

## **APPENDIX A**

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NAWN, J.A. (2003) CENTRAL BUSINESS DISTRICT BACK IN ANGLE PARKING. *PE REPORTER*, NOVEMBER/DECEMBER ISSUE, P. 11-13.

# Central Business District Back In Angle Parking

John A. Nawn, P.E., PTOE



In August 2003, the Pottstown borough completed back in angle parking along the main street through its central business district (CBD). This is the first such application of back in angle parking in the Commonwealth of Pennsylvania.

In many community's central business districts, lack of parking close to retail and commercial establishments is seen as a deterrent to continued retail development and reinvestment into the CBD. In many instances, the CBD is also bisected by an urban arterial, or "Main Street." Competing needs of parking versus efficient vehicle movement can impede mobility and sometimes compromise safety.

Since the middle 1990's, the Borough of Pottstown, Montgomery County, Pennsylvania, has struggled to revitalize and reinvigorate its downtown core. The Borough's 1994 Downtown Comprehensive Plan identified several goals for revitalization, specifically dealing with creation of a pedestrian friendly, multi-modal environment while maximizing the amount of parking and its proximity to retail establishments that line the downtown core. Through leveraging of and improvement to the existing transportation infrastructure, the community attempted to realize these goals.

Located in the Philadelphia, Pennsylvania metropolitan area and situated on the Schuylkill River, the Borough of Pottstown traces its routes to 1752. As the Borough developed, the CBD developed

centered along High Street, making High Street the Borough's main street. At 5.5 square miles, Pottstown population is 21,859 (2000 census). Following the increase in automobile traffic after World War II, the High Street cross section was reconfigured to maximize automobile mobility. With 68 feet available between the curb lines, two 11-foot through lanes and a 7-foot parallel

parking lane were created in each direction along with a 10-foot wide center turn lane/painted median. Combined with a 16-foot sidewalk on each side, the face of the buildings on each side of the street are 100 feet apart, creating a very wide corridor through the CBD. The width of the corridor is visually perceived by some to be a deterrent to downtown redevelopment.

In 1972, a four lane, grade separated, limited access freeway, U.S. Route 422, was constructed along the opposite side of the river from the Borough, essentially bypassing the CBD and drawing large amounts of the existing through traffic volume from High Street. High Street quickly became an underutilized transportation asset.

As a highway facility, High Street was an operational success. The 85<sup>th</sup> percentile

speeds were within 5 miles per hour of the posted speeds and an attractive level of service was maintained for vehicles. However, High Street was failing to meet

*As a highway facility, High Street was an operational success...*

*however, High Street was failing to meet more recent and progressive economic development and transportation goals.*

more recent and progressive economic development and transportation goals endorsed at local, state, and national levels.

Increasing pedestrian traffic is one of the key objectives in the

Borough's efforts to revitalize the CBD. However, High Street's configuration impeded these efforts. With four lanes of rapidly moving traffic, it was neither pedestrian nor shopper friendly. High Street's 68-foot cross-section was intimidating and discouraged pedestrians and shoppers from crossing the street. Pedestrian injuries and deaths were not uncommon. In addition, vehicle traffic along High Street moved too quickly to allow passengers adequate time to identify shopping opportunities and find a parking space.

Downtown business owners identified a perceived lack of parking as a concern. Although metered, parallel parking was available on both sides of High Street throughout the CBD, it was generally 50%

*"Back-in" continued on p. 12*

*“Back-in” continued from p. 11*

utilized and, therefore, considered to be insufficient in addressing the potential needs of the downtown businesses, considering the number of vacancies. While a number of small surface lots had been created along High Street, the linear nature of the CBD makes this parking convenient to only adjacent businesses with long walks necessary for all other businesses.

One of the region’s transportation goals is to encourage the use of bicycles as an alternative to the automobile. High Street had been designated by Montgomery County



as an official Bicycle Route connecting Pottstown with other communities along the Schuylkill River corridor. But, in its former configuration, High Street was not conducive to bicycle travel with no dedicated bike lanes and swiftly moving vehicular traffic.

State and regional plans recognize the connection between revitalizing older communities and solving the problems of traffic congestion on our roads and highways. Encouraging people to live, work and shop in denser, walkable communities fosters the use of existing public transportation, helps reduce sprawl and relieves the pressure on our road system. Creating vibrant downtowns in our cities and smaller urban communities ensures a growing demand for public transportation. Therefore, the general thinking was that reconfiguring and calming traffic on High Street would address Pottstown’s own economic development goals and have a positive impact on regional transportation and growth issues.

