bicycling – along multi-use paths, on low volume streets, or using marked bicycle lanes along streets with moderate traffic volume – can encourage children to bicycle to these locations, and can make parents feel more comfortable about allowing their children to bicycle.

By establishing access routes to schools and parks, the same corridors can also be developed for walking trips. Since trips become increasingly dispersed with distance from the attraction, the provision of bicycle routes is most critical for a distance of approximately one-half mile from the school or park.

Figure 1 depicts the location of schools and parks in the Princeton community.

2. Other trip attractions

In addition to schools and parks, Princeton's downtown, the University and the Princeton Shopping Center are important trip attractions for all residents. Providing routes to these locations can encourage increased use of bicycles. Other trip attractions include employment centers along Mount Lucas Road and Ewing Street in Princeton Township, employment and retail centers in West Windsor along Route 1, public transit locations including the Dinky Station and major bus stops, and churches and synagogues.

Figure 2 depicts these additional bicycle trip attractions.

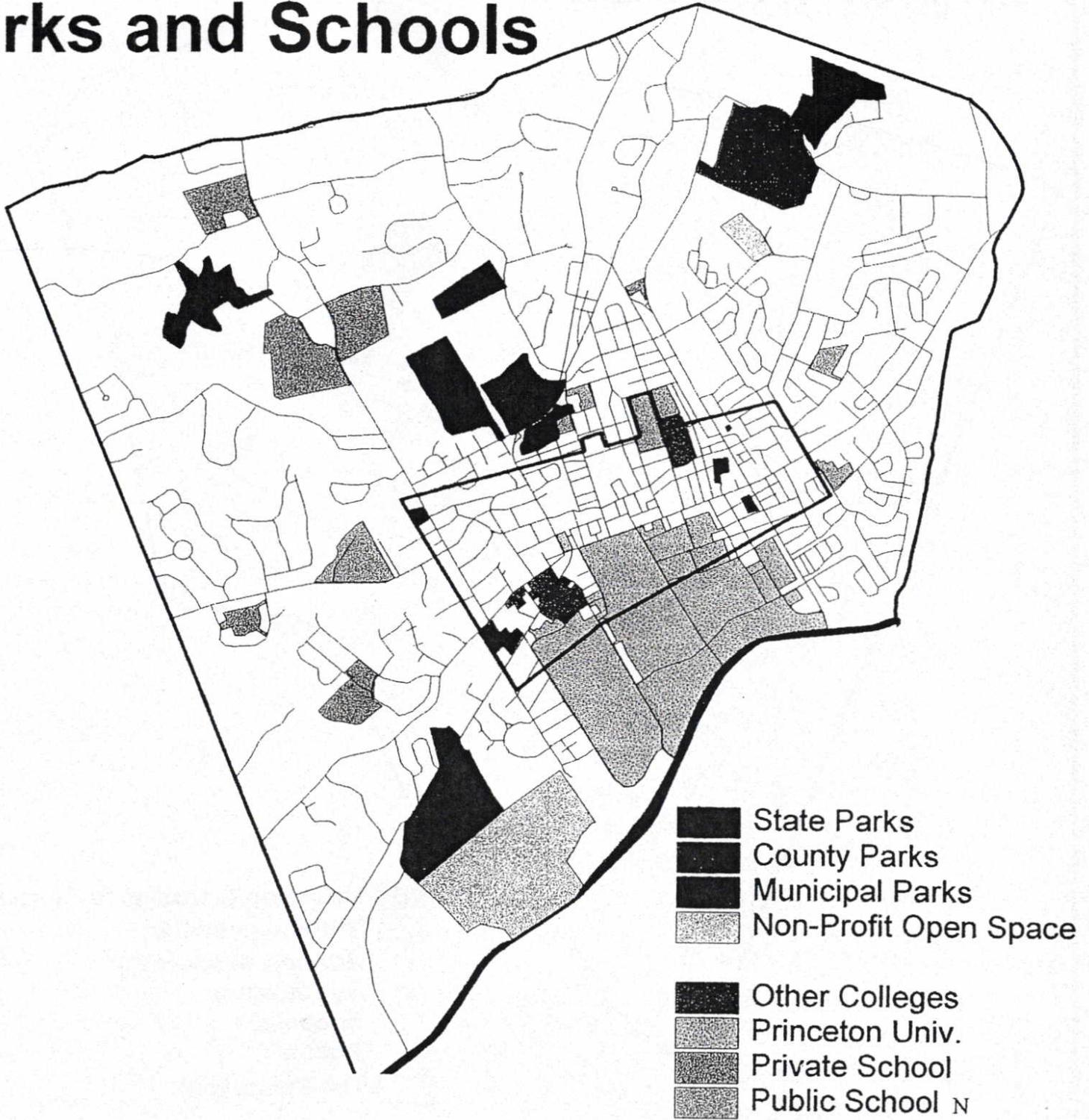
B. Provide a network of bicycle routes

Trip origins and destinations are spread throughout the Princeton community. As a result, although certain trip attractions, especially the downtown, the shopping center, the university, schools and parks, may be the most important attraction, to assure adequate mobility for bicyclists a network of bicycle routes is desirable.

Elsewhere in the nation cities have sought to establish improved bicycle routes along corridors spaced approximately half a mile apart. In western cities having a strongly developed grid of streets, this usually means that all collector and minor arterial streets are provided with bicycle lanes.

Princeton's irregular system of streets and roads will require that a less rigid system be used to define a bicycle network. However, the half-mile spacing can still serve as an evaluation tool for determining if an adequate network has been established.

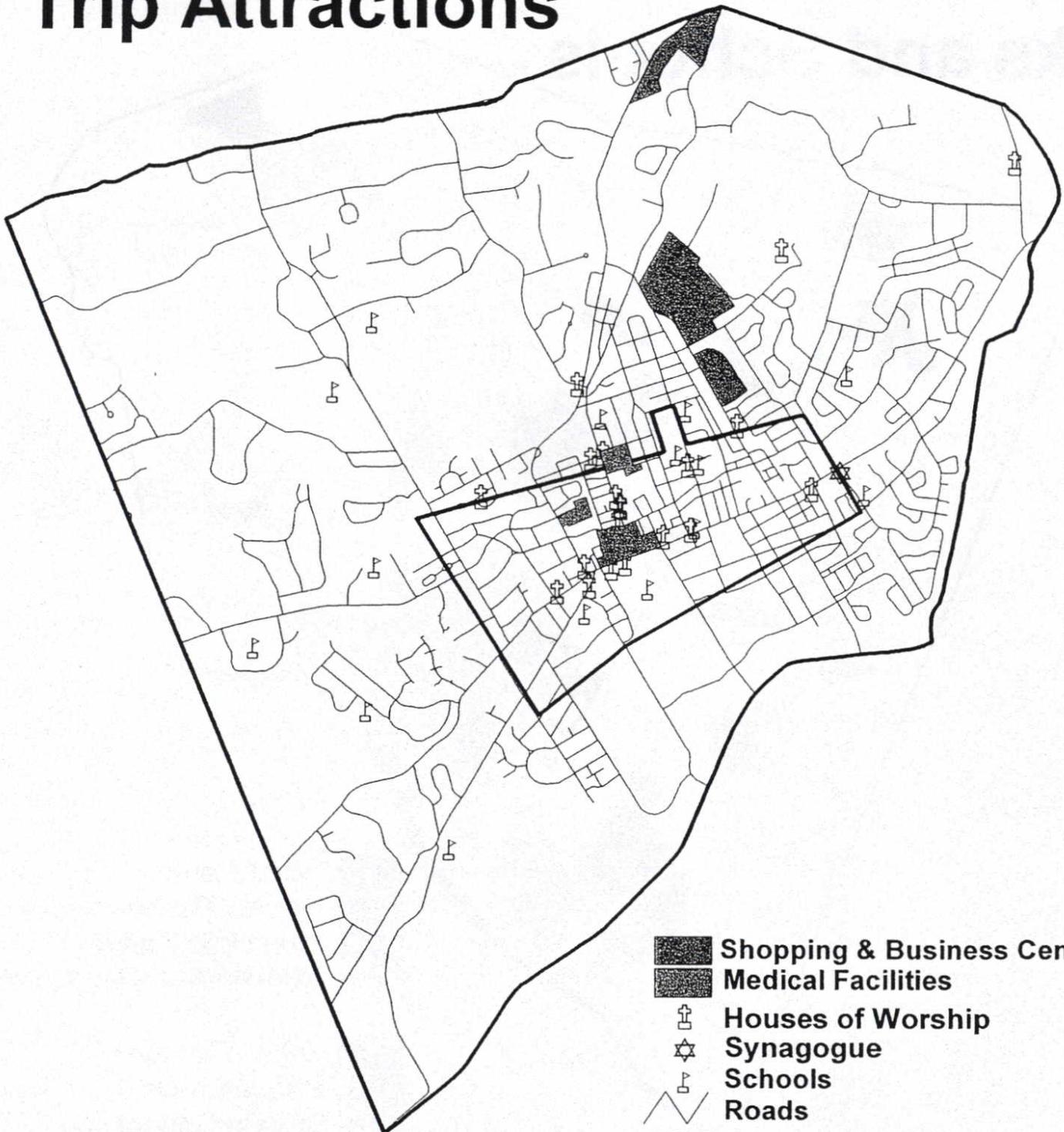
Trip Attractions Parks and Schools



1 0 1 2 Miles



Trip Attractions



-  Shopping & Business Centers
-  Medical Facilities
-  Houses of Worship
-  Synagogue
-  Schools
-  Roads
-  The Princetons

1 0 1 2 Miles



C. *Assure compatibility*

Streets, including arterial streets that do not form part of a bicycle network, should still be compatible with bicycle use. In order to make streets compatible while still protecting other community values, the preferable approach in most situations should be to reduce vehicle speeds in order to create compatible conditions. Use of edge lines to narrow travel lanes would be a second option. However, on some roads with high traffic volumes, the only method of creating a compatible roadway may be to provide minor roadway widening.

VI. Current Princeton Inventory of Bicycle Facilities

A. *Downtown*

With the exception of Nassau Street, most streets in town are relatively narrow and require that bicycles and motor vehicles operate in a mixed flow of traffic. However, speeds are also generally low, allowing this mixed flow to occur with reasonable safety.

On Nassau Street a number of inverted U bicycle racks have been installed in the portion of the sidewalk located immediately adjacent to the curb. These racks have been located close to intersections, where they serve the secondary benefit of restricting pedestrian crossings of Nassau Street outside of designated crosswalks.

A limited number of traditional bicycle racks are available elsewhere in the borough. These racks only allow a bicycle wheel to be secured and do not support the frame of the bicycle. They require that a bicycle be equipped with a kickstand, which most bicycles now lack. Because these types of racks fail to support the frame of a bicycle and do not allow a bicycle to be fully secured without a chain or cable, they are frequently not used. Bicyclists instead will seek to secure their bicycles to signposts, fences or other objects. When used, bicyclists will frequently lean their bicycle along the length of the rack, thus restricting its use to only one or two bicycles, or they may lift their bicycle frame over the rack in order to secure it.

B. *University*

Princeton University is both a major bicycling destination and an important generator of bicycle trips.

The University encourages a sharing of transportation facilities by pedestrians, bicyclists and motor vehicles, with pedestrians generally given priority. The University informally divides walkways into vehicle and pedestrian areas through the use of a mixture of surfacing materials. However, observations indicate that this demarcation is so subtle that it is generally not observed. Instead there appears to be a general willingness to share the space available, and an understanding that pedestrians have priority on campus.

Because of its location on a hillside, and its lengthy history, the University walkway system is interrupted in numerous locations by staircases, both short and long. These staircases pose a substantial constraint to bicycle mobility and an obstacle to mobility for persons who are disabled. The University is seeking to improve the accessibility of the campus by developing an adequate system of at-grade, barrier free routes on the campus.

The University has invested extensively in the provision of bicycle racks at dormitories, classroom buildings, the library and other destinations. The University uses a variety of rack systems including ribbon racks, inverted U's, and a metal bollard with locking brackets. According to the Facilities Planning office, the University attempts to monitor bicycle parking behavior on a regular basis, and it supplies additional facilities, as

needed, to assure that an adequate supply of secure bicycle parking spaces will be available.

C. *Borough Outside of Downtown*

Streets in the Borough outside of the downtown are generally 30' wide, curb-to-curb, with parking permitted on one side of the street. However, some streets are narrower, notably Witherspoon Street, which is 28' wide between Wiggins and Franklin Streets.

D. *Township*

Development streets in older sections of the township also have streets that are generally 30' in width. In lower density areas, rural collector roads that remain rural in design are only 20' in width or narrower, while streets that the township has improved in recent years are generally 24' to 26' in width. Streets have been improved with and without Belgian block curbing.

The township has also invested extensively in the provision of 6' wide asphalt sidewalks that are designated as bicycle routes, especially along collector roads and arterial streets.

In new developments the township has required developers to construct pathway systems to segregate pedestrians and bicyclists from motor vehicle traffic, especially on collectors and minor arterial roadways.

Linkage paths have been constructed on separate alignments at various locations in the township including:

- Linkage between Edgerstoune Road cul-de-sac and Rosedale Road.
- Trail on the right-of-way of the Trenton-Princeton Traction Line between the Stony Brook and Great Road.
- Trail linking the Princeton Shopping Center with Grover Avenue.

New developments are frequently required to construct linkage paths to provide additional connectivity for pedestrians and bicyclists. Linkage paths are most frequently required at the end of cul-de-sacs or in areas where the development street network would otherwise divide adjacent developments.

However, many older developments in the township with loop streets or cul-de-sacs did not incorporate linkage paths. In these developments residents are artificially separated from nearby trip attractions, making walking and bicycling trips more difficult.

E. *Bicycle Paths on Sidewalks*

For over a quarter century the Princeton community has encouraged a policy of designating sidewalks as two directional bicycle routes, and of constructing new paths adjacent to arterial streets for shared use by bicyclists and pedestrians. This policy will be discussed in the next section, which evaluates the quality of facilities for bicycling in Princeton.

Existing Sidewalk Bicycle Routes

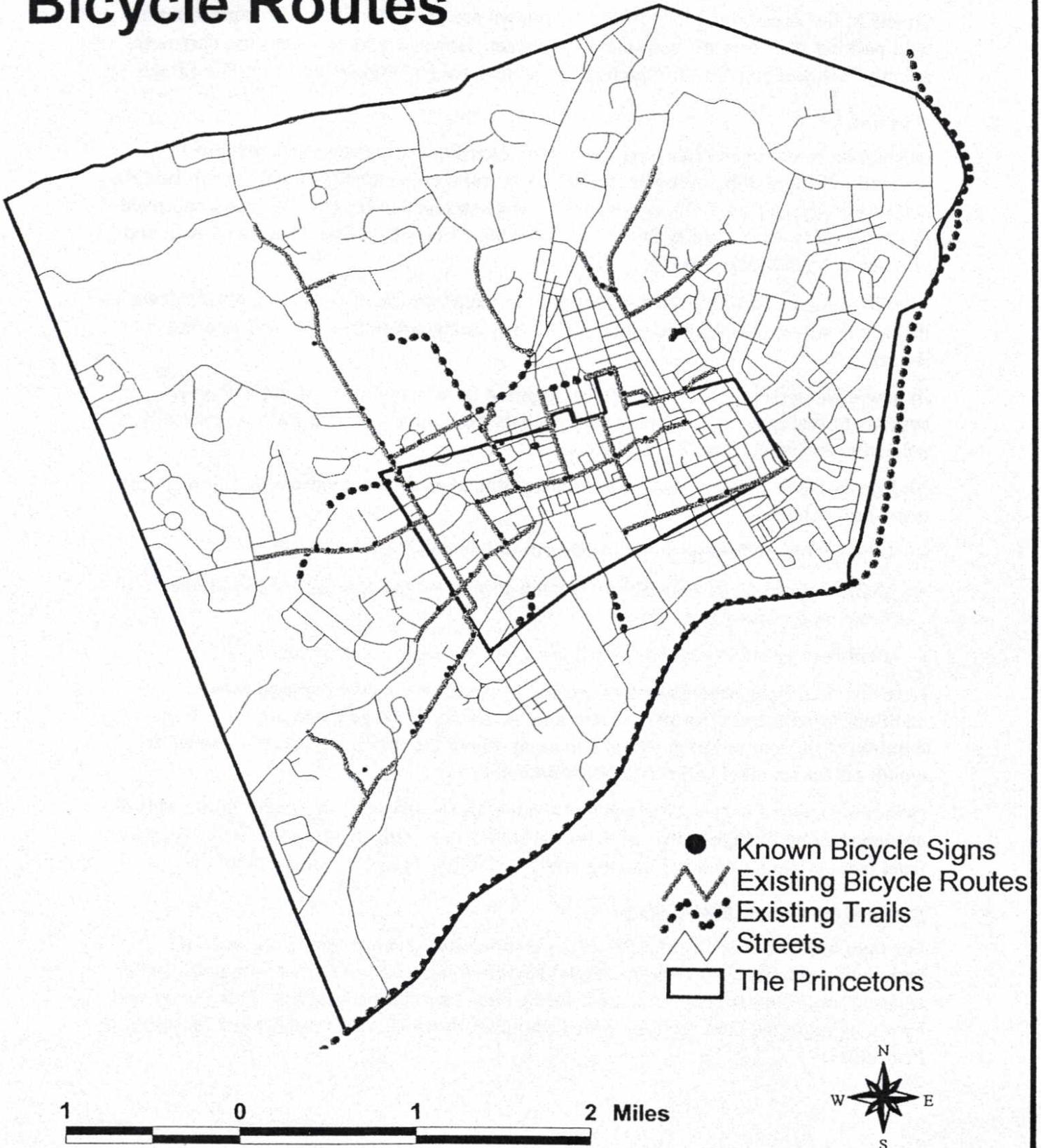


Figure 3 illustrates existing bicycle routes that were designated in the borough and township in 1999. Most signs in the borough designating sidewalks as bicycle routes have since been removed.

