Appendix O
Noise and Vibration Technical Memorandum

Chicago Red Line Extension Project

Noise and Vibration

Technical Memorandum

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Abbreviations

BRT	Bus Rapid Transit
CTA	Chicago Transit Authority
dBA	A-weighted decibel
EIS	Environmental Impact Statement
ft	Feet
FTA	Federal Transit Administration
Ldn	day-night average sound level
Leq	Equivalent continuous sound level
Lmax	Maximum noise level
micro in./sec	microinch per second
mph	miles per hour
NEPA	National Environmental Policy Act
ppv	peak particle velocity
rms	root mean square
RLE	Red Line Extension
ROW	right-of-way
SEL	sound exposure level
UPRR	Union Pacific Railroad
VdB	decibels referenced to 1 microinch per second

Section 1
Summary

This technical memorandum was prepared to support the environmental impact statement (EIS) for the Chicago Transit Authority (CTA) Red Line Extension (RLE) Project. The purpose is to identify, evaluate, and characterize potential noise and vibration impacts and potential mitigation measures associated with each of the RLE Project alternatives. The following is a summary of the results of the noise and vibration analysis for each of the project alternatives.

1.1 No Build Alternative

The No Build Alternative assumes no change in the existing conditions and therefore would result in no change to the existing noise and vibration levels within the project area. The No Build Alternative would result in no noise and vibration impacts.

1.2 BRT Alternative

The results of the noise analysis for the Bus Rapid Transit (BRT) Alternative indicate that noise impacts could occur along the project alignment. Figure 5-1 shows the noise contours for moderate noise impact for the BRT Alternative. Residential receptors within the noise contours could be affected by the project. Because the buses would travel along local streets that have small blocks, numerous cross streets, and driveways, noise abatement mitigation such as barriers would not be feasible for the BRT Alternative.

1.3 UPRR Rail Alternative – Right-of-Way Option

The Union Pacific Railroad (UPRR) Rail Alternative Right-of-Way (ROW) Option would only occur if the freight relocation project were implemented prior to RLE Project implementation. UPRR trains would relocate to another corridor as part of a separate, earlier project that may occur regardless of RLE implementation. The City of Chicago is evaluating the UPRR train relocation in an independent study. If the freight relocation project were implemented, the noise levels along the rail corridor would decrease by 5 to 7 decibels (dBA) from existing conditions due to the removal of the freight rail operations. Because of the reduction in noise level due to replacing the freight operations with the RLE Project, noise mitigation was not considered for the UPRR Rail Alternative ROW Option.

No mitigation measures are proposed for vibration because the aerial structure with continuously welded rail would have vibration levels that are below the Federal Transit Administration (FTA) impact criterion of 72 VdB (root mean square [rms] velocity levels expressed in decibels [VdB] relative to one micro-inch per second). In addition, by moving the freight operations out of the rail corridor, the existing vibration levels generated during freight rail pass-bys would be eliminated from the rail corridor.

1.4 UPRR Rail Alternative – East Option

Based on FTA analysis methods, the UPRR Rail Alternative East Option could result in both moderate and severe noise impacts along the project corridor. Figure 5-2 shows the noise contours for moderate and severe noise impacts from the East Option. Residential receptors within these noise contours could be affected by implementation of this alternative. A noise barrier approximately 4 feet in height (measured from the top surface of the concrete deck) installed along the outer tracks of the aerial structure could provide a 7 to 10-dBA reduction in noise level. A noise barrier approximately 4 feet in height on the aerial structure that could provide a 10-dBA reduction could result in no affected receptors remaining after mitigation.

With regard to vibration, no mitigation measures are proposed. The aerial structure with continuously welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB at the residential receptors along the project corridor.

1.5 UPRR Rail Alternative – West Option

The UPRR Rail Alternative West Option could result in both moderate and severe noise impacts along the project corridor. Figure 5-3 shows the noise contours for moderate and severe noise impacts from the West Option. Residential receptors within these noise contours could be affected by implementation of this alternative. Noise barrier mitigation measures could be the same as for the East Option. A noise barrier approximately 4 feet in height on the aerial structure that could provide a 10-dBA reduction could result in no affected receptors remaining after mitigation. As it would be for the East Option, vibration levels for the West Option could be below the FTA impact criterion of 72 VdB, and no mitigation measures are proposed for vibration.

1.6 Halsted Rail Alternative

The Halsted Rail Alternative could result in both moderate and severe noise impacts along the project corridor. Figure 5-4 shows the noise contours for moderate and severe noise impact from the Halsted Rail Alternative. Residential receptors within these noise contours could be affected by implementation of this alternative. Noise barrier mitigation measures would be the same as for the East and West Options. Based on a noise reduction of 10 dBA, a noise barrier approximately 4 feet in height on the aerial structure could substantially reduce the number of impacts; however, a noise barrier approximately 4 feet in height on the aerial structure could still result in moderate noise impacts along Halsted Street after mitigation. No severe noise impacts would remain after mitigation.

No mitigation measures are proposed for vibration because the aerial structure with continuously welded rail would have vibration levels that are below the FTA impact criterion of 72 VdB.

1.7 2014-2015 Red Line Extension Project Update

Updated July 27, 2015

In August 2014, based on the technical analysis and public input until then, CTA announced the NEPA Preferred Alternative—the UPRR Rail Alternative. CTA is considering two alignment (route) options of this alternative: the East Option and the West Option. At this time, CTA is also

considering only the South Station Option of the 130th Street Station. In late 2014 and early 2015, CTA conducted additional engineering on the East and West Options to refine the East and West Option alignments. Appendix A of this technical memorandum summarizes the refined alignments and any additional or different impacts that could result. The information in Appendix A supersedes information presented in other chapters of this technical memorandum.

Section 2
Project Description

The CTA is proposing to extend the Red Line from the existing 95th Street Terminal to the vicinity of 130th Street, subject to the availability of funding. The proposed RLE would include four stations. Each station would include bus transfer and parking facilities. This project is one part of the Red Ahead Program to extend and enhance the entire Red Line. The CTA is also planning 95th Street Terminal improvements that are anticipated to be completed prior to the proposed RLE construction.

The project area is 11 miles south of the Chicago central business district (commonly referred to as the Loop) and encompasses approximately 20 square miles. The boundaries of the project area are 95th Street on the north, Ashland Avenue on the west, Stony Island Avenue on the east, and the Calumet-Sag Channel/Little Calumet River and 134th Street on the south. The I-57 Expressway and I-94 Bishop Ford Freeway cross the western and eastern edges of the project area, respectively. Lake Calumet is in the eastern portion of the project area. The project area encompasses parts of nine community areas in the City of Chicago and the eastern section of the Village of Calumet Park. Chicago community areas include Beverly, Washington Heights, Roseland, Morgan Park, Pullman, West Pullman, Riverdale, Hegewisch, and South Deering. The project area comprises residential (primarily single family), industrial (both existing and vacant), transportation (including freight), and commercial development.

The Draft EIS focuses on the following alternatives (shown in Figure 2-1), which emerged from the Alternatives Analysis and the National Environmental Policy Act (NEPA) scoping process:

- No Build Alternative
- BRT Alternative
- UPRR Rail Alternative
  - ROW Option
  - East Option
  - West Option
- Halsted Rail Alternative

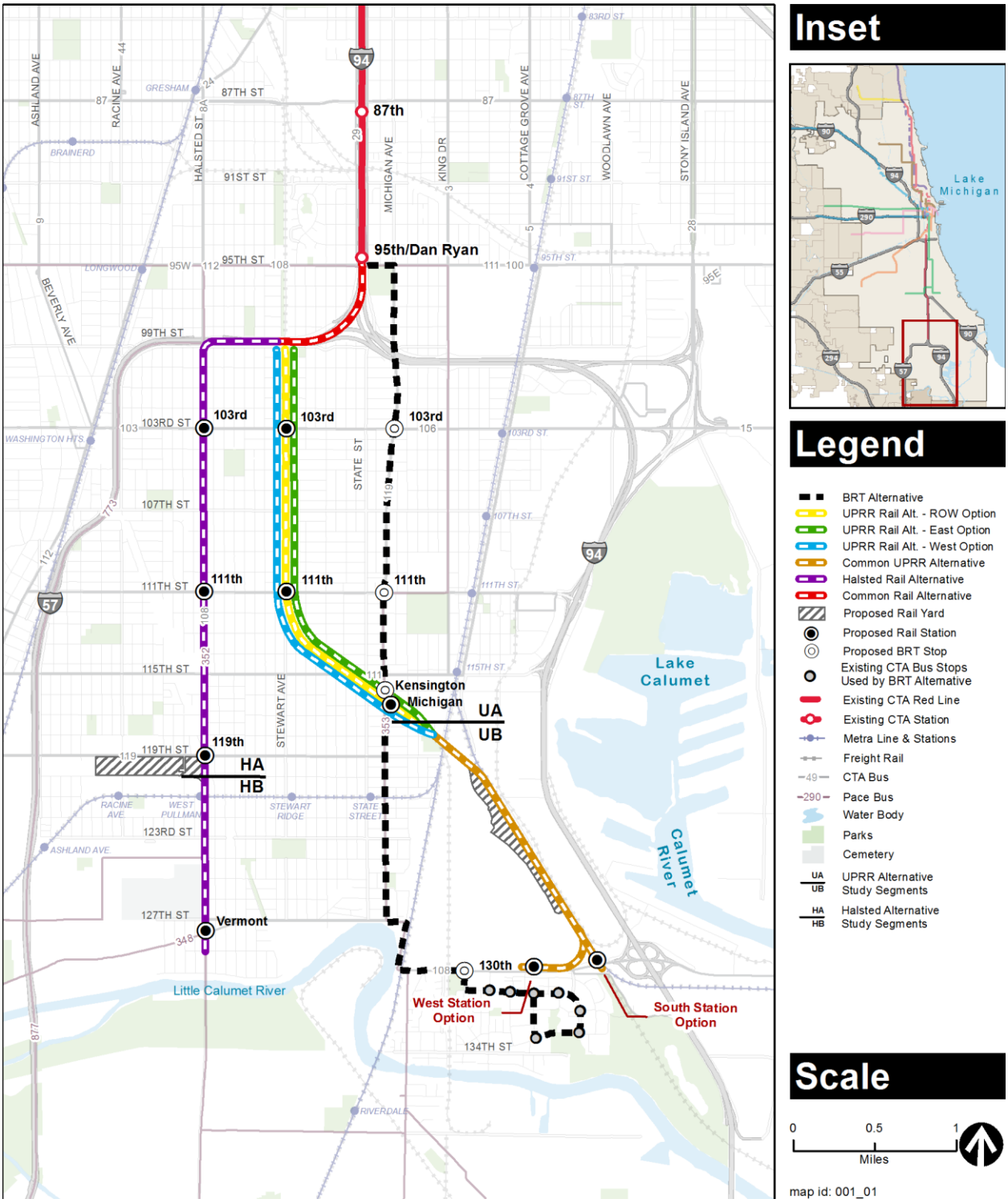

Figure 2-1: Red Line Extension Project Alternatives

The No Build Alternative is a required alternative as part of the NEPA environmental analysis and is used for comparison purposes to assess the relative benefits and impacts of extending the Red Line. The No Build Alternative is carried into the Draft EIS phase of the project development regardless of its performance versus the build alternatives under consideration. No new infrastructure would be constructed as part of the No Build Alternative other than committed transportation improvements that are already in the Chicago Metropolitan Agency for Planning (CMAP) Fiscal Year 2010–2015 Transportation Improvement Program (TIP) and the improvements to 95th Street Terminal. The TIP projects within the project area consist of four bridge reconstructions, several road improvement projects including resurfacing and coordination of signal timing on 95th Street, work on Metra's facilities, construction of a bicycle/pedestrian multi-use trail, and preservation of historic facilities. The No Build Alternative includes regular maintenance of existing track and structures, and bus transit service would be focused on the preservation of existing services and projects. All elements of the No Build Alternative are included in each of the other alternatives. Under this alternative, travel times would not improve from existing conditions.

