Planning and Designing Bicycle Facilities

Why should we accommodate bicycles?

- Bicycles are legally considered to be vehicles, with the right to use roadways
- One in ten U. S. households do not own an automobile
- There are 9 million bike trips in the U. S. everyday

More reasons:

- 48.8% of all trips are shorter than 3 miles - a 15 minute bike ride
- 40% of U. S. adults say they would commute by bike if safe facilities were available
- 1/3 of the population is either too old or too young to drive an automobile

And still more reasons:

- Better environment: reductions in air pollution and traffic congestion
- Better health: 60% of Americans lead completely sedentary lifestyles, 40% are clinically overweight
- Improved safety: over 750 bicyclists killed and 59,000 injured per year
  (1996 figures)


TOKO
BANK

Federal Goals for Bicycling

Set by USDOT in National Bicycling and Walking Study (1994)

- Double the percentage of total trips made by bicycling and walking (from 7.9 to 15.8%)
- Simultaneously reduce by 10% the number of bicyclists and pedestrians killed or injured in traffic crashes

Federal Legislation

- ISTEA - Intermodal Surface Transportation Efficiency Act (1991):

  $2.6 Billion for Enhancements

- TEA 21 - Transportation Equity for the Twenty-First Century:

  $3.8 Billion for Enhancements

Spending on Bike/Ped Facilities
Pre-ISTEA and During ISTEA

- Pre-ISTEA: $4 million/year nationwide
- During ISTEA: $160 million/year nationwide

Bicycling in Other Countries

- Japan: 15% of workers commute by bicycle
- Netherlands: 20%-50% of all trips are by bicycle
- Germany: 20% of all trips are by bicycle
- China: Beijing - 48% by bicycle
  Tianjin - 77% by bicycle

Developing a Local Bicycle Master Plan

- Policy planning
- Intergovernmental coordination
- Training and education
- Public outreach
- Plan for physical improvements
- Long-term citizen involvement

Designing bicycle facilities: Who sets the standards?

- AASHTO Guide for the Development of Bicycle Facilities
- Manual on Uniform Traffic Control Devices (MUTCD)
- State and local manuals (example: Oregon DOT Bicycle and Pedestrian Plan)
- ADAAG - American with Disability Act Accessibility Guidelines