F. Schools and Other Attractions

Bicycle routes on sidewalks and trails in the township and borough have generally been established to mark routes to schools. However, bicycle parking facilities at schools are limited to conventional bicycle racks, which, as indicated above, do not provide adequate security or support for most bicycles.

Similarly, the Princeton Shopping Center has a number of conventional bicycle racks. During observations of the shopping center, bicyclists who used these racks avoided the wheel supports and instead leaned their bicycles against the frame of the bicycle rack. More frequently, bicycles at the shopping center were observed secured to sign posts or fences.

G. County Roads

Mercer County roads consist of Rosedale Road, Elm Road between Rosedale Road and Route 206 and Washington Road. Harrison Street in Princeton Township and River Road may also be under county jurisdiction. The county in its master plan has proposed transferring jurisdiction over those roads to the township.

County and municipal roads are similar in design and construction. As a result, they will be treated commonly in this paper and in the bicycle circulation element. However, any changes to the use or design of county roadways would require county approval.

Mercer County also has jurisdiction over most bridges and larger culverts that are not under state jurisdiction. Modifications to those facilities would also require county approval.

H. State Highways

Two state highways, US 206 and NJ 27, pass through the Princetons and are the most heavily traveled roads in the Princetons.

1. US Route 206

In Princeton Borough, US 206 is known as Stockton Street south of Nassau Street and Bayard Lane north of Nassau Street. In Princeton Township Route 206 is known as State Road north of the Borough boundary. South of the borough boundary it is depicted as the Lincoln Highway on maps.

Along most of its length through the borough and township, US 206 has a width of between 30 and 36 feet. This provides sufficient room for a modest shoulder of 3' to 6'. The roadway has been striped to provide slightly wider shoulders on upgrades and narrower shoulders on downgrades. Stockton Street has no shoulders between Nassau Street and Elm Road and between Lover's Lane and Farrand Road; instead a wide outside lane is provided that has a variable width.

At the following locations, US 206 has been striped to eliminate the shoulder area and instead provide a center left turn lane:

- Stockton Street from Lover's Lane to Elm Road
- Bayard Lane from Nassau Street to Leigh Avenue

In the township, the road has been striped to provide a southbound climbing lane from the Stony Brook Bridge south to the vicinity of Hutchinson Road where a center left turn lane is provided.

In November 1999 the NJDOT released a "Concept Development Report" that described how bicycle and pedestrian compatibility could be increased along these sections of the road. A variety of minor roadway widening or restriping activities were included in the report.

2. NJ Route 27

Within the borough NJ 27 is known as Nassau Street. Within the township it is labeled as the Lincoln Highway on maps.

Through the downtown NJ 27 has relatively wide lanes plus parking on each side of the street between US 206 and Witherspoon Street. Between Witherspoon Street and Washington Road the same 54' wide pavement has been striped to provide four narrow travel lanes plus parking lanes. East of Washington Road, Nassau Street becomes progressively narrower through the intersection of Harrison Street, where it only has a width of 30', similar to most borough streets. East of Harrison Street NJ 27 becomes progressively wider again, eventually gaining a width of 36' to 40' and providing sufficient room for two travel lanes plus shoulders on each side of the roadway.

1. Parks and Open Space

A total of twenty-one parks and other protected open space serve the Princeton Community. Many of these parks include multi-use paths that bicyclists may use; others have park access roads that can support bicycling activity.

A variety of agencies are responsible for maintaining parks in the Princetons including the state, county, township and borough. Municipal parks are jointly operated by the Princeton Recreation Department, but are maintained by the borough and township.

1. D&R Canal Towpath

The D&R Canal forms the boundary between West Windsor and Princeton Townships from Quaker Road to the Millstone River, where the Princeton Township boundary shifts to Carnegie Lake. The D&R Canal State Park includes the canal towpath, an important regional recreational trail that is heavily used by Princeton residents for bicycling and walking.

Despite its relatively wide width, the towpath is frequently subject to congestion, especially on weekends and holidays. Like most heavily used multi-use paths, the towpath also experiences frequent conflicts between users traveling at a wide range of travel speeds. Groups of bicyclists and groups of pedestrians also frequently travel

abreast along the towpath, reducing the amount of lateral space available for faster users to pass slower users.

As a result of the heavy use and the frequent conflicts between users, the Canal Commission is considering methods of constructing a second trail along the east side of the canal in West Windsor and Plainsboro Townships. Portions of this second trail have already been constructed north of Harrison Street and south of Alexander Road.

The canal and its towpath are contained within a linear state park. As a result, it is relatively free of vehicle crossings. However, roadways that do cross the canal and its towpath, Alexander Road, Washington Road and Harrison Street, are all heavily traveled and can be difficult to cross. Washington Road, with a speed limit of 50 MPH in West Windsor, can be especially difficult to cross.

2. Institute Woods and Princeton Battleground State Park

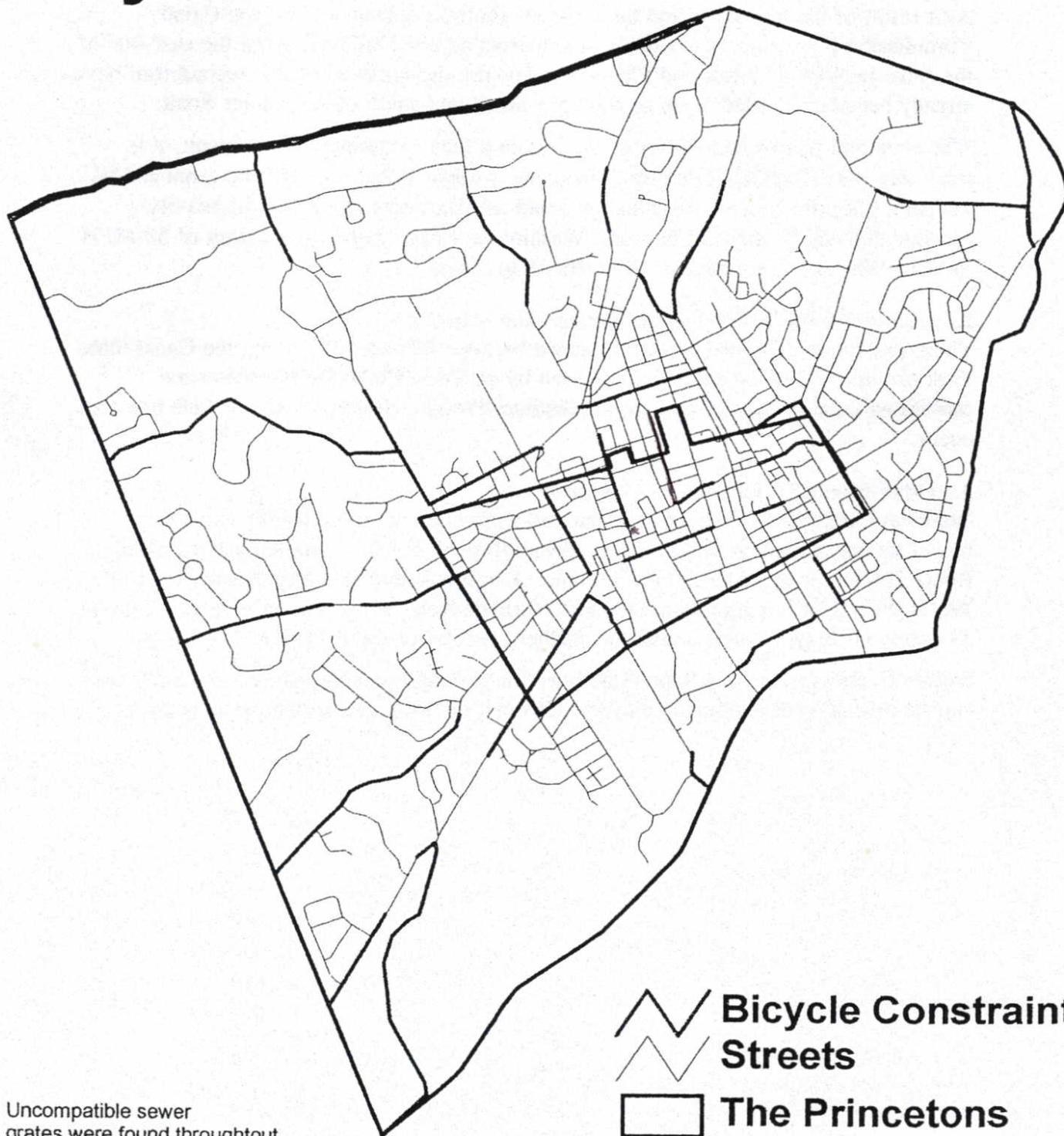
These passive recreational facilities located between Princeton Pike and the Canal State Park provide additional paths that are used by walkers. **Currently bicyclists are prohibited from using trails within the Institute Woods,** although some bicycle use does occur.

3. Other Municipal Parks and Open Spaces

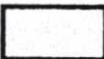
Walkways and trails in other municipal parks provide additional locations where bicyclists may travel. A continuous walkway through North Community Park parallels Route 206 and is signed as a bicycle route. A trail has been recently constructed in the Wight Woods Reservation that links East Terhune Road with Van Dyke Road, creating a continuous bicycle route across the northern portion of the Princeton Township.

Currently parks have only limited facilities for parking bicycles. Where available, they consist primarily of antiquated bicycle racks that do not properly secure bicycles.

Bicycle Constraints



Uncompatible sewer grates were found throughout the borough and township and are too numerous to depict on the map.

-  **Bicycle Constraints**
-  **Streets**
-  **The Princetons**



VII. Compatibility Analysis of Bicycle Facilities and Identification of Constraints

Collector and minor arterial roads generally have traffic volumes reflective of Condition II of the NJDOT criteria, (e.g., an AADT between 2,000 and 10,000 vehicles per day). At these volumes, to be compatible, a roadway in an urban area should provide lane widths of 12' to 15' or a shoulder width of 3' or 4', depending on travel speed.

As part of the preparation of this plan, a compatibility analysis was conducted of streets and roads in the borough and township. This analysis indicates that most streets and roads are compatible with bicycle use. Constraints occur primarily on more heavily traveled collector roads and along Route 206. Figure 4 depicts segments of Princeton streets and roads that were identified as being constrained.

Table 1 of Appendix B of the 1996 Princeton Community Master Plan's Circulation Element presents design standards for township and borough roads. These design standards are generally consistent with the bicycle compatible design standards that have been developed by NJDOT. However, the table states that the improvement standards for arterial and collector roads should be limited where conditions are constrained by "intense abutting development, the presence of historic or cultural resources, environmental sensitivity or other factors limiting street width." Since these conditions exist in almost all of Princeton, the effect of this qualifier is to restrict the ability of the township or borough to make roads compatible with bicycle use as part of road reconstruction projects. Recommended changes to this table are discussed later.

Field inspections indicate that most recent road reconstruction projects have in fact failed to upgrade roads to comply with the construction standards of the table and the roadway compatibility standards developed by NJDOT.

The following section discusses the current compatibility of streets in the Princeton Community. Utilizing the geographical information system prepared as part of this study, the compatibility of streets and roads in the Princetons has also been mapped. However, because of insufficient data regarding the traffic volumes of streets and roads, the analysis conducted represents only an estimate of actual conditions. Revised compatibility analyses can be produced in the future using the GIS model and additional traffic count volumes.

A. Princeton Township

Outside of developed subdivisions, many of Princeton Township's roads consist of narrow, two-lane country roads located within narrow rights of way. As indicated in the NJDOT standards for bicycle compatible roads and bikeways, these types of roadways are highly compatible with shared use by bicyclists, provided that the roads have low traffic volumes. Indeed, recreational bicyclists often seek out these types of roadways on which to ride and are disturbed when roadways are widened.

For example, Herrontown Road in the vicinity of Herrontown Woods is a very enjoyable route for bicyclists despite its narrow width. Canal Road in Franklin

Township is used intensely by bicyclists despite its narrow width, or perhaps in part because of the roadway's narrow width.

However, many of the country roads in Princeton Township support travel volumes well in excess of 2,000 ADT and many operate in excess of 5,000 ADT. On these roads, motorists have few opportunities to safely pass bicyclists, and the relatively fast speed with which motorists drive increases the risk of injury in the event of a crash between a motorist and a bicyclist.

Since rights-of-ways on the township's roadways are narrow, often only 33', improvements requiring roadway widening may require acquisition of additional rights-of-way, a costly and politically difficult task. Even if right-of-way is not required, clearing woodland within the right-of-way can arouse strong opposition by adjoining property owners. As a result, it is frequently difficult to adequately accommodate bicycle or pedestrian travel on township collector roads that now must serve higher volumes of traffic generated by housing developments and attracted to suburban employment, retailing and cultural land uses.

The compatibility analysis indicates that despite recent improvements the following roads have inadequate width based on traffic volumes and speeds:

- Great Road from the borough boundary to Cherry Valley Road
- Cherry Hill Road from Route 206 to Stuart Road
- Cherry Valley Road for its entire length
- Snowden Lane from Route 27 to Franklin Avenue
- Pretty Brook Road
- Rosedale Road from the Stony Brook to Province Line Road
- Harrison Street from the borough boundary to Carnegie Lake

1. State Highways

The compatibility analysis indicates that Route 27 in the township is compatible with bicycle use except for the narrow width of the bridge over Harry's Brook. NJDOT has recently striped that portion of roadway to narrow the travel lanes to 10' and provide a 3' shoulder for bicyclists. Bicyclists report that the revised striping has been successful at making the bridge comfortable to cycle across.

Route 206 is compatible with bicycle use in the township except for the following short segments that NJDOT identified in its compatibility report. The climbing lane between the Stony Brook and Hutchinson Road results in the elimination of shoulders. Drainage grates in the roadway in this section present an added hazard to bicyclists. As a result, this section is not compatible with bicycle use and in fact is quite hazardous. It can be made compatible, and safer for motor vehicles, through the elimination of the passing lane and restriping the roadway to provide an 11' travel lane and a 4' shoulder in each direction.

Between Ewing Street and Arreton Road, the width of State Road narrows to approximately 28'. Although the striping provided meets minimal compatibility requirements, additional shoulder width would be desirable. By widening the road to 30' it would be possible to stripe an 11' travel lane and a 4' shoulder in each direction.

B. Princeton Borough

Most streets in Princeton Borough have a width of 30', which is compatible with bicycle use if traffic volume is less than 2,000 vehicles per day. Even streets with higher volumes are generally acceptable for bicycle use because vehicle speeds are low. For example, both Chambers and Hulfish Streets have traffic volumes greater than 2,000 vehicles per day but are reasonably comfortable for bicycling because the slow travel speeds allow bicycles and motor vehicles to share the road.

Streets that are thirty feet wide can also be compatible for bicycle use if motor vehicle volumes are less than 10,000 vehicles per day and if on-street parking is either prohibited or only occurs at isolated locations. With frequent use of on street parking, the borough's streets quickly become incompatible once volumes begin to exceed 5,000 vehicles per day.

A method of making heavily traveled borough streets compatible with bicycle use would be to prohibit on-street parking along those streets having an AADT greater than 5,000 unless sufficient width is available to accommodate the compatible roadway standards. However, the elimination of parking needed by adjacent businesses would impact other community values.

Significant constraints to bicycle traffic created by the combination of high traffic volumes, narrow roadway width and the presence of on-street parking exist on the following streets that are under the borough's jurisdiction:

Borough Streets with Constrained Street Width

- Alexander Street
- Chambers Street
- Hamilton Avenue
- Hulfish Street
- Mercer Street
- Prospect Street
- University Place
- Wiggins Street
- Witherspoon Street

The degree of the constraint to bicyclists on these streets varies considerably in practice based on the actual roadway width, the frequency with which parking is actually used, the volume of traffic and the character of traffic flow.

Nassau Street, Bayard Lane and Stockton Street, the three most heavily traveled streets in the borough, are under NJDOT jurisdiction. Most of Stockton Street is compatible with bicycle use, as discussed previously. The other two streets are discussed below:

1. Nassau Street (NJ 27)

Because of either wide curb lanes or shoulders, most of Route 27 accommodates bicycles. The only incompatible sections are between Witherspoon and Washington Streets, where Nassau Street has been striped to provide four travel lanes plus parallel parking, and between Washington and Linden Streets, where on-street parking is permitted on a narrow roadway.

The section west of Washington Street could be made compatible by striping the roadway to provide three travel lanes, similar to the striping west of Palmer Square. The only way to make the section of Route 27 east of Washington Road compatible would be to eliminate on-street parking along one side of the road.

