Tahoe Regional Planning Agency / Tahoe Metropolitan Planning Organization

LAKE TAHOE REGION BICYCLE AND PEDESTRIAN MONITORING PROTOCOL

June 2015

Prepared for:

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MOVING**FORWARD**THINKING™

Tahoe Regional Planning Agency / Tahoe Metropolitan Planning Organization

Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol

Final

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GLOSSARY OF SPECIALIZED TERMINOLOGY

Automatic Counter: A count device that can detect and record bicycle and/or pedestrians in a continuous manner.

Manual Count: A count that requires an individual to record bicycles or pedestrians.

Video Observations: Counts that record data by camera and process and summarize at a later date.

Continuous Counts: Counts using an automated device that is in place 24 hours a day, 365 days a year.

Monitoring Criteria: Criteria used to select sites to be monitored.

Screenline Count: Counts that record the number of vehicles, bicycles, or pedestrians that cross a line across a facility.

Intersection Count: Counts that record the number of vehicles, bicycles, or pedestrians that enter an intersection and the turning movement made within the intersection.

Adjustment/Extrapolation Factor: A mathematical multiplier or equation that is applied to count data to adjust or extrapolate the data to represent count data over a different time period or under different conditions (e.g., different weather or land use context).

Correction Factor: A mathematical multiplier or equation applied to count data to correct for systematic error from an automatic count device.

Systematic Error: In the context of data collection, error that is inherent to the way that the data is collected.

Factor Group: A factor group defines count locations that display similar patterns of activity, such as a commuter route or a recreational route.

Section 1
Monitoring Protocol Purpose

MONITORING PROTOCOL PURPOSE

INTRODUCTION: INDICATOR SELECTION RATIONALE

Motor vehicle traffic volume data have been an integral part of transportation planning and engineering since their emergence as professions, and motor vehicle volume monitoring and estimation efforts have evolved into complex and comprehensive programs across the United States. In comparison, relatively few systematic bicycle and pedestrian monitoring programs have been established. As a result, little is known about bicycle and pedestrian activity and travel patterns relative to motor vehicles. Similarly, there are few established guidelines for bicycle and pedestrian monitoring programs. Consequently, basic information that could allow better tracking of active transportation use, greater understanding of bicycle and pedestrian safety and risk, and improved evaluation of bicycle and pedestrian improvements is often lacking or missing entirely. In order to build on previous bicycle and pedestrian monitoring efforts and improve the understanding of active transportation within the Lake Tahoe Region, Tahoe Regional Planning Agency/Tahoe Metropolitan Planning Organization (TRPA/TMPO) has developed the Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol to establish a clear and consistent approach to collecting bicycle and pedestrian volume data within the Region.

PURPOSE

By implementing the Bicycle and Pedestrian Monitoring Protocol, TRPA/TMPO is building on prior bicycle and pedestrian monitoring efforts to create an on-going monitoring program to track changes in bicycle and pedestrian volumes in a consistent manner. The monitoring protocol seeks to provide clear guidelines for bicycle and pedestrian volume data collection by establishing:

1. **Monitoring Criteria**: the protocol establishes criteria to be used by TRPA/TMPO in establishing initial and future bicycle and pedestrian monitoring locations; and,

2. **Data Collection Procedures**: the protocol establishes the procedures to be used by TRPA/TMPO and any partner jurisdictions, organizations, or firms when collecting bicycle or pedestrian volume data.

The data collected as part of this annual program can be used for a variety of purposes. This may include:

- evaluation and prioritization of bicycle and pedestrian projects (before and after studies);

- analyzing bicycle and pedestrian safety by establishing exposure (crashes per unit of volume) and risk (the likelihood of a collision or injury), as well as helping prioritize bicycle and pedestrian safety improvements (such as improved intersection crossings);

- tracking overall utilization trends of bicycle and pedestrian facilities as indicators or benchmarks relative to the bicycle and pedestrian goals in TRPA/TMPO and its member agencies' plans and programs including the 2010 Lake Tahoe Bicycle and Pedestrian Plan, the Mobility 2035 Regional Transportation Plan, and future benchmarks established in the on-going Linking Tahoe: Active Transportation Plan; and,

- integration of bicycle and pedestrian monitoring data into evaluation and analysis methods that quantify the benefits of active transportation. This could include integration into the Transportation Mobility Conceptual Model, shown in **Error! Reference source not found.** on the next page.

GOALS

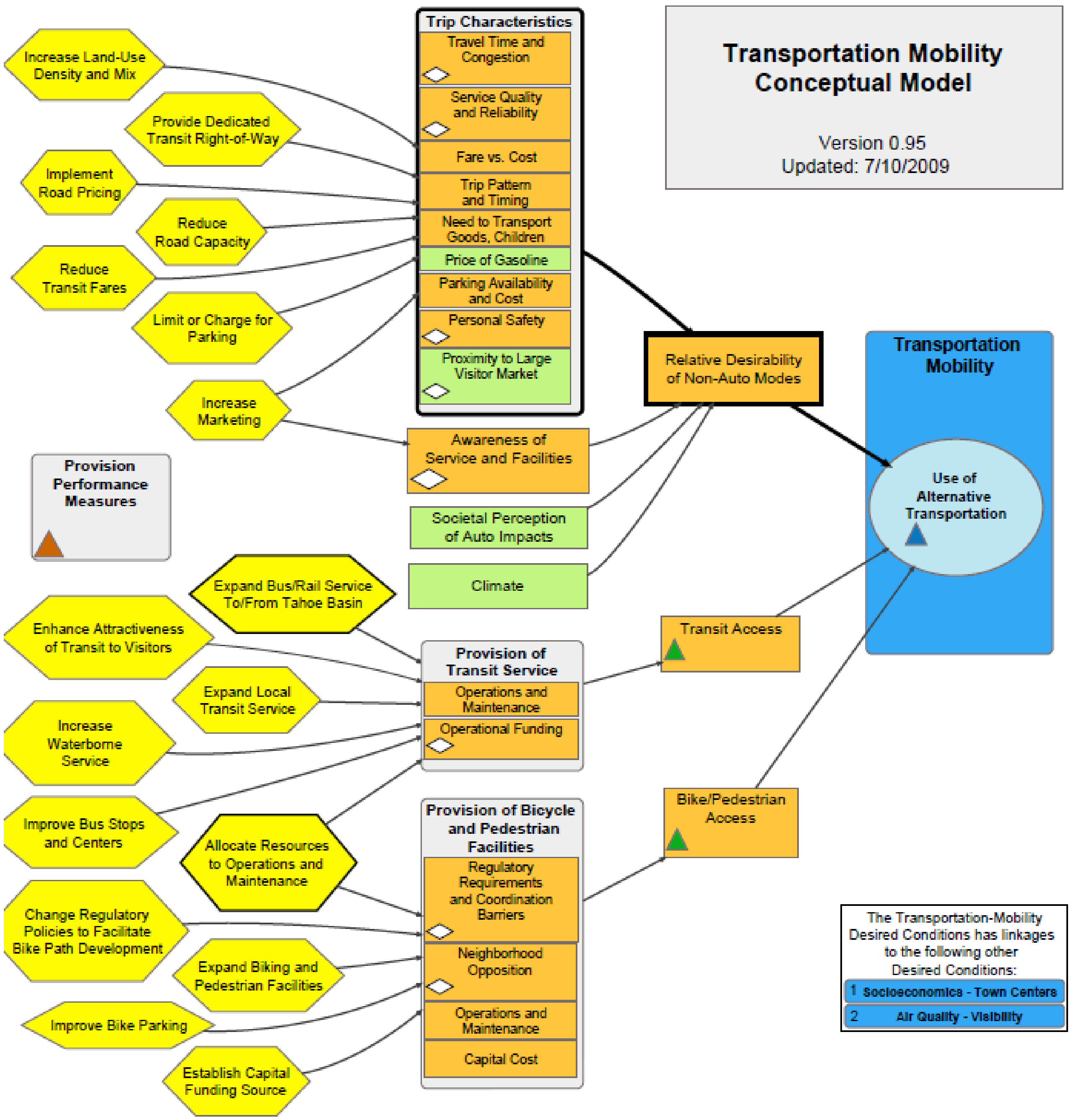
There are three primary goals that the Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol is designed to achieve:

- Create an easy to implement monitoring program for bicycle and pedestrians.

- Assist TRPA in the tracking of bicycle and pedestrian trends and benchmarks, including evaluating current and future bicycle and pedestrian improvement projects' effectiveness.

- Provide a regional resource for bicycle and pedestrian data collection practices, encourage the integration of the protocol with local jurisdictions in the Lake Tahoe Region, and create a regional clearinghouse for bicycle and pedestrian count data.

Figure 1. Transportation Mobility Conceptual Model



Section 2
Synthesis of Research Findings

SYNTHESIS OF RESEARCH FINDINGS

HISTORIC CHANGES IN MONITORING PROGRAM

TRPA/TMPO has published four prior bicycle and pedestrian monitoring reports. The most recent monitoring report was completed in 2013. The 2013 Lake Tahoe Basin Bicycling and Walking Monitoring Report measured the level of non-motorized activity on several shared-use paths around the Lake Tahoe Region using three passive infrared monitors. The 2013 report also documented trends in path activity using data from the 2009 monitoring report. The 2009 report included pedestrian and bicyclist manual counts on a series of paths around Lake Tahoe and also presented bicycle/pedestrian intercept survey results performed near the Camp Richardson Resort. Comparison of the 2009 and 2013 count data and survey results allowed inferences of path usage trends and user behavior to be made. The first two iterations of the report, in 1997 and 2007, included surveys to determine whether active transportation projects and programs were working as intended to reduce automobile dependency and encouragement of active transportation.

HISTORIC COUNT EFFORTS

TRPA/TMPO and other jurisdictions and organizations have also collected bicycle and pedestrian counts for various project efforts. In 2014, the Tahoe City Public Utility District (TCPUD) collected screenline counts on the Lakeside Trail and at three other trail locations. The Lake Tahoe Unified School District for the South Tahoe Middle School Area Connectivity Plan, a project funded by TRPA/TMPO's On Our Way grant program, also collected intersection counts of bicycles and pedestrians at intersections near the Middle School. Beyond these recent counts, additional historic counts have been collected by the TRPA/TMPO, TCPUD, the City of South Lake Tahoe, and TCORP dating back to 1994.

A summary matrix of the historic count information is provided in Appendix 1.

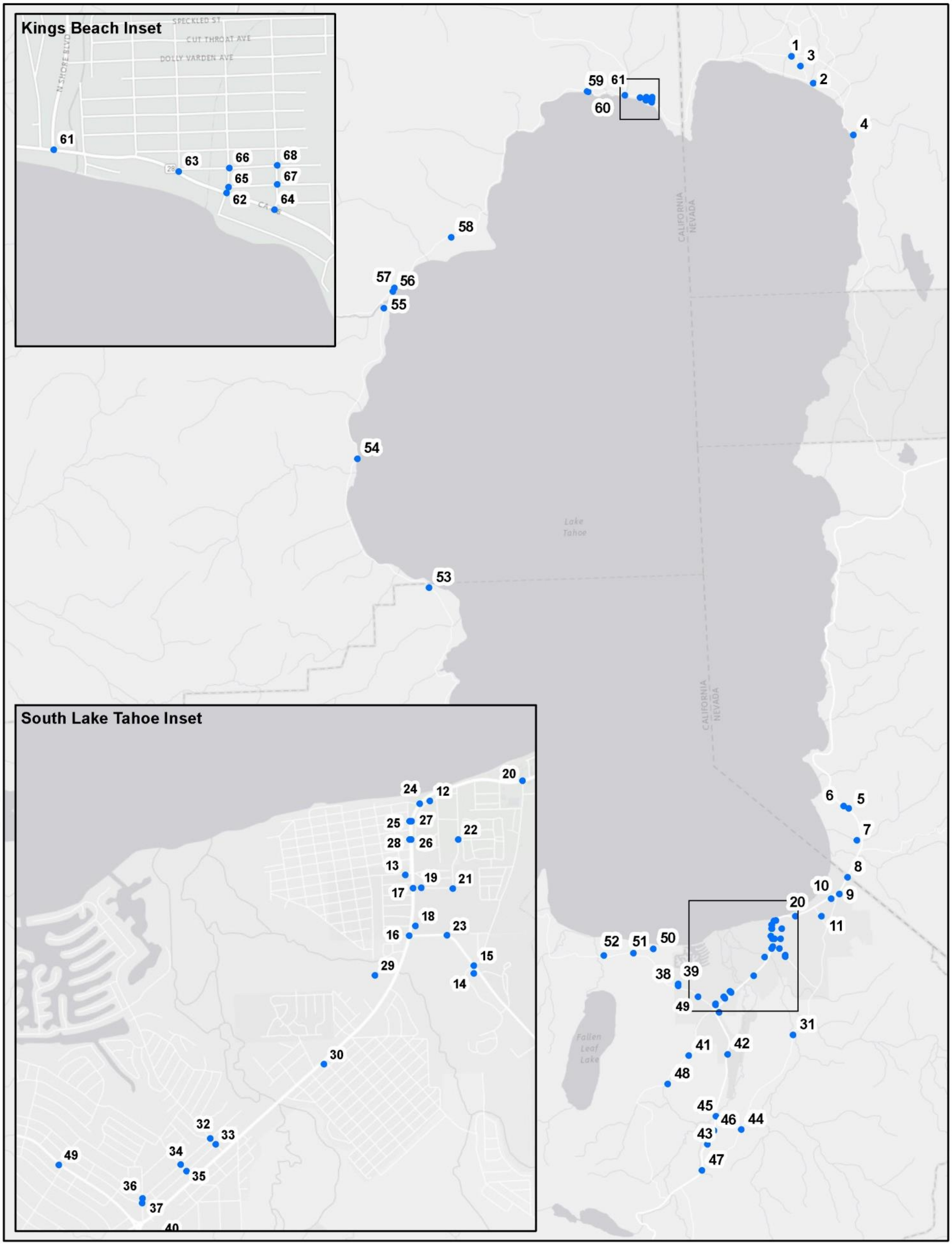
HISTORICAL INDICATOR STATUS AND TREND

As part of establishing the history of bicycle and pedestrian monitoring in the Lake Tahoe Region, historic counts were documented and mapped. Additionally, historic count data was analyzed against the most recent available counts (2014) to track changes and establish trends in bicycle and pedestrian volumes over time. The results of this review and analysis are provided below.

Historic Count Data

As part of TRPA/TMPO's and partnering agencies' historic bicycle and pedestrian monitoring efforts, a total of 62 sites have been used to collect bicycle and pedestrian volumes. Figure 2 shows a map of all of the historic count locations.

Figure 2. Historic Count Locations



Based on the most recent 12-hour screenline bicycle and pedestrian counts collected by TCPUD at the Lakeside Trail, Truckee River Trail, North Shore Trail and West Shore Trail in 2014, historic trends in bicycle and pedestrian volumes are summarized below.

The four locations, including their average a.m., p.m., daily volumes as well as the peak hour at each location are shown in Table 1.

Table 1. 2014 Bicycle and Pedestrian Mid-Week Screenline Count Summary

Location	Mid-Week Morning Peak Hourly Average (7 - 9a.m.)	Mid-Week Evening Peak Hourly Average (4 - 6p.m.)	Mid-Week Daily Average Volume	Peak Hour, Mid-Week
Truckee River Trail	20.5	83.5	83.8	1:00 – 2:00p.m.
Lakeside Trail	31.5	232.5	133.4	4:00 – 5:00p.m.
North Shore Trail	23.5	49.5	59.6	1:00 – 2:00p.m.
West Shore Trail	23.5	31	37.8	12:00 – 1:00p.m.

Source: TRPA/TMPO.

Figure 3 shows the four 2014 screenline volumes over the course of a 12-hour mid-week day (Tuesday – Thursday from 7 a.m. to 7 p.m.). The high afternoon/evening peak on the Lakeside Trail is an indication that the path is used for evening commuting or a special event occurring during the counts that increased the evening peak hour count at this location, while the other three locations show typical recreational patterns with peaks occurring in the early afternoon.

Figure 3. 2014 Full Day Hourly Counts (Mid-Week)

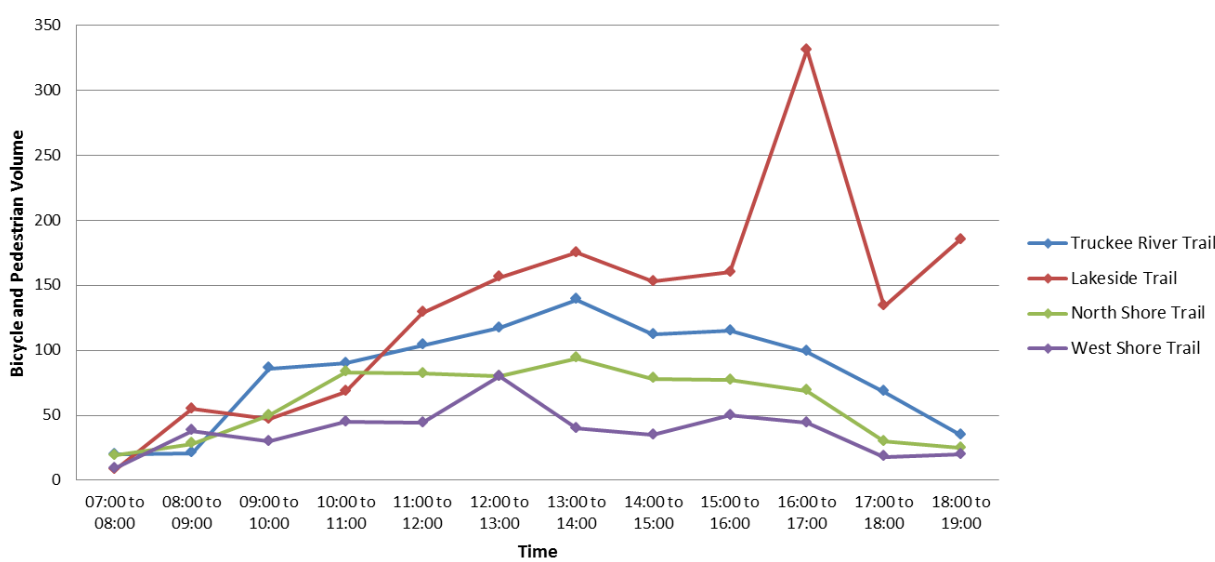


Figure 4 shows the daily (7 a.m. to 7 p.m.) bicycle and pedestrian volumes at the four 2014 count locations. Figure 5 provides the average hourly bicycle and pedestrian volumes at each of the sites.

Figure 4. 2014 Daily Bicycle and Pedestrian Volumes (Mid-Week)

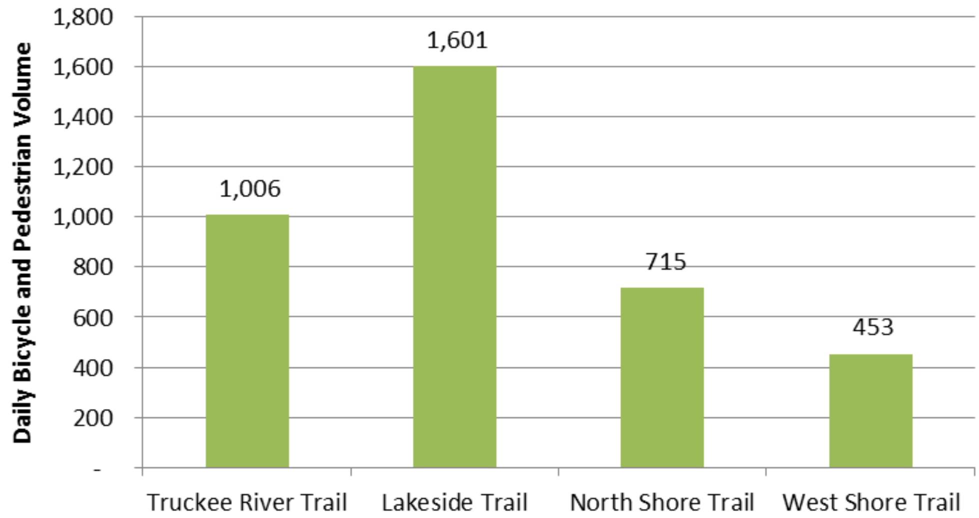
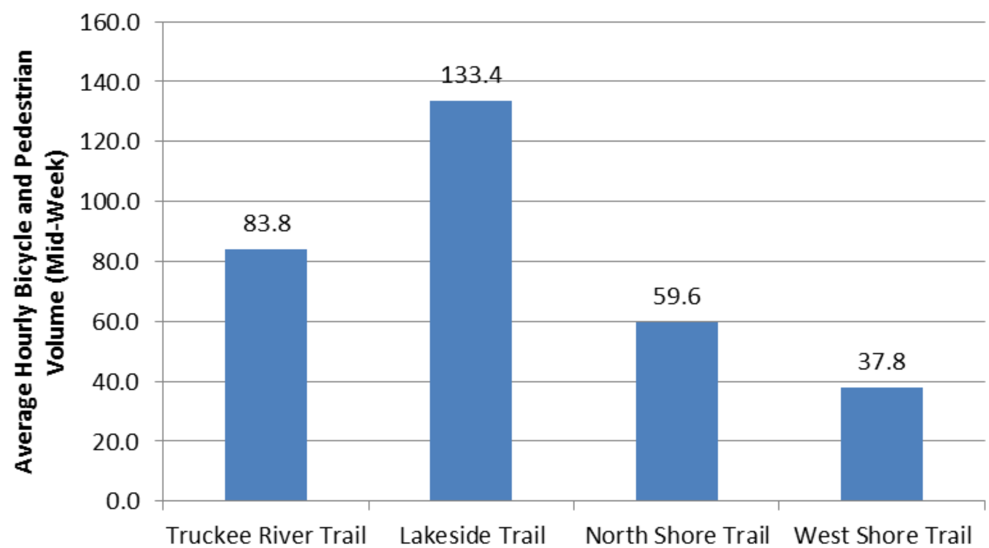


Figure 5. 2014 Average Hourly Bicycle and Pedestrian Volumes (Mid-Week)



In addition to the counts conducted in 2014, TCPUD has historic counts at three other trail locations.

Figure 6 shows the total daily bicycle and pedestrian volumes on each trail for the years data are available from 1994 to 2014.

Figure 6. Daily Bicycle and Pedestrian Volume Comparison (Mid-Week, 1994-2014)

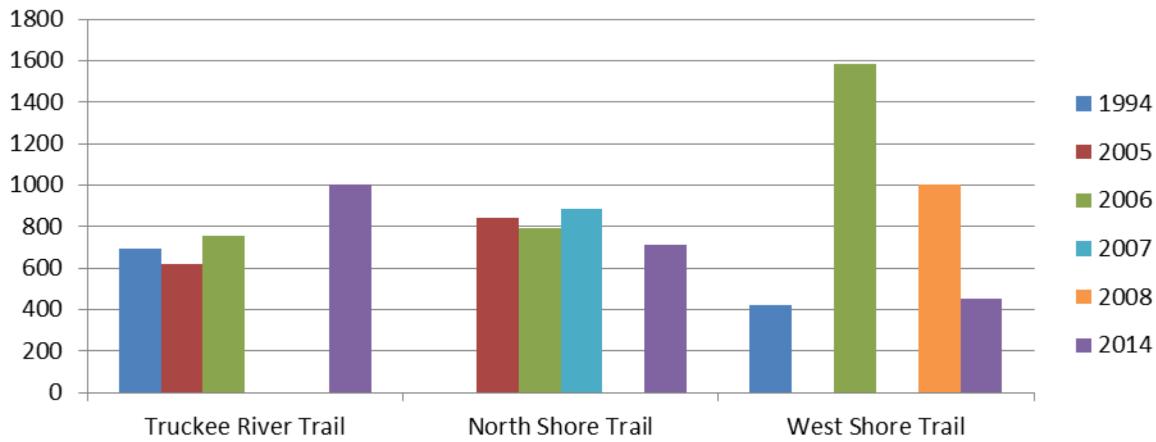


Figure 7. Average Trail Count Location Hourly Volumes by Year (Mid-Week)

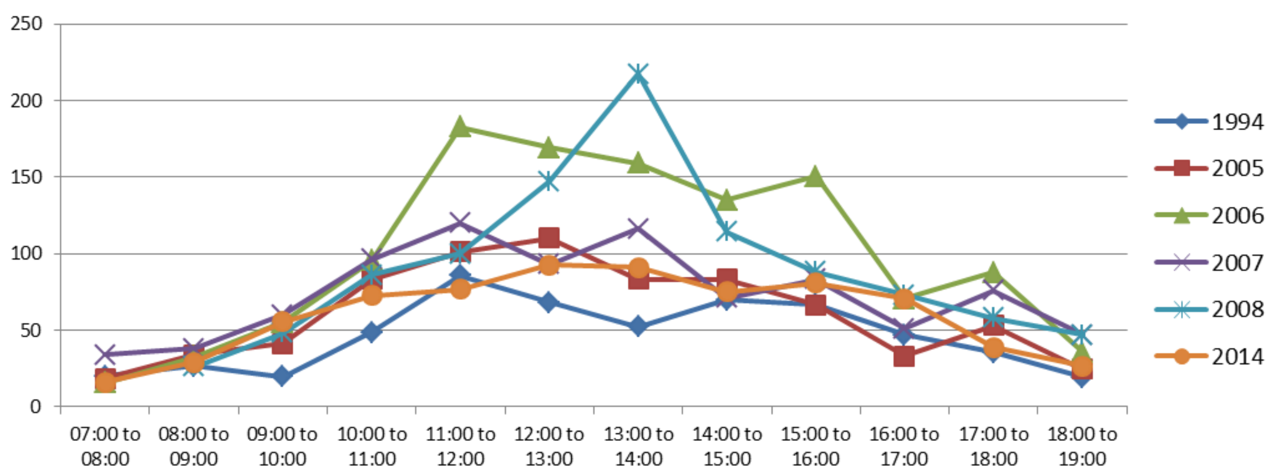
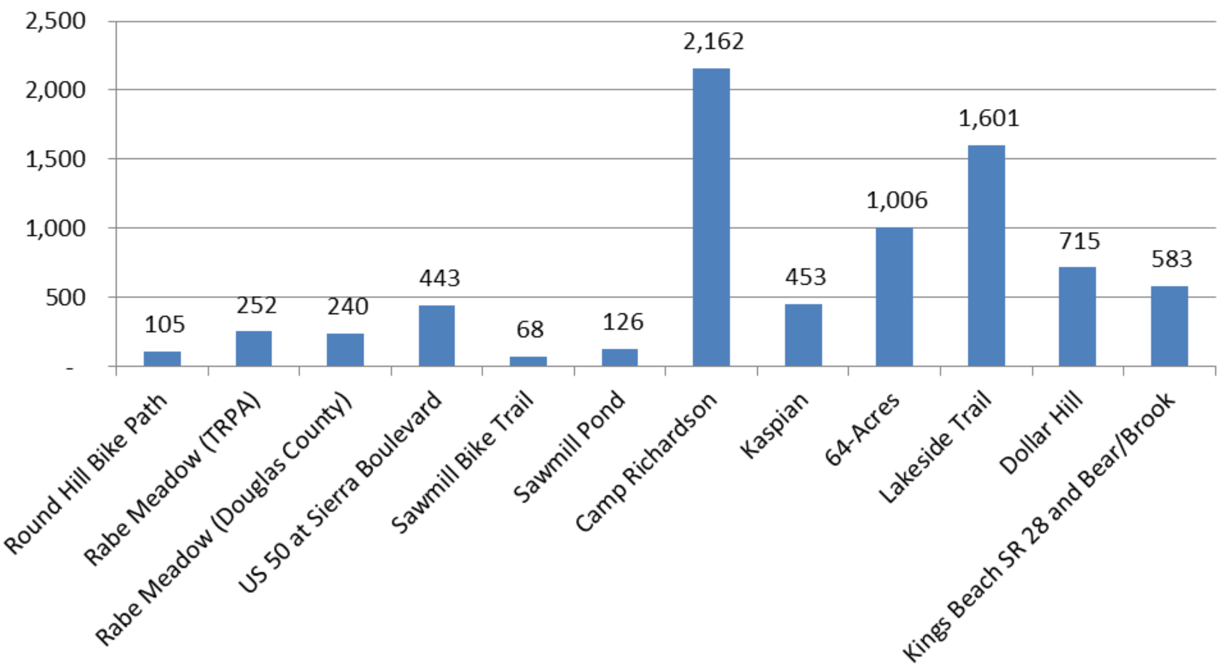


Figure 7 shows the average hourly volumes for data collected at the three trail count locations between 1994 and 2014 (Truckee River, North Shore, and West Shore). These data indicate that average volumes have remained relatively stable but with 2006 and 2008 having higher mid-day average hourly volumes than other years. This increased activity may represent fluctuations in bicycle volumes over time or could be due to variations in the time of year collected, the weather during the days of collection, or special events occurring during the count periods.

In addition to the counts collected in 2014, TRPA/TMPO and its member jurisdictions have collected 12-hour counts (7 a.m. to 7 p.m.) at a number of locations. Figure 8 shows the total volume of bicyclists and pedestrians for the twelve locations where 12-hour counts have been conducted in the Region between 2012 and 2014.

Figure 8. 12-Hour Count Volumes, 2012-2014



In addition to the 12-hour counts, the peak hour usage at a number of locations has been collected since 2009. An estimate of daily usage at each location was calculated by multiplying the observed peak hour by a peak hour factor of 0.14. The peak hour factor was taken from the Bicycle Trail User Model. The results of these estimates are shown in Figure 9.

Figure 9. Estimated Full Day Usage, 2009 - 2014

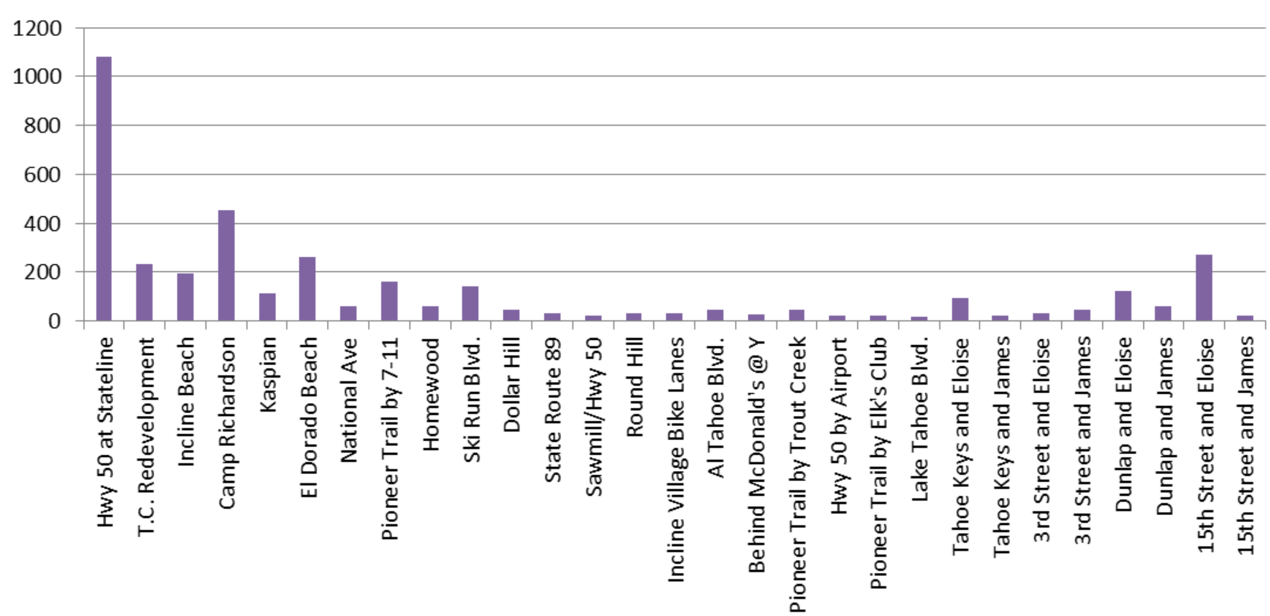
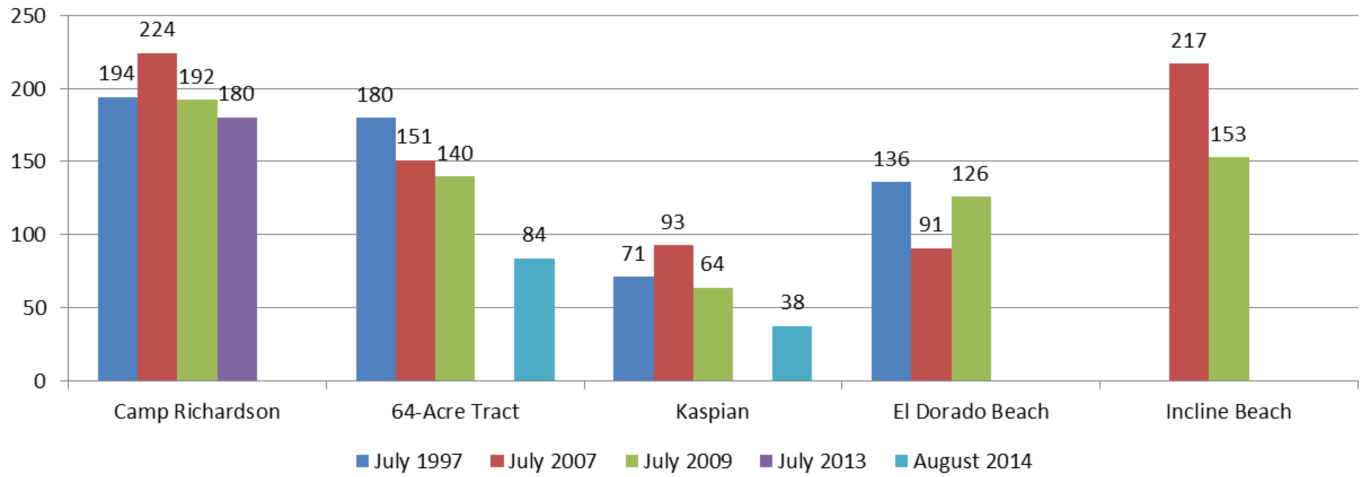


Figure 10 compares sites that were counted in previous years dating back to July 1997 with more recent counts conducted in July 2013 and August 2014. However, not all sites were observed for each year.

Figure 10. Average Hourly Volume Comparison to Past Surveys, 1997 - 2014



Section 3
Monitoring Approach Rationale

MONITORING APPROACH RATIONALE: BICYCLE AND PEDESTRIAN COUNT METHODOLOGIES

PEER REVIEW OF PLANS AND PROTOCOLS

As part of the development of the *Lake Tahoe Bicycle & Pedestrian Monitoring Protocol*, a review of current best practices and research on bicycle and pedestrian monitoring was performed. Based on a review of the current literature and case studies of jurisdictions similar to TRPA/TMPO, the following recommendations for the Protocol were developed:

- Establish key count locations based on locally-determined criteria similar to the Portland Area Comprehensive Transportation System (PACTS) count program, including selected winter count locations;
- Partner with local agencies and transit agencies in the Region for assistance in conducting counts. These agencies could include:
    - City of South Lake Tahoe
    - Douglas County
    - El Dorado County
    - Placer County
    - Tahoe Transportation District
    - Tahoe City Public Utility District
    - Tahoe Area Regional Transit
    - Washoe County
- Partner with local nonprofits following the PACTS example to engage stakeholders and reduce need for initial internal staff time. These could include:
    - Lake Tahoe Bicycle Coalition
    - League to Save Lake Tahoe
    - Sustainability Collaborative – Community Mobility Workgroup
- Develop standardized count forms, training materials, and outreach materials for volunteers to use while collecting counts to increase accuracy and consistency;
- Establish permanent automatic count locations to help develop regional extrapolation factors; and,
- Adjustment factors for the Lake Tahoe Region. These should include but are not limited to:
    - Seasonal and temporal adjustments
    - Trip type adjustments
    - Land use/area type adjustments.