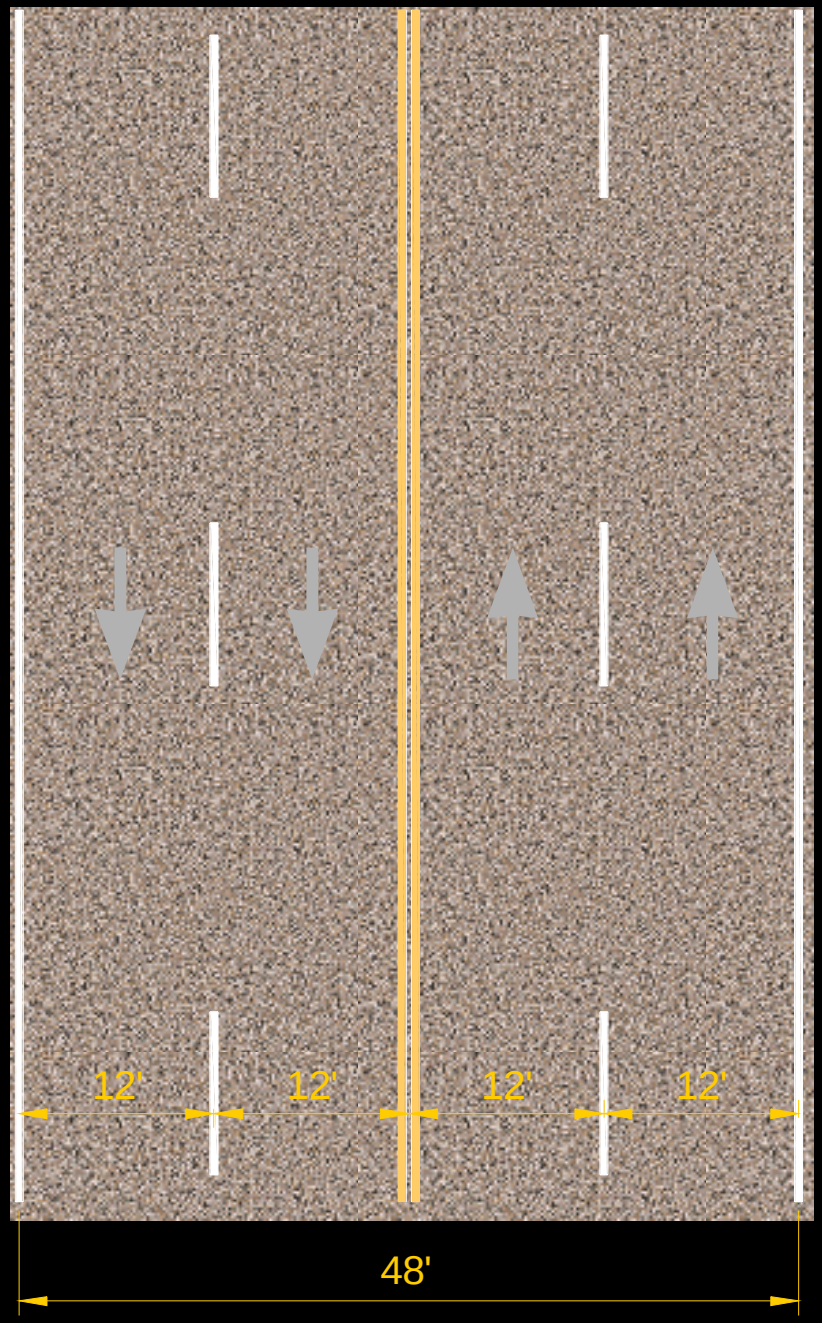
Types of Bicycle Facilities


LEFT
TURN
SIGNAL
KEEP
RIGHT
ONLY
ONLY


MERRIMAC BEACH RESORT HOTEL


BIKE ROUTE


BIKE



Bicycle LOS - Before

ADT = 13,500 vpd

Assume: K_d = 0.10
D = 0.50
PHF = 1.00

L_n = 2

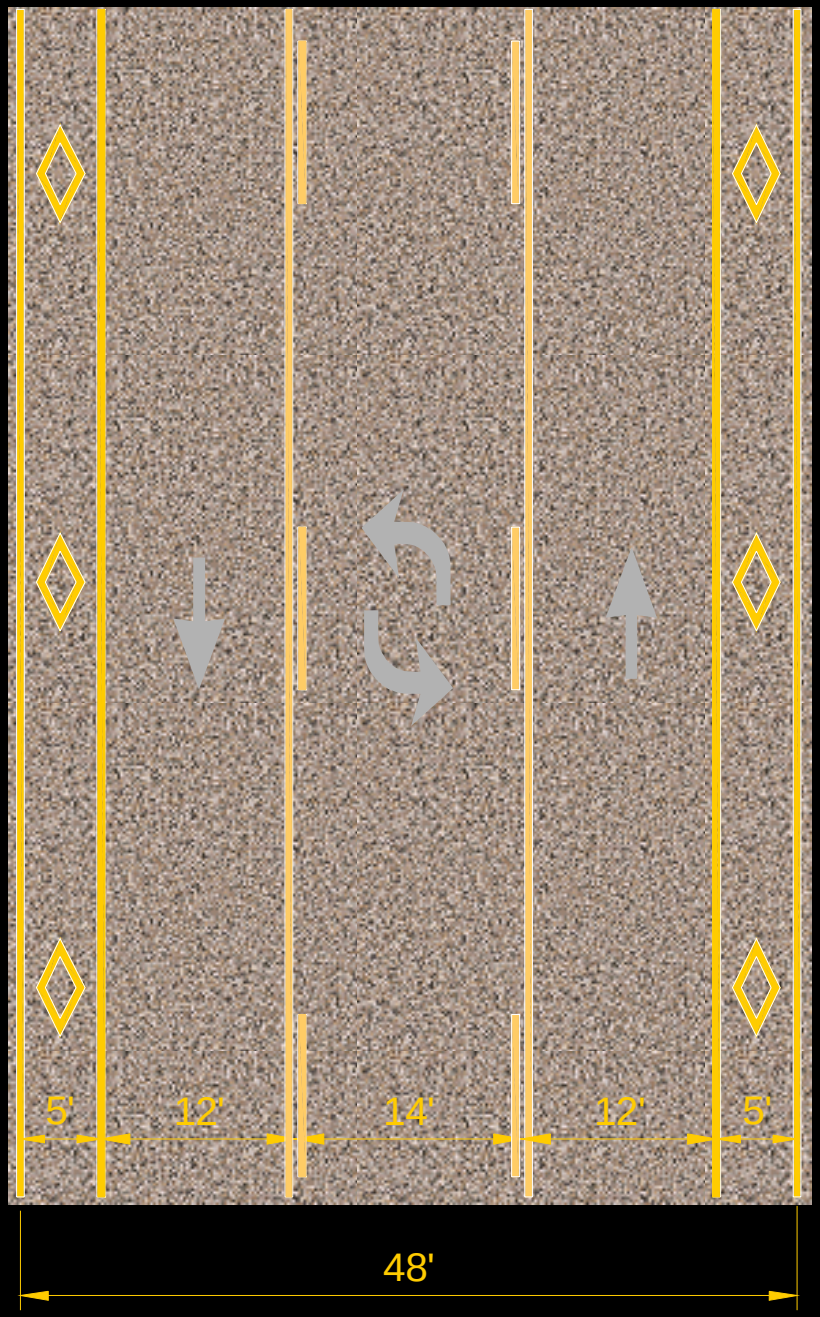
PC_5 = 4 (good pavement)

