Modeling Guidelines for Health Risk Assessments
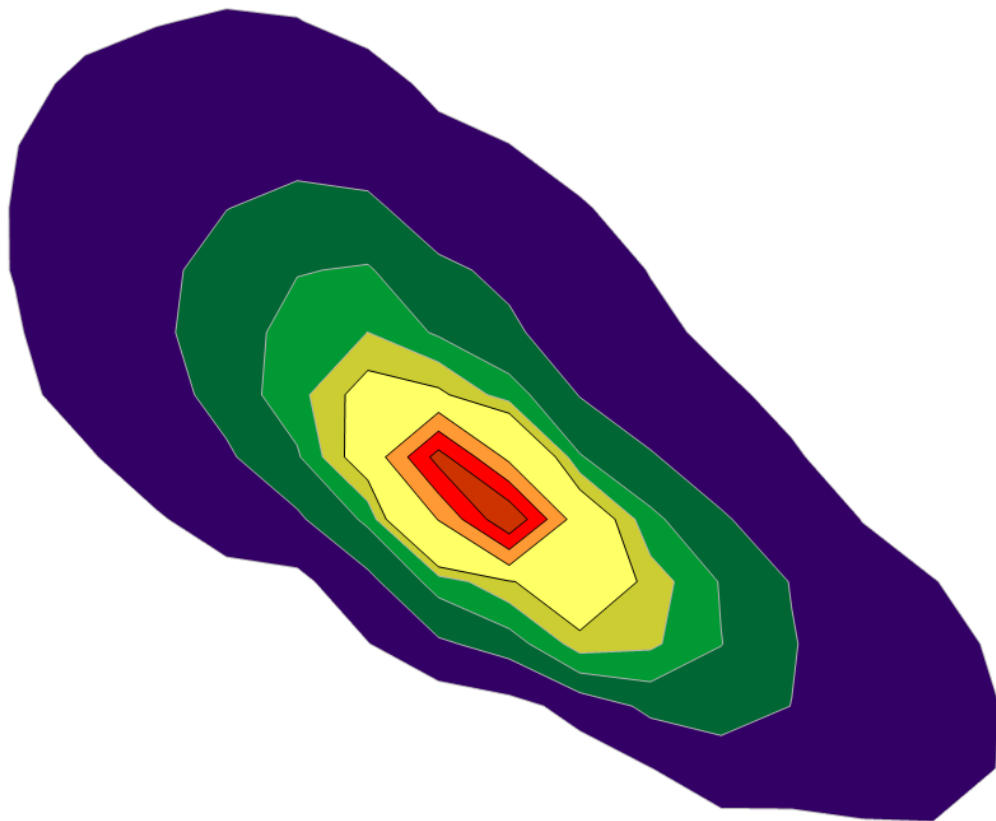
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1.   Introduction

This document explains the requirements for performing health risk assessments for the Santa Barbara County Air Pollution Control District (District) using AERMOD and the Hotspots Analysis and Reporting Program Version 2 (HARP 2[1]). It is assumed that the reader has some modeling experience with these programs; therefore, this document is not intended as a user's guide for HARP 2 or AERMOD. User's guides for HARP 2 and AERMOD are noted in the References section of this document and should be consulted for troubleshooting or when background information is needed.

A health risk assessment (HRA) must be completed for any of the following situations:

1. The District has determined that an HRA is necessary as part of the District's New Source Review (NSR) permitting program.

2. An HRA is necessary as part of the California Environmental Quality Act (CEQA) process.

3. The District has determined that an HRA is necessary as part of the District's evaluation of the facility in the AB 2588 Air Toxics "Hot Spots" Program.

2.   Emissions

2.1   Pollutants

HRAs evaluate the health risk from emissions of toxic air contaminants (TACs). All TACs with health values can be found in the California Air Resources Board's (CARB's) *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values*, noted in the References section of this document.

2.2   Emission Sources

Contact the District to confirm which emission sources should be included in the HRA. Sections 2.2.1 through 2.2.4 below explain the requirements for different types of HRAs.

2.2.1   NSR HRA with Only New Equipment

An HRA for an NSR project at a new stationary source (i.e., no existing equipment) must include all emitting equipment at its maximum potential to emit (PTE). Emissions from routine and predictable operations (i.e., non-emergency usage) from both permitted and permit-exempt equipment must be included.

2.2.2   NSR HRA with Existing Equipment

For an NSR project at a stationary source with existing equipment, both the new equipment emissions and the existing equipment emissions must be included in the HRA. Emissions from routine and predictable operations (i.e., non-emergency usage) from both permitted and permit-exempt equipment must be included. The new equipment must be modeled at its maximum PTE, and the existing equipment emissions must be modeled based on historical usage. However, if actual emissions for existing equipment will increase over the historical baseline levels as a result of the project, that equipment must be modeled at its maximum PTE.

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[1] For the purpose of this document, HARP 2 refers to the California Air Resources Board's *HARP 2- Air Dispersion & Risk Tool*. Other modules of HARP 2 are available (e.g., Emission Inventory, Risk Assessment Standalone Tool), but are not referenced in this document.

2.2.3 CEQA HRA

For CEQA HRAs, all emissions from the NSR HRA must be included. See Sections 2.2.1 and 2.2.2 above for the requirements for NSR HRAs. In addition to routine and predictable emissions, ongoing permit-exempt emissions (i.e., not construction-related) from mobile and stationary equipment must be included. For example, combustion emissions from vehicles, fugitive emissions from well workovers and combustion emissions from drill rigs at oil and gas leases must be included in the CEQA HRA. All operational mobile emissions in a 1,000-foot line extending outside the property boundary must be modeled. An HRA for CEQA should *not* include emissions from site grading, welding, vehicle combustion emissions, or other activities associated with construction. Emissions from oil and gas well drilling must be included in the CEQA analysis; the District does not consider drilling wells on an oil and gas lease to be a construction activity because it occurs over the life of the project.

2.2.4 AB 2588 Air Toxics "Hot Spots" Program HRA

HRAs performed under AB 2588 are based on an inventory year. Therefore, all emissions calculated for the HRA should reflect actual operations during the inventory year. All emissions from routine and predictable operations (i.e., non-emergency usage) from both permitted and permit-exempt equipment must be included in the HRA. CARB clarified that "the "Hot Spots" program addresses all sources within a subject facility that emit listed toxics during routine and predictable operations of the facility. Both permitted and unpermitted sources located within the facility property are included."[2]

All AB 2588 HRAs must be performed after the District has approved the Air Toxics Emission Inventory Plan and Report (ATEIP&R) for the stationary source. The District's *Guidelines for Preparing Air Toxics Emission Inventory Plans and Reports*, noted in the References section, includes specific requirements for ATEIP&R submittals in Santa Barbara County.

2.3 Emission Calculations

The District has published approved toxic air contaminant emission factors for various source types in the spreadsheet *SBCAPCD-Approved TAC Emission Factors.xlsx*, noted in the References section of this document. The District's *Approved Emission Factors for Toxic Air Contaminants*, also noted in the References section, presents formulas to calculate toxic emissions for HRAs. For any method or emission factor not listed in the document, contact the District for approval. **When available, use site-specific emission factors from District-approved source tests.**

Detailed emission calculation spreadsheets, containing all calculation assumptions for both the average annual and maximum hourly TAC emissions, must be submitted to the District with the HRA[3]. All calculations within spreadsheets must contain formulas (i.e., spreadsheets showing only values in the cells will be returned to the applicant for revision).

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[2] This information was included in an enclosure to a letter sent by Linda C. Murchision (Chief of CARB's Emission Inventory Branch at the time) to Ed Romano (with the Glenn County Air Pollution Control District at the time) on August 18, 1997. This letter is noted in the References section of this document.

[3] This information is submitted in the Air Toxics Emission Inventory Plan and Report for AB 2588 HRAs.

3.   Air Dispersion Model

The District requires that USEPA's AERMOD be used to perform the air dispersion modeling for HRAs. The current version of AERMOD at the time of writing this document is dated 19191. Furthermore, the District requires that the HRA be performed in CARB's HARP 2. The current version of HARP 2 at the time of writing this document is *HARP 2 - Air Dispersion Modeling and Risk Tool (19121)*, which incorporates the following programs: AERMOD; AERMAP, USEPA's terrain preprocessing program; and BPIP Prime, USEPA's program that applies the building downwash algorithms. HARP 2 is available for download at CARB's *Hotspots Analysis and Reporting Program (HARP)* webpage, noted in the References section of this document.

HARP 2 can be used to complete both the air dispersion modeling and risk analysis; alternatively, the air dispersion modeling can be run outside HARP 2 and the plotfiles imported into HARP 2 to complete the risk analysis. Either method is acceptable, as long as all the files needed to run the HRA are submitted to the District. The AERMOD executable is available for free from USEPA. There are also many software options that incorporate AERMOD in a more user-friendly interface, such as Lakes Environmental's AERMOD View and Providence/Oris' BEEST. While the District does not recommend any one particular software product, the District primarily uses Lakes Environmental's AERMOD View. The use of Lakes Environmental's AERMOD View by the applicant for any air dispersion modeling run outside of HARP 2 may help with the ease of review and sharing of files.

3.1   Control Options

AERMOD contains several regulatory options, which are set by default, as well as non-regulatory options. The District requires that the regulatory options are used. The use of any non-regulatory default options must be justified with a discussion in the HRA report and approved by the District.

3.2   Defining Urban and Rural Conditions

The Auer method for classifying a site as urban or rural is specified in USEPA's *40 CFR Part 51, Appendix W*, noted in the References section of this document. Follow the Auer method, explained below, for the selection of either urban or rural dispersion coefficients:

1. Draw a circle with a radius of 3 km from the center of the emission source or centroid of the polygon formed by the facility emission sources.

2. If the industrial, commercial, dense single/multi-family, and multi-family, two-story land use types account for 50% or more of the area within the circle, then the area is classified as urban; otherwise, the area is classified as rural.

3. To verify if the area within the 3 km circle is predominantly rural or urban, overlay a grid on top of the circle and identify each square as primarily urban or rural. If more than 50% of the total number of squares is urban, then the area is classified as urban; otherwise, the area is rural. See Figure 3.2-1 for an example of this grid method.
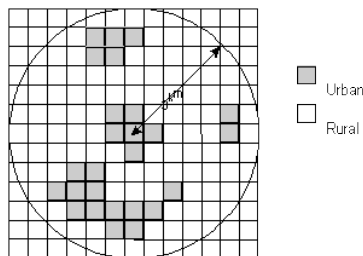
Figure 3.2-1: Auer Method for Determining Urban or Rural Dispersion

From the Auer method, areas typically defined as rural include:

- Residences with large grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer defines an area as urban if it has less than 35% vegetation coverage or if the area falls into one of the land use types described in Table 3.2-1.

Table 3.2-1: Urban Land Use

Use and Structures	Vegetation Coverage
Heavy industrial	Less than 5%
Light/moderate industrial	Less than 5%
Commercial	Less than 15%
Dense single/multi-family	Less than 30%
Multi-family two-story	Less than 35%

After the site classification has been determined, apply it to all sources (i.e., do not model some sources as rural and other sources as urban). If the urban option is selected, enter the population of the city where the project is located. If the facility is located in an unincorporated area, use the closest city listed in Table 3.2-2. The default value of 1 meter for urban surface roughness length is appropriate for most urban sites. Use of any value other than 1 meter for the urban roughness length is considered a non-regulatory option, and requires appropriate documentation and justification.

Table 3.2-2: Population Data for Urban Dispersion Modeling

City Name	Population in 2010
Buellton	4,828
Carpinteria	13,040
Goleta	29,888
Guadalupe	7,080
Lompoc	42,434
New Cuyama	517
Santa Barbara	88,410
Santa Maria	99,553
Solvang	5,245

3.3   UTM Coordinate System

The coordinate system that should be used in HARP 2 is Universal Transverse Mercator (UTM). Coordinates must be in entered in UTM WGS84 or UTM NAD83 format. Ensure all modeled sources, buildings and receptors are defined in the correct datum. In the HRA report, state the datum used in the model.

3.4   Source Parameters

The primary source types and their input requirements are outlined in Sections 3.4.1 through 3.4.5. Detailed descriptions of the input fields are found in the AERMOD user's guide, noted in the References section of this document. All source parameter units specified in brackets are the default units in the AERMOD executable and HARP 2.

After entering all the source information into AERMOD, the user should create a separate source group for each source, as well as including a source group containing all the sources in the model. The source group of all sources will allow the impact from all sources to be easily identified. The separate source groups for each source will help identify the health risk driving devices.

3.4.1   Point Sources – POINT, POINTCAP, POINTHOR

A point source is the most common type of release and is characterized by a traditional stack or isolated vent. Examples of point sources include combustion equipment with stacks and closed fixed roof tanks. AERMOD includes three options for point sources: the POINT source is used for a non-capped vertical stack; the POINTCAP source is used for a vertical stack with a rain cap; and the POINTHOR source is used for a horizontal stack.

The point source parameter inputs are:

- X Coordinate [m]: Easting UTM at the center of the point source.

- Y Coordinate [m]: Northing UTM at the center of the point source.

- Release Height [m]: Source release height (or stack height) above the ground.

- Stack Diameter [m]: Inner diameter of the stack.

- Exit Velocity [m/s]: Stack gas exit velocity.

- Stack Temperature [K]: Stack gas exit temperature.

- Emission Rate [g/s]: Pollutant emission rate.

3.4.2   Area Sources – AREA, AREAPOLY, AREACIRC

Area sources are used to model releases that occur over an area. Examples of area sources include landfills, open tanks, slag dumps and lagoons. AERMOD includes three options for specifying the shape of an area source: the AREA source is used to specify rectangular areas that may also have a rotation angle specified relative to a north-south orientation; the AREAPOLY source is used to specify an area source as an irregularly-shaped polygon; and the AREACIRC source is used to specify a circular-shaped area source. All three of the area source types use the same calculations for estimating impacts from area sources, and are merely different options for specifying the shape of the area source.

The source parameter inputs for each of the area source types are described in Sections 3.4.2.1 through 3.4.2.3 below.

3.4.2.1 AREA Sources Options

AERMOD accepts rectangular areas that may have a rotational angle specified relative to a north-south orientation. The AREA source parameter inputs are:

- X Coordinate [m]: Easting UTM for the southwest corner of the area source.

- Y Coordinate [m]: Northing UTM for the southwest corner of the area source.

- Release Height [m]: Release height above ground. For example, a tank open to the atmosphere would have a release height equal to the tank height.

- Xinit [m]: Length of X side of the area (in the east-west direction if Angle is 0 degrees).

- Yinit [m]: Length of Y side of the area (in the north-south direction if Angle is 0 degrees). This parameter is optional; if no value is entered, AERMOD sets Yinit equal to Xinit.

- Szinit [m]: Initial vertical dimension of the area source plume. For more passive area source emissions, such as evaporation or wind erosion, the Szinit parameter is typically omitted, which is equivalent to using a Szinit of 0 meters.

- Angle [degrees]: Orientation angle for the rectangular area from North, measured positive in the clockwise direction.

- Emission Rate [g/s/m^2]: Pollutant emission rate. Note that the g/s emission rate must be divided by the area of the area source to calculate the emission rate in units of g/s/m^2.

The only option for defining the area is a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If the aspect ratio is greater than 10, use the AREAPOLY source type. See Section 3.3.2.4, AREA source inputs, of the AERMOD user's guide for more information on the AREA source inputs.

3.4.2.2 AREAPOLY Sources Options

The AREAPOLY source type is used to specify an area source as an arbitrarily-shaped polygon with between 3 and 20 sides. This source type option provides the user with flexibility for specifying the shape of an area source. The AREAPOLY source parameter inputs are:

- X Coordinate [m]: Easting UTM for the first vertex point of the area source.

- Y Coordinate [m]: Northing UTM for the first vertex point of the area source.

- Release Height [m]: Release height above ground. For example, a tank open to the atmosphere would have a release height equal to the tank height.

- Number of Vertices: Number of vertices (or sides) of the area source polygon.

- Xv(1), Xv(2) … Xv(i) [m]: Easting UTM values of the vertices of the area source polygon. Xv(1) must match the X coordinate identified for the source.

- Yv(1), Yv(2) … Yv(i) [m]: Northing UTM values of the vertices of the area source polygon. Yv(1) must match the Y coordinate identified for the source.

- Szinit [m]: Initial vertical dimension of the area source plume. For more passive area source emissions, such as evaporation or wind erosion, the Szinit parameter is typically omitted, which is equivalent to using a Szinit of 0 meters.

- Emission Rate [g/s/m^2]: Pollutant emission rate. Note that the g/s emission rate must be divided by the area of the area source to calculate the emission rate in units of g/s/m^2.

3.4.2.3 AREACIRC Sources Options

The AREACIRC source type may be used to specify an area source as a circular shape. AERMOD will automatically generate a regular polygon of up to 20 sides to approximate the circular area source. The polygon will have the same area as that specified for the circle. The AREACIRC source parameter inputs are:

- X Coordinate [m]: Easting UTM at the center of the area source.

- Y Coordinate [m]: Northing UTM at the center of the area source.

- Release Height [m]: Release height above ground. For example, a tank open to the atmosphere would have a release height equal to the tank height.

- Radius [m]: Radius of the circular area source.

- Number of Vertices: Number of vertices (or sides) of the area source polygon. This parameter is optional; if no value is entered, AERMOD will generate a polygon with 20 sides.

- Szinit [m]: Initial vertical dimension of the area source plume. For more passive area source emissions, such as evaporation or wind erosion, the Szinit parameter is typically omitted, which is equivalent to using a Szinit of 0 meters.

- Emission Rate [$g/s/m^2$]: Pollutant emission rate. Note that the g/s emission rate must be divided by the area of the area source to calculate the emission rate in units of $g/s/m^2$.

3.4.3 OPENPIT Sources

The OPENPIT algorithm uses an effective area for modeling emissions from open pits, based on meteorological conditions. AERMOD then treats the effective area as an area source to determine the impact of emissions. The OPENPIT source parameter inputs are:

- X Coordinate [m]: Easting UTM for the southwest corner of the open pit.

- Y Coordinate [m]: Northing UTM for the southwest corner of the open pit.

- Release Height [m]: Average release height above the base of the pit. The release height cannot exceed the effective depth of the pit, which is calculated by the model based on the length, width and volume of the pit. A release height of 0 indicates emissions that are released from the base of the pit. For example, an asphalt holding pit that is 1 meter in depth, filled with an average height of 0.6 meters of asphalt, would have a release height of 0.6 m.

- Xinit [m]: Length of X side of the open pit (in the east-west direction if Angle is 0 degrees).

- Yinit [m]: Length of Y side of the open pit (in the north-south direction if Angle is 0 degrees).

- Pitvol [m^3]: Volume of the open pit.

- Angle: Orientation angle for the rectangular area from North, measured positive in the clockwise direction. If the Angle is not zero, the model will rotate the OPENPIT source clockwise around the southwest corner.

- Emission Rate [$g/s/m^2$]: Pollutant emission rate. Note that the g/s emission rate must be divided by the area of the open pit source to calculate the emission rate in units of $g/s/m^2$.

The only option for defining the open pit is a rectangle or square. The maximum length/width aspect ratio for open pit sources is 10 to 1. Because the open pit algorithm generates an effective area for modeling emissions from the pit, and the size, shape and location of the effective area is a function of wind direction, an open pit cannot be divided into a series of smaller sources. If the aspect ratio is greater than 10, the user should model the pit as a rectangular shape of equal area. See Section 3.3.2.7, OPENPIT source inputs, of the AERMOD user's guide for more information on the OPENPIT source inputs.

3.4.4 VOLUME Sources

The VOLUME source type is used to model releases that occur over a three-dimensional volume. Examples of volume sources include fugitive leaks, multiple vents, sloped conveyor belts, wipe cleaning and general solvent usage. The VOLUME source parameter inputs are:

- X Coordinate [m]: Easting UTM at the center of the volume source.

- Y Coordinate [m]: Northing UTM at the center of the volume source.

- Release Height [m]: Release height above ground at the center of volume. For example, a building with solvent releases from various open windows and doors should be modeled as a volume source with a release height equal to half the building height.

- Length of Side [m]: Length of the side of the volume source. The volume source cannot be rotated, and the X side is equal to the Y side (i.e., a square surface area).

- Syinit [m]: The initial lateral dimension is calculated by dividing the Length of Side in meters by 4.3. However, if a series of adjacent volume sources is used to represent a line source, the initial lateral dimension is calculated as shown in Table 3.4.4-1. See Appendix I for additional information on modeling adjacent volume sources.

- Szinit [m]: The initial vertical dimension is calculated differently for different types of volume sources, explained in Table 3.4.4-2.

- Emission Rate [g/s]: Pollutant emission rate.

An irregularly-shaped volume can be represented by dividing the volume source into multiple smaller volume sources. The user should create volume sources that cover approximately the same area where the emissions actually occur.

Table 3.4.4-1: Summary of Suggested Procedures for Estimating Initial Lateral Dimensions for Volume Sources

Type of Source	Procedure for Obtaining Initial Lateral Dimension
Single Volume Source	$\dfrac{(\text{Length of Side})}{4.3}$
Line Source Represented by Adjacent Volume Sources[4]	$\dfrac{(\text{Length of Side})}{2.15}$
Line Source Represented by Separated Volume Sources[5]	$\dfrac{(\text{Center to Center Distance})}{2.15}$

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[4] See Figure 1-8 (a) of USEPA's *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Model Algorithms.* Figure 1-8 (a) is reproduced in Appendix I of this document.

[5] See Figure 1-8 (b) of USEPA's *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Model Algorithms.* Figure 1-8 (b) is reproduced in Appendix I of this document.

Table 3.4.4-2: Summary of Suggested Procedures for Estimating Initial Vertical Dimensions for Volume Sources

Type of Source	Procedure for Obtaining Initial Vertical Dimension
Surface-Based Source ($h_e \sim 0$)	$\dfrac{\text{(Vertical Dimension of Source in Meters)}}{2.15}$
Elevated Source ($h_e > 0$) on or Adjacent to a Building	$\dfrac{\text{(Building Height in Meters)}}{2.15}$
Elevated Source ($h_e > 0$) NOT on or Adjacent to a Building	$\dfrac{\text{(Vertical Dimension of Source in Meters)}}{4.3}$

3.4.5 LINE Sources

The LINE source type is used to model releases from a variety of sources, such as horizontal conveyor belts, rail lines and roadways. See Appendix I for more information on modeling roadways. AERMOD allows a LINE source to be entered by specifying one line segment with a start point, end point and width. AERMOD uses the same algorithms for LINE sources that are used for AREA sources, and will give identical results for equivalent source parameter inputs. The LINE source parameter inputs are:

- X Coordinate [m]: Easting UTM for the start of the line source.

- Y Coordinate [m]: Northing UTM for the start of the line source.

- X End [m]: Easting UTM for the end of the line source.

- Y End [m]: Northing UTM for the end of the line source.

- Release Height [m]: Source release height above the ground.

- Width [m]: Width of the source (minimum width is 1 m).

- Szinit [m]: Initial vertical dimension of the line source.

- Emission Rate [g/s/m^2]: Pollutant emission rate. Note that the g/s emission rate must be divided by the area of the line source to calculate the emission rate in units of g/s/m^2.