Clearly if the Borough was to increase pedestrian traffic and attract new business to the CBD, while not reducing available parking, the existing automobile and truck traffic would have to be calmed. The CBD study area generally encompassed a 1.1-mile corridor centered along High Street. Within this corridor, there are 10 signalized intersections. Of those, only two were

equipped with pedestrian push buttons; side streets were not actuated; and all signals were uncoordinated, operating on fixed time cycles with side street phases sufficient to also support lengthy pedestrian times required to cross High Street. Improvements would include coordination of the signals and the addition of pedestrian push buttons to improve mobility and support the thorough

lane reduction necessary to support additional angle parking. One method used to provide more parking is creation of traditional, pull-in angle parking. However, in order to properly implement

traditional angle parking, a substantial amount of right-of-way is necessary to provide the proper maneuver space for vehicles to back out of the spaces without impeding traffic flow on the adjacent roadway. With traditional angle parking in place on both sides of a main street, the width of the street and subsequently pedestrian crossing distances become excessive, creating a non-unified downtown unattractive to pedestrians; pedestrians who are critical to the success of the retail and commercial establishments in the CBD. At signalized intersections, pedestrian crossing times can be excessive, leading to decreased vehicle mobility and progression. More

typically, the width of available right-of-way is insufficient to support angle parking. While the angle of the parking can be reduced to narrow the required width of street, as the parking angle becomes more acute, the angle-parking yield becomes not much more than that with parallel parking. Ideally, angle parking without the wide maneuver space would address the problem.

It was clear that if the Borough wished to leverage additional parking and a

friendlier pedestrian environment as a means to revitalize the downtown area, that conventional methods and thinking would not likely meet those goals. The concept of employing reverse angle or back in angle parking was initiated by the Borough’s Planning Commission and upon request from the Commission, the Borough commissioned a new study to evaluate the appropriateness of back in angle parking on High Street.

The initial plan was to establish minimum required lane widths for the conventional elements of the roadway cross-section. In accordance with PennDOT’s criteria for an urban arterial, the minimum acceptable width for through lanes is 11 feet. The center median/turn lane would remain, as it was critical to maintaining the necessary levels of service. PennDOT’s minimum criterion for auxiliary lanes is 10 feet, therefore leaving 36 feet of the 68-foot width available to support the parking and bicycle lanes.

PennDOT has detailed regulations governing implementation of angle parking on state highways and specifies a minimum width for parking and maneuver space. With 36 feet available, it would be possible to implement angle parking on one side of the street only, with 6 feet available for a single bike lane. Downtown stakeholders were not



inclined to limit parking to one side of the street. Furthermore, with parking provided on only one side of the street, the question was raised as to how drivers proceeding in the opposite direction would be able to utilize the spaces. There was

little interest in reducing the angle of the spaces as the additional yield, as noted previously, was not sufficient to justify the installation of the angled spaces.

Having determined that angle parking would likely only be possible on one side of the street, the decision was made retain parallel parking on the opposite side. It was also determined at this point to set a minimum width for the bicycle lane, in accordance with AASHTO criteria, which

recommend a width for two directional travel of 12 feet. This width was also consistent with PennDOT's criteria. With all the other minimum widths established and agreed upon, this left 18 feet for angle parking.

In order to maximize the amount of parking, it was decided to utilize an 8 foot, 6 inch (2.59 meter) wide space, which is consistent with National Parking Association (NPA) criteria for a 45-degree angle space. The available 18-foot width, however did not meet PennDOT's minimum criteria. The design team, lead by John A. Nawn, P.E., PTOE, in meetings with the Department, pointed out that PennDOT standards did not specify whether the angle parking criteria applied to traditional pull in or back in angle parking, and since there were no examples of back in angle parking in Pennsylvania, it was clear that the PennDOT criteria only applied to pull in angle parking. It was agreed that a maneuver area was necessary for traditional pull in angle spaces so vehicles can re-enter the roadway safely. When backing up from a pull in angle space, an operator temporarily has no view of approaching traffic dependent upon the length of his or her vehicle and the length and composition of the vehicle to the right. The maneuver area is necessary to provide the operator a safe place to back into during this essentially blind reverse maneuver. However, with back in angle parking, it was argued that no such maneuver area was necessary since vehicles exit forward.