The BRT Alternative (formerly referred to as the Transportation Systems Management Alternative) is a 5.0-mile, limited-stop, enhanced BRT route, which is assumed to operate 24 hours per day between the existing 95th Street Terminal and the intersection of 130th Street and Eberhart Avenue. No dedicated bus lanes would be provided for the BRT Alternative; however, parking lanes would be removed for some portions of the alignment and four stops with improved bus shelters and park & ride facilities would be created at 103rd Street and Michigan Avenue, 111th Street and Michigan Avenue, Kensington Avenue and Michigan Avenue, and 130th Street and Eberhart Avenue. Although BRT service elements would not continue south of the 130th Street stop, the bus route would continue through Altgeld Gardens along the existing route with six stops. The BRT Alternative would be consistent with bus routing changes that may occur as part of improvements to the 95th Street Terminal. Under this alternative, travel times between 130th Street and the Loop would improve over existing conditions.

The UPRR Rail Alternative is a 5.3-mile extension of the heavy rail transit Red Line from its existing 95th Street Terminal to 130th Street, just west of I-94. The Chicago Transit Board designated the UPRR Rail Alternative as the Locally Preferred Alternative at its August 12, 2009 board meeting. This alternative includes construction and operation of new heavy rail transit tracks, mostly in existing transportation corridors. The UPRR Rail Alternative has three options for alignment (ROW, East, and West), all of which would include operation on elevated structure from 95th Street to just past the Canadian National/Metra Electric District tracks near 119th Street. The alignment would then transition to at-grade through an industrial area with no public through streets, terminating at 130th Street in the vicinity of Altgeld Gardens. Four new stations would be constructed at 103rd Street, 111th Street, Michigan Avenue, and 130th Street. The 130th Street station would be the terminal station, with two options under evaluation: the South Station Option and the West Station Option. A new yard and shop facility would be sited near 120th Street and Cottage Grove Avenue. The bus routes in the vicinity of the UPRR Rail Alternative would be modified to enhance connectivity between the Red Line and the bus network. The hours of operation and service frequency for the UPRR Rail Alternative are assumed to be the same as

for the current Red Line. Under this alternative, travel times between 130th Street and the Loop would improve substantially over existing conditions.

The Halsted Rail Alternative is a 5.0-mile heavy rail transit extension of the existing Red Line. In this alternative, the Red Line would operate on an elevated structure running south from 95th Street along I-57 until Halsted Street. The alignment would then turn south and continue along Halsted Street to the intersection of Halsted Street and Vermont Avenue near 127th Street. This alternative would include four new stations at 103rd Street, 111th Street, 119th Street, and Vermont Avenue. The Vermont Avenue station would be the terminal station. A new yard and shop would be sited west of Halsted Street and between the 119th Street and Vermont Avenue stations. The bus routes in the vicinity of the Halsted Rail Alternative would be modified to enhance connectivity to the Red Line. The hours of operation and service frequency for the Halsted Rail Alternative are assumed to be the same as for the current Red Line. Under this alternative, travel times between 127th Street and the Loop would improve substantially over existing conditions. This alternative would not extend rail to Altgeld Gardens, which would be served by bus connecting to the Vermont terminal station.

Section 3
Methods for Impact Evaluation

This section describes the regulatory framework, the impact analysis thresholds, the area of potential impact, and the methods used to assess the potential for noise and vibration impacts from the RLE Project.

3.1 Regulatory Framework

3.1.1 Federal

The noise and vibration analyses for this project were prepared in accordance with the FTA (2006) *Transit Noise and Vibration Impact Assessment* guidance manual. This manual sets forth the basic concepts, methods, and procedures for evaluating the extent and severity of the noise and vibration impacts from transit projects. All aspects of the noise and vibration analyses were coordinated with CTA and FTA. The FTA employs three levels of analysis that may be applied depending on the complexity of the project. The first level is a screening procedure to determine whether noise-sensitive receivers are present based on the land uses in the vicinity of the project and is used to determine whether more detailed noise and vibration analysis is required. There are two levels of quantitative analysis for predicting impacts: a general assessment and a detailed analysis. The general assessment is used to identify and estimate the severity of noise and vibration impacts in an area. This method is used to provide information needed to differentiate potential alternatives. The detailed analysis is used to quantify impacts through an in-depth analysis of a single alternative.

The screening procedure was not required for this project because a majority of the corridor is within residential area and is known to contain noise- and vibration-sensitive land uses (Category 2). Three parks, six schools, and four churches (Category 3) are near the corridor. There are no Category 1 land uses within the corridor. Because there are known sensitive receivers for the RLE Project, further analysis was required. CTA completed a general assessment for the UPRR corridor to provide basic information for comparing the severity of impacts from implementation of the East and West Options. The impacts disclosed in this Draft EIS are maximum, worst-case impacts. More detailed analysis in the Final EIS may identify areas where impacts may be further reduced through design.

3.1.2 State

The State of Illinois in Title 35: Environmental Protection; Subtitle H: Noise; Part 900 established Sound Emission Standards and Limitations for Property Line Noise Sources for different land use classifications; however, the State of Illinois indicates that the noise limits do not apply to sound emitted from transit systems, or from equipment being used for construction.

3.1.3 Local

The City of Chicago Municipal Code Article XXI: Environmental Noise and Vibration Control (also referred to as the Chicago Environmental Noise Ordinance) established “noise disturbance”

requirements. The City of Chicago noise limits do not apply to sounds or vibration generated in the operation of any mass transit system. In addition, these noise limits do not apply to any construction, demolition, or repair work of an emergency nature or to work on public improvements authorized by a governmental body or agency.

The Village of Calumet Park also has a Noise Code that refers to nuisance noise. Municipal services, such as transit systems that provide a public service, are exempt from such nuisance noise regulations.

3.2 Impact Analysis Thresholds

Because the State of Illinois and the City of Chicago noise limits do not apply to transit projects, the FTA's operational and construction noise and vibration criteria, as described in the guidance manual, were used to determine the thresholds of significance for this project.

3.2.1 Operational Noise

The FTA's *Transit Noise and Vibration Impact Assessment* guidance manual sets forth the basic concepts, methods, and procedures for evaluating the extent and severity of noise impacts from transit projects. In order to determine whether the noise levels from a proposed project might have an impact on an area, a comparison is made of the existing noise levels in the vicinity of the proposed project and the projected future outdoor noise levels from the project. The FTA guidance manual provides a set of criteria to determine land use types where noise-sensitive receptors would most likely occur (see Table 3-1). The FTA does not consider most commercial and industrial receptors to be sensitive to transit-related noise. Existing noise levels at representative noise-sensitive receptor locations along the RLE corridor were measured. Using the general noise assessment process, estimated noise levels were predicted for the No Build Alternative and the build alternatives. The results of the analysis were compared to the existing conditions and FTA noise criteria to determine the potential for impact.

Table 3-1: Federal Transit Administration Land Use Categories and Noise Metrics

Land Use Category[1]	Noise Level[2]	Description
1	$L_{eq}(h)$	Tracts of land set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and historic landmarks.
2	L_{dn}	Buildings used for sleeping, including residences, hospitals, hotels, and other areas where nighttime sensitivity to noise is of utmost importance.
3	$L_{eq}(h)$	Institutional land uses with primarily daytime and evening uses including schools, libraries, churches, museums, cemeteries, historical sites and parks, and certain recreational facilities used for study or meditation.

1. Land Use categories are based on sensitivity to noise intrusions.
2. The threshold noise limits include an hourly equivalent noise level (or $L_{eq}(h)$) for Category 1 and 3 receptors to the day-night noise level (or L_{dn}) for Category 2 receptors. The Federal Transit Administration noise limits, which are based on the existing background levels, are determined using empirical formulas shown graphically in Figure 3-1

The FTA noise impact criteria are delineated into two categories: moderate impact and severe impact. The moderate impact threshold defines areas where the change in noise would be

noticeable but might not be sufficient to cause a strong, adverse community reaction. The severe impact threshold defines the noise limits above which a substantial percentage of the population would be highly annoyed by the change in noise. As shown in Figure 3-1, the FTA noise impact criteria are defined by two curves that allow increasing project noise levels as existing noise increases up to a point, beyond which impact is determined based on project noise alone.

Category 1 receptors (such as an amphitheater or historic landmark) are represented along the left axis and are described by the hourly equivalent noise level (hourly L_{eq}). Category 2 receptors (such as residences, hotels, and hospitals) are also represented along the left axis, but are described by the 24-hour day-night level (L_{dn}). Category 3 receptors (such as schools and churches) are represented along the right axis and are described by the hourly L_{eq} noise metric.

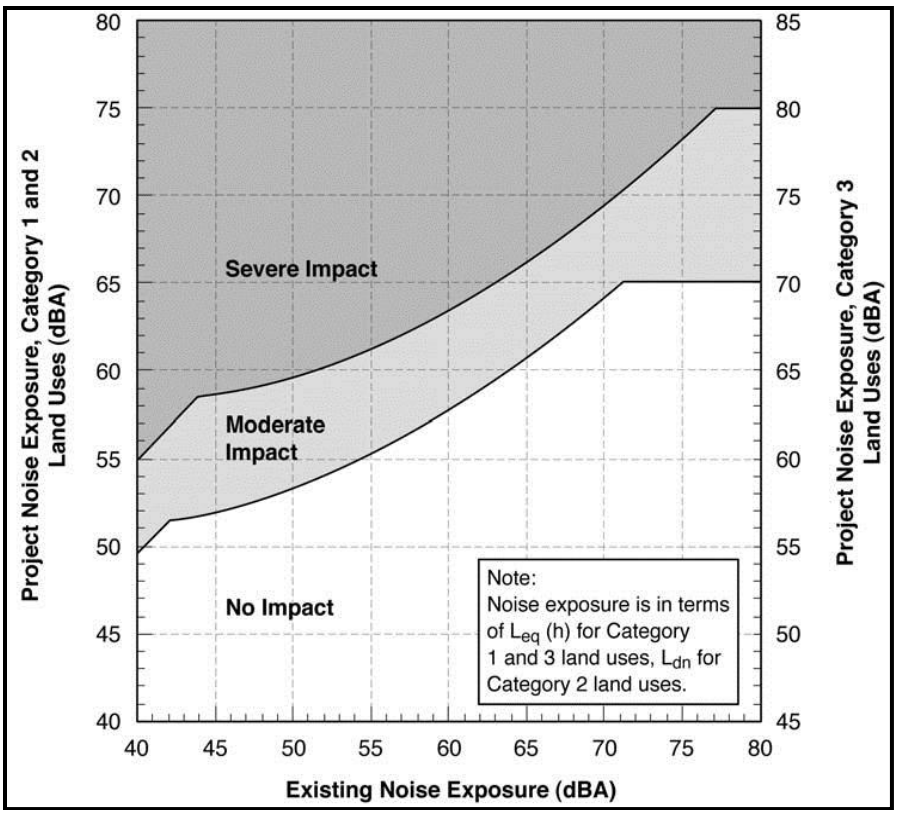

Figure 3-1: Federal Transit Administration Noise Impact Criteria for Transit Projects
Source: Transit Noise and Vibration Impact Assessment (FTA 2006)

Although the curves in Figure 3-1 are defined in terms of the project noise exposure and the existing noise exposure, it is the project's increase in noise from the existing noise levels that is the basis for the criteria. To illustrate this point, Figure 3-2 shows the noise impact criteria for Category 1 and 2 land uses in terms of the allowable increase in the existing noise exposure. The horizontal axis is the existing noise exposure and the vertical axis is the increase in noise level due to the RLE Project. The curves in Figure 3-2 indicate that the criterion for impact allows a noise exposure increase of 10 dBA if the existing noise exposure is 42 dBA or less, but only a one dBA

increase when the existing noise level is 70 dBA. As the existing level of noise increases, the total amount that the community noise exposure is allowed to increase is reduced.