UTM coordinates for the start and end points should reflect the center of the width of the line. The Szinit parameter may be important for a line source that is meant to represent mechanically generated emission sources, such as mobile sources. In these cases, the emissions may be turbulently mixed near the source by the process that is generating the emissions, and therefore occupy some initial vertical depth. For more passive line source emissions, such as a horizontal conveyor belt, the Szinit parameter is typically omitted, which is equivalent to using a Szinit of 0 m.

3.5 Building Impacts

Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations. Building downwash for point sources that are within the area of influence of a building must be considered when running AERMOD. A building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five times the lesser of the building height or the projected width of the building (PBW), as described in Equation 3.5-1.

$$D \leq 5L \hspace{5cm} \text{Eq. 3.5-1}$$

where: D = shortest distance from the exhaust stack to the building

L = lesser of the building height and projected building width (PBW)

PBW = maximum cross-sectional length of the building;
for rectangular buildings, PBW = $\sqrt{(length^2 + width^2)}$

The PBW is the maximum length of a building that could affect air flow around and over the structure. For more information on building downwash and PBW, see USEPA's *Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document For the Stack Height Regulations)*, noted in the References section of this document.

AERMOD requires the user to input the UTM coordinates for all building corners and the height of each building. For buildings with more than one height or roofline, the UTM coordinates and height are required for each building tier.

3.6   Terrain

All sources, buildings and receptors are required to have a base elevation, which is affected by the terrain of the site. Terrain elevations can have a large impact on the air dispersion modeling results. Use the default option (elevated terrain), with the appropriate digital elevation model (DEM) files. Elevation data can be obtained from DEM files by running AERMAP in AERMOD or HARP 2. USGS DEM files are available online at CARB's *HARP Digital Elevation Model Files* webpage, noted in the References section of this document.

Alternatively, if the site will be graded and post-grading elevations are known, those elevations should be entered when defining the source parameters and building information in AERMOD. Do not import source and building elevation data from the DEM file(s) when running AERMAP if graded elevations are used. Furthermore, the HRA report must clearly identify that graded elevations were used, and include a spreadsheet with the graded elevations. The preferred format for submitting these graded elevations to the District is the Lakes' AERMOD View source file (*_Sources.xlsx) and the building file (*_Buildings.xlsx) that are generated when the user exports the source data and the building data from AERMOD View. If Lakes' AERMOD View was not used for the HRA, spreadsheets should be submitted to the District that show the graded elevations for each source and building with the corresponding Source IDs and Building IDs.

For any stacks modeled as point sources on top of buildings, the modeler should ensure that the elevation of the building and the stack match so that building downwash is calculated correctly. If AERMAP is used to obtain elevations of the stack and building, these two elevation values may not match. AERMAP calculates a single elevation for the building by extrapolating the value based on the elevation at each corner of the building. AERMAP determines the stack's elevation based on a single point where the stack is located. To ensure that the height of the stack above the building is correct, edit the building elevation to match the stack elevation.

3.7   Meteorological Data

District-processed AERMOD meteorological data should be used, and is available online at the District's *Meteorological Data* webpage, noted in the References section of this document, as well as in Table 3.7-1 below. All years of data should be used when running AERMOD. Please contact the District if you have any questions about which meteorological data to use or if you wish to use alternative meteorological data. For approval to use alternative meteorological data, submit a justification for the data use, including

information regarding representativeness and quality assurance, along with the meteorological data to the District for review.

The PROFBASE parameter is used to specify the base elevation above mean sea level of the primary met tower. The elevations of the Santa Barbara County sites are displayed in Table 3.7-1. All coordinates in Table 3.7-1 are in the NAD83 datum.

Table 3.7-1: Meteorological Data Sets in Santa Barbara County

Met Data Set Name	Latitude (degrees)	Longitude (degrees)	Elevation (m)	Met Data Files
Carpinteria	34.403	-119.459	137.0	Carp12-16.zip
El Capitan	34.462	-120.026	42.0	ElCap12-16.zip
Ellwood	34.430	-119.911	20.0	Ellwood12-16.zip
Goleta	34.446	-119.828	14.0	Goleta12-16.zip
Las Flores Canyon	34.490	-120.047	184.0	LFC12-16.zip
Lompoc H Street	34.638	-120.457	41.0	Lompoc12-16.zip
Lompoc Watt Rd	34.781	-120.607	48.0	WattRd93-96.zip
Nojoqui Pass	34.527	-120.196	303.0	Nojoqui12-16.zip
Paradise Road	34.542	-119.791	371.0	Paradise12-16.zip
Santa Barbara Airport[1]	34.426	-119.842	4.0	SBA12-16Ustar.zip
SB National Guard	34.428	-119.691	20.0	SBNG12-16.zip
Santa Maria Airport[1]	34.899	-120.448	79.6	SMX12-16Ustar.zip
Santa Maria Broadway	34.949	-120.438	76.0	SMBroadway12-16.zip
UCSB West Campus	34.415	-119.879	9.0	UCSB12-16.zip
VAFB South	34.596	-120.631	104.0	VAFB12-16.zip

[1] The Santa Barbara Airport and Santa Maria Airport meteorological data sets were processed using the U star adjustment option (ADJ_U*). The ADJ_U* option was used for these data sets because they do not include turbulence, or sigma-theta, measurements. AERMOD automatically detects that the meteorological data was processed using the ADJ_U* option.

3.8   Receptors

Receptor selection is critical to capturing the point of maximum impact (PMI), the maximally exposed individual resident (MEIR) and the maximally exposed individual worker (MEIW). The receptor network shall include a Cartesian grid, property boundary receptors, residential receptors (if any), worker receptors (if any), sensitive receptors (if any), onsite receptors (if applicable) and pathway receptors (if applicable). The flagpole height shall be set to 1.5 meters for all receptors, except for pathway receptors. Pathway receptors used for multipathway analysis (i.e., water bodies and pastures) shall have a flagpole height of 0 meters.

3.8.1   Pathway Receptors

Pathway receptors are required for a multipathway analysis, explained in Section 4.4 of this document, if there are beef or dairy grazing pastures, fishable ponds or lakes, open drinking water sources or residences raising pigs or chickens near the facility. Sections 4.4.5 through 4.4.9 of this document discuss the specific requirements for when these pathways must be evaluated.

Pathway receptors include pastures, fishable water bodies and drinking water bodies. The location and elevation of the pathway receptors must be included in the air dispersion model. The beef and dairy cow

water source is assumed to be at the same location as the pasture, and the location of the surface water source for pigs and chickens is assumed to be at the same location as the human water source in HARP 2. Set the flagpole height of all pathway receptors to 0 meters. The locations of the pathway receptors may be entered as a discrete location or as a grid for spatial averaging. If the pasture or water body is large, spatial averaging is recommended. Spatial averaging is discussed in more detail in Section 4.5 and Appendix C of this document.

When determining the concentrations for the pathway receptors in the Import/Calc GLCs tab of HARP 2, select "Get average concentrations from NETID" if spatial averaging was used for the pathway receptors. If a discrete location was used for the pathway receptors, select "Get concentrations from receptor index."

3.8.2   Cartesian Receptor Grids

AERMOD and HARP 2 can create grids of Cartesian receptors that are defined by an origin with receptor points in x and y directions. The grid spacing shall be no larger than 25 meters out to 200 meters from the property boundary. Between 200 and 500 meters from the boundary, the spacing shall be no larger than 50 meters. Between 500 and 2000 meters from the boundary, the receptor spacing shall be no larger than 100 meters. If there are significant impacts near the edge of the grid, the grid must be extended farther.

For small properties like gas stations, the grid spacing must be no greater than 20 meters apart. For efficiency, a small facility may want to use a grid spacing of five meters or less to avoid additional air dispersion runs. This will allow the user to determine the PMI and immediately proceed to spatially average the risk results in the Risk Analysis tab of HARP 2. See Section 4.5 and Appendix C of this document for additional information on spatial averaging.

If it appears that the grid receptors are not close enough to capture the maximum pollutant concentrations, the District may require the HRA to be rerun with a finer grid. For facilities with a large number of emitting sources and a large property boundary, fine grid spacing will significantly impede the model run time. It may be necessary to run the HRA with a coarse grid to determine the areas of highest risk and then rerun the HRA with finer grids in those areas. If this method is used, finer grids shall be used for all areas with high concentrations, not just the area around the PMI. AERMOD and HARP 2 allow for multiple grids to be included in one dispersion run.

3.8.3   Property Boundary Receptors

Receptors shall be placed along the property boundary and may be used to determine the PMI. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. However, a maximum distance of 25 meters spacing along the property boundary is required. For facilities with emissions only from short stacks or vents and a close property line, a receptor spacing of 10 to 25 meters may be required. For larger facilities, like oil and gas leases, a spacing of 25 meters is more practical. A second run may be required with a finer spacing if the PMI is at or near the property boundary.

3.8.4   Residential Receptors

Receptors shall be placed at each offsite location where a person lives or spends the majority of their day, within 2 km of the proposed site, unless otherwise determined by the District. This may include indoor and outdoor areas. Generally, one residential receptor is placed in the middle of each residential building. However, if the Cartesian grid receptors show the potential for a significant risk, the District may require that additional residential receptors be placed in other areas where people live including backyards, garages, etc. In addition, the District may require that multiple residential receptors be placed for large buildings. If multiple receptors are required for a building, they must be placed no greater than 20 meters

apart. Cartesian grid receptors may be used in lieu of placing discrete residential receptors, as long as a Cartesian grid receptor is placed at every residential home/living area.

3.8.5 Worker Receptors

Receptors shall be placed at each offsite location where a person works, within 2 km of the proposed site, unless otherwise determined by the District. This may include indoor and outdoor areas. Generally, one worker receptor is placed in the middle of each building. However, if the Cartesian grid receptors show the potential for a significant risk, the District may require that additional worker receptors be placed in other areas where people work. Outside areas (e.g., parks, golf courses, agricultural fields, etc.) where a worker may be exposed must be evaluated. However, locations that workers occasionally visit, but an employee is not permanently stationed (e.g., cell towers), are not required to be evaluated for cancer risk, chronic non-cancer risk or 8-hour chronic non-cancer risk. Please note that acute non-cancer risk must still be evaluated in these locations. In addition, the District may require that multiple worker receptors be placed for large buildings. If multiple receptors are required for a building, they must be placed no greater than 20 meters apart. Cartesian grid receptors may be used in lieu of placing discrete worker receptors, as long as a Cartesian grid receptor is placed in every work location.

3.8.6 Sensitive Receptors

All sensitive receptors within 2 km of the proposed site, unless otherwise determined by the District, shall be included in any modeling runs. Sensitive receptors include any of the following:

- Schools

- Daycare facilities (this includes public and private childcare centers, and worksites with onsite childcare facilities)

- Hospitals

- Care facilities (adult/elderly)

Generally, one sensitive receptor is placed in the middle of each building. However, if the Cartesian grid receptors show the potential for a significant risk, the District may require that additional sensitive receptors be placed in other areas, including outdoor areas. In addition, the District may require that multiple sensitive receptors be placed for large buildings. If multiple receptors are required for a building, they must be placed no greater than 20 meters apart. Cartesian grid receptors may be used in lieu of placing discrete sensitive receptors, as long as a Cartesian grid receptor is placed at every area where a sensitive receptor could be located.

3.8.7 Onsite Receptors

In some situations, receptors inside the facility boundary will need to be evaluated. Examples of these situations include the following:

- Sensitive receptors for each onsite school, daycare, hospital or adult/elderly care facility where people sleep or spend the majority of their day.

- Worker receptors for each onsite area where a person works if they are not employed by or monetarily tied to the facility being evaluated (e.g. agricultural workers on a field within an oil lease, employees of restaurants located on military bases, etc.). Locations that workers occasionally visit, but an employee is not permanently stationed, (e.g., cell towers) are not required to be evaluated for cancer, chronic non-cancer or 8-hour chronic non-cancer risk.

- Receptors for each onsite area where the public or a person not associated with the facility operations has access (e.g. public access areas on military bases, agricultural fields on oil and gas leases, public roadways within facility boundaries, cell tower at a university, public areas at schools, public areas at hospitals, etc.), must be evaluated for acute non-cancer risk.

- Residential receptors for each onsite building in which people sleep (e.g., dormitories at colleges and housing on military bases).

- Residential receptors for each onsite residential building if it is not owned by or monetarily tied (e.g. mineral rights agreement, lease agreement, etc.) to the facility being evaluated. Any onsite pathway receptors present for these residential receptors must also be evaluated (i.e., pastures water bodies).

- Pathway receptors at onsite pastures, if the pastures are used by nearby residents to graze cattle not owned by the landowner. An example would be an oil and gas facility that allows ranchers who live nearby to bring their grazing cattle onsite.

- Pathway receptors at onsite water bodies, if the water bodies are used for human or livestock drinking water or fishing for human consumption by nearby residents other than the landowner.

3.8.8 Vacant Land & Future Receptors: Building & Land Use Applications

In certain situations, evaluating long-term risk on vacant land[6] may be required. If the District's significant risk thresholds are exceeded for cancer, chronic non-cancer or 8-hour chronic non-cancer risk on vacant land, the applicable Planning Department (e.g., P&D for the County) must be contacted to determine if there are any pending applications for this vacant land. If an application has been submitted to the applicable Planning Department for the development of the vacant land or if the landowner is in pre-application discussions to develop the property, the receptor(s) on the vacant land must be compared to the District's significant risk thresholds and used for risk management decisions. Written confirmation must be obtained from the applicable Planning Department that the above criteria are not met (i.e., no applications or pre-application discussions).

For example, an oil and gas facility is preparing an HRA for New Source Review. The owner of a rural vacant parcel surrounding the oil and gas facility submitted an application to County P&D for a residence with a guesthouse on land that is currently zoned agricultural. The County P&D application shows that the area surrounding the proposed residences will be farmed. Residential receptors must be place at both the proposed location of the primary residence and the proposed guesthouse. Worker receptors must be placed throughout the proposed agricultural fields. Those residential or worker receptors must be compared to the District's significant risk thresholds and used for risk management decisions.

If your project includes rezoning of land for future use, receptors must be placed on the vacant land even if no application has yet been submitted to P&D. For example, a gas station that is part of a new shopping center submits a permit application to the District with an HRA. As part of the project for the shopping center, nearby land is rezoned to residential and other parcels are rezoned to school. Even if no building permits have been submitted for the residential development or the school, residential receptors must be placed in the future residential area and sensitive receptors placed in the future school area. Those residential and sensitive receptors must be compared to the District's significant risk thresholds and used for risk management decisions. Gridded receptors are recommended for rezoning if the exact locations of the future buildings are unknown.

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[6] Vacant land is defined as any unimproved or undeveloped land or parcel. Parking lots are not considered vacant land.

4. Risk Assessment

4.1 Tiered Approach to Risk Assessment

The Office of Environmental Health Hazard Assessment (OEHHA) developed a tiered approach for HRAs to accommodate consideration of site-specific data that may be more appropriate for a given facility than the default values. The Tier 1 HRA is the first step and is the simplest point estimate approach for estimating exposure to facility emissions. **A Tier 1 HRA is always required in Santa Barbara County. The defaults provided in this document and in HARP 2 are for a Tier 1 HRA.**

Tier 2 allows use of site-specific point estimates of exposure variates as long as these estimates can be justified. The risk assessor must supply the data and methods used for the site-specific estimates, and the site-specific estimates must be reproducible and approved by the District. At the facility's option, a Tier 2 risk assessment can be submitted in addition to the Tier 1 HRA described above. **If the applicant plans to conduct a Tier 2 HRA, it is highly recommended that they submit a modeling protocol for District approval prior to running the HRA.**

Tier 3 and 4 HRAs are for informational purposes only; risk management decisions are not made based on the results of Tier 3 or Tier 4 analyses. Tier 3 risk assessment involves stochastic analysis of exposure using data-based distributions for the key exposure variates compiled by OEHHA. A Tier 4 approach uses distributions of exposure variates that may be more appropriate for a specific site. Additional information on Tier 3 and Tier 4 stochastic analyses are found in Sections 1.4.3 and 1.4.4, respectively, of OEHHA's *Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical Support Document for Exposure Assessment and Stochastic Analysis*, noted in the References section of this document.

4.2 Risk Analysis

4.2.1 Cancer Risk Scenarios

The cancer risk for the maximally exposed individual resident (MEIR), the maximally exposed individual worker (MEIW) and the point of maximum impact (PMI) shall be evaluated for the HRA. These risk values shall be calculated using the methodology described in Table 4.2.1-1.

Table 4.2.1-1: Required Cancer Risk Scenarios

Receptor	HARP 2 Receptor Type	HARP 2 Exposure Duration[1]	HARP 2 Intake Rate Percentile[2]
PMI	Individual Resident	30 Year	RMP using the Derived Method
Residential	Individual Resident	30 Year	RMP using the Derived Method
Worker	Worker	25 Year (Worker)	OEHHA Derived Method
Sensitive	Individual Resident	30 Year	RMP using the Derived Method

[1] As a Tier 2 option, short-term projects may be evaluated for shorter exposure durations upon District approval.
[2] RMP refers to the CARB/CAPCOA Risk Management Policy breathing rates. This policy is presented in Appendix D of CARB/CAPCOA's *Risk Management Guidance for Stationary Sources of Air Toxics*, noted in the References section of this document.

4.2.2 Non-Cancer Risk Scenarios

The OEHHA Derived Method shall be used to determine the PMI, MEIR, and MEIW for chronic non-cancer risk. Acute non-cancer risk shall be evaluated for the PMI, MEIR, and MEIW. The 8-hour

chronic non-cancer risk must be evaluated for the MEIW, and if applicable, the MEIR (see Section 4.3.2 of this document for more information on the requirements of the 8-hour chronic non-cancer risk).

4.3 Inhalation Pathway

The inhalation pathway is always evaluated for HRAs. Sections 4.3.1 through 4.3.3 below describe the District's requirements for the inhalation pathway options.

4.3.1 Fraction of Time at Home

The fraction of time at home (FAH) options are used to adjust exposure duration to the facility's emissions, based on the assumption that exposure is not occurring when a person is away from home. Run the initial HRA with all FAH options disabled in order to determine the 1 per million cancer risk isopleth. If there are no schools or daycares within the 1 per million cancer risk isopleth, both FAH options (i.e., ages less than 16 years and greater than or equal to 16 years) may be selected *after* the initial HRA is done. If there is a school or daycare within the 1 per million cancer risk isopleth, the FAH option for ages greater than or equal to 16 years may be selected, but the FAH option for ages less than 16 years shall not be used.

4.3.2 8-Hour Chronic Non-Cancer Risk

The 8-hour hazard index (8-hour chronic non-cancer risk) is a ratio of the predicted air toxic exposure to the air concentrations at or below which health impacts would not be expected with repeated daily 8-hour exposures over a significant fraction of a lifetime. The 8-hour hazard index (8-hour HI) is considered a chronic risk as it uses an 8-hour concentration that represents the long-term average of repeated 8-hour daily averages that occur.

4.3.2.1 Continuous Facilities for 8-Hour Hazard Index

For facilities that operate continuously, the 8-hour HI is required to be calculated for worker receptors and sensitive receptors, but not for residential receptors. The 8-hour chronic non-cancer risk is based on the daily average 8-hour exposure; because the operations are continuous, there is no worker adjustment factor (i.e., annual average concentration may equal the daily 8-hour concentration). However, if significant diurnal-nocturnal meteorological differences are expected, use the post-processing method in HARP 2, as described in Appendix M of OEHHA's *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (HRA Guidance Manual), noted in the References section of this document.

4.3.2.2 Non-Continuous Facilities for 8-Hour Hazard Index

The 8-hour HI must be calculated for residential, sensitive and worker receptors for facilities that do not operate continuously. The 8-hour chronic non-cancer risk is based on the daily average 8-hour exposure, which can be determined by post-processing in HARP 2, as described in Appendix M of OEHHA's HRA Guidance Manual. This is the more refined method and is preferred. Alternatively, the daily average 8-hour exposure can be estimated adjusting the annual average air concentration in HARP 2, as described in Equation 4.3.2.2-1.

$$WAF_{8-hour} = \frac{H_{residential}}{H_{source}} * \frac{D_{residential}}{D_{source}}$$

<div align="right">Eq. 4.3.2.2-1</div>

where: $WAF_{8\text{-}hour}$ = the worker adjustment factor for the 8-hour HI (although it is called the worker adjustment factor, the WAF should also be applied when calculating the 8-hour HI for residential and sensitive receptors, for a non-continuous facility)

$H_{residential}$ = the number of hours per day on which the long-term residential concentration is based = 24 hours

H_{source} = the number of hours per day that the source operates

$D_{residential}$ = the number of days per week on which the long-term residential concentration is based = 7 days

D_{source} = the number of days per week that the source operates

This method is similar to the cancer approximation adjustment method described below in Section 4.3.3.2 with one difference; there is no adjustment for partial overlap between the worker's schedule and the source's emission schedule (i.e., no DF or Discount Factor).

4.3.3   Worker Exposure – Adjustment Factor for Cancer Risk

Modeled long-term averages are typically used for residential and worker cancer risk assessments. For an inhalation cancer risk assessment for an offsite worker, the long-term average should represent what the worker breathes during their work shift. However, the long-term averages calculated from AERMOD typically represent exposures for receptors that are present 24 hours a day and seven days per week (i.e., the schedule of a residential receptor). There are two approaches to estimate the offsite worker's concentration. The more refined, complex and time-consuming approach is to post-process the hourly raw dispersion model output and examine the hourly concentrations that fall within the offsite worker's shift. HARP 2 can simulate the long-term concentration for the offsite worker to estimate inhalation cancer risk, as described in Appendix M of OEHHA's HRA Guidance Manual.

The more typical approach is to obtain the long-term average concentration and approximate the worker's inhalation exposure using an adjustment factor. The factor that is used to adjust the concentration may differ from the example in Section 4.3.3.2 of this document based on the specifics of the source and worker receptor (e.g., work-shift overlap).

4.3.3.1 Continuous Facilities for Worker Cancer Risk

If the source is continuously emitting, then the worker is assumed to breathe the long-term annual average concentration during their work shift and no concentration adjustments are necessary in this situation when estimating the inhalation cancer risk. However, if an assessor does not wish to apply the assumption that the worker breathes the long-term annual average concentration during the work shift (e.g., significant diurnal-nocturnal meteorological differences are expected), then a refined concentration can be post-processed in HARP 2, as described in Appendix M in OEHHA's HRA Guidance Manual. See Section 4.3.3.3 of this document for alternative assumption options.