These recommendations have been integrated into the protocol below to facilitate the establishment of a consistent, effective count program while building toward a more robust understanding of bicycle and pedestrian activity in the Lake Tahoe Region.

The full literature review can be found in Appendix 2.

BICYCLE AND PEDESTRIAN COUNT METHODS

Traffic counts are performed one of four ways. The four methods are as follows:

1. screenline;
2. intersection turning movements;
3. occupancy; and,
4. boarding and alighting counts.

Each of these methods is described below.

Screenline Counts

Screenline counts entail establishing a line across a roadway or sidewalk and counting the number of vehicles, bicyclists, and/or pedestrians that cross the line. They are used to determine general use trends for a segment of trail or roadway. Multiple screenlines when strategically placed can provide information on the distribution of travel.

Intersection Turning Movement Counts

Intersection turning movement counts are performed where two or more roadways and/or major driveways meet. At minimum, these counts capture vehicle turning movement counts. Many traffic firms include bicycle turning movements and pedestrian crossing counts for little to no additional cost. Intersection turn movement counts for bicycles and pedestrians are generally performed for operational or safety analyses under peak-hour conditions. The information from a turning movement count can be converted to screenline equivalents for the purpose of analyzing general use trends or making comparisons to screenline count data.

Occupancy Counts

Occupancy counts are typically used to generate parking data. Parking occupancy counts are generally conducted manually using a one-pass method of counting at specified times, although automated systems at parking garages and some on-street parking areas are enabling real-time, continuous occupancy information. Occupancy counts can include both vehicle and bicycle parking.

On-Off Counts

On-off counts are typically applied to count transit passengers who board and alight. On-off counts can also be done to count passengers who board the transit vehicle with their bicycles.

Given that they are the most commonly collected and produce volume data most suitable for the tracking of general use trends and travel behavior, the focus of this manual is on the screenline and intersection turning movement count methods.

BICYCLE AND PEDESTRIAN COUNT TECHNOLOGIES

There are roughly three categories of data collection technologies:

- Manual counts – Human data collectors perform counts in the field, and record results with a writing implement and paper, automated count board, or smartphone application.
- Video observations – Data is recorded by camera and later processed by technicians in a video lab
- Automated counts – Data is collected and stored using an automatic sensor and summarized by downloading reports.

According to NCHRP Project 7-17, *Pedestrian and Bicycle Transportation along Existing Roads*, 54% of agencies use manual counts to collect bicycle data, 24% use video observations, and 22% use automated counters.

A summary of each data collection category, its strengths and potential weaknesses, and specific technologies are described below.

Manual Counts

Counts are usually recorded for one to four hours in discrete time intervals, generally 15 minutes. However, some count boards are also capable of time-stamping all data points. Manual counts can be done in conjunction with automobile counts and have the flexibility to gather additional information desired about travelers, such as directional and turning information, gender, helmet usage (for cyclists), or behaviors, such as use of mobile devices. Manual counts can be performed at screenline, intersection, or midblock locations.

Many jurisdictions currently rely on manual counts taken on an annual basis at strategically chosen and distributed locations, either with the assistance of hired consultants or volunteers. To reduce error, data collectors should be trained so they have a clear understanding of the count methodology. In addition, managers should plan data collection efforts carefully, ensuring that there are enough data collectors at high-volume locations so that each person can do their portion of the counts accurately.

Video Observations

Video observations are closely related to manual counts, in that humans collect the data and use a variety of tools to record the data. However, field data is collected first by camera installed in the field then the information is processed by technicians in a video lab. Technicians review the tape and typically the accuracy of the count increases due to the ability for technicians to rewind/review the recording to ensure counts are conducted properly. Additionally, the recordings allow for supervisors to better conduct quality control. Depending on the recording quality, video data also enables the collection of bicyclist characteristics more readily, such as helmet use and gender. Using cameras can provide a permanent record of the count for future verification and for collecting additional data that was not specified in the original count. It can also record longer periods of observations for which human observers in the field would not be recommended due to fatigue.

Cameras can only capture a limited area as opposed to human field technicians who have a wider visual range. Cameras must be mounted in such a way that maximizes its scope while also maximizing video quality, which can be a challenge in some locations. Cameras are prone to theft and vandalism as well as occasional malfunctions and vary in video quality due to the cameras themselves, mounting procedures, or weather/lighting factors. Additionally, video quality degrades with light attenuation making it only possible to record data during daylight hours unless lighting is provided.

Costs for video observations are typically high compared to automatic count technologies because of the labor costs involved for technicians to install and remove the cameras and for the labor costs to review and verify the observations. If the data is collected by the agency, sufficient budget and time should be set aside to purchase the camera(s) and any required equipment to mount the device, as well as staff time to install, review, and document the recorded observations. Alternatively, many data collection firms use video observations for traffic data collection and can include bicycle and pedestrian counts as well or counted separately. However, as the number of hours for data collection increases, the necessary budget needed to process the video recordings will increase.

Automatic Counts

There is a large array of automatic count technologies that can be used to count bicyclists. A decision flow chart to help determine the need for automatic counters is shown in Figure 9. The following is a summary of each type.

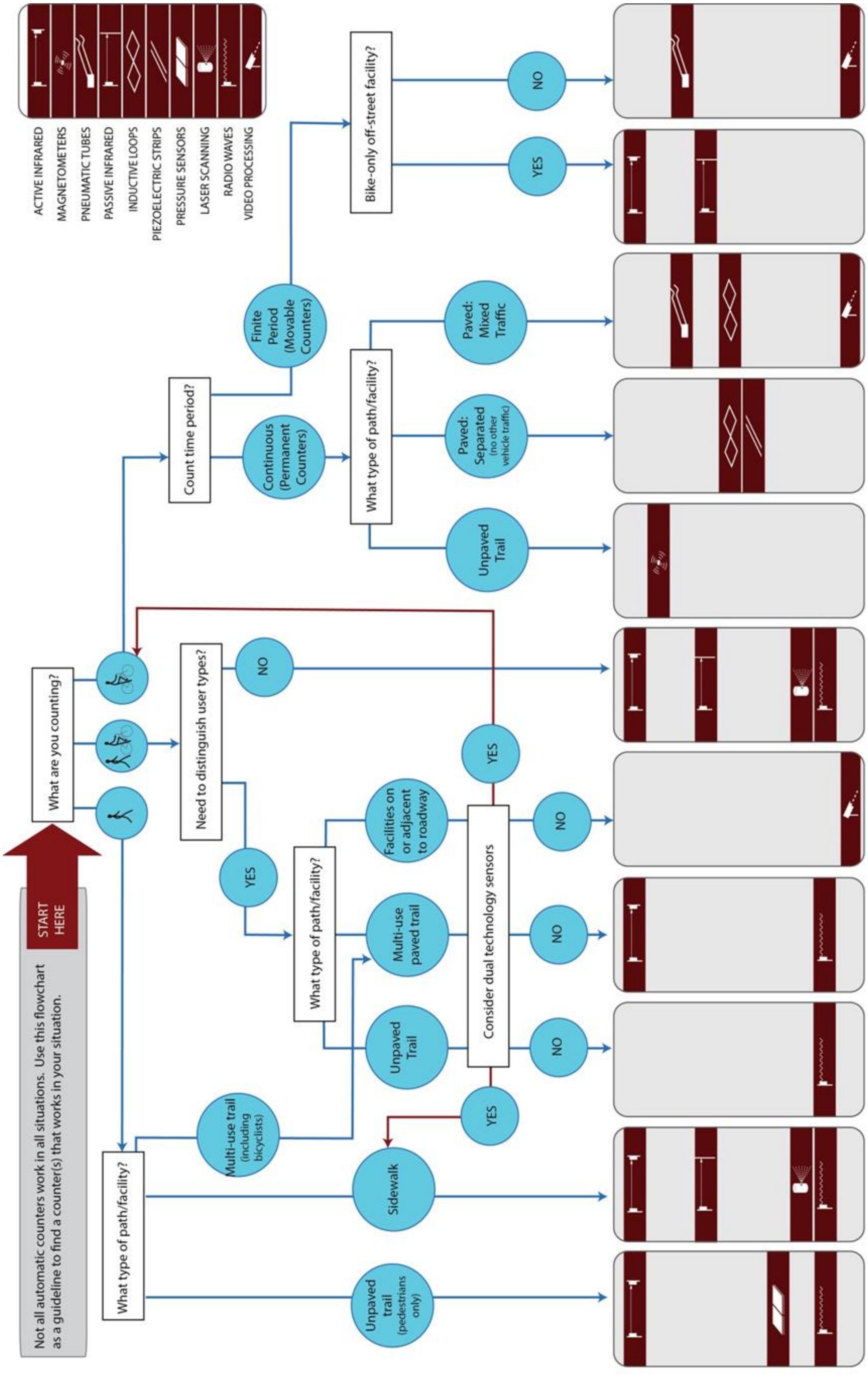
- *Pneumatic tubes:* two rubber tubes are stretched across the right-of-way, and record counts when vehicles and bicycles pass over them.
- *Piezoelectric strips:* material that produces an electric signal when deformed and is laid on or under the ground in two strips.
- *Fiber-optic pressure sensors*: sensors detect changes in the amount of light transmitted through an imbedded fiber-optic cable based on the amount of pressure (weight) applied to the cable.
- *Inductive loop detectors:* wires are installed in or on top of pavement to detect bicycle activity through their disruption of an electromagnetic field.
- *Active infrared:* bicycles are detected when an infrared beam is broken.
- *Passive infrared:* identifies the heat differential of bicyclists or pedestrians when they pass through the detection area.
- *Laser scanning:* laser pulses are sent out in a range of directions and details of the surroundings, including pedestrians and bicyclists, are recorded based on reflected pulses.
- *Radio waves:* detect bicycles when a radio signal between a source and a receiver is broken.
- *Video image processing:* uses visual pattern recognition technology and computerized algorithms to detect bicyclists.
- *Magnetometers:* detect bicycle activity through changes in the normal magnetic field.
- *Radar:* emits radio wave pulses and counts bicyclists based on an analysis of reflected pulses.

A summary of each automatic count technology from the Southern California Association of Governments' *Conducting Bicycle and Pedestrian Counts* report is provided below.

Emerging Technologies

There are a number of other technologies and techniques that are available for gathering bicycle and pedestrian sample data, but they have not been successfully used for estimating total bicycle or pedestrian volumes. These emerging approaches are well suited to developing origin-destination travel patterns, investigating route choice, and developing system-wide mode share estimates. Bluetooth detectors, GPS data collection, pedestrian signal actuation buttons, radio-frequency (RF) tags, and surveys have all been used to gather sample data and establish minimum bicycle volumes on various facilities. However, it is not possible to reliably convert this sample data to total counts due to the influence of multiple location-specific factors (e.g. smart phone usage, transit mode share).

Figure 11. Decision Flow Chart for Automatic Counters



Source: Southern California Association of Governments. *Conducting Bicycle and Pedestrian Counts* (2013).

Pneumatic Tubes

What it counts: Bicycles

What it is: Two rubber tubes are stretched across the right-of-way, and record counts when bicyclists pass over them.

How it works: When a bicycle or other vehicle passes over the tubes, pulses of air pass through to a detector which then deduces the vehicle's axle spacing, and hence classifies it by vehicle type.

Advantages: Familiar technology to most jurisdictions; Widespread use by data collection firms; Portable, easy to set up, and inexpensive; Battery powered; Captures directionality.

Drawbacks: Susceptible to theft, vandalism, and wear-and-tear; May be a tripping hazard for pedestrians; Not appropriate in cold weather conditions; Can deteriorate under high bicycle or vehicular traffic, thus reducing their accuracy; On-site data downloading; May not detect side-by-side riding.

Typical location: On-road bikeways and exclusive bike paths

Best installation: Paved surface, minimal pedestrians, above freezing weather conditions

Count duration: One day to several months

Accuracy: Error rate is 4% or less for 24-hour counts, a higher error rate for 15-minute intervals

Pneumatic tubes on cycle track in Vancouver, BC
Photo Source: Paul Kreuger

Inductive Loop Detectors

What it counts: Bicycles

What it is: Loops of wire with a current running through them. Devices can be placed on top of the roadway or paved trail surface (temporary) or under the surface (embedded).

How it works: Detects bicycles through their disruption of an electromagnetic field.

Advantages: Flexibility to be portable or permanent installations; Novel inductive loops are capable of distinguishing bicyclists from vehicles; Familiar technology to most jurisdictions; May store data on-site or at a remote, centralized location.

Drawbacks: Cannot be installed near sites of high electromagnetic interference; Embedded detectors are expensive to install; Requires a nearby source of electric power; Need to be calibrated to detect bicycles; May not detect side-by-side riding or bicycles with non-metal frames.

Typical location: Paved locations such as on-road bikeways and mixed-use paths

Best installation: Mid-segment and channelized location where bicyclists will travel single file and will not generally stop, exclusive bike use or mixed-traffic environment

Count duration: Weeks to permanent

Accuracy: Error rate is 4% or less for longer duration counts, a higher error rate for shorter intervals

Embedded inductive loop detector in bike lane
Photo Source: Ecocounter

Piezoelectric Strips

What it counts:	Bicycles
What it is:	Two piezoelectric strips that are laid across the right-of-way embedded within a paved surface
How it works:	Emits an electric signal when they are physically deformed by tires
Advantages:	Provide bicyclist speed data and directionality; Low profile and not susceptible to tampering; Can be battery-powered or externally powered; Data can be stored onsite or transmitted wirelessly.
Drawbacks:	Cannot distinguish bicycles in mixed flow traffic or adjacent to vehicle traffic; Cannot detect pedestrians; Detectors require careful installation
Typical location:	Paved locations with no vehicle traffic, such as bicycle and multi-use paths
Best installation:	Two strips across entire width of path or bikeway
Count duration:	Permanent
Accuracy:	Unknown for bicycle counts

Installation of embedded piezoelectric strips
Photo Source: Metrocount

Piezoelectric strips on bike path
Photo Source: Metrocount

Pressure or Acoustic Pads

What it counts: Pedestrians, bicyclists (pressure pads only), pedestrians and bicyclists together (pressure pads only)

What it is: A pad installed at or under the surface

How it works: Pressure pads detect the weight when they come in contact with pedestrians or bicyclists; Acoustic pads detect the sound waves from footsteps of pedestrians only.

Advantages: They work well for counting pedestrians on unpaved trails; Low profile and not susceptible to tampering; Battery-powered; Data can be stored onsite or transmitted wirelessly, depending on vendor.

Drawbacks: Bicyclists and pedestrians must come in direct contact with the pads to be detected; Susceptible to detection problems when ground freezes; Pressure pads do not distinguish between pedestrians and bicyclists; Acoustic pads only count pedestrians; High cost to install on paved paths; lack of mobility.

Typical location: Unpaved trails, unpaved walkways, and public stairways

Best installation: Channelized areas where pedestrians and bicyclists must travel single file and they will not linger, above freezing weather conditions

Count duration: Permanent

Accuracy: Unknown for bicycle or pedestrian counts

Pressure pads on unpaved path before being covered
Photo Source: Scottish National Heritage

Active Infrared

What it counts: Bicycles and pedestrians

What it is: A device on one side of the count corridor transmits a pulsed infrared beam to a receiver at the other side of the right-of-way.

How it works: Pedestrians and bicycles are detected when the infrared beam is broken. A specifically designed algorithm can differentiate between bicycles and pedestrians.

Advantages: Can count bicycles and pedestrians with one device; Portable; Relatively low cost; Battery-powered.

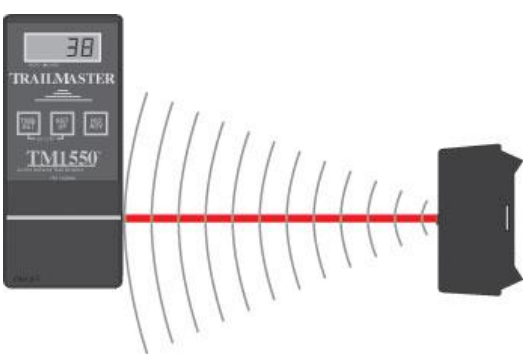
Drawbacks: Cannot be used in mixed vehicle locations; Can be triggered by other objects, such as falling leaves, snow, animals, or insects; Visible and thus susceptible to vandalism; May not accurately count groups or side-by-side pedestrians or bicyclists; Installation requires mounting devices to fixed objects on each side of the trail; On-site data downloading.

Typical location: Off-street paved or unpaved paths.

Best installation: About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, receiver and transmitter should be no more than 90 feet apart, locate where pedestrians or bicyclists will not linger

Count duration: Several weeks to permanent

Accuracy: Error rate varies considerably based on installation site and ranges from 12-48% in published studies.



Active Infrared Receiver (left) and Transmitter (right)
Image Source: Trailmaster

Passive Infrared (a.k.a. Pyroelectric)

What it counts:	Bicycles and pedestrians together
What it is:	A device positioned on one side of the count corridor. It can be disguised inside a post or existing infrastructure.
How it works:	Identifies the heat differential of bicyclists or pedestrians when they pass through the detection area.
Advantages:	Movable and easy to install; Can be used with a bicycle-only count technology to differentiate users; Battery-powered; May store data on-site or transmit data wirelessly, depending on vendor.
Drawbacks:	Cannot be used in mixed vehicle locations; Is prone to error due to changes in the background (e.g. sun reflection); Dual sensors are needed to detect directionality; May not perform as well in cold weather conditions.
Typical location:	Sidewalks or urban pedestrian-only corridors; Off-street paved or unpaved paths
Best installation:	About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, receiver and transmitter should be no more than 90 feet apart, locate where pedestrians or bicyclists will not linger
Count duration:	Several weeks to permanent
Accuracy:	Error rate varies considerably based on installation site and ranges from 1-36% in published studies.

Installed passive infrared sensor
Photo Source: Ecocounter

Bi-directional passive infrared sensor
Photo Source: Ecocounter

Laser Scanning

What it counts: Bicycles and pedestrians

What it is: A horizontally or vertically scanning device at the side or above the detection area.

How it works: Laser pulses are sent out in a range of directions, and pedestrians and bicyclists are recorded based on reflected pulses.

Advantages: Can cover a large detection area; Can be used in mixed traffic areas; Battery-powered

Drawbacks: Does not function well in rain, fog, or snow; Can be triggered by other objects, such as falling leaves, snow, animals, or insects; Expensive; Heavy computational loads; May not capture side-by-side walking or biking.

Typical location: Large detection areas of non-motorized travel, such as a transit station or plaza.

Best installation: Horizontal scanners are best located where there are no obstructions, vertical scanners must be mounted above detection area

Count duration: Weeks to permanent

Accuracy: 5% or more error, may be more in highly crowded environments

Horizontal Laser Scanner
Photo Source: LogObject

Radio Waves

What it counts: Bicycles and pedestrians

What it is: A radio transmitter and receiver positioned on opposite sides of the count corridor.

How it works: Detects bicycles and pedestrians when a radio signal between a source and a receiver is broken. Dual beams with different frequencies can be used to differentiate between bicycles and pedestrians.

Advantages: Can differentiate between bicyclists and pedestrians; Movable and easy to install; Can be hidden within wood or stone posts; Battery powered.

Drawbacks: On-site data collection; Does not accurately count groups or side-by-side pedestrians

Typical location: Off-street trails or on-street detection for bicycles and vehicles.

Best installation: About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, locate where pedestrians or bicyclists will not linger and they will travel single file

Count duration: Months to permanent

Accuracy: Unknown

Radio wave detection box and data download
Photo Source: Trail Counters

Video Image Processing

What it counts: Bicycles, pedestrians, and vehicles.

What it is: Video recorders mounted above the count area to record movements coupled with a software program that processes the video to produce counts.

How it works: Uses visual pattern recognition technology and computerized algorithms to detect bicyclists, pedestrians, and vehicles.

Advantages: Can count in mixed traffic situations; can provide full intersection turning movement counts as well as screenline counts; Portable and easy to install; Can be rented.

Drawbacks: More expensive to purchase and process data than other devices; Not practical for long-term counts; Lighting and weather conditions affect accuracy; Umbrellas result in detection problems; Video must be manually submitted for processing.

Typical location: Roadway intersections or corridors

Best installation: Attach unit to street furniture or tripod and raise camera far enough up to capture the desired area, not during rainy conditions.

Count duration: Finite time periods up to one-week counts

Accuracy: 2% to 14% error rate

Video image recording by the Scout
Photo Source: Miovision Technologies

The Scout video collection unit
Image Source: Miovision Technologies

Magnetometers

What it counts: Bicycles

What it is: A small device that is buried under or next to a bike trail.

How it works: Detects bicycle activity through changes in the normal magnetic field.

Advantages: Invisible after installation, and not susceptible to tampering; Battery-powered; Easy installation

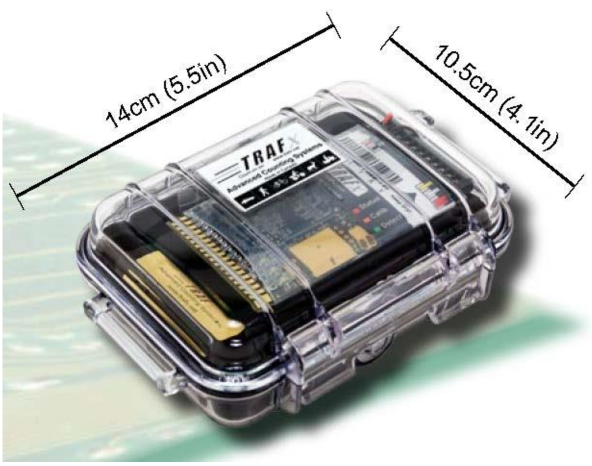
Drawbacks: On-site data downloading; relatively small detection radius of approximately three feet.

Typical location: Mountain bike trails or 6-ft wide off-street trails.

Best installation: Unpaved or paved trails in rural or remote locations where bicyclists must travel single file.

Count duration: Permanent

Accuracy: Unknown



Magnetometer
Image Source: Trafx

Bicycle Barometer

What it counts: Bicycles

What it is: A high visibility display of the number of bicycles counted at a particular location.

How it works: The barometer can be linked to various automatic count technologies, such as inductive loops or pneumatic tubes, and displays the number of bicycles passing that location each day.

Advantages: Provides a high visibility count of bicycles; increases awareness of bicyclists.

Drawbacks: Additional cost and installation.

Typical location: A high bicycle volume corridor in a high visibility area.

Count duration: Permanent

Accuracy: Depends on count technology used

Bicycle Barometer
Photo source: Kittelson & Associates, Inc.

ADJUSTMENT AND EXTRAPOLATION FACTORS

This section summarizes the types of factors for adjusting and extrapolating counts currently in use, based on the available literature and case studies in *NCHRP 797*. An important distinction should be made between the concepts of correction factors and adjustment/extrapolation methods. Both approaches adjust raw data. However, they are differentiated as follows:

- Correction factors are used to eliminate systematic inaccuracies (e.g., over- or undercounting) in pedestrian or bicycle counts that result from the data collection technology used.
- Extrapolation methods are used to expand short-duration counts to estimate volumes over longer time periods or to compare counts taken under different conditions.

Correction factors have been developed for a few pedestrian and bicycle counting technologies based on the accuracy studies described in the proceeding section. These correction factors may not be straightforward, linear, or necessarily similar to motor vehicle counter correction factors. Certain technologies may over- or under-count by different amounts under different conditions, so different correction factors may be needed for the same type of technology in different situations. Most pedestrian and bicycle counting technologies have not been tested rigorously for accuracy, so variable correction factors are rare.

The remainder of this section summarizes extrapolation methods used in pedestrian and bicycle travel monitoring. Extrapolation methods address common challenges faced when converting raw pedestrian or bicycle count data into useful information for technical analysis and public presentation.

Temporal Adjustment Factors

Temporal adjustment factors are used to account for "peaking" patterns, or the tendency for pedestrian or bicycle volumes to be distributed unevenly throughout the day, week, or year. For example, there may be high pedestrian volumes on sidewalks in a developed area at 5 p.m., but relatively low volumes at 3 a.m. A popular recreational trail may have higher bicycle volumes on weekends than weekdays.

The most basic form of extrapolation is to multiply a short-duration count by the inverse of its proportion of the longer time period to estimate the volume during the longer time period. For example, if each hour of the day had exactly the same number of pedestrians or bicyclists at a particular location, each hour would represent approximately 4.2% (1 hour/24 hours) of the daily volume. In this case, it would be possible to multiply the one-hour volume by 24 to estimate the daily volume. However, pedestrian and bicycle volumes are rarely constant over long periods of time. Several studies have developed temporal adjustments to more accurately reflect uneven distributions of pedestrian and bicycle activity.

The draft *2014 Traffic Monitoring Guid*e (TMG) also includes guidance on how non-motorized volume data collection and reporting should account for time of day, day of the week and seasonal variability and should account for any traffic patterns over time. Comprehensive information on this topic is limited, primarily because very few public agencies have collected and analyzed continuous non-motorized traffic data to date. To account for daily, weekly, and seasonal variability, the draft TMG recommends non-motorized data collection programs include both continuously operating data collection sites to provide data on seasonal and day of week trends and short duration sites to account for specific geographic traffic patterns and time of day trends.

The *National Bicycle and Pedestrian Documentation Project* has also started to identify Count Adjustment Factors that can be used to adjust counts conducted during almost any period on multi-use paths and pedestrian districts to an annual figure. These factors adjust one-hour counts to annual totals by considering weekly, monthly, and trends in walking and bicycling rates.

Land Use Adjustment Factors

Land use adjustment factors account for variations in traveler volumes based on particular land uses in the vicinity of the counter. For example, the number of houses or jobs within a ¼ mile of the count location can have an effect on pedestrian volumes. Temporal extrapolation factors should be selected given the land use characteristics of the count location. For example, residential locations are less likely than urban centers to have midday pedestrian peaks.

Weather Adjustment Factors

Weather adjustment factors should be used to account for weather patterns at the time that data is taken. For example, if a count is taken on a rainy day, volumes will likely be significantly lower than an average day. To adjust for this variation, the volume should be adjusted upward. Table 2 shows example weather adjustment factors.

Table 2. Example Weather Adjustment Factors

Weather condition	Definition	Manual Count Time	Multiplicative Adjustment Factor
Cloudy	Ratio of solar radiation measurement to expected solar radiation is ≤ 0.6	All time periods	1.05
Cool temperature	≤ 50°F	All time periods	1.02
Hot temperature	≥ 80°F	1200-1800	1.04
Hot temperature	≥ 80°F	0000-1200 and 1800-2400	0.996
Rain	Measurable rainfall ≥ 0.01 inches	All time periods	1.07

Source: Schneider et al. *Methodology for Counting Pedestrians at Intersections* (2009).

Access/Infrastructure Sufficiency Adjustment Factors

It is possible that facility characteristics could influence pedestrian or bicycle activity patterns. For example, a narrow multi-use trail may not be able to accommodate all bicyclists who would like to use it during a peak hour. Therefore, its peaks would be muted relative to a wider multi-use trail that has the same overall demand.

Demographic Adjustment Factors

Intuitively, one might expect that differences in socioeconomic characteristics of the neighborhoods surrounding count locations would lead to differences in pedestrian and bicycle volume patterns. Income, car ownership rates, household size, and age of residents could all have effects on traveler volumes. However, very few studies have explored these effects.

Section 4
Data Collection Protocol

DATA COLLECTION PROTOCOL: MONITORING GUIDELINES

BEFORE THE COUNT

Defining Bicyclists and Pedestrians

Prior to conducting a count, the first step is to determine whom you want to count. You may want to count only bicyclists, only pedestrians, both together, or both separately. This section is focused on capturing non-motorized travel on streets, paths, and public stairways.

Who Counts as a Pedestrian?

While defining a pedestrian may seem simple initially, it is harder to determine once out in the field. It's very clear that people walking would be counted as pedestrians. But, what about joggers, wheelchair users, babies in strollers, rollerbladers, skateboarders, and so on? If the count methodology allows, it's ideal to separate true pedestrians from most wheeled or other powered forms of transportation (except for those who need it for mobility reasons). Otherwise, all of the following can be counted as pedestrians.

Count the following as a "Pedestrian":

- baby in a stroller
- baby being carried
- person using an assistive walking device (walker, cane, knee walker)
- person walking or jogging
- wheelchair or assistive power scooter user

While some count protocols collect the following as "Other", for most applications they should be included as "Pedestrian":

- bicyclist walking his/her bicycle on the sidewalk
- equestrian
- non-motorized kick scooter rider
- person on toy (pull cart, big wheel, etc.)
- rollerblader
- segway rider
- skateboarder

Who Counts as a Bicyclist?

Counting bicyclists is a bit clearer than pedestrians, but it should not be restricted to two-wheeled pedalcycles. Unicycles, pedi-cabs, tandem cycles, electric bicycles, bicycle trailers, and recumbent cycles should all be included in a bicycle count. For some purposes, the number of people on a cycle as opposed to the number of bicycles may be collected.

Count the following as a bicyclist:

- bicyclist (including electric)
- cyclist on three or four-wheeled cycle
- hand cyclist
- human passenger in bicycle trailer (count each person, if possible)
- human passenger on a cycle (count each person, if possible)
- pedicab operator and passengers (count each person, if possible)
- recumbent bicyclist
- tandem cyclists (count each person, if possible)
- unicyclist

Passenger in bicycle trailer (would count as 2 bicyclists)		Source: transitionwivenhoe .blogspot.com
Unicyclists		Source: Fairhope Middle School, AL Unicycle Club
Hand cyclist		Source: Mobility International USA
Pedicab with passengers (would count as 3 bicyclists)		Source: Homecare.com
Recumbent Bike		Source: AB-Bike

Tandem bike (would count as 4 bicyclists)		Source: popscreen.com
Electric Bicycle		Source: Electric Bikee Toronto
Bike operator and passengers (count as 3 bicyclists, if possible)		Source: howtopedia.org, Bicycle Taxi
Quadcycle (count as 5 bicyclists, if possible)		Source: Eric Staller's Conference Bike

Counting Bicyclists and Pedestrians Together

In some instances, you may want to know only the total number of non-motorized users and you don't need to distinguish between bicyclists and pedestrians. This is common on paths when automated counters are used.

Counting Bicyclists and Pedestrians Separately

In other instances, you may need to count bicyclists separately from pedestrians at the same locations during the same time periods. In this case, counts are done manually or using automated technologies that allow for the ability to distinguish bicyclists from pedestrians.

Counting Other Demographic or Behavioral Variables

When conducting manual counts, counters may collect other variables along with the bicycle and/or pedestrian volumes. For example, these variables could include: the number of female bicyclists, the number of bicyclists riding the wrong way, or the usage of safety equipment. There is a limit to how many of these variables a counter should be tasked with tracking, especially if high volumes are anticipated.

MONITORING MEMORANDUMS OF UNDERSTANDING OR AGREEMENTS: LEVERAGING EXISTING RESOURCES AND COORDINATION

Leveraging Existing Monitoring Resources

Local jurisdictions and state Departments of Transportation often conduct or have control over existing motor vehicle count efforts. These efforts may include regular monitoring or data collection for traffic impact analyses. The easiest way to obtain bicycle and pedestrian count data may be to leverage these existing efforts. TRPA/TMPO should explore opportunities to enter into monitoring memorandums of understanding (MOUs) or agreements with local and state agencies or organizations that currently collect motor vehicle counts to also collect bicycle and pedestrian counts as part of these efforts. Specific opportunities to add bicycle and/or pedestrian count monitoring to existing count efforts are described below.

Add Bicycle Counts to Screenline Counts of Motor Vehicles

Screenline counts of motor vehicles are often collected from automated technologies. These technologies may include pneumatic tubes, inductive loop detectors, or video. Data is typically collected and summarized for one full day or more. Depending on the capabilities of the technology, bicycle counts may be conducted and summarized as part of these data collection efforts for little or no additional costs. It is suggested that local and state agencies explore the opportunity to include bicycle counts for all automated screenline monitoring efforts.

Add Bicycle and Pedestrian Counts to Manual Intersection Counts

Local and state jurisdictions and private entities (often developers) already conduct manual counts of vehicles at intersections. It is typically very cost-effective to collect bicycle and pedestrian data at the same time that vehicles are counted. Many professional traffic data collection firms will include pedestrian and bicyclist counts for little or no additional cost. TRPA/TMPO should require that all intersection counts done for traffic impact studies include pedestrian and bicyclist counts and that the results are summarized in the report and work with local and state agencies and organizations to encourage them to do the same.

When working with professional traffic data collection firms or conducting counts using in-house staff, the following should be made clear to all count staff when adding bicyclist and/or pedestrian counts:

1. Provide a diagram of the intersection with existing vehicle/bicycle lanes and pedestrian marked crosswalks and crossing prohibitions.
2. Count all bicyclist turning movements through the intersection, including those that approach or depart the intersection on the sidewalk or ride the wrong way. Indicate if sidewalk or wrong way riding appears to be common.
3. Count pedestrian crossings by roadway leg.

4. Count people on skateboards, scooters, or skates, as well as joggers, children in strollers or being carried, and people in wheelchairs as pedestrians.
5. Count each bike passenger (children in trailers or seats, pedi-cab, etc.) as one bicyclist.
6. Count all pedestrian crossings that occur within 10 feet of the crosswalk (crosswalks exist on all legs of roadway intersections, whether they are striped or not, unless pedestrians are specifically prohibited from crossing at particular legs).
7. Report each diagonal crossing of a pedestrian scramble intersection. At regular intersections, count the diagonal crossing as 2 separate legs but note the number of pedestrians who cross diagonally.
8. Count bicyclists who walk their bikes through the intersection as you would pedestrian crossings.
9. Summarize the total number of pedestrian crossings and the total bicycle turning movements for their respective peak-hours and for the entire count period.

Existing Bicycle and Pedestrian Monitoring

TRPA/TMPO should also enter into MOUs or agreements with local jurisdictions that are already conducting bicycle and pedestrian counts to have those monitoring efforts added to TRPA/TMPO's count database and collected in a manner consistent with TRPA/TMPO's efforts. Additionally, where count resources are limited TRPA/TMPO should partner with local organizations interested in bicycle and pedestrian monitoring to help collect data and increase the geographic coverage of bicycle and pedestrian monitoring. In doing so, TRPA/TMPO will be best able to utilize the full bicycle and pedestrian monitoring resources of the Lake Tahoe Region to document and track bicycle and pedestrian activity on an ongoing basis.

