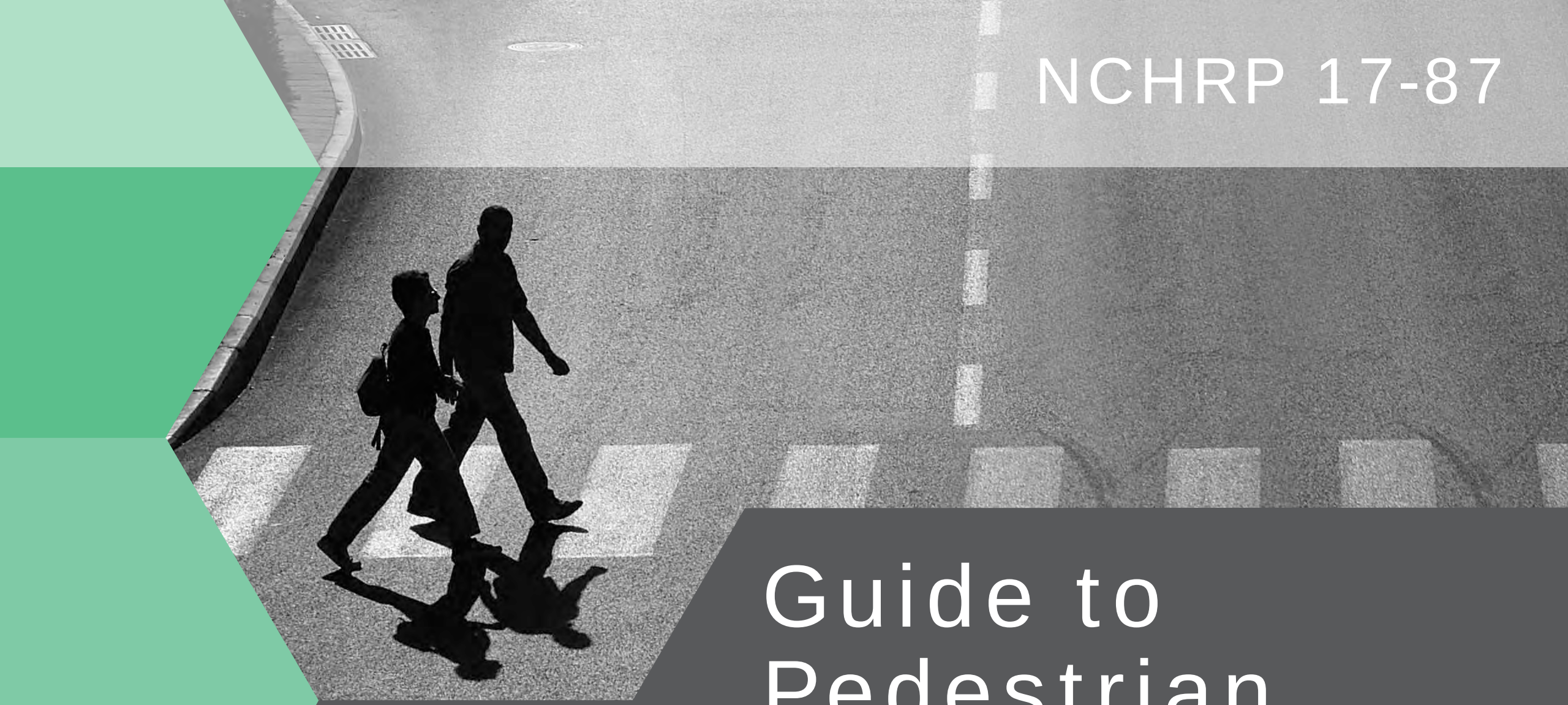
NCHRP 17-87



# Guide to Pedestrian Analysis

# Pedestrian Volume Counting

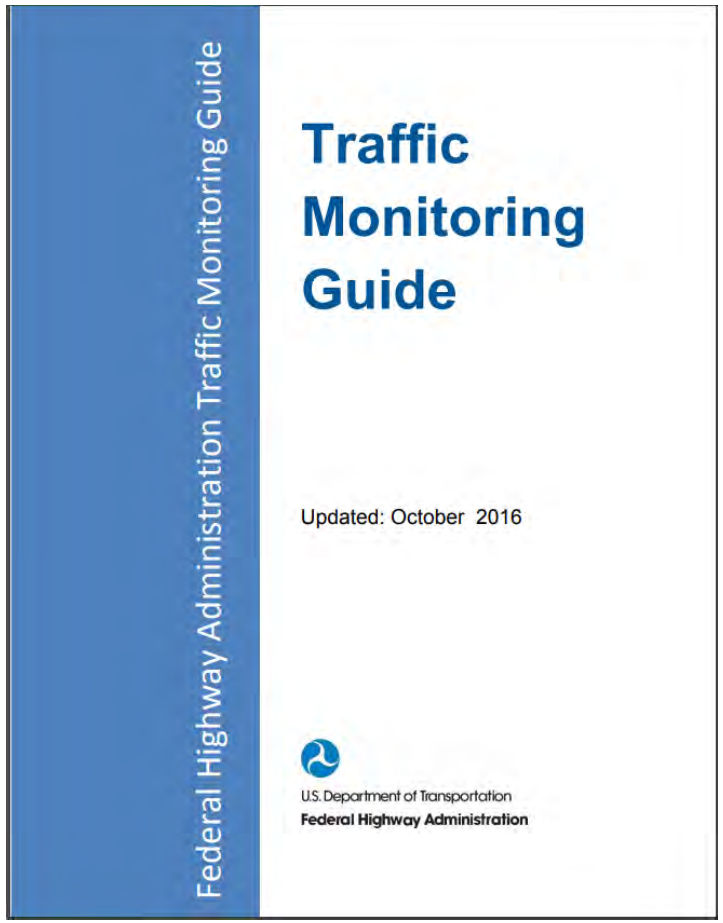
