Bicycle Pedestrian Advisory Committee (BPAC) Regular Meeting Agenda

Sierra Vista Metropolitan Planning Organization
Monday, August 7, 2017
12:00 p.m.
401 Giulio Cesar Avenue
Sierra Vista, AZ 85635
Web: www.SVMPO.org
BPAC: http://www.svmpo.org/bpac/
Email: SVMPO@SierraVistaAZ.gov

SVMPO BPAC Members
(One or more members may participate via teleconference)

Chair	Linda Jones
Vice-Chair	Nicole Miller
Member	Bud Dragoo
Member	John Healy
Member	Jacob Jones-Martinez
Member	Ellen Preiss
Member	Anna Strompro

SVMPO Administrator Dan Coxworth, AICP

1. **CALL TO ORDER AND ROLL CALL**

2. **ACCEPTANCE OF THE AGENDA**

3. **APPROVAL OF MEETING MINUTES (attached)**

   May 1, 2017

4. **ANNOUNCEMENTS AND UPDATES**
   Announcements and updates may be provided by BPAC Members, SVMPO Administrator or other invitees

   - ADOT Pedestrian Safety Action Plan, Segment 7 (attached)

- ADOT SR90/SR80 Corridor Profile Study
- Bike Counts
- Sierra Vista Bicycle Friendly Designation (attached)
- Bicycle Pedestrian Accidents with Vehicles Map

NEW BUSINESS: PRESENTATION / DISCUSSION / POSSIBLE ACTION

5. DISCUSSION: Bicycle/Pedestrian Wayfinding Signage

Summary: The City is organizing information to apply for a grant to install informational, directional, and wayfinding signage along or near bicycle and pedestrian facilities in Sierra Vista.

OLD BUSINESS: PRESENTATION / DISCUSSION / POSSIBLE ACTION

6. DISCUSSION: Arizona Department of Transportation (ADOT) Bicycle and Pedestrian Count Program Strategy Plan (Attached)
Dan Coxworth

Summary: Working Pager No. 2 – Technology Review

7. DISCUSSION: East/West Bicycle Route (Attached)
Dan Coxworth

Summary: Review and comment on proposed east/west bicycle route. The route description and map attached.

8. DISCUSSION: Future Agenda Items
BPAC

9. UPCOMING SCHEDULED MEETINGS

October 16, 2017 Time and Location TBD

10. ADJOURNMENT

For special needs and accommodations, please contact Daniel Coxworth before the meeting or activity. Mr. Coxworth can be reached at 520-439-2178 or email Dan.Coxworth@SierraVistaAZ.GOV or through Arizona Relay Service at 1-800-367-8939, or by dialing 7-1-1.

MINUTES: BICYCLE-PEDESTRIAN ADVISORY COMMITTEE (BPAC) REGULAR MEETING

Sierra Vista Metropolitan Planning Organization
Regular Meeting
Monday, May 1, 2017
11:45 AM
Web: www.SVMPO.org
BPAC: http://www.svmpo.org/bpac/
Email: SVMPO@SierraVistaAZ.gov

Landmark Café
400 W. Fry Blvd.
Sierra Vista, AZ 85635

SVMPO BPAC Members
(One or more members may participate via teleconference)

PRESENT:

Chair	Linda Jones (arrived at 12:15 p.m.)
Vice-Chair	Nicole Miller
Member	Bud Dragoo
Member	John Healy
Member	Jacob Jones-Martinez
Member	Anna Strompro

SVMPO Administrator Dan Coxworth, AICP

ABSENT:

Member Ellen Preiss

Others Present:

Alicia Katz, City Health & Wellness Coordinator

1. CALL TO ORDER AND ROLL CALL

Vice-Chair Miller called the meeting to order at 11:46 a.m.

2. ACCEPTANCE OF THE AGENDA

Member Jones-Martinez made a motion to accept the agenda of the BPAC for Monday, April 3 as written. Member Strompro seconded. The motion passed unanimously, 5/0

3. APPROVAL OF MEETING MINUTES (attached)

Member Strompo made a motion to approve the minutes of April 3, 2017, as written. Member Dragoo seconded. The motion passed unanimously, 5/0

4. ANNOUNCEMENTS AND UPDATES

Announcements and updates may be provided by BPAC Members, SVMPO Administrator or other invitees

- Sierra Vista Strava Cycling Challenge (John Healy) (Flyer Attached). Mr. Healthy informed the BPAC of the Challenge

- Bike and Walk to School Week (Dan Coxworth) (Flyer Attached). Alicia Katz informed the BPAC of the upcoming Bike/Walk to School Week.

- Adventure Cycling S. Arizona Road Tour (Jacob Jones-Martinez) (Info Attached). Mr. Jones-Martinez spoke about a letter written to the County Board of Supervisors from the event director for Adventure Cycling's Southern AZ Road Tour.

NEW BUSINESS: PRESENTATION / DISCUSSION / POSSIBLE ACTION

5. PRESENTATION: Arizona Open Meeting Law
Jill Adams

Summary: Jill Adams, Sierra Vista City Clerk, will provide an overview of Arizona Open Meeting Law.

Ms. Adams discussed the requirements of the Arizona Open Meeting Law. BPAC members asked questions for clarification.

6. DISCUSSION: Arizona Department of Transportation (ADOT) State Bike Pedestrian Count Program
Dan Coxworth

Summary: Introduction of ADOT's Bike-Ped Count Program.

ADOT recently hired Kimley-Horn to conduct a State bicyclist and pedestrian count strategy plan. Development of the plan is expected to take up to 12-months. Mr. Coxworth will provide information to the BPAC during the process for BPAC comment and input.

7. DISCUSSION: East/West Bicycle Route (Attached)
Dan Coxworth

Summary: Review and comment on proposed east/west bicycle route. The route description and map attached.

Item to be placed on the next agenda

8. DISCUSSION: Future Agenda Items
BPAC

- *Bike share research*
- *Streets that need bike lanes*
- *Bike counter locations*

9. UPCOMING SCHEDULED MEETINGS

June 5, 11:45 a.m., Landmark Café (Tentative)

10. ADJOURNMENT

Vice-Chair Miller adjourned the meeting at 12:53 p.m.

Potential Countermeasures for SR 92, High Crash Segment 7

General Project Information

Primary Route/Street: SR 92
City/Town Name: Sierra Vista
County: Cochise
District: Southcentral
Begin Limit: MP 321
End Limit: MP 326.7
Segment Length: 5.7 mile
Right-of-Way Ownership: ADOT
Adjacent Land Ownership: Private
Google Map: https://goo.gl/maps/Y5J3woZsJBA2

Location Summary

The SR 92 segment is located northeast of Sierra Vista. Twelve pedestrian crashes were reported with two resulting in incapacitating injuries and two with fatal injuries.
Programmed Projects: Intersection Improvements at Foothills Blvd (TRACS # H826501C)
Identified in 2009 PSAP: No
Segment Type (High Crash / High Risk): High Crash
Area Type (Urban-Suburban / Rural): Urban-Suburban
Facility Type: 5-Lane Divided / Undivided sections
AADT: 19,000 – 26,000 vehicles per day
Posted Speed Limit: 45 – 55 MPH
Sidewalks: Paved path, north of Buffalo Soldier Trial
Lighting: At signalized locations
Bus Stop Locations (within ¼ mile): Yes
# of Pedestrian Crashes: 12 (5 involved alcohol/drugs)
Crosswalk Locations: At signalized intersections
Other Pedestrian Attractors/Generators: Various commercial, churches, residential

Project Need

Over half of the reported pedestrian crashes, and more severe, along MP 321.0 – 326.7 have occurred at night. The reported crash type is *Crossing Roadway – Vehicle Turning* on/near cross-walk areas at signalized and non-signalized intersections. Consistent application of sidewalks and raised median is needed.

Project Purpose

Reduce the number of pedestrian crashes on SR 92 by increasing the visibility of pedestrians along SR 92 and providing safe crossing opportunities.

Potential Countermeasures — *Conceptual Cost*

Conduct RSA — ***$20,000***
An RSA with an emphasis on pedestrian safety should be conducted on SR 92 within the Sierra Vista area

Provide Roadway Lighting — ***$1,408,000***
Provide continuous lighting along the corridor to improve pedestrian visibility at night along segment. The lighting should extend from Fry Boulevard to East Camino Principal (approximately 5 miles) as the segment is getting fairly developed and high traffic volumes.

