Work Plan: Modeled Air Quality and Human Health Impacts of Proposed Methane Controls on Oil and Gas Production Activities in the Western U.S.

Prepared For:

David McCabe

Clean Air Task Force

Prepared by:

Tammy M Thompson, PhD

Research Scientist II

Colorado State University

1375 Campus Delivery

Fort Collins, CO 80523

February 15, 2015

Table of Contents

List of Figures

I. Introduction

This document outlines the Air Quality Modeling study and resulting deliverables that are proposed in response to a request made by David McCabe of the Clean Air Task Force (CATF) to Tammy M. Thompson. The request was for an Air Quality Modeling study that will evaluate the modeled impacts of potential reductions of volatile organic emissions resulting from methane control strategies proposed by the CATF. Potential impacts to changes in ground level ozone concentrations (both the 8-hr standard and the W126) and human health will be evaluated. The air quality modeling study proposed here will use a publically available modeling episode developed by the Western Regional Air Partnership (WRAP). The base case for the modeling study will be a projected 2020 future year emissions inventory developed for the WRAP episode. This inventory is available by request on the Western Air Quality Data Warehouse website[1]. Meteorological inputs for the modeling episode, representing conditions as they occurred in 2008, are available on the same website.

II. Proposed Air Quality Modeling Episodes

The input emissions inventories for all photochemical modeling simulations will be developed for the analyses proposed in this report using the Sparse Matrix Operator Kernal Emissions (SMOKE) preprocessing system[1]. The simulations are then run using the Comprehensive Air Quality Model with extensions (CAMx)[2]. CAMx is a 3-Dimensional, Eularian photochemical model that simulates the emission, movement, chemistry and removal of chemical species in the atmosphere. CAMx is a photochemical model recommended by the U.S. EPA for regulatory air quality modeling purposes and was the model used in support of the 2008 Denver, Colorado ozone State Implementation Plan[3]. Human health impacts will be evaluated using the Benefits Mapping and Analysis Program (BenMAP)[4].

CAMx version 5.41 will be used for this study with the Carbon Bond 5 (cb05) chemical mechanism. The modeling domain, shown in Figure 1, is the CONUS 36 km domain covering the continental U.S., and the Western 12 km domain covering the Western half of the U.S. The focus of presented results will be the area covered by the 12 km domain. Individual grid cells are not shown in Figure 1; instead, the outline of the domain is shown. Within the 12 km domain, there are 227x230 grid cells that are 12 km on each side.

The meteorological inputs (including temperature, wind speed and direction, pressure, water vapor, cloud/rain, vertical diffusivity, and albedo) were developed by the WRAP using the National Center for Atmospheric Research's (NCAR) Weather Research and Forecasting modeling system Advance Research WRF (WRF-ARW)[5]. The meteorological inputs will remain the same for each of the simulations described below and represent conditions as they occurred on the episode dates in 2008.

Two modeling runs will be conducted using the model set up and meteorological inputs as described. The first will include 2020 projected "future" emissions (described below) and will serve as the base case for this study. The second run will be identical to the first run, but changes will be made to the emissions inventory to reflect the CATF proposed methane controls. This second run will be the "scenario" case. By

[1] http://www.smoke-model.org/index.cfm
[2] www.camx.com
[3] http://www.colorado.gov/airquality/documents/deno308/
[4] http://www.epa.gov/air/benmap/
[5] http://www2.mmm.ucar.edu/wrf/users/docs/arw_v2.pdf

comparing the output from the two runs, the impact of the methane controls on air quality can be evaluated.