The human biomechanical motion necessary to enter a back in angle parking space is similar too, if not easier than entering a parallel parking space. The prescribed method for entering a parallel parking space entails three distinct steps. First, the operator pulls past the parking space. Second, the operator proceeds in reverse into the space, on a diagonal, as far as possible. Third, the operator pulls forward while turning toward the right to bring the vehicle parallel to the curb. The second step, wherein the operator pulls backwards into the parallel space, typically places the vehicle at an approximate 45-degree angle with the travel lane. For a 45 degree back in angle space therefore, the operator only needs to complete the first two

steps of the typical parallel parking maneuver wherein the operator pulls past the space, then proceeds in reverse into the space, completing the move. When leaving the space to re-enter the highway, the back in angle space has a clear advantage over the parallel parking space. When exiting a parallel parking space, an operator must turn his or her field of vision up to 180 degrees and look backward to be able to view approaching vehicles and identify gaps in which to re-enter the traffic stream. In pulling out from a 45 degree angle space, the maximum that the operator must turn his field of vision is 135 degrees to be able to see approaching vehicles from his left. This movement requires only that the operator turn sideways, not backwards presenting a slightly more 'comfortable' position for the operator.

Based on the above discussion, it was successfully presented to the Department that given the fact that it is theoretically easier to enter and exit a back in angle parking space than a parallel parking space, and no maneuver area is typically required for parallel parking lanes in an urban zone, accordingly, no additional maneuver area would be necessary nor should be required for back in angle parking.

The proposed layout was approved by the Borough Council and endorsed by three local, downtown organizations, and the County. The plan was also conditionally approved by PennDOT. Design of the project was funded partially by a grant from the Delaware Valley Regional Planning Commission (DVRPC), through their competitive Transportation and Community Development Initiative (TCDI) program. Implementation of the re-designed striping was carefully orchestrated to follow a planned maintenance resurfacing of High Street.

The decision as to which side of the street to locate the back in angle parking on was cause for much discussion among the stakeholders. Ultimately, the decision was based entirely on which side would yield the biggest increase in parking, and that was found to be the north side of High Street. The additional parking yield over the existing

parallel parking, per block, varied greatly depending on the location of driveways, no parking zones and the like, with some blocks gaining as many as 23 spaces and some blocks as few as 2 spaces. Overall, the downtown area gained a total of 95 new spaces, a 21% increase over existing conditions.

In addition to parking changes, existing electromechanical signal controllers were replaced with new, solid state controllers and coordinated with each other to accommodate the through lane reduction necessary to accommodate the new parking and bike lane.

This context sensitive solution demonstrates that back in angle parking can be effectively integrated into the downtown environment and co-exist along an arterial highway employing current, minimum design standards. In addition to creating more parking over traditional parallel parking, back in angle parking can also be used as a traffic calming/street narrowing tool, can enhance pedestrian functionality and walk-ability within the downtown area and can work harmoniously with bicycle lanes, all resulting in a more attractive and intimate downtown corridor enhancing the downtown experience and leading to increased economic investment. ■

*John A. Nawn, P.E., PTOE was the Project Manager for the Back In Angle Parking design and installation and had been associated with the project and the Borough's efforts since 1995. Mr. Nawn holds a Bachelor of Science Degree from Drexel University, and is currently employed by URS Corporation the Branch Manager of their Philadelphia Office. John, a licensed professional engineer in four states and a certified professional traffic operations engineer, has over 16 years experience in traffic engineering and has been a member of PSPE since 1990. John is currently the President of the Delaware County Chapter of the Pennsylvania Society of Professional Engineers.*

*The project was presented at and appears in the proceedings of both the Second Urban Street Symposium (a Transportation Research Board conference) and the 2003 Institute of Transportation Engineers Annual Conference.*

*For more information please contact Mr. Nawn at, 215-587-9000 x3000 or john\_nawn@urscorp.com.*

## **APPENDIX B**

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CITY OF POTTSTOWN (2001) PROPOSED  
HIGH-STREET TRAFFIC CALMING PLAN.



## 1. Wilmington, Delaware

Contact person: Thomas Warrington  
Department of Public Works  
900 E 11<sup>th</sup> ST  
Wilmington, DE 19802  
302.571.4233

The City of Wilmington, Delaware, has six blocks of 60 and 90-degree back-in angle parking dating back about 50 years. By city ordinance, Wilmington requires all angle parking to be back-in because of the safety factor.