W_t = 12 ft W_l = 0 ft

SP_p = 30 mph

BLOS Evaluation:

LOS score	Category
3.58	**D**



Bicycle LOS - After

ADT = 13,500 vpd

Assume: K_d = 0.10
D = 0.50
PHF = 1.00

L_n = 1

PC_5 = 4 (good pavement)

W_t = 17 ft W_l = 5 ft

SP_p = 30 mph

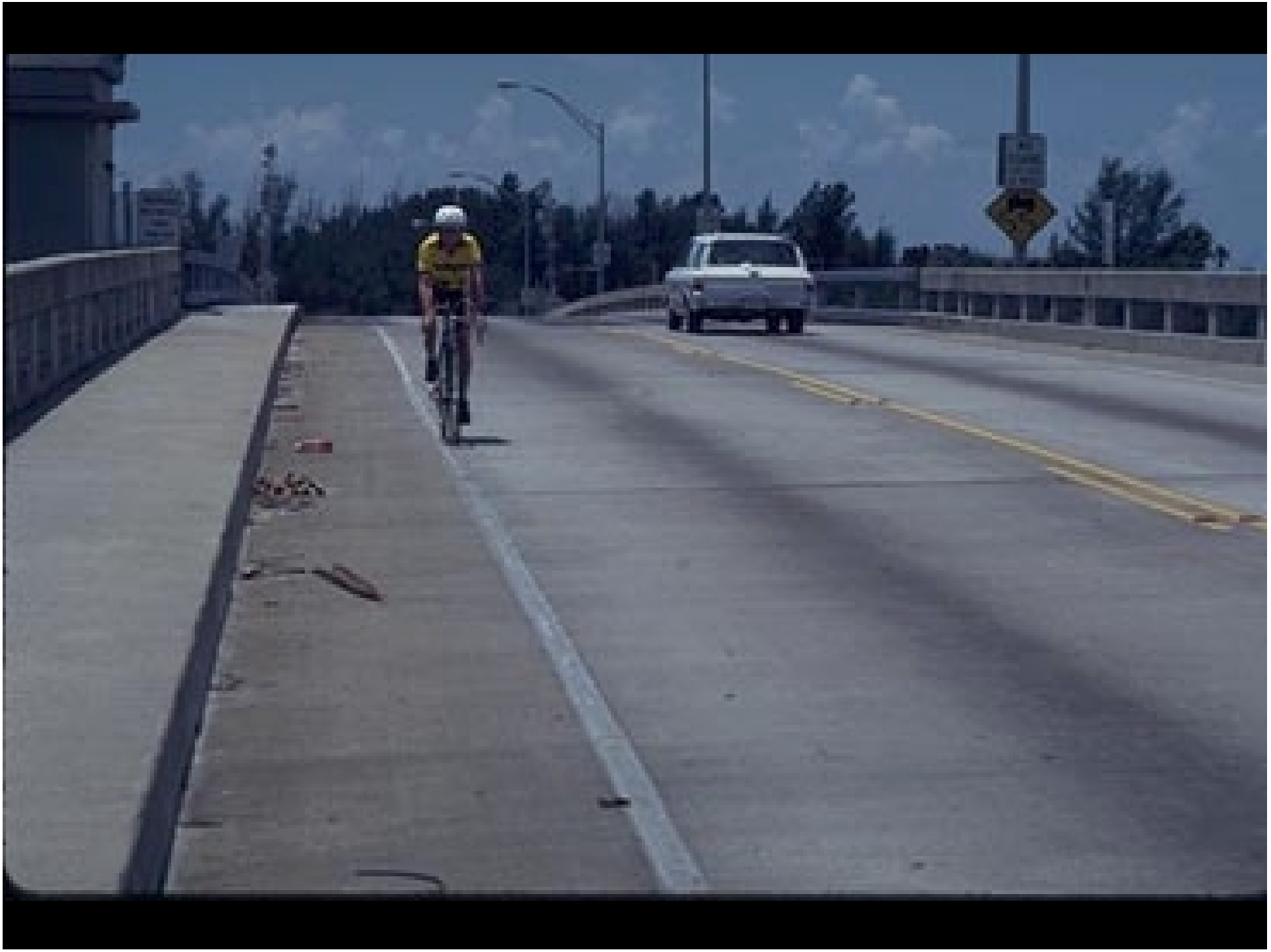
BLOS Evaluation:

LOS score	Category
2.07	**B**


RIGHT LANE
MUST
TURN RIGHT
LANE
BEGIN


VEHICLES
ONLY
LANE
ENDS


LANE
ENDS
NO
STOPPING
ANY
TIME




DO NOT
ENTER
EXCEPT
BICYCLES

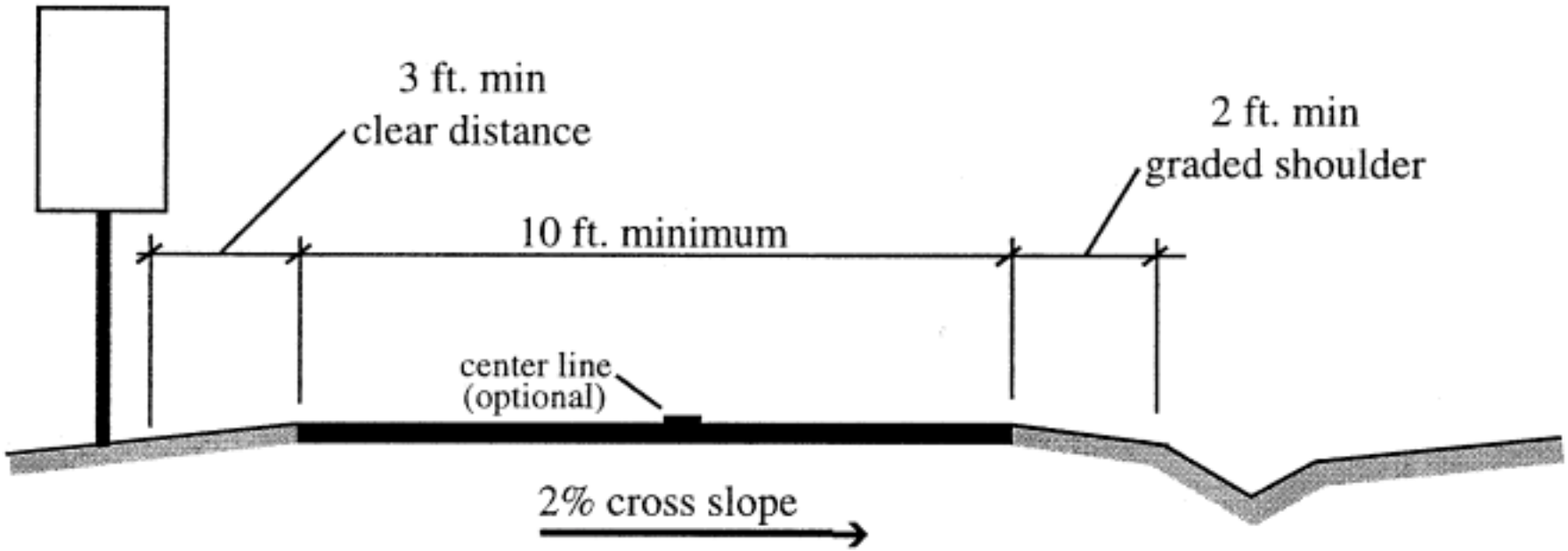

2
Kopenhagen auf eigene Faust mit
HT Sightseeing und City Tourist

Other Barriers and Roadway Hazards Affecting Bicyclists


LANE
ONLY
REDHAWK
REDHAWK


CLEARANCE 13'-5"