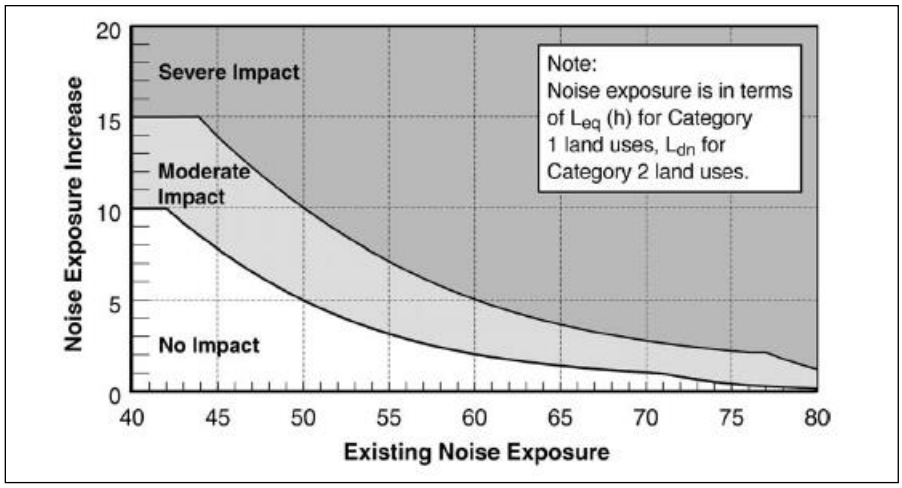

Figure 3-2: Increase in Noise Levels Allowed by Federal Transit Administration Criteria
Source: Transit Noise and Vibration Impact Assessment (FTA 2006)

3.2.2 Operational Vibration

The FTA criteria were used to assess annoyance due to vibration and ground-borne noise from transit operations. Table 3-2 shows the FTA vibration criteria for evaluating ground-borne vibration and noise impacts from train pass-bys at nearby sensitive receptors. These vibration criteria are related to ground-borne vibration levels that are expected to result in human annoyance, and are based on root mean square (rms) velocity levels expressed in decibels (VdB) relative to one micro-inch per second. The FTA's experience with community response to ground-borne vibration indicates that when there are only a few train events per day, it would take higher vibration levels to evoke the same community response that would be expected from more frequent events. This community response to ground-borne vibration is accounted for in the FTA criteria by distinguishing between projects with frequent (more than 70 train events per day), occasional (30 to 70 train events per day), and infrequent events (fewer than 30 train events per day). The vibration levels shown in Table 3-2 are defined in terms of human annoyance for different land use categories: high sensitivity (Category 1), residential (Category 2), and institutional (Category 3). In general, the threshold of human perceptibility of vibration is 65 VdB.

The vibration levels shown in Table 3-2 are well below the damage criteria levels of 95 to 100 VdB. It is extremely rare for vibration from transit operations to cause any sort of building damage, even minor cosmetic damage. Impacts from transit operations were determined for both vibration and ground-borne noise.

Table 3-2: Federal Transit Administration Ground-Borne Vibration and Noise Impact Criteria for Annoyance

Land Use Category	Ground-Borne Vibration Levels (VdB)[1]			Ground-Borne Noise Levels (dBA)[2]		
Description	Frequent Events[3]	Occasional Events[4]	Infrequent Events[5]	Frequent Events[3]	Occasional Event[4]	Infrequent Event[5]
Category 1: Buildings where low vibration is essential for interior operations	65	65	65	N/A[6]	N/A[6]	N/A[6]
Category 2: Residences and buildings where people normally sleep	72	75	80	35	38	43
Category 3: Institutional buildings with primarily daytime use	75	78	83	40	43	48

1. Root mean square vibration velocity levels are reported in decibels (or VdB) referenced to 1 microinch per second.
2. Ground-Borne noise levels are reported in A-weighted decibels (dBA) referenced to 20 micro Pascals.
3. "Frequent Events" is defined as more than 70 vibration events per day.
4. "Occasional Events" is defined as 30 to 70 vibration events per day.
5. "Infrequent Events" is defined as fewer than 30 vibration events per day.
6. N/A means "not applicable." Vibration-sensitive equipment is not sensitive to ground-borne noise.

While vibration criteria are generally used to assess annoyance from transit sources at the exterior facade of receptors, ground-borne noise, or the rumbling sound due to vibrating room surfaces, is typically assessed indoors. In general, the relationship between vibration and ground-borne noise depends on the dominant frequency of the vibration and the acoustical absorption characteristics of the receiving room. Due to the limited data available regarding soil and ground propagation characteristics, average or typical soil conditions (hard compacted soil) were assumed everywhere along the RLE Project corridor. According to the FTA guidance, the dominant vibration frequency from train pass-bys along typical ground and soil conditions generally occurs in the 30–60 Hertz range. The ground-borne noise levels were adjusted accordingly.

3.2.3 Construction Noise

During the preliminary environmental permitting phase of a project, when construction details are limited, the FTA suggests evaluating proposed construction scenarios against the 1-hour L_{eq} thresholds shown in Table 3-3. These criteria are compared to noise levels from the two loudest pieces of equipment that, under worst-case conditions, would operate continuously for 1 hour.

Table 3-3: Recommended Federal Transit Administration Construction Noise Limits (in dBA)[1]

Land Use Category	Daytime[2]	Nighttime
Residential	90	80
Commercial	100	100
Industrial	100	100

1. The FTA construction noise limits are reported for the peak 1-hour period in A-weighted decibels (or dBA).
2. Construction noise limits are established for both daytime (7 AM-10 PM) and nighttime (10 PM-7 AM) activities. The maximum noise limits represent noise levels from the two loudest pieces of equipment operating at full power over a period of 1 hour.

3.2.4 Construction Vibration

For evaluating potential annoyance or interference with vibration-sensitive activities due to construction vibration, the FTA criteria in Table 3-2 were used. In most cases the primary concern regarding construction vibration relates to potential damage effects on buildings. Table 3-4 contains the FTA's guideline vibration damage criteria for various structural categories of buildings. The vibration damage criteria listed for Category IV structures includes historic buildings.

Table 3-4: Construction Vibration Damage Criteria

Building Category	Peak Particle Velocity (inches/second)	Approximate VdB[1]
Reinforced concrete, steel or timber (no plaster)	0.5	102
Engineered concrete and masonry (no plaster)	0.3	98
Non-engineered timber and masonry buildings	0.2	94
Buildings extremely susceptible to vibration damage	0.12	90

1. RMS velocity in decibels (VdB) relative to 1 micro-inch/second

Construction vibration is generally assessed in cases where there is a substantial potential for impacts from construction activity. Such activities include blasting, pile-driving, demolition, and drilling or excavation in close proximity to sensitive structures.

3.3 Area of Potential Impact

A general assessment was conducted to determine the areas that could have a moderate or severe impact along the proposed corridors. A general assessment was used to establish an impact contour (which defines the outer limit of an impact corridor) because there are numerous existing noise-sensitive receptors along the entire length of the project corridor. This noise and vibration assessment estimated the potential for noise and vibration impacts along each of the project alternative alignments.

3.4 Methods

3.4.1 Noise and Vibration Measurements

A noise-monitoring program was conducted to (1) establish the existing ambient background noise levels within the project area, and (2) develop the project criteria noise limits using the FTA guidance. Noise measurements were conducted at representative noise-sensitive receptor locations along each of the proposed project alignments. Using aerial base maps of the project corridor, and information obtained during a site visit, a total of 15 noise measurement locations and 4 vibration measurement locations were selected to represent the different types of residential and other noise-sensitive land uses along each of the project alignments. The primary goal of the initial selection of the noise and vibration measurement locations was to provide a reasonable distribution of locations along the project corridor in order to predict future conditions along the corridor. Only residential receptors were selected for the noise measurement locations because they represent the most noise sensitive locations along each of the proposed project corridors. A total of 15 noise measurement locations was considered reasonable for this project because the Halsted Rail Alternative alignment and the BRT Alternative alignment (along Michigan Avenue) are along streets where local traffic is the major noise source. For the UPRR Rail Alternatives, existing freight rail operation is the primary noise source and is relatively uniform along the project corridor. A distribution of the noise measurement locations along each of these alignments provided a reasonable representation of the existing noise levels. Table 3-5 lists the noise measurement locations along each of the project alternatives and describes the measurement type. Figure 3-3 shows the noise measurement locations along each of the alternative alignments.

The results of the noise-monitoring program were used to establish the existing background noise levels and to develop the allowable project noise increases using the FTA guidance. The noise-monitoring program consisted of measuring peak-hour L_{eq} at non-residential receptors and 24-hour L_{dn} at residential receptors along the RLE Project corridor. Section 4 summarizes the results of the noise-monitoring program. The sound level meters used on this project were Larson Davis Model 820A and CEL Model 593 meters, which are in compliance with the American National Standards Institute standards for Type I accuracy and quality.

Vibration measurements were obtained at four locations along the project corridor to determine the existing vibration levels from freight operations. The four vibration measurement sites are described in Table 3-6, and their locations are shown in Figure 3-3. They are at the same sites (locations 13, 7, 9, and 3) where the noise measurements were obtained. Vibration measurements were obtained using PCB Model 393 accelerometers, with the acceleration levels converted to velocity (in VdB) using a CEL model 293 Integrator, and recorded on a CEL Model 593 analyzer.

The sound level and vibration meters for this project were rented from Scantek. Rental agreements come with calibration verification information and associated documentation for each unit rented.

Table 3-5: Noise Measurement Locations

Location Number	Receptor Description	Measurement Type	Primary Noise Source
Noise Measurement Locations along the BRT Alternative Alignment			
12	Residence at 9630 S. Michigan Avenue	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
13	Residence at 10445 S. Michigan Avenue	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
14	Residence at 12221 S. Michigan Avenue	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
15	Residence at 12505 S. Michigan Avenue	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
Noise Measurement Locations along the UPRR Rail Alternative Alignment			
7	Residence at 354 W. 102nd Place	24-hour L_{dn} Hourly L_{eq}	UPRR Freight Rail
8	Residence at 352 W. 109th Street	24-hour L_{dn} Hourly L_{eq}	UPRR Freight Rail
9	Residence at 307 W. 113th Street	24-hour L_{dn} Hourly L_{eq}	UPRR Freight Rail
10	Residence at 11718 S. Prairie Avenue	24-hour L_{dn} Hourly L_{eq}	UPRR Freight Rail
11	Altgeld Gardens (along East 130 Place)	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
Noise Measurement Locations along the Halsted Rail Alternative Alignment			
1	Residence at 9901 S. Emerald Avenue	24-hour L_{dn} Hourly L_{eq}	Traffic on I-57
2	Residence at 10229 S. Halsted Street	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
3	Residence at 11005 S. Halsted Street	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
4	Residence along 119th Street	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic
5	Residence at 12125 S. Halsted Street	24-hour L_{dn} Hourly L_{eq}	Local Street Traffic

Notes: L_{dn} = day-night average sound level, L_{eq} = equivalent continuous sound level. BRT = Bus Rapid Transit, UPRR = Union Pacific Railroad

Table 3-6: Vibration Measurement Locations

Location Number	Receptor Description	Vibration Source
13	Residence at 10445 S. Michigan Avenue	Local Street Traffic
7	Residence at 354 W. 102nd Place	UPRR Freight Trains
9	Residence at 307 W. 113th Street	UPRR Freight Trains
3	Residence at 11005 S. Halsted Street	Local Street Traffic