For 60-degree angle parking, regulations require 19 feet out from the curb for parking spaces, to allow for vehicles with extended cabs, plus a minimum of 11 feet for a travel lane, for a total of 30 feet for traffic going in one direction.

The highest average daily traffic for any block with angle parking is the 1000 block of Market Street, with an ADT of 6,500 vehicles.

Wilmington has not experienced any significant problems with accidents or impediments to travel flow with angle parking.

(See attached letter from Thomas Warrington.)



## 2. Seattle, Washington

Contact person: **Bill Jack**  
Seattle Transportation  
Municipal Building, Room 410  
600 Fourth Avenue  
Seattle, WA 98104  
206.684.8329.

The City of Seattle, Washington, has about 280 blocks of angle parking spaces, most of which are back-in. Seattle also has pull-in angle parking, but prefers back-in angle parking because it is safer, especially for pedestrians.

North Queen Anne Street, shown above, is one of the higher volume traffic streets, with about 6,500 ADT.

Seattle has had back-in angle parking for more than 30 years.

(See attached letter from Bill Jack.)



### 3. Washington, D.C.

Contact person: Rashid Sleemi  
202.671.1573

Washington, D.C. has six blocks of back-in angle parking going back 15 to 20 years.

The busiest thoroughfare is the 2400 block of 18<sup>th</sup> Street NW, which has an ADT of 9,200. The street has two lanes of traffic going in each direction with no maneuver lane in front of the parking spaces.

Other areas with back-in angle parking are several blocks on Water Street, NW, a low volume traffic area, and Vermont Avenue, NW, between 14<sup>th</sup> and Q streets, with an ADT of 5,000.

Although no traffic records are available, Mr. Sleemi reports the perception is that back-in angle parking does not create any traffic hazards.



#### 4. Indianapolis, Indiana

Contact person: John Burkhardt  
Administrator, Traffic Division  
1725 S. West Street  
Indianapolis, IN 46225  
317. 327.2903

Indianapolis has one block of back-in angle parking, along the federal courthouse on New York Avenue, going back at least 15 years.

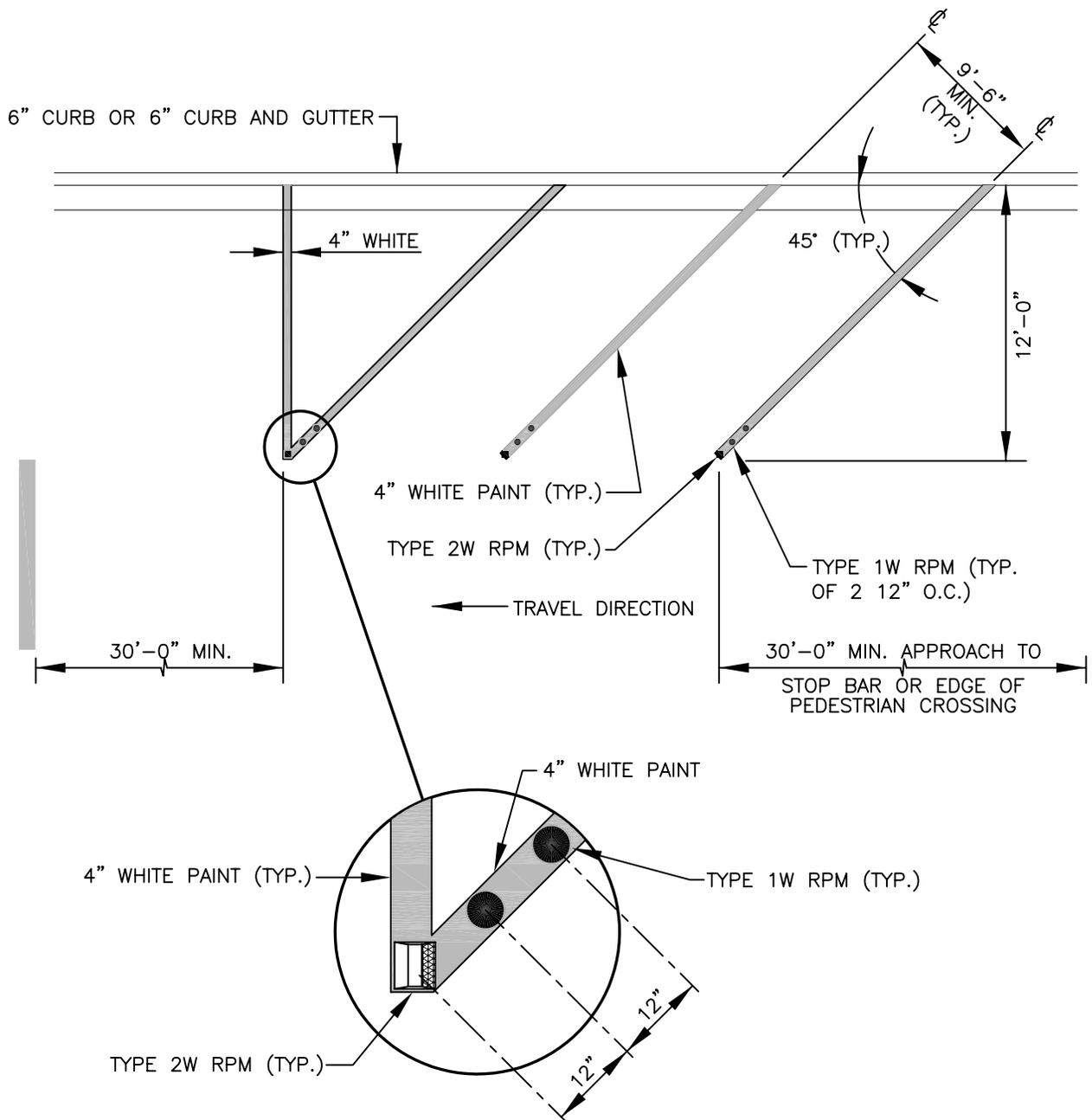
New York Avenue is a one-way street consisting of a north parallel parking lane, three traffic lanes, a right turn lane, and angle parking. The right turn lane is directly adjacent to the angle parking. Average daily traffic is 13,800.