Standardized Training Materials and Data Collection Protocols

In addition to leveraging existing count resources, TRPA/TMPO should work with local agencies and organizations to develop standardized approaches to training staff, volunteers, and data collection firms to ensure that bicycle and pedestrian counts are conducted in a consistent manner.

To assist in this effort, sample instructions for data collection firms, count forms, and training materials from *NCHRP Report 797* have been included in Appendix 4.

SAMPLING DESIGN: PRIORITIZE AND ESTABLISH COUNT LOCATIONS

Establishing clear and consistent criteria to be used for selecting count locations will help ensure that the TRPA/TMPO selects the most appropriate sites for monitoring based on funding availability. These criteria will inform TRPA/TMPO of the need to add or remove count locations, where formal partnerships should be established for interagency coordination with count responsibilities, and help prioritize locations for inclusion in the bicycle and pedestrian monitoring program. Additionally, the criteria can also be used to identify triggers for one-time count audits, when appropriate. This section describes the monitoring criteria proposed to TRPA/TMPO and the Bicycle and Pedestrian Technical Advisory Committee (BPTAC), and the results from the ranking of the potential monitoring criteria. It also includes recommended criteria to be implemented for the Monitoring Protocol.

Criteria for Prioritizing Monitoring Sites

Monitoring criteria are used to determine and prioritize potential locations for inclusion in the bicycle and pedestrian monitoring program. A number of potential criteria for establishing monitoring sites were considered. The considered criteria are listed alphabetically and described below.

- **Bicycle and Pedestrian Facilities Types**: monitoring sites would be considered in order to cover a wide variety of bicycle and pedestrian facilities types to capture any differences in activity by facility type or facility context.
- **High-Collision Locations**: monitoring sites would be considered for selection, removal, or prioritization based on the locations that have experienced bicycle or pedestrian collision totals over a given threshold along a segment or at an intersection for the most recent three years of available data. Bicycle or pedestrian fatalities or serious injuries could also be used to trigger a one-time audit and potential inclusion into future monitoring locations.
- **Historic Count Locations:** monitoring sites at locations where historic monitoring counts have been conducted would be considered for prioritization and selection.
- **Planned Bicycle and Pedestrian Improvement Projects**: monitoring sites would be considered for selection and prioritization based on upcoming improvement projects. Locations could be identified once a project was programmed to ensure bicycle and pedestrian volumes are captured in advance of a project. Additionally, the construction of the improvement could also serve as a trigger for follow-up counts to evaluate the project's effectiveness. Control and parallel route locations would also be necessary if TRPA/TMPO desires to evaluate route-switching to the new facilities by existing bicyclists and/or pedestrians and determine bicycle and pedestrian activity induced by the completion of the project.
- **Schools**: bicycle and pedestrian facilities in close proximity to schools would be considered for selection for monitoring to help capture school trip information.
- **Seasonal Camps/Recreational Facilities**: monitoring sites would be considered for selection and prioritized around seasonal and recreational activity centers to help capture variation in bicycle and pedestrian demand by season.
- **Stakeholder Input**: monitoring sites would be considered for selection and prioritization based on input from stakeholders and the public.
- **Town Centers/Commercial Centers**: monitoring sites would be considered for prioritization and selection to coincide with areas expected to experience high growth within the Region including the regionally-designated town centers and other commercial corridors.
- **Trailheads**: monitoring sites would be considered for selection and prioritization at trailhead locations where bicycles and pedestrians access shared-use paths.

- **Transit Stations and Stops**: monitoring sites would be considered for selection and prioritization based on proximity to transit stations (i.e., intermodal or primary transit locations) or individual transit route stops.

These potential monitoring criteria were presented to the BPTAC. The BPTAC was provided an opportunity to identify additional potential criteria and provide input on preferred monitoring criteria for site selection and prioritization. The results of this stakeholder input and criteria used to prioritize monitoring site selection are described below.

Stakeholder Input

The BPTAC members were asked to rank their preferred criteria to be used in selecting and prioritizing bicycle and pedestrian sites. In addition to the recommended criteria, the BPTAC responses also included potential criteria including:

- **Current Constraints**: monitoring sites would be prioritized at locations where bicycle and pedestrian activity is currently constrained and concentrated through a "bottleneck" in the bicycle or pedestrian network.
- **Winter Use Facilities**: monitoring sites would be prioritized for seasonal winter activity centers and facilities to help identify specific seasonal bicycle and pedestrian activity patterns.

A total of eight responses were received from the BPTAC ranking each of the monitoring criteria in their order of preference as well as listing additional potential criteria. Based on the average rank and the number of responses, five criteria were established for monitoring site selection. All monitoring criteria were ranked by the majority of the BPTAC respondents and had an average rank score under five. The final criteria (in rank order) and the methodology to evaluate each criterion are described below.

Monitoring Criteria and Site Selection Methodology

The five monitoring criteria selected to implement the site selection methodology are:

- **Planned Bicycle or Pedestrian Improvement Projects:** Roadways or paths where improvements are planned, as well as major parallel bicycling or walking routes will be scored for this criterion.
- **Existing Bicycle Facility Types:** Existing bicycle facilities of any type (route, bicycle lane, or path) will be scored for this criterion[1].
- **Historic Count Locations:** Locations with a historic bicycle and pedestrian count site on them will be prioritized under this criterion.

[1] During the final prioritization of sites – once all sites have been scored for each monitoring criteria – if multiple sites are tied, preference will be given to monitoring a different bicycle facility type than those already selected. For example, if a Class II bicycle lane has already been prioritized, in the event of a tie between sites, a Class I or Class III site would be prioritized over monitoring an additional Class II facility.

- **Schools:** Roadway segments within ¼ mile of a school will be scored for this criterion.
- **Transit Stations and Stops:** Roadways segments within ¼ mile of a transit station or stop will be scored for this criterion.

When evaluating the criteria, each criterion should be scored by its rank, with the highest ranked criteria receiving 5 points and the lowest ranked criteria receiving 1 point. The rank and weighted scoring for each criterion is listed below in Table 3. For more detailed information on the GIS-based process used to prioritize the initial recommended sites in the Conclusions and Recommendations section below, see Appendix 5.

Table 3. Monitoring Criteria and Weighting

Rank	Criteria	Weighting Score
1	Planned Bicycle/Pedestrian Improvement Projects (Before/After)	5 points
2	Existing Bicycle Facility Types	4 points
3*	Historic Count Locations	3 points*
3*	Schools	3 points*
5	Transit Stations and Stops	1 points

* The Historic Count Location and School monitoring criteria were tied in the ranking of potential monitoring criteria given to the Bicycle and Pedestrian Technical Advisory Committee. Given the tied ranking, both criteria received an equal weighting score (3 points).

The monitoring criteria and resulting scores for segments should be considered using professional judgement; they are not intended to rigidly select count locations. The monitoring criteria prioritization process is simply a tool to help systematically determine "good" monitoring locations. Professional judgement should always be applied to prioritized sites to gauge whether the highest scoring sites are feasible or make logical sense relative to other siting factors not reflected by the protocol's criteria. Where an identified segment is deemed infeasible, nearby segments capturing the same site characteristics or the next-highest scoring segment should be considered in its place. Once the prioritized locations are finalized, they can be evaluated in the field to determine their suitability as a count site, as described below.

Select Count Sites and Count Technology

Once the bicycle and pedestrian network has been evaluated for each criteria, roadway or trail segments can be prioritized for monitoring based on the total weighted score of the site (i.e., those sites with higher scores should be considered before sites with lower scores).

Once the sites have been prioritized, they must be evaluated for suitability as a monitoring site. Prioritized potential monitoring sites should be excluded if there is no appropriate location to survey bicycle or pedestrian volumes based on available technologies or there are other circumstances that would make data collection at the site difficult or inaccurate. As sites are evaluated for monitoring, staff or the analyst should also consider the feasibility of various count technologies, as some sites may be better suited to certain technologies (e.g., infrared counters for sidewalks or paths, or inductive loops or pneumatic tubes for bicycle lanes). Some sites may only be appropriate for bicycle or pedestrian volumes rather than both and/or able to be monitored using manual or video counts. These factors should be taken into account when estimating costs to determine if more or fewer sites should be considered for monitoring.

Count Duration and Frequency

Aside from the overall purpose of the data collection, the two most important aspects of counts are: the duration of the count, and the frequency of the count. The count duration is typically dependent on the technology used to collect data while the frequency of counts depends on available resources and the purpose for which the count is being collected.

Count Duration

An important consideration when conducting counts is how long counting must occur to have a suitable amount of data for analysis given the count purpose. TRPA/TMPO identified a number of purposes that the monitoring data will be used for including:

- evaluation and prioritization of bicycle and pedestrian projects (including before and after studies);
- analyzing bicycle and pedestrian safety and prioritizing bicycle and pedestrian safety improvements;
- tracking overall trends on bicycle and pedestrian facilities as indicators or benchmarks; and,
- integrating bicycle and pedestrian monitoring data into evaluation model and performance measures.

These purposes will all require different count durations to best inform a given study. If the purpose of data collection is to document an hourly volume pattern to help determine safety and/or operational improvements for a bicycle or pedestrian facility, counts may be collected for as little as a few weeks to develop an accurate profile of hourly patterns. However, to track daily patterns, counts should be collected for multiple months. For longer term trend analysis and determination of seasonal patterns counts should be collected over multiple years. Establishing a baseline for benchmarking changes over time should be accomplished by installing a permanent counter at one or more locations while additional locations can be monitored by rotating a counter to additional sites on a regular basis.

Additionally, short term counts can be collected to extrapolate volumes once factor groups, and bicycle and pedestrian volume patterns are established to estimate volumes over longer periods of time (e.g., daily, monthly, or annual volumes). A factor group defines count locations that display similar patterns of activity, such as a commuter route or a recreational route. As resources are currently limited, TRPA/TMPO can use short-duration manual counts taken once a year by staff or trained volunteers, to document changes in non-motorized volumes over time. Often, these counts have been used to estimate volumes over multiple years. However, very short counts (e.g., 2 hours) at a particular location are subject to high levels of variation, so they may produce inaccurate estimates of annual volumes. Similarly, conclusions about increases or decreases in pedestrian or bicycle activity based on an annual 2-hour count may not be accurate.

Count Frequency

In addition to the duration of the count, the count frequency is an important consideration. For permanently installed automated counters, the count frequency is continuous. At other sites, whether they are counted manually or with temporarily installed automated counters, the frequency might be one to a few times per year, depending on how the data will be used. The FHWA *Traffic Monitoring Guide* recommends collecting short counts at all locations throughout the roadway system at least once every six years. More important roadways in the system should be counted at least once every three years. While collecting bicycle and pedestrian counts on all roads within the Lake Tahoe Region may be infeasible, collecting counts on the most important paths and roadways should be counted at least once every three years, while secondary facilities are counted at least once every six years.

However, for certain count purposes, such as a before and after study to determine the effects of a bicycle or pedestrian improvement, counts should be collected prior to the improvement and again after the improvement once activity patterns have returned to normal conditions (e.g., one to two months after the improvement is complete at a minimum). Counts collected as part of a before and after study should be compared against a continuous count of a facility with a similar factor group in order to account for any overall change in bicycle and pedestrian activity levels not associated with the improvement (i.e., if bicycle and pedestrian volumes had grown by three percent overall while the improvement was being made, a change of five percent from the before and after count would indicate that the facility improvement caused an additional shift of two percent once adjusted for the overall bicycle and pedestrian volume growth).

Additionally, given the seasonal patterns in activity in the Lake Tahoe Region, bicycle and pedestrian activity should also be monitored on a season basis. This would include collecting both summer and winter counts. Typically, summer counts have been collected in mid-July and mid-September to best capture recreational and commute activity peaks, respectively. Winter counts are best conducted in mid-January or February to avoid the effects on activity of the holiday season.

DURING THE COUNT

Coordinate with Monitoring Site Facility Owner(s)

Before installing counting devices at a site, TRPA/TMPO should check with local and state agencies, utilities, and/or other organizations that are responsible for managing poles, signs, pavement, walls, or other features at the site. In many cases, permission is required to install a bicycle and pedestrian counter. Permission may be given informally by e-mail or letter, but may require obtaining an official permit and/or posting a bond (e.g., roadway alteration permit, encroachment or right-of-way use permit, utility permit). Many different types of agencies grant permission (e.g., public works departments, parks departments, utilities), and it may be necessary to obtain permission from more than one agency at a single location.

As mentioned above, TRPA/TMPO should explore the opportunity for MOUs or agreements with other jurisdictions/organizations to help support the bicycle and pedestrian monitoring program and help establish the necessary protocols for obtaining permission to install a counter on the facilities of other agencies or organizations.

Inventory of Specialized Equipment & Equipment Preparation

TRPA/TMPO should maintain an inventory of count equipment to both document available equipment and identify any additional tools or equipment needed for a field installation. Preparation should be done prior to entering the field and should include testing to make sure that the batteries, data loggers, and other electronic components work. Advance preparations make the actual field installation effort much more efficient than opening the equipment boxes for the first time at the data collection site. A checklist for preparing equipment prior to installation in the field is provided below in Table 4.

Table 4. Equipment Preparation Checklist

	EQUIPMENT PREPARATION CHECKLIST
	Take pictures of the equipment immediately after opening the boxes.
	Inventory the equipment received.
	Compare the equipment received to the product's parts list.
	Make a list of the main pieces of hardware included in the shipment.
	Create a database that lists each piece of equipment purchased. The database should include the serial number, date of manufacture (if available), date of arrival, date of installation, and dates of moves. Also include information about each location where the piece of equipment was installed (latitude and longitude from GPS, plus additional description). This information will help track the history of each counter, regardless of where it is installed or moved. This step can be especially helpful when compiling historic data from the device and when communicating with the equipment vendor.
	Review the full installation instructions.
	Contact the vendor to clarify any installation steps that are unclear.
	Identify any hardware and tools not provided with the product that will need to be obtained prior to installation.
	Obtain any additional hardware or tools required for installation.
	If necessary to communicate with the device, obtain a SIM card and set up a cellular data plan for the device.
	Label equipment with contact information. This provides information to citizens and police who may be concerned about an unknown device in a public space and will aid recovery in the event that the counter is removed or stolen.

Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Installation

TRPA/TMPO should budget significant time for installation of count devices to ensure that it is performed correctly. The installation process involves everything from ensuring the installation is properly permitted, to planning and scheduling an equipment installation date, to verifying that the equipment continues to work several weeks after initial installation. It is important to work closely with the equipment vendor during the initial installations to ensure the equipment is installed correctly until TRPA/TMPO has gained enough familiarity with the equipment.

Table 5 is a checklist of the steps involved in preparation for an installation (note that not all steps apply to every counting technology or product):

Table 5. Installation Checklist - Advance Preparation

INSTALLATION CHECKLIST: ADVANCE PREPARATION	
	Site visit to identify the specific installation location. Specifically, note poles that will be used, where pavement will be cut, or where utility boxes will be installed to house electronics. Verify that no potential obstructions (e.g., vegetation) or sources of interference (e.g., doorway, bus stop, bicycle rack) are present.
	Obtain and document necessary permissions. Permits or permissions may include right-of-way encroachment permits, pavement cutting permits or bonds, landscaping permits, or interagency agreements. Obtaining these permissions may take up to several months, particularly if other agencies are involved.
	Create a site plan. Develop a detailed diagram of the planned installation on an aerial photo or ground-level image documenting the intended equipment installation locations and anticipated detection zone (after installation this will be useful for validating equipment either visually or with video monitoring). This diagram may be useful for obtaining installation permissions and working with contractors.
	Hire a contractor if necessary (or schedule appropriate resources from within the organization).
	Arrange an on-site coordination meeting involving all necessary parties (e.g., staff representing the organization installing the counter, permitting staff, contractors). If possible, a vendor representative should be on hand or available by phone. It may take several weeks to find a suitable time when everyone is available.
	Check for potential problems. Problems with the site may include interference from utility wires, upcoming constructions projects, hills, sharp curves, nearby illicit activity, and nearby insect and animal activity. Some of these conditions can be identified from imagery, but they should also be evaluated in the field.

Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Table 6 presents steps recommended for arrival at the installation site and counter installation.

Table 6. Installation Checklist - Installation Day

INSTALLATION CHECKLIST: COUNTER INSTALLATION	
	Review the site with the vendor and other parties to verify there are no potential problems with the site (e.g., interference from utility wires, evidence of planned construction, frequent obstructions [e.g., delivery trucks] in the installation area).
	Prepare the site. Perform any maintenance or preparations for the installation, such as clearing vegetation or sweeping pavement surfaces where inductive loops or pneumatic tubes will be installed.
	Record detailed notes on any aspects of the site that are mentioned by the vendor as potential issues that could affect accuracy.
	Take a picture of the site before the counter is installed.
	Maintain a safe work zone. If the installation requires working within or disrupting the traveled way, be sure to establish a work zone including required signs and detours if needed to avoid creating a safety hazard for the installation team or passers-by.
	Install the counter according to vendor specifications. Document any deviation from the specifications (e.g., difference in mounting height due to site constraints).
	Record detailed notes on any difficulties with the installation—this information may make future installations go more smoothly.
	Take pictures during installation. Action photos (e.g., cutting pavement, securing equipment to poles, installing battries) are useful for documenting that the correct steps were followed. They are also useful for reports and presentations.
	Sync the device's clock with the actual time. The actual time can be obtained from many sources; for example, most smartphones regularly sync with the actual time.
	Verify that the device is working and recording data correctly. Ideally, this will be done while the vendor is present. This activity may include watching counts register on the device, or taking manual counts for 15–60 minutes that can be compared with data downloaded from the device.
	If the test count is not sufficiently accurate, calibrate the device if possible by adjusting the sensor's sensitivity and repeating the previous step.

Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Table 7 provides a checklist of the recommended steps once the device has been installed and appears to be working as intended.

Table 7. Installation Checklist - Post-Installation

INSTALLATION CHECKLIST: POST-INSTALLATION	
	Take a close-up picture of the device. Consider collecting a GPS point to document the exact coordinates where the device is installed.
	Take pictures of the device vicinity: at least one picture each from the front in the direction of travel, from the back in the direction of travel, and perpendicular to the direction of travel
	Take a picture depicting the counter's detection zone. In the picture, have the vendor (or another expert) indicate exactly where the detection zone should be, using chalk, paint, etc. This picture helps when comparing video or manual ground-truth counts with the device's counts, when assessing the device's accuracy.

Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Validation and Calibration

Once the counter has been installed, it is important to follow up periodically to ensure that the counter is still working appropriately.

Validation

The first check after installing a counter is validation – ensuring the device is working properly. Validation involves testing the device both on the installation day (see above) and several days after installation. Immediately after a device is installed, the installation team should check that pedestrian or bicyclists are being detected and recorded. This check involves taking manual counts of all pedestrians or bicyclists who pass the detection zone during an initial test period (typically for 15 minutes to one hour). These manual counts are compared with the total count shown on the device's data logger or the total count downloaded from the device.

Another count check should be performed several days after installation. It should follow the same procedure as the initial check, comparing manual to automated counts. This second test can spot changes in the device that may have occurred over more than a day (due to sun and shade, heating and cooling, etc.). Additionally, the first few days of data should be downloaded and reviewed for any abnormalities (such as zero counts or high volumes) that may indicate a problem with the device or the site location (e.g., the sensor may be blocked or have been knocked out of position). If any abnormalities at the site are shown, the device may need to be moved to a different location or repositioned to ensure proper counting.

Table 8 provides a checklist of recommend follow-up activities.

Table 8. Installation Checklist - Follow-Up Activities

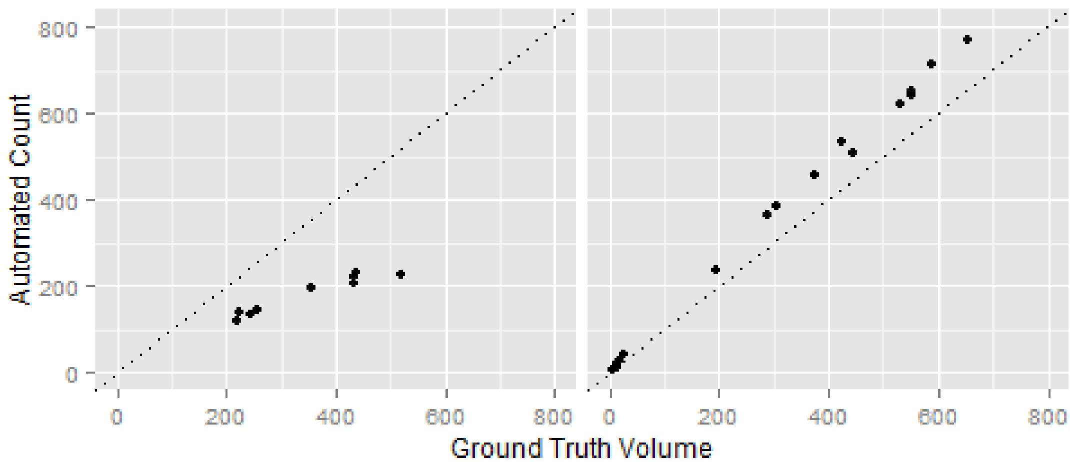
INSTALLATION CHECKLIST: FOLLOW-UP ACTIVITIES	
	Create a site description sheet or diagram containing the notes and photos from the installation day.
	Revisit the site after a couple of days to download data, to check that the recorded volume patterns seem reasonable. It is important to catch any systematic problems with the counter or site conditions right away.
	Revisit the site at least every 3 months—sooner if required for battery replacement or data downloads—to make sure the device is still working. This step is not necessary for temporary installations.
	Monitor count data and patterns routinely to identify any significant anomalies or deviations that could suggest an equipment malfunction. It is advisable to conduct 1–2 hour manual validation counts annually, or as needed based on data anomalies. This step is not necessary for temporary installations.

Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Calibration

Some counting devices sensors (e.g., pneumatic tubes or inductive loops) can be adjusted to reduce systematic under- or over-counting. The initial validation test period (see above) during installation can suggest whether or not an adjustment is needed. Figure 12 compares the accuracy of a pneumatic tube counter before and after calibration. The figure shows that count accuracy improved after the counter's sensitivity was adjusted. Calibration should be performed consistent with the instructions provided by the vendor of the count device.

Figure 12. Example Before and After Calibration Comparison



Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

Permanent count sites should have validation counts taken annually to ensure the device's accuracy is maintained. Shorter duration long-term counts should also have the counts validated halfway through the count period (e.g., six weeks after installation for a three-month count) to maintain accuracy. On-going validation is particularly important for pneumatic tubes and inductive loops as they can wear down and become less accurate over time, if not maintained properly. If the counter appears to be breaking down, the vendor should be contacted to determine if the device can and should be recalibrated, repaired or replaced.

Maintenance

TRPA/TMPO's counting equipment should be regularly maintained to ensure accurate, consistent counts. As mentioned above, count sites should be revisited on a regular basis to determine that the devices are still present (not stolen or vandalized) and operating correctly. Staff should check for the accumulation of dirt, mud, water, or other materials that could affect the sensor or other equipment components. As discussed previously, staff should download and review the count data to make sure that the equipment is working properly. Additionally, staff should follow the maintenance protocols recommended by the vendor of the count device to extend the longevity of the device and its accuracy.

AFTER THE COUNT

Once the data has been collected, it needs to be stored, cleaned, and corrected. Additionally, with the collection of continuous count data, short-term counts may be expanded or adjusted using adjustment factors to account for differences in the time period counts were collected, the weather, or the land use surrounding the count site.

Data Management & Storage Protocol

As part of the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol*, a count database was developed for TRPA/TMPO to store their count data. All available historic bicycle and pedestrian count data in the Region was restructured to conform to Federal Highway Administration's (FHWA) *Traffic Monitoring Guide* (TMG) recommendations. The historic count data covers a 20-year span from 1994 to 2014. The count database was created in Microsoft Excel, and contains three worksheets. The three worksheets document count station description data, screenline volume count data, and intersection movement-specific and total volume count data for non-motorized activity. These data items will assist TRPA/TMPO in ongoing tracking of bicycle and pedestrian activity and assist in future project efforts.

The FHWA TMG is intended to provide guidance on the policies, standards, procedures, and equipment typically used in a traffic monitoring program. The September 2013 edition is the first edition to address non-motorized travel and also includes new data formats for reporting non-motorized data. In following the reporting data formats contained in the TMG, the TRPA/TMPO Bicycle and Pedestrian Monitoring Count Database is as consistent as possible with FHWA data reporting guidelines. The TMG recommended reporting formats are used for both the count station description data as well as the screenline volume count data. For detailed information on the data fields included in the non-motorized count station description data and count data formats, see sections 7.9 and 7.10 in the *Traffic Monitoring Guide*.

Given that the TMG does not specifically address the storage of movement-specific data for intersections, the TMG-recommended data fields were adapted to include as many overlapping fields as possible while also creating fields in the database to store all bicycle-related turning movements as well as pedestrian movements including both crossings of intersections legs and pedestrians that turn the corner at the intersection for a given count period. While all of the count fields will not necessarily be collected as part of each intersection count, the database is set up to flexibly handle intersection movement-specific data provided to or collected by TRPA/TMPO in the future. Additionally, intersections with movement-specific counts can be summed as hourly total intersection volume counts in the screenline/total intersection volume count data sheet if desired where hourly data is available.

Populating the TRPA/TMPO database with counts requires copying data from the counter's output files into the spreadsheet, making sure that counts are pasted into the correct time periods. Additionally, data about the count site as well and the conditions under which the count took place. This approach requires staff time to download the data (often involving a field visit) and add the data to the spreadsheet. Some vendors provide custom software that imports the output files from their products into a spreadsheet. This approach can help avoid mistakes from manually copying counts between data files.

Count data should be summarized and formatted consistent with the TRPA/TMPO count database described above. Appendix 3 provides descriptions of the data fields and an overview of the data structure of the count database.

Analysis Protocol: Cleaning and Correcting Data

Once the data is loaded into the spreadsheet or vendor software, the data needs to be checked for accuracy, cleaned to reflect average data, and corrected for systematic count error.

Cleaning Count Data

Once counts are in a database format, they should be reviewed for unusual data. Some unusual counts are incorrect measurements by the technology itself. Potential reasons for incorrect counts include:

- blocked sensor;
- multiple counts of the same person;
- equipment malfunction; and,
- incorrect initial installation.

Quality Assurance & Quality Control Plan - How To Identify Problems: The only way to be certain of an incorrect count and abnormal (but correct) activity is to observe the site and compare the automated count with the observed count. However, unusual spikes or dips (such as zero counts) can be flagged and investigated. To identify unusual spikes or dips, TRPA/TMPO staff should compare the potential problem count against an average count of similar time periods before and after the potential problem. If the potential problem count is significantly different from the average (i.e., +/- 50), the count should be corrected or omitted.

The following method from *NCHRP Report 797* is recommended for identifying significant differences:

Single Observation Threshold: For the count in question, consider the counts taken at the same time of the week in the previous four weeks and in the following four weeks. The count is "probably incorrect" if it is more than two standard deviations above or below the average of the eight same-time-of-week counts. Note that the same-time-of-week counts should exclude holidays.

Cleaning the count data replaces the incorrect count with an estimate of the correct count. TRPA/TMPO staff should substitute the average value from the previous four weeks for the time period for the incorrect data. However, care should be taken to ensure that data with similar weather or other characteristics is used for the replacement. If an average value cannot be calculated, the data should be removed from the database.

Analysis of Statistical Confidence or Uncertainty

Correcting Count Data

Correction factors account for systematic counting errors associated with a particular counting technology, such as those associated with occlusion (undercounting due to the grouping of individuals). By applying a correction factor, systematic errors can be adjusted to more accurately reflect the actual number of bicyclists or pedestrians that passed by the count device. Table 9 presents correction factors that were developed as part of NCHRP Project 07-19 which led to the development of the *NCHRP 797 Report*. These correction factors are simple multiplicative factors that can be multiplied by the raw count to estimate the "true" count.

Table 9. Correction Factors Developed for NCHRP 07-19

Sensor Technology	Adjustment Factor	Hours of Data
Active Infrared*	1.139	29
Surface Inductive Loops	1.041	29
Embedded Inductive Loops	1.055	79
Passive Infrared	1.134	297
Product A	1.034	176
Product B	1.407	121
Piezoelectric Strips*	1.059	58
Pneumatic Tubes	1.016	161
Product A	1.008	133
Product B	1.520	28
Radio Beam*	1.161	17

Note: *Factor is based on a single sensor at one site; use caution when applying.
Source: Kittelson & Associates et al, *Guidebook on Pedestrian and Bicycle Volume Data Collection* (2014).

However, once TRPA/TMPO's Bicycle and Pedestrian Monitoring Program is better established and more count data is available, local correction factors should be developed for each count technology and/or site location.

This process entails conducting manual counts to compare against the automated count data and then plotting the ground-truth manual count data against the recorded count data. *NCHRP Report 797* recommends a minimum of 30 time periods worth of ground-truth data when developing correction factors and the time periods should include a range of volumes, including time periods during peak volumes.

After plotting the ground-truth data against the recorded counts, if the counts generally appear to fall along a straight line, the correction factor is calculated simply as:

$$Correction\ Factor = \frac{\text{Ground Truth Count}}{\text{Recorded Count}}$$

If the counts appear to curve or follow some other non-linear shape, Microsoft Excel (or another program with statistical methods) will be used to fit a trend line to the count's pattern. In Microsoft Excel, the following steps will develop a correction equation:

Step 1. Plot the data as a scatter plot.
Step 2. Under the Chart Tools→Layout menu, select "Trendline" and choose a trendline type
Step 3. Right-click on the trendline in the graph and select "Format Trendline".
Step 4. Check the "Display Equation on chart" and "Display R-squared value on chart" options under the "Trendline Options" tab.
Step 5. Experiment with the "Trend/Regression Type" options to find the trendline with the highest R-squared value.
Step 6. Record the equation and apply it to the raw count data

Finally, if the count pattern appears shows no discernable pattern (i.e., it appears to be more of a "cloud,") then the counting device may not be installed or calibrated properly, and requires adjustment to properly count.

Statistical Confidence or Uncertainty

The statistical confidence associated with estimates of bicycle and pedestrian volumes is typically lower than those associated with motor vehicle volume estimates. This is due to a variety of factors, including:

- higher error rates in detecting bicycles or pedestrians for both manual and automatic counts (the correction factors described above can help reduce error rates based on detection);
- higher variability in pedestrian and bicycle activity levels; and,
- smaller sample sizes associated with fewer monitoring sites.

Nordback et al note that error rates associated with generating annual average daily bicyclist estimates from 12-hour short-term counts ranged from 21 to 44 percent, while one-week long short-term counts error ranged from 13 to 31 percent. In comparison, 24-hour motor vehicle AADT estimates average between 12 and 15 percent error. Error rates decline and stabilize for count periods greater than one week, as the influence of daily activity fluctuations are reduced. Counting mid-week (Tuesday, Wednesday, or Thursday) also generally reduces estimation error. As a result, the number of locations being monitored and the duration of counts increase, the accuracy of the associated estimates will also increase. Further, as bicycle and pedestrian monitoring technologies develop, error rates associated with bicyclist or pedestrian detection will likely decrease as well.

EXPANSION METHODOLOGIES

Based on a review of the literature and the specific characteristics of the TRPA/TMPO Region, the following adjustment/extrapolation methods are recommended once data is available:

- Develop seasonal and temporal patterns: Strategically located automatic counters would provide continuous data collection that can be used to account for the different levels and types of non-motorized activity resulting from weather and seasonal tourism patterns in the Lake Tahoe Region.

- Establish land use adjustment factors: given the diverse land use types within the Lake Tahoe Region, covering large recreational facilities, as well as urban and rural areas, TRPA/TMPO should explore the applicability of developing land use adjustment factors to allow for adjustment of counts taken within the Region based on the area type in which they fall.
- Develop non-motorized trip type patterns: Different locations will have different types of non-motorized users. Previous studies have indicated the following common trip types:
  - Commuter Trips: highest peaks in the morning/evening and low traffic during midday; more traffic during weekdays than weekends; and month-of-year traffic patterns are consistent regardless of season or climate.
  - Recreation/Utilitarian Trips: strong peak during the middle of the day, more traffic on the weekends than on weekdays varying by season, and strong peak during late spring and summer for recreational and discretionary purposes.
  - Mixed Trips: includes trips that are both for commuting and recreational or utilitarian.

Once sufficient continuous count data has been collected for representative sites, TRPA/TMPO can develop adjustment factors to account for differences in pedestrian and bicycle volumes by time, land use, or weather. Once factors have been established, TRPA/TMPO will be able to expand short term counts to estimate volumes over a longer time period, or adjust counts based the land use surrounding the count site or the weather prevalent during the count. The TMG recommends that three to five continuous count stations are established per factor group, however budgetary constraints make this infeasible in most situations. Methodologies for these three adjustments are described below.

Temporal

As described previously, temporal adjustment factors account for differences in bicycle and/or pedestrian volumes by day, week, month, season, or year. The following steps describe the process to develop temporal adjustments:

Step 1. Volumes from the continuous count site are summarized for each desired time period (day, week, month, season, year).

Step 2. Expansion factors for each time period are calculated by dividing the sum of the volume for all time periods (e.g., annual volume) by each of the time periods (e.g, each month, each week, etc.).

Step 3. The factor can then be applied to the short-term count to adjust the count to an annual volume, or used to divide an annual volume to determine the volume for the desired time period.

Land Use

Land use adjustment factors are used to adjust volumes based on the land use attributes surrounding a count site so that counts taken in different areas of different land use types can be compared. The methodology for land use adjustments is similar to temporal adjustments.

The following steps describe the process to develop temporal adjustments:

Step 1. Volumes from continuous count sites are summarized for each land use type. Land use types could include the Lake Tahoe Region Town Centers, recreational areas, and/or residential neighborhoods

Step 2. Expansion factors relating each land use area to another are calculated by dividing the sum of each land use type's total volume by the sum of each other land use type.

Step 3. These factors can then be used by multiplying the count taken at one land use count site by the relevant adjustment factor to adjust the count with respect to another count site in a different land use context.

Trip Type Patterns

Each continuous count site should be analyzed to determine the overall pattern of bicycle and/or pedestrian activity at the site. This involves visually assessing a chart of daily activity to determine the characteristic of the bicycle and/or pedestrian volume at the site. Colorado Department of Transportation has identified three groups of trip type patterns: commute/school, recreational/utilitarian, and mixed. The characteristics of each of these trip type patterns are described below:

- **Commute/School:** Volumes peak in the morning and evening peak hours (for commuters) or the morning and afternoon school peak hours (for schools). In general volumes are lower on the weekends.
- **Recreational/Utilitarian:** Volumes are more pronounced in the midday period and on the weekends.
- **Mixed:** There is no clear pattern of bicycle and pedestrian volume peaking.

TRPA/TMPO should assign each continuous count site to one of the three above factor groups once sufficient data has been collected at the location, with at least one month's worth of data. If the data is erratic and not easily grouped into one of the three groups above, the site should be revisited once more data has been collected. If the site still exhibits an unusual activity pattern, the site should be monitored to determine the type of activity occurring along the route and, if necessary, a new factor group should be established.