Multi-Use Trail Design



Typical bicycle path cross section


ONLY
BIKE
PED


gamma

Other Programs and Facilities that Benefit Bicyclists


0801


BIKE
TO WORK
DAY

Slideshow Outline: Bicycle Planning and Design

1 Powerpoint Word Slide (title):
Planning and Designing Bicycle Facilities

2 Powerpoint Word Slide:
Why should we accommodate bicycles?

- **Bicycles are legally considered to be vehicles, with the right to use roadways**
- **One in ten U.S. households do not own an automobile**
- **There are 9 million bike trips in the U.S. everyday**

3 Powerpoint Word Slide:
More reasons:

- **48.8% of all trips are shorter than 3 miles - a 15 minute bike ride**
- **40% of U.S. adults say they would commute by bike if safe facilities available**
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4 Powerpoint Word Slide:
And still more reasons:

- **Better environment: reductions in air pollution and traffic congestion**
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5 Photo Slide: CD 278-34 – Street filled with cars

Explanation:
Economics of urban space: a street filled with 4 lanes of single-occupant automobiles is crowded

6 Photo Slide: CD 278-35 – Street filled with people seated

Explanation:
Here's the amount of space that each person would occupy if they were riding bikes (and spread out like cars).

7 Photo Slide: CD 278-37 – Bicyclists on the side of the street

Explanation:
And here's the amount of space that the same number of bicyclists use when riding in a normal formation on the right-hand side of the road.

8 Powerpoint Word Slide:
Federal Goals for Bicycling
Set by USDOT in National Bicycling and Walking Study (1994):

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9 Powerpoint Word Slide:
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- **TEA 21 - Transportation Equity Act of the Twenty-First Century: $3.8 Billion for "Enhancements"**

Explanation:
Bicycle and pedestrian facilities are eligible for funding through the Enhancements program, which (in both ISTEA and TEA-21) sets aside 10% of federal Surface Transportation funds for ten categories of "enhancements" which also include scenic byways, historical transportation facilities, etc.

10 Powerpoint Word Slide:
Spending on Bike/Ped Facilities: Pre-ISTEA and During ISTEA

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11 Powerpoint Word Slide:
Bicycling in Other Countries

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12 Powerpoint Word Slide:
Developing a Local Bicycle Master Plan

- **Policy planning (intergovernmental coordination)**
- **Training and education**
- **Public outreach**
- **Plan for physical improvements**
- **Long-term citizen involvement**

13 Photo Slide: CD 593-77 – Advanced bicyclist

Explanation:
There are many different types of bicyclists with many different skill levels. In general, they fall into several categories. This is a "Type A" advanced bicyclist. These are people who ride regularly - confident, strong riders. They are generally accustomed to riding in traffic, but many will still avoid the worst roadways. They are interested in direct routes (for utilitarian riders) and/or scenic routes (recreational riders).

14 Photo Slide: CD 593-78 – Basic bicyclists – older couple

Explanation:
There is a very large group (the majority) of bicyclists who aren't as confident in their bicycling skills, but still enjoy riding. Traffic conditions are quite daunting to this group, however they also represent an enormous potential for reducing auto trips if bicycling conditions were better. These are referred to as "Type B" bicyclists.

15 Photo Slide: CD 593-54 – Basic bicyclist man

Explanation:
Type B bicyclists may also ride for utilitarian purposes. This group also includes many low income Americans who ride for purely economic reasons – they can't afford an automobile.

16 Photo Slide: CD 593-55 – Child bicyclist

Explanation:
Child bicyclists or "Type C" cyclists are the last group. Their riding is initially monitored by parents. They may have all the confidence of Type A riders, but lack coordination and judgement when it comes to traffic conditions.

17 Powerpoint Word Slide:
Designing bicycle facilities: Who sets the standards?

- **AASHTO Guide for the Development of Bicycle Facilities**
- **Manual on Uniform Traffic Control Devices (MUTCD)**
- **State and local manuals (example: Oregon DOT Bicycle and Pedestrian Plan)**
- **ADA – Americans with Disabilities Act Accessibility Guidelines (in the case of multi-use trails)**

18 Powerpoint Word Slide (title):
Types of Bicycle Facilities

19 Photo Slide: CD 592-55 – Shared Roadway

Explanation:
Since the bicycle is considered a vehicle with the legal right to use most roadways (except limited access freeways in some states), all roadways are shared roadways.

