
Guidance on New R-LINE Additions to AERMOD 19191 for Refined Transportation Project Analyses

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Contents

1	Introduction	1
1.1	Purpose	1
1.2	Background on Transportation Conformity	1
1.3	EPA’s AERMOD Model: Background and Recent History	2
1.4	Finding More Information about AERMOD	3
1.5	EPA’s R-LINE Model: Background	3
1.6	Other Purposes for this Guidance	3
1.7	EPA Contact Information	4
1.8	Guidance and Existing Requirements	4
2	New R-LINE Features in the AERMOD 19191 Release	5
2.1	What features of R-LINE are included in AERMOD 19191, and what is their status?	5
2.2	What is the process for obtaining approval of RLINE as an alternative model?	6
2.3	If RLINE is approved through the alternative model process for use in a transportation conformity determination, what regulations and guidance apply to the transportation conformity determination?	7
2.4	How are RLINE sources included in an AERMOD input file?	7
2.4.1	Control Pathway:	7
2.4.2	Source Pathway	8
2.5	When would RLEMCONV be used with the RLINE source type?	9
2.6	What is MOVES2AERMOD?	10
3	ALPHA Options: RLINEXT, RBARRIER, and RDEPRESS	12
3.1	Can RLINEXT and its associated barrier and depressed roadway features be used through the alternative model process?	12
3.2	How are RLINEXT sources included in an AERMOD input file?	12
3.2.1	Control Pathway:	12
3.2.2	Source Pathway	13
3.3	How would a solid barrier be modeled with RBARRIER?	15
3.4	What are some examples of how barrier could be modeled?	16
3.5	How would a depressed road be modeled with RDEPRESS?	19
3.6	Can RLEMCONV be used with the RLINEXT source type?	20

1 Introduction

1.1 Purpose

On August 21, 2019, EPA released a new version of its preferred dispersion model, AERMOD 19191. AERMOD 19191 builds upon the previous version of AERMOD, AERMOD 18081, and adds new features from EPA's R-LINE model. Information about AERMOD and this latest release can be found on EPA's website at: <https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models>.

This guidance is part of the resources EPA is providing with the release of AERMOD 19191. It addresses the use of the new R-LINE features in AERMOD 19191 for dispersion modeling of transportation sources, which are described in Section 2 of this guidance.

This guidance applies when using the R-LINE features in AERMOD for refined modeling of transportation projects, as appropriate, for transportation conformity and general conformity purposes, and other purposes as well. While some of the features can be used for regulatory purposes such as transportation conformity with EPA approval, others cannot be used for regulatory purposes at this time (see Section 2.1). For those features that can be used with approval, this guidance describes the alternative model approval process that would be used (see Section 2.2).

EPA has coordinated with the Federal Highway Administration and the Federal Transit Administration during the development of this guidance.

1.2 Background on Transportation Conformity

Transportation conformity is required under Clean Air Act (CAA) section 176(c) (42 U.S.C. 7506(c)) to ensure that federally supported highway and transit project activities are consistent with (conform to) the purpose of a state air quality implementation plan (SIP). Conformity to the purpose of the SIP means that transportation activities will not cause or contribute to new air quality violations, worsen existing violations, or delay timely attainment of the relevant national ambient air quality standards (NAAQS) or required interim milestones.

EPA's transportation conformity rule (40 CFR 51.390 and Part 93) establishes the criteria and procedures for determining whether transportation activities conform to the SIP.¹ Criteria and procedures for transportation conformity hot-spot analyses are found specifically in 40 CFR 93.116 and 93.123. EPA also has guidance for PM hot-spot analyses and CO hot-spot analyses. EPA's PM Hot-spot Guidance provides more details for conducting PM hot-spot analyses, including information and guidance about air quality dispersion modeling.² EPA hot-spot guidance for PM and CO analyses as well as training materials and other helpful information can

¹ EPA has provided the complete transportation conformity regulations in a document found at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100E7CS.PDF?Dockey=P100E7CS.PDF>.

² "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM_{2.5} and PM₁₀ Nonattainment and Maintenance Areas, EPA-420-B-15-084, November 2015. This guidance is referred to as the "PM Hot-spot Guidance" and is available on EPA's website at www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance.

be found on EPA's website at www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses.

1.3 EPA's AERMOD Model: Background and Recent History

The American Meteorological Society/EPA Regulatory Model (AERMOD) is EPA's recommended near-field dispersion model for many regulatory applications. A dispersion model is used to determine the concentration of air pollutants in the atmosphere, based on the emission sources in the area and meteorology, as well as other inputs. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. AERMOD includes options for modeling concentrations from emissions that come from area, volume, line, and point sources and can therefore model impacts of many different source types, including highway and transit transportation projects. To date, AERMOD has been used to model air quality near roadways, other transportation sources, and other ground-level sources for regulatory applications by EPA and other federal and state agencies, including transportation conformity hot-spot analyses (see Section 1.2).

EPA initially adopted AERMOD as a preferred model in a November 9, 2005 final rule (70 FR 68218) that amended EPA's "Guideline on Air Quality Models" ("Guideline") after more than ten years of development and peer review that resulted in substantial improvements and enhancements.³

When quantitative PM hot-spot analyses for certain transportation projects were initially required in December of 2010, AERMOD was one of two dispersion models recommended for use. The other model was CAL3QHCR, which is based on the CALINE3 series of models. EPA's PM Hot-spot Guidance provides more details for conducting PM hot-spot analyses; refer to Section 1.2 for more information.

On January 17, 2017, EPA promulgated a final rule to amend the "Guideline" (82 FR 5182).⁴ In this action, EPA included enhancements to the AERMOD modeling system, and established AERMOD as the preferred model for refined dispersion modeling for most regulatory applications. This final rule also removed the CALINE3 model from the Guideline. For refined modeling for hot-spot analyses done for transportation conformity, EPA provided a three-year grace period to fully transition from CALINE3 to AERMOD. This grace period ends January 17, 2020. For PM_{2.5} and PM₁₀ hot-spot analyses, no new analyses can be started with CAL3QHCR after January 17, 2020. New analyses begun after January 17, 2020 will need to use the current version of AERMOD. However, PM hot-spot analyses that were begun before this date with CAL3QCHR can be completed with CAL3QHCR.⁵

Note that as a practical matter, the end of the CALINE3 grace period is relevant only for refined analyses: CAL3QHC can continue to be used for CO hot-spot screening analyses for

³ This 2005 final rule can be found at: www.epa.gov/scram001/guidance/guide/appw_05.pdf. Extensive documentation is available on EPA's SCRAM website describing the various components of AERMOD, including user guides, model formulation, and evaluation papers. See: www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod.

⁴ This final rule can be found at: https://www3.epa.gov/ttn/scram/guidance/guide/appw_17.pdf.

⁵ For questions regarding whether an analysis has begun before the end of the grace period, please contact the transportation conformity contact at the appropriate EPA Regional Office (see Section 1.7).

transportation conformity under the 2017 revisions to Appendix W. Specifically, EPA stated in the preamble to the January 17, 2017 final rule that EPA's 1992 CO guidance that employs CAL3QHC will remain in place as the recommended approach for CO screening for transportation projects until such time that EPA develops a new CO screening approach based on AERMOD or another appropriate model and updates the regulation to include this new screening approach.⁶

1.4 Finding More Information about AERMOD

For more information about AERMOD, see EPA's website at: www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod. This website includes extensive documentation on the various components of AERMOD, such as user guides, model formulation, and evaluation papers. It also includes model change bulletins that describe how each version of the model differs from its predecessor.