# Objective

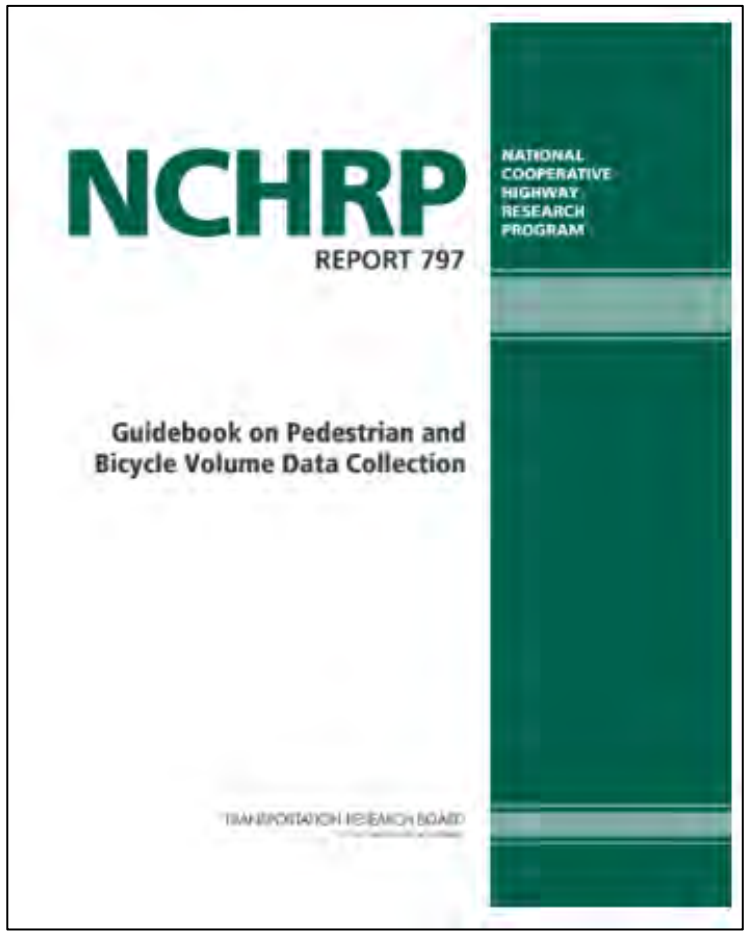
Document current state of the practice for pedestrian volume data collection and estimation methods

