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Air Quality Dispersion Modeling Report in Support of the Application for a Prevention of Significant Deterioration (PSD) Authorization and Significant Revision to Class I Air Quality Permit for Irvington Generating Station

Revision 3

Tucson Electric Power Company

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Quality information

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Appendix B: Technical and Policy Justification for Plume Merging: Tucson Electric Power's IGS RICE Project

Appendix C: Tucson Electric Power Company (Sundt) Generating Station: PLUVUE II Assessment of Visible Plumes at Saguaro National Park East and West – Revision 1

1. Introduction

1.1 Project Overview

The Tucson Electric Power Company ("TEP") owns and operates the Irvington Generating Station ("IGS"), also known as the H. Wilson Sundt Generating Station, pursuant to Class I Air Quality Permit No. 1052 issued by the Pima County Dept. of Environmental Quality ("PDEQ"). The facility currently comprises six electric generating units with a combined, nominal, net generating capacity of 470 megawatts ("MW").

TEP is requesting a revision to the Class I permit for the IGS, an authorization pursuant to the preconstruction Prevention of Significant Deterioration ("PSD") permitting regulations to expand the IGS, and an approval of construction of new affected sources under federal National Emissions Standards for Hazardous Air Pollutants ("NESHAP"). As part of the proposed expansion project, TEP proposes to install up to ten natural gas-fired, reciprocating internal combustion engines ("RICE"), each with a nominal net generating capacity of 19 MW. In conjunction with the RICE project, TEP will permanently cease operation of Units 1 and 2 at IGS, leaving the facility with a nominal, net generating capacity of 498 MW.

The proposed RICE project will modernize and expand the IGS by replacing two 1950's era electric utility steam generating units (IGS Unit 1 and 2) with ten high-efficiency, fast-responding, state-of-the-art RICE, each having a generating capacity of 19 MW (nominal). TEP's basic purpose and fundamental objective for the RICE project is to meet a critical need in its resource portfolio: reliable, efficient, grid-balancing resources which can ramp up quickly and provide 100 percent of their effective load carrying capability (ELCC) during multiple peak periods of any length. In conjunction with Energy Storage Systems (ESS) projects and other efforts described in the 2017 Integrated Resource Plan (IRP), the RICE project will support the integration of renewable resources, consistent with TEP's 30 percent target by 2030. Tangential benefits of the proposed RICE project include anticipated reductions in the capacity factors of the less-efficient steam generating units at IGS and improved overall environmental performance, including decreased water usage and wastewater discharge.

The dispersion modeling analyses conducted for the RICE project adhere to the United States Environmental Protection Agency (EPA) "Revisions to the Guideline on Air Quality Models" (GAQM, which is contained in 40 CFR Part 51, Appendix W)[1], direction received from the Pima County Department of Environmental Quality (PDEQ) and local Pima County air quality guidance[2], with the revised air dispersion modeling protocol submitted to PDEQ on December 22, 2017, and with further guidance from EPA Region 9 and the National Park Service.

This version of the report includes minor updates to the gas exit temperature and velocity associated with two of the ten RICE units that will now be used (instead of the to-be-retired IGS Units 1 and 2) to provide heated steam to an adjacent asphalt plant. An updated building layout for the structures near to and housing the RICE units has also been incorporated.

[1] 82 FR 5182. https://www.federalregister.gov/documents/2017/01/17/2016-31747/revisions-to-the-guideline-on-air-quality-models-enhancements-to-the-aermod-dispersion-modeling .
[2] PCC § 17.16.590(A)(6). https://library.municode.com/az/pima_county/codes/code_of_ordinances.

In addition to the revised modeling parameters for two RICE units, EPA has indicated new guidance is pending for assessing fine Particular Matter ($PM_{2.5}$) impacts, which includes both primary and secondary formation of $PM_{2.5}$. The original modeling only included primary $PM_{2.5}$ from the project as an analysis of secondary $PM_{2.5}$ formation was not required per the existing 2014 EPA guidance[3]. Furthermore, the significant impact level (SIL) for annual $PM_{2.5}$ was reduced from 0.3 $\mu g/m^3$ to 0.2 $\mu g/m^3$, as stated in EPA's April 17, 2018 memorandum on SIL guidance for ozone and fine particles[4].

In April 2018, EPA released a new version of AERMOD (version 18081), along with its meteorological and terrain pre-processors AERMET and AERMAP, respectively. The revised modeling includes the reprocessing of the receptor grids (Class I and Class II) used in the AERMOD dispersion modeling analysis.

1.2 Purpose of Modeling Report

The purpose of this document is to present the air dispersion modeling analyses for the minor project modification that were performed in support of the air permit application for the RICE project. Modeling methods and assumptions, including model selection and options, meteorological data and source parameters used in the modeling analyses, are presented in this document for review and approval by PDEQ.

1.3 Contents of the Modeling Report

Section 2 of this report contains a project description, including information regarding the equipment, location and the expected air pollutant emissions. Sections 3 through 5 present a detailed description of the modeling approach used in evaluating air quality impacts of the proposed RICE project including preconstruction ambient air quality, model selection criteria, good engineering practice stack height determination, refined modeling analyses, ambient air quality compliance, and additional impacts analyses. Section 6 summarizes the modeling changes and its impact on the results.

[3] Available at https://www3.epa.gov/scram001/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf. An updated guidance document is not yet available from EPA as of early September 2018.

[4] EPA Memo on Guidance on Significant Impact Levels for Ozone and Fine Particles in Prevention of Significant Deterioration Permitting Program. April 17, 2018. https://www.epa.gov/sites/production/files/2018-04/documents/sils_policy_guidance_document_final_signed_4-17-18.pdf.

2. Project Description

2.1 Project Location and Layout

As previously stated, the proposed RICE project will be constructed at the existing IGS located in Tucson, Arizona, approximately 2 miles northeast of Tucson International Airport. The coordinates of the IGS are 509,448.00 meters Easting, 3,557,910.00 meters Northing in Universal Transverse Mercator (UTM) Zone 12 referenced to NAD 83. An aerial map of the site region is provided in **Figure 2-1**. This figure shows the project location, which is located only about 450 meters from existing units at the plant.

The terrain surrounding IGS is generally flat within 10 kilometers before the landscape changes with the addition of rolling hills, rugged canyons and mountain peaks. **Figure 2-2** shows the varying elevations associated with these features near IGS.

2.2 Description of the Proposed Engines

The proposed modification at IGS includes the installation of ten RICEs, each with a nominal net generating capacity of 19 MW. These engines will only be fired with natural gas. The ten engines will be grouped into two sets of five engines as shown in Figure 2-3. The five stacks from each group were modeled as two sets of merged stacks; one merged stack that combines 3 RICE stacks with a separation less than one stack diameter from each other, and a second merged stack that combines the remaining 2 RICE stacks (with a separation less than one stack diameter; as depicted in **Figure 2-4**) in the group of 5 RICEs. This method is consistent with EPA Model Clearinghouse Memo 91-II-01[5], creating the appearance of four new stacks at IGS. In consultation with the reviewing agencies, EPA Region 9 has granted TEP approval to use this configuration of 3-and-2 stacks for each group of 5 stacks in the model (Appendix A of this modeling report) as the stacks being merged are separated by a distance that is less than their diameter. Further justification supporting this more accurate characterization of the sources is provided in Appendix B of this modeling report.

Each of the ten RICE installed at IGS will be equipped with two air pollution control devices:

- An oxidation catalyst system to control emissions of volatile organic compounds ("VOC"), carbon monoxide (CO), and organic hazardous air pollutants such as formaldehyde; and,
- A selective catalytic reduction ("SCR") system to control emissions of nitrogen oxides (NO_X). Aqueous ammonia will be injected upstream of the SCR catalyst module to act as a reductant.

[5] Available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=91-II%20%20-01.

Figure 2-1 Aerial Image of the Irvington Generating Station

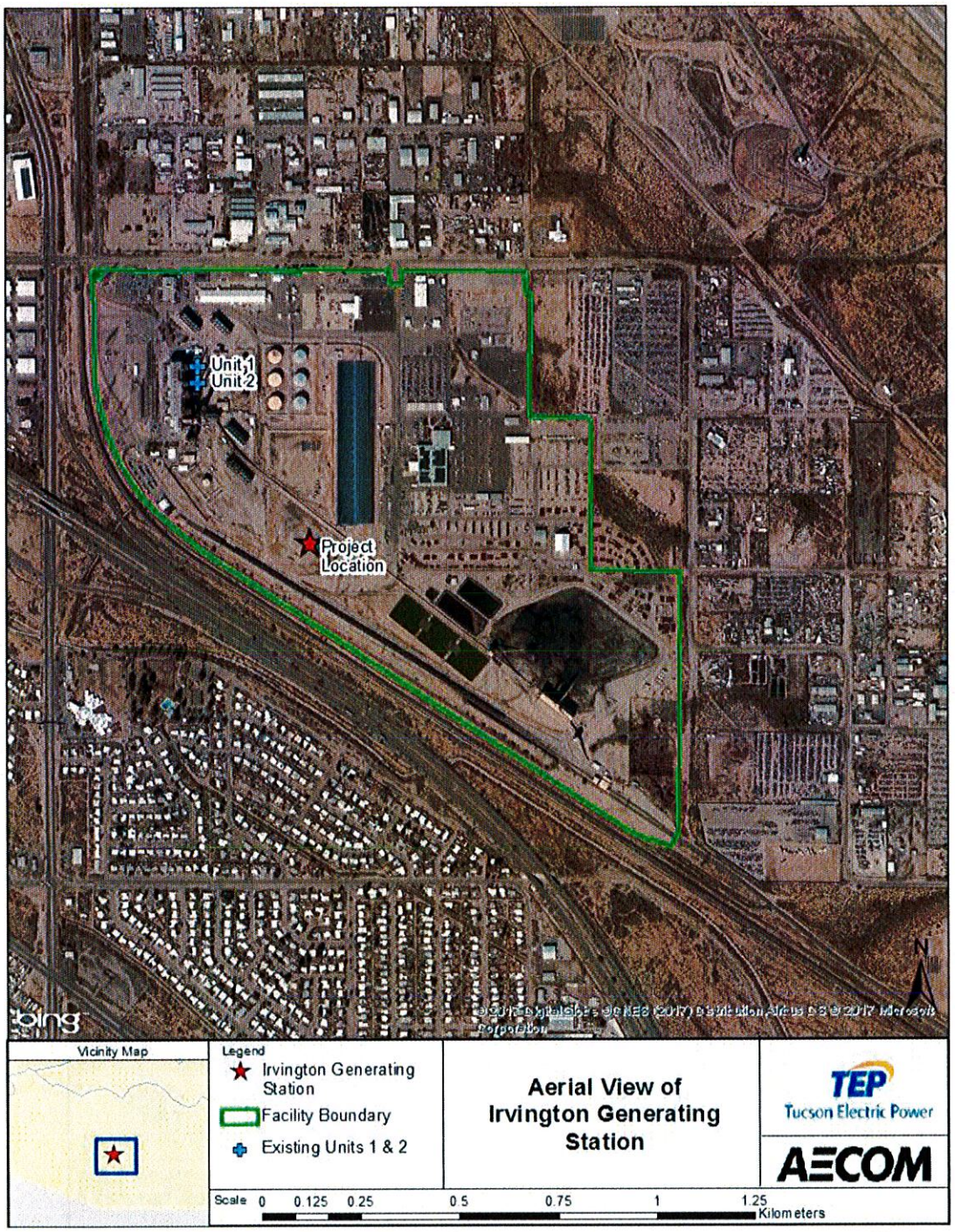


Figure 2-2 Topographic Map Showing Terrain Features Surrounding the Irvington Generating Station