REPORTING PROTOCOL AND FORMAT

A summary report detailing the bicycle and pedestrian activity trends should be prepared every two years. The report should include the following sections and graphics:

- **Monitoring History Summary:** A summary of previous monitoring efforts, including the years that data has been collected and the sites where counts have been collected. A map of all of the historic count locations should be provided.
- **Count Sites, Technology, and Methodology:** The count sites that were monitored, the technology used for the monitoring, and the dates and times of data collection should be documented. A map should be provided illustrating the sites included in the report by type (permanent versus short term). Any problems implementing the count sites should be noted.
- **Monitoring Results:** The results of the monitored sites should be graphed and summarized. The following graphics and data summaries are recommended.
    - **Hourly Monitoring Results:** Hourly mid-week and Saturday counts should be graphed separately for each short-term site monitored. For permanent monitoring stations, the average hourly mid-week counts should be graphed. Once factor groups have been developed for the Region, sites should be grouped by factor group to understand how activity varies by factor group. Any trends shown by the monitoring results should be documented. Prior to developing factor groups, sites could be grouped by geographic area or facility type to help establish differences and trends between sites. Where peak hour-only counts were collected, graphics comparing peak hour volumes between sites should be created.
    - **Daily Monitoring Results:** Average daily mid-week and Saturday counts should also be documented for all sites to compare activity levels. Sites should be grouped by factor group, if available, geographic area, or facility type. For sites where automatic counts are collected over multiple days or weeks, graphics should be prepared showing the average (if available) daily patterns over the course of the week.
    - **Annual Monitoring Results:** For permanent count stations, annual bicycle and pedestrian volumes graphics should be provided to compare activity levels across the permanent count stations. Additionally, graphics detailing average daily volume by month and/or season will provide insight into how activity at each site varies over the course of the year.
- **Expanded Volumes:** Once factor groups and their associated adjustment factors have been developed, the volumes of short term counts can be expanded to average annual daily bicyclist and pedestrian volumes. Graphics comparing activity levels at each site should be provided and any trends described.
- **Historic Comparisons and Inferences:** Where bicycle and pedestrian activity data is available for prior years, average hourly and average daily count data should be compared. Where hourly patterns vary significantly from historic data, the difference should be documented. Additionally, the site's factor group should be reconsidered if the current activity pattern no longer matches the site's prior factor group activity pattern. If the factor group is changed, the site should be monitored in future counts to verify the change is consistent. Inferences should be provided in each case to provide plausible explanations for the data. Judgement should always be exercised as to how strong a given inference is worded or conveyed.

Section 5
Conclusions and Recommendations

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

By implementing the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol*, TRPA/TMPO will build on its prior bicycle and pedestrian monitoring efforts to create an on-going monitoring program to track changes in bicycle and pedestrian activity in a consistent manner. The monitoring protocol seeks to provide clear guidelines for bicycle and pedestrian data collection by establishing:

1. **Monitoring Criteria**: the protocol establishes criteria to be used by TRPA/TMPO in establishing initial and future bicycle and pedestrian monitoring locations; and,
2. **Data Collection Procedures**: the protocol establishes the procedures to be used by TRPA/TMPO and any partner jurisdictions, organizations, or firms when collecting bicycle or pedestrian volume data.

Indicator Selection Rational: Purpose of the Monitoring Protocol

The data collected as part of this program can be used for a variety of purposes. This may include:

- evaluation and prioritization of bicycle and pedestrian projects (before and after studies);
- analyzing bicycle and pedestrian safety by establishing exposure (crashes per unit of volume) and risk (the likelihood of a collision or injury), as well as helping prioritize bicycle and pedestrian safety improvements (such as improved intersection crossings);
- tracking overall trends on bicycle and pedestrian facilities as indicators or benchmarks for bicycle and pedestrian goals in TRPA/TMPO's plans and programs including the benchmarks established in the most recently adopted Lake Tahoe Bicycle and Pedestrian Plan, Regional Transportation Plan, and future benchmarks established in the on-going Linking Tahoe: Active Transportation Plan; and,
- integration of bicycle and pedestrian monitoring data into the Transportation Mobility Conceptual Model.

NEXT STEPS FOR IMPLEMENTATION

In order to fully implement the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol*, TRPA/TMPO will need to inventory (as outlined in Table 4) and purchase additional specialized count equipment and ensure that staff is trained in the use of the equipment and the overall monitoring protocol. Recommended equipment and their associated costs are provided in the following section. Personnel skills required for Monitoring Protocol implementation include:

- understanding of the purpose of monitoring programs and how they are implemented;
- familiarity with bicyclist and pedestrian behavior;
- knowledge of how count technologies are installed and implemented;

- ability to install count equipment and perform field visits to sites;
- ability to coordinate across multiple jurisdictions;
- data management and manipulation skills; and,
- technical writing and report generation.

Additionally, as TRPA/TMPO moves forward with the monitoring program, the collected data should be integrated into and help inform updates of the Lake Tahoe Region's Active Transportation Plan, Regional Transportation Plan/Sustainable Communities Strategy, NEPA/CEQA traffic impact analysis, and capital improvement program prioritization efforts. By integrating the monitoring data into these programs, TRPA/TMPO will ensure that a consistent and systematic data source is available to facilitate its bicycle and pedestrian performance measures and performance monitoring efforts.

RECOMMENDATIONS

It is recommended that TRPA/TMPO begin an annual bicycle and pedestrian monitoring program consisting of continuous count locations supplemented by manual and short-term automatic counts. Detailed recommendations for this program are provided below.

Count Site Locations

Using the five monitoring criteria established in this protocol, the Lake Tahoe Region roadway and path network was evaluated to prioritize locations for bicycle and pedestrian monitoring sites. The results of this prioritization are shown in Figure 13. Seventy of the over 4,000 roadway segments yielded a site score of thirteen points or higher. This indicates that these segments met at least four of the five monitoring prioritization criteria.

Based on the site prioritization results relative to the expected available resources for automatic and manual counts, recommendations for each count type are provided below.

Automatic Count Locations

It is recommended that TRPA/TMPO purchase automatic counters for the following six locations:

- Lakeside Trail between Commons Beach Road and Grove Street (Shared-Use Path/ Tahoe City)
- SR 28 between Village Boulevard and Northwood Boulevard (Bike Lane & Sidewalk/Incline Village)
- West Shore Bike Path between Pine Street and Wilson Avenue (Shared-Use Path/Tahoma)
- US 50/Lake Tahoe Boulevard between Blue Lake Avenue and Al Tahoe Boulevard (Bike Lane & Sidewalk, CSLT)
- Pioneer Trail between US 50 and Glenn Road (Shared-Use Path/ CSLT)
- Rabe Meadow Trail between Kahle Drive and Elks Avenue (Shared-Use Path/Stateline)

Figure 14 shows the location of the six recommended automatic count locations.

Where possible and applicable these count sites should be installed where counts have historically been performed. US 50 near Stateline Avenue was initially prioritized for automatic counting. However, counts at this recommended location would likely be affected by large groups of pedestrians lingering and milling within the casino core area, potentially increasing error rates. Given this, the Pioneer Trail location was chosen to replace the US 50 near Stateline Avenue location due to its similar prioritization score and geographic proximity.

This set of automatic count locations provides a wide geographic coverage of the Lake Tahoe Region while capturing different facility types in different land use contexts. Once data has been collected a year at each of these locations, and the trip type pattern associated with the location has been identified, these automatic count sites can be used to develop adjustment factors to compare and extrapolate short term counts at different locations.

It is recommended that all of the sites use both a pedestrian count technology and a bicycle count technology. For the trail locations it is recommended to use a combination count technology such as the Eco-Multi Counter that combines a pyroelectric infrared counter (passive infrared) with inductive loops. This combination technology will allow bicyclists and pedestrians to be differentiated from each other along the trail.

For the roadway segments, it is recommended that pyroelectric infrared counters and inductive loops be installed separately on each side of the roadway.

Figure 13. Monitoring Site Prioritization Scoring Results

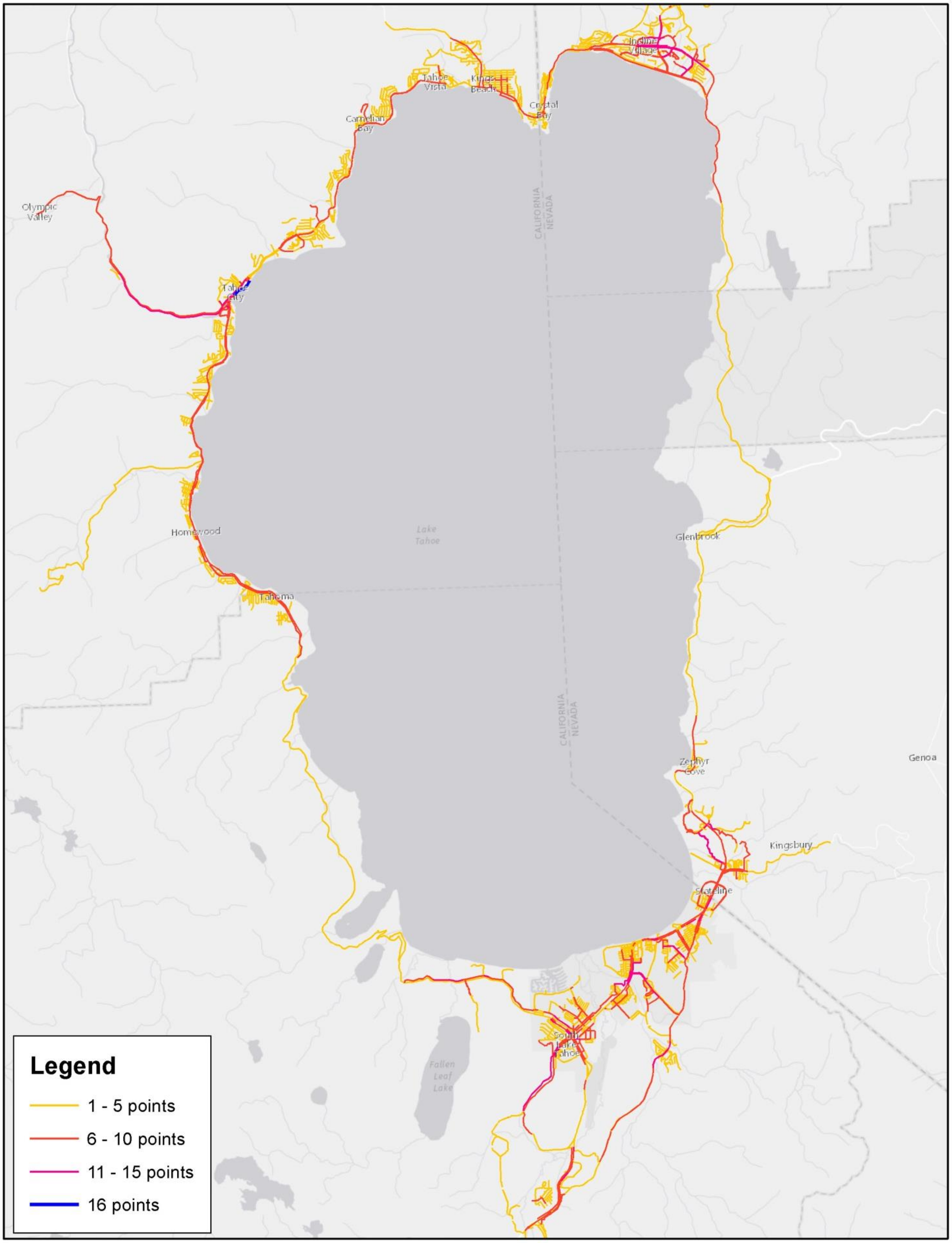
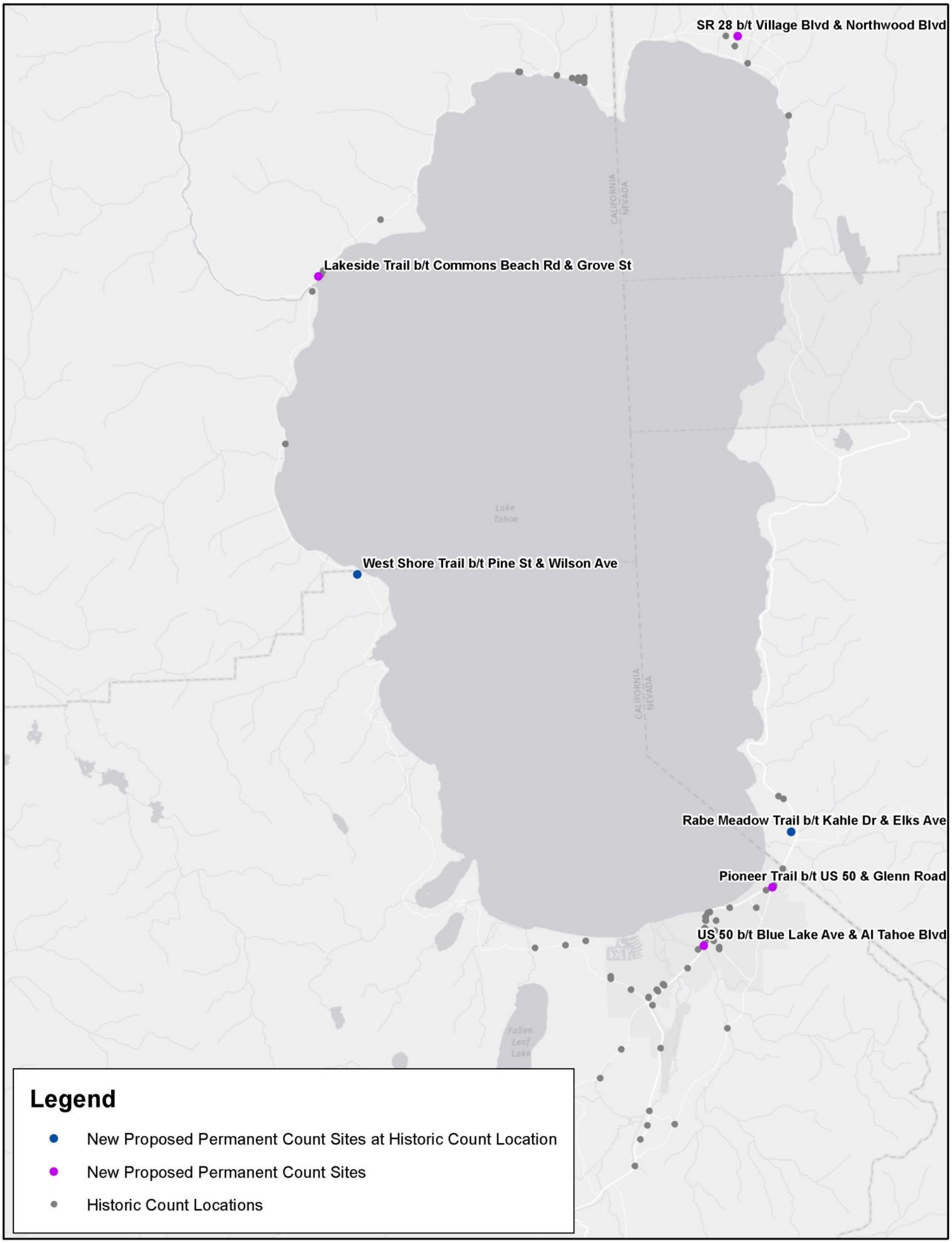


Figure 14. Recommended Permanent Count Locations



Manual and Short-Term Automatic Counts

To track bicycle and pedestrian activity over a broader area of the Region, TRPA/TMPO should supplement the permanent automatic count stations with a rotating biennual manual and/or short-term automatic counts using the automatic TRAFx counters TRPA/TMPO currently owns. A list of 21 recommended short-term count locations were selected using the monitoring criteria prioritization methodology. In order to reduce staff time requirements and associated costs, the 21 sites have been divided into two phases of ten sites each, with one phase to be counted every two years on a rotating basis. These locations are listed by count phase on the following page.

It is estimated that collecting 12-hour manual counts for two days at each monitoring sites will cost $1,000 for a total cost of $20,000 to collect four days of counts every two years for ten sites. If staff time or budget is available to include additional monitoring sites in each phase, the methodology to identify and prioritize potential monitoring sites in ArcGIS is provided in Appendix 5.

Monitoring Schedule

As recommended in the protocol above, manual and short-term automatic counts should ideally be collected in mid-September and will ideally occur on the same day. Mid-September typically provides the most stable bicycle and pedestrian counts due to schools being in session, relatively good weather, and normal commute patterns. In order to capture winter activity, counts should be collected in mid-January once commute and activity patterns have stabilized after the holiday season. Finally, peak summer activity is best measured in mid-July to capture recreational activity changes in the Lake Tahoe Region while avoiding the influence of holidays.

Monitoring Time Periods

For manual counts, it is recommended that 12-hour counts (7 a.m. to 7 p.m.) be conducted on a mid-week day and weekend day. However, if 12-hour counts are infeasible, counts should at a minimum cover the a.m., p.m., and weekend mid-day peak periods for each site. If inclement weather occurs with manual counts, additional days should be counted.

For short-term automatic counts, it is recommended that data be collected for a minimum of 7 days so that all weekday and weekend days are represented. However, if inclement weather occurs during the count, the count period should be extended to 14 days.

Recommended Locations

Phase 1:

- Truckee River Trail at the Truckee River Bridge (Class I/Shared-Use Path)[2]
- Village Boulevard between Northwood Boulevard and College Drive (Class I/Shared-Use Path)
- State Route 28 between Bear Street and Deer Street (Class II and Sidewalk)
- Southwood Boulevard between Incline Way and Village Boulevard (Class I/Shared-Use Path)
- Pope/Baldwin Path between Heritage Way and Baldwin Beach Road (Class I/Shared-Use Path)
- Lake Tahoe Boulevard between Viking Road and Sawmill Road (Class I/Shared-Use Path)
- Pioneer Trail between Golden Bear Trail and Kokanee Trail (Class II/Bike Lane)
- Sawmill Bike Trail / US-50 between Country Club Drive and Meadow Vale Drive (Class I/Shared-Use Path)
- Al Tahoe Boulevard between US-50/Lake Tahoe Boulevard and Johnson Boulevard (Sidewalk)
- Tamarack between Blackwood Road and Pioneer Trail (Class III/Bike Route)

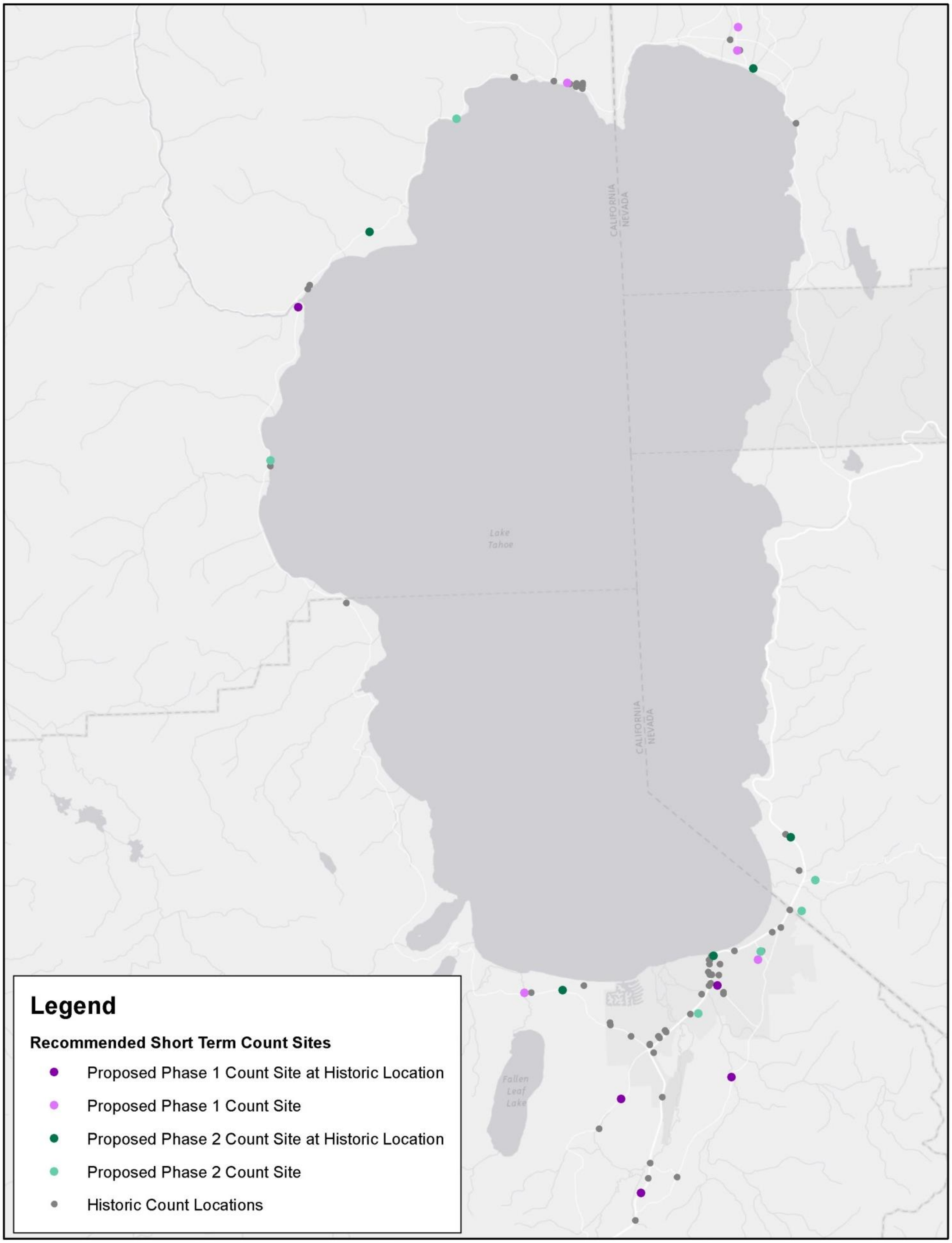
Phase 2:

- Round Hill Bike Path between Sewer Plant Road and Elks Point Rd (Class I/Shared Use Path)
- Lakeshore Boulevard between Village Boulevard and Country Club Drive (Class I/Shared Use Path)[1]
- State Route 28 between Sahara Drive and Onyx Street (Class II/Bike Lane)
- North Shore Path between Lake Forest Road and Lakewood Lane (Class I/Shared Use Path with adjacent Class II on roadway)
- West Shore Bike Path between Barker Pass Road and Elizabeth Drive at Kaspian Campground (Class I/Shared Use Path)[1]
- William Avenue between Sierra Boulevard and Martin Avenue (Class III/Bike Route)
- Ski Run Boulevard between Alder Avenue and Tamarack Avenue (Class I/Shared Use Path)
- Lake Parkway between Heavenly Village Way and US-50/Lake Tahoe Boulevard (Class II and Sidewalk)
- Kingsbury Grade/State Route 207 between US-50 and Pineridge Drive (Sidewalk)
- US-50 150 feet east of Lakeview Drive, at El Dorado Beach (Class I/Shared-Use Path)[1]
- State Route 89 between Jameson Beach Road and Valhalla Road, at Camp Richardson Resort (Class I/Shared-Use Path)[1]

Figure 15 shows the location of the recommended short term count locations, the recommended phasing, and where locations overlap with historic count locations.

[2] These sites are one of the five historic locations that have been counted since 1997.

Figure 15. Recommended Short Term Count Locations



Indicator Limitations

The short-term count locations are recommendations based on the monitoring criteria established in the protocol. These criteria capture high-priority roadway and path segments based on the criteria determined by TRPA/TMPO and its BPTAC. However, the criteria do not take into account existing or projected bicycle and pedestrian activity, the feasibility of installing a count device or manually collected data at the location, or other potential issues with the roadway segment.

All selected sites should be evaluated against local knowledge of bicycle and pedestrian activity, the feasibility of the location as a count site, and the ability to obtain permission to install a count device (or multiple devices) at the recommended locations. While the prioritization method does include proposed bicycle and pedestrian improvements, it does not take into account the timing of the projects. As a result, locations where improvements are programmed in the near future may be prioritized to collect before- and after-improvement data at the location and any major parallel facilities to best allow for the evaluation of the bicycle and pedestrian improvement. Additionally, no roadway or path segments scored highly on the eastern side of the Lake Tahoe Region between Incline Village and Kingsbury or in the area between Emerald Bay and Tahoma, illustrating that the prioritization method is both geographically and jurisdictionally blind. Hence, judgement should be exercised to consider geographic coverage.

Estimated Time & Cost Budgets

In order to provide a generalized estimate of the resources required to implement and maintain the bicycle and pedestrian monitoring program consistent with the protocol, estimates of the time needed to implement the protocol and costs to set up and collect data are provided below.

Estimated Labor Time and Cost Budget

Time estimates for program implementation, count training, and count technology installation as documented in *NCHRP Report 797* were used to estimate the necessary hours to implement each step of the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol.* A labor rate of $110 for a planning or engineering consultant was assumed to estimate the total cost of each component of the program with the exception of the manual counts. Manual screenline counts were estimated to cost a data collection firm $500 per site for peak hour counts (weekday and weekend) or per day of data collection. The estimates provided reflect the initial implementation of the protocol. As the count sites and monitoring program become more established, the necessary preparation time, training, and data management time may decrease. Additionally, the use of volunteers may help reduce costs. The estimated hours and labor costs are included in Table 10 below.

Table 10. Estimated Time for Protocol Implementation

Protocol Component	Estimated Time Needed	Estimated Cost
Implementation Preparation (jurisdictional coordination, location prioritization)	60 hours	$6,600
Count Training (manual counts – assuming volunteer or staff training is required – and automatic count technology setup)	16 hours	$1,800
Site Inspections and Installation	16 hours (per 10 manual counts, assumes one day for each shore of Lake Tahoe) 8 hours (per dual automatic count site or inductive loop installation) 4 hours (per passive infrared only automatic count site)	$1,800 (per 10 manual sites) $1,000 / $500 (per automatic site)
Data Collection and Maintenance (field visits to sites, adjustments to counters – automatic count sites only)	16 hours (per visit to up to 10 automatic counters, assumes one day for each shore of Lake Tahoe)	$1,800 (per visit)
Data Management and Report Preparation	60 hours	$8,500
Manual Counts (1 mid-week day and 1 weekend day count)	peak hours (6 hours) to full day (24 hours) (per site)	$500 (6 hours per site – 4 hours for weekday peak hours and 2 hours for weekend peak hours) $1,000 (24 hours per site – 12 hours for mid-week and 12 hours for weekend)
Total*	**420 hours plus 10 manual count sites**	**$66,300**

*Assumes six automatic count locations, ten manual count locations counted for four 12-hour periods (48 hours), and monthly visits to the automatic count locations.

Estimated Initial Capital Costs

In addition to the ongoing labor costs estimated above, to implement the recommended permanent count sites, TRPA/TMPO will need to purchase and install equipment at each of the recommended permanent count sites. Installation and capital costs to purchase the equipment are based on cost estimates from the City of Davis' 2013 Bicycle and Pedestrian Counting Plan and the Sacramento Area Council of Governments' Regional Bicycle and Pedestrian Data Collection project and are provided in

Table 11. For more accurate costs for each site, vendors should be contacted to determine actual unit costs and installation estimates.

Table 11. Estimated Costs for Count Technologies and Installation

Count Technology	Estimated Capital Cost	Estimated Installation Cost
Pyroelectric infrared	$2,500	$500
Inductive loop	$2,000	$500
Combination pyroelectric infrared and inductive loop	$3,500	$1,000
Bicycle barometer	$25,000	$2,500

Based on the characteristics of the sites (shared use path, bicycle and/or pedestrian facilities on both sides of the street, etc.), recommended count technology and estimated costs to purchase and install the automatic counters for the permanent monitoring sites are included in Table 12.

Table 12. Estimated Automatic Counter Costs for the Count Device and Installation by Site

Recommend Monitoring Site	Recommended Technology	Estimated Cost
Lakeside Trail	Combination pyroelectric infrared and inductive loops	$4,500
	Installation	$1,000
State Route 28	Inductive Loops (2) and pyroelectric infrared (2)	$9,000
	Installation	$2,000
West Shore Bike Path	Combination pyroelectric infrared and inductive loops	$4,500
	Installation	$1,000
US-50/Lake Tahoe Boulevard (Al Tahoe)	Inductive Loops (2) and pyroelectric infrared (2)	$9,000
	Installation	$2,000
Pioneer Trail between US-50 and Glenn Road	Inductive Loops (2) and pyroelectric infrared (2)	$9,000
	Installation	$2,000
Rabe Meadow Trail	Combination pyroelectric infrared and inductive loops	$4,500
	Installation	$1,000
Total		**$49,500**

TRPA/TMPO could also consider installing bicycle barometers on the high-use bicycle segments to demonstrate bicycling activity along the route, and increase awareness of bicyclists and the monitoring program. Implementation of this device could be a good opportunity for a partnership with the Tahoe Fund or other organization interested in increasing awareness of active transportation. However, bicycle barometers are more expensive (approximately $25,000 per barometer) than other devices and increase maintenance needs.

Maintenance

Additional funding should be set aside on an annual basis for maintenance of the count devices. It is recommended that approximately the cost of a count device ($2,000-$4,000) is budgeted annually for on-going maintenance of the count devices (e.g., battery replacement), or equipment replacement. Finally, it is recommended that TRPA/TMPO reach out to its member agencies and partner organizations to help further the goals of the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol*. This includes seeking memorandums of understanding or other agreements with jurisdictions to install and maintain count devices that provide TRPA/TMPO count data consistent with the monitoring protocol and its established formats. By providing these agencies and organizations with the sample materials in Appendix 4, TRPA can work toward developing a consistent approach to the collection of bicycle and pedestrian data within the Lake Tahoe Region.

Section 6
References

REFERENCES

1. Institute of Transportation Engineers & Alta Planning + Design. *National Bicycle and Pedestrian Documentation Project*. 2015.

2. Kittelson & Associates, Inc., Ryan Snyder Associates, and the Los Angeles County Bicycle Coalition. *Conducting Bicycle and Pedestrian Counts: A Manual for Jurisdictions in Los Angeles Count and Beyond*. 2013.

3. Kittelson & Associates, Inc. et al. *Guidebook on Pedestrian and Bicycle Volume Data Collection*. Project 07-19. 2014.

4. Minnesota Department of Transportation. *The Minnesota Bicycle and Pedestrian Counting Initiative: Methodologies for Non-motorized Traffic Monitoring*. 2013

5. Oregon Department of Transportation. *Design and Implementation of Pedestrian and Bicycle-Specific Data Collection Methods in Oregon*. 2014.

