This project is part of Kaiser Permanente Colorado’s commitment to Active Transportation, a critical part of healthy communities. Research shows that walking and biking as little as 30 minutes a day reduces the risk of chronic diseases, cancer, stroke and depression. Through Kaiser Permanente’s Active Transportation work, we will partner with others to ensure Coloradoans of all ages, abilities and incomes have the choice to walk and bike safely.
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Why Measure Active Transportation?
Active transportation—generally referring to purpose-oriented trips by walking or cycling—can be an important component of one's daily travel. Furthermore, active transportation or active travel (hereafter, AT) has important implications for personal health, livability, and environmental resources. Measuring changes in AT via well-established indicators is particularly relevant in two fields: health and transportation. Those working in the transportation field want to understand the demand for different types of facilities to support sustainable, cost-effective mobility for the entire population. They are also interested in how active transportation links to public transportation. Those in the public health field realize that to only focus on exercise misses much routine physical activity done in the course of commuting, paid work, chores, and errands. Both fields aim to measure aspects of active transportation, but a lack of robust, cost-effective, consensus indicators is preventing progress. Standard measures would allow: planners and engineers to better accommodate actual travel demand; public health professionals to better target resources, programs and monitor progress; and decision-makers to direct resources and craft responsible policies that respond to reliable data.

The Project
The goal of this project is to help decision-makers (leaders and practitioners) make informed actions regarding active transportation facilities and programs—and to monitor the results of such actions. There are many data collection approaches and indicators in use; there also remain substantial gaps in existing data and lack of standards. This report offers a recommendation for a robust monitoring system to provide decision makers with the information they currently lack and to make it comparable across geographic boundaries.

Kaiser Permanente Colorado commissioned Charlier Associates, in collaboration with Professors Kevin J. Krizek and Ann Forsyth, to perform three tasks:

1. Leverage existing inventories of tools and methods, as well as our own data collection, to identify exemplary examples of how to measure active transport; with a particular focus on examples currently used in Colorado. The project focuses on three areas of AT data collection and methods: (a) the overall demand for AT (this area is further broken down into two categories: surveys of populations as a whole and counts of users along facilities); (b) inventories of facilities by type and extent; and (c) methods that assess how places support active travel, including the key issue of safety. It examines the methods in general but also looks at specific examples (e.g., particular surveys or counters).

2. Convene experts and stakeholders to advise the best data collection methods to use at a larger scale in Colorado. There are two parts to this task. First is to identify the types of indicators agencies and groups in Colorado need in order to achieve their goals. Working back from the indicators, the second is to uncover a menu of data collection strategies and tools. This is a question of practicality and cost, but is intricately tied to the needs and purposes for collecting information.

3. Identify suitable indicators that many organizations can agree to contribute to and use, as agencies currently contribute to and use counts of motorized vehicles, and recommend a menu of instruments or tools for gathering data for these indicators. The project does not actually collect or compile the data, however.

The research involved several different efforts, including: an inventory of best practices in AT measurement and associated data collection efforts in Colorado and nation-wide; in-depth interviews with experts in the field; and convening of local experts in Colorado. Capitalizing on this background information and research, we filtered the results in two steps. We first compiled a master list of 20 indicators that were policy-relevant, cost-effective, and comprehensive; we also ensured the indicators could be gathered at a local level, are useful for important population groups, and are comparable with national data efforts. We winnowed these 20 to identify those that are easiest to monitor, consistent with national level research and benchmarking efforts, and most likely to be useful, given input during the project and experience among the research team. These resulting eight indicators create the AT Mile Markers.
AT Mile Markers
The prioritized indicators—the AT Mile Markers—correspond with key sections in the report and are presented below.

1. Demand for AT at the Population Level:
   - WT: Number of walk trips per capita
   - BT: Number of bicycle trips per capita
2. Demand for AT at the Facility Level:
   - AT-W: Average traffic-walking
   - AT-B: Average traffic-bicycling
3. Facility Supply for AT:
   - FM-W: Facility miles for walking by class of facility
   - FM-B: Facility miles for bicycling by class of facility
4. Community Environment Supports for AT (including a safety component):
   - Colorado Ped Score
   - Colorado Bike Score

Monitoring the AT Mile Markers
There are a variety of potential data sources to consider when implementing the AT Mile Markers.

1. State-level population: For ongoing monitoring, add questions to an existing national population-based survey such as the Behavioral Risk Factor Surveillance System coordinated by the CDC. This would use what are considered to be “best practice,” “reliable,” and easily comparable questions akin to those in the survey for the Front Range Travel Counts or National Household Travel Survey.

2. Local-level population: To obtain better data about local changes conduct a rolling and/or competitively awarded set of local-level randomly sampled surveys (likely using mail-out/mail-back and internet options). This is inexpensive, can reach a wide population, and can be conducted as a one-off or as ongoing surveillance.

3. Local-level population: Leverage new technologies (such as applications and GPS on smart phones or bikes) by developing an experimental program. This could also involve GPS-assisted travel surveys.

4. Facility use: Enhance and standardize automated monitoring of facilities such as paths and sidewalks. Examples include in-ground and infrared sensors, and traffic cameras.

5. Facility provision: Create and update a state-level database of off-road facilities for walking and cycling and facilities on principal roadways. A consistent, statewide classification of such facilities will aid in this activity.

6. Safety: Centralize collection of data on bicycle and pedestrian accidents and injuries.

7. Supports: An experimental program of rating for pedestrian and cycling friendliness using widely available data (census, roads, facilities) akin to Walkscore.com. These indicators, the Colorado Walk Score and the Colorado Bike Score, would help communities understand the degree to which AT is supported.

The full report details the measurement approaches and instruments, and their alternatives. It also outlines specific indicators that can be derived from these instruments.
**Selected Next Steps**

These AT Mile Marker recommendations are only as strong as their implementation. If implemented successfully over time, they will have a significant impact upon the ability of those in the fields of transportation and health to make informed decisions that will lead to more people walking and biking and to a healthier population. The research and outreach associated with this project led to the following near-, mid-, and long-term recommendations to successfully implement the AT Mile Markers throughout Colorado communities.

**Near-Term**

**Engage Leaders and Stakeholders.** Successful implementation will involve engagement of key leaders, such as elected and appointed officials, boards of directors and foundations, in this process at key points in time. This project is not yet fully funded. Diverse funding sources will ensure long-term sustainability. This project will require innovation funds as well as funding sources associated with existing systems. Additionally, decision-makers need to be aware of the opportunities associated with this work and see the need for the AT Mile Markers in decision-making.

**Form the Colorado AT Mile Marker Partnership.** Building on the partnerships emerging from this project, create state and locally-focused committees to implement the next steps described here. This partnership should include representatives from all the fields and agencies mentioned in this report, from both public and private entities. These partnerships would prime Colorado for becoming a demonstration case for future national policy recommendations and implementation strategies.

**Develop a strategic plan for implementation.** Using the recommendations here and the input of the CO AT Partnership, determine best and most feasible strategy to make sure improved data collection can and does happen.

**Create an interactive AT Mile Marker website.** Under the guidance of the Colorado AT Partnership, an AT Mile Marker website would provide key implementation guidance and support, including a description of the indicators and how to use them, an AT data repository or clearinghouse, and additional resources needed to support those planning and monitoring AT. This site would house the Colorado Ped Score and the Colorado Bike Score, upon development.

**Mid-Term**

**Implement a Colorado Ped Score and Colorado Bike Score.** Implementation of this tool would include the development of and promotion of an interactive website, which calculates Ped scores and Bike scores based on several inputs, as well as guidance on using the tool.

**Long-term**

**Incorporate Active Transportation data into mainstream traffic data collection efforts.** Integration of AT data with automobile data is a critical step to integrate AT into all business and decision-making processes. To do this, it is important to seek traction at the state level for funding and organizational support, and to make AT data part of decision-making inputs.

**Identify targeted projects to refine indicators and implementation steps.** Under the guidance of the AT Partnership, look for opportunities for collaboration on new or expanded data collection efforts. Technology can provide information that has not been previously available or affordable and should be considered among these opportunities. GPS information, made available voluntarily through smartphones or tracking devices, can provide valuable information for AT professionals.

**Create a Colorado Ped/Bike Score Task Force.** There is a need to develop a tool that measures pedestrian and cycling friendliness using multiple inputs, including facility provision, network connectivity, community supports and safety. This task force should be multi-disciplinary in order to capture all elements of transportation, such as planning, engineering and human behavior. Communities could use this tool to measure the degree to which AT is supported on a local level.
I. Active Transport Measures in Context

Why Measure Active Transport (AT)?
Active transportation—generally referring to purpose-oriented trips by walking or cycling—can be an important component of one’s daily travel. Furthermore, active transportation or active travel (hereafter, AT) has important implications for personal health, livability, and environmental resources. Measuring changes in AT via well-established indicators is particularly relevant in two fields: health and transportation. Those working in the transportation field want to understand the demand for different types of facilities to support sustainable, cost-effective mobility for the entire population. They are also interested in how active transportation links to public transportation. Those in the public health field realize that to only focus on exercise misses much routine physical activity done in the course of commuting, paid work, chores, and errands. Both fields aim to measure aspects of active transportation, but a lack of robust, cost-effective, consensus indicators is preventing progress. Standard measures would allow planners and engineers to better accommodate actual travel demand; public health professionals to better target resources, programs, and monitor progress; and decision-makers to direct resources and craft responsible policies that respond to reliable data.

Measures of AT could eventually be used statewide in Colorado to help communities understand AT in their locations. They could also assist municipalities, as well as transportation-related coalitions and organizations at local, state and regional levels, in demonstrating mode shifts and levels of physical activity to then better support and focus planning efforts (e.g., allocate funding to plan for accommodating AT through infrastructure improvements, ensure stronger collaboration with agency partners to accommodate facility planning or construction).

Three Categories of AT Measurement for this Project
There is an endless array of dimensions of and purposes for AT collection. This project’s scope focuses on three of them.

(1) Demand side measures. How much AT is occurring in your community? Measuring AT demand could mean one of two different things; it is important to understand and differentiate between them.

(a) Measuring behavior for the general population including subsets of the general population such as children, the aging, and those with low incomes. For example, how many trips occur among the population in a place? This is referred to as a population-based estimate. It may include understanding where these trips occur, for what trip purposes, along with perceptions about barriers and supports for AT.

(b) Measuring behavior or use of a facility or program such as trails, paths, and safe routes to school programs. This is more straightforward than (a) above though it still requires careful design with a standardized protocol and methods. The results from most of these estimates of specific facilities can only be used to analyze use along such facilities. It is possible, however, to extrapolate to a wider area if counts are made in multiple places in the network over relatively long periods, though such work is not yet well developed in AT. This kind of extrapolation is often pursued for motorized transportation (e.g., cordon transport counts to arrive at general measures of traffic volume such as vehicle miles of travel).1

(2) Supply side measures, chiefly inventories of lanes, paths, trails, and bicycle parking. What is the range and amount of facilities in a community on which to engage in AT? This refers to the level of infrastructure or other investments—the active travel provision question. This is straightforward to do but is rarely done in a systematic and public way. It requires jurisdictions to come up with a shared classification of such facilities such as sidewalks.

(3) Supports for active travel, such as safety. This is a broader topic. It includes such issues as having adequate paths and trails in a usable network as well as places to walk and cycle that are close enough. An important aspect is that AT should be safe—one way to monitor this is to look at problems such as injuries and accidents. The information for this area may be reported via formal means (e.g., police records) but is not always at a level that fully captures critical elements of AT travel (e.g., it may be collected in different formats in different locations, it may not be collected centrally, it may not specify a level of detail to capture AT travel or issues).

Given adequate baselines and consistent measures it should be possible to track related outcomes such as change over time.

Efforts to Date to Measure and Share AT Data
With increasing attention to AT in policy circles, there are many terrific measurement methods and tools in use addressing demand, supply, and supports for AT. More are being developed each year. Among them, they provide hundreds of questions and approaches to measuring behaviors and environments.

Such tools and methods have been used over a number of years. Some measures, mainly from the health field, have also been rigorously tested for validity and reliability (repeatabil-

1 To arrive at a more detailed understanding of behavior, it is still necessary to collect population-level survey data.
To provide access to data from these travel monitoring stations, the Colorado Department of Transportation (CDOT) created a statewide Traffic Data Committee to create a venue for agencies to share data and work together within some common data collection methodologies and formats. With a main focus of acquiring and sharing travel monitoring data, the statewide traffic data committee was also designed to share AT (non-motorized) travel monitoring data. The traffic data committee concept is a model that could serve as an example to creating a future AT statewide committee that could focus on the larger scope of creating “indicators” for AT for which travel monitoring data is one aspect.

Activities sponsored by the Transportation Research Board (TRB) are creating opportunities for Colorado agencies to benefit from specific AT travel monitoring data collection approaches. Spearheaded by the Bicycle and Pedestrian Data Subcommittee a central aim is to offer nationally accepted data collection methods and subsequent strategies for AT data formatting/sharing. This effort will sponsor and facilitate several activities during the annual TRB meeting in January, 2013. These activities will include a workshop on AT travel monitoring data sharing methods, a workshop on how to factor and annualize AT travel monitoring data, and a call for papers will focus on AT travel monitoring methodologies that will likely result in one or more paper sessions to be held at the annual TRB meeting.

On a local level and addressing the here and now, there are several larger-scale and ongoing approaches and measures to choose from. For example:

- CDOT has an established travel monitoring program for both motorized and most recently non-motorized travel. With the help of a Kaiser Permanente funded grant, CDOT installed permanent AT travel monitoring stations throughout the state in 6 different locations with data sharing protocol. This model of managing and serving

By providing access to data from these travel monitoring stations, CDOT developed a data portal (called AVID). As referenced earlier, the Colorado statewide traffic data committee works to provide a venue for sharing data and CDOT requests data for both motorized and non-motorized travel monitoring AT information. When agencies provide data to CDOT, it is loaded into a centralized data warehouse (the TRADAS software system) where access to

The TRADAS data is provided through the AVID system.

The TRB bicycle and pedestrian data subcommittee is working towards creating a national data clearinghouse data structure that will provide guidance to state and local agencies that can contribute to a national data clearinghouse effort.

2 The TRB bicycle and pedestrian data subcommittee is working towards creating a national data clearinghouse data structure that will provide guidance to state and local agencies that can contribute to a national data clearinghouse effort.

3 To provide access to data from these travel monitoring stations, CDOT developed a data portal (called AVID). As referenced earlier, the Colorado statewide traffic data committee works to provide a venue for sharing data and CDOT requests data for both motorized and non-motorized travel monitoring AT information. When agencies provide data to CDOT, it is loaded into a centralized data warehouse (the TRADAS software system) where access to

Why This Project?
With so many disparate efforts to measure AT—many of them serving useful purposes for their community—what is the role for yet an additional initiative? It is helpful to describe and summarize two key matters about existing efforts.

First, in terms of statewide monitoring, or monitoring of specific places in comparison to others in the state, existing approaches have several opportunities for improvement. Existing data collection efforts may:

- Have been administered by a particular agency for a particular purpose at a particular time; they may be “one-offs” and, therefore, have difficulty contributing to an overall consistent monitoring program. Other efforts are only used every decade or so.

- Include questions or a survey protocol that may not be considered a best practice. For example, better surveys have been tested for reliability and validity or can be compared with results from elsewhere. Existing surveys may use a sampling protocol that: (a) precludes generalizability, and/or (b) fails to have a suitable confidence interval. This is explained in more detail later in the report.

- Focus on only a few aspects of AT. For example, a number of health surveys only collect data on active transportation if each bout lasts 10 minutes or more, missing many shorter trips.

- Have a small geographical range.
Second, while there is a great deal of useful work being done, and much of the other data collection could be useful in such a statewide initiative with just a little tweaking, those connections have not been made. The most obvious set of useful connections to be fostered by this project are between health and transportation agencies and organizations. Their complementary data collection efforts could be further aligned.

Third, efforts that only include one type of metric do not provide a detailed picture of change, or progress. We need to know changes in behavior among all people, among users of specific routes, and of those accommodating AT to understand the impact being made.

What We Are Talking About
It is important to have a shared understanding of terms. In the area of AT data and measurement, it is common for the same term to mean different things to different agencies and disciplines.4 To ensure a consistent use of terms for this effort and report, we offer Table 1. This report aims to identify key indicators in order to create a menu of appropriate measurement instruments.