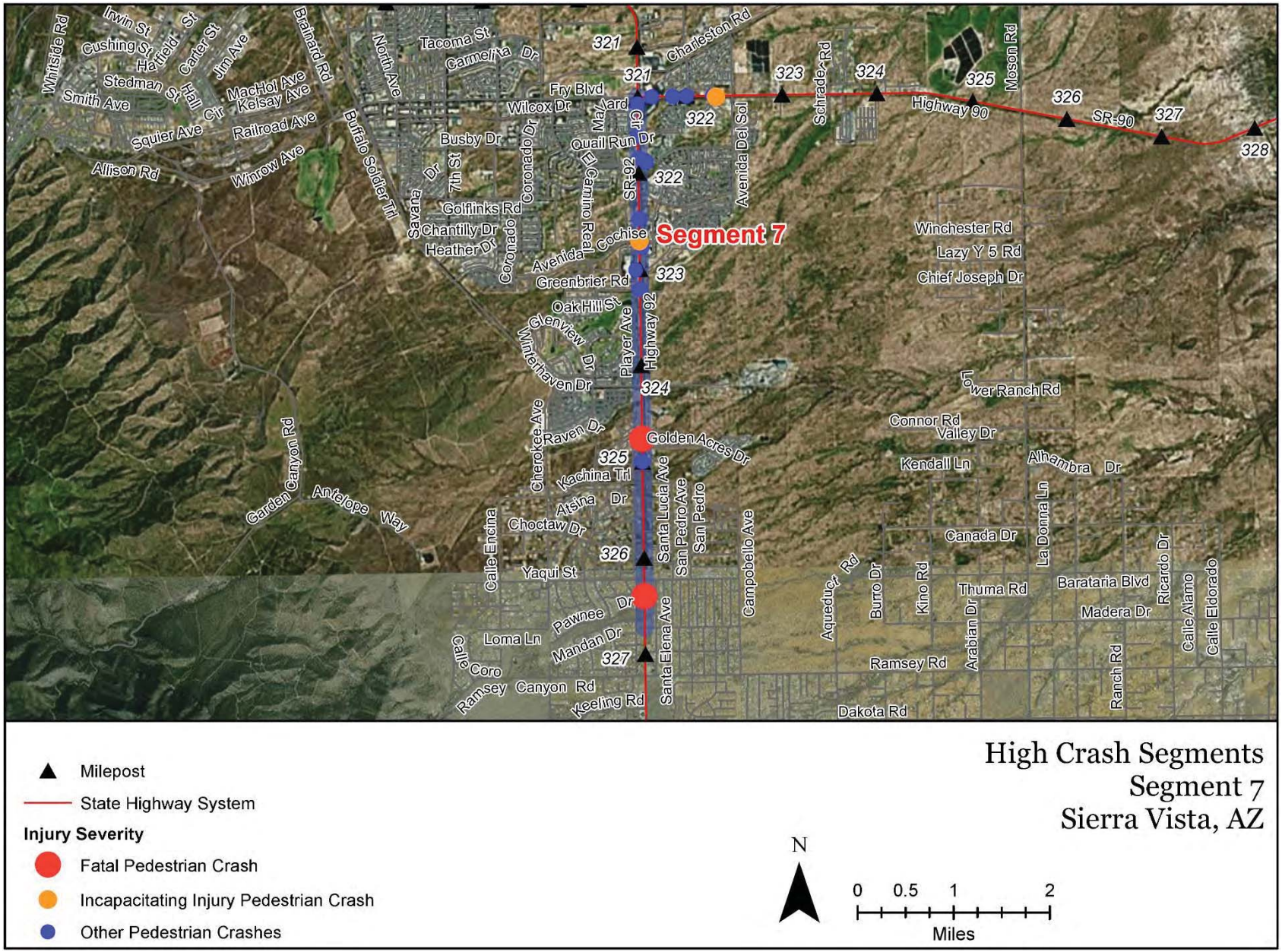
Extend Paved Shared-Use Path — ***$1,092,000***
Extend the existing shared use path north of Buffalo Soldier Trail south to Glenn Road (approximately 0.97 miles) and on the side of SR 92 between Foothills Drive to Avenida Cochise (approximately 0.85 miles).

Improve Signal Operations for Pedestrians — **$3,000**
Evaluate the existing operations at the signalized intersections. Consider leading pedestrian interval (LPI) or right-turn on red restrictions at Avenida Cochise and Foothills Drive. Evaluate signal timing/phasing for pedestrians.

Construct a Raised Median — **$2,718,997**
Provide consistent raised medians throughout the entire segment (approximately 1.9 miles), primarily south of Glenn Road.

Enhance Mid-Block Crossing Opportunities — **$408,300**
Evaluate the need for a PHB or signalized pedestrian crossing on SR 92 between Foothills Drive and SR 90.

Estimated Planning Level Total Segment Conceptual Cost: $5,650,297


Segment 7
Milepost
State Highway System
Injury Severity
Fatal Pedestrian Crash
Incapacitating Injury Pedestrian Crash
Other Pedestrian Crashes
High Crash Segments
Segment 7
Sierra Vista, AZ
N
0 0.5 1 2
Miles

SIERRA VISTA, AZ

BICYCLE FRIENDLY COMMUNITY
Spring 2017
BRONZE
THE LEAGUE OF AMERICAN BICYCLISTS

TOTAL POPULATION
44,286

TOTAL AREA *(sq. miles)*
140.2

POPULATION DENSITY
316

 # OF LOCAL BICYCLE FRIENDLY BUSINESSES 0

 # OF LOCAL BICYCLE FRIENDLY UNIVERSITIES 0

10 BUILDING BLOCKS OF A BICYCLE FRIENDLY COMMUNITY

	Average Silver	*Sierra Vista*
High Speed Roads with Bike Facilities	40%	44%
Total Bicycle Network Mileage to Total Road Network Mileage	47%	35%
Bicycle Education in Schools	GOOD	EXCELLENT
Share of Transportation Budget Spent on Bicycling	11%	5%
Bike Month and Bike to Work Events	GOOD	ACCEPTABLE
Active Bicycle Advocacy Group	YES	YES
Active Bicycle Advisory Committee	MEETS EVERY TWO MONTHS	QUARTERLY
Bicycle–Friendly Laws & Ordinances	SOME	ACCEPTABLE
Bike Plan is Current and is Being Implemented	YES	YES
Bike Program Staff to Population	1 PER 91K	1 PER 63K

CATEGORY SCORES

ENGINEERING *Bicycle network and connectivity*	3 /10
EDUCATION *Motorist awareness and bicycling skills*	5 /10
ENCOURAGEMENT *Mainstreaming bicycling culture*	4 /10
ENFORCEMENT *Promoting safety and protecting bicyclists' rights*	4 /10
EVALUATION & PLANNING *Setting targets and having a plan*	3 /10

KEY OUTCOMES

	Average Silver	*Sierra Vista*
RIDERSHIP *Percentage of Commuters who bike*	2.6%	0.5%
SAFETY MEASURES **CRASHES** *Crashes per 10k bicycle commuters*	549	1000
SAFETY MEASURES **FATALITIES** *Fatalities per 10k bicycle commuters*	7.3	0

KEY STEPS TO SILVER

» Bicycle facilities in Sierra Vista tend to be on high speed roads and may not provide suitable connectivity to enable people of all ages and abilities to be safe and comfortable while biking. Work on building a connected network of bicycle facilities.

» Fry Boulevard was found to be the corridor with the most bicycle crashes and this corridor must be addressed to make bicycling safer in Sierra Vista. Work with appropriate local business interests and other organizations to address bicyclist safety through parallel routes, improved on-street bike lanes, or a high quality path.

» Sidewalk riding can be a sign that people do not feel safe riding on your community's roadways. However, sidewalk riding is often more dangerous because drivers do not expect people to be moving quickly on sidewalks and there are many intersections of sidewalks, often built in ways that encourage fast turns. Mitigate sidewalk riding by improving on-street bicycle facilities or redesigning sidewalks into paths with fewer intersections and curbs.

» Continue efforts to expand bike education programs to local schools, develop additional bike clinics, and grow bicycling awareness in Sierra Vista. The US Bicycle Route designation for Route 90 is a great opportunity to create a brand for bicycling in Sierra Vista.

» Develop outreach methods and programs that specifically target women, minorities, non-english speaking, and other relevant communities.

Example: Wayfinding Signage with Milage

CITY OF GRESHAM
1905
Gresham City Hall
0.4 MI.
2 MIN.
Downtown Gresham
0.3 MI.
2 MIN.
Springwater Corridor
0.6 MI.
4 MIN.

