KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
610 SW Alder Street, Suite 700, Portland, OR 97205 P 503.228.5230 F 503.273.8169

# Technical Memorandum #5.2: Best Practices

Date: October 9, 2015 — Project #: 17453.005

To: Jovi Anderson, Robin Lewis, Nick Arnis; City of Bend

From: Molly McCormick, Kelly Laustsen

Project: Bend Transportation Planning Strategy – Task 5: Multimodal Traffic Count Program

Subject: Technical Memorandum #5.2: Best Practices

This memo provides a summary of the current best practices for multimodal count programs and is intended to assist the City of Bend in researching, planning, and implementing a program. The state of the practice should be examined in order to provide background information and to allow the City of Bend to make an informed choice about methodologies, counting technologies, and data management. This will allow the city to understand how, when, and why certain technologies and methodologies are implemented based on current research and experience from other agencies. This memorandum also provides information on what tools and programs work best in what conditions.

The current state of the practice is summarized below in the following sections:

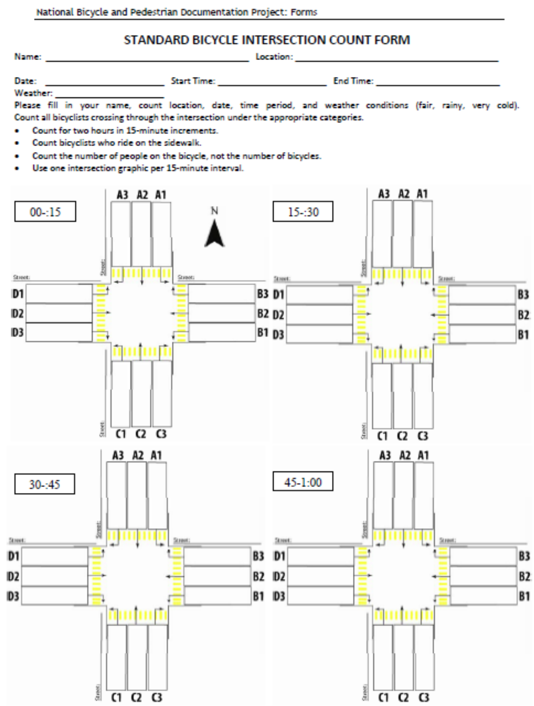
- Recent Research/Guidance on Data Collection Programs;
- Agency Examples;
- Data Applications;
- Counting Technologies;
- Data Management and Sharing
- Conclusion

## RECENT RESEARCH/GUIDANCE ON DATA COLLECTION PROGRAMS

Multimodal data collection is a growing need and priority for agencies across the country, driven by a greater emphasis on multimodal performance measures and desire to serve all users. However, guidance on developing a multimodal data collection program is still limited. There is not a standard method for collecting, storing, or sharing data. Recent projects and publications aimed at starting to address the need for more guidance are discussed in the following sub-sections.

## National Bicycle and Pedestrian Document Project (NBPD)

The National Bicycle and Pedestrian Document Project was started in 2004 and is led by Alta Planning + Design in collaboration with the ITE Pedestrian & Bicycle Council. It was one of the first attempts to create a repository for useful walking and bicycling data, including pedestrian and bicycle counts and survey data from multiple communities throughout the U.S. The following resources are available for practitioners establishing a data collection program:


National Bicycle and Pedestrian Documentation Project: Forms

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.

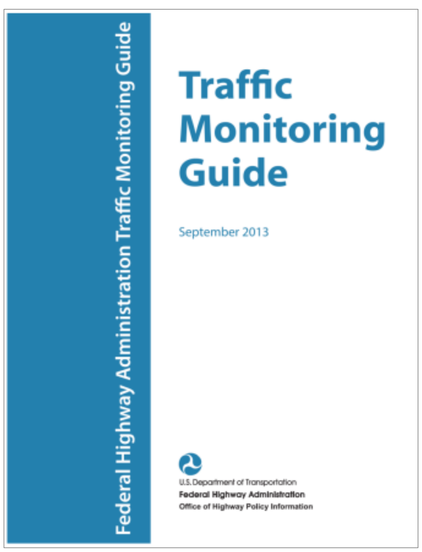
- Count for two hours in 15-minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Use one intersection graphic per 15-minute interval.



- Materials and directions to conduct counts and surveys in a consistent manner (example count sheet shown to the right);
- Standard count dates and times;
- A location where this information can be sent; and
- A mechanism to make this information available to the public.

The NBPD has proposed a methodology for conducting manual volume counts and developed bicycle and pedestrian count and survey forms. The NBPD envisions that participating agencies and organizations will use the forms and methodology provided through the Project Description and Training Guidelines to conduct annual counts and surveys during the National Documentation Days in the second week of September. Supplementary data may be collected during set dates in January, May, and July to provide seasonal data.

## 2013 Traffic Monitoring Guide (TMG)




The Federal Highway Administration's (FHWA) Traffic Monitoring Guide provides guidance to agencies on collecting traffic-related data. Although the guide is focused on motorized traffic counting, the 2013 edition addressed non-motorized travel by adding "Chapter 4: Traffic Monitoring for Non-Motorized Traffic." The chapter includes a discussion of the key differences between monitoring for motorized and non-motorized traffic, outlines the process for developing permanent and short-term non-motorized data collection programs following the same steps discussed for motorized traffic, and introduces data codes to document different aspects of pedestrian and bicycle data collection. Chapter 4 also gives a brief explanation of each of the available bicyclist and pedestrian counting technologies and when each technology is most appropriate to apply in a collection program.

The process recommended for developing permanent and short-term non-motorized data collection programs includes seven distinct steps:

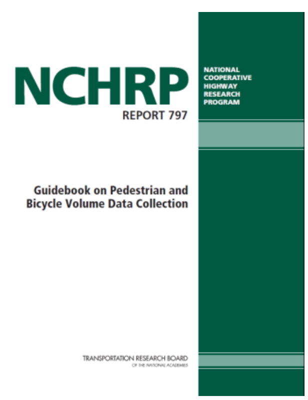
- Review the existing continuous count program;
- Develop an inventory of available continuous count locations and equipment;
- Determine the traffic patterns to be monitored;
- Establish pattern/factor groups;
- Determine the appropriate number of continuous monitoring locations;
- Select specific count locations; and
- Compute monthly, DOW, and hour-of-day (if applicable) factors to use in annualizing short-duration counts.

The TMG includes an appendix with a recommended data format for multimodal counts. The format includes data codes to document different characteristics of both the count location and count data, including direction orientation, road classification, type of facility, and approach and technology used to gather data. The intent of the format is to provide consistent with multimodal counts collected across the Country to provide more comparability.

## NCHRP 797: Guidebook on Bicycle and Pedestrian Data Collection

NCHRP 797: Guidebook on Bicycle and Pedestrian Data Collection was published by the Transportation Research Board in 2014 to provide specific guidance for non-motorized data collection due to a previous lack in established national procedures and technology. The contents of the guidebook include:

- Count applications with case studies;
- Planning and implementing a count program, with checklists and case studies;
- Correcting raw count data for to account for site- and product-specific counting errors;
- Expanding short-term count data to estimate longer-duration volumes; and
- Typical applications, strengths/limitations, relative cost, installation needs, and accuracy of counting technologies.




The Guidebook includes the following sections:

- **Quick Start Guide** – This section highlights the key information discussed in each guidebook chapter to help readers quickly find the material that is of greatest importance to them.

- **Introduction** – The first chapter of the guidebook describes its organization, summarizes the research that led to the development of the guidebook, discusses what is and is not covered in the guidebook, and gives an overview of non-motorized counting concepts.
- **Non-Motorized Count Data Applications** – The second chapter of the guidebook provides examples from real-world count program practitioners to demonstrate the many ways non-motorized count data can be applied to improve the performance of transportation organizations. The most common uses of non-motorized count data was
  - Tracking changes in pedestrian and bicycle activity over time;
  - Evaluating the effects of new infrastructure on pedestrian and bicycle activity;
  - Prioritizing pedestrian and bicycle projects;
  - Modeling transportation networks and estimating annual volumes; and
  - Conducting risk or exposure analyses.
- **Data Collection Planning and Implementation** – The third chapter of the guidebook describes the steps involved in starting and expanding a non-motorized count program. The steps outlined for planning a count program include:
  - Specifying the data collection purpose;
  - Identifying data collection resources;
  - Selecting count locations and the count timeframe; and
  - Considering available counting methods and technologies.

  The steps outlined for implementing the count program include:
  - Obtaining necessary permissions;
  - Procuring counting devices;
  - Taking inventory and preparing devices;
  - Training staff;
  - Installing and validating devices;
  - Calibrating devices;
  - Maintaining devices;
  - Managing count data;
  - Cleaning and correcting count data; and
  - Applying count data.
- **Adjusting Count Data** – The fourth chapter of the guidebook discusses two types of factors, correlation and expansion, that can be applied to count data when developing volume estimates.

   - Correction factors are developed from validation counts and account for systematic inaccuracies in counter technology. These factors are used to adjust raw counts to more closely represent the ground truth.
   - Expansion factors are applied specifically to short-duration counts to estimate volumes over longer periods of time.
- **Sensor Technology Toolbox** – The last chapter of the guidebook summarizes 14 existing and emerging technologies available for non-motorized counting. Each technology is presented in its own subsection including a description, typical applications, installation considerations, relative level of effort and cost, strengths and limitations, accuracy, and current usage. The existing and emerging counting technologies and methods included are:
   - Manual in-field counting;
   - Manual counts from video;
   - Automated counts from video;
   - Pneumatic tubes;
   - Inductive loop detectors;
   - Passive infrared;
   - Active infrared;
   - Piezoelectric strips;
   - Radio beams;
   - Thermal;
   - Laser scanners;
   - Pressure and acoustic pads;
   - Magnetometers; and
   - Fiberoptic pressure sensors.