Notes: UPRR = Union Pacific Railroad

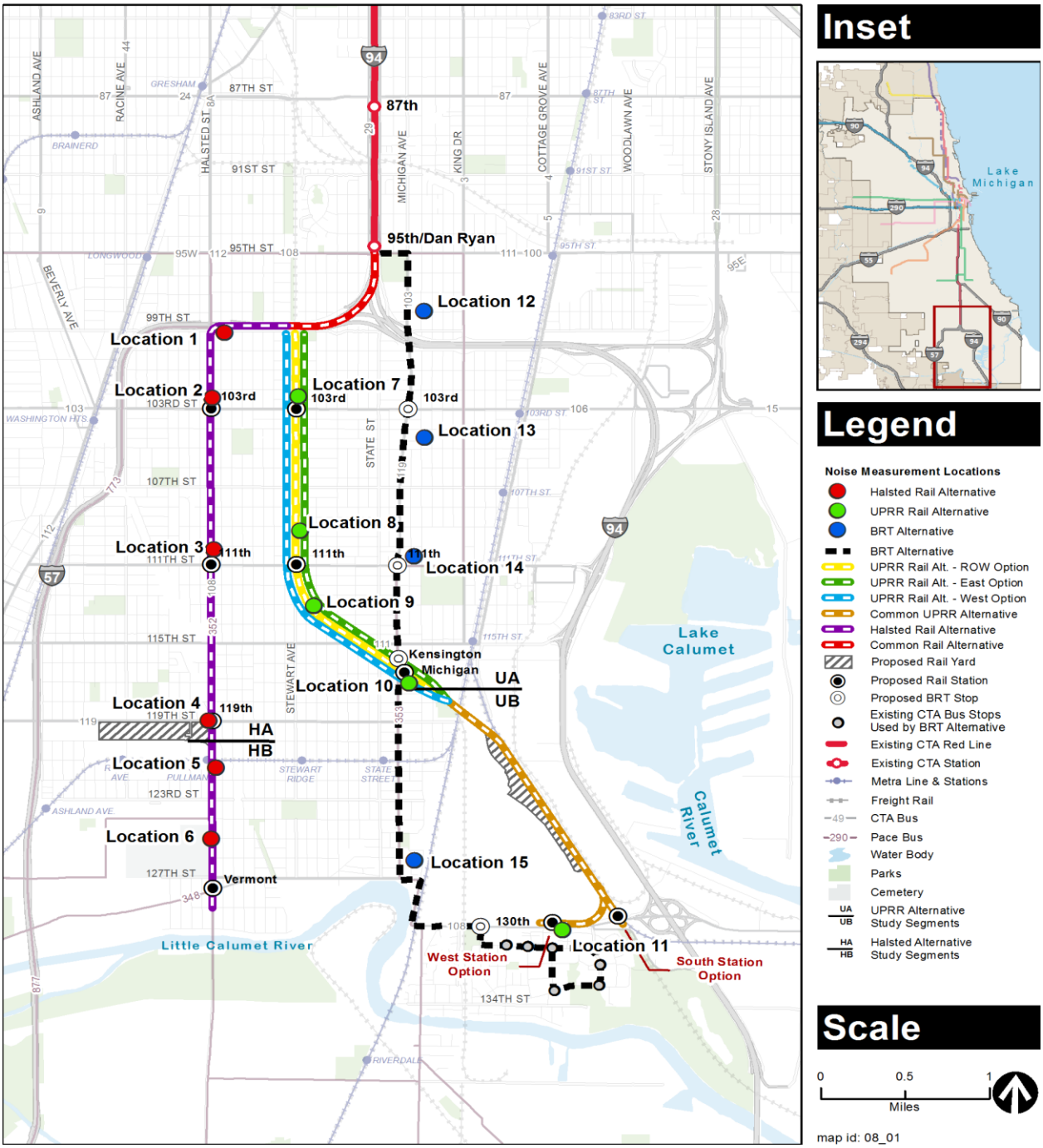

Figure 3-3: Noise Measurement Locations

3.4.2 Impact Assessment

Noise and vibration levels were predicted along the project corridor at the representative sensitive receptors within the project area for the proposed alternatives using FTA modeling methods as described in Section 3.4.2.1 below. Potential corridor-wide impacts were identified at noise-sensitive land uses based on model outcomes to determine areas where increases in noise would be moderate or severe. A similar assessment of the project-related vibration levels was performed to determine the location of vibration impacts. Total project noise levels (e.g., L_{eq} and L_{dn}) and single event transit pass-by vibration levels were compared to the FTA criteria to determine impacts. In addition, the predicted project build noise and vibration levels were compared to the existing measured noise and vibration levels to estimate any expected changes along the project corridor. Maximum hourly L_{eq} construction noise levels and equipment peak particle velocity (ppv) vibration levels were compared to FTA criteria to determine the potential impact during construction.

If the predicted noise and vibration levels exceeded the FTA criteria, the feasibility of abatement measures listed in the FTA guidance was evaluated for mitigating impacts at noise- and vibration-sensitive receptors. For locations where noise barriers were recommended, their feasibility was evaluated in a qualitative manner by identifying potential barrier locations, the approximate length and height of the noise barrier, and other factors that would limit barrier performance.

3.4.2.1 Noise Modeling Analysis

The FTA noise prediction guidance contains mathematical algorithms that allow the computation of project-generated noise levels at the representative receptor locations. The model requires inputs such as maximum noise levels at 50 feet for each type of noise source (e.g., rapid transit pass-bys, wheel squeal) that would occur along the RLE Project corridor. The reference source noise levels to be included in the assessment are described in Table 3-5. Inputs such as vehicle volumes, number of cars, and speeds were used to determine the predicted project noise levels at identified receptors within each of the project corridor alternatives. Other inputs such as track type (continuously welded rail), the presence of an intervening noise barrier, ground attenuation effects, and the shielding effects from rows of buildings were used to refine the modeling assessment. Each of the applicable noise metrics and criteria thresholds, as described in Section 3.2, were used to evaluate project-related noise impacts at receptor locations.

The rail operations proposed along the project corridor would consist of train types similar to those that currently operate along the Red Line corridor. These vehicles consist of electric powered passenger rail cars operating on jointed track. The analysis assumed continuous welded rail on an aerial closed deck structure throughout the RLE rail corridor (CTA 2012). Switches and other trackwork that would increase noise levels were also included in this noise analysis. Adjustments to the predicted noise levels for each pass-by included the following:

- Track type - aerial (closed deck concrete slab) with continuous welded rail
- Train speed

- Distance from the track to the receptor
- Number of cars per train
- Daytime and nighttime train volumes

Table 3-7 shows reference data such as maximum noise level (L_{max}), sound exposure level (SEL), and average acoustical source height for transit pass-by noise sources. The L_{max} level is the maximum noise level generated during the train pass-by. The SEL is the total sound energy generated by the train pass-by compressed into a 1-second time interval.

Table 3-7: Transit Sources Included in the Noise Impact Assessment

Description	Type[4]	Location	Noise Level[1] (L_{max})	Noise Level[1] (SEL)	Time[2] (seconds)	Height[3] (feet)
Rapid Transit Car Pass-bys	Mobile	Alignment	80	82	N/A[5]	2
Wheel Squeal	Stationary	Curves	100	136	4	0
Auxiliary Equipment - Rapid Transit[6]	Stationary	Stations	67	103	30	10

1. Reference Federal Transit Authority maximum noise levels (or L_{max}) or sound exposure levels (or SEL) are reported in A-weighted decibels (dBA) at a reference distance of 50 feet and 50 miles per hour (for mobile sources only).
2. Average duration time for various events is reported in seconds per vehicle or event.
3. The effective acoustical source heights are reported in feet above rail (for train source) or feet above ground.
4. Moving transit sources are modeled as mobile or line sources, while stationary sources are modeled as stationary or point sources.
5. N/A means not applicable. Pass-by and facility noise prediction equations do not require a duration time.
6. Auxiliary equipment refers to the air conditioning units under the passenger rail cars, which are the primary noise source when the trains are stopped at the stations.

Using the peak- and 24-hour train volumes provided by CTA for the build alternatives, pass-by noise levels from train operations were predicted at each of the identified receptor locations along each alternative alignment using the FTA fixed-guideway calculation algorithms from the FTA guidance manual.

3.4.2.2 Vibration Modeling Analysis

As with noise, the FTA guidance was used to predict vibration levels from transit operations. The FTA vibration model combines various algorithms with empirically developed ground surface curves to estimate transit vibration levels in average soil conditions. Figure 3-4 shows the FTA surface vibration curves that were used to predict ground-borne vibration and noise levels from transit operations at receptor locations. For each segment along the RLE Project corridor, other inputs, including source-, path-, and receptor-specific adjustment factors, are specified for each train/receptor combination. The model then computes rms velocity levels and converted ground-borne noise levels at each identified receptor location for single-event train pass-bys. These computed levels were then compared to the FTA ground-borne vibration impact criteria to

determine the onset of impact. As shown in Figure 3-4, vibration curves are specified for locomotives, rapid transit, and buses.

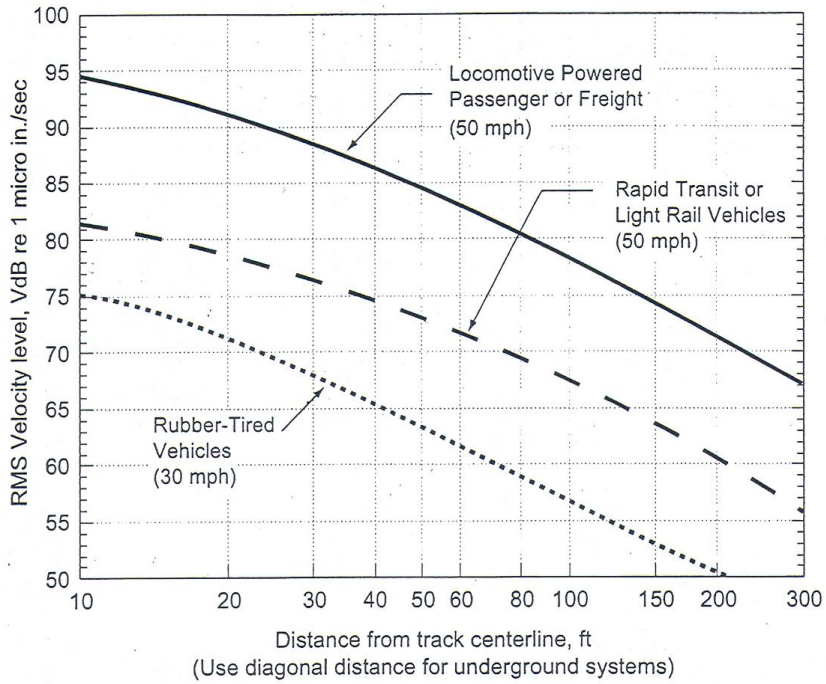

Figure 3-4: Increase in Noise Levels Allowed by Federal Transit Administration Criteria
Source: Transit Noise and Vibration Impact Assessment (FTA 2006)
Notes: mph = miles per hour, ft = feet, micro in./sec = microinch per second

3.4.2.3 Construction Noise and Vibration

Construction noise levels were calculated for the different phases of construction activity associated with the project. The type and number of pieces of construction equipment that could be required during each phase of construction are in the *Construction Technical Report*. Using the construction equipment reference source noise levels and the calculation methods described in the FTA guidance manual, estimates of predicted construction noise levels were determined for the representative receptors to determine potential impacts.

Peak particle velocity (ppv) in inches/second is the metric of interest for evaluating construction vibration impacts on buildings. The ppv is defined as the maximum instantaneous positive or negative peak of the vibration event. Although ppv is appropriate for evaluating the potential for building damage, it is not suitable for evaluating human response to vibration. Because it takes some time for the human body to respond to vibration signals, the average (rms) vibration level expressed in VdB was used to evaluate vibration impacts in terms of annoyance to humans. Vibration from construction activity is caused by general equipment operations, and is usually highest during pile-driving, blasting, soil compacting, jackhammering, and construction-related demolition activities. Construction equipment source vibration levels from the FTA guidance manual were used to assess the potential for structural damage to buildings (ppv) and human annoyance (rms VdB) to building occupants.

Section 4
Affected Environment

4.1 Noise Measurements

Noise measurements were obtained at a total of 15 representative locations near the alignments for the three project alternatives. These 15 measurement locations are shown in Figure 3-3. Six measurement locations were along the Halsted Rail Alternative alignment, five measurement locations were along the UPRR Rail Alternative alignment, and four locations were along the BRT Alternative alignment. All measurement locations represented sensitive receptors that might be affected by noise from the RLE Project.

The noise measurements were obtained during October 19–26, 2012, and consisted of 24-hour noise measurements at residential locations to determine the existing L_{dn} and highest hourly L_{eq} along each of the alignments. Table 4-1 shows the measured L_{dn} and L_{eq} obtained at each of the 15 locations.

4.1.1 BRT Alternative

Measurement Locations 12, 13, 14, and 15 were along Michigan Avenue, the proposed route of the BRT Alternative. The measured L_{dn} levels along Michigan Avenue were due to local street traffic and ranged from 60.8 dBA at measurement Location 13 to 65.5 dBA at measurement Location 15.