6. Schneider, Robert, et al. *Methodology for Counting Pedestrians at Intersections*. 2009.

7. Sacramento Area Council of Governments. *Regional Bicycle and Pedestrian Data Collection Project Application*. 2013.

8. U.S. Department of Transportation Federal Highway Administration. *Traffic Monitoring Guide* (TMG). 2013.

9. Washington Department of Transportation. *Methods for Estimating Bicycling and Walking in Washington State*. 2014

Appendix 1
Historic Count Summary Matrix

Location #	Count Location	Lead Agency	Count Date	Count Time Period	Count Methodology	County Technology	Raw Data Available	Summary Data Available	Unique Count Attributes
1	Incline Village Bike Lanes (Incline Village)	TRPA/TMPO	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Tuesday, July 28, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
2	Incline Beach (Incline Village)	TRPA/TMPO	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Saturday, July 25, 2009	7-10am	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Thursday, July 30, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Wednesday, August 05, 2009	5-7pm	Screenline	Manual Count	Yes	Yes	N/A
3	Incline Village - Village and Sherwood (Incline Village)	--	--	--	--	--	--	--	--
4	Hidden Beach Path (Washoe County)	TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
5	Elks Point Road & US 50 Intersection (Douglas County)	TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
6	Round Hill Bike Path (Douglas County)	USFS	Wednesday, July 18 2012 – Saturday, July 21, 2012	8am -6pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Saturday, August 10, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
7	Rabe Meadow (Douglas County)	USFS	Wednesday, July 18 2012 – Saturday, July 21, 2012	8am -6pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		Douglas County	Monday, July 1, 2013 – Saturday, August 31, 2013	Continuous	Screenline	Automatic Count	Yes	No	N/A
		TRPA/TMPO	Saturday, August 31, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
8	US 50 West of Stateline (South Lake Tahoe)	TRPA/TMPO	Wednesday, July 08, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 11, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
9	Pioneer Trail South of Stateline (South Lake Tahoe)	TRPA/TMPO	Wednesday, July 08, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 11, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
10	Linear Park (South Lake Tahoe)	TRPA/TMPO	Saturday, August 01, 2009	7am-7pm	Screenline	Manual Count	Yes	Yes	N/A
11	Ski Run Blvd (South Lake Tahoe)	TRPA/TMPO	Wednesday, July 08, 2009	7-10am	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Thursday, July 09, 2009	5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 01, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
12	El Dorado Beach (South Lake Tahoe)	TRPA/TMPO	Thursday, July 03, 1997	2 hour count	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Thursday, July 05, 2007	11am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Tuesday, July 21, 2009	5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Thursday, July 23, 2009	7-10am	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 01, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
13	El Dorado Beach, Los Angeles Avenue (South Lake Tahoe)	TRPA/TMPO	--	--	--	--	--	--	Counter Error
14	Al Tahoe Blvd near intersection with Johnson Blvd (South Lake Tahoe)	TRPA/TMPO	Tuesday, July 07, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Tuesday, July 07, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 01, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
15	Al Tahoe Blvd & Johnson Ave (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	No	Movement-Specific Count
		LTUSD	Thursday, November 06, 2014	6-9am, 1-3:30pm, 4-7pm	Intersection	Manual Count	Yes	Yes	Approach Only
16	US 50 & Al Tahoe Blvd (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	No	Movement-Specific Count

Location #	Count Location	Lead Agency	Count Date	Count Time Period	Count Methodology	County Technology	Raw Data Available	Summary Data Available	Unique Count Attributes
		LTUSD	Thursday, November 06, 2014	6-9am, 1-3:30pm, 4-7pm	Intersection	Manual Count	Yes	Yes	Approach Only
17	US 50 & Lyons Ave (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7:10-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	No	Movement-Specific Count
		LTUSD	Thursday, November 06, 2014	6-9am, 1-3:30pm, 4-7pm	Intersection	Manual Count	Yes	Yes	Approach Only
18	US 50 & South Tahoe Middle School Driveway (South Lake Tahoe)	LTUSD	Tuesday, November 04, 2014	6-9am, 1-3:30pm	Intersection	Manual Count	Yes	Yes	Approach Only
19	Lyons Ave & South Tahoe Middle School Driveway (South Lake Tahoe)	LTUSD	Tuesday, November 04, 2014	6-9am, 1-3:30pm	Intersection	Manual Count	Yes	Yes	Approach Only
20	US 50 & Johnson Blvd (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7:10-8:55am, 4-6pm	Intersection	Manual Count	Yes	Yes	Total Intersection Volume Only
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	No	Movement-Specific Count
21	Rufus Allen Blvd & Lyons Avenue (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
22	Rufus Allen Blvd & Pickett Avenue (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	Yes	Movement-Specific Count
23	Al Tahoe Blvd & El Dorado (South Lake Tahoe)	LTUSD	Thursday, October 02, 2014	7-9am, 1:30-2:30pm, 4-6pm	Intersection	Manual Count	Yes	No	Movement-Specific Count
		LTUSD	Saturday, October 04, 2014	10am-12pm	Intersection	Manual Count	Yes	No	Movement-Specific Count
24	US 50 & Lakeview Avenue (South Lake Tahoe)	City of South Lake Tahoe	Friday, August, 2001	4-6pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
		City of South Lake Tahoe	Saturday, August, 2001	10am-12pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
25	US 50 & San Jose Avenue (South Lake Tahoe)	City of South Lake Tahoe	Friday, August, 2001	4-6pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
		City of South Lake Tahoe	Saturday, August, 2001	10am-12pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
26	US 50 & Tallac Avenue (South Lake Tahoe)	City of South Lake Tahoe	Friday, August, 2001	4-6pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
		City of South Lake Tahoe	Saturday, August, 2001	10am-12pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
27	Harrison Avenue & San Jose Avenue (South Lake Tahoe)	City of South Lake Tahoe	Friday, August, 2001	4-6pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
		City of South Lake Tahoe	Saturday, August, 2001	10am-12pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
28	Harrison Avenue & Tallac Avenue (South Lake Tahoe)	City of South Lake Tahoe	Friday, August, 2001	4-6pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
		City of South Lake Tahoe	Saturday, August, 2001	10am-12pm	Intersection	Manual Count	No	Yes	Approximate Total Intersection Volume Only
29	City of South Lake Tahoe Bike Path behind Meeks (South Lake Tahoe)	TRPA/TMPO	--	--	--	--	--	--	Counter Error
30	US 50 at Sierra Boulevard (South Lake Tahoe)	TRPA/TMPO	Saturday, July 14, 2012	7am-7pm	Screenline	Manual Count	Yes	Yes	N/A
31	Pioneer Trail near Trout Creek (El Dorado County)	TRPA/TMPO	Tuesday, July 07, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
32	Tahoe Keys & Eloise (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
33	Tahoe Keys & James (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
34	3rd Street & Eloise (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
35	3rd Street & James (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A

Location #	Count Location	Lead Agency	Count Date	Count Time Period	Count Methodology	County Technology	Raw Data Available	Summary Data Available	Unique Count Attributes
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
36	Dunlap & Eloise (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
37	Dunlap & James (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
38	15th Street & Eloise (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
39	15th Street & James (South Lake Tahoe)	City of South Lake Tahoe	Wednesday, August 13, 2014	3pm-6pm	Screenline	Manual Count	Yes	Yes	N/A
		City of South Lake Tahoe	Saturday, August 16, 2014	11am-2pm	Screenline	Manual Count	Yes	Yes	N/A
40	Behind McDonalds at "Y" (South Lake Tahoe)	TRPA/TMPO	Tuesday, June 30, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Tuesday, June 30, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 15, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
41	Lake Tahoe Blvd (El Dorado County)	TRPA/TMPO	Wednesday, July 01, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 22, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
42	US 50 near Airport (South Lake Tahoe)	TRPA/TMPO	Wednesday, July 01, 2009	7-9am	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Friday, July 24, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
43	Sawmill Bike Trail	TRPA/TMPO	Saturday, August 25, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Tuesday, August 28, 2007	7-10am, 4-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Saturday, July 27, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
44	Pioneer Trail at Elks Club (El Dorado County)	TRPA/TMPO	Thursday, July 23, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
45	Sawmill Road at US 50 (El Dorado County)	El Dorado County	August 13, 2009	7:30-9:30am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
46	Sawmill Bike Trail on US 50 at Lake Tahoe Golf Course (El Dorado County)	El Dorado County	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		El Dorado County	Thursday, August 13, 2009	7:30-9:30am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
47	Sawmill Bike Trail at Santa Fe Trail (El Dorado County)	El Dorado County	Saturday, August 25, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		El Dorado County	Tuesday, August 28, 2007	7-10am, 4-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		El Dorado County	Wednesday, September 24, 2008	7-10am, 3-6pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		El Dorado County	Saturday, September 27, 2008	10am – 2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		El Dorado County	Thursday, August 13, 2009	7:30-9:30am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
48	Sawmill Pond (El Dorado County)	TRPA/TMPO	Saturday, August 31, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
49	Emerald Bay Road West of 10th Street (South Lake Tahoe)	TRPA/TMPO	Tuesday, June 30, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, August 15, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
50	Pope Beach - USFS counter (El Dorado County)	USFS	Wednesday, August 08 – Monday, August 20, 2012	Continuous	Screenline	Automatic Count	No	Yes	Average Daily Volumes Only
51	Camp Richardson (El Dorado County)	TCORP	Thursday, July 03, 1997	2 hour count	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Saturday, July 27, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A

Location #	Count Location	Lead Agency	Count Date	Count Time Period	Count Methodology	County Technology	Raw Data Available	Summary Data Available	Unique Count Attributes
52	Taylor Creek Visitor Center (El Dorado County)	USFS	Wednesday, August 08 – Monday, August 20, 2012	Continuous	Screenline	Automatic Count	No	Yes	Average Daily Volumes Only
53	Homewood (Placer County)	TRPA/TMPO	Saturday, July 18, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Thursday, August 20, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
54	West Shore Trail - Kaspian (Placer County)	TCPUD	Wednesday, August 24, 1994	8am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 03, 1997	2 hour count	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday/Thursday, August 10 & 11, 2005	7am-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday, August 09, 2006	7am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday, August 08, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Thursday, August 09, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday/Thursday, August 06 & 07,2008	8am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Wednesday, July 15, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Saturday, July 18, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday/Thursday, August 13 & 14, 2014	7am-7pm	Screenline	Automatic Count	Yes	Yes	User Intercept Survey Given
55	64-Acres Park (Placer County)	TCPUD	Wednesday, August 24, 1994	7am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 03, 1997	2 hour count	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday/Thursday, August 10 & 11, 2005	7am-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday, August 09, 2006	7am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday, August 08, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Thursday, August 09, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	
		TCPUD	Wednesday/Thursday, August 06 & 07, 2008	9am-6pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday/Thursday, August 13 & 14, 2014	7am-7pm	Screenline	Automatic Count	Yes	Yes	User Intercept Survey Given
56	Lakeside Trail (Tahoe City)	TCPUD	Wednesday/Thursday, August 13 & 14, 2014	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
57	Tahoe City Redevelopment (Tahoe City)	TRPA/TMPO	Saturday, July 18, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Tuesday, August 25, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
58	Dollar Hill (Placer County)	TCPUD	Wednesday, August 24, 1994	7am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Thursday, August 11, 2005	7am-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday, August 09, 2006	7am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCORP	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TCPUD	Wednesday, August 08, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Thursday, August 09, 2007	10am-4pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday/Thursday, August 06 & 07, 2008	9am-7pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given

Location #	Count Location	Lead Agency	Count Date	Count Time Period	Count Methodology	County Technology	Raw Data Available	Summary Data Available	Unique Count Attributes
		TRPA/TMPO	Saturday, July 18, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Tuesday, August 25, 2009	7-10am, 5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TCPUD	Wednesday/Thursday, August 13 & 14, 2014	7am-7pm	Screenline	Automatic Count	Yes	Yes	User Intercept Survey Given
59	SR 28 & National Avenue Intersection (Placer County)	TRPA/TMPO	Friday, August 28, 2009	6:45-8:45am	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
60	National Avenue (Placer County)	TRPA/TMPO	Thursday, July 05, 2007	10am-2pm	Screenline	Manual Count	Yes	Yes	User Intercept Survey Given
		TRPA/TMPO	Saturday, July 25, 2009	10am-2pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Wednesday, August 12, 2009	5-7pm	Screenline	Manual Count	Yes	Yes	N/A
		TRPA/TMPO	Thursday, August 13, 2009	7-10am	Screenline	Manual Count	Yes	Yes	N/A
61	SR 28 & SR 267 Intersection (Kings Beach)	TRPA/TMPO	Friday, August 28, 2009	6:45-8:45am	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
62	SR 28 & Bear Street/Brook Avenue Intersection (Kings Beach)	TRPA/TMPO	Wednesday, August 26, 2009	6:45-8:45am	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
		TRPA/TMPO	Saturday, July 27, 2013	7am-7pm	Screenline	Automatic Count	Yes	Yes	N/A
63	SR 28 & Coon Street Intersection (Kings Beach)	TRPA/TMPO	Wednesday, July 24, 2013	7am-7pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg and Bicycle Approach Only
		TRPA/TMPO	Saturday, July 27, 2013	7am-7pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg and Bicycle Approach Only
64	SR 28 & Fox Street Intersection (Kings Beach)	TRPA/TMPO	Friday, August 28, 2009	6:45-8:45am, 3:45-5:45pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
65	Coon Street & Salmon Avenue Intersection (Kings Beach)	TRPA/TMPO	Thursday, September 3, 2009	3:45-5:45pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
		TRPA/TMPO	Friday, September 4, 2009	7:15-9am	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
66	Coon Street & Brook Avenue Intersection (Kings Beach)	TRPA/TMPO	Thursday, August 27, 2009	6:45-8:45am, 3:45-5:45pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
67	Fox Street & Salmon Avenue Intersection (Kings Beach)	TRPA/TMPO	Friday, September 4, 2009	6:45-8:45am, 3:45-5:45pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
68	Fox Street & Brook Avenue Intersection (Kings Beach)	TRPA/TMPO	Friday, September 4, 2009	7-9am, 2:45-4:45pm	Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only
		TRPA/TMPO	Friday, September 4, 2009		Intersection	Manual Count	Yes	Yes	Crosswalk Leg Only

Appendix 2
Literature Review

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MEMORANDUM

Date:	July 7, 2015	Project #: 13913.01
To:	Morgan Beryl Tahoe Regional Planning Agency / Tahoe Metropolitan Planning Organization 128 Market Street Stateline, NV 89410	
From:	Matt Braughton; Kamala Parks; Jim Damkowitch	
Project:	Lake Tahoe Region Bicycle & Pedestrian Monitoring Protocol	
Subject:	Bicycle and Pedestrian Monitoring Best Practices Literature Review	

INTRODUCTION

Leading up to the *Linking Tahoe: Active Transportation Plan – Bicycles, Pedestrians & Safe Routes to Schools*, Kittelson & Associates, Inc. (KAI) is working with the Tahoe Regional Planning Agency/Tahoe Metropolitan Planning Organization (TRPA/TMPO) to develop a Bicycle and Pedestrian Monitoring Protocol. The purpose of the monitoring protocol project is to establish an efficient and effective monitoring program to inform active transportation trends and investment benefits. As a first step in this monitoring implementation protocol, KAI has reviewed the literature for current best practices in monitoring bicycle and pedestrian activity, as well as adjustment and extrapolation methodologies to assist TRPA/TMPO in its ongoing monitoring efforts.

This memorandum summarizes the findings from the literature reviews conducted as part of *NCHRP 797: Guidebook on Pedestrian Bicycle Volume Data Collection* and the Southern California Association of Governments' *Conducting Bicycle and Pedestrian Counts: A Manual for Jurisdictions in Los Angeles County and Beyond*. First, a summary matrix of case studies of bicycle and pedestrian count programs across the county is provided, along with recommendations for TRPA/TMPO's monitoring protocol based on these programs. Second, existing monitoring technologies are summarized. Third, adjustment and extrapolation factors are discussed and summarized. Recommendations based on the unique characteristics of the Lake Tahoe Basin (including seasonal activity, tourism, and land use patterns) recommendations are made for adjustment and extrapolation factors to be used by TRPA/TMPO as data is available.

CASE STUDY SUMMARIES

This section presents summaries of bicycle and pedestrian monitoring protocols programs and studies relevant to TRPA/TMPO, focusing specifically on identifying monitoring programs in areas with snow conditions, high levels of recreational activity, and similar areas using extrapolation factors.

The Minnesota Bicycle and Pedestrian Counting Initiative

The Minnesota Bicycle and Pedestrian Counting Initiative is an initiative and research study undertaken by the Minnesota Department of Transportation (MnDOT) to take stock of bicycle and pedestrian monitoring efforts taking place within Minnesota. Minneapolis Department of Public Works is one of the agencies reviewed, and is collecting over 400 manual counts following the National Bike and Pedestrian Documentation Project (NBPD) protocols[1] and automatic counts on three trails. In addition, the Three Rivers Park District is collecting manual counts on 250 trail segments following NBPD protocols as well as 7 semi-permanent infrared automatic count locations. The scan of the state's bicycle and pedestrian monitoring efforts found a wide range of communities and organizations interested in collecting data, ranging from nonprofit organizations to regional councils. Many of the agencies included in the count evaluation based their efforts off the NBPD protocols, however these were frequently adjusted for local use. Additionally, state and local recreational agencies were found to often use different protocols than those typically used for monitoring efforts. These protocols include infrequent counting or counting that occurs across various time scales (annual, several times annual, or every few years) and variable durations (counts of several hours to multiple months). Often the data is aggregated from these counts in ways that is not directly comparable to screen-line or cordon counts.

In response to these findings, MnDOT recommended guidance for bicycle and pedestrian monitoring including:

- Standard forms for field counts;
- Training materials to ensure consistent count practices;

[1] The National Bicycle and Pedestrian Documentation (NBPD) Project is an annual count and survey effort sponsored by the Institute of Transportation Engineers Pedestrian and Bicycle Council. The NBPD protocol proposes conducting annual counts during the second week of September for at least one weekday and a Saturday. Additional optional count dates are suggested in January, May, and July. The September National Count Date was selected because it represents peak periods for both walking and bicycling for work- and school-related trips, and weather conditions are usually moderate.

- Development of sample public information sheets to explain the purpose of non-motorized monitoring efforts;
- Determining the purpose for counting prior to conducting counts;
- Checklists to ensure valid counts; and,
- Spreadsheets for storing the results of counts.

MnDOT's effort to standardize data collection across a wide range of agencies and jurisdictions represents a good example of interagency coordination. In particular, the MnDOT highlights the importance of coordinating with organizations focused on recreational activity, because while the organizations may be interested in collecting activity data, the format and type of count collected may differ. Given the numerous recreational organizations and large number of jurisdictions within the Lake Tahoe Region, a strong emphasis on interagency coordination and efforts to standardize bicycle and pedestrian data collection are critical to ensuring the monitoring protocol's success.

Portland Area Comprehensive Transportation System (Maine)

The Portland Area Comprehensive Transportation System (PACTS) Count Project consists of a partnership of the Bicycle Coalition of Maine with the PACTS MPO to conduct regular bicycle and pedestrian counts at key locations in the region consistent with the NBPD protocols. The count program seeks to understand regional bicyclist and pedestrian behavior with counts occurring in May and September (when demand is high) as well as in mid or late January to understand seasonal variations in bicycling and walking once people have resumed their normal schedules after the holidays. The partnership with the Bicycle Coalition of Maine involves the provision of training materials, count forms, and establishment of count times, durations, and dates for volunteers. Volunteers from the Bicycle Coalition are assigned times and days on which to collect data and the data is collected and verified by the Bicycle Coalition, and stored in a web map by PACTS.

Counts are conducted mid-week during the AM and PM commute hours and on Saturdays during the midday peak hour. Locations were chosen based on historical count locations, non-motorized activity, regional corridors, path or park access points, on-street bicycle facilities, employment/mixed-use areas, nearby transit, and stakeholder recommendations. Winter counts are performed at a more limited set of locations where year-round bicycle and pedestrian activity is expected. Training materials and count forms are made available to the public to capture counts and input their data into online spreadsheets.

The PACTS Count Project represents a good example of a region dealing with strong seasonal variation collecting data during both the peak fall season, as well as during the winter season when activity patterns are significantly different. Given the high variability in activity centers between the summer and fall recreational seasons and winter activities in the Lake Tahoe

Region, TRPA/TMPO should ensure that seasonal data collection occurs through the use of automatic counters and/or supplemental winter manual counts of bicycle and pedestrian activity.

Boulder County Bicycle Counting Program

Boulder County Transportation Department has adapted its motor vehicle count program to integrate bicycling counting in a cost-effective manner using motor pneumatic tubes to collect bicycle volume data. As part of this effort Boulder County developed a new classification scheme (BOCO, the Boulder County Scheme) that included new classes to better capture bicyclists and groups of bicyclists. This new classification scheme has allowed Boulder County to collect bicycle count data as part of its general motor vehicle count program. Additionally, Boulder County has also developed daily and monthly factors using an estimate of average annual daily bicyclists. These efforts have resulted in the development of annual maps of average annual weekend and weekday bicyclists for the unincorporated portions of the County.

Boulder County represents a region similar to the Lake Tahoe Region with snowy conditions, mountainous terrain, and high levels of seasonal recreational activity. As such, the system used by Boulder County offers an opportunity for TRPA/TMPO to adapt an existing, successful system of bicycle activity pattern well-suited to conditions and activity patterns similar to the Lake Tahoe Region.

Additional Monitoring Programs

In addition to the monitoring programs highlighted above, high-level summaries of numerous case studies performed as part of *NCHRP 797* are highlighted below. Exhibit 1 and Exhibit 2 present examples of monitoring programs for pedestrians and bicyclists, respectively.

Exhibit 1. Examples of Pedestrian Count Programs

Agency	Number of Sites	Count Frequency	Count Duration	Time Period	Count Method	Location Type	NBPD[1] Method	Site Selection Criteria
Minneapolis Public Works Department	23 annual sites 300 three-year sites	Annual and 3-year	2, 12, and 24- hour	Midweek Sept.	Manual	Mid-block screenlines	X	• High traffic locations • Range of facility types • Near planned projects
Delaware Valley Regional Planning Commission	Numerous locations	2010-11	Weeklong		Automated	Mid-block screenlines		
BikeArlington	11 locations	Continuous	Continuous	Continuous	Automated	Trails	X	• Trail locations
Portland (Oregon) Bureau of Transportation	14 automated demonstration sites 156 manual sites	Automated: Continuous Manual: annual	Automated: Continuous Manual: 2-hour PM	Automated: Continuous Manual: Midweek July-Sept	Pushbutton actuations Manual	Bridges, paths, intersections	X	• Bridges • Trails • Geographic diversity
Boston Region Metropolitan Planning Organization	500+ counts	Varies (1974 to present)	Varies		Manual	Varies		
San Francisco Metropolitan Transportation Commission	100-150 sites	Periodic	2-hour	Midweek Sept/Oct midday & PM	Manual	Intersections/ crossings	X	• Bicycle count locations
Puget Sound Regional Council	384 sites	One-time (2010)	3-hour	Midweek Oct. AM and PM	Manual	Trails, intersections		
San Francisco Municipal Transportation Agency	25 manual sites per year Rotating automated counter sites	Annual	Manual: 2-hour Automated: 2-week	Manual: Midweek AM and PM Automated: continuous	Manual and automated	Intersections/ crossings		• Geographic distribution • Land use characteristics • Demographic characteristics • Proximity to transit
Mid-Ohio Regional Planning Commission	22 sites	Biannual	2-hour	AM and midday	Manual	Midblock screenlines	X	• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas
City of Glendale, California	24 sites	One-time (2009)	2-hour peaks	Weekday AM and PM Weekend midday	Manual	Intersections	X	• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas

Agency	Number of Sites	Count Frequency	Count Duration	Time Period	Count Method	Location Type	NBPD[1] Method	Site Selection Criteria
Washington State Department of Transportation	229 sites	Annual	3-hour	Midweek Sept. AM and PM	Manual	Paths and midblock screenlines	X	• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas
Colorado Department of Transportation	6 permanent sites 5 rotating temporary sites	Continuous	Continuous	Continuous	Automated	Trails/paths	X	

[1]National Bicycle and Pedestrian Documentation Project.
Source: *NCHRP 7-19 Methods and Technologies for Pedestrian and Bicycle Volume Data Collection*

Exhibit 2. Examples of Bicycle Count Programs

Agency	Number of Sites	Count Frequency	Count Duration	Time Period	Count Method	Location Type	NBPD[1] Method	Additional Data Recorded	Site Selection Criteria
Minneapolis Public Works Department	30 annual sites 300 three-year sites	Annual and 3-year	2, 12, and 24- Hour	Midweek Sept.	Manual and automated	Trails and midblock screenlines	X	• Sidewalk riding	• High traffic locations • Range of facility types • Near planned projects
Delaware Valley Regional Planning Commission	Numerous locations	2010-11	Weeklong		Automated	Mid-block screenlines			
BikeArlington	11 locations	Continuous	Continuous	Continuous	Automated	Trails	X		• Trail locations
Portland Bureau of Transportation	14 automated sites 4 automated bridge sites 156 manual sites	Automated: Continuous Manual: annual	Automated: Continuous Manual: 2-hour PM	Automated: Continuous Manual: Midweek July-Sept.	Loop detectors Manual and automated	Bridges, paths, and intersections		• Bicycle delay • Helmet use • Gender • Turning movement	• Bridges • Trails • Bike routes Geographic diversity
Boston Region Metropolitan Planning Organization	500+ counts	1974 to present		Varies	Manual	Varies		• Varies	
San Francisco Metropolitan Transportation Commission	100-150 sites	Periodic (2002-04, 2010-11)	2- Hour	Midweek Sept/Oct Midday or AM and PM	Manual	Intersections/ crossings	X		• High bicycle collision rates • On the local or regional bicycle network • Proximity to major transit facilities • Proximity to schools and colleges/universities • Proximity to attractions/destinations
Puget Sound Regional Council	384 sites	One-time count (2010)	3-hour	Midweek Oct. AM and PM	Manual	Trails, intersections		• Turning movement • Helmet use • Bicycles on buses • Weather	
San Francisco Municipal Transportation Agency	41 manual sites 16 automated sites		Manual: 2-hour Automated: Continuous	Manual: Midweek Sept. PM Automated: Continuous	Manual and automated	Intersections	X	• Wrong-way and sidewalk riding • Turning movement • Helmet use	• New bicycle facilities • Heavy transit/pedestrian sites • High bicycle traffic

Agency	Number of Sites	Count Frequency	Count Duration	Time Period	Count Method	Location Type	NBPD[1] Method	Additional Data Recorded	Site Selection Criteria
Mid-Ohio Regional Planning Commission	22 sites	Biannual	2-hour	AM and midday	Manual	Midblock screenlines	X	• Sidewalk riding • Gender • Weather	• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas
Glendale, California	24 sites	One-time count (2009)	2-hour	Weekday AM and PM Weekend midday	Manual	Intersections	X	• Helmet use • Wrong-way riding • Sidewalk riding	• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas
Washington State Department of Transportation	229 sites	Annual	3-hour	AM and PM Midweek September	Manual	Paths and midblock screenlines	X		• Activity areas or corridors • Representative locations • Key corridors • Previous count locations • Potential improvement areas • High-collision areas
Colorado Department of Transportation	6 permanent sites 5 rotating temporary sites	Continuous	Continuous	Continuous	Automated	Trails/paths			

[1]National Bicycle and Pedestrian Documentation Project.

Case Study Summary Recommendations

Given the case studies above, KAI has developed the following recommendations for the TRPA/TMPO *Bicycle and Pedestrian Monitoring Implementation Protocol*:

- Establish key count locations based on locally-determined criteria similar to Portland, Maine's Portland Area Comprehensive Transportation System count program, including selected winter count locations;
- Partner with local bicycle and pedestrian nonprofits following the PACTS example to engage stakeholders and reduce need for initial internal staff time;
- Develop standardized count forms, training materials, and outreach materials for volunteers to use while collecting counts to increase accuracy and consistency;
- As funding permits, establish permanent weather-sensitive automatic count locations to help develop regional extrapolation factors for different bicycle and pedestrian activity patterns (commute vs. recreational) and area types.

COUNT METHODOLOGIES

There are roughly three categories of data collection technologies:

- *Manual counts* – Human data collectors perform counts in the field, and record results with a writing implement and paper, automated count board, or smartphone application.
- *Video observations* – Data is recorded by camera and later processed by technicians in a video lab
- *Automated counts* – Data is collected and stored using an automatic sensor and summarized by downloading reports.

According to NCHRP Project 7-17, *Pedestrian and Bicycle Transportation along Existing Roads*, 54% of agencies use manual counts to collect bicycle data, 24% use video observations, and 22% use automated counters.

What follows is a summary of how each category of count works, its issues, and specific technologies.

Manual Counts

Counts are usually recorded for one to four hours in discrete time intervals, generally 15 minutes. However, some count boards are also capable of time-stamping all data points. Manual counts can be done in conjunction with automobile counts and have the flexibility to gather additional information desired about travelers, such as directional and turning information, gender, helmet usage (for cyclists), or behaviors, such as use of mobile devices. Manual counts can be performed at screenline, intersection, or midblock locations.

Many jurisdictions currently rely on manual counts taken on an annual basis at strategically chosen and distributed locations, either with the assistance of hired professional consultants or volunteers. To reduce error, data collectors should be trained so they have a clear understanding of the count methodology. In addition, managers should plan data collection efforts carefully, ensuring that there are enough data collectors at high-volume locations so that each person can do their portion of the counts accurately.

Video Observations

Video observations are closely related to manual counts, in that humans collect the data and use a variety of tools to record the data. However, field data is collected first by camera installed in the field then the information is processed by technicians in a video lab. Technicians review the tape and typically the accuracy of the count increases due to the ability for technicians to rewind/review the recording to ensure counts are conducted properly. Additionally, the recordings allow for supervisors to better conduct quality control. Depending on the recording quality, video data also enables the collection of bicyclist characteristics more readily, such as helmet use and gender. Using cameras can provide a permanent record of the count for future verification and for collecting additional data that was not specified in the original count. It can also record longer periods of observations for which human observers in the field would not be recommended due to fatigue.

Cameras can only capture a limited area as opposed to human field technicians who have a wider visual range. Cameras must be mounted in such a way that maximizes its scope while also maximizing video quality, which can be a challenge in some locations. Cameras are prone to theft and vandalism as well as occasional malfunctions and vary in video quality due to the cameras themselves, mounting procedures, or weather/lighting factors. Additionally, video quality degrades with light attenuation making it only possible to record data during daylight hours unless lighting is provided.

Costs for video observations are typically high compared to automatic count technologies because of the labor costs involved for technicians to install and remove the cameras and for the labor costs to review and verify the observations. If the data is collected by the agency, sufficient budget and time should be set aside to purchase the camera(s) and any required equipment to mount the device, as well as staff time to install, review, and document the recorded observations. Alternatively, many data collection firms use video observations for traffic data collection and can include bicycle and pedestrian counts as well or counted separately. However, as the number of hours for data collection increases, the necessary budget needed to process the video recordings will increase.

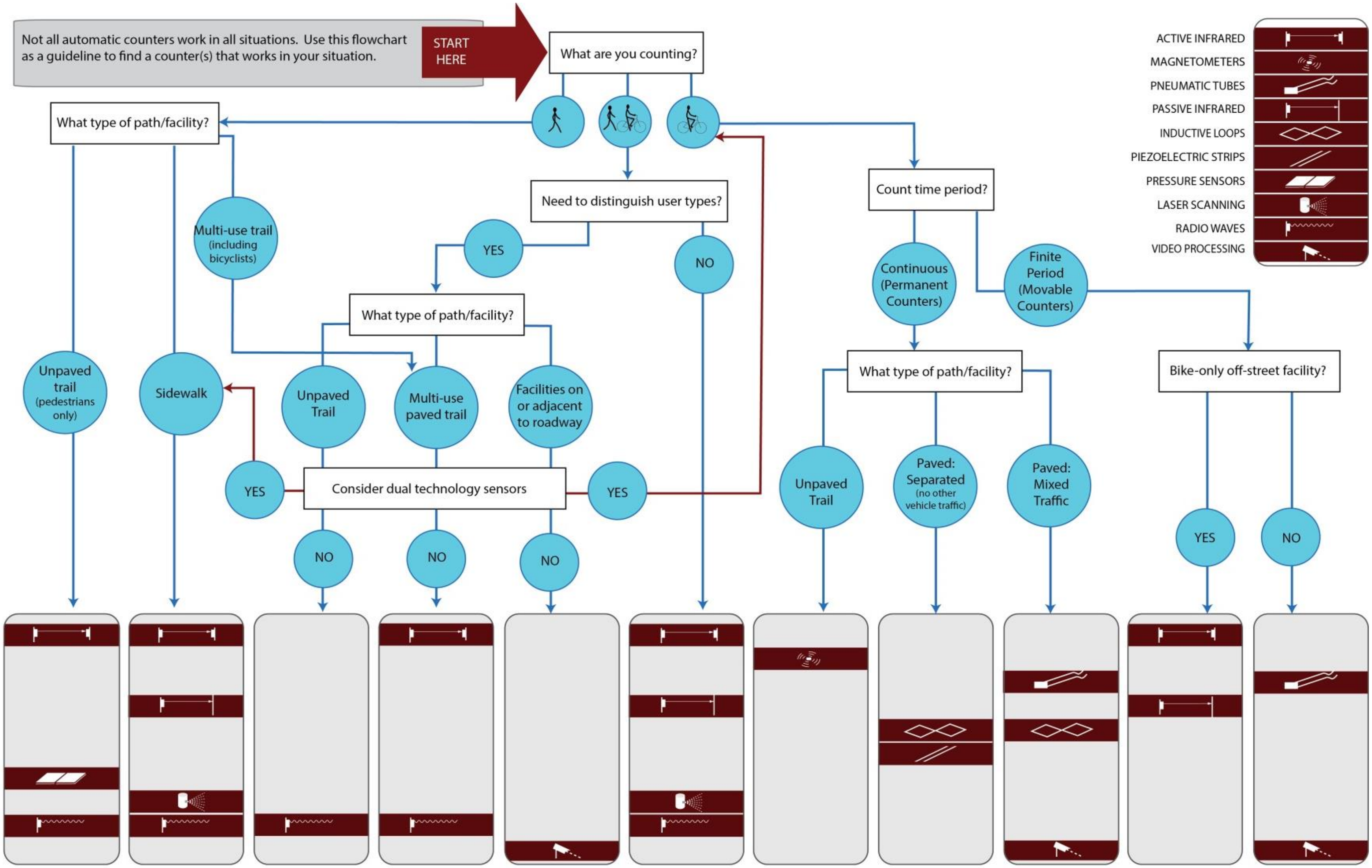
Automatic Counts

There is a large array of automatic count technologies that can be used to count bicyclists. A decision flow chart to help determine the need for automatic counters is shown in Exhibit 3. The following is a summary of each type.

- *Pneumatic tubes:* two rubber tubes are stretched across the right-of-way, and record counts when bicycles pass over them.
- *Piezoelectric strips:* material that produces an electric signal when deformed and is laid on or under the ground in two strips.
- *Fiber-optic pressure sensors*: sensors detect changes in the amount of light transmitted through an imbedded fiber-optic cable based on the amount of pressure (weight) applied to the cable.
- *Inductive loop detectors:* wires are installed in or on top of pavement to detect bicycle activity through their disruption of an electromagnetic field.
- *Active infrared:* bicycles are detected when an infrared beam is broken.
- *Passive infrared:* identifies the heat differential of bicyclists or pedestrians when they pass through the detection area.
- *Laser scanning:* laser pulses are sent out in a range of directions, details of the surroundings, including pedestrians and bicyclists, are recorded based on reflected pulses.
- *Radio waves:* detect bicycles when a radio signal between a source and a receiver is broken.
- *Video image processing:* uses visual pattern recognition technology and computerized algorithms to detect bicyclists.
- *Magnetometers:* detect bicycle activity through changes in the normal magnetic field.
- *Radar:* emits radio wave pulses and counts bicyclists based on an analysis of reflected pulses.

A summary of each automatic count technology from the Southern California Association of Governments' *Conducting Bicycle and Pedestrian Counts* report is provided below.

Exhibit 3. Decision Flow Chart for Automatic Counters



Source: Southern California Association of Governments. *Conducting Bicycle and Pedestrian Counts* (2013).

Pneumatic tubes

What it counts:	Bicycles
What it is:	Two rubber tubes are stretched across the right-of-way, and record counts when bicyclists pass over them.
How it works:	When a bicycle or other vehicle passes over the tubes, pulses of air pass through to a detector which then deduces the vehicle's axle spacing, and hence classifies it by vehicle type.
Advantages:	Familiar technology to most jurisdictions; Widespread use by data collection firms; Portable, easy to set up, and inexpensive; Battery powered; Captures directionality.
Drawbacks:	Susceptible to theft, vandalism, and wear-and-tear; May be a tripping hazard for pedestrians; Not appropriate in cold weather conditions; Can deteriorate under high bicycle or vehicular traffic, thus reducing their accuracy; On-site data downloading; May not detect side-by-side riding.
Typical location:	On-road bikeways and exclusive bike paths
Best installation:	Paved surface, minimal pedestrians, above freezing weather conditions
Count duration:	One day to several months
Accuracy:	Error rate is 4% or less for 24-hour counts, a higher error rate for 15-minute intervals

Pneumatic tubes on cycle track in Vancouver, BC
Photo Source: Paul Kreuger

Inductive loop detectors

What it counts:	Bicycles
What it is:	Loops of wire with a current running through them. Devices can be placed on top of the roadway or paved trail surface (temporary) or under the surface (embedded).
How it works:	Detects bicycles through their disruption of an electromagnetic field.
Advantages:	Flexibility to be portable or permanent installations; Novel inductive loops are capable of distinguishing bicyclists from vehicles; Familiar technology to most jurisdictions; May store data on-site or at a remote, centralized location.
Drawbacks:	Cannot be installed near sites of high electromagnetic interference; Embedded detectors are expensive to install; Requires a nearby source of electric power; Need to be calibrated to detect bicycles; May not detect side-by-side riding or bicycles with non-metal frames.
Typical location:	Paved locations such as on-road bikeways and mixed-use paths
Best installation:	Mid-segment and channelized location where bicyclists will travel single file and will not generally stop, exclusive bike use or mixed-traffic environment
Count duration:	Weeks to permanent
Accuracy:	Error rate is 4% or less for longer duration counts, a higher error rate for shorter intervals

Embedded inductive loop detector in bike lane
Photo Source: Ecocounter

Piezoelectric strips

What it counts:	Bicycles
What it is:	Two piezoelectric strips that are laid across the right-of-way embedded within a paved surface
How it works:	Emits an electric signal when they are physically deformed by tires
Advantages:	Provide bicyclist speed data and directionality; Low profile and not susceptible to tampering; Can be battery-powered or externally powered; Data can be stored onsite or transmitted wirelessly.
Drawbacks:	Cannot distinguish bicycles in mixed flow traffic or adjacent to vehicle traffic; Cannot detect pedestrians; Detectors require careful installation
Typical location:	Paved locations with no vehicle traffic, such as bicycle and multi-use paths
Best installation:	Two strips across entire width of path or bikeway
Count duration:	Permanent
Accuracy:	Unknown for bicycle counts

Installation of embedded piezoelectric strips
Photo Source: Metrocount

Piezoelectric strips on bike path
Photo Source: Metrocount

Pressure or acoustic pads

What it counts:	Pedestrians, bicyclists, pedestrians and bicyclists together
What it is:	A pad installed at or under the surface
How it works:	Pressure pads detect the weight when they come in contact with pedestrians or bicyclists; Acoustic pads detect the sound waves from footsteps of pedestrians only.
Advantages:	They work well for counting pedestrians on unpaved trails; Low profile and not susceptible to tampering; Battery-powered; Data can be stored onsite or transmitted wirelessly, depending on vendor.
Drawbacks:	Bicyclists and pedestrians must come in direct contact with the pads to be detected; Susceptible to detection problems when ground freezes; Pressure pads do not distinguish between pedestrians and bicyclists; Acoustic pads only count pedestrians; High cost to install on paved paths; lack of mobility.
Typical location:	Unpaved trails, unpaved walkways, and public stairways
Best installation:	Channelized areas where pedestrians and bicyclists must travel single file and they will not linger, above freezing weather conditions
Count duration:	Permanent
Accuracy:	Unknown for bicycle or pedestrian counts

Pressure pads on unpaved path before being covered
Photo Source: Scottish National Heritage

Active infrared

What it counts: Bicycles and pedestrians

What it is: A device on one side of the count corridor transmits a pulsed infrared beam to a receiver at the other side of the right-of-way.

