Standard Operating Procedure: Analysis of US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification by Direct Assessment (GMAP-REQ-DA) Method Data for Methane Emission Rate Quantification using the WindTrax 2.0 Model

Scope: The following protocol describes procedures for analysis of data collected with the US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification–Direct Assessment (GMAP-REQ-DA) technique to yield methane emission rates using the WindTrax 2.0 model. This protocol describes guidance on preparing input data files for use with the model, importing the input files into the model software, instructions for initiating the model and processing the data, and guidance on interpretation of output data.

Purpose: To provide specific guidance on analyzing data collected with the GMAP-REQ-DA technique to yield methane emission rates using the WindTrax 2.0 model.

1.0 Overview

The US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification by Direct Assessment (GMAP-REQ-DA) mobile measurement system has been developed as a tool to assess emissions of air pollutants from distributed point sources. The system consists of a fast-response Greenhouse Gas Analyzer laser absorption spectroscopy unit, global positioning system (GPS), and wind monitors, installed in a measurement vehicle. The integrated system uses customized software to control operation of instrumentation, and acquisition of data. The system has been deployed to assess emissions at upstream oil and gas production sites and other well sites. During the measurement campaigns, the

system is deployed to assess emissions from multiple sites, on a site-by-site basis.

Data elements collected with the GMAP-REQ-DA technique include methane concentrations, GPS data, 3-D Sonic Anemometer data, and AIO Compact Weather Station data. The GMAP-REQ-DA data elements are used to calculate target compound emission rates from the measurement sites using two approaches. The current document describes the procedures for calculating methane emission rates using the WindTrax 2.0 Model (ThunderBeach Scientific, www.thunderbeachscientific.com). Procedures for calculating emission rates using the second approach are detailed in Appendix C, *Standard Operating Procedure: Analysis of U.S. EPA Geospatial Monitoring of Air Pollution-Remote Emissions Quantification-Direct Assessment (GMAP-REQ-DA) Method Data for Methane Emission Rate Quantification using the Point Source Gaussian Method.*

The WindTrax model is a free software tool that can be used for simulating atmospheric dispersion over a small downwind range (downwind horizontal distances less than 1 km from the source). The model is used to assess turbulent transport on a micro-meteorological scale using Langrangian stochastic particle models. The software can be downloaded from the ThunderBeach Scientific website, and installed on any personal computer by following the instructions on the website.

After downloading the software, it is necessary to create a root folder that contains files with saved internal settings for the WindTrax software to run correctly. The folder will contain the following files, which should be saved to the computer C: drive in a folder labeled “bLs Example Folder”:

- bLs Input File Example.txt

- bLs Output File Example.wxf
- WindTrax Model.wxf

The file “WindTrax Model.wxf” contains internal settings for the model necessary for calculating the methane emission rate. If the file is not located in the root folder, the internal model settings will not be saved prior to initiating the model for calculation of methane emission rates.

The user prepares an input file using actual data collected in the field, and after importing the file to the WindTrax 2.0 software, the emission rate of the target compound is calculated. Instructions on preparing and importing the input file, utilizing the software for emission rate calculation, and processing the data output file are discussed in the sections below.

2.0 Preparing the Data Input File

The first step in utilizing the WindTrax 2.0 software is to create a data i`nput file in .txt format using Microsoft Notepad. Prior to creating the data input file, a customized MATLAB® code is used to average raw data collected in the field and format it for use in the WindTrax 2.0 software. The output from the customized MATLAB® code is contained in columns A-V of the summary spreadsheet. Columns W-Y of the spreadsheet are parameters calculated based on the data output from the MATLAB® code. Columns AA-AV of the spreadsheet contain the output data from the WindTrax 2.0 software (added to the summary spreadsheet after the model is run and discussed in Section 4.0 of this document). Each line of the spreadsheet shows averaged data elements from individual stationary monitoring surveys during a particular measurement campaign. The number of lines in the

spreadsheet and resultant data input file is dependent upon the number of events to be analyzed.

