S P T
Sea Port Oil Terminal

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October 1, 2019

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Return Receipt Requested

Ms. Ashley Mohr
Environmental Scientist
U.S. Environmental Protection Agency
Air Permits Section (6PD-R), Region 6 Main Office
1445 Ross Avenue
Dallas, TX 75202

Subject: Request for Approval for Use of COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for use with AERMOD

Dear Ms. Mohr,

SPOT Terminal Services LLC, a subsidiary of Enterprise Products Partners L.P. is proposing to construct, own, and operate the Sea Port Oil Terminal (SPOT, also the Project) in the Gulf of Mexico. SPOT will allow for the loading of crude oil on Very Large Crude Carriers (VLCCs) for export to the global market. SPOT deepwater port (DWP) would be located in federal waters within the Outer Continental Shelf (OCS), approximately 25 to 30 nautical miles (28.8 to 34.5 statute miles, or 46.3 to 55.6 kilometers) off the coast of Brazoria County, Texas. The DWP would be capable of loading crude oil at a rate of 85,000 barrels per hour (bbls/hr) to VLCCs. SPOT has filed an application for a license to construct, own, and operate the DWP pursuant to the Deepwater Port Act of 1974, as amended (DWPA), and in accordance with the U.S. Coast Guard's (USCG's) and the Maritime Administration's (MARAD's) implementing regulations.

The Project is subject to Prevention of Significant Deterioration (PSD) preconstruction permitting and the associated source impact analysis requirements of 40 Code of Federal Regulations [CFR] 52.21(k). The primary pollutant to be emitted would be volatile organic compounds (VOCs) from crude oil loading to the VLCCs. The primary sources of emissions are expected to be devices used to control VOCs from crude oil loading to the VLCCs. Platform-based minor sources would include a diesel engine for power generation, intermittent sources, such as a firewater pump diesel engine, an emergency electrical generator diesel engine, and a diesel engine stationary crane on the platform. Mobile sources for National Environmental Policy Act (NEPA) evaluation would include VLCC engine and support vessels.

SPOT is seeking approval for the proposed Project to use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented in the meteorological data processor program AERCOARE, to prepare meteorological data for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). AERCOARE, in conjunction with AERMOD (referred to as AERMOD-COARE in this request) is an alternative refined model for assessing compliance with air quality standards when emission sources and dispersion occur over water. The Offshore and Coastal Dispersion (OCD) model is currently listed as a preferred model for over-water dispersion in USEPA's Guideline on Air Quality Models (see Section 4.2.2.3 of Appendix W).

AERMOD-COARE is preferred by the Project over OCD because of the following technical reasons, options, and features available in the model:

1. The Plume Rise Model Enhancements (PRIME) downwash algorithm can be used to assess impacts in the cavity and wake regions of structures. While the OCD model does incorporate platform downwash, SPOT has proposed use of PRIME considering the platform as a solid structure which will result in conservative, overprediction of concentrations;

2. While not proposed for use in the SPOT project, the Plume Volume Molar Ratio Method (PVRMR) and Ozone Limiting Method (OLM) can be used to estimate the conversion of oxides of nitrogen (NOx) to nitrogen dioxide (NO_2). The Ambient Ratio Method (ARM2) screening technique however was used and was applied within the model;

3. Output can be generated in the statistical form that is needed to assess compliance with the newer statistically based National Ambient Air Quality Standards (NAAQS), such as 1-hour NO_2;

4. While SPOT has not proposed to model any area sources, concentrations can be estimated for dispersion resulting from point, area, and volume sources;

5. Calm wind conditions can be processed by the model;

6. The dispersion algorithm used in the AERMOD portion of AERMOD-COARE is considered state-of-art by USEPA. OCD is over 30 years old and the dispersion algorithms have not been updated to account for current advancements in dispersion theory. In addition, the OCD model is only applicable for evaluating dispersion of emissions from offshore sources that are located within 27 nautical miles (50 kilometers) of the shoreline. OCD requires input coordinates that define the shoreline and terrain elevation of the shoreline. OCD contains specific air pollutant calculation procedures to determine pollutant concentrations at these shoreline receptors that account for the change in the atmospheric boundary layer, hence dispersion characteristics, at the water/land transition at the shoreline. OCD's dispersion science becomes questionable near the 27-nautical-mile (50–kilometer) limit of the model and not applicable at and beyond 27 nautical miles (50 kilometers). Application of OCD for the SPOT Project is questionable at best because the shoreline is close to or beyond the 27-nautical-mile (50-kilometer) limit of the model, depending on the final location selected for the Project; and