20 Photo Slide: (From collection) – Bad traffic

Explanation:
Unfortunately, most roads in urban areas are not good for bicycling. Heavy traffic, high speeds, narrow lanes and vast intersections with multiple turn lanes make bicycling very difficult in urban and suburban areas. Bicyclists are left with very little space in which to safely operate.

21 Photo Slide: CD 592-24 – Wide outside lane

Explanation:
By adding just a few feet of width, roadways can accommodate bicyclists effectively. This photo shows a wide outside lane – 14' in width instead of the normal 12'. Both the bicyclist and motorist can occupy the same lane. The downside is that motorists tend to travel faster in a wide lane, and this makes bicyclists more uncomfortable.

22 Photo Slide: 160-85 – Paved shoulder

Explanation:
By striping additional space on the edge of the road to create a shoulder (4' is preferred, but 2' – 3' is better than nothing), you can improve a bicyclist's sense of comfort.

23 Photo Slide: CD 160-82 – Bike route

Explanation:
In some cases, the road is already in good condition – quiet, with low speeds and traffic volumes. Bike routes can be designated on these streets if they are part of a network of facilities. Green bike route signs are also used in rural areas for bicycle touring routes.

24 Photo Slide: CD 592-38 – Bike lane

Explanation:
Bike lanes are typically 5' in width (4' minimum if there is no curb) with marking and signs (standardized by MUTCD) that define the space as a bike lane. They are always on both sides of the street, and travel in the same direction as the adjacent travel lane.

25 Photo Slide: (From collection) – Restriping photo

Explanation:
Bike lanes can be created at a lower cost by re-striping roadways either during normal repaving projects, or by removing and replacing markings (this photo shows a bike lane that was developed this way in Santa Barbara, CA).

26 Graphic Slide: (From collection) – Restriping roadways to create bike lanes

Explanation:
This method basically redistributes roadway space, either narrowing lanes or reducing the number of lanes (on roads with excess capacity), in order to achieve more room on the sides for bike lanes. In this example, a four lane roadway will be restriped to create bike lanes. It is important to analyze the effects of re-distributing roadway space, particularly if you plan to remove through lanes. In this slide, the existing condition provides a bicycle level of service of D.

27 Graphic Slide: (From collection) – After Condition

Explanation:
By reducing this street to two through lanes with a center left turn lane and bike lanes on both sides, the bicycle level of service is raised to a Level B. It is also important to know the effects of restriping on motor vehicle level of service, in order to avoid an unacceptable level of delay for motorists.

28 Photo Slide: CD 592-31 – Bike lane photo with arrow

Explanation:
Bike lanes should include an arrow to indicate direction of travel, since wrong-way riding is a problem (particularly in college towns).

29 Photo Slide: CD 592-37 – Bike lane at right turn lane

Explanation:
At exclusive right turn lanes (either at intersections or driveways), bike lanes must transition to the left-hand side of the turn lane.

30 Photo Slide: (from collection) – Bike lane ends sign

Explanation:
Must take care in locations where bike lanes end – do not leave bicyclist in a dangerous or difficult traffic situation. (Photo taken on Ben Franklin Parkway in Philadelphia)

31 Photo Slide: (from collection) – Bike lane ending/transition

Explanation:
Provide advance warning that the bike lane will end ahead, use appropriate pavement markings to signal the end of the lane. If necessary, end lanes in a location where the

bicyclist would have the option to turn onto a side street, if traffic conditions ahead are particularly bad.

32 Photo Slide: CD 592-65 – Bike lane needing maintenance

Explanation:
Maintenance for bike lanes is important – a bike lane that has gathered rocks, trash and debris can't be used. This is a common problem and a source of great criticism for local governments who haven't provided adequate maintenance. Motor vehicle lanes are swept automatically by vehicular movement – in some cases, that debris ends up in the bike lane.

33 Photo Slide: CD 592-59 – Contra-flow lane

Explanation:
Innovative solutions: contra-flow lanes on one-way streets can sometimes be warranted, particularly if they provide a route for bicyclists that is shorter or avoids a difficult traffic situation. There should always be a double yellow line between the bike lane and the motor vehicle lanes, and signage should be used to make it clear that bicycles - and not automobiles - are allowed in this direction.

