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OZONE FORMATION STUDY: EMISSIONS INVENTORY QUALITY ASSURANCE PROJECT PLAN

LOUISVILLE METRO AIR POLLUTION CONTROL DISTRICT

RAMBOLL

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ACRONYMS AND ABBREVIATIONS

AQM	Air Quality Model
BenMAP	Benefits Mapping and Analysis Program
BenMAP-CE	Benefits Mapping and Analysis Program – Community Edition
CAMD	Clean Air Markets
CAMx	Comprehensive Air Quality Model with Extensions
CB6r4	Carbon Bond version 6 revision 4
CO	carbon monoxide
CPRM	coarse particulate matter
CSA	Combined Statistical Area
FEDOOP	Federally Enforceable District Origin Operating Permits
FIPS	Federal Information Processing Standard
FPRM	primary others
HONO	nitrous acid
HRVOCs	highly reactive Volatile Organic Compounds
IN	Indiana
IPP	Inventory Preparation Plan
km	kilometers
KY	Kentucky
lb/hour	pounds per hour
Louisville NAA	Louisville-Jefferson County, Kentucky-Indiana ozone nonattainment area
Louisville MSA	Louisville-Jefferson County Kentucky-Indiana Metro Statistical Area
LMAPCD	Louisville Metro Air Pollution Control District
MJO	Multi-jurisdictional Organizations
MOVES	Motor Vehicle Emission Simulator
MSA	metropolitan statistical area
NAA	ozone nonattainment area
NAAQS	National Ambient Air Quality Standard
NH3	ammonia
NOx	oxides of nitrogen
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
PEC	primary elemental carbon
PNO_3	primary nitrate
POA	primary organic aerosol
POTW	Publicly Owned Treatment Works
ppb	parts per billion
ppm	parts per million
PSO_4	primary sulfate
QA	quality assurance
QAPP	Quality Assurance Project Plan
SCC	Source Classification Code
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	sulfur dioxide
SOx	sulfur dioxide
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1. PROJECT DESCRIPTION AND OBJECTIVES

Ramboll has prepared this Level IV Quality Assurance Project Plan (QAPP) for the Louisville Metro/Jefferson County Air Pollution Control District (LMAPCD) following United States Environmental Protection Agency (USEPA) guidelines. The nature of the technical analysis and tasks to be conducted as part of this project are consistent with quality assurance (QA) Category IV: Data Evaluation or Use for Secondary Purpose. The appropriate USEPA guidance for this type of work was used to develop the QAPP. While not required for Category IV projects, we will conduct audits of data quality at a level of at least 10% of the data generated.

1.1 Purpose of Study

On June 4, 2018, USEPA designated a portion of the Louisville/Jefferson County – Elizabethtown – Madison, Kentucky-Indiana Combined Statistical Area (CSA) as Marginal nonattainment for the 2015 ozone National Ambient Air Quality Standard (NAAQS), effective August 3, 2018 (Federal Register Volume 83, Number 107, p. 25776). The 2015 ozone NAAQS is 0.070 parts per million (ppm). The annual fourth-highest daily maximum 8-hour concentration averaged over 3 years is not to exceed the 2015 ozone NAAQS. The Louisville CSA counties designated as nonattainment by USEPA for the 2015 ozone NAAQS included Bullitt, Jefferson, and Oldham in Kentucky (KY) and Clark and Floyd in Indiana (IN). The nonattainment designation was based on ozone design value[1] concentrations measured in 2014 through 2016 in the Louisville CSA (USEPA 2018a), when the Cannons Lane NCore monitoring site (site identifier 21-111-0067) had a 2014-2016 design value of 0.074 ppm. The USEPA completed a 5-factor analysis to determine the nonattainment area boundaries and classification for the Louisville, KY-IN nonattainment area (USEPA 2018a). The Louisville-Jefferson County Kentucky-Indiana ozone nonattainment area is referred to as the Louisville NAA.