# AGENCY EXAMPLES

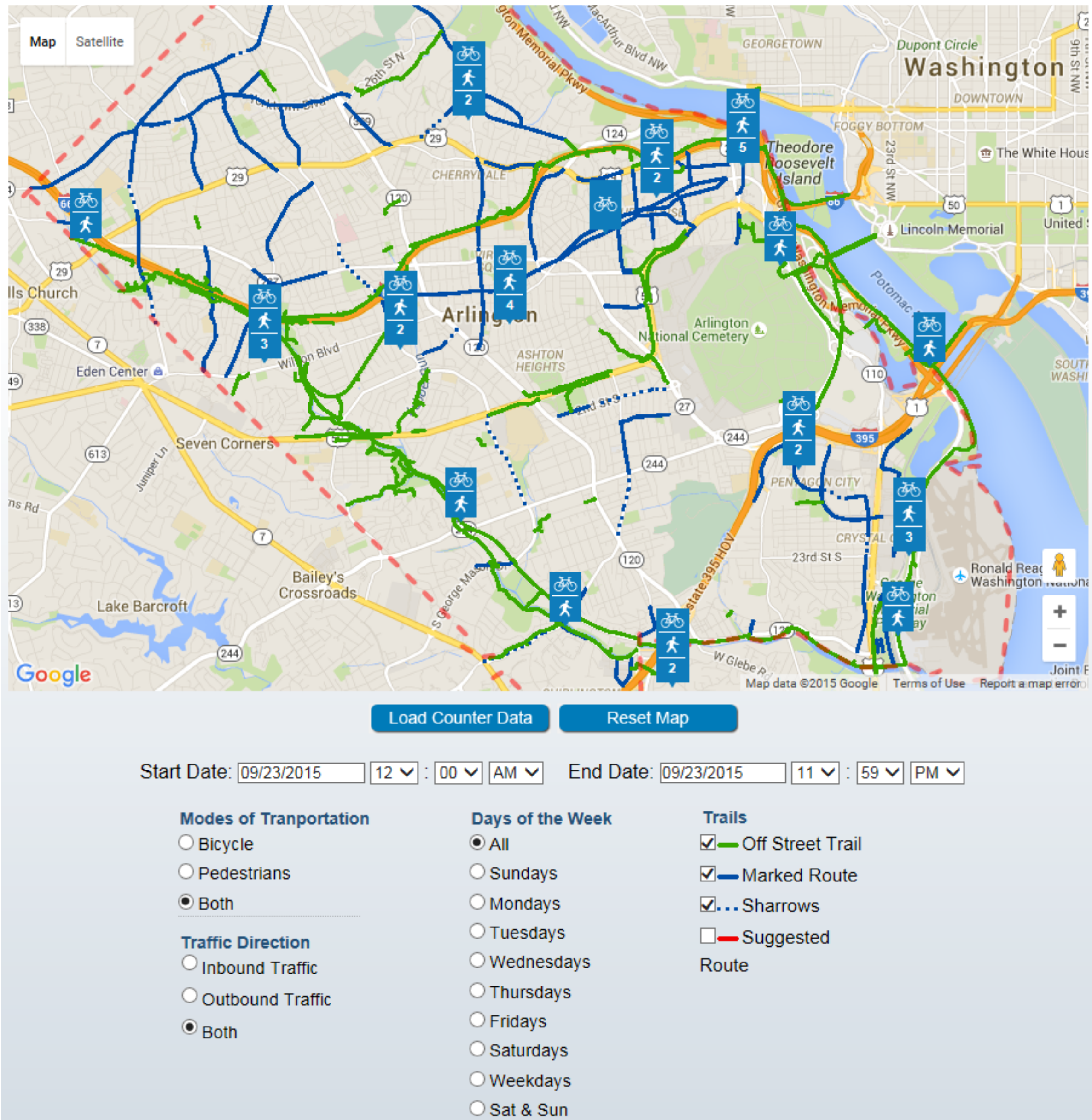
As part of the research associated with NCHRP 797, agency surveys and interviews were conducted to assess the state of the practice for bicycle and pedestrian data collection and identify agencies with particularly robust multimodal data collection programs. The following agencies provide example data collection programs the City of Bend can review to help determine what elements of other programs may be applicable to them. These examples illustrate the range of data collection technologies, data applications, data storage system, and multimodal reports that Bend may choose to emulate or build from.

## BikeArlington

BikeArlington is a bicycling-enthusiast program that works to get more people in the Arlington, Virginia area on their bikes. A count program is included through Arlington County to provide data for any interested agencies to use. Continuous automatic counters are maintained in the area to collect bicycle and pedestrian volumes throughout the day. There are currently 32 permanent count locations and 6 portable counters used in the county. The types of counters included are passive infrared and inductive loops, used separately and in combination.

To display the data collected by the counters, BikeArlington has a Bicycle & Pedestrian Counter Dashboard where volumes of bicyclists and/or pedestrians are shown for the selected location during the selected time period. Exhibit 1 shows how the counter dashboard is displayed online. The data is also available to be downloaded in a spreadsheet format.

**Exhibit 1. BikeArlington Bicycle & Pedestrian Counter Dashboard**



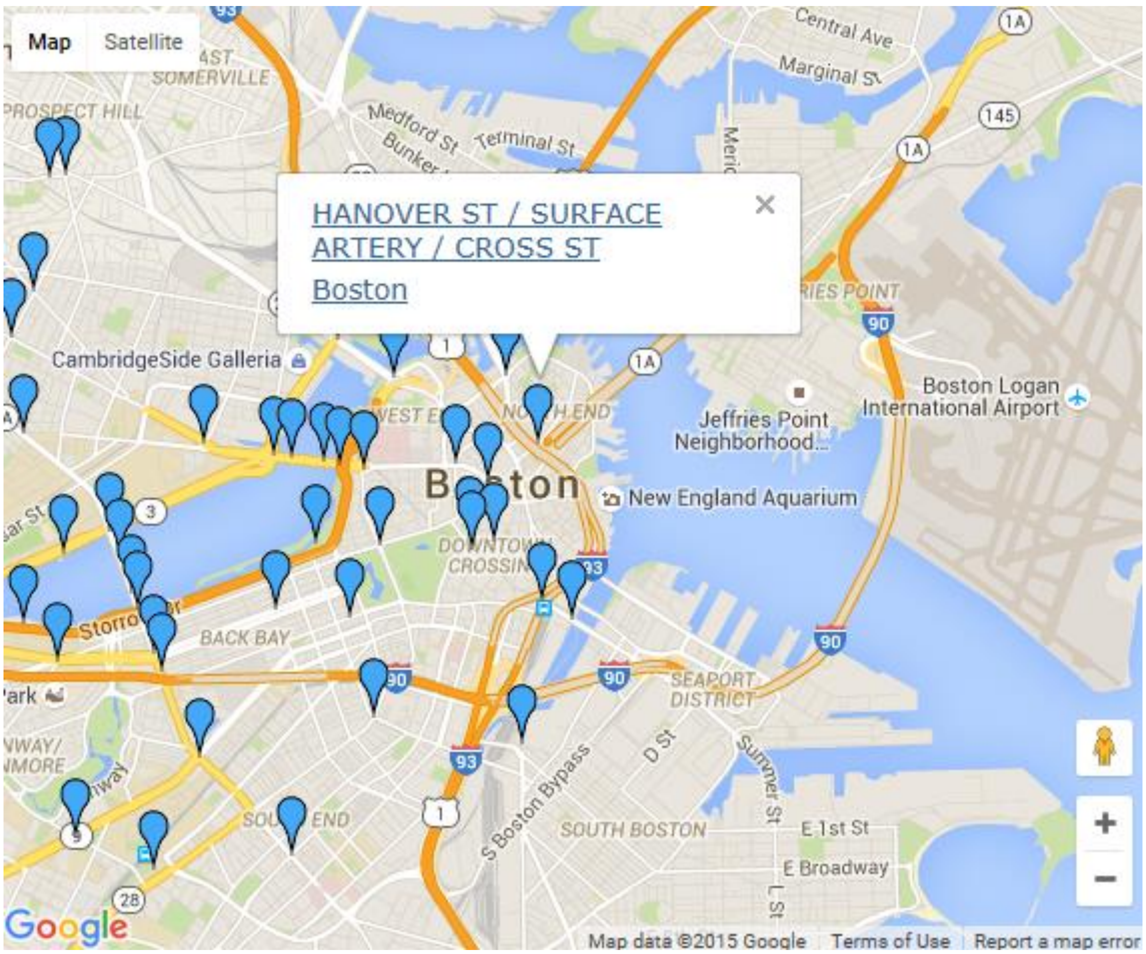

Source: BikeArlington (2015)

## Boston Region Metropolitan Planning Organization

The Boston Region Metropolitan Planning Organization manually collects annual pedestrian and bicycle volume counts every year, dating back to 1976. 71 facilities from the Boston region are included in the count database.

Exhibit 2 shows how the database is displayed online. The individual location information and count data can be downloaded in spreadsheet format.

**Exhibit 2. Pedestrian and bicyclist count database display online**




Source: Boston Region Metropolitan Planning Organization (2015)

## Portland Bureau of Transportation

The Portland Bureau of Transportation (PBOT) has been participating in the National Bicycle and Pedestrian Document Project since 2008, conducting manual counts every September and in May 2010. There are 66 count locations throughout the city, specifically focused on trails.

Exhibit 3 shows an example count sheet to collect user characteristics and volumes used by PBOT, similar to forms used as part of the National Bicycle and Pedestrian Document Project. Non-motorists are split into categories based on mode and gender, including wheelchair and other categories. This information is used for several purposes from supporting projects within the area to providing data to the NBPDP. The information collected is provided in an annual report.