2. Bayard Lane (US 206)

Most of Route 206 south of Nassau Street is compatible with bicycle use as a result of wide outside travel lanes. North of Nassau Street, the thirty foot width of the street has been striped to provide two 11' travel lanes and a 10' center turn lane. This narrow width is required to accommodate the heavy traffic volumes on this, the most heavily traveled street in the Princetons. As a result, there will be little opportunity to make this section of roadway compatible with bicycle use without creating substantial impacts to other values of the community.

C. *Bicycle Paths along Roadways*

As mentioned earlier, the Princeton community has encouraged a policy of designating sidewalks as two directional bicycle routes, and of constructing new paths along township roads for shared use by pedestrians and bicyclists. The intent of this policy has been to provide "safe" bicycle routes to schools and parks for children.

AASHTO, the Federal Highway Administration and NJDOT, however, now strongly discourage these types of facilities because of data demonstrating that they in fact do not represent safe facilities and in fact can cause increased crashes between motor vehicles and bicycles. Bicyclists riding on sidewalks or narrow paths also conflict with pedestrians and can collide with them.

Bicyclists, pedestrians and other users may share a path adjacent to a roadway if it is properly designed and if it is located in a rural area, a low-density residential area or an area where driveway access is restricted through the use of an internal roadway system. Such a path should have the following characteristics:

- A minimum width of eight feet and a desirable width of ten feet.
- A smooth and predictable surface free of abrupt vertical deflections or warpage.
- A sufficiently strong roadbed to protect against deflections or premature deterioration in the pavement structure following construction.
- 2' of horizontal clearance on either side of the trail.
- Adequate sight distance to support a design speed of 20 miles per hour. This is especially important at intersections, including driveway intersections.
- A minimum of 5' of horizontal separation from the adjacent roadway, or a physical barrier to separate the path from the road.
- Properly designed intersections with cross-streets and driveways.
- Drainage design that assures that surface flows are quickly removed, and that ponding, icing and debris build-up does not occur.

Several paths in the township constructed over the past decade closely achieve these conditions except for pavement width, which is only 6'. A good example is the path extending from Quaker Road to the vicinity of Gallup Road along Princeton Pike.

Numerous older paths in the township are severely deficient in profile, width, sight distance and drainage. Obstacles located within paths, including utility poles and mailboxes, reduce the effective width of paths to as little as two feet. Substantial vertical drops exist immediately adjacent to paths, either a vertical curb at the edge of

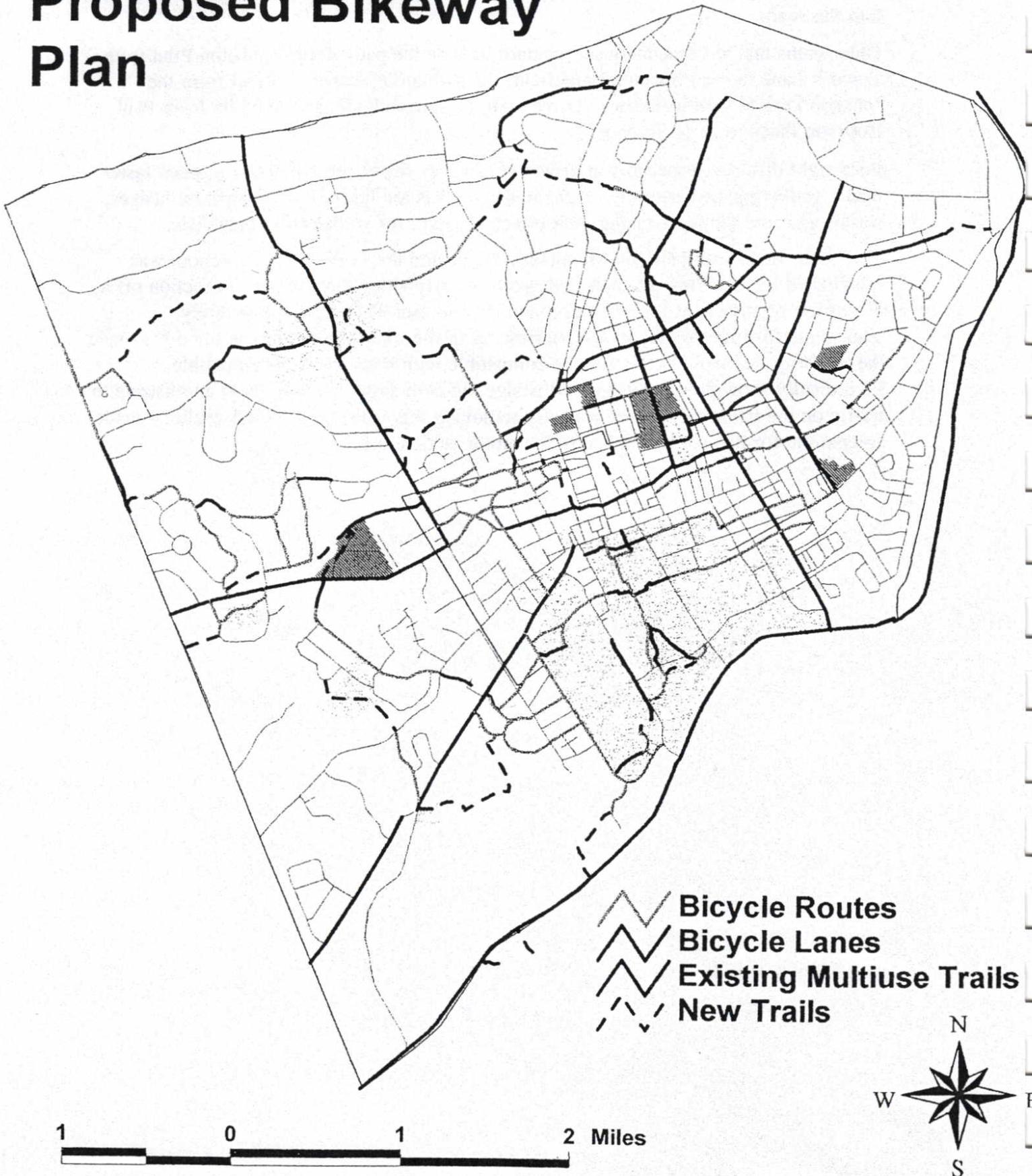
the roadway or an embankment leading to the roadway. Some paths have a warped surface directed towards the roadway, which in the event of a fall can direct a bicyclist into the road.

Older paths that are especially substandard include the path along Princeton Pike from Lover's Lane to the Princeton Battlefield, the path along Rosedale Road from the Johnson Park School to Fairway Drive, and the sidewalk along Route 206 from Paul Robeson Place to Birch Avenue.

Poor sight distance, especially at driveways, makes riding these paths at a speed faster than a walking pace hazardous. Paths in some areas are heavily overgrown by hedges, shrubs and tree limbs, reducing their effective width for walkers and bicyclists.

The Great Road path between Mountain Avenue and the Princeton Day School was established by installing modular curb stops linearly along the roadway to section off a 5' portion of pavement for pedestrian and bicycle use. This design is severely inadequate for bicycle use, and the narrowing of the roadway that has resulted has made the roadway that would otherwise be compatible with bicycle use incompatible. Periodically snowplows or vehicles dislodge the curb stops, making them an obstacle to traffic on the path, the road or both. By removing this path, Great Road could be made compatible for bicycle use and safer for motor vehicle use.

Proposed Bikeway Plan



VIII. Bicycle Improvement Plan

This chapter describes the components of a recommended bicycle improvement plan for the Princeton community. The first section of the plan recommends modest improvements that would assure that most community roadways would at least be compatible with bicycle use.

The second section of the plan recommends a network of bikeways that would link major trip attractions within the community, including schools and recreational facilities. The bikeways would consist of a combination of bike lanes on more heavily traveled roads, signed bike routes using local streets and multi-use trails. The compatibility improvements recommended in the first section of the plan would in some cases allow the marking of bike lanes, thereby allowing the roads to become part of the bikeways network.

A. *Make Roads Compatible with Bicycle Use*

1. Increase space available for bicycle use by restriping

Restripe collector and minor arterial roads that do not have on-street parking so that they provide a shoulder width of 3', if speeds are below 40 MPH, or 4' where operating speeds are above 40 MPH. Example of roadways where this could be applied include:

- Cherry Hill Road – 10' lanes and 3' shoulders
- Great Road – 10' lanes and 5' shoulders (remove modular concrete curbs)
- Route 206 climbing lane – 11' travel lanes and 4' shoulders

2. Increase space available for bicycle use by prohibiting parking

To make urban collector or arterial streets having traffic volumes greater than 5,000 AADT compatible with bicycle use, prohibit on-street parking; on streets having a width greater than 32', prohibit parking along one side.

Heavily traveled streets that could be made compatible through the prohibition of on-street parking are:

- Hamilton Street
- Wiggins Street
- Mercer Street
- Alexander St
- Harrison St
- Witherspoon St

3. Widen Roadway Widths

Minor widening of sections of roadway that are currently constrained, along with narrowing of the travel lanes, can result in a more compatible roadway for bicyclists, with very limited impacts on surrounding land uses.

- Cherry Hill Road from 26' to 28'
- Cherry Valley Road from 24' to 30'
- Snowden Lane from Route 27 to Franklin Avenue – from 24' to 28'
- Herrontown Road from River Road to Snowden Lane – from 20' to 28'
- Quaker Road from Princeton Pike to the D&R Canal – from 24' to 28'
- Rosedale Road from Stony Brook to Province Line Road – from 26' to 30'
- Route 206 between Cherry Hill and Arreton Roads and Edgerstoune and Quaker Roads – from 28' to 32'
- Princeton Pike from Stony Brook to Lawrence Twp – from 26' to 30'

4. Eliminate Curbing

Vertical curbing adjacent to roadways reduces the effective width of the roadway for both bicyclists and vehicles. Curbing also represents a hazard for bicycles traveling at modest to high speeds.

The Roadway Design Standards of the Princeton Regional Planning Board currently discourage curbing except where gradients exceed 3.5% or in an "In-Town" location. Alternative methods are available for controlling drainage on slopes steeper than 3.5%. These include providing swales with velocity reduction characteristics, use of erosion control fabrics or the closer spacing of catch basins. This report therefore recommends that the improvement standards be revised to state that curbs should only be installed on streets on which on-street parking will occur on a regular basis, such as streets "In-Town".

When roads are reconstructed curbing should be eliminated where alternative drainage control measures can be provided. If an engineering analysis indicates that curbing is required for drainage, the roads should be widened by two feet on each side on which a curb is present as part of the roadway's reconstruction.

5. Reduce Vehicle Speeds

Traffic calming measures establish vertical or horizontal restrictions to travel that require vehicles not to exceed the intended design speed. Examples include small diameter traffic circles, speed humps, roadway narrowings, chicanes or twisted roads, and raised intersections.

Traffic calming devices are generally beneficial to bicyclists by forcing motor vehicles to travel at lower speeds. However, the devices can also constrain bicycle activity if not properly designed.

When installing traffic calming measures, it is important for designers to ask themselves what impact the proposed devices will have on pedestrians and on bicyclists. For each mode, the range of users must be considered. For pedestrians, the needs of both able-bodied persons and mobility-limited persons must be considered. For bicyclists, all classes of bicyclists must be considered, and the potential fears of less confident riders respected.

Excessive motor vehicle speed is a major concern for many members of the Princeton Community, not just bicyclists. Implementing measures to assure that drivers will be operating within a desired speed profile should therefore receive broad political support. On constrained township roads that seek to preserve a country road environment, consideration should be given to adopting the following desired speed profile:

- Median speed: No greater than 35 MPH
- 85% speed: No greater than 40 MPH.

This would require the frequent installation of traffic calming devices that establish a maximum design speed of approximately 30 miles per hour. Devices should be installed between 500' and 1,000' feet apart to keep speeds within the desired speed profile. For a desired median speed of 30 MPH, devices would be required every 500'.

On urban streets with and without parking, more constraining traffic calming measures may be appropriate to establish a lowered desired speed profile. Specifically, on most urban streets where pedestrian activity is likely, the following desired speed profile is appropriate:

- Median speed: No greater than 25 MPH
- 85% speed: No greater than 30 MPH.

To attain this control, traffic calming devices limiting speeds to less than 20 MPH should be established between 250' and 500' apart. Greater spacing of speed controlling devices will result in vehicles traveling faster than the desired speed profile.

On local residential streets and on streets in the center of town, a desired speed profile should be consistent with frequent pedestrian activity. The following profile is recommended:

- Median speed: No greater than 20 MPH
- 85% speed: No greater than 25 MPH.

To attain this control, traffic calming devices limiting speeds to between 15 MPH and 20 MPH should be established at least every 250'.

A large number of roads in the Princeton Community would benefit from the installation of traffic calming measures. These measures would benefit bicyclists, but would also benefit adjoining residents, pedestrians and motorists.

In particular, **small diameter traffic circles** could help improve motor vehicle safety and reduce motor vehicle delays at a number of intersections that do not currently warrant traffic signals. Circles in these locations would also slow motor vehicle speeds to a pace consistent with the adjoining residential land uses.

Examples where traffic circles would be desirable include:

- Franklin Avenue and Snowden Lane
- Franklin Avenue and Grover Avenue
- Intersections along Hamilton Avenue and Wiggins Street.
- Intersections along Terhune Road and Valley Road at Jefferson Road and Walnut Lane
- Intersections along Cherry Hill Road with Foulet Drive, Crestview Drive, Stuart Road, Balcort Drive and Ridgeview Road

Alternatively, on Cherry Hill Road chicanes or other devices could be employed to restrict the median speed of motor vehicles to less than 35 miles per hour.

B. Develop Network of Bikeways

Bikeways consist of bicycle lanes, bicycle routes and multi-use paths that provide a bicycling environment that can encourage greater use of bicycles. The network presented in this report was developed with the objective of creating a system or routes to serve the Princeton Community, and in particular to provide access to destinations that attract the community's children, including schools, parks and the downtown.

Figure 5 at the end of this section depicts most of the components of the recommended system.

1. Bike Lanes

Stripe shoulders and designate them as bicycle lanes. Bike lanes should have a minimum width of 4'; on roads with curbs or parking, 5' is the minimum width. Bicycle lanes are recommended on the following roads that provide mobility through the Princeton community and provide access to schools or parks:

- Hamilton, Wiggins, Paul Robeson and Hodge. These streets provide a continuous east-west bicycle route between Harrison Street and Library Place and provide access to the downtown, the library, the high school and middle school and Westminster Choir College.
- Franklin Street. Consider striping bicycle lanes along Franklin Street from Snowden Lane to Walnut Lane to provide additional protected bicycle access to the school complex from the eastern portion of Princeton Township.
- Walnut Lane between Hamilton Street and Terhune Road. Walnut Lane provides access to the educational complex and would link east-west bicycle routes to provide access to the schools.
- Snowden Lane between Nassau Street and Herrontown Road. Snowden Lane provides important connections through the eastern portion of Princeton Township where there are few alternative routes and serves as a route to the high school and middle school. It also provides access to the recreational facilities in Smoyer Park.
- Terhune Road. This minor collector street provides a second east-west route through the community. At State Road (US 206) linkages can be created to multi-use paths providing connections to the west and north; at Snowden Lane a multi-use path provides continuation to the east. This connection, over time, can become part of a bicycle boulevard along the north side of the community.
- Harrison St between the D&R Canal and Bunn Drive. This north-south route provides similar linkages between a number of additional bicycle routes through the densely settled eastern portion of the community and provides access to the shopping center.
- Mercer Street. Provides a route into the downtown from the south and connects with recreational destinations including the Battlefield Park. A continuation of bicycle lanes to the south along Princeton Pike would connect with bicycle lanes recently constructed in Lawrence Township.

- Great Road. Great Road provides north-south access to the same private school complex. The existing pavement width on Great Road permits striping of bicycle lanes if the modular curb stops are removed.
- Rosedale Road. This county road in the northwestern portion of Princeton Township provides regional connections to and from Princeton, provides access to the Johnson Park School and the Hun School and can be used by students from the western portions of the township to reach the high school and middle school complex. The current county engineer objects to the designation of bike lanes on county roads; as a result, marking of bike lanes on Rosedale Road will likely be opposed by the county at this time.
- Bunn Drive. Provides access from the Princeton Community Village to numerous community destinations including the downtown, the school complex and the Princeton Shopping Center. Also intersects various possible east-west trails. Can serve as an extension of the bicycle lanes along Harrison Street to provide a continuous north-south corridor through the eastern portion of the Princetons.

2. Bicycle Routes

Bicycle routes consist of local streets that provide important connections for bicyclists but which have low motor vehicle volumes and usually have low vehicle speeds. As a result, bike lanes are not needed. Frequently local streets can be used as connections between trails or other bicycling opportunities, thereby offering bicyclists travel continuity that is not the streets do not provide to motor vehicles.

Examples of local streets that already serve bicyclists include College Road, Edgerstoune Road and Wendover Drive. Additional streets could function in this fashion if short linkage easements could be acquired through private property in order to establish continuity. Some of these opportunities are discussed in conjunction with multi-use trail opportunities that are described below.

North of Nassau Streets a network of local streets and linkage paths can be developed to provide bicyclists with an alternative route through the downtown. This system would include, from east to west, Bainbridge Street, Spruce Circle, Spruce Street, Willow Street, Park Place, Spring Street, Hulfish Stret, Bank Street and Boudinot Street. Linkage connections would be required between Boudinot and Bank Streets through Palmer House, and between the Spruce Center and Bainbridge Street through Queenston Commons.