7. While not proposed for use in the SPOT project, predicted meteorology from the Weather Research Forecasting (WRF) model can be used with AERCOARE. This capability eliminates the common difficulties associated with overwater buoy data collection and assimilation, such as hourly data recovery that does not meet minimum modeling requirements and the necessity to patch together data from multiple buoys and fill in missing values to meet minimum requirements. The Mesoscale Model Interface (MMIF) program can be used to read WRF data to generate the meteorology necessary for input to AERCOARE.

Pursuant to Section 3.0 and 3.2.2.a of 40 CFR 51, Appendix W (Guideline on Air Quality Models[1]), approval of an alternative refined model is the responsibility of the Regional Administrator—in this case, USEPA Region 6. There are three separate conditions outlined in Section 3.2.2.b of Appendix W under which an alternate model may be approved by the Regional Administrator for regulatory use. The first two conditions involve demonstrating that the alternative refined model produces concentrations equivalent to the preferred model or demonstrating that the alternative model performs better than the preferred model based upon measured air quality data. The Project is requesting approval for use of the AERMOD-COARE modeling system under Condition 3 which states that there is no preferred model. Even though OCD is listed as a preferred model in Appendix W, this request is made because the preferred model is less appropriate (i.e., old science) for its application to the Project. In addition, model performance of the AERMOD-COARE modeling approach has been found to be comparable to OCD using the tracer studies from overwater field studies.[2] In this study, the authors conclude that AERMOD-COARE could be applied as an alternative to OCD for many regulatory applications.

It should be noted that while the AERMOD-COARE model is technically superior to the OCD model, OCD currently has capabilities that AERMOD-COARE does not. Namely, OCD has algorithms to estimate the effects of both platform downwash as well as shoreline fumigation. The SPOT facility will employ a platform, so consideration of platform downwash effects is relevant. However, shoreline fumigation is of less concern given the distance of the proposed facility from the shoreline and considering that controlling concentrations will occur close to the facility overwater. In addition, SPOT has proposed to treat the platform as a solid structure without airflow under the platform. This procedure will result in an overestimate of downwash effects and lead to conservative, overprediction of concentrations.

Under Condition 3, there are five elements that must be addressed (see Section 3.2.2.e):

1. The model has received scientific peer review;
2. The model can be demonstrated to be applicable to the problem on a theoretical basis;
3. The databases that are necessary to perform the analysis are available and adequate;
4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and
5. A protocol on methods and procedures to be followed has been established.

In April of 2011, the U.S. Environmental Protection Agency (USEPA) Region 10 (R10) granted approval pursuant to Section 3.0 and 3.2.2.a for the use of output from the COARE algorithm coupled with AERMOD to estimate ambient air pollutant concentrations in an ice-free marine environment. [3,4] The COARE algorithm output was assembled with other meteorological variables in a spreadsheet to form the AERMOD overwater meteorological input files. The Applicant's request for the use of the COARE algorithm was modeled after R10's April 2011 approval. The 2011 approval was based upon the spreadsheet version of the COARE algorithm, not the current version of the COARE algorithm which is now included in the AERCOARE program. The Applicant has proposed to use the AERCOARE program, which includes the programmed version of COARE algorithm.

After USEPA's 2011 approval of the use of the COARE algorithm in spreadsheet form, R10 initiated additional studies in late 2011. One of the studies was designed to code the COARE air-sea flux procedure into the AERCOARE program, thereby eliminating the need to process the data in a spreadsheet. The AERCOARE program also provides support for missing data, adds options for the treatment of overwater mixing heights, and can consider many different data input formats. The results of this study are documented in an October 2012 USEPA report, Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources (EPA 910-R-12-007). The 2012 study employed the same four tracer studies that were employed in the initial study supporting the April 2011 approval of the spreadsheet version of the COARE output. The 2012 report demonstrates that the programmed AERCOARE version of the COARE results are similar to those made by the spreadsheet version of the COARE results. Comparison of the Q/Q and Sigma Plots from the 2011 and 2012 reports for each of the four tracer studies are nearly identical indicating similar model performance. The previous R10 approval of the COARE algorithms in spreadsheet form should therefore apply to the current COARE algorithms as included in AERCOARE.