**Exhibit 3. Example Portland Bureau of Transportation Counting Sheet**

STANDARDIZED TRAIL COUNT FORM

THE INTERTWINE

**Site ID:** 065 **Trail Name:** Springwater Corridor **Location:** SE 82nd Avenue
**To be completed by Data Collector:** Date: 9.11.12 Time Period: 5-7pm Weather: warm, windy
Name of Data Collector: John Smith Notes:

| | Bicycles | | Pedestrians | | Wheelchairs | | Others | |
|---|---|---|---|---|---|---|---|---|
| | Female | Male | Female | Male | Female | Male | Female | Male |
| :00-:15 | 2 | 12 | 4 | 2 | | | | |
| :15-:30 | 3 | 12 | Ø | 4 | | | | 1 |
| :30-:45 | 2 | 20 | 2 | 2 | | 1 | | |
| :45-1:00 | 6 | 17 | Ø | 1 | | | | 2 |
| 1:00-1:15 | Ø | 14 | Ø | 2 | | | | |
| 1:15-1:30 | Ø | 13 | 1 | 1 | | | 1 | |
| 1:30-1:45 | 4 | 10 | 1 | | | | | |
| 1:45-2:00 | 6 | 22 | 1 | 3 | | | | |
| Total 172 | 23 | 120 | 9 | 15 | | 1 | 1 | 3 |

Source: Portland Bureau of Transportation (2012)

# DATA APPLICATIONS

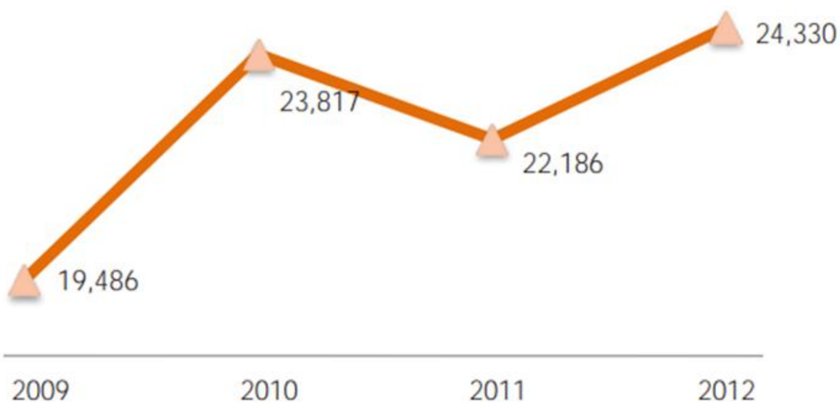
Multimodal data can be used for a number of applications. This section provides a list of potential applications with relevant case studies. This material is largely drawn from NCHRP 797, which features a chapter of data applications.

## Measure Facility Usage

Collecting consistent multimodal data at set locations and regular intervals can aid in measuring facility usage and changes over time. This is helpful for tracking progress towards established goals and measuring success. Particularly as agencies move towards more multimodal performance goals, data on bicyclists, pedestrians, and vehicles is important to monitor a transportation system. If counts are collected at a regular time each month or year, trends over time can be assessed and metrics like percentage of users biking or walking or total bicyclists and pedestrians using a facility can be tracked.

Exhibit 4 shows an example graph from Washington State DOT, which uses a regular count program to monitor bicycling and walking activity. The state has set goals for bicycling and walking and uses data collected each year to assess progress.

**Exhibit 4. Change in walking and bicycling activity at Washington State count sites, 2009–2012**



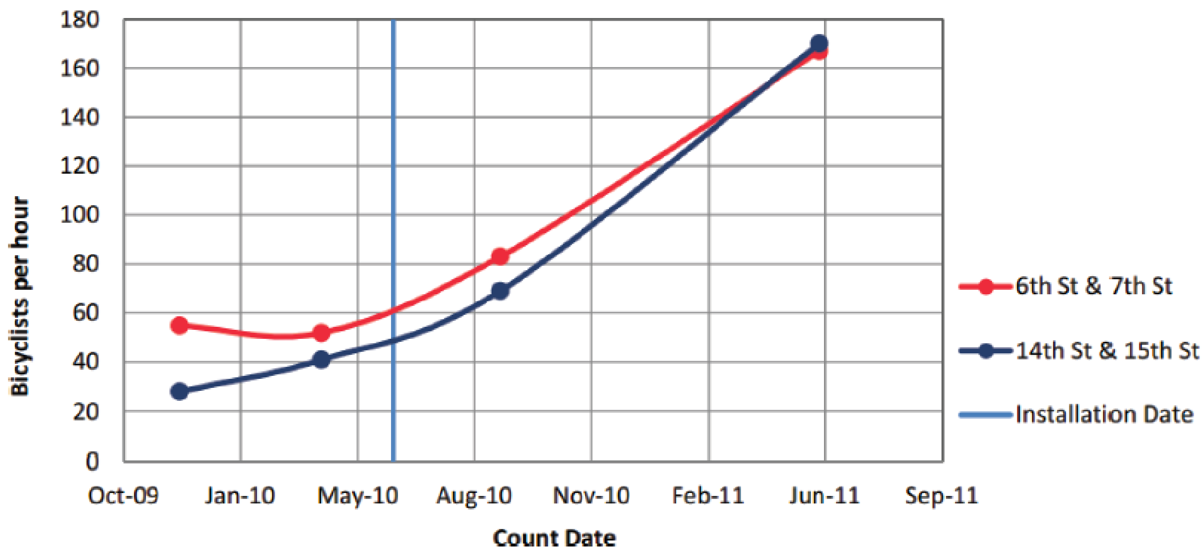

Source: Washington State DOT (2012)

## Evaluate Before & After Volumes

By collecting multimodal data before and after a new facility is opened or improvement to a facility made, volume changes can be measured and conclusions about the success of the facility can be made. It is valuable to track these changes because they can be later used to forecast usage of planned facilities or to justify additional improvements based on past results.

Exhibit 5 shows an example graph of before-and-after bicycle facility usage from the District Department of Transportation in Washington, DC (DDOT). DDOT used before-and-after counts to access the change in bicycle volumes after buffered bicycle lanes were added in the center median of Pennsylvania Avenue. The significant bicycle volume increase seen after the installation could be used to demonstrate project success, support similar treatments in the future, and forecast future bicycle activity for planning future treatments.

**Exhibit 5. Before-and-after bicycling activity at two improvement sites in Washington, DC, 2009-2011**




Source: Kittelson & Associates, Portland State University, and Tool Design Group (2012)

## Analyze Safety

By including non-motorized counts in safety analysis for a facility or area, before-and-after safety effects can be identified for new facilities or upgrades and exposure can be quantified. Exposure generally refers to an estimate of the potential for conflict to occur and can be applied to both pedestrians and bicyclists. Exposure is a component of risk and is defined as the probably that a physical conflict will occur. Exposure is only one of the factors that contribute to risk. One method proposed for estimating exposure is to consider crash data compared to user volumes. For example, pedestrian exposure could be assessed by considering the number of crashes compared to the number of pedestrians using a facility or the number of pedestrian users multiplied by the number of vehicle users. If only the number of crashes was taken into account, the non-motorist exposure would not be linked to the number of users on a facility and could misconstrue where risk is the highest. Non-motorized counts are therefore important for analyzing safety by leading to better evaluations of risk and crash data that are not solely based on the number of crashes reported at a location.

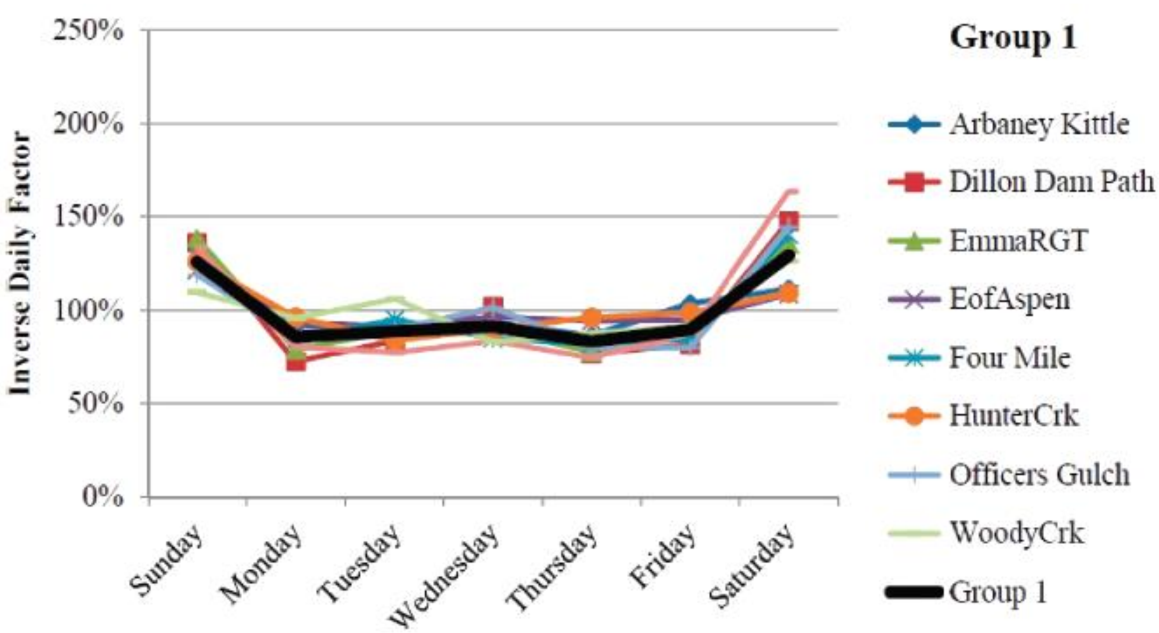
An example of safety analysis using non-motorized counts is provided by Montreal, Quebec. 647 signalized and 435 unsignalized intersections were evaluated by Strauss, Miranda-Moreno, and Morency (2014) to estimate the correlation between non-motorist injuries and intersection demand or intersection characteristics. For instance, models were developed to determine the percentage increase of pedestrian or bicyclist injuries due to percent increase of vehicle volumes at signalized or unsignalized intersections, respectively.

## Identify User Characteristics

Count data that expresses user characteristics can be used to better explain what drives mode choice and whether certain characteristics are more influential than others for increasing non-motorized travel. Agencies can use this information to guide policies, access performance goals, and prioritize facility improvements and future projects. In addition, recording user characteristics like wrong-way riding or sidewalk riding can help identify high-priority facility gaps where demand is present.

