QUALITY ASSURANCE AND QUALITY CONTROL PROCESSES FOR LARGE-SCALE AND REGIONAL BICYCLE & PEDESTRIAN VOLUME DATA PROGRAMS: A 2019 UPDATE

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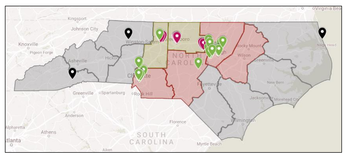
OVERVIEW

- The North Carolina Non-Motorized Volume Data Program (NC NMVDP) was established in 2013 to test a regional bicycle and pedestrian count data collection protocol and to determine how to replicate the methodology across the state. The program aims to monitor bicycle and pedestrian traffic, establish volume patterns that define factor groups, and develop a protocol for calculating annual volume estimates from short duration and continuous counting locations.
- This poster highlights programmatic and data handling updates to the program's pilot methodology.
- All counting equipment installed are Eco-Counter MULTI counters that detect pedestrians with a passive infrared sensor and bicyclists with an inductive loop sensor.
- 71 total counting systems are incorporated in the NC NMVDP. Sensor locations are highlighted on the map below.



KEY OUTCOMES

- The NC NMVDP owes its success to a solid programmatic foundation that was updated, streamlined, and better documented in order to expand the program.
- A summary of recommendations related to establishing and maintaining a regional counting program include:
  - ❖ Closely monitoring and maintenance of equipment
    - Observe impact of vehicles passing near or over bicycle sensors for bicycle loops that are installed in roadways to determine if motor vehicles influence counting error
    - Test sensitivity settings of sensor while in field to confirm if recommended setting is appropriate for site
  - ❖ Leveraging existing resources by partnering with local agencies
    - e.g., a regional count management entity can quality assure locally-owned counting systems and install additional counting systems to fill gaps in data collection
  - ❖ Robust validation and verification of data recorded by sensors to ensure quality
  - ❖ Detailed documentation of hardware and software maintenance
  - ❖ Automating data processes for better program scaling
  - ❖ Leveraging technology updates for efficient data reporting

PROGRAMMATIC ORGANIZATION

- In late 2018, the NC NMVDP was restructured from a linear set of research tasks into a formal program structure based on three coordination areas (Local Agency, Equipment, and Data) encompassed by overall program management. The resultant modular structure allows for: 1) each coordination area to be assigned a technical lead for oversight of its discrete day-to-day tasks thereby reducing the need for a single program manager to micromanage, and the 2) ability to apply, and scale services by opting clients into the scope of work for one or more coordination areas.

SITE SELECTION

- The site selection process was tested during Phase 1 and Phase 2 of the NC NMVDP. Counters were placed in locations where volumes were believed to be high enough to establish a factor group that described temporal volume patterns.
- Two counters were discontinued from their originally selected sites: Winston-Salem – Polo Road and Winston-Salem – Academy Drive.
- Issues encountered related to site selection are highlighted below.

Issues Related to Original Site Selection	Sites Affected
Low pavement quality	Winston-Salem – Polo Road
User volumes too low to establish factor group	Winston-Salem – Academy Drive
Bicycle sensors installed on shared lanes over-detecting cars	Davidson – Main Street
Motor vehicle collisions with hardware	Charlotte – Pecan Street
	Charlotte – South Tryon Road
Water runoff washed out installed hardware	Raleigh – Crabtree Creek Greenway
	Apex – Beaver Creek Greenway
Cell phone tower upgrades interrupted data transmission services	Durham – American Tobacco Trail at I-40 Bridge

LOCAL AGENCY COORDINATION

- Local agencies entered an agreement with NCDOT to install and maintain counting equipment. ITRE assisted the local agency in determining the best site to install continuous counters to meet NCDOT data needs, the local agency and ITRE partnered to install the counters, then ITRE managed counter maintenance for the first two years after a counter was installed when ownership transferred to the local agency. After the ownership transfer, local agencies were financially responsible for all counter maintenance, including costs related to automated data transmission services, batteries, and replacement components or systems.
- Several challenges arose from this model, which are highlighted in the table below.

Challenge	Solution
Smaller agencies less willing to enter agreement because they were less willing to accept the monetary risk.	Piloted creative partnership with Department of Health and Human Services on healthy communities project that targeted smaller communities.
NCDOT counter placement and type did not meet the data needs of certain agencies.	Identified permanent and short duration counters that local agencies purchased and installed independently of the NC NMVDP; provided consultation services to agencies and incorporated data collected from these local counters into NC NMVDP data services and data reporting.
Local agencies originally involved in traditional partnership model were underprepared for counter maintenance at the time of ownership transfer.	Developed ownership training packet with vendor to provide to local agencies at time of ownership transfer; implemented an ownership transfer discussion with agency to set expectations, determine who was responsible for counter maintenance, and answer questions regarding data services.
Local agency investment in NC NMVDP counting equipment and punctuality of addressing counter maintenance was variable.	The expanded program model provides stronger sense of local agency ownership and responsibility since agency invested personal funds and oversaw site selection; considered increasing technical assistance role with local agency to assist staff or contractors in best practice counter maintenance.