The AERMOD User's Guide, referred to in this guidance, can be accessed on EPA's website directly from: https://www3.epa.gov/ttn/scram/models/aermod/aermod_userguide.pdf.

1.5 EPA's R-LINE Model: Background

EPA has developed a separate line source model for research and development purposes called the Research LINE source model (R-LINE). R-LINE is a dispersion model developed by EPA's Office of Research and Development (ORD) for near-roadway assessments. This research model is based on wind tunnel and field studies that EPA designed and conducted to evaluate pollutant transport and dispersion of near-surface releases. These studies provided new and expanded databases for development and evaluation of line source algorithms. The R-LINE model is based upon a steady-state Gaussian formulation and is designed to simulate line type source emissions (e.g. mobile sources along roadways) by numerically integrating point source emissions.

The R-LINE model also includes algorithms to account for how concentrations of air pollutants are affected by solid barriers, such as noise barriers (also referred to as sound walls), along line sources. It also includes algorithms that allow modeling of depressed roadway segments, such as a highway that is below grade. These algorithms continue to be developed and refined by EPA ORD.

In this document, "R-LINE" refers to the original R-LINE model developed by EPA, whereas "RLINE" refers to a specific feature, the RLINE source type, that is now included within AERMOD 19191. (Source types are further described in Section 2.1.)

1.6 Other Purposes for this Guidance

The technical information included in this guidance is relevant for any refined project-level analysis, regardless of whether its purpose is regulatory or research. Information about how these new R-LINE features are described in an AERMOD input file and how the parameters are used to represent transportation projects applies to all users of these AERMOD features. More

⁶ "Guideline for Modeling Carbon Monoxide from Roadway Intersections," EPA-454/R-92-005, November 1992; available online at: www.epa.gov/scram001/guidance/guide/coguide.pdf.

information about these features and the appropriate cases for their use is found in Section 2.1 of this guidance.

1.7 EPA Contact Information

For questions concerning transportation conformity in a specific nonattainment or maintenance area, please contact the transportation conformity staff person responsible for your state at the appropriate EPA Regional Office. Contact information for transportation conformity personnel at EPA Regional Offices can be found at: <https://www.epa.gov/state-and-local-transportation/epa-regional-contacts-regarding-state-and-local-transportation>.

For questions regarding air quality modeling in a specific nonattainment or maintenance area, please contact the dispersion modeling staff person responsible for your state at the appropriate EPA Regional Office. Contact information for dispersion modeling personnel can be found on EPA's website at: <https://www.epa.gov/scram/air-modeling-regional-contacts>.

General questions about this guidance and its applicability for transportation conformity can be directed to Laura Berry at EPA's Office of Transportation and Air Quality, berry.laura@epa.gov.

Questions or feedback about AERMOD 19191 and its new features and questions regarding the Model Clearinghouse (discussed in Section 2.2) can be directed to Chris Owen at EPA's Office of Air Quality Planning and Standards, owen.chris@epa.gov.

1.8 Guidance and Existing Requirements

This guidance does not create any new requirements. This guidance is based on CAA requirements and existing associated regulations and does not create any new requirements. This guidance describes the new R-LINE features in AERMOD and the circumstances in which they can be used.

The CAA, EPA's transportation conformity regulations at 40 CFR part 51 subpart T and part 93 subpart A, EPA's general conformity regulations at 40 CFR part 51 subpart W and part 93 subpart B, and EPA's "Guideline on Air Quality Models" regulation at Appendix W of 40 CFR part 51, contain legally binding requirements. This document is not a substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on EPA, the U.S. Department of Transportation (DOT), states, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA retains the discretion to adopt approaches on a case-by-case basis that may differ from this guidance but still comply with the statute and applicable regulations. This guidance may be revised periodically without public notice.

This guidance does not address FHWA's noise abatement program in any way. It does not interpret or address procedures for noise studies and noise abatement measures, supply noise abatement criteria, or establish requirements pursuant to 23 USC 109(i) or 23 CFR 772. This guidance does not in any way interpret or address procedures for determining when a depressed road is needed for engineering purposes or design requirements.

2 New R-LINE Features in the AERMOD 19191 Release

2.1 What features of R-LINE are included in AERMOD 19191, and what is their status?

AERMOD 19191 incorporates the R-LINE research model into the AERMOD framework. The R-LINE model features are now available within the AERMOD model and can be accessed within AERMOD using specific keywords and parameters in an AERMOD input file.

Each of these R-LINE features is either a “BETA” or “ALPHA” feature in AERMOD:

- BETA features have been vetted through the scientific community and are waiting to be promulgated as regulatory options. Until such features are included in the preferred model via regulation, BETA options of AERMOD require alternative model approval for use in regulatory applications, including transportation conformity. This process is described in Section 2.2.⁷
- ALPHA features within AERMOD are research or experimental options that are provided for review and evaluation by the user community. These options are ALPHA because they need additional research and evaluation. They do not have the necessary level of reliability or validity that the regulatory AERMOD model has, or the BETA options have. ALPHA options are not intended for any regulatory purpose at this time – whether such purposes are related to the Clean Air Act or other statutes.

BETA R-LINE Features:

- The RLINE source type is a new BETA feature that can be used to model a line source such as a road segment with the R-LINE algorithm.

ALPHA R-LINE Features:

- The RLINEXT source type, which stands for “RLINE-extended,” is a new ALPHA feature. Like RLINE, RLINEXT can be used to model a line source. The RLINE and RLINEXT sources use the same dispersion calculations, but the source characteristics are defined in different ways for each source type (more details below). RLINEXT can be used to model a source that includes a barrier extending to the ground, such as a noise barrier next to the source, or model the source as a depressed roadway, whereas the RLINE source cannot be used to model these additional roadway features.
 - The RBARRIER keyword can be used with RLINEXT to describe a barrier the extends to the ground next to the source.
 - The RDEPRESS keyword can be used with RLINEXT to describe a depressed roadway.
- The URBAN option applied to either RLINE or RLINEXT source types is an ALPHA feature. The URBAN option is a setting within AERMOD that affects dispersion. The

⁷ EPA believes all users of a BETA option for a refined project-level analysis should consult with EPA, regardless of the purpose of the analysis, to ensure that the use of these features is appropriate in the specific situation and that agencies use time and resources efficiently. See Section 1.7 for EPA contact information.

original R-LINE model did not include a way to account for the “urban heat-island effect,” e.g., the URBAN option in AERMOD.⁸ EPA has added the URBAN option for the new RLINE and RLINEXT sources in AERMOD.

Available under both options:

- The keyword RLEMCONV, which stands for “RLINE Emission Conversion,” can be used with both RLINE and RLINEXT source types. This feature allows the user to input emissions for RLINE or RLINEXT sources in terms of grams per link per hour (e.g., from MOVES).⁹

Both the RLINE and RLINEXT source types account for plume meander during low-wind conditions.

Each of these features is discussed further below:

- BETA features, that is, the RLINE source type and RLEMCONV, are covered further in this section; and
- ALPHA features, including the RLINEXT source type and associated keywords, are covered in Section 3.