Exhibit 6 shows an example graph of how pedestrian and bicyclist volumes can be used to identify user characteristics from the Colorado Department of Transportation. Count data was used to identify three trail usage patterns using cluster analysis: Mountain Non-Commute, Front-Range Non-Commute, and Commute. Each pattern was associated with certain trip purposes and activities. By establishing three user patterns, CDOT was able to more accurately extrapolate short-term volumes to annual trail user volumes.

**Exhibit 6. Colorado DOT commute trail factor group**



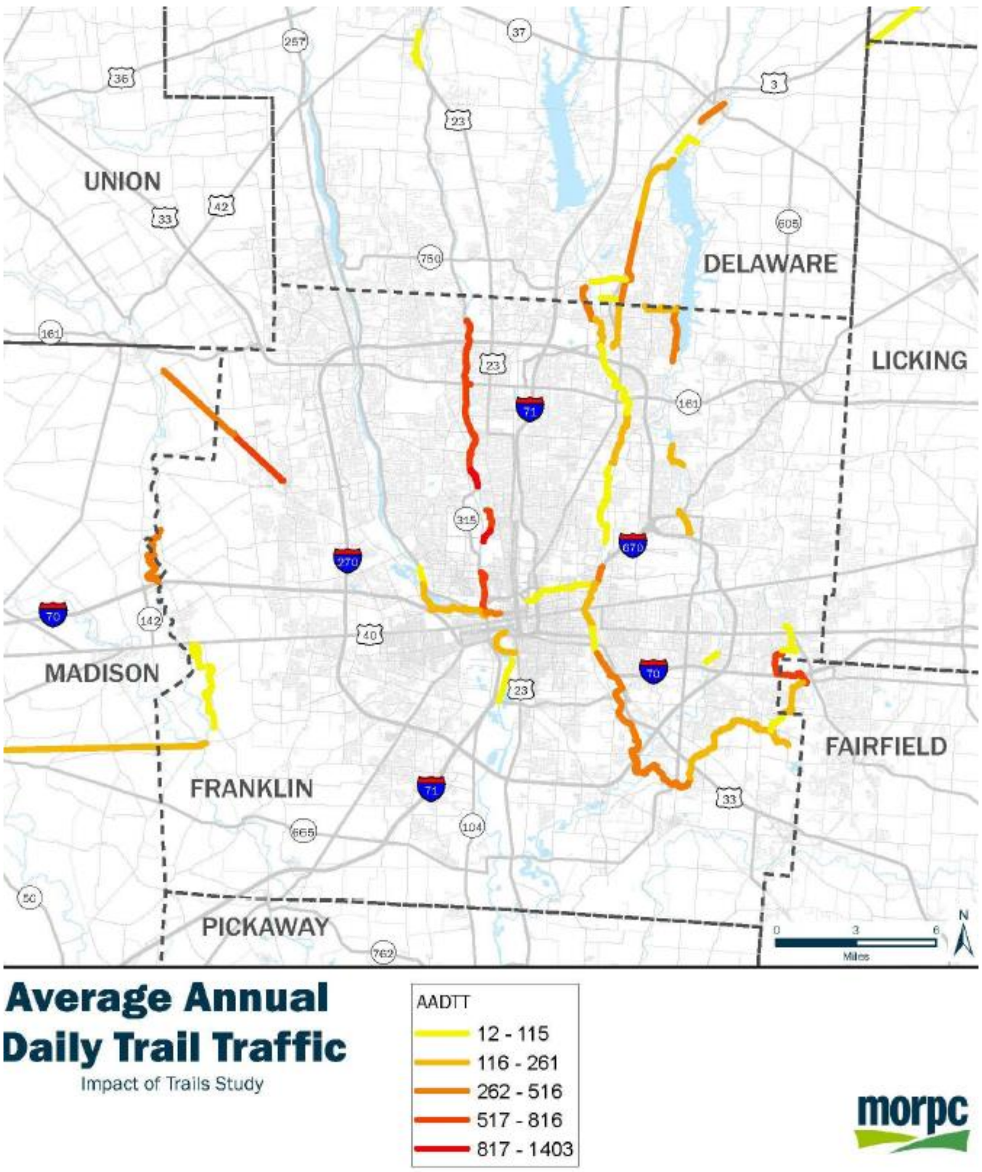

Source: Nordback Marshall, Janson (2013)
Note: Inverse daily factor is the percentage of the average daily volume observed on each specific day. Each legend item represents a different bicycle monitoring location. The bold line is the average of all locations.

## Estimate Network Volumes

Multimodal count data can be aggregated to estimate the pedestrian and bicyclist volumes across a network. Tracking network volumes helps to prioritize future improvements or projects within a region. It is also valuable for forecasting future usage in the network or for comparing the change in volumes with different proposed improvements. As with measuring facility usage, estimating network volumes is important for monitoring a transportation system and measuring multimodal usage goals.

Exhibit 7 shows a map-based example of network volumes estimated using both short-term and long-term counts from the Mid-Ohio Regional Planning Commission (MORPC) and local partners, including the City of Columbus and the Rails to Trails Conservancy. The MORPC has been monitoring trail traffic for the last several years and producing reports to describe the results. As seen in the figure, a trail network is present and has ranging usage depending on corridor.

**Exhibit 7. Estimated annual trail volumes**



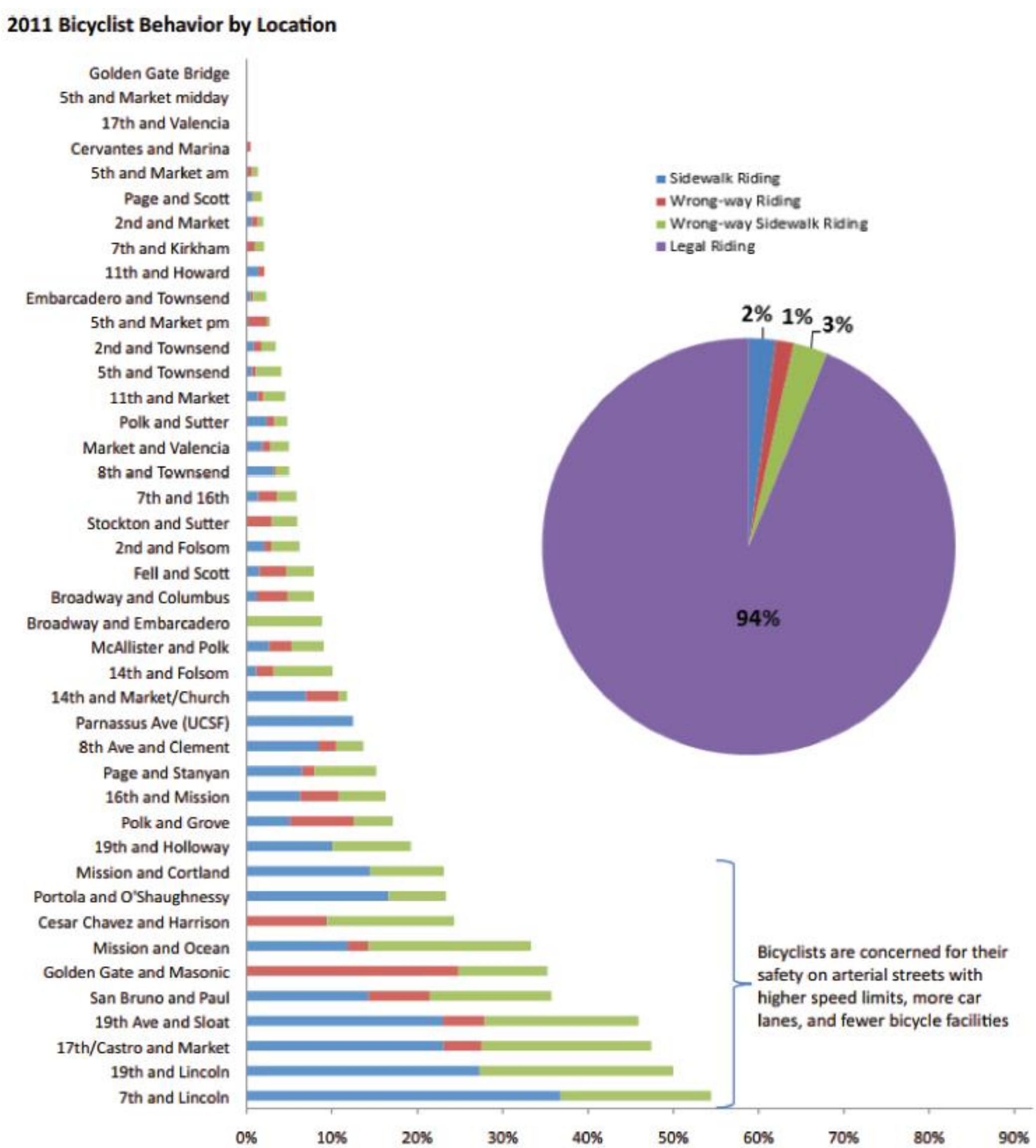

Source: Mid-Ohio Regional Planning Commission (2015)

## Prioritize Projects

Agencies can use non-motorized counts to help prioritize improvement locations and multimodal networks and to determine projects that have the highest potential to influence walking and bicycling rates. Pedestrian and bicycle volumes can identify the facilities where improvements can have the greatest impact and improve already essential multimodal networks. Counts can also expose areas where improvements may be needed due to deficiencies that result in improper user behaviors (like wrong-way and sidewalk riding).

Exhibit 8 shows an example figure from the San Francisco Municipal Transportation Agency (SFMTA) that shows rates of wrong-way and sidewalk riding for bicyclists at different locations in San Francisco. A total 6% of bicyclists were observed improperly using the facilities. The report from SFMTA concludes that improper riding most frequently occurs when the location has higher speeds, more car lanes, and fewer bicyclist facilities, as shown in the figure.