4.3.3.2 Non-Continuous Facilities for Worker Cancer Risk

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set, even if the emitting source is modeled using a non-continuous emissions schedule. Thus, this long-term average concentration includes the hours when the source was not operating. To address this discrepancy, the long-term concentration the worker is breathing during their work shift must be determined to calculate the offsite worker inhalation risk. Therefore, the long-term concentration needs to be adjusted so it is based only on the hours when the worker is present. This can be accomplished by applying a worker adjustment factor (WAF) in HARP 2. **This WAF is for worker cancer risk only**. The WAF does not apply to the worker chronic or acute non-cancer risk, or to the residential risk. An adjustment factor for the 8-hour HI for non-continuous facilities is discussed in Section 4.3.2.3 of this document.

$$WAF_{cancer} = \frac{H_{residential}}{H_{source}} * \frac{D_{residential}}{D_{source}} * DF \qquad \text{Eq. 4.3.3.2-1}$$

where: WAF_{cancer} = the worker adjustment factor for cancer risk

$H_{residential}$ = the number of hours per day on which the long-term residential concentration is based = 24 hours

H_{source} = the number of hours per day that the source operates

$D_{residential}$ = the number of days per week on which the long-term residential concentration is based = 7 days

D_{source} = the number of days per week that the source operates

DF = the discount factor (default value is 1); see Section 4.3.3.3 of this document for the requirements for using a DF less than 1

For example, assuming the emitting source and worker's schedules are the same, the adjustment factor is 4.2 = (24 hours per day/8 hours per shift) * (7 days in a week/5 days in a work week). In this example, the long-term residential exposure is adjusted upward to represent the exposure to a worker. Alternative concentration adjustments may be appropriate depending on the work shift overlap.

4.3.3.3 Tier 2 Adjustments for Worker

The following assumptions may be used for a Tier 2 analysis for worker risk. See Section 4.1 of this document for more information on the four tiers in risk assessments.

1. Eight-hour breathing rate: Lower breathing rates of sedentary/passive and light intensity work activities may be substituted in site-specific Tier 2 scenarios. Use of different breathing rates requires a survey of the exposed workplace and approval by the District.

2. Exposure Frequency: The Tier 1 default for exposure frequency is 250 days/year, which is equivalent to working 5 days/week, 50 weeks/year. Use of a different exposure frequency requires a survey of the exposed workplace and approval by the District.

3. Discount Factor (DF): Use of a DF less than 1 (in the Worker Adjustment Factor equation) requires a survey of the exposed workplace and approval by the District. The survey is required to verify that some portion of the offsite worker shift is not exposed to the facility emissions. If the offsite worker's schedule partially overlaps with the source's emission schedule, then calculate the discount factor according to Equation 4.3.3.3-1.

$$DF = \frac{H_{coincident}}{H_{worker}} * \frac{D_{coincident}}{D_{worker}} \qquad \text{Eq. 4.3.3.3-1}$$

where: DF = the discount factor

$H_{coincident}$ = the number of hours per day that the offsite worker's schedule and the source's emission schedule overlap

H_{worker} = the number of hours per day that the offsite worker works

$D_{coincident}$ = the number of days per week that the offsite worker's schedule and source's emission schedule overlap

D_{worker} = the number of days per week that the offsite worker works

4.4 Multipathway Analysis

A multipathway analysis considers exposure of airborne emissions not only by direct exposure through the inhalation pathway, but also non-inhalation pathways. Significant exposure can occur for some pollutants following deposition of airborne material onto soil, skin, surface water and plants and through ingestion of meat, dairy, eggs and breast milk.

If the applicant's facility emits any multipathway pollutants, a multipathway analysis is required. Use all the pathways that are required as described in Sections 4.4.2 through 4.4.9 below. HARP 2 will determine the appropriate pathway for each pollutant based on the pathways specified for the HRA. The list of multipathway pollutants and the specific pathways that can be evaluated for those pollutants are found in Table 5.1 of OEHHA's HRA Guidance Manual and are reproduced in Table 4.4-1.

Table 4.4-1 Pathways to be Analyzed for Each Multipathway Pollutant

Pollutant	Soil Ingestion	Dermal	Meat, Milk & Egg Ingestion	Fish Ingestion	Exposed Vegetable Ingestion	Leafy Vegetable Ingestion	Protected Vegetable Ingestion	Root Vegetable Ingestion	Water Ingestion	Breast Milk Ingestion
Arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X[1]	X	X	X	X	X	X	
Fluorides	X	X	X	X	X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	X
Mercury & compounds	X	X	X	X	X	X	X	X	X	
Nickel & compounds	X	X	X	X	X	X	X	X	X	
Selenium & compounds	X	X	X	X	X	X	X	X	X	
Creosotes	X	X	X	X	X	X			X	X
Diethylhexylphthalate	X	X	X	X	X	X			X	
Hexachlorobenzene	X	X	X	X	X	X			X	
Hexachlorocyclohexanes	X	X	X	X	X	X			X	
4,4'-Methylene dianiline	X	X			X	X			X	
Polychlorinated biphenyls	X	X	X	X	X	X			X	X
Polychlorinated dibenzo-p-dioxins and dibenzofurans	X	X	X	X	X	X			X	X
Polycyclic aromatic hydrocarbons	X	X	X	X	X	X			X	X

[1] Chromium VI & compounds are evaluated for the cow's milk pathway, but not the egg or meat pathways.

4.4.1 Deposition Rate

A deposition rate must be chosen when determining potential multipathway health impacts. Use the conservative deposition rate of 0.05 m/s for the risk assessment if any multipathway pollutant-emitting (MPE) sources are uncontrolled. The deposition rate of 0.02 m/s may be used if all MPE sources have verifiable particulate matter control devices. Any uncontrolled MPE sources must only emit particulate

matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas) in order to use the deposition rate of 0.02 m/s. If a deposition rate of 0.02 m/s is used for an uncontrolled device, documentation of the particle size must be submitted as part of the HRA report.

4.4.2   Soil Ingestion

Always include this pathway for all receptors. No default information is required.

4.4.3   Dermal

Always include this pathway for all receptors. Select "Warm" climate for all of Santa Barbara County.

4.4.4   Mother's Milk

Always include this pathway for residential and sensitive receptors. No default information is required.

4.4.5   Drinking Water

Do not include this pathway for the initial HRA. Rerun the HRA with this pathway for residential and sensitive receptors only if there is a pond or other water source that is used for human drinking water within the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.[7] Municipal water sources should not be included. The fraction of drinking water consumed from the contaminated water source and the location, surface area, volume and number of volume changes per year of the water source are required information to use this pathway. Values for the surface area, water volume and number of volume changes per year can be obtained from the Department of Water Resources for some reservoirs (e.g., reservoirs part of the California State Water Project). The contact information for the office covering the region that includes Santa Barbara County can be found at the *Southern Region Office* webpage, noted in the References section of this document. While a site-survey is recommended, OEHHA allows a default fraction of 1.0 for drinking water consumed from the contaminated source.

The location of the water body must be included in the air dispersion model. See Section 3.9.1 of this document for additional information on modeling pathway receptors.

4.4.6   Fish

Do not include this pathway for the initial HRA. Rerun the HRA with this pathway for residential and sensitive receptors only if there is a fish pond or lake within the isopleth of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.[7] The fraction of human diet of fish consumed from the contaminated water source and the location, surface area, volume and number of volume changes per year of the pond/lake are required information to use this pathway. Values for the surface area, water volume and number of volume changes per year can be obtained from the Department of Water Resources for some reservoirs. The contact information for the office covering the region that includes Santa Barbara County can be found at the *Southern Region Office* webpage, noted in the References section of this document. While a site-survey is recommended, OEHHA allows a default fraction of 1.0 for human diet of fish from the contaminated source.

The location of the water body must be included in the air dispersion model. See Section 3.8.1 of this document for additional information on modeling pathway receptors.

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[7] On a case-by-case basis, the District may require that this pathway is included in the final HRA if there is a water body within the modeling domain, even if the initial HRA does not show a water body within the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.

4.4.7 Homegrown Produce

Include this pathway for the initial HRA for residential and sensitive receptors. Select the HARP 2 default fractions, shown in Table 4.4.7-1, unless site-specific information is available. Choose the default values for households that garden for receptors located in residential and urban areas. Choose the default values for households that farm for residential receptors located in rural areas or on agricultural land.

Table 4.4.7-1: Default Fractions of Human Diet from Contaminated Vegetables

Type of Vegetable	Households that Garden	Households that Farm
Leafy	0.137	0.235
Exposed	0.137	0.235
Protected	0.137	0.235
Root	0.137	0.235

If the risk is significant, determine if the receptors of interest do not have fruit trees or a garden. If the receptors of interest clearly do not have a garden or fruit trees (e.g., at a college dormitory), rerun the HRA without this pathway for the receptors of interest.

4.4.8 Beef & Dairy

Do not include these pathways for the initial HRA. Rerun the HRA with these pathways for residential and sensitive receptors only if there is a pasture in the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.[8]

The location of the pasture must be included in the air dispersion model. The beef and dairy cow water source is assumed to be at the same location as the pasture in HARP 2. See Section 3.8.1 of this document for additional information on modeling pathway receptors.

Select the HARP 2 default fractions for the fraction of human diet from the contaminated source, shown in Table 4.4.8-1, unless site-specific information is available. Choose the default values for households that raise/hunt for residential receptors that are not engaged in farming. Choose the default values for households that farm for residential receptors that farm. OEHHA's default of 0.5 may be used for the grazing fraction of beef and dairy cows from the contaminated source.

Table 4.4.8-1: Default Fractions of Human Diet from Contaminated Beef and Dairy

Pathway	Households that Raise/Hunt	Households that Farm
Beef	0.485	0.478
Dairy	0.207	0.254

Water ingestion is included for the beef and dairy pathways if there is a source of drinking water for the animals, such as springs, ponds or lakes, which are exposed to airborne deposition of facility emissions. Values for the surface area, water volume and number of volume changes per year can be obtained from the Department of Water Resources for some reservoirs. The contact information for the office covering the region that includes Santa Barbara County can be found at the *Southern Region Office* webpage, noted in the References section of this document. Due to the site-specific nature for this exposure pathway,

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[8] On a case-by-case basis, the District may require that these pathways are included in the final HRA if there is a pasture within the modeling domain, even if the initial HRA does not show a pasture within the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.

OEHHA recommends that the risk assessor conduct a survey at the site to estimate the fraction of contaminated drinking water ingested by the animals, if such sources exist. Alternatively, the District allows a default value of 1.0 for the fraction of animal drinking water from the contaminated source.

4.4.9   Pig, Chicken & Egg

Include only the chicken and egg pathways for the initial HRA for residential and sensitive receptors. If the risk is significant, determine if the receptors of interest do not have chickens. If the receptors clearly do not have chickens, rerun the HRA without the chicken and egg pathways. If it seems possible that the receptors have chickens, the facility may have the opportunity to prove that there are no chickens in the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk (e.g., citing a regulation/city ordinance that farm animals are not allowed in that area).

Do not include the pig pathway for the initial HRA. Rerun the HRA with this pathway for residential and sensitive receptors only if there is a pig farm in the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.[9]

Select the HARP 2 default fractions for human diet from the contaminated source, shown in Table 4.4.9-1, unless site-specific information is available. Choose the default values for households that raise/hunt for receptors located in residential areas. Choose the default values for households that farm for residential receptors located in rural areas or on agricultural land.

Table 4.4.9-1: Default Fractions of Human Diet from Contaminated Pig, Chicken and Egg

Pathway	Households that Raise/Hunt	Households that Farm
Pig	0.242	0.239
Chicken	0.156	0.151
Egg	0.146	0.214

The water ingestion pathway is applied if there are surface water sources of drinking water for the animals, such as springs, ponds or lakes, which are exposed to airborne deposition of facility emissions. Values for the surface area, water volume, and number of volume changes per year can be obtained from the Department of Water Resources Southern Region Office for some reservoirs. Due to the site-specific nature for this exposure pathway, OEHHA recommends that the risk assessor conduct a survey at the site to estimate the fraction of contaminated drinking water ingested by the animals, if such sources exist. Alternatively, the District allows a default value of 1.0 for the fraction of animal drinking water from the contaminated source.

The location of the drinking water source must be included in the air dispersion model. The surface water source for pigs and chickens is assumed to be at the same location as the human drinking water source in HARP 2, and therefore this location must be specified whether or not the drinking water pathway is included. See Section 3.8.1 of this document for additional information on modeling pathway receptors.

Use the default fractions for animal diets that are recommended by OEHHA and shown in Tables 4.4.9-2 and 4.4.9-3, unless site-specific information is available.

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[9] On a case-by-case basis, the District may require that this pathway is included in the final HRA if there is a pig farm within the modeling domain, even if the initial HRA does not show a pig farm within the isopleths of 1 per million for cancer risk or a hazard index of 0.1 for chronic non-cancer risk.

Table 4.4.9-2: Default Fractions of Animal Diet from Contaminated Vegetables

Pathway	Leafy	Exposed	Protected	Root
Pig	0.25	0.25	0.25	0.25
Chicken	0.25	0.25	0.25	0.25
Egg	0.25	0.25	0.25	0.25

Table 4.4.9-3: Default Fractions of Contaminated Animal Feed

Pathway	Fraction of Feed Grown Onsite
Pig	0.1
Chicken	0.05
Egg	0.05

4.5   Spatial Averaging

Spatial averaging is a refinement to a risk assessment. It is performed after the initial HRA if the results show a significant cancer or chronic non-cancer risk. Spatial averaging cannot be used for 8-hour or acute non-cancer risk. It averages the air concentration over a small area, instead of a single point. A person, when home, will not spend all their time at one location within their residence; instead, residents spend time throughout their living areas. Likewise, some workers, such as agriculture field workers, may spend time in various locations throughout their work day.

Spatial averaging can also be performed for pathway receptors in multipathway analyses. Spatially averaging the deposition concentrations provides a better estimate by evaluating the entire area rather than using a single point. For example, using spatially averaged deposition concentrations over pasture land will account for cows grazing the entire pasture instead of just one point on the pasture.

Appendix C of this document discusses spatial averaging in more detail and provides guidance for performing spatial averaging for HRAs in Santa Barbara County.

4.6   Refined Acute Analysis

HARP 2 includes the option to perform a refined acute analysis. The screening acute non-cancer risk calculated by HARP 2 under Calculate Risk in the Risk Analysis tab is a timesaving approximation that is conservative in nature. It is calculated by assuming that the contribution of risk from each emitting source is at its maximum at the same instant in time. If there is more than one emitting source in the HRA, the maximum hourly risk from each source is summed to give the screening value, as if they had all occurred at the same time. In reality, the time that the risk from each emitting source is at a maximum will differ depending on location and meteorology. If the screening acute non-cancer HI at the PMI is greater than 1.0, the applicant may perform a refined acute analysis.

To perform a refined acute analysis in HARP 2, the 1-hour POSTFILES must be created during the air dispersion run. The user can select this option under the Output Pathway in the Air Dispersion tab of HARP 2. This option greatly increases processing time due to the creation of very large files. After the air dispersion is ran and the GLCs have been calculated, the refined acute analysis can be performed under Refined Acute Analysis in the Risk Analysis tab. Note that this method can only be used if the air dispersion was run in HARP 2. **In order to show that the acute non-cancer HI at the PMI is 1.0 or lower, the refined acute non-cancer HI must be calculated at all offsite receptors (and any**

applicable onsite receptors) that were calculated to have a screening acute non-cancer HI greater than 1.0.

Running the refined acute analysis for a single receptor in HARP 2 can take hours or even days for a large project, a facility with hundreds of emitting sources and thousands or tens of thousands of receptors. In situations where there are dozens or hundreds of receptors with a simple acute risk greater than one, using HARP 2 to calculate the refined acute risk is unfeasible. The alternative refined acute method (ARAM) significantly reduces the run time required to calculate the refined acute risk. ARAM uses normalized emission rates directly in AERMOD, accounting for each pollutant's REL and target endpoints, to determine the refined acute risk for all receptors simultaneously, thus avoiding the need to run the refined acute analysis within HARP 2. Appendix H, *Alternative Refined Acute Method (ARAM)*, of this document provides a detailed procedure for the ARAM.

4.7   Significant Risk Thresholds

In June 1993, the Santa Barbara County Air Pollution Control Board of Directors (District's Board) adopted health risk notification levels. The risk notification levels were set at 10 per million for cancer risk and a hazard index of greater than 1.0 for non-cancer risk. Risk reduction thresholds were adopted by the District's Board on September 17, 1998. These risk reduction thresholds were set at the same level as the public notification thresholds. Use Appendix E, *Health Risk Calculation and Rounding Policy,* of this document to properly round health risk values when comparing them to the significant risk thresholds for risk management decisions.

Health risk assessment results shall be compared to the significant risk thresholds as follows:

- **Cancer Risk:** The risk values for the MEIR, MEIW, sensitive receptors (if any), and onsite residential and worker receptors (if any) are compared to the cancer significant risk threshold.

- **Chronic Non-Cancer Risk:** The risk values for the MEIR, MEIW, sensitive receptors (if any), and onsite residential and worker receptors (if any) are compared to the chronic non-cancer significant risk threshold.

- **8-hour Chronic Non-Cancer Risk:** The risk values for the MEIW, sensitive receptors (if any) and onsite worker receptors (if any) are compared to the 8-hour chronic non-cancer significant risk threshold. The MEIR and onsite residential receptors (if any) must be assessed for the 8-hour HI and compared to the risk threshold only if the facility does not operate continuously.

- **Acute Non-Cancer Risk:** The risk values for the PMI, MEIR, MEIW, sensitive receptors (if any), and onsite receptors (if any) are compared to the non-cancer significant risk threshold. To further clarify, the acute non-cancer PMI can be at any boundary or offsite receptor (or onsite receptors in specific situations), including the ocean. No residence or business is required to occupy the offsite PMI. On a case-by case basis, certain receptors may be excluded from the acute non-cancer analysis if the public cannot reasonably be expected to be at that location (e.g., areas where fencing prevents public access). Please contact the District to determine if any receptors may be excluded.

If any of the above significant risk thresholds are met or exceeded for an existing source, the District will require public notification and risk reduction. If any of the above significant risk thresholds are met or exceeded for a new project, the project will be denied or must be revised to include measures that reduce the risk below the significance thresholds.

5. Health Risk Assessment Report

The applicant is required to perform the HRA and submit the HRA report and electronic files for the District's review. A $1500 non-refundable fee is required for the District to review the HRA. Alternately, the District may assess fees for the HRA review on the cost reimbursement basis specified in District Rule 210 section I.C. The District will notify the applicant if it is determined that the work will be done on the cost reimbursement basis.

All HRAs must include the results of a Tier 1 exposure assessment. If the applicant would like to present additional information (i.e., exposure duration adjustments or the inclusions of risk characterizations using Tier 2 exposure data), then this information should be presented in separate, clearly titled sections, tables and text. The required elements of the HRA report are discussed in Sections 5.1 through 5.12 below.

The District's *Modeling Protocol Tables for HRA Report*, noted in the References section of this document, must be completed and submitted with the HRA Report. The *Modeling Protocol Tables for HRA Report* consists of the *AERMOD Options Table*, *Source Parameters Table*, *Building Parameters Table* and the *HARP 2 Options Table*, discussed further in the sections below.

5.1 Facility Information

Report the following information regarding the facility and its surroundings:

- Facility name
- Stationary source identification number (SSID)
- Location (street address and UTM coordinates, including datum)
- Description of facility operations and a list identifying emitted substances, including a table of the average annual and maximum hourly TAC emissions

Provide both a plot plan and an aerial photo map with the following labeled:

- Facility boundary
- Buildings (labeled by ID or name)
- Emitting sources (labeled by HARP 2 Source ID or name)

5.2 Source and Emission Inventory Information

The District's *Modeling Protocol Tables for HRA Report*, noted in the References section of this document, must be completed and submitted with the HRA Report. The *Modeling Protocol Tables for HRA Report* consists of the *AERMOD Options Table*, *Source Parameters Table*, *Building Parameters Table* and the *HARP 2 Options Table*. Documentation (e.g., manufacturer specifications, source test reports, photos/diagrams showing volume/area sources with written description explaining choice of parameters) of source parameters is required.

5.2.1 Source Parameters Table

The *Source Parameters Table* must be completed and submitted with the HRA Report in electronic format which contains the following for each emitting source:

- Source (i,e., stack or release point) identification number

- Source name/description

- Source type (point, area, open pit, volume, line)

- Source UTM coordinates

- Source modeling parameters

5.2.2   Device Tables

Include the following tables in the HRA Report:

- *Device Operation Schedule Table* with the following information for each device:
    - Device name and identification number (use District device IDs when available)
    - Device description
    - Number of operating hours per day and per year, including which hours the device operates in a 24-hour day
    - Number of operating days per week, including which days (i.e., Monday through Sunday) the device operates in a 7-day week
    - Number of operating days or weeks per year
    - Indicate whether the device is part of the primary function of the stationary source
    - HARP 2 Source ID for the sources where emissions are released
- *TAC Device Table* with the following information for each device:
    - Device name and identification number (use District device IDs when available)
    - All TACs emitted by device (see example in Appendix A of this document)

5.3   Emission Quantification

The information in this section is not required for AB 2588 HRAs with a District-approved Air Toxic Emission Inventory Plan & Report. Report the following information for each device in table format:

- Emission control equipment and efficiency by source and by pollutant, if efficiency varies by pollutant

- Emission rates for each pollutant, grouped by source, including the following information:
    - Device name and identification number
    - Pollutant name and CAS number
    - Emission factors for each pollutant
    - Average annual emissions for each pollutant
    - Maximum hourly emissions for each pollutant

5.4   Model Information

The *AERMOD Options Table*, part of the District's *Modeling Protocol Tables for HRA Report*, lists all the options that are required for the air dispersion modeling. The table includes the District default values (if applicable), an empty column for the facility's values, a reference to the sections of Form-15i with more information, and a column with additional notes about some of the modeling options. The

completed table must be submitted with the HRA Report.

The report should clearly state the following:

- Name and version number of the software used to run the air dispersion and risk assessment

- The date of the *health.mdb* file used in the HRA

- The date of the Form-15i used to prepare the HRA

- Selected control options

- List of electronic input/output file names for air dispersion and risk assessment (see Section 5.12 of this document)

5.5   Building Parameters - Modeling Protocol Table

Parameters for buildings and other structures impacting building downwash must be submitted in electronic format in the *Building Parameters Table* with the HRA Report.

5.6   HARP 2 Options Table

The *HARP 2 Options Table* lists all the options that are required for the risk assessment calculations. The table includes the District default values (if applicable), a reference to the sections of Form-15i with more information, a column with additional notes about some of the HARP 2 options and two empty columns; one for the initial value and one for the final value used in HRA. For most options, the initial and the final value will be identical. However, some HARP 2 options are dependent on the isopleths of the initial HRA. Therefore, the "Initial Value" is the value used in the initial HRA (e.g., no FAH option, no fish pathway) and the "Final Value" is the value used in final HRA (e.g., only FAH for option for age greater than or equal to 16 years old, fish pathway included due to fishable lake in the 1 in a million initial isopleth). The completed table must be submitted with the HRA Report.

5.7   Receptor Placement

In addition to the receptor information included in the *AERMOD Options Table* and the HRA files, discuss the receptor grids and justification for the receptor spacing, including a discussion of the placement of more refined grids for the receptors of interest for refined acute risk, spatial averaging or the PMI. Ensure the following information is included in the written HRA Report:

- Onsite Receptors:
    - Location shown in aerial photo and UTM coordinates in table
    - Description of any onsite receptors (e.g., rental farmhouse, vineyard workers)
    - Type of onsite receptor (i.e., residential, worker)
- Sensitive Receptors:
    - Location shown in aerial photo and UTM coordinates in table
    - Name/description of sensitive receptors (e.g., Happy Time Preschool, Sutter Hospital)
    - Type of sensitive receptor (i.e., daycare, hospital)
- Residential and Worker Receptors:
    - UTM coordinates in table
    - Location shown in aerial photo that identifies each receptor as a resident or worker

For each receptor type (e.g., PMI, MEIR and MEIW) that was spatially averaged, the domain size and grid resolution must be identified. If a domain or grid resolution other than 20 meters by 20 meters with 5-meter grid spacing was used for the spatial averaging, supporting documentation must be submitted, as detailed in Appendix C of this document.

