Cargill Stewart Parcel Rail Yard Modeling Report

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1.0 PROJECT DESCRIPTION

Cargill, Incorporated (Cargill) operates a corn milling plant in southeast Cedar Rapids and is exploring potential rail yard locations. NV5 was hired to perform dispersion modeling to evaluate the location for air emissions compared to the National Ambient Air Quality Standards (NAAQS) for particulate matter.

1.1 POTENTIAL LOCATION

The Stewart Parcel is a property bordered by Cole Street SE and Otis Ave SE along the railroad about 1.5 miles southeast of the Cargill 10th Street SE plant. This site was modeled for PM10 and PM2.5 and results will be presented in this report.

The potential railyard site is shown in Figure 1 below.

Figure 1. Stewart Parcel.

2.0 AERMOD AIR DISPERSION MODEL

An air dispersion model uses simplified physical models to estimate the hourly impact that facility emissions will have in ambient air at specified ground level locations. Following IDNR guidelines, the AERMOD dispersion model will be used for predicting ambient air concentrations that could result from the proposed railyard location. The model settings used are described further in sections to follow.

2.1 MODEL SELECTION AND OPTIONS

AERMOD version 18081 was used for this analysis. The user interface was the BEEST Suite version 11.12 by Providence Engineering and Environmental Group, LLC.

2.1.1 Land Use

Rural air dispersion algorithms were used based on land use classifications from United States Geological Survey (USGS) topographical maps. If the land use is less than 50 percent urban out to three kilometers from the sources, then rural algorithms should be used. The area within a radius of three kilometers of the proposed railyard locations have significant green space and undeveloped area on the edge of town. Therefore, use of rural dispersion algorithms is justified.

2.1.2 Terrain Option

Digitized terrain data for the project area was retrieved from the Iowa DNR's modeling website. GeoTIFF files from the National Elevation Dataset (NED) for the state of Iowa were imported for use in AERMAP Version 18081 to calculate terrain heights for input into the AERMOD model. The NED file used for the proposed rail yard was for Linn County.

2.1.3 Concentration/Deposition Option

The concentration option was used to provide maximum pollutant concentrations that could be compared to the National Ambient Air Quality Standards (NAAQS). The model was set to provide output in terms of receptor concentration.

2.1.4 Merging of Stacks

Merged stack are not employed in the modeling of the rail yard.

2.1.5 Model Averaging Periods

The proposed rail yard was modeled for PM10 and PM2.5 emissions. PM10 emissions were modeled for impacts for the 24-hour averaging period. PM2. 5 emissions were modeled for both 24-hour and annual impacts against the NAAQS.

2.1.6 Meteorological Data

Meteorological data required by AERMOD include hourly averages for wind speed and wind direction that are the basis of the modeled speed and directional transport of emissions. Wind speed, ambient temperature and boundary layer parameters (for example, mixing height and friction velocity) are used to estimate the horizontal and vertical rate that emissions disperse in the atmosphere. AERMET, a preprocessor to AERMOD, calculated the boundary layer parameter values as a function of the user provided meteorological data and surface characteristics. Pre-processed meteorological data for Cedar Rapids for 2010 – 2014 supplied by the Iowa DNR were used for the analysis.

2.1.7 Receptor Data

Ambient air concentrations were predicted associated with the proposed rail yard at ambient air ground level locations (x,y,z). The development of ambient air locations (x,y) followed Iowa DNR guidelines 3-20-18. Receptors were placed along the property line at 50 meter intervals. Off property receptors were placed at 50 meter intervals within 0.5 kilometers of the property line. Receptors were placed at 100 meter intervals out to 1.5 kilometers, 250 meters out to 3 kilometers and 500 meters beyond 3 kilometers. AERMAP version 18081 was used to import terrain elevations from the National Elevation Dataset (NED) file for Linn County as pre-processed files from the IDNR website. A receptor grid containing 3017 receptors covering an area 11.5 kilometers by 11 kilometers was used and is shown in Figure 2 below.