**Exhibit 8. Use of manual counts to evaluate unsafe bicyclist behaviors**



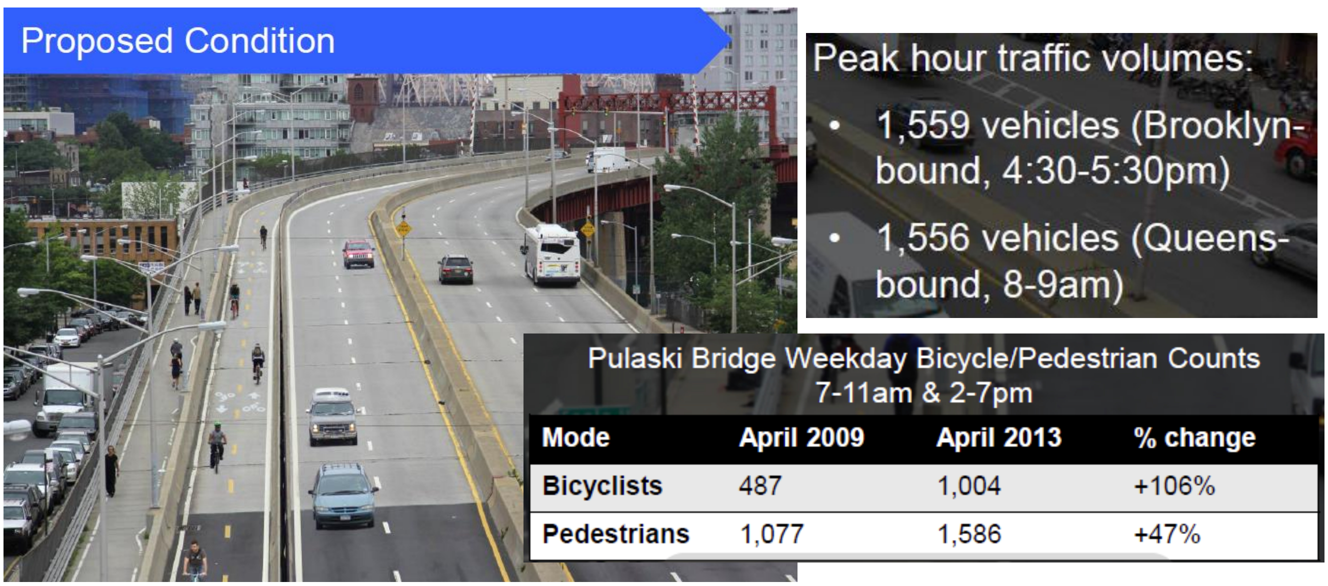

Source: San Francisco Municipal Transportation Agency (2011)

### Assess Mode Split

Collecting multimodal data can be used to assess mode split on a roadway and better understand the balance of users. This can be used to better define priorities on a roadway and assess what facilities are most appropriate. For example, collecting vehicle and bicycle data on a roadway could help inform the decision to install enhanced bicycle facilities, like a buffered bicycle lane or cycle track. In addition, tracking mode split over time could help assess the impact of improvements made aimed at impacting mode split by encouraging walking or bicycling.

As shown in the example from New York City, collecting data on bicycle, pedestrian and vehicle volumes on a roadway can help determine the most appropriate cross-section and evaluate the feasibility of improvements. The City collected counts of all users on the Pulaski Bridge to help assess potential improvements and ultimately recommend replacing a travel lane with two-way bicycle lanes.

**Exhibit 9. Proposed condition on Pulaski Bridge justified by multimodal traffic counts**

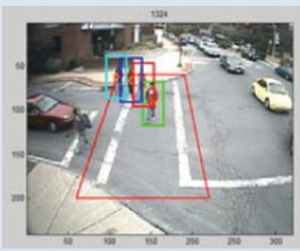
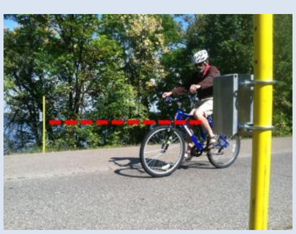


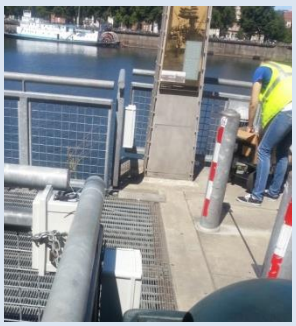

Source: New York City Department of Transportation (2013)

## COUNTING TECHNOLOGIES

There are a variety of technologies for counting vehicles, pedestrians, and bicyclists currently available, and a number of products still under development. Based on the count location and duration, as well as metrics desired (i.e. volume of bicyclists, volume of pedestrians, directionality, helmet use), different technologies may be appropriate for different locations. Chapter 5 of NCHRP 797 provides a toolbox of technologies, with typical applications, considerations, images, and other key information provided on each technology. However, because the industry is moving so quickly, this information should serve as a starting point. Improvements in these technologies are anticipated and new technologies are entering the market. A table below is provided summarizing some of the most common data collection technologies.

## Table 1. Data Collection Technologies

| Technology | Data | Typical Applications | Considerations |
|---|---|---|---|
| **Manual counts**<br> | • Intersection turning movement counts or screenline counts<br>• Pedestrians, vehicles, and/or bicyclists<br>• Demographic data or user characteristics | • Short-term counts<br>• Counts where demographic or user data is desired<br>• Instances where counts are needed at many locations | • Longer-term counts can be expensive.<br>• Data can be counted live or reduced from video. Quality tends to decrease when individual is counting for a longer period of time or responsible for counting a large number of variables. |
| **Automated video counts**<br> | • Intersection turning movement counts or screenline counts<br>• Pedestrians and/or bicyclists | • Short-term counts<br>• Can be used for up to 1 week at a time<br>• Video can be used for additional purposes | • Multiple cameras to collect data from an entire intersection.<br>• Some data storage limitations.<br>• Cameras need to be mounted high enough to capture the desired area.<br>• Should try to use existing infrastructure for mounting but avoid sources of vibration<br>• Not currently possible to process video in-house – algorithms still being further developed |
| **Passive infrared**<br> | • Screenline counts<br>• Pedestrians or bicyclists | • Long-term or permanent counts<br>• Often combined with inductive loops or piezoelectric strips in integrated units<br>• Multi-use paths or sidewalks | • Sensor is located on one side of facility<br>• Not able to differentiate between pedestrians and bicyclists.<br>• Best for facilities with one user type or in conjunction with another technology to differentiate users.<br>• Placement of counter is important for good results.<br>• Subject to occlusion errors.<br>• Results can be affected by extreme temperatures.<br>• Can undercount pedestrians, especially as pedestrian volumes increase<br>• Good mobility; can be taken to a new site |
| **Active infrared**<br> | • Screenline counts<br>• Pedestrians or bicyclists | • Temporary or permanent counts<br>• Often combined with inductive loops or piezoelectric strips in integrated units<br>• Multi-use paths or sidewalks | • Infrared beam is between a transmitter and a receiver facing each other on opposite sides of facility.<br>• Need a clear line of sight between transmitter and receiver<br>• Not able to differentiate between pedestrians and bicyclists.<br>• Best for facilities with one user type or in conjunction with another technology to differentiate users.<br>• Subject to occlusion errors.<br>• Good mobility; can be taken to a new site<br>• Is fairly accurate although can count false positives if objects interfere with the infrared beam |
| **Pneumatic tubes** | • Screenline counts | • Short-term or long-term | • Should be located where bicyclists are |

| | | | |
|---|---|---|---|
|  | • Vehicles and/or bicyclists<br>• Speed and directionality (when using two tubes) | counts<br>• Paved surfaces | not likely to stop.<br>• Work best when temperatures are above freezing<br>• Most jurisdictions are already familiar with this technology due to high use with motorized traffic<br>• Subject to undercounting error. |
| **Radio beam**<br> | • Screenline counts<br>• Pedestrians and/or bicyclists | • Short-term or long-term counts<br>• Multi-use paths or sidewalks | • Radio beam is between a transmitter and a receiver facing each other on opposite sides of facility.<br>• Need a clear line of sight between transmitter and receiver<br>• Subject to occlusion errors.<br>• Narrow recommended maximum separation between transmitter and receiver<br>• Good mobility; can be taken to a new site<br>• Has not been widely used by jurisdictions |
| **Inductive loops**<br> | • Screenline counts<br>• Vehicles and/or bicyclists | • Temporary or permanent counts<br>• Normally on paved facilities | • Shown to work best where bicycles are separated from motorized traffic.<br>• Should be located where bicyclists are not likely to stop and are more likely to travel single file<br>• Considerable lead time might be required to install embedded loops<br>• Most jurisdictions are already familiar with this technology due to high use with motorized traffic |

## DATA MANAGEMENT AND SHARING

Having an efficient, robust system to enter, store, and share counts is important to make sure that count data is easily available to those that need it. Consistently collecting and storing data helps ensure that the data is reliable and comparable over time. Key steps in developing a system to manage and share data include:

- **Determine key metrics** that should be counted and collected. The TMG provides recommended metrics as well as optional metrics for consideration, like demographic data.
- **Establish a consistent reporting format** to ensure data is comparable over time. A consistent data collection methodology helps make sure results are easily comparable. The data format provided in the FHWA Traffic Monitoring Guide should serve as a base.
- **Provide public access to count data** through an online database, downloadable spreadsheets, and/or annual reports. This will help ensure the use of the data and maximize the return on investment.
- **Visualize count data** through bar charts, maps and graphics. There are several examples of databases that use GIS to illustrate patterns and trends.

As referenced above, FHWA has developed a format for multimodal data collection and is currently developing formal repository for these data within its Travel Monitoring Analysis System (TMAS) 3.0. Data must meet certain standards, including basic information about the count location, type of count (pedestrian or bicycle), direction of travel, time, count interval, and method of counting to be included in the system. The intent of the system is to make data accessible and enable comparisons over time and across the United States.

Examples of data management and sharing programs from agencies across the county are provided below.