Remington
BIKEWAY
Swallow Bikeway
Spring Creek Trail
3 min
0.6 miles
Old Town
5 min
.75 miles
Decision sign
Confirmation sign
Supplemental sign
Fort Collins
BIKEWAYS
Spring Creek Trail
Fort Collins
BIKEWAYS
Spring Creek Tr .06

Task Assignment: MPD0043-17

ADOT Bicyclist and Pedestrian Count Strategy Plan

Working Paper No. 2 – Technology Review

May 2017

ADOT Planning Bid/Proposal Number: ADOT11- 00000507
Contract Number: ADOT11-013152

Prepared by:

Kimley-Horn

333 E. Wetmore Road, Suite 280
Tucson, AZ 85705

In association with:

Lee Engineering

Texas A&M Transportation Institute

NOTICE

Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings, pursuant to sections 130, 144, and 148 [152] of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

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1. OVERVIEW

The Kimley-Horn team is conducting a project for the Arizona Department of Transportation (ADOT) entitled "Development of a Bicyclist and Pedestrian Count Strategy Plan for the Arizona State Highway System." This project will develop a framework for establishing a pedestrian and bicyclist count database with the goal of establishing a baseline of pedestrian and bicyclist use on the Arizona State Highway System (SHS). The framework will include recommended approaches for collecting, storing, and distributing this data to various stakeholders. Key project objectives include:

- Summarize existing literature on methods and technologies for pedestrian and bicycle volume data collection
- Review other state DOT programs for collecting, storing, and distributing pedestrian and bicycle volume data
- Inventory past and ongoing programs in Arizona for the collection of pedestrian and bicycle volume data
- Build stakeholder knowledge, understanding, and consensus on the scope and structure of the SHS pedestrian and bicycle volume database
- Collect pedestrian and bicycle volume data at select SHS sites
- Establish goals, roles, responsibilities, and resource needs for continued implementation of the framework

The goal of Task 2 of this project is to summarize available pedestrian and bicyclist count technologies for ADOT. This document, Working Paper No. 2, is intended to meet this Task 2 goal.

Focus on Proven Count Technologies

Working Paper No. 2 focuses on technologies that collect pedestrian and bicyclist count data. The reviewed technologies are applicable to the Arizona state highway environment and include both permanent and temporary equipment installations.

Several technologies are primarily intended to gather data other than counts, such as route choice, trip waypoints, trip origin and destination, or presence of at least one pedestrian or bicyclist. Examples of these technologies include:

- GPS-enabled smartphones with certain apps (e.g., Strava)
- Bluetooth or WiFi readers
- Intersection control presence detectors
- Pedestrian crosswalk push buttons

It is possible that these technologies could be used to estimate the total pedestrian or bicyclist count, but it is important to remember that the count estimation process for these technologies has not been firmly established, and the resulting count estimation error may be unacceptable when compared to other proven count technologies.

Therefore, this paper focuses on proven count technologies, while also acknowledging other emerging technologies that are primarily intended for other data collection applications.

2. SUMMARY OF COUNT TECHNOLOGIES

Several comprehensive national reports provide detailed information on technologies used to count pedestrians and bicyclists:

- Federal Highway Administration (FHWA) *Traffic Monitoring Guide*, Chapter 4: Traffic Monitoring for Non-Motorized Traffic, October 2016, https://www.fhwa.dot.gov/policyinformation/tmguide/.
- National Cooperative Highway Research Program (NCHRP) Report 797, *Guidebook on Pedestrian and Bicycle Volume Data Collection*, 2014, http://www.trb.org/Publications/Blurbs/171973.aspx.
- NCHRP Web-Only Document 229, *Methods and Technologies for Pedestrian and Bicycle Data Collection: Phase 2*, 2016, http://www.trb.org/Main/Blurbs/175860.aspx.
- Report FHWA-HPL-16-026, *Exploring Pedestrian Counting Procedures: A Review and Compilation of Existing Procedures, Good Practices, and Recommendations*, May 2016, https://www.fhwa.dot.gov/policyinformation/travel_monitoring/pubs/hpl16026/hpl16026.pdf.
- Alta Planning + Design, *Innovation in Bicycle and Pedestrian Counts: A Review of Emerging Technology*, 2016, http://altaplanning.com/resources/innovative-counting-technologies/.

The material in this section has been mostly compiled and adapted from these sources, particularly FHWA's Traffic Monitoring Guide (TMG) and NCHRP Report 797. The sources are cited where applicable. The following 15 count technologies are summarized (listed alphabetically):

- Inductance loops
- Infrared: Active
- Infrared: Passive
- Laser scanners
- Magnetometers
- Manual observers
- Piezoelectric strips
- Pneumatic tubes
- Pressure and seismic/acoustic sensors
- Radar
- Radio beams
- Stereoscopic sensors
- Thermal imaging
- Video: Automated reduction
- Video: Manual reduction
- Other emerging technologies

Each technology is described in the following pages, and pictures are included to show a typical application.

Inductance Loops

Wires are installed under (embedded) or on top (temporary) of the pavement surface. Small electrical currents running through the wires that form the loops generate a magnetic field. The processing unit detects changes in this magnetic field that occur when metal parts of a bicycle (e.g., frame, spokes, and pedals) pass over the loops (description used or adapted from NCHRP Report 797).

Figure 1 shows an elongated diamond shape that is used specifically for counting bicyclists. Other inductance loop shapes used for bicyclists include quadrupole, diamond quadrupole, and double chevron (see FHWA TMG).

Figure 1 – Inductance loops for counting bicyclists

Infrared: Active

An infrared beam is projected from an emitter to a receiver located on opposite sides of a traveled way (e.g., path or sidewalk). When the infrared beam is broken for a set period of time by an object crossing it, a detection is recorded (description used or adapted from NCHRP Report 797). **Figure 2** shows two different views of an active infrared sensor deployed for counting sidewalk users.

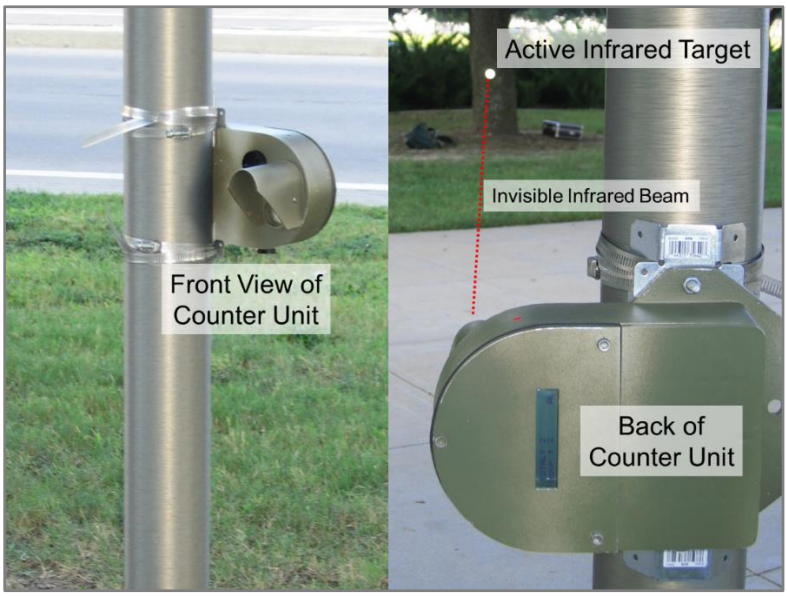


Figure 2 – Active infrared sensor for counting pedestrians and bicyclists

Infrared: Passive

An infrared sensor compares the temperature of the background to the infrared radiation (heat) patterns emitted by persons passing in front of the sensor. A passive infrared sensor is placed on one side of the facility being counted (description used or adapted from NCHRP Report 797). **Figure 3** shows a passive infrared sensor being used to count pedestrians on a sidewalk.