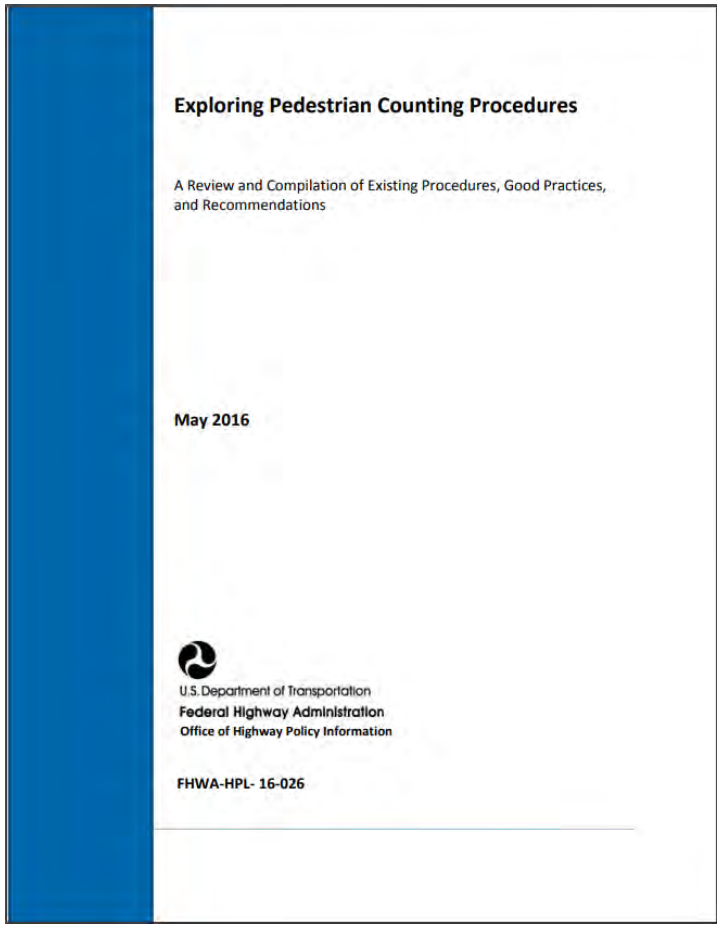
# Outline

- Identifying count applications
- Identifying count locations and durations
- Identifying counting methods
- Ensuring data quality
- Identifying the need for supplemental data

# Resources




NCHRP 17-87: Guide to Pedestrian Analysis

# Potential Applications

- Monitoring facility usage
- Conducting before–after studies
- Monitoring travel patterns
- Safety analysis
- Project prioritization
- Multimodal model development

# Selecting Count Durations

- Count durations
  - Continuous counts
  - Short-duration counts
    - Two-hour counts
    - One week
    - One month
- When to count?
  - Counting at times with higher activity levels
  - Good weather
  - Several short counts during different time periods

# Selecting Count Locations (1)

- Types of locations
  - Representative locations
  - Target locations
  - Control locations
  - Random locations
- Desired location characteristics
  - Located in different geographic parts of the community
  - Surrounded by different land uses
  - Located on different facility types
  - Reflective of the community's socioeconomic characteristics
- *"Limiting count sites to locations that are convenient, have the highest pedestrian or bicycle volumes, or are expected to have the greatest increases in walking and bicycling does not produce a representative sample"*

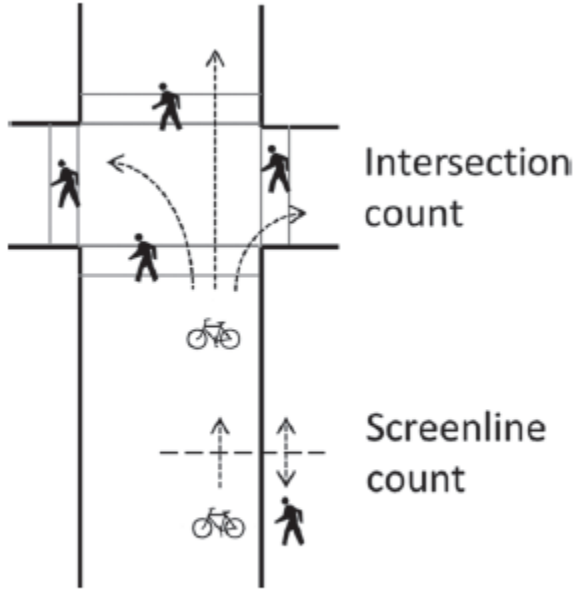
# Selecting Count Locations (2)