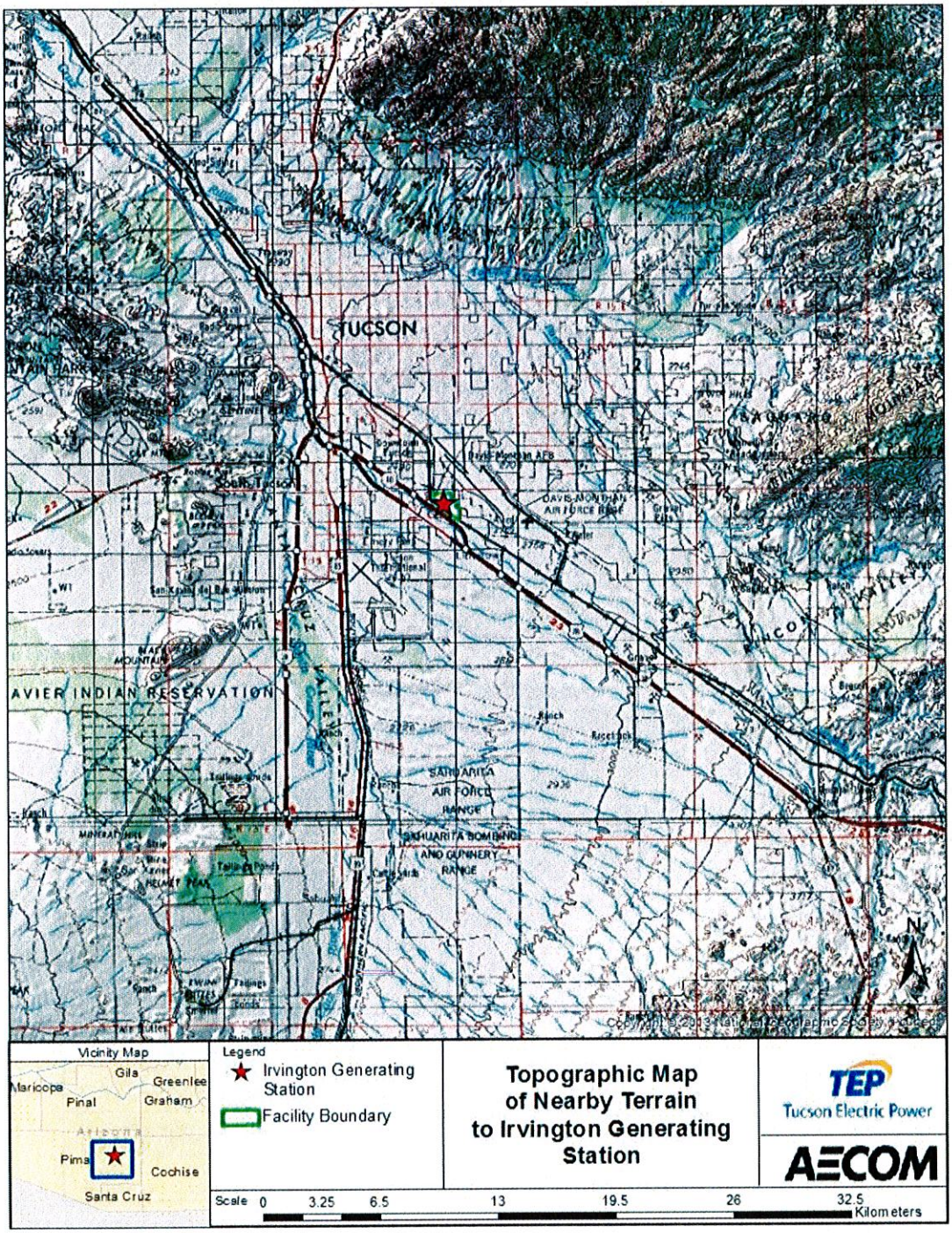


Figure 2-3 Proposed Project Layout in the Vicinity of the RICEs

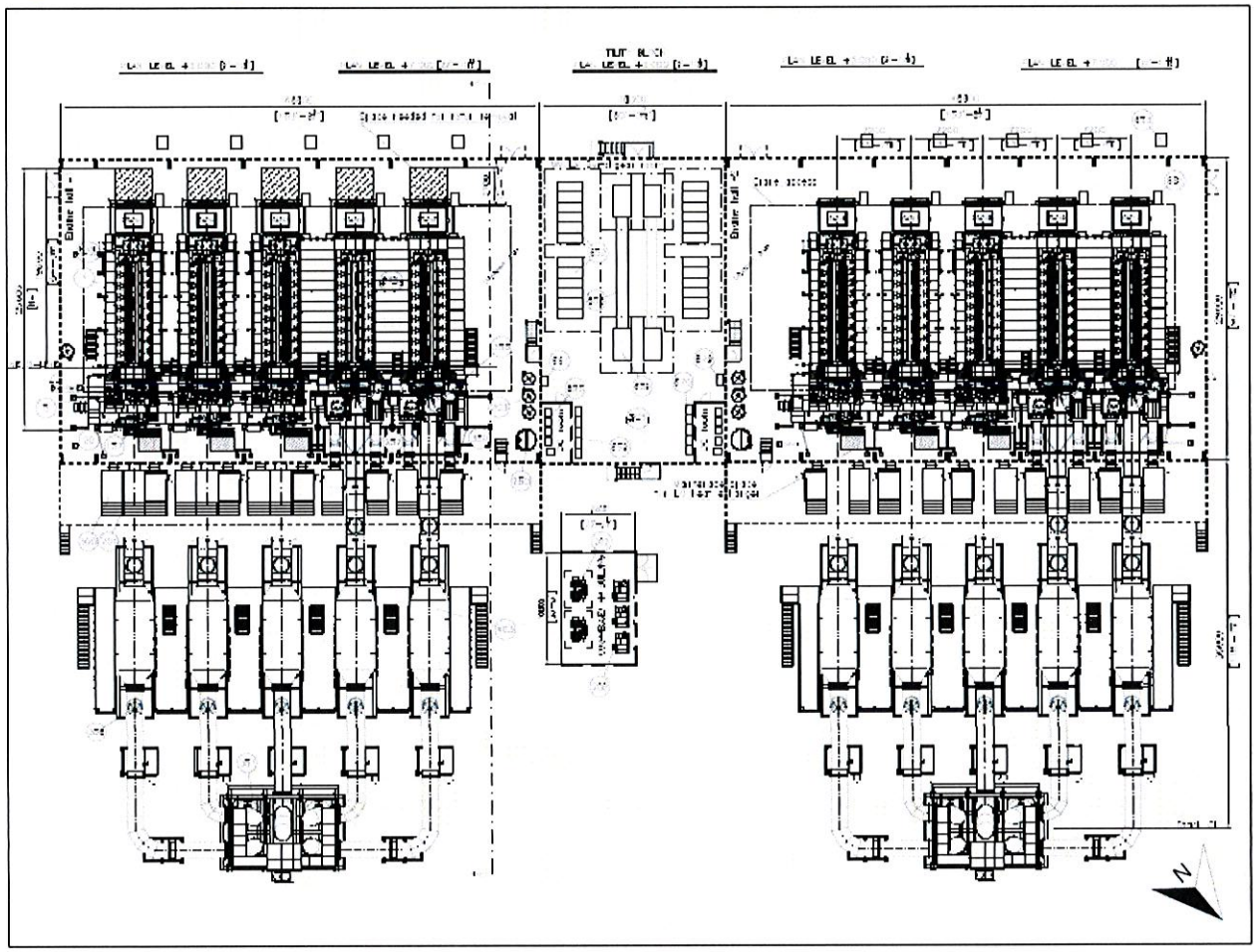
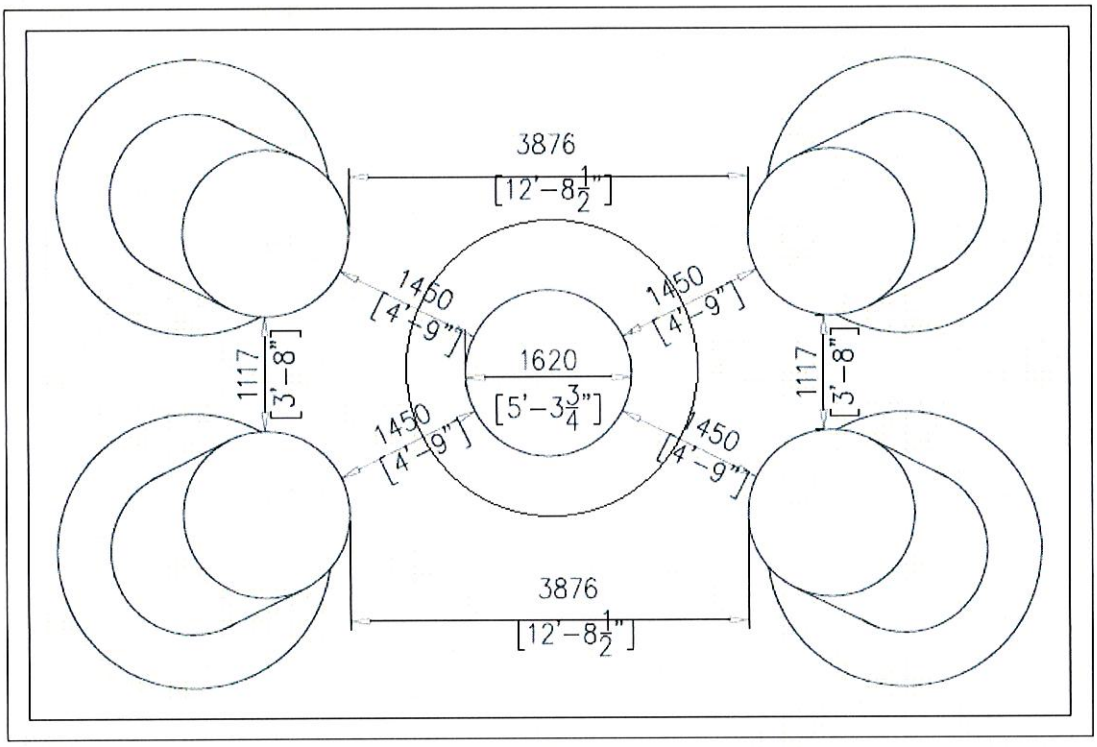


Figure 2-4 Drawing of RICE Stack Configuration with Dimensions



Note: Exterior stack diameter value provided in drawing. The interior flue diameter is 5.25'.

2.3 PSD Applicability

IGS is considered a fossil fuel-fired steam electric plant (one of the "major source categories" identified in section 169 of the Clean Air Act), and is therefore subject to the Prevention of Significant Deterioration (PSD) permitting requirements. The area around IGS is currently designated as attainment or unclassifiable for all criteria pollutants[6]. The expected annual emissions increases from the proposed engines were compared to the PSD significant levels in **Table 2-1** to determine the PSD applicability. The RICE project at IGS will constitute a major modification at IGS and has the potential to increase emissions by more than 100 tons per year of carbon monoxide (CO), 15 tons PM_{10}, 10 tons of $PM_{2.5}$, and 40 tons of volatile organic compounds (VOC). In addition, the project will exceed the PSD threshold for Greenhouse Gas (GHG). The Project will not exceed PSD thresholds for NO_x, SO_2, or Lead. Based on this review, CO, VOC, PM_{10} and $PM_{2.5}$ will trigger dispersion modeling requirements.

Table 2-1 PSD Significant Emission Rate Thresholds

Pollutant	PSD Threshold Emission Rates (tons/year)
Carbon monoxide (CO)	100
Nitrogen oxides (NO_x)	40
Sulfur dioxide (SO_2)	40
Particulate matter (PM)	25
Particulate matter (PM_{10})	15
Particulate matter ($PM_{2.5}$)	10
Volatile Organic Compounds (VOC)	40

[6] 40 CFR § 81.303. https://www.gpo.gov/fdsys/granule/CFR-2012-title40-vol18/CFR-2012-title40-vol18-sec81-303.

3. Background Air Quality and Pre-Construction Monitoring

3.1 Pre-construction Monitoring Requirements

In accordance with pre-construction monitoring requirements (40 CFR 52.21(m)), an application for a PSD permit must contain an analysis of ambient air quality in the vicinity of the proposed Project for each pollutant subject to PSD review. The definition of existing air quality can be satisfied by air measurements from either a state-operated or private network, or by a pre-construction monitoring program that is specifically designed to collect data in the vicinity of the proposed source. A source can fulfill the pre-construction monitoring requirement for PSD without conducting on-site monitoring if data collected from existing monitoring sites are conservatively representative of the air quality in the vicinity of the proposed Project site.

The existing monitoring data must be determined by the reviewing authority to be representative of air quality for the area in which the proposed project would be constructed and operated. In determining whether ambient monitoring data can be considered representative for satisfying the PSD pre-construction monitoring requirement for a project, the EPA guidance in "*Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*" (EPA-450/4-87-007, May 1987) was reviewed. The PSD ambient monitoring guidelines note three major items which need to be considered in determining the representativeness of existing data: 1) ambient monitor location, 2) quality of the data, and 3) temporal representativeness (how current the data is). These three criteria are discussed below.

Figure 3-1 shows the locations of these monitors relative to the Project site. The CO/ozone monitor at 22nd and Craycroft is approximately 5 kilometers northeast of IGS. The South Tucson PM10 monitor is located approximately 6 kilometers northwest of IGS and the Children's Park PM2.5 monitor is located approximately 15 kilometers north-northwest of IGS. These monitors are well situated such that emissions from IGS and other sources in the downtown Tucson area would impact these monitors based on the wind rose in **Figure 4-1**.

EPA maintains data capture statistics for all monitors in their design value tables[7]. Data capture for CO is 99%, O3 is 100%, PM10 is 96% and PM2.5 is 90%. These monitors meet the 75% data capture requirements set by EPA for the most recent three-year period available (2014-2016).

For temporal representativeness, it is desirable that the data generally have been collected for the most recent one-year period preceding a PSD permit application. However, in some cases, older ambient monitoring data could be considered conservative for representative background purposes if there have not been substantial changes in the operations of existing sources in the area and no new sources have been permitted in the interim. In fact, it is more likely that emissions have been retired, and the older monitoring data overstates the pollutant concentration levels. This is likely to be the case since various new air pollution control programs, such as the reduction in particulate emissions

[7] https://www.epa.gov/air-trends/air-quality-design-values#report

from diesel vehicles, have been implemented in the interim period between data collection and submittal of the permit application.

Table 3-1 provides a summary of the most recent 3-year period (2014-2016) ambient background design values.

Table 3-1 Background Design Values for TEP Project Site

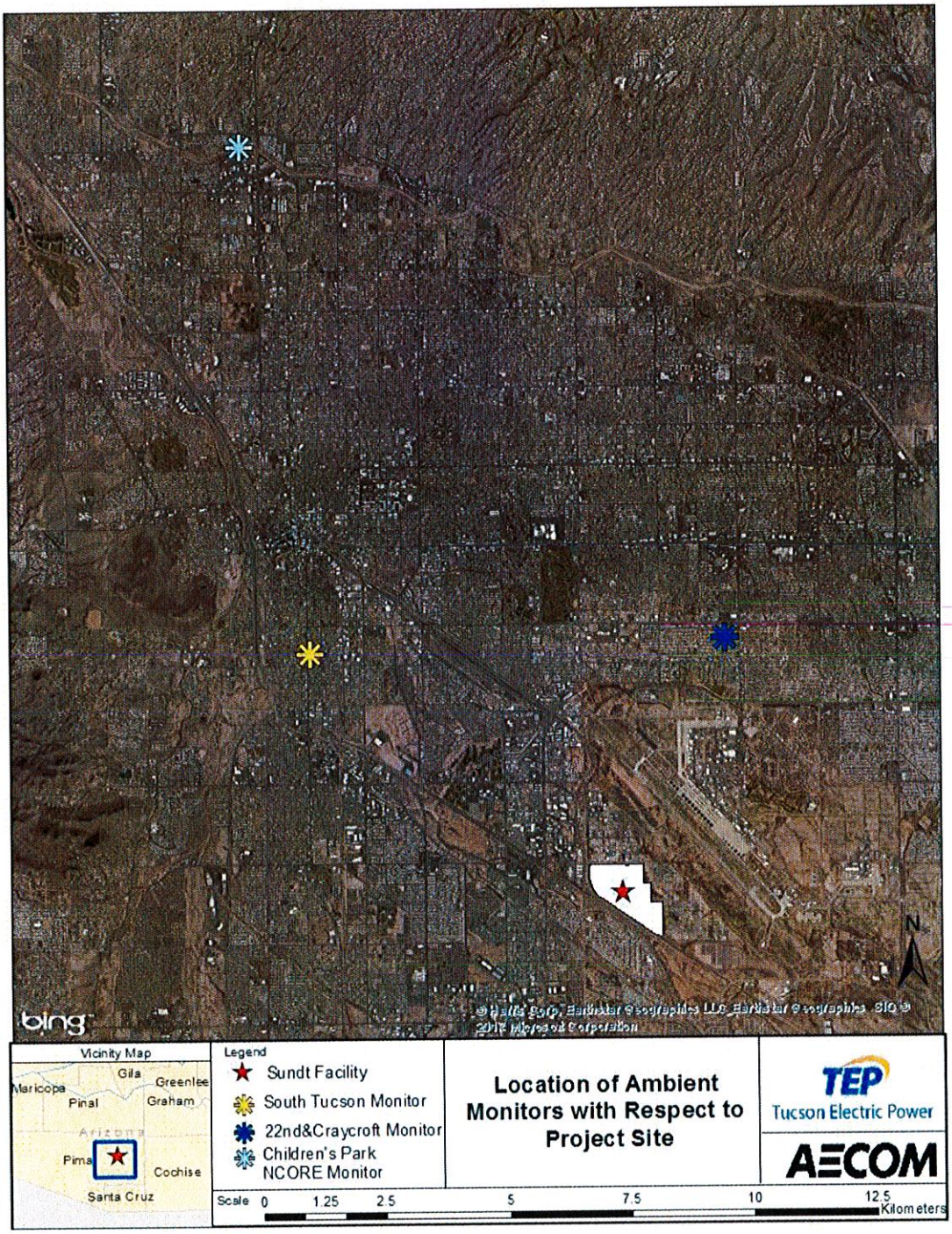
Pollutant	Monitor Location	Avg. Period	Design Value[1]	SIL	NAAQS	Units
CO	22nd & Craycroft	1-hr	1.2	1.75[2]	35	ppm
CO	22nd & Craycroft	8-hr	0.7	0.44[2]	9	ppm
O_3	22nd & Craycroft	8-hr	0.062	0.001[3]	0.070	ppm
PM_{10}	South Tucson	24-hr	101	5.0[2]	150	µg/m³
$PM_{2.5}$	Children's Park NCORE	24-hr	11	1.2[3]	35	µg/m³
		Annual	5.1	0.2[3]	12	

[1] *Design Values based on 2014-2016 period.*
[2] *40 CFR 51.165(b)(2).https://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol2/pdf/CFR-2011-title40-vol2-sec51-165.pdf.*
[3] *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. hhttps://www.epa.gov/sites/production/files/2018-04/documents/sils_policy_guidance_document_final_signed_4-17-18.pdf.*

3.2 Background Concentrations for Modeling

Recent guidance states that modeled impacts should not be compared to the Significant Impact Levels (SILs) if the background monitor values, when added to the SILs, exceed the NAAQS. **Table 3-1** shows the ambient monitor values for the most recent three years in comparison to the SILs and the NAAQS. It is evident that the monitored values plus the SILs are well below the NAAQS, so the SILs may be used to obtain a waiver from cumulative modeling for this modeling application.