5.8   Multipathway Information

If multipathway substances are emitted, identify the exposure pathways analyzed for each receptor. If receptor numbers at the same location vary for different dispersion runs, include the run name and/or number and UTM coordinates for each receptor. An example multipathway receptor analysis table is shown in Table 5.8-1.

Table 5.8-1: Example Multipathway Receptor Analysis

Pathway	Residential Rural Receptors #1-333	Sensitive Receptors #334-346	Residential Urban Receptors #347-356	Worker Receptors #357-411
Soil	X	X	X	X
Dermal	X	X	X	X
Mother's milk	X	X	X	
Drinking water				
Fish				
Homegrown produce	X	X	X	
Beef				
Dairy				
Pig	X			
Chicken	X			
Egg	X			

In addition to the information provided in the *HARP 2 Options Table*, provide the multipathway parameters used for each exposure pathway if it differs by receptor. For example, Receptor #1-333 used the HARP 2 default fractions of human diet from the contaminated source for households that farm, while Receptors #334-346 and 347-356 used the HARP 2 default fractions of human diet from the contaminated source for households that garden.

Provide justification and documentation for any site-specific inputs (e.g., water intake or animal grazing assumptions). If any multipathway parameters other than the HARP 2 defaults were used, then the derivation and data used must be presented. The justification for using Tier 2 exposure parameters must be clearly presented.

5.9   Summary of Results

Present the risk assessment results, including the information shown in Tables 5.9-1 through 5.9-4.

Table 5.9-1: Summary of Cancer Health Risk Results

Receptor Type	Receptor Number	UTME (m)	UTMN (m)	Cancer Risk (in a million)	Significance Threshold (in a million)
Offsite PMI					NA
Onsite PMI (if present)					NA
MEIR					≥10
MEIW					≥10
Sensitive Receptor(s)					≥10

Table 5.9-2: Summary of Chronic Non-Cancer Health Risk Results

Receptor Type	Receptor Number	UTME (m)	UTMN (m)	Chronic HI	Health Endpoint(s)	Significance Threshold (HI)
Offsite PMI						NA
Onsite PMI (if present)						NA
MEIR						>1
MEIW						>1
Sensitive Receptor(s)						>1

Table 5.9-3: Summary of 8-Hour Chronic Non-Cancer Health Risk Results

Receptor Type	Receptor Number	UTME (m)	UTMN (m)	8-Hour HI	Health Endpoint(s)	Significance Threshold (HI)
Offsite PMI						NA
Onsite PMI (if present)						NA
MEIR						>1
MEIW						>1
Sensitive Receptor(s)						>1

Table 5.9-4: Summary of Acute Non-Cancer Health Risk Results

Receptor Type	Receptor Number	UTME (m)	UTMN (m)	Acute HI	Health Endpoint(s)	Significance Threshold (HI)
Offsite PMI						>1
Onsite PMI (if present)						>1
MEIR						>1
MEIW						>1
Sensitive Receptor(s)						>1

5.10   Risk Driver Tables

Present the risk drivers, including the information shown in Tables 5.10-1 through 5.10-14. If many pollutants are emitted at the facility, and a large number of emitting sources are present, only those that account for more than five percent of the health risk should be presented in the tables.

Table 5.10-1: Cancer Risk by Pollutant at the MEIR

Pollutant	Cancer Risk Contribution at the MEIR (in a million)	Percentage Contribution to Total Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-2: Cancer Risk by Source at the MEIR

HARP 2 Source ID	Cancer Risk Contribution at the MEIR (in a million)	Percentage Contribution to Total Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-3: Cancer Risk by Pollutant at the MEIW

Pollutant	Cancer Risk Contribution at the MEIW (in a million)	Percentage Contribution to Total Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-4: Cancer Risk by Source at the MEIW

HARP 2 Source ID	Cancer Risk Contribution at the MEIW (in a million)	Percentage Contribution to Total Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-5: Chronic Non-Cancer Risk by Pollutant at the MEIR

Pollutant	Chronic Non-Cancer Risk Contribution at the MEIR (HI)	Percentage Contribution to Total Chronic Non-Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-6: Chronic Non-Cancer Risk by Source at the MEIR

HARP 2 Source ID	Chronic Non-Cancer Risk Contribution at the MEIR (HI)	Percentage Contribution to Total Chronic Non-Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-7: Chronic Non-Cancer Risk by Pollutant at the MEIW

Pollutant	Chronic Non-Cancer Risk Contribution at the MEIW (HI)	Percentage Contribution to Total Chronic Non-Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-8: Chronic Non-Cancer Risk by Source at the MEIW

HARP 2 Source ID	Chronic Non-Cancer Risk Contribution at the MEIW (HI)	Percentage Contribution to Total Chronic Non-Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-9: 8-Hour Chronic Non-Cancer Risk by Pollutant at the MEIR

Pollutant	8-Hour Chronic Non-Cancer Risk Contribution at the MEIR (HI)	Percentage Contribution to Total 8-Hour Chronic Non-Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-10: 8-Hour Chronic Non-Cancer Risk by Source at the MEIR

HARP 2 Source ID	8-Hour Chronic Non-Cancer Risk Contribution at the MEIR (HI)	Percentage Contribution to Total 8-Hour Chronic Non-Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-11: 8-Hour Chronic Non-Cancer Risk by Pollutant at the MEIW

Pollutant	8-Hour Chronic Non-Cancer Risk Contribution at the MEIW (HI)	Percentage Contribution to Total 8-Hour Chronic Non-Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-12: 8-Hour Chronic Non-Cancer Risk by Source at the MEIW

HARP 2 Source ID	8-Hour Chronic Non-Cancer Risk Contribution at the MEIW (HI)	Percentage Contribution to Total 8-Hour Chronic Non-Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Table 5.10-13: Acute Non-Cancer Risk by Pollutant at the PMI

Pollutant	Acute Non-Cancer Risk Contribution at the PMI (HI)	Percentage Contribution to Total Acute Non-Cancer Risk
Total		100%
Pollutant A		
Pollutant B		
Pollutant C		

Table 5.10-14: Acute Non-Cancer Risk by Source at the PMI

HARP 2 Source ID	Acute Non-Cancer Risk Contribution at the PMI (HI)	Percentage Contribution to Total Acute Non-Cancer Risk
Total		100%
Source X		
Source Y		
Source Z		

Additionally, if there is a significant risk at a sensitive receptor or an onsite receptor, risk driver tables are required for those significant risk receptors. Clearly identify the primary target organ(s) that are impacted from acute, 8-hour and chronic exposures for sensitive receptors/onsite receptors with a significant risk.

5.11   Isopleth Maps and Aerial Photos

The user can export the risk results from HARP 2 into isopleth maps in Google Earth. Provide separate aerial photo maps showing the following:

- The 1 in a million and 10 in a million residential cancer risk isopleths

- The 1 in a million and 10 in a million worker cancer risk isopleths

- The residential chronic non-cancer hazard index isopleths of 0.1 and 1.0

- The worker chronic non-cancer hazard index isopleths of 0.1 and 1.0

- The residential 8-hour chronic non-cancer hazard index isopleths of 0.1 and 1.0 (if the 8-hour HI was required to be calculated for residential receptors)

- The worker 8-hour chronic non-cancer hazard index isopleths of 0.1 and 1.0

- The acute non-cancer hazard index isopleths of 0.1 and 1.0

Each map described above should also include the facility boundary and the locations of the PMI, MEIR, MEIW and sensitive receptors. If any of the isopleths listed above cannot be shown (e.g., if there were no receptors with a cancer risk equal to or greater than 10 in a million), please state the reason that they are absent from the maps.

If any of the risk results were spatially averaged, provide zoomed-in aerial photo maps clearly showing the spatial averaging grid(s) used for the risk analysis.

5.12 Electronic Files

The following files are required to be submitted electronically:

- HRA report (*.pdf)

- Modeling Protocol Tables for HRA Report (*.xlsx)

- Emissions calculations spreadsheet (*.xlsx)

- Air Dispersion Files:
  - Surface meteorological data file (*.sfc)
  - Profile meteorological data file (*.pfl)
  - Digital elevation map files (*.dem)
  - AERMAP receptor file
  - AERMAP source file
  - BPIP input file
  - BPIP summary file
  - BPIP output file
  - AERMOD input file (for each AERMOD run, if multiple runs were performed)
  - AERMOD output file (for each AERMOD run, if multiple runs were performed)
  - AERMOD error file
  - Plotfiles for each source group (*.PLT)

- Risk Analysis Files:
  - HARP 2 project file (*INPUT.adm)
  - HARP 2 facility and emissions database (*.mdb)
  - Health database (*.mdb)
  - Ground-level concentration files for each pollutant (*.txt)
  - Project summary report (ProjectSummaryReport.txt)
  - For each type of risk that was analyzed in the HRA (i.e., cancer risk and chronic, 8-hour and acute non-cancer risks):
    - Input file with GLCs (*GLCList.csv)
    - HRA input file (*HRAInput.hra)

- ➢ Output files with risk details (*Risk.csv, *RiskSumByRec.csv, and *RiskSumByRecBySrc.csv)

- ➢ Output log file (*Output.txt)

- ➢ Pathway receptor information (*PathwayRec.csv)

- ➢ Input file with health values (*PolDB.csv)

- o Refined acute non-cancer risk file, if applicable (RefinedMaxHISummary.csv)

- o Spatial averaging files, if applicable:

  - ➢ Plot files (*.PLT)

  - ➢ GLC files (*PER.txt)

  - ➢ Cancer input file with GLCs (CANCERSAGLCList.csv)

  - ➢ Cancer HRA input file (CANCERSAHRAInput.hra)

  - ➢ Cancer risk output files (CANCERSACancerRisk.csv, CANCERSACancerRiskSumByRec.csv, CANCERSACancerRiskSumByRecBySrc.csv)

  - ➢ Cancer output log file (CANCERSAOutput.txt)

  - ➢ Chronic non-cancer input file with GLCs (CHRONICSAGLCList.csv)

  - ➢ Chronic non-cancer HRA input file (CHRONICSAHRAInput.hra)

  - ➢ Chronic non-cancer risk output files (CHRONICSACancerRisk.csv, CHRONICSACancerRiskSumByRec.csv, CHRONICSACancerRiskSumByRecBySrc.csv)

  - ➢ Chronic non-cancer output log file (CHRONICSAOutput.txt)

- • Alternative Refined Acute Method (ARAM) files, if applicable:

  - o Alternate Refined Acute Calculation (*.xlsx)

  - o Summary of AERMOD Concentrations for ARAM (*.xlsx)

  - o Lakes' AERMOD View Files for ARAM

    - ➢ Surface meteorological data file (*.sfc)

    - ➢ Profile meteorological data file (*.pfl)

    - ➢ Digital elevation map files (*.dem)

    - ➢ AERMAP receptor file

    - ➢ AERMAP source file

    - ➢ BPIP input file

    - ➢ BPIP summary file

    - ➢ BPIP output file

    - ➢ AERMOD input file, for each target endpoint

    - ➢ AERMOD output file, for each target endpoint

    - ➢ AERMOD error file

    - ➢ Plotfiles for Source Group All (*.PLT), for each target endpoint

> ➢ Lakes-compatible Excel source file for each target endpoint *(e.g., Sources_Eyes.xlsx.)*

- Google Earth files (*.kml, *.kmz)

If the HRA or HRA report fail to comply with these guidelines, the HRA and HRA report will be returned, with District comments, to the applicant for revision.

6. References

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- Santa Barbara County Air Pollution Control District. 2019. *Modeling Protocol Tables for HRA Report.* https://www.ourair.org/wp-content/uploads/Modeling-Protocol-Tables-for-HRA-Report.xlsx.

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7.   Contacts

For questions about the District's requirements for modeling, contact the District at:

> phone: 805-979-8050
> email: engr@sbcapcd.org

The District does not provide technical support for AERMOD or HARP 2. For questions about HARP 2, contact CARB at:

> phone: 916-323-4327
> email: harp@arb.ca.gov

For questions about AERMOD, contact USEPA's Region IX Modeling Contact, Carol Bohnenkamp, at:

> phone: 415-947-4130
> email: bohnenkamp.carol@epa.gov

Appendix A – Variable Emissions Modeling

During some air quality studies, modelers may encounter certain emitting scenarios that require the use of variable emissions modeling. This appendix outlines modeling techniques to account for special operating schedules.

Typically, the air dispersion is run with a unit emission rate of 1 g/s for 24 hours a days, 365 days a year for an HRA. AERMOD includes options for modeling source emissions that fluctuate over time. With the variable emissions option, the modeler can select the hours of operation and the emission rate for each individual source. Emission variations can be characterized across many different periods, including hourly, daily, monthly and seasonally. If variable emissions are used, the applicant must submit documentation with the HRA that justifies using that variable emission scenario. The District may require permit conditions to enforce the operating hours, days, months, etc. selected in the variable emission scenario.

In order to maintain a consistent emissions inventory for dispersion modeling using HARP 2, certain rules must be followed. Failure to adhere to the rules discussed in Section A.1 and A.2 below will result in either generating or depleting inventory from your analysis. **The same rules must be followed for air dispersion runs modeled outside of HARP 2 (e.g., Lakes' AERMOD View), if HARP 2 is used for the risk assessment**. (These rules do not apply to modeling performed for an Air Quality Impact Assessment, which uses actual emission rates instead of the unit emission rate of 1 g/s.)

See Section 4.2.b, *Variable Emissions*, of CARB's *User Manual for the Hotspots Analysis and Reporting program Air Dispersion Modeling and Risk Assessment Tool Version 2* for more information about the variable emission requirements for HARP 2:
https://www.arb.ca.gov/toxics/harp/docs2/harp2admrtuserguide.pdf.

A.1   Variable Emission Rates for Annual Emissions

Air dispersion modeling for an HRA is typically run using the unit emission rate of 1 g/s for 24 hours a day, 365 days a year (i.e., 8760 hr/yr). When emissions vary temporally, the annual emissions in AERMOD are still required to sum to 31,536 kg/yr (i.e., 31,536 kg/yr = 1 g/s * 3600 s/hr * 8760 hr/yr). Therefore, the emission rate in the variable emissions window must be adjusted accordingly. For example, the HROFDY (Hour of Day) option allows the user to select the emission rate factor for certain hours of the day. The total emission rate factor (n) for the entire day is equal to 24 for the Hour of Day option. Therefore, for a source operating 12 hours a day (from 6AM to 6PM), 365 days a year, the user should input a factor of 2 for each hour that the source operates; n = 2 * 12 = 24. The variable emission rates for this source would be entered as shown in Table A.1-1.

It is important to note that the hours of the day displayed in AERMOD correspond to the hour *ending* at the time displayed. Therefore, hour 7 corresponds to the hour from 6AM to 7AM, and hour 18 corresponds to the hour from 5PM to 6PM.

Table A.1-1: Example Variable Emission Scenario (Hour of Day)

Hour of Day	Emission Rate Factor by Hour	Hour of Day	Emission Rate Factor by Hour
1	0	13	2
2	0	14	2
3	0	15	2
4	0	16	2
5	0	17	2
6	0	18	2
7	2	19	0
8	2	20	0
9	2	21	0
10	2	22	0
11	2	23	0
12	2	24	0

Table A.1-2 shows the emission rate factor for each variable emission option.

Table A.1-2: Variable Emission Options with Emission Rate Factors

Variable Emission Option	Definition	Emission Rate Factor
SEASON	Seasons	$n = 4$
MONTH	Monthly	$n = 12$
HROFDAY	Hour-of-day	$n = 24$
WSPEED	Wind speed category	$n = 6$
SEASHR	Season-by-hour	$n = 96$
SHRDOW	Season by hour-of-day by day-of-week (M-F, Sat, Sun)	$n = 288$
SHRDOW7	Season by hour-of-day by day-of-week (M, Tu, W, Th, F, Sat, Sun)	$n = 672$
HRDOW	Hour-of-day by day-of-week (M-F, Sat, Sun)	$n = 72$
HRDOW7	Hour-of-day by day-of-week (M, Tu, W, Th, F, Sat, Sun)	$n = 168$
MHRDOW	Month by hour-of-day by day-of-week (M-F, Sat, Sun)	$n = 864$
MHRODW7	Month by hour-of-day by day-of-week (M, Tu, W, Th, F, Sat, Sun)	$n = 2,016$

A.2   Variable Emission Rates for Maximum Hourly Emissions

When emissions are allowed to vary temporally for any of the conditions described above, a second dispersion modeling run is required for the maximum hourly emissions (i.e., for the acute non-cancer risk). Specifically, the user must enter a value of 1 for the times during which the source is emitting and a value of 0 for the times during which the source is not emitting. HARP 2 includes a checkbox that, if selected, will create a second AERMOD input file with all variable emission rates set to the correct factor of 1 for the acute non-cancer risk analysis. If the modeler is using HARP 2 to perform the air dispersion analysis, this checkbox should be selected. However, if the modeler is using another program to run AERMOD, they must create and submit two AERMOD input files: one with the variable emission rate factors described in Section A.1 for creating the period plotfiles and another with all variable emission rate factors set to 1 for creating the 1-hour plotfiles.

Appendix B – Modeling Specific Source Types

This appendix will be updated with additional source types in the future.

B.1　Gasoline Dispensing Facilities

See District Form-25T (http://www.ourair.org/wp-content/uploads/apcd-25T.pdf) for specific modeling instructions for gas stations.

B.2　Liquid Storage Tanks

Storage tanks are generally of two types—fixed roof tanks and floating roof tanks. In the case of fixed roof tanks, most of the pollutant emissions escape from a vent, with some additional contribution from hatches and other fittings. In the case of floating roof tanks, most of the pollutant emissions escape through the seals between the roof and the wall and between the deck and the wall, with some additional emissions from fittings, such as ports and hatches.

Approaches for modeling emission impacts from various types of storage tanks are outlined in Sections B.2.1 and B.2.2 below.

B.2.1　Fixed Roof Tanks

Model a fixed roof tank as a point source (i.e., a stack). The point source location and release height should represent the tank vent, which is usually in the center of the tank. The tank should also be represented as a building for downwash modeling. Table B.2.1-1 shows the values that should be entered for the velocity, diameter and temperature.

Table B.2.1-1: Stack Parameters for Modeling Tanks

Velocity	Diameter	Temperature
Near zero, i.e., 0.001 m/s	Nero zero, i.e., 0.001 m	Ambient – a value of 0 prompts the model to use the ambient temperature

There is virtually no plume rise from tanks. Therefore, the stack parameters for the stack gas exit velocity and stack diameter should be set to near zero for the stacks representing the emissions. In addition, stack temperature should be set equal to the ambient temperature. This can be accomplished in AERMOD by inputting a value of 0 for the stack gas temperature.

Note that it is very important for the diameter to be at or near zero. With low exit velocities and larger diameters, stack tip downwash will be calculated. A very small stack diameter effectively eliminates the stack tip downwash. Because all downwash effects are being modeled with the building downwash algorithm, the additional stack tip downwash calculations would be inappropriate.

B.2.2　Floating Roof Tanks

Model a floating roof tank as an area source. The area source inputs should represent the diameter of the tank and the height of the tank. The tank should also be represented as a building for downwash modeling if there are nearby point sources that may be affected.

Appendix C – Spatial Averaging

Spatial averaging is a refinement to a risk assessment. OEHHA approves the use of the spatial averaging method for risk management decisions; see Section 4.7.3 of OEHHA's HRA Guidance Manual. It is done *after* the initial risk assessment if the results show a significant cancer or chronic non-cancer risk. Spatial averaging cannot be used for 8-hour or acute non-cancer risk. It averages the air concentration over a small area, instead of a single point. This allows the risk assessor to base decisions on concentrations over an entire residential living area, instead of a single point within the residence. A person, when home, will not spend all their time at one location within their residence. Instead, residents spend time throughout their living areas. Likewise, some workers, like agriculture field workers, may spend time in various locations throughout their work day.

Spatial averaging may also be used for the pathway receptors in multipathway analyses. Spatially averaging the deposition concentrations provides a better estimate by evaluating the entire area rather than using a single point. For example, using spatially averaged deposition concentrations over pasture land accounts for cows grazing the entire pasture instead of just one point on the pasture.

C.1   Nested Grid Size

C.1.1   Residential and Sensitive Receptors

Use a domain size of 20 meters by 20 meters with a grid spacing resolution of equal to or less than five meters for a residential or sensitive receptor. This domain represents an area that is approximately the size of a small urban lot.

If part of the domain is off of the receptor's property boundary (e.g., domain covers part of two parcels), the grid points outside of the receptor's property must be omitted. If the risk with the omitted grid points shows a significant risk, then the grid may be repositioned so that the full 20-meter by 20-meter domain is only on the receptor's property.

Although a domain size of 20 meters by 20 meters is generally appropriate for residential and sensitive receptors, there may be cases where that size is considerably larger than the receptor's actual living area. If the District finds that the modeled domain size is not representative of the area where the receptor spends time, the District may require a smaller domain size or not allow spatial averaging.

C.1.2   Worker Receptors

Worker locations (e.g., the MEIW) may also be a candidate for spatial averaging. However, spatial averaging is not applicable for workers stationed at the same location during the majority of their daily work shift (e.g., desk/office workers). In this situation, the traditional method of using a single location and corresponding modeled concentration must be used. If the worker location is a candidate for spatial averaging, submit documentation identifying that no workers are stationed at the same location during the majority of their daily work shift.

A domain size of no larger than 20 meters by 20 meters with a grid spacing resolution of equal to or less than five meters is recommended for a worker receptor. A larger grid size may be used for a worker receptor if the workers routinely and continuously move throughout the worksite over a space greater than 20 meters by 20 meters. Documentation supporting the larger domain must be submitted to the District for approval for any worker domain larger than 20 meters by 20 meters. This documentation must include showing the area where each worker routinely performs their duties and the percentage of time spent in those areas, for all workers. The final domain size should not be greater than the smallest area of

worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. A fine grid spacing (e.g. five meters) must be used within the domain to obtain a representative concentration across the area of interest.

C.1.3 Pasture and Waterbody Receptors

The District recommends using spatial averaging over a deposition area (e.g., a body of water used for fishing, a pasture used for grazing) for a multipathway analysis. Alternatively, the simplified approach of using the concentration at the centroid, a specific point of interest, or the PMI location for an area being evaluated for non-inhalation exposures is acceptable for use in the HRA. However, evaluating deposition concentrations over pasture land, or a water body for multipathway exposure scenarios using spatial averaging could give more representative estimates of the overall deposition rate.

If spatial averaging will be done, follow the steps in Section C.3 below. When using spatial averaging over the deposition area, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size of the area of interest (e.g., pasture or water body) should be identified and used for the modeling domain.

A reasonably fine grid spacing must be used within the domain to obtain a representative concentration across the area of interest. One way to determine the grid spacing resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA report shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size of the pasture or water body, maps, representative coordinates, grid spacing resolution, concentration gradients). The size of the domain and grid spacing resolution is subject to approval by the District.