4.1.2 UPRR Rail Alternative

Measurement Locations 7, 8, 9, and 10 were along the UPRR Rail Corridor. Because of the existing freight rail operations along the UPRR Rail Corridor, the L_{dn} measurements were high, ranging from 74.6 dBA at Location 8 to 77.0 dBA at Location 9. Measurement Location 11 was at Altgeld Gardens along East 130 Place across from the proposed 130th Street West Station Option. The measured L_{dn} at Location 11 was 63.2 dBA due to the local street traffic on 130th Street.

4.1.3 Halsted Rail Alternative

The measured L_{dn} of 65.0 dBA at Location 1 at 9901 S. Emerald Avenue is representative of the traffic noise along I-57. Measurement Locations 2, 3, 5, and 6 were along Halsted Street, where L_{dn} measurements from local street traffic ranged from 60.5 dBA at Location 3 and 64.2 dBA at Location 2. Measurement Location 4 was along 119th Street adjacent to the proposed yard and shop location. The measured L_{dn} at Location 4 was 58.6 dBA.

Table 4-1: Noise Level Measurements at Representative Locations

Location Number	Receptor Description	Measured L_{dn}	Highest Hourly L_{eq}
Noise Measurement Locations along the BRT Alternative Alignment			
12	Residence at 9630 S. Michigan Avenue	63.7 dBA	63.2 dBA
13	Residence at 10445 S. Michigan Avenue	60.8 dBA	67.5 dBA
14	Residence at 12221 S. Michigan Avenue	64.1 dBA	63.7 dBA
15	Residence at 12505 S. Michigan Avenue	65.5 dBA	71.0 dBA
Noise Measurement Locations along the UPRR Rail Alternative Alignment			
7	Residence at 354 W. 102nd Place	75.5 dBA	76.7 dBA
8	Residence at 352 W. 109th Street	74.6 dBA	73.6 dBA
9	Residence at 307 W. 113th Street	77.0 dBA	78.4 dBA
10	Residence at 11718 S. Prairie Avenue	74.2 dBA	73.0 dBA
11	Altgeld Gardens (along East 130 Place)	63.2 dBA	62.5 dBA
Noise Measurement Locations along the Halsted Rail Alternative Alignment			
1	Residence at 9901 S. Emerald Avenue	65.0 dBA	64.5 dBA
2	Residence at 10229 S. Halsted Street	64.2 dBA	69.2 dBA
3	Residence at 11005 S. Halsted Street	60.5 dBA	59.1 dBA
4	Residence on 119th Street	58.6 dBA	59.7 dBA
5	Residence at 12125 S. Halsted Street	63.7 dBA	70.0 dBA
6	Residence at 12412 S. Halsted Street	61.6 dBA	68.4 dBA

Notes: L_{dn} = day-night average sound level, L_{eq} = hourly equivalent sound level, dBA = A-weighted decibels, BRT = Bus Rapid Transit, UPRR = Union Pacific Railroad

4.2 Vibration Measurements

Vibration measurements were obtained at four locations to determine the existing vibration levels along the alignments of each of the project alternatives. Vibration measurements were obtained at noise measurement Location 3 along the Halsted Rail Alternative alignment, vibration measurements were obtained at two locations along the UPRR Rail Alternative alignment (noise measurement Locations 7 and 9), and the fourth vibration measurement location was along the BRT Alternative alignment (noise measurement Location 13). The vibrations measured along Halsted Street and Michigan Avenue were due to local street traffic, primarily trucks and buses. Typical measured vibration levels from trucks and buses along Halsted Street and Michigan Avenue ranged from 60 to 70 VdB. The vibration levels measured along the UPRR Rail Corridor were due to freight rail operations. At a distance of approximately 100 feet from the freight train pass-bys, the measured vibration levels ranged from 75 to 80 VdB. Table 4-2 shows the results of the vibration measurements.

Table 4-2: Measured Vibration Levels

Location Number	Receptor Description	Measured Vibration Levels
Vibration Measurement Location along the BRT Alternative Alignment		
13	Residence at 10445 S. Michigan Avenue	60 to 70 VdB
Vibration Measurement Locations along the UPRR Rail Alternative Alignment		
7	Residence at 354 W. 102nd Place	75 to 80 VdB
9	Residence at 307 W. 113th Street	75 to 80 VdB
Vibration Measurement Location along the Halsted Rail Alternative Alignment		
3	Residence at 11005 S. Halsted Street	60 to 70 VdB

Notes: BRT = Bus Rapid Transit, UPRR = Union Pacific Railroad, VdB = decibels referenced to 1 microinch per second

Section 5
Impacts and Mitigations

The following sections describe the results of the noise and vibration analysis, identify areas of impact along each of the project alternatives, and present the results and effectiveness of the potential mitigation measures.

5.1 No Build Alternative

The No Build Alternative assumes no change in the existing conditions and therefore no change to the existing noise and vibration levels would occur within the project area.

5.1.1 Permanent Impacts and Mitigations – No Build Alternative

The No Build Alternative would result in no noise and vibration impacts. As a result, mitigation measures were not considered.

5.1.2 Construction Impacts and Mitigations – No Build Alternative

The No Build Alternative would not include any construction. As a result, mitigation measures were not considered.

5.2 Bus Rapid Transit Alternative

In accordance with FTA guidance for residential receptors, the L_{dn} measurements were used to determine the FTA moderate and severe impact criteria for the BRT Alternative using the curves in Figure 3-1. For example, the measured L_{dn} at location 12 was 63.7 dBA. From the curves in Figure 3-1, an existing L_{dn} noise exposure of 63.7 dBA for a residential receptor (Category 2) could result in a moderate noise impact criterion of 60.0 dBA, and a severe noise impact criterion of 65.4 dBA. Table 5-1 shows the measured L_{dn} at each of the four measurement locations along the BRT Alternative Alignment, along with the corresponding FTA moderate and severe noise impact criteria.

Table 5-1: Federal Transit Administration Moderate and Severe Impact Criteria for the Bus Rapid Transit Alternative

Location Number	Receptor Description	Measured Noise Level (L_{dn})	FTA Moderate Impact Criterion	FTA Severe Impact Criterion
12	Residence at 9630 S. Michigan Avenue	63.7 dBA	60.0 dBA	65.4 dBA
13	Residence at 10445 S. Michigan Avenue	60.8 dBA	58.2 dBA	63.8 dBA
14	Residence at 12221 S. Michigan Avenue	64.1 dBA	60.2 dBA	65.7 dBA
15	Residence at 12505 S. Michigan Avenue	65.5 dBA	61.2 dBA	66.5 dBA

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibel

For the BRT Alternative, buses would operate on 4-minute headways in each direction between the hours of 6 AM and 8 PM, and on 12-minute headways in each direction between the hours of 8 PM and 6 AM. Based on these headway times, the total number of northbound and southbound bus operations over a 24-hour period would be 520 (410 daytime bus operations between 7 AM and 10 PM, and 110 nighttime bus operations between 10 PM and 7 AM). Based on the number of daytime and nighttime bus operations and a speed of 35 miles per hour (mph), the 24-hour L_{dn} from the bus operations would be 62.1 dBA at a distance of 50 feet. Extrapolating this noise level using the distance attenuation methods described in the FTA guidance manual results in the impact distances within which moderate and severe noise impacts would occur for the BRT Alternative. For example, for noise measurement Location 12, which represents the existing noise level along the BRT Alternative alignment from 95th Street to 103rd Street, the noise at residential receptors within 69 feet of the buses would exceed the FTA's moderate impact criteria level of 60 dBA, and the noise at residential receptors within 30 feet of the buses would exceed the FTA's severe impact criteria level of 65.4 dBA shown in Table 5-1. Table 5-2 lists the moderate and severe impact distances for the BRT Alternative.

Table 5-2: Federal Transit Administration Moderate and Severe Impact Distances for the Bus Rapid Transit Alternative

Location Number	Receptor Description/(Area of Impact)	Measured Noise Level (L_{dn})	FTA Moderate Impact Distance	FTA Severe Impact Distance
12	Residence at 9630 S. Michigan Avenue/ (from 95th Street to 103rd Street)	63.7 dBA	69 feet	30 feet
13	Residence at 10445 S. Michigan Avenue/ (from 103rd Street to 115th Street)	60.8 dBA	91 feet	38 feet
14	Residence at 12221 S. Michigan Avenue/ (from 115th Street to 124th Street)	64.1 dBA	67 feet	29 feet
15	Residence at 12505 S. Michigan Avenue/ (from 124th Street to 130th Street)	65.5 dBA	57 feet	26 feet

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibel

5.2.1 Permanent Impacts and Mitigations – Bus Rapid Transit Alternative

Using the impact distances from Table 5-2, noise contours were developed for the BRT Alternative to show the areas of moderate and severe impact along the project corridor. Figures 5-1a through 5-1f show the BRT Alternative with the moderate and severe noise impact contours. From 95th Street to 103rd Street, the moderate noise impact distance would be 69 feet from the nearest bus lane, and the severe noise impact distance would be 30 feet from the nearest bus lane. From 103rd Street to 115th Street, the moderate noise impact distance would be 91 feet, and the severe noise impact distance would be 38 feet. From 115th Street to 124th Street, the moderate noise impact distance would be 67 feet, and the severe impact distance would be 29 feet. From 124th Street to 130th Street, the moderate noise impact distance would be 57 feet, and the severe noise impact distance would be 26 feet. Residential receptors within the FTA moderate noise impact contours shown in Figure 5-1 would be affected by the BRT Alternative.