Table 1. Key Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description, definition</th>
<th>Types or examples</th>
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<tbody>
<tr>
<td><strong>Data Collection</strong></td>
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<tr>
<td><strong>Items</strong></td>
<td>Individual questions from a survey, type of count being collected. There are literally hundreds, if not thousands, of potential items. Information collected from the items combine to comprise the data.</td>
<td>• How many walking trips did you make last week</td>
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<td></td>
<td></td>
<td>• Number of “counts” from any variety of count-type devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Survey forms</td>
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<tr>
<td></td>
<td></td>
<td>• Counting checklists</td>
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<tr>
<td></td>
<td></td>
<td>• Mechanical counters</td>
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<tr>
<td></td>
<td></td>
<td>• GPS units</td>
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<tr>
<td></td>
<td></td>
<td>• Smart phones + applications</td>
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<tr>
<td><strong>Instruments (device, tool)</strong></td>
<td>The mechanical or paper device used to collect various AT data.</td>
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<tr>
<td><strong>Sample</strong></td>
<td>The population (or behavior) from which you are collecting data. The sample aims to represent a larger population, statistically speaking. Alternatively, it may just be aiming to collect any available data for a phenomenon.</td>
<td>• Randomly selected people in a given neighborhood.</td>
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<td></td>
<td></td>
<td>• Every third trail user</td>
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<tr>
<td><strong>Data collection effort</strong></td>
<td>The integration of the above three phenomena—items, instruments, samples; they typically include a manual or protocol for doing the multiple steps.</td>
<td>• Random-sample mail-out/mail-back survey to a neighborhood (asking about behavior and preferences)</td>
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<td></td>
<td>• Intercept-survey on a trail (compiling demographics and purpose)</td>
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<td><strong>Indicators</strong></td>
<td>These are created combining results from the data collection effort with an eye on policy relevance. Indicators are heavily used in transportation policy and planning activities and in public health.</td>
<td>• Average bicycle miles traveled</td>
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<td></td>
<td></td>
<td>• Pedestrian trips per person per week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Miles of bicycle trails per capita</td>
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<tr>
<td></td>
<td></td>
<td>• Walkscore</td>
</tr>
<tr>
<td><strong>Surveillance system</strong></td>
<td>Ongoing monitoring system.</td>
<td>• Behavioral Risk Factor Surveillance System</td>
</tr>
<tr>
<td><strong>Other Issues</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Active Transport</strong></td>
<td>Narrowly, walking and cycling for getting around; however as many people walk and cycle both to get around and get exercise, AT is broadly any outdoor walking and cycling.</td>
<td>• Walking to work</td>
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<td></td>
<td></td>
<td>• Cycling to get groceries</td>
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<td></td>
<td></td>
<td>• Walk trip to a dog park for exercise and to meet friends</td>
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<tr>
<td></td>
<td></td>
<td>• Cycling to a lake-side picnic spot for exercise and to have a picnic</td>
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<tr>
<td><strong>Purpose (need, goal)</strong></td>
<td>The needs and goals for which the indicators will be used. Needs may vary in terms of how frequently data are collected, at what geographical scale, about people and their behaviors, or about facilities and places.</td>
<td>• To know AT volumes in a city</td>
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<td></td>
<td></td>
<td>• Inform a trip generation model in a region</td>
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<td></td>
<td></td>
<td>• Understand changed physical activity patterns on a trail</td>
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<td></td>
<td></td>
<td>• Determine exposure or risk of injury</td>
</tr>
<tr>
<td><strong>Menu</strong></td>
<td>Alternatives to be developed.</td>
<td></td>
</tr>
</tbody>
</table>
II. Developing an Approach to Measure Active Transport

In reviewing alternatives for AT data collection strategies, it is first necessary to clearly identify a central purpose for the exercise. We review several AT data collection approaches, described in Appendices A and B. They include national level surveys and inventories (e.g., in Table 2), which are the best known, but also important state and local efforts. Not all national data are available for smaller geographical areas, even states, but even national efforts may provide models for more localized data collection. We describe in more detail some issues with each approach below.

Table 2. Example National Level Surveys, Inventories or Protocol

<table>
<thead>
<tr>
<th>Survey/Protocol</th>
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<tbody>
<tr>
<td>American Community Survey (ACS)</td>
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<td>American Time Use Survey</td>
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<tr>
<td>Behavioral Risk Factor Surveillance System (BRFSS)</td>
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<tr>
<td>Fatality Analysis Reporting System (FARS)</td>
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<tr>
<td>Injury Facts</td>
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<tr>
<td>National Ambulatory Medical Care Survey (NAMCS) and National Ambulatory Hospital Medical Care Survey (NAHMCS)</td>
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<tr>
<td>National Automotive Sampling System (NASS)</td>
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<tr>
<td>National Bicycle and Pedestrian Documentation Project</td>
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<td>National Bike Helmet Use Survey (1999)</td>
</tr>
<tr>
<td>National Electronic Injury Surveillance System (NEISS)</td>
</tr>
<tr>
<td>National Emergency Medical Services Information System (NEMSIS)</td>
</tr>
<tr>
<td>National Household Travel Survey (NHTS)</td>
</tr>
<tr>
<td>National Health and Nutrition Examination Survey (NHANES)</td>
</tr>
<tr>
<td>National Health Interview Survey</td>
</tr>
<tr>
<td>National Sporting Goods Association Sports Participation Survey</td>
</tr>
<tr>
<td>National Transportation Statistics</td>
</tr>
<tr>
<td>Walkscore.com</td>
</tr>
</tbody>
</table>

**What is the Central Purpose for Measuring AT?**

A well-rounded surveillance system for AT has different components which broadly fall into one of the three categories previously mentioned. First is the demand question and this is most complicated. The second is a supply question and the third relates to supports for AT; these are more straightforward (notwithstanding the issue of one’s perception of the safety in a community versus reality—an extremely complicated issue). It is most important to clearly identify the purpose(s) for which AT needs to be collected. For example, consider the following questions:

- What is the likelihood an individual in a community would pursue a trip by bicycling?
- Are rates of bicycling use on a particular trail increasing over time?
- How many bicycle miles of travel are in a given community?
- What is the best way to account for exposure of bicyclists to more robustly calculate crash rates for cycling?

Each question above is restricted to bicycling (therefore, already limited in its purview). Answers to each question are useful for policy implications. But suitably answering each question requires different data and approaches. Data used to capture counts rarely can be used to reliably measure information about the route overall route taken by a specific cyclist. Examining intersection data is yet a different issue as is a wide-ranging population-based survey. Identifying the purpose of the surveillance effort is paramount.

**Guidelines for Approaches and Instruments**

In designing new population-based studies (or even supplementing questions for existing studies), the most difficult of the tasks in this report, there are several key factors to consider. There is a golden rule that applies to data collection and survey efforts. The closer your sampling frame is to (and pulled from) the population (or entity) to which you want to say something about, the stronger your conclusions. Taken to the extreme, you don’t sample pedestrians to arrive at conclusions about cyclists.

It is typically too difficult and costly to collect data among an entire population of anything (e.g., every trail user, every pedestrian in town, every household). This is why researchers sample. The golden rule is that you sample from the population/attribute that you want to scale up to. For example, to scientifically say anything that can apply to or infer a characteristic of the general population of a community, you need to employ a sampling frame that draws from the entire population. This does not mean you need to survey every individual (e.g., a census); it is more important to employ a sampling frame that can be traced back to the probability individuals will have been selected. If you seek information on an attribute or want to know something about a particular behavior—amount of cycling in town—then you sample from all activities of that behavior.

For example, it is common practice in roadway planning to draw counts of traffic along the roadway (i.e., cordon counts) to understand rates, speeds, and levels of vehicular use. This information is then used to forecast attributes of the transport system such as throughput, congestion, and general...
rates of use. It is difficult and complex if not impossible, however, to use such information to infer information about trip behavior for the average family in a community.

It is best if the data collection effort’s needs and purpose overlap with consideration of where the data will be pulled from. Table 3 provides further examples.

There are some black and white matters when thinking about approaches and instruments that specifically relate to the generalizability (i.e., external validity) of any data collection effort. For example, it is inappropriate to use data from an intercept survey to say something about a population-based behavior (e.g., including those who don’t walk or cycle for transport). With care, it is possible to interpolate and infer behaviors about some populations based on data that is similar in nature, but not pulled exactly from the sample (e.g., polling pedestrians at a shopping mall to arrive at conclusions about other commercial areas). However, such processes are relatively complex and need to deal with substantial bias.

Costs

Finally, different methods have different costs. Lower cost methods are more likely to be done frequently and with large enough sample sizes to provide data at a city or neighborhood scale rather than a county and regional scale. For example, installing bicycle counters along key facilities or trafficked corridors is relatively low cost with potentially high payback. For population-based surveys, there is typically a wide range of possibility, where higher cost methods often provide more detail and reliability. Just considering surveys for population-based surveys, there is a wide range.

At the low cost end administering and compiling data from a mail-out/mail-back survey with reminder cards, and the survey mailed twice, may cost $10-25 per completed survey even at relatively low response rates of 20-40 percent. Similarly monitoring AT facilities can be built into the work of a transportation department inexpensively. 5

At the middle range are methods such as regional travel surveys with a phone interview and a travel diary covering one to two days. Two separate reviews of travel surveys found they cost around $150 and $170 per completed survey.6 This was the cost of the Front Range Travel Survey ($1.8 million for 12,000 responses). The BRFSS costs approximately $50 for a completed interview and between $1,500 and $2,500 for adding a question.8

5 For example, Krizek et al. 2010 found that costs to print and mail a 4 page mail out and mail back survey with three reminder post cards, and two copies of the survey, complete with a postage paid return envelope would be about $5.10 per survey. The cost per completed survey depends on the response rate. (Krizek, K. A. Forsyth, and A. W. Agrawal. 2010. Pedestrian and Bicycling Survey (PABS): User’s Manual. http//www.designforhealth.net/ resources/PABS.html)
8 The state of Texas Department of Health Services has helpful guidance on the cost of adding questions to the BRFSS (http://www.dshs.state.tx.us/chs/brfss/attachments/attach_b.shtm).

<table>
<thead>
<tr>
<th>You want to say something about:</th>
<th>Then a best scenario is to carefully draw data using:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidewalk traffic in a particular neighborhood</td>
<td>An intercept survey (or counts) of neighborhood sidewalk users</td>
</tr>
<tr>
<td>Likelihood of cycling use among the population</td>
<td>A probability survey representing the entire community</td>
</tr>
<tr>
<td>Bicycle miles of travel in a community</td>
<td>A survey of all residents OR a model using counts on a range of facilities and a detailed inventory of facility by type</td>
</tr>
<tr>
<td>Characteristics of users and purposes of AT trips</td>
<td>A detailed intercept survey of users</td>
</tr>
<tr>
<td>Why residents do not use more AT in a community; or, what might be the latent demand</td>
<td>Survey of residents who DO NOT use AT (e.g., a home survey)</td>
</tr>
<tr>
<td>The degree to which AT is increasing or decreasing in a community</td>
<td>A survey of residents OR a model using counts on a range of facilities and a detailed inventory of facility by type</td>
</tr>
<tr>
<td>Rates of children using AT to go to school</td>
<td>Counts of children using AT to go to school (normalized by population)</td>
</tr>
<tr>
<td>Routes of AT use and other information useful for route planning exercises</td>
<td>Route information collected via smartphones supplemented by information from those not using smart phones (e.g. low-income populations)</td>
</tr>
</tbody>
</table>
At the **high end** are more elaborate health-oriented surveys that combine multiple tools: monitoring participants for a week or more with gadgets such as accelerometers (motion detectors) or GPS, asking survey questions, keeping week-long travel or activity logs, and developing GIS- and field-based environmental measures. Such studies could be in the range of $500-$1,000 per participant.\(^9\) It is possible to do a sub-study with these more expensive measures, however sample size becomes an issue (see later discussion).

### Criteria for Selecting Measures

Given the great variety of possible data collection strategies, we propose five filters to help guide the selection of AT surveillance efforts. The filters are guided by the underlying aim of this project—to create indicators that can be used by various levels of government, local to state, in long-term monitoring of health-relevant aspects of AT. They reflect the three categories described above (demand side, supply side, support); they focus on issues most crucial to this project. Can the AT effort:

1. Collect data on demand side measures (general population use of AT or facility use) OR inventory AT facilities in an ongoing manner OR measure relevant support and safety issues?

   This first filter simply ensures that the data collection is focused on relevant topics.

2. Be inexpensive enough to be more than a “one-off” exercise OR is already being used in an ongoing way in Colorado?

   Surveys, indicators, and instruments will only be used widely if: (1) they are straightforward to administer for the organizations tasked with collecting such data and (2) they are consistent with the resources (financial or other) available to analyze the data afterwards. If the process of collection is too expensive, cumbersome, not well thought out, or difficult to understand then it won’t be done or if it is done once it will not likely be repeated (at least more frequently than, for example, once per decade). An exception would be measures already used in long-term on-going monitoring state-wide in Colorado.

3. Be comprehensive enough in content—not looking at just part of the AT picture?

   One of the more significant problems with current data collection efforts is that they look at only part of the picture of AT. For example, a survey may only measure walking for exercise not all walking; or only examine how people use a facility for a few hours in the summer but not 24/7/365. Many surveys do not measure those who use AT modes infrequently not just in the last few days or look at all groups including the young, old, those with low incomes, and those with health challenges.

In transportation planning and modeling, there are a number of key variables—in particular, those relating to the trip (representing a decision to travel from one address to another and usually captured by quantity, duration, and mode), vehicle miles traveled (representing a measure of energy use, and an indirect measure of time and potential congestion), and levels of service (a more direct measure of congestion and the extent of free-flow travel—used particularly for vehicular trips). Some of this information, particularly for a given facility or corridor, can be detected via automatic counting. Such counts are currently ongoing at selected locations, being conducted by the Colorado Department of Transportation. It is relatively straightforward to arrive at analogs to these indicators for walking and cycling.

However, health professionals are interested in how much walking—not just how many trips—and how many people. An extra concern is with people who might be encouraged to do more—for example infrequent cyclists who may be encouraged to do more cycling. This means that at least some of the approaches and instruments need to survey people who infrequently use these modes and also to ask about perceived barriers. Also, special care needs to be taken to ensure that measurement tools don’t unfairly exclude participants—e.g., if a smart phone app is difficult to use for those with arthritis and too expensive for those with low incomes, can it be made cheaper and easier or can an alternative be found for those groups?

4. Provide local level data to assess AT use or infrastructure change over time at the city level (for very detailed purposes, it might be necessary to examine an intervention at the neighborhood level)? This is a question about the combination of how costly, cumbersome, and precise the measurement approaches and instruments are.

An example might explain this best. There are lots of partial data sets showing some sidewalks and some bicycle striping. It is possible to inventory a community using GIS data, photos or images (even Google Earth and Google Streetview), and then field checking. But how can you build incentives for public works and transportation departments to update such data so it
doesn’t need to be checked as a whole each year? For example, can the MPO call for project process include a requirement to update a central database? Will that work for all projects?

5. Create indicators that can be compared with existing national, state, and regional indicators OR be used effectively to monitor policy/project-relevant change over time.

The ultimate aim is to provide data that is useful for as wide array of users that can reliably answer the variety of questions that are being posed. There seem to be no shortage of anecdotes about various AT data collection exercises which are either “one-offs” or where the data was collected but there were no resources available to analyze the data.

It is therefore important to first consider the degree to which data can be aggregated across different levels of geography. For example, to what degree can data that is possibly collected at the neighborhood level be easily aggregated to surmise conclusions at a statewide level (or vice versa?). Is it important to do so?

It is also important to think about the degree to which any data that is collected can be harmonized or compared with other aligned efforts. This, for example, involves defining bicycle and pedestrian data formats—up front—and possibly considering the central databases that might be employed, a consideration that the Colorado Department of Transportation has been increasingly been accounting for in their collection of bicycle count data.

The following sections correspond with the three categories of AT measurement for this project: (a) demand side measures, (b) supply side measures, and (c) supports for active travel. Owing to the two different ways to capture demand, across a population or for a facility, we devote a separate section for each. Each section recommends specific types of instruments and provides example indicators.
III. Population Level Measurement Approaches and Indicators

Key Issues

Tracking AT demand at the population level is the most challenging endeavor in this project. Because it can provide information on levels of current physical activity for individuals as well as insights into areas where it can be increased, it represents some of the most important data to collect.

- While advancing technologies make it possible to track people’s movements using devices such as GPS, these are still relatively cumbersome and complicated to use. They typically fail to provide information on demographics, purpose of movement, and related topics. Substantial groups in the population may find such instruments difficult or expensive to use. The technology is getting simpler and cheaper; however we still recommend an experimental program using such devices.

- Designing a survey requires substantial testing and review of questions to ensure reliable results (that people provide similar answers at different times). It is also important to understand the key features of interest. For example:
  
  - As noted above, public health professionals are often interested in the duration and intensity/speed of active modes such as walking and cycling. They are, therefore, less interested in the number of trips.
  
  - For the purposes of planning interventions to promote walking and cycling, it may also be important to know about people who may use the modes regularly but not necessarily every day or even every week (e.g., seasonal cyclists, or people who walk to a transit stop from time to time). Obtaining this information requires asking questions not just about trips made in the past few days or a typical week but also about activities that may have occurred in the past month or year.
  
  - It is unclear how useful trip purpose (e.g., grocery shopping versus going to work) is for health researchers and practitioners. Many walking and cycling trips are for both exercise and to get around; even a recreational trip may be to a destination such as a park, making the distinction extremely hard to measure.

- A practical challenge is reaching the entire population within a community, not just those already walking and cycling, using a specific trail, or who belong to similar social networks. Collecting this type of data requires using some form of random (also called “probability”) sampling. However, at least two factors are difficult to address. The first relates to the relative rarity of cycling for transportation purposes (as opposed to recreational) Most travel surveys/diaries in the U.S. cover only 1 or 2 days, therefore making it unlikely to capture activities that happen less frequently (e.g., a bicycle trip). The second is that most travel surveys account for only one travel mode for a trip. Thus, walking trips to transit or across the parking lot rarely get recorded. Combined, these factors mean it is difficult to assemble a sufficiently large sample of people who cycle and/or walk, or of walking and cycling trips.