C.2 Tilted Grids

The dominant plume centerline is sometimes tilted from the cardinal directions. If the nested grids for spatial averaging are placed along the cardinal directions, the results may underestimate a spatial average centered on the dominant plume centerline. Tilting the nested grid to coincide with the dominant plume centerline can provide a more accurate value of the spatial average. A tilted polar grid is easier to implement than a tilted rectangular grid. The domain of the polar receptor field should be limited to a 15 meter radius.

See *Appendix C-5 – Tilted Spatial Averaging*, of OEHHA's *Technical Support Document for Exposure Assessment and Stochastic Analysis* dated August 2012 for guidance on creating tilted grids: http://oehha.ca.gov/media/downloads/crnr/appendixc2012.pdf.

C.3 Spatial Averaging Instructions

OEHHA's directions are available in Section 4.7.3.1 of OEHHA's HRA Guidance Manual and are included below, with modifications for use in our District:

1. Create an initial nested grid with five meter spacing centered on the receptor of interest (e.g., PMI, MEIW, MEIR). The initial nested grid should extend out the length of the original grid spacing in each of the cardinal directions. For example, if the original grid spacing was 100 meters, the nested grid should extend 100 meters to the north, south, east and west from the center of the receptor of interest.

2. After the initial nested grid is created, rerun the dispersion and risk modules. Determine the new PMI of the nested grid. If necessary, create an additional nested grid(s) centered on the new PMI with a finer grid spacing (i.e., less than five meters) to determine the final PMI. To achieve this,

two or more modeling runs with successively finer nested grid resolutions may be needed to find the final location where the nested grid that will be used for spatial averaging will be placed.

3. Center the spatial average nested grid on each receptor's location of interest (i.e., final PMI of nested grid) determined in Step 1. Limit the nested grid to no larger than 20 meters by 20 meters or 400 square meters for residential or sensitive receptors. Note if a portion of the centered and nested grid falls within the facility boundary and the receptor location of interest is outside of the boundary, then adjustments to the nested grid to obtain the spatially-averaged risk for the offsite receptor are reasonable. This may be done by deleting any onsite grid points so that only the offsite grid points surrounding the receptor are used in the spatially averaged concentration. If additional risk refinement is required, reposition the nested grid to cover 400 square meters of off-boundary area surrounding the residential or sensitive receptor. The grid resolution spacing should be no greater than five meters for residential, sensitive, and work receptors. With a five meter grid resolution, the 20 meter by 20 meter domain will result in 25 receptors. The size and placement of the domain and the resolution of points are subject to approval by the District. See Sections 4.7.3.1.2 and 4.7.3.1.3 of OEHHA's HRA Guidance Manual for additional discussion on domain sizing and grid spacing at worksites, pastures, and water bodies.

4. Some configurations of source activity and meteorological conditions result in a predominant downwind plume center line that is significantly askew from one of the four cardinal directions. In this case, a tilted nested grid may be necessary to coincide with the dominant plume centerline. Section C.2 above has additional information on tilted grids.

5. After specifying the grid, AERMOD must be rerun. HARP 2 assists with creating the nested grid and allows AERMOD to easily be rerun in the Risk Analysis tab.

6. While rerunning AERMOD in the Risk Analysis module, HARP 2 also calculates the risk at each receptor in the nested grid. Report the Average Risk that is displayed at the bottom right-hand corner of the Step 3. Calculate Risk & View Risk Results page of the Spatial Averaging Risk (Optional) Tab.

7. Document and include all methods, assumptions, data, maps, and files used in the spatial averaging analysis and clearly present this information in the risk assessment report.

Appendix D – Default DICE Stack Parameters

The table below contains default stack parameters for stationary diesel-fired internal combustion engines (DICE). These parameters are based on a 2016 survey of the District's permitted DICE. A total of 174 engines were included in the survey. **These default stack parameters are only to be used when engine-specific data is unknown.**

Table D-1: Default Stationary DICE Stack Parameters

Engine Size (bhp)	Stack Temp (°F)	Stack Inner Diameter (in)	Release Height (ft)	Exhaust Flow Rate (cfm)
<100	992	4.6	7.1	468
100-250	899	4.1	7.4	779
251-500	931	5.3	8.2	1829
501-750	799	8.0	7.6	2930
751-1000	886	7.3	10.1	3559
>1000	880	11.5	11.0	9894

Appendix E – Health Risk Calculation and Rounding Policy

This policy provides guidance on how to calculate and round health risk values when comparing them to the District's Air Toxics Significant Risk Thresholds for risk management decisions.

Background:

In June 1993, the Santa Barbara County Air Pollution Control District's Board of Directors (District's Board) adopted health risk notification levels. Risk reduction thresholds were adopted by the District's Board on September 17, 1998. These risk reduction thresholds were set at the same level as the public notification thresholds. The risk notification and reduction levels are as follows:

	Significance Threshold
Cancer Risk:	**≥ 10 per million**
Chronic Non-Cancer Risk:	**> 1.0**
8-Hour Chronic Non-Cancer Risk:	**> 1.0**
Acute Non-Cancer Risk:	**> 1.0**

Policy:

The following procedure is used to calculate and round the health risk values:

- Calculate toxic emissions as accurately as possible, without rounding during the calculation procedure.

- Input the calculated toxic emissions into the HARP modeling program without any rounding or truncating.

- Calculate the cancer, chronic non-cancer and acute non-cancer health risk values using the HARP 2 modeling program.

- Round the calculated risk values to the nearest tenth (first decimal place).

  o If the digit in the hundredths (second decimal) place is 4 or less, round down.

  o If the digit in the hundredths place is 5 or greater, round up.

- Compare the rounded calculated risk values to the District's significant risk thresholds above for risk management decisions. Examples:

  o A hazard index of 1.049 rounds to 1.0 and is below the District's significant risk threshold (i.e., passes the HRA).

  o A hazard index of 1.050 rounds to 1.1 and is above the District's significant risk threshold (i.e., fails the HRA).

  o A cancer risk of 9.96/million rounds to 10.0/million and is above the District's significant risk threshold (i.e., fails the HRA).

Appendix F – Placement of Portable Equipment

Modeling portable equipment presents the challenge of determining the appropriate locations to model the equipment and distributing emissions to these locations in a representative and health protective manner. Ideally, records would indicate the location of the equipment and the time spent at each location. This allows the modeler to ensure that long-term *and* short-term impacts at each location are included in the analysis. If detailed records are not kept, or the equipment has not yet been installed, health protective assumptions can be made as discussed below.

If portable equipment operates at specific locations on a consistent schedule, the portable equipment's emissions can be modeled at multiple locations using an appropriate variable emission scenario for each AERMOD source. More information on variable emissions modeling can be found in Appendix A of this document.

If there is no consistent operational schedule for the portable equipment, use the following methodology to apportion the emissions:

1. The average annual emissions should be distributed evenly throughout all locations where the equipment emits throughout the year.

2. When determining the acute non-cancer risk, the HRA should first be run with the maximum hourly emissions from any portable equipment set to zero. After the point of maximum impact (PMI) is determined, a second analysis should be performed with the maximum hourly emissions for all portable equipment assigned to the closest location to the PMI that the equipment operates.

3. If there is concern that emissions from the portable equipment may drive the acute non-cancer risk, a third acute non-cancer risk analysis should be performed. In this analysis, the portable equipment should be placed at the location closest to the property boundary that it operates. The acute HI at the PMI from this run should be compared to the acute HI at the PMI for the second analysis described in Step 2, with the higher of the two values reported as the PMI.

An example of the methodology described above is well drilling at an oil and gas facility. In this example, a total of 50 wells will be drilled over a 10-year period:

1. One volume source is modeled at each well location. The average annual emissions for each volume source are equal to the total well drilling emissions over the lifetime of the project divided by 10 years and by 50 wells.

2. Next, the acute non-cancer risk is analyzed without any maximum hourly emissions from well drilling. The PMI for this initial analysis is determined, and then the maximum hourly emissions from well drilling activity are assigned to the well located closest to the PMI, as there will be only one drilling rig in operation at a time. This well is located approximately 300 meters from the property boundary. The second analysis shows the resulting acute HI at the PMI is 0.68.

3. Additionally, an acute non-cancer risk analysis is performed with the maximum well drilling hourly emissions assigned to the well located closest to the property boundary, which is approximately 60 meters from the property boundary. The resulting acute HI at the PMI in this third analysis is 0.53. Therefore, the reported acute HI is the PMI from the second analysis, 0.68.

Appendix G – Source-Receptor Distance Policy for Acute Risk

When receptors are located at a close distance to an emitting source, the results of the air dispersion model have a higher level of uncertainty. For that reason, the District allows a 20 meter minimum source-receptor distance for acute non-cancer risk *on a case-by-case basis*. Receptors at locations where an actual person is not expected to be located for at least an hour may be omitted from the HRA if the risk-driving source is within 20 meters of the receptor. However, the District will not apply the minimum source-receptor distance policy on any land parcels with a sensitive receptor (e.g., sidewalk of hospital, school parking lot).

To request the use of this policy, use the following procedure:

1. Conduct the HRA or HRA screening without any minimum source-receptor distance (i.e., include all receptors in the risk analysis).

2. If an offsite receptor has an acute HI greater than 1, determine if it is within 20 meters of the risk-driving source. If it is within 20 meters of the risk-driving source, proceed to Step 3. Otherwise, the receptor is not eligible for this policy.

3. In the HRA report, provide a list of proposed receptors to be omitted from the analysis along with the information listed below.

    - Acute HI for each proposed receptor

    - UTM coordinates for each proposed receptor

    - Risk driving source and percent of contribution to acute HI

    - Distance from proposed receptor to risk driving source

    - Description of area surrounding each proposed receptor

    - Aerial photo showing the source location and the proposed receptor locations

    An example of the required information is shown in Table G-1 below.

**Table G-1: Example Data for Omitting Acute Receptors
within the Minimum Source-Receptor Distance**

Proposed Acute Receptor No.	Acute HI	UTM Coordinates (m)	Risk Driving Source	Percentage of Contribution to Risk	Distance to Risk Driving Source (m)	Description of Surrounding Area
1015	1.7	E 733054.3, N 3850674	STCK1 (Boiler 1)	87.2%	6	Rugged steep terrain
907	1.2	E 725597.0, N 3846560	STCK5 (Tank 3)	76.5%	18	Driveway of parking lot

After the District reviews your request along with the HRA report, the District will notify you if your request was approved or denied. If your request is denied, a revised HRA report will be required. If your request is approved, additional receptors may be required to be placed outside of the minimum source-receptor distance at the District's discretion.

Risk management decisions for long-term risk are based on actual residential and worker receptors, and are therefore not affected by this policy.

Appendix H – Alternative Refined Acute Method (ARAM)

Running the refined acute analysis for a single receptor in HARP 2 can take hours or even days for a large project, a facility with hundreds of emitting sources and thousands or tens of thousands of receptors. In situations where there are dozens or hundreds of receptors with a simple acute risk greater than one, using HARP 2 to calculate the refined acute risk is unfeasible. The alternative refined acute method (ARAM) significantly reduces the run time required to calculate the refined acute risk. ARAM uses normalized emission rates directly in AERMOD, accounting for each pollutant's REL and target endpoints, to determine the refined acute risk for all receptors simultaneously.

H.1   Simple Acute Risk Methodology in HARP 2

To calculate the simple acute risk, HARP 2 assumes that the relative concentration, X/Q, at each receptor location and the emission rates from each source are at their maximum values at the same instant in time. This approximation allows HARP 2 to simply use the maximum hourly X/Q for each source-receptor combination rather than considering the temporal variation of X/Q to calculate the ground level concentration (GLC). HARP 2 then adds the GLCs from all sources together at each receptor as if they had all occurred at the same time. The simple acute risk is calculated from this approximated GLC.

To further explain, each receptor has one GLC of each pollutant included in the acute analysis. For the simple acute risk, the GLC is calculated from the summed maximum X/Q values. For example, consider a facility with three sources that each emit hydrogen sulfide and xylene. Each receptor in the analysis will have a GLC of hydrogen sulfide and a GLC of xylene that varies in time based on the meteorological data. For the simple acute risk, the GLC of hydrogen sulfide at a receptor is the sum of the maximum X/Q of the three sources, multiplied by the maximum hourly emission rate of hydrogen sulfide from those three sources. Similarly, the GLC of xylene at a receptor, is the sum of the maximum X/Q of the three sources, multiplied by the maximum hourly emission rate of xylene from those three sources.

The hazard quotient (HQ) is calculated by dividing the GLC by the reference exposure level (REL) for each pollutant. If a receptor is exposed to multiple pollutants that target the same organ system or endpoint, then the HQs for the individual pollutants are summed to obtain a Hazard Index (HI) for that target organ. For example, for Receptor A, if the HQ for xylene is 0.4 and the HQ for hydrogen sulfide is 0.3, then the HI at Receptor A is 0.7, as both pollutants have a target endpoint of the nervous system. The only acute target organ for hydrogen sulfide is the nervous system, but xylene also has target organs of eyes and the respiratory system. Therefore, the dominant pathway for the analysis would be the nervous system since it creates the largest HI.

H.2   Refined Acute Risk Methodology in HARP 2

The refined acute risk method in HARP 2 considers the temporal variation of X/Q to calculate the GLCs. The refined acute risk calculation in HARP 2 uses the hourly X/Q and the maximum emission rates from each source to calculate an hourly GLC from each source for each hour at a specified receptor. For each hour, the GLCs from all sources are added together to get the total GLC at that hour at the specified receptor. From this, the refined HQs and then the refined acute HIs are calculated for the specified receptor at each hour. HARP then locates the maximum HI over the time (i.e., meteorological period) considered for the analysis. This approach accounts for the fact that the X/Q from different sources will not necessarily be at their maximums at the same time, and may produce a lower estimate of acute risk than the screening approximation (i.e., simple acute method).

H.3   Alternative Refined Acute Risk Method

ARAM uses the air dispersion model (AERMOD) with normalized emission rates that account for each pollutant's REL and target endpoints, avoiding the need to run the refined acute analysis within HARP 2. To calculate the normalized hourly emission rate from each source, the maximum hourly emission rate (in grams per second) of each pollutant emitted from that source is divided by its corresponding acute REL, and then multiplied by a temporary scaling factor of 1,000 (to avoid any loss of data from low emission rates). When two or more acute pollutants are emitted by a single source, the normalized emission rates are summed and then assigned to applicable acute target organs to arrive at the source-specific acute target organ normalized emission rates. Separate refined acute modeling runs (AERMOD dispersion runs) are then conducted for each of the applicable acute target organs. When these normalized emissions rates are input into AERMOD, the 1 hour "concentration" output from AERMOD is the refined acute hazard index for that specific target organ. The maximum 1 hour AERMOD results for each target organ are then compared for each receptor to determine the highest value and the dominant endpoint. The highest value is the refined acute hazard index for that receptor.

H.4   ARAM Procedure using Lakes Environmental's AERMOD View

1. Set up the air dispersion run in Lakes Environmental's AERMOD View (Lakes), including source information. The set-up of the project file should be identical to that of the cancer risk, chronic non-cancer risk and simple acute risk, excluding variable emissions. Variable emissions scenarios do not need to be entered at this step and are addressed in Step 7 below.

2. Export the sources from Lakes (as shown below) to an Excel file titled *Sources.xlsx*. Use this source ID order from the Lakes *Sources.xlsx* file in steps 3 through 6 below.
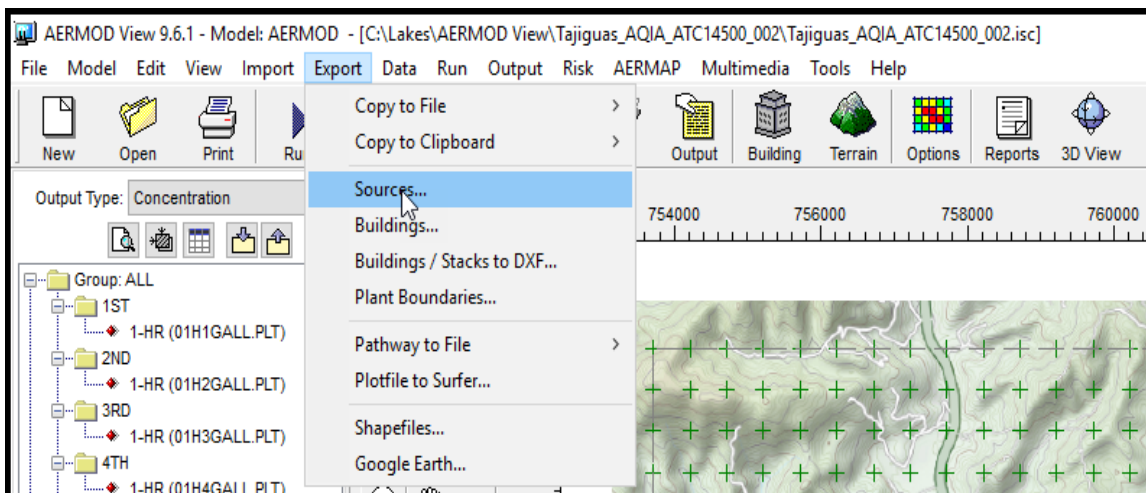
3. The District's spreadsheet for calculating the normalized emission rates for ARAM, titled *Alternate Refined Acute Calculation Template.xlsx*, is available at: https://www.ourair.org/wp-content/uploads/Alternate-Refined-Acute-Calculation-Template.xlsx. Open this spreadsheet and confirm the pollutant risk data (acute RELs and applicable target endpoints) in the *Pollutant Health Data* tab are current. A screenshot is shown on the next page. The *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values* is available here: https://www.arb.ca.gov/toxics/healthval/contable.pdf.

Pollutant	ID	Acute REL	CV	CNS	IMMUN	KIDNEY	GILV	REPRO/DEVEL	RESP	SKIN	EYE	BONE/TEETH	ENDO	BLOOD	ODOR	GENERAL
								Endpoints								
Acetaldehyde	75070	470	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Acrolein	107028	2.5	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Acrylic acid	79107	6000	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Ammonia	7664417	3200	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Arsenic and compounds (inorganic)	1016	0.2	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Arsine	7784421	0.2	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Benzene	71432	27	0	0	1	0	0	1	0	0	0	0	0	0	1	0
Benzyl chloride	100447	240	0	0	0	0	0	0	1	0	1	0	0	0	0	0
1,3-butadiene	106990	660	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Caprolactam	105602	50	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Carbon disulfide	75150	6200	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Carbon monoxide	630080	23000	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon tetrachloride (tetrachloromethane)	56235	1900	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Carbonyl sulfide	463581	660	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chlorine	7782505	210	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Chloroform	67663	150	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Chloropicrin	76062	29	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Copper and compounds	7440508	100	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cyanide compounds (inorganic)	57125	340	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen cyanide (Hydrocyanic acid)	74908	340	0	1	0	0	0	0	0	0	0	0	0	0	0	0

4. Use the *Source Emissions* tab of the *Alternate Refined Acute Calculation Template.xlsx* to calculate the Endpoint-Specific Normalized Emission Rate for each source/pollutant combination. To ensure the emission rates are assigned to the correct source, **use the Source ID order shown in *Sources.xlsx*.** Example screenshot shown below.

   a. Enter the source ID, pollutant ID and maximum hourly emissions in lb/hr in the *Source Emissions* tab. The pollutant ID must use the same formatting as the pollutant ID shown in *Pollutant Health Data* tab (i.e., no hyphens). This formatting is consistent with the pollutant ID formatting in the HARP 2 CSV emissions file.

   b. Repeat for every source ID and pollutant. If more than 10,000 rows are needed, the formulas in the spreadsheet must be manually edited. Contact the District for assistance in adding formulas to this spreadsheet.

Table notes:
* If the user needs to enter data past row 10,000 in this tab, formulas in this spreadsheet will need to be edited. Contact the toxics engineer for help.
** The pollutant name will be shown in column E if the pollutant ID entered in column B corresponds to a pollutant with an acute REL. If the pollutant does not have an acute REL, column E will say "No Acute REL."
*** The normalized emission rate is multiplied by 1000 to avoid reducing the emissions to such low values that they are not counted in AERMOD.
**** The totals shown in row 6 will be highlighted in green if they match the totals in the *AERMOD Emission Rates* tab; they will be shown in orange if the totals do **not** match.

Total****: CV 0.00E+00, CNS 1.74E+00, IMMUN 1.88E+00, KIDNEY 0.00E+00, GILV 0.00E+00, REPRO/DEVEL 8.76E-01

Source ID*	Pollutant ID	Max Hourly Emissions (lb/hr)	Row Match	Pollutant Name**	Acute REL	Max Hourly Emissions (g/s)	Normalized Emission Rate (g/s per µg/m³)***	CV	CNS	IMMUN	KIDNEY	GILV	REPRO/DEVEL	RESP	SKIN	EYE	BONE/TEETH	ENDO	BLOOD	ODOR	GENERAL	CV	CNS	IMMUN	KIDNEY	GILV	REPRO/DEVEL
S001	7783064	0.000036	33	Hydrogen sulfide	42	4.53592E-06	0.000107998	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	1.08E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S001	100414	6.72E-08	N/A	No Acute REL	N/A	8.46705E-09	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S001	108883	0.000000533	67	Toluene	37000	6.71568E-08	1.81505E-09	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0.00E+00	1.82E-09	0.00E+00	0.00E+00	0.00E+00	1.82E-09
S001	1330207	9.12E-08	75	Xylenes	22000	1.1491E-08	5.22318E-10	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0.00E+00	5.22E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S001	71432	0.00000156	9	Benzene	27	1.96557E-07	7.27987E-06	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0.00E+00	0.00E+00	7.28E-06	0.00E+00	0.00E+00	7.28E-06
S001	7664417	0.000582993	6	Ammonia	3200	7.34558E-05	2.29549E-05	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S001	91203	6.14E-08	N/A	No Acute REL	N/A	7.73626E-09	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S002	7783064	0.000036	33	Hydrogen sulfide	42	4.53592E-06	0.000107998	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	1.08E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S002	100414	6.72E-08	N/A	No Acute REL	N/A	8.46705E-09	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S002	108883	0.000000533	67	Toluene	37000	6.71568E-08	1.81505E-09	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0.00E+00	1.82E-09	0.00E+00	0.00E+00	0.00E+00	1.82E-09
S002	1330207	9.12E-08	75	Xylenes	22000	1.1491E-08	5.22318E-10	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0.00E+00	5.22E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S002	71432	0.00000156	9	Benzene	27	1.96557E-07	7.27987E-06	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0.00E+00	0.00E+00	7.28E-06	0.00E+00	0.00E+00	7.28E-06
S002	7664417	0.000582993	6	Ammonia	3200	7.34558E-05	2.29549E-05	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S002	91203	6.14E-08	N/A	No Acute REL	N/A	7.73626E-09	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	7783064	0.0000335	33	Hydrogen sulfide	42	4.22093E-06	0.000100498	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	100414	0.00000111	N/A	No Acute REL	N/A	1.39858E-07	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	108883	0.00000281	67	Toluene	37000	3.54054E-07	9.56902E-09	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0.00E+00	9.57E-09	0.00E+00	0.00E+00	0.00E+00	9.57E-09
S003	110827	0.00000126	N/A	No Acute REL	N/A	1.58757E-07	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	1330207	0.00000249	75	Xylenes	22000	3.13734E-07	1.42607E-08	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0.00E+00	1.43E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	67561	0.0000475	37	Methanol	28000	5.98489E-06	2.13746E-07	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	2.14E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S003	71432	0.0000028	9	Benzene	27	3.52794E-07	1.30664E-05	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0.00E+00	0.00E+00	1.31E-05	0.00E+00	0.00E+00	1.31E-05
S003	91203	0.000000509	N/A	No Acute REL	N/A	6.41329E-08	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

5. Use the *AERMOD Emission Rates* tab of the *Alternate Refined Acute Calculation Template.xlsx* to calculate the Emission Rate for AERMOD Run for Each Endpoint. **Use the Source ID order shown in *Sources.xlsx*.** The normalized emission rates shown in the AERMOD Emission Rates tab on the *Alternate Refined Acute Calculation Template.xlsx* are multiplied by 1000 to ensure low values are not rounded to zero in AERMOD. This requires that the **AVERAGE CONC results from the AERMOD plotfiles must be divided by 1000 to correctly represent the HI**, as described in Step 10 below.

