OVERVIEW AND EXAMPLE DESIGN OF A REUSABLE MODELING FRAMEWORK FOR AIR QUALITY MODELING

Note to Readers: *This example of an 'Add-on' air quality modeling approach is intended to highlight a strategy for the development of air quality modeling products that can be used at the various stages in National Environmental Policy Act (NEPA) documents (refer to Modeling Approach Tables (Tables A and B) in the MOU Appendix). This framework is not intended to be prescriptive, but an example that could be adapted to reflect project specific information.*

This framework is intended to promote the development of air quality modeling analysis in a manner that reduces overall resource expenditures through reuse of data, modeling systems, or results. With early consideration, modeling systems can generate input datasets or become the foundation of future applications with simple modification. In some situations, an existing modeling analysis may fulfill the requirements of the MOU that states: 'Modeling will not be required…[i]f EPA and the Agencies whose lands are affected concur (in writing or by electronic transmission) that: an existing modeling analysis addresses and describes the impacts to air quality and AQRVs for an area under consideration, and the analysis can be used to assess the impacts of the proposed action.' (Section V.E.4.b).

Conceptual Description

For the purposes of this document, a Reusable Modeling Framework (RMF) refers to an existing air quality modeling analysis with underlying emission inventories, regional meteorology, and appropriate growth factors (oil/gas emissions) that are considered applicable to a new or modified project proposal. It may be possible to infer potential impact(s) for a new or modified project without the need for additional air quality analyses, as described in the following example.

In this example, an RMF is designed to work in conjunction with a regional scale photochemical model to evaluate potential impacts for criteria pollutant National Ambient Air Quality Standards (NAAQS) of concern (focused primarily upon a cumulative regional assessment of ozone and secondary particulate) and air quality related values (AQRV's). This RMF is most appropriate when specific numbers, size, and location of development are not well known for a proposed project, typically at the resource management plan (RMP), forest plan (FP), or leasing stage. These proposals often include large scale planning and leasing decisions that have potential to affect distant air quality values. However, a RMF can be adapted for additional models, approaches, and scale.

This RMF uses emissions sensitivities analyses to bracket potential impacts from future growth scenarios. If the emission projections for a stage of a new or modified project falls within the range of emissions growth used in prior sensitivity analyses, then existing modeling potentially satisfies analysis needs without having to perform additional air quality modeling.

Example Design:

This RMF suggests that regional air quality assessments for both base year and future years be conducted at predetermined intervals. These intervals usually occur, at a minimum, every three (3) years corresponding to the cycle of the development by EPA's national emission inventory (NEI). To maximize quality and representativeness, this RMF could leverage existing national, regional, and state/local emission databases. New base and future year modeling may be necessary prior to the next 3 year interval if regional development exceeds emissions growth projections for that planning period.

The regional air quality assessments may be conducted on a multistate basis to encompass nearby states to ensure complete airshed coverage. Grid resolution should adequately represent the geophysical characteristics of the domain and anticipated development.

For future year emissions, projections should be made from the base year to 10-15 years forward to examine the potential for maximum growth in the planning area. Emissions projections for non-oil and -gas emission sectors potentially can be leveraged from existing inventory databases. Examples may include: regional planning organizations (RPO's), States, or EPA databases. For the oil and gas sector (O&G), emission growth estimates over the future year baseline should be estimated to characterize the potential range in growth. Future year growth estimates should examine the potential for low, medium, and high development based on the anticipated regional growth.

Emission sensitivities can be conducted using methods developed by the photochemical modeling community. The most straight forward method to address emission sensitivities uses photochemical modeling runs to examine incremental growth in the O&G sector. This approach is often referred to as the "brute force method" which examines the impact of emission growth through successive model runs showing impacts from alternative growth scenarios (e.g., High, Medium, and Low). Other probing techniques, which are more sophisticated, allow for the development of area specific source-receptor relationships. Examples include the Response Surface Methods (RSM), as developed from iterative model runs, and the Direct Decoupled Method (DDM), as developed within a particular photochemical model. RSM provides model sensitivity estimates across a wide range of emission changes, but is costly due to need for numerous iterations of the photochemical model. DDM allows for model sensitivity estimates for small emission changes (*e.g.*, 10% - 20%) without having to rerun the model for each scenario, but is costly due to large upfront development.

Table 1 - Reusable Data Products

Category	BASE YEAR	FUTURE YEAR
Meteorology	Base Year (corresponds to 3-YR NEI baseline)	Base Year
Emissions Modeling	3-YR NEI	10 – 15 year projection
Basecase Analysis	Base Year Performance	NA
Emissions Sensitivity Analyses (Photochemical	NA	O&G Growth Scenario (Low, Medium, and High)

EXAMPLE SCOPE OF WORK

Task 1. Preparation of Work Plan

A work plan shall be prepared that provides details of the modeling effort and approach.

Task 2. Development of Comprehensive Modeling Protocol

In this subtask, the Contractor will develop a modeling protocol which addresses the development of meteorological, emissions, and air quality modeling for this project. The Contractor will prepare a draft protocol for review by participating agencies. Upon receipt of comments, the Contractor will coordinate with the responsible organization to incorporate comments as warranted and submit a final modeling protocol to all study participants.