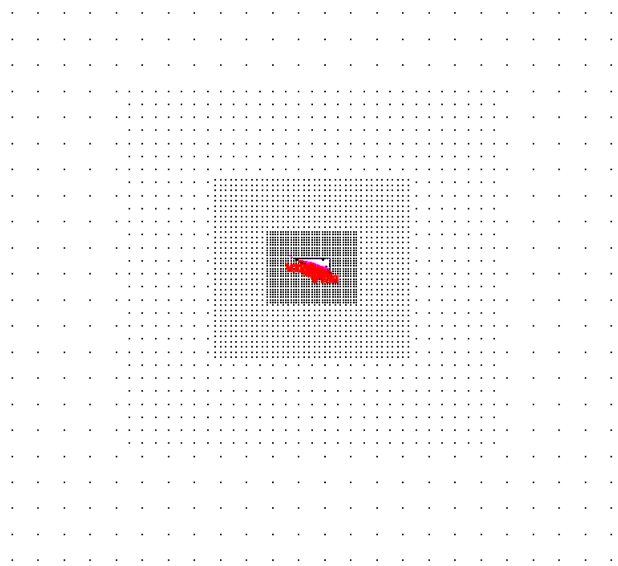

Figure 2. Receptor Grid for Stewart Parcel.

2.1.8 Building Downwash

Building downwash is an aerodynamic event that has the tendency to pull plumes downward with the air movement that descends downwind of building obstacles. The trajectory of the rising plume downwind of a building is thus impeded by the air descending after it passes over a building. AERMOD includes algorithms to model the effects of building downwash on emissions from nearby or adjacent point sources. The US EPA Building Profile Input Program (BPIP-PRIME) version 04274 is the current version to determine downwash parameters included with the BEEST dispersion modeling package. The PRIME algorithm includes enhanced dispersion coefficients due to turbulent wake and reduced plume rise caused by a combination of the descending stream lines in the lee of the building and the increased entrainment in the wake.

The rail yard emissions are modeled as volume sources to represent movement of the locomotive. The rail yard model does not contain point sources so BPIP-PRIME was not utilized.

2.1.9 Background Concentrations

Appropriate background values must be added to modeled concentrations when a NAAQS analysis is conducted. Current statewide default background values were obtained from the Iowa DNR background data on the IDNR Dispersion Modeling website.

- The background value for PM10 24-hour averaging period is 52 ug/m^3. This value was added to the final results of the model.
- The background value for PM2.5 annual averaging period is 9.8 ug/m^3. This value was included in the model so final results include background.
- The background values for PM2.5 24-hour averaging period are 23 ug/m^3 in the winter and 20 ug/m^3 for spring, summer and fall. These values were included in the model at temporally varying values by season. Final results include background values.

2.1.10 Regulatory Defaults

The designated regulatory defaults used in conducting the AERMOD model included: 1) using buoyancy induced dispersion; 2) not using gradual plume rise; 3) using calms processing routines; 4) using default wind profile exponents; and 5) using vertical potential temperature gradients. Ambient air ground locations were assigned ground elevations. This ground level elevation option complies with the Air Dispersion Modeling Guidelines, which states that receptors be assigned elevations obtained from USGS National Elevation Dataset (NED) data files.

2.1.11 Guidance from Other Studies

A literature review of previous rail yard modeling was completed prior to starting this project. Two references were used as guidance for this project.

- Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Los Angeles/Hobart Rail Yard submitted to California Air Resources Board dated December 1, 2006 found here: https://www.arb.ca.gov/railyard/hra/env_sb_admrpt.pdf .

- Roseville Rail Yard Study by the California Air Resources Board dated October 14, 2004 located here: https://www.arb.ca.gov/diesel/documents/rrstudy/rrstudy101404.pdf

The Los Angeles/Hobart Rail study modeled idling locomotives as point sources and volume sources for locomotives moving along specific pathways.

The locomotives Cargill would choose to use at this location are Tier 3 and equipped with minimal idling. The engines shut down after 10 minutes of idling. Because this is such a short period of time, no point sources were included in the model.

According to the Los Angeles/Hobart Rail study, the locomotives have been modeled as volume sources to represent movement on the rail lines. Volume sources were set up to be the width of the combined rail lines plus the width of a locomotive (10 ft) with a length up to 125 meters. Volume sources do not overlap. As the rail lines converge and diverge, the volume sources change size to represent the appropriate rail lines.