Sampling

Therefore, a population based AT surveillance effort requires attention to a single and central challenge: appropriate sampling.

A key question is how many completed surveys are needed? Answers to this question are relatively straightforward using well-known statistical formulas. The formulas are based on four pieces of information which are either known or agreed upon:

- Population size: Most survey data is intended to represent a particular population. Specifically, who is the population that you intend to generalize about?

- Acceptable “certainty”: How “certain” do you want to be about the study’s findings and what margin of error is your organization or municipality willing to tolerate? The confidence interval is the plus-or-minus figure usually reported in poll results. For example, if you use a confidence interval of +/- 4 percent and 47 percent of your sample picks an answer, you can be “sure” that if you had asked the question of the entire relevant population, between 43% (47 minus 4) and 51% (47 plus 4) would have picked that answer. The confidence level tells you how sure you can be. It is expressed as a percentage and represents how often the true percentage of the population that would pick an answer lies within the confidence interval. The 95% confidence level means you can be 95% certain. Putting the confidence level and the confidence interval together allows an analyst to say they are 95% sure that the true percentage of the population is between 43% and 51%.

Expected response rates: This probably is the most difficult issue to consider. Response rates to surveys—of all kinds—are plummeting dramatically. People’s reluctance to complete surveys, concerns about privacy, and increasing use of cell phones (which may or may not be linked to an address—a good foundation for probability based samples). For a mail-out and mail-back survey, it is not uncommon to receive less than 25 percent of those surveys initially mailed out.11

The proportion of sample with a particular characteristic (prevalence rate): How prevalent is the behavior in which your organization is interested? Most statistics that are presented (such as those mentioned above) are based on two assumptions: (1) the sample was random and (2) the responses to the survey have roughly a 50-50 split for most of the questions (for example, 50 percent will favor a position, 50 percent will oppose). Aiming to learn about rare events undermines these assumptions. For example, if the survey wants to know more about women who cycle after sundown, the prevalence rate is typically extremely low; this suggests that your endeavor will require a larger sample size to reliably detect information about this relatively rare behavior.

More information and detail about sampling guidance is available in Appendix E.

To provide one example of a potential tool, it is helpful to describe the most well-known and largest, ongoing health survey in the world.13 The Behavioral Risk Factor Surveillance System (BRFSS), conducted by the Centers for Disease Control, completes 1,000 telephone surveys each month in Colorado (part of 350,000 collected across the country). However, even doubling the number of participants in Colorado over a year at perhaps $50 per completed survey14 ($600,000) would still leave large margins of error in smaller municipalities. A community with 50,000 people would only have on average 240 responses, meaning that the margin of error would be +/-6%—too large to detect small changes in walking and cycling.15 However, for larger areas such as counties, this could be a cost effective approach to surveillance. If state-wide information is needed it is also possible to just add questions to the survey for approximately $2,000 to $2,500 each—such questions have been added to the Colorado surveys in the past. Appendix D shows some of those questions relevant to AT.

Approaches and Instruments
A second important consideration in population based surveys relates to the data collection approach that is employed. Common considerations in this respect are further detailed in Table 4. These include surveys conducted through the mail or internet, diaries, interviews, and instruments (GPS and accelerometers). In general:

- Questionnaires can be an inexpensive way to reach local populations based on their residential addresses. This precludes surveys that use only the internet because there is not a complete listing of people by internet addresses (with some exceptions such as universities and work places). However, people can be given an option to answer online.
- Interviews are more expensive but can be made cost effective by adding questions or participants to an existing national survey. There are a number of such in the health field—the largest being the BRFSS which is also the main survey with Colorado state-level data. It is also possible to add questions.
- An option may be to do a survey calling back people who have responded to the BRFSS. In this case the BRFSS is used to screen participants (e.g., locate frequent cyclists). This is already done with the Colorado Child Health Survey (http://www.cdphe.state.co.us/hs/yrbs/childhealth.html). Gadgets such as global positioning systems (GPS) and accelerometers (motion detectors) provide a great deal of information about location and motion respectively. However, they can be cumbersome for pedestrians to use (need to be worn or carried; have batteries that need to be recharged), and provide a great deal of data to process potentially stressing the research capacity of organizations. They can be expensive to buy for organizations; or if data collection relies on personal gadgets (such as smart phones) raise large equity issues. However, the technologies are evolving fast which is why we are suggesting an experimental program.

11 It is important to mention, however, that the BRFSS does include some cell phone respondents.
12 Strategies to overcome low response rates also increase costs. The American Association for Public Opinion Research estimates that, on average, it costs twice as much to complete a cell-phone survey interview as a landline one primarily due to time needed to screen and recruit participants (see: American Association for Public Opinion Research Cell Phone Task Force. 2010. New Considerations for Survey Researchers when Planning and Conducting RDD Telephone Surveys in the U.S. with Respondents Reached vial Cell Phone Numbers. http://www.aapor.org/AM/Template.cfm?Section=Cell_Phone_Task_Force_Report&Template=/CM/ContentDisplay.cfm&ContentID=3181)
13 Centers for Disease Control. 2012. About the BRFSS. http://www.cdc.gov/brfss/about.htm
14 This estimate is from the Texas Department of State Health Services at http://www.dshs.state.tx.us/chs/brfss/attachments/attach_b.shtml
15 Assuming a 50% prevalence rate (e.g., 50% vote for Obama) and a 95% confidence interval (you are 95% sure it is within +/- 6%). This can be checked using a standard calculator such as the one available at http://www.surveystem.com/sscalc.htm.
### III. Population Level Measurement Approaches and Indicators

#### Approach Advantages Disadvantages

**Questionnaire Forms / Self-Response**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mail out/mail back</td>
<td>Inexpensive.</td>
<td>Need mailing list. Response rates can be low, therefore affecting the generalizability</td>
</tr>
<tr>
<td>Mail out survey/mail-back or internet option for response</td>
<td>Flexible—people who like paper can use it and those who want the internet can use that. Some find increases response rates modestly compared to a survey with only a mail-back option but evidence on this is mixed.</td>
<td>Adds complexity for both survey team and respondents.</td>
</tr>
<tr>
<td>Drop off/mail back</td>
<td>Surveyor can check addresses; may meet respondents and encourage response.</td>
<td>Dropping off is labor intensive; only viable for small areas or when using cluster sampling approaches.</td>
</tr>
<tr>
<td>Mail out postcard/internet response only</td>
<td>Inexpensive.</td>
<td>Requires multiple steps; difficult for those without ready access to internet.</td>
</tr>
<tr>
<td>Internet-only (the sample receives an e-mail invitation to take a web-based survey)</td>
<td>Very inexpensive, assuming the sample of Internet addresses are not costly to obtain.</td>
<td>To date, it is virtually impossible to obtain Internet addresses for a random sample of people in a city or county.</td>
</tr>
</tbody>
</table>

| **Surveillance system** | Ongoing monitoring system | Behavioral Risk Factor Surveillance System |

#### Diaries

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diary (mail out/mail back or mail out/phone interview)</td>
<td>People record trips as they occur, increasing accuracy.</td>
<td>Time consuming; may need multiple follow ups and incentives, particularly for multi-day diaries.</td>
</tr>
</tbody>
</table>

#### Interviews

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door to door survey (in person)</td>
<td>Forms filled in completely—little missing data.</td>
<td>Expensive; people may not answer door.</td>
</tr>
<tr>
<td>Telephone (Computer Assisted Telephone Interviewing)</td>
<td>Forms filled in completely—little missing data.</td>
<td>Telephone listings by address are increasingly hard to find given the move to cell-phone only households; not everyone has a telephone; no-call lists; expensive.</td>
</tr>
</tbody>
</table>

#### Instruments and Observations

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS on bicycles</td>
<td>Traces location of movement well.</td>
<td>Lacks information on purpose</td>
</tr>
<tr>
<td>GPS in phones</td>
<td>Traces location of movement well, Noninvasive</td>
<td>Typically not representative of population</td>
</tr>
<tr>
<td>Accelerometers</td>
<td>Limited to just physical activity data</td>
<td>Inefficient in detecting physical activity of cycling</td>
</tr>
</tbody>
</table>

Source: Adapted from PABS Report and Manual: http://transweb.sjsu.edu/project/2907.html Note: Other methods can be used for more qualitative information. Good approaches would also include focus groups and workshops.
Recommended Menu: Instruments and Approaches

Specific Measurement Approach

State-level: For ongoing monitoring add questions to an existing national population-based survey such as the Behavioral Risk Factor Surveillance System coordinated by the CDC, using questions akin to those in the Front Range Travel Survey or National Household Travel Survey. Using existing questions means that data collection efforts can build on best practices and allows comparison with these other surveys. It would be worth investigating whether it is possible to add a travel-diary type set of questions in a call-back survey.

Local-level: To obtain better data about local changes conduct a rolling and/or competitively awarded set of local level randomly sampled surveys (likely using mail-out/mail-back and internet options) or a similar approach. If the technique is well-chosen, this can be done inexpensively and can reach a wide population.

Local-level: Leverage new technologies (such as applications and GPS on smartphones or bikes) by developing an experimental program. There are a number of new technologies that may automate data collection in the future once enough people have access and various other kinks are worked out. This experimental program could test different approaches (see also next section).

Potential Indicators

A good starting indicator—using information from population based surveys—is to measure the number of AT trips per person per week. A next level would be measure, per capita, average distances for these trips, for both walking and cycling.

Indicator 1: WT: Number of walk trips per capita.
Indicator 2: BT: Number of bicycle trips per capita.

These measures could then be augmented with duration/distance data (if available) for the total population in a community (or subgroups) to calculate ATMT (Active Travel Miles Traveled) consisting of two components:

Indicator 3: WMT: Walk miles traveled, for total population and key subgroups.
Indicator 4: BMT: Bicycling miles traveled, for total population and key subgroups.

It is also suggested that similar indicators be used to monitor more specific dimensions of AT, particularly access to transit. These might consist of:

Indicator 5: WAT: Number of walk access trips to transit
Indicator 6: BAT: Number of bike access trips to transit

Case Study: Surveys in Colorado

Communities all across Colorado have a variety of ways to arrive at the percentage of residents who use AT. The most common, straightforward, and limited—but available to all communities—focus on data from the American Community Survey. While largely deemed reliable, this measure (a) focuses just on the work commute, (b) measures the “primary” way of getting to work in a week, and (c) pertains just to those who work (see appendix A).

A broader measure of travel behavior representative of the entire Front Range population was recently administered by DRCOG in association with other agencies, the Front Range Travel Survey. This is a statistically robust survey that carefully sampled to draw from populations that are reflective of the general population at large. This data reveals that about 7 percent of all trips (not just the commute) in the region are made by AT. There is wide variation within this average. Residents who live in communities with higher relative densities are higher than this average; residents living in lower density communities are lower. An average bike trip distance is 1.7 miles and the average walk trip distance is 0.4 miles.16

IV. Facility Use

Key Issues
Compared with population-level data, measuring the use of the AT network—either specific facilities (e.g., trails and paths) or more general notions of routes—may appear relatively straightforward. Important issues, however, still need to be addressed.

- Which facilities should be measured? Is the aim to assess use of major, key or selected routes? Alternatively, is the purpose to gain an overall sense of how the network works?
- Use varies over time and by season. Should measurement focus on peak times or try for a more robust assessment of overall use?
- If intercepting users on paths, should the sampling method be a census or some form of random sampling? How can an instrument be designed to maximize response (i.e., gaining enough information but not too long given people will want to move on).
- To count every user on a path, some researchers use automated counters or video; however these fail to capture substantial demographic information, purposes, and the like.

A major national attempt to create an instrument and sampling approach to get at many of the above matters has been provided via the National Bicycle and Pedestrian Documentation Project. The protocol adopted by this effort is, to date, the most consistent in this regard and includes both counts (with adjustment factors) and a survey that randomly samples users (meaning they are representative of facility users though not of the population as a whole).

However, the survey does not ask such questions as duration and intensity. Furthermore, the manual count effort is based on efforts to extrapolate from two hour counting procedures as opposed to extrapolating from 24 hour counts which is becoming the industry standard. As described in the text box below, there is an emerging science behind the art of converting two-hour counts to uncover reliable and robust measures of facility use by season or by day of week. Any analyst needs to be sensitive to the ability learn, for example, how use varies by season or between days of the week. For this reason, it is worth considering the extent to which one can

Table 5. Facility Level Measures of Active Transport

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In Person</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation: manual counts</td>
<td>Captures numbers of users in certain places</td>
<td>Not easy to generalize beyond the time and place; accuracy of extrapolation to the specific facility being observed depends on when/for how long counts are made</td>
</tr>
<tr>
<td>Intercept survey</td>
<td>Can capture purpose and demographics</td>
<td>Limited length given people will want to move on; bias related to time of day, people refusing to answer in order to continue their trip</td>
</tr>
<tr>
<td>Intersection turning movement counts—adding pedestrians and cyclists</td>
<td>Turning movement observations are already being done in relation to motorized vehicles—this is a cost effective add on</td>
<td>Turning movement observation sites are chosen in regards to importance for the motorized network and may be less well suited for AT; hard to scale up to overall counts</td>
</tr>
<tr>
<td>Mail out postcard/internet response only</td>
<td>Inexpensive</td>
<td>Requires multiple steps; difficult for those without ready access to internet</td>
</tr>
<tr>
<td><strong>Automated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tracking devices—GPS and smartphone applications</td>
<td>Can capture detailed route information</td>
<td>Can be cumbersome; extremely self-selected population</td>
</tr>
<tr>
<td>Counters, in general</td>
<td>Captures level of use across time in different places</td>
<td>Data may be hard to interpret; may be errors; may need different counters for bikes and pedestrians; Not easy to generalize beyond the time and place</td>
</tr>
<tr>
<td>Infrared sensors</td>
<td>Relatively affordable</td>
<td>Can produce false readings (e.g., leaves blowing across, dogs, or squirrels)</td>
</tr>
<tr>
<td>Time lapse video camera</td>
<td>Good for intersections</td>
<td>Costly to decipher</td>
</tr>
<tr>
<td>Difficult to strategically locate</td>
<td>Limited to just physical activity data</td>
<td>Inefficient in detecting physical activity of cycling</td>
</tr>
<tr>
<td>In-pavement (inductive) loop detectors or pneumatic tubes*</td>
<td>Relative inexpensive</td>
<td>Fails to detect pedestrians</td>
</tr>
</tbody>
</table>

*There are some other sensor types that are less used, such as Peizo sensors.
carry out automated 365-day, 24-hour counts at enough locations to be able to make conclusive determinations of seasonality and day-of-week variations. Furthermore, it might be better to collect data at fewer locations with more complete information rather than employ more locations for a smaller subset of the year.

Table 5 outlines the range of general measures including manual and automated methods.

**Recommended Data Collection Approaches and Indicators**

**Specific Measurement Approach**

The recommended approach is to enhance and standardize automated monitoring of facilities such as paths and sidewalks. Examples include in-ground sensors, infrared sensors, and traffic cameras. None of these approaches is currently foolproof but technology is evolving fast and in the long term they could be extremely cost effective.

**Potential Indicators**

Indicators of general use that could include an increasingly comprehensive set of counts to assist in transportation planning:

- **Indicator 7: ADT-W**: Average traffic—walking (for facility/corridor/neighborhood).
- **Indicator 8: ADT-B**: Average traffic—bicycling (for facility/corridor/neighborhood).

Some of the above might be best focused on key sites such as downtowns and corridors. In the longer term it may also be possible to forecast or model counts on the network.

**Case Study: Counting AT in Portland and San Francisco**

Many “early adopter” municipalities have been gathering annual counts of AT—mostly cycling—on particular facilities or at key points in the community. The bulk of existing efforts employ manual labor and, often, a systematized protocol for counting both pedestrians and cyclists. Manual counts typically provide a snapshot of how bicycling varies throughout the day, week, and season not to mention variation by weather. Recent advances in inductive loop technology and video detection provide increased options and availability for automated counting. As more such technologies are installed on city streets, on recreational paths and even rural roads, many communities are acquiring count data.\(^{17}\)

In the most straightforward application, values measured from these counts—manual or other—are used to assess trends in use. This is relatively basic information that resonates closely with the “chart heard around the world” showing the gradual increase of bicycle traffic to downtown Portland crossing the Willamette river, shown below (Figure 1). In comparison, for example, San Francisco is able to display average use along their 16 automatic count locations by day of week.

**Figure 1. Average Daily Bicycle Traffic Trends in Portland**

![Average Daily Bicycle Traffic Trends in Portland](http://bikeportland.org/wp-content/images/AverageDailyBicycleTraffic_01.jpg)


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The next level of sophistication—beyond raw counts—is to carefully analyze data from particular locations or time frames to scale up short term bicycle counts and estimate and predict annual bicycle use on various roads and paths. There is a developing science behind doing such; national efforts are focused on establishing methods for annualizing data, including the factoring, centralization, grouping of sites, and publication of AT travel monitoring data. There are a variety of “best practice” case studies available (mainly for manual count procedures), but also for more recent and progressive collection techniques. The particularly vexing issue is to estimate AT volumes in locations without counts, to test for trends in AT use over time and also to employ two-hour counts and model of how bicycle and pedestrian volumes vary with time and weather in order to create a method for annualizing such short term counts. Extending such counting applications even further, it is possible to collect counts from strategic points of a community’s entire system and then use this information to arrive at system-wide measures of AT use (in contrast to use along specific corridors). The process is akin to those models used for motorized facilities. It would also be possible to do this for walking but would require substantial data collection. However, walking is an important health-related behavior and many more people walk than cycle; such an effort may be worth investigating.