Figure 3-1 Locations of Nearby Ambient Monitors



4. Air Quality Impact Assessment

4.1 Background Discussion

The proposed Project will be a major modification for VOCs, CO, $PM_{2.5}$, and PM_{10}; therefore, PSD review and associated dispersion modeling analysis is required for these pollutants. Modeling analyses performed for these pollutants have been evaluated for compliance with applicable thresholds and are presented in Sections 4.7 and 4.8. The evaluation for VOC is discussed in Section 4.9. There are no modeling requirements for GHGs.

As will be discussed in the following sections of this report, the dispersion modeling for the RICE project has been conducted in a manner that tests a range of the engines' operating conditions, as advised by the reviewing agencies, in an effort to predict the highest impact for each pollutant and averaging period.

4.2 Source Data

The air dispersion modeling analysis was conducted with emission rates and flue gas exhaust characteristics (flow rate and temperature) for a range of operating conditions for the proposed RICE project. The stacks from each of the 10 engines were bundled or clustered together in two groups of five and were modeled as four merged stacks. Modeling assumes that the exhaust from three RICE units in each of the two groups of five engines are tied into two of the four merged stacks, while exhaust from two RICEs in the two groups of five engines are tied into the remaining two merged stacks.

A summary of the engine exhaust data for the PSD-regulated pollutants that were modeled is provided in **Table 4-1**. An equivalent diameter and gas exit velocity calculation for the merged stack configuration noted above, is also shown in the table. The formulas used to calculate the equivalent diameter and gas exit velocity of the merged stacks are provided in equations 1 and 2, respectfully.

$$\text{Equivalent Diameter} = 2 * \sqrt{\frac{\left(\pi * \left(\frac{d}{2}\right)^2\right) * n}{\pi}} \quad (1)$$

$$\text{Velocity} = \frac{ACFM * n}{60 * \pi * \left(\frac{equivalent\ d}{2}\right)^2} \quad (2)$$

Where;

ACFM = Gas flow from single stack in units of actual cubic feet per minute,

n is the number of individual engine stacks being merged,

d is the diameter of each individual stack in units of feet,

equivalent diameter is in units of feet, and

velocity is in units of feet per second.

Criteria pollutant emissions for the engines are presented in the following sub-sections.

4.2.1 Normal and Startup Emissions

Each engine was modeled assuming 8,760 hours of operation per year. For CO (a pollutant with a 1-hour average NAAQS), all ten engines were conservatively assumed to start simultaneously for each hour modeled over the course of the 5-year period. Startup conditions apply to engine loads less than 25% of full load; when the 25% load is attained, the pollution control equipment is fully operational. The time needed for a startup is, at most, about 30 minutes for a "cold start" (with several hours in between engine operations), while it is even shorter for starts in which the engine is still warmer than ambient temperature. The modeling for startup for CO emissions was conservatively done assuming a cold start each hour, which is physically impossible.

The vendor for the RICEs provided TEP with estimated emission rates and exhaust parameters for the varying load conditions (25%, 50%, and 100%), as shown in **Table 4-1**. Since these emission specifications are not guaranteed, TEP has added a buffer to the emission rates to ensure they will be able to comply with the proposed PSD conditions, which include 5 startups per day per engine for $PM_{10}/PM_{2.5}$. Startup emission rates are shown in **Table 4-2**. The buffer was calculated by scaling the vendor-supplied emission rates such that the full load emission rate would match the proposed permit value. For example, PM_{10} and $PM_{2.5}$ the scaling factor is 1.331 (2.37 lb/hr (1-hour non-startup) / 1.78 lb/hr (vendor 1-hour non-startup)). This scaling factor was subsequently applied to the vendor-supplied non-startup emission rates for min and mid-loads.

Modeling of PM_{10} and $PM_{2.5}$ (with daily average NAAQS) assumed a maximum of 5 startup events per day. For example, for the full load case, the daily average emission rates assumed 5 startup event emissions (1.8 lb/30 minutes during these events) and 21.5 hours of non-startup (normal) emissions (2.37 lb/hr during these periods). The daily average emission rates in this case would be calculated as: ((2.37 lb/hr x 21.5 hours + 1.8 lb/event x 5 startups) / 24 hours in day) = 2.5 lb/hr. This 24-hour average rate of 2.5 lb/hr was used for the 24-hour and annual averaging periods. For the 8-hour averaging period of CO at full load, the emission rate assumes 8 hours of startup emissions. As stated above, for the 1-hour averaging period of CO at full load, the modeled emission rate assumes all 10 engines start simultaneously in the same hour, every hour of the year.

Table 4-1 Vendor-Supplied Maximum Emission Rates and Exhaust Parameters During Non-Startup Operations for Various Loads

Engine Load (%)	CO[1] (lb/hr)	PM_{10}[1] (lb/hr)	$PM_{2.5}$[1] (lb/hr)	Gas Exit Temperature (K)	Exhaust Gas Flow (lb/s)
100	2.64	1.78	1.78	628.706	64.8
50	1.85	1.47	1.47	700.372	33.8
25	1.14	0.96	0.96	703.706	21

(1) Emission rates are per engine under ambient conditions of 90°F, 9% relative humidity, and altitude of 2,630 ft.

Table 4-2 Vendor-Supplied Cold Startup Emission Rates

Startup	CO[1] (lb/30 min)	PM_{10}[1] (lb/30 min)	$PM_{2.5}$[1] (lb/30 min)
Cold	9.1	1.8	1.8

(1) A cold catalyst start is when the temperature of the catalyst material inside the reactor is close to ambient temperature. Cold catalyst starts are expected after over haul periods or when the engine has not been operated during the last 2-3 days.

The scaled emission rates for each engine at 25%, 50%, and 100% operating loads are summarized in **Table 4-4**. The emission rates during startup conditions are either equal to or greater than the normal operations; therefore the worst-case scenario modeled included the startup emission rates.

IGS currently provides heated steam to an adjacent asphalt plant by means of existing IGS Units 1 and 2. Both existing units will be decommissioned as part of the installation of 10 RICE units at TEP. Therefore, 2 of the 10 RICE units will serve as replacement heat sources for the asphalt plant. This process will result in lower exhaust gas temperatures from the 2 RICE units.

The RICE vendor provided TEP with adjusted exhaust gas temperatures and velocities for the two RICE units that would supply heat to the asphalt plant. Exhaust temperatures and velocities were provided for 100%, 50% and 25% engine loads for varying wind speeds as shown in **Table 4-3**. Wind speed thresholds were selected based upon the minimum, maximum and average wind speeds reported from the 2012-2016 Tucson meteorological data used in the modeling and provided by the Arizona Department of Environmental Quality (ADEQ). For the revised modeling, the worst-case temperature (lowest) and velocities (lowest) for plume dispersion were selected for each engine load, which happened to occur at the maximum wind speed.

Table 4-3 Exhaust Temperature and Velocity for RICE Units Supplying Steam to Asphalt Plant by Load and Wind Speed Conditions

Scenario[(1)]	Wind Speed (m/s)	Exit Temperature (°C)	Exit Velocity (m/s)
100% Load	0.00	165	17.2
	3.53	159	17.0
	27.46	**148**	**16.5**
50% Load	0.00	149	8.6
	3.53	140	8.4
	27.46	**140**	**8.2**
25% Load	0.00	142	5.2
	3.53	132	5.1
	27.46	**122**	**5.0**

1. Bold values denote worst-case stack parameters for modeling.

RICE units 5 and 6 will be used to supply heated steam to the adjacent asphalt plant. Both of these units are modeled as a 3-unit merged stack. For example, RICE units 3, 4 and 5 were grouped as a merged stack and units 6, 7, 8 are merged for modeling purposes, as discussed in Section 4.2. Therefore, only the stacks involving 3 merged unit exhaust streams are affected by this supply of steam process. For these merged stacks, the weighted average of the temperature and velocity were calculated. **Table 4-4** summarizes the stack parameters for each merged stack and operating load.

The exhaust flow (lb/s) is converted to standard cubic feet per second based on the molecular weight of the flue gas and the ideal gas law for standard conditions (385.55 scf/lb mole at 1 atm and 68 F). The molecular weight of the RICE unit flue gas was not available. Air has an O_2 concentration of 20.9% and a molecular weight of 28.97 lb/lb mole. The molecular weight of flue gas for large natural gas fired gas turbines operating at approximately 13% O_2 is approximately 28.31 lb/lb mole. Lean burn engines such as the RICE units operate with fuel gas O_2 concentrations of approximately 10%, resulting in a molecular weight between 28.31 lb/lb mole and 28.97 lb/lb mole.

The exhaust flow as standard cubic feet per second is converted to actual cubic feet per second based on the actual temperature from the RICE units (provided by the RICE vendor) and the atmospheric pressure at the site. At the site elevation of 800 m, the atmospheric pressure is 0.91 atm. The actual flow rate is converted to velocity based on the stack cross sectional area.

Table 4-4 Emissions Summary and Stack Parameters for Modeling (pounds per hour per engine)

Scenario[1]	Stack Height (ft)	Stack Diameter (ft)	Exit Temp. (°F)	Exit Velocity (m/s)	Maximum Short-Term Emissions (lb/hr per RICE)[2], [3]		
					CO[3]	PM_{10}[4]	$PM_{2.5}$[4]
100% Load; 2 Merged Stacks	160	7.4	**628.706**	28.985	**18.220**	**2.500**	**2.500**
50% Load; 2 Merged Stacks	160	7.4	700.372	16.842	**18.220**	2.128	2.128
25% Load; 2 Merged Stacks	160	7.4	703.706	**10.513**	**18.220**	1.520	1.520
100% Load; 3 Merged Stacks	160	9.1	576.624[5]	25.790[5]	**18.220**	2.500	2.500
50% Load; 3 Merged Stacks	160	9.1	634.943[5]	14.536[5]	**18.220**	2.128	2.128
25% Load; 3 Merged Stacks	160	9.1	636.055[5]	8.975[5]	**18.220**	1.520	1.520

(1) Data presented are for multiple operating loads/conditions for 2 types of merged stack configurations.
(2) Bold italicized numbers indicate highest emissions, lowest temperature, and lowest exhaust velocity.
(3) Emission rates based on cold start for every hour.
(4) Emission rates include five 30 minute cold startup events per day.
(5) Temperature and velocity adjusted based on Units 5 & 6 supply heat steam to asphalt plant.

4.3 Model Selection

The suitability of an air quality dispersion model for a particular application is dependent upon several factors. The following selection criteria were evaluated:

- stack height relative to nearby structures;
- dispersion environment;
- local terrain; and
- representative meteorological data.

Pima County's rule pertaining to air quality modeling refers to EPA's 2005 version of Appendix W and does not yet reflect the recent EPA rule promulgation of Appendix W in May 2017. Section 6 part B of Pima County's rule (PCC § 17.16.590(A)(6)) states that if the "guideline" model is inappropriate it may be modified or substituted with another model. We assume that given the very recent EPA rule that Pima County and the EPA would accept the most recent version of AERMOD as the most appropriate model and the recently promulgated Appendix W guidance as the most appropriate for this analysis. In April, 2018, EPA released a new version of AERMOD (18081), along with its meteorological and terrain pre-processors AERMET and AERMAP, respectively. Based on a review of the factors discussed below, the latest version of AERMOD (18081) was used in this modeling of IGS.

In rulemaking for changes to Appendix W (82 FR 5182, January 17, 2017), the EPA changed the status of the ADJ_U* refinement (an adjustment to the computation of the friction velocity for low wind conditions) from a beta option to an approved regulatory option. The modeling conducted for the proposed project at IGS utilizes the approved regulatory low wind model option.

4.4 Rural versus Urban

One of the factors affecting input parameters to dispersion models is the presence of either rural or urban conditions near the project site. According to Section 7.2.1.1. of Appendix W, the applicant should follow either the land use or population density procedure to determine the selection of urban vs. rural dispersion. EPA Region 9 in consultation with EPA's Office of Air Quality Planning and Standards (OAQPS) has recommended that TEP should use the population density procedure in determining the rural or urban selection for the modeling of the RICE project. The population density procedure states that if the average population density is greater than 750 people per square kilometer, use urban, otherwise rural would be appropriate. EPA Region 9 provided TEP with an average population density for the Tucson metro area as 860 people per square kilometer. Therefore, for the TEP RICE project, the urban dispersion option in AERMOD was used.

For urban areas, AERMOD requires the user to provide a representative population value. In 2015, the U.S. Department of Commerce Bureau of Economic Analysis (BEA) reported the Metropolitan Statistical Area (MSA) for Tucson, AZ was 1,010,025 people[8]. This MSA population for Tucson was used to fulfill the population requirement in AERMOD.

4.5 Meteorological Data for AERMOD

Meteorological data required for AERMOD include hourly values of wind speed, wind direction, and ambient temperature. Since the AERMOD dispersion algorithms are based on atmospheric boundary layer dispersion theory, additional boundary layer variables are derived by parameterization formulas,

[8] BEA. Published on November 17,2016. https://bea.gov/regional/bearfacts/action.cfm?geoType=5&fips=46060&areatype=MSA.

which are computed by the AERMOD meteorological preprocessor, AERMET[9]. These parameters include sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient, convective and mechanical mixing heights, Monin-Obukhov length, surface roughness length, Bowen ratio, and albedo.

4.5.1 Available Meteorological Data for AERMOD

Arizona Department of Environmental Quality (ADEQ) has pre-processed meteorological data[10] for 2012-2016 for the Tucson International Airport (surface and upper air), using AERMET version 16216 along with AERMINUTE version 15272 and AERSURFACE version 13016. As of September 7, 2018 ADEQ has not reprocessed the meteorological data for Tucson International Airport with AERMET 18081; however, based on sensitivity studies with other datasets, there is little to no change between 16216 and 18081. The EPA-approved low wind ADJ_U* guideline option was utilized for this data set. The representative airport site is located approximately 5 kilometers to the southwest of IGS and is the only ASOS station in the Tucson area. It is representative of the application site because there is no intervening terrain between the airport and IGS, and both sites share similar (arid) surface characteristics. This data set was used for the air quality impact analysis. A wind rose using the five-year period from 2012 to 2016 is provided as **Figure 4-1**.

4.6 Good Engineering Practice Stack Height Analysis

A Good Engineering Practice (GEP) stack height analysis was performed to determine the potential for building-induced aerodynamic downwash. The analysis procedures described in EPA's Guidelines for Determination of Good Engineering Practice Stack Height[11], Stack Height Regulations (40 CFR 51), and current Model Clearinghouse guidance was used.

The GEP formula height is based on the observed phenomena of disturbed atmospheric flow in the immediate vicinity of a structure resulting in higher ground-level concentrations at a closer proximity to the building than would otherwise occur. It identifies the minimum stack height at which significant aerodynamics (downwash) are avoided. The GEP formula stack height, as defined in the 1985 final regulations, is calculated from:

$$H_{GEP} = H_{BLDG} + 1.5L$$

where:

H_{GEP} is the maximum GEP stack height;

H_{BLDG} is the height of the nearby structure; and

L is the lesser dimension (height or projected width) of the nearby structure.

Both the height and width of the structure are determined from the frontal area of the structure projected onto a plane perpendicular to the direction of the wind. In all instances, the GEP stack height is based on the plane projections of any nearby building that results in the greatest justifiable height.

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[9] EPA 2016. User's Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-16-010 (December 2016). Office of Air Quality Planning and Standards, Research Triangle Park, NC. https://www3.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.pdf.

[10] Arizona Department of Environmental Quality (ADEQ) AERMOD-ready meteorological data files are available at http://www.azdeq.gov/node/2127.

[11] EPA 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) - Revised. EPA-450/4-80-023R, US EPA, Research Triangle Park, NC 27711. https://www3.epa.gov/scram001/guidance/guide/gep.pdf.

For purposes of the GEP analysis, "nearby" refers to the "sphere of influence," defined as five times the height or width of the building, whichever is less, downwind from the trailing edge of the structure. In the case where a stack is not influenced by nearby structures, the maximum GEP stack height is defined as 65 meters.