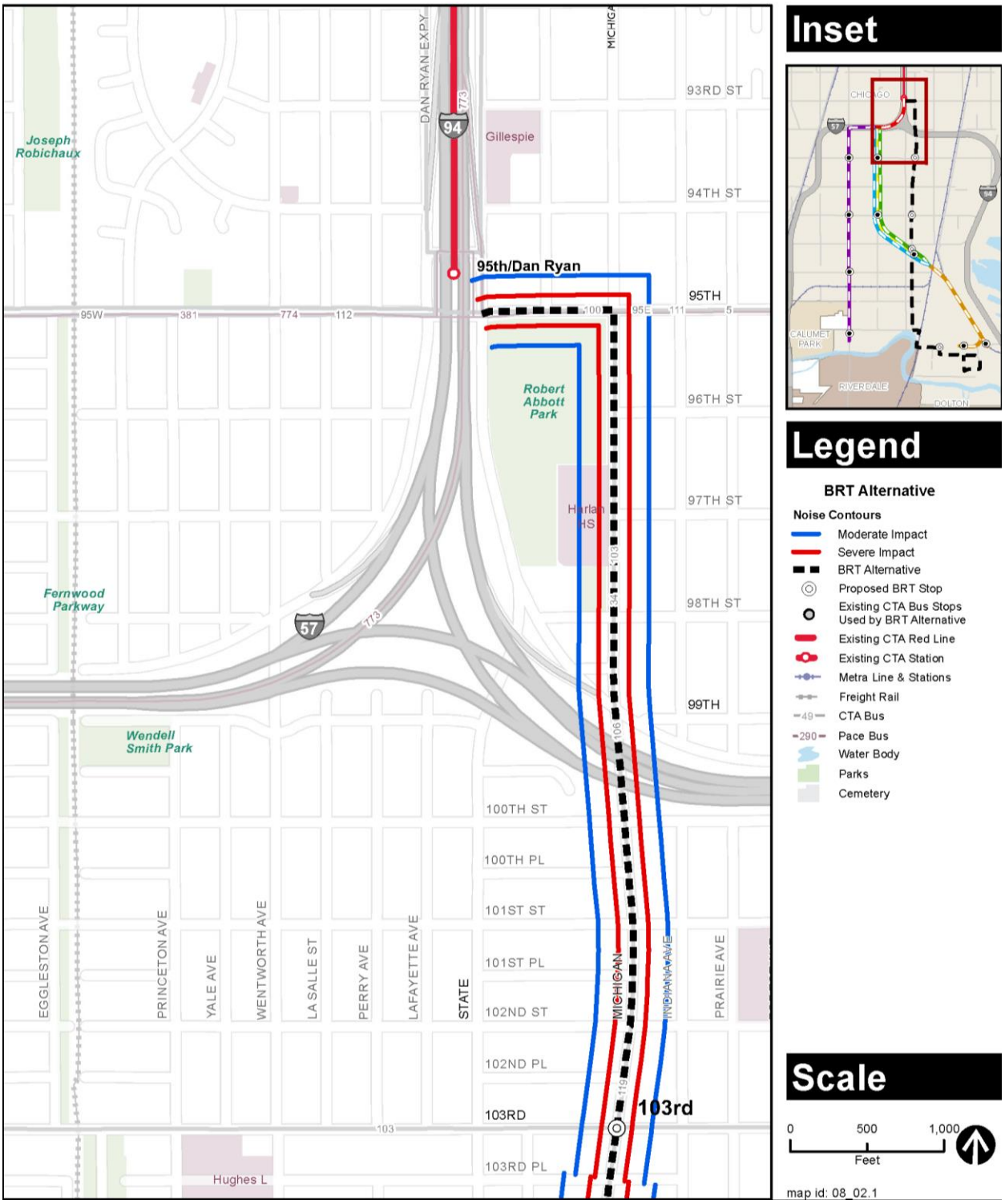

Figure 5-1a: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

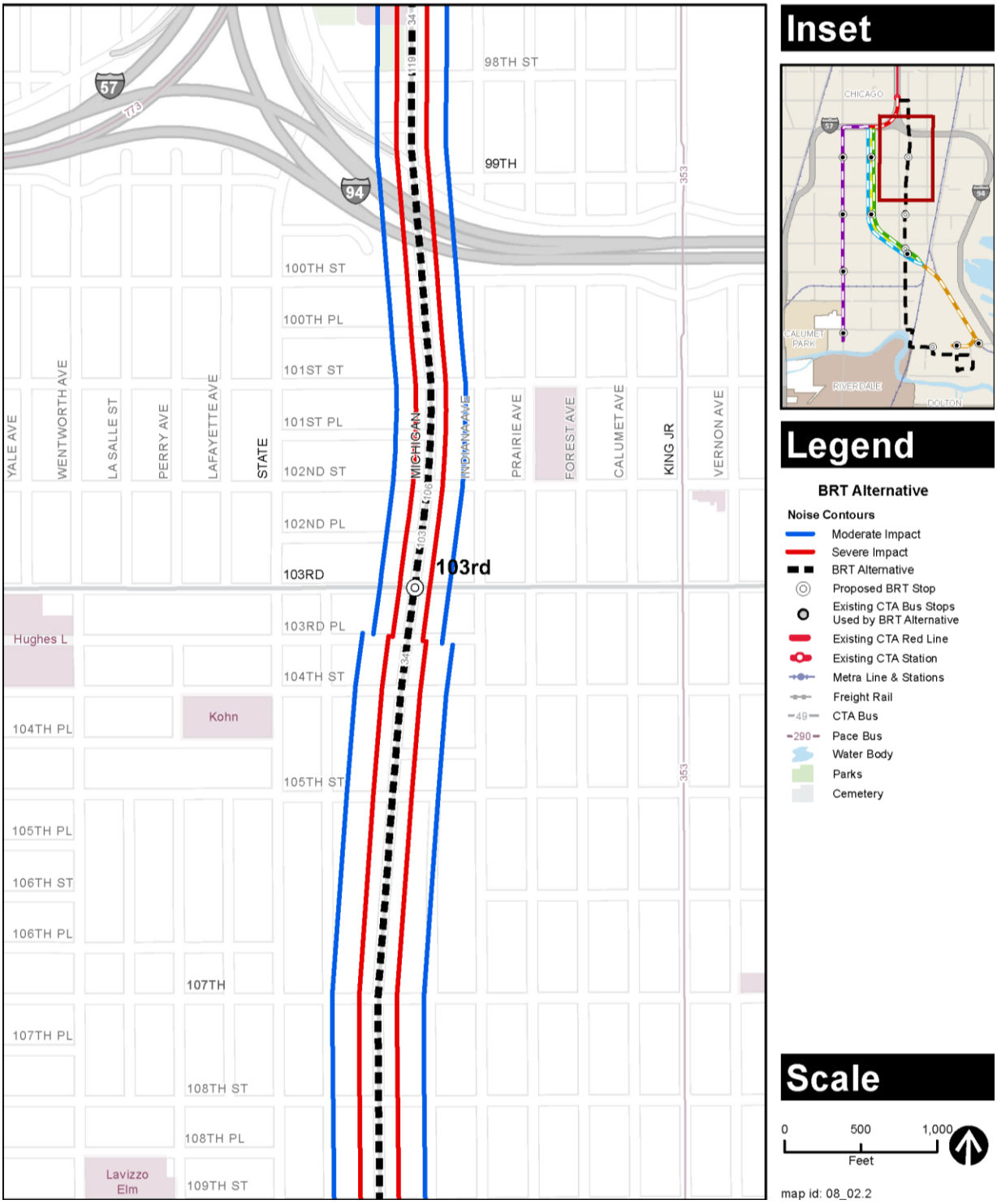

Figure 5-1b: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

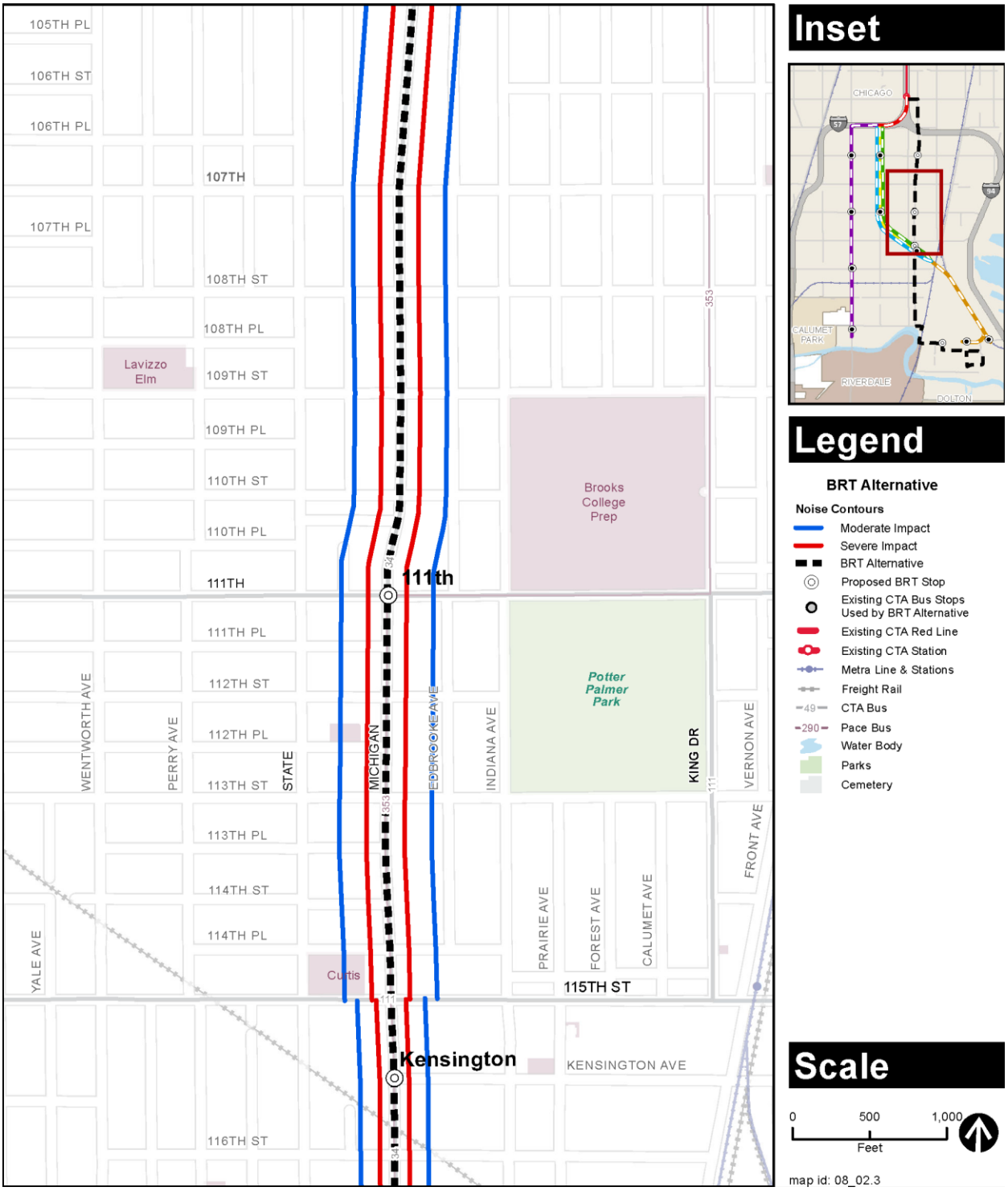

Figure 5-1c: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

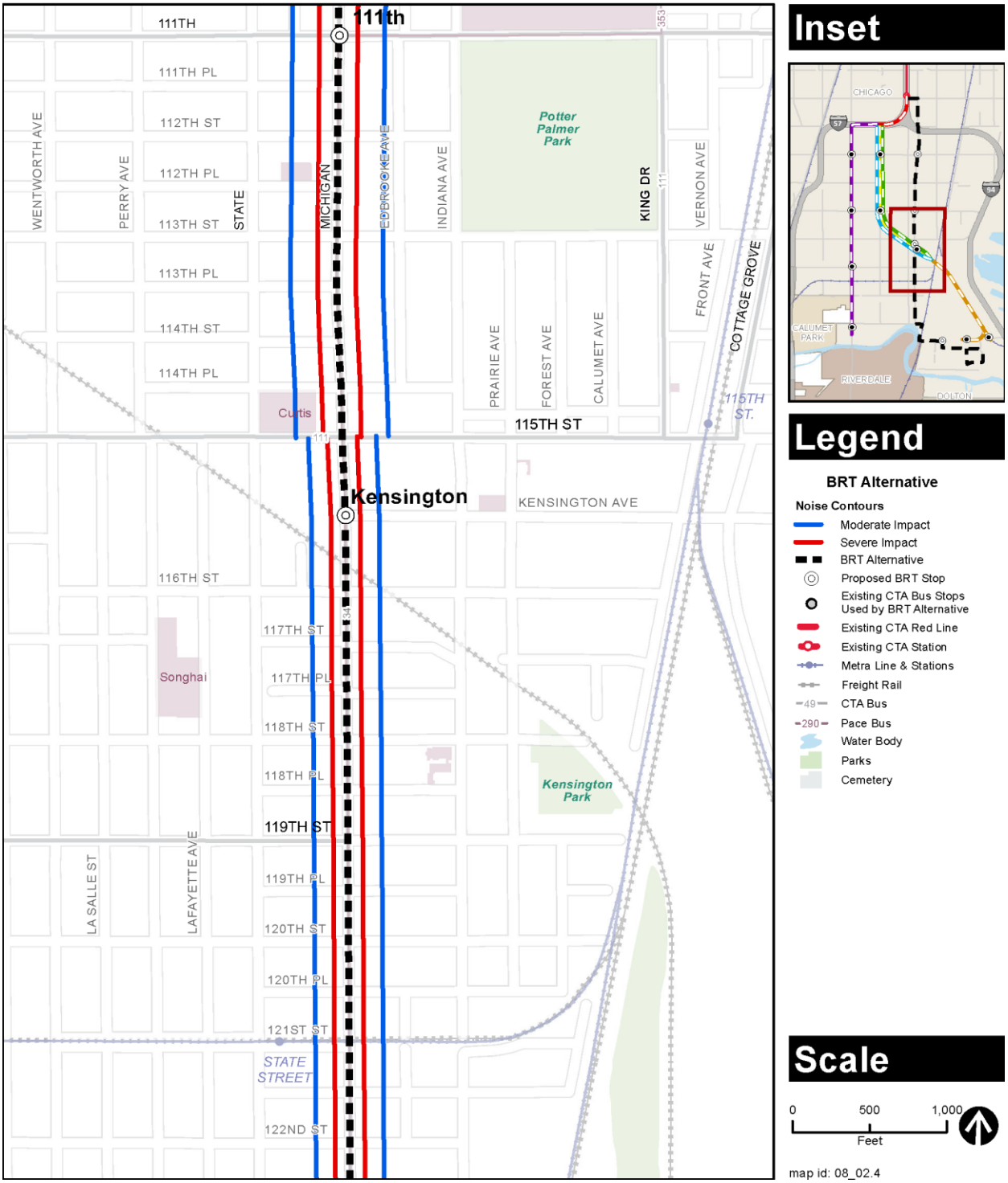

Figure 5-1d: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

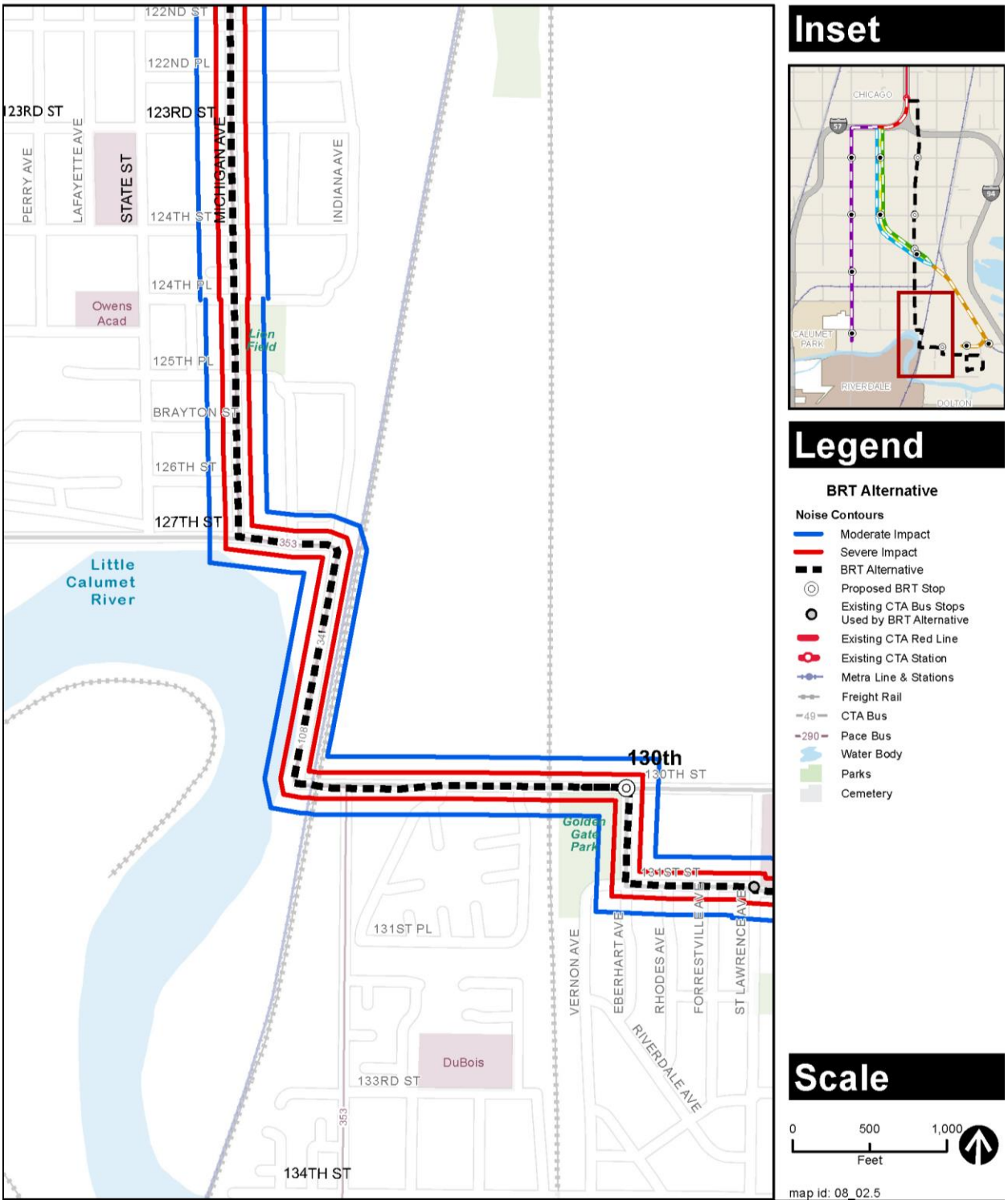

Figure 5-1e: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

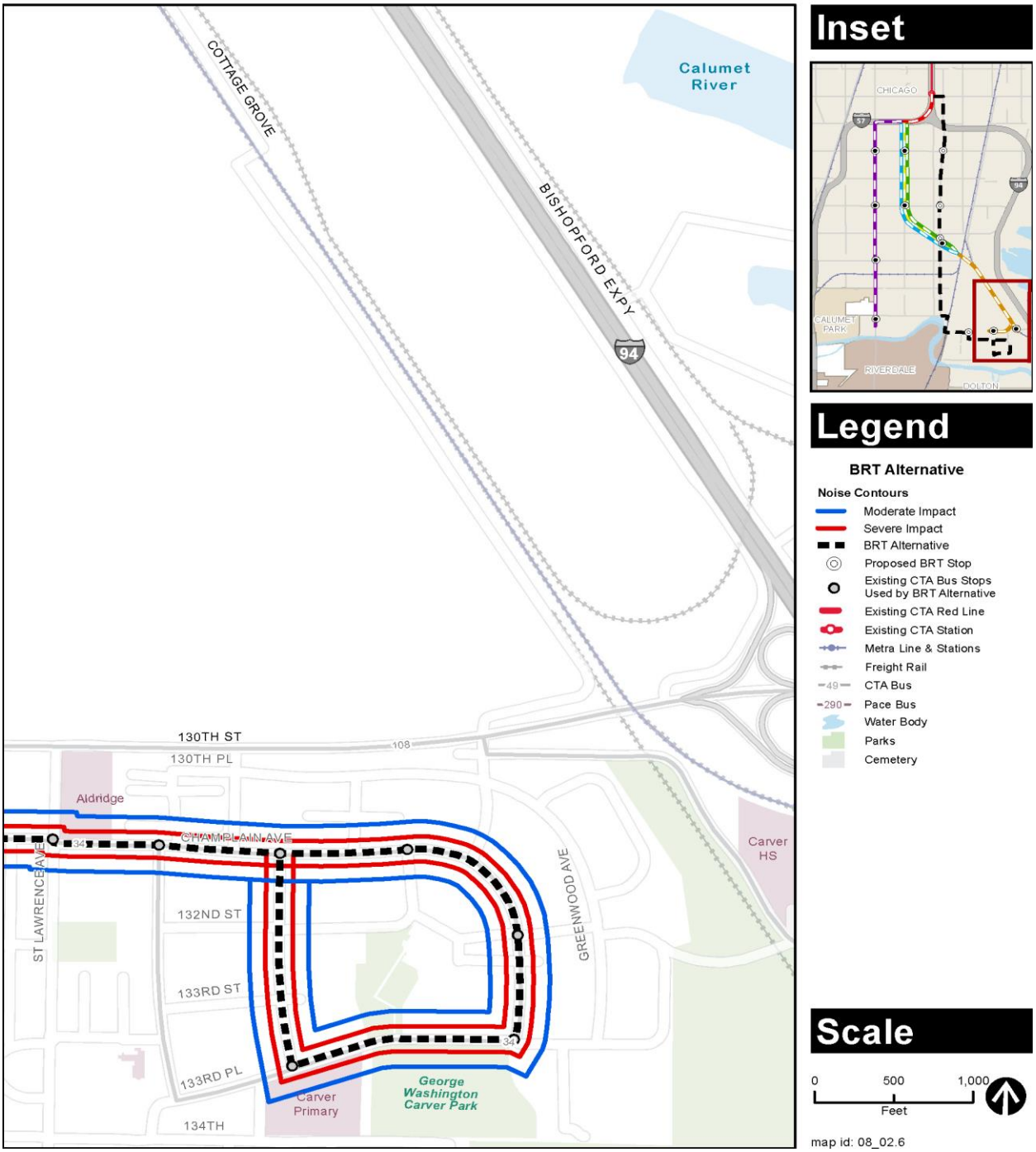

Figure 5-1f: Bus Rapid Transit Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

Because the buses would travel along local streets that have small blocks, numerous cross streets, and driveways, noise abatement mitigation such as barriers would not be feasible for the BRT Alternative.

5.2.2 Construction Impacts and Mitigations – Bus Rapid Transit Alternative

Construction noise from the BRT Alternative is expected to consist of minor construction activity at the stop locations. Construction noise levels are not expected to exceed the FTA construction noise limits described in Table 3-3.

5.3 Union Pacific Railroad Rail Alternative - Right-of-Way Option

For the UPRR Rail Alternative, the trains would operate on an aerial structure with continuous welded rail. Based on the headway times shown in Table 5-3, the total number of northbound and southbound trains over a 24-hour period would be 378 (286 daytime trains between 7 AM and 10 PM, and 92 nighttime trains between 10 PM and 7 AM). Based on the number of daytime and nighttime trains traveling at a speed of 55 mph, the 24-hour L_{dn} would be 76.3 dBA at a distance of 50 feet. Near the stations, where the trains would decelerate and accelerate as they enter and leave the station area, the 24-hour L_{dn} would be 65.0 dBA.

Table 5-3: Proposed Red Line Extension Train Operations

Service Period	Time Period	Hours	Average Northbound Headways	Number of Cars/Train
Early Morning	3 AM to 6 AM	3	13 minutes	8
AM Peak	6 AM to 9 AM	3	5 minutes	8
Mid-day	9 AM to 3 PM	6	7 minutes	8
PM Peak	3 PM to 6 PM	3	5 minutes	8
Evening	6 PM to 10 PM	4	7.5 minutes	4
Nighttime	10 PM to 3 AM	5	15 minutes	4

5.3.1 Permanent Impacts and Mitigations – Union Pacific Railroad Rail Alternative - Right-of-Way Option

The UPRR Rail Alternative ROW Option would only occur if the freight relocation project were implemented prior to RLE Project. As a result, the noise levels along the rail corridor would decrease by 5 to 7 dBA due to the removal of the freight operations. Because of the reduction in noise level due to replacing the freight operations with the RLE Project, noise mitigation was not considered for the UPRR ROW Option.