As documented in the April 1, 2011, USEPA Region 10 memorandum, the AERMOD-COARE model was approved for use in an Artic marine ice-free environment because it satisfied the five criteria contained in Section 3.2.2.e of Appendix W. In its May 2011 concurrence memorandum, USEPA's Model Clearinghouse stated that its concurrence with USEPA Region 10's approval did not constitute a generic approval of AERMOD-COARE for other applications. However, USEPA's Model Clearinghouse stated:

> *"the scope of the assessment submitted with the R10 Model Clearinghouse request provides a good basis for consideration of AERMOD-COARE for other applications, subject to Regional Office approval based on an assessment of the appropriateness of the performance evaluations (element 4) and the availability of the necessary data bases (element 3) on a case-by-case basis".*

1. Therefore, the Project provides the following justification for each of the five elements contained in Section 3.2.2.e, with emphasis on elements 3 and 4. It should be noted that Region 10 approved of the use AERMOD-COARE based upon tracer studies conducted offshore California and Louisiana, areas far removed from an artic environment. As noted below, the Cameron, LA tracer study was conducted less than 250km from the proposed Project location. These data are more representative of the SPOT Project location than any data from the tracer studies used in Region 10's approval.**The model has received scientific peer review.**

The science behind COARE has been published in scientific peer review journals. The following information is provided as justification that the model has received scientific peer review. Information pertaining to scientific peer review can be found at the following site:

http://www.coaps.fsu.edu/COARE/.

In addition, a more thorough AERMOD-COARE evaluation study has been performed since the first case-by-case approval by USEPA Region 10 and the Model Clearinghouse of the alternative model. This study was conducted by ENVIRON under contract with USEPA (Contract No. EP-D-07-102, completed in October 2012)[5].

The following is an excerpt from Shell's February 18, 2011, response to the USEPA Region 10 Technical Staff AERMOD-COARE Information and Data Request, dated February 14, 2011, as presented in the April 1, 2011, USEPA Region 10 memorandum:

> *"As reflected in the report provided to EPA in December, Shell believes that COARE reflects the most up-to-date science for marine boundary layer conditions. The Coupled Ocean Atmosphere Response Experiment (COARE) began with research in the late 1970s that culminated in the release of the first COARE code in 1993. It has been updated and improved several time since 1993, the current version of the code was released in 2003. It has world-wide acceptance by organizations such as NOAA, the Institute of Atmospheric Physics, CSIRO in Australia, Woods Hole Oceanographic Institute, the French Centre d'Etude des Environments Terrestre et Planetaires and many others. In the ENVIRON report on the evaluation of the COARE-AERMOD method provided to EPA on December 16, 2010, a*

number of links were provided to reference papers on the topic. For example, one link leads to the following paper:

Brunke, Michael A., Chris W. Fairall, Xubin Zeng, Laurence Eymard, and Judith A. Curry, "Which Bulk Aerodynamic Algorithms are Least Problematic in Computing Ocean Surface Turbulent Fluxes", Journal of Climate, 15 February 2003, pp. 619-635.

This study reports that the COARE algorithm is a preferred method for estimating air mixing in a marine environment. There are many other papers referenced or linked to in the December ENVIRON report that provide a sound scientific basis for the COARE algorithm. We are not stating that it is the only method that could be used, but we have clearly made the required showing that, '[t]he technique has received scientific peer review."

2. The model can be demonstrated to be applicable to the problem on a theoretical basis.

The COARE Bulk Air-Sea Flux algorithm has been well vetted in the regulatory modeling community and has been shown to be applicable on a theoretical basis. USEPA has previously deemed the model appropriate for use in an Arctic marine ice-free environment.

As presented in the April 1, 2011, USEPA Region 10 memorandum:

Version 3.0 of the COARE algorithm with journal references and a User's Manual can be accessed at:

ftp://ftp.etl.noaa.gov/users/cfairall/wcrp_wgsf/computer_programs/cor3_0/

and

http://www.coaps.fsu.edu/COARE/flux_algor/

These references provided copies of the code, descriptions of the scientific basis for the code, and detailed descriptions on how to use the COARE program. However, Shell acknowledges that COARE was not specifically designed to provide an input file for AERMOD, and there are certain steps that must be taken to produce the input files for AERMOD.