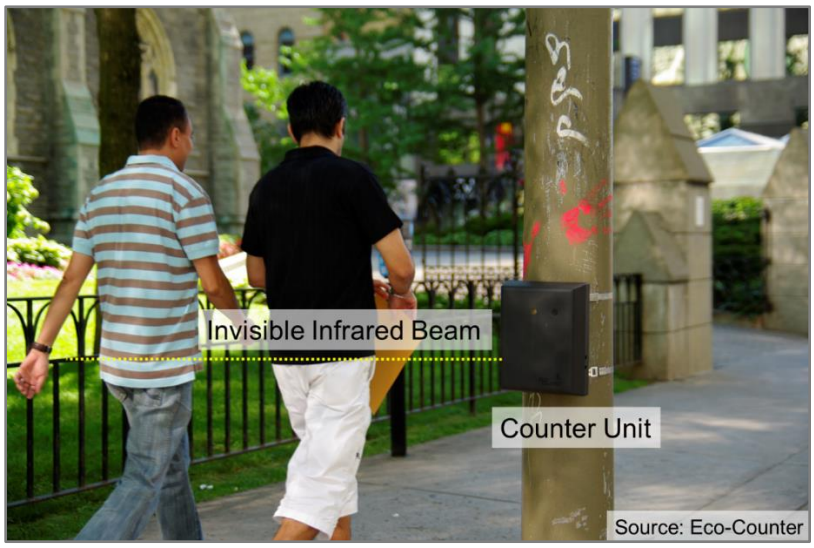


Figure 3 – Passive infrared sensor for counting pedestrians and bicyclists

Laser Scanners

Laser scanners emit laser pulses in a range of directions and analyze the reflections of the pulses to determine characteristics of the device's surroundings, including the presence of pedestrians or bicyclists. Two varieties of laser scanners exist: horizontal and vertical (description used or adapted from NCHRP Report 797). Laser scanners for counting pedestrians and bicyclists are still considered experimental and are not widely or commercially available.

Figure 4 shows an overhead laser scanner being used in a controlled experiment.

Figure 4 – Overhead laser scanner in lab experiment

(Source: Akamatsu et al., Development of a Person Counting System Using a 3D Laser Scanner, IEEE 2014)

Magnetometers

Magnetometers operate by detecting a change in the normal magnetic field of the earth caused by a ferrous metal object (e.g., bicycle frame or components). It may be possible to use existing motorized traffic magnetometers for counting bicyclists; however, the installation and configuration may not be optimal for accurate bicyclist counting (description used or adapted from FWHA TMG). **Figure 5** shows a magnetometer being installed for a motor vehicle application.

Figure 5 – Magnetometer that could be used for counting bicyclists

(Source: FHWA-HRT-08-001, https://www.fhwa.dot.gov/publications/publicroads/07nov/04.cfm)

Manual Observers

Human data collectors record pedestrian and bicyclist counts using paper sheets, traffic count boards/devices, or smartphone apps. Counts are usually recorded for one to four hours in discrete time intervals, generally 15 minutes, although counts can be collected in shorter intervals if desired. Some count devices can timestamp all data points (description used or adapted from NCHRP Report 797).

Figure 6 shows the data collection screen on the Go Counter smartphone-based app that is provided free of charge by the Rails-to-Trails Conservancy.

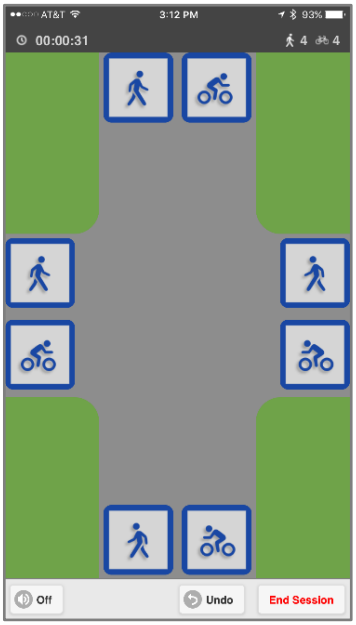


Figure 6 – Smartphone-based manual count app

Piezoelectric Strips

Thin strips of metal are installed under (embedded) or on top of the pavement surface, and the piezoelectric materials emit an electric signal when they are physically deformed by wheeled traffic (e.g., bicycles). The electric signal is detected by a roadside processing unit (description used or adapted from NCHRP Report 797).

Figure 7 shows an installation of piezoelectric strips being used to count bicyclists.

Figure 7 – Piezoelectric strips for counting bicyclists

(Source: NCHRP Report 797)

Pneumatic Tubes

One or more rubber tubes are stretched across the expected bicyclist travel path of a roadway or pathway. When a bicycle or other wheeled vehicle passes over a rubber tube, a pulse of air passes through the tube to a roadside processing unit, which then registers an axle count. Multiple tubes can be used to determine speed and directionality (description used or adapted from NCHRP Report 797). **Figure 8** shows a two-tube system that is used to get directional bicyclist counts.

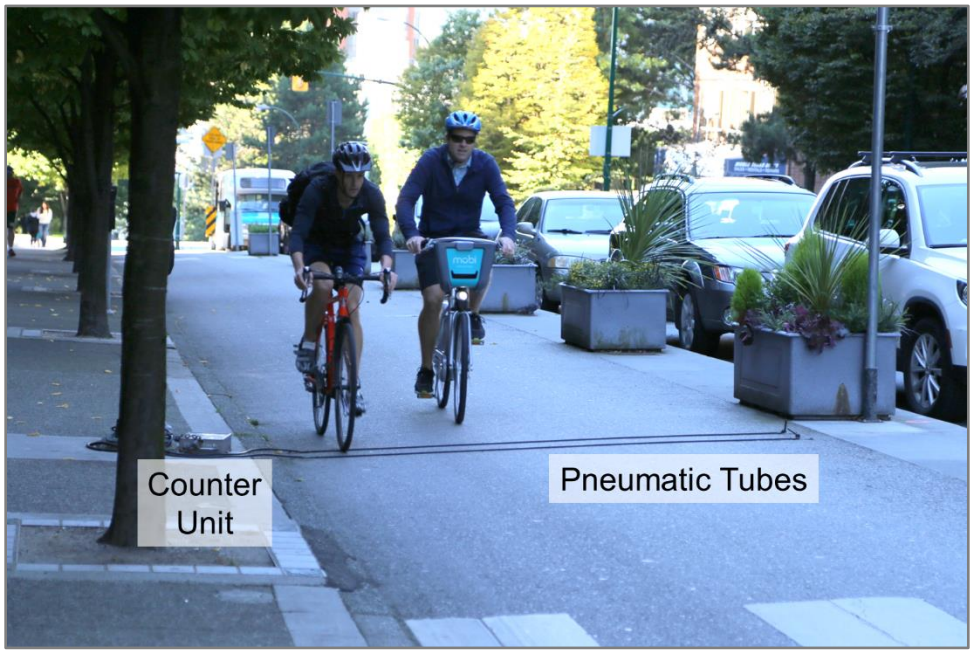


Figure 8 – Pneumatic tubes for counting bicyclists

Pressure and Seismic/Acoustic Sensors

Pressure sensors operate by detecting changes in force (i.e., weight), much like an electronic bathroom scale. Seismic sensors (also sometimes called acoustic sensors) operate by detecting the passage of energy waves through the ground caused by feet, bicycle tires, or other non-motorized wheels (description used or adapted from FWHA TMG). **Figure 9** shows a pressure pad that has been installed on a paved pathway.

Figure 9 – Pressure sensor for counting pedestrians

(Source: Eco-Counter)

Radar

Ultra-low power, high-frequency pulses are transmitted and reflected off a target object (e.g., bicyclist), and return pulses are analyzed to determine object type, distance, and motion. The radar sensors are typically installed in the pavement.

Figure 10 shows a radar sensor that is embedded just below the pavement surface, similar to the magnetometer sensor shown in **Figure 5**.

Figure 10 – Radar unit for counting bicyclists

(Source: http://sensysnetworks.com/products/flexradar)

Radio Beams

A radio transmitter and receiver are positioned on opposite sides of the facility to be counted. A radio beam is sent from the transmitter to the receiver, and when the beam is broken, a user is detected. Devices that use multiple radio frequencies can differentiate between pedestrians and bicyclists (description used or adapted from NCHRP Report 797).

Figure 11 shows an application of radio beam sensors for counting pedestrians.

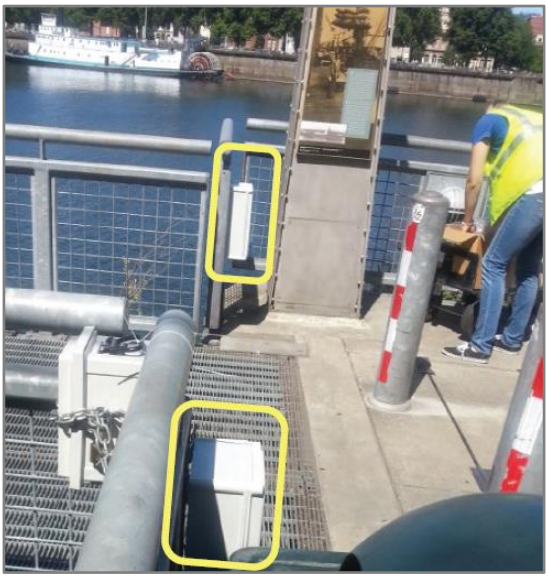


Figure 11 – Radio beam sensors

(Source: NCHRP Report 797)

Stereoscopic Sensors

Stereoscopic sensors are similar to video imaging with automated reduction but use a pair of stereoscopic video inputs instead of a single video input. Computer algorithms are still used to automatically identify and count pedestrians and bicyclists. **Figure 12** shows close-up and areawide views of a stereoscopic sensor at a pedestrian crosswalk.