- NCDOT criteria
  - Gather potential site locations
  - Conduct a site visit
  - Select continuous count sites
  - Select short-duration count sites

| Critical Criteria | Valuable Criteria |
|---|---|
| Ranking | Existing count data (where available) or estimate of hourly volume |
| Site location | Number of roadway lanes |
| Area type (urban, suburban, rural) | Sidewalks (one side, two sides, none) |
| Anticipated user type (mixed/everyday, recreation/weekend, commuter/weekday) | Agency submitting location |
| Facility type (paved path, unpaved path, sidewalk) | Local contact information |
| Type of count (pedestrian, pedestrian and bicycle) | Notes from agency |
| Ownership (municipal, county, state) | |
| Duration (short, continuous) | |
| Notes from virtual site audit | |
| Volume potential (high, medium, low) | |

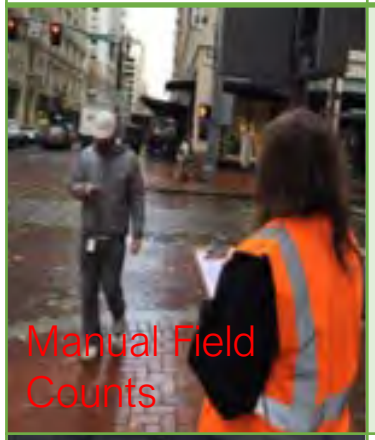
# Counting Methods (1)

- Screenline or intersection count?
- Short-term or continuous count?
- Site constraints?




Source: NCHRP 797

# Counting Methods (2)

| Type | Description | Typical Usage | Advantages | Disadvantages | Ease of Installation | Cost |
|---|---|---|---|---|---|---|
|  Manual Field Counts | Most appropriate for short-duration counts | Useful for obtaining supplemental data such as age, gender mobility | • Can be accurate with training<br>• Can capture directional counts and user characteristics<br>• Minimal equipment costs | • High labor-cost<br>• Applicable for short-term counts only<br>• Data cannot be verified | Requires data collector training | High |
|  Manual Video Counts | Accurate for collecting nonmotorized counts | Useful for obtaining supplemental data such as age, gender, compliance | • High accuracy<br>• Can capture directional counts and user characteristics<br>• Fewer personnel required<br>• Data can be verified | • High labor cost | • Requires video camera setup | • High |

# Counting Methods (3)

| Type | Description | Typical Usage | Advantages | Disadvantages | Ease of Installation | Cost |
|---|---|---|---|---|---|---|
|  Automated Video Counts | Most appropriate for continuous counts | Useful for realtime counts when users are spatially separated | • Portable<br>• Data can be reviewed and verified<br>• Good for crowded areas | • High cost<br>• May not produce directional counts | Requires video camera setup | High set-up cost but low hourly cost |
|  Active Infrared | Count objects that break an infrared beam | Commonly used on shared-use paths with a bicycle only counting technology | • Portable<br>• Easy installation<br>• Can be used for long term counts | • Undercounting due to occlusion<br>• Cannot distinguish bicycles from pedestrians<br>• Directional counts not possible | • Requires a site where the emitter and receiver can be installed facing each other | • Low equipment cost and low hourly cost |

# Counting Methods (4)

| Type | Description | Typical Usage | Advantages | Disadvantages | Ease of Installation | Cost |
|---|---|---|---|---|---|---|
|  Passive Infrared | Detect warm bodies and cannot distinguish bicyclists from pedestrians | Useful for pedestrian only environments or in combination with bicycle counting technology | • Portable<br>• Can be used for long term counts<br>• Not affected by wet or foggy weather | • Undercounting due to occlusion<br>• Cannot distinguish bicycles from pedestrians<br>• Directional counts not possible | Requires proper installation training and permit | Low equipment cost and low hourly cost |
|  Pressure Pad | Installed underground and detects user passing directly over the sensor | Primarily used on unpaved trails or where infrared counter cannot be used | • Low maintenance cost<br>• Low power consumption<br>• Can be installed on sidewalks | • High cost<br>• May not be able to differentiate groups of pedestrians<br>• Requires users to pass directly over the sensor<br>• Not suitable for locations with severe winters | Requires pavement cutting if installed in sidewalks | Low equipment but high installation costs |

# Quality Control – Equipment

- Test equipment and ensure it meets accuracy standards before field placement
- Calibrate equipment routinely
- Validate equipment performance periodically to ensure intended performance
- Conduct routine quality assurance tests,
- Analyze and deliver data quickly so that data quality errors caught by users familiar with data patterns can be addressed quickly,
- Implement a feedback process for quick response to data quality concerns