Communication with Ken Richmond of ENVIRON and marine boundary layer experts Dr. Andrey Grachev and Dr. Chris Fairall from the National Oceanic and Atmospheric Administration (NOAA) provided the following insight:

From Dr. Chris Fairall:

"The original COARE version (2.5) (and the 2003 version (3.0)) was set up so that it could handle water and air temperatures from the tropics to the Arctic. Parameters such as the kinematic viscosity of air have T dependencies. I have listed below a few references to Arctic applications I dug up.

Minimum meteorological variables needed to run the COARE algorithm are the wind speed, the sea surface temperature, the air temperature, and some form of humidity measurement (e.g. relative humidity, absolute humidity, dew point, and wet bulb temperature). Barometric pressure, precipitation, and a typical mixed layer height are also input variables that can be provided or assigned by COARE default parameters. If options are selected for warm-layer heating and/or cool-

skin effects then solar radiation and downward longwave radiation are needed. Shell is not planning to invoke these options but has tested and provided a framework for the provision of these variables using measured solar radiation, cloud cover and ceiling height. COARE also contains several options for the surface roughness length based on wave period and wave height. Shell plans to use the default option that does not need these variables."

As stated in the AERCOARE User Manual:

"*AERCOARE uses Version 3.0 of the COARE algorithm that has been updated several times since the initial international TOGA-COARE field program in the western Pacific Ocean from November 1992 to February 1993. The basic algorithm uses air-sea temperature difference, overwater humidity, and wind speed measurements to estimate the sensible heat, latent heat, and momentum fluxes. The original algorithm was based on measurements in the tropics with winds generally less than 10 m/s, but has since been modified and extensively evaluated against measurements in high latitudes with winds up to 20 m/s. Based on these studies, AERCOARE is expected to be appropriate for marine conditions found at all latitudes including. The current version considers both warm-layer diurnal heating and cool-skin effects and allows alternative parameterizations of the surface roughness when wave measurements are available.*"

The COARE algorithms have been evaluated based upon data collected in field studies conducted in the Gulf. Based on this, and other studies, EPA has determined that the model is applicable to dispersion applications over a marine, ice free environment similar to the Gulf.

3. The databases that are necessary to perform the analysis are available and adequate.

The model evaluation datasets used in the AERCOARE validation studies were obtained from the archives supporting development of the Minerals Management Service (MMS) version of CALPUFF and OCD Version 4. Three datasets were evaluated: Carpinteria, and Pismo Beach, California, as well as Cameron, Louisiana. These studies occurred under a wide range of overwater atmospheric stabilities that might be expected in coastal waters regardless of the latitude. A key positive consideration in approving AERMOD-COARE for use by the Project is the availability of a validation study in the same Gulf of Mexico region as the Project location.

The pollutant dispersion tracer gas measurement study in Cameron, Louisiana, occurred in level terrain near the shoreline downwind of offshore tracer gas releases. The terrain and offshore conditions of this study mimic those found in the Project location since both are offshore in the western Gulf of Mexico. The Cameron, Louisiana, study, in conjunction with the Pismo Beach, California, study, provide two tests of overwater dispersion without the complications introduced due to air modification over the land or complex terrain[4]. The location of the Cameron, Louisiana, tracer gas experiment in the Gulf of Mexico in proximity to the proposed SPOT Project location is shown on Figure 1. The Cameron, Louisiana, evaluation database is, therefore, representative of the atmospheric conditions in the Gulf of Mexico in the vicinity of the Project.

Figure 2 shows the land use, release points, receptors, and meteorological stations for the Cameron, Louisiana, evaluation dataset. Twenty-six (26) tracer gas samples from the field studies in July 1981 and February 1982 were used in the evaluation. Tracer gas was released from both a boat and a low-profile platform at a height of 42.7 feet (13 meters) above the water surface. The receptors were located in flat terrain near the shoreline, with transport distances ranging from 2.5 to 6.2 statute miles (4 to 10 kilometers).