Figure 12 – Stereoscopic sensor for counting pedestrians and bicyclists

(Source: http://migmasys.com/documents/MigmaMidblock.pdf)

Thermal Imaging

Thermal imaging sensors generate infrared images of body heat and work similarly to passive infrared counters but are typically mounted above the detection area. The overhead positioning allows thermal sensors to monitor the movement of persons and not just count the number of persons that pass the device. Thermal sensors are not affected by changes in ambient light (description used or adapted from NCHRP Report 797).

Figure 13 shows a thermal imaging sensor that is intended for elevated mounting (not necessarily directly overhead).

Figure 13 – Thermal imaging sensor for counting pedestrians and bicyclists

(Source: http://www.flir.com/traffic/display/?id=62071)

Video: Automated Reduction

Computer algorithms are used to automatically identify and count pedestrians and bicyclists in a defined zone from video. Some computer algorithms can operate in real-time in the field, whereas other algorithms process video recordings at a later time. Some algorithms can process video in both of these ways. **Figure 14** shows an example of a computer algorithm identifying and tracking pedestrians as they cross the street in a marked crosswalk.

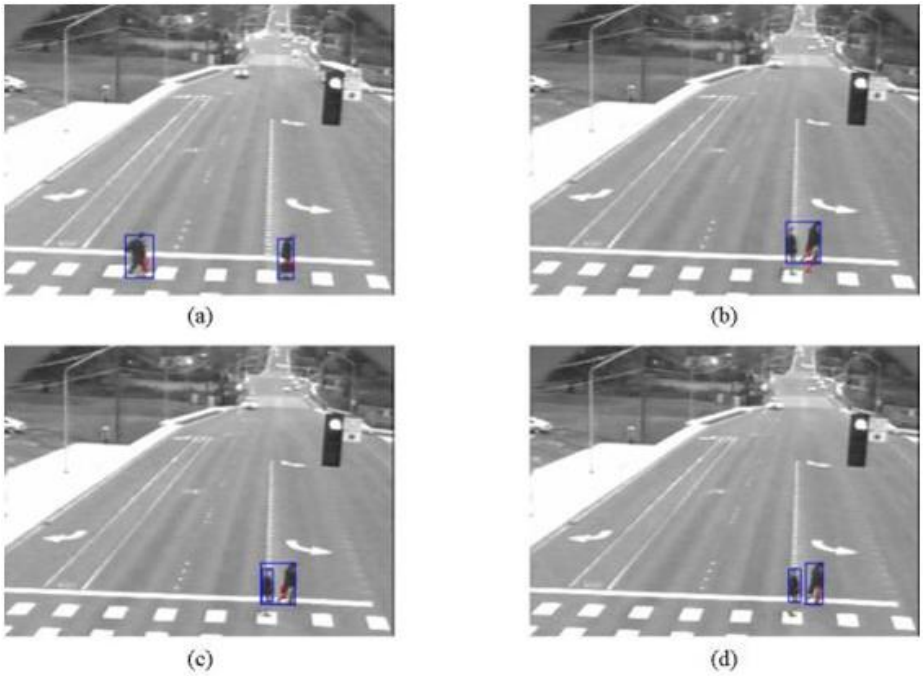


Figure 14 – Automated video reduction for counting pedestrians and bicyclists

(Source: FHWA TMG)

Video: Manual Reduction

Video recordings are created from permanent or temporary camera field installations. Counts and other information (e.g., gender, helmet use, behavior, etc.) are transcribed manually from the video recordings by human observers, typically in an office environment.

Figure 15 shows a technician installing video cameras on a utility pole. The video will be retrieved and reduced later in the office.

Figure 15 – Manual video reduction for counting pedestrians and bicyclists

(Source: NCHRP Report 797)

Other Emerging Technologies

As mentioned earlier, several technologies are primarily intended to gather data other than total counts, such as route choice, trip waypoints, trip origin and destination, or presence of at least one pedestrian or bicyclist. Examples of these technologies include:

- GPS-enabled smartphones with certain apps (e.g., Strava)
- Bluetooth or WiFi readers
- Intersection control presence detectors
- Pedestrian crosswalk push buttons

With all of these emerging technologies, only a sample of pedestrians and bicyclists are captured. In some cases, it is a very small and biased sample that is captured. Current research is investigating methods that can be used to accurately estimate total counts of pedestrians and bicyclists from these small samples, but these approaches are still experimental and have not been adopted by most practitioners.

Examples of Commercially Available Equipment

The previous sections have described count technologies in a generic way, without mentioning actual available equipment. **Table 1** lists examples of commercially available equipment for the technologies summarized in this paper. This list includes the most commonly known equipment manufacturers in North America but may not include all possible manufacturers. *Inclusion of a manufacturer in* **Table 1** *does not indicate or imply endorsement of their product(s).*

Table 1 – Examples of commercially available equipment for various types of technology

Technology (Alphabetical)	Examples of Commercially Available Equipment (Alphabetical)
Inductance Loops	Eco-Counter ZELT Roadsys HI-TRAC CMU
Infrared: Active	Diamond Traffic Trail Counter TTC-4420 TrailMaster TM1550
Infrared: Passive	Eco-Counter PYRO Roadsys HI-TRAC CMU TRAFx Trail Counter
Laser Scanners	No commercially available models identified
Magnetometers	Econolite AccuSense Mag
Manual Observers	N/A
Piezoelectric Strips	MetroCount RidePod BP Roadsys HI-TRAC CMU
Pneumatic Tubes	Diamond Traffic Traffic Tally 6 Eco-Counter TUBE Jamar TRAX Cycles Plus MetroCount RidePod BT TimeMark Delta NT, TimeMark Gamma NT
Pressure and Seismic/Acoustic Sensors	Eco-Counter SLAB TRAFx Mountain Bike Counter
Radar	Econolite AccuSense MicroRadar Roadsys SDR Sensys Networks MicroRadar
Radio Beams	Chambers Electronics Bike and People Counters
Stereoscopic Sensors	Migma PedCount, Migma Bicycle
Thermal Imaging	Eco-Counter CITIX-IR FLIR TrafiSense
Video: Automated Reduction	Miovision Scout Numina Placemeter
Video: Manual Reduction	CountingCars.com CountCloud Miovision Scout Various consumer video cameras with manual reduction

3. SELECTING THE MOST APPROPRIATE COUNT TECHNOLOGY

The previous section summarized 15 different types of technology that could be used for counting pedestrians and bicyclists. In some cases, it may seem like a daunting task to select a specific technology that is best for a particular application, but there are several criteria that can be used to narrow the choices to the most appropriate technology. The FWHA TMG contains a selection matrix (**Figure 16**) that contains these criteria:

1. What are you counting?
    a. Bicyclists only
    b. Pedestrians only
    c. Pedestrians and bicyclists combined
    d. Pedestrians and bicyclists separately
2. How long are you counting?
    a. Permanent
    b. Temporary or short term
3. What is the life cycle (equipment plus operating/maintenance) cost per amount of data?
4. What technologies are used in common practice?
    a. Is there commercially available equipment for a given technology?

Table 2 contains additional information about counting technologies and is sourced from the TMG. **Tables 3, 4,** and **5** contain additional information about counting technologies and are sourced from NCHRP Report 797.

Another important criterion is the accuracy of a technology. However, the TMG indicates that the "accuracy of commercially available products can vary significantly based on configuration, installation, and level of use, even within a specific technology." There are two important points in this statement:

- Even if a technology has proven to be accurate in controlled tests, if that technology is not installed and configured correctly, it may not be as accurate in actual field conditions.
- Accuracy in actual field conditions may vary among equipment manufacturers due to sensor design, algorithm sophistication, etc. Therefore, a certain technology may not have a fixed and known accuracy, but instead a range of accuracy among several manufacturers' products.

NCHRP Web-Only Document 229 describes extensive field accuracy tests of pedestrian and bicyclist counter equipment, but no names of equipment manufacturers are included. **Table 6** summarizes the results from these extensive NCHRP evaluation tests.