The UP rail lines are not modeled because these lines have other traffic not associated with the new rail yard and they are not owned by Cargill. Emissions from rail traffic on the UP rail lines have been accounted for in the background concentrations used in the modeling demonstration.

2.1.12 Source Information

To capture the site layout in the model, the rail lines were added as Other Boundary Options. These are just flat lines without volume or height used to represent where the rail lines are located on the property. In addition, Other Boundary Options were used to place boxes in the model to determine the dimensions and locations of the volume sources. The office building and the berm were included as structures.

No emission sources other than the volume sources for the rail lines are included in this model. Cargill is not proposing to operate any other emission sources at this time.

2.1.13 Hours of Day

Cargill provided a general operating plan for the rail yard including hours sorting cars and hours spent at the Cargill Corn plant. Hours of operation at the rail yard were set in the model as operating hours and the remaining hours as non-operational. Locomotives will not operate overnight at the rail yard. In addition, the locomotive will spend 4 hours of the day at the plant and the remaining 8 hours at the rail yard.

2.1.14 Volume Sources

Once the dimensions of the volume sources were determined, the data were entered into the Iowa DNR Volume Source Tool. Volume sources represent emissions that initially disperse in three dimensions without upward velocity of the plume from an associated flow rate. The volume source tool requires the **building corners, the building height, the emission rate and the enclosure credit** be entered. Once these data are entered, the Volume Source Tool determines how many volume sources are needed and the inputs for each source to be input to the model. The inputs to the Volume Source Tool are discussed further below. The initial horizontal dimension and the initial vertical dimension are outputs determined by the Volume Source Tool following EPA guidance for entry into the model.

2.1.14.1 Building Corners

Volume sources are more typically indoor vented sources so building corners where emitted are used. This application, however, uses volume sources to represent locomotives traveling along rail lines. Boxes were set up as Other Boundary Options in the model to show the dimensions for the building corners to enter into the IDNR Volume Source Tool. The IDNR Volume Source Tool uses the original dimensions to determine volume source inputs for the model.

2.1.14.2 Building Height

The building height when entered into the Volume Source Tool will set the Release Height at half the building height. Again, this application does not have a building, but instead represents a locomotive. The height of a locomotive is 15 feet so the release height for the volume sources was set at 15 feet. This is a very conservative assumption because the exhaust of a locomotive has an airflow.

Review of the Roseville Rail Yard study found that an adjusted initial plume release height was used for these locomotive volume sources. The adjusted initial plume release height was calculated by adding the physical height of the stack on the locomotive (15 feet) plus the plume rise determined by using SCREEN3 modeling for Stability D and F categories. The adjusted initial plume release heights used in both the Roseville study and the LA/Hobart study are all greater than 15 feet dependent on meteorological stability. This confirms that the release height of 15 feet used in this study is representative and conservative. Adjusting the plume release height would reduce the final model results by increasing vertical dispersion, however, this analysis was not completed because meteorological data are provided by the IDNR.

2.1.14.3 Emission Rate

Cargill proposes to use a Tier 3 locomotive at the proposed rail yard. Emission rates for a Tier 3 locomotive are required to meet the limits in §1033.101 Table 2. Because the locomotive will travel along the rail lines, emissions will not occur in one place nor will all emissions occur in one volume source in one hour. Consistent with the previous studies, the total hourly emission rate was divided by the number of volume sources at the rail yard. The emission rates for a Tier 3 locomotive are shown in Table 1 below. The hourly emission rate was divided by 36 volume sources for a PM10 / PM2.5 emission rate of 0.0092 lb/hr.

Table 1. Tier 3 Locomotive Emission Rate

Pollutant	g/hp-hr	Lb/hr
PM.25	0.1	0.33
PM10	0.1	0.33
NOx	5	16.53
CO	2.4	7.94
VOC	0.6	1.98

2.1.14.4 Enclosure Credit

The enclosure credit is applied if the volume source represents a source vented inside a building. This is not the case for the rail yard modeling so no enclosure credit was taken.

2.1.15 Site Layout

The Stewart Parcel proposed layout is shown below in Figure 3. It will include a ten plus foot berm along Otis Avenue SE and approximately 200 car capacity.