The Cameron, Louisiana, meteorological data used in the AERCOARE evaluation were based on the OCD and CALPUFF model evaluation dataset. The dataset contains both very stable and fairly unstable conditions. There are several hours of stable lapse rates accompanied by unstable air-sea temperature differences, thus providing a range of dispersion conditions.

Furthermore, the meteorological inputs needed to populate AERCOARE are available and adequate.

4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates.

The April 1, 2011, memorandum from USEPA Region 10, in conjunction with the USEPA/ENVIRON October 2012 Model Evaluation Study, present the detailed results of the model evaluation studies. These studies demonstrate that the model is not biased toward underestimates.

As documented in the October 2012 Model Evaluation Study, AERCOARE Version 1.0 (12275) was applied to prepare the overwater meteorological data for the Cameron, Louisiana, offshore dataset. AERCOARE simulations were conducted using five different methods for the preparation of the meteorological data, including the estimation of mixing heights, the use of horizontal wind direction (sigma theta data), and limitations on other variables provided to AERMOD to calculate concentrations from the field studies.

AERMOD was run using default dispersion options for rural flat terrain for the Cameron, Louisiana, simulations. Peak calculated concentrations were compared to peak observed concentrations (from tracer gas in-field concentration measurements), resulting in a total of 101 paired samples for statistical analysis. Quantile-quantile (Q-Q) plots were prepared, among other statistical analyses, to test the ability of the model predictions to represent the frequency distribution of the observations. Q-Q plots are ranked pairings of predicted and observed concentrations. The rank of the predicted concentration is plotted against the same ranking of the observed concentration. The Q-Q plots were evaluated to determine whether the models are biased toward underestimates at the important upper end of the frequency distribution.

The Q-Q plot for the Cameron, Louisiana, dataset is presented as Figure 3. As shown, the model concentrations generally are within the factor of 2 bounds of the plot. In addition, no apparent difference in the model performance under the five different AERCOARE meteorological data preparation cases were observed. The AERMOD predictions using AERCOARE-prepared meteorological data tend to be biased toward over-prediction for the highest concentrations, with less than a factor of 2 under-prediction at the lower concentrations. Importantly, COARE-AERMOD does not appear to be biased toward underestimates for the higher end of the frequency distribution, regardless of the five different meteorological preparation options examined in this study.

5. A protocol on methods and procedures to be followed has been established.

SPOT has developed and submitted a modeling protocol document for USEPA Region 6 review and approval. The modeling protocol outlines the modeling techniques that were employed by the SPOT Project, and it conforms with the modeling procedures outlined in the Guideline on Air Quality Models (Appendix W of 40 CFR 51), associated USEPA modeling policy and guidance, as well as Texas Commission on Environmental Quality (TCEQ) Air Quality Modeling Guidelines.

Summary

Based on the information and reasoning provided in this document, along with supporting references and data, SPOT believes that the proposed AERMOD-COARE modeling approach is justified as a more suitable method for estimating dispersion in the OCS of the Gulf of Mexico than OCD. The surface fluxes calculated by the COARE algorithm in conjunction with the overwater meteorological data are preferred to the conventional application of AERMET, which is only applicable over land surfaces. In addition, AERMOD is preferred over OCD because of the PRIME downwash algorithm, the ability to simulate volume sources, the ability to incorporate NOx to NO_2 conversion using ARM2, AERMOD's ability to generate the concentrations in the statistical form of the new NAAQS, and the distance of the proposed source location from the shoreline.

If you have any questions or require additional information, please contact Mr. David Keen (919) 845-1422 Ext. 41, Mr. Bruce Wattle (716) 651-3610, or the undersigned.

Sincerely,
SPOT Terminal Services LLC

Bradley J. Cooley, P.E.
Senior Manager, Environmental

Rodney M. Sartor
Senior Director, Environmental

/bjm

cc: Rodney Sartor, SPOT Terminal Services LLC
David Keen, RTP Environmental Associates, Inc.
Antonino Riccobono, Ecology and Environment, Inc.
Bruce Wattle, Ecology and Environment, Inc.

