Appendix C. Intalco SO_2 Attainment Plan Modeling Report by AECOM, June 2022

AECOM

Intalco SO_2 Attainment Plan Modeling Report

Intalco Aluminum LLC

Project number: 60614274

June 24, 2022

Delivering a better world

Quality information

Prepared by	Reviewed by	Approved by
Laura L. Warren Air Quality Scientist	Kimberly Zuk Air Quality Scientist	Robert J. Paine Associate Vice President, Air Quality

Prepared for:

Intalco Aluminum LLC
4050 Mountain View Road
Ferndale, Washington 98248

Prepared by:

Laura L. Warren
Air Quality Scientist
T: 978-905-2422
E: laura.warren2@aecom.com

AECOM
250 Apollo Drive
Chelmsford, MA 01824
aecom.com

Table of Contents

Figures

Tables

1. Introduction

On April 30, 2021, a nonattainment designation was finalized for the area around Intalco with regard to the 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standard (NAAQS)[1]. The designation was based on three years (2017-2019) of ambient air monitoring in the vicinity of Intalco, with one monitor (Mountain View) recording violations of the NAAQS. Because of the SO_2 nonattainment area (NAA) designation, Washington State Department of Ecology (Ecology) is required to develop a State Implementation Plan, confirmed with dispersion modeling, to return the area to attainment.

It should be noted that on April 22, 2020, Alcoa Corporation announced its decision to curtail operations at the Intalco facility. All of the production processes at the facility were curtailed by the end of August 2020. The curtailment is not considered a permanent closure of the facility; however, as of the date of this report, there is not a scheduled re-start date.

This modeling report presents an attainment strategy with dispersion modeling which is required in order to demonstrate compliance with the 1-hour SO_2 NAAQS. The modeling approach presented herein follows US Environmental Protection Agency (EPA) standard guideline modeling approaches as described in Appendix W of 40 CFR Part 51 (82 FR 5182, January 17, 2017) and has been subject to review by Ecology and EPA Region 10. The final attainment plan modeling protocol is included in Appendix A.

Section 2 of this document provides a discussion of the Intalco attainment plan as well as Intalco and nearby refinery SO_2 emission sources. Section 3 describes the modeling approach used herein to demonstrate that the attainment plan will result in attainment of the SO_2 NAAQS. Section 4 provides a creditable stack height modeling study as required by Ecology when raising existing emission source stacks. Section 5 provides the modeling results demonstrating that the attainment plan will result in attainment of the 1-hour SO_2 NAAQS.

Appendix A contains the modeling protocol document. Appendix B is the description of the modeling archive that contains modeling input and output files for all analyses in this model application as well as other supporting calculations. The actual electronic files described in this document were delivered separately to Ecology.

[1] During the 2017-2019 monitoring period, exceedances of the 75 ppb standard at the single monitor near Intalco (Mountain View) were reported on only 24 days in the 3-year period, and there was only one hour which included a 5-minute period >200 ppb (the measured maximum 5-minute concentration for that hour was 258.6 ppb). This one hour event represented 0.004% of the time during the three-year period. The Aluminum Association filed a Petition for Reconsideration with EPA regarding the SO_2 NAAQS requesting that if the peak 5-minute value is below 200 ppb (the "benchmark concentration" level at which the 75 ppb standard was intended to protect), there is no SO_2 NAAQS exceedance for that hour.

2. SO_2 Emission Sources

The SO_2 nonattainment area (NAA) within Whatcom County is an approximately a 4.2 km x 3.3 km area, or about 5.7 square miles. This small NAA encompasses the Intalco aluminum smelter and a limited area around it. The NAA excludes two nearby emission sources that SO_2 ambient air monitors and the area designation modeling demonstrated do not cause or contribute to 1-hour SO_2 NAAQS exceedances in the NAA. The Intalco facility and the other nearby SO_2-emitting facilities, BP Cherry Point refinery and Phillips 66 refinery, are shown with the NAA boundary and nearby SO_2 ambient air monitors in **Figure 2-1**. The focus of the modeling described herein is to document that the attainment strategy described in Section 2.1.1 and in the forthcoming Washington State Implementation Plan submittal is adequate to return the area to attainment with the 1-hour SO_2 NAAQS. This section also describes the methods used to account for impacts from the nearby refineries and regional background concentrations.

2.1 Intalco Aluminum Smelter

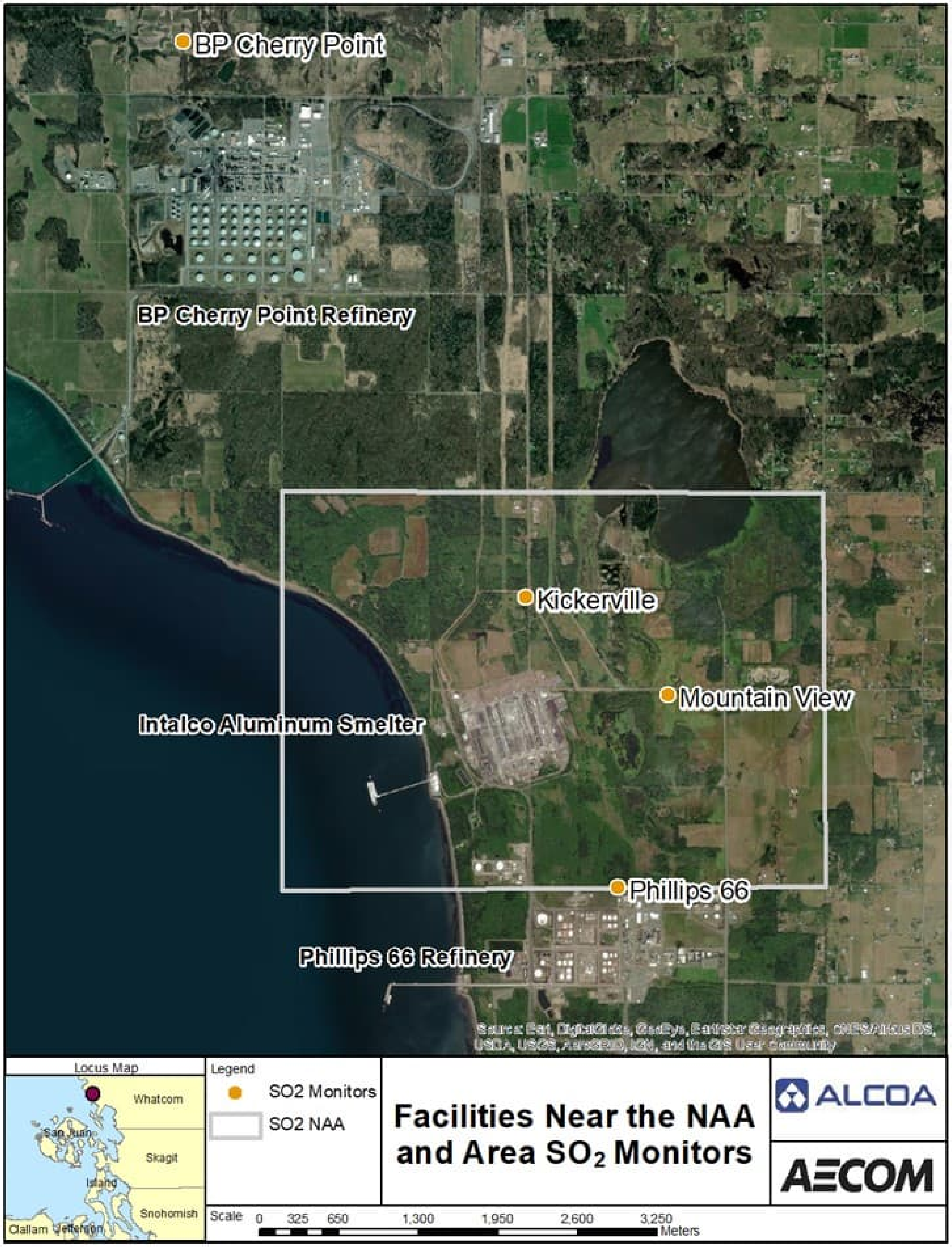
Intalco is an integrated primary and secondary aluminum production facility permitted to produce 307,000 short tons of primary aluminum per calendar year (full capacity). It is located in Whatcom County along the Strait of Georgia, approximately 6 km west of downtown Ferndale, WA. The area surrounding Intalco is rural with simple terrain in most directions out to approximately 50 km from the facility, including some local areas above stack height. In addition, the Fraser River Valley to the north and northeast has been shown to influence seasonal wind conditions, especially in winter with drainage winds from the northeast. The facility has a number of sources emitting SO_2, including three side-worked prebake potlines with primary and secondary emission controls (dry alumina scrubbers and roofline wet scrubbers, which serve to minimize fluoride emissions), one anode baking furnace controlled by an alumina injection system (bake oven scrubber), and fourteen (14) natural gas-fired melting/holding furnace stacks (casthouse stacks). Most of the SO_2 emissions are emitted from the dry alumina scrubber centers, two (2) per potline, for a total of six (6) “Centers”. The focus of the attainment strategy is to merge and raise the potline “Centers” and bake oven stacks combined with the installation of a SO_2 emission control device on one (1) of the Centers.

Intalco SO_2 emissions for these sources are generally steady with limited variability as demonstrated by low peak-to-mean ambient air monitoring data. SO_2 emissions in the Hall-Heroult aluminum smelting process are primarily a product of sulfur contained in the carbon anodes being released during electrolysis. Carbon anodes are comprised of calcined petroleum coke (coke) with pitch as a binding agent. The coke used to make anodes contains sulfur (up to 3 percent [%] at Intalco) which converts to SO_2 and Carbonyl sulfide (COS) as the carbon anodes are consumed (carbon consumption) in the potlines. Carbon consumption is directly proportional to the total aluminum produced at a smelter. The total aluminum produced is directly proportional to the operating current of the potline, how efficient that current is at reducing alumina to aluminum (current efficiency), and the total number of pots in operation.

Since the % sulfur in the anodes and carbon consumption are relatively constant, the SO_2 emissions are proportional to the amount of aluminum produced.

For modeling done to characterize the location(s) of anticipated maximum ambient SO_2 concentrations for purposes of placing ambient air monitors and for modeling done to determine the NAA boundary, monthly average SO_2 emission rates were used. For this attainment modeling, 1-hour maximum SO_2 emission rates were used to test the effectiveness of the attainment strategy and for the purpose of establishing proposed emission limits for the SO_2 sources at Intalco.

Figure 2-1: SO_2-Emitting Facilities and SO_2 Monitors Near the NAA



2.1.1 Attainment Strategy

Intalco with input from Ecology has identified an attainment strategy that meets federal and state requirements in order to achieve attainment of the SO_2 NAAQS in the NAA. The proposed attainment strategy would require the adoption of a facility-wide SO_2 emission limit of 5,000 tons per year (tpy) to enable modeling credit for merging and raising the potline dry scrubber stacks at the six (6) Centers and the bake oven stack. For perspective, total potline emissions are limited to 5,240 tpy. This potline emission limit does not include emissions for the bake oven and casthouse sources; however, the proposed 5,000 tpy limit would be inclusive of all Intalco sources. The attainment strategy also calls for the potline dry scrubber stacks to be merged into one (1) stack on a per Center basis with stacks raised to a height sufficient to counteract building downwash effects, for the bake oven stack to be raised to counteract building downwash, and Intalco would install one (1) SO_2 emission control device with a planned average SO_2 control efficiency of 90% on the merged dry scrubber center stack at Center 1.

In this model application, the attainment strategy is represented using exhaust characteristics that were developed for the proposed merged and raised Center stacks. Potline emissions consist of dry scrubber emissions and roofline wet scrubber emissions, with most of the SO_2 emissions (about 97%) from the dry scrubber stacks. Modeling of the Center 1 merged dry scrubber stack accounted for the typical operational case with the future installed SO_2 emission control device (with an associated lower stack temperature). Although the future installed Center 1 SO_2 emission control device will be designed for at least 90% removal of SO_2 emissions, the operational case ("Scenario 1") conservatively assumed only 80% removal to demonstrate attainment. Another case is modeled ("Scenario 2") for Center 1 in which the future installed SO_2 emission control device is not operating, for example due to a maintenance outage or a malfunction event. The potline roofline wet scrubbers, constituting only about 3% of total potline emissions, were characterized by modeling each of the six (6) buildings' roofline wet scrubber releases as a single point source per building (half potline). This approach was used to address a comment from EPA Region 10.

Representative exhaust characteristics of the merged and raised stacks were developed with the expectation that no additional ingress air would enter into the system given the assumption that all new infrastructures will be built for all manifolds. With this assumption, temperature drop would be negligible, and the average smelter exhaust temperature of 180 degrees Fahrenheit (°F) was used for modeling. All merged and raised stacks assumes the same stack parameters except for Center 1, where the addition of the future installed SO_2 emission control device creates a lower exhaust temperature, larger stack diameter and subsequent lower stack exhaust velocity. For Scenario 2, where the future installed SO_2 emission control device is assumed to not be operating, the exhaust temperature for Center 1 returns to the higher temperature consistent with the other Centers and the flow increases somewhat.

The full compilation of stack exhaust characteristics for the Intalco emission sources are shown in **Table 2-1** for Scenario 1 and in **Table 2-2** for Scenario 2.

The facility buildings and SO_2 emission sources modeled are shown in **Figure 2-2**.