On December 6, 2018, the USEPA finalized the Implementation Rule for the 2015 ozone NAAQS, which includes State Implementation Plan (SIP) requirements (Federal Register Volume 83 Number 234, p. 62998). Areas classified as Marginal nonattainment, such as the Louisville NAA, have 3 years from the date of designation to attain the standard (i.e., August 3, 2021 for the Louisville NAA). If an ozone monitor in the Louisville NAA exceeds the 2018 ozone NAAQS during the 2018-2020 ozone season, the area could be reclassified to the more stringent "Moderate" nonattainment level. Moderate nonattainment levels have additional SIP requirements, including a requirement to demonstrate attainment by the future attainment date using an air quality model.

In order to better understand ozone precursor emissions and ozone formation processes in the Louisville/Jefferson County area, LMAPCD is undertaking this Ozone Formation Study. Ozone is formed in the atmosphere through a set of complex nonlinear photochemical reactions involving oxides of nitrogen (NOx) and Volatile Organic Compounds (VOCs) in the presence of sunlight. Ozone formation within Louisville/Jefferson County area has previously been characterized as being either NOx-limited or VOC-limited (radical-limited); for example, typically earlier in the day ozone formation is limited by the rate of radical initiation so is more VOC (radical)-limited and by the afternoon, when photochemical reactions are greatest, ozone formation tends to be more NOx-limited. The level of precursor limitation can also vary greatly across an urban area. For example, in areas with high NOx emissions (such as urban downtowns where mobile source emissions predominate or downwind of large NOx point sources) ozone formation may be more VOC-limited, while a few kilometers (km) away in the suburbs ozone formation may be more NOx-limited. Beyond a certain ratio of VOC to NOx, however, further NOx reductions may act to increase ozone formation through radical initiated

[1] A design value is the monitored concentration reported in the form of the NAAQS. For both the 2008 and the 2015 ozone NAAQS, the design value is the 3-year average of the annual forth highest daily maximum 8-hour average ozone concentration.

reactions of VOC and subsequent photochemical reactions that produce ozone, the so-called NOx disbenefit.

Louisville/Jefferson County has a unique heterogenous source mixture. While Louisville/Jefferson County has conditions like many other urban areas containing an urban core surrounded by suburban and rural areas, the industrial sources in the county are highly diverse, both from the perspective of industrial activities (such as power generation, automotive manufacturing, chemical manufacturing, commercial product manufacturing, petroleum terminals, sewage treatment, landfills, etc.), as well as air quality emissions. Furthermore, some areas, such as Rubbertown, have a high density of highly reactive VOCs (HRVOCs) while other areas have relatively large distances between NOx emissions sources or low reactivity VOCs.

A photochemical model is the best tool to assess spatial and temporal variations in ozone formation, as found in Louisville/Jefferson County, and analyze the sensitivity of ozone formation to NOx versus VOC precursors. Photochemical models are also the - USEPA recommended tool for ozone modeling (USEPA 2018b). In order to better understand the ozone formation processes contributing to elevated periods of ozone in Louisville/Jefferson County, ozone modeling will be conducted with an existing air quality model (AQM) with an existing air quality database.

Emissions inputs will be refined based on LMAPCD information to better represent the unique source characteristics and emissions profiles in Louisville/Jefferson County, as described in this Emissions Inventory Quality Assurance Project Plan as well as the Inventory Preparation Plan (Ramboll 2019a). These emissions inputs generated specifically for the Louisville Ozone Formation Study will be used in combination with other publicly available data in an AQM to assess:

1. The extent to which areas and periods of elevated ozone in Louisville, KY-IN nonattainment area is NOx-limited or VOC-limited, and
2. For VOC-limited areas/periods, the ozone formation potential of VOC emissions.

This information can inform voluntary ozone reduction measures to attain compliance with the ozone NAAQS by the Marginal attainment date (August 3, 2021) as well as inform potential future control strategies should the area be reclassified to Moderate. Model results can also be used to assess health effects using the USEPA Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE) model (AAI 2018).