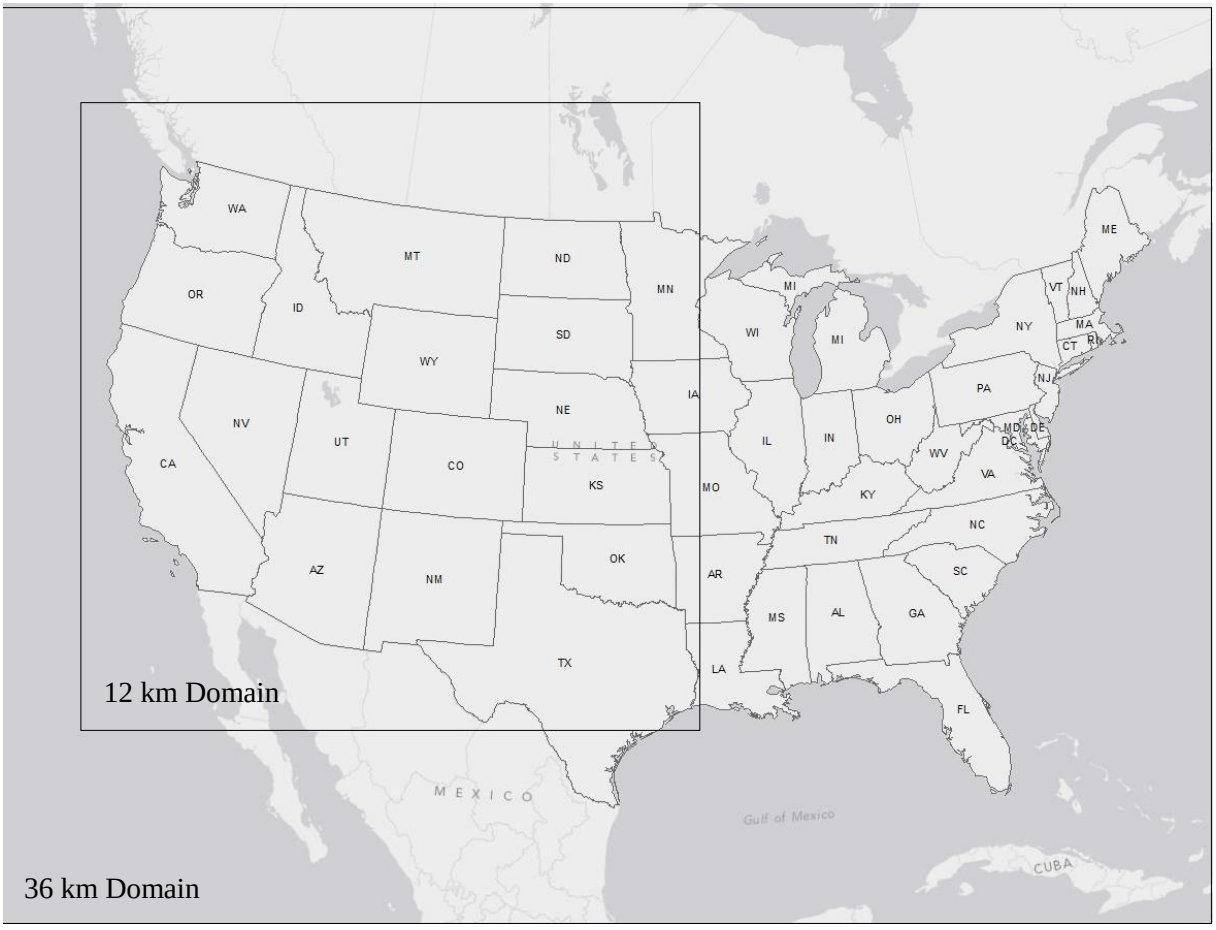

Figure 1. CAMx 36 km and 12 km Modeling Domains.

a. Western Regional Air Partnership 2020 Base Case

The year-long 2020 projected "future" case emissions inventory will be run with model inputs as described above and will serve at the base case for this modeling study. The 2020 future case includes emissions projected to 2020 by the U.S. EPA for all non-oil and gas emissions sectors[6], plus non-WRAP state oil and gas, while the 2020 projected oil and gas inventories for the WRAP states were developed by the WRAP[7]. The 2020 future case will be run with projected 2020 future case emissions inventories, and 2008 meteorology as described by the WRAP modeling protocol[7]. Projection methods for non-oil and gas emissions sectors vary by sector but include only federal and state regulations promulgated by 2012.[6]

The 2020 oil and gas emissions for the Western U.S. are based on the 2008 WRAP Phase III inventory project and include detailed updates to Colorado, Utah and Wyoming. Areas outside of this