A bicyclist count technology review (Working Paper #2) conducted for the Maricopa Association of Governments by Chen Ryan Associates summarized the most common count technologies (shown in **Table 7**). This study (focused just on counting bicyclists) recommended three different options that included different mixes of manual counts, video with manual reduction, and pneumatic tubes.

1. What Are You Counting?	Technology	Bicyclists Only	Pedestrians Only	Pedestrians & Bicyclist Combined	Pedestrians & Bicyclist Separately	Cost
Permanent	Inductance Loops[1]	●			◐	$$
↑	Magnetometer[2]	○				$-$$
	Pressure Sensor[2]	○	○	○	○	$$
	Radar Sensor	○	○	○		$-$$
	Seismic Sensor	○	○	○		$$
2. How Long?	Video Imaging: Automated	○	○	○	○	$-$$
	Infrared Sensor (Active or Passive)	○[3]	●	●	◐	$-$$
	Pneumatic Tubes	●			◐	$-$$
↓	Video Imaging: Manual	○	○	○	●	$-$$$
Temporary/ Short Term	Manual Observers	●	●	●	●	$$-$$$

○ Indicates what is technologically possible.
● Indicates a common practice.
◐ Indicates a common practice, but must be combined with another technology to classify pedestrians and bicyclists separately.
$, $$, $$$: Indicates relative cost per data point.
[1] Typically requires a unique loop configuration separate from motor vehicle loops, especially in a traffic lane shared by bicyclists and motor vehicles.
[2] Permanent installation is typical for asphalt or concrete pavements; temporary installation is possible for unpaved, natural surface trails.
[3] Requires specific mounting configuration to avoid counting cars in main traffic lanes or counting pedestrians on the sidewalk.

Figure 16 – Simplified flowchart for selecting non-motorized count equipment

(Source: FHWA TMG, Figure 4-1)

Table 2 – Comparison of technologies for counting pedestrians and bicyclists

TABLE 4-1 COMMERCIALLY-AVAILABLE BICYCLIST AND PEDESTRIAN COUNTING TECHNOLOGIES

Technology	Typical Applications	Strengths	Weaknesses
Inductance Loop	Permanent counts Bicyclists only	Accurate when properly installed and configured Uses traditional motor vehicle counting technology	Capable of counting bicyclists only Requires saw cuts in existing pavement or pre-formed loops in new pavement construction May have higher error with groups
Magnetometer	Permanent counts Bicyclists only	May be possible to use existing motor vehicle sensors	Commercially-available, off-the-shelf products for counting bicyclists are limited May have higher error with groups
Pressure sensor/pressure mats	Permanent counts Typically unpaved trails or paths	Some equipment may be able to distinguish bicyclists and pedestrians	Expensive/disruptive for installation under asphalt or concrete pavement
Seismic sensor	Short-term counts on unpaved trails	Equipment is hidden from view	Commercially-available, off-the-shelf products for counting are limited
Radar sensor	Short-term or permanent counts Bicyclists and pedestrians combined	Capable of counting bicyclists in dedicated bike lanes or bikeways	Commercially-available, off-the-shelf products for counting are limited
Video Imaging – Automated	Short-term or permanent counts Bicyclists and pedestrians separately	Potential accuracy in dense, high-traffic areas	Typically more expensive for exclusive installations Algorithm development still maturing
Infrared – Active	Short-term or permanent counts Bicyclists and pedestrians combined	Relatively portable Low profile, unobtrusive appearance	Cannot distinguish between bicyclists and pedestrians unless combined with another bicycle detection technology Very difficult to use for bike lanes and shared lanes May have higher error with groups

(Source: FHWA TMG, Table 4-1)

Table 2 – Comparison of technologies for counting pedestrians and bicyclists (continued)

Technology	Typical Applications	Strengths	Weaknesses
Infrared – Passive	Short-term or permanent counts Bicyclists and pedestrians combined	Very portable with easy setup Low profile, unobtrusive appearance	Cannot distinguish between bicyclists and pedestrians unless combined with another bicycle detector Difficult to use for bike lanes and shared lanes, requires careful site selection and configuration May have higher error when ambient air temperature approaches body temperature range May have higher error with groups Direct sunlight on sensor may create false counts
Pneumatic Tube	Short-term counts Bicyclists only	Relatively portable, low-cost May be possible to use existing motor vehicle counting technology and equipment	Capable of counting bicyclists only Tubes may pose hazard to trail users Greater risk of vandalism
Video Imaging – Manual Reduction	Short-term counts Bicyclists and pedestrians separately	Can be lower cost when existing video cameras are already installed	Limited to short-term use Manual video reduction is labor-intensive
Manual Observer	Short-term counts Bicyclists and pedestrians separately	Very portable Can be used for automated equipment validation	Expensive and possibly inaccurate for longer duration counts

(Source: FHWA TMG, Table 4-1)

Table 3 – Comparison of count technologies: user and site characteristics

Table 3-1. Comparison of common pedestrian and bicycle counting methods: user characteristics and site characteristics.

Characteristic	Passive Infrared	Active Infrared	Pneumatic Tubes	Inductive Loops	Piezoelectric Sensor	Passive IR + Inductive Loops	Radio Beam (One Frequency)	Radio Beam (High/Low Frequency)	Automated Video[1]	Manual Counts[2]
Type of users counted										
All facility users	Yes	Yes				Yes	Yes	Yes	Yes	Yes
Pedestrians only						Yes		Yes	Yes	Yes
Bicycles only			Yes	Yes	Yes	Yes		Yes	Yes	Yes
Pedestrians vs. bicycles						Yes		Yes	Yes	Yes
Bicycles vs. automobiles			Yes	Yes					Yes	Yes
Characteristics collected										
Different user types						Yes		Yes	Yes	Yes
Direction of travel[3]	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
User characteristics[4]									Yes	Yes
Types of sites counted										
Multiple-use trail segments	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sidewalk segments	Yes	Yes				Yes	Yes	Yes	Yes	Yes
Bicycle lane segments			Yes	Yes	Yes				Yes	Yes
Cycle track segments		Yes	Yes	Yes	Yes			Yes	Yes	Yes
Shared roadway segments			Yes	Yes					Yes	Yes
Roadway crossings (detect from median)[5]		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Roadway crossings (detect from end of crosswalk)									Yes	Yes
Intersections (identify turning movements)										Yes

Notes:

(1) Existing "automated video" systems may not use a completely automated counting process; they may also incorporate manual data checks of automated video processing.
(2) Includes manual counts from video images
(3) Technologies noted as "Yes" have at least one vendor that uses the technology to capture directionality.
(4) User characteristics include estimated age, gender, helmet use, use of wheelchair or other assistive device, pedestrian and bicyclists behaviors, and other characteristics.
(5) Roadway crossings at medians potentially have issues with overcounting due to people waiting in the median. Median locations were not tested during this project.

(Source: NCHRP Report 797, Table 3-1)

Table 4 – Comparison of count technologies: volume, width, and duration capabilities

Table 3-2. Comparison of common pedestrian and bicycle counting methods: volume, width, and duration capabilities.

Characteristic	Passive Infrared	Active Infrared	Pneumatic Tubes	Inductive Loops	Piezoelectric Sensor	Passive IR + Inductive Loops	Radio Beam (One Frequency)	Radio Beam (High/Low Frequency)	Automated Video[1]	Manual Counts[2]
User volume[3]	++	+++	++	++	+	++	++	++	+++	++
Detection zone width[4]	++	+++	+	++	++	++	++	+	+++	+++
Count duration[5]	+++	+++	++	+++	+++	+++	+++	+++	+	+

Notes:

(1) Existing "automated video" systems may not use a completely automated counting process; they may also incorporate manual data checks of automated video processing.

(2) Includes manual counts from video images

(3) +: provides consistent counts (although some accuracy adjustment may be necessary) up to approximately 200 users per hour, ++: up to 600 users per hour, +++: beyond 600 users per hour. These are approximate ranges under typical conditions. The range also depends on specific characteristics (e.g., average user group size, mix of pedestrians and bicyclists, detection zone width). The maximum user volume range for manual counts assumes a single data collector is counting one type of user and no additional characteristics. Multiple manual data collectors can count more than 600 users per hour. Counts can be adjusted at user volumes above these levels.

(4) +: typical detection zone width narrower than 4 meters (13 feet), ++: narrower than 6 meters (20 feet), +++: 6 meters (20 feet or wider). In the case of automated video and manual counts, the detection width may be 25 meters (82 feet) or wider.