# Quality Control – Data

| Source | Upper Bound | Data Gaps | Direction Split | Repeating Values | Number of Consecutive Zeros | Maximum/Minimum Daily Total |
|---|---|---|---|---|---|---|
| FHWA TMAS | | | | | • Data flagged if seven consecutive zeros encountered | • Total minimum daily count < 100 or total maximum daily count > 5,000 |
| Colorado Department of Transportation | | • Weekly Check: Identify count sites with missing data days and flag sites with > 5 days of missing data<br>• Annual Check: A count is valid only if it has a full 24 hours of count data for each 24-hour period | • Weekly Check: Flag any count site exhibiting a direction split greater than 70/30<br>• Annual Check: Same as weekly check | | • Weekly check: During warm weather months, sites with more than two continuous days of hourly zero values flagged; this check is not applicable for cold-weather locations<br>• Annual check: Same as weekly check | • Weekly check: Flag counts with any daily total higher than three times the previous year's average daily traffic (ADT)<br>• Annual Check: Suspicious daily totals for each continuous count site are identified using the interquartile range formula:<br>$IQR = 2.5 (Q_3-Q_1) + Q_3$<br>$Q_3$ = Third quartile of quarterly data<br>$Q_1$ = First quartile of quarterly data |
| Minnesota Department of Transportation (*13*) | • Data greater than two standard deviations above the mean flagged | | | | • Check daily zero values in summer months | |
| North Carolina | • Data flagged if the upper bound exceeds $IQR = Q_3 + 3 (Q_3 - Q_1)$ | | • Splits greater than three standard deviations over average | | • Over three days of zero counts | |
| BikePed Portal, Portland State University | • Flagged when hourly counts exceed 1,000 (low-volume sites), 2,000 (medium-volume sites), 4,000 (high-volume sites) | | | • Suspicious if:<br>7+ consecutive non-zero values;<br>6+ consecutive non-zero values, volume >2;<br>5+ consecutive non-zero values, volume >5;<br>4+ consecutive non-zero values, volume >16;<br>3+ consecutive non-zero values, volume >100 | • Possibly suspicious at 12.5 hours; suspicious at 25 hours | |
| Turner and Lasley (*12*) | • $IQR = 2.5 (Q_3-Q_1) + Q_3$ | | | | | |

Source: Where not specifically noted otherwise, information in the table was derived from agency contacts by NCHRP Project 17-87.
Note: IQR = interquartile range.

# Supplemental Data

- Sampling counts
- Land use
- Sociodemographic factors
- Travel behavior data
- Transit data
- Infrastructure data
- Pedestrian crash and pedestrian–vehicle conflict data
- Motorized traffic and bicycle volume data
- Transportation model output

# Sampling Counts


GPS Data Collection
(Source: Strava)

Bluetooth Equipment
(Source: Malinovskiy et al. 2012)