2.2 What is the process for obtaining approval of RLINE as an alternative model?

As noted above, the use of the RLINE source type without the URBAN option is a BETA feature, and therefore could be used in a regulatory application if it is approved through EPA’s alternative model process. EPA’s Appendix W regulation of January 17, 2017 (82 FR 5182) describes the use of alternative models in Section 3.2.

An alternative model can be used instead of a preferred model if approved by the EPA Regional Office in consultation with EPA’s Model Clearinghouse. This process provides a public record of the application of the alternative model, so that future applications of the model can be consistent with a previously approved application. Such approval is documented through a series of memos between the EPA’s Model Clearinghouse and the approving Regional Office. These memoranda may inform other situations where transportation modelers would like to use the RLINE source in AERMOD for other regulatory purposes. Therefore, once this process has been completed for a specific project, subsequent alternative model approvals may be simplified for projects where the circumstances are substantively similar. However, in situations that are substantively different, the project sponsor would need to provide new or additional information to justify the alternative model approval in their case. For more information about the Model Clearinghouse, see EPA’s webpage at <https://www.epa.gov/scram/air-quality-model-clearinghouse>.

The process for obtaining approval of RLINE as an alternative model begins with making a request to use RLINE in a regulatory application to the appropriate EPA Regional Office. Please

⁸ This effect is described in Section 7.5.5 of EPA’s PM Hot-spot Guidance. See Section 1.2 for PM Hot-spot Guidance reference information.

⁹ MOVES is EPA’s emissions model for onroad and nonroad sources. For the latest version of MOVES that can be downloaded as well as other documentation, please see EPA’s website at <https://www.epa.gov/moves>.

consult with the appropriate EPA Regional Office before any work begins on an analysis to understand the requirements and time needed to receive alternative model approval. See the link to the list of dispersion modeling contacts in Section 1.7. EPA Regional Office contacts can help modelers begin the process. As the transportation conformity regulation also requires that interagency consultation procedures include a specific process for “evaluating and choosing a model (or models) and associated method and assumptions to be used in hot-spot analyses,” (40 CFR 93.105(c)(1)(i)), consulting with the transportation conformity contact at the appropriate EPA Regional Office would also be necessary. Section 1.7 includes a link to these contacts as well.

2.3 If RLINE is approved through the alternative model process for use in a transportation conformity determination, what regulations and guidance apply to the transportation conformity determination?

EPA’s transportation conformity regulations at 40 CFR Part 93 provide the criteria and procedures for transportation conformity determinations, including those that apply to projects.

EPA has also issued guidance, “Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM_{2.5} and PM₁₀ Nonattainment and Maintenance Areas,” known as the “PM Hot-spot Guidance.” EPA recommends that this guidance be followed when conducting a PM hot-spot analysis for transportation conformity to ensure that the statutory and regulatory requirements are met. This guidance can be found at EPA’s web site at: <https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance>. The guidance includes an overview of the regulatory requirements, as well as technical guidance for modeling emissions, modeling concentrations, developing background calculations, and calculating design values.

Please refer to EPA’s web site at <https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses> for additional information and resources for project-level transportation conformity determinations.

2.4 How are RLINE sources included in an AERMOD input file?

This section provides an overview of the information the user would need to run the model with the RLINE source type within AERMOD. However, it is not a substitute for the AERMOD User’s Guide, which provides the complete descriptions of keywords and parameters, and the syntax necessary for their use in an AERMOD input file.¹⁰

2.4.1 Control Pathway:

To use the RLINE source type, the AERMOD input file has to include the BETA flag in the MODELOPT keyword within the Control pathway; the model will not run without this flag. This flag labels each page of the AERMOD output file with the word “BETA” to notify reviewers that the output cannot be used for regulatory applications unless the use of the BETA option, i.e., use of the RLINE source type, is approved through the alternative model process as explained in Section 2.2.

¹⁰ See 1.4 for reference information.

The exception to RLINE's BETA status is the use of RLINE with the URBAN option. This combination is an ALPHA option and must be accompanied by the ALPHA flag in addition to the BETA flag required for the RLINE source type (i.e., the ALPHA and BETA flag and options would be used together). This means that RLINE with the URBAN option is not eligible for possible regulatory application under the alternative model approval process.

As at least the BETA flag is required for RLINE source types, (and in the case of RLINE with URBAN, both the ALPHA and BETA flags are required), RLINE source types cannot be used with the regulatory default mode (the DFAULT option in the MODELOPT keyword).

In addition, the FLAT MODELOPT flag is also required if any RLINE sources are included in the AERMOD run. R-LINE was formulated as a flat terrain model, and therefore RLINE source types in AERMOD can only represent roads located on flat terrain. Using RLINE for any other type of terrain would lead to erroneous results because the underlying algorithm does not take terrain into account.

2.4.2 Source Pathway

The syntax for the RLINE source type in AERMOD is identical to the LINE source syntax in AERMOD. To describe an RLINE source in an AERMOD input file, the user needs a LOCATION statement and a source parameter (SRCPARAM) statement:

- LOCATION: The LOCATION statement would include a source name (or source id, abbreviated as Srcid) and the endpoints of the source in terms of (X,Y). Specifying elevation, in a (Zs) term, is optional and would apply to the entire source. However, since the RLINE sources will not process with terrain, this Zs term is not operational at this point and if used, should be set to "0.0" or "FLAT." Since the FLAT MODELOPT keyword is also required in the Control Pathway, any other input for elevation of an RLINE source will produce an error and the model will not run. Please refer to the AERMOD User's Guide for more information.¹¹
- SRCPARAM: The SRCPARAM statement would include the source name, its emissions rate, release height, width, and optionally, the initial vertical dimension (or initial Sigma z, abbreviated as "Szinit").

Figure 2-1 illustrates that a LINE source and an RLINE source are defined in the same manner. In the figure, the endpoint at the top of both the LINE and RLINE sources is indicated as first (i.e., "(X_{S1}, Y_{S1})") but they can be specified in either order.

¹¹ See 1.4 for reference information.