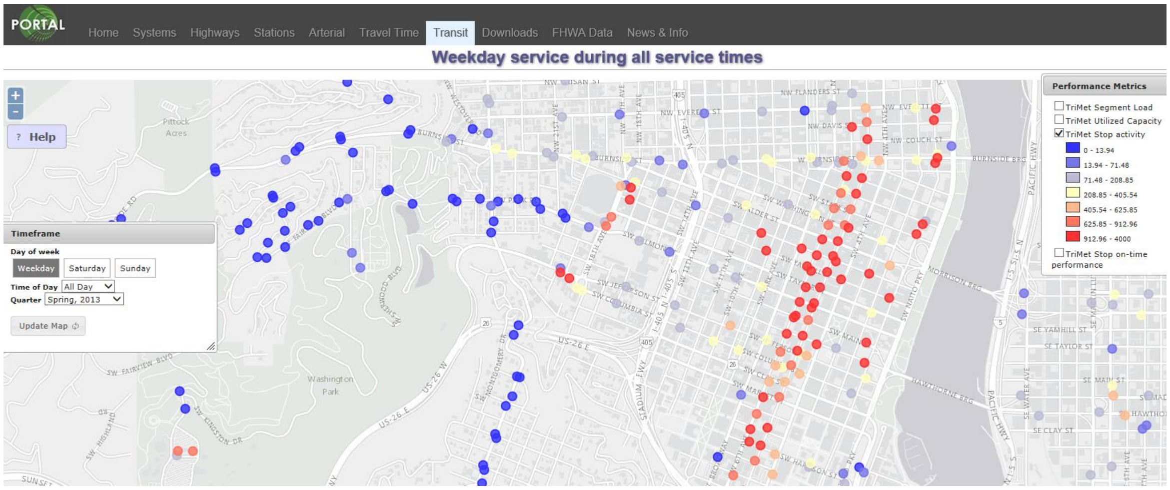
## Portland State PORTAL System

Portland State University, in partnership with Metro, Oregon Department of Transportation, Regional Transportation Council, and FHWA, provides a great data management and sharing program through PORTAL. It is an online database where any interested party can view collected data for the highway, arterial, and transit networks within the Portland metropolitan area in Oregon. PORTAL has current data available for the roadway network including live traffic speeds, average speeds over the last 5 weekdays, daily vehicle miles traveled (VMT), and a travel time calculator. In terms of non-motorized traffic, transit information is available to show TriMet stop activity, stop on-time percentage, utilized capacity, and segment load. As of October 2015, the most recent TriMet data available is from summer 2013. Most of the information provided through the site is map-based or graphical and certain time intervals can be specified for examination.

Exhibit 10 shows an example of how data is portrayed on the PORTAL website through maps illustrating the weekday stop activity for spring 2013 in downtown Portland. Exhibit 11 shows another example from the PORTAL website of a graphical summary of highway I-5 in the northbound direction for the morning of October 5, 2015.

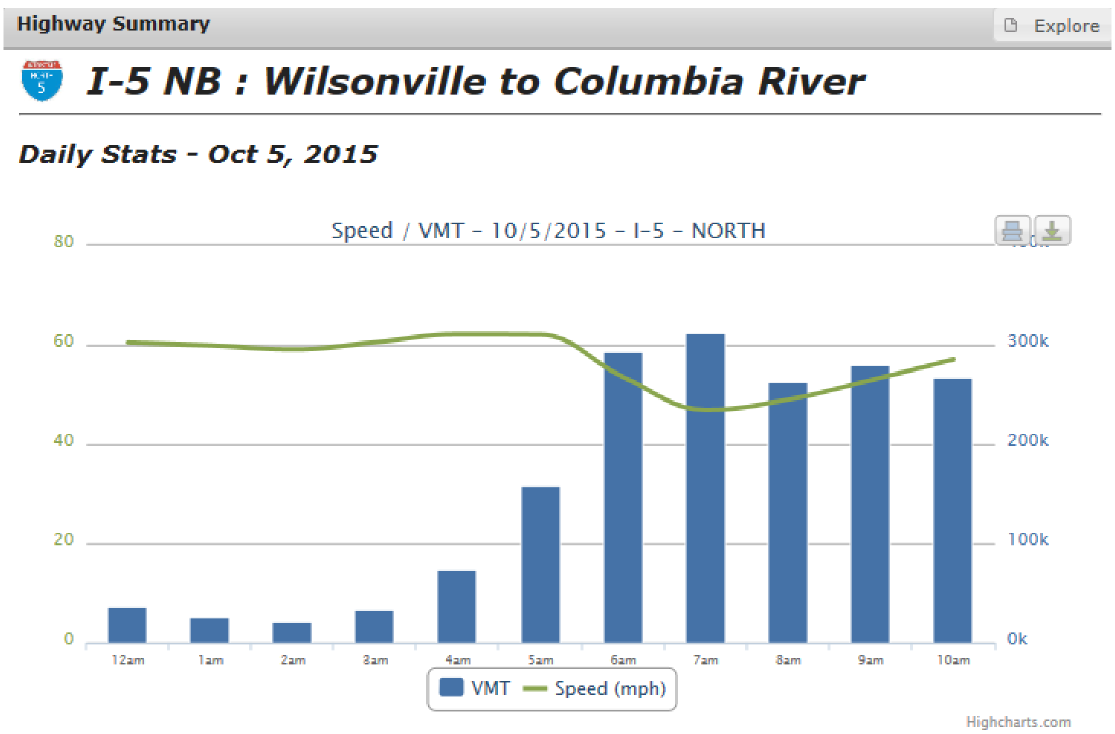
Additionally, a demonstration website is accessible to see how the PORTAL system could be used for pedestrian and bicyclist count data. Data is available from December 2011 to December 2012 for pedestrian volumes and from May 2012 to May 2013 for bicycle volumes. As with the TriMet database, the pedestrian and bicyclist data can be searched by date, time, and day of the week. Figure 11 shows an example from the demo PORTAL website of pedestrian search. This data is estimated from pedestrian pushbutton actuations at crossings. This limits the count locations to 7 crossings equipped with pushbuttons. Figure 12 shows a bicycle search from the demonstration database. Uni-directional bicycle volumes were collected at 16 locations.

**Exhibit 10. Example of PORTAL transit database online**



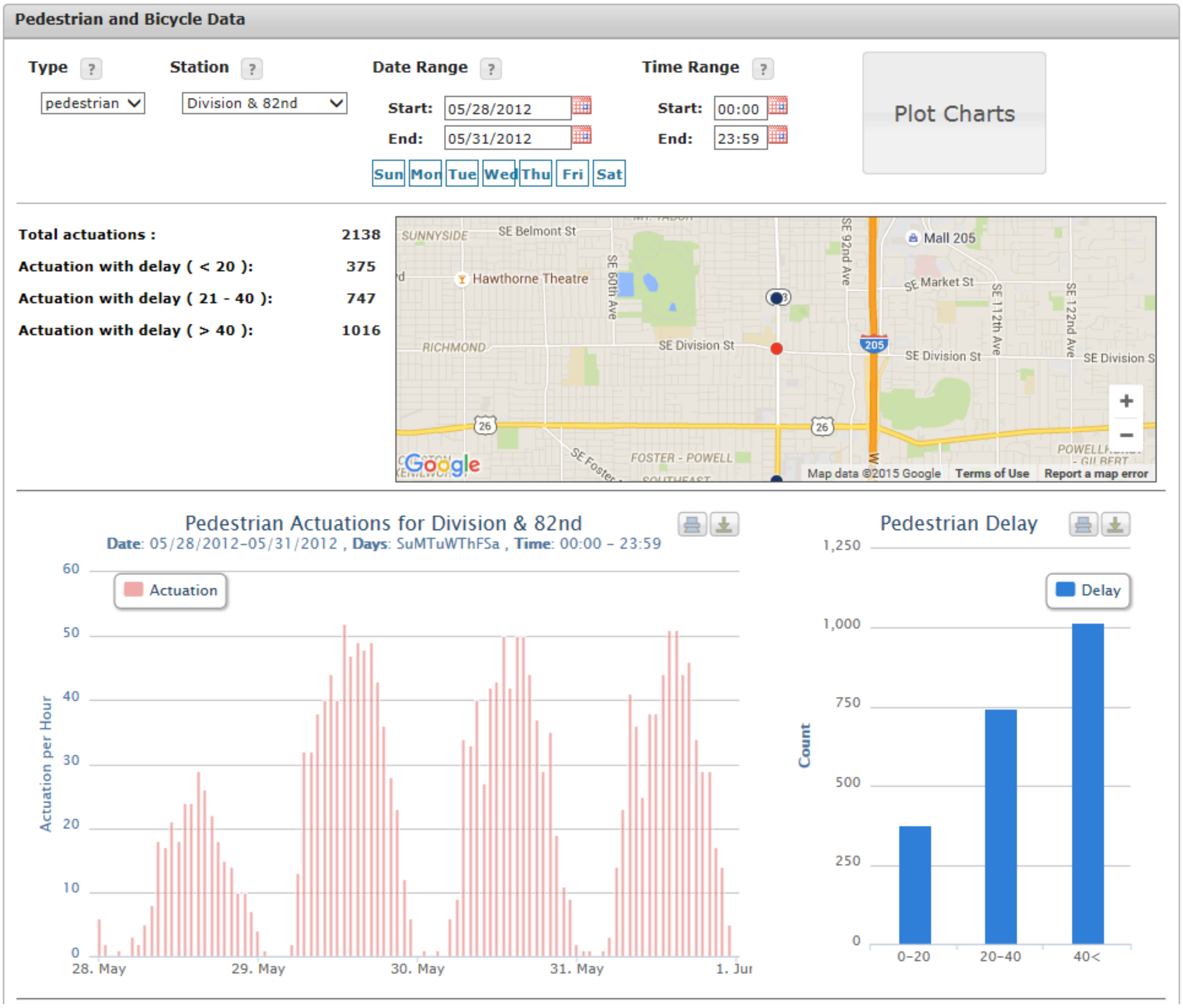

Source: PORTAL (2015)