The following data elements are found in columns A-Y, and are used to create the data input file:

- *Column A: "Date":* The date of the stationary monitoring survey
- *Column B: "Event":* The sequential stationary monitoring survey number from a particular day
- *Column C: "Distance":* The estimated distance from the source to the sampling mast, based on field distance/angle measurements and Google Earth overhead maps
- *Column D: "Sensor Height":* The height of the measurement mast during the time of measurements
- *Column E: "Source Height"*: The estimated height of the source measured
- *Column F: "a1 + Bkgrnd":* Sum of the peak methane concentration (obtained from the Gaussian fit of plot of measured concentration vs. prevailing wind angle) and the determined methane background concentration
- *Column G: "Background":* Methane background concentration determined by averaging the lowest 100 concentration values measured during the survey
- *Column H: "Pressure":* Average atmospheric pressure during the survey, measured by the AIO Compact Weather Station
- *Column I: "u":* Average of the "u" component of the wind during the survey, measured by the 3-D Sonic Anemometer

- *Column J: "v":* Average of the "v" component of the wind during the survey, measured by the 3-D Sonic Anemometer
- *Column K: "w":* Average of the "w" component of the wind during the survey, measured by the 3-D Sonic Anemometer
- *Column L: "Sonic Temperature":* Average temperature during the survey, measured by the AIO Compact Weather Station
- *Column M: "u*u":* Average of the dot product of the "u" component of the wind during the survey
- *Column N: "u*v":* Average of the dot product of the "u" and "v" components of the wind during the survey
- *Column O: "u*w":* Average of the dot product of the "u" and "w" components of the wind during the survey
- *Column P: "v*v":* Average of the dot product of the "v" component of the wind during the survey
- *Column Q: "v*w":* Average of the dot product of the "v" and "w" components of the wind during the survey
- *Column R: "w*w":* Average of the dot product of the "w" component of the wind during the survey
- *Column S: "u*T":* Average of the dot product of the "u" component of the wind and sonic temperature during the survey
- *Column T: "v*T":* Average of the dot product of the "v" component of the wind and sonic temperature during the survey
- *Column U: "w*T":* Average of the dot product of the "w" component of the wind and sonic temperature during the survey

- *Column V: "T*T":* Average of the dot product of the sonic temperature during the survey
- *Column W: "X location":* Parameter calculated using estimated distance from the source to the measurement, and the average "u" and "v" components of the wind
- *Column X: "Y location":* Parameter calculated using estimated distance from the source to the measurement, and the average "u" and "v" components of the wind
- *Column Y: "Number of Particles":* Parameter calculated by multiplying the distance from the source by 4,000

The data input file is created in Microsoft Notepad by copying the headings and data from columns A-Y of the summary spreadsheet. Before saving the file, it is necessary to remove any comma separators contained in any numbers in the file. Once the .txt file is created, it can be saved under any filename and structure that is convenient.

3.0 Utilizing the WindTrax 2.0 Software to Calculate Emission Rates

After downloading the WindTrax 2.0 software, open the software program. A box will appear indicating "There was a problem sending the command to the program". Click OK. Using "File/Save As", the model can be saved under any filename and structure that is convenient. The following steps describe how to run the model to calculate emission rates of the target compound:

1. In the yellow field of the model there is an icon that resembles a spreadsheet. When the mouse pointer is on this icon a pop up box will appear that reads "Input Data File 1: bLs Input File Example.txt". Right click on this icon and

select “Input Data File Properties…”. Click the “Browse” button for the “Input Data File” field and select the location of the data input text file that was created using procedures described in Section 2.0. Close the dialog box by clicking “OK”.

2. The icon to the right of the “Input Data File” icon will display a pop up box that reads “Output File 1: bLs Output File Example” when the mouse pointer is on it. Right click this icon and select “Output File Properties…” Click the “Browse” button for the “Output Data File” field and specify a convenient path and filename for the output text file. Click “Save” then “OK” to close the dialog boxes.
3. The model is now ready to run. It can be started using the single green arrow on the toolbar, by selecting “Simulation/Run” from the menu, or by pressing the F5 key. The simulation will take anywhere from minutes to hours to complete, depending on the speed of the computer, the number of surveys being analyzed, and the measurement distance to the source.
4. When the simulation is complete, close the WindTrax 2.0 model. A dialog box will appear asking whether to save the touchdown catalogs generated by the session. Saving the catalogs may speed up future simulations.

For more information on how the WindTrax 2.0 model simulation works and the effects of changing various model parameters, refer to the ThunderBeach Scientific website.

4.0 Processing Output Data File

The WindTrax 2.0 data output file will be located at the path and filename created using the procedures in Section 3.0. The output

file will have a .wxf file extension. Right click the file and choose “Open with” then “Notepad”. Copy only the output data characters (not the headers) and paste it into block AA2 of the summary spreadsheet previously saved with the input data. Column AG is the calculated source emission rate in g/s for each event that was analyzed.