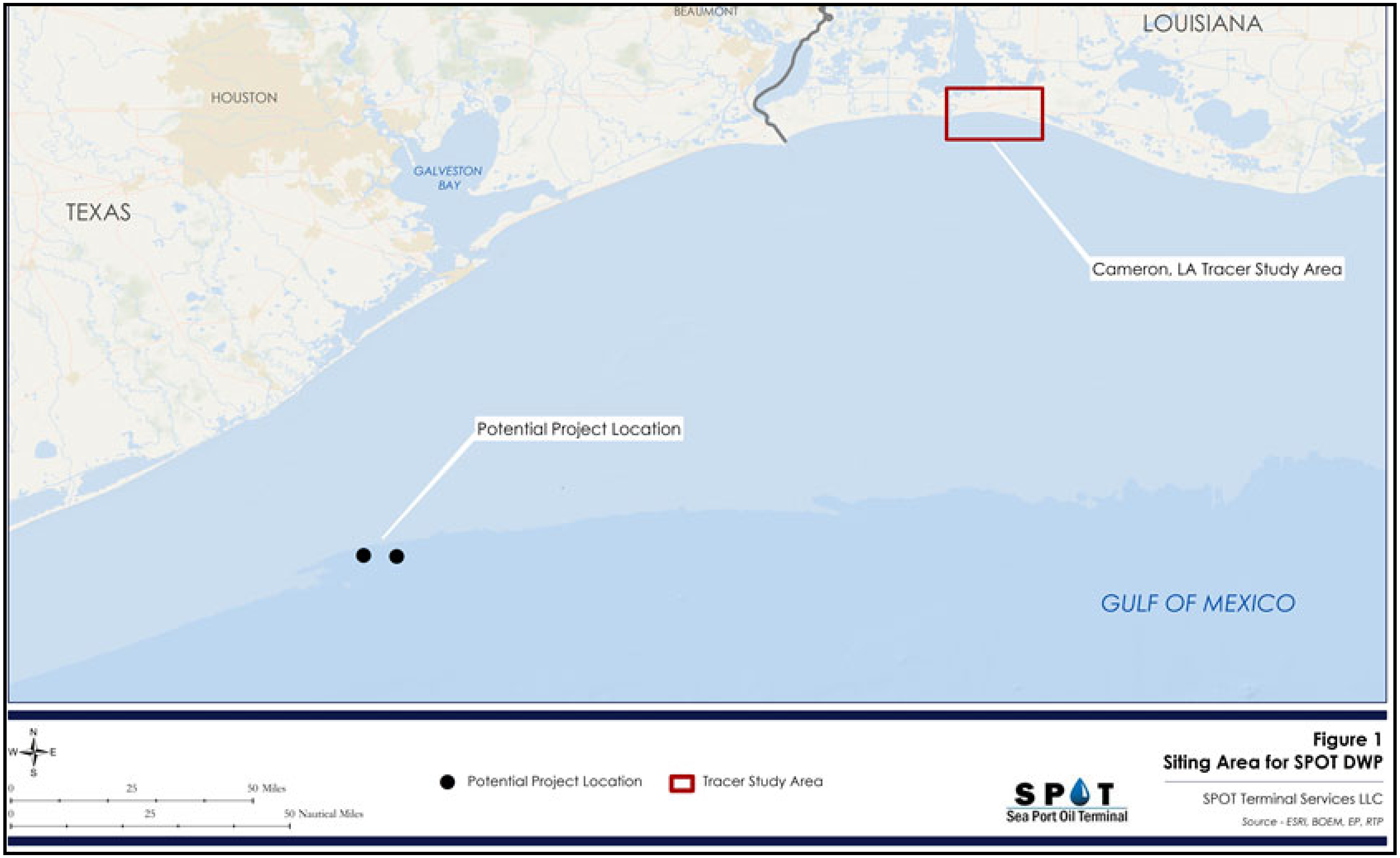

Figure 1. Siting Area for SPOT DWP

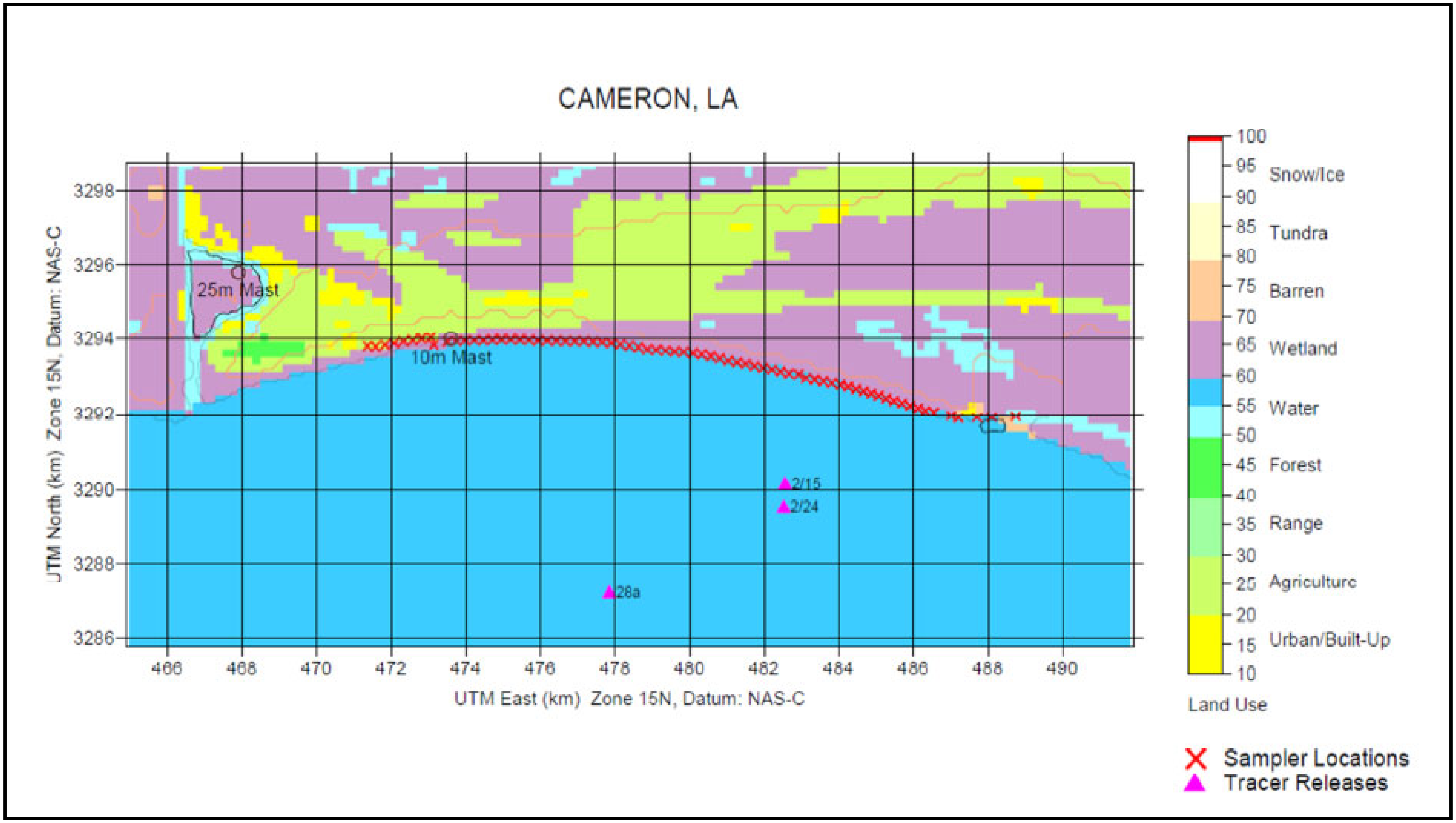

Figure 2. Cameron, Louisiana, Tracer Study Location Relative to the Contemplated Locations of the SPOT Loading Project