1.2 Project Objectives

The purpose of the present study is to compile a comprehensive 2016 base year emissions inventory of ozone precursors impacting ambient ozone levels in the Louisville Metro area, develop model-ready emissions for input into the PGM, and perform photochemical modeling. This QAPP addresses the compilation of the emissions inventory for this project and the development of the model-ready emissions dataset. A separate Modeling QAPP has been prepared to describe the model execution (Ramboll 2019b).

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Responsibilities of Project Participants

This study will be conducted by Ramboll under contract to the LMAPCD. The Ramboll team working on this project and their specific responsibilities are listed in Table 1. The LMAPCD staff and Advisory Board members, listed in Table 2, will review the analysis of model results and provide comments. The reporting and communication structure are shown in Figure 1.

Table 1. The Ramboll Project Team Participants and Responsibilities

Participant	Project Responsibility
Greg Yarwood	Principal Investigator, technical consultant
Tejas Shah	Project Manager with technical oversight of the modeling emissions development, quality assurance review, and preparation of final project report and presentation
Shannon Logan Ling Huang Amanda Ai Mahshid Etesamifard Fiona Jiang	Various tasks including emissions evaluation, emissions processing, and quality assurance

Table 2. LMAPCD Project Team and Expertise

Participant	Role	Expertise	Email	Phone
Byron Gary	Project Coordinator	Regulatory Coordinator	Byron.Gary@Louisvilleky.gov	(502) 574-7253
Michelle King	Project Sponsor	Director of Program Planning and Executive Administrator	Michelle.King@Louisvilleky.gov	(502) 574-7252
Keith Talley, Sr.	Sponsor	Director of LMAPCD	Keith.Talley@Louisvilleky.gov	(502) 574-7229
Rachael Hamilton	Champion	Assistant Director of LMAPCD	Rachael.Hamilton@Louisvilleky.gov	(502) 574-5218
Matt King	Champion	Permitting	Matt.King@Louisvilleky.gov	(502) 574-6714
Steven Gravatte	Champion	Excess Emissions	Steven.Gravatte@Louisvilleky.gov	(502) 574-7232
Billy Dewitt	Team Member	Monitoring/Met	Billy.DeWitt@Louisvilleky.gov	(502) 574-7274
Bryan Paris	Team Member	Monitoring/Met	Bryan.Paris@Louisvilleky.gov	(502) 574-7251
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Craig Butler	Team Member	Modeling/MOVES	Craig.Butler@Louisvilleky.gov	(502) 574-7237
Torend Collins	Team Member	Stakeholder Engagement	Torend.Collins@Louisvilleky.gov	(502) 574-5237