Parallel to count data, more detailed use data can provide a rich accounting of use patterns through leveraging smartphones. For example, a new application, CycleTracks, uses smartphone GPS support to record users’ bicycle trip routes and times, and display maps of their rides, albeit for a relatively small and self-selected sample. At the end of each trip, data representing the trip purpose, route, and the date and time are sent to a central source. This data can then be used by transportation planners to make informed decisions about bicycle use in the community and even use it to inform regional modeling applications. The data collection, cleaning, and analysis has successfully played out in the San Francisco County Transportation Authority (SFCTA); research efforts in Fort Collins are getting started using this technology.

19 See, for example, a methodology report available from the Puget Sound Regional Council (http://psrc.org/assets/5430/UDP_Bicycle_Studio_Final_20110111.pdf)
20 See, for example, a working paper, Estimating use of non-motorized infrastructure: Models of bicycle and pedestrian traffic in Minneapolis, Minnesota by Steve Hankey; Greg Lindsey; Xize Wang; Jason Borah; Kristopher Hoff; Brad Utecht; Zhiyi Xu
21 There is an ongoing research project at the Colorado Department of Transportation to arrive at a method to annualize short term counts, thereby providing a rich dataset in the CDOT traffic division of all the pedestrian and bicycle data from around the state of Colorado.
22 For a good explanation of how this is done for vehicular travel, counts, and VMT estimation, see Federal Highway Administration, 2011. Sample Methodologies for Regional Emissions Analysis in Small Urban and Rural Areas, see: http://www.fhwa.dot.gov/environment/air_quality/conformity/research/sample_methods/emitmeth02.cfm
23 For more about how CycleTracks has influenced the transportation planning process, see: http://www.sfcta.org/content/category/12/97/483/
V. Inventorizing Active Travel Infrastructure

Key Issues
Compared with use, facility provision (the supply side issue) is not as much discussed. There is a large literature on environmental features that are friendly to AT users—topics such as density, destinations, and design—and on arriving at measures of AT friendliness. Practitioners, however, consistently lament the lack of information about AT facilities such as sidewalks and bicycle paths. Very few places have comprehensive data on these topics.

We take up the issue of more general land use-transportation related features in the next section as the topic of supports for AT is also important. Here we focus on inventorizing specific facilities for AT.

Types of Infrastructure
A key question is how should such facilities be categorized? An initial—and somewhat “clean” way—to demarcate matters is to first consider facilities by mode: walking versus cycling. Walking is mostly done on sidewalks with opportunities for recreational walking done on paths. Some paths may be shared with bicyclists who may or may not have a delineated section of the path.

The cycling issue alone raises several questions:

- How should facilities be categorized?
- Should the whole network be measured or key parts (e.g., separated facilities)?
- What types of facilities should be measured?
- Are there useful measures of quality that can be reliably used across locations?

Despite seemingly countless accounts and planning guidelines, an authoritative handbook of different types of facilities is lacking. A typology—specific to cycling—that is gaining most traction recently comes from the National Association of Transportation Officials. For example, they identify bike lanes, cycle tracks, intersections, signals, and signs/markings. A different approach is to arrive at a taxonomy based on a continuum with a principal factor being the degree to which the cyclist has contact with automobile traffic. On one end is a bike-only highway, completely separated from any moving traffic. The other end is a street without any physical marking for cycling other than perhaps a sign indicating the street is a demarcated bicycle route. In between are all sorts of variations.

All are important and most mapping efforts focus on the provision of route level infrastructure. Some descriptions include as many as eight types of bicycle facilities; others three (in traffic, on-street demarcation, off-street facility). Further adding to the confusion, similar facilities sometimes have different labels. Some facilities are primarily recreational and may be omitted from standard transportation inventories. Any existing guidelines need to be flexible enough to account for the widening array of different cycling treatments that exist—a list that has increased in just the past few years.

Many bicycle maps for cities prescribe highly recommended, or other types of routes. The assessments are subjective and based on the type of facility but also potential problems such as difficult intersections and the nature and amount of vehicular traffic.

Creating a facility inventory involves three issues:

1. Consistently classifying facilities state-wide. This means coming up with a workable taxonomy of facilities. This taxonomy may also identify specific network discontinuities and/or problems with infrastructure quality. As suggested above, the number of categories are almost endless, however, the most straightforward are demarcating:
   - off–street facilities (typically bike only),
   - on-street bicycle lanes,
   - recommended shared use roadways (if applicable),
   - standard roadways, and
   - pedestrian facilities.

2. Creating an initial inventory in a common format. This would require agreements about computer platform (e.g., GIS vs. CAD); data sources (e.g., when to use aerial photos; how much ground checking is required); and levels of precision and accuracy. Someone would also need to then implement these decisions.

3. Developing a process of updating the inventory preferably as part of normal work practices. This is an issue requiring agreements between a number of agencies but once made, the inventory should be relatively easy to maintain.

25 National Association of Transportation Officials, see guidelines available at: http://nacto.org/cities-for-cycling/design-guide/
V. Inventorying Active Travel Infrastructure

Recommended Data Collection Approaches and Indicators

Specific Measurement Approach
Facility provision: Create and update a state-level database of off-road facilities and facilities on principal roadways. A consistent, state-wide classification of such facilities will aid in this activity. This would be a first step to later compiling a more complete list including such facilities as paths, sidewalks, and bicycle parking. In order to do this a working group is needed.

Potential Indicators
Collected state-wide, these could include:

- **Indicator 9:** LOS—W: Level of service for walking (for facility/corridor/neighborhood). This is a quality measure not a measure of congestion.

- **Indicator 10:** LOS-B: Level of service for bicycling (for facility/corridor/neighborhood). This is a quality measure not a measure of congestion.

- **Indicator 11:** FM--W: total facilities for those walking by classes of facility.

- **Indicator 12:** FM--B: total facilities for those bicycling by classes of facility.

- **Indicator 13:** Facility discontinuities/mile—for bicycling (as cyclists are the most sensitive to gaps in the network while distance matters more to pedestrians).

Case Study: Kirkland, WA and Minneapolis, MN

The most straightforward measure for walking infrastructure is knowing the existing infrastructure of sidewalks. Many communities have GIS layers for their roadways. Increasingly, sidewalks can be added to this inventory. The manner in which these layers are added to such GIS layers, however, varies widely. Automated aerial photography and remote sensing applications can be of use.

Kirkland, Washington is among those communities who have taken efforts to carefully inventory the sidewalk infrastructure. For example, they analyzed the existence and quality of the sidewalk infrastructure along all roadways in the community.

There are typically two ways communities go about prescribing the available infrastructure for bicycle traffic.

The first is a quasi-Delphi (expert user) process where demarcated or preferred routes are highlighted. The manner in which they are highlighted is a process of qualitatively triangulating between space available for cycling, absence of problematic intersections (or elevation gains), and having less vehicular traffic. Such maps may result in three grades of route identification: preferred, comfortable, standard. The second alternative is to map all roads or facilities using GIS according to a chosen classification such as the one suggested above.

Discontinuities or gaps in the bicycle system are another important issue. One of the more systematic efforts to address these comes from Minneapolis, Minnesota. As of 2010, they had 54 gaps in their system which are slowly being addressed via planning efforts.

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27 It is envisioned this would be a reflection of the overall quality of the infrastructure and environment (as opposed to auto-based measures of LOS which focus more on speeds along routes owing to levels of congestion).


VI. Support and Safety

Key Issues
Aside from the specific measure of AT facilities (above), it is also necessary to inventory appropriate measures addressing overall levels of support provided by the larger land use-transportation built environment. This includes two main areas: environmental (and cultural) support and safety.

A. Environmental (and cultural) support: While cyclists are sensitive to the route network and infrastructure quality, walking for transportation is particularly sensitive to distance—are there enough destinations close enough to make walking a viable mode?\(^{31}\)

Practitioners and researchers have been investigating both individual measures (like density) and walkability indices. Some use time-consuming fieldwork and some are tied more closely to actual use patterns of AT.\(^{32}\) None are widely used for larger surveillance efforts, though products promoted by semi-proprietary providers such as walkscore.com or walkonomics.com (both based largely on a database of destinations) have become popular among the public (the former, more for domestic use). It would be possible to use census and road network data, as well as any inventory of AT facilities, to document such supports for Colorado. It is important to mention that such products only measure the supply side and have little to say as to actual active transportation demand.

While dimensions of the broad-based land use and transportation system are important to assess opportunities that support AT, there are non-infrastructure-specific elements that relate to the broader community. These address the culture that is provided for AT and its larger planning efforts—this is,

Table 6. Ongoing National Transportation Accident, Death, and Injury Reporting Systems

<table>
<thead>
<tr>
<th>Name</th>
<th>URL</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Ambulatory Medical Care Survey Centers for Disease Control</td>
<td><a href="http://www.cdc.gov/nchs/ahcd.htm">http://www.cdc.gov/nchs/ahcd.htm</a></td>
<td>Sample of injuries</td>
</tr>
<tr>
<td>National Automotive Sampling System (National Highway Traffic Safety Administration)</td>
<td><a href="http://www.nhtsa.gov/NASS">http://www.nhtsa.gov/NASS</a></td>
<td>Samples Police reports on motor vehicle crashes including ones with AT users</td>
</tr>
<tr>
<td>National Electronic Injury Surveillance System (Consumer Products Safety Commission)</td>
<td><a href="http://www.cpsc.gov/library/neiss.html">http://www.cpsc.gov/library/neiss.html</a></td>
<td>Sample of hospitals; deals with bicycles (among other consumer products)</td>
</tr>
<tr>
<td>National Emergency Medical Services Information System (NEMSIS)</td>
<td><a href="http://www.nemsis.org/index.html">http://www.nemsis.org/index.html</a></td>
<td>Can produce false readings (e.g. leaves blowing across, dogs, or squirrels)</td>
</tr>
<tr>
<td>National repository used to store EMS data. Commercial vendor.</td>
<td><a href="http://www.nemsis.org/index.html">http://www.nemsis.org/index.html</a></td>
<td>National repository used to store EMS data. Commercial vendor</td>
</tr>
</tbody>
</table>

Source: Appendix A.
whether there is a culture or walking and cycling in an area and government activities to support such.

**B. Safety:** The second area addresses safety which is often measured through failures—accident and injury rates, deaths, and conflicts with traffic. Some locations compile some such data in a way that is useful for monitoring and planning—particularly the easier to measure death and accident rates. Few do large scale monitoring of conflicts, near misses, and the like. Key questions include:

- Deaths, reported injuries, and reported accidents are relatively rare. How are they best reported?
- Such rates are likely to be very low where AT is rare. Are they useful?
- Other issues may be more complicated to measure—such as traffic conflicts—are they worth measuring?
- Perceived problems with safety may be more important than actual safety and these are best measured through surveys such as those described in earlier sections. Is it a worthwhile use of funds to collect data on actual safety problems?

In terms of safety, there are several sources of national data, explained in more detail in Appendix A and listed in Table 6. These are useful but many only focus on deaths; some only provide data at a national level and sample only some injuries; other provide information only when an accident involves a motor vehicle. Given the relatively small number of AT-related injuries and deaths, having a sample may not be useful for local decision making.

Other information is local. Each state has its own way of collecting crash data and storing it. Some data, such as emergency room records, is available but would need to be collected. This is an area where it is important to think how cost effective data collection is, given the purposes for which it will be used.

### Recommended Data Collection Approaches and Indicators

#### Specific Measurement Approach

There are three likely additions and efforts to address more suitable measurement for safety and supports:

The first is to centralize collection of data on bicycle and pedestrian accidents and injuries. The most detailed recording is provided by municipal police departments and only some of this is centralized.

The second is to examine planning and policy supports for AT. For example, issues such as the extent of professional staff devoted to AT-related issues, the presence of various AT guidelines in ordinances (e.g., bicycle parking policy), or other publicity events to raise awareness of AT make a difference.

The third is to consider the feasibility of a task force (or experimental program) to better capture how supportive the overall built environment is for AT. The Walkscore example, as described, provides a good start; but, it is limited to just measuring the distance of key origins and destinations (modified by a connectivity score). Such a task force could explore the possibility of, for areas in Colorado, enhancing the product by building on the algorithm. For example, it could complement land use data with information about AT use (e.g., counts) or the incidence of AT crashes. In more advanced applications it would capture related elements about AT friendliness using widely available data (census, roads, facilities, transit routes, posted speeds).

### Safety: Potential Indicators

Collected state wide, these could include:

- Indicator 14: Colorado Ped Score: a GIS based measure to capture land use aspects.
- Indicator 15: Colorado Bike Score (similar to the above, but based on cycling networks)
- Indicator 16: ATE: Active transportation employees—percent of local government employees directly working on AT issues.
- Indicator 17: ATP: Active transportation policies—number of local government policies that directly advance AT goals (e.g., requiring bicycle parking).
- Indicator 18: IF-W: Injuries and fatalities per pedestrian.
- Indicator 19: IF-B: Injuries and fatalities per bicyclist.
- Indicator 20: PSF: Perceived safety of facilities (based on survey data).

### Case Study: CODES Project

The CODES application from Utah (available at [http://www.utcodes.org/](http://www.utcodes.org/)), part of a National Highway Traffic Safety Administration project, provides a clever triangulation between three different crash data sources to provide a more comprehensive approach to understanding problematic locations.33

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VII. Recommended Data Collection Strategies and Indicators

Recommended Measurement Approaches
The initial menu of data collection approaches includes seven items:

1. **State-level population**: For ongoing monitoring add questions to an existing national population-based survey such as the Behavioral Risk Factor Surveillance System coordinated by CDC using questions akin to those in the Front Range Travel Survey or National Household Travel Survey.

2. **Local-level population**: To obtain better data about local changes conduct a rolling and/or competitively awarded set of local level randomly sampled surveys (likely using mail-out/mail back and internet options). This is inexpensive and will reach a wide population.

3. **Local-level population**: Leverage new technologies (such as applications and GPS on smartphones or bikes) by developing an experimental program. This could also involve GPS-assisted travel surveys.

4. **Facility use**: Enhance and standardize automated monitoring of facilities such as paths and sidewalks. Examples include in-ground and infrared sensors, and traffic cameras.

5. **Facility provision**: Create and update a state-level database of off-road facilities and facilities on principal roadways. A consistent, state-wide classification of such facilities will aid in this activity.

6. **Safety**: Centralize collection of data on bicycle and pedestrian accidents and injuries.

7. **Supports**: Consider an experimental program of rating for pedestrian and cycling friendliness using widely available data (census, roads, facilities, speed limits).

Final List AT Indicators
Based on the information described in the three categories of AT measurement, we present a total of 20 AT possible indicators - the AT Mile Markers. This full menu was arrived at by combining national best practices with suggestions from participants at the workshop (see Appendix E and F).

Next, we prioritized this list into three levels based on: (a) criteria in section II, (b) ease by which data could be gathered, (c) ability to make them consistent with national level research and benchmarking efforts, and (d) experience among the research team.

Table 7 lists the 20 indicators presented in the order in which they are described in the report and also indicates the three levels of priority: A, B or C. The final recommended and “A” Priority list of indicators includes one indicator from each section of the report and for each mode (walking and bicycling).

**The AT Mile Markers are:**
- **WT**: Number of walk trips per capita
- **BT**: Number of bicycle trips per capita
- **AT-W**: Average traffic–walking
- **AT-B**: Average traffic–bicycling
- **FM-W**: Facility miles for those walking by classes of facility
- **FM-B**: Facility miles for those bicycling by classes of facility
- **Colorado Ped Score**
- **Colorado Bike Score**

The AT Mile Markers can be arrived at using a variety of data approaches. The indicators themselves more suggestively and less definitive than the measurement approaches but are reflective of important data needs and planning goals identified in Colorado. In each case they would need to be part of an ongoing surveillance system.
### Table 7. Menu of Indicators and Possible Measurement Approaches
(Note: the below measurement approaches coincide with the seven categories above; XX = approach is primary measurement approach, X = secondary measurement approach)

<table>
<thead>
<tr>
<th>Category</th>
<th>Indicator</th>
<th>Priority Level</th>
<th>State Survey</th>
<th>Local Survey</th>
<th>Leverage new technology</th>
<th>Counts (auto)</th>
<th>Facility Inventory</th>
<th>Accident / Injury</th>
<th>GIS data</th>
<th>Other secondary data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population level demand</td>
<td>1. WT: Number of walk trips per capita.</td>
<td>A</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. BT: Number of bicycle trips per capita.</td>
<td>A</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. WMT: Walk miles traveled, for total population and key subgroups.</td>
<td>B</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. BMT: Bicycling miles traveled, for total population and key subgroups.</td>
<td>B</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td></td>
<td>5. WAT: Number of walk access trips to transit</td>
<td>B</td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>6. BAT: Number of bike access trips to transit</td>
<td>B</td>
<td></td>
<td>xx</td>
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<tr>
<td>Facility use demand</td>
<td>7. ADT-W: Average daily traffic—walking (for facility/corridor/neighborhood)</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. ADT-B: Average daily traffic—bicycling (for facility/corridor/neighborhood)</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
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<tr>
<td>Infrastructure supply</td>
<td>9. LOS—W: Level of service for walking (for facility/corridor/neighborhood)</td>
<td>B</td>
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<td></td>
<td>xx</td>
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</tr>
<tr>
<td></td>
<td>10. LOS-B: Level of service for bicycling (for facility/corridor/neighborhood)</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
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<tr>
<td></td>
<td>11. FM—W: Facility miles for those walking by classes of facility.</td>
<td>A</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12. FM—B: Facility miles for those bicycling by classes of facility.</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support and safety</td>
<td>14. Colorado Ped Score</td>
<td>A</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15. Colorado Bike Score</td>
<td>A</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>xx</td>
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<tr>
<td></td>
<td>16. ATE: Active transportation employees—percent of local government employees directly working on AT issues.</td>
<td>C</td>
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<td></td>
<td></td>
<td>xx</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17. ATP: Active transportation policies—number of local government policies that directly advance AT goals (e.g., requiring bicycle parking)</td>
<td>C</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18. IF-W: Injuries and fatalities per pedestrian.</td>
<td>C</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19. IF-B: Injuries and fatalities per bicyclist.</td>
<td>C</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20. PSF: Perceived safety of facilities.</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xx</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To provide concrete examples of how various indicators could be arrived at using different data collection strategies, we provide four examples, one from each section of the report.