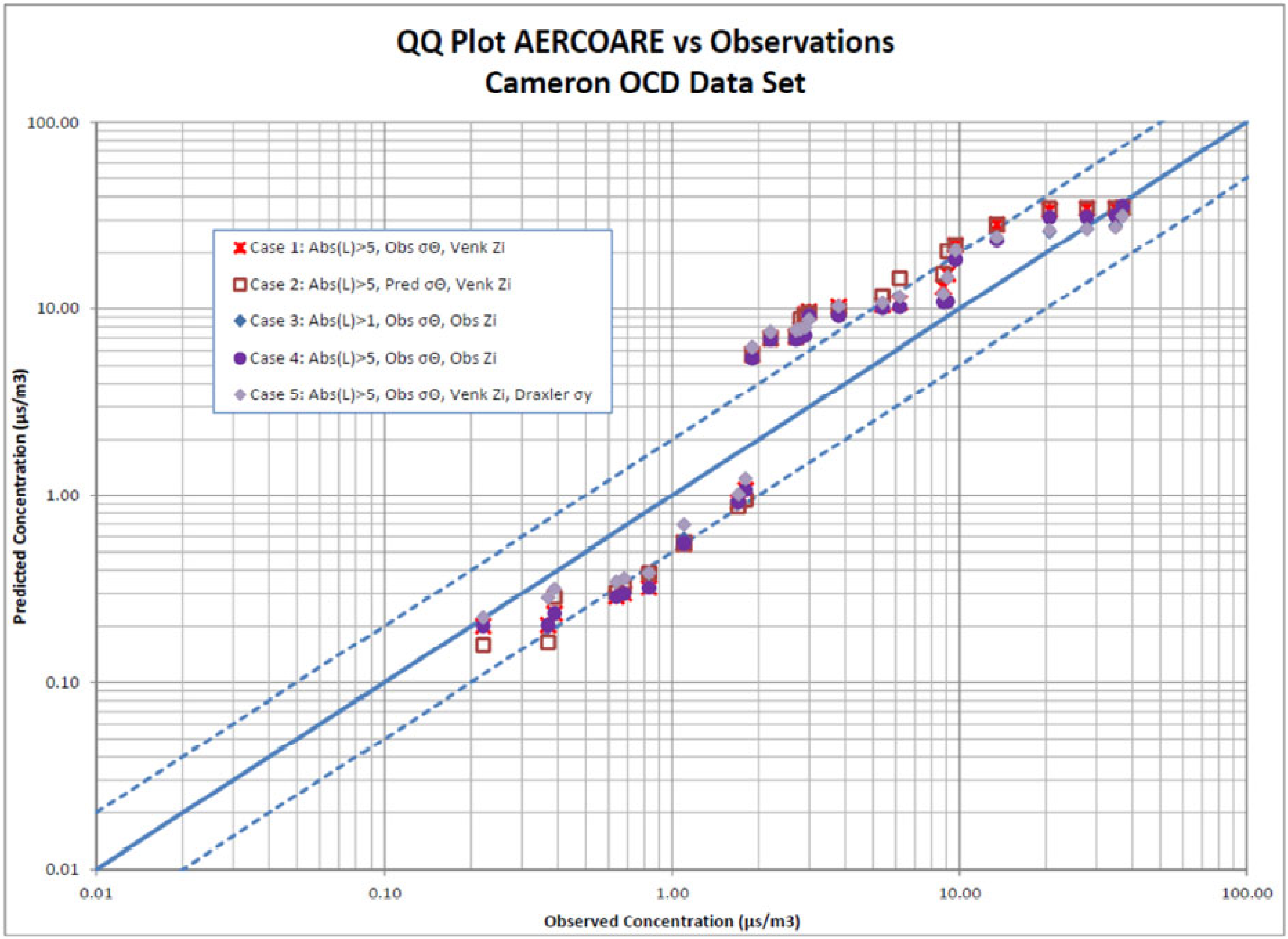

Figure 3. QQ Plot of AERCOARE vs Cameron, Louisiana, Tracer Study Results

REFERENCES

1. Guidelines on Air Quality Models, Appendix W of 40 CFR Part 51, January 17, 2017.

2 AERCOARE: An Overwater Meteorological Preprocessor for AERMOD, Wong, Herman, et. al, Journal of the Air & Waste Management Association, 2016, Vol 66, No 11, 1121-1140.

3. COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for Use with the AERMOD Dispersion Program; Section 3.2.2.e Alternative Refined Model Demonstration, Herman Wong, USEPA to Tyler Fox, USEPA, April 1, 2011.

4. Model Clearinghouse Review of AERMOD-COARE as an Alternative Model for Application in an Arctic Marine Ice-Free Environment, George Bridgers, USEPA to Herman Wong, USEPA, May 6, 2011.

5. Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources, USEPA Contract No. EP-D-07-102, EPA 910-R-12-007, October 2012.