The latest traffic records, for the years 1999-2000, reflect there were a total of two accidents over two years at the nearest intersection. They do not know if those accidents had anything to do with the angle parking.

## **APPENDIX C**

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CITY OF VANCOUVER (2004) ANGLE  
BACK IN PARKING STRIPING.



49 ANGLE BACK IN PARKING STRIPING AND MARKINGS

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TRANSPORTATION SERVICES

APPROVED BY: *[Signature]*

TRAFFIC ENGINEER MANAGER

DATE: 8/30/2004

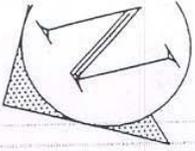


CITY OF VANCOUVER	STANDARD PLAN NUMBER
<b>ANGLE BACK IN PARKING STRIPING</b>	<b>T29-62</b>

## **APPENDIX D**

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CITY OF SEATTLE (2005) ANGLE BACK IN  
PARKING DIMENSIONS (SOURCE: FRANK  
NELSON, SEATTLE TRANSPORTATION  
DEPARTMENT).

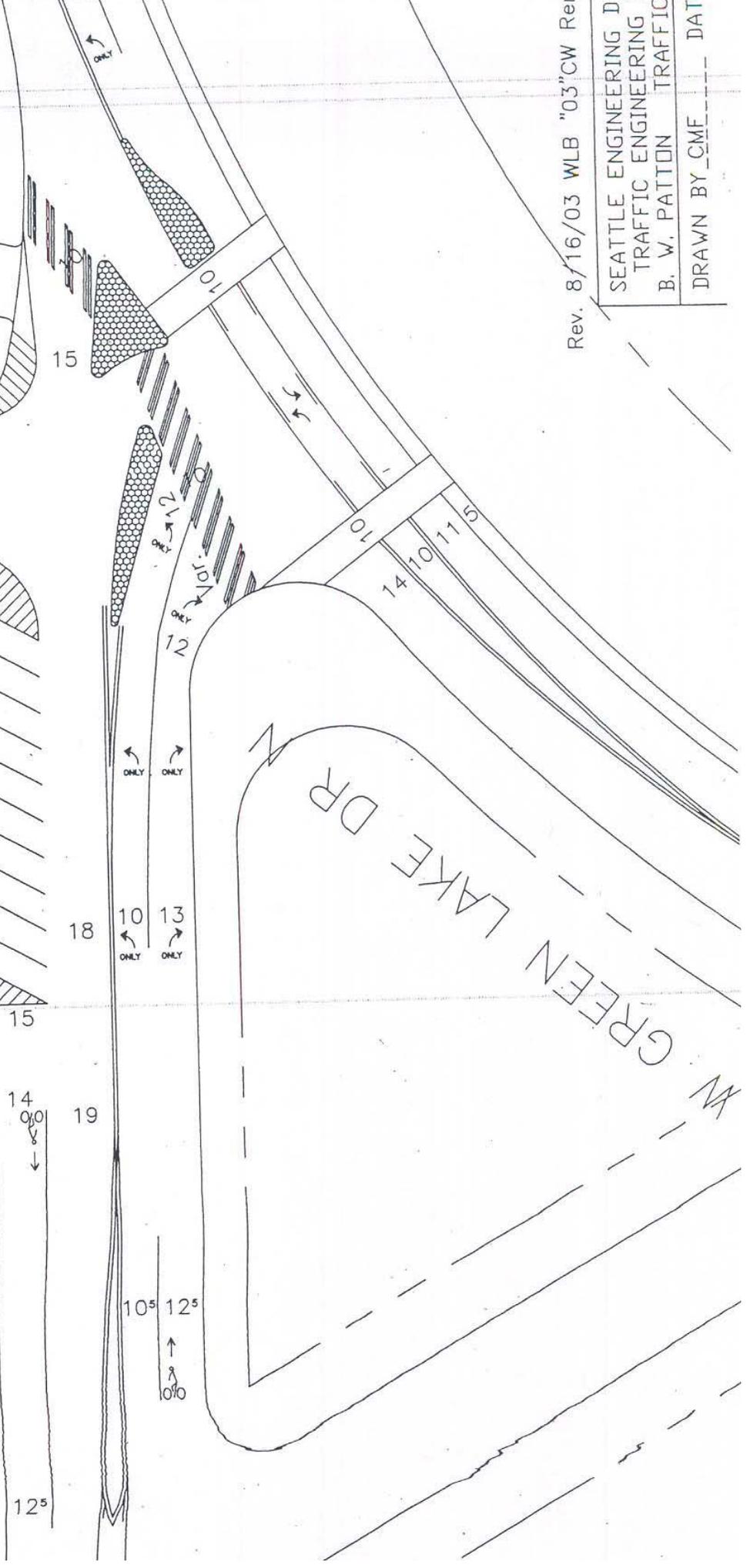


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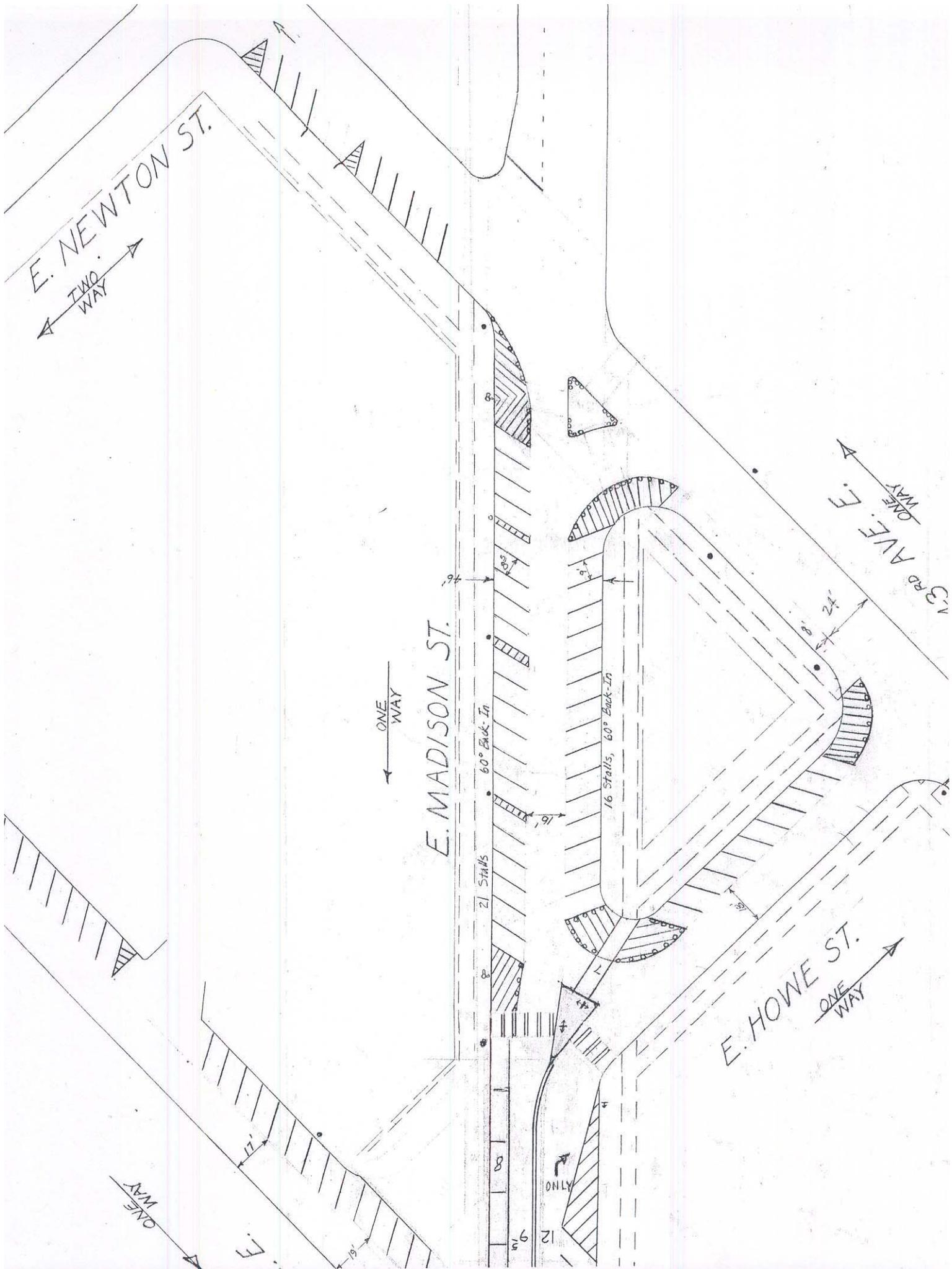
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## **ATTACHMENT 2**

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NABTI, J.M. (2002) INNOVATIVE BICYCLE TREATMENTS : AN INFORMATIONAL REPORT OF THE INSTITUTE OF TRANSPORTATION ENGINEERS (ITE) AND THE ITE PEDESTRIAN AND BICYCLE COUNCIL. EXCERPT P. 38-39.  
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### 3.3 ADVANCE STOP LINE (ASL)/BICYCLE BOX

**Objective:** To improve the visibility of cyclists at intersections and to enable bicyclists to correctly position themselves for turning movements during the red-signal phase by allowing them to proceed to the front of the queue. Also, to provide a transition from a left-side or median bike lane to a right-side lane.