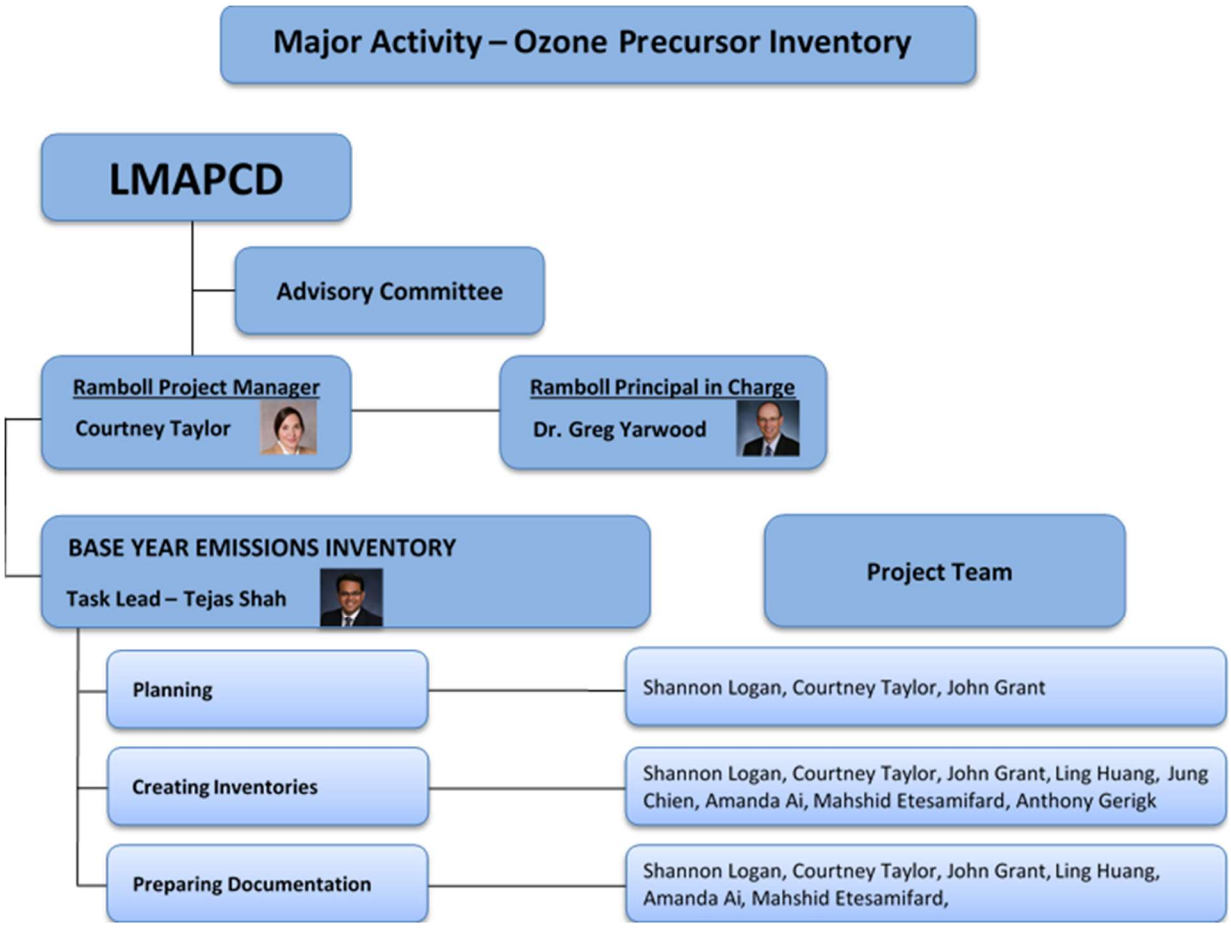

Figure 1. Organizational Chart

2.2 Project Schedule

The emissions inventory schedule and milestones are shown in Table 3.

Table 3. Emissions Inventory Schedule and Milestones

Task	Duration (weeks)	Completion Date	Responsibility
Kick-off	0	5/15/2019	All
Draft Emissions Inventory QAPP/IPP	3	6/5/2019	Ramboll
LMAPCD/USEPA review Draft QAPP and IPP	2	6/19/2019	LMAPCD/USEPA
Finalize Emissions Inventory QAPP/IPP	1	6/26/2019	Ramboll
LAMPCD provides event emissions reports, non-point, on-road	2	5/29/2019	LMAPCD
Incorporate emissions inputs into SMOKE modeling	6	7/10/2019	Ramboll
Draft Emissions inventory Report	6	7/10/2019	Ramboll
Meeting to Present Emissions Inventory	1	7/17/2019	Ramboll
LMAPCD/USEPA review Draft Emissions Inventory Report	2	7/24/2019	LMAPCD
Finalize Emissions Inventory Report	1	7/31/2019	Ramboll

3. SCIENTIFIC APPROACH

3.1 Data Needed to Meet Project Objectives

Primary data will not be gathered in the course of this study. Secondary data will be used in this study consisting of (1) 2016beta Emissions Modeling Platform (EMP) developed by the USEPA and multi-jurisdictional organizations (MJOs) consisting of SMOKE outputs for all emissions categories, (2) on-road mobile emissions for Jefferson County developed by the LMAPCD, (3) non-point emissions for minor point sources reported by industry to the LMAPCD, and (4) Excess Emissions Events forms reported by industry to the LMAPCD. The main data sets required to accomplish the project objectives are the 2016beta EMP data developed by USEPA including gridded, speciated, hourly PGM model-ready emissions.

