**ABSTRACT**

The accuracy of air quality modeling is reliant on the validity of model input. For modeling projects that include emissions from mobile sources, real-time traffic measurements of volume, speed, and vehicle type are needed to determine emissions from a roadway. Traffic measurements, like all measurements, can have uncertainties, inaccuracies, and errors. However, unlike other measurement tools, there are fewer standards for calibration and QA. Thus, when there are unexpected changes in traffic, such as lane shifts or instrumental errors resulting in missing data, they are often underestimated. As a result, inaccurate traffic measurements misrepresent roadway conditions and hinder the ability to produce reasonable emissions estimates for an air-quality model. In the Las Vegas Near Road Field Study, missing traffic measurements and measurements with suspiciously low volumes and speeds were identified for significant periods in the past year. In this work, we leverage nearby and on-site traffic measurements to fill the gaps when traffic measurements are suspicious or missing. We examine traffic volume and speed patterns across multiple measurement locations and develop a methodology to determine the most accurate estimates of traffic volume and speeds throughout the Las Vegas near-road field study when traffic measurements are missing or inconsistent. The adjusted traffic estimates will be used in a refined modeling exercise, which will be compared with air quality measurements to determine the importance of accurate traffic estimates in the air quality modeling process.

**TRAFFIC MEASUREMENTS**

- Las Vegas, Nevada with an estimated 260,000 Average Daily Traffic (AADT) traveling on Interstate 15 (North-South).
- Traffic measurements of volume, length, and speeds for each lane of Northbound (NB) and Southbound (SB) traffic.
- Measurements from December 2008 – January 2010. We focus on 2009 measurements only. Measured traffic >= 30m are assumed to be Heavy Duty (HD) vehicles. All others are assumed to be Light Duty (LD) vehicles.
- Roadside pattern of each site inter-lane and intra-lane traffic patterns and a trade corridor.

**EPA Traffic Volume Measurements**

Northbound hourly measurements:
- Traffic for all lanes has discontinuities in March and October.
- Lane 1 traffic counts reduce to nearly zero April – October, then missing.
- Lane 2 missing October – December. Lane 3 maintains the most "steady" volume throughout the year.

Southbound hourly measurements:
- All lanes have "steady" traffic volumes throughout the year.
- The spread of hourly traffic measurements is consistent throughout all lanes and throughout the year, suggesting similar diurnal patterns throughout the year.

**Supplemental Traffic Measurements from Nevada DOT**

- Sahara: About 5.3 miles north of the EPA site.
- No interchanges with expressways, only 4-lane, between measurement and EPA site.
- 2009 AADT: 233,000.
- NB and SB volume only.

- Blue Diamond:
  - About 5.3 miles south of the EPA site.
  - Measurement on the other side of 215 interchange.
  - 2009 AADT: 102,000.
  - NB and SB volume, plus aggregated diurnal hourly speeds by month.

**FILLING THE GAPS**

In an effort to replace missing traffic volume and speed measurements we used data from each lane at the EPA site as well as the Nevada DOT and supplemented with the following methodology to determine and determine similarities and differences in traffic patterns when measurements exist. From these patterns we make recommendations to replace missing traffic volume and speed data so we have complete time-period coverage.

**Normalized AADT**

- Monthly:
  - Blue Diamond is missing Oct. and Nov. No analysis of the Blue Diamond NB measurements (this drop is not present in EPA, NBL3).
  - The drop in EPA, NB in Oct. & Nov. causes normalized trend to be higher in other months.

- Weekly:
  - EPA, SB shows trend between Blue Diamond and Sahara.
  - EPA, NB and EPA, NBL3 trends are in between Blue Diamond and Sahara.
  - Diurnal:
    - Separate patterns for weekday (shown).
    - Saturday (not shown) and Sunday (not shown).
  - Blue Diamond is missing Oct. and Nov.

**Normal Heavy Duty Percentage**

- Monthly:
  - HD percentage increase in Jan. and Feb. for NB & SB measurements.
  - Monthly variability (past Mar.) is not pronounced.
  - NBL3 & NBL4 do not show decrease in HD and all NBL2 shows increase for Oct. – Dec.

- Weekly:
  - HD traffic decreases in NB and SB during the weekend, more pronounced in SB. SB shows highest HD fraction on Wednesdays, lowest on Saturdays.
  - Diurnal:
    - Separate patterns for weekday (shown), Saturday (not shown) and Sunday (not shown).
    - HD traffic still decreases in SB.
  - All lanes show similar Saturday and Sunday patterns, although NB and SB are quite different.

**Traffic Recommendations**

- Use EPA_NB with monthly, weekly, and diurnal normalized AADT profiles and HD percentages (no adjustment).

**Determining AADT**

Once we determined normalized traffic patterns to use for the EPA traffic. We explored four options to determine the AADT for EPA NB. The options consisted of using the non-suspicious EPA NB lanes, and looking at the ratio of traffic volumes between the NB and SB lanes for the Sahara and Blue Diamond sites and using the EPA SB measured traffic. This AADT will be used with the normalized traffic volume patterns to determine an hourly traffic volumes estimate for the EPA NB source.

**AADT Recommendations**

- Use ratio of Sahara NB to SB volumes.
  - New EPA_NB = 0.9646 * EPA_SB = 90,224.56
- Use ratio of Blue Diamond NB to SB volumes.
  - New EPA_NB = 0.9868 * EPA_SB = 92,003.71
- Use ratio of Sahara & Blue Diamond NB to SB volumes.
  - New EPA_NB = 0.9539 * EPA_SB = 91,264.13
- Use ratio of all NB & SB measurements.
  - New EPA_NB = 0.9575 * EPA_SB = 91,264.13

**Supplemental Measurements**

- Given the small difference between the four options, we recommend use OPTION D for AADT of EPA NB (modeling as 1 source), because that uses the supplemental measurements at both Sahara and Blue Diamond, which are to the north and south of the EPA site.
  - Use EPA, SB AADT (no adjustment).

As shown in the Figure (to left) during the period mid-September through early-November there is a drop off in the measured Northbound hourly traffic volume. This drop off was corrected by using the profiled traffic techniques to “fill the gaps” in traffic measurements. The estimated traffic volumes for the Southbound traffic match up very nicely with the measured traffic volumes during this time. The method of profiled traffic estimates also preserves the temporal patterns of traffic as seen in the measurements.

**CONCLUSIONS**

Methods similar to this could be used to adjust traffic volumes when there are incomplete or suspicious traffic volume measurements to allow comparisons of modeled air quality to measured air quality to increase accuracy and performance of both air quality and emissions models. The authors would like to thank Sue Kimbrough (U.S. EPA) for her thoughtful insights into this dataset and analysis effort.