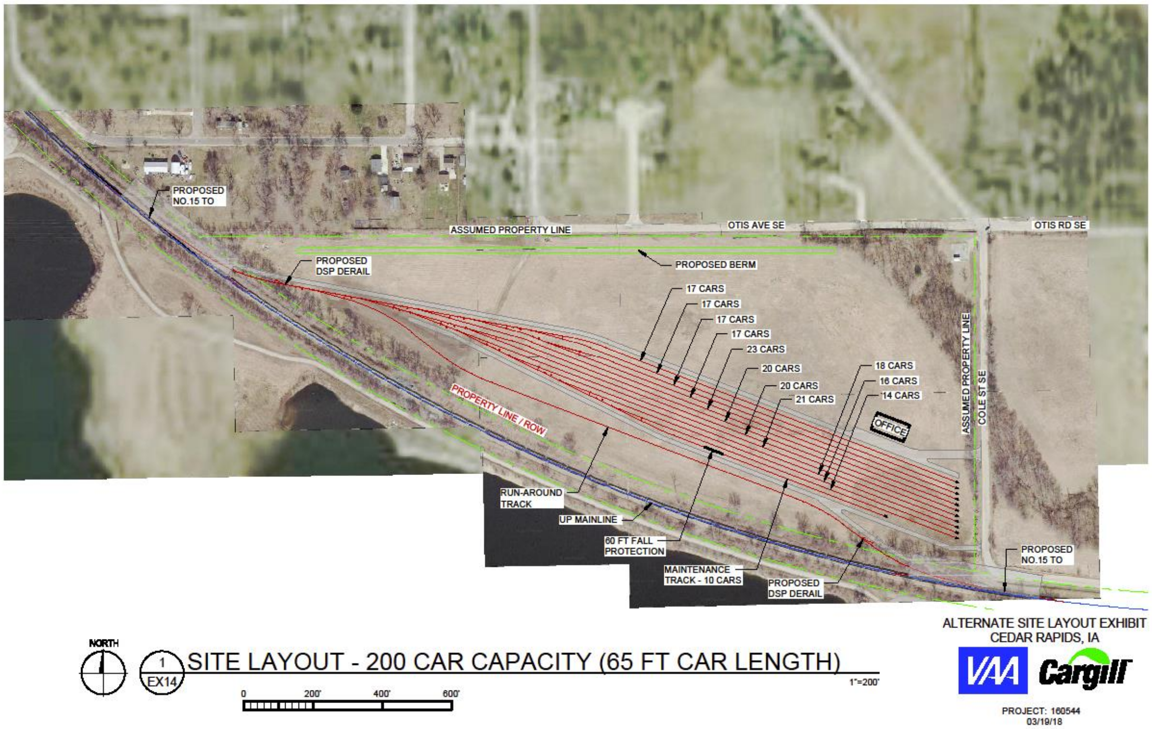

Figure 3. Stewart Parcel Layout

Figure 4 below shows the model setup for the Stewart Parcel. The pink boxes are the dimensions used to determine the volume sources in the Iowa DNR Volume Source Tool. The pink lines as Other Boundary Conditions have no volume or height but are merely placeholders to identify rail locations on the site. The red labels are the volumes sources determined using the IDNR Volume Source Tool.