3.2 Data Sources

The data sources that will be used in the study are listed below. An evaluation of the USEPA 2016 emissions will be conducted to determine if other source categories should be updated.

3.2.1 2016 Modeling Platform

The USEPA and Multi-jurisdictional Organizations (MJOs) are co-developing a 2016 Air Quality Modeling (AQM) platform. The 2016beta EMP is the first product from the National Emissions Inventory Collaborative that includes a full suite of base year (2016) and future year inventories, ancillary emissions data, and scripts and software for preparing the emissions for air quality modeling[2]. Details on the 2016beta EMP development is available on its wiki[3].

3.2.2 On-road Mobile Emissions

Ramboll will incorporate on-road emissions generated by the LMAPCD into a 2016 base year emissions inventory for the project. The LMAPCD will develop 2016 on-road inventory data for five counties of the LMA: Bullitt, Jefferson and Oldham counties in KY and Floyd and Clark counties in IN and provide them to Ramboll. The emissions data will be generated with MOVES2014b (USEPA, 2014a,b,c) in inventory mode for the 8 ozone months (March through October). The inventory data will consist of monthly total emissions by Source Classification Code (SCC) for the five counties. Ramboll will process the on-road emissions with SMOKE using weekly and diurnal temporal profiles from the 2016beta EMP.

3.2.3 Non-point Emissions

Ramboll will revise the USEPA 2016beta EMP non-point emissions for Jefferson County based on synthetic minor source emissions supplied by LMAPCD and incorporate the revisions into a 2016 base year emissions inventory for the project. Specifically, the LMAPCD will provide Jefferson county emissions from sources permitted through federally enforceable district origin operating permits (FEDOOP). Ramboll will isolate the SCC codes in the non-point source emissions file that correspond with the LMAPCD-supplied FEDOOP emissions and update the non-point emissions file for those SCC codes. Non-point source emissions are typically estimated using a top-down approach with county-level activity data and not easy to reconcile with individual source-specific inventory. Therefore, only select SCC with a complete county emission inventory from the LMAPCD will be updated. The proposed source categories to be updated is provided below:

- Bulk Gas Terminals/Plants

2 National Emissions Inventory Collaborative (2019). 2016beta Emissions Modeling Platform. Retrieved from http://views.cira.colostate.edu/wiki/wiki/10197.

3 http://views.cira.colostate.edu/wiki/wiki/9169

- Waste Disposal: Publicly Owned Treatment Works (POTW)
- Graphic Arts
- Industrial Natural Gas Combustion
- Land Clearing Debris

4. QUALITY METRICS

4.1 Quality Metrics for Input Data

The purpose of this study is to compile a comprehensive 2016 base year emissions inventory of ozone precursors impacting ambient ozone levels in Louisville/Jefferson County, including all point, nonpoint (both anthropogenic and biogenic), mobile (on-road and non-road), and event emissions, as well as background emissions and perform photochemical modeling. This will be achieved by using the USEPA 2016beta EMP input data as a framework, updating emissions data to better represent Louisville/Jefferson County, and processing updated emissions through SMOKE to develop model-ready emissions.