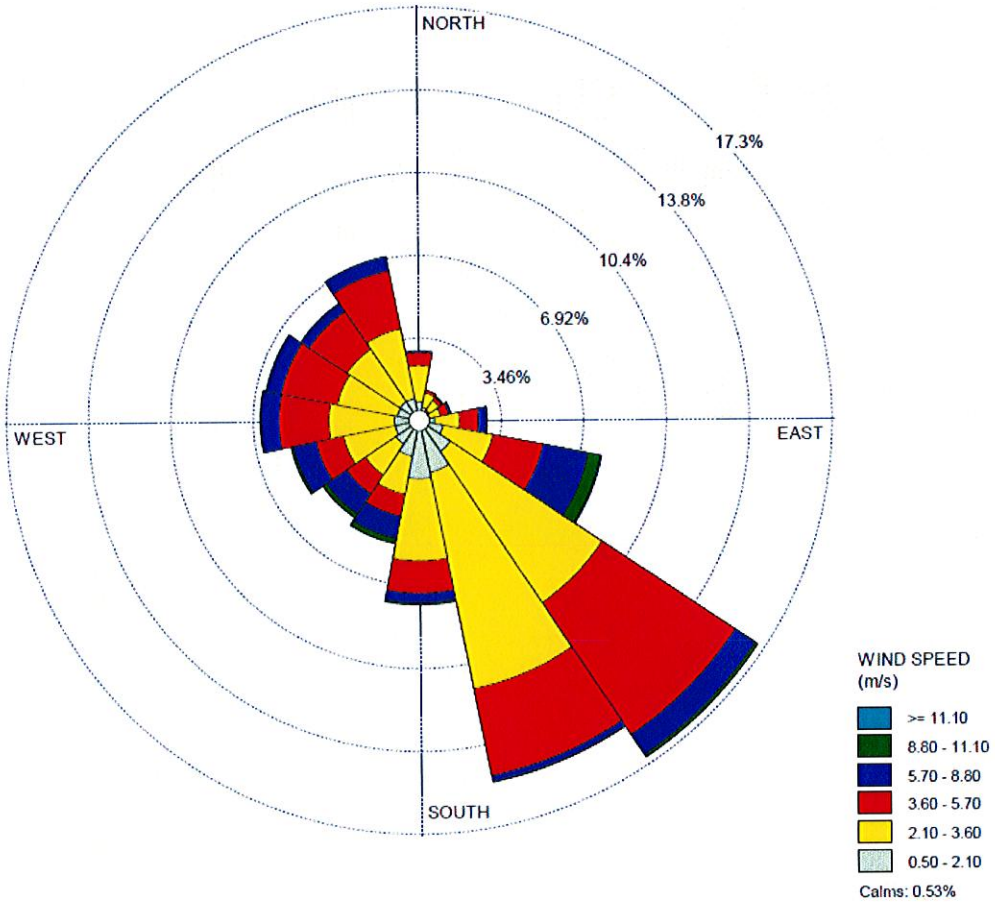
Figure 4-2 is a plot plan (which has been recently updated) showing the locations of the power plant equipment, and structures that could potentially produce aerodynamic downwash of the plumes for the reciprocating RICEs. The direction-specific building dimensions were determined using the latest version of EPA's Building Profile Input Program software (BPIP PRIME Dated 04274) using the design values of the stack and building heights.

TEP provided updated building dimensions and layout for structures that will be built near the RICE units to support them operationally. The previous layout called for a single long building to house the RICE units. The updated layout now includes two separate engine buildings (one for each set of 5 RICE units), and a smaller electrical building located between the two engine buildings as shown in **Figure 4-2**.

Figure 4-1 Wind Rose from Tucson International Airport 2012-2016

WIND ROSE PLOT:
Tucson International Airport
2012-2016

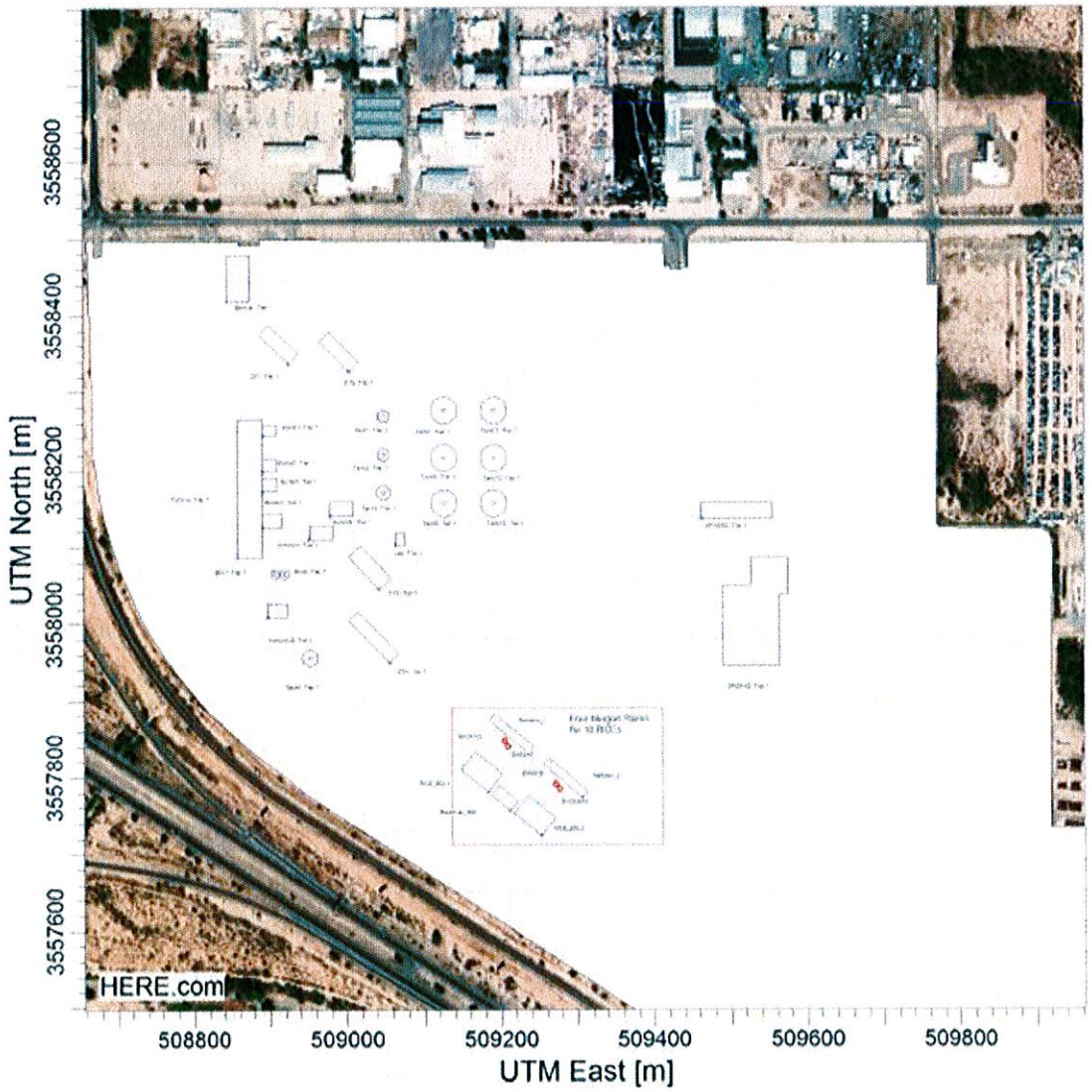
DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2012 - 00:00 End Date: 12/31/2016 - 23:59	AECOM	AECOM
	CALM WINDS: 0.53%	TOTAL COUNT: 43696 hrs.	
	AVG. WIND SPEED: 3.53 m/s	DATE: 6/8/2017	PROJECT NO.:

Figure 4-2 Plot Plan Used in the GEP Analysis

PROJECT TITLE:
Tucson Electric Power Cooperative, Irvington Generating Station Building Layout



COMMENTS:	SOURCES: 30	COMPANY NAME:	
	RECEPTORS: 7469	MODELER:	
		SCALE: 1:8,305 0 0.3 km	
		DATE: 10/16/2018	PROJECT NO.:

4.7 Receptor Grid and AERMAP Processing

The modeling analysis was conducted using the following Cartesian receptor grid design for Class II areas.

- 25-m receptor spacing along the IGS boundary;
- 100-m receptor spacing extending out 2 kilometers from the grid center (located near the center of the facility at 509448.00 meters Easting, 3557910.00 meters Northing);
- 250-m receptor spacing between 2 and 6 kilometers from the grid center;
- 500-m receptor spacing between 6 and 10 kilometers from the grid center;
- 1,000-m receptor spacing between 10 and 20 kilometers from the grid center; and
- 2,000-m receptor spacing beyond 20 kilometers (out to 50 km).

The receptor grid used in the modeling analysis was based on Universal Transverse Mercator (UTM) coordinates referenced to NAD 83 datum Zone 12 and is shown in **Figure 4-3** and **Figure 4-4**.

4.7.1 Terrain Processing (AERMAP)

The recently released (April 2018) version of AERMAP (version 18081), the AERMOD terrain preprocessor program, was used to calculate terrain elevations and critical hill heights for the modeled receptors using National Elevation Data (NED). The dataset was downloaded from the USGS website (http://viewer.nationalmap.gov/viewer/) and consists of 1/3 arc second (~10 m resolution) NED. As per the AERMAP User's Guide[12], the domain was sufficient to ensure all significant nodes were included such that all terrain features exceeding a 10% elevation slope from any given receptor are considered.

4.8 Modeling of Secondary $PM_{2.5}$ Emissions

On December 2, 2016, EPA released guidance on the development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 demonstration tool for $PM_{2.5}$. At the most recent EPA-organized Regional, State, and Local Modeling Workshop held in Boston, MA in June 2018, EPA announced that new guidance was in preparation for assessing fine Particulate Matter ($PM_{2.5}$) impacts, which would be based in part on the December 2, 2016 guidance. This guidance (not yet released as of early September 2018) provides a detailed framework on estimating single source impacts on secondary pollutants. This framework involved obtaining daily (24-hour) and annual $PM_{2.5}$ values for hypothetical sources across the United States through a photochemical grid modeling assessment. The most representative hypothetical site selected for the assessment of secondary $PM_{2.5}$ for TEP's RICE project is Gila County, Arizona. The Tier 1 demonstration of the formation of $PM_{2.5}$ for a project is based on the tons per year of NOx and SO_2 from the project and the hypothetical MERP values for 24-hour and annual averaging periods. **Table 4-5** provides the calculated secondary $PM_{2.5}$ for the RICE project. The project secondary concentrations were then added to the AERMOD prediction of primary $PM_{2.5}$ to obtain the combined primary and secondary formation.

[12] EPA 2004. User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003 (October 2004 – Addendum March 2011). Office of Air Quality Planning and Standards, Research Triangle Park, NC. https://www3.epa.gov/scram001/dispersion_related.htm.

Table 4-5 Secondary $PM_{2.5}$ for RICE Project Using MERP Tier 1 Demonstration Tool

Pollutant	Permit Limits (tpy)	24-hr MERP (µg/m³)	Annual MERP (µg/m³)	Project Secondary 24-hr $PM_{2.5}$ (µg/m³)	Project Secondary Annual $PM_{2.5}$ (µg/m³)
NOx	170	0.01	0.001	0.00170	0.00017
SO2	14.2	0.04	0.001	0.00057	0.00001

4.9 Class II Area Modeling Analysis

A refined modeling analysis was conducted using AERMOD (version 18081). The analysis was conducted to demonstrate compliance with both federal and local applicable ambient air quality standards.

4.9.1 PSD Class II Significant Impact Level Analysis Results

Impacts were assessed using AERMOD at the Class II receptor locations described previously, and compared to the Class II SILs to determine if the impacts were significant for CO, PM_{10} and $PM_{2.5}$. Five years (2012-2016) of representative meteorological data were used as input to AERMOD, as discussed in **Section 4.5**. Significance for 24-hour and annual $PM_{2.5}$ is determined by averaging the maximum daily concentrations for each year modeled at each receptor over the 5 years (AERMOD performs this calculation internally), then adding the secondary formation per the MERPS guidance discussed in Section 4.8, and comparing sum of primary and secondary $PM_{2.5}$ formation to the SIL. All other pollutants/averaging periods are determined by comparing the maximum concentration for any year modeled to the SIL. Since the exhaust parameters and emission rates vary by operating load, minimum (25%), mid-range (50%), and full load (100%) were modeled and those modeling results were compared against the SILs.