EQUIPMENT MAINTENANCE

- Maintenance events became frequent enough to justify hiring a full-time field technician and equipment coordinator to adequately document and address maintenance issues.
- Causes of non-routine maintenance visits included:
  - ❖ Cell phone tower interference with data transmission from the system modem
  - ❖ Utility interference that was not present at the time of installation
  - ❖ Bug infestation of wooden posts that contained pedestrian sensors*
  - ❖ Water runoff eroding area around the valve box that contained the system components
  - ❖ Cigarettes burns on the pedestrian sensor lenses
  - ❖ Wooden posts containing pedestrian sensors rotting*
  - ❖ Water infiltration into system components*
  - ❖ Vendor system recalls*
    - Degradation of wire casing
  - ❖ Inductive loops cut by road or lawn care crews
  - ❖ Graffiti and flyers on posts containing pedestrian sensors

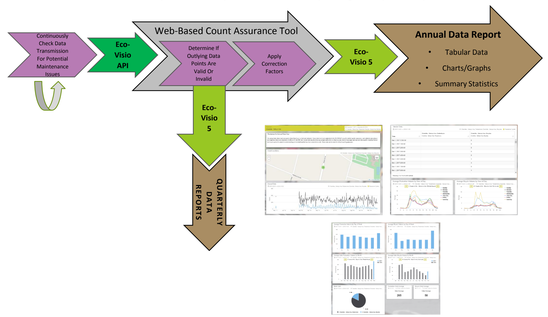
  ** Indicates most common causes of damage*

DATA COORDINATION

- QA/QC checks at the data reporting stage identify invalid data recorded by malfunctioning equipment and tag atypical days of valid data.
- Issues encountered during program expansion led to the development of supplemental quality assurance checks to filter invalid data from statistical calculations. A summary of quality assurance checks are outlined below:

Order	Test	Type	Description	Purpose
1	gap	Conditional	Test the number of hours in a day labelled NULL (no transmission)	Scrub no transmission days
2	zero	Conditional	Determines if daily sum equals zero, tests how many days in a row where daily sum equals zero	Scrub days with unreasonable length of consecutive zero counts
3	max_day	Conditional	Autoscrubs days with daily sums greater than a designated maximum value	Scrub days with physically impossible daily sums
4	max_hour	Conditional	Autoscrubs days containing an hourly sum greater than a designated maximum value	Scrub days with physically impossible hourly sums
5	3AM	Conditional	Tests if any hour between 3:00 AM and 5:00 AM has an hourly total greater than a designated maximum value	Flag days with unreasonably high "low-activity hours" volumes
6	prop	Conditional	Determines if any hour of the day accounts for an "unreasonable" proportion of the days total counts	Looks for "spikes" in hourly data; days where the volumes during certain hours are disproportionately higher than the rest of the day
7	dirsam	Statistical	Calculates mean and standard deviation of the ratio of NB/SB or EB/WB travelling users on the same facility, flags days with ratios outside of x standard deviations of the mean	Identifies outliers to the "normal trend" direction travelled on the same facility/side of street
8	diropp	Statistical	Calculates mean and standard deviation of the ratio of E/N side of street data with W/S side of street data, flags days with ratios outside of x standard deviations of the mean	Identifies outliers to the "normal trend" in facility occupancy on opposing sides of the street
9	interquartile	Statistical	Calculates the interquartile range of all remaining unflagged data, flags outlier data outside of Q3 + x*(Q3-Q1)	Identifies extreme outliers of dataset; volumes are too low and variable to include a lower bound
Key		New Test	Checks that were developed in 2018 – 2019 Phase 2 to remediate check issues related to large blocks of invalid data present in datasets. Parameter recommendations are currently in testing phase.	
		Historic Test	These checks were developed during the NC NMVDP 2014 Pilot Phase (Phase 1). The statistical checks can only be performed after at least three months of verified data (no equipment malfunction) are collected.	

- Data reporting of cleaned and corrected data was migrated to Eco-Visio 5, a vendor provided dashboard platform released in 2018 that provides data visualizations. Cleaned data are provided on a quarterly basis. Cleaned and corrected data are provided on an annual basis. A summary of the data process and data reporting examples are provided below.

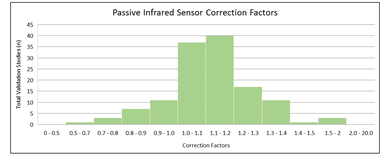


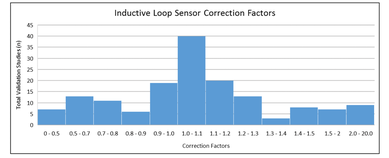
VALIDATION RESULTS

- Validation studies were conducted after any counting system was installed or any component related to the counting functionality of the system was replaced. Technicians simulated ten counting events on each sensor in the field. If at least 80% of simulated counting events were detected, a video camera was installed at the site to observe for multiple days to determine a correction factor. Correction factors are applied to raw hourly data.

$$CF = \frac{\sum two\ day\ bidirectional\ manual\ count}{\sum two\ day\ bidirectional\ count\ as\ recorded\ by\ sensor}$$

- Correction factors as observed in the 2015 to 2019 period are summarized below. Variability in equipment performance support continuation of robust validation efforts.





- The results indicate that bicycle loops experience errors that are out of acceptable range regularly and require careful calibration. Once properly calibrated, bicycle loops are relatively accurate. Error for pedestrian sensors is less often out of acceptable range.

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