Table 2-1: Exhaust Characteristics for Proposed Center Stacks and Other Intalco Emission Sources – Scenario 1 (New Planned Center 1 SO_2 Control Device Operating)

ID / Center	No. of Stacks	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
DSA1 / Center 1	1	65.4	45.0	3.14	20.33	303.65
DSA2 / Center 2	1	63.9	45.0	3.11	22.86	355.37
DSB3 / Center 3	1	62.2	45.0	3.11	22.86	355.37
DSB4 / Center 4	1	61.4	45.0	3.11	22.86	355.37
DSC5 / Center 5	1	59.7	45.0	3.11	22.86	355.37
DSC6 / Center 6	1	59.0	45.0	3.11	22.86	355.37
Roofline Wet Scrubber A1 (A1_13)	1	65.4	15.2	21.06	4.31	291.76
Roofline Wet Scrubber A2 (A2_13)	1	64.1	15.2	20.68	4.31	291.76
Roofline Wet Scrubber B1 (B1_13)	1	62.9	15.2	20.29	4.31	291.76
Roofline Wet Scrubber B2 (B2_13)	1	61.7	15.2	20.29	4.31	291.76
Roofline Wet Scrubber C1 (C1_13)	1	60.5	15.2	20.29	4.31	291.76
Roofline Wet Scrubber C2 (C2_13)	1	59.3	15.2	20.29	4.31	291.76
BAKEOVEN	1	57.5	45.0	2.13	15.64	341.3
CAST1_6	6	70.4	26.9	0.79	13.80	532.5
CAST7_8	2	70.7	23.2	0.79	13.80	532.5
CAST9_10	2	70.2	18.4	0.79	13.80	532.5
CAS11_12	2	68.8	23.2	0.79	13.80	532.5
REMELT/Remelt Furnace	1	67.4	10.8	0.91	6.04	463.69
HGF/Homogenization Furnace	1	66.4	19.8	0.76	7.33	451.48

Table 2-2: Exhaust Characteristics for Proposed Center Stacks and Other Intalco Emission Sources – Scenario 2 (New Planned Center 1 SO_2 Control Device Not Operating)

ID / Center	No. of Stacks	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
DSA1 / Center 1	1	65.4	45.0	3.14	22.42	355.37
DSA2 / Center 2	1	63.9	45.0	3.11	22.86	355.37
DSB3 / Center 3	1	62.2	45.0	3.11	22.86	355.37
DSB4 / Center 4	1	61.4	45.0	3.11	22.86	355.37
DSC5 / Center 5	1	59.7	45.0	3.11	22.86	355.37
DSC6 / Center 6	1	59.0	45.0	3.11	22.86	355.37
Roofline Wet Scrubber A1 (A1_13)	1	65.4	15.2	21.06	4.31	291.76
Roofline Wet Scrubber A2 (A2_13)	1	64.1	15.2	20.68	4.31	291.76
Roofline Wet Scrubber B1 (B1_13)	1	62.9	15.2	20.29	4.31	291.76
Roofline Wet Scrubber B2 (B2_13)	1	61.7	15.2	20.29	4.31	291.76
Roofline Wet Scrubber C1 (C1_13)	1	60.5	15.2	20.29	4.31	291.76
Roofline Wet Scrubber C2 (C2_13)	1	59.3	15.2	20.29	4.31	291.76
BAKEOVEN	1	57.5	45.0	2.13	15.64	341.3
CAST1_6	6	70.4	26.9	0.79	13.80	532.5
CAST7_8	2	70.7	23.2	0.79	13.80	532.5
CAST9_10	2	70.2	18.4	0.79	13.80	532.5
CAS11_12	2	68.8	23.2	0.79	13.80	532.5
REMELT/Remelt Furnace	1	67.4	10.8	0.91	6.04	463.69
HGF/Homogenization Furnace	1	66.4	19.8	0.76	7.33	451.48

Figure 2-2: Aerial View of Intalco Buildings and SO_2 Emission Sources for Modeling

The 1-hour SO_2 emission rates were the same in both modeling scenarios for the following sources:

- The bake oven stack ("BOS", or also "Center 7") was modeled with an SO_2 emission rate of 117.5 pounds/hour (lb/hr).
- The six (6) emission points for the potline's roofline wet scrubber stacks were each modeled with an SO_2 emission rate of 8.75 lb/hr.
- The total casthouse emissions, which are based on a conservative emission rate for pipeline-quality natural gas firing furnaces of 0.70 lb/hr, are modeled as being emitted through the following stacks:
  - 0.273 lb/hr from Casthouse Furnace Stacks 1-6
  - 0.091 lb/hr from Casthouse Furnace Stacks 7-8
  - 0.091 lb/hr from Casthouse Furnace Stacks 9-10
  - 0.091 lb/hr from Casthouse Furnace Stacks 11-12
  - 0.056 lb/hr from Remelt Furnace Stack
  - 0.105 lb/hr from Homogenized Furnace.

For Scenario 1, the merged and raised dry scrubber stack for Center 1 with the future installed SO_2 emission control device was modeled with an SO_2 emission rate of 70 lb/hr (representing 80% control from an assumed maximum uncontrolled emission rate of 350 lb/hr). The Scenario 1 emission rates for Centers 2-6 were modeled as five (5) separate cases in which four (4) of the five (5) Center stacks have SO_2 emissions set at 320 lb/hr, while the remaining Center stack has SO_2 emissions set to 400 lb/hr. This modeling allows the following 1-hour average emission limits to be specified for Scenario 1 for Centers 2-6 (Scenario 1 applies for any hour when the SO_2 emissions from Center 1 do not exceed 70 lb):

- Any one of Centers 2-6 can emit as high as 400 lb for a given hour, as long as
- All of the other Centers 2-6 each have SO_2 emissions not exceeding 320 lb for that hour.

The Center 1-6 SO_2 emission limits for Scenario 1 as described above are demonstrated to show attainment with the SO_2 NAAQS by having each of the five (5) modeling cases show design concentrations below the NAAQS of 196.4 $\mu g/m^3$.

For Scenario 2, the merged and raised dry scrubber stack for Center 1 was modeled as if the future installed SO_2 emission control device is not operating. The Scenario 2 emission rates for Centers 1-6 were modeled as six (6) separate cases in which five (5) of the six (6) Center stacks have SO_2 emissions set at 280 lb/hr, while the remaining Center stack has SO_2 emissions set to 400 lb/hr (except that it is 350 lb/hr for Center 1's stack). This modeling allows the following emission limits to be specified for Scenario 2 for Centers 1-6:

- Any one (1) of Centers 1-6 has a permitted 1-hour SO_2 emission rate of 400 lb/hr (except for Center 1, for which the limit is 350 lb/hr) for a given hour, while
- All of the other Centers 1-6 each have SO_2 emissions not exceeding 280 lb for that hour.

The Center 1-6 SO_2 emission limits for Scenario 2 as described above are demonstrated to show attainment with the SO_2 NAAQS by having each of the six (6) modeling cases show design concentrations below the NAAQS of 196.4 $\mu g/m^3$.

The SO_2 emission rates for the five (5) cases modeled for Scenario 1 and six (6) cases modeled for Scenario 2 are provided in **Table 2-3.**

Table 2-3: SO_2 Emission Rates for Attainment Modeling Scenarios

ID / Center	SO_2 Emission Rates by Modeling Source*			
	Scenario 1		Scenario 2	
	lb/hr	g/s	lb/hr	g/s
DSA1 / Center 1	70	8.82	350 / 280	44.10 / 35.28
DSA2 / Center 2	400 / 320	50.40 / 40.32	400 / 280	50.40 / 35.28
DSB3 / Center 3	400 / 320	50.40 / 40.32	400 / 280	50.40 / 35.28
DSB4 / Center 4	400 / 320	50.40 / 40.32	400 / 280	50.40 / 35.28
DSC5 / Center 5	400 / 320	50.40 / 40.32	400 / 280	50.40 / 35.28
DSC6 / Center 6	400 / 320	50.40 / 40.32	400 / 280	50.40 / 35.28
Roofline Wet Scrubbers - Per Building (each)	8.75	1.10	8.75	1.10
BAKEOVEN	117.50	14.80	117.50	14.80
CAST1_6	0.273	0.0344	0.273	0.0344
CAST7_8	0.091	0.0115	0.091	0.0115
CAST9_10	0.091	0.0115	0.091	0.0115
CAS11_12	0.091	0.0115	0.091	0.0115
REMELT/Remelt Furnace	0.056	0.0071	0.056	0.0071
HGF/Homogenized Furnace	0.105	0.0132	0.105	0.0132

* For sources with two emission rates specified (e.g., 400 / 320 lb/hr), this means that one of the sources with the dual emission rates can have emissions as high as the higher rate as long as the others for that scenario have emissions not exceeding the lower rate.

2.2 Nearby SO_2 Emission Sources

Only two other SO_2 sources (both petroleum refineries) have been identified by Ecology and EPA Region 10 as nearby facilities to be modeled for this NAAQS attainment demonstration. The BP Cherry Point refinery is located about 5 km north-northwest of Intalco, and the Phillips 66 refinery is located about 2 km south-southeast of Intalco. The 3-year average SO_2 emissions from these facilities were about 745 and 30 tpy in 2017-2019 for BP Cherry Point and Phillips 66, respectively. Both emission rates are well below the 2,000 tpy threshold for characterizing SO_2 emissions according to the Data Requirements Rule[2]. SO_2 monitoring near each of these facilities indicates design concentrations are well below 50% of the SO_2 NAAQS. For 2017-2019, the monitored design concentration was about 11 ppb near BP Cherry Point and 23 ppb near Phillips 66, respectively. Design concentrations were somewhat similar in 2018-2020 at 10 ppb for the BP Cherry Point monitor and 26 ppb for Phillips 66. These low readings indicate that the elevated SO_2 concentrations due to Intalco emissions are very localized.

The area designation modeling performed by Intalco/AECOM showed that these nearby refineries do not cause or contribute to the 1-hour SO_2 NAAQS exceedances in the NAA. The attainment demonstration modeling presented herein includes a conservative estimate of the refineries impacts by including the maximum monthly average emissions from the refineries' SO_2-emitting sources with the Intalco emissions. For this modeling, EPA Region 10 has recommended a constant hourly SO_2 emission rate for each SO_2 release point at the neighboring refineries. To remain as consistent as possible with Table 8-1 of Appendix W (the EPA Modeling Guideline), EPA recommends that the emission rates should be determined from the monthly maxima of actual 2017-2019 SO_2 emissions, as we do not possess data with higher time resolution. It has been demonstrated that these refineries do not cause or contribute to NAAQS exceedances in the nonattainment area. Therefore, the inclusion of the nearby source emissions assumed to emit constantly at the highest monthly emission rate from the 2017-2019 period is conservative[3,4] for evaluation of impacts within the nonattainment area.

Ecology has provided the refineries' emissions data discussed above. Corresponding stack parameters and building dimensions are the same as those used in the designations modeling. Maximum monthly average refinery emissions for the 2017-2019 period, provided by Ecology, were selected as discussed above.

2.3 Regional Background

Regional background concentrations are used in modeling to represent emission sources that are not directly modeled as well as naturally occurring levels of the pollutant of interest. Once regional background levels have been identified, they are added to the modeled results at each receptor for a cumulative modeling result. As discussed above, nearby emission sources in the SO_2 characterization modeling included Phillips 66 and BP Cherry Point refineries. Although the nearby refinery emissions do not line up with Intalco's emissions for winds from the west-southwest that would impact the Mountain View Road monitor where its design value is greater than the SO_2 NAAQS, and monitored concentrations near the refineries are low, these sources were included in the Intalco attainment demonstration modeling as requested by Ecology and EPA Region 10. Because the refineries were explicitly modeled, the monitors operated by the refineries were not considered for characterization of regional background. This is because these monitors may be impacted by Intalco emissions as well as the refineries' emissions, and because the refineries' emissions would already be accounted for in the cumulative modeling.

In consultation with Ecology, two candidate ambient air monitors were identified to represent regional $SO_{2,}$ monitors when the refineries are explicitly modeled. These monitors are located in Custer, WA and Anacortes, WA. Ecology considers Custer to be influenced by a wastewater treatment plant to its immediate south. Therefore, Ecology expressed a preference for the Anacortes monitor (ID 53-057-0011). The Anacortes design value for 2017-2019 is 3 ppb while its 2018-2020 design value was not valid, potentially due to not meeting data completeness requirements in 2020. Therefore, this modeling application used 3 ppb (7.86 µg/m^3) as the regional concentration since the refineries were explicitly modeled along with Intalco emissions.

Because Intalco is currently curtailed (temporarily ceasing operations on August 26, 2020), local area ambient air monitors can provide an alternative depiction of the real-world regional background for the NAA. The Mountain View

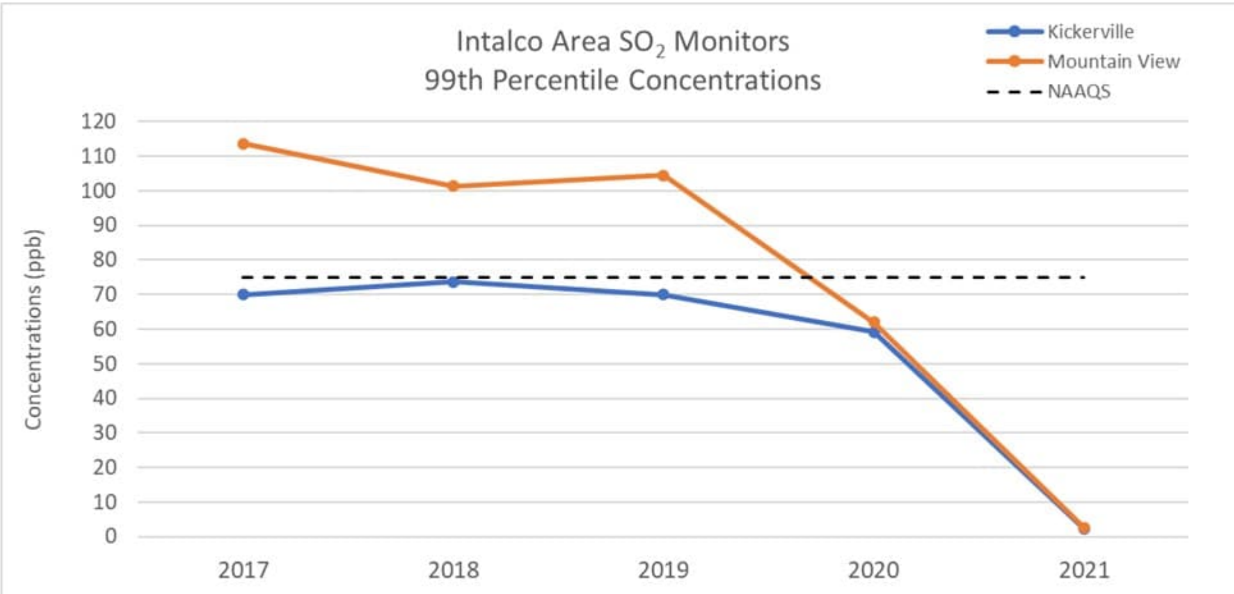
[2] SO_2 Data Requirements Rule: 80 FR 51051, August 21, 2015.