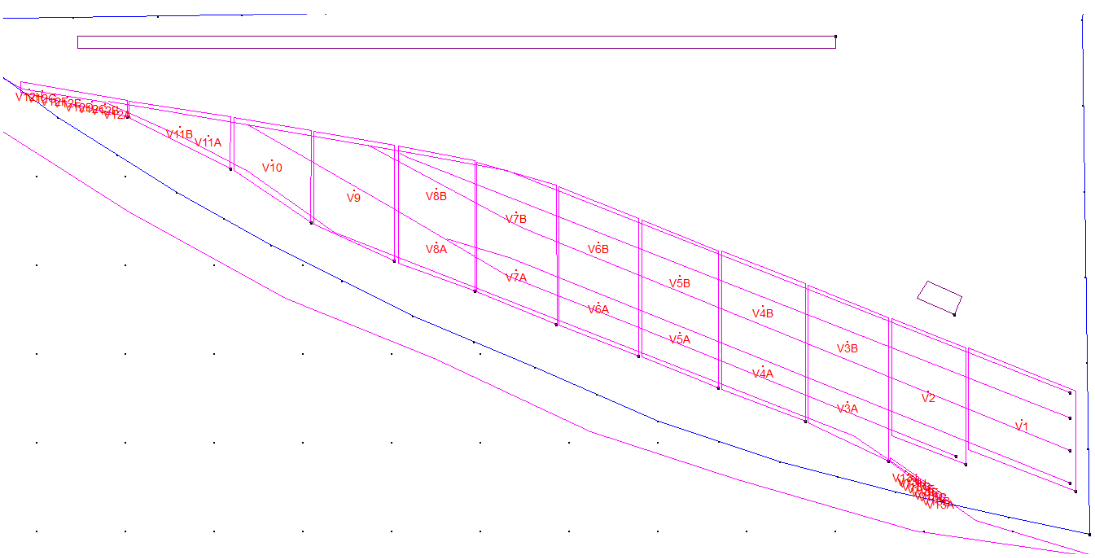

Figure 4. Stewart Parcel Model Setup.

2.1.16 Model Inputs

The model source inputs from the Volume Source Tool are shown in Table 2 below.

Table 2. Model Inputs

ID	Easting (m) x	Northing (m) y	Base Elevation (m)	Release Height (ft)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	PM10 / PM2.5 Emission Rate (lb/hr)
V1	614055.2	4645063	219.12	15	14.12	4.25	0.0092
V2	614002.5	4645079	219.6	15	12.63	4.25	0.0092
V3A	613957.2	4645073	219.71	15	20.67	4.25	0.0092
V3B	613957.2	4645107	219.63	15	20.67	4.25	0.0092
V4A	613909.5	4645093	219.27	15	20.55	4.25	0.0092
V4B	613909.5	4645127	219.43	15	20.55	4.25	0.0092
V5A	613862.5	4645112	219.3	15	19.66	4.25	0.0092
V5B	613862.5	4645144	219.03	15	19.66	4.25	0.0092
V6A	613816.5	4645129	218.89	15	20.13	4.25	0.0092
V6B	613816.5	4645163	218.02	15	20.13	4.25	0.0092
V7A	613770.4	4645147	217.29	15	19.72	4.25	0.0092
V7B	613770.4	4645180	217.37	15	19.72	4.25	0.0092
V8A	613725.1	4645163	217.32	15	18.39	4.25	0.0092
V8B	613725.1	4645193	217.57	15	18.39	4.25	0.0092
V9	613678.8	4645192	217.33	15	12.33	4.25	0.0092
V10	613632.7	4645209	217.37	15	10.31	4.25	0.0092
V11A	613597.1	4645223	217.39	15	9.17	4.25	0.0092
V11B	613580.7	4645228	217.4	15	9.17	4.25	0.0092
V12A	613545.6	4645239	217.3	15	3.53	4.25	0.0092
V12B	613538.5	4645241	217.32	15	3.53	4.25	0.0092
V12C	613531.4	4645242	217.32	15	3.53	4.25	0.0092
V12D	613524.4	4645243	217.33	15	3.53	4.25	0.0092
V12E	613517.3	4645245	217.34	15	3.53	4.25	0.0092
V12F	613510.2	4645246	217.35	15	3.53	4.25	0.0092
V12G	613503.2	4645248	217.36	15	3.53	4.25	0.0092
V12H	613496.1	4645249	217.35	15	3.53	4.25	0.0092
V13A	614009.4	4645019	219.44	15	1.33	4.25	0.0092
V13B	614007.2	4645021	219.47	15	1.33	4.25	0.0092
V13C	614005.1	4645023	219.5	15	1.33	4.25	0.0092
V13D	614002.8	4645024	219.52	15	1.33	4.25	0.0092
V13E	614000.5	4645026	219.56	15	1.33	4.25	0.0092
V13F	613998.3	4645028	219.58	15	1.33	4.25	0.0092
V13G	613996.1	4645029	219.6	15	1.33	4.25	0.0092
V13H	613993.8	4645031	219.62	15	1.33	4.25	0.0092
V13I	613991.6	4645032	219.64	15	1.33	4.25	0.0092

V13J	613989.4	4645034	219.65	15	1.33	4.25	0.0092

3.0 MODEL RESULTS

The proposed rail yard is not subject to permitting by the Iowa DNR and is not subject to dispersion modeling, however, the analysis was completed and demonstrates that it does meet the NAAQS. A model was completed for the 24-hour PM10 averaging period, the 24-hour PM2.5 averaging period and the annual PM2.5 averaging period. Results are as follows.