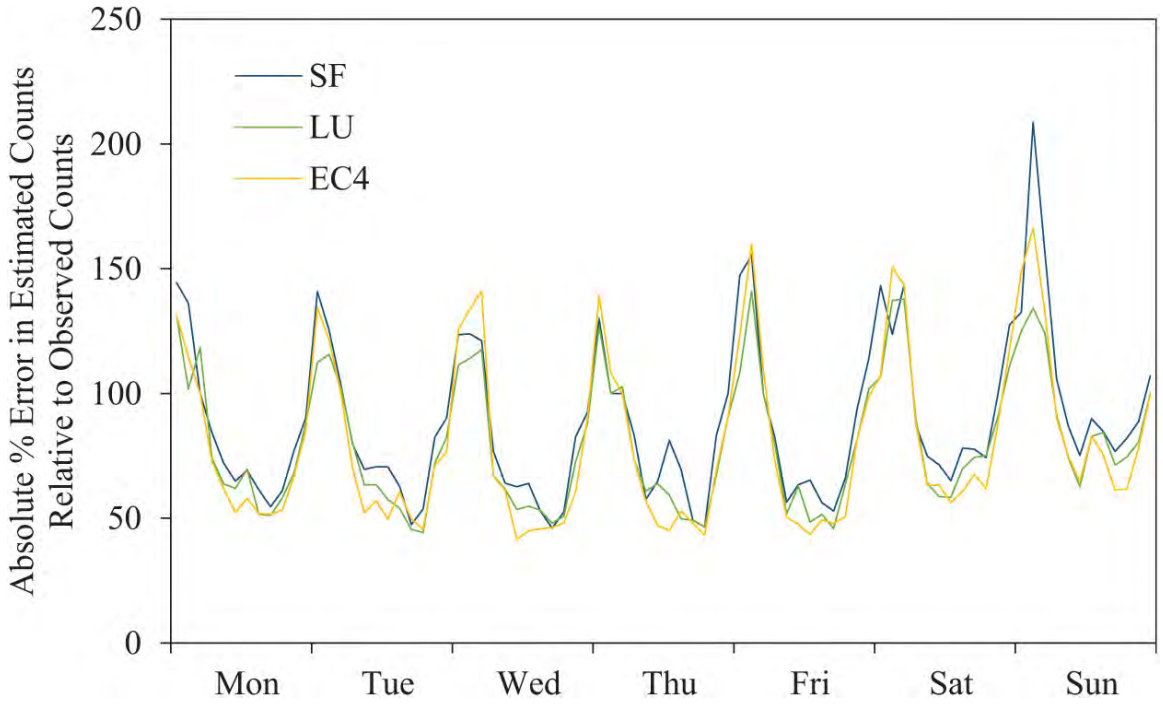

Pushbutton Actuations
Source: Kittelson &
Associates, Inc.

# Land Use

**Table 1.** Land Use Definitions

| Category | Definition |
|---|---|
| Central business district | In the downtown area as labeled on Google Maps or from expert knowledge of the area |
| School | School facility on adjacent block or yellow crosswalk present at intersection |
| Trail | Count location within a block of trail access point |
| Commercial | Two or more commercial (retail or office) businesses on adjacent blocks |
| Residential | Residential land use and no commercial on adjacent blocks |
| Park | Park on adjacent blocks |
| Rural | Agricultural fields on at least two adjacent blocks |