Similarly, south of Nassau Street a local street route can be established to create a continuous route into the downtown from the east. This system would consist of Patton Avenue, paths and roadways around the east and north sides of the Engineering Quad and William Street.

Stuart Road provides connections to Princeton Day School and Stuart Country Day School. With connecting multi-use paths it can form part of a continuous east-west trail system linking the Great Road and Terhune Road.

3. Multi-Use Trail Opportunities

Trails on separate alignment provide an alternative method of encouraging both bicycle and pedestrian travel. Trails are especially valuable in encouraging more cautious bicyclists to ride more frequently. Through more frequent bicycling along trails, these riders can gain the experience and confidence required to also ride in mixed traffic on streets.

The large number of parks, open spaces and institutional lands in Princeton provide a variety of opportunities for expanding the number of shared use trails. Two types of trails are worth considering – true trails that provide an independent right-of-way for an extended distance, and trail connectors that allow bicyclists and pedestrians to travel between local streets or other compatible shared facilities to complete longer distance trips. This latter approach can result in extensive bikeways with only a minimal expenditure for new independent facilities. A common term used to describe such facilities is a “Bicycle Boulevard”.

The Friends of Princeton Open Space in 1995 prepared “Linking Princeton Open Spaces with Trails and Greenways”, a report recommending a number of Greenway trails and paths that would link the open space parcels in Princeton. The trails presented in that report, called in this plan the Greenways Plan, sought to create recreational trails that would link the open spaces of the borough and township together and would provide improved access to parks in the Princeton Community. As a result, many of the trails tended to circle around Princeton rather than pass to and from the center of town.

In comparison, the multi-use trails recommended in this report focus on trails that could serve trip-making needs by connecting trip attractions. However, the concepts developed by the Greenways plan are important and insightful and have been employed to the maximum extent possible in this report.

We have identified the following possible corridors for consideration: These trails are described in more detail in Appendix 3.

a. Chambers Street Extension

From Princeton YM/YWCA to Race Street

b. South Community Park Trail

From Race Street to Mountain Avenue jughandle and

c. Mountain Lakes to PDS

From Mountain Lakes to intersection of Old Great Road and Great Road near entrance to PDS

d. Princeton University Connectors

Princeton University is a major generator of bicycle traffic and an important focus of bicycle activity, including recreational bicycling. However, with the exception of the D&R Towpath, few good recreational bicycle trails are available for students.

A number of barrier free east-west connectors should be considered, including one linking College Road and Ivy Lane.

e. Faculty Road/Hardin Road Connector
Along south side of the Springdale Golf Course.

f. Trail to Market Fair and Housing for the Theological Seminary
From Hardin Road/Faculty Road trail to D&R Canal along south side of Institute Woods

Requires bridge across the Stony Brook. An additional bridge across the canal would also improve access to the Canal Point development in West Windsor

g. Princeton Cemetery
From Wiggins Street to Harris Road or Witherspoon Lane

h. Trenton-Princeton Traction ROW
From Johnson Park School to Brookstone Drive (requires new bridge across Stony Brook using existing bridge pier).

Short linkage trails, existing subdivision streets and a route through the campus of the American Boychoir School could reestablish the general alignment of the trolley line to provide a path connecting with Lawrence Township

i. Linkage Trail between Wilson Road and Community Park
Between Wilson Road and Mountain Avenue in the vicinity of North Community Park

j. Other Linkage Trails
When new development is proposed, linkage trails should be required.

4. Improve Trail or Bikeway Crossings

Where trails or bikeways cross roadways at mid-block locations or minor street intersections, provide median refuge island combined with a raised pedestrian crossing.

Existing crossing locations that warrant improvement include the D&R Towpath at Harrison Street, Washington Street and Alexander Street, the Hun Trail at Rosedale Road and the Johnson Trolley Line trail at Elm Road.

C. Mercer County Green Links

The Mercer County Green Links program has been established to encourage open space linkages between municipalities in Mercer County. Identified Green Links in the Princeton Community include the following:

- Delaware & Raritan Canal
- Stony Brook Greenway
- Transco Pipeline
- Mountain Lakes Park to Woodfield Reservation
- Community Park to the D&R Canal.

IX. Implementation Program

This chapter takes the components of the bicycle improvement plan described in the previous section and categorizes the improvements into short-term actions, mid-term actions and long-term actions.

- Short-term actions consist of activities that would involve small to moderate expense and no acquisition of land.
- Mid-term actions would require moderate expense, in some cases acquisition of land, and/or would require removing parking in commercial areas. Many of the mid-term actions would require cooperation from a variety of agencies.
- Long-term actions involve more costly construction projects and/or projects involving costly land acquisitions.

Recommended changes to the Community Master Plan and the land development ordinances of the Borough and Township are presented as an attachment to this report. Adoption of changes are considered a short-term action, although changes implemented as a result of revised planning procedures would be implemented over an extended period of time.

A. Short-term Actions

Activities that involve small to moderate expense and no acquisition of land

1. De-designate sidewalk bicycle routes

Remove existing "Bike Route" signs from sidewalks and paths adjoining roadways. (Bike Route signs have already been removed from sidewalks in the Borough.)

Paths that are well separated from roadways, have no driveway crossings and few street crossings, such as the path along Princeton Pike south of Quaker Road, can continue to be signed as Bike Routes. These paths should be widened to 10' in the future.

2. Roadway Improvements

a. Increase space available for bicycle use on roads

- Stripe Cherry Hill Road to demark shoulder area
 - Stripe 10' travel lanes and 3' shoulders
- Remove curb stops from Great Road and mark bike lanes
 - Stripe 10' travel lanes and 5' bike lanes
- Eliminate climbing lane on Route 206 south of Stony Brook and mark shoulders (NJDOT project)
 - Stripe 11' travel lanes and 4' shoulders
- Eliminate on-street parking from the following 30' wide streets - Hamilton Avenue and Wiggins Street in borough; Harrison Street in township
 - Stripe streets to mark 10' travel lanes and 5' bike lanes

b. Reduce travel speeds

Reduce travel speeds on targeted roads through the provision of traffic calming devices. Traffic calming devices could include small diameter traffic circles, one-lane chicanes, raised intersections, four-way stop signs or speed humps. The selection of techniques appropriate for specific locations should take into considerations the speed control being sought, sight conditions, drainage and preferences of neighbors.

Consider providing small diameter traffic circles at the following locations:

- Franklin Avenue and Snowden Lane
- Franklin Avenue and Grover Avenue
- Intersections along Hamilton Avenue and Wiggins Street
- Intersections along Terhune Road and Valley Road at Jefferson Road and Walnut Lane
- Intersections along Cherry Hill Road with Foulet Drive, Crestview Drive, Stuart Road, Balcort Drive and Ridgeview Road

Consider providing one lane chicanes or road narrowings with bicycle and pedestrian bypasses at various locations along Snowden Lane, Franklin Avenue and Grover Avenue to slow speeds to less than 20 MPH.

3. Bicycle Routes

Designate the following streets as bicycle routes

- Stuart Road
- College Road
- William Street

4. Paths and Trails

a. Improve existing multi-use trails

Widen multi-use trails to 10' and improve vertical and horizontal geometry to assure adequate sight distance .

- Community Park North trail from parking lot to Cherry Hill Road.
- Princeton Pike trail from bridge over Stony Brook to south end of trail.
- Grover Park trail from Grover Street to Princeton Shopping Center
- Guyot Avenue Trail between Moore Street and Carnahan Place
- Trenton/Princeton Traction Trail from Elm Road to Johnson Park School

b. Improve Crosswalks Where Trails Cross Major Roads

Provide median refuge islands and consider providing raised pedestrian crosswalks (speed tables) at the following locations.

- D & R Canal towpath at Quaker Road
- D & R Canal towpath at Alexander Road
- D & R Canal towpath at Washington Road
- D & R Canal towpath at Harrison Street
- Edgerstoune Road trail at Rosedale Road
- Princeton Trenton Traction Line at Elm Road

5. Enforcement

a. Enforce Share the Road Concept

Instruct police to warn or ticket drivers who pass bicyclists with insufficient clearance. Ticket drivers who honk or otherwise seek to intimidate bicyclists by honking or yelling at bicyclists. (Note: current state law states that all drivers must honk whenever passing any vehicle, and the NJDMV Driver's Manual instructs drivers to honk at bicyclists when passing. Therefore, police would have to determine that motorists were seeking to intimidate bicyclists and not merely warn them.)

b. Ticket Drivers Who Fail to Yield ROW to Bicyclists

Bicyclists generally share the same rights to use streets and roads in Princeton as motor vehicle drivers. Drivers who fail to yield right-of-way to bicyclists when the bicyclist has the right-of-way should be ticketed. For example, when a motorist is making a left turn or entering the roadway from a stop sign.

c. Enforce Bicyclist Observation of Traffic Laws

Issue tickets to drivers who fail breach the following vehicle regulations:

- Failure to yield right-of-way to pedestrian
- Riding on wrong side of the street
- Failure to obey traffic signal
- Failure to yield right-of-way at intersection

Children or adults without licenses should be issued warnings.

6. Education

Township and borough police departments should continue to present programs to youth in the community regarding how to ride in traffic and how to care for bicycles

Schools should continue to provide safety programs on bicycling

Schools should incorporate into driver education curricula instruction on how to share the road with bicyclists

7. Bicycle parking

a. Provide Additional Bicycle Parking and Replace Ineffective Parking

Municipal funding programs should be established to increase bicycle parking at the following locations and to replace old fashioned bicycle racks:

- Along Nassau Street and other streets in the town center including Witherspoon, Palmer Square and Chambers Street
- Long-term and short term parking in municipal parking lots
- At the Princeton Library
- At all schools
- At all parks
- Dinky Station

- b. Encourage Property Owners to Provide Bicycle Parking
Encourage property owners to replace antiquated racks and provide additional bicycle parking at:
 - Princeton Shopping Center
 - Chambers Street garage
 - Office complexes along Harrison Street, Ewing Street and Bunn Drive
8. **Ordinances, regulations and plans**
 - a. Require Bicycle Parking at New Developments
Amend development ordinances to require bicycle parking in new developments and as part of redevelopment projects.
 - b. Revise Roadway Improvement Standards to Conform with Compatibility Standards
Revise language of the circulation element of the master plan to conform with bicycle compatibility standards, and revise Table 1 of Appendix B of the master plan, which presents Roadway Design Standards for Princeton Borough and Township.

B. Mid-term Actions

Actions that require moderate expense, in some cases acquisition of land, and/or would require removing parking in commercial areas

1. Roadway

- a. Increase space available for bicycle use on roads
Eliminate on-street parking from the following streets and mark streets to provide 10' travel lanes and 5' bicycle lane.
 - Franklin Street from Snowden Lane to Walnut Lane
 - Walnut Lane from Hamilton Street to Terhune Road
 - Terhune Road from Snowden Lane to State Road (US 206)
 - Bunn Drive
 - Mercer Street
 - Alexander Street in borough

Restripe Nassau Street between Witherspoon and Washington Streets in order to provide bicycle compatible wide outside lane.

Eliminate on-street parking on one side of the following 40' wide streets and stripe the roads to mark an 11' travel lane and 5' bike lane in each direction plus one 8' parking lane. Use chicanes to shift the parking from side of the street to the other, thereby introducing horizontal deflections to control traffic speeds.

- Alexander Street in township from borough line to Faculty Drive
- Paul Robeson Place from Witherspoon Street to Chambers Street
- Nassau Street from Washington Street to Chestnut Street

b. Widen Roadway Pavements

Widen the following collector roads to 28' and stripe to provide 10' travel lanes and 4' bike lanes. Do not use curbs - where curbs are present, remove as part of the road widening.

- Snowden Lane between Route 27 and Franklin Avenue
- Snowden Lane between Overbrook Drive and Herrontown Road
- Herrontown Road between River Road and Snowden Lane
- Great Road between Stuart Road and Cherry Valley Road

Work with NJDOT to widen US 206 from 28' to 32' and stripe to provide 11' travel lanes and 5' shoulders in the following two locations.

- Between Cherry Hill and Arreton Roads
- Between Edgerstoune and Quaker Roads

Widen the following minor arterials and major collector roads to 30' and stripe to provide 10' travel lanes and 5' bike lanes, or widen to 34' to provide 11' travel lanes and raised 6' cycle tracks on each side of road.

- Cherry Valley Road from Province Line Road to US 206
- Quaker Road between D&R Canal and Princeton Pike
- Princeton Pike from Lawrence Township to Lover's Lane (except for historic bridge over Stony Brook).
- Rosedale Road between Elm Road and Province Line Road (county road)

Provide streetscape improvements including reduced height street lighting, stamped concrete pavement and similar enhancements to tell drivers that they are entering an area with more intense pedestrian activity and narrow roadway width. Consider use of long speed humps or other calming devices.

- Nassau Street between Chestnut Street and Linden Lane.

c. Eliminate curbing

When other roads are reconstructed, consider eliminating curbing where on-street parking will not occur on a regular basis.

2. **Paths and Trails**

The following opportunities have been identified to develop new multi-use trails that would either extend existing trails or create new ones that would link important destinations within the Princeton community. Most of these trails involve the use of existing parkland, campuses, open space on lands owned by non-profit corporations or connections through parking lots. In some cases existing low volume streets or lanes would form some of the trail connection, such as the access road to Mountain Lake Park.

a. Trail from Palmer Square to PDS/Stuart

The following trail sections would connect the schools in the northwest corner of Princeton Township with the center of town, providing students and faculty with a pathway alternative to Great Road. It would also create a north-south corridor running parallel to US 206 and Witherspoon Street.

- Chambers Street Trail Extension - from Paul Robeson Place to Leigh Ave

- Rear of YMCA property
- Rear of Merwick
- Streets within Stanworth Village
- Linkage path from Stanworth Village to Leigh Avenue
- Leigh Avenue to Mountain Lakes Park
 - Trail around west end of Community Park South tying into the jughandle at Mountain Avenue
 - Existing trail along the south side of Community Park North
- Mountain Lakes Park/Community Park Trail to PDS & Stuart
 - Mountain Lakes Park access drive – provide traffic calming features to slow vehicles to 15 MPH
 - New trail linking Mountain Lakes Park with Old Great Road/New Great Road intersection
 - Designate Old Great Road as bicycle route

b. Princeton Cemetery linkage path

A set of lanes within the Princeton Cemetery could be used for north-south bicycle and pedestrian travel, provided that appropriate protection was assured for the character of the cemetery. The lanes that could serve a transportation function connect the Greenview Avenue gate with the Medical Center's parking lot near Witherspoon Place. Currently no gate is available along the northern boundary of the cemetery.

c. East-west connections across Princeton University campus

The University is an important bicycling destination, and many of its students use bicycles both within the campus and when traveling off-campus. Elm Drive provides a continuous north-south route between Nassau Street and Faculty Drive. Additional north-south routes are available to augment this principal spine road.

In the east-west direction, a number of obstacles restrict the ability of bicyclists to pass through the campus, which in turn blocks travel parallel to Nassau Street within the Princeton Community. The community can work with the University to develop a series of barrier-free crossings across the campus that would serve both University bicycle traffic and bicyclists seeking routes across the campus. In addition to serving bicyclists, barrier-free routes through the campus would also assist the University in providing a barrier-free environment for its disabled students, guests and employees. Since this study was initiated the University has already begun reconstructing numerous pathways to eliminate barriers.

Through the central portion of the campus, such routes should not be signed as bicycle routes, since signage could attract through bicyclists who would want to travel at speeds incompatible with the dense pedestrian activity on the campus.

However, along the south end of the campus where pedestrian activity is less dense, one or two signed routes could be created to guide through bicyclists

across the campus and to encourage greater use of bicycles for traveling to and from the campus. Corridors appropriate for east-west bicycle travel include:

- William Street to University Place south of Nassau Street
- Prospect Avenue to vicinity of Dickinson Street
- Ivy Lane to College Road
- Jadwin Gymnasium to Baker Rink
- FitzRandolph Observatory to Harrison Street near Sycamore Road

d. Southeastern Trail Extensions

Springdale Golf Course, the Rogers Wildlife Preserve, the Institute Woods and the campus of the Institute for Advanced Study, the Princeton Battlefield State Park, the campus of the Princeton Friends School, the Princeton Country Club (a Mercer County Park) and the ,, Farm combined create a broad area of open space that is greatly valued by the Princeton Community, but which also currently separates the community, including the University, from the intense development along the Route 1 Corridor with its many trip generators and attractions.

A limited number of trails through this open space area would provide residents, students and employees with desirable pedestrian and bicycle connections. However, the location and development of any such trails would have to occur in a fashion that would protect the other valuable uses of this open space district.