The following steps will be performed in order to assure data quality:

1. The USEPA 2016beta EMP data will be summarized and plotted to compare against any corresponding local inventory data compiled by the LMAPCD and National Emissions Inventory (NEI) data (example, 2014NEI version 2) for representativeness.
2. For on-road mobile emissions, we will evaluate LMAPCD-provided county-level emissions against what USEPA has in their 2016 Modeling Platform. For this Platform, the USEPA generated on-road mobile emissions directly on the 12-km model grids rather than county-level totals using SMOKE-MOVES processing approach. The gridded emissions will be summarized by county using 12-km grid cells masking approach and compared against LMAPCD county-level total emissions to help with QA/QC of new mobile emissions.
3. SMOKE is designed with flexible QA capabilities to generate standard and custom reports for checking the emissions modeling process. It includes reporting features to keep track of the adjustments at each processing stage and ensure that data integrity is not compromised. SMOKE generates diagnostic files and summary reports which will be carefully reviewed for error and warning messages;
4. Visual displays will be generated that include: Spatial plots of the emissions for each ozone precursor species (e.g., NO_X, VOC and CO). Summary tables of emissions for ozone precursors for each grid and by major source category. This QA information will be examined against the original point and area source data and summarized in an overall QA/QC assessment.

4.2 Data Quality Audits

Although not required, a minimum of 10% of the data developed in this study will be audited by direct inspection of the model-ready emissions files for CAMx input.

5. DATA ANALYSIS, INTERPRETATION AND MANAGEMENT

5.1 Data Reporting Requirements

Ramboll will compile a comprehensive 2016 base year emissions inventory of ozone precursors impacting ambient ozone levels in the Louisville Metro area, develop model-ready emissions for input into the AQM and include summary tables of emission totals, spatial locations of emissions, and relevant information, as applicable, in the Draft and Final Reports.

5.2 Data Quality Assessment

The approach used to develop and quality assure the model-ready emissions will include the following steps:

1. Ramboll will evaluate the USEPA 2016beta EMP inventory against local inventory compiled by the LMAPCD and will compare against the available National Emissions Inventory (NEI) data (example, 2014NEI version 2) for representativeness;
2. Ramboll will compare the new on-road mobile emissions against the USEPA 2016 Modeling Platform;
3. Ramboll will review ancillary data in the USEPA Modeling Platform to process the new on-road emissions to properly characterize speciation, spatial and temporal allocation of emissions;
4. Ramboll will carefully review SMOKE diagnostic files and summary reports for error and warning messages to ensure that emissions are being processed correctly;
5. Ramboll will create Visual displays of the emissions distribution and emissions summary table for each ozone precursor species by major source category. This QA information will be examined against the original point and area source data and summarized in an overall QA/QC assessment;
6. Ramboll will perform CAMx test runs with the resultant model-ready emissions to ensure that the files are in correct format.

Reported data will be thoroughly reviewed by senior level staff for consistency with other similar data for completeness and reasonability considering unique source mix within the Louisville/Jefferson County.

5.3 Data Storage Requirements

Data generated for this project including emissions inputs will be securely archived during the project on portable hard drives and stored for a period of at least five years following the completion of the project. All data obtained for this project will be stored in electronic format.

6. REPORTING

6.1 Project Deliverables

The schedule for all deliverables is presented in Section 2.2, Table 3.

6.2 Final Project Deliverables

Draft and Final Model Preparation of Emissions Inventories for the Ozone Formation Study Report will be delivered to the LMACPD Project Manager electronically (i.e., via file transfer protocol (FTP) or e-mail) in Microsoft Word format no later than the deliverable due date shown in Table 3. The pre-merged and model-ready emissions files will be transferred on external hard drives formatted for Windows computers. The Emissions Inventory Reports will detail the methods and results and will include the following components:

1. An executive summary or abstract
2. A brief introduction discussing the background and objectives, including relationships to other aspect of the studies
3. A discussion of the pertinent accomplishments, shortfalls, and limitations of the work completed.
4. Recommendations, if any, for what should be considered next as a new study.

The Final Report will provide a comprehensive overview of activities undertaken and data collected and analyzed during the work. The Final Report will highlight major activities and key findings, describe problems encountered and associated corrective actions, and detail the resulting emissions inventory proposed for modeling.

7. REFERENCES

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