[3] Further EPA guidance on emission rates for nearby sources not affected by the regulatory action is presented on Slide 20 of the EPA webinar on modeling nearby sources presented on August 3, 2017, available at PowerPoint Presentation (epa.gov). The text that EPA used in this discussion indicates that 'for the "few" nearby sources to be explicitly modeled, typical / representative actual emissions (adjusted by operating level) should be used.'

[4] Also see the 2018 EPA Modeling Workshop presentation by Clint Tillerson that describes the more realistic modeling of nearby background sources that would select a constant "high actual" emission rate to characterize the impact of these sources; available at ftp://newftp.epa.gov/Air/aqmg/SCRAM/workshops/2018_RSL_Modelers_Workshop/Presentations/1-18_2018_RSL-Cumulative_Impact_Modeling.pdf.

and Kickerville monitors are located inside the NAA and can quantify how much impact the refineries and all unmodeled SO_2 sources have on the NAA. These monitors' 99th percentile daily maximum 1-hour SO_2 concentrations from 2017-2021 are shown in **Figure 2-3**. SO_2 at both monitors decreased in 2020 with a significant decline in 2021. During the 2021 time period, there were no Intalco operations, attributing to the decreased concentrations (about 3 ppb, a level similar to Anacortes monitor). Furthermore, measurements after the Intalco curtailment at the Kickerville and Mountain View monitors show that 99th percentile concentrations are approximately 3 ppb from September 1, 2020 – December 31, 2021. Therefore, 3 ppb is representative of the all SO_2 emission sources in the NAA without influence from Intalco, including the refineries' impact on the NAA. This is a conservative regional background concentration for the NAA, especially when the refinery emissions are explicitly modeled as they are in this modeling application.

Figure 2-3: 99th Percentile SO_2 Concentrations from 2017 – 2021 for Intalco Area Monitors



3. Dispersion Modeling Approach

Modeling aluminum smelters is challenging due to issues such as partial plume merging of the many closely spaced emission point sources and buoyant line sources as well as the presence of a localized heat signature that can be generated from the facility itself. As such, aluminum smelters cannot be accurately characterized using the guideline model, AERMOD, without consideration of site-specific features associated with this type of large industrial area. Because part of the attainment strategy is to merge and raise Center stacks as described in Section 2, the need to consider the effects of partial plume merging from separate stacks are eliminated, such that the guideline model can more accurately characterize SO_2 concentrations in the NAA as long as the localized heat signature caused by the facility is addressed. Therefore, this model application did not use the wind-direction dependent partial plume merging modeling approach that was implemented in the area designations modeling.

Although the area designation modeling demonstrated that the refineries do not contribute to the SO_2 NAAQS exceedances in the NAA and are therefore unnecessary to include in modeling, at Ecology's request, modeling was performed to include refinery emissions for all attainment strategy scenarios in order to capture potential refinery impacts and regional background. Modeling was conducted for the Intalco, BP Cherry Point, and Phillips 66 facilities with an additional regional background concentration of 3 ppb from the Anacortes monitor.

Further details of the dispersion modeling approach used in this model application are discussed in this section.

3.1 Urban Heat Island Characterization for Intalco Sources

The model used in this application is the AERMOD version 21112 modeling system. The choice of rural or urban for dispersion conditions generally depends upon the land use characteristics within 3 kilometers of the facilities as described in Appendix W to 40 CFR Part 51.[5] Factors that affect the rural/urban choice, and thus the dispersion, include the extent of vegetated surface area, the water surface area, types of industry and commerce, and building types and heights within this area. This analysis would indicate that the land use around the Intalco smelter is rural.

Emission sources such as the Intalco aluminum smelter are unique in that they are associated with large fugitive heat releases that result in a local urban-like dispersion environment. Updates to Appendix W proposed in July 2015[6] that were promulgated in 2017 allow the consideration of the urban effects that are created by large industrial complexes, even if located in rural areas. The "highly industrialized area" effect can be addressed by a technique that accounts for the excess heat from an industrial complex and derives an effective population related to the excess heat generated by the highly industrialized area as input to AERMOD.[7] A study of satellite-derived temperature differences between Intalco and the surrounding area was undertaken and presented during the SO_2 area designation modeling and area designation phase with supporting documentation.[Error! Bookmark not defined.]

For the Intalco smelter, the urban-rural temperature difference is measured to be about 14 K, which would result in an effective urban population of about 10 million. However, model performance demonstrated in past modeling studies[Error! Bookmark not defined.] indicated that using an effective urban population as low as 2 million, equivalent to a 12 K temperature difference, may be used for conservatism (i.e., less dispersion of pollutants than a 10 million population would result in). In using the urban option in combination with the AERMOD "DFAULT" keyword, a default 4-hour half-life for exponential decay of SO_2 is automatically turned on for urban sources. At the request of Ecology, this modeling application used the default half-life in order to ensure the use of AERMOD default options. This half-life will have negligible influence on modeling results due to the small spatial extent of the nonattainment area for which is characterizes herein.

3.2 Meteorological Data Processing

Hourly surface meteorological data were processed with AERMET (version 21112). This model application was performed for a 3-year period, 2017-2019, the same meteorological period as was used in the area designation modeling.[Error! Bookmark not defined.] This data was demonstrated to be of PSD-quality for the area designation modeling by Ecology.[8] Meteorological data processing used in this application are identical to the area designation modeling with

[5] EPA, Guideline on Air Quality Models. https://www.epa.gov/sites/production/files/2020-09/documents/appw_17.pdf
[6] 80 FR 45340, July 29, 2015
[7] Paine, et al., March 2016. Source characterization refinements for routine modeling applications. Atmospheric Environment, Volume 129. https://www.sciencedirect.com/science/article/pii/S1352231016300036
[8] Ecology, 2020. Analysis of Sulfur Dioxide Monitoring Data in Whatcom County: Air Quality Technical Report. Appendix F: Summary of PSD Quality Assurance Procedures for Meteorological Data at Ferndale – Mountain View Road Monitoring Site. https://apps.ecology.wa.gov/publications/SummaryPages/2002015.html

the exception of using the latest AERMET and AERSURFACE processors, use of more recent digital land use files, substitution of missing upper air data, and a correction to the Mountain View temperature sensor height during AERMET processing.

As with the area designation modeling, default model options were used with the low wind speed refinement called ADJ_U*. The Mountain View SO_2 monitor, approximately 1 km east of Intalco, also measures meteorological parameters on a 10-m tower, making this site the most representative surface meteorological station for Intalco. This station's available wind direction, wind speed, and temperature data were used where wind conditions are measured at 10 meters and temperature is measured at 2 meters. The Bellingham International Airport (KBLI), a National Weather Service (NWS) Automated Surface Observing Systems (ASOS) station, was used for cloud cover and to substitute temperature and wind data when missing from Mountain View. Cumulative data completeness of wind and temperature data from the Mountain View monitor for the 3-year period were previously examined and were confirmed to meet the acceptable criteria (data completeness of 90% or greater per quarter and per year) for modeling when substitution of Bellingham data was implemented. These criteria would not have been met with Mountain View alone due to missing temperature data in 2017. In total, Mountain View temperature was missing approximately 12.4% in 2017 and approximately 0.2% in 2018 and 2019. Wind direction was missing 0.7% in 2017, 1.4% in 2018, and 10.1% in 2019. Wind speed was missing 0.5% in 2017, 1.3% in 2018, and 10% in 2019. Calm winds were observed a total of 26 hours during the 2017-2019 period. The total counts of onsite observations in 2017-2019 per meteorological parameter are provided in the modeling archive, **Appendix B.**

For upper air meteorological data, the closest NWS station, Quillayute Airport (KUIL), was used. At the request of EPA Region 10, missing upper air data were replaced as needed with Salem, OR (KSLE) upper air data when synoptic weather patterns were verified to be similar to Quillayute Airport. A total of 2 missing upper air soundings were substituted with soundings from the Salem, OR station (8/1/2017 and 6/19/2019). Total counts of upper air observations in 2017-2019 per meteorological parameter and height are provided in the modeling archive, **Appendix B**.

AERMET creates two output files for input to AERMOD:

- SURFACE: a file with boundary layer parameters such as sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer, and convective and mechanical mixing heights. Also provided are values of Monin-Obukhov length, surface roughness, albedo, Bowen ratio, wind speed, wind direction, temperature, and heights at which measurements were taken.
- PROFILE: a file containing multi-level meteorological data with wind speed, wind direction, temperature, sigma-theta (σ_θ) and sigma-w (σ_w) when such data are available.

AERMET requires specification of the meteorological station site characteristics including surface roughness (z_o), albedo (r), and Bowen ratio (B_o). These parameters were developed according to the guidance provided by EPA in the recently revised AERMOD Implementation Guide (AIG).[9] The AIG recommends that the surface characteristics be determined based on digitized land cover data. EPA has developed a tool called AERSURFACE that determines the site characteristics in accordance with the recommendations from the AIG. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. AERSURFACE was applied with the instructions provided in the AERSURFACE User's Guide.

The current version of AERSURFACE (Version 20060) was used in conjunction with land cover, the percentage imperviousness, and the percentage tree canopy data from the USGS National Land Cover Data 2016 archives (NLCD). NLCD 2019 data was not used due to missing tree canopy data. The AIG recommends that the surface characteristics be determined based on the land use surrounding the site where the surface meteorological data were collected. As recommended in the AIG for surface roughness, the 1-km radius circular area centered at the meteorological station site was created. For this analysis, the area around the Mountain View station was divided into 12 default 30° sectors. This approach was also used for the Bellingham station as it was used to substitute missing wind and temperature data.

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics. As such, AERSURFACE requires specification of the seasonal category for each month of the year. The following five seasonal categories are supported by AERSURFACE. The applicable seasons associated with the 3-year 2017-2019 modeling period for this site were determined using AIG and AERSURFACE guidance, as indicated in the parentheses.

[9] EPA, 2021. AERMOD Implementation Guide. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 2021.

1. Midsummer with lush vegetation (June, July, August)
2. Autumn with un-harvested cropland (September, October, November)
3. Late autumn after frost and harvest, or winter with no snow (December, January, February)
4. Winter with continuous snow on ground (not applicable for this modeling period)
5. Transitional spring with partial green coverage or short annuals (March, April, May)

For Bowen ratio, the land use values are linked to three categories of surface moisture corresponding to average, wet, and dry conditions. The surface moisture condition for the site may vary depending on the meteorological data period for which the surface characteristics is applied. AERSURFACE applies the surface moisture condition for the entire data period. Therefore, if the surface moisture condition varies significantly across the data period, then AERSURFACE can be applied multiple times to account for those variations. As recommended in the AERSURFACE User's Guide, the surface moisture condition for each month was determined by comparing precipitation for the period of data processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th percentile, "dry" conditions if precipitation is in the lower 30th percentile, and "average" conditions if precipitation is in the middle 40th percentile.

The 30-year precipitation data set used in this modeling was taken from the NOAA Online Weather Data (NOWData).[10] Because Bellingham airport precipitation data were missing from June 1996-Sept 1998 and 4 additional months within the 30-year dataset, substitution by an alternative station was required. The Bellingham 3SSW station, used for substitution, was the closest available station with precipitation data during the 30-year period of interest, 1990-2019. A total of 32 months / 360 months were substituted, which is approximately 9% of the dataset. As a result, the majority of the precipitation data are from Bellingham airport.

3.3 Receptor Processing

The receptor grid used in this analysis is identical to that used in the area designation modeling as reviewed by Ecology and EPA Region 10 with two exceptions. The receptor grid was reprocessed with different digital elevation files and the receptor grid is smaller in size to better focus on the NAA, which is approximately a 4.2 km x 3.3 km area in the immediate vicinity of the Intalco facility. As demonstrated by the area designation modeling, it was confirmed that there are no high SO_2 concentrations beyond a few kilometers from Intalco. The grid is larger than the NAA in that it covers a 10-km domain with spacing similar to Ecology air toxics modeling guidance.[11] A nested receptor grid was developed where a polar grid centered on Intalco is used close to Intalco while a Cartesian (rectangular) grid is used for the outer areas. The ambient air boundary represents the property boundary around the facility within which Intalco controls public access. Receptor spacing is described below.

- 25-m spacing along the ambient air boundary,
- 100-m spacing out to 2,000 m from the plant,
- 300-m spacing between 2,000 m and 4,500 m from the plant, and
- 600-m spacing between 4,500 m from plant out to 10,000 m.

Figure 3-1 and **Figure 3-2** show the near-field and far-field views receptor grid. No additional 100-m spaced receptors were necessary because the location of the maximum impact was already in an area covered by 100-m (or denser) grid spacing.

Receptor height scales at each receptor location were developed by AERMAP (version 18081), the terrain preprocessor for AERMOD, which requires processing of terrain data files. Terrain elevations from 10-m National Elevation Dataset (NED) were used to develop the receptor terrain elevations required by AERMOD. After AERMAP processing was complete, all receptors were assigned flagpole heights of 1.4 m as required by Ecology.

3.4 Building Downwash Treatment

In this modeling application, building downwash effects were characterized for all Intalco emission sources using the building processor, BPIP Version 04274. The building layout for Intalco is shown in **Figure 2-2** in the previous section. Note that building locations may appear slightly offset in figures with the aerial imagery due to the angle that the satellite image was taken, where a view from directly above the buildings is often not available. Building downwash parameters

[10] https://w2.weather.gov/climate/xmacis.php?wfo=sew

were also generated for SO_2-emitting sources at the Phillips 66 and BP Cherry Point refineries using building input information provided by Ecology.

Because part of the Intalco attainment strategy is to merge and raise Center stacks, Ecology required a modeling demonstration to identify the maximum creditable stack heights applicable for reducing building downwash effects for the Center stacks. This demonstration is described in the following section.