Some recommended connections appropriate for trail connections are suggested below:

- College Road/Ober Road Connector along northwest perimeter of Springdale Golf Course
- Springdale Road/Factory Road Connector along southern perimeter of Springdale Golf Course
- Springdale Road/Market Fair Connector with bridges across the Stony Brook and the D&R Canal in the vicinity of the Princeton Country Club
- Trail from Stone House Drive on the Institute Campus through Princeton Battlefield State Park to the Princeton Friends School.
- Edgerstoune Road/Mercer Street linkage path along the west edge of Drumthwacket

3. Linkage Paths

In Princeton Township a large number of cul-de-sac streets and loop streets have been constructed that largely limit residents to driving for trip making because of the extensive additional travel distances imposed on travelers. Linkage paths connecting the end of cul-de-sacs to adjacent streets, and in particular adjoining cul-de-sacs, provide a method of creating bicycle and pedestrian connections while restricting motor vehicle travel. Similarly, mid-blocks linkages within loop streets can help to create a more dense pathway network, thereby facilitating bicycle and pedestrian travel.

The following linkage paths are recommended as mid-term actions because of their value in linking important community facilities.

- Roper Rd connector to Littlebrook School
- Connector between Wilson Road and Old Bayard Lane providing pedestrian and bicycle access from the west end of the borough to Community Park North and South
- Franklin Avenue connector between Moore Street and Walnut Lane around north side of high school

4. Bicycle parking

Monitor parking demand within the borough and township. Supply additional bicycle parking devices as needed. Repair or replace damaged racks.

5. Plans

Review development plans to assure that new developments encourage bicycle use and incorporate improvements to serve both local riders and community riders.

C. Long-term Actions

1. Provide reserved space for bicyclists on arterial streets

Stripe bike lanes along Nassau Street from University Place to Washington Road

2. Paths and Trails

The following possible trails are worth pursuing to expand opportunities for bicycle use in the Princeton community.

- Trenton/Princeton Traction ROW
- Bridge over Stony Brook from Magie/Hibben Apartments to D&R Canal adjacent to east side of Dinky Bridge
- Harry's Brook trail, a bicycle boulevard trail that can be created by constructing linkage paths between Bainbridge Street and Gordon Way, between Bainbridge Street and Wheatsheaf Lane, and between Wheatsheaf Lane and White Pine Lane
- Other linkage paths created at ends of cul-de-sacs or in the middle of long loop streets

The Stuart Road corridor, including those sections that have not been constructed, could create a bicycle and pedestrian trail across the north side of the township and would connect the independent schools along Great Road with approach corridors from both the north and the west. Similar to the "bicycle boulevard" concept, a Stuart Road trail would use existing lower volume collector streets in conjunction with sections of trails on which motor vehicles would be excluded to allow bicyclists to complete longer distance trips without encouraging through motor vehicle trips.

Additional opportunities for providing greenway trails within the Princeton Community have been identified in the Open Space Element. Some of these trails could be considered for inclusion in a bicycle network, although many passing through parks or nature preserves would be most appropriately limited to only hikers.

BICYCLE CIRCULATION PLAN FOR THE PRINCETON COMMUNITY

ATTACHMENTS

RECOMMENDED CHANGES TO:

MASTER PLAN CIRCULATION ELEMENT

DEVELOPMENT ORDINANCES

APPENDICES

- APPENDIX 1SUMMARY OF NATIONAL RESEARCH
ON BICYCLE CRASHES
- APPENDIX 2BICYCLE DESIGN GUIDELINES
- APPENDIX 3MULTI-USE TRAIL OPPORTUNITIES
- APPENDIX 4BICYCLE PARKING

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

ATTACHMENT 1
RECOMMENDED CHANGES TO THE
CIRCULATION ELEMENT OF THE
PRINCETON COMMUNITY MASTER PLAN

Attachment 1

Recommended Master Plan Changes

PEDESTRIAN AND BICYCLE IMPROVEMENTS

The Princeton community is served by a comprehensive system of pedestrian and bicycle paths. The policy of the Regional Planning Board of Princeton is to promote bicycling as a safe choice for personal transportation. In order to achieve this policy it is necessary to plan and provide appropriate facilities which will accommodate all levels of bicycling skill. Roadways, sidewalks and bike paths should be designed to meet current state and federal requirements, where appropriate.

Bicyclists in Princeton form a diverse group and range from highly experienced riders who ride frequently to more casual riders who are less comfortable riding in traffic to young children who have not developed adequate judgment to ride in the street. To meet the needs of this diverse group a variety of facilities are needed. Advanced bicyclists are best served by streets and highways which have been designed for cars and bicycles to share the road. Casual riders may prefer a separate path or marked bike lane which encourages bicycle usage. Young children and others learning how to ride a bicycle need separate paths or to share sidewalks due to areas free of motor vehicle and pedestrian traffic where they can develop their limited-riding skills. Young children should only be allowed to ride under the supervision of a responsible adult until they have developed the riding skills and judgement that can permit them to safely ride in mixed traffic and anticipate possible conflicts with motor vehicles.

The Planning Board recommends that a community-wide bicycle system that addresses all levels of bicycle riding ability be developed. Special attention should be given to developing routes which allow school aged children to safely ride bicycles to and from school, parks, the library and other areas in the community. Proposed bike routes and areas to have sidewalks are indicated on the Bike Route Plan and Sidewalk Plan.

Because of national experience indicating that motor vehicle crashes with bicycles are particularly likely when bicycles operate on two directional paths adjacent to roadways, sidewalks and trails immediately adjacent to streets shall not be designated as bicycle routes. When off-road trails are to be marked as bicycle routes, they shall meet the following minimum conditions:

- The trail shall be separated from roadways by a minimum of five feet.
- All intersections with driveways, alleys or streets shall be located at least one car length from any adjacent roadway intersection and preferably by a distance of at least 100 feet.
- Trails shall provide sight distance based on a design speed of 20 miles per hour.
- Trails shall have a clear zone free of physical obstructions and having a minimum width of 2' on either side of the trail surface.
- New trails should have a width of 10' and must have a minimum width of 8'. Existing trails of 6' may continue to be posted as bicycle routes provided that other conditions are met.

Listed below are improvements that the Planning Board has which we have identified as necessary to further bicycle and pedestrian mobility.

Pedestrian Crossing Princeton Pike at Stony Brook — A pedestrian bridge should be constructed over the Stony Brook to facilitate pedestrian and bicycle traffic along the existing Princeton Pike bike path system which connects to the path system in Washington Oaks development. Mercer County has committed to fund the construction of this project.

Pedestrian Bike-Path Extensions —

The existing pedestrian bike-path along Rosedale Road should be extended to Province Line Road. The bike pedestrian path along Cherry Hill Road should be extended along Route 206 south to Mountain Avenue, including a bridge over Mountain Brook. This path should also cross Route 206 and continue on the western side of Mount Lucas Road to the intersection of Valley Road and Witherspoon Street. The Mercer Street bike-multi-use path should

What has changed?

be extended from the Heatherstone development to Gallup Road, and the existing path should be widened from 6' to 10' from the bridge over the Stony Brook south to the existing path terminus. A bike path extending from the Institute for Advanced Study on Olden Lane through the Institute lands and over the Stony Brook and D & R Canal linking the County Park, Seminary Apartments and Market Fair Shopping Center should be considered.

Sidewalks, bikeways, and paths --

The Planning Board encourages development of a continuous network of sidewalks, bikeways and paths to create linkages between neighborhoods, open spaces, recreational areas, and schools as well as providing an alternative to motorized vehicular traffic. Sidewalks, bicycle paths or pedestrian paths should be provided along all major roadways. Since 1989 many of the sidewalks, bikeways and paths recommended in the Master Plan have been constructed. The remaining sidewalks, bikeways and paths indicated in the 1989 plan remain valid and should be constructed when feasible. The sidewalk plan indicates the existing as well as proposed sidewalks, bikeways, and paths.

Pedestrian Enhancements -

Areas of high pedestrian activity should be studied to determine what actions are appropriate to better protect and encourage pedestrian activity. Pedestrian crossing markings and signage should be enhanced where appropriate. Stricter enforcement of pedestrian safety rules should be encouraged. A community wide pedestrian safety program should be developed.

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De-designate sidewalk bicycle routes

Existing "Bike Route" signs should be removed from sidewalks and paths adjoining roadways that do comply with the conditions listed above. Paths that are well separated from roadways and have no driveway and few street crossings, such as the path along Princeton Pike south of Quaker Road, can continue to be signed as Bike Routes. These roads should be widened in the future to provide a width of 10'.

Increase space available for bicycle use on roads

- Stripe Cherry Hill Road to provide 10' travel lanes and 3' shoulders
- Remove curb stops from Great Road. Stripe road to provide 11' travel lanes and 4' shoulders
- Eliminate climbing lane on Route 206 south of Stony Brook and stripe road to provide 11' lanes and 4' shoulders
- Eliminate on-street parking from existing 30' streets. Consider providing 4' bike lanes. Streets from which parking should remove include:

Alexander Street
Hamilton Avenue
Mercer Street
Wiggins Street

Witherspoon Street
Nassau Street north of Washington Road
Harrison Street in township

- Restripe Nassau Street from Witherspoon Street to Washington Road to provide a center left turn lane plus one wide travel lane and a parking lane in each direction.

Widen Roadway Pavements

Widen the following collector roads to 28' and stripe to provide 10' travel lanes and 4' shoulders.

- Cherry Hill Road
- Snowden Lane between Route 27 and Franklin Avenue
- Snowden Lane between Overbrook Drive and Herrontown Road
- Herrontown Road between River Road and Snowden Lane
- Great Road between Stuart Road and Cherry Valley Road

Widen the following minor arterials and major collector roads to 30' and stripe to provide 11' travel lanes and 4' shoulders

- Cherry Valley Road from Province Line Road to US 206
- Quaker Road between D&R Canal and Princeton Pike
- ^{more MERCE} Province Line Road from Lawrence Township to Lover's Lane (except for historic bridge over Stony Brook).
- Rosedale Road between Elm Road and Province Line Road (county road)

Work with state to provide widening of US 206 from 28' to 32' and stripe to provide 11' travel lanes and 5' shoulders in the following two areas.

- Between Cherry Hill and Arretton Roads
- Between Edgarstoune and Quaker Roads
- Between Stony Brook Bridge to south of Hutchinson Road

Eliminate curbing except "In-Town" or in other locations where on-street parking can be anticipated on a regular basis. Consider removing curbing from collector roads and minor arterials that do not meet these conditions when roads are reconstructed.

Reduce travel speeds on targeted roads through the provision of traffic calming devices. ^{Such as} Consider providing small diameter traffic circles at the following locations to control traffic speeds and to improve motor vehicle safety.

- Franklin Avenue and Snowden Lane
- Franklin Avenue and Grover Avenue
- Intersections along Hamilton Avenue and Wiggins Street
- Intersections along Terhune Road and Valley Road at Jefferson Road and Walnut Lane
- Intersections along Cherry Hill Road with Foulet Drive, Crestview Drive, Stuart Road, Belcort Drive and Ridgeview Road

Multiple Use Trails

The following possible trails are worth pursuing to expand opportunities for bicycle use in the Princeton community.

- Chambers Street Extension
- Mountain Lakes Park/Community Park Trail to PDS
- Ivy Lane/College Road Connector
- Hardin Road/Factory Road Connector
- Connector to Market Fair and housing for the Theological Seminary
- Princeton Cemetery linkage path
- Trenton/Princeton Traction ROW
- Linkage trail between Wilson Road and Community Park
- Bridge over Stony Brook from Magie /Hibbon Apartments to D&R Canal adjacent to east side of Dinky Bridge

Improved Crosswalks Where Trails Cross Roads

Provide median refuge islands and consider providing raised pedestrian crosswalks (speed tables) at the following locations.

- D & R Canal at Alexander Road
- D & R Canal at Washington Road

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- D & R Canal at Harrison Street
- Edgarstoune Road Trail at Rosedale Road
- Princeton Trenton Traction Line at Elm Road

Provide Funding for Bicycle Parking

Municipal funding programs should be established to increase bicycle parking at the following locations and to replace old fashioned bicycle racks:

- Along Nassau Street and other streets in the town center including Witherspoon, Palmer Square and Chambers Street
- Long-term parking in municipal parking lots and in the Chambers Street garage
- At the Princeton Library
- At all schools
- At all parks
- Dinky Station *commercial*

Encourage Property Owners to Provide Bicycle Parking

Encourage property owners to replace antiquated racks and provide additional bicycle parking at:

- Princeton Shopping Center
- Office complexes along Harrison Street, Ewing Street and Bunn Drive

Require Bicycle Parking at New Developments

Amend development ordinances to require bicycle parking in new developments and as part of redevelopment projects.

*commercial
non residential*

TIP

Transportation Improvement Plan

Is it the goal of the master plan to encourage walking + cycling

Table 1
ROADWAY DESIGN STANDARDS
Princeton Borough and Township

Classification	Traffic Lanes ¹	Shoulder/ Parking ²	Total Pavement	Total R.O.W.
Primary Arterial ³	2 @ 42_11'	* (4)	24' + ⁴	66'
Secondary Arterial	2 @ 42_11'	2 @ 7'	38'	60'
Secondary Arterial, Cons ⁵	2 @ 42_11'	2 @ 3_4'	30' ⁶	50'
Major Collector	2 @ 42_11'	2 @ 3_4'	30'	50'
Major Collector, Cons	2 @ 42_10'	2 @ 0_4' - Uncurbed 2 @ 4_5' - Curbed	24_28' ⁶ 26_30'	50' 50'
Minor Collector	2 @ 42_10'	2 @ 0_3' - Uncurbed ⁷ 2 @ 1_4' - Curbed	24_26' 26_28'	50' 50'
Local Street ⁸	2 @ 42_10'	2 @ 0' if not curbed ⁷ 2 @ 2' if curbed ⁹	20' 24'	50'

¹ Additional lanes or shoulders may be needed at intersections to facilitate turning movements.

² Existing streets shall be curbed only when gradient exceeds 3-1/2%, or in an "In-Town" location or other locations to control parking or inappropriate automobile access; otherwise 4' minimum gross shoulder shall be provided. Where gradients exceed 3-1/2%, erosion control measures will be employed.

³ In Princeton all Primary Arterials are constrained by intense abutting development, the presence of historic or cultural resources, environmental sensitivity, or other factors limiting street width.

⁴ Shoulder width shall be minimized the minimum required to provide bicycle compatibility, and when shoulder width is expanded, the design of the project shall reflect the historic character and environmental sensitivity of surrounding lands.

⁵ Constraints reflect intense abutting development, the presence of historic or cultural resources, environmental sensitivity, or other factors limiting street width.

⁶ Minor width adjustments may be needed to accommodate existing field conditions.

⁷ Shoulder width and total width shall vary according to the need for on-street parking; gravel or reinforced grass is encouraged instead of pavement.

⁸ Residential streets shall conform to improvement requirements established by the New Jersey Residential Site Improvement Standards (RSIS).

⁹ All new local streets shall be curbed with laid-back Belgian block curbing if the RSIS require the use of curbs.

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

ATTACHMENT 2
RECOMMENDED CHANGES TO
DEVELOPMENT REGULATIONS

Attachment 2

Recommended Additions to Development Ordinances

OFF-STREET PARKING AND LOADING REQUIREMENTS

New Section

Bicycle Parking

Bicycle parking spaces shall be defined by an area 6' in length and 2' in width. Parking spaces may be organized in pairs. Between each pair of parking spaces an access aisle shall be provided that is 30" in width to permit a bicyclist to secure the bicycle. In addition, a 5' maneuvering area shall be provided in front of the bicycle parking space.

Bicycle parking spaces shall consist of a bicycle parking stall adjacent of security device that can support the bicycle frame in at least two locations and that allow the frame and one wheel to be locked to the device with a high security, U-shaped shackle lock. Security devices must be securely anchored.

Old fashioned bicycle racks that only support a bicycle by its wheel and that provide no support for a bicycle's frame shall not be permitted to be used to satisfy the bicycle parking requirements listed below.

All developments shall supply convenient and secure bicycle parking. All non-residential developments shall provide a combination of short-term and long-term bicycle parking. Bicycle parking shall be provided at the following rates:

Land Use	Short-Term	Long-Term
Residential		
Single family	None	2 per dwelling
Multi-family	1 per 20 dwellings	1 per 2 dwellings
Retail or service	1 per 5,000 sq ft	1 per 12,000 sq ft
Office	1 per 40,000 sq ft	1 per 20 auto spaces
Commercial parking lots	1 per 40 auto spaces	1 per 40 auto spaces
Parking garages		1 per 20 auto spaces
Schools	1 per 100 students	1 per 10 students
All other	1 per 20 auto spaces	1 per 20 auto spaces

A minimum of 2 short-term parking spaces shall be provided for all non-residential land uses.

Short-term parking spaces shall be located within 50 feet of the principal entrance of a structure, except that bicycle parking may be located adjacent to a secondary entrance if the applicant can demonstrate that bicyclists will be more likely to approach by that direction. For buildings having multiple entrances and for developments with multiple buildings, required bicycle parking shall be distributed to serve all buildings and main entrances. A minimum of 2 bicycle parking spaces shall be provided in front of each entrance.

Long-term parking spaces shall be located within 750 feet of the principal entrance to a building. Long term parking spaces shall be located so that at least 50% of the spaces are covered. All long term spaces shall be provided with security through one of the following means:

1. In a locked room, or in a cage that is enclosed by a fence with a locked gate
2. Within view of an attendant or security guard
3. In an area that is monitored by a security camera, and which a security guard can access within 30 seconds of notification of a security breach
4. In a location that is visible from an employee's or student's work area

Developments that are required to provide more than 20 bicycle parking spaces by the above formulas will initially only be required to provide 50% of the parking spaces greater than 20. The developer will then be required to monitor the bicycle parking facilities. When bicycle parking demand exceeds 80% of the parking supply provided, additional parking devices shall be added so that the available supply will be equal to at least 80% of the typical demand.