Figure 4-3 Near-Field Receptor Grid

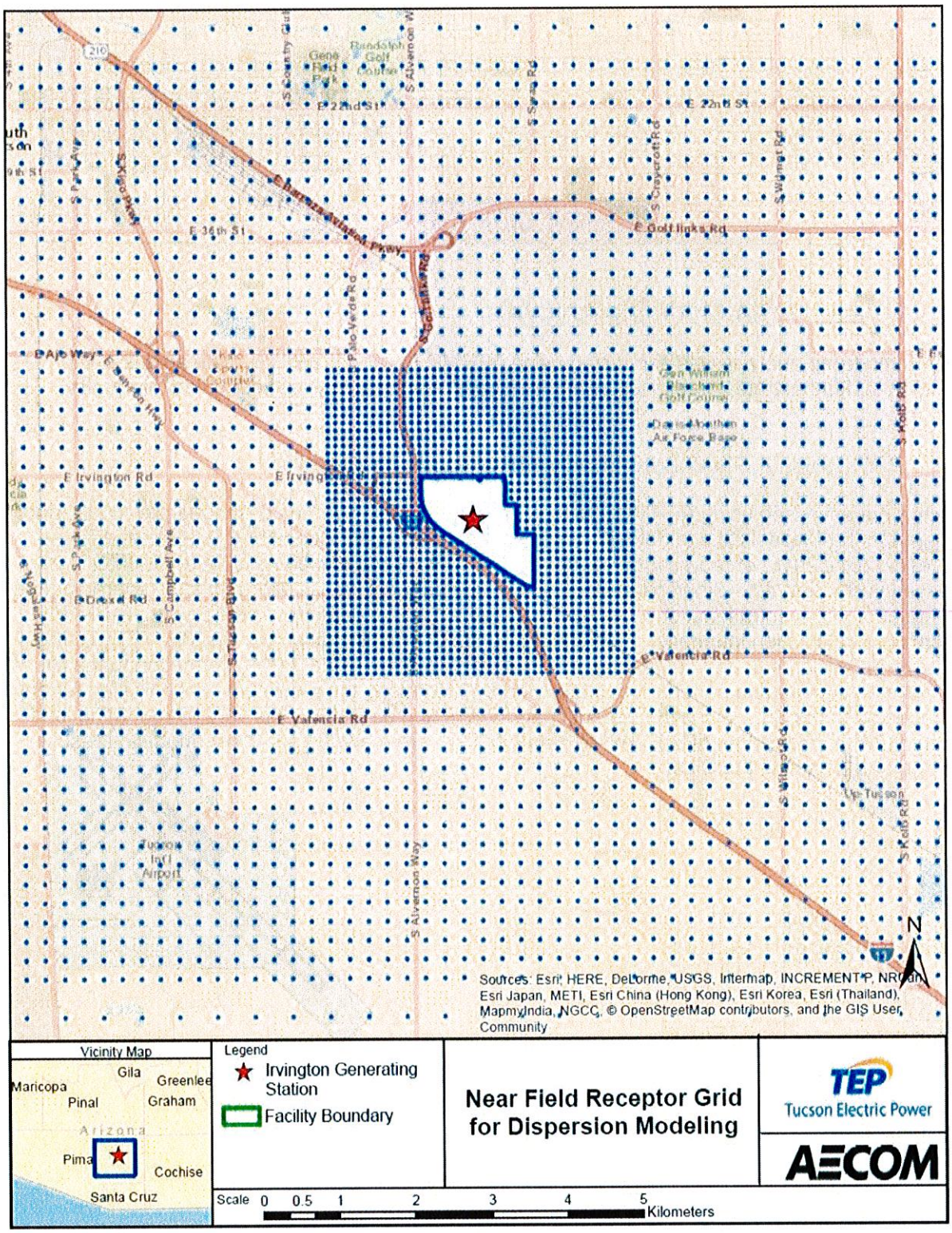
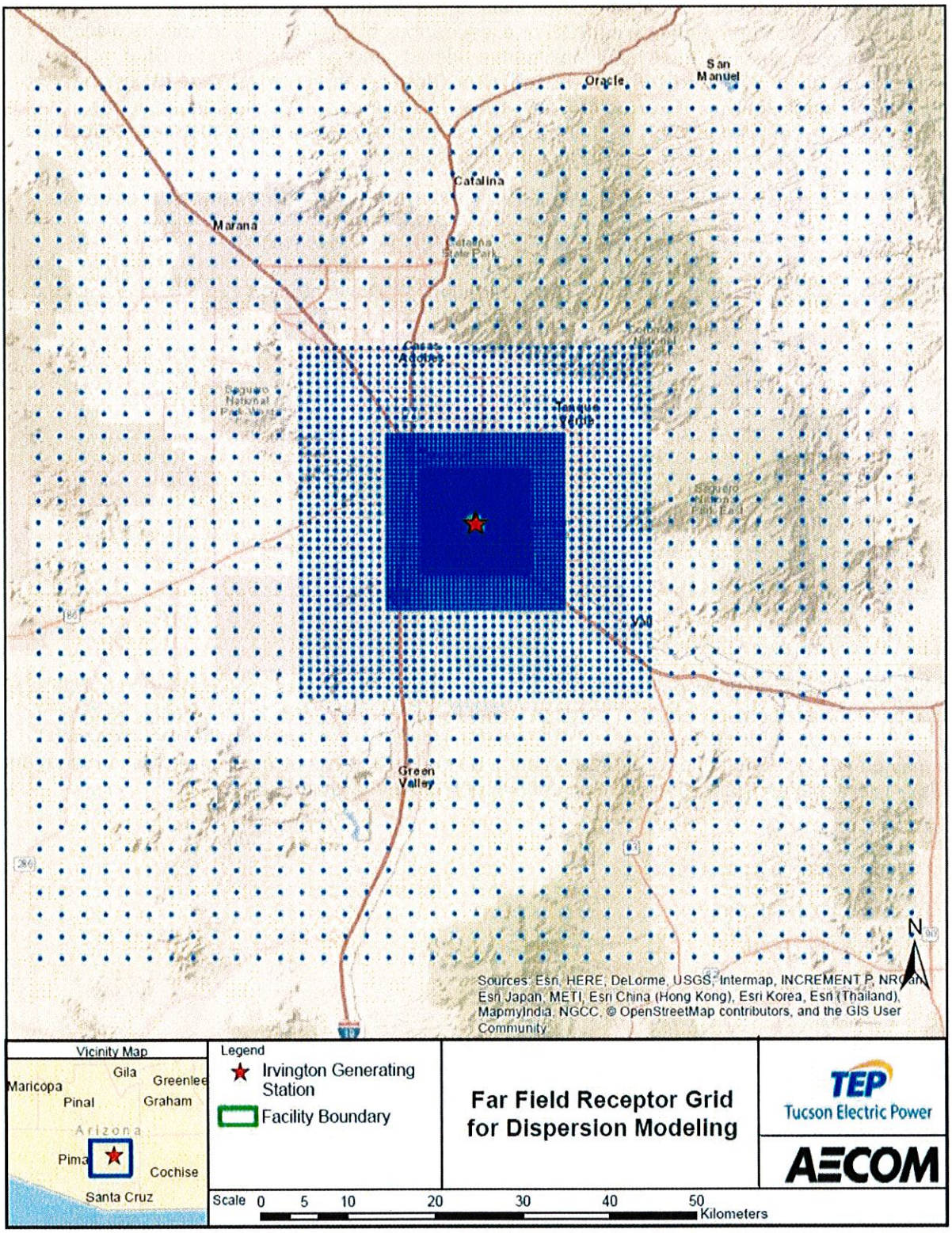


Figure 4-4 Far-Field Receptor Grid



For those pollutants and averaging periods with modeled concentrations less than their SILs, no further modeling was required because, by definition, those pollutants and averaging periods cannot cause or contribute to a violation of a NAAQS or exceedances of the PSD increments as discussed in Section 3.2. A comparison of the overall maximum modeled concentrations with the SILs, across all operating loads (25%, 50%, and 100%) is presented in **Table 4-4** for the worst-case emission rates. and the locations are shown in **Figures 4-5, 4-6** and **4-7** for min, mid and full operating loads, respectfully. As is depicted in **Table 4-4,** all modeled concentrations are below their respective SILs. As such, no further analyses were required for these pollutants.

Table 4-6 Summary of Maximum AERMOD Concentrations to Significant Impact Levels

Pollutant	Averaging Period	Min-Load (25%) Maximum Concentration (μg/m³)	Mid-Load (50%) Maximum Concentration (μg/m³)	Full-Load (100%) Maximum Concentration (μg/m³)	SIL	Significant? (Yes or No)
CO	1-Hour[1]	***53.836***	40.338	29.757	2,000	N
	8-Hour[1]	***36.760***	28.468	21.435	500	N
PM_{10}	24-Hour[1]	1.127	***1.185***	1.080	5	N
	Annual[1]	0.194	***0.204***	0.179	1	N
$PM_{2.5}$	24-Hour[2]	1.051	***1.113***	0.975	1.2	N
	Annual[2]	0.183	***0.191***	0.169	0.2	N

Note: Bold italicized numbers indicate the maximum modeled concentration for each criteria pollutant.
(1) Highest concentration over the 5-year meteorological period (2012-2016) modeled.
(2) Maximum concentration averaged over 5-years.

4.10 Class I Area

PSD guidance[13] recommends that facilities within 100 km of a PSD Class I area perform a modeling evaluation of the ambient air quality in terms of Class I PSD Increments and Air Quality Related Values. In addition, large projects beyond 100 km (but less than 300 km) from the nearest Class I area may be requested to conduct an evaluation of air quality impacts by the Federal Land Managers (FLMs). There are ten Class I areas within 300 km of IGS as shown in **Figure 4-8**:

1. Chiricahua NM
2. Chiricahua Wilderness
3. Galiuro Wilderness
4. Gila Wilderness
5. Mazatzal Wilderness
6. Mount Baldy Wilderness
7. Pine Mountain Wilderness
8. Saguaro National Park (East and West)
9. Sierra Ancha Wilderness

[13] 1992 EPA Memorandum. Clarification of Prevention of Significant Deterioration (PSD) Guidance for Modeling Class I Area Impacts. https://www.epa.gov/sites/production/files/2015-07/documents/class1.pdf.

10. Superstition Wilderness

Figure 4-5 Location of Maximum Concentrations (25% Operating Load)

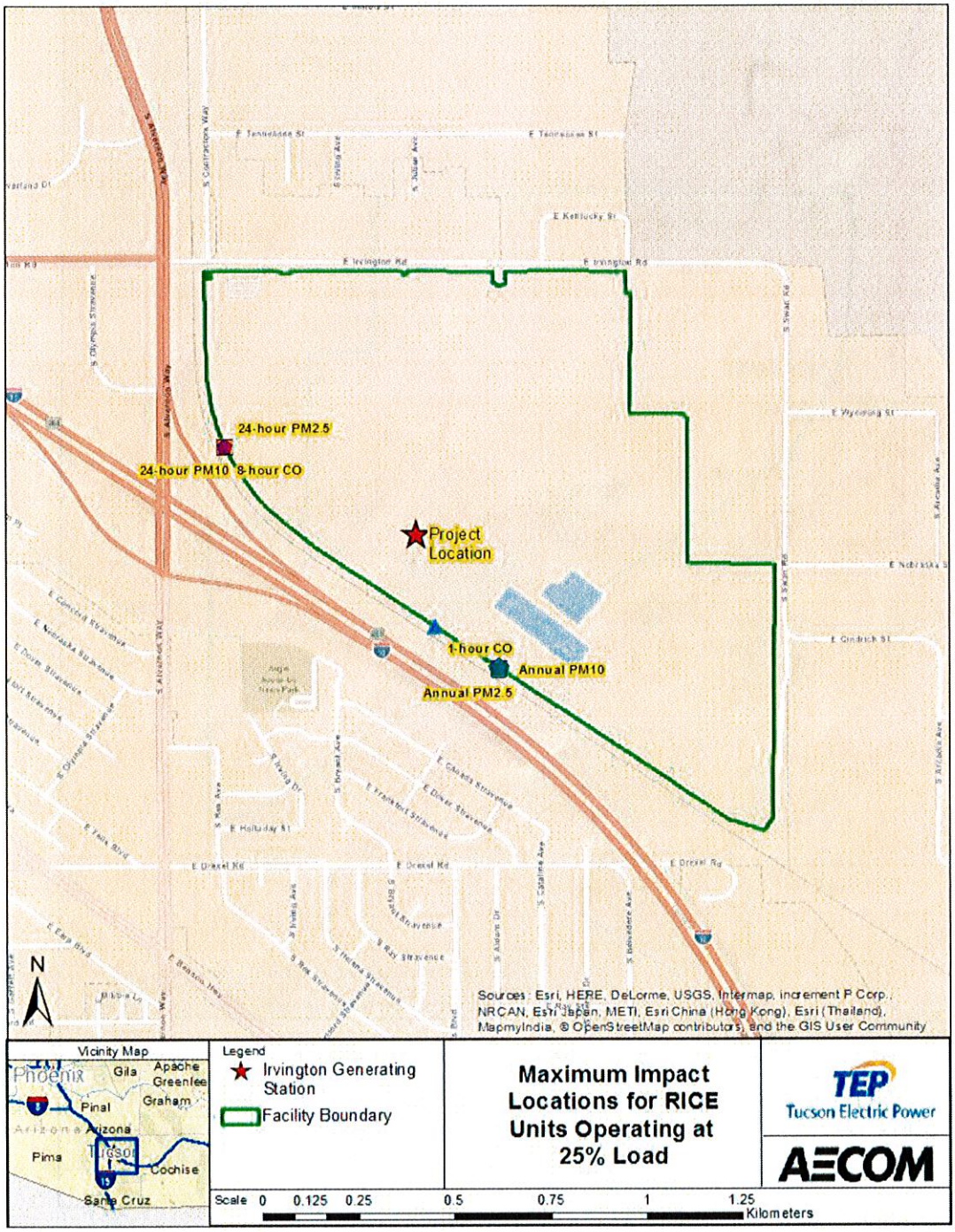


Figure 4-6 Location of Maximum Concentrations (50% Operating Load)

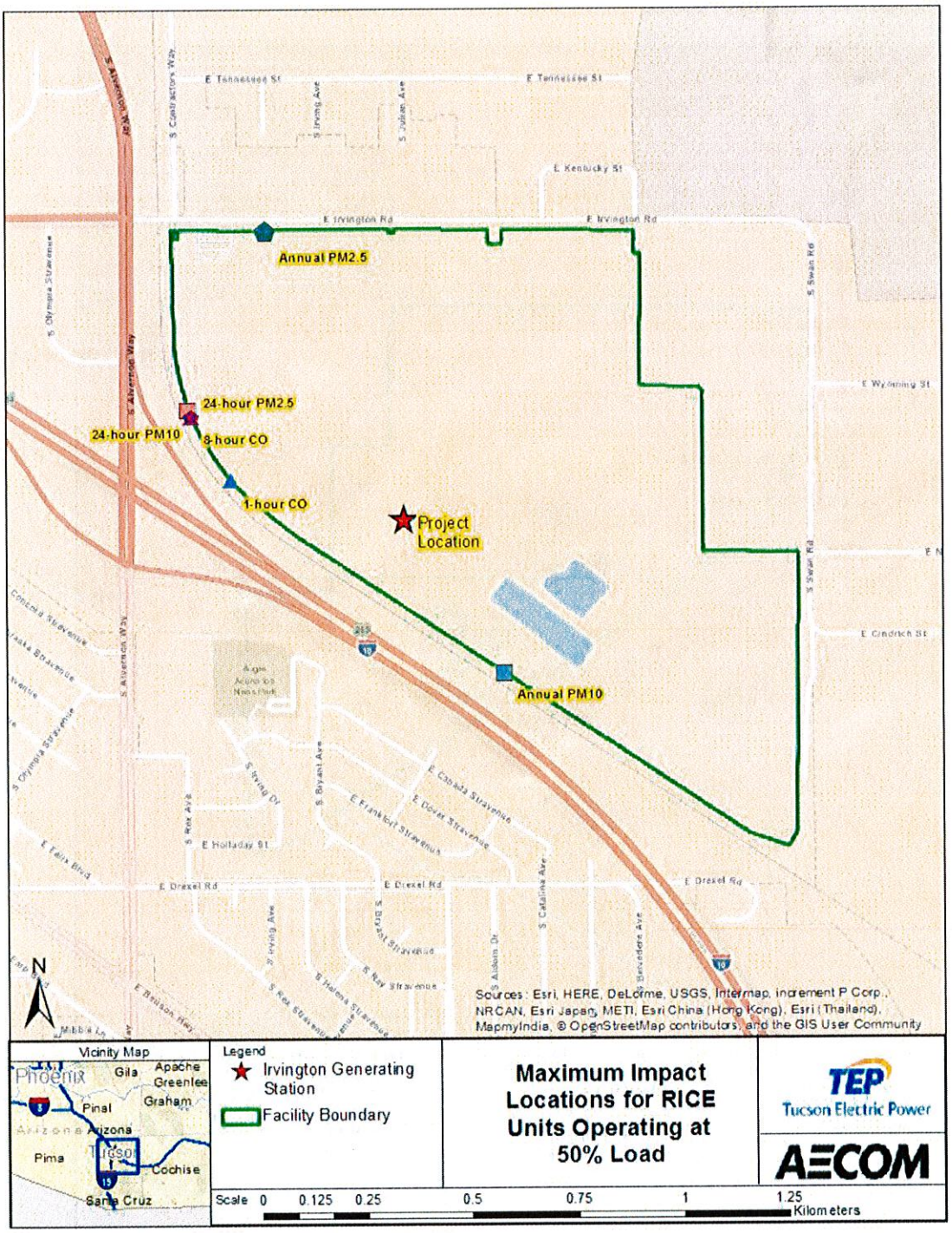


Figure 4-7 Location of Maximum Concentrations (100% Operating Load)