**Applications:** For use at intersections with high motor vehicle and bicycle ADTs, frequent turning conflicts and/or intersections with a high percentage of turning movements by both cyclists and motorists. According to DETR Traffic Advisory Leaflet 8/93, “ASLs have been used successfully at sites with motor vehicle flows up to 1,000 vehicles per hour and with two lane approaches.” In Bristol, United Kingdom, they have been used on the approach to a signalized roundabout. An atypical application is where a left-side (or median) bike lane switches to a right-side one (such as on one-way streets). An ASL can serve to link the two lanes, as is the case in Eugene, OR, USA. It is not meant to be used when the signal is green.

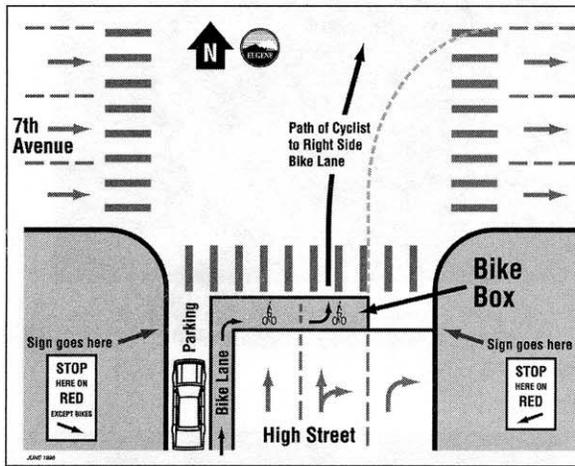


FIGURE 3-3A. A bike box design in Eugene, OR, USA. (SOURCE: City of Eugene.)