NEW SECTION

Requirements for linkage paths.

Under the following situations, a pedestrian linkage path shall be required to be constructed to maintain pedestrian and bicycle mobility and connections both within the development and to provide access to surrounding developments and community services.

- At the end of a cul-de-sac.
- In the middle of a loop street
- Along any block that is greater than 600' feet in length.

Linkage paths shall be located within a 33' wide general easement and shall be constructed of either Portland cement or asphalt concrete and shall employ a pavement design to be approved by the municipal engineer.

NEW SECTION

Accommodation of bicycles

All development streets shall be constructed to comply with the standards for bicycle compatibility as presented in the Bicycle Circulation Plan for the Princeton Community.

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

APPENDIX 1
SUMMARY OF NATIONAL
RESEARCH ON BICYCLE CRASHES

Appendix 1

Summary of National Research on Bicycle Crashes

To provide good facilities for all bicyclists, it is important to understand what constitutes a safe bicycle facility. As discussed by Forester¹, public decision makers frequently exaggerate the risk associated with bicycles and motor vehicles sharing roadways. Contrary to the expectation of persons who do not regularly bicycle, accidents between motor vehicles and bicycles are least likely to occur if a bicyclist treats his or her bicycle as a vehicle and adheres to the "rules of the road".

Hunter, et al, of the Highway Safety Research Center at the University of North Carolina², recently completed a comprehensive study of crashes between bicycle and motor vehicles that provides an exhaustive analysis of reported bicycle crashes. The analysis conducted by Hunter was based on accidents that were reported to police departments in six states. Unlike studies that are based on surveys of specific groups of bicyclists, this study analyzed all reported bicycle crashes with motor vehicles. The data missing from the study included accidents that were not reported and accidents that did not involve a motor vehicle/bicycle crash.

A number of other studies have been conducted using survey responses of specific groups of bicyclists, in particular a series of surveys conducted of adult members of the League of American Wheelmen (LAW)³. The principal problem with these surveys is that they focus on the riding behavior of the sub-population of

bicyclists having the greatest experience as bicyclists. However, these studies do report all types of bicycle accidents, including accidents that do not involve a motor vehicle.

The survey-based studies of adult cyclists indicate that crashes with a moving motor vehicle reflect only a small percentage of total bicycle accidents, 11% according to Moritz. Moritz also reports that 59% of all bicycle accidents, and 38% of serious accidents, consist of a fall involving no other vehicle or object.

As indicated earlier, the survey-based results reflect the riding experience of experienced adult bicyclists. However, according to Hunter, this group reflects only a small portion of the total number of riders involved in bicycle/motor vehicle crashes. Hunter's data indicates that almost 60% of bicyclists involved in crashes are under the age of 20, while Moritz reports that only 1% of the survey responses received for his study were from people under the age of 25. Interestingly, the Hunter study also found that in over 50% of bicycle/automobile crashes the bicyclist was fully or partially at fault. Riders under the age of 20 were much more likely to be at fault than were riders over that age. This data indicates the tremendous importance of developing and maintaining effective cycling education programs in the schools to educate children on how to safely ride a bicycle, and on the responsibilities of riding a bicycle, especially in traffic.

A major reason for encouraging the use of off-road trails or routes for bicyclists is the perceived risk associated with riding in mixed traffic. However, the combined findings from on the various accident studies indicate that when properly driven bicyclists riding on public roads are relatively safe. As indicated by the Moritz study, and similar studies, most bicycle accidents, including most serious accidents, occur as a result of falls that do not involve a motor vehicle.

¹ John Forester, "Cycling Accidents", *Bicycle Transportation: A Handbook for Cycling Transportation Engineers*, MIT Press, 1994.

² William W. Hunter, Jane C. Stutts, Wayne E. Pein and Chante L. Cox, *Pedestrian and Bicycle Crash Types of the Early 1990's*, University of North Carolina Highway Safety Research Center, Federal Highway Administration, Publication No. FHWA-RD-95-163.

³ Bill Moritz, "Profiling Adult U.S. Cyclists: A National Survey", in *Bicycle USA*, January February 1998, p. 10. Jerrold A. Kaplan, *Characteristics of the Regular Adult Bicycle User*, National Technical Information Service, Springfield, VA, 1976, as reported in Forester.

The type of accident most feared by inexperienced bicyclists, and by policy makers with little bicycling experience, is a crash with a passing motor vehicle. However, the analysis by Hunter indicates that these accidents represented only 8.6% of total crashes between motor vehicles and bicycles. Combined with the finding of Moritz that crashes between bicycles and automobiles account for only 11% of all bicycle accidents, the combined studies indicate that crashes with a passing motor vehicle represent less than 1% of all bicycle accidents.

Although only a very small percentage of total bicycle accidents, an accident with an overtaking motor vehicle is more likely to result in serious injury or death. These accidents, when they do occur, are more likely to occur on higher speed rural roadways having insufficient roadway width. Making roadways compatible with bicycle use by either controlling the speed of motor vehicles or providing adequate pavement widths on higher speed roadways can further reduce the already low risk of these accidents occurring.

Hunter found that the majority of crashes between bicycles and motor vehicles (57%) involved crossing movements, primarily at intersections. An additional 19% of accidents were associated with turning movements by bicycles or motor vehicles that had been following parallel paths prior to the crash. Combined, this data indicates that over 75% of all bicycle/motor vehicle accidents were associated with turning or crossing maneuvers.

Hunter provides additional analysis of specific groups of accidents that constituted a relatively high percentage of crashes. One group, accounting for 21% of all crashes between bicycles and motor vehicles, consisted of accidents at intersections in which a motorist was found to be at fault by not having yielded the right-of-way to a passing bicyclist. These could be further divided into two subgroups of accidents: those in which the motorist was obviously at fault by running a red light or failing to stop at a stop sign, and a second subgroup in which the motorist did stop but then crashed with the bicyclists when entering the intersection.

In the sub-group of crashes, in which the motorist did stop first, a large majority of the bicyclists struck were approaching from the driver's right side. At this type of location, a driver's attention is focused on motor vehicles approaching from the left and secondarily motor vehicles approaching on the right on the opposite side of the roadway. A bicyclist, either traveling in the wrong direction on the road or riding on a sidewalk, is not in the driver's area of surveillance. It is therefore not surprising that the majority of bicyclists struck were found to be traveling in the opposite direction. In this situation, bicyclists were also more likely to be struck if riding on a sidewalk or path rather than in the street.

In presenting data for this situation, Hunter indicates that at driveways or alleys, 48% of all bicyclists struck were riding on sidewalks, and 67% of all bicyclists were traveling in the wrong direction, either in the street or sidewalk. Similarly, under right-turn-on red conditions, 55% of struck bicyclists were riding on sidewalks, and 80% were traveling in the wrong direction.

In contrast, in the sub-group of accidents in which the driver ran through a red light or stop sign, the motorist was much less likely to strike a bicyclist riding in the sidewalk or traveling in the wrong direction on the roadway. To some extent this condition represents a control condition for the previous conditions and allows one to recognize the inherent hazards associated with riding a bicycle in a sidewalk or in riding the wrong direction on a street.

In summary, national data regarding bicycle accidents indicate that educating bicyclists regarding how to ride safely with traffic continues to be a critical issue. Riding the wrong direction on streets, and riding on sidewalks, are both causes of accidents; bicyclists should be taught not to use their bicycles in that manner. Making roads compatible with bicycle use can help reduce the risk of accidents with vehicles on highways. Providing good riding surfaces on streets and highways can also help to reduce the risk of falls, the principal cause of bicycle accidents.

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

APPENDIX 2
BICYCLE DESIGN GUIDELINES

Appendix 2

Summary of Bicycle Design Guidelines

Accommodating and Encouraging Bicycling on Roadways

The NJDOT Planning and Design Guidelines for Bicycle Facilities, published in April 1996, describe how roadways and trails can be constructed to promote the use of bicycling as a transportation mode. The NJDOT Guidelines make a distinction between providing facilities that merely accommodate bicycling and facilities that encourage bicycling.

- Facilities that accommodate bicycling (bicycle compatible roadways) permit a moderately experienced bicyclist to safely ride in mixed traffic. Since bicycles are treated as a vehicle in New Jersey, all streets and roads should be designed to accommodate bicycle traffic.
- Facilities that encourage bicycling (bikeways) have characteristics that make them inviting for use by both experienced and less experienced bicyclists. These characteristics could be low traffic volumes, wide shoulders, low vehicle speeds or a combination of these features.

Because the street system is extensive, and because it is generally well maintained, most bicycle activity occurs on public streets. As a result, it is important to assure that the public street system is appropriately designed to accommodate this use.

The characteristics associated with streets that accommodate or encourage bicycling are largely associated with the width of the roadway and the volume of traffic on the roadway. Some factors, such as the presence of parked cars, vertical curbs or other obstructions or hazards impact the usable roadway width and need to be considered in the management plan for a roadway.

Increases in traffic volume increase the probability that a bicyclist will have to share the roadway with two motor vehicles at the same time. Under these conditions, narrow country roads become hazardous to bicyclists unless more pavement width is provided. The amount

of additional space required depends upon both the speed of traffic and the volume of traffic. The volume of traffic affects the extent to which vehicles, when passing a bicyclist, may encroach into the opposite travel lanes. The speed of traffic affects the amount of space that both bicyclists and motorists would like to have between them during a passing maneuver.

Required sight distances increase geometrically with speed. As this indicates, drivers of motor vehicles are better able to take corrective action when vehicle speeds are slow. At the same time, the speed differential between a bicycle and a motor vehicle will be less on low speed roadways. As a result, controlling vehicle speed is often an effective method of making a roadway compatible with bicycle use.

Table 1 and Table 2 at the end of this section present characteristics for streets and roads that accommodate bicycling and encourage bicycling respectively, as recommended by NJDOT. These tables are similar to guidelines that have been developed by AASHTO and FHWA. The New Jersey recommendations, however, have been adjusted to reflect the public's preference to limit roadway improvements on low volume, low speed roads that residents, bicyclists and motorists would all prefer not be widened. NJDOT's standards recognize that 10' and 11' travel lanes may be appropriate dimensions for shared use on lower volume roadways.

For both roads that accommodate bicyclists and roads that encourage bicycling, NJDOT has divided roadways into four broad groups based on the volume of traffic on the roadway. Roads with fewer than 1,200 vehicles per day are assumed to encourage bicycle use regardless of roadway width. Category I roads have volumes between 1,200 and 2,000 vehicles per day, Category II between 2,000 and 10,000 and Category III have over 10,000 vehicles per day.

Table 1

**NJDOT Bicycle Compatible
Roadway Pavement Widths**

Condition I

AADT 1200 - 2000*

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
<30	12' shared lane	11' shared lane	11' shared lane	10' shared lane	10' shared lane
31-40	14' shared lane	14' shared lane	14' shared lane	12' shared lane	12' shared lane
41-50	15' shared lane	15' shared lane	15' shared lane	3' shoulder	3' shoulder
>50	NA	NA	4' shoulder	4' shoulder	4' shoulder

For volumes less than 1200 a shared lane is acceptable.

Table 2

**NJDOT Bikeway Designation and
Roadway Pavement Width**

Condition I

AADT 1200 - 2000*

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
<30	14' shared lane	14' shared lane	14' shared lane	10' shared lane	10' shared lane
31-40	5' Bike Lane	5' Bike Lane	5' Bike Lane	4' shoulder	4' shoulder
41-50	6' Bike Lane	6' Bike Lane	6' Bike Lane	6' shoulder	6' shoulder
>50	N/A	N/A	6' Bike Lane	6' shoulder	6' shoulder

For volumes less than 1200 AADT a shared lane is acceptable.

Condition II

AADT 2000-10,000

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
<30	14' shared lane	12' shared lane	12' shared lane	12' shared lane	12' shared lane
31-40	14' shared lane	14' shared lane	14' shared lane	3' shoulder	3' shoulder
41-50	15' shared lane	15' shared lane	15' shared lane	4' shoulder	4' shoulder
>50	NA	NA	6' shoulder	6' shoulder	6' shoulder

Condition II

AADT 2000 - 10,000

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
30	14' shared lane	14' shared lane	14' shared lane	4' shoulder	4' shoulder
31-40	5' Bike Lane	5' Bike Lane	5' Bike Lane	6' shoulder	6' shoulder
40-50	6' Bike Lane	6' Bike Lane	6' Bike Lane	6' shoulder	6' shoulder
>50	N/A	N/A	6' Bike Lane	8' shoulder	8' shoulder

Condition III

AADT over 10,000 or Trucks over 5%

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
<30	14' shared lane				
31-40	14' shared lane	4' shoulder	4' shoulder	4' shoulder	4' shoulder
41-50	15' shared lane	6' shoulder	6' shoulder	6' shoulder	6' shoulder
>50	NA	NA	6' shoulder	6' shoulder	6' shoulder

NOTE: NJDOT minimum shoulder width of 2.4 meters (8 feet) should be provided wherever possible on roadways having an AADT greater than 10,000 vehicles.

Condition III

AADT Over 10,000

SPEED (mph)	URBAN		URBAN W/O		RURAL
	W/PARKING	PARKING	PARKING	PARKING	
<30	5' Bike Lane	5' Bike Lane	5' Bike Lane	4' shoulder	4' shoulder
31-40	6' Bike Lane	6' Bike Lane	6' Bike Lane	6' shoulder	6' shoulder
41-50	6' Bike Lane	6' Bike Lane	6' Bike Lane	6' shoulder	6' shoulder
>50	N/A	N/A	6' Bike Lane	8' shoulder	8' shoulder

These traffic volume categories were created to reflect the relative ease of sharing the roadway under different roadway travel conditions. The NJDOT guidelines were based on a Federal Highway Administration document, *Selecting Roadway Design Treatments to Accommodate Bicycles*.

Roadways that Accommodate Bicyclists

Standards for bicycle compatibility reflect how much roadway space a typical bicyclist needs to safely use a roadway in compliance with vehicle laws. On low volume roadways, little additional pavement space is required, since motorists will have ample opportunities to pass a bicyclist. Similarly, on low speed roads, the speed of a bicyclist will be only slightly less than a motorist's, resulting in little delay for the motorist waiting for an opportunity to pass. As the speed of traffic on a roadway increases, or the volume of traffic increases, additional roadway space is needed to safely accommodate bicyclists.

Under Condition I, a driver of a motor vehicle seeking to pass a bicyclist will do so by encroaching into the opposing lane of traffic. As long as traffic volumes are low, there will be a high probability that a suitable passing opportunity will be available. As a result, little additional roadway pavement is required to accommodate bicyclists, who will be riding with motor vehicles rather than on a bike lane or shoulder.

In contrast, at higher traffic volumes, motorists will be unable to encroach into the opposing traffic lane. As a result, Condition II requires that sufficient roadway space be available to allow a motorist to drive around a bicyclist without encroaching into the opposing lane of traffic, either through the provision of a shoulder or a wider outside travel lane.

Under the high traffic volumes of Condition III, motor vehicles will be passing bicyclists almost continuously, especially during peak travel periods. As a result, it is desirable to provide bicyclists with additional separation from the passing motorists to reduce the stress that a

bicyclist will experience. In addition, the added space is valuable in allowing trailing motorists to see a bicyclist that they will be passing by.

Thus only Category I conditions actually result in situations that require a driver to actually pass a bicyclist and that could result in delay to the motor vehicle driver.

The type of impact on the driver's perceived qualitative the analytical tools can approximate driving experience used to measure the level of service along a two lane rural highway. Using these tools, the 2,000 AADT threshold translates into a very good Level of Service of B, indicating that a driver will experience only limited delay when confronted with a bicyclist, even though it is necessary to encroach into the opposing traffic lanes to pass the bicyclist. Platoons of vehicles are not likely to form behind a vehicle delayed by a bicyclist, and motorists will seldom have to wait for a safe opportunity to pass.

Facilities that Encourage Bicycling

When a road is designated as a bikeway, either through the posting of bike route signs or the delineation of bike lanes, the use of the roads by less experienced bicyclists will be encouraged. As a result, standards for designating a roadway as a bikeway have traditionally been made more conservative to assure that bicyclists who have less experience riding in traffic will not feel intimidated by the traffic conditions.

Roadways however should not be designated as bikeways just because the roadway geometry supports such designation. Creation of bikeways should respond to actual bicycle travel demand and should serve bicycling needs. Appropriate reasons for establishing a bikeway could include:

- Identifying an appropriate and direct route to an important trip attraction
- Identifying a continuous route for recreational bicyclists that is especially enjoyable, or
- Establishing a route for bicyclists separate but parallel to heavily traveled arterial roads that do

not comply with bicycle compatibility standards.

Off-Road Use of Bicycles

One of the best methods of encouraging increased bicycling is to provide bicyclists with well designed off-road facilities. Although accident data may indicate that off-road trails and paths are not as safe as on-road facilities, many bicyclists, and especially inexperienced bicyclists, prefer bicycling on trails, and especially on trails that pass through parks or other natural areas. One of the best methods of increasing the experience level of bicyclists is providing less experienced riders a place where they will feel comfortable riding.