How it works: Pedestrians and bicycles are detected when the infrared beam is broken. A specifically designed algorithm can differentiate between bicycles and pedestrians.

Advantages: Can count bicycles and pedestrians with one device; Portable; Relatively low cost; Battery-powered.

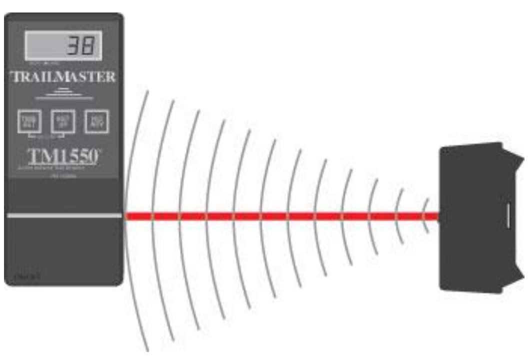
Drawbacks: Cannot be used in mixed vehicle locations; Can be triggered by other objects, such as falling leaves, snow, animals, or insects; Visible and thus susceptible to vandalism; May not accurately count groups or side-by-side pedestrians or bicyclists; Installation requires mounting devices to fixed objects on each side of the trail; On-site data downloading.

Typical location: Off-street paved or unpaved paths.

Best installation: About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, receiver and transmitter should be no more than 90 feet apart, locate where pedestrians or bicyclists will not linger

Count duration: Several weeks to permanent

Accuracy: Error rate varies considerably based on installation site and ranges from 12-48% in published studies.



Active Infrared Receiver (left) and Transmitter (right)
Image Source: Trailmaster

Passive infrared (aka Pyroelectric)

What it counts: Bicycles and pedestrians together

What it is: A device positioned on one side of the count corridor. It can be disguised inside a post or existing infrastructure.

How it works: Identifies the heat differential of bicyclists or pedestrians when they pass through the detection area.

Advantages: Movable and easy to install; Can be used with a bicycle-only count technology to differentiate users; Battery-powered; May store data on-site or transmit data wirelessly, depending on vendor.

Drawbacks: Cannot be used in mixed vehicle locations; Is prone to error due to changes in the background (e.g. sun reflection); Dual sensors are needed to detect directionality; May not perform as well in cold weather conditions.

Typical location: Sidewalks or urban pedestrian-only corridors; Off-street paved or unpaved paths

Best installation: About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, receiver and transmitter should be no more than 90 feet apart, locate where pedestrians or bicyclists will not linger

Count duration: Several weeks to permanent

Accuracy: Error rate varies considerably based on installation site and ranges from 1-36% in published studies.

Installed passive infrared sensor
Photo Source: Ecocounter

Bi-directional passive infrared sensor
Photo Source: Ecocounter

Laser scanning

What it counts:	Bicycles and pedestrians
What it is:	A horizontally or vertically scanning device at the side or above the detection area.
How it works:	Laser pulses are sent out in a range of directions, and pedestrians and bicyclists are recorded based on reflected pulses.
Advantages:	Can cover a large detection area; Can be used in mixed traffic areas; Battery-powered
Drawbacks:	Does not function well in rain, fog, or snow; Can be triggered by other objects, such as falling leaves, snow, animals, or insects; Expensive; Heavy computational loads; May not capture side-by-side walking or biking.
Typical location:	Large detection areas of non-motorized travel, such as a transit station or plaza.
Best installation:	Horizontal scanners are best located where there are no obstructions, vertical scanners must be mounted above detection area
Count duration:	Weeks to permanent
Accuracy:	5% or more error, may be more in highly crowded environments

Horizontal Laser Scanner
Photo Source: LogObject

Radio waves

What it counts:	Bicycles and pedestrians
What it is:	A radio transmitter and receiver positioned on opposite sides of the count corridor.
How it works:	Detects bicycles and pedestrians when a radio signal between a source and a receiver is broken. Dual beams with different frequencies can be used to differentiate between bicycles and pedestrians.
Advantages:	Can differentiate between bicyclists and pedestrians; Movable and easy to install; Can be hidden within wood or stone posts; Battery powered.
Drawbacks:	On-site data collection; Does not accurately count groups or side-by-side pedestrians
Typical location:	Off-street trails or on-street detection for bicycles and vehicles.
Best installation:	About two to three feet above ground, set to capture data at a 45 degree angle to the path of travel, locate where pedestrians or bicyclists will not linger and they will travel single file
Count duration:	Months to permanent
Accuracy:	Unknown

Radio wave detection box and data download
Photo Source: Trail Counters

Video image processing

What it counts: Bicycles, pedestrians, and vehicles.

What it is: Video recorders mounted above the count area to record movements coupled with a software program that processes the video to produce counts.

How it works: Uses visual pattern recognition technology and computerized algorithms to detect bicyclists, pedestrians, and vehicles.

Advantages: Can count in mixed traffic situations; can provide full intersection turning movement counts as well as screenline counts; Portable and easy to install; Can be rented.

Drawbacks: More expensive to purchase and process data than other devices; Not practical for long-term counts; Lighting and weather conditions affect accuracy; Umbrellas result in detection problems; Video must be manually submitted for processing.

Typical location: Roadway intersections or corridors

Best installation: Attach unit to street furniture or tripod and raise camera far enough up to capture the desired area, not during rainy conditions.

Count duration: Finite time periods up to one-week counts

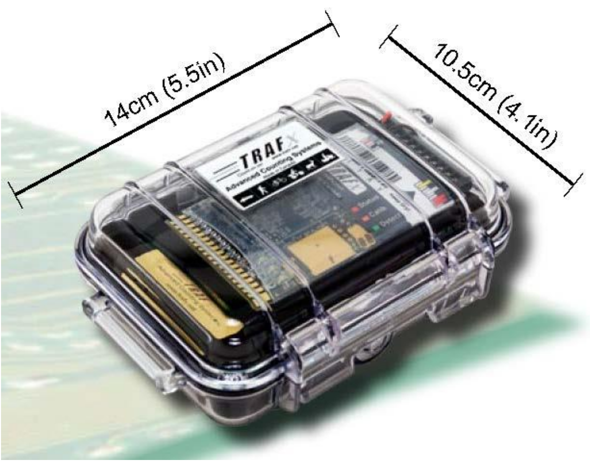
Accuracy: 2% to 14% error rate

Video image recording by the Scout
Photo Source: Miovision Technologies

The Scout video collection unit
Image Source: Miovision Technologies

Magnetometers

What it counts:	Bicycles
What it is:	A small device that is buried under or next to a bike trail.
How it works:	Detects bicycle activity through changes in the normal magnetic field.
Advantages:	Invisible after installation, and not susceptible to tampering; Battery-powered; Easy installation
Drawbacks:	On-site data downloading; relatively small detection radius of approximately three feet.
Typical location:	Mountain bike trails or 6-ft wide off-street trails.
Best installation:	Unpaved or paved trails in rural or remote locations where bicyclists must travel single file.
Count duration:	Permanent
Accuracy:	Unknown



Magnetometer
Image Source: Trafx

Bicycle Barometer

What it counts:	Bicycles
What it is:	A high visibility display of the number of bicycles counted at a particular location.
How it works:	The barometer can be linked to various automatic count technologies, such as inductive loops or pneumatic tubes, and displays the number of bicycles passing that location each day.
Advantages:	Provides a high visibility count of bicycles; increases awareness of bicyclists.
Drawbacks:	Additional cost and installation.
Typical location:	A high bicycle volume corridor in a high visibility area.
Count duration:	Permanent
Accuracy:	Depends on count technology used

Bicycle Barometer
Photo source: Kittelson & Associates, Inc.

Emerging Technologies

There are a number of other technologies and techniques that are available for gathering bicycle and pedestrian sample data, but they have not been successfully used for estimating total bicycle or pedestrians volumes. These approaches are better suited to developing origin-destination travel patterns, investigating route choice, and developing system-wide mode share estimates. Bluetooth detectors, GPS data collection, pedestrian signal actuation buttons, radio-frequency (RF) tags, and surveys have all been used to gather sample data and establish minimum bicycle volumes on various facilities. However, it is not possible to reliably convert this sample data to total counts due to the influence of multiple location-specific factors (e.g. smart phone usage, transit mode share).

The applicability of different count technologies is summarized below in Exhibit 4.

Exhibit 4. Applicability of Count Technologies to Different Counting Environments

Counting Environments	Radar	Infrared	Pneumatic Tube	Inductive Loop	Fiberoptic Cable	Video	Manual
Cycle track	X	X	X	X	X	X	X
Shared-use paths	(X)[6]	(X)[6]	X	X	X	X	X
Low speed	X	X			X	X	X
Mixed traffic[1]	(X)[4]	(X)[4]	(X)[5]			--[7]	X
High traffic volume	X	X	X	X	X	X	X
Snow-covered street	X[3]	X		X		X[3]	X
Intersections						X	X

Source: Niska et al. *VTI Report 743* (2012).
Notes: Parentheses indicate that the technology is possible, but may have detection problems.
[1] Mixed motor vehicle and bicycle traffic.
[2] Adhesive loops exist that do not need to be permanently installed.
[3] High snowfall can create problems.
[4] Distinguishing bicyclists can be problematic with high volumes, with many missed detections.
[5] Vibrations for motor vehicles, particularly trucks, interpreted as bicyclists.
[6] Difficult to distinguish between pedestrians and biyclists.
[7] No experience with this application.

ADJUSTMENT AND EXTRAPOLATION FACTORS

This section summarizes the types of factors for adjusting and extrapolating counts currently in use, based on the available literature and case studies in *NCHRP 797*. An important distinction should be made between the concepts of correction factors and adjustment/extrapolation methods. Both approaches adjust raw data. However, they are differentiated as follows:

- Correction factors are used to eliminate systematic inaccuracies (e.g., over- or undercounting) in pedestrian or bicycle counts that result from the data collection technology used.
- Extrapolation methods are used to expand short-duration counts to estimate volumes over longer time periods or to compare counts taken under different conditions.

Correction factors have been developed for a few pedestrian and bicycle counting technologies based on the accuracy studies described in the proceeding section. These correction factors may not be straightforward, linear, or necessarily similar to motor vehicle counter correction factors. Certain technologies may over- or under-count by different amounts under different conditions, so different correction factors may be needed for the same type of technology in different situations. Most pedestrian and bicycle counting technologies have not been tested rigorously for accuracy, so variable correction factors are rare.

The remainder of this section summarizes extrapolation methods used in pedestrian and bicycle travel monitoring. Extrapolation methods address common challenges faced when converting raw pedestrian or bicycle count data into useful information for technical analysis and public presentation.

Temporal Adjustment Factors

Temporal adjustment factors are used to account for “peaking” patterns, or the tendency for pedestrian or bicycle volumes to be distributed unevenly throughout the day, week, or year. For example, there may be high pedestrian volumes on sidewalks in an urbanized area at 5 p.m., but relatively low volumes at 3 a.m. A popular recreational trail may have higher bicycle volumes on weekends than weekdays.

The most basic form of extrapolation is to multiply a short-duration count by the inverse of its proportion of the longer time period to estimate the volume during the longer time period. For example, if each hour of the day had exactly the same number of pedestrians or bicyclists at a particular location, each hour would represent approximately 4.2% (1 hour/24 hours) of the daily volume. In this case, it would be possible to multiply the one-hour volume by 24 to estimate the daily volume. However, pedestrian and bicycle volumes are rarely constant over long periods of time. Several studies have developed temporal adjustments to more accurately reflect uneven distributions of pedestrian and bicycle activity.

The draft *2014 Traffic Monitoring Guid*e (TMG) also includes guidance on how non-motorized volume data collection and reporting should account for time of day, day of the week and seasonal variability and should account for any traffic patterns over time. Comprehensive information on this topic is limited, primarily because very few public agencies have collected and analyzed continuous non-motorized traffic data to date. To account for daily, weekly, and seasonal variability, the draft TMG recommends non-motorized data collection programs include both continuously operating data collection sites to provide data on seasonal and day of week trends and short duration sites to account for specific geographic traffic patterns and time of day trends.

The *National Bicycle and Pedestrian Documentation Project* has also started to identify Count Adjustment Factors that can be used to adjust counts conducted during almost any period on multi-use paths and pedestrian districts to an annual figure. These factors adjust one-hour counts to annual totals by considering weekly, monthly, and trends in walking and bicycling rates.

Land Use Adjustment Factors

Land use adjustment factors account for variations in traveler volumes based on particular land uses in the vicinity of the counter. For example, the number of houses or jobs within a ¼ mile of the count location can have an effect on pedestrian volumes. Temporal extrapolation factors should be selected given the land use characteristics of the count location. For example, residential locations are less likely than urban centers to have midday pedestrian peaks.

Weather Adjustment Factors

Weather adjustment factors should be used to account for weather patterns at the time that data is taken. For example, if a count is taken on a rainy day, volumes will likely be significantly lower than an average day. To adjust for this variation, the volume should be adjusted upward. Exhibit 5 shows example weather adjustment factors

Exhibit 5. Example Weather Adjustment Factors

Weather condition	Definition	Manual Count Time	Multiplicative Adjustment Factor
Cloudy	Ratio of solar radiation measurement to expected solar radiation is ≤ 0.6	All time periods	1.05
Cool temperature	≤ 50°F	All time periods	1.02
Hot temperature	≥ 80°F	1200-1800	1.04
Hot temperature	≥ 80°F	0000-1200 and 1800-2400	0.996
Rain	Measurable rainfall ≥ 0.01 inches	All time periods	1.07

Source: Schneider et al. *Methodology for Counting Pedestrians at Intersections* (2009).

Access/Infrastructure Sufficiency Adjustment Factors

It is possible that facility characteristics could influence pedestrian or bicycle activity patterns. For example, a narrow multi-use trail may not be able to accommodate all bicyclists who would like to use it during a peak hour. Therefore, its peaks would be muted relative to a wider multi-use trail that has the same overall demand.

Demographic Adjustment Factors

Intuitively, one might expect that differences in socioeconomic characteristics of the neighborhoods surrounding count locations would lead to differences in pedestrian and bicycle volume patterns. Income, car ownership rates, household size, and age of residents could all have effects on traveler volumes. However, very few studies have explored these effects.

Adjustment and Extrapolation Recommendations

Based on a review of the literature and the specific characteristics of the TRPA/TMPO region, KAI recommends the following adjustment/extrapolation methods:

- Develop seasonal and temporal patterns: Strategically located automatic counters would provide continuous data collection that can be used to account for the different levels and types of non-motorized activity resulting from weather and seasonal tourism patterns in the Lake Tahoe Region.
- Develop non-motorized trip type patterns: Different locations will have different types of non-motorized users. Previous studies have indicated the following common trip types:
    - Commuter Trips: highest peaks in the morning/evening and low traffic during midday; more traffic during weekdays than weekends; and month-of-year traffic patterns are consistent regardless of season or climate.
    - Recreation/Utilitarian Trips: strong peak during the middle of the day, more traffic on the weekends than on weekdays varying by season, and strong peak during late spring and summer.
    - Mixed Trips: includes trips that are both for commuting and recreational or utilitarian.
- Establish land use adjustment factors: given the diverse land use types within the Lake Tahoe Region, covering large recreational facilities, as well as urban and rural areas, TRPA/TMPO should explore the applicability of developing land use adjustment factors to allow for adjustment of counts taken within the region based on the area type in which they fall.

CONCLUSION: RECOMMENDATIONS FOR THE TRPA/TMPO REGION

Based on a review of current best practices and research for bicycle and pedestrian monitoring, KAI recommends the following for the *Lake Tahoe Regional Bicycle and Pedestrian Monitoring Protocol*:

- Establish key count locations based on locally-determined criteria similar to the PACTS count program, including selected winter count locations;
- Partner with local agencies and transit agencies in the Region for assistance in conducting counts. These agencies could include:
    - Tahoe Transportation District
    - City of South Lake Tahoe
    - El Dorado County
    - Placer County
    - Washoe County
    - Douglas County
    - Tahoe Area Regional Transit
- Partner with local nonprofits following the PACTS example to engage stakeholders and reduce need for initial internal staff time. These could include:
    - Lake Tahoe Bicycle Coalition
    - League to Save Lake Tahoe
    - Sustainability Collaborative – Community Mobility Workgroup
- Develop standardized count forms, training materials, and outreach materials for volunteers to use while collecting counts to increase accuracy and consistency;
- Establish permanent automatic count locations to help develop regional extrapolation factors; and
- Adjustment factors for the Lake Tahoe Region. These should include but are not limited to (if found relevant through monitoring data analysis):
    - Seasonal and temporal adjustments;
    - Trip type adjustments; and,
    - Land use/area type adjustments.

The recommendations above will facilitate TRPA/TMPO to quickly establish a consistent, effective count program while building toward a more robust understanding of bicycle and pedestrian activity in the Lake Tahoe Region.

Appendix 3 Database Structure and FHWA *Traffic Monitoring Guide* Extracts

TRPA/TMPO BICYCLE AND PEDESTRIAN COUNT DATABASE STRUCTURE

A count database to store all available bicycle and pedestrian activity data was developed for TRPA/TMPO as part of the *Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol*. In order to be consistent with the Federal Highway Administration's (FHWA) recommendations for data collection and storage, all available historic bicycle and pedestrian count data in the Region was restructured to conform, where possible, to FHWA's *Traffic Monitoring Guide* (TMG) recommendations for non-motorized data. The count database was created in Microsoft Excel, and contains three worksheets. The three worksheets document: count station description data, screenline volume count data and intersection movement-specific, and total volume count data for non-motorized activity.

The TMG's recommendations were adopted for the count location and screenline count worksheets. An excerpt from the TMG documenting formats for non-motorized count stations and count data is provided in the following section below. This excerpt provides a description of each field for both count station or individual count records as well as the codes to be used when inputting the data.

In addition to the recommended TMG data fields, additional fields were included specific to TRPA/TMPO's count database including:

- **Local Name of the Site (Count Locations)**: This field provides the general name of the site, while the "Station Location" field contains the more detailed location description.
- **Other Notes (Count Locations):** This field provides for notes regarding the count station.
- **Corridor (Screenline Counts):** This field denotes the TRPA/TMPO Corridor that the count data is located within.
- **Weekday / Weekend Count (Screenline/Intersection Counts):** This field indicates whether the count was conducted on a weekday or on the weekend.
- **Notes (Screenline/Intersection Counts):** This field provides for notes regarding the count data.
- **Total Hours Counted (Screenline/Intersection Counts):** This field provides the total number of hours counted for the count data record.
- **Total Volume (Screenline/Intersection Counts):** This field provides the total number of hours counted for the count data record.
- **Average Hourly Volume (Screenline/Intersection Counts):** This field provides the average hourly volume for the count data record based on the Total Hours Counted and Total Volume fields.

Given that the TMG does not specifically address the storage of movement-specific data for intersections, the TMG-recommended data fields were adapted for the intersection count worksheet to include as many overlapping fields as possible while also creating fields in the database to store all bicycle-related turning movements as well as pedestrian movements including both crossings of intersections legs and pedestrians that turn the corner at the intersection for a given count period. While all of the count fields will not necessarily be collected as part of each intersection count, the database is set up to flexibly handle intersection movement-specific data provided to or collected by

TRPA/TMPO in the future. Additionally, intersections with movement-specific counts can be summed as hourly total intersection volume counts in the screenline/total intersection volume count data sheet if desired where hourly data is available.

The additional fields added to store intersection-related bicycle and pedestrian volume data are described below:

- **Count Period:** The timeframe over which count data was collected at the intersection.
- **Pedestrians:** This section of the worksheet provides data fields to store pedestrian-related volume data.
  - **North Leg:** The total volume of pedestrians crossing the north leg of the intersection.
  - **North-East Corner:** The total volume of pedestrians turning at the north-east corner of the intersection.
  - **South Leg:** The total volume of pedestrians crossing the south leg of the intersection.
  - **North-West Corner:** The total volume of pedestrians turning at the north-west corner of the intersection.
  - **East Leg:** The total volume of pedestrians crossing the east leg of the intersection.
  - **South-East Corner:** The total volume of pedestrians turning at the south-east corner of the intersection.
  - **West Leg:** The total volume of pedestrians crossing the west leg of the intersection.
  - **South-West Corner:** The total volume of pedestrians turning at the south-west corner of the intersection.
  - **Total Pedestrians:** The total pedestrians entering the intersection during the count period.
- **Bicyclists:** This section of the worksheet provides data fields to store bicycle-related volume data.
  - **NB Left:** The total volume of bicyclists traveling northbound and turning left.
  - **NB Through:** The total volume of bicyclists traveling northbound and continuing through the intersection.
  - **NB Right:** The total volume of bicyclists traveling northbound and turning right.
  - **SB Right:** The total volume of bicyclists traveling southbound and turning right.
  - **SB Left:** The total volume of bicyclists traveling southbound and turning left.
  - **SB Through:** The total volume of bicyclists traveling southbound and continuing through the intersection.
  - **EB Right:** The total volume of bicyclists traveling eastbound and turning right.
  - **EB Left:** The total volume of bicyclists traveling eastbound and turning left.
  - **EB Through:** The total volume of bicyclists traveling eastbound and continuing through the intersection.
  - **WB Right:** The total volume of bicyclists traveling westbound and turning right.
  - **WB Left:** The total volume of bicyclists traveling westbound and turning left.
  - **WB Through:** The total volume of bicyclists traveling westbound and continuing through the intersection.
  - **Total Bicyclists:** The total bicyclists entering the intersection during the count period.

FHWA TRAFFIC MONITORING GUIDE NON-MOTORIZED EXCERPT

7.9 NON-MOTORIZED COUNT STATION DESCRIPTION DATA FORMAT

This publication of the *TMG* includes a new chapter (Chapter 4) on the collection of non-motorized data. Collecting and reporting on non-motorized travel is growing in importance, due to the significant efforts being made to encourage the use of more active modes of transportation (walking/biking) in order to gain a variety of health, financial, and environmental benefits. It is therefore, important to be able to track changes in the amount of walking and biking that result from changes in public attitudes and land uses, the implementation of new policies, and the construction of new facilities.

Two record formats are defined for submitting non-motorized data:

- Count Station Description Record; and
- Non-Motorized Count Record.

The Count Station Description Record parameters are described in this section, and Section 7.10 describes the requirements for the Non-Motorized Count Record.

The Non-Motorized Count Station Description Record is needed for reporting all non-motorized data to FHWA. If a Non-Motorized Station Description record is omitted, any succeeding records containing non-motorized data will not be processed by the TMAS software. The Non-Motorized Count Station Description file contains one record per traffic monitoring station for each land by direction per year. In addition, updated station records can be submitted at any time during the year if an equipment change occurs at a site, which would result in a different type of data being submitted at that location. All fields on each record are considered to be character fields.

The TMAS software retains all approved station records as of December 31st of each year. FHWA recommends that a yearly review of all station record fields be conducted to insure the records are current and reflect what is in the field.

An example file naming convention for the Non-Motorized Station Description Record is:

ssabcxyzmmyyyy.SNM

The non-motorized record formats should be submitted to FHWA on a quarterly basis. A future version of TMAS (3.0 or prior) will include pedestrian and bicycle data formats, processing and reporting.

TABLE 7-31 NON-MOTORIZED COUNT STATION DESCRIPTION RECORD

Field	Columns	Width	Description	Type
1	1	1	Non-motorized station/location record identifier (L)	C
2	2-3	2	State FIPS Code	C
3	4-6	3	County FIPS Code	C
4	7-12	6	Station ID	C
5	13	1	(Functional) classification of road (expanded)	C
6	14	1	Direction of route	C
7	15	1	Location of count relative to roadway orientation	C
8	16	1	Direction of travel	C
9	17	1	Crosswalk, sidewalk, or exclusive facility	C
10	18	1	Intersection	O
11	19	1	Type of count (bike/pedestrian/both)	C
12	20-21	2	Method of counting	C
13	22-23	2	Type of Sensor	O
14	24-27	4	Year of data	C
15	28	1	Factor Group 1	O
16	29	1	Factor Group 2	O
17	30	1	Factor Group 3	O
18	31	1	Factor Group 4	O
19	32	1	Factor Group 5	O
20	33	1	Primary Count Purpose	O
21	34-35	2	Posted Speed Limit	O
22	36-39	4	Year station established	C
23	40-43	4	Year station discontinued	O
24	44	1	National highway system	O

Field	Columns	Width	Description	Type
25	45-52	8	Latitude	C
26	53-61	9	Longitude	C
27	62-63	2	Posted Route Signing	O
28	64-71	8	Posted Signed Route Number	O
29	72-131	60	LRS Identification	O
30	132-139	8	LRS Location Point	O
31	140-189	50	Station location	O
32	190-239	50	Other Notes	O

Note: *C = Critical, O = Optional*

Fields designated as Critical *are required for this record format.*

Fields designated as Optional *are not required for this record format. Code these fields according to the instructions for each optional field.*

Non-motorized station/location record identifier (Column 1) – *Critical*

Code the letter "L"

State FIPS Code (Columns 2-3) – *Critical*

TABLE 7-32 FIPS STATE CODES

State	Code	State	Code	State	Code
Alabama	1	**Maine**	23	**Pennsylvania**	42
Alaska	2	**Maryland**	24	**Rhode Island**	44
Arizona	4	**Massachusetts**	25	**South Carolina**	45
Arkansas	5	**Michigan**	26	**South Dakota**	46
California	6	**Minnesota**	27	**Tennessee**	47
Colorado	8	**Mississippi**	28	**Texas**	48
Connecticut	9	**Missouri**	29	**Utah**	49
Delaware	10	**Montana**	30	**Vermont**	50
D.C.	11	**Nebraska**	31	**Virginia**	51
Florida	12	**Nevada**	32	**Washington**	53
Georgia	13	**New Hampshire**	33	**West Virginia**	54
Hawaii	15	**New Jersey**	34	**Wisconsin**	55
Idaho	16	**New Mexico**	35	**Wyoming**	56
Illinois	17	**New York**	36	**Puerto Rico**	72
Indiana	18	**North Carolina**	37	**American Samoa**	60
Iowa	19	**North Dakota**	38	**Guam**	66
Kansas	20	**Oregon**	41	**Northern Mariana Islands**	69
Kentucky	21	**Ohio**	39	**Virgin Islands of the U.S.**	78
Louisiana	22	**Oklahoma**	40		

Canadian Provinces may use TMAS with the following codes (based on the LTPP):

State	Code	State	Code	State	Code
Alberta	81	**Nova Scotia**	86	**Yukon**	91
British Columbia	82	**Ontario**	87	**Northwest Territory**	92
Manitoba	83	**Prince Edward Island**	88	**Labrador**	93
New Brunswick	84	**Quebec**	89	**Nunavut**	94
Newfoundland	85	**Saskatchewan**	90		

County FIPS Code (Columns 4-6) – *Critical*

Use the three-digit FIPS county code (see Federal Information Processing Standards Publication 6, *Counties of the States of the United States*).

Station ID (Columns 7-12) - Critical

This field should contain an alphanumeric designation for the station where the survey data is collected. Station identification field entries should be identical in all records for a given station. Differences in characters, including spaces, blanks, hyphens, etc., prevent proper match.

This field should be right-justified with unused columns zero-filled. Do not use embedded blanks.

Functional Classification of Road (expanded) (Column 13) – Critical

This starts with the current U.S. DOT functional classification system, but also adds categories for trail or share use path, and general activity count (i.e., for pedestrian counts in an open area like the Mall in Washington, D.C.). It is used in association with a second variable that indicates for roads whether the count was made on the main roadway, on a sidewalk, or on a special lane intended for use exclusively by non-motorized vehicles (e.g., bike lane.)

TABLE 7-33 CLASSIFICATION CODES

Code	Classification
1	Interstate
2	Principal Arterial – Other Freeways and Expressways
3	Principal Arterial – Other
4	Minor Arterial
5	Major Collector
6	Minor Collector
7	Local
8	Trail or Shared Use Path
9	General Activity Count

6. Direction of Route (Column 14) – *Critical*

   This is the direction of travel of the main roadway. Note that a north/south roadway can be coded as either a “N” or as a “S” but the selection of the direction affects how the “Location of Count Relative to Roadway Orientation” variable (the next variable) is coded in order to effectively define the location and direction of the non-motorized count.

TABLE 7-34 DIRECTION OF TRAVEL CODES

Code	Direction
0	East-West or Southeast-Northwest combined (volume stations only)
1	North
2	Northeast
3	East
4	Southeast
5	South
6	Southwest
7	West
8	Northwest
9	North-South or Northeast-Southwest combined (volume stations only)

7. Location of Count Relative to Roadway Orientation (Column 15) – *Critical*

   1 = the count is taken on the side of the road for the listed direction of travel;

   2 = the count is taken on the opposite side of the road from the listed direction (i.e., the side with on-coming traffic, given the listed direction of travel);

   3 = both sides of the road combined (appropriate for example, if counting a trail or other shared use path); and

   4 = traffic moving perpendicular to the roadway (that is, crossing the street).

   Example: If you code the Direction of Route as "North" and are in fact driving in that northbound direction, a "1" for this variable would indicate that you are counting on the right (eastern) side of the road; a "2" would indicate you are counting non-motorized traffic on the left (western) side of the road; a "3" would indicate that you are counting all non-motorized traffic, regardless of which side of the road, and would be appropriate for use on a trail or other shared use path. For that same facility, if Direction of Route were coded as "South" then a count performed on the eastern side of the road would be coded as a "2", since it would be on the opposite side of the road for vehicle traveling southbound.

8. Direction of Travel (Column 16) – *Critical*

   1 = travel monitored only occurring in the Direction of Route;

   2 = travel monitored only occurring opposite to the Direction of Route;

   3 = travel in both (all) directions; and

   4 = travel at an intersection that includes all movements (e.g., the sum of movements on all four crosswalks, or all movements occurring during a pedestrian scramble (or "Barnes Dance") phase. *Note: The "Intersection" variable should also be coded as a 1 or 2 if this variable is coded as a 4. For a "General Activity Count" that includes all movements in all directions, code direction of travel as a "3" "all directions."*)

   Note: To actually understand where a count is being taken (what side of the road, and which directions of travel are being counted) it is necessary to look at all three variables, Direction of Route, Location of Count Relative to Roadway Orientation, and Direction of Travel. It may also be necessary to look at the Crosswalk variable immediately below.

9. Crosswalk, Sidewalk, Exclusive Facility, or Total Intersection Count (Column 17) – *Critical*

   Indicates if the count was taken outside of the primary right-of-way:

   1 = in roadway/trail right of way (potentially shared with motorized vehicles)

2 = exclusively in a crosswalk

3 = on a sidewalk

4 = on an exclusive (for non-motorized traffic) right-of-way, parallel to the primary facility (including exclusive bike lanes, whether those lanes are separated from motorized vehicles by paint stripes or by some specific physical barrier but not including sidewalks, crosswalks, or trails or other shared use paths that are not for licensed, motorized vehicles)

5 = on a grade separate facility designed to allow non-motorized traffic to pass over top of a roadway (e.g., a pedestrian bridge)

6 = on a grade separate facility designed to allow non-motorized traffic to cross underneath a roadway (e.g., a pedestrian undercrossing)

For an "Area Count" leave this field blank.

Note 1: if "perpendicular to traffic" is selected in "Location of Count Relative to Roadway Orientation" variable and the "Crosswalk" variable is coded as "in roadway right of way" then the count includes ALL people crossing a roadway. If "exclusively in a crosswalk" is indicated, then only those in the crosswalk (or directly next to the crosswalk) are being counted. This coding differentiation is designed to indicate if all pedestrians crossing a street within a given block (including jaywalkers) are being counted, or whether only pedestrians actually using a marked crosswalk are being counted.

Note 2: if the count is being taken on a trail or other shared use path that is not intended for conventional passenger cars or licensed commercial vehicles, code the trail count as a "0", even if the trail may be routinely used by motorcycles, snowmobiles or other motorized vehicles designed for off-road uses.

10. Intersection (Column 18) – *Optional*

    1 = count is taken at an intersection (but not an intersection with a roundabout),

    2 = count taken at an intersection with a roundabout

    otherwise (blank) NOT at an intersection

11. Type of Count (Column 19) – *Critical*

    1 = pedestrians (only) are being counted

    2 = bicycles (only) are being counted

    3 = equestrians (only) are being counted

    4 = both pedestrians and bicycles are included in this count

    5 = all passing non-motorized traffic are included in this count

    6 = motorized vehicles are being counted (intended for counts of snowmobiles, all terrain vehicles, and other off-road vehicles using a trail or other shared use path)

    7 = all motorized and non-motorized traffic using the facility (intended for trails and share use paths that experience a combination of pedestrian, bicycle, equestrian, and off-road vehicle traffic)

    8 = other animals (specify in Field #32 (Other Notes) what kind of animals)

12. Method of Counting (Columns 20-21) – *Critical*

    1 = Human observation (manual)

    2 = Portable traffic recording device

    3 = Permanent, continuous count station (CCS)

13. Type of Sensor (Columns 22-23) – *Optional*

    Code for the type of sensor used for detection.

    9 = Multiple counts are made at this location, different counts may use different sensors (see the individual count records for the sensors used for specific counts)

    H = Human observation (manual)

    I = Infrared (passive)

    2 = Active Infrared (requires a target on other side of facility being monitored)

    K = Laser/lidar

    L = Inductive loop

    M = Magnetometer

    P = Piezoelectric

    Q = Quartz piezoelectric

    R = Air tube

    S = Sonic/acoustic

    T = Tape switch

    3 = other pressure sensor/mat

    U = Ultrasonic

    V = Video image (with automated or semi-automated conversion of images to counts)

    1 = Video image with manual reduction of images to counts performed at a later time

    W = Microwave (radar)

    X = Radio wave (radar)

    Z = Other

14. Year of Data (Columns 24-27) – *Critical*

    Code the four digits of the year in which the data were collected.

    FACTOR GROUPS: A total of five single digit fields are provided so that States can list the identifiers used to factor the count provided. The values in these records are not the factors themselves, but simply identifiers of the factor groups used. The factors are used to convert short duration counts to estimates of daily travel or annual travel. In the case of permanent, continuous count locations these identifiers describe which factor group that count location belongs to, so that these adjustment factors can be computed. States and other submitting agencies can use the text field in the "other information" category at the end of this record to further describe the factor groups to which the site is assigned. At this time, the use of these factor groups is both optional and flexible. A submitting agency may assign each factor identifier to purposes as the agency sees fit.