(5) +: typically used for 48 hours or less, ++: typically used for non-permanent short-or longer-term counts, +++: often used for permanent count sides. Most inductive loops are installed in the pavement, but there are also varieties that can be installed on the top of the pavement for up to 6 months.

Includes

(Source: NCHRP Report 797, Table 3-2)

Table 5 – Comparison of count technologies: resources

Table 3-3. Comparison of common pedestrian and bicycle counting methods: resources.

Characteristic	Passive Infrared	Active Infrared	Pneumatic Tubes	Inductive Loops	Piezoelectric Sensor	Passive IR + Inductive Loops	Radio Beam (One Frequency)	Radio Beam (High/Low Frequency)	Automated Video[1]	Manual Counts[2]
Equipment cost[3]	$$	$$$	$$	$$	$$	$$$	$$$	$$$	$$	$
Preparation cost[4]	$$	$$	$$	$$$	$$$	$$$	$$	$$	$$	$
Installation time[5]	🕐	🕐🕐	🕐	🕐🕐🕐	🕐🕐🕐	🕐🕐🕐	🕐🕐	🕐🕐	🕐	N/A
Hourly cost[6]	$	$	$$	$	$	$	$	$	$$$	$$$$
Data collector training time[7]	🕐	🕐	🕐	🕐	🕐	🕐	🕐	🕐	🕐	🕐🕐🕐
Mobility[8]	+++	++	+++	-	-	-	++	++	+++	+++
Pavement cuts	No	No	No	Yes	Yes	Yes	No	No	No	No

Notes: N/A: not applicable

This table presents generalized information specific to particular counting technologies. Other aspects of counting products, such as battery life and communication interfaces, are also important to consider but are highly vendor-specific.

(1) Existing "automated video" systems may not use a completely automated counting process; they may also incorporate manual data checks of automated video processing.

(2) Includes manual counts from video images

(3) $: equipment (not including permitting and installation) typically costs less than $1,000 as of 2013, $$: typically costs between $1,000 and $3,000, $$$: typically costs more than $3,000. The cost of most counting technologies is subject to economies of scale, so the site cost can be reduced by purchasing more counters.

(4) Fewer dollar signs ($) indicate that it takes less time (and therefore fewer financial resources) to find an appropriate site and to obtain any required permits to install the counting product. Preparation can range from less than one day for manual counts to several months for technologies with more restrictive installation requirements.

(5) More clocks are given to methods that require more installation time (e.g., cut pavement, secure the data logger, test and adjust the equipment). Installation can range from no time for manual counts and less than 30 minutes for passive infrared to more than a half day for inductive loops.

(6) More dollar signs ($) indicate that the method is costlier for an average hour of counts, given the typical count duration for a particular method. These costs can range from a few cents per hour for automated technologies (the full equipment, preparation, and installation cost is spread across months of counts) to more than $50 per hour or manual counts (including training preparation time, management, and on-site labor costs).

(7) More clocks indicate that more time is needed to prepare field data collectors to implement the counting method. A single data collector can be trained how to install or download data from a particular automated technology in less than 30 minutes, but it often takes more than one hour to thoroughly train data collectors to collect accurate manual counts.

(8) More plusses (+++) indicate that a counting technology is easier to move after it has been installed. A minus sign (-) indicates that the technology is generally not intended to be used in more than one location based on the installation being permanent.

(Source: NCHRP Report 797, Table 3-3)

Table 6 – Accuracy of counting technology for pedestrians and bicyclists

Table S-2. Counting Technology Key Findings: Combined Results from Phases 1 and 2

Technology	Mode	Research Phase	APD	AAPD	WAPD	*r*	N	Average Hourly Volume
Passive infrared	C	1, 2	−3.5%	22.5%	−9.5%	0.938	398	258
Product A	C	1	8.7%	22.2%	−1.6%	0.949	244	279
Product B	C	1	−26.0%	26.4%	−27.0%	0.982	115	263
Product C	C	2	−13.5%	13.5%	−13.6%	0.988	39	113
Active infrared	C	1	−6.6%	7.3%	−7.6%	0.998	34	327
Thermal imaging camera	B, P	2	5.5%	22.5%	2.7%	0.912	28	101
Bicycle–specific tubes	B	1	−19.8%	22.2%	−17.1%	0.979	262	167
Product A	B	1	−9.5%	10.8%	−11.1%	0.993	172	203
Product B	B	2	−69.1%	69.1%	−59.6%	0.841	47	117
Product C	B	2	−7.3%	16.6%	−9.4%	0.920	43	76
Standard tubes	B	2	−15.2%	17.1%	−17.9%	0.936	17	62
Radar	B, P	1	22.7%	27.8%	14.2%	0.918	31	72
Surface inductive loops	B	1	3.8%	10.5%	4.8%	0.959	136	155
Embedded inductive loops	B	1	0.3%	7.6%	−3.1%	0.997	29	145
Surface inductive loops (facility counts)	B	1	139.5%	159.7%	−11.5%	0.971	136	183
Embedded inductive loops (facility counts)	B	1	−10.8%	49.6%	−35.3%	0.980	66	186
Piezoelectric strips	B	1, 2	−4.0%	4.5%	−4.1%	0.995	120	105
Product A	B	1, 2	−3.4%	3.7%	−3.4%	0.997	81	112
Product B	B	2	−5.2%	6.1%	−5.8%	0.994	39	91
Radio beam	C	1	−9.6%	9.7%	-11.1%	0.991	56	321

Notes: Mode: B = bicycle, C = combined bicycle and pedestrian, P = pedestrian
APD = average percentage deviation, AAPD = average of the absolute percent difference, WAPD = weighted average percentage deviation, r = Pearson's Correlation Coefficient, N = number of hours evaluated, Average volume = hourly average pedestrian and bicycle counts based on video observation.

Facility count statistics reflect both errors inherent to the counting device or technology, and bypass errors (i.e., missed detections due to bicyclists traveling outside the devices' detection area).

[1]A negative APD indicates undercounting of device.

[2]AAPD weights overcounting and undercounting as absolute percentages.

[3]WAPD accounts for the low-volume bias of the AAPD measure by weighting the AAPD based on the ground truth volume.

[4]Values of Pearson's r closer to +1 indicate a stronger positive correlation.

(Source: NCHRP Web-Only Document 229: Methods and Technologies for Pedestrian and Bicycle Volume Data Collection: Phase 2, http://www.trb.org/Main/Blurbs/175860.aspx)

Table 7 – Maricopa Association of Governments count technology summary

TABLE 5
Summary of Bicycle Counting Technologies

Count Methodology	Accuracy	Cost	Other Considerations
Manual Counts	Depends on training and experience (1% - 25% subject to human error)	High (depending on duration of counts)	– Few equipment costs; – Labor intensive, requires trained observers; – Impractical for long-term counts; Comprehensive applications; – Directional counts possible.
Video (manual analysis)	High (subject to human error)	High (depending on duration of counts)	– Costs of video camera installation and operation; – Labor Intensive; – Can capture some user characteristics; – Directional counts possible.
Active Infrared (can detect speed of traveler, and therefore estimate mode)	Systematic Undercounting (5% - 15% due to clusters of people)	Low	– Portable; – Visual obstructions may affect counts; – Can provide long-term counts; – Directional counts possible??
Passive Infrared (cannot detect speed of traveler, and therefore no modal information)	Systematic Undercounting (5% - 50% due to clusters of people)	Low	– Widely tested and available; – Directional counts possible. – What about long-term counts??
Computer Visioning	Depends on Computer Algorithms	Medium	– Well suited for crowded environments; – Costs of video camera installation; – Requires greater sophistication for analysis.
Inductive Loops	Varies depending on installation and maintenance of system	Depends on location of installation	– Directional counts possible if maintained; – Can provide long-term counts; – Difficult to use in shared lanes.
Pneumatic Tubes (commonly used to count cars)	High	Depends on location of installation	– Requires trained personnel; – Can provide long-term counts; – Can provide estimates of speed; – Poses problems for skaters on paths.

(Source: Chen Ryan Associates, Bicycle Counting Technology Review: Working Paper #2, MAG Bicycle Count Project, June 5, 2013)

4. CURRENT ADOT COUNT CAPABILITIES

Input on the current mechanisms and technologies used to collect pedestrian and bicycle data was solicited from ADOT.