[6] http://epa.gov/ttn/chief/emch/2007v5/2007v5_2020base_EmisMod_TSD_13dec2012.pdf
[7] http://vibe.cira.colostate.edu/wiki/Attachments/Modeling/3SAQS_2008_Modeling_Protocol_Final.pdf

Phase III study area include emissions inventories as developed by the U.S. EPA National Emissions Inventory (NEI). VOC reductions as a result of CATF defined methane controls will be applied to all oil and gas production emissions in both the phase III three-state area as well as other states covered by the U.S. EPA NEI.

b. Western Regional Air Partnership 2020 Scenario Case

A second year-long model run will be developed and run and will serve as the scenario case. The scenario case will be based on the 2020 base case, but will include changes to the 2020 oil and gas emissions inventory that represent reductions in volatile organic compounds (VOCs) that could result from methane emissions controls that will be defined by the CATF. No other changes will be made to the 2020 base case for the scenario case.

The scenario case oil and gas emissions inventory will be altered by applying controls to VOC emissions only from Standard Classification Codes (SCCs) associated with specific locations of O&G production. SCCs are used by the SMOKE pre-processing system to identify individual processes within the emissions inventory. SCC codes applicable to oil and gas production emissions are outlined in Appendix A of the 2007/2020 U.S. EPA emissions inventory technical document.[8] The percentage reduction applied to emissions of VOCs, and the equipment/locations from which the reductions will be made, will be identified in a detailed call between the CATF and Tammy M. Thompson and will be approved by CATF before modeling begins.

III. Emissions Inventory Reporting

Before modeling begins, an emissions inventory report will be created that will present total 2020 emissions of NOx and VOC species by state and by SCC for oil and gas emissions only. This report will help guide the development of the VOC control scenario. Not all SCCs will be presented individually, but will be grouped by equipment/process type. As part of this step in the project, before modeling begins and once VOC reductions have been applied, VOC reductions resulting from the CATF proposed methane controls will be reported by state, both by total reduction and by percentage of total anthropogenic VOC emissions. This will include a map showing annually averaged VOC emissions reductions by 12 km grid cell to visually identify areas of particularly strong impact.

IV. Evaluation of Impacts to Ozone and Human Health due to changes in VOC emissions from Oil and Gas Production

This study will investigate the modeled impacts to ozone and human health due to reductions of VOC emissions from oil and gas production activities in the Western U.S. These emissions reductions are associated with methane controls defined by the CATF. The area that will be evaluated for impacts includes the 12 km domain covering the Western U.S. as shown in Figure 1.

Changes to ozone concentrations resulting from the modeled VOC reductions will be evaluated by comparing modeled output from the 2020 base case to the 2020 scenario case. Because the only difference between the two model runs is the change in VOC emissions from the oil and gas inventory, the difference in ozone concentrations between the two runs is the modeled predicted change in ozone due

[8] http://epa.gov/ttn/chief/emch/2007v5/2007v5_TSD_Appendices_14dec12.pdf

to the VOC emissions reductions. The results will be evaluated in the 12 km domain only, for the change in the fourth highest daily maximum 8-hr ozone concentrations, the ecology based W126 ozone metric, and human health impacts as described below.

Maps showing the change in fourth highest daily maximum 8-hr ozone, and the change in W126 ozone, as a result of the methane control scenario will be created for the Western U.S. Modeled changes in daily maximum 8hr averaged ozone concentrations in the 12 km domain will be input to the Benefits Mapping and Analysis Program (BenMAP) in order to estimate potential changes to human health. Modeled changes in ozone concentrations and concentration response functions (crfs) are combined with census data (2020 population data) and county-level mortality incidence rates to determine changes in health outcomes. The health impacts that will be evaluated are mortality and morbidity. The mortality crfs that will be applied in this study are those peer-reviewed epidemiological studies in BenMAP version 4.0.67 that estimate increased mortality risk due to changes in ambient concentrations of ozone. Changes to morbidity will also be evaluated, and will be done so in a way that is consistent with the methods used to conduct the US EPA's recent regulatory analysis[9]. Health impacts will be estimated and presented by state.

V. Time Frame

The work as described within this document will be completed and a draft report presented within 60 days of the date the inventory is received by Tammy M. Thompson.

[9] http://www.epa.gov/airtransport/pdfs/FinalRIA.pdf