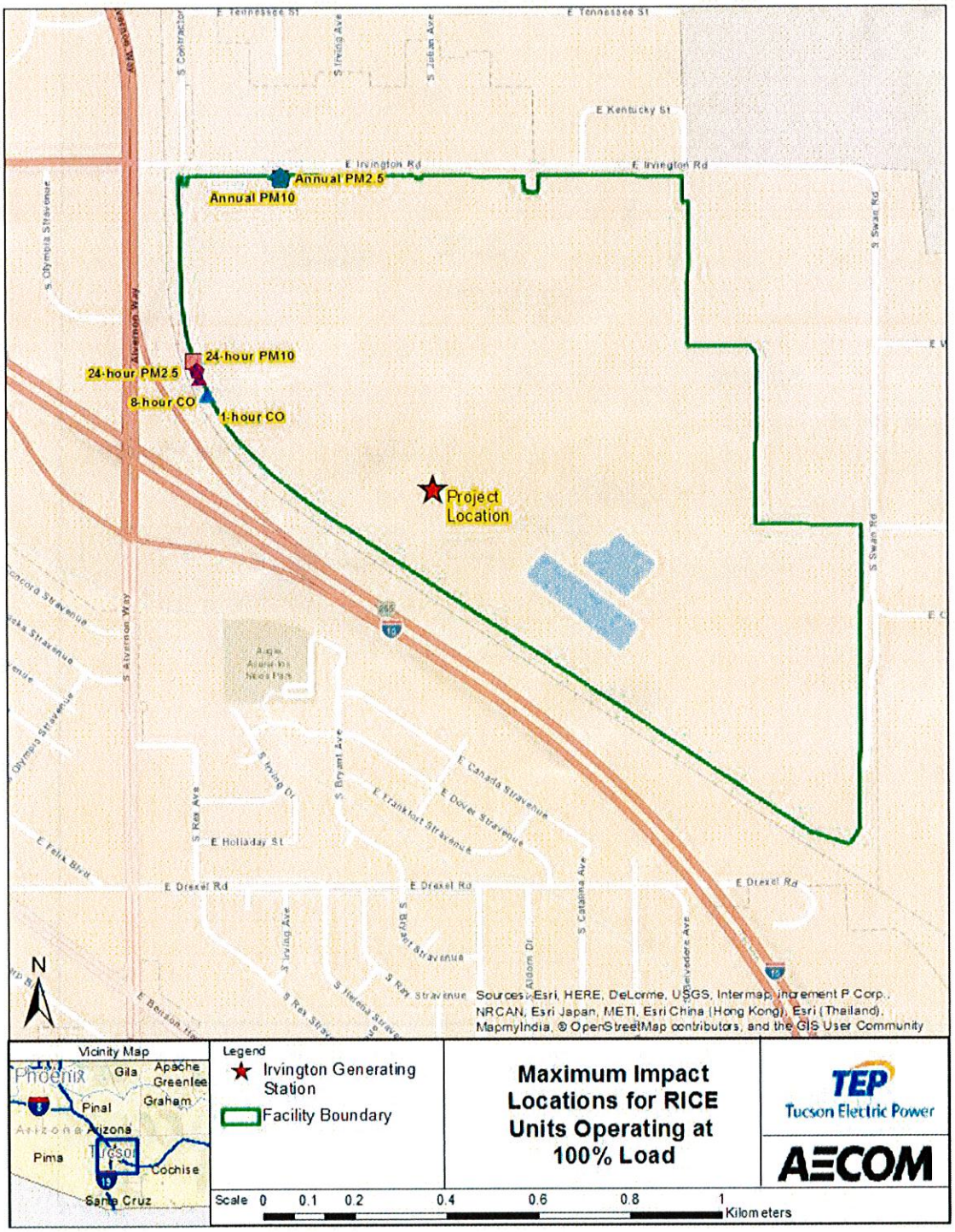
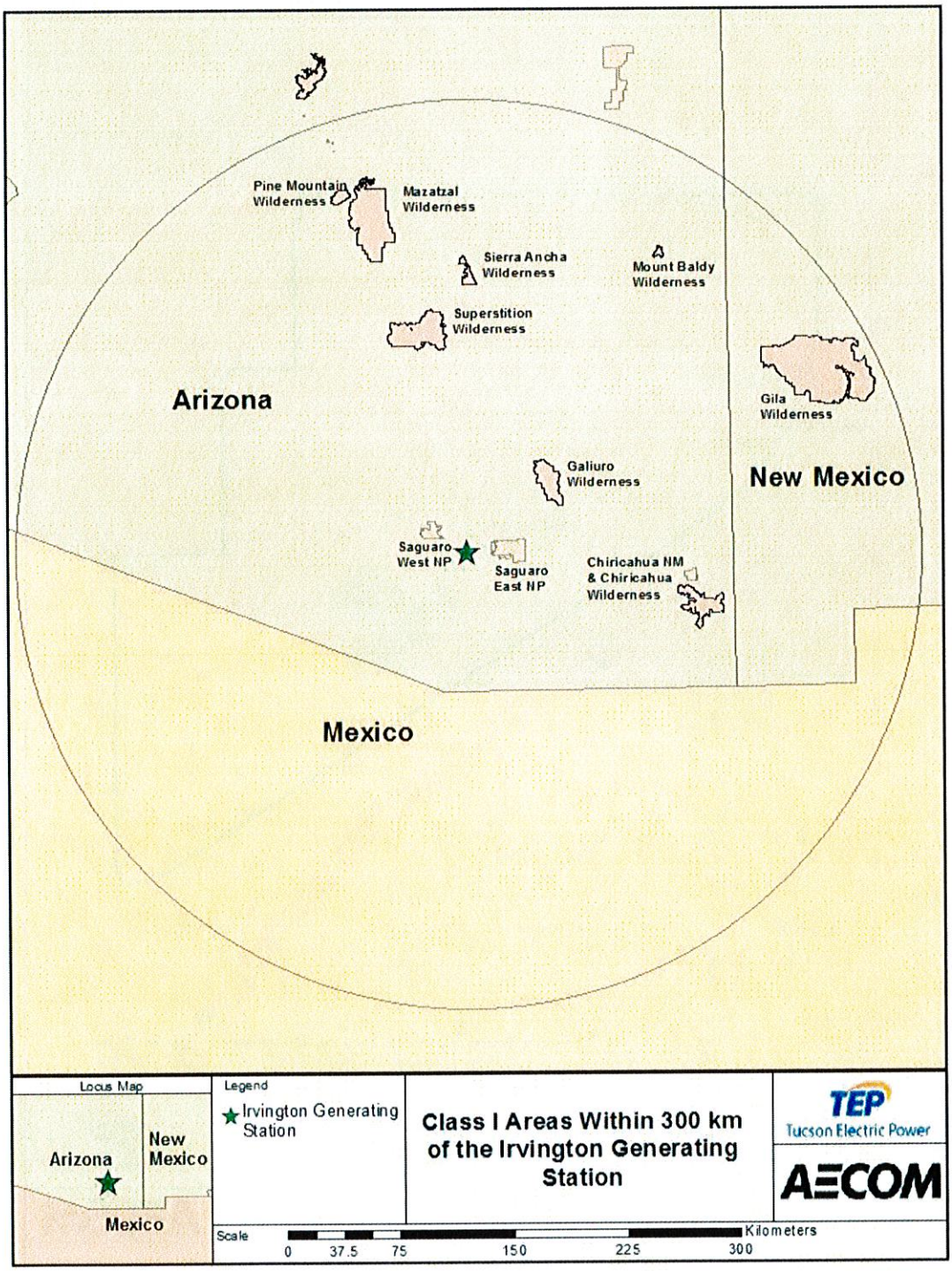


Figure 4-8 Class I Areas within 300 km of IGS



There are no other Class I areas within 300 km of IGS. Project impacts for PM_{10} and $PM_{2.5}$ pollutants subject to PSD review were assessed for the Class I areas (and portions thereof) within 300 km of the facility. The Class I SILs that the project impacts were compared to are summarized in **Table 4-5**. In 1996, EPA proposed rulemaking[14] for Class I specific SILs for PM_{10} 24-hour (0.3 µg/m^3) and annual (0.2 µg/m^3). Although this rule was never finalized, the proposed SILs for PM_{10} have been widely used in previous permitting applications. The $PM_{2.5}$ SILs are based upon guidance[15] issued by EPA in August, 2016.

Table 4-7 Criteria Pollutant Class I Significant Impact Levels

Pollutant	Averaging Time (1)	
	Annual µg/m^3	24-hour µg/m^3
PM_{10}	0.2	0.3
$PM_{2.5}$	0.05	0.27
(1) Highest concentration		

4.10.1 Class I Significant Impact Level Analysis Results (within 100 kilometers)

This PSD Class I analysis considers the closest Class I areas, Saguaro National Park (East and West) and Galiuro Wilderness, which are within 100 kilometers of IGS. The Significant Impact Analysis for compliance with PSD Class I increments was conducted with AERMOD using the same meteorological data as the Class II modeling.

Class I receptor grids were obtained from EPA Region 9's Class I database[16] and were used for the PSD Class I modeling. The Galiuro Wilderness Class I area resides approximately 60 km from IGS, yet AERMOD has a maximum distance applicability of 50 km. Therefore, modeling for impacts at Galiuro was conducted with receptors conservatively placed at a distance of 50 km along a line connecting the project location to Galiuro. In doing so, all of the Galiuro receptor elevations and hill heights were preserved from what they are at their actual locations. **Figure 4-9** shows the model receptor locations for Class I areas. All of the modeled pollutants and averaging periods resulted in modeled concentrations less than their SILs; therefore, no further analysis was performed.

For those pollutants and averaging periods with modeled concentrations less than their SILs, no further modeling was conducted. A comparison of the overall maximum modeled concentrations with the SILs, for each operating load (25%, 50%, and 100%) is presented in **Table 4-6** for the worst-case emission rates. As is depicted in **Table 4-6**, all modeled concentrations are below their respective SILs. As such, no further analyses were required for these pollutants.

[14] 61 FR 38249. https://www.gpo.gov/fdsys/pkg/FR-1996-08-20/pdf/96-21281.pdf.
[15] https://www.epa.gov/nsr/draft-guidance-comment-significant-impact-levels-ozone-and-fine-particle-prevention-significant.
[16] EPA, Region 9 Federal Class I Areas. https://www3.epa.gov/region9/air/maps/r9_clss1.html .

Figure 4-9 Class I Receptor Grid

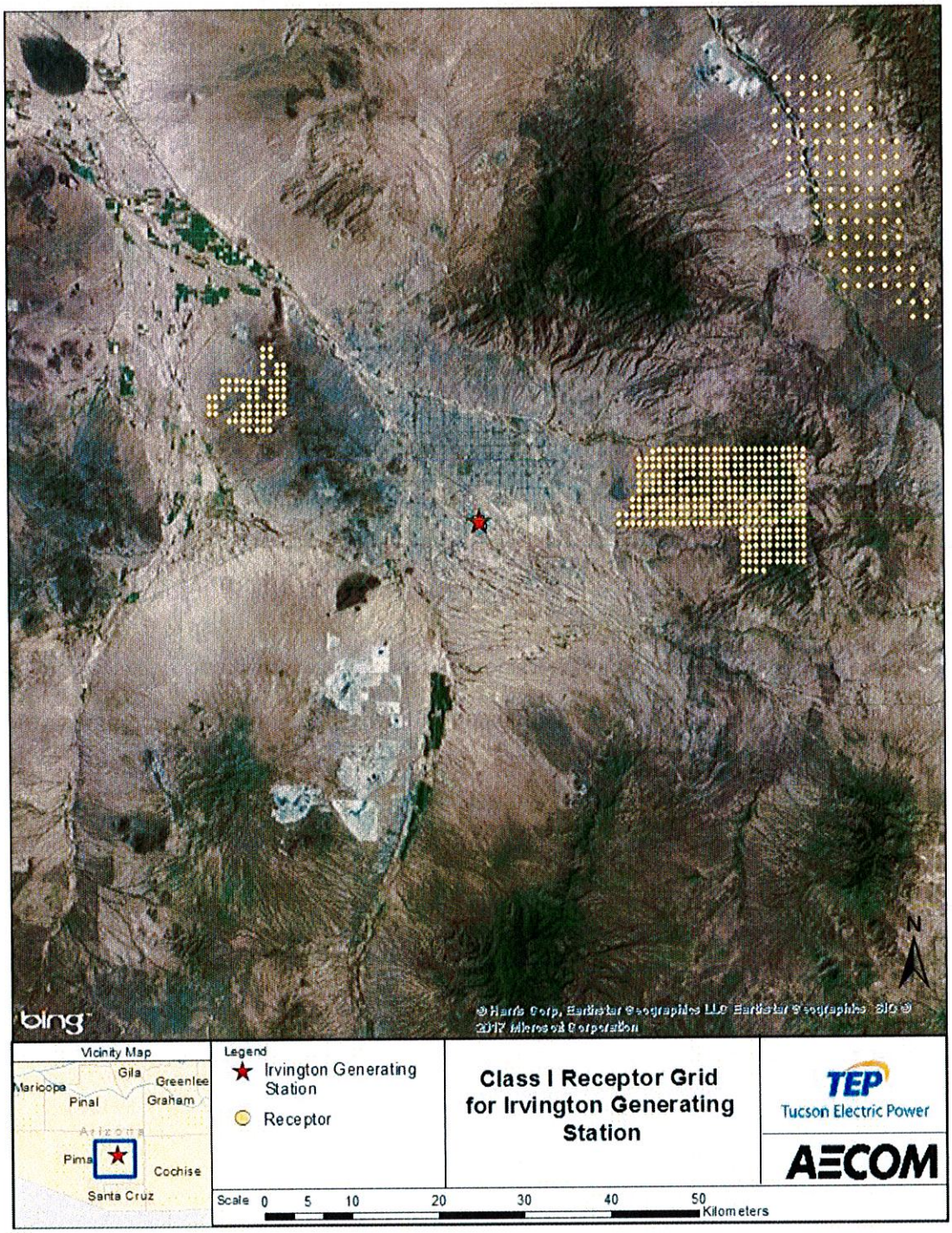


Table 4-8 Summary of Maximum AERMOD Concentrations to Significant Impact Levels

Pollutant	Averaging Period	Min Load (25%) Maximum Concentration (µg/m³)	Mid Load (50%) Maximum Concentration (µg/m³)	Full Load (100%) Maximum Concentration (µg/m³)	SIL	Significant? (Yes or No)
Saguaro National Park - East						
PM_{10}	24-Hour	0.056	**0.064**	0.062	0.3	N
	Annual	0.006	**0.007**	**0.007**	0.2	N
$PM_{2.5}$	24-Hour	0.043	**0.050**	0.049	0.27	N
	Annual	0.006	**0.007**	**0.007**	0.05	N
Saguaro National Park - West						
PM_{10}	24-Hour	0.037	0.046	**0.049**	0.3	N
	Annual	0.008	**0.009**	**0.009**	0.2	N
$PM_{2.5}$	24-Hour	0.036	0.045	**0.047**	0.27	N
	Annual	0.008	**0.010**	**0.010**	0.05	N
Galiuro Wilderness Area						
PM_{10}	24-Hour	0.006	0.007	**0.008**	0.3	N
	Annual	**0.001**	**0.001**	**0.001**	0.2	N
$PM_{2.5}$	24-Hour	0.007	0.008	**0.009**	0.27	N
	Annual	**0.001**	**0.001**	**0.001**	0.05	N

Note: Bold italicized numbers indicate the maximum modeled concentration for each criteria pollutant. $PM_{2.5}$ concentrations includes both primary and secondary formation.

4.11 Modeling of Ozone Precursors

In rulemaking that was effective as of May 22, 2017, EPA's Appendix W, Revisions to the Guideline on Air Quality Models, provided a more specific procedure for assessing the impacts of an individual source on ozone. In conjunction with this new procedure, the EPA finalized a two-tiered demonstration approach for addressing individual source impacts on ozone. The first tier involves the use of technically credible relationships between precursor emissions and a source's impacts while the second tier involves application of more sophisticated case-specific chemical transport models. The EPA has recently issued draft guidance providing recommendations on air quality modeling and related technical analyses to satisfy compliance demonstration requirements for ozone for permit-related assessments under the PSD program; Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (December 02, 2016)[17] and Errata Memo (February 23, 2017)[18]. The draft guidance provides a Tier 1 demonstration tool for ozone (and $PM_{2.5}$). The MERPs are screening thresholds for precursor emissions, where VOC and NO_x screening values are provided for ozone,

[17] Available at https://www3.epa.gov/ttn/scram/guidance/guide/EPA454_R_16_006.pdf.
[18] Available at https://www3.epa.gov/ttn/scram/guidance/guide/MERPs_Data_Distribution_and_Errata_Memo-02232017.pdf.

that are expected to result in an insignificant increase in ambient ozone relative to the NAAQS; i.e., an impact less than the 8-hour ozone SIL of 1 ppb. The MERP values were derived based on modeling conducted by EPA for locations across the U.S.