Land Use Definitions
Source: Griswold et al., 2018

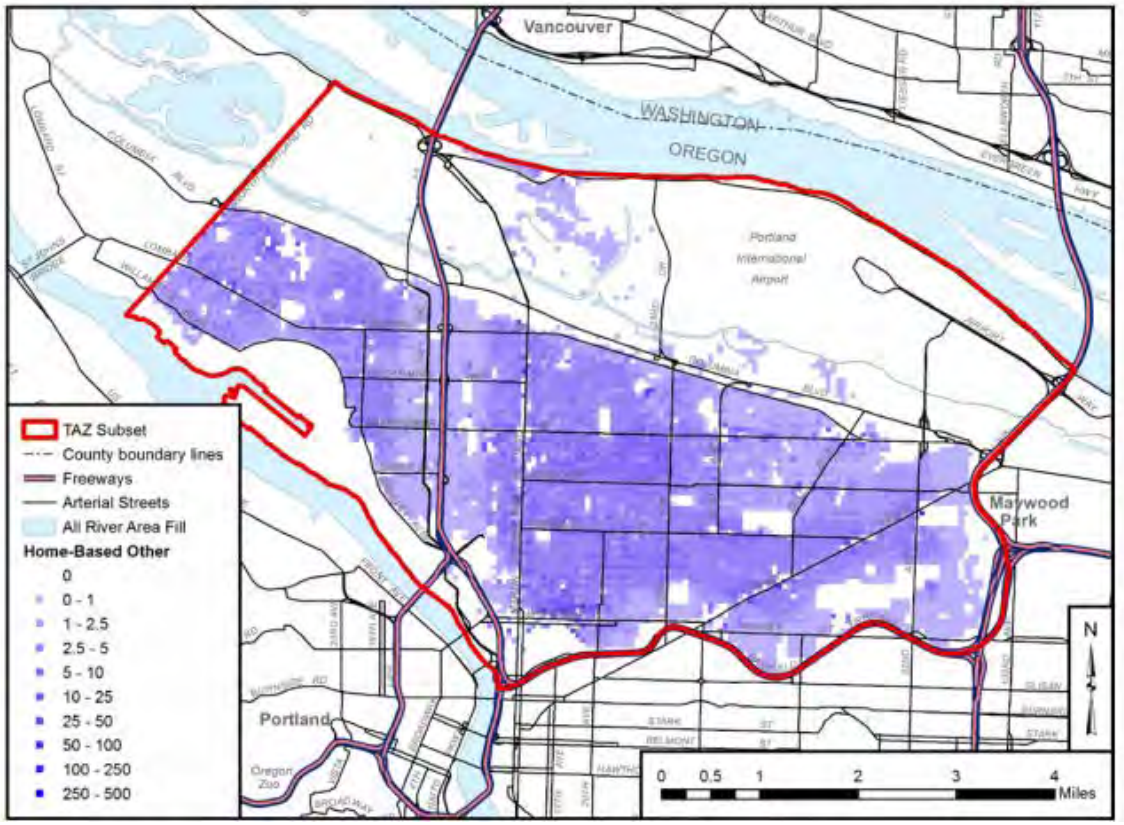



Expansion Factor Accuracy using 2-h counts
Source: Griswold et al., 2018

# Transportation Model Output

| Variable | Home-based work (HBW) B | SE | p | Home-based shopping (HBS) B | SE | p | Home-based recreation (HBR) B | SE | p |
|---|---|---|---|---|---|---|---|---|---|
| Distance (miles) | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Distance (miles) × Auto (yes) | -1.35 | 0.124 | 0.00 | -- | -- | -- | -- | -- | -- |
| Distance (miles) × Auto (no) | -0.96 | 0.182 | 0.00 | -- | -- | -- | -- | -- | -- |
| Distance (miles) × Child (yes) | -- | -- | -- | -2.26 | 0.174 | 0.00 | -1.75 | 0.074 | 0.00 |
| Distance (miles) × Child (no) | -- | -- | -- | -1.52 | 0.140 | 0.00 | -1.51 | 0.063 | 0.00 |
| Size terms (ln) | 0.51 | 0.074 | 0.00 | 0.91 | 0.089 | 0.00 | 0.05 | 0.019 | 0.01 |
| Retail jobs (#) | -- | -- | -- | 5.5 | 0.71 | 0.00 | 6.5 | 1.36 | 0.00 |
| Finance jobs (#) | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Government jobs (#) | -- | -- | -- | -- | -- | -- | 17.1 | 5.65 | 0.00 |
| Retail + government jobs (#) | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Retail + finance + government jobs (#) | 2.0 | 0.85 | 0.02 | -- | -- | -- | -- | -- | -- |
| All other jobs (#) | 0.0 | -- | -- | 0.0 | -- | -- | 0.0 | -- | -- |
| Households (#) | -- | -- | -- | -- | -- | -- | -3.2 | 1.34 | 0.02 |
| Park (yes) | -- | -- | -- | -- | -- | -- | 0.46 | 0.127 | 0.00 |
| PIE, mean | 0.030 | 0.010 | 0.00 | -0.014 | 0.012 | 0.24 | 0.011 | 0.007 | 0.11 |
| Slope (degrees), mean | -0.12 | 0.079 | 0.15 | -0.20 | 0.100 | 0.05 | -0.05 | 0.049 | 0.28 |
| Freeway (yes) | -0.30 | 0.260 | 0.25 | -1.02 | 0.350 | 0.00 | -0.17 | 0.213 | 0.43 |
| Industrial jobs (proportion) | -0.99 | 0.480 | 0.04 | -1.74 | 0.609 | 0.00 | -0.09 | 0.205 | 0.66 |
| Sample size (# walk trips) | | | 305 | | | 405 | | | 643 |
| Initial log-likelihood | | | -694.163 | | | -924.806 | | | -1,458.715 |
| Final log-likelihood | | | -371.460 | | | -288.303 | | | -840.664 |
| McFadden's adjusted pseudo-$R^2$ | | | 0.453 | | | 0.680 | | | 0.416 |

Pedestrian Destination Choice Models
Source: Clifton et al., 2015




Predicted HB) Walk-Trip Productions in Portland-area PAZ's
Source: Clifton et al., 2015