With regard to vibration, no mitigation measures are proposed. The aerial structure with continuously welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB at the residential receptors along the project corridor. In addition, by moving the freight operations out of the rail corridor, the existing vibration levels generated during freight rail pass-bys would be eliminated from the rail corridor.

5.3.1.1 Segment UA

Because of the reduction in noise level due to replacing the freight operations with the rail transit operations, noise mitigation was not considered for the UPRR ROW Option.

5.3.1.2 Segment UB

Because of the reduction in noise level due to replacing the freight rail operations with the rail transit operations, noise mitigation was not considered for the UPRR ROW Option.

5.3.2 Construction Impacts and Mitigations – Union Pacific Railroad Rail Alternative - Right-of-Way Option

This alternative would include the construction of an aerial structure, stations, and parking facilities at the stations. Typical construction equipment could include excavators, front-end loaders, cranes, drilling rigs, compressors, and trucks depending on the type of construction work required. The FTA construction noise impact assessment is based on the cumulative noise level from the two loudest pieces of equipment that, under worst-case conditions, would operate continuously at full power over a period of 1 hour. From the list of construction equipment in the FTA guidance manual, the two noisiest pieces of equipment would be the excavator (85 dBA at a distance of 50 feet) and truck (88 dBA at a distance of 50 feet). The combined noise level from these two pieces of equipment is 90 dBA at a distance of 50 feet. In addition to equipment mentioned, pile-driving may be required to support permanent structures such as the aerial track structure. Pile-driving can produce maximum short-term noise levels of 101 dBA at 50 feet. Actual levels vary, depending on the distance and topographical conditions between the pile-driving location and the receiver location. An alternative to impact pile-driving is to drill holes and use impact only to set piles. Using the recommended FTA construction noise limits described in Table 3-3, any construction activity that occurred within 50 feet of a noise sensitive receptor could result in a noise impact during daytime hours. For commercial and industrial areas, the FTA daytime construction noise impact criterion is 100 dBA. For construction that occurs during nighttime hours, the FTA construction noise limit is 80 dBA for residential receptors, resulting in an impact distance of 150 feet.