15. Factor Group 1 (Column 28) – *Optional*

    The first of five allowable (but optional) variables that allow identification of a factor group that is used to adjust short duration counts at this location to estimates of annual average condition. (For example, this first factor group could be used to identify this site's time-of-day pattern, but it does not have to be used for that purpose.)

16. Factor Group 2 (Column 29) – *Optional*

    The second of five allowable (but optional) variables that allow identification of a factor group that is used to adjust short duration counts at this location to estimates of annual average condition. For example, this second factor group could be used to identify DOW patterns (Is this a commuter route or a recreational route?), but it does not have to be used for that purpose.

17. Factor Group 3 (Column 30) – *Optional*

    The third of five allowable (but optional) variables that allow identification of a factor group that is used to adjust short duration counts at this location to estimates of annual average condition. (For example, this third factor group could be used to identify monthly or seasonal patterns, but it does not have to be used for that purpose.)

18. Factor Group 4 (Column 31) – *Optional*

    The fourth of five allowable (but optional) variables that allow identification of a factor group that is used to adjust short duration counts at this location to estimates of annual average condition. (For example, this factor group could be used to identify equipment adjustment patterns needed because of the specific type of equipment being used, but it does not have to be used for that purpose.)

19. Factor Group 5 (Column 32) – *Optional*

    The fifth of five allowable (but optional) variables that allow identification of a factor group that is used to adjust short duration counts at this location to estimates of annual average condition. (For example, this factor group could be used for adjustments due to the type of weather being experienced during the count, but does not have to be used for that purpose.)

20. Primary Count Purpose – (Column 33) – *Optional*

    This field indicates the primary purpose for installing the station and hence which organization is responsible for it and supplies the data.

    O = Operations and facility management purposes

    P = Planning or statistic reporting purposes

    R = Research purposes

    S = Count taken as part of a Safe Route to School data collection effort

    L = Facility design purposes

    E = Enforcement purposes

21. Posted Speed Limit (Columns 34-35) – *Optional*

    If count is taken on a facility with posted speed limit indicate that limit in miles per hour. Otherwise leave blank.

22. Year Station Established (Columns 36-39) – *Optional*

    Code the four digits of the appropriate year if known

23. Year Station Discontinued (Columns 40-43) – *Optional*

    Code the four digits of the appropriate year if known

24. National Highway System (Column 44) – *Optional*

    N = No, not on National Highway System

    Y = Yes, on National Highway System

25. Latitude (Columns 45-52) – *Critical*

    This is the latitude of the station location with the north hemisphere assumed and an implied decimal place understood as XX.XXX XXX.

26. Longitude (Columns 53-61) – *Critical*

This is the longitude of the station location with the west hemisphere assumed and an implied decimal place understood as XXX.XXX XXX.

27. Posted Route Signing – (Columns 62-63) – *Optional*

    This is the same as Route Signing in the 2012 *HPMS Field Manual* (Data Item 18 in HPMS Sections dataset). These codes are shown below.

TABLE 7-35 POSTED ROUTE SIGNING CODES

Code	Description
1	Not signed
2	Interstate
3	U.S.
4	State
5	Off-Interstate Business Marker
6	County
7	Township
8	Municipal
9	Parkway Marker or Forest Route Marker
10	None of the above

28. Posted Signed Route Number (Columns 64-71) – *Optional*

    If the station is located on a city street and is not on a U.S. Bike Route, zero-fill this field.

29. Linear Referencing System (LRS) Identification (Columns 72-131) – *Optional*

    The LRS Identification reported in this item for the station must be the same as the LRS identification reported in the HPMS for the section of roadway where the station is located. The LRS identification is a 60-character, right justified value. The LRS ID can be alphanumeric, but must not contain blanks; leading zeros must be coded. More information concerning the LRS may be found in Chapter III of the HPMS Field Manual (Sept. 2010), Linear Referencing System Requirements.

30. Linear Referencing System (LRS) Location Point (Columns 132-139) - *Optional*

    This is the LRS location point for the station. It is similar information to the LRS Beginning Point and LRS Ending Point in the HPMS. The milepoint for the station must be within the range of the LRS beginning point and LRS ending point for the roadway section upon which the station is located. It is coded in miles, to the nearest thousandth of a mile, with an implied decimal in the middle: XXXX.XXX.

31. Station Location (Columns 140-189) – *Optional*

    This is an English text entry field. For stations located on a numbered route, enter the name of the nearest major intersecting route, State border, or landmark on State road maps and the distance and direction of the station from that landmark to the station (e.g., "12 miles south of the Kentucky border"). If the station is located on a city street, enter the city and street name. Abbreviate if necessary. Left justify.

32. Other Notes (Columns 190-239) - *Optional*

    This is an English text field that can be used to provide notes to others users of data from this location. For example, it can be used to describe the specific use of factor groups 1 through 5. Also, if Field #11 (Type of Count) is coded as 8 (other animals), indicate the type(s) of animals in this field (Other Notes).

TABLE 7-36 NON-MOTORIZED COUNT STATION DESCRIPTION RECORD EXAMPLE

Column Number:	1	2-3	4-6	7-12	13	14	15	16	17	18	19	20-21	22-23	24-27	28	29	30	31	32	33	34-35	36-39
Content Example:	L	08	045	GLWD06	2	3	1	1	4	Blank	2	01	-H	2011	Blank	Blank	Blank	Blank	Blank	R	65	2010

continued

Column Number:	40-43	44	45-52	53-61	64-71	72-131	132-139	140-189	62-63
Content Example:	Blank	Y	39550600N	107324200	- - - - US-6	0000….00LRSID123456		2 miles east of US 6 and SH82	03

continued

Column Number:	190-239
Content Example:	This station is for collection of bicycle counts using human observation

7.10 NON-MOTORIZED COUNT DATA FORMAT

The Non-Motorized Count Record format is a variable length, fixed field record. One record is used for each calendar day for which traffic monitoring data is being submitted. Considerable flexibility is built into this record. It allows non-motorized data to be reported at a variety of time intervals. The time interval being counted can be 5, 10, 15, 20, 30, 60, or 120 minutes, with the interval being reported as a field on each record. Table 7-37 describes all the fields used in this record.

As with previous data formats, all numeric fields should be right-justified and blank fill the columns for which no data is being reported. All fields should be blank filled if not used.

> An example file naming convention for the Volume record is:
>
> ssabcxyzmmyyyy.VNM

TABLE 7-37 NON-MOTORIZED COUNT RECORD

Field	Columns	Width	Description	Type
1	1	1	Non-motorized count record identifier (N)	C
2	2-3	2	State FIPS Code	C
3	4-6	3	County FIPS Code	C
4	7-12	6	Station ID	C
5	13-20	8	Latitude	O
6	21-29	9	Longitude	O
7	30	1	Direction of route	C
8	31	1	Location of count relative to roadway orientation	C
9	32	1	Direction of travel	C
10	33	1	Crosswalk, sidewalk, or exclusive facility	C
11	34	1	Intersection	O
12	35	1	Type of count (e.g., bike/pedestrian/both)	C
13	36-37	2	Type of sensor	C
14	38	1	Precipitation (yes/no)	O
15	39-41	3	High temperature	O
16	42-44	3	Low temperature	O
17	45-48	4	Year of count	C
18	49-50	2	Month of count	C
19	51-52	2	Day of count	C
20	53-56	4	Count start time for this record (military time, HHMM)	C
21	57-59	3	Count interval being reported (in minutes) Allowable entries: 05, 10, 15, 20, 30, 60, or 120)	C
22	60-64	5	Count for interval 1	C
23	65-69	5	Count for interval 2	C/O
24	70-74	5	Count for interval 3	C/O
25	75-79	5	Count for interval 4	C/O
26	80-84	5	Count for interval 5	C/O
27	85-89	5	Count for interval 6	C/O
28	90-94	5	Count for interval 7	C/O
29	95-99	5	Count for interval 8	C/O
30	100-104	5	Count for interval 9	C/O
31	105-109	5	Count for interval 10	C/O

Field	Columns	Width	Description	Type
32	110-114	5	Count for interval 11	C/O
33	115-119	5	Count for interval 12	C/O
34	120-124	5	Count for interval 13	C/O
35	125-129	5	Count for interval 14	C/O
36	130-134	5	Count for interval 15	C/O
37	135-139	5	Count for interval 16	C/O
38	140-144	5	Count for interval 17	C/O
39	145-149	5	Count for interval 18	C/O
40	150-154	5	Count for interval 19	C/O
41	155-159	5	Count for interval 20	C/O
42	160-164	5	Count for interval 21	C/O
43	165-169	5	Count for interval 22	C/O
44	170-174	5	Count for interval 23	C/O
45	175-179	5	Count for interval 24 – End of hourly count record	C/O
46-309	180-2500		Count intervals 25 – 288 are used only if the reported day contains this many reporting time periods. Only report those periods for which data were collected. Up to 288 reporting periods are needed if 5-minute intervals are used. Up to 144 periods are needed for 10-minute intervals. Up to 96 periods are needed for 15-minute intervals Up to 72 periods are needed for 20-minute intervals Up to 48 periods are needed for 30-minute intervals Up to 24 periods are needed for 60-minute intervals	O

Note: C = Critical, O = Optional and C/O = Critical or Optional

1. Non-motorized count record identifier (Column 1) – *Critical*

   Code the letter "N"

2. State FIPS Code (Columns 2-3) – *Critical*

   See Section 7.9, Field #2 of Non-Motorized Count Station Description Record.

3. County FIPS Code (Columns 4-6) – *Critical*

   Use the three-digit FIPS county code (see Federal Information Processing Standards Publication 6, "Counties of the States of the United States").

4. Station ID (Columns 7-12) – *Critical*

   This field should contain an alphanumeric designation for the station where the survey data is collected. Station identification field entries should be identical in all records for a given station. Differences in characters, including spaces, blanks, hyphens, etc., prevent proper match.

   This field should be right-justified with unused columns zero-filled. Do not use embedded blanks.

5. Latitude (Columns 13-20) – *Optional*

   This is the latitude of the station location with the north hemisphere assumed and an implied decimal place understood as XX.XXX XXX.

6. Longitude (Columns 21-29) – *Optional*

   This is the longitude of the station location with the west hemisphere assumed and an implied decimal place understood as XXX.XXX XXX.

7. Direction of route (Column 30) – *Critical*

   This is the direction of travel of the main roadway. Note that a north/south roadway can be coded as either a "N" or as a "S" but the selection of the direction affects how the "Location of Count Relative to Roadway Orientation" variable (the next variable) is coded in order to effectively define the location and direction of the non-motorized count.

TABLE 7-38 DIRECTION OF TRAVEL CODES

Code	Direction
1	North
2	Northeast
3	East
4	Southeast
5	South
6	Southwest
7	West
8	Northwest
9	North-South or Northeast-Southwest combined (volume stations only)
0	East-West or Southeast-Northwest combined (volume stations only)

8. Location of count relative to roadway orientation (Column 31) – *Critical*

   1 = the count is taken on the side of the road for the listed direction of travel

   2 = the count is taken on the opposite side of the road from the listed direction (i.e., the side with on-coming traffic, given the listed direction of travel)

   3 = both sides of the road combined (appropriate for example, if you were counting a trail)

   4 = traffic moving perpendicular to the roadway (that is, crossing the street)

   Example: if you code the Direction of Route as "North" and are in fact driving in that northbound direction, a 1 for this variable would indicate that you are counting on the right (eastern) side of the road. A "2" would indicate you are counting non-motorized traffic on the left (western) side of the road. A "3" would indicate you are counting all non-motorized traffic, regardless of which side of the road, and would be appropriate for use on a trail or other shared use path. For that same facility if Direction of Route were coded as "South" then a count performed on the eastern side of the road would be coded as a "2" as it would be on the opposite side of the road for vehicle traveling southbound.

9. Direction of Travel (Column 32) – *Critical*

   1 = travel monitored only occurring in the Direction of Route

   2 = travel monitored only occurring opposite to the Direction of Route

   3 = travel in both (all) directions

   4 = travel at an intersection that includes all movements (e.g., the sum of movements on all four crosswalks, or all movements occurring during a pedestrian scramble (or "Barnes Dance") phase. *Note: The "Intersection" variable should also be coded as a 1 or 2 if this variable is coded as a 4. For a "General Activity Count" that is not taken on a linear facility, and that includes all movements in all directions, code the Direction of Travel variable as a "3" all directions.*

   Note: To actually understand where a count is being taken (what side of the road, and which directions of travel are being counted) it is necessary to look at all three variables, Direction of Route, Location of Count Relative to Roadway Orientation, and Direction of Travel. It may also be necessary to look at the Crosswalk variable immediately below.

10. Crosswalk, sidewalk, or exclusive facility (Column 33) – *Critical*

    Indicates if the count was taken outside of the primary right-of-way:

    1 = in roadway/trail right of way (potentially shared with motorized vehicles)

    2 = exclusively in a crosswalk

    3 = on a sidewalk

    4 = on an exclusive (for non-motorized traffic) right-of-way, parallel to the primary facility (including exclusive bike lanes, whether those lanes are separated from motorized vehicles by paint stripes or by some specific physical barrier. But not including sidewalks, crosswalks, or trails or other shared use paths that are not for licensed, motorized vehicles)

    5 = on a grade separate facility designed to allow non-motorized traffic to pass over top of a roadway (e.g., a pedestrian bridge)

    6 = on a grade separate facility designed to allow non-motorized traffic to cross underneath a roadway (e.g., a pedestrian undercrossing)

    For an "Area Count" leave this field blank

    Note 1: if "perpendicular to traffic" is selected in "Location of Count Relative to Roadway Orientation" variable and the "Crosswalk" variable is coded as "in roadway right of way" then the count includes ALL people crossing a roadway. If "exclusively in a crosswalk" is indicated, then only those in the crosswalk (or directly next to the crosswalk) are being counted. This coding differentiation is designed to indicate if all pedestrians crossing a street within a given block (including jaywalkers) are being counted, or whether only pedestrians actually using a marked crosswalk are being counted.

    Note 2: if the count is being taken on a trail or shared use path that is not intended for conventional passenger cars or licensed commercial vehicles, code the trail count as a "0", even if the trail may be routinely used by motorcycles, snowmobiles or other motorized vehicles designed for off-road uses.

11. Intersection (Column 34) – *Optional*

    1 = count is taken at an intersection (but not an intersection with a roundabout)

    2 = count taken at an intersection with a roundabout

    otherwise (blank) NOT at an intersection

12. Type of Count (Column 35) – *Critical*

    1 = pedestrians (only) are being counted

    2 = bicycles (only) are being counted

    3 = equestrians (only) are being counted

    4 = both pedestrians and bicycles are included in this count

    5 = all passing non-motorized traffic are included in this count

    6 = motorized vehicles are being counted (intended for counts of snowmobiles, all terrain vehicles, and other off-road vehicles using a trail or other shared use path)

    7 = all motorized and non-motorized traffic using the facility (intended for trails and share use paths that experience a combination of pedestrian, bicycle, equestrian, and off-road vehicle traffic)

    8 = other animals (specify what kind of animals in Field #32 of the Non-Motorized Count Station Description Record)

13. Type of Sensor (Columns 36-37) – *Optional*

    Code for the type of sensor used for detection:

    H = Human observation (manual)

    I = Infrared (passive)

    2 = Active Infrared (requires a target on other side of facility being monitored)

    K = Laser/lidar

    L = Inductive loop

    M = Magnetometer

    P = Piezoelectric

    Q = Quartz piezoelectric

    R = Air tube

    S = Sonic/acoustic

    T = Tape switch

    3 = other pressure sensor/mat

    U = Ultrasonic

    V = Video image (with automated or semi-automated conversion of images to counts)

    1 = Video image with manual reduction of images to counts performed at a later time

    W = Microwave (radar)

    X = Radio wave (radar)

    Z = Other

14. Precipitation (Column 38) (yes/no) – *Optional*

    1 = measurable precipitation fell at some time during this record's data collection at this location

    2 = measurable precipitation did not fall at some time during this record's data collection at this location

15. High Temperature (Columns 39-41) – *Optional*

    Approximate high temperature for either the day (if a day or longer count), or the high temperature during the duration of the count, if the count is less than a day in duration. Expressed in Fahrenheit

16. Low Temperature (Columns 42-44) – *Optional*

    Approximate low temperature for either the day (if a day or longer count), or the low temperature during the duration of the count, if the count is less than a day in duration. Expressed in Fahrenheit

17. Year of count (Columns 45-48) – *Critical*

    Code the four digits of the year in which this data was collected.

18. Month of count (Columns 49-50) – *Critical*

    Code the two digits for the month in which this data was collected

19. Day of Count (Columns 51-52) – *Critical*

    Code the two digits for the day on which this data was collected

20. Count Start Time for this record (Columns 53-56) – *Critical*

    Expressed in military time. The count start time must be on a five minute interval. For hourly records it is expected to be on the hour (e.g., 0900), and if a 15-minute count interval, it is expected to be on one of the 15-minute intervals (e.g., 0900, 0915, 0930, or 0945)

    Note that this value will change from record to record.

21. Count Interval being reported (Columns 57-59) – *Critical*

    Must be 05, 10, 15, 20, 30, 60, or 120.

    NOTE: The remaining data items are the actual count data being submitted. They can represent 5, 10, 15, 20, 30, 60, or 120 minute time intervals, depending on how the record is coded. (See Item #21 - The first count interval is for the time period starting at "Start Time for this Record" (Item #20)).

    NOTE 2: Data from different days should be submitted on different records. This allows each record to be read independently. One entire day of data can be submitted on one record, regardless of the count interval being reported. If 24 consecutive hours of data is collected on two separate days (e.g., 9 a.m. on June 1 – 8:59 a.m. on June 2) then two records are required to submit the data. If a 48 hour count, reported at 15-minute intervals, is taken starting at 9 a.m. on June 1 and ending at 8:59:59 a.m. on June 3rd, three records are needed. The first record provides data from 9:00 a.m. on June 1 through 11:59:59 p.m. on June 1. This count data is supplied in the count interval variable fields "Count Interval 1" through "Count Interval 60." The "Start Time for this Record" variable should be recorded as "0900." The second record provides all 24-hours of data for June 2nd. It requires the use of count interval variable fields "Count Interval 1" through "Count Interval 96." The variable "Start Time for this Record" should be "0000." The last record for reporting this 2 day count should also have a "Start Time for this Record" of "0000." It will use only variables Count Interval 1 through Count Interval 36.

22. Count for interval 1 (Columns 60-64) – *Critical*

    This contains the number of pedestrians, bicycles or other units counted in the first time interval being reported. The beginning of the time period reported is given by the variable "Start Time for this Record." Right justify the integer being reported. Blank fill leading columns as needed. If no traffic was counted during this time period, place a zero (0) in column 64. Blank fill columns 60 through 63.

23. Count for interval 2 (Columns 65-69) – *Optional*

    This contains the number of pedestrians, bicycles or other units counted in the second time interval being reported. Right justify the integer being reported. Blank fill leading columns as needed. If no traffic was counted during this time period, place a zero (0) in column 69. Blank fill columns 65 through 68 as necessary.

24. Count for interval 3 (Columns 70-74) – *Optional*

    This contains the number of pedestrians, bicycles or other units counted in the third time interval being reported. Right justify the integer being reported. Blank fill leading columns as needed. If no traffic was counted during this time period, place a zero (0) in column 74. Blank fill columns 70-73 as necessary.

25 - 309. Count intervals 4-288 (Columns 75-79; 80-84; 85-89; … 2496-2500) – *Optional*

    These variables are used as needed for fields 25 - 309. Five columns are required for each time period reported for that day. All time periods from start to end of the count on that day should be reported. Right justify each reported count in the 5 columns allocated for that time interval. Blank fill any required leading columns. If no traffic was counted during a given time period, place a zero (0) in the right most column for that count interval. Blank fill the prior columns for that time period.

Note: It is assumed that the software reading each record can determine the end of each record and the start of the next record (which indicates either a new day of counting or a new station location.) The software should then parse the data based on the information included in the record (time interval being reported, and start time of the count).

TABLE 7-39 NON-MOTORIZED COUNT RECORD EXAMPLE

Column Number:	2-3	4-6	7-12	13-20	21-29	30	31	32	33	34	35	36-37	38	39-41	42-44	45-48	49-50	51-52	53-56	57-59
Content Example:	08	045	GLWD06	39550060	107324200	3	1	1	4	-	2	H	2	- 60[a]	- 45[a]	2011	06	15	0800	060

[a] This is 60◦ (high temp) or 45◦ (low temp) Fahrenheit, not 'minus 60◦ or 45◦. The '-' indicates a blank prior to the number 60 (or 45).

continued

Column Number:	60-64	65-69	70-74	75-79	80-84	85-89	2496-2500
Content Example:	- - - 45	- - - 30	- - - 25	- - - -0	- - - -0	- - - - 0	…

Appendix 4 Sample Data Collection Instructions, Forms, and Training Materials

NCHRP REPORT 797 EXAMPLE DATA COLLECTOR INSTRUCTIONS

Manual Pedestrian and Bicyclist Counts: Example Data Collector Instructions

About These Example Instructions

These instructions describe how to count pedestrians and bicyclists at intersections. There are many other ways that pedestrians and bicyclists can be counted at intersections, but this method is designed to gather counts in the most accurate, efficient, and consistent manner possible.

Gender is captured using this method, but age, helmet use, jaywalking, wrong-way riding, and other characteristics are not included so that data collectors can focus on counting accurately.

In addition, it is also possible to count pedestrians and bicyclists at locations such as trail, sidewalk, and bicycle lane segments and at building entrances. However, different methods are used to capture counts at these other locations.

This document describes the procedure that you will use to count pedestrians and bicyclists at intersections. Review this document before visiting the field, and refer to it when you have questions in the field. Ideally, you will be trained on the counting methods described below before taking counts. However, it is not necessary to have formal training to follow these procedures.

SAFETY FIRST: You will be standing near roadway intersections to take counts. Use caution traveling to the count locations, including crossing roadways near the sites. Follow traffic laws at all times. Maintain a constant awareness of your surroundings, including traffic conditions and social situations, and ensure that data collection does not interfere with your attention to safety. If you feel unsafe, uncomfortable, or threatened, stop data collection and move to a safer location.

BRING COUNT MATERIALS:

- Data Collection Sheets (8 total sheets; 1 for each 15-minute period)
- Pencil or Pen
- Clipboard (or something to write on)
- Watch (or other timing device that can identify 15-minute periods)
- Short letter from the agency sponsoring the counts. This letter should have the name, email, and phone number of someone at the agency so that you can tell people with questions about the counting effort who they can contact (See attached Example Agency Letter).

FILL IN GENERAL INFORMATION ON FIRST SHEET (See top of attached Data Collection Sheet):

- Arrive at the count intersection at least 15 minutes before the count period is scheduled to find a location where you can see all of the intersection crossings and to fill in general information.
- Record the name of the mainline roadway (roadway with more traffic) and intersecting roadway.
- Label the intersection diagram with the names of each roadway.
- Add an arrow to indicate which direction is NORTH.
- Record your name as the observer.
- Record the date and time period of the count.
- Estimate the current temperature (°F) and weather (sunny, cloudy, rainy, etc.).
- Describe the intersection, including surrounding buildings (e.g., restaurants, single-family houses, and offices) and roadway characteristics (e.g., traffic signals, median islands, and fast traffic).
- Record the appropriate 15-minute time period in the upper left corner of each sheet.

FOLLOW PEDESTRIAN COUNTING PROCEDURE (See Side 1 of Data Collection Sheet):

- Tally each time a pedestrian crosses each leg of the intersection from either direction.
- Pedestrians should be counted whenever they cross within the crosswalk or when they cross an intersection leg within 50 feet of the intersection.
- Do NOT count pedestrians who do not cross the street (e.g., turn the corner on the sidewalk without crossing the street).
- If the pedestrian is female, mark an "O"; if male, mark an "X"; if unknown, mark a "+". If the pedestrian volume is so high that it is difficult to count by gender, use standard line tally marks.
- If the pedestrian is using a wheelchair or other assistive device, underline the "O", "X", or "+".
- Count for 2 hours. Use a new sheet for each 15-minute period.
- If the intersection is a "T" intersection with only three legs, you should still count four sides of the intersection. Pedestrians using the "sidewalk side" of the intersection should be counted when they travel along the sidewalk for at least half of the width of the intersection. Label the "sidewalk side" on the intersection diagram.
- Pedestrians include people in wheelchairs, people using canes and other assistive devices, children being carried by their parents, children in strollers, runners, skateboarders, people walking with a bicycle, etc., but do NOT include people riding bicycles, people in cars, etc.

FOLLOW BICYCLIST COUNTING PROCEDURE (See Side 2 of Data Collection Sheet):

- Tally each time a bicyclist approaches from each leg of the intersection and arrives at the intersection (this includes turning left, going straight, or turning right).
- Count bicyclists who may be riding on the wrong side of the street (against traffic).
- Count bicyclists who ride on the sidewalk (i.e., if a bicyclist on the sidewalk turns right without crossing the street, they should still be counted as turning right).
- If the bicyclist is female, mark an "O"; if male, mark an "X"; if unknown, mark a "+." If the bicycle volume is so high that it is difficult to count by gender, use standard line tally marks.
- If the bicyclist is wearing a helmet, underline the "O," "X," or "+."
- Count for 2 hours. Enter tally marks in a new row after each 15-minute period. Record totals at the bottom of the sheet after the 2 hours are completed.
- Bicyclists include people riding bicycles. They do NOT include people who are walking their bicycles across the intersection.

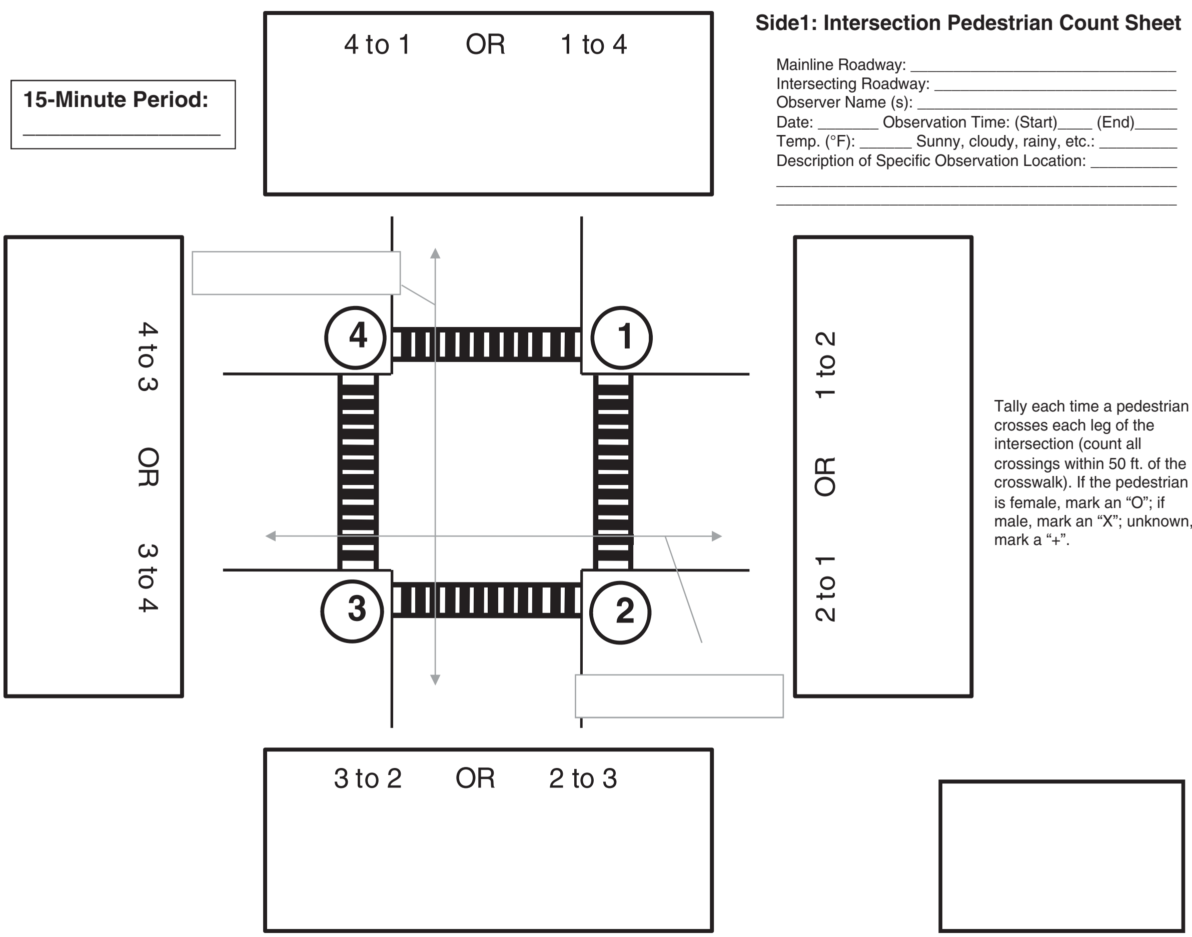
UNDERSTAND DATA PRIORITY:

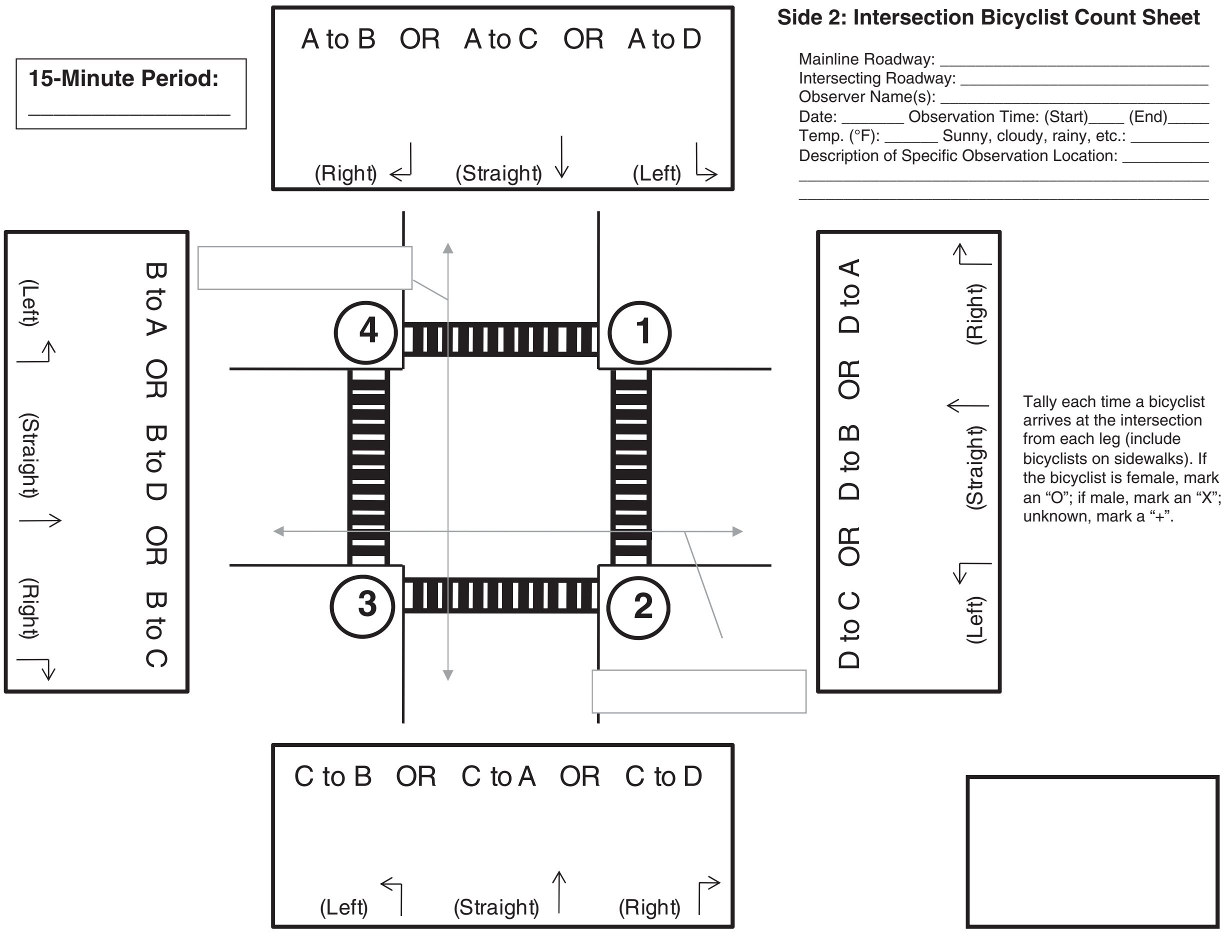
If you do not feel you (or you and your fellow data collectors at the intersection) can keep up with all observations at a location, collect the data according to the following priority ranking:

1. Count of Pedestrians
2. Count of Bicyclists
3. Gender
4. Helmet Use
5. Pedestrian Crossing Direction
6. Bicyclist Turning Movement

GIVE DATA COLLECTION SHEET TO THE COUNT MANAGER:

- Give your data sheets to the count manager as soon as possible after completing the counts.
- Keep the completed data collection sheet in a safe place until you can turn it in.





Example Pedestrian & Bicycle Counting Information Letter for Field Data Collectors

[INSERT DATE]

[AGENCY] is collecting pedestrian and bicycle counts in the Lake Tahoe Region as part of research to track how local roadway, trail, and side-walk systems are used by all types of transportation modes. Locations for counts have been selected by [AGENCY, CONTACT]. Data collectors are being used to count pedestrians and bicyclists in the field.

If you have any questions about the count procedures or how the count data will be used by [AGENCY], please feel free to contact [INSERT NAME]. You can reach [FIRST NAME] by email at [E-MAIL ADDRESS] or by phone at [PHONE NUMBER].

Thank you.