The modeling protocol will describe in detail how the air quality modeling inputs will be developed. The protocol shall address, at a minimum, the following:

1. Numerical meteorological model configuration including the following:
   - Horizontal and vertical model domain configuration
   - Physics options selection
   - Data sources for initial and boundary condition development
   - Four dimensional data assimilation (FDDA) strategy
2. Numerical meteorological performance evaluation methods
3. Emissions database development including:
   - Data sources for inventory development
   - Growth factor development
   - Oil and Gas Sector Development Scenarios
4. Base Year Air Quality Modeling Simulations
   - Processing of numerical meteorological fields
   - Initial and boundary condition development
   - Photolysis rate development
   - Photochemical model configuration and option selection
5. Base Year Air Quality Model Performance Evaluation
6. Emissions Sensitivity Scenarios for Future Oil and Gas Development Scenarios
   - Air quality model methods (“brute force” or model probing tools.)

The deliverables for this task will include a draft and final modeling protocol submitted to the responsible organization and participants.

Task 3a. Annual Meteorological Modeling Simulation

For this subtask, the Contractor will develop a numerical meteorological model fields necessary to support regional scale air quality modeling recommended under the MOU. Meteorological fields will be developed in accordance with details outlined in the protocol developed under Task 2 of this project.

Deliverables under this subtask will include hourly numerical meteorological model fields for specified domains that can be used for development of meteorological inputs for photochemical modeling.

Task 3b. Meteorological Model Performance Evaluation

For this subtask, the Contractor will conduct a statistical performance evaluation of the numerical meteorological fields using methods and metrics described in Emery et al. (2001) and Tesche et al. (2002). The statistical performance evaluation will be conducted in accordance with details outlined in the protocol developed under Task 2 of this project.

The deliverable under this subtask will include a report documenting the evaluation of performance of the numerical weather model.

Task 3c. Process Numerical Meteorological Fields for Input into Photochemical Model

The purpose of this subtask is to provide meteorological inputs for the photochemical modeling platform and period(s) delineated in the protocol under Task 2 of this project. The Contractor will (1) process the numerical meteorological model data through the appropriate meteorological preprocessor for input into the photochemical, including subdomains identified in the protocol under Task 2; (2) quality assure (QA) meteorological inputs and results of vertical layer aggregation; and (3) document methods and QA results, and instructions for future processing of meteorological data.

The deliverables of this subtask are (1) the processed meteorological fields; (2) preprocessor run scripts; (3) the results of QA measures and log files from meteorological preprocessor; and (4) a report describing the approach and instructions for reproducing the preprocessing and analysis of meteorological fields for preparation as input to photochemical models.

Task 4. Development of Emissions

The purpose of this task is to create emissions inputs for use in the photochemical model identified under Task 2 of this project. Emissions will be developed for the modeling domain(s) determined under Task 2 for at least a 12-month consecutive period corresponding to the most current national emission inventory (NEI) baseline period.

For this task, the Contractor will (1) create speciation input files, emissions surrogate data, and landuse data appropriate for the photochemical model; (2) run SMOKE processors needed for photochemical platform specific emissions; (3) quality assure SMOKE outputs, correct and rerun as needed; and (4) document all processing steps, processing and data decisions, and provide an interim report on photochemical model emission inputs.

Emissions will be developed for the following:

1. Actual baseyear emissions (corresponding to most current NEI baseline year) for purposes of air quality model performance evaluation
2. "Typical" baseyear emissions for development of future year emissions projections

3. Future year emissions
4. Future year emissions with Oil and Gas Sector emissions growth scenarios

Task 5a. Base Year Air Quality Model Simulations

The purpose of this subtask is to create a suitable baseyear modeling analysis that can serve as a platform to assess potential air quality impacts from future development scenarios. The Contractor will (1) use meteorological and emissions inputs created under Subtasks 3c and 4; (2) create initial and boundary condition (IC/BC) and photolysis rates data for input.

Deliverables for this subtask will include (1) all input data files (meteorology, emissions, IC/BC, photolysis); (2) all base base model output data files; and (3) model run scripts and log files created for completion of this task.

Task 5b. Base Year Performance Evaluation

The purpose of this subtask is to evaluate photochemical model performance for ozone and its precursor data (where available) and speciated fine particulate matter in order to achieve reasonable baseyear model performance for development of future year emissions. The Contractor will (1) acquire all observational data sets (IMPROVE, STN, CASTNET, and SLAMS/NAMS ozone) to conduct performance analysis; (2) conduct a phenomenological and statistical performance evaluation of base year simulations; and (3) document results of performance analysis.

Deliverables for this subtask include (1) an interim report documenting final model configuration, outstanding issues not resolved from subtask 5b; (2) further recommendations for baseyear model performance improvement; (3) model performance analyses and results; (4) final datasets and software used to conduct model performance evaluation; and (5) documentation on how to perform analyses.

Task 6. Future Year Emissions Sensitivity Scenarios

The purpose of this task is to complete emissions sensitivity analyses for future development scenarios for the oil and gas sector consistent with the goals of MOU to provide a basis for describing future development projects within the airshed. Emissions sensitivity analyses will use model techniques and probing tools described in the protocol developed under task 2 of this project. The Contractor will (1) develop model ready emissions inputs from the future year inventory developed under Task 4 of this project; (2) develop model emission ready emission based upon projections for oil and gas growth scenarios to conduct sensitivities of future oil and gas development; (3) conduct air quality simulations for oil and gas emissions sensitivities using methods described in the protocol developed under Task 2 of the project; and (4) develop final documentation suitable for use as a technical support document for future resource development plans with emissions projections consistent with the emission ranges assumed for future year development scenarios.

Deliverables for this task include (1) a final report documenting future year emissions sensitivities; (2) documentation of methods for all model inputs and run scripts; and (3) all model output from emissions sensitivity scenarios.