3-3B. A bike box in Hawaii, USA. (SOURCE: Vincent M. Llorin, Hawaii State DOT.)

**Description:** Bike lane leading up to a bicycle “reservoir” located between the motor-vehicle stop line and the crosswalk. According to DETR Traffic Advisory Leaflet 8/93, the bike box should be 4- to 5-m deep. If it is shallower, bicyclists tend to feel intimidated by the motor vehicles, and if it is deeper, motorists tend to encroach. To increase its effectiveness, a bicycle stencil should be placed in the bike box and a contrasting surface color is strongly recommended for the reservoir and the approach bike lane. Instructional signs and separate cyclist signal heads can be installed in conjunction with the bike box. Encroachment and violation of the bike box must be enforced by local law enforcement.

#### Advantages:

- Increases cyclist visibility, allowing them to move to the front of the line where they are in full view of motorists on all sides of the intersection;
- Allows cyclist to maneuver to the correct position for turning movements during the red-signal phase;
- Does not significantly delay motorists, since cyclists are usually able to accelerate quickly through intersections;
- Reduces conflicts between turning bicycles and vehicles by clearly delineating location for movements to occur; and
- Provides buffer between vehicles and pedestrians/bicycles crossing the street.

#### Disadvantages:

- May not be effective during the green-signal phase;
- Effectiveness of the bicycle box may be decreased by motorists encroaching into the bike box area;
- Allowing motorists to turn right on red may be hazardous to bicyclists since the approach bike lane leads right up to the intersection (or left-turning vehicles in the United Kingdom and other countries where motorists drive on the left);

- If the signal turns green as a cyclist is approaching the intersection, he/she may not have enough time to correctly position himself to effectively and safely use the box;
- Unfamiliar drivers may be confused or uncertain about the intended purpose of markings;
- Local traffic laws may not permit the use of this treatment;
- Cost of on-going maintenance to maintain color may be a concern; and
- Pavement markings obscured by snow may lead to driver uncertainty in winter conditions.

**Cost:** Dependent on the materials and whether signage and new signal heads are needed.

**Evaluation Studies:**

- TRL Project Report 181—Advanced Stop Line for Cyclists: The Role of Central Cycle Lane Approaches and Signal Timings.
- A Wheeler (TRL)—Advanced Stop Lines: A Simplified Layout. Traffic Engineering and Control, May 1995.
- William Hunter, “Evaluation of an Innovative Application of the Bike Box.” University of North Carolina Highway Safety Research Center. Prepared for U.S. Department of Transportation, Federal Highway Administration. Publication Number FHWA-RD-00-141, Aug. 2000.
- Traffic Advisory Leaflet 10/86: Innovatory Cycle Scheme, Oxford-Parks Road/Broad Street, Advanced Cycle Stop Line, Nov. 1986.
- Traffic Advisory Leaflet 3/89: Innovatory Cycle Scheme, Newark, Advanced Cycle Stop Line, April 1989.
- Traffic Advisory Leaflet 6/91: Innovatory Cycle Scheme, Bristol, Advanced Cycle Stop Line, Sept. 1991.
- Traffic Advisory Leaflet 8/93: Advanced Stop Lines for Cyclists, Aug. 1993.
- Traffic Advisory Leaflet 5/96: Further Development of Advanced Stop Lines, May 1996.

**Sample Sites:**

**Eugene, OR, USA:** High St. at Seventh Ave.  
Hawaii, USA; Cambridge, MA, USA; United Kingdom; The Netherlands

**Contact Information:**

**Eugene, OR, USA**

Diane Bishop  
Bicycle and Alternative Modes Coordinator  
Transportation Division  
Ph: 541-682-5471  
Fax: 541-682-5598  
E-mail: [diane.l.bishop@ci.eugene.or.us](mailto:diane.l.bishop@ci.eugene.or.us)

**Cambridge, MA, USA**

Cara Seiderman  
Transportation Program Manager  
Environmental and Transportation Planning  
57 Inman St.  
Cambridge, MA 02139 USA  
Ph: 617-349-4629  
E-mail: [cseiderman@ci.cambridge.ma.us](mailto:cseiderman@ci.cambridge.ma.us)

**United Kingdom**

Driver Information and Traffic Management Division  
3/24 Great Minster House  
76 Marsham St.  
LONDON SWIP 4DR  
Ph: 0171-271-518