**WT: Number of walk trips per capita:** Relying on data recently collected, the Front Range Travel Counts, and courtesy of analysis performed by the Denver Regional Council of Government, Figure 6 shows that the average person from the Front Range of Colorado takes 0.20 walk-only trips per day. Smaller units of geography in the rest of the chart reveal slightly different rates. It is important to note, these are non-loop trips, and therefore do not necessarily include recreational walk trips.

**AT-B: Average traffic - bicycling:** Relying on bicycle count data collected in Boulder, Colorado over the past several years, the second example focuses on volumes of bicycle traffic. Figure 7 shows the top 20 locations for which bike count data are available in Boulder. Using the raw count data, Krista Nordback (UC Denver) applied robust factors to arrive at average annual daily estimates—an adjustment necessary to account for seasonal or daily fluctuations.

![Figure 6. Average walk-only trips per day by residents of the Colorado Front Range](image-url)

![Figure 7. The 20 highest bicycle traffic locations in Boulder, CO](image-url)
FM-B: Facility miles for those bicycling by classes of facility: Relying on GIS technology, a good start of a bicycle facility inventory is provided for various municipalities by the Regional Data Catalog from Denver Regional Council of Governments. Figure 8 shows bicycle facilities for communities North and West of Denver; similar, though not identical, information is available from Googlemaps. A more precise version of this would further distinguish the miles by type of facility and perhaps, quality.

Colorado Ped Score: The central idea behind the Colorado Ped Score is to develop an indicator that builds on information currently available via Walkscore.com. Figure 9 provides an example of a Walkscore walkability heat map, centered on Golden CO (just west of Denver), showing areas in green that are more supportive of walking environments. The current scope of this application, however, focuses on supply side aspects of the built environment - and mainly just land use - which is why we suggest refining such an application to better capture demand or safety considerations.

Figure 8. Map of bicycle facility miles in communities north and west of Denver, CO

Figure 9. Example of a walkscore walkability heat map
VIII. Next Steps

These AT Mile Marker recommendations are only as strong as their implementation. If implemented successfully over time, they will have a significant impact upon the ability of those in the fields of transportation and health to make informed decisions that will lead to more people walking and biking and to a healthier population. The research and outreach associated with this project led to the following recommendations to successfully implement the AT Mile Markers throughout Colorado communities.

Near-Term

Engage Leaders and Stakeholders. Successful implementation will involve engagement of key leaders, such as elected and appointed officials, boards of directors and foundations, in this process at key points in time. This project is not yet fully funded. Diverse funding sources will ensure long-term sustainability. This project will require innovation funds as well as funding sources associated with existing systems. Additionally, decision-makers need to be aware of the opportunities associated with this work and see the need for the AT Mile Markers in decision-making.

Form the Colorado AT Mile Marker Partnership. Building on the partnerships emerging from this project, create state and locally-focused committees to implement the next steps described below. This partnership should include representatives from all the fields and agencies mentioned in this report, from both public and private entities. These partnerships would prime Colorado for becoming a demonstration case for future national policy recommendations and implementation strategies.

Develop a strategic plan for implementation. Using the recommendations here and the input of the CO AT Partnership, determine best and most feasible strategy to make sure improved data collection can and does happen.

Create an interactive AT Mile Marker website. Under the guidance of the Colorado AT Partnership, an AT Mile Marker website would provide key implementation guidance and support, including a description of the indicators and how to use them, an AT data repository or clearinghouse, and additional resources needed to support those planning and monitoring AT. This site would also house the Colorado Ped Score and the Colorado Bike Score, upon development.

Identify targeted projects to refine indicators and implementation steps. Under the guidance of the AT Partnership, look for opportunities for collaboration on new or expanded data collection efforts. Technology can provide information that has not been previously available or affordable and should be considered among these opportunities. GPS information, made available voluntarily through smartphones or tracking devices, can provide valuable information for AT professionals.

Mid-Term

Implement a Colorado Ped Score and Colorado Bike Score. Implementation of this tool would include the development of and promotion of an interactive website, which calculates Ped Scores and Bike Scores based on several inputs, as well as guidance on using the tool.

Long-term

Work to incorporate Active Transportation data into mainstream traffic data collection efforts. Integration of AT data with automobile data is a critical step to integrate AT into all business and decision-making processes. To do this, it is important to seek traction at the state level for funding and organizational support, and to make AT data part of decision-making inputs.
Appendices
Appendix A: Surveys and Inventories with Colorado Data (National, State, and Local)

National-Level Surveys

American Community Survey (ACS)¹
The American Community Survey is conducted by the U.S. Census Bureau to provide data on a variety of topics. Now that the census no longer uses the long form, it is the only source of data that records a dimension of travel—limited to only the primary mode of travelling to work. Each year the census conducts about three million interviews per year. The ACS reports the modes of travel for the journey to work trip for communities across the country. While limited, this measure allows for a comparison of travel between various and similar communities, and with the regional and national averages. Questions are added to the ACS as they relate to the needs of federal agencies.

American Time Use Survey²
This national phone survey, collected by the Census Bureau, includes detailed one-day time logs from 112,000 people in the period 2003-2011. It is ongoing and includes transportation activity. However, geographical data for respondents are collected but not available for research.

Behavioral Risk Factor Surveillance System (BRFSS)³
This large, phone-based survey, sponsored by the Centers for Disease Control and Prevention, has been conducted continuously in Colorado since 1990 with 12,000 adults interviewed each year (350,000 nationwide). The 2011 version of the survey asked about “walking for exercise” in the context of a general question about types of physical activity outside the workplace. It recorded the amount of time spent walking if that was the activity respondents engaged in the most, or the second most (section 10).⁴

Colorado has, in the past has added questions related to physical activity and exercise; such types of questions could be better targeted to glean more general behaviors related to active transportation (see questions in Appendix D).⁵ Also, even with 12,000 participants in Colorado each year, neighborhood-level inferences would be limited. For example for Colorado’s population of 5 million, a sample of 12,000 would allow one to be 95% sure a measure of walking was within +/-1% of a given estimate (assuming half of the population walked). But a smaller area of say 50,000 people would likely yield on average only 120 responses, meaning that the confidence interval would considerably enlarge to +/-9%. In addition when questions are added, they are typically only asked of half the sample. Considering that cycling is done by only a small percentage of the population (as opposed to the 50% rate assumed above) suggests that the margin of error could be quite problematic.

➢ Adding questions is relatively inexpensive statewide—adding one question to all 12,000 people interviewed each year in Colorado would be about $4,000-$5,000 (half that if the questions are only added to half the respondents, which is the default). Questions are submitted in June for the following year. There are, however, limits on how long the survey can become in terms of time (20 minutes).⁶

➢ The overall and average cost for a completed survey is about $50. There is the option of asking additional questions to the existing sampling frame (i.e., adding five questions to people who were already being surveyed) or, alternatively, oversampling in smaller areas (i.e., asking the same questions to more people in a particular area).⁷

Fatality Analysis Reporting System (FARS)⁸
A national census of fatalities compiled by the National Highway Traffic Safety Administration this includes pedestrian and bicycle fatalities when they involve a motor vehicle. Data are available from 1975 on and can be downloaded. For example, in 2009 4,092 pedestrians and 630 bicyclists died in such crashes nationwide according to the FARS encyclopedia (http://www-fars.nhtsa.dot.gov/People/PeopleAllVictims.aspx). However numbers are small for individual states—for Colorado the 2009 numbers are 47 and 10 respectively.

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⁶ Calanan, Renee; Colorado Department of Public Health and Environment (CDPHE). Telephone Interview. February 2012.
Injury Facts
Since the 1920s the National Safety Council has published statistics on unintentional injuries and deaths. The latest version is called Injury Facts and is available in book and CD form. In terms of this project, Injury Facts may provide comparative data.

National Ambulatory Medical Care Survey (NAMCS) and National Ambulatory Hospital Medical Care Survey (NAHMC)$^{10}$
Conducted by the CDC, these surveys report on a sample of visits over one week at a sample of physician offices and a sample of hospital emergency rooms. The survey is annual and covers all types of medical care but is not a census of all AT accidents and injuries. In terms of this project, these two surveys may provide comparative data.

National Bicycle and Pedestrian Documentation Project$^{12}$
The project has been evolving and as of early 2011 has four components focused on facility use:  

1. Automatic counter technology for year round, 24 hour counts of cycling and walking  
2. Periodic manual counts  
3. Periodic intercept surveys  
4. An extrapolation method that help estimate total users of a facility from counts that might include 2 hour counts from parts of a day and/or a week.

National Bike Helmet Use Survey (1999)$^{13}$
This is a survey conducted infrequently. It was first conducted in 1991 and then in 1999 (conducted in 1998) when it was sponsored by the Consumer Products Safety Commission and McDonald’s and conducted by Yankelovich Partners. The nation-wide survey had 1020 respondents. While state-level data are not available, questions from the survey may provide useful models for questions in a new Colorado survey.

National Electronic Injury Surveillance System (NEISS)$^{14}$
Conducted by the Consumer Products Safety Commission this program collects data from a sample of hospitals about every emergency visit related to a consumer product. This is used to estimate national level of hospital visits related to consumer products. A For example, it estimates about 531,000 injuries related to standard bicycles in 2010 (nationally), and another 11,000 related to mountain bikes. The cases the estimates are based on are also available online—over 15,000 in the case of standard bikes. The location of the injury is coded in terms of types or places e.g. street or home, not the geographical place. In terms of this project, the estimates may provide comparative data.

National Emergency Medical Services Information System (NEMSIS)$^{15}$
This is an incidents reporting system which is a partnership between a number of organizations including the Centers for Disease Control, the National Highway Traffic Safety Administration, the Health Resources and Services Administration, and the Federal Emergency Management Administration. All states have signed on. It is intended to create a national emergency medical services database although it is currently a work in progress.

National Health Interview Survey (NHIS)$^{16}$
Collected by the CDC, this survey reaches over 87,000 people through personal interviews and deals with some issues related to “leisure time” physical activities such as “exercise, sports, physically active hobbies”.  

National Household Travel Survey (NHTS)$^{18}$
Collected by the Federal Highway Administration, the National Household Travel Survey is the most significant national survey dealing with personal transportation. It and its precursor, the National Personal Travel Survey, have been conducted in 1969, 1977, 1983, 1990, 1995, 2001, and 2009.
This telephone survey, also using a paper travel diary to jog memories, conducted across an entire year, focuses on trips over a one-day period and collects data on a variety of topics including trip purpose, length, and mode as well as demographic and related topics. This includes walking and cycling and data on walking, in particular, has been improving in recent years. The USDOT/FHA has used data from 2009 in a brief on active travel. It is possible to add additional participants in an area for a fee. The core NHTS sample is 25,000 households but 20 states and Metropolitan Planning Organizations collectively added another 125,000 households (for a total of about 300,000 respondents). No government in Colorado participated in this program and data are generally available only for larger areas (e.g. a metropolitan area). For the purposes of this project, if data are collected for smaller geographies they could be compared with the NHTS—using questions from that survey.

**National Health and Nutrition Examination Survey (NHANES)**

Conducted by the CDC, this survey samples about 5,000 people each year. While far smaller than the BRFSS it is very detailed. It uses face-to-face interviews in respondents homes to ask about a variety of diseases and measurements are taken in mobile centers (such measures include blood tests, body measurement, and electrocardiograms). From 2003-2006 NHANES participants wore activity monitors (accelerometers) and from 1999-2010 it asked questions about walking and cycling for transportation. Results are not available for the state level.

**National Sporting Goods Association Sports Participation Survey**

This is a panel survey of 41,000 people related to exercise. However, as much AT combines travel and exercise purposes, it has relevance. It includes both walking and cycling which are popular forms of exercise. Data are available by state.


Administered by Gallup this was a joint effort of the National Highway Traffic Safety Administration (NHTSA) and the Bureau of Transportation Statistics (BTS). It sampled 9,516 people. Questions may provide models for Colorado and a new survey is planned for 2012.

**National Transportation Statistics**

A compilation of statistics by the Bureau of Transportation Statistics, data includes accidents and injuries. Such data may be useful for comparative purposes.

**Walkscore.com**

Walkscore is a commercial web site that identifies more walkable neighborhoods using an algorithm (patent pending). The algorithm focuses on weighted proximity of destinations for shopping errands, parks, and schools (specifically grocery stores, restaurants, shopping, coffee, park, parks, schools, book stores, and entertainment). Data come from Google, localeze.com (both businesses), education.com, and openstreetmap.org. They have received funding from Active Living Research to refine their approach. The advantage of this database is that it is easily searchable and offers a compelling set of maps that is widely accessible. It does what it does very well. The disadvantage for surveillance purposes that it focuses on a narrow set of destinations (e.g. not civic facilities, work places), does not consider some other topics such as safety or density, is less relevant to cycling, and seems to be constantly updated so it may be difficult to track change over time.

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Colorado and Local Survey Examples (Annualized or Regular Data Collection Efforts)31
This section describes many of the local and state data collection efforts related to active transport. A number of other surveys occur regularly but do not have active transport questions, for example the Denver Citizen Survey.32 Others collect data but not in a consistent manner that is easily accessible for employed for AT purposes (e.g., police accident reports and hospital admissions/emergency room data [collected for insurance purposes]).

Colorado Statewide Efforts

Accident and Rates Book33
This data source describes traffic crash severities in Colorado from 1996-2008. It involves computerized traffic volume data and crash data from the Division of Transportation Development and Traffic Records Unit of the Safety and Traffic Engineering Branch.

Colorado Child Health Survey34
This survey, started in 2004, uses a sample of those who have answered the BRFSS in Colorado (approximately 1,000 people each year). The survey includes two questions which were asked in 2011 and 2012 about the number of days in which children 5-14 walk and cycle to school and the distance.

Colorado Department of Transportation Bicycle Counts35, 36
CDOT has as two different counting efforts used to collect data from various locations throughout the state. The first consists of eight permanent counters to collect data along particular facilities; this data is collected 24/7/365. The second consists of approximately 31 portable counters used to collect data for varying facilities or projects. These portable counters are usually used to collect data for around 2 weeks at a time; a disadvantage of the later is the inability to separate out pedestrian movements.

Along with these counting efforts, there are two projects underway that specifically relate to AT counting. The first, involving the Texas Transportation Institute, is to develop criteria for selecting geographic sites most appropriate for bicycle/pedestrian counts. The second is a research project, Development of Estimation Methodology for Bicycle and Pedestrian Volumes Based on Existing Counts, led by Krista Nordback and Wesley Marshall at UC Denver, to uncover reliable and robust conversion factors to account, for example, for seasonality.

Public Health Improvements Plans37
Since 2008, Public Health Improvements Plans are required by Colorado State Law. Each local health agency needs to develop a plan that assesses the health of the community (e.g., they select priority areas for various interventions) and to monitor progress in those areas. There is an final set of indicators being used for the community health assessment, some of which address the built environment, and the supply of facilities that support active transportation. These plans are to be updated every 5 years.

Local or Regional Efforts

Boulder: Boulder Valley Employee Survey38
As the City of Boulder web site states: “The Boulder Valley Employee Survey (BVES) is a biennial survey of employees who work within the Boulder Valley. The BVES was designed to tap an important dimension of travel behavior within Boulder, that of employees who work in Boulder, but may not necessarily live here. The first survey of Boulder Valley employees’ transportation habits was conducted in the summer of 1991. This report tracks changes in the number of trips, trip type and characteristics, and mode of travel used over the years for Boulder Valley employees. Trip characteristics are also compared to regional and national data and are reported by standard demographic characteristics such as age, sex, owner/renter, income, distance from work, city of residence, job requirements, and car, bike and Eco Pass availability.”