Few off-road facilities are constructed exclusively for bicyclists. Instead trails and paths are generally available for a wide variety of users. Most importantly, most off-road trails that would attract bicyclists will also attract walkers, joggers and roller bladers. As a result, these types of facilities, although often called bicycle trails, are more appropriately termed multi-use or shared-use trails.

In addition to attracting a wide variety of travel modes, multi-use trails tend to encourage users to occupy more horizontal space than they would if walking or bicycling on a road. Recreational walkers especially enjoy company, and usually will seek to walk abreast. As a result, it is quite normal on paths or trails to find the full width of the pathway occupied by a group traveling in a single direction. Bicyclists also will often take advantage of being on a trail to ride side by side rather than staying in single file as they would on a road. For these reasons, multi-use trails frequently require added width to accommodate anticipated travel usage.

Because of their wide variety of travel modes and travel speeds, it is important that multi-use trails be appropriately designed to accommodate intended use. The NJDOT Guidelines provide criteria for the design of multi-use trails. As with the guidelines for roadways, NJDOT's guidelines for trails reflect

national research and experience regarding the proper design of facilities for off-road use by bicyclists.

Critical elements of these guidelines are as follow:

Bicycle Use of Paths Adjacent to Roadways

Guidelines on bicycle facility design published by NJDOT, FHWA and AASHTO all strongly discourage the development of two-way bicycle paths immediately adjacent to roadways, including the designation of sidewalks as bikeways. These types of facilities are discouraged because they have been shown to be unsafe, encourage unsafe bicycling practices, provide a false sense of security for inexperienced bicyclists and expose bicyclists to unanticipated hazards. As with sidewalks, bicycle use of paths constructed adjacent to streets expose pedestrians to serious risks unless the paths are constructed with dimensions that permit safe multiple use of the facility.

As indicated in the accident analyses previously cited, a major problem with bicycle paths adjacent to roadways is the increased risk of collisions between bicyclists and motorists at intersections. A motorist stopped at an intersection must concentrate on the flow of motor vehicles on the intersecting street. Drivers frequently may not be fully aware of bicyclists approaching from the right, either riding on a path or in the wrong direction on the street. Similarly, motorists may not have full view of bicyclists approaching on a path to the left. As a result, national data indicate a greater chance of bicyclists being struck when riding on a path that is adjacent to a road.

Bicyclists using a bicycle path adjacent to a roadway will also be subject to substantial additional delay, both because of interruptions at frequent intersections and because of conflicts with pedestrians. Finally, paths along roads are less likely to be maintained as well as roads. Bicycles require a high quality roadway surface, and improperly maintained paths can be a cause of falls or tire punctures.

For these various reasons, bicycle paths adjacent to roads are often not used by bicyclists, who instead will ride on the street.

Bicycle paths adjacent to roadways may be appropriate under limited conditions. In particular, a path that essentially operates independently of a roadway, such as a path within a park or along a greenway, may need to be located next to a roadway for a short distance. When this occurs, it is important to maintain as much separation between the roadway and the path as possible. AASHTO recommends that a suitable physical barrier be provided between a path and a roadway when the horizontal separation must be less than 1.5 m (5'). Such a barrier can prevent path users from making unwanted movements between the path and the roadway, and it helps to reinforce the concept that the path is an independent facility.

Design of Multi-Use Paths to Accommodate Bicycles

Trail width

Multi-use paths that are intended for two-way bicycle use should have a width of 10 feet. The NJDOT Guidelines indicate that under specified conditions an absolute minimum width of 8 feet may be acceptable. Wider widths of trails, or provision of parallel trail facilities, may be required where demand for trails is extensive.

Pavement design

Bicycles are vehicles. As with motor vehicles, bicycles require a surface that is reasonably smooth and predictable. Because there are just two wheels and on most bicycles no springs, bicycles can be easily made unstable by poor surface conditions. Touring and road bicycles that have narrow, high-pressure tires are especially dependent on smooth riding surfaces.

Bicycling on Sidewalks

Identifying a sidewalk as a bicycle path is undesirable for a variety of reasons. *Sidewalks are typically designed for pedestrian speed and maneuverability and are not safe for higher speed bicycle use. Conflicts are common between pedestrians traveling at low speeds (or exiting stores, parked cars, etc.) and bicycles, as are conflicts with fixed objects (e.g., parking meters, utility poles, sign posts, bus benches, trees, fire hydrants, mail boxes, etc.). Walkers, joggers, skateboarders, and roller skaters can, and often do, change their speed and direction almost instantaneously, leaving bicycles insufficient time to react to avoid collisions.*

Similarly, pedestrians often have difficulty predicting the direction an oncoming bicyclist will take. At intersections, motorists are often not looking for bicyclists (who are traveling at higher speeds than pedestrians) entering the crosswalk area, particularly when motorists are making a turn. Sight distance is often impaired by buildings, walls, property fences, and shrubs along sidewalks, especially at driveways.

In residential areas, children can be anticipated to ride bicycles, tricycles, scooters and other riding toys on sidewalks. This type of use is an acceptable exception to the general finding that use of sidewalks by bicyclists is undesirable. Sidewalks in residential areas generally have low pedestrian volumes and are accepted as extended play areas for children. Pedestrians anticipate and usually enjoy encounters with young children who are playing in the sidewalk. This type of bicycle use of the sidewalk is generally acceptable, and provides young children who do not have the judgement or skill to ride in the street an opportunity to develop their riding skills.

Source: NJDOT, *Bicycle Compatible Roadways and Bikeways Planning and Design Guidelines*, April 1996, p. 43.

Sections in italics are quoted from American Association of State Highway and Transportation Officials (AASHTO), *Guide for the Development of Bicycle Facilities*, 1991. A revised AASHTO guide was released in 1999 that contains identical language.

Small vertical irregularities, including angular pebbles or small vertical differences in concrete slabs, can impact a bicyclist's steering or puncture a tire.

As a result, multi-use paths that are intended to serve bicyclists should be constructed with a pavement structure that can assure a smooth surface. NJDOT recommends that pavement structure should provide a 2" asphalt concrete top course on top of a 6" granular base. Where soil conditions are poor, a soils investigation should be conducted to determine the load carrying capabilities of the native soil and the need for any special construction provisions.

Although motor vehicle use by the public will be prohibited on off-road paths, maintenance and security vehicles will likely use them. This is especially true along sewer easements where the trails can provide access to sewer structures. As a result, the pavement structure should be designed to support the type of motor vehicles that can be anticipated to use the path. A trail's pavement can rapidly deteriorate if these motor vehicle loadings are not anticipated, especially if soil conditions are not good.

Design speed and sight distance

Like a road, a bicycle path has to be designed with appropriate horizontal and vertical alignment for anticipated vehicle speeds, and should provide appropriate sight distance to allow bicyclists to safely respond to changes in conditions. Because bicyclists will be sharing multi-use paths with groups of pedestrians who may be occupying the entire path and traveling at a slow rate of speed, failure to provide effective decision sight distance can result in the potential for serious bicycle/pedestrian accidents.

On flat surfaces, NJDOT recommends that a minimum design speed of 20 MPH be used, requiring a minimum sight distance of 150'. On downslopes, where bicyclists will be traveling faster, and where at any given speed braking distance will be greater as a result of the downslope, additional sight distance is required.

Linkage Paths

Linkage paths are multi-use trails that are shorter than approximately 400' and that link suburban developments together or augment the pedestrian and bicycle network. Numerous linkage paths have been constructed in Princeton, and these trails can substantially increase travel opportunities for walkers and bicyclists. These paths, because they will be very lightly used, can frequently be constructed with a width of only 5'. This narrow width is only appropriate however if use of the facility can be anticipated to be light and its length is less than 400'. Such a path can support two pedestrians walking abreast or a single bicyclist. Bicyclists encountering a pedestrian or an opposing bicyclist must partially dismount. Because of the short distance and light traffic, a bicyclist should experience only a very minimal risk of encountering oncoming traffic.

For longer distances, the probability increases that cyclists traveling in opposite directions will encounter each other, or that a cyclist will meet a pedestrian. As a result, paths longer than 400' should have a width of 10' and be constructed as multi-use paths. Similarly, in areas where pedestrian or bicycle activity is likely to be greater, additional width is required. Because it is not always possible to anticipate future travel demand on linkage paths, it is desirable to ensure that sufficient land is available to permit future widening if conflicts occur.

Examples of linkage paths in Princeton include the trail through Grover Park linking Grover Avenue with the Princeton Shopping Center, pathway segments of Guyot Avenue, and the recently constructed trail linking the Ettl Farm development with Wendover Drive.

Bicycling in Parking Lots and Alleys

Bicycles have excellent maneuverability. As a result, bicyclists are frequently able to augment the roadway network by using alleys or parking lots for a portion of a trip. This type of use generally poses few problems provided that adequate sight distance is available and provided that bicyclists respect the rights of pedestrians and motorists.

In new commercial and high density residential developments, the use of alleys can make streets better places for both bicyclists and pedestrians since they eliminate the use of driveways. To facilitate the safe shared use of new alleys by bicyclists or pedestrians, construction and right-of-way standards established by the Residential Site Improvement Standards (RSIS) should be employed. These standards require the construction of a 12' cartway within a 20' right-of-way. Commercial alleys have to accommodate higher vehicle volumes and greater access by trucks. As a result, these facilities generally should be located within a 30' right-of-way and have a cartway width of 16'.

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

APPENDIX 3
MULTI-USE TRAIL OPPORTUNITIES

Appendix 3

Multi-Use Trail Opportunities

Princeton Trail Opportunities

Trails on separate alignment provide an alternative method of encouraging both bicycle and pedestrian travel. Trails are especially valuable in encouraging more cautious bicyclists to ride more frequently. Through more frequent bicycling along trails, these riders can gain the experience and confidence required to also ride in mixed traffic on streets.

The large number of parks, open spaces and institutional lands in Princeton provide a variety of opportunities for expanding the number of shared use trails. Two types of trails are worth considering – true trails that provide an independent right-of-way for an extended distance, and trail connectors that allow bicyclists and pedestrians to travel between local streets or other compatible shared facilities to complete longer distance trips. This latter approach can result in extensive bikeways with only a minimal expenditure for new independent facilities. A common term used to describe such facilities is a “Bicycle Boulevard”.

The Friends of Princeton Open Space in 1995 prepared “Linking Princeton Open Spaces with Trails and Greenways”, a report recommending a number of Greenway trails and paths that would link the open space parcels in Princeton. The trails presented in that report, called in this plan the Greenways Plan, sought to create recreational trails that would link the open spaces of the borough and township together and would provide improved access to parks in the Princeton Community. As a result, many of the trails tended to circle around Princeton rather than pass to and from the center of town.

In comparison, the multi-use trails recommended in this report focus on trails that could serve trip-making needs by connecting trip attractions. However, the concepts developed by the Greenways plan are important and

insightful and have been employed to the maximum extent possible in this report.

We have identified the following possible corridors for consideration:

Chambers Street Extension

Parking lots of the Princeton YM/YWCA and Merwick abut each other and provide an opportunity to create a bicycle trail through those properties. Such a trail could tie in to the Stanworth Drive development, providing a continuous connection between that housing complex and downtown Princeton. The intersection of John Street with Paul Robeson Place would have to be closed and either Green Street converted to operate one-way westbound or John Street converted to operate one-way southbound.

A further connection to Race Street from Stanworth Drive would create a continuous trail system from Palmer Square and Chambers Street to South Community Park that would provide bicyclists and pedestrians with an alternative to Witherspoon Street and Route 206 for north south travel. Creating a connection to Race Street from Stanworth Drive however would be intrusive because of the fully developed frontage along Leigh Avenue. A connection would have to be secured by providing an easement along an existing driveway. Appropriate methods of creating such a connection are beyond the scope of this study.

Until a connection could be found, a multi-use trail extension of Chambers Street could connect use the existing connection between Stanworth Drive and John Street to provide access to John Street. From this point north to Community Park, John Street could be posted to permit two-way bicycle traffic. With two-way bicycle traffic, parking should be permitted only on the east side of John Street so that southbound vehicles would not have to ride

against cars parked headed in the opposite direction.

An alternative to this concept would be to build a southbound one-way street between Stanworth Drive and Paul Robeson Place, thereby creating a one-way pair with John Street.

Mountain Lakes Park/North and South Community Park Trail

From the entrance to South Community Park, the above trail could be further extended along the western edge of the park to the Mountain Avenue jughandle and from there to Mountain Lakes Park. A trail either on independent alignment or using the existing access road could then be provided into and through Mountain Lakes Park. Extension of this trail system to the Stuart School and Princeton Day School would provide a link from the center of Princeton to these two trip attractors.

This trail system would create an off-road alternative to the Great Road bicycle route. The substandard bicycle path along the Great Road described previously was created in part to provide such off-road access to the two schools. According to the Greenways report, the connection from Mountain Lakes Park to Stuart and PDS is feasible if endorsed by the two schools.

Ivy Lane/College Road Connector

Princeton University is a major generator of bicycle traffic and an important focus of bicycle activity, including recreational bicycling. However, with the exception of the D&R Towpath, few good recreational bicycle trails are available for students.

The University campus, with its complex maze of buildings and paths also serves as a partial constraint for residents of the Princetons when seeking to travel north and south. In speaking with Princeton University officials, staff indicated that the university had a long term plan to establish a continuous barrier free pathway that would link College Road and Ivy Lane. Such a pathway would be valuable to the broader Princeton Community as well as to the

University, especially if additional links east and west of this trail could be established.

Faculty Road/Hardin Road Connector

This trail would run parallel to College Road on the south side of the Springdale Golf Course. A connecting trail into the Institute Woods would be provided at the intersection of Hardin Road and Olden Lane.

Trail to Market Fair and Housing for the Theological Seminary

A number of lands uses located in West Windsor Township along Canal Point Boulevard have a strong orientation to Princeton, including Market Fair, housing for students at the Princeton Theological Seminary, the Canal Point housing development and commercial development along Route 1. A multi-use trail linking these developments to Princeton would serve Princeton students seeking access to the commercial developments along Route 1, and would provide seminary students with a much shorter route to school. Such a multi-use trail would also help to strengthen ties between the Princetons and the Canal Point housing development.

*fundis!
Save
god's
earth
etc.*

A multi-use trail could make use of College Road, portions of the perimeter of the Springdale Golf Course, and existing trails in the Institute for Advanced Studies. The Hardin Road/Faculty Road trail would also provide a method of accessing this trail.

This trail would have to cross the flood plain and wetlands associated with the Stony Brook. An existing pedestrian suspension bridge over the Stony Brook would have to be stabilized, widened and have ramp approaches constructed. A trail bridge over the Delaware and Raritan Canal would also be required.

We would anticipate that the principal users of such a trail would be University students and faculty who would use it both for transportation and recreation. However, it would obviously also attract people from outside the University, just as the Institute Woods attract recreational walkers and bicyclists. An important design

objective of such a trail system therefore would have to be the protection of the various land uses through which it would pass.

Creation of a trail linking Canal Point to Princeton would require the establishment of a partnership between Princeton University, the Institute for Advanced Studies, the Theological School, the D&R Canal Commission and local governments. NJDEP employees who regulate flood plains and wetlands would also have to be included in this partnership. This group would have to identify an acceptable, continuous route for a trail, appropriate methods for crossing the Stony Brook and the canal, acceptable methods of trail construction in the Stony Brook flood plain, and methods of mitigating any disruption to adjoining land uses.

Princeton Cemetery

Cemeteries historically were considered important public green spaces and were frequently used for recreational purposes. Cemeteries in other cities are used as nature sanctuaries and places for recreational walking and bicycling.

The roadways within the Princeton Cemetery could create an additional north-south linkage trail for bicyclists and walkers, and would provide an alternative route between the center of town and both the Medical Center and the township Municipal Building. It would be important to establish reasonable rules and operating procedures to protect the principal function of the cemetery as a place of respect and remembrance.

A route through to Harris Road or Witherspoon Lane should be further examined in partnership with the Cemetery and surrounding neighbors to determine if this concept should be pursued.

Trenton-Princeton Traction ROW

The right-of-way of the Trenton-Princeton Traction Line provides an opportunity in Princeton for a trail system that can link developments located along Rosedale Road and provide access to the Johnson Park School.

Piers for the railroad still exist in the bed of the Stony Brook.

The principal constraint to such a connection would be the need to traverse portions of the ROW that have been incorporated into developments. Most important would be an extension from the bridge site across the Stony Brook to Brookstone Drive.

The route of the traction line is largely located along lot lines, so it would be possible to reestablish this linkage without acquiring structures. However, the use of the ROW for a trail would impact the abutting property owners.

Lawrence Township has sought to develop its portion of the Traction Line as a multi-use Greenway trail that could be used by bicyclists. That township has constructed trail sections south of I-95 and in the village of Lawrenceville. Although the opportunities to create a continuous trail along the actual right-of-way may no longer be possible, Lawrence Township has identified a series of linkage trails connecting subdivision streets. These linkage trails could be used to reestablish a continuous trail route that would use a combination of local roads and portions of the traction line right-of-way.

A similar concept appears to be feasible in Princeton Township. Short linkage trails, existing subdivision streets and a route through the campus of the American Boychoir School could reestablish the general alignment of the trolley line west from the Johnson Park School. With the Lawrence trail system, eventually a continuous trail could be developed extending between Lawrenceville and Princeton at Great Road.