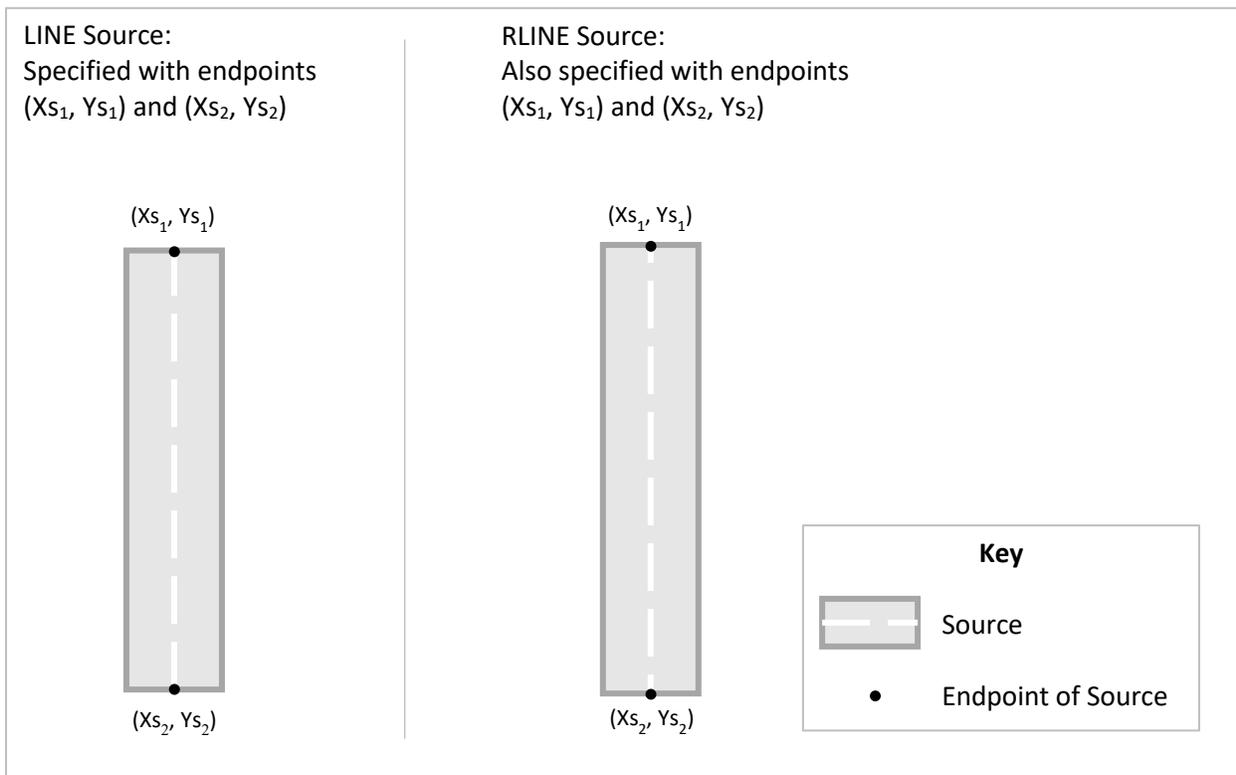


Figure 2-1: LINE Source and RLINE Source

Because the syntax for the RLINE source is the same as the LINE source, the user can run an existing AERMOD input file that uses the LINE source type with R-LINE dispersion calculations just by using the BETA and FLAT model options in the Control Pathway, and changing the source type from LINE to RLINE in the Source Pathway.

2.5 When would RLEMCONV be used with the RLINE source type?

The units that AERMOD uses for emissions for the RLINE source are the same as the AERMOD AREA and LINE source types, grams per second per square meter, noted as $g/s/m^2$.¹² However, emissions generated by an emissions model such as MOVES are not formatted in these units. For example, a project scale MOVES run that uses the “Inventory” calculation type in the MOVES model would result in emissions for each link over the hour, i.e., grams per link per hour, and these units would need to be converted for use within AERMOD.

An additional keyword, RLEMCONV, which stands for “RLINE emissions conversion” can be used with the RLINE source type. This additional keyword allows the user to define the source emission rates in grams per link per hour, instead of $g/s/m^2$. This keyword has no additional inputs, but when present, emissions for all RLINE sources are assumed to be in grams per link per hour. This feature is included to allow the user to include emission rates directly from an emissions model without converting them.

RLEMCONV could be used with the MOVES results as-is if each AERMOD source is a unique MOVES link. However, if one MOVES link represents more than one AERMOD source, the

¹² In the R-LINE model, units are grams per second per meter. The RLINE source type in AERMOD is based on the R-LINE model algorithm, but its units are the same as the LINE source type, grams per second per square meter.

MOVES output cannot be used as-is, even with RLEMCONV. Instead, the user will need to determine what portion of the link's total emissions belong to each source. One MOVES link might need to be represented with more than one source if the MOVES link is curved. MOVES can estimate the emissions over the link, but for AERMOD purposes, the curved link may need to be broken into multiple straight segments to correspond to RLINE sources, and the emissions apportioned to each source accordingly.

If MOVES has been run for different hours in different seasons of the year, more than one MOVES emissions rate would be associated with each AERMOD source. These different rates would need to be applied to each hour of the year appropriately within AERMOD, which is done with the EMISFACT keyword.

EPA believes that using the MOVES2AERMOD script may be a more convenient method for including emission rates from MOVES in an AERMOD input file at this time. When the MOVES2AERMOD script is used, emission rates are converted into $g/s/m^2$, the units AERMOD uses for AREA, LINE, and RLINE sources. See Section 2.6 for more information.

2.6 What is MOVES2AERMOD?

MOVES2AERMOD is a tool that EPA has provided, in the form of a MOVES script, that converts emissions results from MOVES project-scale runs into a format for use within an AERMOD input file. The AERMOD keyword EMISFACT is used to allow the emission factors of a source to vary, and it is followed by a parameter indicating the number of factors. The parameter SEASHR, or "season-hour," indicates that emissions vary for each hour of each of four seasons, for a total of 96 factors.

The MOVES2AERMOD script uses output from MOVES runs to create a table of emission rates in $g/s/m^2$, the units AERMOD uses for AREA, LINE, and RLINE sources, for every source, for each hour of four seasons. This table can then be used with the AERMOD keyword EMISFACT with the SEASHR parameter, for any of these three source types.

To use the MOVES2AERMOD script, the user fills out three tables. The first is a list of how the AERMOD sources relate to the MOVES links; the second is the area of each MOVES link in square meters; and the third is a list of which MOVES run applies to each of the hour of each season of the year. With these inputs, the MOVES2AERMOD script generates 96 emission factors for each source, so the table it creates can be lengthy when there are multiple sources. The MOVES2AERMOD script converts emission factors from MOVES into $g/s/m^2$. The table generated by MOVES2AERMOD can then be included in an AERMOD input file.

Within AERMOD, the season-hour factors in the EMISFACT keyword are multiplied by the emissions rate for the source. Therefore, the emission rate for the source should be defined as "1" in the source parameter statement because the EMISFACT table generated with the MOVES2AERMOD script includes the specific emission rates for each hour.

More information about MOVES2AERMOD, including a ZIP file that includes directions for how to "install" the tool (i.e., copy the script and place it in the right folder) and instructions on using it for PM hot-spot analyses can be found on EPA's website at: <https://www.epa.gov/moves/tools-develop-or-convert-moves-inputs#emisfact>.

Note: When the MOVES2AERMOD script is used to generate an EMISFACT table for the AERMOD input file, the input file *should not* include RLEMCONV, because the conversion of emissions into the correct units for AERMOD LINE, AREA, or RLINE sources, which is grams/second/meter², has already occurred within the MOVES2AERMOD script.

3 ALPHA Options: RLINEXT, RBARRIER, and RDEPRESS

3.1 Can RLINEXT and its associated barrier and depressed roadway features be used through the alternative model process?

As noted above, RLINEXT with RBARRIER and RDEPRESS are ALPHA features and therefore are not intended to be used for regulatory applications. EPA has labeled these features ALPHA instead of BETA because they are not as far along in the model development process (e.g., there may be less scientific certainty about the appropriateness of the formulation). EPA has provided them so that the user community can review and evaluate them. EPA would value user input on these features and be interested in data gathered by the user community.

Even though any use of these ALPHA options would not be for regulatory purposes, EPA recommends that any experimentation and evaluation of these sources be conducted in consultation with the EPA Regional Office dispersion modeling contact person and EPA Headquarters to address any usability issues that may not otherwise be addressed here. See EPA contact information in Section 1.7.

As more research is conducted with these features, EPA will be evaluating available data to determine how well model algorithms are performing and whether additional algorithm development is needed.