51 Note, many parts of this part of the appendix were taken from the City of Boulder’s Transportation Use Measurements page: http://www.boulder-colorado.gov/index.php?option=com_content&task=view&id=467&Itemid=1657. Direct quotes are indicated.
35 Jacobsen, Betsy; Colorado Department of Transportation (CDOT). Telephone Interview. February, 2012.
36 Moss, Aaron; Colorado Department of Transportation (CDOT). Telephone Interview. March, 2012.
Boulder: City of Boulder Annual Transportation Survey of Residents (annual)\textsuperscript{39}

As the City of Boulder web site states: "Since 1997, Boulder city has conducted the Annual Transportation Survey of Residents in the fall to assess citizen's opinions and experience relative to the transportation system. The first part of the survey asks a standard set of questions relating to the transportation challenges facing the community, the citizen's experience in getting around town, and their rating of various aspects of the transportation system. The second part of this survey focuses on a topical area of interest to the city, and has included neighborhood traffic mitigation, photo enforcement, traffic signals and transportation financing. This report tracks the changes in citizen opinion over time, and reports results by standard demographic characteristics such as age, sex, student, owner/renter, type of housing unit, income, and car availability."

Boulder: Downtown Boulder Employees and the University of Colorado (2005, 2008)\textsuperscript{40}

As the City of Boulder web site states: "A similar survey to the BVES was also conducted for downtown Boulder employees in the fall of several years. For the 2005 survey, the downtown survey was combined with the BVES to achieve cost savings. The University of Colorado also joined the effort and the study was expanded to include a survey of students, faculty and staff on the Boulder campus. The same set of questions, with slight variances, was used for all of the study groups in 2005 to allow for comparisons and to realize cost-efficiency savings."

Boulder: Downtown Bike Count Report (2009)\textsuperscript{41}

As the City of Boulder web site states: "The 2009 Downtown Boulder Bicycle Parking Count was completed in August 2009 by city staff and volunteers. It suggests that the number of people bicycling downtown continues to grow. The annual count was conducted to estimate the demand for bicycle parking and the impact of converting old parking meters to bicycle parking racks as well as determine the need for and location of additional bicycle parking in the downtown area. This was the third annual count conducted by the city. Since the count was initiated, the downtown area has experienced a significant growth in the number of bicycles parked downtown, and in many areas, the demand for bicycle parking exceeds the supply."

Boulder: Boltage\textsuperscript{42}

Boltage (formerly Freiker) is a program at select schools in Boulder to count the number of days children ride their bike to school. It is done via RFID counter tag readers (counters) download data using a propriety software package (with functions to separate class by grade, class, number of trips).

Boulder: Modal Shift Report, Annual\textsuperscript{43}

As the City of Boulder web site states: "The Modal Shift Report documents the results of the bi- or tri-annual travel diary survey administered by the Audit and Evaluation Division of the city. This survey has been conducted since 1990 and asks representatives from more than a thousand households in the Boulder Valley to track all their trips greater than two blocks in length for a 24-hour period. This report tracks changes in the number of trips, trip type and characteristics, and mode of travel used over the years for Boulder Valley residents. Trip characteristics are also compared to regional and national data and are reported by standard demographic characteristics such as age, sex, student, owner/renter, type of housing unit, income, and car, bike and Eco Pass availability."

Boulder: Report on Progress\textsuperscript{44}

As the City of Boulder web site states: "For a number of years following the 1996 TMP, the city produced a Transportation Annual Report as an effort to bring together all the data collected by the city related to transportation and evaluate this data relative to the objectives of the 1996 TMP. This effort was discontinued with the 2003 TMP planning process, which started with a comprehensive assessment of results under the city’s transportation policy direction. However, there remained an interest in periodically reporting progress to Boulder citizens and the numerous communities and organizations interested in Boulder’s transportation story. The November 2010 Transportation Report on Progress is intended to both present the results of Boulder’s transportation policy direction as well as tell the story of how the community and city developed the policies and programs that helped produce these results. We expect to update this report about every two years."


\textsuperscript{40} City of Boulder. 2008. Transportation Use Measurements: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=467&Itemid=1657


\textsuperscript{42} Boltage. 2012. The Program: http://www.boltage.org/overview.html


Denver: Denver Partnership Commuting Survey\textsuperscript{45}

The Downtown Denver Partnership is a Transportation Management Association for the downtowns. It has conducted this commuting survey every year since 2005, although only the 2007-2009 surveys are available on the website.

Denver: Denver Police Department Accident Reports\textsuperscript{46}

This data source includes reports for 2011 by month showing where accidents have occurred, broken down by time and day of week.

Fort Collins: Fort Collins Community Scorecard/Fort Collins Citizen Survey\textsuperscript{47}

This scorecard includes a number of transportation indicators from a citizen survey, the census, and other local data collection. Indicators include perceptions about the ease of traveling by bicycle and the degree to which Fort Collins is a walkable city. The report also includes data on transit ridership and operating costs, cycle commuting (from the American Community Survey), and road maintenance. The scorecard is presented in an appealing report that could be a model for other communities.

Front Range: Front Range Travel Counts (2011)\textsuperscript{48}

Recently completed, Front Range (Colorado) Travel Counts is an in-depth survey of urban household travel behavior along the Front Range. The almost $2 million project was supported by the North Front Range Metropolitan Planning Organization, the Pikes Peak Area Council of Governments, the Pueblo Area Association of Governments, the Denver Regional Council of Governments, the Colorado Department of Transportation, the Federal Highway Administration, and the Regional Transportation District.

More than 12,000 households participated in the survey (29,388 persons), recording the travel of each member of the household for one 24-hour period. Of the data collected for over the 14 million daily regional trips, 6.7\% were by walking or bicycling. While 6.7\% is higher than the national average, it is still a relatively small percentage of activity, especially when aiming to understand specific dimensions by geography, groups, or even mode (bicycling is likely 1/8 of this amount). Three communities were oversampled in this survey.\textsuperscript{49}

Roaring Fork: Local & Regional Travel Patterns Study -- Garland County, the City of Rifle, Pitkin County, Snowmass Village, City of Aspen\textsuperscript{50}

This study was conducted in 1998 and 2004. The 2004 study was based on two surveys—one of employers and another of employees. Discussions currently underway about repeating the study. It provides a model of cooperative data collection.


\textsuperscript{49} Snyder, Emily; City and County of Denver. Telephone Interview. February, 2012.

Appendix B: Spreadsheet of Existing Measures (National, Colorado, and Selected Others)

This appendix is not an exhaustive list but provides a range of types of tools. It should be read in conjunction with Appendix A and tables 4, 5 and 6.

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<thead>
<tr>
<th>Type</th>
<th>Tool</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection of tools</td>
<td>NCCOR Measures Registry</td>
<td>A database of measurement tools including many related to measuring physical activity behavior and the built environment; oriented toward research applications.</td>
<td>NCCOR. 2012. Measures Registry: <a href="http://tools.nccor.org/measures/">http://tools.nccor.org/measures/</a></td>
</tr>
<tr>
<td>Facility inventory</td>
<td>Statewide Bicycle and Pedestrian Facility Inventory (Summary)</td>
<td>Description of the methodology and the lessons learned from the inventory of all state-owned non-motorized facilities in 2002-2003 in the state of Washington.</td>
<td>Washington State Department of Transportation. n.d. Statewide Bicycle and Pedestrian Inventory: <a href="http://www.wsdot.wa.gov/NR/rdonlyres/3FBE90E2-77C7-4895-8D8D-81D251C7AF47/0/Inventory.pdf">http://www.wsdot.wa.gov/NR/rdonlyres/3FBE90E2-77C7-4895-8D8D-81D251C7AF47/0/Inventory.pdf</a>.</td>
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Appendix C: Existing Related Transportation Indicators

A key advantage of having reliable measures of AT is to better inform and enhance dialogue and policy deliberations related to larger transportation issues. Other modes of travel (e.g., auto) have high levels of use and subsequently richer data. It is common practice to infer overall levels of auto use based on relatively limited data; calibration, modeling, and other procedures over the past 40 years have matured to a point where it is mainstream practice to recite common statistics for auto travel such as VMT (vehicle miles of travel), occupancy, and number of trips per household. There are mature, routine and well-funded systems for counting traffic and measuring level-of-service (LOS) for motorized vehicles. An outstanding challenge is to translate such “mainstream” measures in robust ways applicable to AT.

Unlike quantifying VMT, methods for quantifying bicycle miles of travel are not well established. For instance, bicycling in the U.S. is commonly estimated from mode choice data derived from travel diaries and surveys—a process fraught with many limitations. Some approaches have aimed to estimating Bicycle Miles of Travel (BMT) using VMT; these exercises have not gained traction owing to poor data and unproven procedures.

Table 8. How We Measure Vehicular Traffic

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Average daily traffic (ADT)</strong></td>
<td>Measured at national, state, regional, local, corridor and segment levels. Most cities and counties and all state DOTs operate routine count programs. Many state DOTs and some cities and counties have permanent counters. Many cities (e.g., Boulder) have routine local count programs on some kind of periodic cycle. Most counters can classify traffic (truck, auto, etc.). Data varies seasonally, so many transportation agencies use “seasonal factors” and “annualization factors.” So this data is often reported as AADT – annual average daily traffic. Possible corresponding AT measures: average daily pedestrian trips; average daily bicycling trips.</td>
</tr>
<tr>
<td><strong>Peak hour traffic (PHT)</strong></td>
<td>Measured primarily at the corridor and segment levels. Same data gathering techniques as ADT. Timing of the peak can vary by city and region. As cities and regions grow, the percentage of traffic in the peak hour drops. Typical peak hour factors for small town or city: AM peak 10% of ADT; PM peak 14% of daily. Typical peak hour factors for large metro region: AM peak 8%; PM peak 11%. Data is often reported directionally, especially in arterial corridors. Possible corresponding AT measures: peak hour pedestrian trips; peak hour bicycling trips.</td>
</tr>
<tr>
<td><strong>Vehicle miles of travel (VMT)</strong></td>
<td>Measured at national, state, regional and local levels. May be reported annually, monthly, weekly, daily or hourly. A key variable in transportation planning and in scenario planning that is directly related to air quality measures, traffic congestion, energy use, greenhouse gas emissions and other outcomes. Federal government requires state reporting as part of the HPMS system, but accuracy is very low. Most regional and local VMT measurement comes from traffic models, although other techniques are available. Possible corresponding AT measures: person miles of pedestrian travel; person miles of bicycle travel.</td>
</tr>
<tr>
<td><strong>Average delay per vehicle</strong></td>
<td>Measured at the corridor, segment and intersection level. A measure of the congestion related to volume/capacity and to signal timing. A key performance indicator in corridor planning &amp; capital improvement programming. Corresponding AT measures: average delay per pedestrian/per bicycle. (These are relevant, as signal timing &amp; intersection congestion affect walk &amp; bike mode shares and the length of walk &amp; bike trips.)</td>
</tr>
<tr>
<td><strong>Level of service</strong></td>
<td>A measure of congestion or “functional sufficiency.” Measured at the corridor, segment and intersection level. May be reported as an all-day measure or for peak hours or peak periods. Vast amounts of published research on this subject including TRB’s Highway Capacity Manual. LOS has been popular in part because of its apparent simplicity with the letter grade reporting (A – F), but in fact most LOS measurement and forecasting tends to be highly inaccurate. Multimodal LOS systems are now being implemented in many cities and regions that include pedestrian and bicycle LOS measures. Corresponding AT measures: pedestrian LOS, bicycle LOS.</td>
</tr>
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</table>
Appendix D: Survey Questions Added to BRFSS in Colorado Since 2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009, 2011</td>
<td>The next few questions ask about facilities in your neighborhood where people can walk, bike, or be active. [Interviewer clarification: These items assess what is available to support walking, biking, and other types of physical activity in the local area around where the respondent lives. Are there sidewalks or shoulders of the road in your neighborhood that are sufficient to safely walk or bike? That is they have a smooth surface are wide and are clean?]</td>
<td>1. Yes 2. No 7. Don’t Know/Not Sure 9. Refused</td>
</tr>
<tr>
<td>2009, 2011</td>
<td>Are there any parks or trails in your neighborhood where you can walk, run, or bike?</td>
<td>1. Yes 2. No 7. Don’t Know/Not Sure 9. Refused</td>
</tr>
<tr>
<td>2009, 2011</td>
<td>Do you have access to public exercise facilities such as walking or running tracks, basketball or tennis courts, swimming pools, sports fields, etc., in your neighborhood? [Interviewer note: If necessary say “Public exercise facilities are facilities that are generally free, low-cost, or affordable such as a Parks and Rec facility, the YMCA, or a community center.”]</td>
<td>1. Yes 2. No 7. Don’t Know/Not Sure 9. Refused</td>
</tr>
<tr>
<td>2009, 2011</td>
<td>In the past 30 days have you been to a park, playground, or public open space? [Interviewer note: An open space refers to recreational lakes, rivers, or beach sports field, hiking trail, or other recreation area, including public places for hiking, biking, golf, basketball, baseball, tennis, soccer, football, skateboarding, etc.]</td>
<td>1. Yes 2. No 7. Don’t Know/Not Sure 9. Refused</td>
</tr>
<tr>
<td>2000, 2001, 2003, 2007, 2009</td>
<td>If respondent is employed or self-employed (S10Q07 = 1 or 2), continue. I would like to ask you a few more questions about exercise in a slightly different way. When you are at work, which of the following best describes what you do?</td>
<td>1. Mostly sitting or standing 2. Mostly walking 3. Mostly heavy labor or physically demanding work 7. Don’t know/Not sure 9. Refused</td>
</tr>
<tr>
<td>2000, 2001-every odd year</td>
<td>There are three categories of physical activity: light, moderate, and vigorous. I will be asking you about your moderate and vigorous activities, even if you have included them in your previous answers. Now thinking about activities that you do when you are not working, please tell me: In a usual week do you do moderate activities for at least 10 minutes at a time such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes some increase in breathing or heart rate? (If yes ask how many days do you do moderate activities)</td>
<td>___ Days per week 0. No (no days of moderate activity) 8. Don’t know/Not sure 9. Refused</td>
</tr>
<tr>
<td>2000, 2001-every odd year</td>
<td>On days when you do moderate activities for at least 10 minutes at a time, how much total time do you spend doing these activities?</td>
<td>___ Hours and minutes per day 777. Don’t know/Not sure 999. Refused</td>
</tr>
<tr>
<td>2000, 2001-every odd year</td>
<td>In a usual week do you do vigorous activities for at least 10 minutes at a time such as running aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate? (If yes ask how many days do you do vigorous activities)</td>
<td>___ Days per week 0. No (no days of moderate activity) 8. Don’t know/Not sure 9. Refused</td>
</tr>
<tr>
<td>2000, 2001-every odd year</td>
<td>On days when you do vigorous activities for at least 10 minutes at a time, how much total time do you spend doing these activities?</td>
<td>___ Hours and minutes per day 777. Don’t know/Not sure 999. Refused</td>
</tr>
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Note: These are questions in addition to the standard BRFSS questions.
Source: accessed using the online database at https://www.ark.org/adb_brfss_questions/results.aspx
Appendix E: Additional Information About Sampling Population-Based Approaches


Common folklore suggests that larger sample sizes are always preferred. However, depending on the preferred confidence intervals and levels, one only needs to collect a certain number of responses; efforts to collect more than that number can be redundant and costly. Arriving at a “magic number” of responses comes down to straightforward statistics. Fortunately, there are a variety of on-line “calculators” to aid in this process.

Given that communities thinking about implementing a pedestrian and bicycle survey might range from 20,000 residents to 5 million, it is helpful to offer a few examples. Table 9 suggests the number of complete surveys needed, assuming a 95 percent confidence level and an prevalence rate around 50-50. Select the approximate population of your city and then choose your margin of error for such prevalence rates. The population of Colorado is approximately five million.

Table 9. Sample Sizes for Areas with Different Populations.

<table>
<thead>
<tr>
<th>Population</th>
<th>Sample Size Needed (95% confidence level)</th>
<th>Margin of error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ / - 3%</td>
<td>+ / - 4%</td>
</tr>
<tr>
<td>2,000</td>
<td>696</td>
<td>462</td>
</tr>
<tr>
<td>5,000</td>
<td>880</td>
<td>536</td>
</tr>
<tr>
<td>10,000</td>
<td>965</td>
<td>566</td>
</tr>
<tr>
<td>20,000</td>
<td>1,014</td>
<td>583</td>
</tr>
<tr>
<td>50,000</td>
<td>1,045</td>
<td>593</td>
</tr>
<tr>
<td>100,000</td>
<td>1,058</td>
<td>597</td>
</tr>
<tr>
<td>500,000</td>
<td>1,065</td>
<td>600</td>
</tr>
<tr>
<td>1,000,000</td>
<td>1,066</td>
<td>600</td>
</tr>
<tr>
<td>5,000,000</td>
<td>1,067</td>
<td>600</td>
</tr>
</tbody>
</table>

Note: The above values were obtained by inputting values to the on-line “calculator” available at http://www.surveysystem.com/sscalc.htm. Any similarly oriented calculator would yield the same results, since the calculators are all based on standard statistical formulas.

However, along with total population size, the analyst choosing a sample size needs to be aware that the confidence interval also depends on how prevalent the behaviors being studied are in the population. Prevalence refers to the proportion of the population who will choose a particular response to a question. For example, if the survey asks whether or not people bicycled last week and get 50 percent of people saying yes, then the prevalence cycling is 50 percent.