34 Photo Slide: CD 592-58 – Blue bike lane

Explanation:
Another innovative solution: blue bike lanes have been used in Europe and in parts of the United States to draw attention to bike lanes and to discourage motorists from encroaching upon them. (In U.S., they've been used in Cambridge, MA, Portland, OR and Philadelphia, PA)

35 Photo Slide: CD 2476-72 – Red bike lane

Explanation:
Same concept, except the lane is red. Experiments have included non-skid paint, and asphalt imbued with thermoplastic material for color. The latter method is generally accepted as being more durable (paint wears off), although imbued asphalt is considerably more expensive. What ever method is used, it must be a non-skid surface under wet conditions.

36 Photo Slide: CD 2498-19 – Traffic calming

Explanation:
Like pedestrians, bicyclists can benefit greatly from traffic calming. Traffic calming devices should be designed with the bicyclist in mind, however. This photo shows a speed hump with a cut-through for bicyclists.

37 Powerpoint Word Slide (title):
Other Barriers and Roadway Hazards Affecting Bicyclists

38 Photo Slide: CD 593-7 – Unsafe grate

Explanation:
Drain grates parallel to travel can catch a bicycle wheel and cause a major crash.

39 Photo Slide: CD 593-5 – Safe grate

Explanation:
Grate openings should be perpendicular to travel. Some cities have instituted programs to locate and replace all unsafe grates.

40 Photo Slide: CD 592-2 – Bicyclist waiting at an intersection

Explanation:
At actuated signals, loop detectors in the pavement are designed to react to the presence of a motor vehicle – and are often not sensitive enough to detect the small amounts of metal in a bicycle. So unless an automobile pulls up, a bicyclist may not be able to get a green light.

41 Photo Slide: CD 592-7 – Loop marking

Explanation:
One solution is to find the spot along the loop wire that is most sensitive (i.e. the location a bicycle should stand in order to trip the signal). A special marking should be placed on that spot so that bicyclists can find it. Unfortunately, this doesn't always work. Many of the newer bikes have very little detectable metal.

42 Photo Slide: CD 593-59 – Loop marking in a bike lane

Explanation:
The Traffic Detector Handbook recommends a quadrupole loop detector for bike lanes. It should be placed directly in the bike lane to insure that bicycles can trip the signal.

43 Photo Slide: CD 593-1 – Railroad crossing

Explanation:
Railroad and trolley crossings create rough, uneven conditions. Bicycles are much more susceptible to these surface irregularities because they have no suspension. A rough railroad crossing can not only cause permanent damage to a bicycle, it can cause the bicyclist to lose control and crash. This photo shows an improved crossing – smoother for both motorists and bicyclists. Railroad crossings that are at an acute angle can be particularly bad, since a bicycle tire can get caught between the edge of the rail and the edge of the pavement.

44 Photo Slide: CD 593-10 – Metal bridge deck

Explanation:
Metal bridge decks can be very slippery when wet. The best solution is to avoid using a metal deck in a location that will be used by bicyclists. If a temporary solution is needed, a concrete filler can be used on the right hand side of the lane to reduce sliding.

45 Photo Slide: (from collection) – Recessed manhole cover and grate

Explanation:
Surface irregularities can often be worse in CBD's and urban downtown areas where the streets have been repaved and patched many times. Manhole covers and inlet grates should always be raised during repaving projects, rather than leaving them at their former height.

46 Photo Slide: CD 592-56 – Rumble strips

Explanation:
Designers should be aware that rumble strips make roadway shoulders useless for bicycling, unless placed so that bicyclists still have a 4-5 foot wide smooth paved shoulder in which to ride. The benefits of rumble strips should be carefully weighed against the problems they cause for bicyclists.

47 Photo Slide: CD 592-71 – Narrow roadway underpass

Explanation:
Pinch points like this one are obviously difficult for bicyclists. Narrow bridges cause the same problems.

48 Photo Slide: CD 592-72 – Roadway underpass with adjacent bicycle underpass

Explanation:
Here's one solution.

49 Photo Slide: CD 592-62 – Bridge with separated bicycle area

Explanation:
Here's a solution for bicycle access over a bridge.