3.2 How are RLINEXT sources included in an AERMOD input file?

This section provides an overview of the information the user would need to run the model with the RLINEXT source type within AERMOD. However, it is not a substitute for the AERMOD User's Guide, which provides the complete descriptions of keywords and parameters, and the syntax necessary for their use in an AERMOD input file.¹³

3.2.1 Control Pathway:

To use the RLINEXT source type and its other keywords, RBARRIER and RDEPRESSED, the input file has to include the ALPHA flag in the MODELOPT keyword within the Control pathway. As in the case with the BETA flag, the ALPHA flag labels each page of the AERMOD output file with the word "ALPHA" as a reminder of the status of the output, i.e., that the output is for research and experimental purposes only.

As in the case with RLINE sources, the URBAN option can also be used with RLINEXT source types in AERMOD. This is also an ALPHA option.

Because the ALPHA flag is required for RLINEXT source types, they cannot be used with the regulatory default mode (the DFAULT option in the MODELOPT keyword).

Just like with RLINE sources, the FLAT MODELOPT flag is also required if any RLINEXT sources are included in the AERMOD run. R-LINE was formulated as a flat terrain model, and therefore RLINEXT source types in AERMOD can only represent roads located on flat terrain.

¹³ See 1.4 for reference information.

Using RLINEXT for any other type of terrain would lead to erroneous results because the underlying algorithm does not take terrain into account.

3.2.2 Source Pathway

While the RLINE and RLINEXT source types have the same underlying algorithm, the syntax for each of these source types differs. The RLINE source type was created to be identical to the LINE source type in terms of syntax of LOCATION and SRCPARAM statements. While LOCATION and SRCPARAM statements are also needed for RLINEXT sources, additional parameters are needed to describe an RLINEXT source type:

- **LOCATION:** As in the RLINE source LOCATION statement, the RLINEXT LOCATION statement would include a source name (or source id, abbreviated as “Srcid”) and specify the endpoints of the source. However, for an RLINEXT source, endpoints must be provided in terms of X, Y, and Z. This is illustrated below in Figure 3-1, where the endpoints of the RLINEXT source on the right side of the figure are labeled as (X_{S1}, Y_{S1}, Z_{S1}) and (X_{S2}, Y_{S2}, Z_{S2}) . The endpoint Z terms represent release heights and could potentially be different. In addition, the LOCATION statement can also include an optional “Zs” term that applies to the entire source, which represents elevation. However, since the RLINEXT sources will not process with terrain, this Zs term is not operational at this point and if used, should be set to “0.0” or “FLAT.” Since the FLAT MODELOPT keyword is also required in the Control Pathway, any other input for elevation of an RLINEXT source will produce an error and the model will not run. Please refer to the AERMOD User’s Guide for more information.¹⁴
- **SRCPARAM:** The SRCPARAM statement for an RLINEXT source type would include the source name, its emissions rate, the distance from the center line (abbreviated as “DCL” and explained further below), the source width, and the initial vertical dimension (Szinit). All these parameters are required in the input file, but the user can enter “0” for any parameter that is not needed.

¹⁴ See 1.4 for reference information.

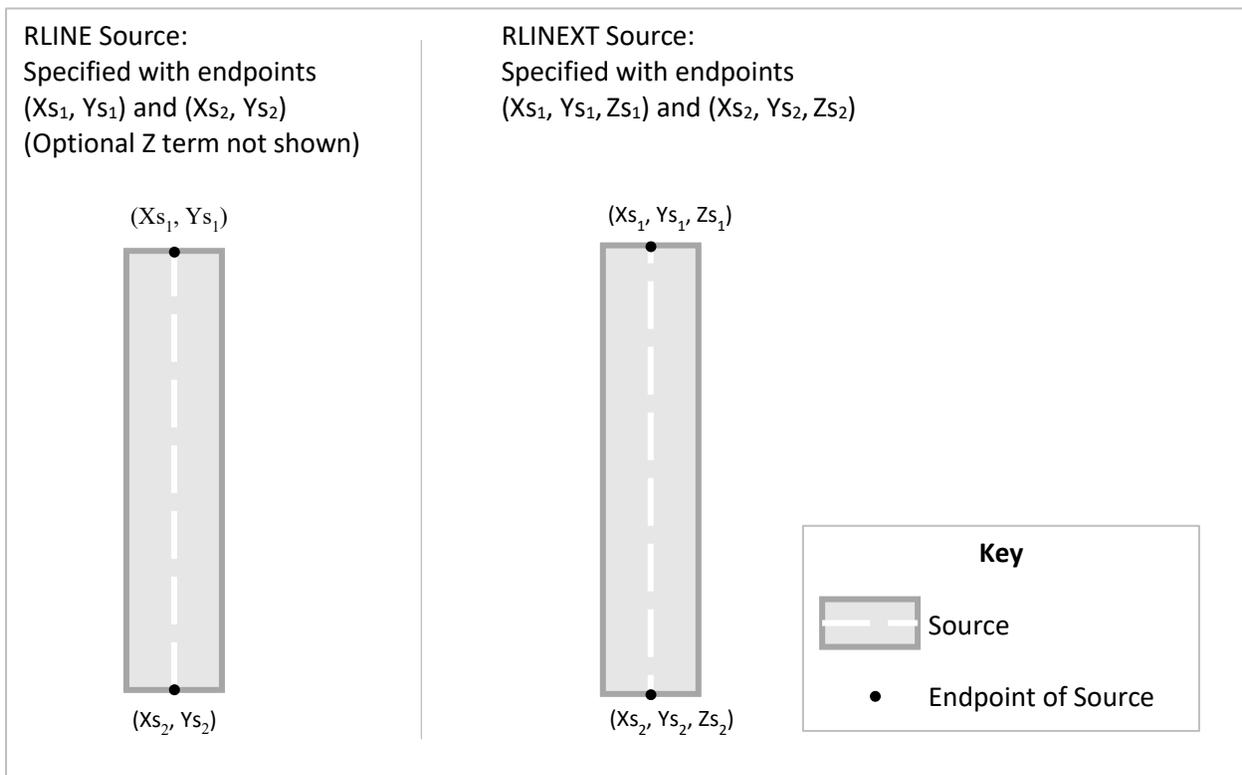


Figure 3-1: RLINE and RLINEXT Source Types

The DCL parameter is optional for defining RLINEXT sources. It can be defined as “0” if it is not used to describe the source. However, when using RLINEXT with the RDEPRESS keyword to define a depressed road, all RLINEXT sources need to have coordinates that reflect the roadway centerline, rather than coordinates representing an individual lane. Thus for modeling a depressed road, the DCL term would be necessary, and would define the distance of each source to a common location.

The DCL parameter is useful for describing multiple sources that are parallel and of the same length. Figure 3-2 illustrates two different ways that parallel sources can be defined.

- On the left side of this figure, the endpoints for Source A (southbound) are ($X_{s1,A}$, $Y_{s1,A}$) and ($X_{s2,A}$, $Y_{s2,A}$). The endpoints for Source B (northbound), ($X_{s1,B}$, $Y_{s1,B}$) and ($X_{s2,B}$, $Y_{s2,B}$), are different from Source A. The DCL for both of these sources would be defined as “0.”
- On the right side of the figure, these same two sources are defined with the same endpoints: (X_{s1} , Y_{s1}) and (X_{s2} , Y_{s2}) are the same for both Source A and Source B. The DCL for Source A would be a negative value and the DCL for Source B would be a positive value. This example shows two sources; additional parallel sources could be defined in a similar manner.