**Exhibit 11. Example PORTAL daily highway summary**



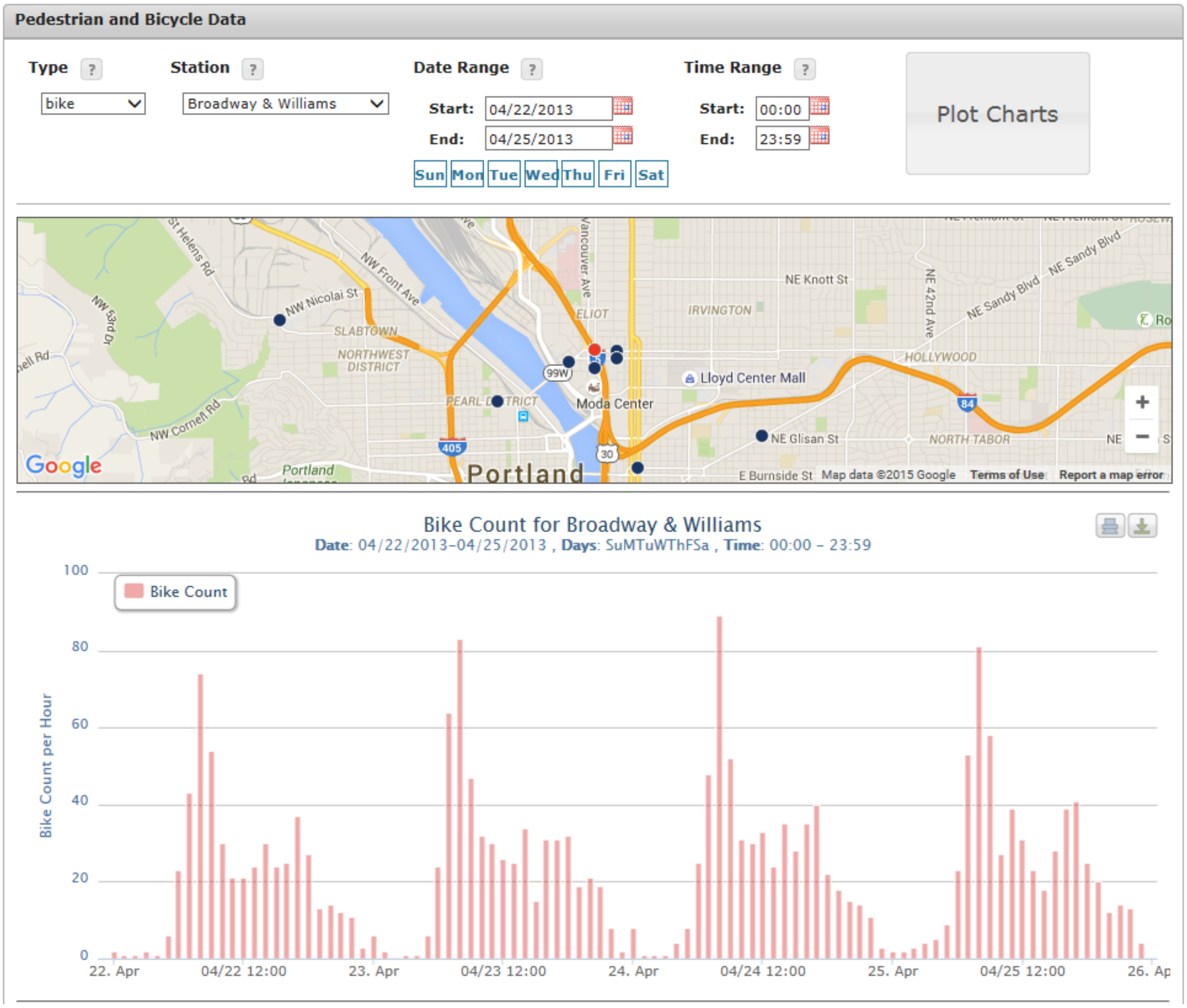

Source: PORTAL (2015)

**Exhibit 12. Example pedestrian data search from demonstration PORTAL website**




Source: PORTAL Demo Site (2015)

**Exhibit 13. Example bicycle data search from demonstration PORTAL website**



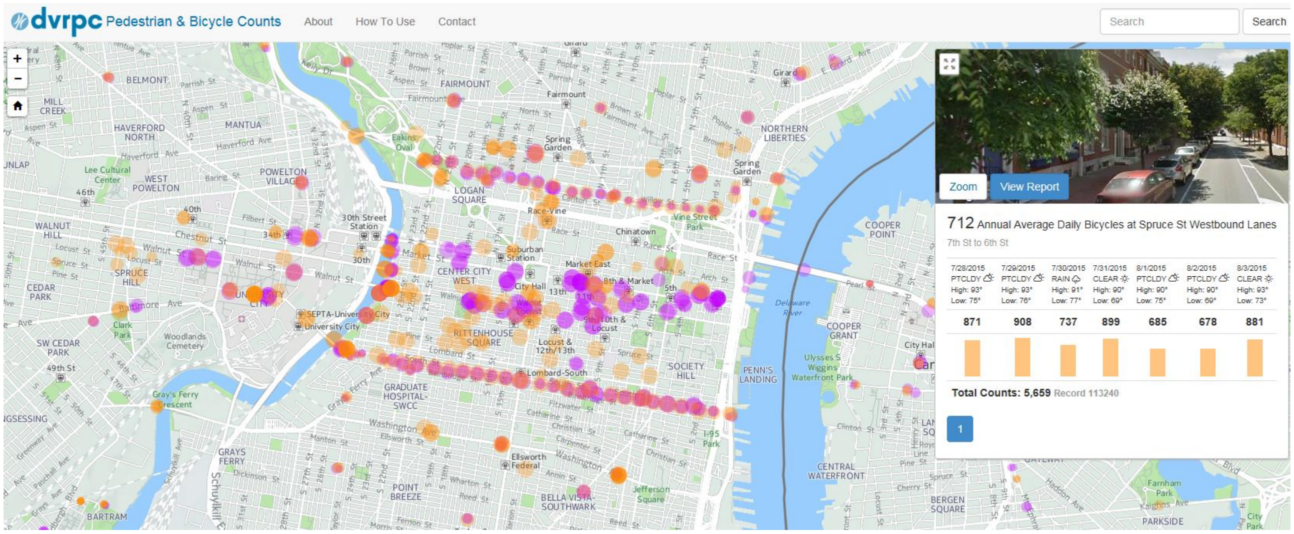

Source: PORTAL Demo Site (2015)

## Delaware Valley Regional Planning Commission

The Delaware Valley Regional Planning Commission (DVRPC) has a pedestrian and bicyclist count program set up to collect continuous counts at 12 locations along Circuit Trails in the region. Exhibit 12 shows how the data is displayed online as of October 2015. Anyone interested is able to access the data easily online and view a summary or the full 24-hour counts at specific locations.

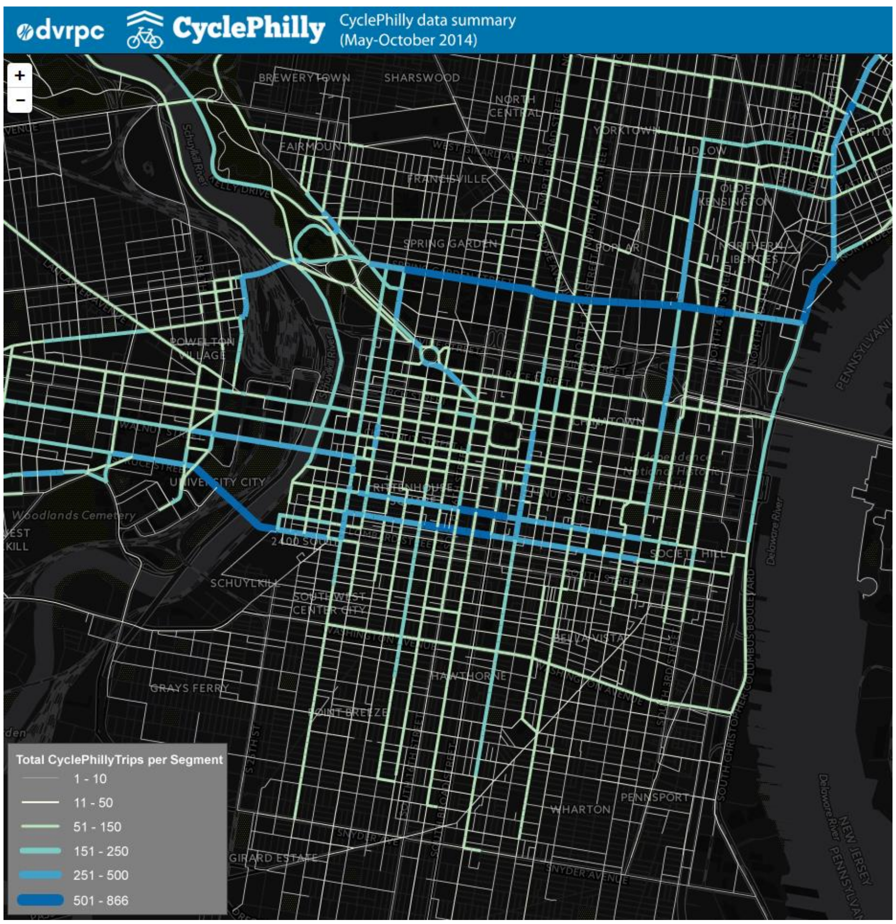
The DVRPC has also partnered with Code for Philly to launch an app called CyclePhilly where bicyclists can track their own trips to help generate data. Exhibit 13 shows how the data is displayed online as of October 2015.