Linkage Trail between Wilson Road and Community Park

A linkage trail between Wilson Road and Mountain Avenue in the vicinity of North Community Park could provide a better method of connecting residents on the western end of Princeton Borough with the recreational assets at North and South Community Park and

Mountain Lakes Park. A specific method of accomplishing such a linkage trail is not proposed as part of this report.

In lieu of such a trail, a bicycle route could be signed along Library Place, Wilson Road and Pardoe Road that would show how Route 206 could best be avoided when traveling to the parks. This type of bicycle route could also serve as an alternative for bicyclists seeking to travel through Princeton on Route 206 and who would like to avoid the incompatible section of the highway between Birch Avenue and Nassau Street.

Other Linkage Trails

Princeton Borough and Township have already established a number of linkage trails to enhance bicycle and walking mobility in the community. However, ample opportunities exist for additional trails. In particular, linkage trails are valuable where cul-de-sacs, loop streets or long blocks limit the ability of bicyclists and pedestrians to make efficient trips. The Sidewalk and Bicycle Advisory Committee can work with local residents to examine opportunities to create additional linkage paths in these situations.

When new development is proposed, linkage trails should be required. Under the Residential Site Improvement Standards (RSIS) municipalities may require developers to construct linkage paths when block lengths exceed 600 feet. Linkage trails should be required on all cul-de-sacs, loop streets and other locations where land development patterns would result in the creation of such block lengths through the creation of such long blocks. Cul-de-sacs should not qualify as blocks for purposes of this requirement, but instead be treated as continuations of a block face. This is also how tax maps treat cul-de-sacs.

Improved Trail Crossings

Where trails cross roadways at mid-block locations, drivers of motor vehicles may not anticipate pedestrian and bicycle crossings. At these locations, consideration should be given to

providing improved crossing designs both to facilitate the crossing and to make the crossings more prominent and identifiable for motorists. The best method of enhancing a trail crossing is to provide a median refuge island combined with a raised pedestrian crossing.

Median refuge islands

Median refuge islands are physical islands in a roadway that divide the opposing travel lanes. Provision of a median refuge island allows persons crossing a roadway to make the crossing in two stages. This in turn allows trail users to make use of gaps in each travel stream rather than looking for a simultaneous gap in the traffic flow occurring in both directions. Statistical analyses indicate that this can reduce the delay in finding an adequate opportunity to cross a roadway by as much as 90%.

A median refuge island must have a minimum width of 6'; a width of at least 10' would be preferable, a distance that would provide a minimum of 2' clearance on either end of a 6' long bicycle.

The Manual of Uniform Control Devices requires that a median refuge island have a minimum length of 20' and provide a minimum usable opening for pedestrians equal to either 12' or the width of the marked crosswalk, which is greater. Marked crosswalks should have a width equal to the full width of intersecting trail or 6' whichever is greater.

Parallel crosswalk lines should have a minimum width of 6" at a trail crossing, and it may be necessary on collector or arterial roads to provide a line width as great as 24" since it will occur at a location that motorists might not otherwise expect a pedestrian.

Raised crosswalks

Raising the crosswalk area can further enhance a trail crossing by requiring vehicles to reduce their speeds, elevating the height of trail users to make them more visible, and by providing a vertical ramp surface on which to provide warning markings.

A raised crosswalk should be 4" above the roadway surface. The length of ramps approaching a raised crosswalk should be determined based on a desired design speed for the intersecting roadway. For 15 MPH, a length of 3', for 20 MPH 4', and for speeds greater than 20 MPH an additional 2' for each 5 MPH increment above 20 MPH. Thus, for a 30 MPH design speed the ramps to a raised crosswalk should be 8' in length, and for a design speed of 40 MPH 12'.

It is desirable for ramps designed for a speed greater than 25 MPH to incorporate small vertical curves to smooth the vertical transitions to which vehicles will be exposed.

Mercer County Green Links

The Mercer County Green Links program has been established to encourage open space linkages between municipalities in Mercer County. Identified Green Links in the Princeton Community include the following:

Delaware & Raritan Canal

The canal and its towpath were described previously and represent an important recreational asset for Princeton. Providing additional pedestrian and bicycle bridges across the canal and the Stony Brook would provide better access to the canal and allow the towpath to serve additional transportation purposes. A pedestrian and bicycle bridge across the canal and Stony Brook on the east side of the Dinky crossing would be especially valuable in linking trails on the campus of Princeton University to the canal.

As indicated in the description of the Canal State Park, trail crossings at Alexander Road, Washington Road and Harrison Street can be difficult to negotiate during periods of heavy traffic. Improvements to these crossings could substantially improve user safety and reduce user delays. The best method of improving the crossings would be to provide the following at each crossing:

- A median refuge island which would also serve as a gateway island to Princeton

- A raised pedestrian crosswalk, designed for an approach speed of 35 MPH
- Advanced warning signs and park directional signage
- On Washington Road the speed limit should be reduced to 35 MPH at least 500 feet to the east of the canal crossing.

Stony Brook Greenway

The Princeton Greenways Plan, described previously, proposes the development of a trail along the Stony Brook that would connect an existing trail in Lawrence Township at the ETS Campus with the D&R Canal. Environmental constraints may limit the amount of this trail that will be accessible to bicycles. However, significant portions of a trail along the Stony Brook could be made available to bicyclists, as the existing path between Rosedale and Edgarstoune Roads demonstrates. Paths constructed along sewer easements are particularly appropriate for development as bicycle trails, since the trail can facilitate access to sewer structures and reduce motor vehicle damage to wetland areas in the floodplain.

Transco Pipeline

The Transco Pipeline right-of-way, which traverses the northern portion of Princeton Township between Autumn Hill Park and the Stony Brook, was also identified in the Princeton Greenways Plan. It can make an effective route for a recreational multi-use trail. Its inclusion in the Mercer County Green Links plan demonstrates that the right-of-way also can provide linkages into Lawrence Township to the southwest and Montgomery Township in Somerset County to the northeast. Because development in the right-of-way must be restricted and the right-of-way must be kept clear of trees, use of the right-of-way for a trail system appears particularly appropriate.

Mountain Lakes Park to Woodfield Reservation

This Green Link would pass through the campuses of Stuart Country Day School and Princeton Day School to link the Woodfield

Reservation with Mountain Lakes Park. This link is also recommended in the Greenways Plan and was described earlier as an important off-road trail opportunity to facilitate bicycling in Princeton. The Green Links plan recommends that this link be extended into Hopewell Township and Lawrence Townships to provide a link back to the Stony Brook, perhaps by using the right-of-way of Province Line Road and the bridge over the Stony Brook that has been closed to motor vehicles.

Community Park to the D&R Canal.

The Green Links Plan recommends that Princeton Borough, Princeton Township and Princeton University work to create a connection between Community Park and the D&R Canal that would pass through the center of town and the university. Multi-use trail concepts presented earlier in this section, the Chambers Street extension, a bike route through the Princeton Cemetery and the linkage from the Theological School to Market Fair -- would help to create this linkage.

BICYCLE CIRCULATION PLAN FOR THE
PRINCETON COMMUNITY

APPENDIX 4
BICYCLE PARKING

Appendix 4

Bicycle Parking

One of the greatest problems that bicyclists in Princeton and most other communities face is finding a secure place to conveniently park a bicycle away from home. As indicated in the section of this report describing existing bicycling facilities, Princeton University is well supplied with a variety of bicycle parking facilities, and provides good examples of how bicycle parking facilities can be distributed.

Some bicycle parking devices have been provided along Nassau Street and other areas in the center of town. However, with the exception of the University, adequate bicycle parking is currently very limited. Except on Nassau Street, the parking that does exist consists of old-fashioned racks that most cyclists avoid (see below).

The absence of good bicycle parking substantially limits the extent to which bicycles can be used for non-recreational trips. Conversely, one of the best methods of encouraging more bicycle activity is to provide good bicycle parking facilities at land uses that attract trips.

According to Bicycle Planner for the City of Denver, bicycle parking facilities, to be effective, should provide the following features:¹

- Support the bike frame at two locations
- Support the use of both cable or "U-type" locks
- Allow for locking the bike frame and at least one wheel
- Not require that the bike have a kickstand
- Not conflict with water bottle cages

As these features indicate, old fashioned bicycle racks, which secure only the front wheel of a bicycle, do not serve bicycle parking requirements. These racks require that bicycles have kick-stands to support the bikes, heavy steel wheels that will not bend and the owner must use a cable or chain lock if the frame is to be secured to the bicycle rack. Because modern bicycles do not usually have this equipment, these traditional bicycle racks are either avoided or are used in unconventional ways that limit their utility.

Appropriate siting of bicycle parking must also be considered. A bicycle parking facility must be sufficiently convenient that it will encourage bicycling, and sufficiently secure that it can safeguard against bicycle theft.

Requirements for Bicycle Parking

What is required in providing a bicycle parking facility will depend in part on how the bicycle parking is to be used. For short-term parking the emphasis will be on providing convenient parking close to the destination in a highly visible location that will deter thieves. For long-term parking, the parking facility must offer stronger safeguards against theft, since the bicyclist will not be returning to the bicycle in a short period of time. In addition, the location should provide some protection against changing weather conditions. However, convenience is not as great a concern, and a bicyclist will be willing to trade a longer walk to his or her destination for a more desirable parking space.

¹ James Mackay, PE, "Bicycle Parking - Good and Bad Practices from Around the World", *Pro Bike News*, August 1998.

Short Term Parking

For short-term parking, convenience is essential. As a result, except where trips are highly concentrated, an effective bicycle parking program will provide many well distributed bicycle parking racks, each of which can accommodate a few bicycles. Practice has shown that bicycles can be effectively parked in pairs, and a variety of parking devices have been developed based on that concept, including inverted U racks, such as those found along Nassau Street, bollard racks, such as are used at Princeton University, and bicycle hitching posts. Use of these devices can be monitored, and as use increases, more locking devices can be deployed.

Where short-term parking demand is more concentrated, such as at bicycle shops, shopping centers or larger stores, facilities that concentrate bicycle parking may be appropriate, such as ribbon racks. Appropriate racks should provide sufficient space to allow bicycles to be conveniently parked and locked. This requires that an access aisle of at least 30" be provided between each pair of parked bicycles. Ribbon racks that are designed without an access aisle will be avoided by bicyclists because of the inconvenience experienced in locking and unlocking bicycles.

Bicycles are approximately six feet in length. In addition, a maneuvering area must be provided in front of the rack to allow the bicycle to be conveniently installed and removed. This maneuvering area should be 5' in width, nearly the length of the bicycle. Parallel ribbon racks or other concentrated bicycle parking facilities thus can be installed 11' on center. However, it is usually more convenient to install racks in a single line along a building wall or other architectural feature.

Since convenience is an important concern for short-term parking, parking spaces should be provided within a short distance of the intended destination. The City of Portland, Oregon recommends that bicycle parking spaces be located within 50' of a main entrance in a prominent and visible location where there is high pedestrian activity. Where a parking facility is to serve two adjacent uses, it should be placed midway between the entrances.

Long Term Parking

Bicyclists parking for a longer period of time will be willing to trade some convenience for greater security and better weather protection. Many bicycle commuters will bring their bicycles into their work places because they do not trust the security of available parking locations. However, this frequently involves substantial inconvenience to the employee and may result in violations of fire codes.

Long term bicycle parking will be used by employees, students, residents, commuters or others who will stay at a site for several hours and want a highly secure, weather protected place to park. Parking should be located within 750 feet of the destination, a recognition that bicyclists leaving their bicycle for a longer period of time will be willing to walk a couple of blocks to their final destination. The heightened security sought for long-term bicycle parking can be provided in a number of ways. The City of Portland lists the following:

- A locked room, or a "caged" area enclosed with a fence and provided with a locked gate. These areas should provide individual bicycle locking facilities in addition to the group locking facilities.
- An area within view of an attendant or security guard
- An area that is monitored by a security camera
- An area that is visible from employee work areas

Secure areas that are well lit and are under surveillance by security personnel will be more likely to be used by bicyclists. Since bicycles will be stored for a longer time, and the emphasis on security requires that a more centralized location be selected, most long term bicycle parking facilities should allow for

use by greater numbers of bicyclists. Ribbon racks, provided that they provide sufficient aisle width between pairs of bicycles, and other rack arrangements are suitable. A number of vertical parking facilities are also available that suspend bicycle either by the front wheel or the handlebars. These types of facilities can reduce the floor area required for the bicycle parking facility.

More elaborate bicycle parking "garages" have been used in other countries in locations having a high demand for long term, secure bicycle parking.

Parking garages with attendant parking are especially appropriate areas for providing long term, secure parking. Portions of a garage that cannot be used for motor vehicle parking can be allocated for bicycles with little additional cost. Parking areas however must either be within sight of the attendant or monitored by security personnel and security cameras.

New Development

Development regulations for the borough and township need to establish bicycle parking requirements that should be established as part of the development review process. Standards regarding number of spaces for different uses, location of spaces, and facility design need to be adopted. Regulations should be performance based and allow for creativity in resolving how required supply should be provided.

New developments should be required to provide bicycle storage facilities as an integral element of their development. Typical standards for the provision of bicycle storage require that one bicycle parking space be provided for every 20 motor vehicle parking spaces.

Recommended ordinance language is presented in an appendix to this report.

When public buildings are constructed or reconstructed, their plans should include generous bicycle parking facilities, both to serve the land use itself and to provide parking for surrounding land uses. For example, the construction of the new library and parking garage in the downtown provides an opportunity to provide additional short and long term bicycle parking for both the library and the downtown.

Existing Development

New development will likely constitute only a small increment in the total future development of the Princeton Community. As a result, it is important that the current deficiency in bicycle parking be eliminated through a combination of private and public actions.

Downtown

Short-term and long-term bicycle parking opportunities are currently limited. On Nassau Street and in the University numerous excellent examples exist of how bicycle parking can be provided. A funding mechanism needs to be developed to permit expansion of this bicycle parking.

On Nassau Street near the intersection of Vandeventer Avenue several U racks have been installed as part of streetscape improvements. The inverted U rack is an especially appropriate design for this type of downtown location, as is the installation between the main pedestrian flow and the curb line. The racks at this location also help to limit jaywalking by partially obstructing pedestrian access to the curb, thereby channelizing pedestrian travel, without restricting access to curb side parking.

Additional U-racks or bollard racks along Nassau Street are currently needed, since the current racks are frequently occupied and since many storefronts are far removed from the available racks. Additional U-racks or bollard racks should be installed approximately 200' apart in pairs permitting a total of four bicycle parking spaces per site.

The borough should monitor the parking of bicycles during peak bicycle access periods, which probably would occur on Saturday afternoons from noon to 3:00 and on week-day afternoons between 3:00 and 6:00. If the parking stalls continue to show high occupancy during those time periods, additional facilities should be installed.

However, as with most parking programs, it is important to also assure that these most convenient parking facilities are primarily being used for short term parking. If monitoring indicates both that occupancy of spaces is high and that turn-over appears low, measures should be initiated to encourage longer term bicycle parking to occur at more removed locations.

In addition, as can be seen at the University, some bicyclists may inadvertently abandon their bicycles in racks. Bicycle racks should therefore also be monitored at low periods of use, and bicycles that appear to have been abandoned should be removed following an appropriate warning period.

Long term bicycle storage facilities should be considered in Borough owned parking lot and in all parking garages. These facilities should offer protection from weather and provide sufficient visibility to deter theft. In particular, consideration should be given to adding bicycle brackets along walls and other areas of the Chambers Street parking garage where bicycles will be visible to the parking attendants or can be monitored by security personnel. An inspection of the garage also indicates that it should be possible to install some group racks close to attendants in areas that are dead space within the garage currently.

Constrained Areas

There are eight important groups of trip attractions, both in the center of town and in outlying areas, that require additional or new concentrated facilities for bicycle parking. These are:

Princeton Shopping Center	Parks
Schools	Dinky station
Municipal buildings	YMCA
Office buildings	

Many of these areas do provide old-fashioned bicycle parking racks. However, these racks are either not used, or are not used as intended, resulting in only a few bicycles being parked. At all of these locations, a process is needed to encourage the provision of additional parking facilities. Processes could include:

- Negotiate with the current owners to encourage them to provide bicycle facilities
- Provide municipal capital funding to install facilities
- Require provision of facilities as a condition for any needed municipal approvals
- Apply for NJDOT grant programs, including NEXTEA Enhancement Funds, congestion mitigation and air quality funds or local aid funds.
- Incorporate advertising opportunities into the design of storage facilities such as kiosks or signage structures.

It is recommended that both the borough and the township initiate capital programs for the installation new bicycle parking facilities at municipal buildings, parks and schools. Funding for upgraded school bicycle racks could either be secured through the school budget, or the two municipalities could create a grant program for this purpose, with the provision that the facilities serve other public purposes when not required for the schools. This would be especially useful at school locations close to parks or recreation facilities that could attract bicycle riders during week-ends, holidays and afternoons.

At the Princeton Shopping Center, the shopping center operator should be encouraged to provide weather protected bicycle parking facilities along the walkways linking the parking lots to the open courtyard in the center of the shopping complex. Spaces should be provided at the rate of one bicycle parking space per twenty motor vehicle parking spaces.

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bike*