Figure 3-1: Near-field View of the Receptor Grid

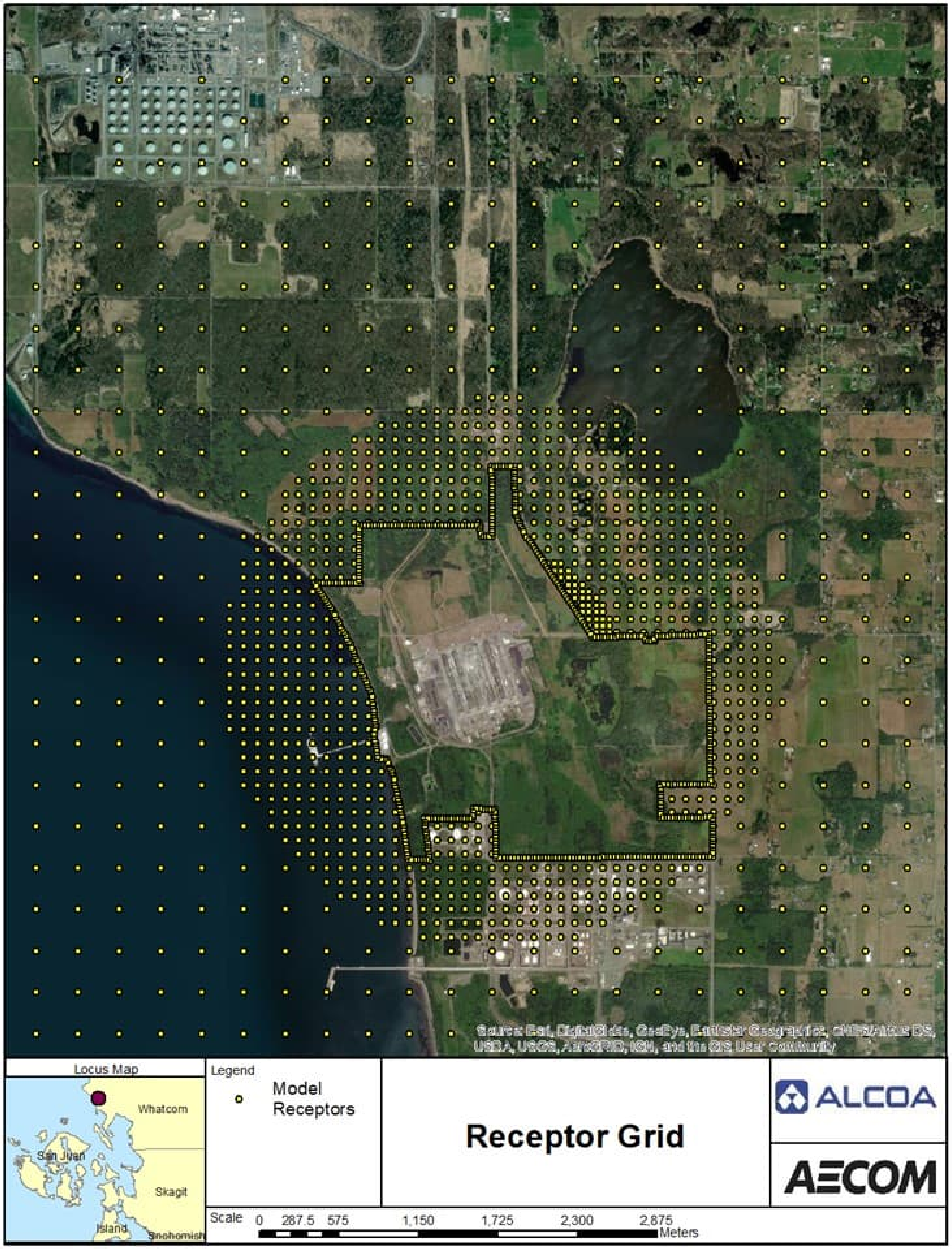
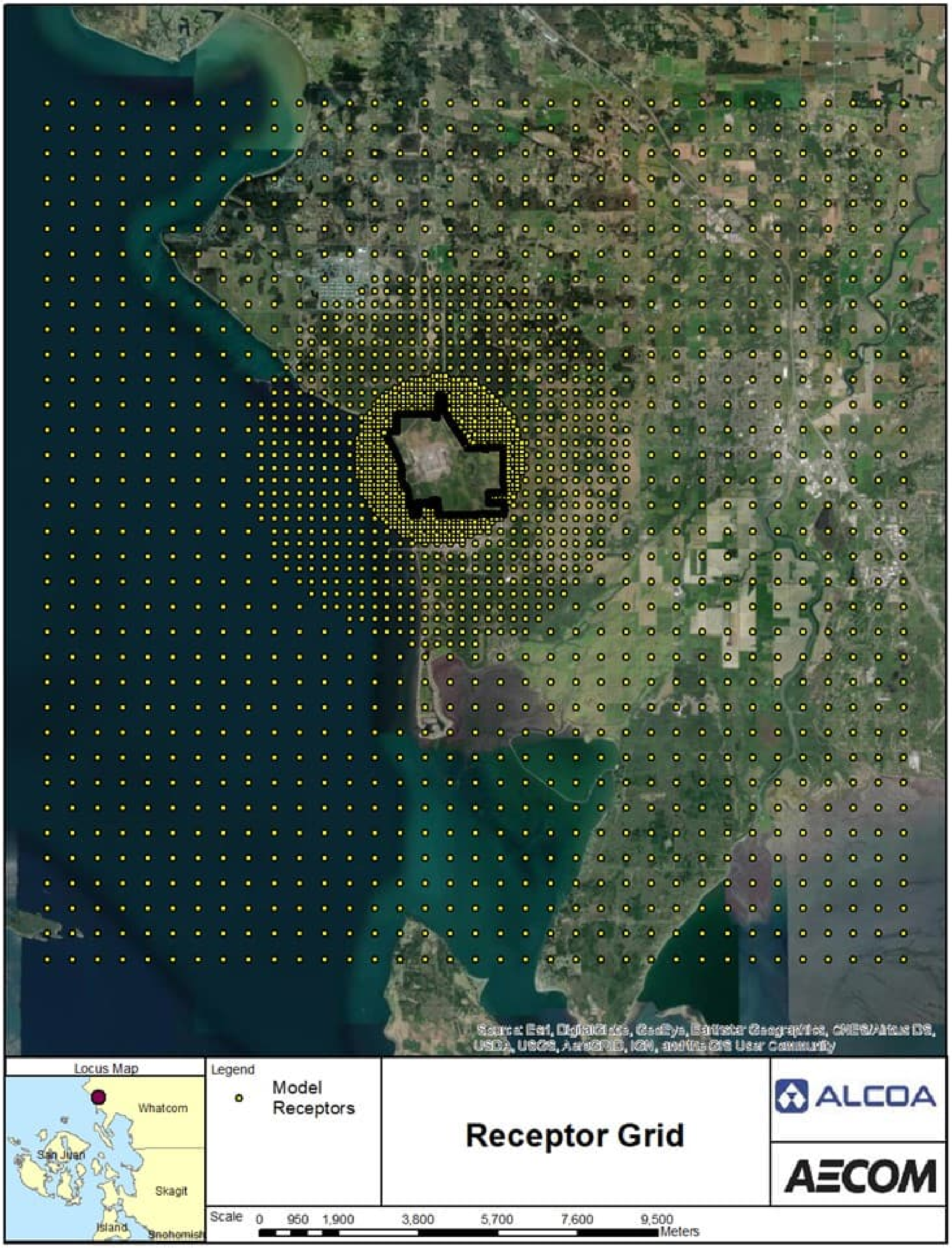


Figure 3-2: Far-field View of the Receptor Grid



4. Maximum Creditable Stack Height

As part of the attainment strategy, Intalco plans to merge dry scrubber stacks into one (1) newly constructed stack for each potline center. Each center stack would be identical in height to one another, with a creditable height to be determined based upon the procedures described below. In addition, the bake oven stack (also referred to as "Center 7") will also be raised to a creditable stack height to avoid building downwash effects.

The modeling protocol in **Appendix A - Section 3** states the following:

"If stacks will be raised as part of the control strategy, the maximum creditable height of each stack must be calculated separately. Modeling credit cannot be claimed for stacks taller than this. If flues from each baghouse center will be ducted through a new merged stack, the minimum height of existing, unmerged stacks in each corresponding center will be considered as the 'base case'. Stacks may be raised to avoid a 'significant downwash effect' as defined in WAC 173-400-200(3)(b) by conducting the following assessment:

(i) Determine the receptors with Highest 1st High (H1H) SO_2 concentrations over 75 ppb when all sources and background are considered. Use the existing un-merged individual stack configuration. On-site receptors can be included. EPA guideline model would be used.

(ii) Raise and merge 'base case' stack heights in approximately 5m increments and perform two model runs, one with and another without downwash. Each time determine the downwash effect at the violating receptors identified above. Each baghouse center should be evaluated separately using AERMOD source groups. EPA guideline model would be used and background concentrations do not need to be considered in these source group-specific tests.

$$Downwash\ effect_{SRCGRP} = \left[\frac{(H1H\ concentration)_{with\ downwash}}{(H1H\ concentration)_{without\ downwash}} \right]_{SRCGRP}$$

(iii) The maximum creditable stack height for a source group is reached when the downwash effect at all receptors identified in [Appendix A, modeling protocol] 3.(i) drop below 1.4."

Intalco will be merging and raising the dry scrubber (i.e., baghouse) center stacks (and raising the bake oven stack) as part of the attainment strategy. Therefore, Ecology requires a modeling study that identifies the maximum creditable stack height of these future stacks. It is important to note that because Intalco proposes to adopt a 5,000 tpy SO_2 emission limit in a revised permit, EPA stack height regulations do not require this modeling study. EPA stack height regulations allow for stacks to be merged and raised as high as the Good Engineering Practice (GEP) height of 65 m if a 5,000 tpy facility-wide SO_2 emission limit is federally enforceable.

For the creditable stack height modeling study, the first step, step (i), is to determine the significant receptors that are over 75 ppb by modeling the creditable stack height base case. As described above, the base case uses the same AERMOD default model approach as described in the attainment modeling except the existing unmerged, individual dry scrubber stacks are modeled. The modeling approach used refinery emissions and the Anacortes background. Emission rates were set to a base case where the current permit limit of 37,780 lb/day was used as basis for emissions from Centers 1-6. A control efficiency of 80% was assumed for Center 1, roofline wet scrubber emission rates were assumed to account for 3% of the limit, and the bake oven stack assumed a lower 116.69 lb/hr rate based on historical production. Casthouse sources' emissions were also based on historical production. The exhaust parameters and emission rates used for the base case are provided in **Table 4-1**. For this determination of receptors, locations within the Intalco fenceline can be included, and they were included for this analysis.

Next, the significant receptors identified by the base case are used to model the merged and raised Center stacks and the taller bake oven stack as they would be constructed in step (ii). Exhaust parameters used for the step (ii) downwash/no downwash comparison modeling are shown in **Section 2, Table 2-1**. Emissions were set to a unit emission rate of 10 g/s. Because step (ii) is a comparison between downwash and no downwash modeling, the emission rates are not required to be equal to the base case. Instead, emissions between the downwash and no downwash modeling scenarios (and all other parameters except downwash parameters) must be equal to one another for an accurate comparison. Each future stack to be raised was evaluated individually using the modeling feature called "source groups".

In this model application, stack heights as high as 45 m were tested[12], and their downwash effects were calculated for significant receptors as described in step (iii) where a Center's stack height is creditable if at least one significant receptor has a downwash effect of equal to or greater than 1.4. Results showed that all merged and raised Center stacks are creditable up to at least 45 m. **Table 4-2** lists the number of receptors with a downwash effect equal to or greater than 1.4 for each stack. Full downwash effect model results are provided within the model archive.

Table 4-1: Base Case Exhaust Parameters and Emission Rates for Each Existing SO_2 Emission Source

ID / Center	No. of Stacks	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	Emission Rate: AOP SO_2 Limit (lb/day) [converted lb/hr]	Emission Rate (lb/hr)	Emission Rate (g/s)
DSA1 / Center 1	6	65.4	19.8	1.52	15.85	355.37	37,780 [1,574]	58.73	1.23
DSA2 / Center 2	6	63.9	19.8	1.52	15.85	355.37		293.64	6.17
DSB3 / Center 3	26	62.2	17.9	0.76	14.63	355.37		293.64	1.42
DSB4 / Center 4	26	61.4	17.9	0.76	14.63	355.37		293.64	1.42
DSC5 / Center 5	22	59.7	17.9	0.76	17.07	355.37		293.64	1.68
DSC6 / Center 6	22	59.0	17.9	0.76	17.07	355.37		293.64	1.68
Roofline Wet Scrubber A1_13	1	65.4	15.2	21.06	4.31	291.76		7.87	0.99
Roofline Wet Scrubber A2_13	1	64.1	15.2	20.68	4.31	291.76		7.87	0.99
Roofline Wet Scrubber B1_13	1	62.9	15.2	20.28	4.31	291.76		7.87	0.99
Roofline Wet Scrubber B2_13	1	61.7	15.2	20.29	4.31	291.76		7.87	0.99
Roofline Wet Scrubber C1_13	1	60.5	15.2	20.29	4.31	291.76		7.87	0.99
Roofline Wet Scrubber C2_13	1	59.3	15.2	20.29	4.31	291.76		7.87	0.99
BAKEOVEN	1	57.5	25.5	2.13	15.64	341.33	---	116.69	14.70
CAST1_6	6	70.4	26.9	0.79	13.80	532.48	---	0.060	0.0075
CAST7_8	2	70.7	23.2	0.79	13.80	532.48	---	0.019	0.0024
CAST9_10	2	70.2	18.4	0.79	13.80	532.48	---	0.014	0.0018
CAS11_12	2	68.8	23.2	0.79	13.80	532.48	---	0.032	0.0040
REMELT/Remelt Furnace	1	67.4	10.8	0.91	6.04	463.69	---	0.011	0.0014
HGF/Homogenization Furnace	1	66.4	19.8	0.76	7.33	451.48	---	0.019	0.0024

Table 4-2: Creditable Stack Height Evaluation – Downwash Effect Results for a 45-m Stack Height

	DSA1 / Center 1	DSA2 / Center 2	DSB3 / Center 3	DSB4 / Center 4	DSC5 / Center 5	DSC6 / Center 6	BAKEOVEN
Number of Significant Receptors with a Downwash Effect equal to or greater than 1.4	936	1,621	755	1,322	813	1,279	3,229

[12] While stack heights up to 65 m could be tested, Intalco determined that the future modeling results for 45-m stacks were acceptable for future operations. This determination does not mean that a 45-m stack is the highest creditable stack height; rather, it indicates the highest stack height that Intalco is planning to implement at this time for resolving the nonattainment issue.