For the IGS RICE project, there is a net decrease in NOx emissions, as shown in **Table 4-7**. As a result, only a comparison against the VOC MERPs can be accomplished. Since the project will involve the retirement of existing boiler units 1 and 2 and cooling towers, RTP Environmental Associates, Inc. (RTP)[19] determined the maximum combined NOx and PM 24-hour (daily) emission rate based on the most recent two years (2015-2016) of actual emissions to represent the worst case emission rates for Units 1 and 2. Units 1 and 2 emitted 4,096 lbs combined on June 20, 2016 which converts to 747.52 tons/year of NOx.

Table 4-9 Short-Term NOx Emissions for Existing Sources and Future Sources of the Project

Existing Units 1 and 2 NOx	RICE NOx Emissions[1]	Change in NOx for the Project
747.52 tons/year	153.3 tons/year	-594.22 tons/year
(1) Tons per year rate is based on the daily average that consists of 5 startup events (30 minutes) at 10.3 lb/event plus the remaining 21.5 hours at a rate of 1.5 lb/hr.		

Table 7.1 of the guidance, as updated in the Errata Memo, provides the "Most Conservative (Lowest) Illustrative MERP Values (tons per year) by Precursor, Pollutant and Region". MERP values are provided for VOCs in the central, eastern and western U.S. To determine whether this project would exceed the critical air quality threshold for ozone, the project VOC emissions increase can be compared to the lowest western MERP for VOC, which is 1,049 tons per year[20]. Since the project net increase of VOC is only 130 tons per year, the project's ozone impact is presumed to have an insignificant impact on ozone concentrations. The project impacts would be well below the MERPs as shown in the calculation in EPA's Scenario A presented below:

(248.3 TPY VOC from source/6,000 TPY VOC 8-hr daily maximum O_3 MERP) = 0.041 * 100 = 4.1% of the SIL, or 0.041 ppb.

Per Pima County Code § 17.16.590(A)(5)(b)), a major modification to a major source of volatile organic compounds or oxides of nitrogen may contribute to violations of the Arizona ambient air quality standards for ozone if it will be located within fifty kilometers of a nonattainment area for ozone. The only ozone nonattainment area in Arizona is located in Maricopa County and a small portion of Pinal County, more than 100 kilometers from IGS. Therefore, a demonstration that the project will not cause or contribute to a violation is not required, especially since the Project's ozone impact is below the EPA-proposed SIL.

[19] RTP Environmental Associates, Inc. prepared the Air Quality Permit Application for TEP.
[20] Table 7.1 on page 30 of Guidance on the draft MERP guidance (December 2, 2016).

5. Additional Impact Analysis

Under the PSD regulations, permit applicants must prepare an additional impact analysis for each pollutant subject to regulation. This analysis assesses the impacts of air, ground and water pollutions on soils, vegetation, and visibility caused by any increase in emissions of any regulated pollutant from the source or modification under review, and from associated growth. The various components of the additional impact analyses are discussed below.

5.1 Visibility Analysis (within 50 kilometers)

For any new major source or major modification, Pima County requires (PCC § 17.16.630) an analysis of the anticipated impacts of the proposed sources on visibility in any Class I areas which may be affected by the emissions from that source. Furthermore, *Federal Land Managers' Air Quality Related Values Work Group Phase 1 Report – Revised (2010)*[21] recommends that the applicant perform an analysis of visibility impairment (i.e., plume blight) at Class I areas within 50 kilometers of the proposed Project site, in this case Saguaro National Park (eastern and western units).

The preliminary visible plume analysis was conducted with EPA's screening model, VISCREEN to determine if project emission during both normal and startup operations have the potential to cause visibility impairment at the Saguaro National Park units. Upon further review, the National Park Service recommended that a refined visibility analysis using the PLUVUE-II model be conducted. Given the complex nature of the refined visibility assessment using PLUVUE-II, a separate report was developed and submitted to the NPS (see Appendix C).

5.2 Class I Analysis (beyond 50 kilometers)

In accordance with the revised FLAG 2010 guidance that is recommended by the Federal Land Managers, we have excluded from modeling consideration Class I areas that are beyond the FLAG-specified screening distance from IGS. The screening distance is determined by adding the permitted short-term emissions from proposed routine (non-emergency) point sources for SO_2 + NO_x + PM_{10} + H_2SO_4. A FLAG-prescribed screening distance has been calculated for the RICE project to determine what Class I areas will be considered for the Air Quality Related Values (AQRVs) analysis.

The sum of these emissions is not expected to exceed 277.59 tons per year (12.6 tons SO_2 + 153.3 tons NO_x + 109.5 tons PM_{10} and 2.19 tons H_2SO_4) for the RICE project, not including the reductions in emissions from Unit 1 and 2. With a FLAG-prescribed screening distance of 278/10 = 27.8 km, this results in the determination that only impacts within the Saguaro National

[21] National Park Service, 2010. Phase I Report of the Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Revised 2010. National Park Service, Air Resources Division; U.S. Forest Service, Air Quality Program; U.S. Fish and Wildlife Service, Air Quality Branch. http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf.

Park were considered for Air Quality Related Values (AQRVs), since all other Class I areas are beyond this distance and beyond 50 km from the project location.

5.3 Growth Analysis

A growth analysis examines the potential emissions from secondary sources associated with the proposed Project. While these activities are not directly involved in the RICE project, the emissions involve those that can reasonably be expected to occur; for instance, industrial, commercial, and residential growth that will occur in the RICE project area due to the RICE project itself. Secondary emissions do not include any emissions which come directly from a mobile source, such as emissions from the tailpipe of any on-road motor vehicle or the propulsion of a train. They also do not include sources that do not impact the same general area as the source under review.

The RICE project is not expected to employ additional personnel at this time, especially with the retirement of IGS units 1 and 2. Therefore, population growth from this project is not expected, and thus an analysis of such growth was not performed.

5.4 Soils and Vegetation Analysis

An analysis of the RICE project's potential impact on soils and vegetation in the vicinity of the facility was performed in accordance with the procedures recommended in EPA's "A Screening Procedure for Impacts of Air Pollution Sources on Plants, Soils and Animals"[22]. For particulate matter, the 1980 screening procedure does not have a threshold to compare against; therefore, the impacts were compared to the NAAQS.

The highest modeled concentrations of PM_{10}, O_3 and CO from the RICE project were compared to the screening concentrations as shown in **Table 5-1**. As shown, the modeled concentrations are all well below their screening thresholds; therefore, no significant impacts on local vegetation is expected as a result of the RICE project.

[22] EPA 1980. A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals. EPA-450/2-81-078. EPA, Research Triangle Park, NC 27711.

Table 5-1 Injury Threshold for Vegetation

Pollutants	Averaging Period	Maximum Modeled Concentration (µg/m³)	NAAQS (µg/m³)	EPA's 1980 Screening Concentration[1] (µg/m³)
PM (as PM_{10})	24-hour	1.19	150	None
O_3	1-hour[2]	0.64	None	392
	4-hour[3]	0.16	None	196
	8-hour[4]	0.08	140	118
CO[5]	Weekly	36.76	None	1,800,000

1. "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals". EPA 450/2-81-078, December 1980.
2. O_3 concentration calculated in Section 4.11 multiplied by 8.
3. O_3 concentration calculated in Section 4.11 multiplied by 4.
4. O_3 concentration calculated in Section 4.11.
5. CO concentration is the 8-hour concentration.

6. Summary of Modeling Results

An updated dispersion modeling analysis using the latest version of AERMOD (18081) was conducted for TEP's proposed installation of 10 RICE units at IGS in Tucson, AZ. This version of the report includes minor updates to the gas exit temperature and velocity associated with two of the ten RICE units that will now be used (instead of the to-be-retired IGS Units 1 and 2) to provide heated steam to an adjacent asphalt plant. An updated building layout for the structures near to and housing the RICE units has also been incorporated.

In addition to the revised modeling parameters for two RICE units, EPA has indicated that new guidance is pending for assessing fine Particular Matter ($PM_{2.5}$) impacts, which includes both primary and secondary formation of $PM_{2.5}$. The original modeling only included primary $PM_{2.5}$ from the project as an analysis of secondary $PM_{2.5}$ formation was not required per the existing 2014 EPA guidance[23]. Furthermore, the significant impact level (SIL) for annual $PM_{2.5}$ was reduced from 0.3 $\mu g/m^3$ to 0.2 $\mu g/m^3$, as stated in EPA's April 17, 2018 memorandum on SIL guidance for ozone and fine particles[24]. In anticipation of the new guidance, this modeling demonstration assessed both primary and secondary $PM_{2.5}$ formation.

Revised AERMOD dispersion modeling was conducted based upon changes to building dimensions and gas exit temperature and velocity for 2 of the 10 RICE units proposed to be installed at TEP's IGS. A PSD modeling analysis for Class I and II receptors was conducted using the latest version of AERMOD (18081). The results from this modeling show all modeled concentrations are below their respective SILs. As expected, the findings from this modeling analysis for the minor change to two stack exhaust parameters are consistent with those presented in the original PSD modeling analysis with the previous stack characteristics.

[23] Available at https://www3.epa.gov/scram001/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf. An updated guidance document is not yet available from EPA as of early September 2018.
[24] EPA Memo on Guidance on Significant Impact Levels for Ozone and Fine Particles in Prevention of Significant Deterioration Permitting Program. April 17, 2018. https://www.epa.gov/sites/production/files/2018-04/documents/sils_policy_guidance_document_final_signed_4-17-18.pdf.

Appendix A EPA Region 9 Letter

Kaplan, Mary

From: Rupesh Patel <Rupesh.Patel@pima.gov>
Sent: Thursday, October 19, 2017 6:12 PM
To: 'Suzanne Kennedy'; 'Kate Graf'; 'Scott McCann'; Brian McNamara; Richard Grimaldi; Mellanie Fuller
Cc: 'CSpencer@tep.com'; Charles W. Komadina; ZFang@tep.com; 'Colin Campbell'; Kaplan, Mary; Paine, Bob; Holladay, Cleveland
Subject: FW: Tucson Electric Power's IGS RICE Project: Urban vs Rural Determination Land Use Classification; Approval of Merge Plumes

Hi Cleve,

Thank you for your comments on the modeling procedures for the Tucson Electric Power's IGS RICE Project.

Rupesh Patel
Air Permit Engineering Manager
Pima County Department of Environmental Quality
33 N. Stone Ave, 7th Floor
Tucson, Arizona 85701
Tel: (520) 724-7341

From: Holladay, Cleveland [mailto:Holladay.Cleveland@epa.gov]
Sent: Thursday, October 19, 2017 3:03 PM
To: Rupesh Patel <Rupesh.Patel@pima.gov>
Cc: Chen, Eugene <Chen.Eugene@epa.gov>; TSAI, YA-TING <Tsai.Ya-Ting@epa.gov>; Rios, Gerardo <Rios.Gerardo@epa.gov>; Brode, Roger <Brode.Roger@epa.gov>; john_notar@nps.gov; 'don_shephard@nps.gov'; 'kirsten_king@nps.gov'
Subject: Tucson Electric Power's IGS RICE Project: Urban vs Rural Determination Land Use Classification; Approval of Merge Plumes

Hi Rupesh,

Here are my comments and approvals of the following modeling procedures. Tucson Electric Power may proceed to the use the "urban" land use option based on the procedure in Section 5 of the AERMOD Implementation Guide (Last Revised December, 2016). The use of this option is also based on population density data indicating urban (867/km2 vs 750 km2) and the Tucson International Airport wind rose showing predominant winds blowing from the southeast over the proposed project to the urban area to the northwest.

Tucson Electric may also proceed to use plume merging provided that the stack arrangement is the following as described in the applicant's "Technical and Policy Justification for Plume Merging: Tucson Electric Power's IGS RICE Project". For each group of the IGS RICE project's five stacks shown in Figure 2, two sets of stacks indicated by red boxes are proposed to be modeled as separate merged stacks (see orange stars in the figure) due to their separation in each group by slightly less than one stack diameter from every other stack in that group. One group of 3 stacks would be modeled as a single merged stack and the remaining 2 stacks would be modeled as a second (smaller) merged stack (a "3 + 2" configuration). This merging approach follows the

policy decisions from past EPA Model Clearinghouse memos that the merged stacks should be within one diameter of each other in the merging approach.

-Cleve Holladay
US EPA Air Division, Air 07
75 Hawthorne Street, San Francisco, CA 94105
415-947-4140

Appendix B Technical and Policy Justification for Plume Merging: Tucson Electric Power's IGS RICE Project

AECOM Imagine it. Delivered.

Technical and Policy Justification for Plume Merging: Tucson Electric Power's IGS RICE Project

Project number	Client	Date	Prepared by
60530048	Tucson Electic Power Company	October 10, 2017	AECOM

Introduction

The calculation of plume rise from a point source is a key component in determining the downwind impacts associated with that source. Regulatory models such as AERMOD do not account for merging of plumes from nearby stacks, which can result in enhancements in the plume buoyancy. However, for stacks that are closely spaced, this consideration results in a more accurate characterization of the source.

For flues combined in a single stack, the assumption of enhancement of the plume buoyancy is intuitively obvious. For stacks with some finite separation, the determination of the enhancement is more complicated. In previous policy decisions[1,2], EPA has determined that full enhancement can effectively be assumed for stacks within 1 diameter of each other, citing the similarity of this situation to combining building tiers in EPA's Building Input Profile Program[3]. Studies cited below in this document refer to analyses of actual field data of plume merging as well as wind tunnel studies that indicate that plumes from adjacent, aligned stacks tend to combine, resulting in a buoyant plume rise greater than that from any one of the individual sources. The arrangement of the stacks as well as the stack exhaust parameters are factors involved in calculating the enhanced buoyancy flux.

AECOM has developed a procedure called AERLIFT, as documented in a peer-reviewed paper[4], to determine whether and to what extent the buoyancy of adjacent stacks will be enhanced. This procedure is based upon the Briggs algorithm involving plume rise from a row of stacks[5] that EPA has not yet incorporated into its guideline models.

In the following sections, a review of the Tucson Electric Power Company (TEP) proposed quick-start engine project and components of the AERLIFT formulation provide further support that specific stack groups associated with the TEP project should be modeled as merged.

Project Overview and Stack Merging Issue

TEP is proposing to modify the existing Irvington (Sundt) Generating Station (IGS) located in Tucson, Arizona, approximately 2 miles northeast of Tucson International Airport. The reciprocating internal combustion engine (RICE) project involves adding ten quick-start RICEs for the purpose of load stabilization to accommodate intermittent renewable energy sources (solar and wind) that feed into the system.

Figure 1 shows the proposed project layout for the RICE engines and the updated stack configuration. There are two sets of five RICE engine stacks shown in the Figure. A closer view of one of the two identical stack arrangements is shown in Figure 2.

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[1] Model Clearinghouse memo 91-II-01, available at https://cfpub.epa.gov/oarweb/mchisrs/.
[2] Model Clearinghouse memo 6-V-10, available at https://cfpub.epa.gov/oarweb/mchisrs/.
[3] BPIP user manual is available at https://www3.epa.gov/scram001/userg/relat/bpipdup.pdf.
[4] Paine, R., Warren, L.L., Moore, G.E.,2016. Source Characterization Refinements for Routine Modeling Applications, *Atm. Env.* 129 (2016), 55-67. doi: 10.1016/j.atmosenv.2016.01.003. http://www.sciencedirect.com/science/article/pii/S1352231016300036
[5] Briggs, G.A., 1984. Plume rise and buoyancy effects. In *Atmospheric Science and Power Production*, edited by D. Randerson. U.S. Department of Energy Document DOE/TIC-27601 (DE84005177).