As previously mentioned, the behaviors under discussion—in particular cycling—likely have prevalence rates well below 50% for any particular day or week. Table 9 is based on behaviors that would be prevalent for large portions of the sample. Behaviors with lower prevalence rates have smaller confidence intervals, which is an additional consideration. Table 10 presents a generalized table of sampling errors for samples of various sizes and for various proportions assuming a simple random sample.

Table 10. Confidence Intervals for Variability Attributable to Sampling (assuming a 95 Percent Confidence Level)

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Percentage of Sample with Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5/95</td>
</tr>
<tr>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>300</td>
<td>3</td>
</tr>
<tr>
<td>500</td>
<td>2</td>
</tr>
<tr>
<td>1,000</td>
<td>1</td>
</tr>
<tr>
<td>1,500</td>
<td>1</td>
</tr>
</tbody>
</table>


In general, as prevalence decreases, the confidence interval width decreases. For example, if your organization or municipality decided to interview 500 people and ask if they cycled in the past year, and the prevalence of the behavior was 50 percent, then the confidence interval would be 50 +/- 4 percent. That is, you would be 95 percent sure that between 46 percent and 54 percent of the population cycled over the year. However, if the prevalence of cycling was 10 percent, then the confidence interval is +/- 3 percent, or you would be 95 percent confident that 7 percent to 13 percent of people cycled. This is a fairly narrow margin of error in absolute terms but big in relative terms (13 percent is 86 percent more than 7 percent). These wide margins make it more difficult to track change over time. Consequently, this means that Table 10 is as important as Table 9 in figuring out how many people to survey.

Given these considerations, there is unfortunately no foolproof strategy to determine the bottom line for a needed sample size. Such matters usually come down to a combination of:

1. Suggested thresholds (based on the calculators previously discussed)
2. The confidence interval and confidence level that are likely to be acceptable, related to the expected prevalence of behaviors
3. Available resources

As a very rough rule of thumb, many communities will think that 500 or 600 returned surveys is a good number, although some may be happy with fewer and some want more.

A separate but related question is figuring out the number of people who will need to be contacted in order obtain the necessary number of responses (in other words, reach the desired sample size). This is a function of the strength of the recruitment plans (see below), and available time. Briefly, with a 30 percent response rate your organization or municipality would need 2,000 surveys sent out to get 600 responses (600/2,000 = 30 percent). Thus, with a higher response rate you can send out fewer surveys but if it is lower you need to send out more and also deal with the issue of non-response bias (that those who do end out answering are somewhat different those who do not, biasing results). There is substantial guidance. A very interesting review of studies of 292 randomized control studies of increasing response rates in mail surveys recommended the following such strategies as multiple contracts, personalized letters, colored ink for addressing and signing, providing monetary incentives, and the like.\(^2\) However, this is still a substantial issue.

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Appendix F: Workshop Report

The Kaiser Permanente Active Transportation Indicators Workshop, March 15, 2012: Summary

The purpose of the Kaiser Permanente Active Transportation Indicators Workshop was to help establish a set of consensus indicators for measuring various aspects of Active Transportation (AT) in Colorado that meet the needs identified by the attendees’ organizations and other organizations with which they work. It was one data collection process, which is part of a larger project sponsored by Kaiser Permanente (KP) to: identify model examples of how to measure active transport; a particular focus is on those currently being used in Colorado; convene experts and stakeholders to advise the best data collection methods to use at a larger scale in Colorado; and recommend a menu of instruments or tools for gathering data for those indicators.

The Kaiser Permanente Active Transportation Indicators Workshop was held at the Kaiser Permanente Educational Theater Program Facility in Englewood. There were 30 participants and 7 Project Team members. Prior to the Workshop, participants participated in a brief survey to begin the process of articulating how and why they use data related to AT. These results can also be found at the end of this report.

The Workshop results, including the list of indicators identified by participants, will be incorporated into both the project report Measuring Active Transportation: Recommendations for Colorado and the final list of recommended indicators to be presented during the Active Transportation Indicators Webinar on April 19, 2012.

Assignment 1: Assessing the Needs of Participating Agencies & Organizations

After an introduction to the background research conducted prior to the Workshop and a review of recommended indicators based upon this research, small groups were asked to prioritize needs and associate them with the appropriate indicators. For example, what information would help you/your organization move forward on promoting/building facilities for AT? Is it, for example, how many pedestrian trips are being generated? If so, by what group of people; over what timeframe and how frequently do you need to know this? Which of these needs are most important and which of these initial indicators meet those needs?

After working in small groups, participants returned to the large group to report on their results. There were a number of recurring and consensus needs identified during the workshop. People want to know answers to the following questions.

What programs and projects have the greatest positive impact on AT? Improved data is needed to achieve and demonstrate increases in AT. Many participants expressed the need to see changes over time, particularly before and after: projects and programs are implemented; and weather events. This suggests a continuous data collection effort, such as the use of imbedded counters, on as many facilities as possible and regularly reported results that are consistent over time.

How supportive of AT is a community? Many participants want to know the degree to which AT is a priority from the perspective of both policy and practice. Included in this is qualitative and quantitative data about the supply of facilities, including safety and perceived safety for the user. There is also a desire to know policy indicators, such as: does the comprehensive plan or transportation master plan mention the promotion or prioritization of AT? How many people in the local government are working on issues related to – specifically promoting, AT such as a bicycle or pedestrian planner? Do parking policy and other related land-use objectives consider and prioritize AT access?

Related to the first question, but requiring a different approach, is the desire to understand the latent demand for AT. Many organizations want to understand what they need to do to promote AT; and what is preventing people (certain groups) from participating in it. This information is best achieved through surveys. The CDC’s Behavioral Risk Factor Surveillance System (BRFSS) may be appropriate for this type of data collection effort.
What groups are using AT facilities? Many people want to know details about specific users (or non-users?), such as demographic information, which can only be collected through surveys. One idea is to add a call-back survey to the BRFSS, similar to how the Child Health survey is conducted. BRFSS respondents may be asked if they walk or ride a bicycle to make trips with a purpose (work, errands) and if they answer yes, they would be called back separately for a second survey. In this way, it may be possible to collect detailed demographic information about AT users.

How can we effectively share data? There was discussion of the availability of data, collected from both primary and secondary sources and many thought that the first step in collaboration would be creating a kind of data clearinghouse. Many parties, some not represented at the Workshop, are collecting important data but it is not used to its fullest potential because other agencies are not aware of it. By creating and collaborating on a shared data website, the partnership process can be quickly and easily started.

What tools are available to collect AT information? The group discussed the need to provide tools as first steps for agencies and organizations working at every level (local, regional, state.) The idea of a data collection toolkit evolved over the course of the Workshop. For example, in small towns, where resources may prevent extensive and regular data collection efforts, we may need to offer guidance on how to do a proper inventory of supply, as a first step. The best inventory efforts include qualitative and quantitative data, and carefully itemize bicycle facilities and pedestrian facilities separately. Some organizations really want fine-grained data; data that is representative of what is happening in one (small) place, such as a neighborhood. This type of data collection requires small-scale projects to be affordable. The toolkit should offer some suggestions about how to best get very localized AT data.

What are the benefits of AT? People are interested in indicators that will further the acceptance and prioritization of AT by decision makers and the general public. People want the data to demonstrate the need for and the positive impacts associated with AT, such as economic and public health benefits, resulting from improved facilities and advanced policies.

At the end of this report back, the group took a break. During the break, participants were asked to vote, using a total of three votes per person, on the needs for which indicators should be developed.

Table 11. Results of Voting Exercise: Which (three) needs are the most important?

<table>
<thead>
<tr>
<th>Identified Need</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data standardized e.g., like we do for cars for comparison/scaling</td>
<td>18</td>
</tr>
<tr>
<td>Impacts of AT projects / programs – before &amp; after (14 votes)</td>
<td>14</td>
</tr>
<tr>
<td>Understand disadvantaged groups / small areas as key focus / different demographics</td>
<td>13</td>
</tr>
<tr>
<td>Latent demand / population</td>
<td>11</td>
</tr>
<tr>
<td>Frequent / annual data / continuous counts – frequent data as providing positive feedback for AT</td>
<td>9.5</td>
</tr>
<tr>
<td>Infrastructure description, facility inventory (current baseline)</td>
<td>9</td>
</tr>
<tr>
<td>Use of infrastructure / volume baseline</td>
<td>7</td>
</tr>
<tr>
<td>Understand the different needs/behaviors of cyclists vs. pedestrians</td>
<td>4</td>
</tr>
<tr>
<td>Baseline population info – general population “deep data”</td>
<td>2.5</td>
</tr>
<tr>
<td>Data can be aggregated from neighborhood to region (relevant to decision matrices, e.g. a city, county)</td>
<td>2</td>
</tr>
</tbody>
</table>

Assignment 2: Identifying Indicators to Meet the Needs

After discussing the voting results, the group was asked to think about indicators that would provide the needed information as well as data collection efforts required to support those indicators.
Assignment 3: Building Partnerships and Next Steps

During and after lunch, the group discussed the opportunities associated with collaborating on standardized measures and data collection efforts. The potential benefits of pooling resources and joining together are improved (more reliable, more accurate, more frequent, more in-depth) data that serves multiple needs, with shared-costs.

The comments and discussion during this portion of the Workshop have been organized into general questions that were posed at the beginning of the exercise, with associated responses.

What entities are best suited to move standardized data collection efforts forward?

This may be best achieved by entities at the State level; possible statewide organizations to lead that effort are CDPHE (Colorado Department of Public Health and Environment) and CDOT (Colorado Department of Transportation).

What should be considered when collaborating on data collection?

We need to make sure we are: collecting the data that people/organizations need (and delivering it to them – or making it readily accessible); AND not collecting a lot of data that is not useful. There is also an opportunity with existing data and existing sources of data – how can we centralize data to maximize its use? Let’s put it all in one place.

Some participants would like to see AT data collection mandated at the federal level, or mandated by an Executive Order at the state level, to justify implementation, associated costs, and fairness requirements. Some thought that would require significant political will and is therefore, a long-term goal. Performance measures will be used for the new statewide bike/pedestrian plan; data will be needed for monitoring that as well. CDOT would like to foster improved statewide data collection but cannot do local-level data collection.

We need data collection to be a partnership effort – much like the Front Range Travel Counts model, which involved multiple front range MPOs and member communities; and it needs to be automatic (especially with reporting) and recurring on a regular basis.

---

<table>
<thead>
<tr>
<th>Recommended Indicator</th>
<th>What it Measures (Identified Need)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk Miles Traveled (per capita); to compare with VMT*</td>
<td>How much walking travel is happening, as a function of distance</td>
</tr>
<tr>
<td>Bicycle Miles Traveled (per capita); to compare with VMT*</td>
<td>How much bicycle travel is happening, as a function of distance</td>
</tr>
<tr>
<td>LOS - quality of facilities</td>
<td>The quality of AT facilities; how well they meet user needs</td>
</tr>
<tr>
<td>Safety Indicator - Perceived Safety of Facilities</td>
<td>How safe facilities are perceived to be</td>
</tr>
<tr>
<td>Walk Score (aggregate of indicators?)</td>
<td>How walkable the local environment is</td>
</tr>
<tr>
<td>Bike Score</td>
<td>How bike-able the local environment is</td>
</tr>
<tr>
<td># of injuries of AT users (separate for peds and bikes and per capita)</td>
<td>How many injuries are happening in walking and biking travel</td>
</tr>
<tr>
<td>Neighborhood mapping indicator – connectivity?</td>
<td>The quality and quantity of facilities on the local level</td>
</tr>
<tr>
<td>Access to bike and footwear</td>
<td>Barriers affecting AT use</td>
</tr>
<tr>
<td>Number of local government employees working on AT</td>
<td>The degree to which the community supports AT</td>
</tr>
<tr>
<td>Other policy indicators, such as: AT mentioned as a goal in local planning documents; parking space policy supportive of AT (prioritizes access by non-motorized modes)</td>
<td>The degree to which the community supports AT</td>
</tr>
<tr>
<td>Walk Trips to Transit</td>
<td>How people are accessing transit</td>
</tr>
<tr>
<td>Bike Trips to Transit</td>
<td>How people are accessing transit</td>
</tr>
<tr>
<td>Economic Impact of AT (health impacts)</td>
<td>How to “prioritize” AT to decision makers</td>
</tr>
<tr>
<td>Land Use Measures (no exact indicator created)</td>
<td>To understand how supportive land uses (and local land use policy) are of AT</td>
</tr>
</tbody>
</table>

*Team note: Distance may not be the most compelling comparable between walking, biking and driving because non-motorized modes will often be used for short-haul trips. A better indicator to compare with driving may be Walk Trips and Bike Trips per Capita to compare with Drive Trips per Capita.
MPOs already do a lot of data collection, especially with respect to traffic. AT is just another form of traffic and should, therefore, be easily and readily adopted by MPOs as an important effort. MPOs could establish guidelines for data collection as well. Air quality data collection mandate could be used as a model for collaboration and incentive.

Counties are an important entity for possible local data collection, in part due to their affiliation and outreach effort through CDPHE. Every county should do the same AT data collection.

Oversampling existing surveys seems to be an attractive option for getting more detail about AT users but it may not ever be affordable. CDPHE has tried over-sampling for specific racial profiles and it has not worked (been statistically significant.) We need to find other ways to get fine-grained data.

We could expand our partnership even outside this group to get more funding and momentum on the issue (e.g. environmental groups, real estate, etc.)

What are other possible sources – points at which – we could collect data?

We could look into collecting data about AT during the patient-intake process done by doctors’ offices. It would be possible to add questions to intake questionnaires but there may be a bias toward the employed/insured population. Privacy issues and respondent burden would need to be addressed.

Let’s consider getting information through entities such as high schools or universities about trip-generation, origins and destinations and mode share. Could we add questions to enrollment processes at schools? What about collecting data through law enforcement?

How can we use crowd sourcing and technology to collect data?

We need to take advantage of free data by asking large groups of people to contribute free information to tell us certain things about AT. It will always be a self-selected group and a group with certain characteristics (those who own smartphones) but it may be an attractive option to understand certain demographics or route selection choices (indicating quality of AT network.) Mobile applications can be arranged to be less self-selected, and the project team should identify those methods.

There may be a time when cyclists are able to document safety concerns and accident information directly by uploading images and videos, similar to that done by police cameras at intersections. This movement to put data collection in the hands of individuals will mean less “government” control. Let’s consider how we could use this type of information in the future.

SUPPLEMENT

Direct Notes from Small Group Report Backs for Assignment 1

Below are the notes from the large format sheets that the groups used during their individual report-backs.

Green Group

The Green Group posed the following questions.

- Does data drive policy or vice versa? This question was asked in the context of understanding the protocol for affecting change, such as improved data collection efforts. Many agreed that the right data can change policy and the opinions of decision makers
- We need to be able to show impacts; the before and after of a project or program
- We also recognize that different cities may have different needs
- We need to know the amount of use of facilities
- We need to demonstrate the connection between AT and values/quality of life
- We need to be able to demonstrate changes in physical activity
- We need to know about costs (elaboration?)
We need to know:
- Latent demand – why is AT not occurring? What is preventing people from doing AT?
- BMT/WMT

Yellow Group

- Data should indicate where grant money/funding should be directed?
- We need to collect data on change of use over time
- We want to know more about latent demand
- Data should be collected at neighborhood level and scaled upwards toward regional levels
- Data and methods of collection should produce accurate data (measures what you intended to measure); 80% chance that data and methods are reliable

Blue Group

- Baseline data (population and facilities) to know about change over time;
- To know about travel behaviors;
- Information about various subgroups, such as women;
- To track changes in AT “before and after” to measure the impacts of policies, infrastructure, events on AT behavior;
- To get fine-grain data (neighborhood level) and upscale it;
- Data that is reliable, scalable and consistent between and across communities; and
- To measure AT the same way we measure automobile traffic.

Red Group

- Data that is frequent, visible and provides positive feedback (ex: measurement system on highways is not aimed at changing behavior; AT measure is):
  - Provide rapid feedback to public
  - Almost constant collection
  - Episodic and programmatic (focusing on a neighborhood, maybe randomly; in the same place over time – annually?)
  - Go deep/less frequent:

- Who’s doing what, (with respect to data collection?) and why?
- Accurate and reliable counting of bike/peds is needed

To understand various levels of geography:
- Examine neighborhoods, important in discerning certain groups, e.g. disadvantaged
- Consistency is important to support the ability to compare across jurisdictions (different gov’ts collecting data for different reasons right now)

Information about the AT user:
- There are different risks and tolerances among different demographic groups and we need to be able to tailor data collection to understand behaviors
- Need to capture all demographics as well (collectively or individually?)

General Comments

Walkers and bikers have different needs and show different data collection efforts. We need to identify the needs specific to each group: walkers and bikers. We also need to get at changing behavior because infrastructure improvements are too long-term.

Direct Notes from Small Group Report Backs for Assignment 2

Below are the notes from the large format sheets that the groups used during their individual report-backs.