5. Attainment Plan Modeling Results and Conclusions

Modeling results demonstrating that the Intalco attainment strategy attains the SO_2 NAAQS are provided in this section. The modeling results are presented as the 99th percentile daily maximum 1-hour concentrations averaged over the three years modeled for the five (5) Scenario 1 cases and the six (6) Scenario 2 cases. These results can be found in **Table 5-1** and **Table 5-2** for Scenarios 1 and 2, respectively. Corresponding concentration isopleths within the NAA for the Scenario 1 cases are provided in **Figure 5-1** through **Figure 5-5** and for Scenario 2 cases in **Figure 5-6** through **Figure 5-11**. Concentration units are shown in micrograms per cubic meter (µg/m^3). Regional background concentrations of 7.86 µg/m^3 (3 ppb) have been added and an SO_2 concentration of 196.4 µg/m^3 corresponds to the concentration of 75 ppb as the 1-hour SO_2 NAAQS[13].

As shown in the results tables, all cases run for Scenarios 1 and 2 resulted in total maximum modeled design concentrations less than the 1-hour SO_2 NAAQS of 196.4 µg/m^3. Therefore, the permit SO_2 emission limits discussed in Section 2 are demonstrated to be protective of the NAAQS for the future Intalco facility.

Although the Intalco operations remain curtailed, operations could restart in the future. Intalco has identified an attainment strategy that meets federal and state requirements in order to achieve attainment in the SO_2 NAA. The proposed attainment strategy would require the adoption of a facility-wide SO_2 emission limit of 5,000 tpy, which is less than Intalco's current total potline emissions limit of 5,240 tpy that does not include bake oven and casthouse emissions. With this new, more stringent emission limit, the attainment strategy calls for all potline dry scrubber stacks to be merged into one newly constructed stack on a per Center basis with stacks raised to a height of 45 m. The bake oven stack (BOS) will also be raised to a height of 45 m. Intalco would also install one (1) SO_2 emission control device on Center 1's merged stack with a planned control efficiency of at least 90% (modeled conservatively as 80% removal to demonstrate attainment). In addition, casthouse furnaces and miscellaneous combustion sources would be required to use natural gas only.

Table 5-1: Modeling Results for the 45 m Merged Center Stack Heights – Scenario 1

45 m Center Stack Height Results				1-hour SO_2 NAAQS Comparison		
#	Model Scenario	Maximum Modeled Design Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Design Concentration (µg/m^3)	NAAQS (µg/m^3)	Meets NAAQS?
1	Scenario 1, Center 1 at 70 lb/hr, Center 2 at 400 lb/hr, other Centers at 320 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	180.5	7.9	**188.4**	196.4	Yes
2	Scenario 1, Center 1 at 70 lb/hr, Center 3 at 400 lb/hr, other Centers at 320 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	178.6	7.9	**186.4**	196.4	Yes
3	Scenario 1, Center 1 at 70 lb/hr, Center 4 at 400 lb/hr, other Centers at 320 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	183.0	7.9	**190.8**	196.4	Yes
4	Scenario 1, Center 1 at 70 lb/hr, Center 5 at 400 lb/hr, other Centers at 320 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	175.6	7.9	**183.5**	196.4	Yes
5	Scenario 1, Center 1 at 70 lb/hr, Center 6 at 400 lb/hr, other Centers at 320 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	188.4	7.9	**196.3**	196.4	Yes

[13] EPA cites 196.4 µg/m^3 as equivalent to the 2010 SO_2 NAAQS of 75 ppb using a 2.619 µg/m^3 conversion factor; https://www.epa.gov/sites/production/files/2017-08/documents/43_wa_so2_rd3-final.pdf

Table 5-2: Modeling Results for the 45 m Merged Center Stack Heights – Scenario 2

45 m Center Stack Height Results				1-hour SO_2 NAAQS Comparison		
#	Model Scenario	Maximum Modeled Design Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Design Concentration (µg/m^3)	NAAQS (µg/m^3)	Meets NAAQS?
1	Scenario 2, Center 1 at 350 lb/hr, other Centers at 280 lb/hr [total 1750 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	184.4	7.9	**192.2**	196.4	Yes
2	Scenario 2, Center 2 at 400 lb/hr, other Centers at 280 lb/hr [total 1800 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	179.9	7.9	**187.8**	196.4	Yes
3	Scenario 2, Center 3 at 400 lb/hr, other Centers at 280 lb/hr [total 1800 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	188.1	7.9	**196.0**	196.4	Yes
4	Scenario 2, Center 4 at 400 lb/hr, other Centers at 280 lb/hr [total 1800 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	182.4	7.9	**190.2**	196.4	Yes
5	Scenario 2, Center 5 at 400 lb/hr, other Centers at 280 lb/hr [total 1800 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	180.3	7.9	**188.1**	196.4	Yes
6	Scenario 2, Center 6 at 400 lb/hr, other Centers at 280 lb/hr [total 1800 lb/hr], each roofline wet scrubber point at 8.75 lb/hr, BOS =117.5 lb/hr	187.1	7.9	**195.0**	196.4	Yes

Figure 5-1: Scenario 1 Modeling Results for 45 m Center Stack Heights – Center 2 at 400 lb/hr

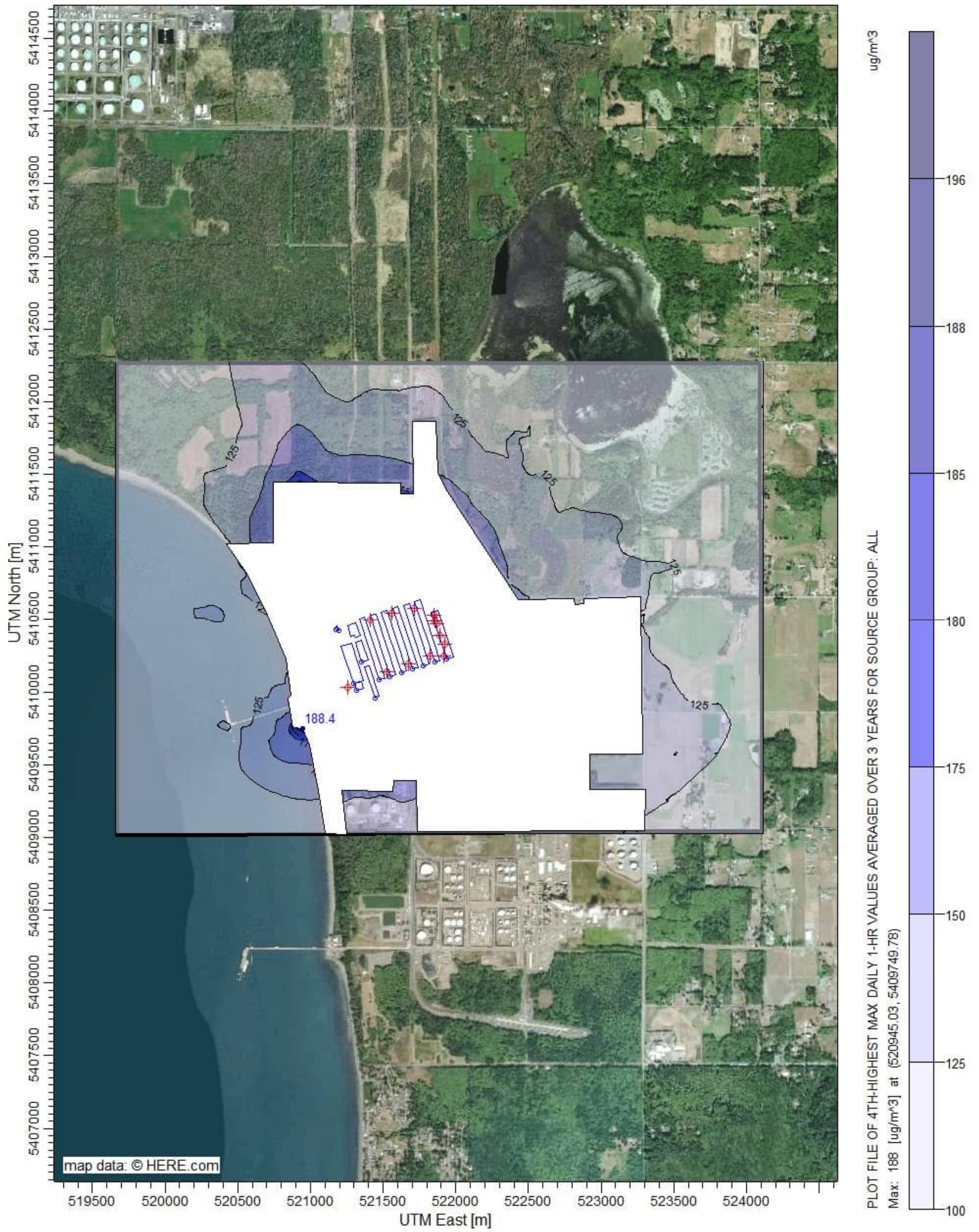


Figure 5-2: Scenario 1 Modeling Results for 45 m Center Stack Heights – Center 3 at 400 lb/hr

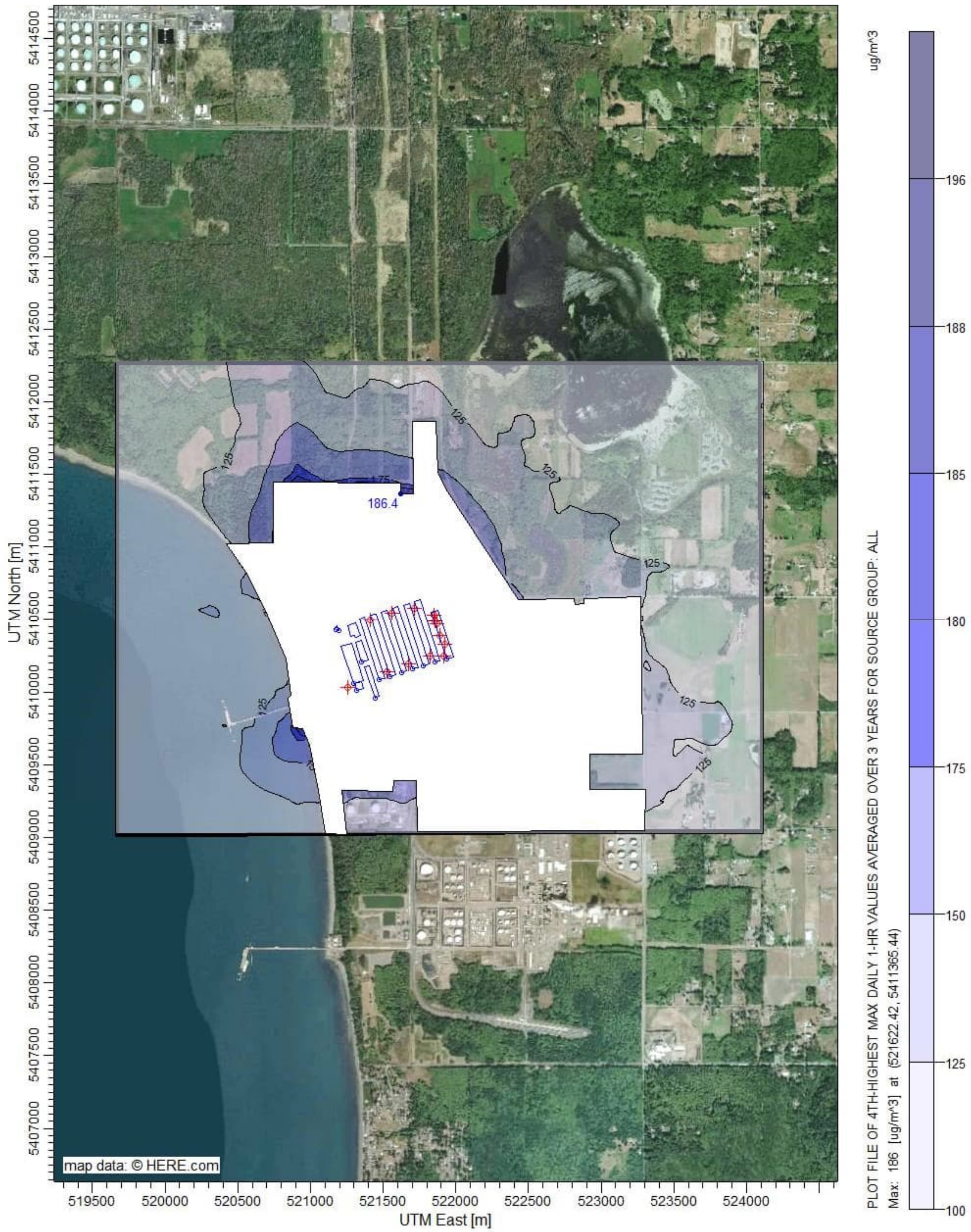


Figure 5-3: Scenario 1 Modeling Results for 45 m Center Stack Heights – Center 4 at 400 lb/hr