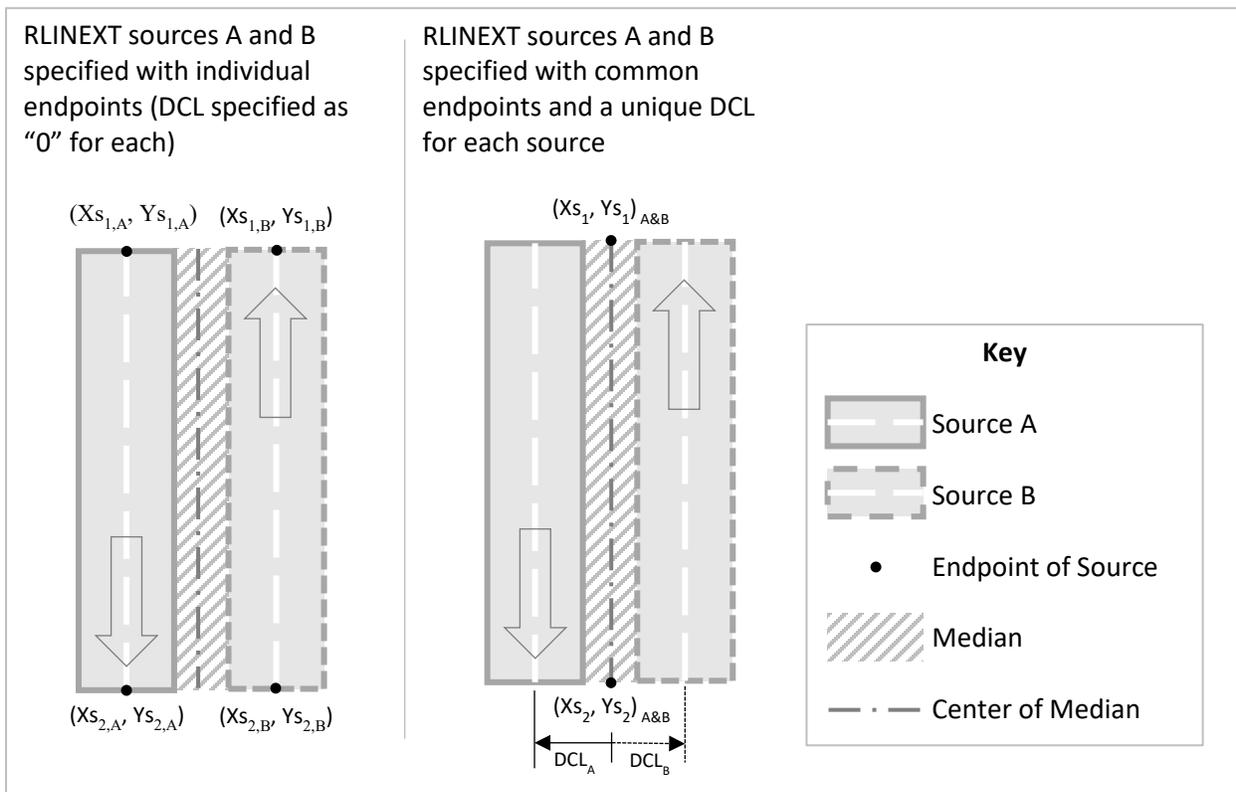


Figure 3-2: Different Methods to Specify RLINEXT Sources

In Figure 3-2, each direction of traffic is modeled as a source. Another option would be to model each lane as a unique source. Where each lane is a unique source, each source would have a DCL reflecting the distance from the midpoint of the median to the middle of the individual lane of traffic. Note that sources in the figure are shown oriented north to south. If sources are oriented east to west and DCL is used, parallel sources north of the centerline should have positive DCL values and parallel sources south of the centerline should have negative values.¹⁵

The AERMOD User's Guide further explains the meaning of the distance from the roadway centerline with examples of how it is applied in different cases, including when the source is modeled as a depressed roadway.

3.3 How would a solid barrier be modeled with RBARRIER?

An RLINEXT source can optionally include a solid barrier that extends to the ground (such as a noise barrier) with the keyword RBARRIER. The barrier defined with this keyword is associated with a specific source. For example, if a roadway with a solid barrier is made up of several sources, each one of the RLINEXT sources would have an RBARRIER statement. The length of the barrier will be the length of the RLINEXT source it is associated with. Therefore, an RLINEXT source with an RBARRIER statement should be defined as no longer than the barrier. If the road extends beyond the barrier, then more than one source would be used, one or more with an RBARRIER statement, and one or more without.

¹⁵ For any questions about road orientation and whether the DCL should be positive or negative, please consult EPA (see Section 1.7 for contact information). As mentioned in Section 3.1, EPA recommends that the use of ALPHA features be conducted in consultation with EPA.

To describe the barrier, the user would need to include the source name (Srcid), the height of the barrier (abbreviated as Htwall), and the distance from the centerline of the source to the barrier (abbreviated as DCLwall). There is no limit to the Htwall parameter, but an error message is issued if the height of the barrier is negative.

Note: A barrier defined in AERMOD with RBARRIER affects the dispersion of emissions only from the RLINEXT source it is associated with. It does not affect the modeled dispersion of emissions from any other source in the vicinity; dispersion will be modeled for these other sources as if the barrier is not present.

Note that other regulations and highway design processes, such as the Federal Highway Administration's (FHWA's) Noise Regulation and Guidance, would dictate whether a federally funded transportation project would include new barriers.

FHWA has resources related to noise available on their website at <https://www.fhwa.dot.gov/environment/noise/>, including information about solid barriers and their use for noise abatement. The Federal Transit Administration (FTA) also has resources related to noise available on their website at www.transit.dot.gov/regulations-and-guidance/environmental-programs/noise-and-vibration.

3.4 What are some examples of how barrier could be modeled?

Example: Divided Arterial with a Barrier on One Side

Figure 3-3 shows two different ways to define a divided arterial with a barrier on one side of the arterial only. In both cases, there are two sources, Source A and Source B. On the left side of the figure, the two sources have the same endpoints, but different DCL terms as shown in the figure. DCL_A would be negative, and DCL_B would be positive. The modeler would include an RBARRIER statement for each source to define a barrier, with the DCLwall term representing the distance from the source endpoints to the barrier. That is, the DCLwall term would be the same in both RBARRIER statements, for both Source A and Source B. The height of the barrier is not shown in this two-dimensional figure, but it is needed in both RBARRIER statements and would be defined the same in each. The barrier would affect dispersion of emissions from travel in both directions because each source includes the RBARRIER statement.

Alternatively, the two sources could be modeled with their own unique endpoints defined, as shown on the right side of the figure. To ensure that the barrier has an effect on the emissions from both directions of travel, the modeler would include an RBARRIER statement for each source and define each of them to be in the same location. In other words, the two RBARRIER statements would locate the barrier in the identical place with the identical height. As shown in the figure, the two RBARRIER statements for Source A and Source B would have different DCLwall terms, because this term is the distance from the center of each source to the barrier.