50 Powerpoint Word Slide (title):
Multi-Use Trail Design

51 Photo Slide: (from collection) – Baltimore and Annapolis Trail

Explanation:
Multi-use trails are popular among bicyclists for both recreation and transportation use. These are some great examples of trails in urban areas that are used for transportation:

- Burke-Gilman Trail, Seattle, Wash.
- Baltimore and Annapolis Trail, MD
- Schylkill River Greenway, Philadelphia, PA
- Rock Creek Park, Washington, DC
- University Parks Trail, Toledo, Ohio

(and many more)

52 Graphic Slide: (from collection) – Trail cross section

Explanation:
Trail design is covered extensively by the AASHTO Guide for the Development of Bicycle Facilities. The standards cover everything from horizontal and vertical curvature to trail/roadway intersections to trail bridge structures. A few basics: trails should be a minimum of 10' wide to accommodate two-way bicycle travel (some urban areas are installing 12' and 14' wide trails due to heavy use). Trails should have a 2' minimum level shoulder (with no vertical obstructions)

53 Photo Slide: (from collection) – Railing next to a trail - Monterrey, CA

Explanation:
There should be a minimum of 5' between the edge of the trail and a steep slope. Otherwise, a safety rail is needed (minimum height: 42")

54 Photo Slide: CD 593-27 – Trail with painted lane lines

Explanation:
Trails have become so popular in urban areas that they are often crowded, leading to conflicts (and sometimes injuries). One solution is to develop separate lanes of travel.

55 Photo Slide: (from collection) – Trail/roadway intersection at the Washington and Old Dominion Trail in Washington, DC

Explanation:
Trail/roadway intersections should be carefully designed to increase the safety of trail uses. Often, these intersections occur at midblock locations, where motorists are not expecting pedestrians and bicyclists to cross. There are several methods that can improve safety:

56 Photo Slide: (from collection) – Trail user-actuated signal

Explanation:
This is a trail/roadway intersection on the West Orange Trail near Orlando, FL. The light stays green until a trail user hits the signal button. Decisions about whether this type of signal is warranted are usually made after an engineering analysis that considers anticipated trail volumes, available "gap" time for pedestrians to cross, and other factors such as visibility and traffic speed. Warning signage and crosswalk markings are important features of the crossing as well.

57 Photo Slide: (from collection) – Trail bridge

Explanation:
Grade-separated crossings (overpasses and underpasses) are expensive solutions, but sometimes necessary due to severe traffic conditions that would make an at-grade crossing dangerous or impossible. This bridge carries the East Coast Greenway across Rt. 100 (a limited access freeway) in Maryland.

58 Photo Slide: CD 593-36 – Traffic calming

Explanation:
Traffic calming prior to, and at the site of the crossing can help to reduce speeds and alert motorists of the trail crossing. A speed table combined with median refuge island can be a very effective approach.

59 Powerpoint Word Slide (title):
Other Programs and Facilities that Benefit Bicyclists

60 Photo Slide: (from collection) – Bike on bus rack

Explanation:
Bike on transit programs can greatly expand the service area for transit programs. Many cities and towns in the U.S. are instituting these programs, and have been very successful. This is a photo of a Bike-on-Bus rack – they are usually installed on the fronts of buses, and hold two bikes. Bike-on-Rail programs have also become popular (transit agencies allow riders to bring their bikes aboard, sometimes providing special cars with extra storage space. In some cities, this service is limited to non-peak hours.

61 Photo Slide: (from collection) – Bike to Work Day, Philadelphia, 1998

Explanation:
Bike-to-Work Day is usually in June of every year. Most major cities host an event or a week of events (Denver hosts a Bike-to-Work month). There are a variety of commuter incentive programs that have been used across the country to encourage bicycle commuting, including cash incentives.

62 Photo Slide: (from collection) – Bike rack

Explanation:
Most cities lack adequate bike parking. This can be a disincentive to bicycling – both because of the inconvenience and because bicycles that aren't locked to a sturdy structure may very likely be stolen. Bike racks should be simple in design, and should support the frame of the bike (not just the wheel). This is the popular U-rack.

63 Photo Slide: (from collection) – Bike locker

Explanation:
Long term bike parking is important at transit stations and other locations where people may need to leave their bike for extended periods of time.

64 Photo Slide: (from collection) – Kids learning bike skills

Explanation:
There are a number of bicycle education programs for children and adults. Several curricula for children are available. They work best when they combine classroom instruction with on-bike training. More and more colleges and universities are offering bicycle training courses. Another national bicycle education program for adults is the Effective Cycling program (contact the League of American Bicyclists in Washington)..