3.1 ANNUAL PM2.5 RESULTS

The annual PM2.5 result is the highest average of the annual mean over 5 years (2010 – 2014) compared to the annual NAAQS standard of 12 ug/m^3. Rounding conventions for the PM2.5 NAAQS standards are found in 40 CFR 50 Appendix N sections 3 and 4. A result that meets the annual PM2.5 NAAQS standard is 12.04 ug/m3 with consideration of the rounding conventions. The model was run including the background concentration so the final results require no adjustment for background. The result is 11.9968 ug/m3 which meets the annual PM2.5 standard of 12.04 ug/m3 and therefore, demonstrates compliance with the annual PM2.5 NAAQS standard.

Table 3. PM2.5 Annual Averaging Period Results.

Period	Highest-High Concentration (ug/m3)	NAAQS (ug/m^3)	Receptor X	Receptor Y
Annual	11.9968	12	614016	4645015

A map showing the location of the highest result is shown below in Figure 5. The high result occurs on the south property line along the river where the rail line enters the property. The predicted model results are around 10 ug/m^3 (16% below the standard) along the north and east property lines and below 10 ug/m^3 moving away from the parcel. Figure 6 shows the results on a Google Earth overlay.

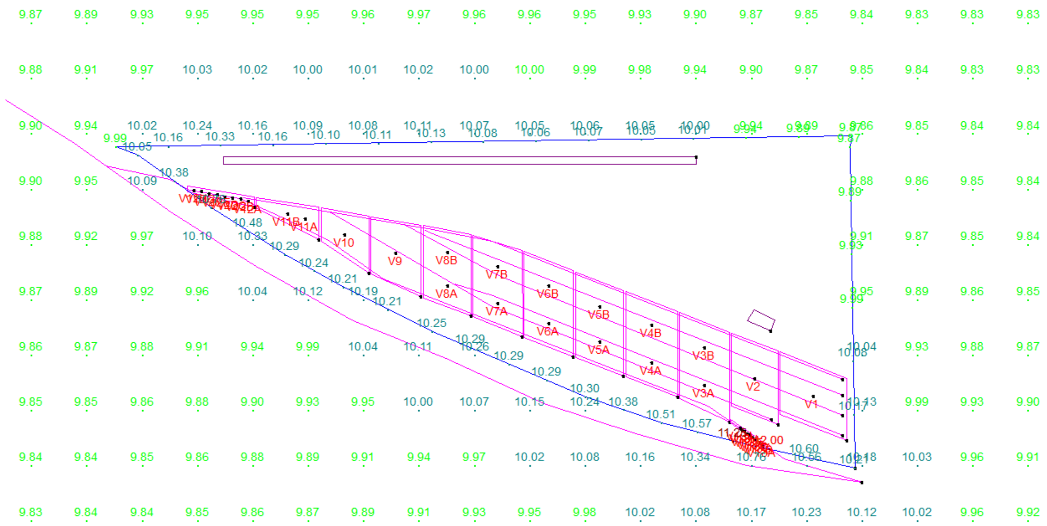

Figure 5. PM2.5 Annual Result Distribution. High value of 12 ug/m3 is along south property line.

Figure 6. PM2.5 Annual Result Distribution. High value of 12 ug/m3 is along south property line. Results along north property line 10 ug/m3 or below.

3.2 PM2.5 24-HOUR RESULTS

For PM2.5 24-hour averaging period, the highest average 8th high result over 5-years is compared to the NAAQS of 35 ug/m3. Rounding conventions are located in 40 CFR 50 Appendix N sections 3 and 4 which show that a result of 35.4 ug/m3 meets the NAAQS. As with the PM2.5 annual standard, the model was run including background so the results require no adjustment. The result is 31.8205 ug/m3 demonstrating compliance with the PM2.5 24-hour NAAQS standard. Please note the PM2.5 annual and 24-hour result occur at the same receptor location as shown in Figure 7 below. Results around the facility are 24 ug/m3 or below (31% below the standard).