The Regional Traffic Engineer for ADOT's Central District, Tony Abbo, provided the following input on bicycle and pedestrian data collection:

- The Central District collects bicycle and pedestrian data only rarely. Mr. Abbo estimated that approximately 10 data collection efforts were undertaken during the most recent 12-month period.
- Mr. Abbo estimated that about 20 percent of bicycle and pedestrian count efforts conducted by the Central District involved "full-day" data collection, whereas the majority collected data for only two hours at a time.
- Either pedestrian or bicycle volume, or both, are collected depending on the issue under study.
- When bicycle or pedestrian data is needed, the Central Region collects the data manually using staff. Contractors are not used because of the added expense.
- The most common reasons for collecting pedestrian and bicycle data include:
    - Evaluating existing signalized intersections to restrict right turns on red
    - Evaluating unsignalized intersections to determine if a signal is warranted based on pedestrian or bicycle volume
    - Evaluating a safety concern raised by a resident
- Developers have not been required to submit pedestrian and bicycle volume data in conjunction with their development submittals.
- Once collected, pedestrian and bicycle data is not stored in a centralized electronic database but is available in association with other information related to the project or issue at hand.

As the Central District comprises the Phoenix metropolitan area and is the most heavily populated and urbanized region in the state, its needs for bicycle and pedestrian data are likely representative of most ADOT Districts.

One of ADOT's Traffic Signal Engineers, Karim Rashid, indicated that pedestrian and bicycle demand data are not usually collected, except during traffic studies related to specific projects, such as traffic signal or pedestrian hybrid beacon warrant studies. Mr. Rashid is not aware of any data collection methods except manual collection (or a staff member manually monitoring a video of the site).

The Traffic Design Manager in ADOT's Traffic Engineering Group, Scott Orrahood, concurred that pedestrian counts are taken only in conjunction with projects, but added that ADOT's Traffic Design Section has never collected bicycle volume data to his knowledge.

According to Michael Sanders, ADOT's Bicycle and Pedestrian Program Coordinator, there is an eco-counter bicycle inductive loop system at milepost 307 on SR 179. The device collected data for approximately five years but recently stopped working because of corrosion on the loop detector.

ADOT did not indicate an ability (or awareness of an ability) to collect pedestrian data using signal infrastructure such as pushbuttons.

5. SUMMARY OF FINDINGS

Section 1 of this Working Paper provided an overview of this research project and its key objectives. Task 2 of the research project is a technology review, which is contained in this Working Paper. Section 1 also indicated that the technology review was focused on proven technologies for counting pedestrians and bicyclists. Other emerging technologies (e.g., smartphone apps, Bluetooth or WiFi readers, etc.) can gather data on a sample of people, but these methods to estimate total counts have not yet been firmly established.

Section 2 of this Working Paper summarized 15 different technologies that may be used to count pedestrians and bicyclists. In some cases, a specific technology may be suitable for only one non-motorized mode (e.g., inductance loops for bicyclists). In other cases, a technology may be able to count all non-motorized users, but may not be able to accurately distinguish between pedestrians and bicyclists (e.g., passive and active infrared). Some technologies are better suited for temporary or short-duration applications rather than permanent continuous operation (e.g., video with manual reduction or manual observers). Some technologies are still being developed for pedestrian and bicyclist applications and may not have a wide choice of manufacturer models that are commercially available.

Section 3 of this Working Paper provided the best available guidance for selecting the most appropriate counting technology. Several selection criteria from the FHWA TMG were listed, as follows:

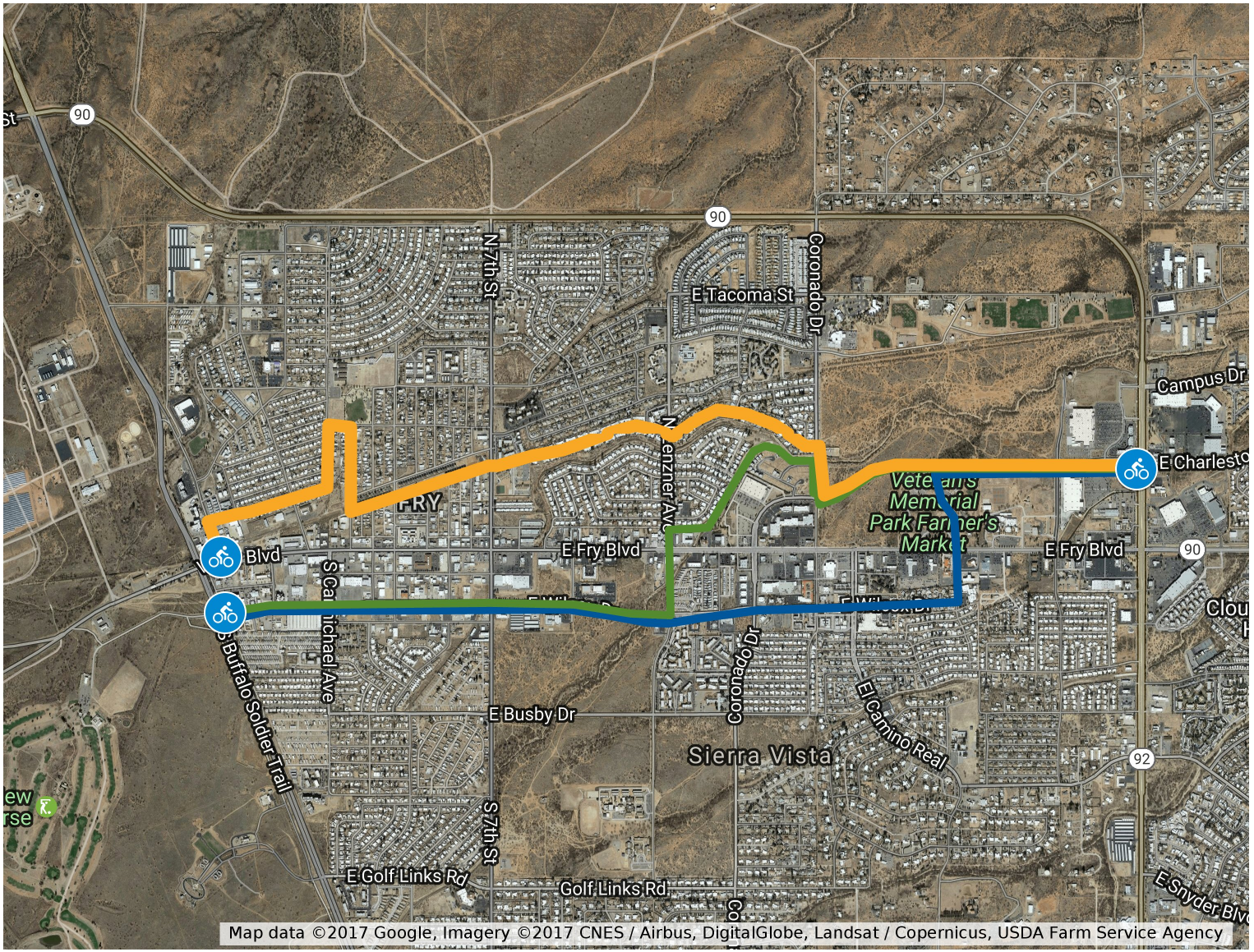
1. What are you counting?
    a. Bicyclists only
    b. Pedestrians only
    c. Pedestrians and bicyclists combined
    d. Pedestrians and bicyclists separately
2. How long are you counting?
    a. Permanent
    b. Temporary or short term
3. What is the life cycle (equipment plus operating/maintenance) cost per amount of data?
4. What technologies are used in common practice?
    a. Is there commercially available equipment for a given technology?

Other relevant technology-based criteria from NCHRP Report 797 were included in **Tables 3, 4, and 5** in Section 3. Accuracy was indicated as an important criterion, but accuracy can vary significantly within a technology type. The most recent accuracy results for different count technologies (available from NCHRP Web-Only Document 229) are shown in **Table 6**; however, no manufacturer or model names are provided for these accuracy results.

Ultimately, the selection of most appropriate technologies for ADOT also may depend on data uses as well as available resources. The selection criteria in Section 3 will be influenced by whether the ADOT data uses are better served by collecting data at more locations for a shorter duration (i.e., temporary placement of count equipment) versus fewer locations but permanent installations. The FHWA TMG recommends the use of permanent counters to annualize short-duration counts. However, there are no definitive guidelines for the balance between permanent versus short-duration counts. The FHWA TMG indicates a "…rule of thumb of three to five continuous count locations should be installed for each distinct factor group (based on trip purpose and seasonality)." The next task in this project (Task 3) will address these issues in developing a data collection methodology and plan.

East/West Bicycle Route

Option 1

Option 2

Option 3