# Pedestrian Volume Estimation

| Factor | Relationship with Pedestrian Activity | Source(s) |
|---|---|---|
| Employment density | + | *31, 49* |
| Population density | + | *49, 50* |
| Presence of nearby retail | + | *49* |
| Transit stops | + | *50, 51* |
| Commercial space | + | *50* |
| Open space within 150 meters | – | *50* |
| Presence of subway station | + | *50* |
| Number of schools within 400 meters | + | *50* |
| % of major arterials within 400 meters | – | *50* |
| Street segments within 400 meters | + | *50* |
| Four-way intersections | + | *50* |
| Distance to downtown | – | *50, 52* |
| Households within ¼ mile | + | *31* |
| High parking meter activity zone | + | *31* |
| Slope of any intersection approach | – | *31* |
| Traffic signal present | + | *31* |
| % Non-white | + | *52* |
| % with 4-year degree | + | *52* |
| Crime rate | + | *52* |
| Land use mix | – | *52* |
| Distance from water | – | *52* |
| Arterial street | + | *52* |
| Collector street | + | *52* |
| Principal arterial street | – | *52* |
| Employment within ¼ mile | + | *51* |
| Population within ½ mile | + | *51* |
| Urban residential area ¼ to 1 mile | + | *51* |
| Mixed land use within ¼ mile | – | *51* |
| Single family residential ¼ mile | – | *51* |
| Speed limit ½ to 1 mile | – | *51* |

Source: Nordback and Sellinger (*33*).

Note: "+" represents a positive relationship (i.e., high employment density correlated with high pedestrian activity), while "–" represents an inverse relationship (i.e., large distance from downtown correlated with low pedestrian activity).

Factors Influencing Pedestrian Volumes

# Error Correction

- Land use adjustments
- Seasonal and weather adjustments
- Systematic count error adjustments

| Sensor Technology | Adjustment Factor |
|---|---|
| Thermal imaging camera | 0.974* |
| Passive infrared | 1.106** |
| Radio beam | 1.125 |

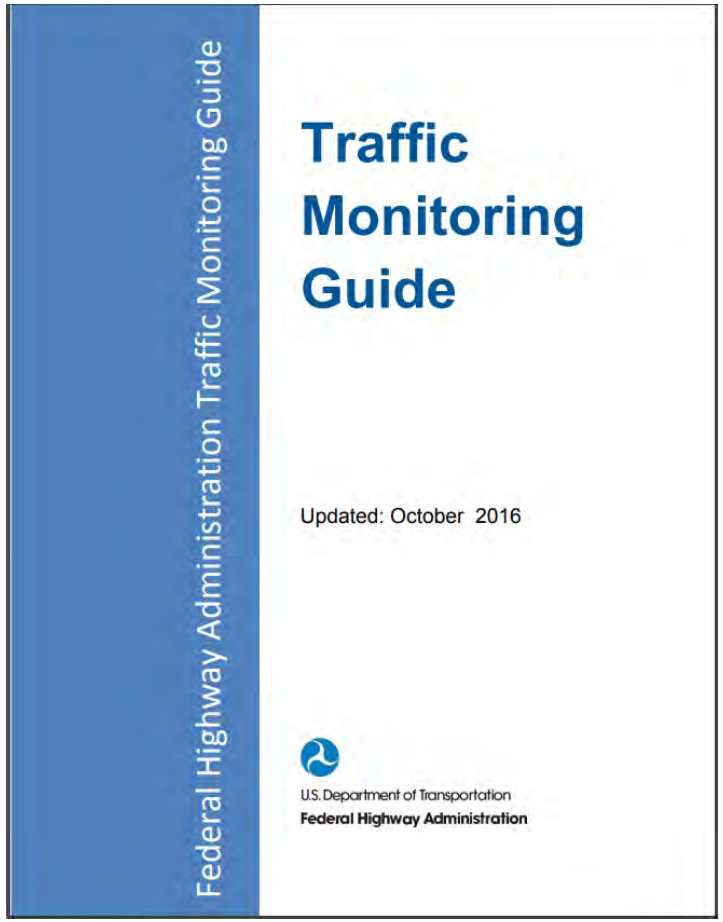
Source: *NCHRP Web-Only Document 229* (3).

Notes: *Factor is based on a single sensor at one site: use caution when applying.

**Correction factor is based on a weighted average of results from three products from different vendors, which had product-specific adjustments of 1.016, 1.157, and 1.369.

# Estimating Annual Volumes

- From continuous counts
  - Average yearly counts
- From short-duration counts
  - Create factors (hourly, daily, monthly, day-of-year)
  - Apply factors to expand short-duration count to annual average estimate




# Discussion

- What else should we include?
- What have we missed?
- Is the material useful?