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Feasibility of the Global Positioning System (GPS) for the Collection of Motor Vehicle Dynamics and Activity Data

A dissertation submitted in partial satisfaction

of the requirements for the degree

Doctor of Environmental Science and Engineering

by

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The dissertation of Michael Thomas Benjamin is approved.

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PUBLICATIONS AND PRESENTATIONS

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ABSTRACT OF THE DISSERTATION

Feasibility of the Global Positioning System (GPS)

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Professor Arthur M. Winer, Chair

To improve current data collection and validation methodologies used in motor vehicle emission inventory and transportation models, this study assessed the feasibility of using GPS as a tool for the collection of motor vehicle dynamics and activity data. A single vehicle, instrumented with two GPS receivers - one subject to Selective Availability, the other equipped with a real-time differential correction signal receiver - were driven over a number of known and blind routes in metropolitan Los Angeles to assess the accuracy of the two receivers in measuring speed, acceleration, latitude, longitude, and altitude on a second-by-second basis.

For most driving environments, standard GPS (SGPS) and differential GPS (DGPS) speed data were within +/- 2 to 3 miles per hour (mph) of the vehicle speedometer. The accuracy of GPS-derived vehicle acceleration varied depending upon the receiver type, route driven and data sampling rate (R^2 values ranging from 0.65 - 0.99 and 0.55 - 0.78 for the SGPS and DGPS receivers, respectively). The value of differential correction was most apparent in measurement of vehicle latitude, longitude, and altitude. Relative to a digital street map, 90% of the SGPS and DGPS latitude and longitude data fell within 160 ft and 80 ft, respectively, of the actual routes driven. Depending upon the extent of GPS and differential correction signal blockage, SGPS and DGPS altitude data deviated from topographic profiles by between 50-230 ft and 3-225 ft, respectively.

GIS analysis of both SGPS and DGPS data collected on nine blind routes indicated that routes driven can by correctly identified based on visual inferrence; however, utility of GIS buffer algorithms for route identification are limited by the accuracy of the GPS receivers and digital streetmap database used. Assignment of GPS speed data to the nearest roadway links shows promise as a means of measuring vehicle speed as a function of roadway type. By overlaying GPS data on landuse maps using GIS, landuse of trip origins and destinations can be identified, suggesting possible application as a trip purpose inferrence tool.