Table notes:

* If the sum in row 7 is 0 for any endpoints, an AERMOD run does not need to be conducted for those endpoints, and the endpoints will be shown in ~~strikethrough~~ font in row 10. The endpoints for which AERMOD must be run are highlighted in blue in row 10.

** Enter each unique Source ID in column A (they do not have to be in numerical/alphabetical order). If there are more than 10,000 sources in the project, and/or entries past row 10,000 in the *Source Emissions* tab, formulas in this spreadsheet will need to be edited. Contact the toxics engineer for help.

*** Information must be entered in column B if the user would like the spreadsheet to calculate the AERMOD emission rate in g/s/m² for area sources. If the source is not an area source, leave the corresponding cell in this column blank. If information is not entered in this column, the spreadsheet will calculate the emission rate in g/s and the user will have to convert the emission rates for area sources into g/s/m², which can be performed within Lakes AERMOD View, if preferred.

**** See note above about the units of the emission rates. Because these emission rates were multiplied by 1000 in the *Source Emissions* tab, the results from the AERMOD run must be divided by 1000 to determine the refined acute HI for each receptor and each endpoint.

Source ID**	Area (m²)***	CV	CNS	IMMUN	KIDNEY	GILV	REPRO/DEVEL	RESP	SKIN	EYE	BONE/TEETH	ENDO	BLOOD	ODOR	GENERAL
Total*		0.00E+00	1.74E+00	1.88E+00	0.00E+00	0.00E+00	8.76E-01	1.76E+01	1.58E+01	2.16E+01	0.00E+00	0.00E+00	5.88E-01	0.00E+00	0.00E+00
S001	201.157	0.00E+00	5.37E-07	3.62E-08	0.00E+00	0.00E+00	3.62E-08	1.14E-07	0.00E+00	1.14E-07	0.00E+00	0.00E+00	3.62E-08	0.00E+00	0.00E+00
S002	201.157	0.00E+00	5.37E-07	3.62E-08	0.00E+00	0.00E+00	3.62E-08	1.14E-07	0.00E+00	1.14E-07	0.00E+00	0.00E+00	3.62E-08	0.00E+00	0.00E+00
S003	7.26303	0.00E+00	1.39E-05	1.80E-06	0.00E+00	0.00E+00	1.80E-06	3.28E-09	0.00E+00	3.28E-09	0.00E+00	0.00E+00	1.80E-06	0.00E+00	0.00E+00
S004	0	0.00E+00	3.57E-02	0.00E+00	0.00E+00	0.00E+00	3.57E-02	3.57E-02	0.00E+00	3.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S005	0	0.00E+00	0.00E+00	4.55E-03	0.00E+00	0.00E+00	4.55E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-03	0.00E+00	0.00E+00
S006	0	0.00E+00	0.00E+00	3.03E-03	0.00E+00	0.00E+00	3.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.03E-03	0.00E+00	0.00E+00
S007	0	0.00E+00	5.70E-03	4.50E-02	0.00E+00	0.00E+00	1.80E-02	2.62E-02	0.00E+00	7.97E-02	0.00E+00	0.00E+00	1.18E-02	0.00E+00	0.00E+00
S008	0	0.00E+00	5.70E-03	4.50E-02	0.00E+00	0.00E+00	1.80E-02	2.62E-02	0.00E+00	7.97E-02	0.00E+00	0.00E+00	1.18E-02	0.00E+00	0.00E+00
S009	0	0.00E+00	1.13E-08	0.00E+00	0.00E+00	0.00E+00	6.54E-10	1.13E-08	0.00E+00	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S010	396.368	0.00E+00	5.62E-07	7.29E-08	0.00E+00	0.00E+00	7.29E-08	1.33E-10	0.00E+00	1.33E-10	0.00E+00	0.00E+00	7.29E-08	0.00E+00	0.00E+00
S011	396.368	0.00E+00	5.62E-07	7.29E-08	0.00E+00	0.00E+00	7.29E-08	1.33E-10	0.00E+00	1.33E-10	0.00E+00	0.00E+00	7.29E-08	0.00E+00	0.00E+00
S012	0	0.00E+00	1.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-05	0.00E+00	5.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S013	0	0.00E+00	1.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-05	0.00E+00	5.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S014	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-03	9.10E-03	9.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
S015	0	0.00E+00	5.91E-08	1.45E-05	0.00E+00	0.00E+00	1.45E-05	5.89E-08	0.00E+00	5.89E-08	0.00E+00	0.00E+00	1.45E-05	0.00E+00	0.00E+00
S016	97.5921	0.00E+00	4.33E-08	1.06E-05	0.00E+00	0.00E+00	1.06E-05	4.32E-08	0.00E+00	4.32E-08	0.00E+00	0.00E+00	1.06E-05	0.00E+00	0.00E+00
S017	0	0.00E+00	1.13E-07	2.78E-05	0.00E+00	0.00E+00	2.78E-05	1.13E-07	0.00E+00	1.13E-07	0.00E+00	0.00E+00	2.78E-05	0.00E+00	0.00E+00
S018	0	0.00E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	9.67E-10	1.67E-08	0.00E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

*(Emission Rate for AERMOD Run for Each Endpoint****)*

6. For the selected endpoint, enter the Emission Rate for AERMOD Run for Each Endpoint from the *AERMOD Emission Rates* tab of the *Alternate Refined Acute Calculation Template.xlsx* into AERMOD by the following steps:

   a. Delete all sources from Lakes.
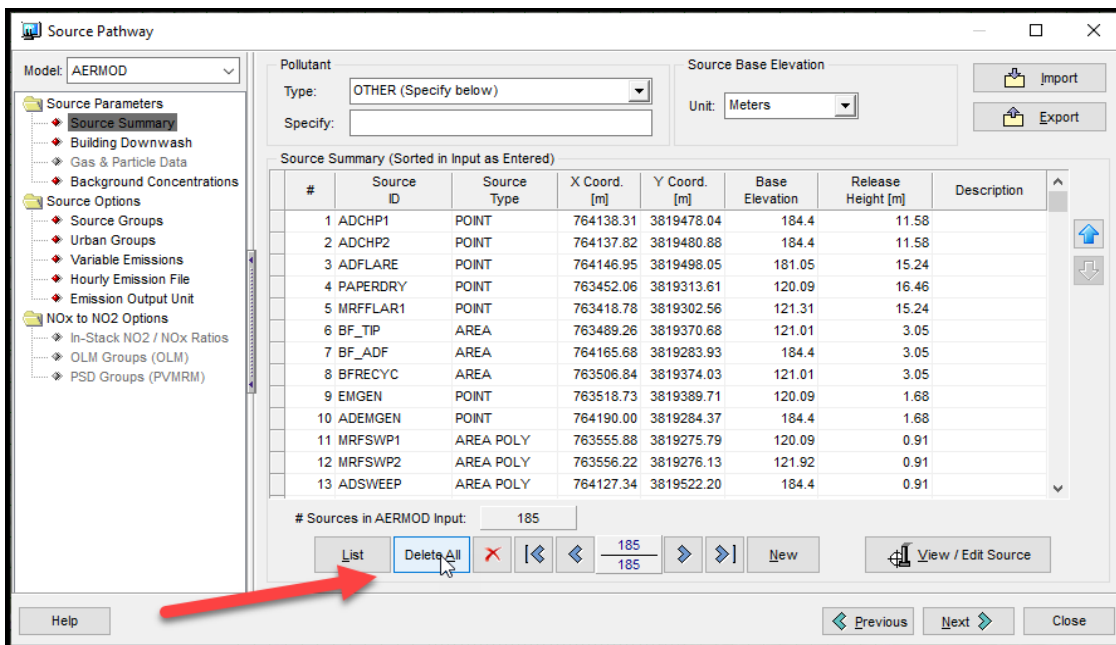
b. For the selected endpoint, copy the corresponding column of Emission Rate for AERMOD Run for Each Endpoint and paste the values into *Sources.xlsx*. Rename the Excel file appropriately to indicate that the emission rates in the file are for that selected endpoint.

c. Import the *Sources.xlsx* file into Lakes.
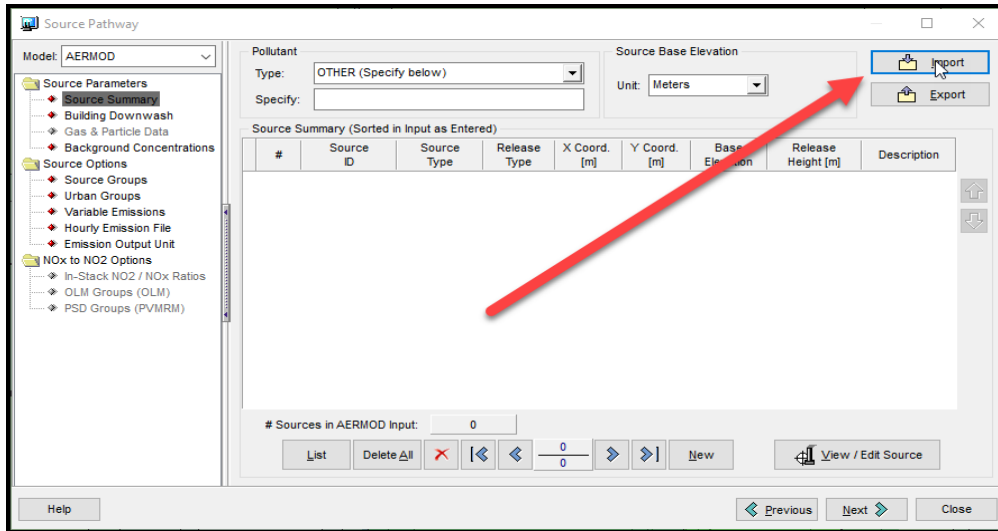
7. Run AERMOD in Lakes by the following steps:

a. Ensure contour plot for the 1 hour highest value is selected.
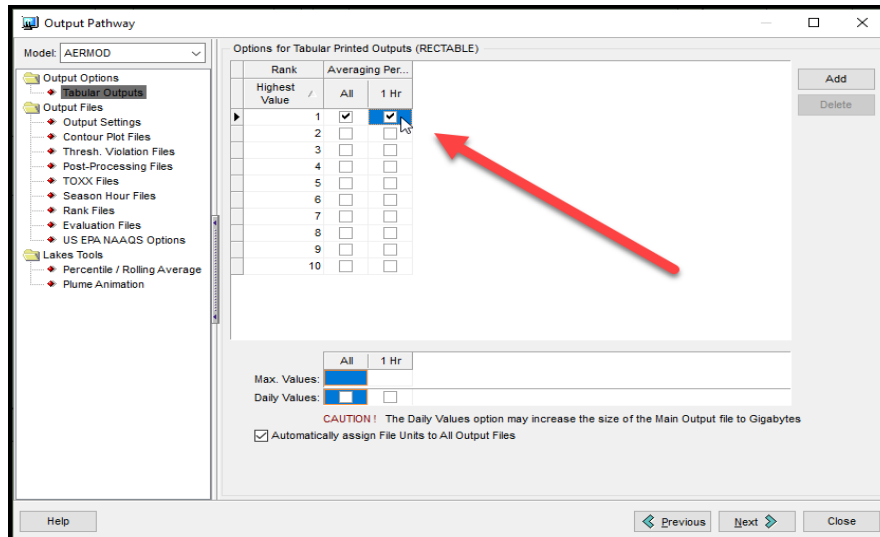
b. Ensure *only* the Source Group ALL is selected.
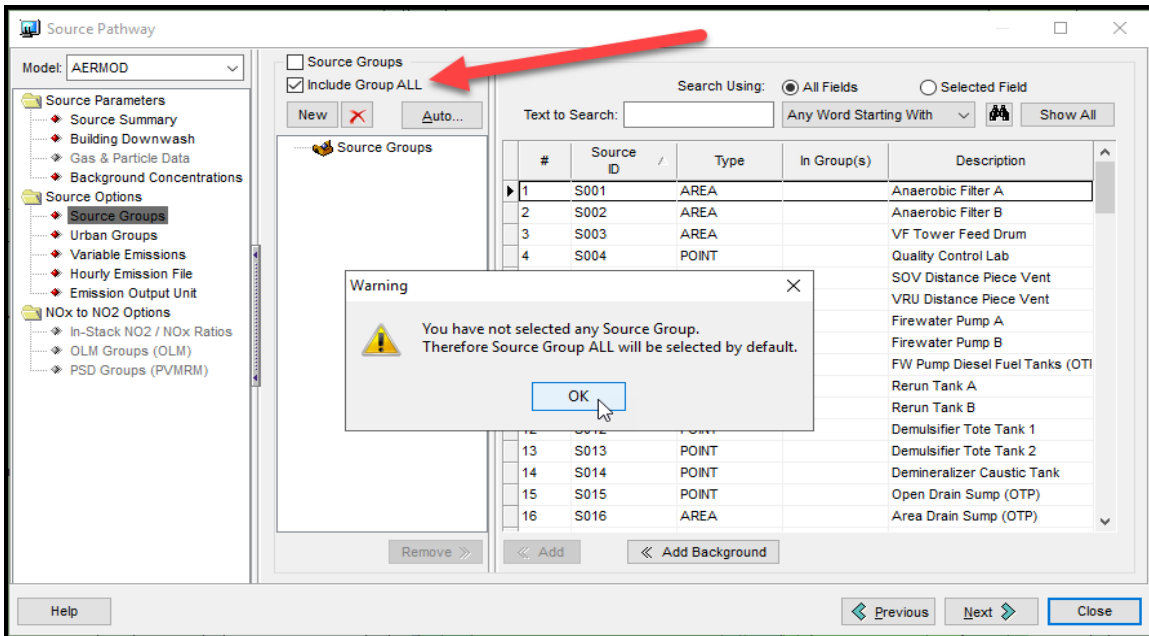
c. Change the title under the Control Pathway to indicate the endpoint being run.
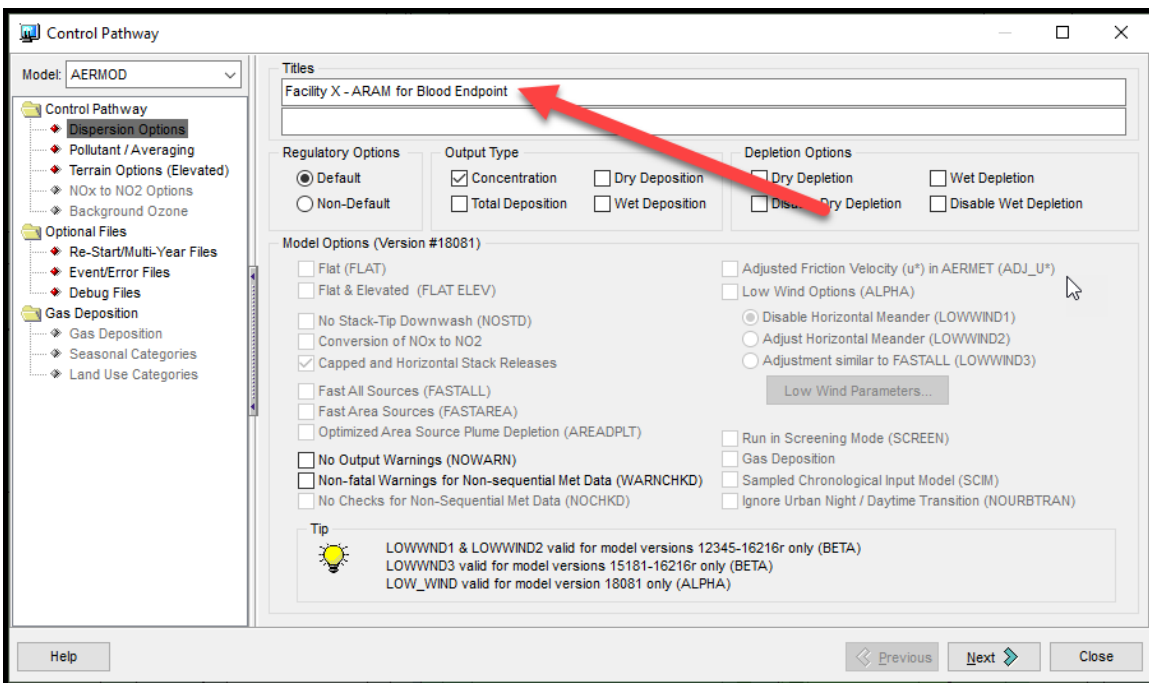
d. If variable emissions are used, the variable emissions scenarios will need to be re-entered for each AERMOD run because all the sources will have been deleted and then re-imported. See Section A.2, *Variable Emission Rates for Maximum Hourly Emissions*, of this document for more information on entering variable emission information for the acute non-cancer risk analysis.

e. Run AERMOD and BPIP. BPIP must be rerun for each endpoint run because the sources will have been deleted and then re-imported. Alternatively, the user may import the BPIP files (*.PRO*) that were created during the run for the first target endpoint.

8. Copy the results from the PLT file to an Excel spreadsheet, *Summary of AERMOD Concentrations for ARAM.xlsx*. (Use the *Text to Columns* feature under the *Data* header in Excel to ensure that the data is properly entered into columns.) Change the AVERAGE CONC header to the name of the target endpoint. Label the tab with the endpoint. **Do not sort data.** It is important that the order remain unchanged because the results for all endpoints will be compiled into one worksheet, as described in Step 10 below.

9. Repeat steps 6 - 8 for each endpoint.

10. The AERMOD results from each endpoint run must be combined into one worksheet to determine the refined acute HI at each receptor and the corresponding endpoint. Follow the steps below to combine the endpoints:

   a. Copy one of the endpoint tabs to a new tab, named *All*.

   b. Insert columns after the UTM Northing coordinate column. The number of columns that must be inserted is one more than the total number of endpoints.

c. From each endpoint tab, copy the column previously called, "Concentration (AVERAGE CONC) [ug/m^3]" in the PLT file, now the name of endpoint in the worksheet. The UTM coordinates do not need to be copied because the data was not sorted; the order is the same for each endpoint run.

d. In the column directly to the right of the last endpoint, name the header "Refined Acute HI". To determine the HI at the first receptor, use the maximum formula in Excel (e.g., =MAX(D2:K2)) on the first row of data with the endpoint values, and divide the result by 1000. The Excel formula will be similar to =MAX(D2:K2)/1000; where column D is the first endpoint and column K is the last endpoint. The value calculated by this formula is the refined acute HI at the first receptor.

e. Copy the formula down the column to the end of the data.

f. In the column directly to the right of the refined acute HI, name the header "Max Endpoint". Use a nested IF statement to determine the target endpoint for the maximum refined acute HI. The Excel formula will be similar to:

=IF(L2*1000=D2,D$1,IF(L2*1000=E2,E$1,IF(L2*1000=F2,F$1,IF(L2*1000=G2,G$1,IF(L2*1000=H2,H$1,IF(L2*1000=I2,I$1,IF(L2*1000=J2,J$1,IF(L2*1000=K2,K$1))))))))

g. Copy the formula down the column to the end of the data.

h. Use the *All* tab to create the refined acute HI isopleth as described in Section H.5 below.

11. To determine the PMI or all refined risk greater than one, and to create isopleths using Surfer, create a copy of the *All* tab in a new workbook, called *Refined Acute HI.xlsx* or similar.

   a. The tab *All* of *Refined Acute HI.xlsx* may be sorted and/or filtered to determine the point of maximum impact and/or all values over 1.0. In the example below, all refined acute HIs greater than 1.0 are shown in red. In the example below, the data is sorted by the column *Refined Acute HI* using Excel's Filter feature.

H.5   Procedure for Creating Isopleths using Surfer 16 and Google Earth

1. In Surfer, select "Grid Data" from the "Home" tab menu.
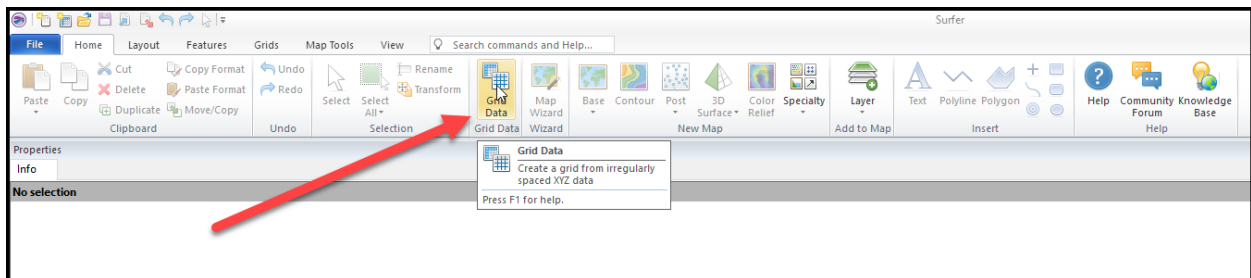
2. Navigate to the file, *Refined Acute HI.xlsx*, the ARAM spreadsheet created in Step 11 of the *ARAM Procedure using Lakes Environmental's AERMOD View*.