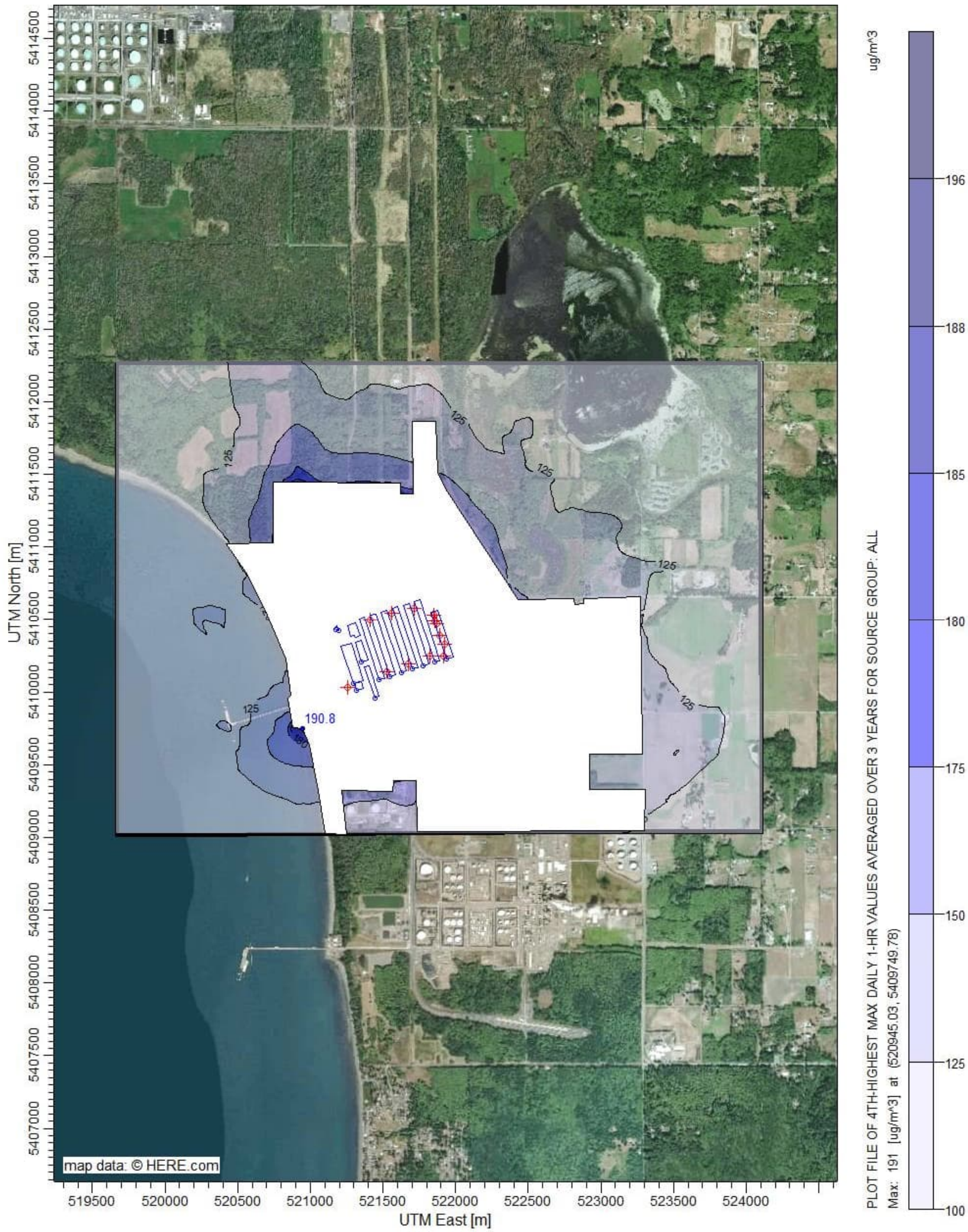


Figure 5-4: Scenario 1 Modeling Results for 45 m Center Stack Heights – Center 5 at 400 lb/hr

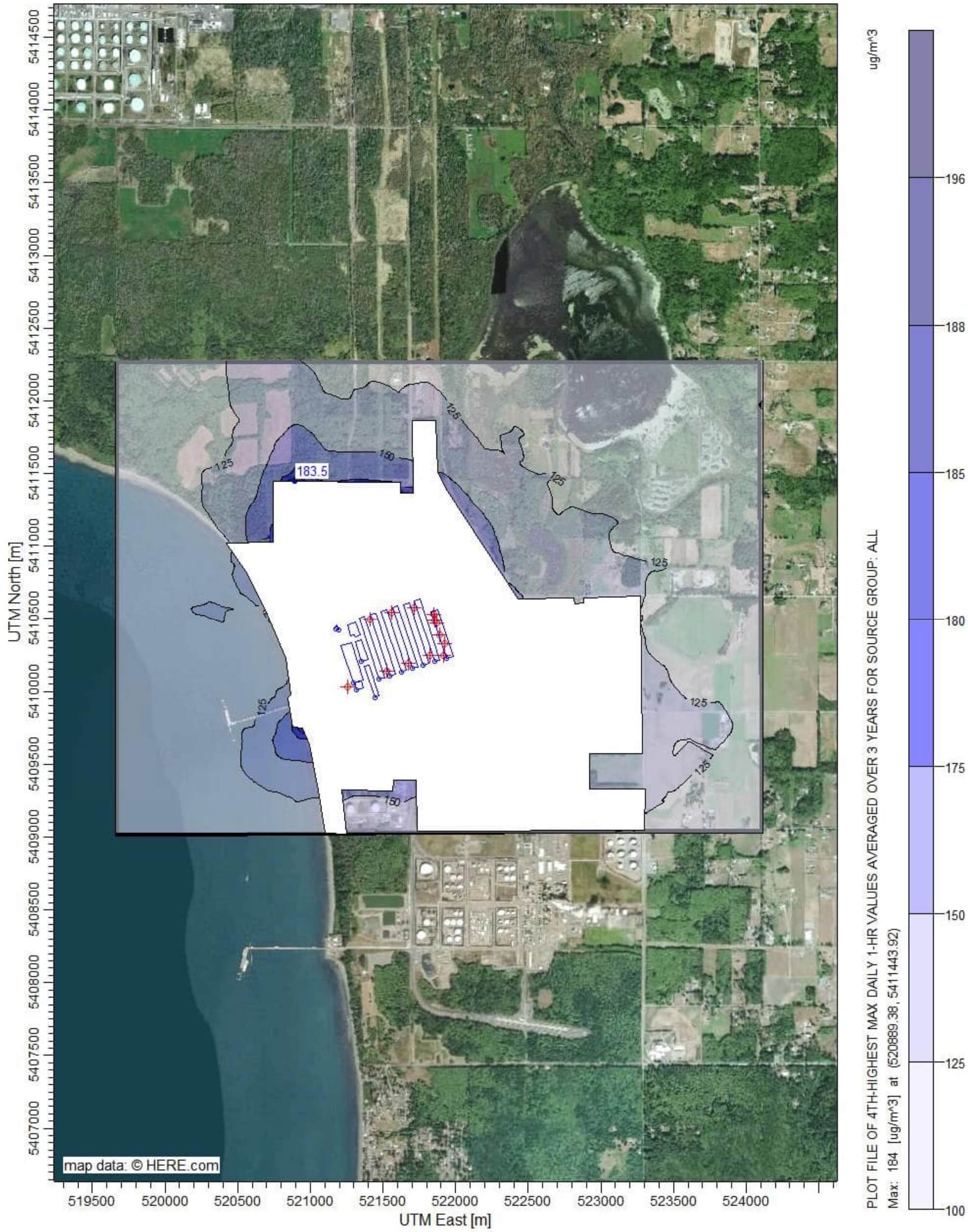


Figure 5-5: Scenario 1 Modeling Results for 45 m Center Stack Heights – Center 6 at 400 lb/hr