Blue Group

- WMT/BMT for different user groups; including disadvantaged groups
- LOS on network level
- Perceived safety of facilities

Yellow Group

- Gaps
  - Lack of connection between bike and pedestrian facilities, as it relates to AT
  - Walk/bike score – include measure of crime/safety (how it relates to lack of AT use)
  - LOS at facilities level, related to LOS by facility miles (what % meets the minimum LOS) Access to bike and footwear with which to do AT
  - Injuries and safety; measure of injuries by location; mapping at neighborhood level
Strengths of “Straw Person Indicators”

- Collect data each season of year; important to measure more than once a year
- VMT and BMT per capita; total walking biking miles travelled – look at it per trip or per capita more important than looking at it as a total number

Red Group

- Type of person using facilities; lack of information about who is using AT and why
- Policy indicators such as FT employees in AT (bike/ped planners) & parking space policy in plans (laws and policies that encourage AT)
- Latent demand indicator – could be used as a tool to measure what we could have; discussion of a possible online tool where you could adjust how different investments affect AT use

Green Group

- Demand, values, and purpose of AT in communities
- Origins and destinations of AT, including transit; walking and biking trips to transit is important and able to be measured
- Quality of facility (LOS) – could include discontinuity
- Quantity of facility; facility miles
- Annualized ADT for #5 and #7 straw-person indicators:
  - WT and BT to transit - important
  - Land use measure; consider (AT) origins and destinations, mixed-use
  - Economic impact/ RDI

General Comments

- Do we collect data on active transportation or active living? Some just want to get people moving; others think it’s more important to have high-quality measures of walking; some want to replace auto travel (want bike measures). We need to be clear about the difference between a) any time a person is actively moving (including recreation) and b) when a person is actively moving to get to/from certain destinations (trips with purpose).
  - How important is land use?
  - How important is trip purpose?

Direct Notes from Partnerships Discussion

- Health region – every county is doing a health data collection; add AT into this
- Governor should make an Executive Order that any construction has to plan for bikes (and peds) too
- Recommendation from this group – executive order for bike/ped data; Mandate to MPOs that they have to consider bike/ped data as part of the scoring tool for projects
- Needs to have the support; agencies struggle to get bike/ped data to show demand for it
- Idea of having public/private partnerships to provide funding for surveys
- Very important to have the data standardized, esp. in counts
- Two sides to problem:
  - What would be measured and how to measure it?
  - How to get the money?
- Funding source – everyone has to add a data collection cost to their projects
- Process has to become automatic, so how do we institutionalize it?
- CDOT / CDPHE (big partnership) – air quality conformity (EPA standards, analysis process to figure out whether or not in violation) – work together to do the analysis
- Recently COG provided information on how to use count data, how to analyze COGs beginning to have a mechanism for working together, and then it can trickle down to smaller municipalities
- Idea that DRCOG had more resources and would have all done surveys separately, but then managed the project as a partnership with a lot of cost savings and also a technology sharing opportunity for COGs MPOs with less resources
- Oversampling the ACS to get more data in CO, or the BRFSS to get local data
- Ft Collins does its own local health survey b/c can’t get local enough data from BRFSS (funded by sales tax)
- Walk score – now funded by realtors, but who initially funded it (university professors grant) – happened without government agency involved (bike share too)
- We can be looking outside of this room – expand to environmental communities as well as health communities (transportation & health too)
• Built Environment Strategic Collaborative; group coordinated by CDHPE – trying to coordinate meetings between environmental & health staff

• Possibility of asking additional questions to certain populations at point of healthcare?
  • Need electronic systems (KP have electronic records)
  • Selection bias – employed, insured persons
  • Long forms already, etc. need the right person to give

• Ft Collins using cycletracks (phone app), will use incentives to increase participation

• Number of new apps may be very large, are some ways to make it less self-selective

• Univ of Wash – just detecting blue tooth devices that are passing; not self-selected but still small segment of population

• Working with AARP—because the aging population is growing so fast

• Some discussion of looking at legal policies about using cameras to record dangerous vehicle behavior, license plate, picture of face

• National effort through TRB to bring health & transportation planners together – a data-focused conference; project team to get info
Appendix G: Survey Results

In advance of the March 15, 2012 workshop, the project team administered a survey to workshop participants to query about the needs and nature of AT data. Over 30 responses were recorded and the results of the 13 questions are presented below.

1. Select the occupation that most appropriately describes your current position (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>State or local bike/pedestrian coordinator</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>Metro (metropolitan planning org) planner</td>
<td>9.1%</td>
<td>3</td>
</tr>
<tr>
<td>State transportation planner</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>Regional transportation planner</td>
<td>6.1%</td>
<td>2</td>
</tr>
<tr>
<td>Municipal transportation planner</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>Local health professional</td>
<td>9.1%</td>
<td>3</td>
</tr>
<tr>
<td>State health professional</td>
<td>6.1%</td>
<td>2</td>
</tr>
<tr>
<td>Local government worker, generally</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>Consultant</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>National advocate</td>
<td>6.1%</td>
<td>2</td>
</tr>
<tr>
<td>State/local advocate</td>
<td>6.1%</td>
<td>2</td>
</tr>
<tr>
<td>General researcher (non-profit, academic, think tank)</td>
<td>24.2%</td>
<td>8</td>
</tr>
<tr>
<td>Safety/design researcher</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>System planning/demand analysis researcher</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>Elected official</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>Policy advisor</td>
<td>3.0%</td>
<td>1</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>12.1%</td>
<td>4</td>
</tr>
</tbody>
</table>

answered question 33
skipped question 1

2. Please select the category that most accurately reflects your primary responsibilities (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and analysis</td>
<td>37.5%</td>
<td>12</td>
</tr>
<tr>
<td>Help advise officials (elected or other) about policies</td>
<td>21.9%</td>
<td>7</td>
</tr>
<tr>
<td>Set and establish policy</td>
<td>6.3%</td>
<td>2</td>
</tr>
<tr>
<td>Program management</td>
<td>25.0%</td>
<td>8</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>9.4%</td>
<td>3</td>
</tr>
<tr>
<td>Local health professional</td>
<td>9.1%</td>
<td>3</td>
</tr>
</tbody>
</table>

answered question 32
skipped question 2

2) Please select the category that most accurately reflects your primary responsibilities (select only one):
3. In what manner do you interact with data in your current position? (check all that apply):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>I process and analyze data regularly</td>
<td>56.3%</td>
<td>18</td>
</tr>
<tr>
<td>I frequently bring data to meetings</td>
<td>68.8%</td>
<td>22</td>
</tr>
<tr>
<td>I make recommendations for future data collection</td>
<td>65.6%</td>
<td>21</td>
</tr>
<tr>
<td>I use reports prepared by others to make decisions</td>
<td>65.6%</td>
<td>21</td>
</tr>
<tr>
<td>Data is an issue for others at my organization</td>
<td>6.3%</td>
<td>2</td>
</tr>
<tr>
<td>My organization does not use much data</td>
<td>3.1%</td>
<td>1</td>
</tr>
</tbody>
</table>

answered question: 32
skipped question: 2

4. What type of organization do you work for? (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government (or quasi government) planning agency</td>
<td>34.4%</td>
<td>11</td>
</tr>
<tr>
<td>Government health organization</td>
<td>15.6%</td>
<td>5</td>
</tr>
<tr>
<td>Private or non-profit health organization</td>
<td>6.3%</td>
<td>2</td>
</tr>
<tr>
<td>Private or non-profit consultancy</td>
<td>12.5%</td>
<td>4</td>
</tr>
<tr>
<td>Other governmental organization</td>
<td>9.4%</td>
<td>3</td>
</tr>
<tr>
<td>Academic institution</td>
<td>15.6%</td>
<td>5</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>6.3%</td>
<td>2</td>
</tr>
</tbody>
</table>

answered question: 32
skipped question: 2
5. How does your organization use active travel data? (check all that apply):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>We routinely collect data</td>
<td>59.4%</td>
<td>19</td>
</tr>
<tr>
<td>We use data to determine our effectiveness</td>
<td>50.0%</td>
<td>16</td>
</tr>
<tr>
<td>We use data to determine the effectiveness of other organizations</td>
<td>37.5%</td>
<td>12</td>
</tr>
<tr>
<td>We use data to make policy recommendations</td>
<td>75.0%</td>
<td>24</td>
</tr>
<tr>
<td>We use data to make policy decisions</td>
<td>40.6%</td>
<td>13</td>
</tr>
</tbody>
</table>

Please provide any additional information you feel is necessary to help us understand the importance of data to your organization

answered question 32
skipped question 2

6. Consider the active travel needs of the organization for which you work. Please rank the three most important reasons you seek to collect data on active travel:

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Second-most important</th>
<th>Third-most important</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance of the transportation network</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Demand for transportation facilities</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Economic impacts of active travel</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Levels of physical activity</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Environmental issues (e.g., emissions)</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Safety</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Equity</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

answered question 32
skipped question 2
7. What is it that you would like to learn from active travel data? Please rank the 3 categories that are most important to you in your current position:

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Most important</th>
<th>Second-most important</th>
<th>Third-most important</th>
<th>Rating Average</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know more about WHO engages in active travel</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>2.33</td>
<td>9</td>
</tr>
<tr>
<td>Know more about WHERE, generally, people are using active travel</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>2.33</td>
<td>9</td>
</tr>
<tr>
<td>Know more about WHAT specific facilities (e.g., trails) are being used for active travel</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>2.60</td>
<td>10</td>
</tr>
<tr>
<td>Know more about WHY people use active travel</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2.13</td>
<td>8</td>
</tr>
<tr>
<td>Know more about HOW MUCH active travel is happening</td>
<td>7</td>
<td>8</td>
<td>1</td>
<td>1.63</td>
<td>16</td>
</tr>
<tr>
<td>Know more about THE EXTENT to which active travel leads to improved public health</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>2.08</td>
<td>12</td>
</tr>
<tr>
<td>Know more about active travel PATTERNS to improve community’s system or modeling (e.g., routes, safety)</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>1.62</td>
<td>13</td>
</tr>
<tr>
<td>MAKE THE CASE for increased funding (or infrastructure) to support active travel</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>1.81</td>
<td>16</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

answered question: 31
skipped question: 3
8. What types of data or information are most useful? Assume you had 100 points. Please distribute the points to the below categories, allocating more points in categories that would be most useful to you (the survey will automatically add your responses to ensure they sum to 100 points):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Third-most important</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand/usage indicators (ways to best track or forecast use of active transportation)</td>
<td>22.12</td>
<td>575</td>
<td>26</td>
</tr>
<tr>
<td>Trip and user characteristics (frequency, distance, destination, purpose, age, gender, etc.)</td>
<td>23.08</td>
<td>600</td>
<td>26</td>
</tr>
<tr>
<td>Counts/volumes on specific facilities</td>
<td>16.88</td>
<td>405</td>
<td>24</td>
</tr>
<tr>
<td>Travel patterns of children, school trips</td>
<td>14.81</td>
<td>311</td>
<td>21</td>
</tr>
<tr>
<td>Trip generation rates for active travel (inputs to forecasting models)</td>
<td>14.44</td>
<td>260</td>
<td>18</td>
</tr>
<tr>
<td>Household survey data (inputs to forecasting models)</td>
<td>12.06</td>
<td>205</td>
<td>17</td>
</tr>
<tr>
<td>Bicycles in use/owned</td>
<td>8.53</td>
<td>128</td>
<td>15</td>
</tr>
<tr>
<td>Helmet use</td>
<td>3.09</td>
<td>34</td>
<td>11</td>
</tr>
<tr>
<td>Location and behavior characteristics contributing to active travel crashes</td>
<td>10.29</td>
<td>175</td>
<td>17</td>
</tr>
<tr>
<td>Crashes involving active travelers and vehicles</td>
<td>9.76</td>
<td>166</td>
<td>17</td>
</tr>
<tr>
<td>Nonfatal crashes and injury data specific to active travelers</td>
<td>7.50</td>
<td>105</td>
<td>14</td>
</tr>
<tr>
<td>Links to other data (facilities, exposure, injury)</td>
<td>4.00</td>
<td>36</td>
<td>9</td>
</tr>
</tbody>
</table>

answered question 30  
skipped question 4
9. Select one response that best represents the type of active travel data YOU USE MOST FREQUENTLY at your organization (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience samples</td>
<td>10.0%</td>
<td>3</td>
</tr>
<tr>
<td>Population based random-sample</td>
<td>13.3%</td>
<td>4</td>
</tr>
<tr>
<td>Secondary sources</td>
<td>33.3%</td>
<td>10</td>
</tr>
<tr>
<td>Any data we can get our hands on</td>
<td>40.0%</td>
<td>12</td>
</tr>
<tr>
<td>We do not use data at our organization</td>
<td>3.3%</td>
<td>1</td>
</tr>
</tbody>
</table>

answered question 30
skipped question 4

10. Assume you can only collect data from a certain number of people (or at a certain number of locations). Then, consider the importance of trend (or time-series) information. Select one response that best reflects your data needs at your organization (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>More data, in more depth, at less frequent time intervals</td>
<td>33.3%</td>
<td>10</td>
</tr>
<tr>
<td>Less data at more frequent time intervals</td>
<td>53.3%</td>
<td>16</td>
</tr>
<tr>
<td>No preference</td>
<td>3.3%</td>
<td>1</td>
</tr>
<tr>
<td>Don’t know</td>
<td>10.0%</td>
<td>3</td>
</tr>
</tbody>
</table>

answered question 30
skipped question 4
11. How important is it to know information (e.g., characteristics, preferences) about people who RARELY use active travel (select only one):

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very important</td>
<td>43.3%</td>
<td>13</td>
</tr>
<tr>
<td>Somewhat important</td>
<td>40.0%</td>
<td>12</td>
</tr>
<tr>
<td>Not very important</td>
<td>16.7%</td>
<td>5</td>
</tr>
</tbody>
</table>

answered question 30
skipped question 4

12. How important is it to know information (e.g., land uses, street characteristics, amount of active travel) about locations or neighborhoods WITH VERY LITTLE active travel?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very important</td>
<td>63.3%</td>
<td>19</td>
</tr>
<tr>
<td>Somewhat important</td>
<td>26.7%</td>
<td>8</td>
</tr>
<tr>
<td>Not very important</td>
<td>10.0%</td>
<td>3</td>
</tr>
</tbody>
</table>

answered question 30
skipped question 4

13. Assume you had to allocate your organization’s total annual budget for monitoring active travel in your community. Given some alternative approaches and relative cost estimates described below, allocate a percent of the funds to each alternative (the survey will automatically add your responses to ensure they sum to 100 - please do not include a percent symbol).

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Average</th>
<th>Response Total</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing automatic counters (e.g., inductive loop or infrared counters) at key locations to count AT traffic (low cost, individual counters are relatively inexpensive)</td>
<td>34.33</td>
<td>1,030</td>
<td>30</td>
</tr>
<tr>
<td>Administering a travel survey to a representative sample of the entire community (high cost)</td>
<td>26.07</td>
<td>704</td>
<td>27</td>
</tr>
<tr>
<td>Creating a smart-phone application to track willing active transportation users (very low cost)</td>
<td>22.32</td>
<td>558</td>
<td>25</td>
</tr>
<tr>
<td>Leveraging (or supplementing) other national data collection efforts (American Community Survey, Behavioral Risk Factor Surveillance System) (medium cost to add questions)</td>
<td>27.23</td>
<td>708</td>
<td>26</td>
</tr>
</tbody>
</table>

answered question 30
skipped question 4
Appendix H: Acknowledgements and Steering Committee

Monica Buhlig from Kaiser Permanente in Colorado was an able sponsor of this project—a real partner.

We would like to thank the members of the steering committee who provided valuable insights:

Erik Sabina  
Teri Whitmore  
Jill Locantore  
Betsy Jacobsen  
Dr. Eric France  
Karen Ryan  
Dan Grunig  
Gabriel Kaplan  
Renee Calanan  
Tareq Wafaie  
Suzette Mallette  
Aaron Fodge  
Kristin Kirkpatrick  
Crissy Fanganello  
Emily Synder  

The following people participated in the workshop or provided additional written comments on the report:

Gretchen Armijo  
Tim Byers  
Renee Calanan  
Craig Casper  
Kate Cooke  
Melina Dempsey  
Andy Duvall  
Jim Eshelman  
Aaron Fodge  
Eric France  
Dan Grunig  
Gabriel Guillaume  
Betsy Jacobsen  
Jaclyn King  

Kristin Kirkpatrick  
Jill Locantore  
Monica Lyle  
Scott McCarey  
Aaron Moss  
Jennifer Newcomer  
Krista Nordback  
Jessica Osborne  
Dan Piatkowski  
Marissa Robinson  
Martha Roskowski  
Karen Ryan  
Erik Sabina  
Sandy Stenmark  
Liz Stolz  
Jeremy Synder  
Kristina Kirkpatrick  
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DRCOG  
The Colorado Health Foundation  
Boulder County  
CDOT  
Piton Foundation  
UCD PhD Program  
CDPHE  
Bikes Belong  
LiveWell Colorado  
DRCOG  
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Jesse Hawke  
Walt Hecox  
Holly Hedegaard  
Deb Hubsmith  
Peter Hurst  
Betsy Jacobsen  
Colin Laird  
Wendy Landman  
Colorado Department of Public Health and Environment  
Colorado State University  
Denver Bikesharing / B-Cycle  
Colorado Department of Public Health and Environment  
Freikers  
Portland State University Initiative for Bicycle and Pedestrian Innovation  
Colorado Department of Public Health and Environment  
Colorado College  
Colorado Department of Public Health and Environment  
SRTS National Partnership  
Boulder Valley School District  
Colorado Department of Transportation  
Healthy Mountain Communities  
Walk Boston