### Exhibit 14. Pedestrian and bicyclist count database display online




Source: The Delaware Valley Regional Planning Commission (2015)

### Exhibit 15. CyclePhilly database display online



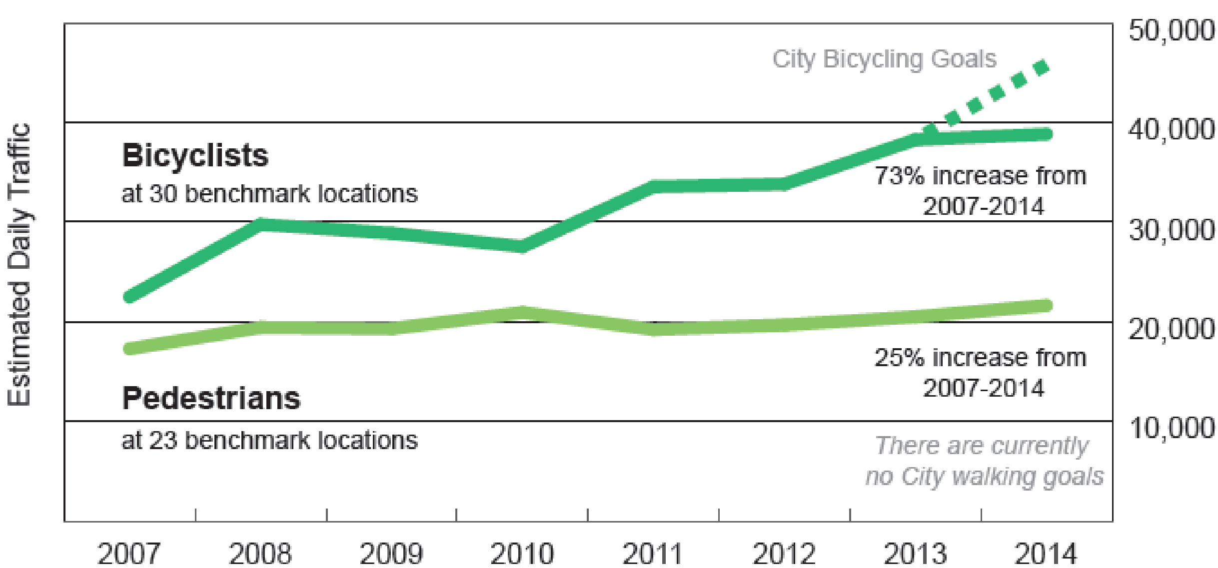

Source: The Delaware Valley Regional Planning Commission (2015)

## Minneapolis Public Works Department

The Minneapolis Public Works Department has established an annual report to express current bicyclist and pedestrian volume counts and volume trends since 2007 throughout Minneapolis. The program uses trained volunteers to conduct counts during mid-September weekday p.m. peak hours using a standardized form and methodology. Traffic for a 24-hour period can then be estimated from the counts using a simple extrapolation factor. Over 300 locations are counted every three to four years. Additionally, 30 bicyclist benchmark locations and 23 pedestrian benchmark locations are counted every year to determine annual changes in non-motorized traffic.

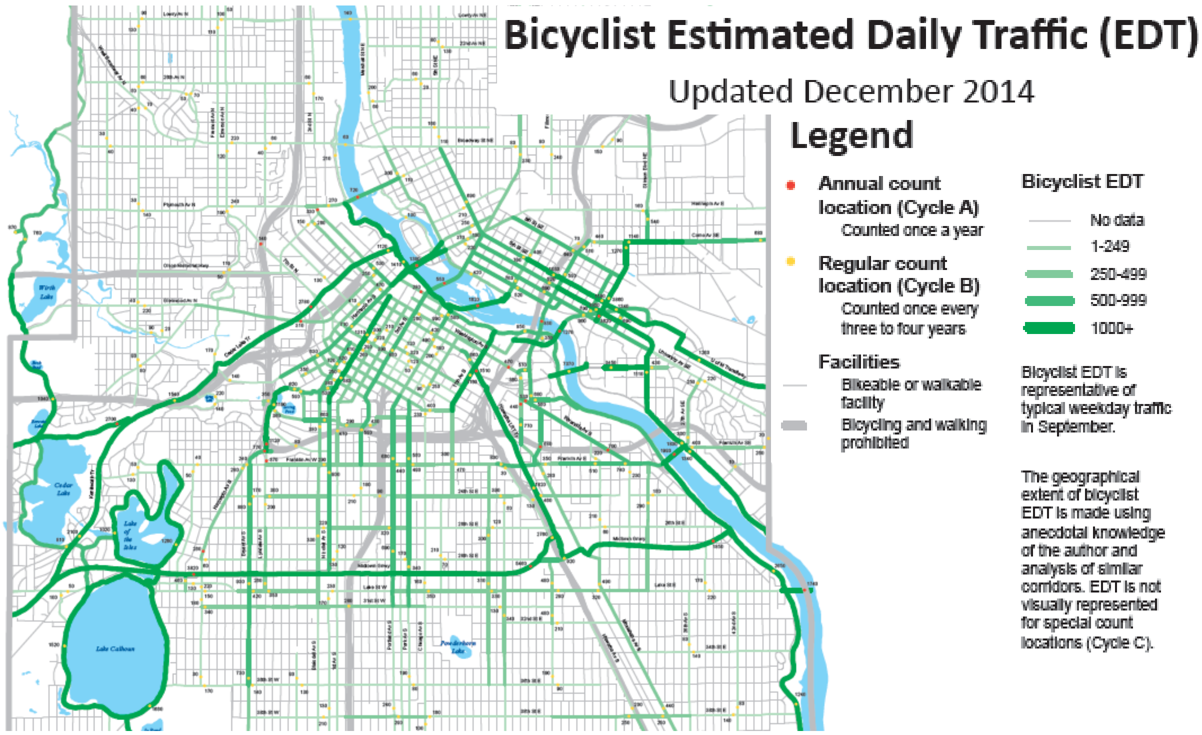
In addition to conducting annual counts, the Minneapolis Public Works Department expresses the results of the counts and trend analysis in an annual count report and bicycle traffic map, which are available on the department website. The annual bicyclist and pedestrian count report includes a summary of the count program, methodology, and the current year's volumes. The report also summarizes the trends seen in bicyclist and pedestrian activity before showing all the data and estimated daily traffic totals for all count locations since the beginning of the program. Exhibit 14 shows an example graphical representation of the trends seen at the benchmark locations for both bicyclists and pedestrians. Exhibit 15 shows how the Minneapolis Public Works Department expresses the bicyclist estimated daily traffic in map form. The roadways with higher bicyclist activity have wider line widths than those with lower bicycle volumes or no data, information that can be used to inform facility improvement locations or to prioritize projects.

**Exhibit 16. Change in walking and bicycling activity at Minneapolis count sites, 2007–2014**




Source: Minneapolis Public Works Department (2014)

**Exhibit 17. Annual report pedestrian and bicyclist count database display**




Source: Minneapolis Public Works Department (2014)

## CONCLUSION

This document is intended to provide best practices in developing and maintaining a multimodal data collection program for the City of Bend. Recent national research and case studies help illustrate applications for count data; means of collecting, managing, and sharing data; and guidance on developing a count program. This memorandum will be reviewed alongside technical memorandum #1 to help inform Task 3 of the Multimodal Traffic Count Program (Implement the Count Program).

## REFERENCES

1. Alta Planning & Design and Institute of Transportation Engineers Pedestrian and Bicycle Council. *National Bicycle and Pedestrian Documentation Project.* http://bikepeddocumentation.org/
2. Federal Highway Administration. *2013 Traffic Monitoring Guide, Chapter 4: Traffic Monitoring for Non-Motorized Traffic.* https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_2013/
3. Transportation Research Board. *NCHRP 797: Guidebook on Bicycle and Pedestrian Data Collection.* http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_797.pdf
4. BikeArlington Bicycle & Pedestrian Counters website. http://www.bikearlington.com/pages/biking-in-arlington/counting-bikes-to-plan-for-bikes/counter-dashboard/
5. Boston Region Metropolitan Planning Organization Bicycle-Pedestrian Count Program website.

http://www.ctps.org/bike_ped_count_1

6. Portland Bureau of Transportation Pedestrian Information Website. https://www.portlandoregon.gov/transportation/34778
7. Washington State Bicycle and Pedestrian Documentation Project website. http://www.wsdot.wa.gov/bike/Count.htm
8. District Department of Transportation Website. http://ddot.dc.gov/
9. Strauss, Miranda-Moreno, and Morency. *Multimodal injury risk analysis of road users at signalized and non-signalized intersections.*
10. Nordback, Marshall, Janson. *Colorado Department of Transportation Report CDOT-2013-18: Development of Estimation Methodology for Bicycle and Pedestrian Volumes Based on Existing Counts.* https://www.codot.gov/programs/research/pdfs/2013/bikecounts.pdf
11. Mid-Ohio Regional Planning Commission Bicycle-Pedestrian Count Program website. http://www.morpc.org/transportation/bicycle-pedestrian/counts/
12. San Francisco Municipal Transportation Agency. *2011 City of San Francisco Pedestrian Count Report.* http://www.sfbike.org/download/bike_count_2011/2011BicycleCountReportsml_002.pdf
13. New York City Department of Transportation. *Pulaski Bridge: Pedestrian and Bicycle Improvements Presentation.* http://www.nyc.gov/html/dot/downloads/pdf/2013-12-pulaski-bridge-bicycle-path.pdf
14. PORTAL website. http://portal.its.pdx.edu/Portal/index.php/home
15. PORTAL Demonstration website. http://demo.portal.its.pdx.edu/Portal/index.php/pedbike
16. Delaware Valley Regional Planning Commission Pedestrian and Bicycle Counts website. http://www.dvrpc.org/webmaps/pedbikecounts/
17. Delaware Valley Regional Planning Commission CyclePhilly website. http://www.dvrpc.org/webmaps/cyclephilly/
18. Minneapolis Public Works Department Traffic and Parking Services. *Minneapolis Bicyclist & Pedestrian Count Report 2014.* http://www.minneapolismn.gov/www/groups/public/@publicworks/documents/images/wcms1p-135319.pdf