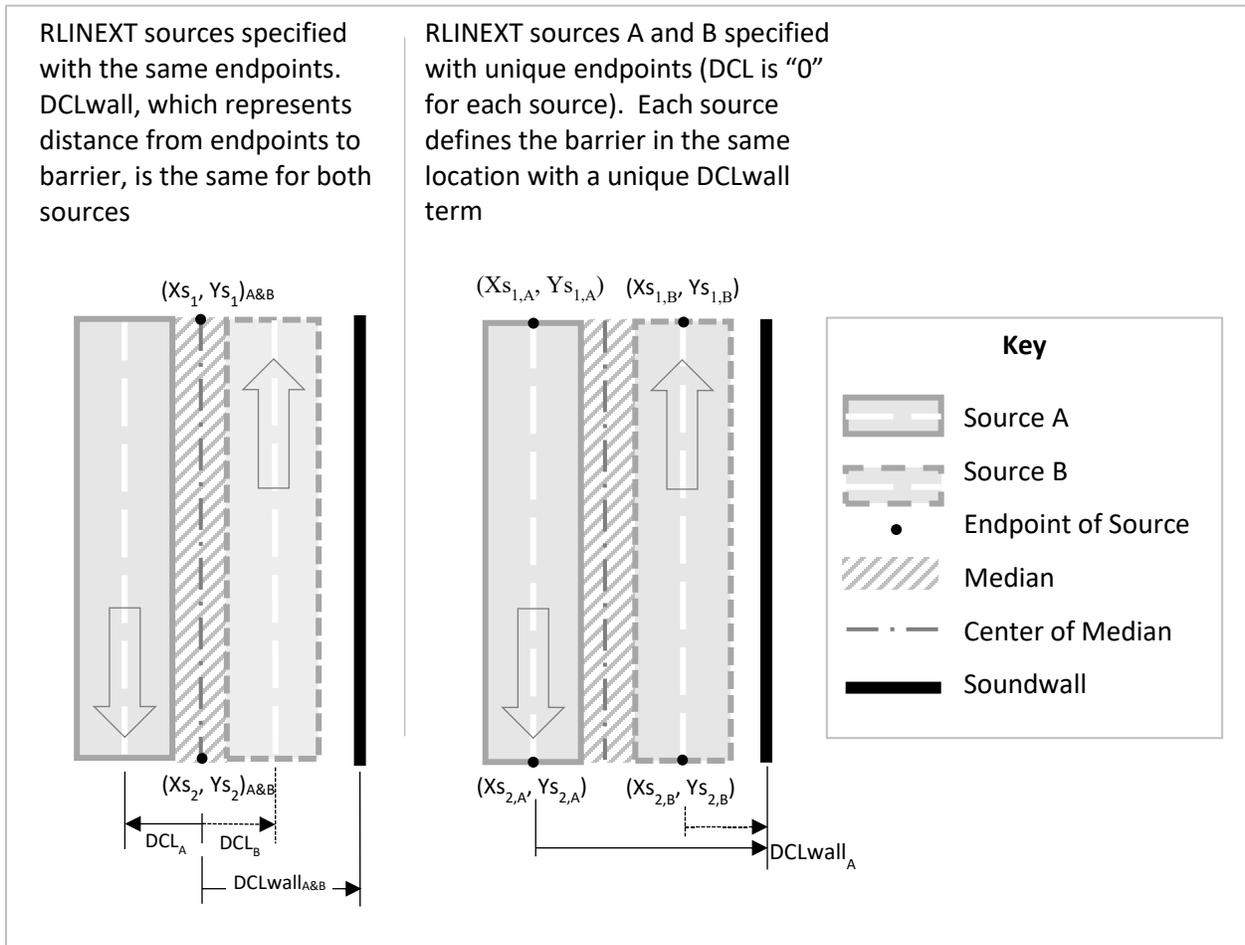


Figure 3-3: Two Methods to Define a Divided Arterial with a Barrier on One Side

In both of these approaches, the two directions of travel are unique sources, which is important in representing emissions for a transportation facility. The emissions rates for each direction of travel are likely to be different from each other over the course of the day. For example, one direction could be congested during the morning peak and the other direction congested during the evening peak. Because the purpose of the analysis is to determine the air quality effects of a transportation project, accurately characterizing the quantity and location of emissions in AERMOD over time is key. The analysis could be further refined if travel data was available by lane. In such a case, separate sources could be defined for each lane of travel, using either the method on the right or on the left of the figure to define the sources and barrier.

An additional variation that could be applied to either of these approaches would be to model light-duty and heavy-duty emissions separately, that is, as separate sources located in the same place. The sources are in effect, superimposed over one another. Appendix J of the PM Hot-spot Guidance¹⁶ describes modeling different vehicle types as overlapping sources. If this were to be done for the example above, each source would have its own RBARRIER statement.

¹⁶ See Section 1.2 for reference information.

- For the option on the left side of Figure 3-3, there would be four RLINEXT sources: southbound light-duty, southbound heavy-duty, northbound light-duty, and northbound heavy-duty, and all four would have an identical RBARRIER statement.
- For the option on the right side of the figure, there would also be four RLINEXT sources, and each of these would also have an RBARRIER statement with the same height. The two RBARRIER statements associated with the southbound sources would both include the distance of $DCLwall_A$, and the two RBARRIER statements for the northbound sources would both include the distance of $DCLwall_B$.

Example: A Divided Arterial with Barriers on Both Sides

If a highway has solid barriers on both sides, one way to include both barriers would be to model each direction of the highway as a separate RLINEXT source, so that a barrier can be defined for each one. For example, if a north-south highway has barriers on both sides, the northbound side can be defined as an RLINEXT source with a barrier to the east, and the southbound side can be defined as a different RLINEXT source and include a barrier to the west, as shown in Figure 3-4. In this example, there are two sources, A and B, each defining a different barrier. $DCLwall_A$ would be a negative value, and $DCLwall_B$ would be a positive value.