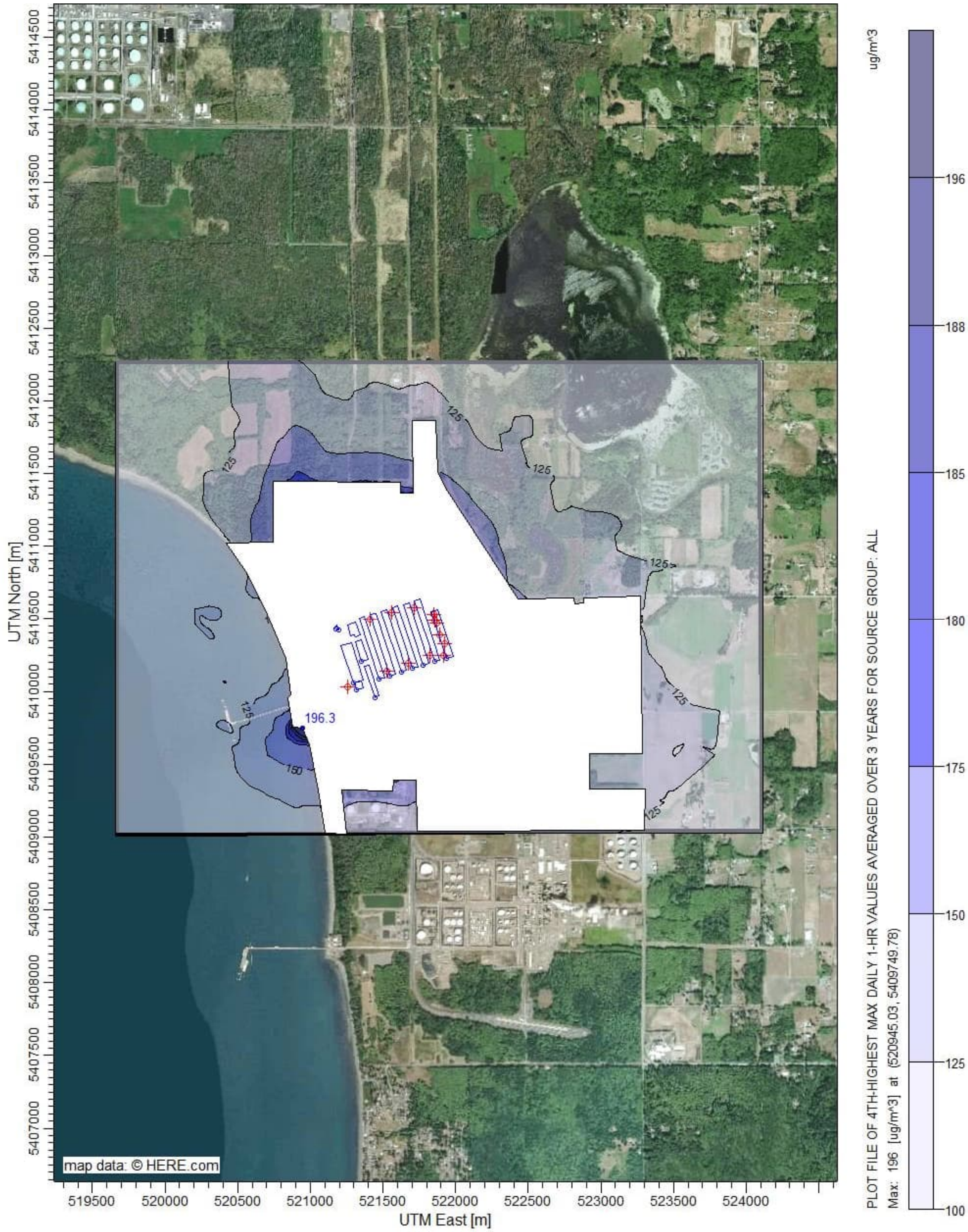


Figure 5-6: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 1 at 350 lb/hr

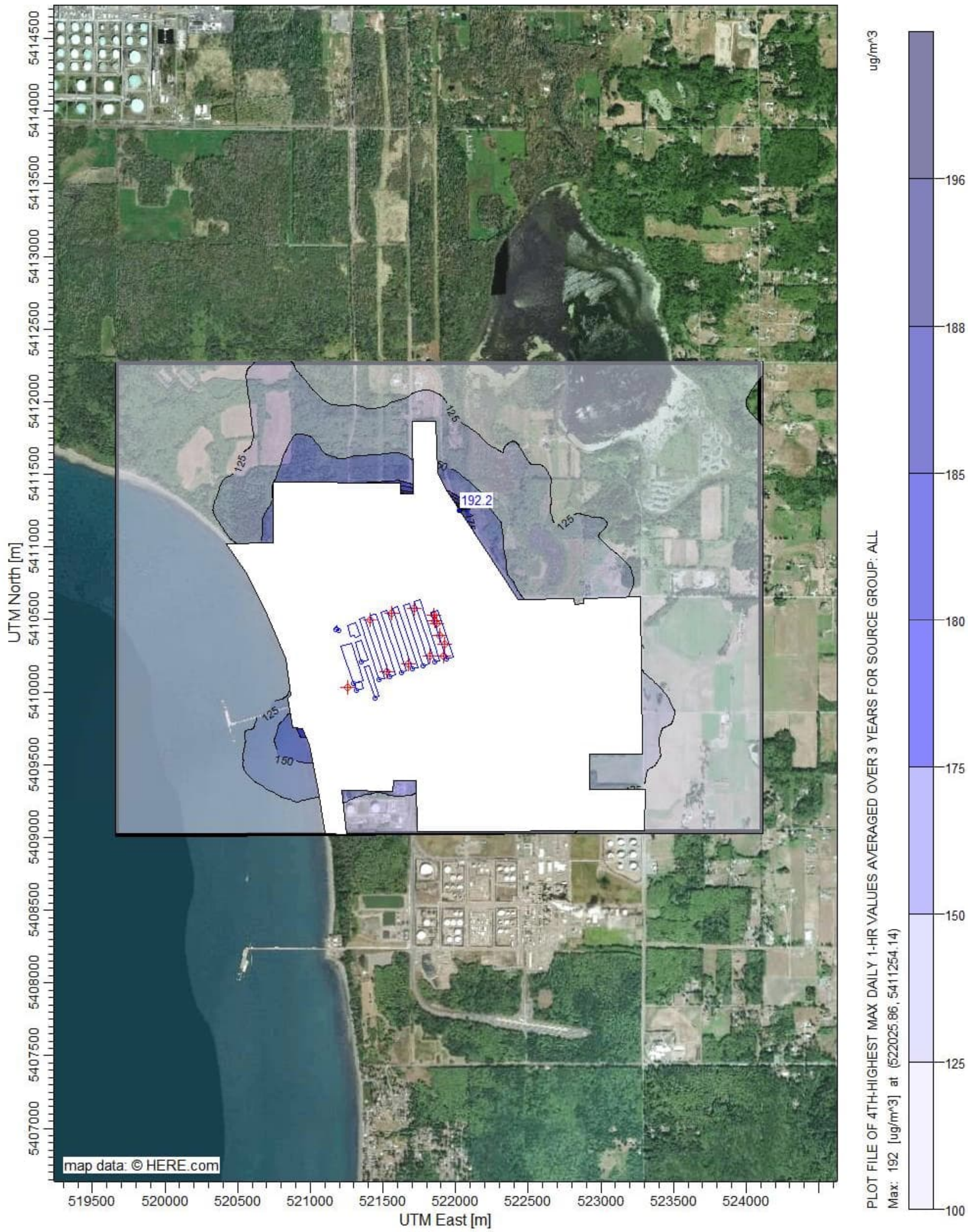


Figure 5-7: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 2 at 400 lb/hr

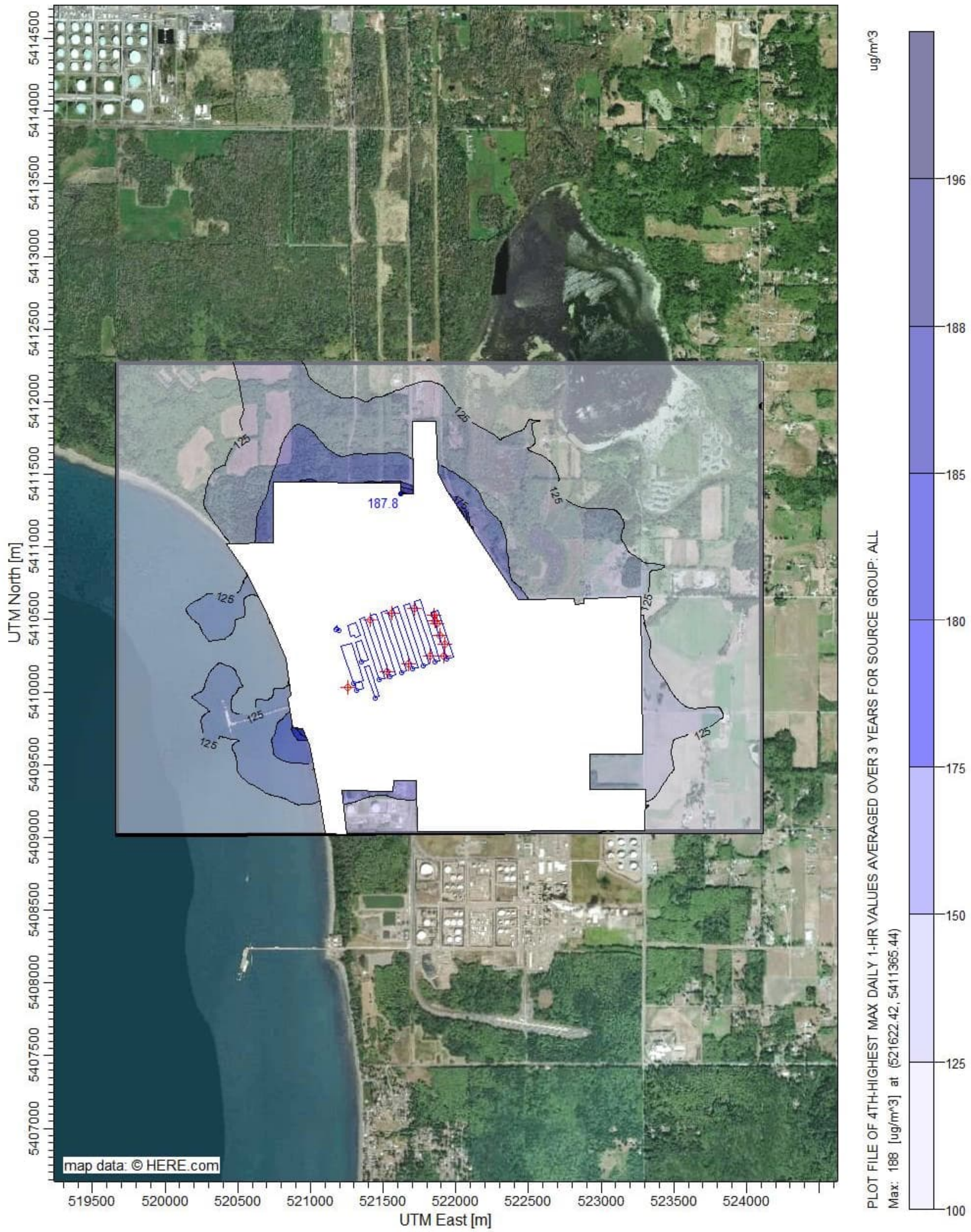


Figure 5-8: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 3 at 400 lb/hr

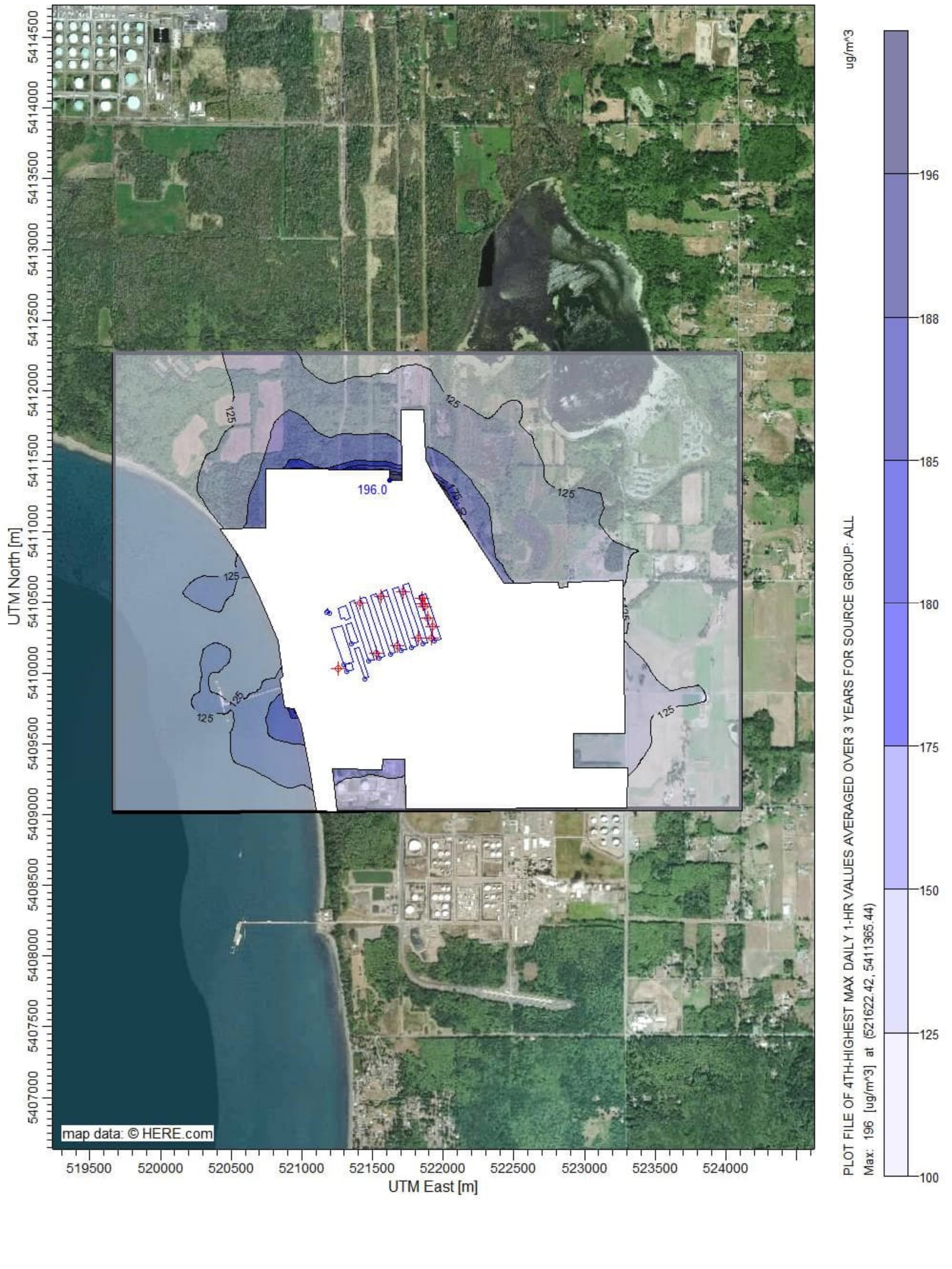


Figure 5-9: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 4 at 400 lb/hr

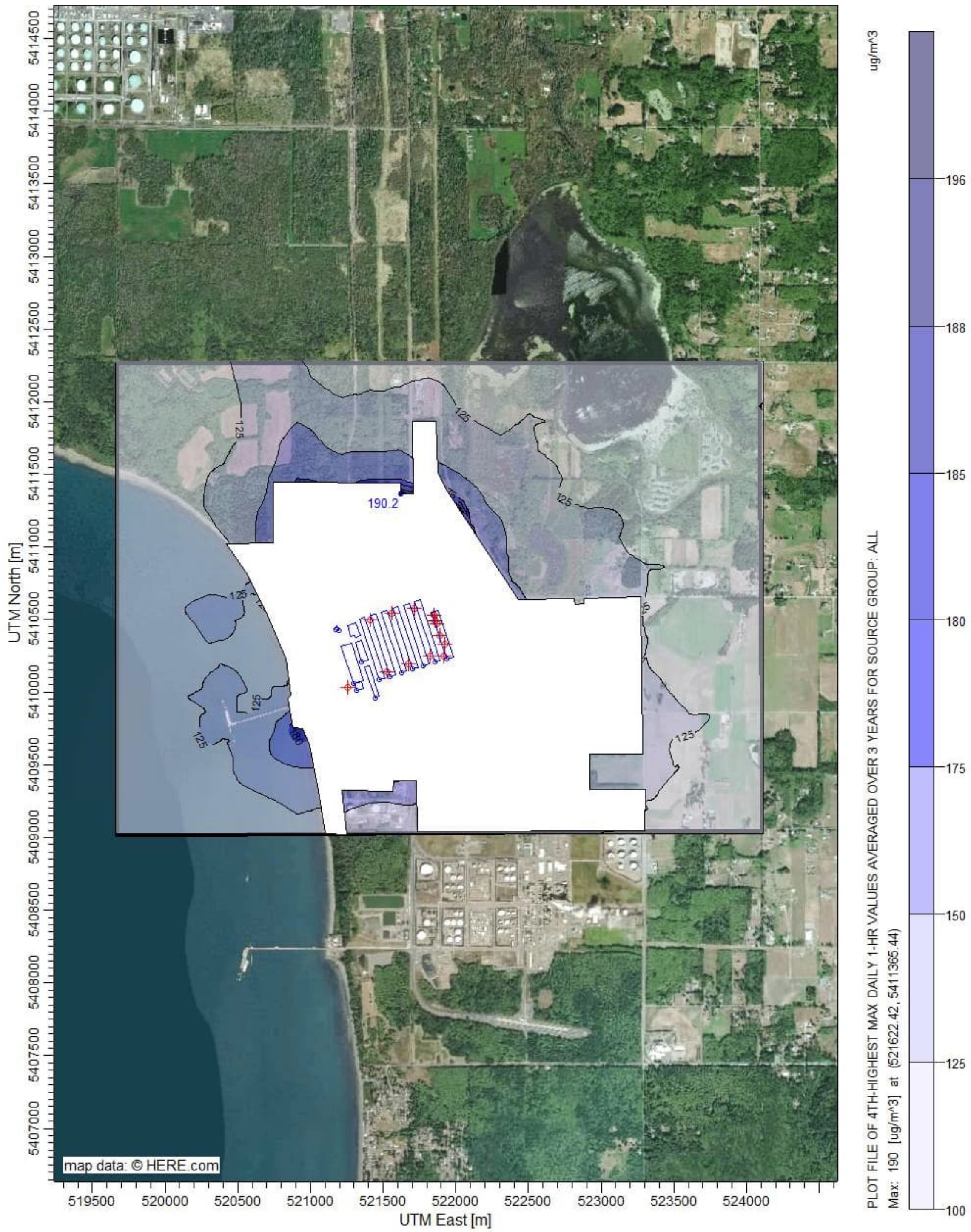


Figure 5-10: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 5 at 400 lb/hr

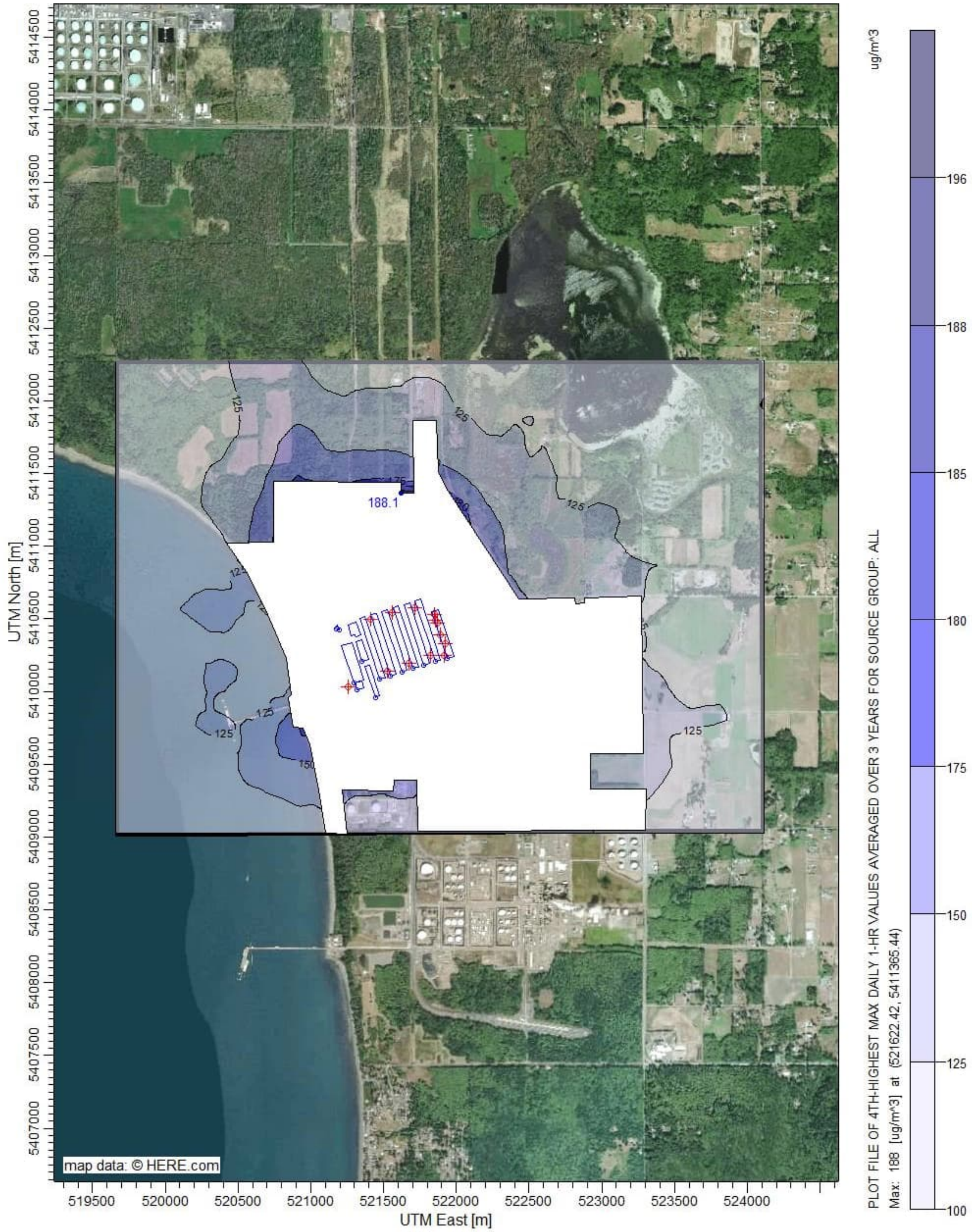
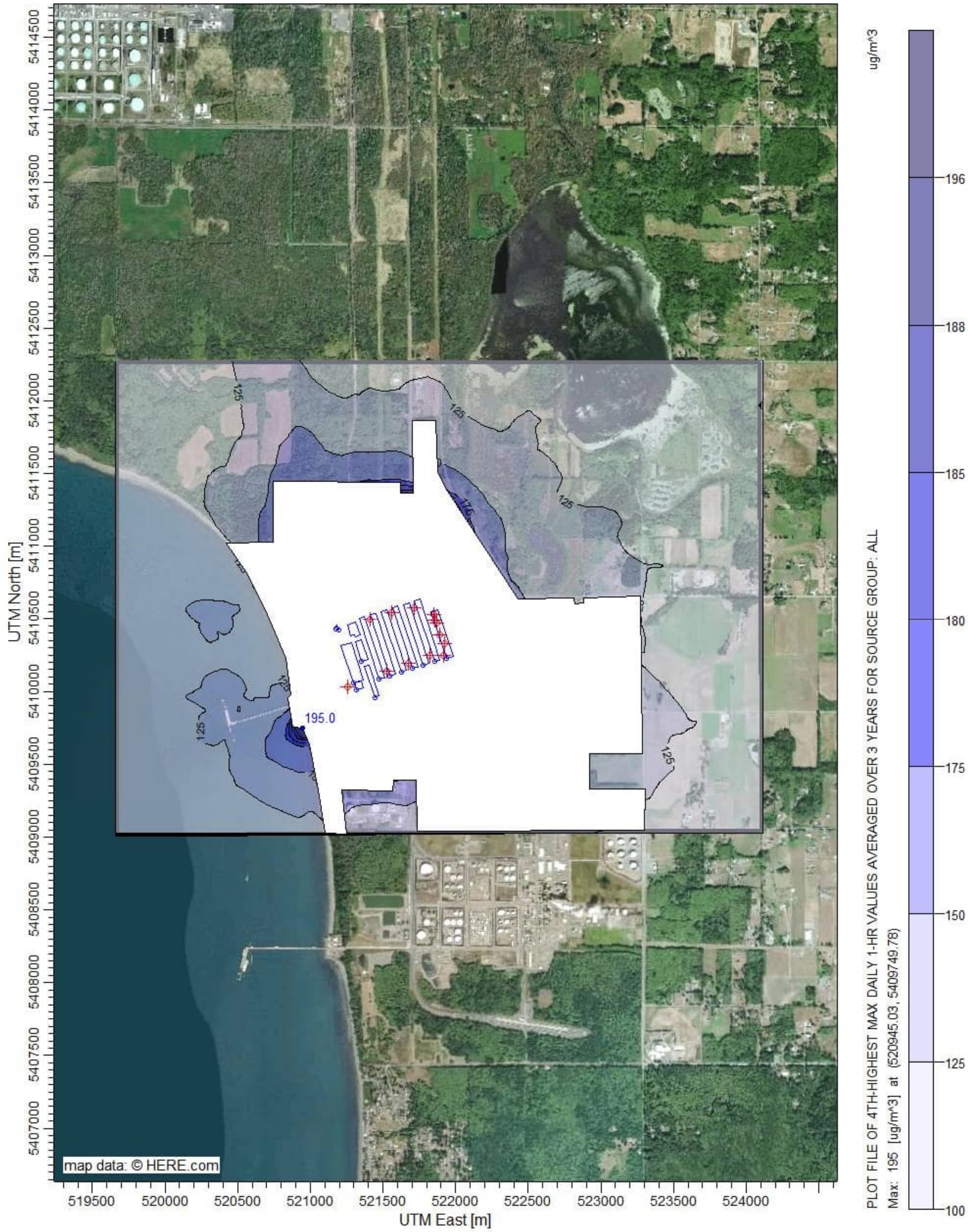


Figure 5-11: Scenario 2 Modeling Results for 45 m Center Stack Heights – Center 6 at 400 lb/hr



Appendix A Final Attainment Plan Modeling Protocol

Final attainment plan modeling protocol with clarifications that address EPA Region 10 comments and with obsolete language (e.g., involving a non-guideline modeling approach) removed.

Summary

On December 21, 2020, EPA designated[1] the following area within Whatcom County as being in nonattainment of the 1-hr SO_2 standard of 2010:

Area bounded by lines connecting the UTM zone 10 coordinates

Southwest Corner: 519671, 5409010

Northwest Corner: 519671, 5412272

Northeast Corner: 524091, 5412261

Southeast Corner: 524111, 5409044.

This is a 4.2km x 3.3km area, or about 5.7 square miles. Figure 18 from EPA's report is reproduced below, indicating the small area around the Alcoa- Intalco facility that is in nonattainment. SO_2 monitors used to support this designation are also shown.

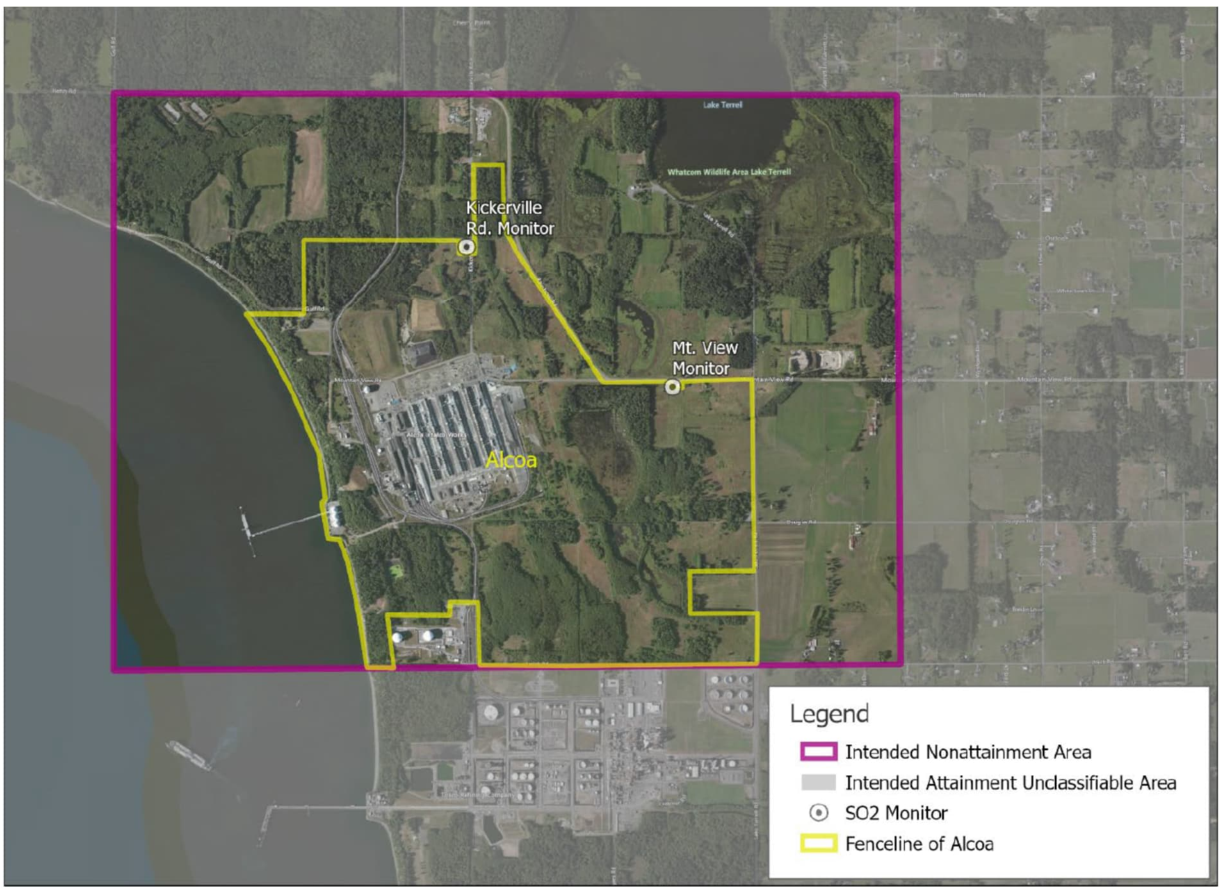


Figure 1: EPA's Nonattainment Area (Figure 18 in EPA letter)

[1] https://www.epa.gov/sites/production/files/2020-08/documents/10-wa-rd4_intended_so2_designations_tsd.pdf

An air dispersion modeling protocol must now be developed to demonstrate the adequacy of the attainment plan. Ecology requests Intalco to use the same modeling methodology as in the attainment modeling exercise, but for the novel wind direction dependent plume merging technique. This document captures the modeling configuration we have discussed over the past several months.

1 Meteorological inputs

The same 2017- 2019 PSD-quality site-specific dataset collected adjacent to Intalco will be used. Missing data are substituted using measurements from a local representative NWS ASOS station (KBLI). The same options used in the designations modeling will be used along with AERMET v21112. The same surface inputs will be used with the newest version of AERSURFACE (v20060).

2 Terrain processing

AERMAP v18081 will be used with the same nested receptor grid as in the designations modeling. Instead of a 41.7km x 47km domain used in the designations modeling (which confirmed that there were no high concentrations beyond a few km from Intalco), the receptors will extend 10km in each direction from Intalco. Flagpole receptor heights will be 1.4m.

3 Building downwash

Downwash effects around all release points at the nearby refineries and Intalco will be accounted for with BPIP v04274. For emissions to be used with the nearby refineries, see Section 5 "Nearby emissions".

If stacks will be raised as part of the control strategy, the maximum creditable height of each stack must be calculated separately. Modeling credit cannot be claimed for stacks taller than this. If flues from each baghouse center will be ducted through a new merged stack, the minimum height of existing, unmerged stacks in each corresponding center will be considered as the "base case". Stacks may be raised to avoid a "significant downwash effect" as defined in WAC 173-400-200(3)(b) by conducting the following assessment:

(i) Determine the receptors with Highest 1st High (H1H) SO_2 concentrations over 75 ppb when all sources and background are considered. Use the existing un-merged individual stack configuration. On-site receptors can be included. EPA guideline model would be used.