Table 4. PM2.5 24-Hour Averaging Period Results.

Period	Highest-8th High Concentration (ug/m3)	NAAQS (ug/m3)	Receptor X	Receptor Y
24-Hour	31.8205	35	614016	4645015

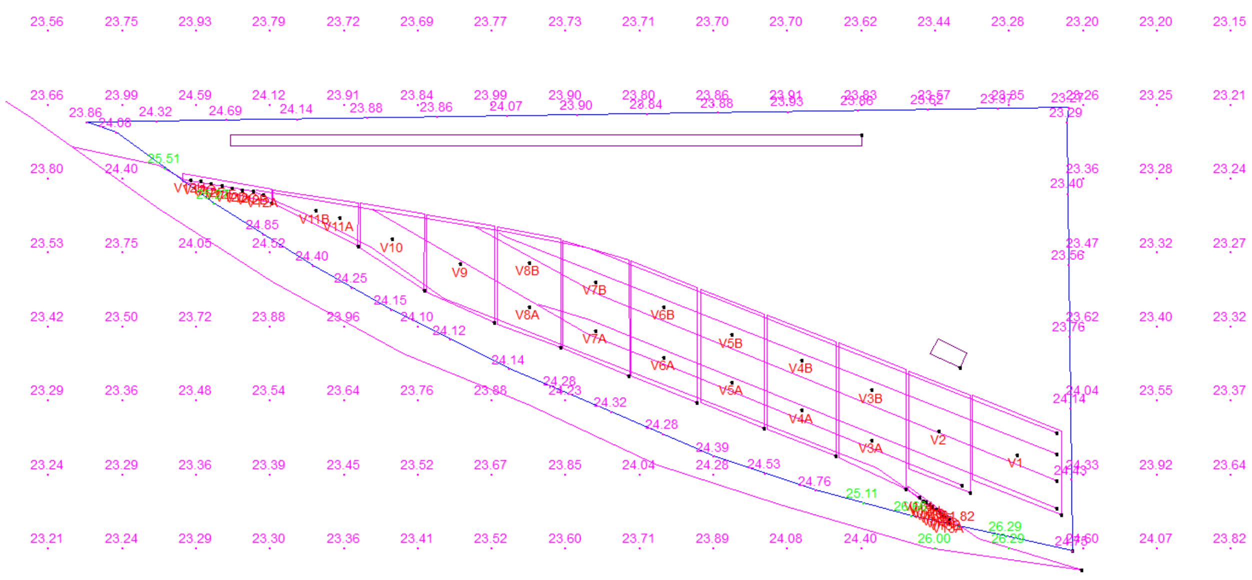

Figure 7. PM2.5 24-Hour Result Distribution. High value 31.82 ug/m3 along south property line.

An overlay view with Google Earth image shows where the high values are predicted from the model in Figure 8.

Figure 8. PM2.5 24-Hour Result Distribution. High value 31.82 ug/m3 along south property line and 23 ug/m3 surrounding property.

3.3 PM10 24-HOUR RESULTS

The high second high result for PM10 24-hour for each year is compared to the NAAQS standard of 150 ug/m^3. The background for this standard is 52 ug/m^3 and must be added to the model results. The highest result is 67.1902 ug/m^3 on December 8, 2010, which demonstrates compliance with the NAAQS of 150 ug/m^3. The high result is at the same receptor for all 5 years for PM10 and at the same receptor that demonstrated high results for the PM2.5 standards. The high results is on the south property line along the river with predicted results 2 ug/m^3 or below (98% below the standard) surrounding the property.

Table 5. PM10 24-Hour Averaging Period Results.

Period	Highest-2nd High Concentration (ug/m3)	Receptor X	Receptor Y	Background (ug/m3)	Total Impact (ug/m3)	NAAQS (ug/m^3)
2010 – 12/08/24	15.1902	614016	4645015	52	67.1902	150
2011 – 01/19/24	12.1533	614016	4645015		64.1533	
2012 – 11/20/24	12.1153	614016	4645015		64.1153	
2013 – 04/02/24	10.8117	614016	4645015		62.8117	
2014 – 12/18/24	11.0439	614016	4645015		63.0439	

*Period notation refers to the time period during which the high value occurred (year – mo/day/hr).