3. Create the grid file by selecting the UTM Easting coordinates for the X column, UTM Northing coordinates for the Y column, and the column with the maximum refined risk results for the Z column. No other selections must be made at this time. The Gridding Method defaults to Kriging, which typically produces an attractive isopleth.
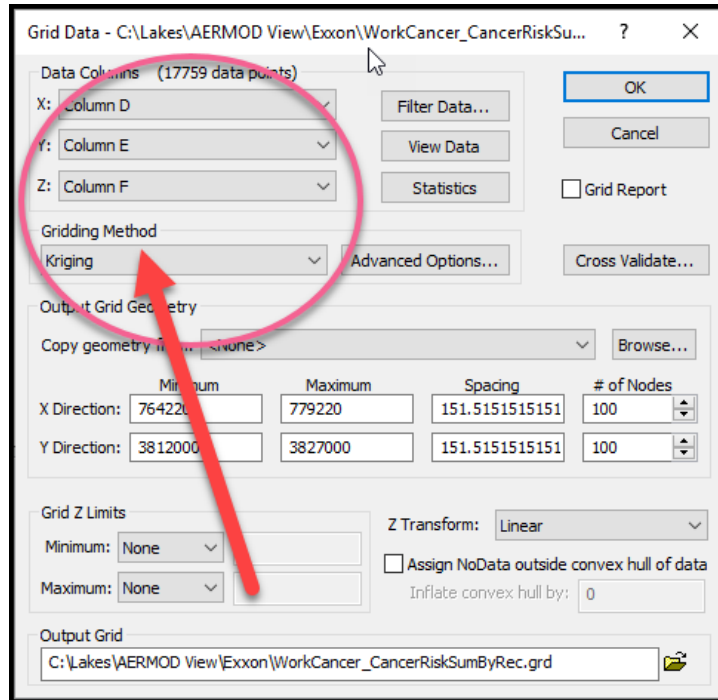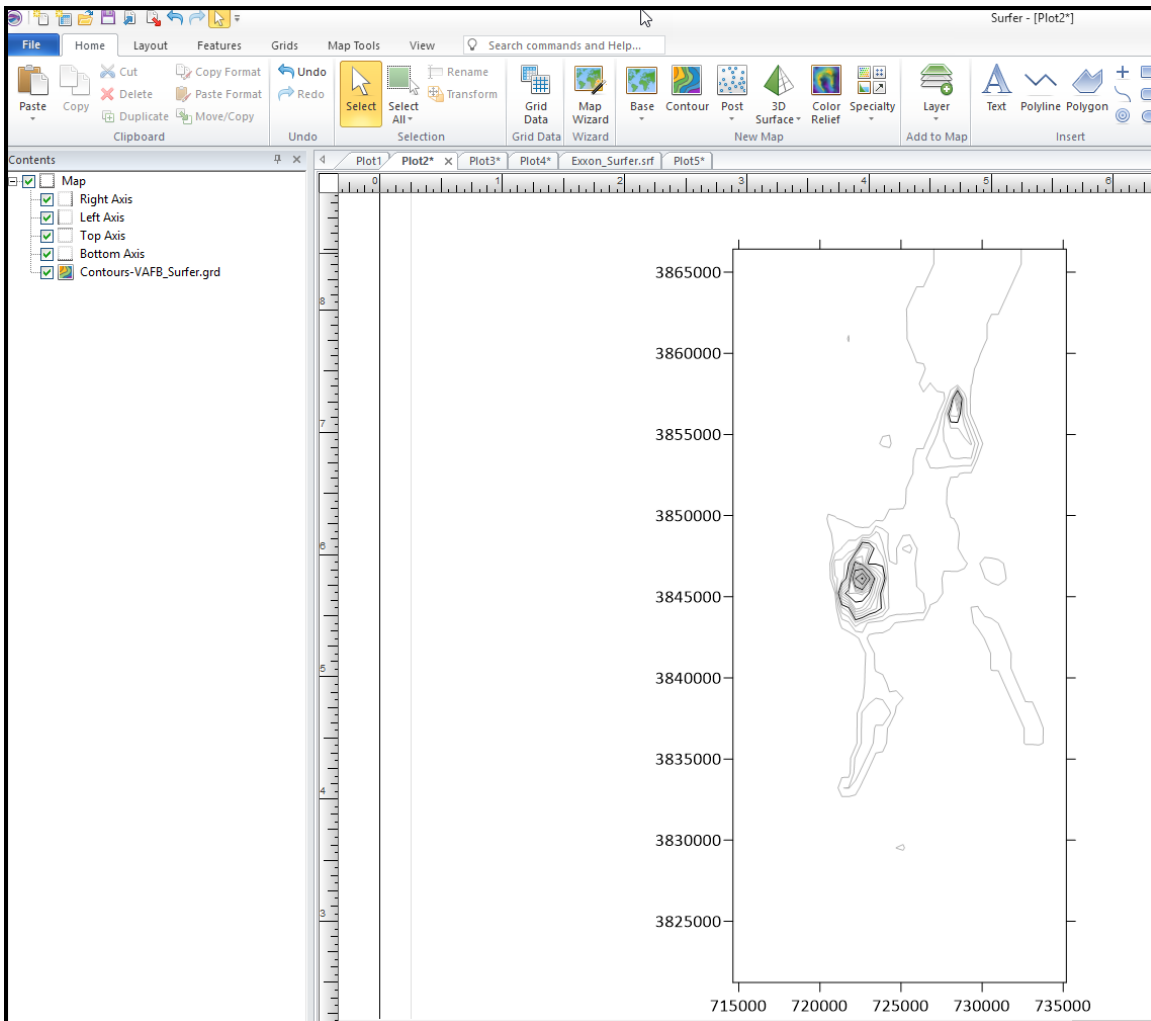

4. In Surfer, select "File" menu, "New" menu, and then "Plot Document".
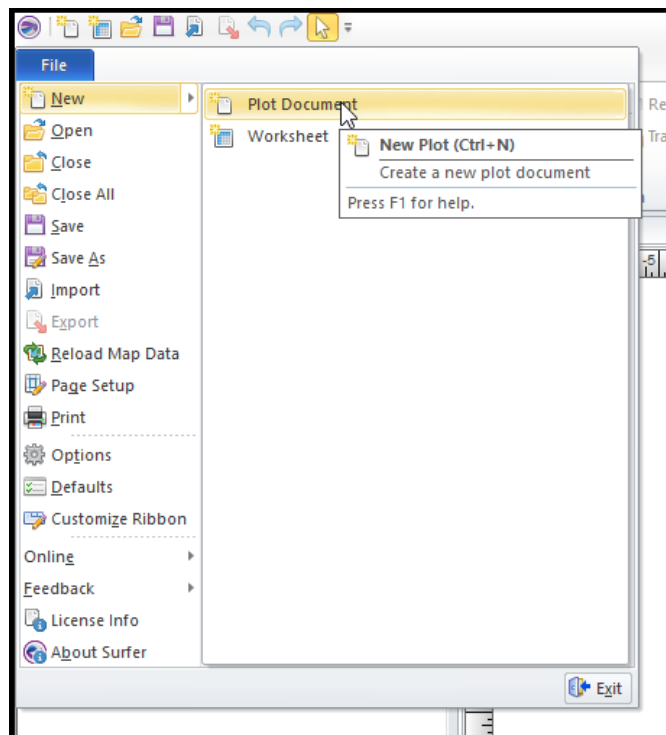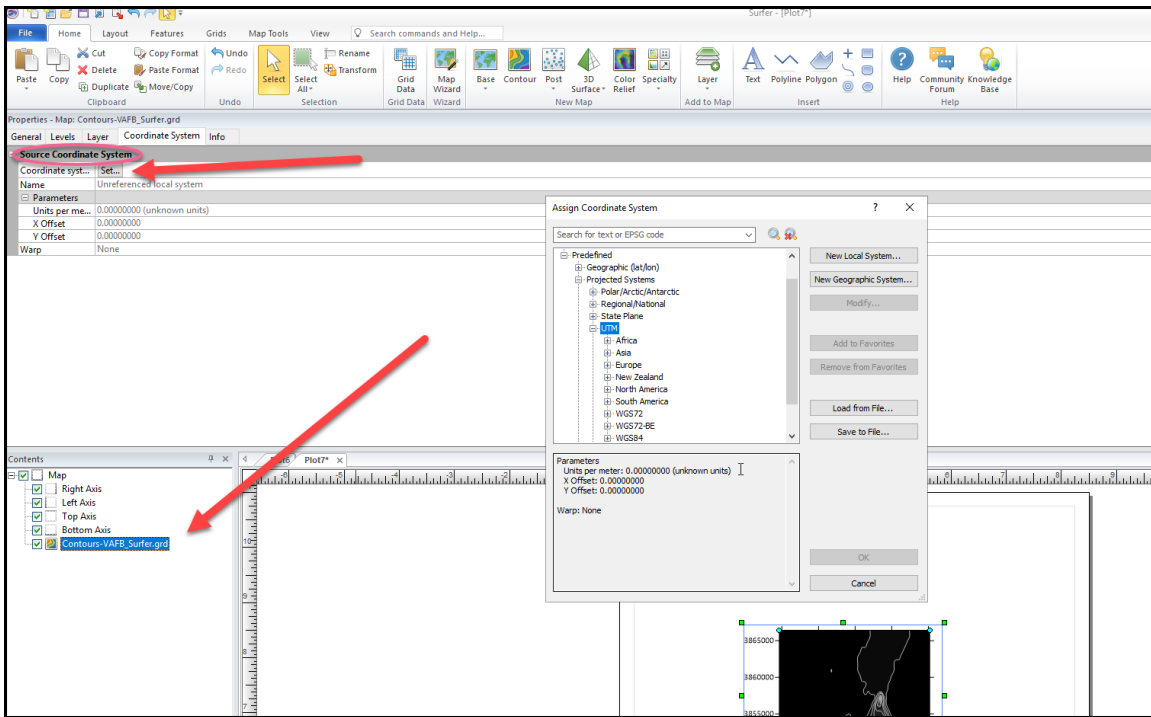
5. After the new plot document is created, select "Contour" from the "Home" tab menu and then navigate to the grid file you created in Step 3.
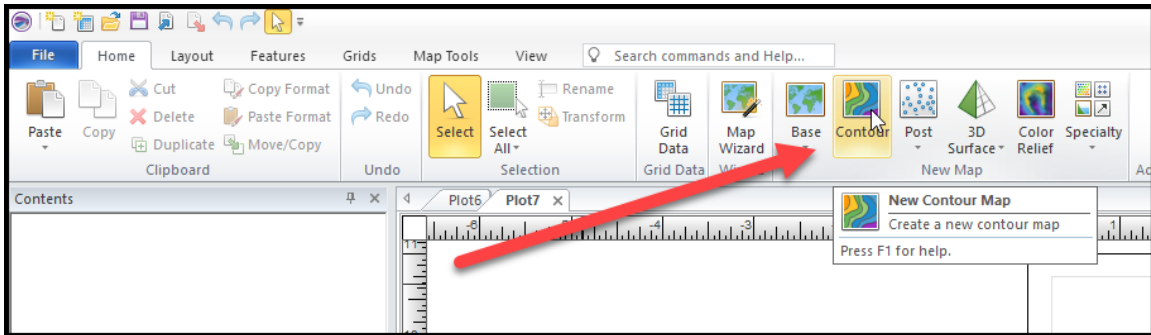

6. A contour (isopleths) map will be created based on the data in the grid file.

7. Set the "Source Coordinate System" under the "Properties" of the contour map to the UTM coordinates and datum that your project is using.


8. The coordinates must be changed to latitude/longitude for the isopleths to appear in the correct location on Google Earth. Change the coordinates of the Map (not the Contours, but the Map) by going to Map "Properties", then "Coordinate System" tab and changing the "Target Coordinate System".
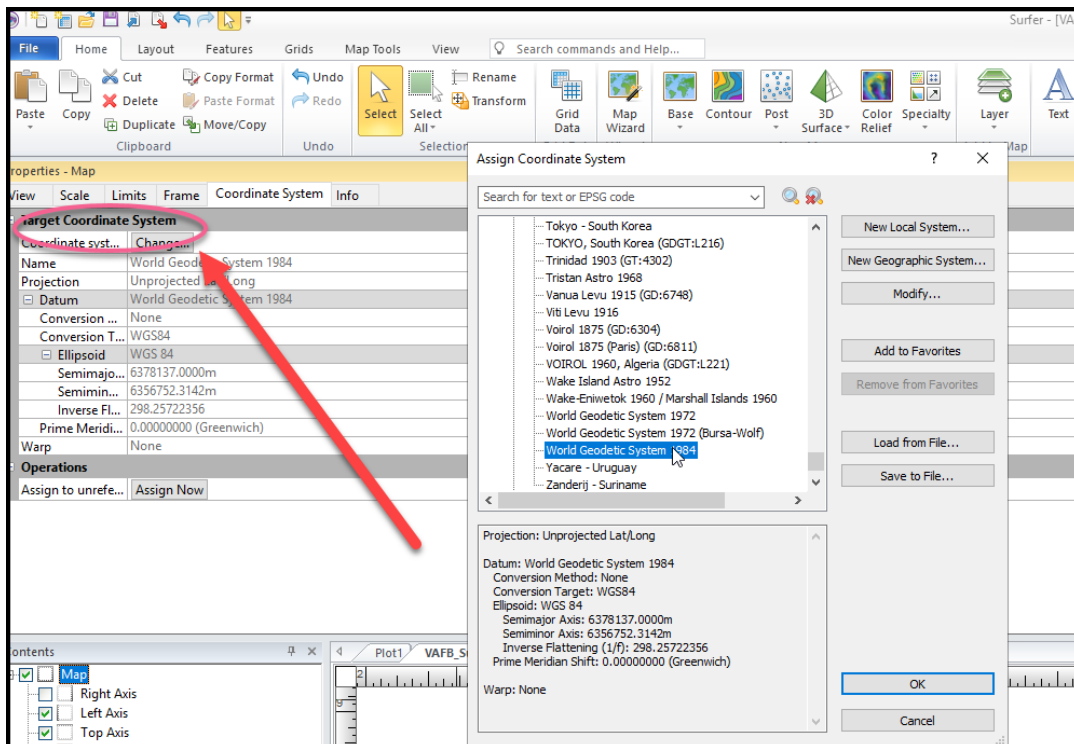
9. The contour map may contain more contours or isopleths than necessary for the aerial photo. You can delete or add levels by selecting the "Level Method" as "Advanced". Then the "Edit Levels" option will appear.
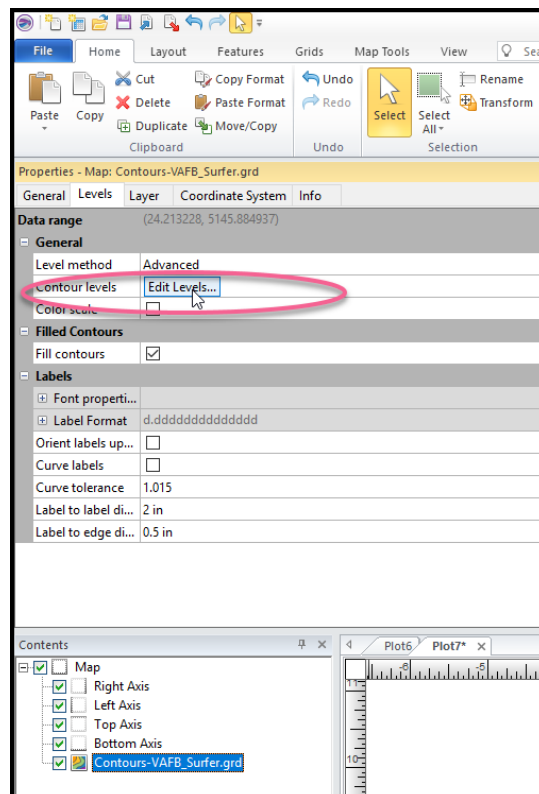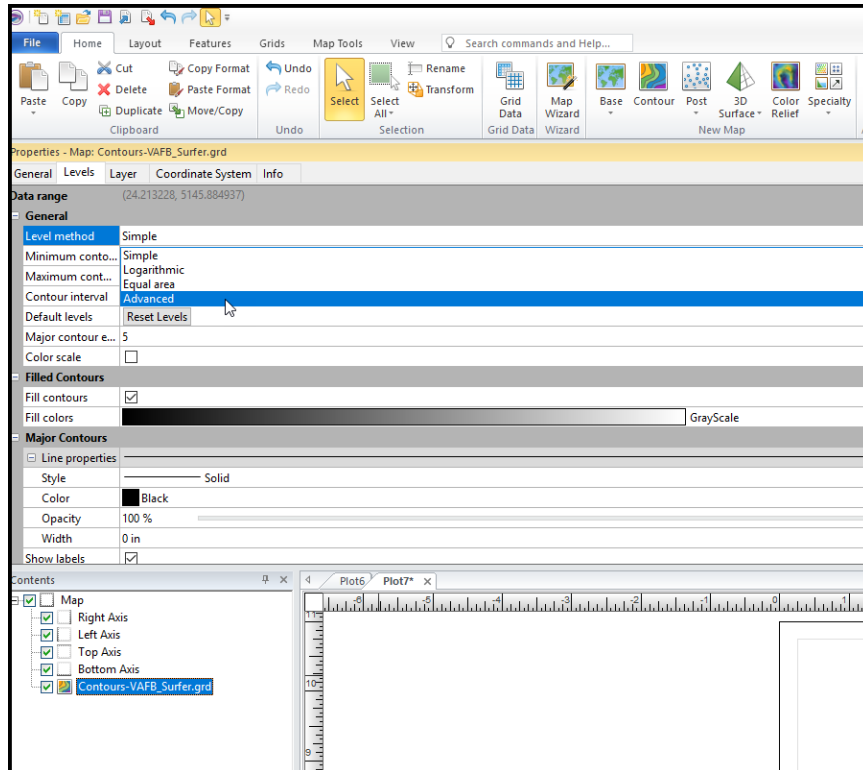
10. Click on the "Edit Levels" button to change the color, width and fill of the isopleths as desired. Make the line width at least 0.05 in to ensure the isopleths are thick enough to be visible in Google Earth. Keep the opacity of the line at 100%. Change the opacity of the fill (Foreground) to around 50%, then modify as desired.
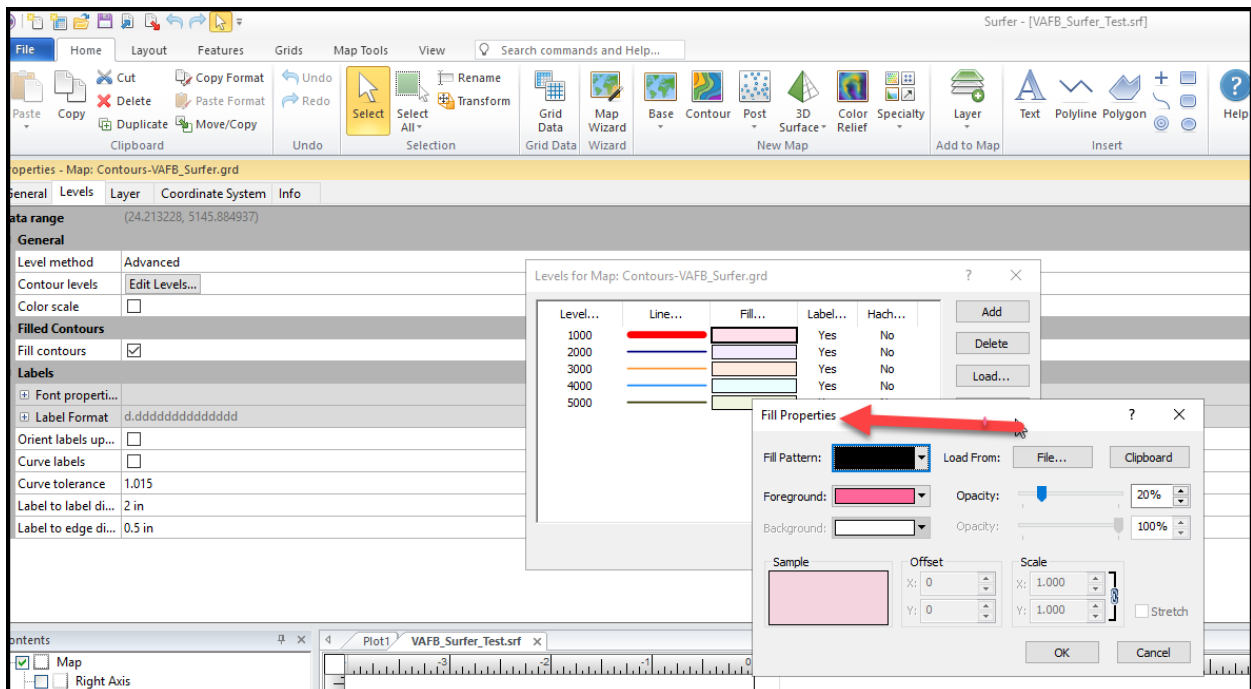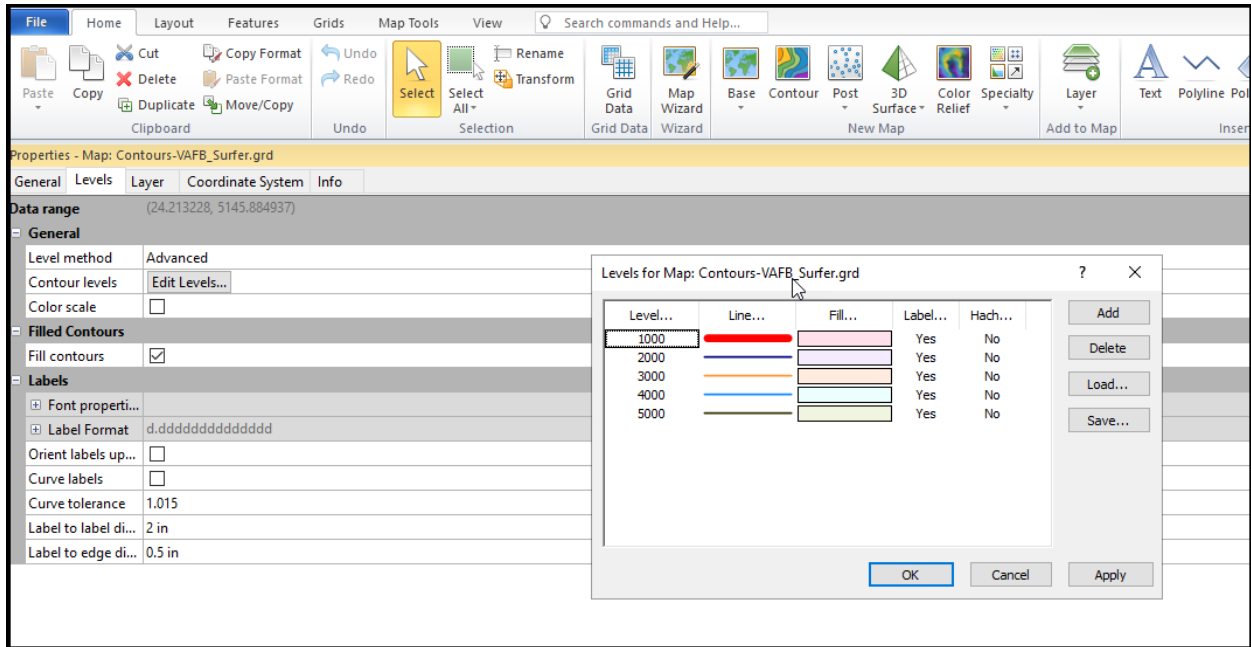
11. Deselect each axis on the map so that the axes do not appear on the Google Earth image.
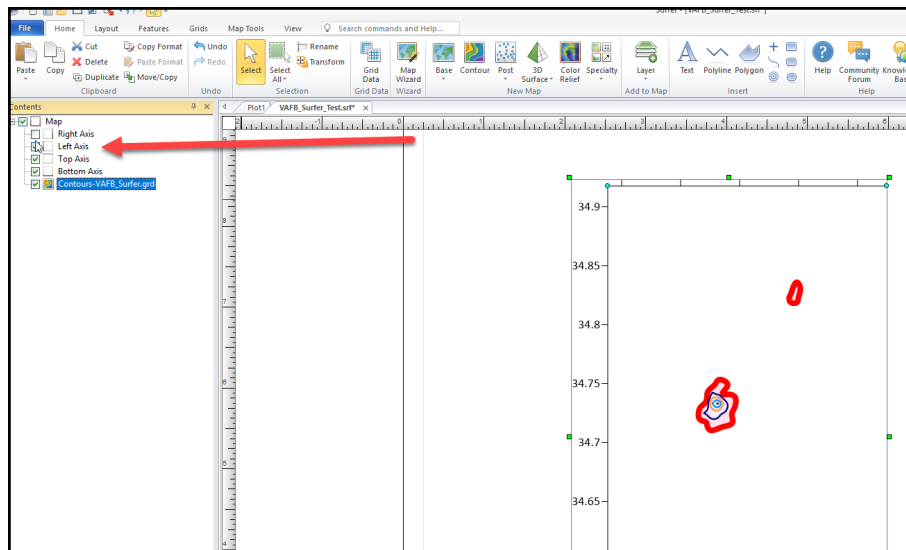
12. Create the Google Earth kml file by going to the "File" menu, then "Export" and selecting the kml file extension from the drop down.
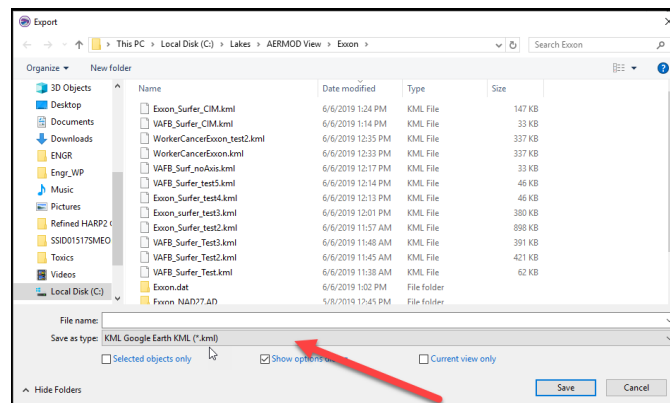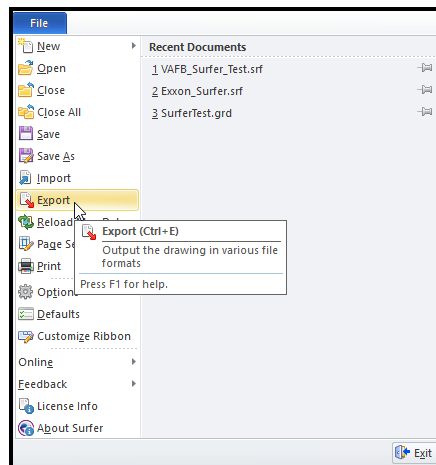
13. Navigate to the location you saved the kml file and open it in Google Earth. Take a screenshot of the isopleths and insert the image into the HRA report.