Figure 1: Proposed project layout in the vicinity of the RICE engines (top of figure faces SW)

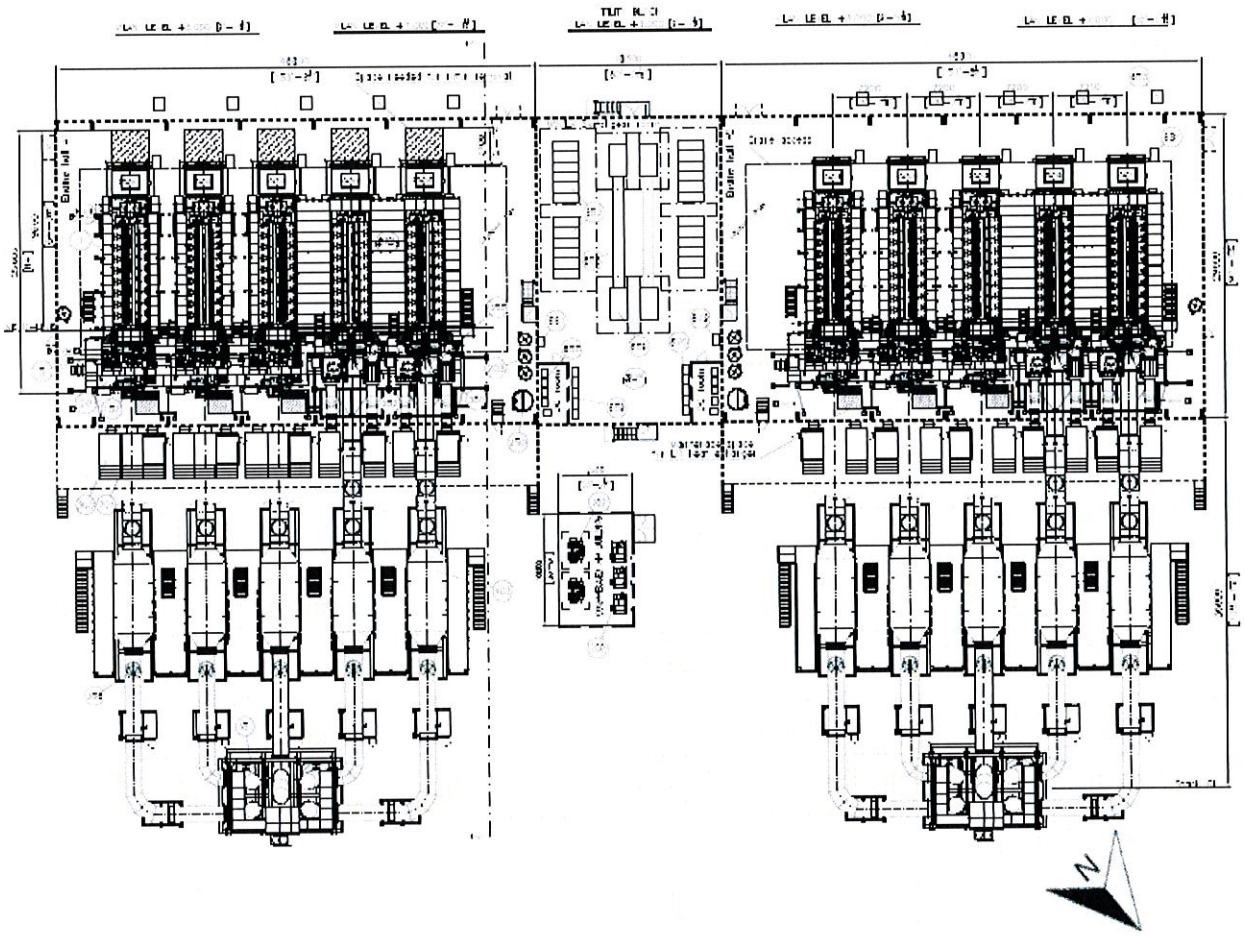
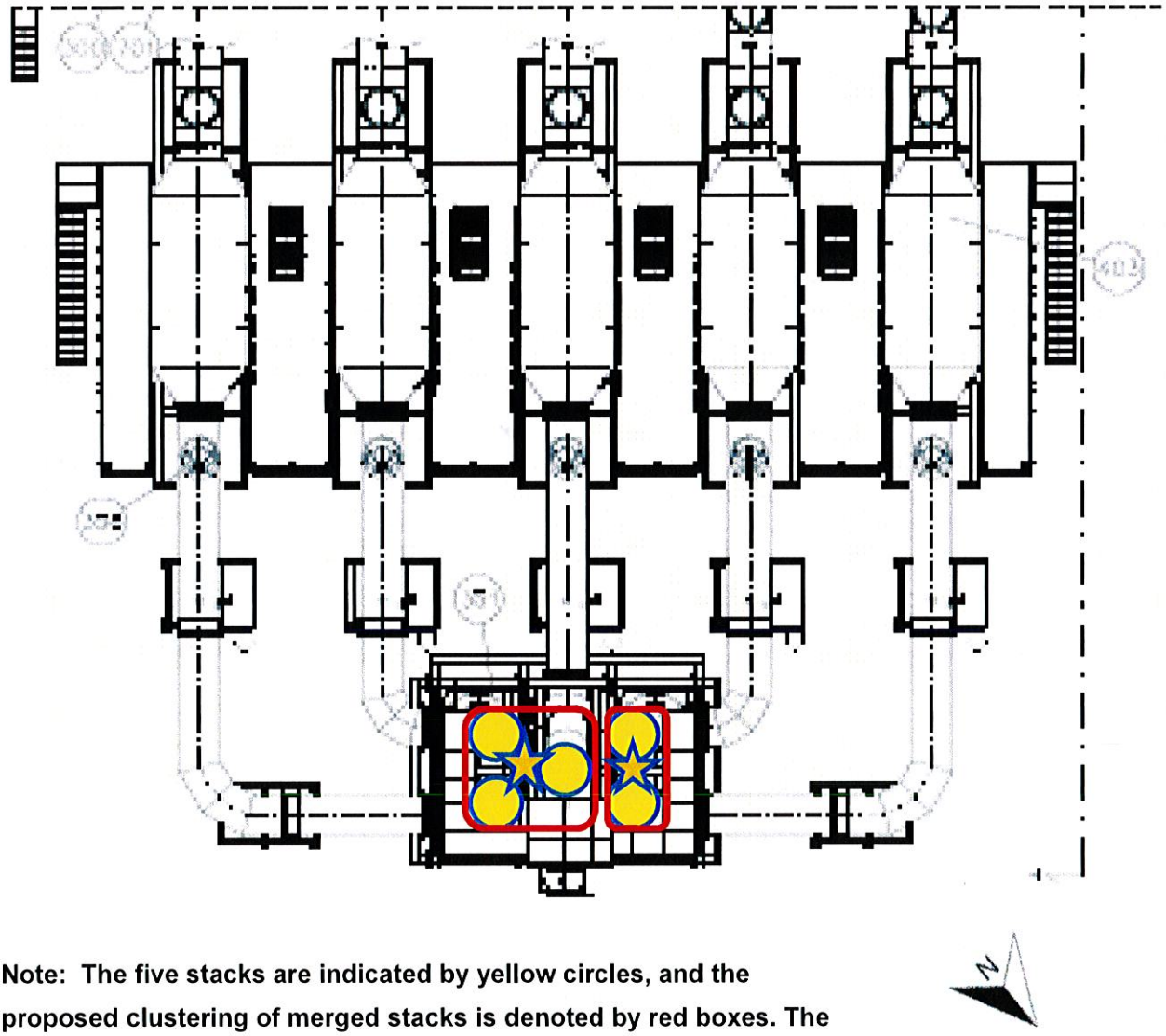


Figure 2: Close-up view of the 3+2 arrangement for one cluster of RICE engine stacks



Note: The five stacks are indicated by yellow circles, and the proposed clustering of merged stacks is denoted by red boxes. The orange stars indicate the locations of the merged stacks for modeling.

The stack configuration for the group of five stacks shown as yellow circles in Figure 2 for the proposed TEP RICE project is nearly identical to a similar project conducted in Oregon. The Port Westward Generating Plant (PWGP), owned and operated by Portland General Electric (located in Portland, Oregon), received approval from the Oregon Department of Environmental Quality to construct and operate 12 RICE generators (in groups of 6) in February of 2013 (see Appendix A, page 36). For the modeling demonstration, the stacks for each group of 6 RICE generators were located adjacent to each other in two rows of three stacks, as shown in Figure 3. Each six-stack group for the PWGP was represented in the modeling as a single point source with an effective stack diameter that equals the area of the six individual stacks. The stack diameters for the PWGP RICEs are 1.6 meters, which is identical to the RICEs that TEP are planning to install. With each of the PGWP stacks being within one diameter of each of the *nearest* stacks, it was realized that the cluster of stacks would result in air flow going around the cluster of plumes, which would effectively merge.

For each group of the IGS RICE project's five stacks shown in Figure 2, two sets of stacks indicated by red boxes are proposed to be modeled as separate merged stacks (see orange stars in the figure) due to their separation in each group by slightly less than one stack diameter from every other stack in that group. One group of 3 stacks would be modeled as a single merged stack and the remaining 2 stacks would be modeled as a second (smaller) merged stack (a "3 + 2" configuration). This merging approach is more conservative (less merging) than that approved for the Port Westward Generating Project, and it strictly follows the policy decisions from past EPA Model Clearinghouse memos that the merged stacks should be within one diameter of each other in the merging approach.

Preliminary modeling of the individual stacks shown in Figure 1 indicates that high SW wind conditions (with ~10 m/s winds blowing in a direction with the stacks lined up), result in peak daily concentrations for $PM_{2.5}$. Accordingly, we examined AERLIFT treatment of adjacent stacks for these conditions in the following section.

Figure 3: Photo of the operational Port Westward Power Plant RICE stacks

Photo Credit: Portland General Electric Company, http://www.pennenergy.com/articles/pennenergy/2015/01/pge-begins-operations-at-new-220-mw-natural-gas-fired-power-plant.html.

AERLIFT Calculations

In his "Plume Rise and Buoyancy Effects" Chapter 8[5], Briggs refers to the results of wind tunnel studies that indicate the usefulness of a merge parameter, S', to determine the effect of the angle of the wind relative to the stack alignment:

$$S' = [\Delta s \sin\Theta] / [L_B^{1/3} (\Delta s \cos\Theta)^{2/3}] \quad \text{(Eq. 1)}$$

Where,

Δs is the average spacing between the aligned stacks

Θ is the wind angle relative to the alignment angle of the adjacent, inline stacks

L_B is the buoyancy length scale = F_B / U^3 (Eq. 2)

F_B is the buoyancy flux = $g\, v_S^{\,2} D_S^2/4\, (T_S - T_A)/T_S$ (Eq. 3)

U is the wind speed at plume height

V_S is the stack gas exit velocity

T_S is the stack gas temperature

T_A is the ambient temperature

D_S is the stack diameter

Due to the stack alignment for winds blowing across the proposed engine building structures (and no downwash for winds blowing perpendicular to the sets of stacks considered for merging), we considered alignment angles up to 75 degrees from a line associated with winds from the SW for this technical review.

Briggs indicated that wind tunnel studies using neutral conditions showed that if S' is less than 2.3, then buoyancy enhancement would take place, while values above 3.3 indicate very little enhancement (intermediate values would indicate partial enhancement).

The value of S' was calculated for the TEP RICE project to determine if buoyancy enhancement would occur for 2 stacks with up to 1 diameter in stack separation (from the outside of the stacks). The stack diameter is 1.6 meters, gas exit temperature is 633.16 K, and gas exit velocity is 29.45 m/s. An ambient temperature of 295 K was used, based on a 5-year annual average from Tucson International Airport. A buoyancy flux (F_B) of 2,906 m^4/s^3 was determined for each individual stack by applying TEP's RICE-specific variables to Eq. 3. The final step required before S' was calculated was the determination of the buoyancy length (L_B) (Eq. 2). A review of the top 50 maximum 24-hour PM near-field impacts (Class II receptors) was conducted to see what the wind speed at plume height (U) was for the controlling modeled impacts. Table 1 summarizes the dates and the corresponding 24-hour average wind speed at plume height. The highest controlling wind speed from this dataset is 8.66 m/s. For this worst-case wind speed, the buoyancy length (L_B) is about 4.47 meters.

For all angles considered, the value of S' was below the threshold value of 2.3, indicating that buoyancy enhancement calculations are appropriate.

Table 1: Dates and 24-hour wind speeds from top 10 modeled impacts for 24-hour Class II modeling

Date (mm/dd/yyyy)	24-hour Average Wind Speed at Plume Height (m/s)
01/02/2012	7.77
11/12/2013	8.66
11/13/2013	7.71
11/26/2013	6.96
01/24/2014	6.90
01/09/2015	6.03
01/02/2016	7.97
01/03/2016	7.68
11/09/2016	8.31
11/26/2016	7.29

With the confirmation that plume merging should be accounted for in an arrangement with any stack within a diameter of any other stack, we then applied an AERLIFT formulation for the buoyancy enhancement of at least 2 stacks. We also accounted for other factors noted above due to the merging of adjacent plumes which can be taken from Manins implementation[6] of Briggs formulation:

Buoyancy enhancement factor $E = [n+S]/[1+S]$ (Eq. 4)

where,

n is the number of stacks in the row

S is a separation factor $= 6\,\{[(n-1)\,\Delta s]/[n^{1/3}\,\Delta h]\}^{3/2}$ (Eq. 5)

and

Δh is the plume rise for one stack.

For Eq. 2, we computed the enhancement factor for 2 stacks to determine if the total is close to 2.0, indicating full enhancement.

Modeling for a single RICE engine stack for effective wind speeds of about 8.66 m/s yields a plume rise of at least 42 m.

The appropriate value for Δs in this case is 2 stack diameters (where Δs is the separation of the stacks between stack *centers*) for the case of 1 stack diameter between the stack outer walls.

For a separation between stacks as proposed (Δs = 3.2 meters for 2 stack diameters between stack centers, although the actual separation will be slightly less), the buoyancy enhancement as calculated by Eq. 4 is 1.996, which is very close to a full merging of buoyancy fluxes. The buoyancy enhancement for a cluster of 3 stacks as shown in Figure 2 (e.g., 3 stacks arranged in a triangular formation), would also be expected to be very close to a full merging because the cluster of 3 stacks will be more likely to force air flow around the plume cluster from all directions.

[6] Manins P, Carras J and Williams D, (1992), Plume Rise from Multiple Stacks. Clean Air (Australia). Volume 26, Part 2. pp 65-68.; see http://www.planning.nsw.gov.au/asp/pdf/08_0021_bamarang_ps_stage2_ea_app_c_pt3.pdf

Summary and Conclusions

A technical analysis was conducted to determine the likelihood that enhancement of the plume buoyancy occurs from stacks that are very close in proximity to each other. We have demonstrated, through a quantitative and peer-reviewed approach, that for the proposed RICE stacks with a separation distance slightly less than their diameter, plume buoyancy would effectively be fully enhanced by the interaction of the adjacent stack plumes. The result of this analysis, in addition to precedent policy decisions cited above, supports merging of 3 adjacent stacks arranged in a triangular formation with each stack having a separation from the outside of the stack within 1 diameter of the other 2 stacks, as well as the other 2 adjacent stacks in a line, as shown in Figure 2.

Appendix C Tucson Electric Power Company Irvington (Sundt) Generating Station: PLUVUE II Assessment of Visible Plumes at Saguaro National Park East and West – Revision 1