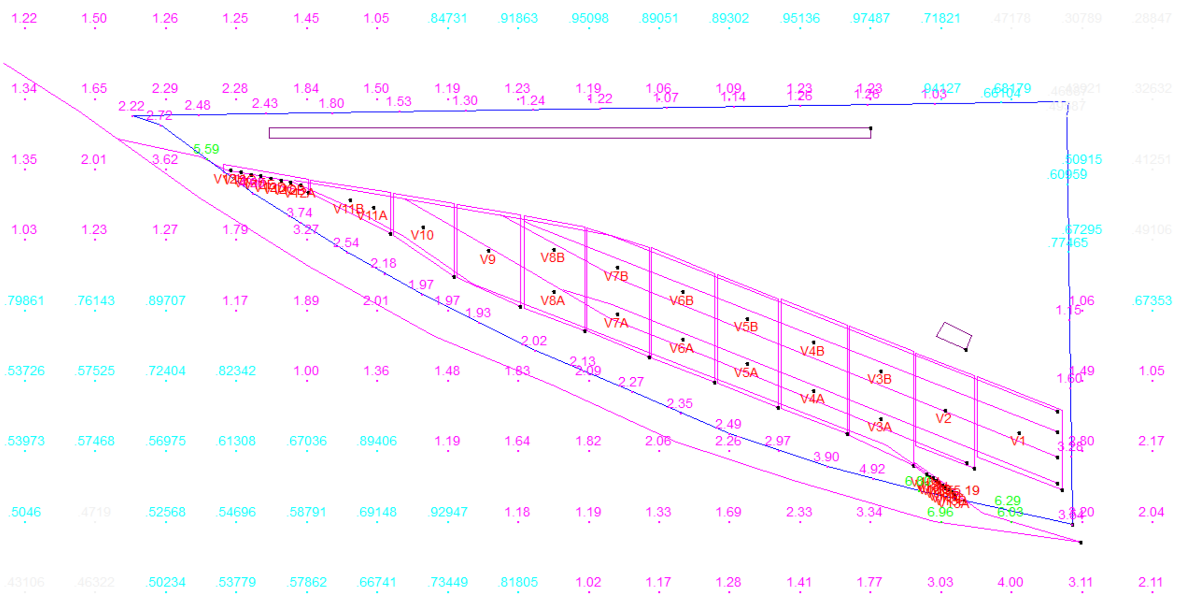

Figure 9. PM10 24-Hour Result Distribution. High value 15.19 ug/m³ along south property line. Results 2 ug/m³ or below around property.

3.4 CONSERVATIVE ASSUMPTIONS

Dispersion modeling utilizes several conservative assumptions that are approved by the agency because the ultimate goal is to protect the National Ambient Air Quality Standards. The model is set to predict the worst case result. If the worst case results meets the standard, the agency is comfortable the standard will be met. Some conservative assumptions from the modeling demonstration include the following:

- Emission unit will operate at max capacity on operating schedule year round.
- Background values are determined by the agency based on monitored values. The agency may choose higher monitored values to ensure the NAAQS are protected.
- Five years of actual meteorological data are used in the analysis and results are reported based on worst case meteorological conditions.
- Locomotive engine emissions have velocity and therefore increased release height which is conservatively represented at height of locomotive without credit for that velocity.

Most decisions made during the model setup represent a worst case scenario. A passing result considering these worst case assumptions is protective of the NAAQS and suggests that actual ambient air quality is much better than the worst case results that were predicted for one period in time with worst case conditions.

4.0 STEWART PARCEL SUMMARY

Cargill is considering installing a rail yard. Dispersion modeling was completed for PM10 24 Hour, PM2.5 24 Hour and PM2.5 Annual NAAQS standards for the emissions from the locomotive. The modeling demonstration used conservative settings and demonstrates compliance with the NAAQS standards for all averaging periods modeled. The high value occurs along the south property line where the rail cars enter the property with lower results surrounding the property boundary.

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