SCREENLINE COUNT FORM

Bicycle/Pedestrian Data Collection - Screenline Supervisor Form

Date ______ ______ 20____
DAY MONTH YEAR

Location ____________ STREET / PATH
BETWEEN ____________ AND ____________

Count Periods at This Location
1. ____ : ____ AM / PM START ____ : ____ AM / PM END
2. ____ : ____ AM / PM START ____ : ____ AM / PM END
3. ____ : ____ AM / PM START ____ : ____ AM / PM END

Pages ____ OF ____
PAGE TOTAL

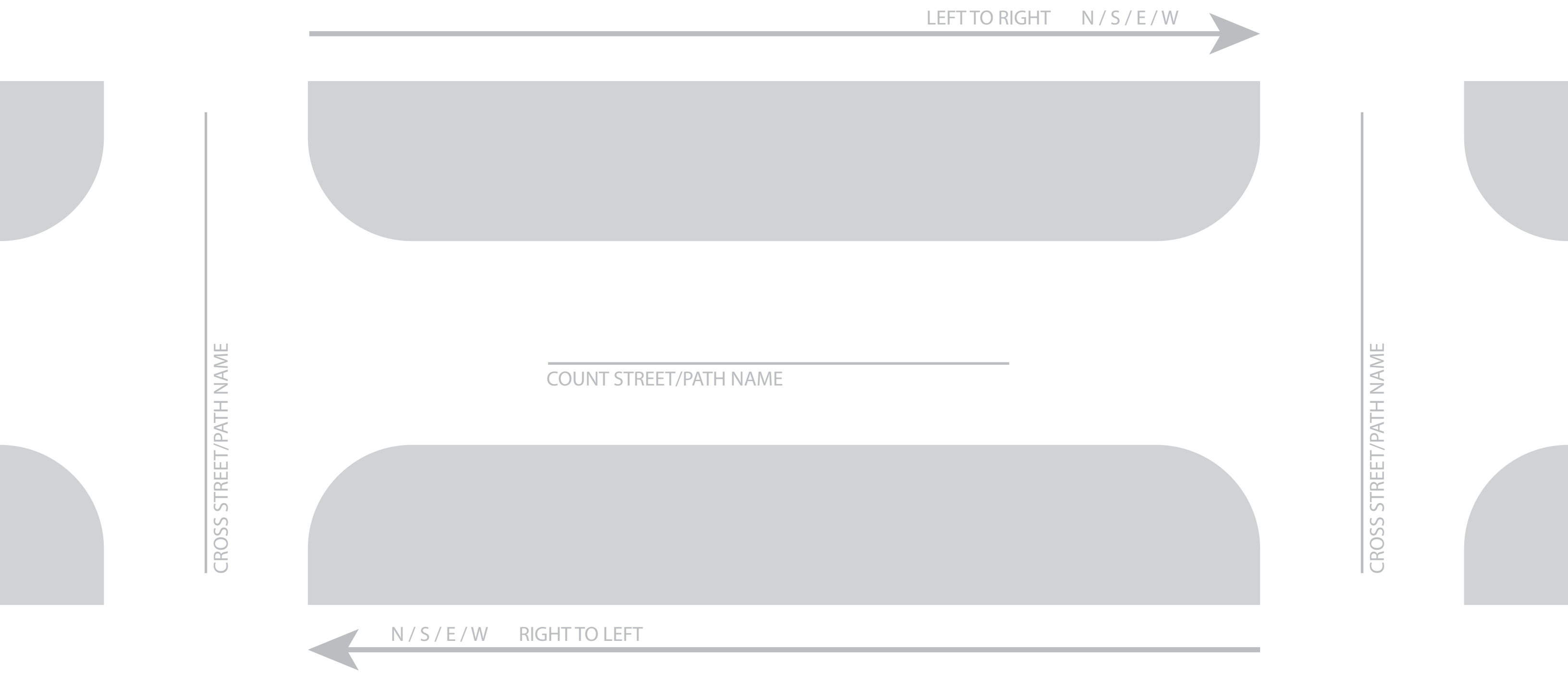
Show Them Where to Count...

Mark where the counter should be located with an "X" on the Count Location Schematic below. Then, draw in the counter's screenline.

Label the street the counter will be counting on, as well as the nearest cross streets, as they will appear from the count location.

Indicate which way will be "left to right" and "right to left" on the arrows below.
Also mark cardinal directions (N, S, E, or W. Note that NW, SE, etc. are not allowed) as they will appear to the counter.
If you are not sure which cardinal direction to assign because the street does not run exactly north-south or east-west, please consult any previous counts and be consistent with what has been chosen in the past.

Count Location Schematic



Bikeway Type at This Location

Record the bikeway type present at this location, if any, including sub-options.

- ☐ BIKE PATH
- ☐ BIKE LANE
  - ☐ *COLORED*
  - ☐ *PAINTED BUFFER*
  - ☐ *PHYSICAL BUFFER*
- ☐ BIKE ROUTE
  - ☐ *SHARROWS*
- ☐ BIKE BOULEVARD
  - ☐ *SHARROWS*
- ☐ NONE

Additional Variables to Count

Indicate any additional attributes the counter should count using the checkboxes below.

Bicycle	☐ FEMALE	☐ WRONG WAY RIDING	☐ SIDEWALK RIDING	☐ OTHER: ______	☐ OTHER: ______
Pedestrian	☐ WHEELCHAIR/ SPECIAL NEEDS	☐ SKATEBOARD/ SCOOTER/SKATES	☐ CHILD	☐ OTHER: ______	☐ OTHER: ______

Bicycle/Pedestrian Data Collection - Screenline Count Form

Date ______ ______ 20______
DAY MONTH YEAR

Location ________________ STREET / PATH
BETWEEN ________ AND ________

This Page ___:___ AM/PM ___:___ AM/PM
FROM TO

Count Period ___:___ AM/PM ___:___ AM/PM
START END

Pages ______ OF ______
PAGE TOTAL

Rain ☐ YES ☐ NO

Bicyclists

Count bicyclists when they cross this imaginary line

Make additional marks to count other characteristics

Bikes - Right to Left

TOTAL

Bikes - Left to Right

TOTAL

Female — TOTAL

Sidewalk Riding — TOTAL

Wrong Way Riding — TOTAL

Other: — TOTAL

Other: — TOTAL

Pedestrians

Count pedestrians when they cross this imaginary line

Make additional marks to count other characteristics

Pedestrians - Right to Left

TOTAL

Pedestrians - Left to Right

TOTAL

Wheelchair/Special Needs — TOTAL

Skateboard/Scooter/Skates — TOTAL

Child — TOTAL

Other: — TOTAL

Other: — TOTAL

INTERSECTION COUNT FORMS AND INSTRUCTIONS

National Bicycle and Pedestrian Documentation Project

COUNT AND SURVEY INSTRUCTIONS

Please review these instructions before going to the count or survey site.

Items you should bring to the site include:

1. These instructions
2. Safety vest
3. Location map
4. Count/Survey forms
5. Clipboard
6. Pen or pencil and a spare
7. Watch or time to record 15 minute intervals
8. Count/survey manager business cards
9. Optional: hat, sunscreen, jacket, snacks, water

Once you've reached the site please ensure your safety. Be aware of your surroundings.

It is best to arrive at the site 15 minutes before the count period. Once you've arrived:

1. Find a safe location to conduct the survey or counts.
2. Record the background information at the top of the count/survey form.

If conducting a survey, be sure to approach the bicyclists or pedestrians in a friendly engaging manner. A suggested script is:

> "Hello, do you have time to answer a few questions about walking and biking?"
>
> If yes:
>
> "My name is __________ and I'm conducting this survey for _________________. The information will be used to better understand why people walk and bike where they do. The survey will take about 5 minutes.
>
> "You don't have to answer all the questions, and you can stop taking the survey at any time. I won't ask for any personal information. Would you like to take the survey?

After completing your count or survey period, return your forms to the count/survey manager as soon as possible.

STANDARD BICYCLE INTERSECTION COUNT FORM

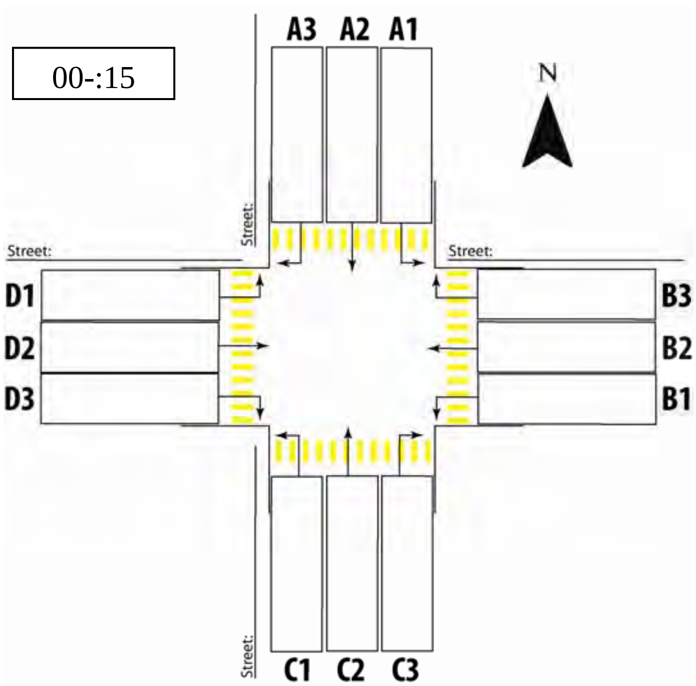
Name: ____ Location: ____

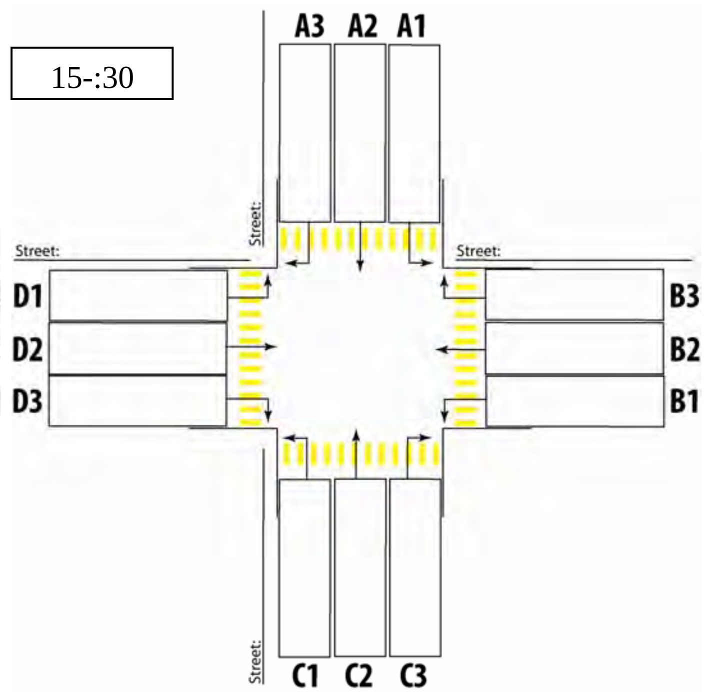
Date: __________________________ Start Time: ________________________ End Time: ___________________________

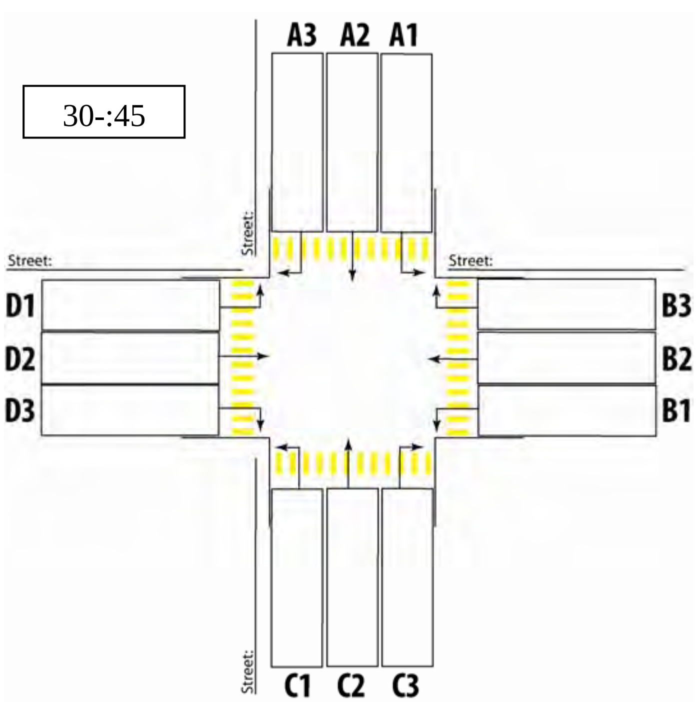
Weather: ________________________

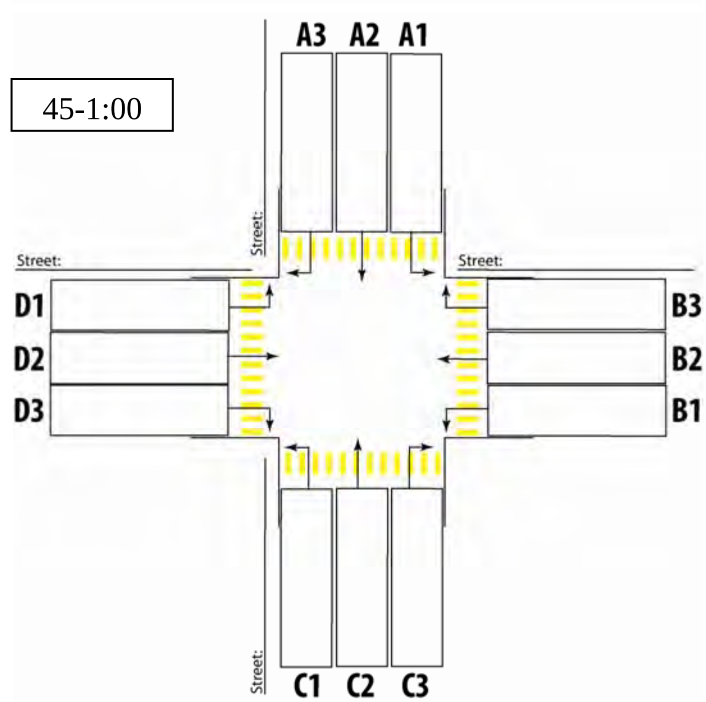
Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists crossing through the intersection under the appropriate categories.

- Count for two hours in 15-minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Use one intersection graphic per 15-minute interval.

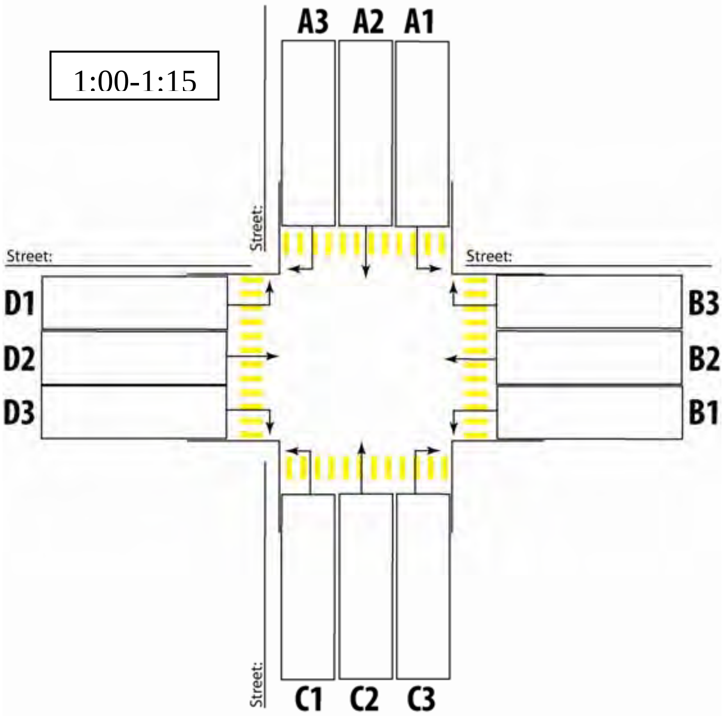




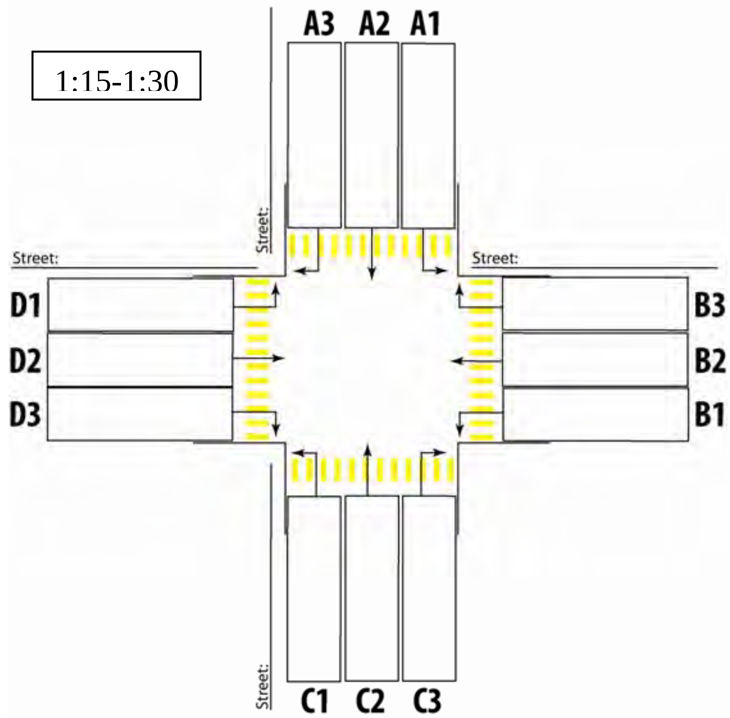




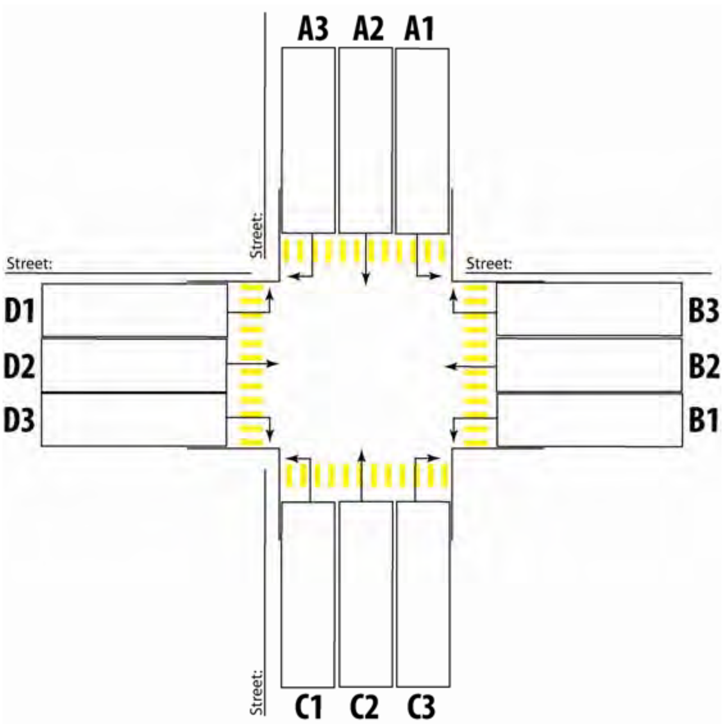
1:00-1:15



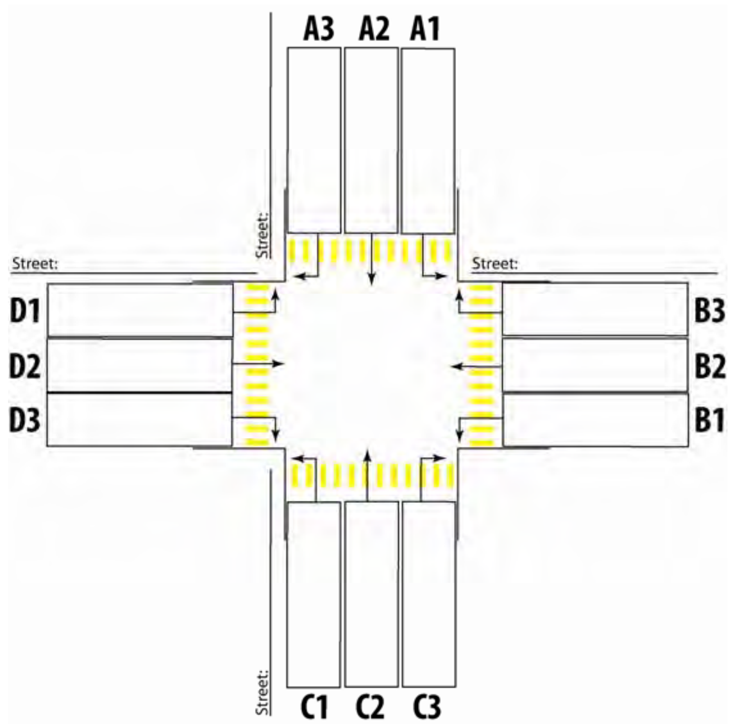
1:15-1:30



1:30-1:45



1:45-2:00



Notes:

STANDARD BICYCLE INTERSECTION COUNT TALLY SHEET

	Bicycle Counts											
Time Period	Leaving Leg A			Leaving Leg B			Leaving Leg C			Leaving Leg D		
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
00-:15												
15-:30												
30-:45												
45-1:00												
1:00-1:15												
1:15-1:30												
1:30-1:45												
1:45-2:00												
Total												
Total Leg:												
Street Name A to C:							Location 1 (Total Leg A + Total Leg C) =					
Street Name B to D:							Location 2 (Total Leg B + Total Leg D) =					

Pedestrian and Bicyclist Intersection Counts (2-hour counts, 1 sheet per 15-minute period)
Data Collector Instructions

Robert Schneider, Lindsay Arnold, and David Ragland
UC Berkeley Safe Transportation Research & Education Center (SafeTREC)
April 2011

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- Pencil or Pen
- Clipboard (or something to write on)
- Watch (or other timing device that can identify 15-minute periods)
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- Label the intersection diagram with the names of each roadway
- Add an arrow to indicate which direction is NORTH
- Record your name as the observer
- Record the date and time period of the count
- Estimate the current temperature (°F) and weather (sunny, cloudy, rainy, etc.)
- Describe the intersection, including surrounding buildings (e.g., restaurants, single-family houses, offices, etc.), roadway characteristics (traffic signals, median islands, fast traffic, etc.)
- Record the appropriate 15-minute time period in the upper left corner of each sheet

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[1] These instructions describe how to count pedestrians and bicyclists at intersections. There are many other ways that pedestrians and bicyclists can be counted at intersections, but this method is designed to gather counts in the most accurate, efficient, and consistent manner. Gender is captured using this methodology, but age, helmet use, jaywalking, wrong-way riding, and other characteristics are not included so that data collectors can focus on counting accurately. In addition, it is also possible to count pedestrians and bicyclists at locations such as trail, sidewalk, and bicycle lane segments and building entrances. However, different methodologies are used to capture counts at these other locations.

FOLLOW PEDESTRIAN COUNTING PROCEDURE (See Side 1 of Data Collection Sheet):

- Tally each time a pedestrian crosses each leg of the intersection from either direction.
- Pedestrians should be counted whenever they cross within the crosswalk or when they cross an intersection leg within 50 feet of the intersection.
- Do NOT count pedestrians who do not cross the street (e.g., turn the corner on the sidewalk without crossing the street).
- If the pedestrian is female, mark an "O"; if male, mark an "X"; if unknown, mark a "+". If the pedestrian volume is so high that it is difficult to count by gender, use standard line tally marks.
- If the pedestrian is using a wheelchair or other assistive device, underline the "O", "X", or "+".
- Count for two hours. Use a new sheet for each 15-minute period.
- If the intersection is a "T" intersection with only three legs, you should still count four sides of the intersection. Pedestrians using the "sidewalk side" of the intersection should be counted when they travel along the sidewalk for at least half of the width of the intersection. Label the "sidewalk side" on the intersection diagram.
- Pedestrians include people in wheelchairs, people using canes and other assistive devices, children being carried by their parents, children in strollers, runners, skateboarders, people walking with a bicycle, etc., but do NOT include people riding bicycles, people in cars, etc.

FOLLOW BICYCLIST COUNTING PROCEDURE (See Side 2 of Data Collection Sheet):

- Tally each time a bicyclist approaches from each leg of the intersection and arrives at the intersection (this includes turning left, going straight, or turning right)
- Count bicyclists who may be riding on the wrong side of the street (against traffic)
- Count bicyclists who ride on the sidewalk (i.e., if a bicyclist on the sidewalk turns right without crossing the street, they should still be counted as turning right)
- If the bicyclist is female, mark an "O"; if male, mark an "X"; if unknown, mark a "+". If the bicycle volume is so high that it is difficult to count by gender, use standard line tally marks.
- If the bicyclist is wearing a helmet, underline the "O", "X", or "+".
- Count for two hours. Enter tally marks in a new row after each 15-minute period. Record totals at the bottom of the sheet after the two hours are completed.
- Bicyclists include people riding bicycles. They do NOT include people who are walking their bicycles across the intersection.

UNDERSTAND DATA PRIORITY:

If you do not feel like you (or you and your fellow data collectors at the intersection) may not be able to keep up with all observations at a location, collect the data according to the following priority ranking:

- 1. Count of Pedestrians
- 2. Count of Bicyclists
- 3. Gender
- 4. Helmet Use
- 5. Pedestrian Crossing Direction
- 6. Bicyclist Turning Movement

GIVE DATA COLLECTION SHEET TO THE COUNT MANAGER:

- Give your data sheets to the count manager as soon as possible after completing the counts.
- Keep the completed data collection sheet in a safe place until you have an opportunity to turn it in.

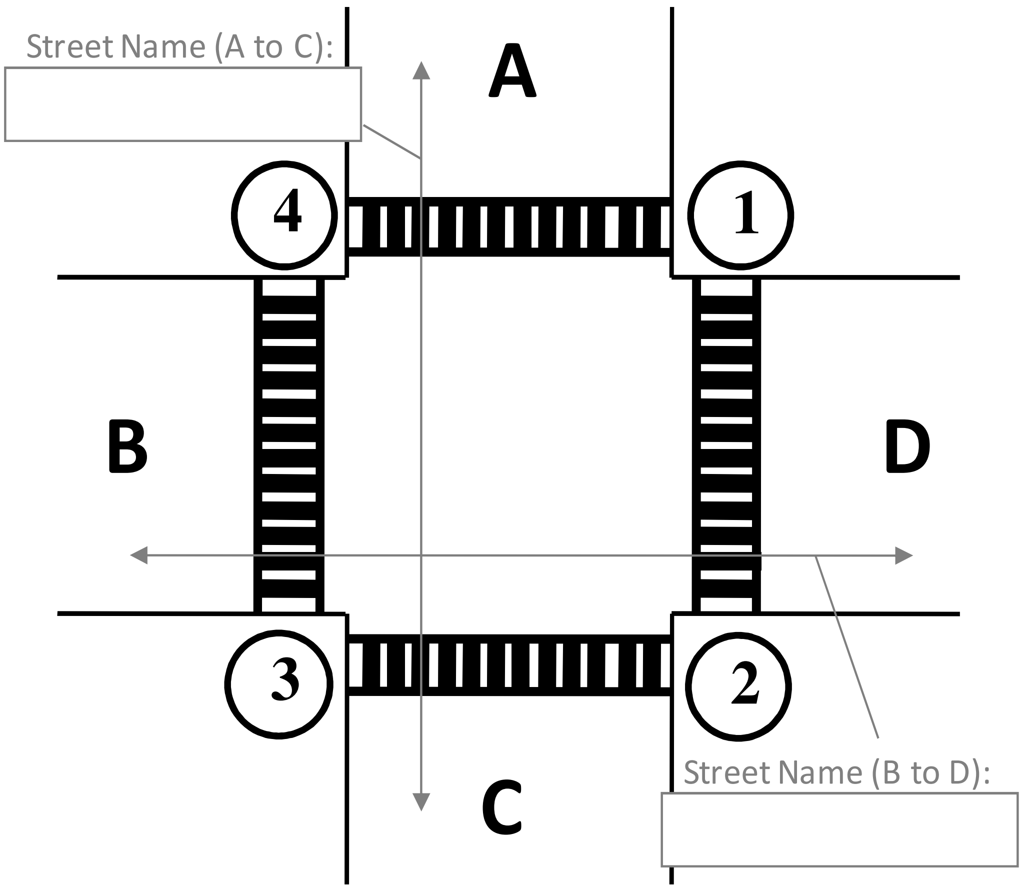
Side 1: Intersection Pedestrian Count Sheet

15-Minute Period: ________________

4 to 1 OR 1 to 4

Mainline Roadway: ______________________________
Intersecting Roadway: ____________________________
Observer Name(s): ______________________________
Date: ________ Observation Time: (Start)____ (End)_____
Temp. (°F): _______ Sunny, cloudy, rainy, etc.: ___________
Description of Specific Observation Location: ___________
____
____

4 to 3 OR 3 to 4



1 to 2 OR 2 to 1

Tally each time a pedestrian crosses each leg of the intersection (count all crossings within 50 ft. of the crosswalk). If the pedestrian is female, mark an "O"; if male, mark an "X"; unknown, mark a "+".

3 to 2 OR 2 to 3

Please give completed form to:
Name:
Address:

Tel:
Fax:
Email:

Side 2: Intersection Bicyclist Count Sheet

15-Minute Period: ____________________

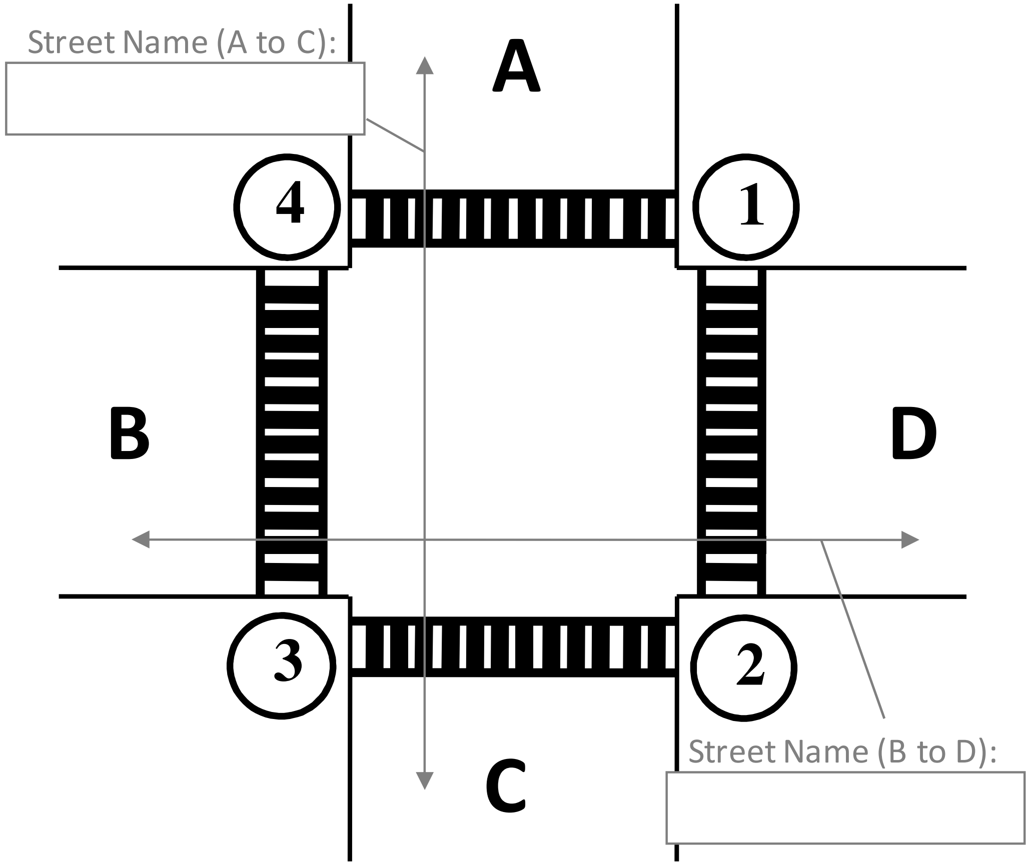
Mainline Roadway: ______________________________
Intersecting Roadway: ___________________________
Observer Name(s): ______________________________
Date: ________ Observation Time: (Start)____ (End)____
Temp. (°F): _______ Sunny, cloudy, rainy, etc.: __________
Description of Specific Observation Location: ___________
____
____

A to B OR A to C OR A to D

(Right) ↲ (Straight) ↓ (Left) ↳

B to A OR B to D OR B to C

(Left) (Straight) (Right)



D to C OR D to B OR D to A

(Left) (Straight) (Right)

Tally each time a bicyclist arrives at the intersection from each leg (include bicyclists on sidewalks). If the bicyclist is female, mark an “O”; if male, mark an “X”; unknown, mark a “+”.

C to B OR C to A OR C to D

(Left) (Straight) ↑ (Right)

Please give completed form to:
Name:
Address:

Tel:
Fax:
Email:

Appendix 5 Implementing the Monitoring Criteria Prioritization Methodology in ArcGIS

IMPLEMENTING THE MONITORING CRITERIA PRIORITIZATION METHODOLOGY IN ARCGIS

The recommended sites for permanent monitoring stations and the rotating biennial manual counts in the Lake Tahoe Region Bicycle and Pedestrian Monitoring Protocol were developed by applying the protocol's five monitoring criteria to the Lake Tahoe Region's network of streets and paths in ArcGIS. The specific step-by-step methodology for implementing the monitoring criteria prioritization methodology is described below.

Step 1. Merge Lake Tahoe Region Street Network and Non-Motorized Facilities

The TRPA/TMPO street network shapefile and the existing bicycle and pedestrian facilities shapefile should be merged using the Merge tool in ArcGIS 10.2.2 to form the Prioritization Network.

Step 2. Prepare Monitoring Criteria Data

The preparation of each of the five monitoring criteria data is described below, where needed:

- *Planned Bicycle /Pedestrian Improvement Projects*: The proposed bicycle and pedestrian facility shapefile data does not require any additional processing.
- *Existing Bicycle Facility Type*: This criteria is already integrated into the Prioritization Network through the merge of bicycle and pedestrian facilities with the street network, so no further processing is required.
- *Historic Count Locations*: The historic count location shapefile developed as part of this project does not require any additional processing.
- *Schools*: Buffer each school point by one-quarter mile to evaluate the criteria.
- *Transit Stations and Stops*: Buffer each transit station and/or stop within the region by one-quarter mile to evaluate the criteria.

Step 3. Add Field for Each Monitoring Criterion in the Prioritization Network

Add a field to the attribute table of the Prioritization Network for each monitoring criteria. This field will act as an indicator field as to whether the criteria is met for a given segment or not.

Step 4. Select Prioritization Network Segments Overlapping Monitoring Criteria Data

A spatial selection should be performed using the "Select by Location" tool. Any Prioritization Network segment that intersects the monitoring criteria data prepared in Step 2 should be used for the selection. For the Historic Count Locations use a ten-foot search distance to ensure that count locations are associated with the Prioritization Network.

Step 5. Calculate Indicator Field for Each Criterion

Once the Prioritization Network segments have selected for each criterion, perform a field calculation on the indicator field for the given criterion. Calculate the selected segments to the value of 1. This will indicate that the segment met the criterion. Step 4 and Step 5 should be repeated for each of the monitoring criteria.

Step 6. Calculate Weighted Prioritization Score

After indicating the criteria met for each segment, add a prioritization score field to the Prioritization Network's attribute table. This field is used to calculate the prioritization score by multiplying each indicator field by the criteria's associated weighting score. This yields a given segment's Prioritization Score.

Step 7. Prioritize Segments for Monitoring

With all segments scored, the highest scoring sites should be selected for evaluation as monitoring sites. Where scores are tied preference should be given to segments that provided a diversity of facility types and geographic contexts. Sites adjacent or in close proximity to other previously selected monitoring sites can be excluded from consideration.

It should be noted that the monitoring criteria prioritization process is simply a tool to help systematically determine "good" monitoring locations. Professional judgement should always be applied to prioritized sites to gauge whether the highest scoring sites are feasible or make logical sense relative to other siting factors not reflected by the protocol's criteria.