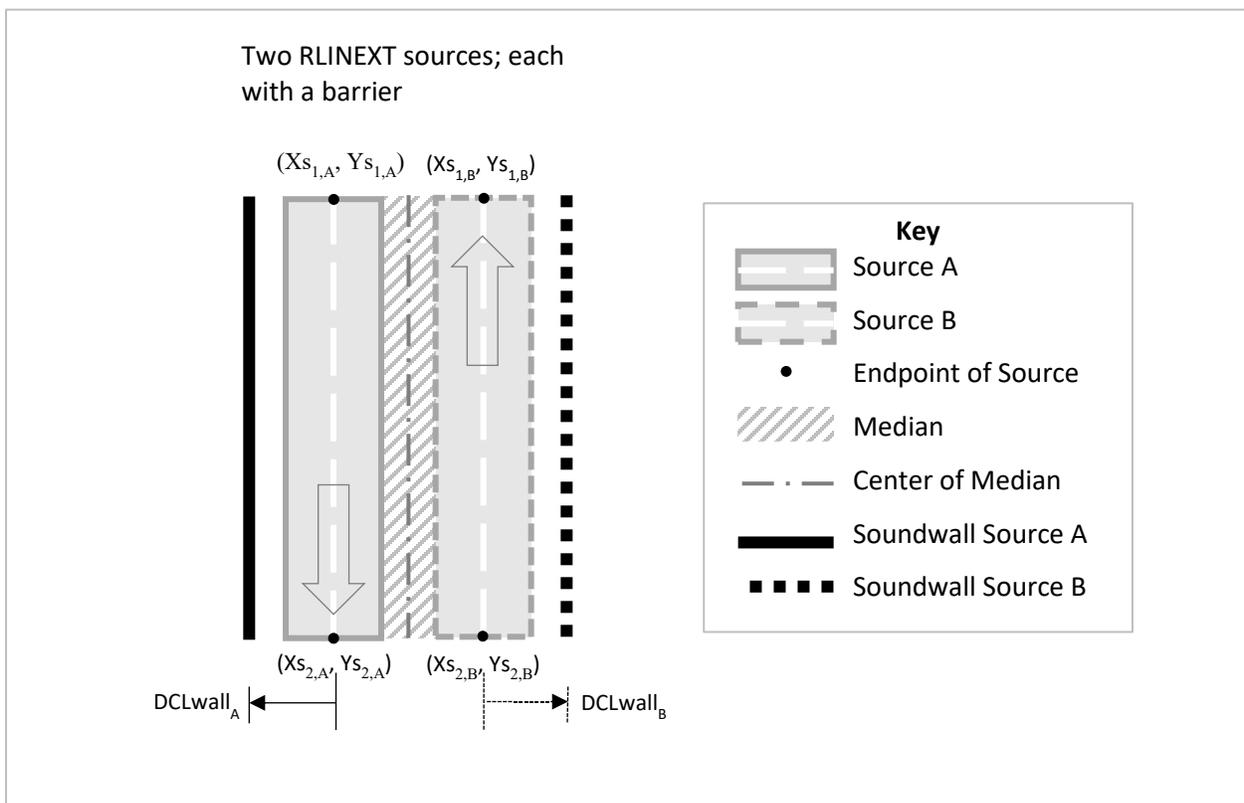


Figure 3-4: Divided Arterial with Solid Barriers on Both Sides

Again, note that any barrier affects modeled dispersion of only the source it is associated with and does not affect the modeled dispersion of emissions from any other source. Using the example of the north-south highway above, the barrier associated with Source A (solid line), would only affect the modeled dispersion of Source A and would have no effect on modeled

dispersion from Source B or any other sources in the vicinity. Similarly, the barrier associated with Source B (dashed line) would affect the modeled dispersion of Source B only, and not Source A or any other sources in the vicinity.

3.5 How would a depressed road be modeled with RDEPRESS?

An RLINEXT source can also represent a depressed roadway with the addition of the keyword RDEPRESS. With this keyword, the user would include the source name (Srcid), the depth of the depression (a negative value, reflecting a lower elevation than the surrounding terrain), and the width of both the top (Wtop) and bottom (Wbottom) of the depression that contains the source.

Use of the RDEPRESS keyword requires that all RLINEXT sources have coordinates reflecting the roadway centerline coordinates, and not coordinates representing the individual lane of traffic. That is, when using RDEPRESS, the user would have to specify the centerline endpoints and use a non-zero DCL for RLINEXT sources. The DCL is necessary in the depressed road model computations, because the DCL tells the model the location of the source within the depression, thus the amount of recirculation and dispersion of that source before its emissions are emitted on the downwind edge of the depression.

The depth parameter must be negative; the user will get an error if the depth parameter is greater than zero. Also, the user will get an error if Wtop or Wbottom parameters are less than zero, or if the Wbottom is greater than Wtop for the source (i.e., the bottom width cannot be greater than the top width).

Figure 3-5, which is a view of the cross-section of a depressed road, illustrates the parameters necessary for RDEPRESS. In this figure, the roadway is made up of two sources, A and B. The SRCPARAM statement for each of these sources would define a non-zero DCL. The RDEPRESS statement for each of these sources would define the depth, W_{top} , and W_{bottom} .

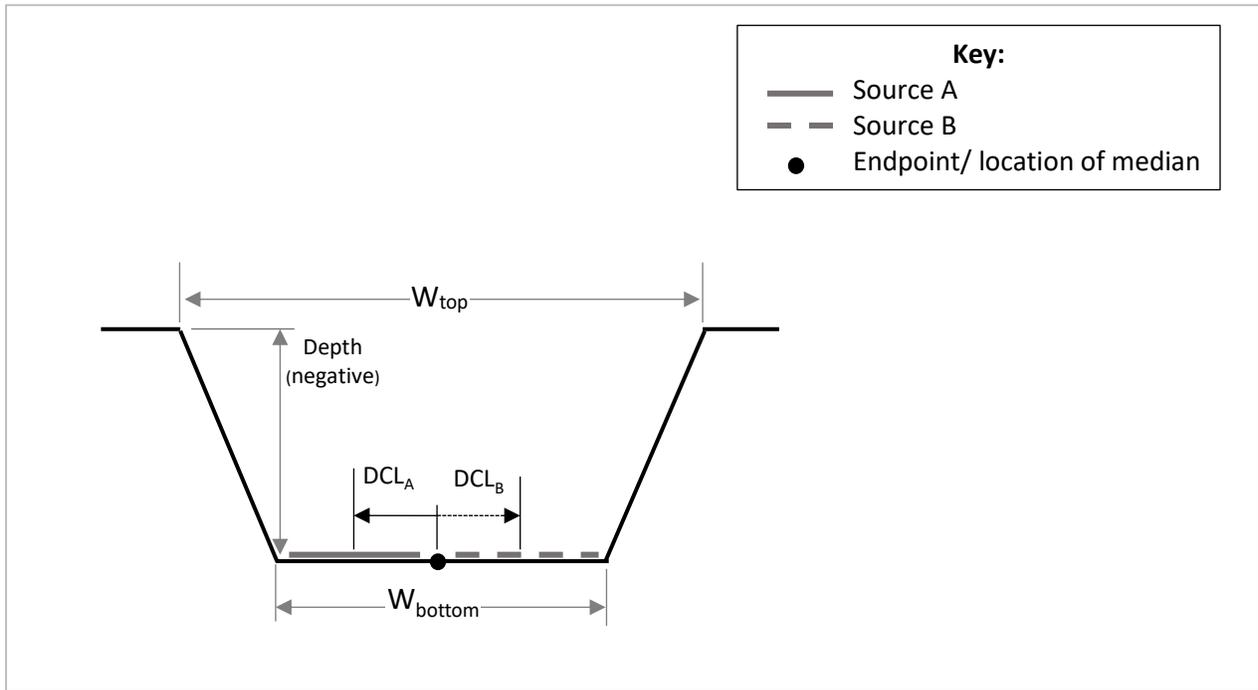


Figure 3-5: Depressed Roadway Parameters

3.6 Can RLEMCONV be used with the RLINEXT source type?

Yes. RLEMCONV, described in Section 2.5, can work with both RLINE and RLINEXT source types, even though the units that AERMOD uses for these two source types are different. The units that AERMOD uses for emissions for the RLINE source are the same as the AERMOD AREA and LINE source types, grams per second per square meter, noted as $g/s/m^2$. The emission units for the RLINEXT source type is the same as the original R-LINE model, which is grams per second per meter, noted as $g/s/m$.

The RLEMCONV keyword allows the user to define the RLINEXT source emission rates in grams per link per hour, instead of grams per second per meter. This keyword has no additional inputs, but when present, emissions for all RLINEXT sources are assumed to be in grams per link per hour. This feature is included to allow the user to include emission rates directly from an emissions model without converting them. See Section 2.4 for more information.