Appendix I – Modeling Emissions from Roadways

Roadways may be modeled as LINE sources, RLINE sources, a series of VOLUME sources, or a series of AREA sources. LINE sources are recommended for modeling vehicle exhaust emissions in urban areas and in rural areas where the elevation may have significant impacts on the dispersion results. The RLINE source may be used to model vehicle exhaust emissions in rural areas with minimal elevation changes. Adjacent VOLUME sources are recommended for modeling fugitive dust from haul roads.

Groups of idling vehicles may also be modeled as one or more VOLUME sources. In those cases, the initial dimensions of the source, dispersion coefficients, and release heights should be calculated assuming that the vehicles themselves are inducing no turbulence. Source characterization should be based on the type of vehicles idling; e.g., if the vehicles idling are primarily heavy-duty trucks, then the release height would be 4 meters. Furthermore, sources should be placed in the location(s) where the majority of emissions occur. For example, if buses enter and exit a bus terminal from a single driveway, the bus exhaust emissions should be modeled using one or more VOLUME sources at the location of that driveway, rather than spreading the emissions across the entire terminal yard.

I.1   Modeling Roadways with LINE Sources

AERMOD can represent rectangular area sources using the LINE or AREA keywords. The three area source types and the LINE source type use the same numerical integration algorithm for estimating impacts from area sources. These are merely different options for specifying the shape of the area source. The LINE source type utilizes the same routines as the AREA source type and will give identical results for equivalent source inputs.

Sources that may be modeled as LINE sources may include roadways and areas within which emissions occur relatively evenly. USEPA recommends that the LINE source keyword be used for modeling roadway sources as it greatly simplifies defining the physical location and orientation of sources. The LINE source type option allows users to specify line-type sources based on a start-point and end-point of the line and the width of the line.

The LINE source parameter inputs are:

- Emission Rate [g/s]: Pollutant emission rate.

- UTM coordinates of midpoint of the start and end of the lines (X1,Y1; X2,Y2) [m].

- Width [m]: Width of the source; e.g., the width of a lane or multiple lanes, depending on how the source is defined.

- Szinit [m]: Initial vertical dimension coefficient. Default: 1.2 m for light-duty vehicles; 3.2 m for heavy-duty vehicles.

- Release Height [m]: Release height above the ground. Default: 1.3 m for light-duty vehicles; 3.4 m for heavy-duty vehicles.

The District's recommended method for calculating LINE source modeling parameters is described in Sections I.1.1 through I.1.3 below.

I.1.1 Determining Width for LINE Sources

To estimate the width of the LINE source for a roadway, use one of the following options:

1. The width of the traveled way, typically 3.7 m (12 ft) per lane for a high-speed, high volume roadway and 3.3 m (11 ft) per lane for an arterial/collector; or

2. The width of the traveled way (all travel lanes) + 6 meters.

I.1.2 Determining Szinit for LINE Sources

To account for the effects of vehicle-induced turbulence, assume the **Top of Plume Height is 1.7 times the average vehicle height**. For light-duty vehicles, this is about 2.6 meters, using an average vehicle height of 1.53 meters (5.0 feet). For heavy-duty vehicles, this is about 6.8 meters, using an average vehicle height of 4.0 meters (13.1 feet). Since most roadways will experience a combination of light-duty and heavy-duty traffic, the Top of Plume Height should be a combination of their respective values. There are two options available to estimate the Top of Plume Height:

1. Estimate the Top of Plume Height using an emissions-weighted average[1]. For example, if light-duty and heavy-duty vehicles contribute 40 percent and 60 percent of the emissions of a given volume source, respectively, the Top of Plume Height would be calculated as: $(0.4 * 2.6) + (0.6 * 6.8) = 5.1$ meters.

2. Alternatively, the Top of Plume Height may be estimated using a traffic volume weighted approach based on light-duty and heavy-duty vehicle fractions.

The initial vertical dimension coefficient, **Szinit, is then estimated by dividing the Top of Plume Height by 2.15**. For typical light-duty vehicles, this corresponds to a Szinit of 1.2 meters. For typical heavy-duty vehicles, the value of Szinit is 3.2 meters.

I.1.3 Determining Release Height for LINE Sources

The release height, which is the height at which wind effectively begins to affect the plume, may be estimated as the midpoint of the Top of Plume Height. In other words, the **release height is the Top of Plume Height multiplied by 0.5**. As noted above, most roadways will experience a combination of light-duty and heavy-duty traffic. For each roadway source, the **release height should be based on the same Top of Plume Height used for calculating its Szinit, as described above**. This value is 1.3 m for light-duty vehicles, and it is 3.4 m for heavy-duty vehicles.

An alternate method to determine source parameters that vary with different fractions of light-duty and heavy-duty traffic is to create two overlapping versions of each roadway source, corresponding to either light-duty or heavy-duty traffic. These two sources would be superimposed in the same space, but would have emission rates, initial vertical dimensions and release heights that are specific to light-duty or heavy-duty vehicles.

I.2 Modeling Roadways with RLINE Sources

The AERMOD RLINE source algorithm is used to model near-surface releases from mobile sources and can be used to represent a travelled roadway with either single or multiple lanes of traffic. The AERMOD model simulates mobile source emissions using Romberg numerical integration of POINT sources, with the number of points included in the integration determined by error analysis.

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[1] If multiple pollutants are being modeled and the emission factors vary significantly for different vehicle types, then determine the Top of Plume Height based on the traffic volume weighted approach.

Beginning with version 19191, use of the RLINE source type requires the use of the non-regulatory BETA flag for the Control pathway MODELOPT keyword. As the BETA flag is required for RLINE, the RLINE source type is currently non-regulatory and cannot be used with the DFAULT option. In addition, the FLAT MODELOPT flag is also required if any RLINE sources are included in the AERMOD run. Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-regulatory FLAT terrain option on a source-by-source basis. If FLAT and ELEV are used, Zs (optional elevation of the source above sea-level) for all RLINE sources needs to be set =0.0 or ='FLAT'. As RLINE was formulated as a flat terrain model, receptor flagpole heights are used as receptor heights, while elevation and hill heights are currently ignored. RLINE should not be used in locations with severe elevation changes which are expected to impact the modeled concentration (e.g., large elevation difference between roadway and receptor).

The URBAN option applied to the RLINE source type is an ALPHA feature and shall not be used in Santa Barbara County at this time.

The RLINE source parameter inputs are:

- Emission Rate [g/s]: Pollutant emission rate.

- Width [m]: Width of the source; e.g., the width of a lane or multiple lanes, depending on how the source is defined.

- Szinit [m]: Initial vertical dimension coefficient. Default: 1.2 m for light-duty vehicles; 3.2 m for heavy-duty vehicles.

- Release Height [m]: Release height above the ground. Default: 1.3 m for light-duty vehicles; 3.4 m for heavy-duty vehicles.

The District's recommended method for calculating RLINE source modeling parameters is described in Sections I.2.1 through I.2.3 below.

I.2.1 Determining Width for RLINE Sources

To estimate the width of the RLINE source for a roadway, use one of the following options:

1. The width of the traveled way, typically 3.7 m (12 ft) per lane for a high-speed, high volume roadway and 3.3 m (11 ft) per lane for an arterial/collector; or

2. The width of the traveled way (all travel lanes) + 6 meters.

I.2.2 Determining Szinit for RLINE Sources

To account for the effects of vehicle-induced turbulence, assume the **Top of Plume Height is 1.7 times the average vehicle height**. For light-duty vehicles, this is about 2.6 meters, using an average vehicle height of 1.53 meters (5.0 feet). For heavy-duty vehicles, this is about 6.8 meters, using an average vehicle height of 4.0 meters (13.1 feet). Since most roadways will experience a combination of light-duty and heavy-duty traffic, the Top of Plume Height should be a combination of their respective values. There are two options available to estimate the Top of Plume Height:

1. Estimate the Top of Plume Height using an emissions-weighted average[2]. For example, if light-duty and heavy-duty vehicles contribute 40 percent and 60 percent of the emissions of a given

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[2] If multiple pollutants are being modeled and the emission factors vary significantly for different vehicle types, then determine the Top of Plume Height based on the traffic volume weighted approach.

volume source, respectively, the Top of Plume Height would be calculated as:
(0.4 * 2.6) + (0.6 * 6.8) = 5.1 meters.

2. Alternatively, the Top of Plume Height may be estimated using a traffic volume weighted approach based on light-duty and heavy-duty vehicle fractions.

The initial vertical dimension coefficient, **Szinit, is then estimated by dividing the Top of Plume Height by 2.15**. For typical light-duty vehicles, this corresponds to a Szinit of 1.2 meters. For typical heavy-duty vehicles, the value of Szinit is 3.2 meters.

I.2.3   Determining Release Height for RLINE Sources

The release height, which is the height at which wind effectively begins to affect the plume, may be estimated as the midpoint of the Top of Plume Height. In other words, the **release height is the Top of Plume Height multiplied by 0.5**. As noted above, most roadways will experience a combination of light-duty and heavy-duty traffic. For each roadway source**, the release height should be based on the same Top of Plume Height used for calculating its Szinit, as described above**. This value is 1.3 m for light-duty vehicles, and it is 3.4 m for heavy-duty vehicles.

An alternate method to determine source parameters that vary with different fractions of light-duty and heavy-duty traffic is to create two overlapping versions of each roadway source, corresponding to either light-duty or heavy-duty traffic. These two sources would be superimposed in the same space, but would have emission rates, initial vertical dimensions and release heights that are specific to light-duty or heavy-duty vehicles.

I.3   Modeling Roadways with VOLUME Sources

Another option for modeling roadways is to use VOLUME sources. However, when modeling highways and intersections, LINE sources may be easier to characterize than VOLUME sources. Furthermore, the VOLUME source type requires significantly longer computational time compared to the LINE or RLINE source types, as more sources are required to simulate the same distance.

The VOLUME source algorithms are applicable to line sources with some initial plume depth, such haul roads, areas designated for truck or bus queuing or idling, driveways and pass-throughs in transit or freight terminals, and locomotive emissions. USEPA recommends modeling fugitive dust from haul roads as adjacent VOLUME sources, unless there are receptors located within the volume source exclusion area, which is further explained in Section I.3.3.

The goal of using VOLUME sources to represent a roadway is to create a uniform emissions characterization. Ensure that VOLUME sources are not spaced too widely along the roadway. Adjacent VOLUME sources should overlap and the distance between the center of one VOLUME source to the next should be equal to the width of each source, as described in the AERMOD user's guide and represented in Figure 1-8(a) of USEPA's September 1995 *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Model Algorithms* (and reproduced on the following page). Any other approximation of roadways with VOLUME sources will result in nearby receptors being over or under-estimated depending on their proximity to the center of the volume source.

$\sigma_{yo} = \dfrac{W}{2.15}$

•10

•9

•8

•7

•6

W

1   2   3   4   5

W

(a) EXACT REPRESENTATION

$\sigma_{yo} = \dfrac{2W}{2.15}$

•5

•4

2W

W

1   2   3

W

(b) APPROXIMATE REPRESENTATION

FIGURE 1-8.   EXACT AND APPROXIMATE REPRESENTATIONS OF A LINE
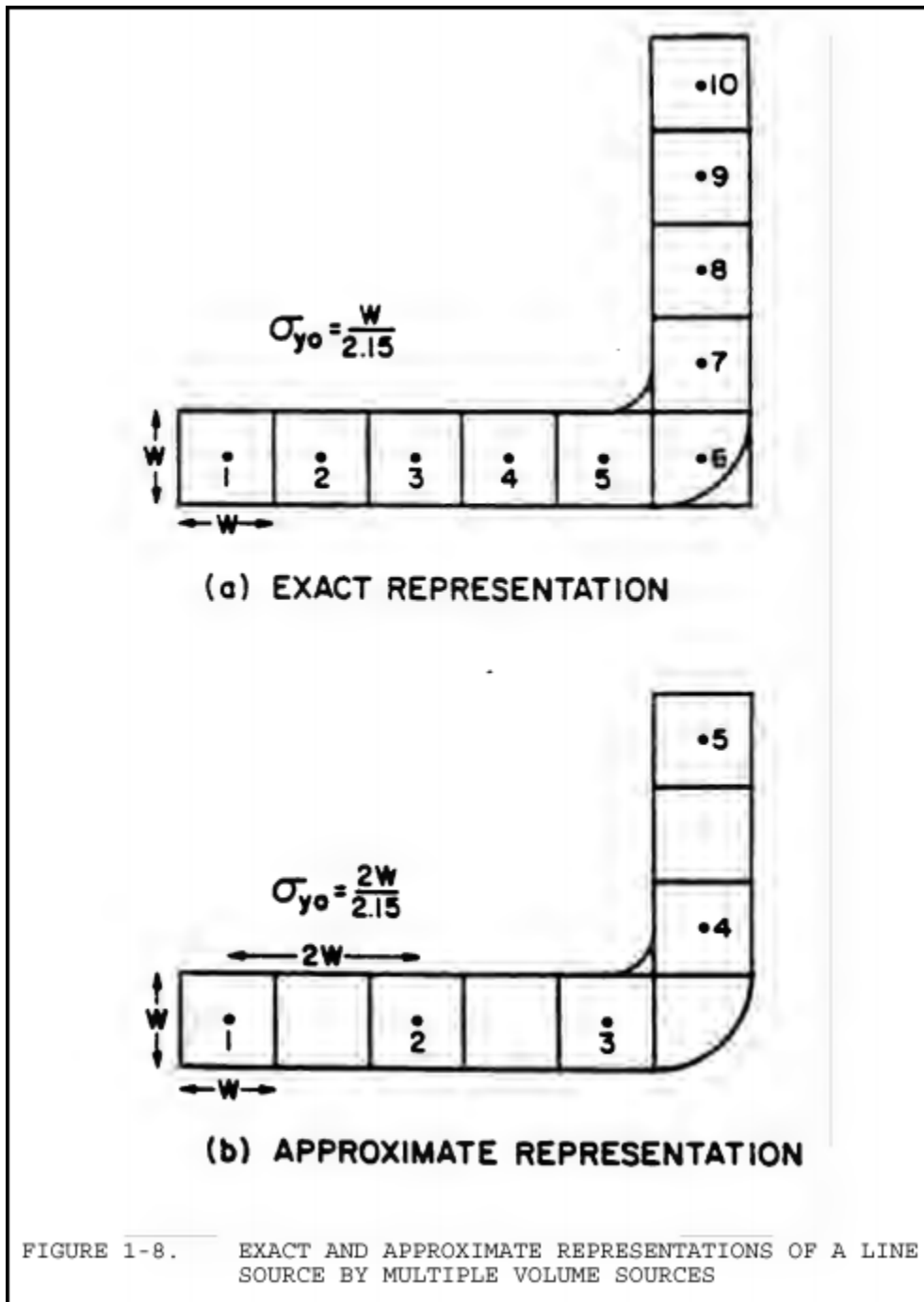SOURCE BY MULTIPLE VOLUME SOURCES

Figure 1-8 Reproduced from Section 1.2.2 of USEPA's September 1995 *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Model Algorithms.*

The VOLUME source parameter inputs are:

- Emission Rate [g/s]: Pollutant emission rate.
- X Coordinate [m]: Easting UTM at the center of the volume source.
- Y Coordinate [m]: Northing UTM at the center of the volume source.
- Syinit [m]: Initial lateral dimension of the volume.
- Szinit [m]: Initial vertical dimension of the volume.
- Release Height [m]: Release height above ground at the center of volume.

The District's recommended method for calculating VOLUME source modeling parameters is described in Sections I.3.1 through I.3.3 below.

I.3.1   Determining Syinit for VOLUME Sources

USEPA recommends that Syinit is calculated by dividing the Plume Width by 2.15, where the Plume Width is calculated as:

- Plume Width for Single Lane Roadways = Vehicle Width + 6m;
- Plume Width for Two-Lane Roadways = Road Width + 6m for two-lane roadways. Two-lane roadways are for cases with heavy two-way traffic where the combined plume needs to be approximated; not typically used for haul roads.

I.3.2   Determining Szinit for VOLUME Sources

To account for the effects of vehicle-induced turbulence, assume the **Top of Plume Height is 1.7 times the average vehicle height**. For light-duty vehicles, this is about 2.6 meters, using an average vehicle height of 1.53 meters (5.0 feet). For heavy-duty vehicles, this is about 6.8 meters, using an average vehicle height of 4.0 meters (13.1 feet). Since most roadways will experience a combination of light-duty and heavy-duty traffic, the Top of Plume Height should be a combination of their respective values. There are two options available to estimate the Top of Plume Height:

1. Estimate the Top of Plume Height using an emissions-weighted average[3]. For example, if light-duty and heavy-duty vehicles contribute 40 percent and 60 percent of the emissions of a given volume source, respectively, the Top of Plume Height would be calculated as: (0.4 * 2.6) + (0.6 * 6.8) = 5.1 meters.

2. Alternatively, the Top of Plume Height may be estimated using a traffic volume weighted approach based on light-duty and heavy-duty vehicle fractions.

The initial vertical dimension coefficient, Szinit, is then estimated by dividing the Top of Plume Height by 2.15. For typical light-duty vehicles, this corresponds to a Szinit of 1.2 meters. For typical heavy-duty vehicles, the value of Szinit is 3.2 meters.

I.3.3   Determining Release Height for VOLUME Sources

The release height, which is the height at which wind effectively begins to affect the plume, may be estimated as the midpoint of the Top of Plume Height. In other words, the **release height is the Top of Plume Height multiplied by 0.5**. As noted above, most roadways will experience a combination of

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[3] If multiple pollutants are being modeled and the emission factors vary significantly for different vehicle types, then determine the Top of Plume Height based on the traffic volume weighted approach.

light-duty and heavy-duty traffic. For each roadway source, the **release height should be based on the same Top of Plume Height used for calculating its Szinit, as described above**. This value is 1.3 m for light-duty vehicles, and it is 3.4 m for heavy-duty vehicles.

In addition, when the source-receptor spacing in AERMOD is shorter than the distance between adjacent volume sources, AERMOD may produce aberrant results. Therefore, ensure that no receptors are placed within a distance of (2.15 x Syinit + 1 meter) of the center of a VOLUME source, known as the "receptor exclusion zone."[4] As a practical recommendation, when using VOLUME sources to simulate a roadway where receptors are placed five meters from the edge of the roadway, the width of a volume source should be less than eight meters. This will ensure that no receptors fall within the receptor exclusion zone. If the width of the roadway is larger than eight meters, it is recommended that additional VOLUME sources be defined (e.g., separate each lane of traffic), or LINE sources be used.

I.4   Toxics Emissions from Fugitive Dust from Haul Roads

Section 6.2 of the District's *Approved Emission Factors for Toxic Air Contaminants* provides a discussion of calculating particulate matter and toxics emissions from paved and unpaved roads. The toxic weight fractions for landfill haul roads, mineral-source haul roads and general haul roads are provided in the *Misc. Fugitive Dust* tab of the spreadsheet titled *SBCAPCD-Approved TAC Emission Factors.xlsx*, noted in the references below.

I.5   References for Appendix I

- Santa Barbara County Air Pollution Control District. June 2020. *Approved Emission Factors for Toxic Air Contaminants*. https://www.ourair.org/wp-content/uploads/SBCAPCD-Approved-Emission-Factors-for-TACs.pdf.

- Santa Barbara County Air Pollution Control District. June 2020. *SBCAPCD-Approved TAC Emission Factors.xlsx*. https://www.ourair.org/wp-content/uploads/SBCAPCD-Approved-TAC-Emission-Factors.xlsx.

- U.S. Environmental Protection Agency. September 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models Volume II – Description of Model Algorithms. https://www3.epa.gov/scram001/userg/regmod/isc3v2.pdf.

- U.S. Environmental Protection Agency. Memorandum. March 2, 2012. *Haul Road Workgroup Final Report Submission to EPA-OAQPS*. https://www3.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

- U.S. Environmental Protection Agency. November 2015. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM$_{2.5}$ and PM$_{10}$ Nonattainment and Maintenance Areas*. https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100NN22.pdf.

- U.S. Environmental Protection Agency. August 2019. *User's Guide for the AMS/EPA Regulatory Model (AERMOD)*. https://www3.epa.gov/ttn/scram/models/aermod/aermod_userguide.pdf.

- U.S. Environmental Protection Agency. September 2019. *Guidance on New R-LINE Additions to AERMOD 19191 for Refined Transportation Project Analyses.* https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100XI3C.pdf.

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[4] Acute, residential, worker and sensitive receptors must not be excluded. If acute, residential, worker or sensitive receptors fall within the "receptor exclusion zone" and using adjacent VOLUME sources results in aberrant modeled concentrations, then the LINE source type must be used instead of adjacent VOLUME sources.