(ii) Raise and merge "base case" stack heights in approximately 5m increments and perform two model runs, one with and another without downwash. Each time determine the downwash effect at the violating receptors identified above. Each baghouse center should be evaluated separately using AERMOD source groups. EPA guideline model would be used and background concentrations do not need to be considered in these source group-specific tests.

$$Downwash\ effect_{SRCGRP} = \left[\frac{(H1H\ concentration)_{with\ downwash}}{(H1H\ concentration)_{without\ downwash}} \right]_{SRCGRP}$$

(iii) The maximum creditable stack height for a source group is reached when the downwash effect at all receptors identified in 3.(i) drop below 1.4.

4 Regional Background

As with the designations modeling, the background will be set to the 1-hr SO_2 design value measured at the Anacortes monitor. This was 3 ppb for 2017- 2019.

5 Emissions

Ecology understands that as part of the emissions reductions, Intalco will:

i. Avail itself of the 5,000 tons/ year exemption limit outlined in 40 CFR 51.100(hh)(2)(v), AND
ii. Install at least one new SO_2 wet scrubber control system, AND
iii. Physically combine flues from un-scrubbed stacks at different baghouse centers, AND
iv. Ensure new stacks in (iii) are no taller than the creditable stack height for each center, derived in Section (3) above.

Intalco emissions will be set to their new federally enforceable permit limits. If Intalco plans to meet that plant-wide limit by dynamically adjusting production at different centers or modifying anode parameters (i.e., sulfur content of coke and/or pitch), we will require multiple model runs. Each such run must demonstrate attainment at all ambient receptors and when the makeup of the production limit shifts between centers or the operational limit(s) (sulfur content in coke and/or pitch) is adjusted.

The existing roofline wet scrubber emissions constitute a small percentage of the SO_2 emissions relative to Intalco's current dry scrubber stacks. EPA Region 10 has requested these sources be modeled by characterizing their emissions at their true height of release as either volume or point sources in AERMOD. The approach can involve a simplified parameterization of these emissions, as long as the emissions are released from a representative elevation with reasonably representative release parameters. Other point sources such as the bake oven should be modeled as typical point sources.

Nearby emissions

For SIP modeling, EPA Region 10 recommends a constant hourly SO_2 emission rate for each SO_2 release point at the neighboring refineries. To remain as consistent as possible with Table 8-1 of The Guideline, this should be determined from the monthly maxima of actual 2017-2019 SO_2 emissions, as we do not possess data with higher time resolution. It was previously shown these refineries do not contribute to NAAQS exceedences in the nonattainment area. Therefore, the inclusion of the nearby source emissions is conservative for evaluation of impacts within the nonattainment area. The proposed approach provides a pseudo- capacity-to-emit by using the maximum monthly emissions in the three-year period. It does not necessarily provide for the short-term actual operating conditions required under Table 8-1, but is considered a conservative compromise, since the true allowable emission rates for each unit are unknown.

Ecology will provide a file with these data. Corresponding stack parameters and building dimensions are the same as those used in the designations modeling.

Other model options

As of 2017, the Guideline allows modelers to account for the added dispersion from fugitive heat created by large industrial complexes, even if located in rural areas. As such the Urban Dispersion option may be used. The effective population related to the excess heat was estimated to be around 2 million. As in the designations modeling, only the Intalco sources (not the refineries) should be assigned Urban Source Groups.

Although the regulatory default half-life of SO_2 (4-hours) is not appropriate for the rural setting, it should be used here to ensure the SIP modeling only uses AERMOD v21112 with DFAULT options. Since most of the impacts are nearby, this is not expected to under-estimate design values.

Appendix B Attainment Plan Modeling Archive

Provided as a separate zipped file.

aecom.com

aecom.com