Construction noise levels are not expected to exceed the FTA recommended construction noise limits. There are no noise sensitive receptors within 50 feet of construction. As a result, construction noise mitigation measures were not considered. Construction activities would, however, be limited to daytime hours for locations that are within 150 feet of the residential locations, and all construction equipment exhaust mufflers would be kept in a state of good repair. As part of the construction specifications, the contractor would be responsible for adhering to the noise control requirements of the project. To the maximum extent possible, vehicles not in use would not remain idling on the construction site. For construction that could occur during the nighttime hours within the expressway median, there would be no residential receptors within 150 feet of the construction activity and no noise impacts are anticipated.

High-vibration activities during construction include demolition of buildings, construction of aerial structures, pavement breaking, and ground compaction. Vibration limits are the levels at which there is a risk for damage, not the level at which damage would occur. The impact

threshold distances were calculated and it was determined from the analysis that most of the equipment can be operated without risk of damage at distances of 15 feet or greater from non-engineered timber and masonry buildings or at distances of 8 feet or greater from reinforced concrete buildings. Pile-driving activities would be avoided in the vicinity of the historic Roseland Pumping Station.

5.3.3 120th Street Yard and Shop

Because there are no sensitive receptors in the vicinity of the 120th Street yard and shop site and because of the much lower amount of train activity in and out of the facility and the lower train speeds compared to other parts of the project corridor, the noise levels generated in this area are anticipated to be lower than the noise levels generated along other parts of the project corridor even with noise generated by maintenance activities conducted at the yard and shop. As a result, the noise generated at the 120th Street yard and shop would not exceed the FTA impact criteria at the nearest sensitive receptors. Therefore, noise mitigation was not considered at the 120th Street yard and shop. In addition, because there are no sensitive receptors in the vicinity of the 120th Street yard and shop site, there would be no construction noise impacts.

5.4 Union Pacific Railroad Rail Alternative - East Option

In accordance with FTA guidance for residential receptors, the L_{dn} measurements were used to determine the FTA moderate and severe impact criteria for the UPRR Rail Alternative using the curves in Figure 3-1. Table 5-4 shows the measured L_{dn} at each of the five measurement locations along the UPRR Rail Alternative alignment, along with the corresponding FTA moderate and severe noise impact criteria.

Table 5-4: Federal Transit Administration Moderate and Severe Impact Criteria for the Union Pacific Railroad Rail Alternative

Location Number	Receptor Description	Measured Noise Level (L_{dn})	FTA Moderate Impact Criterion	FTA Severe Impact Criterion
7	Residence at 354 W. 102nd Place	75.5 dBA	65.0 dBA	73.6 dBA
8	Residence at 352 W. 109th Street	74.6 dBA	65.0 dBA	72.9 dBA
9	Residence at 307 W. 113th Street	77.0 dBA	65.0 dBA	74.8 dBA
10	Residence at 11718 S. Prairie Avenue	74.2 dBA	65.0 dBA	72.6 dBA
11	Altgeld Gardens (along East 130th Place)	63.2 dBA	59.7 dBA	65.1 dBA

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA= A-weighted decibels

For the UPRR Rail Alternative, the trains would operate on a new aerial structure with continuous welded rail. For the East Option, the aerial structure would be located along the east side of the UPRR rail corridor. Based on the headway times shown in Table 5-3, the total number of northbound and southbound trains over a 24-hour period would be 378 (286 daytime trains between 7 AM and 10 PM, and 92 nighttime trains between 10 PM and 7 AM). Based on the number of daytime and nighttime trains traveling at a speed of 55 mph, the 24-hour L_{dn} would be

76.3 dBA at a distance of 50 feet. Extrapolating this noise level using the distance attenuation methods described in the FTA guidance manual results in the impact distances within which moderate and severe noise impacts would occur for the UPRR Rail Alternative. Table 5-5 indicates the moderate and severe impact distances for the UPRR Rail Alternative.

Table 5-5: Federal Transit Administration Moderate and Severe Impact Distances - Union Pacific Railroad Rail Alternative - East Option (at 55 miles per hour)

Location Number	Receptor Description	Measured Noise Level (L_{dn})	FTA Moderate Impact Distance	FTA Severe Impact Distance
7	Residence at 354 W. 102nd Place	75.5 dBA	280 feet	75 feet
8	Residence at 352 W. 109th Street	74.6 dBA	280 feet	85 feet
9	Residence at 307 W. 113th Street	77.0 dBA	280 feet	65 feet
10	Residence at 11718 S. Prairie Avenue	74.2 dBA	280 feet	90 feet
11	Altgeld Gardens (along East 130 Place at 45 mph)	63.2 dBA	265 feet	117 feet

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibels

At the stations, where the trains idle, the 24-hour L_{dn} is 65.0 dBA. Extrapolating this noise level using the distance attenuation methodology described in the FTA guidance manual results in the impact distances within which moderate and severe noise impacts are expected to occur for the UPRR Rail Alternative. Table 5-6 indicates the moderate and severe impact distances from the idling trains at the station for the UPRR Rail Alternative East Option.

Table 5-6: Federal Transit Administration Moderate and Severe Impact Distances - Union Pacific Railroad Rail Alternative - East Option (at the Stations)

Location Number	Receptor Description/(Station Location)	Measured Noise Level (L_{dn})	FTA Moderate Impact Distance	FTA Severe Impact Distance
7	Residence at 354 W. 102nd Place/ (103rd Street station)	75.5 dBA	50 feet	13 feet
8	Residence at 352 W. 109th Street/ (111th Street station)	74.6 dBA	50 feet	15 feet
10	Residence at 11718 S. Prairie Avenue/ (Michigan station)	74.2 dBA	50 feet	15 feet
11	Altgeld Gardens (along East 130th Place)/ (130th Street station - West and South Station Options)	63.2 dBA	110 feet	50 feet

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibels

5.4.1 Permanent Impacts and Mitigations – Union Pacific Railroad Rail Alternative - East Option

Using the impact distances from Tables 5-5 and 5-6, noise contours were developed for the UPRR Rail Alternative East Option to show the areas of moderate and severe impact along the project corridor. Figures 5-2a through 5-2e show the East Option with both the moderate and severe noise impact contours. From I-57 to the Metra Electric District rail corridor, the moderate noise impact distance would be 280 feet from the centerline of the RLE aerial structure. Near the proposed stations, the moderate noise impact distance would be 50 feet. For the 130th Street station options, the moderate noise impact distance would be 110 feet. Residential receptors within these noise contours would be affected by implementation of the East Option. In addition, there would be a transition zone that extends for a distance of approximately 200 feet north and south of the station platforms where the trains decelerate and accelerate as they enter and leave the station area. Residential receptors within the noise contours shown in Figure 5-2 in the transition zones north and south of the stations would be affected by implementation of the East Option.

From I-57 to 103rd Street, the severe noise impact distance would be 75 feet. From 103rd Street to 111th Street, the severe noise impact distance would be 85 feet. From 111th Street to the Michigan Avenue station, the severe noise impact distance would be 65 feet. From the Michigan Avenue station to the Metra Electric District rail corridor, the severe noise impact distance would be 90 feet. Near the proposed stations, the severe noise impact distance would be approximately 15 feet. For the 130th Street station options, however, the severe noise impact distance would be 50 feet.

Figures 5-2a through 5-2e show the UPRR Rail Alternative East Option with both the moderate and severe noise impact contours. Mitigation measures for noise-affected residential receptors along the project corridor were considered. The moderate impact noise contours shown in Figure 5-2a through 5-2d extend into the residential areas along both sides of the rail corridor. As a result, noise barriers were considered along both sides of the aerial structure from the 95th Street Terminal to the Metra Electric District Rail Corridor. Noise barriers were not considered south of the Metra Electric District Rail Corridor because this area is primarily industrial land use. A noise barrier approximately 4 feet in height (measured from the top surface of the concrete deck) installed along the outer tracks of the aerial structure would reduce the wheel/rail noise that would propagate into the surrounding community. A noise barrier approximately 4 feet in height would provide a 7 to 10-dBA reduction in noise level in the surrounding community. A noise barrier approximately 4 feet in height on the aerial structure that would provide a 10-dBA reduction could result no impacts remaining after mitigation. Figures 5-2a through 5-2e show the location of the proposed noise barriers for the UPRR Rail Alternative East Option.

With regard to vibration, no mitigation measures are proposed. The aerial structure with continuously welded rail could result in vibration levels that would be below the FTA impact criterion of 72 VdB at the noise sensitive receptors along the project corridor.

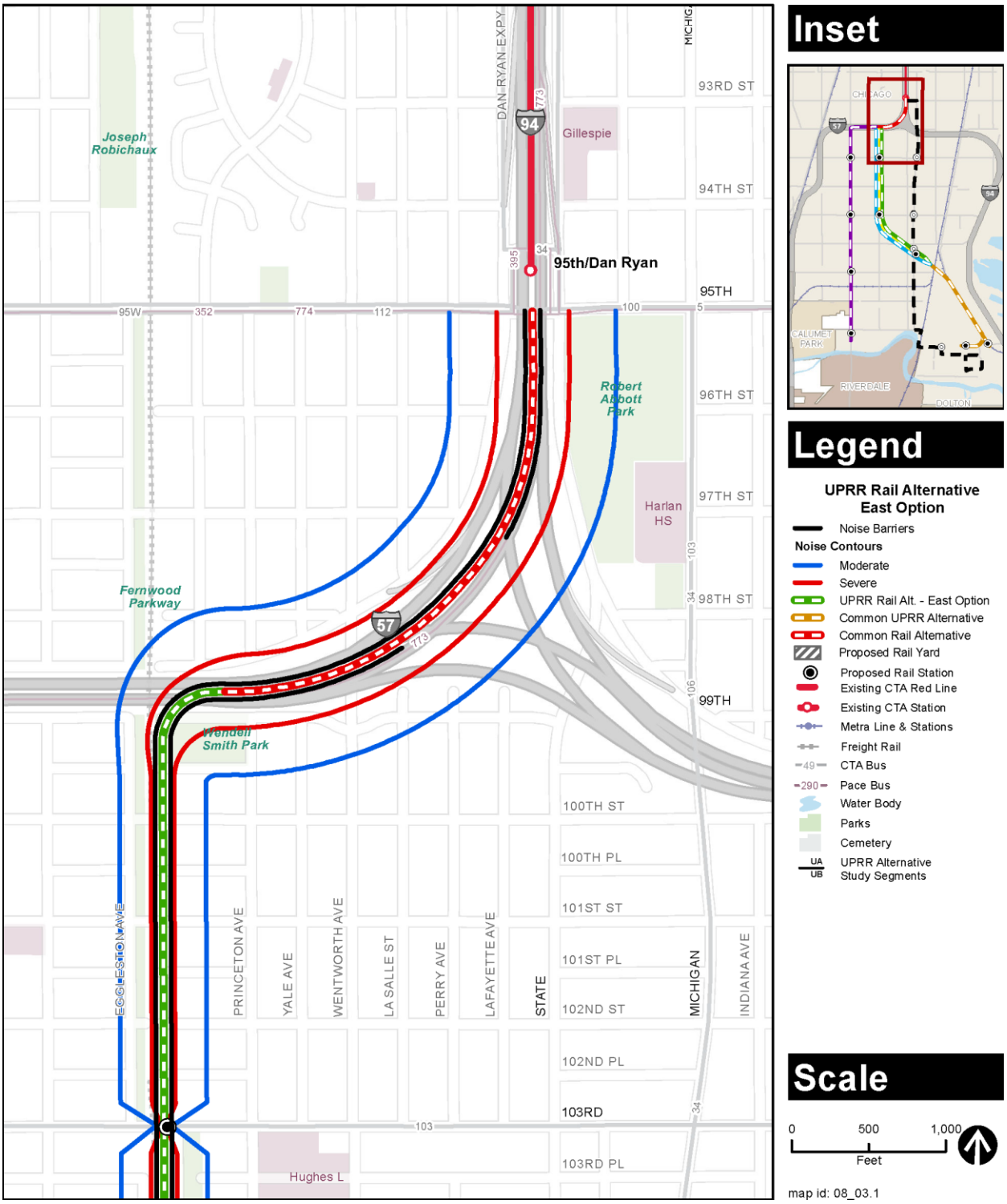

Figure 5-2a: Union Pacific Railroad Rail Alternative - East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

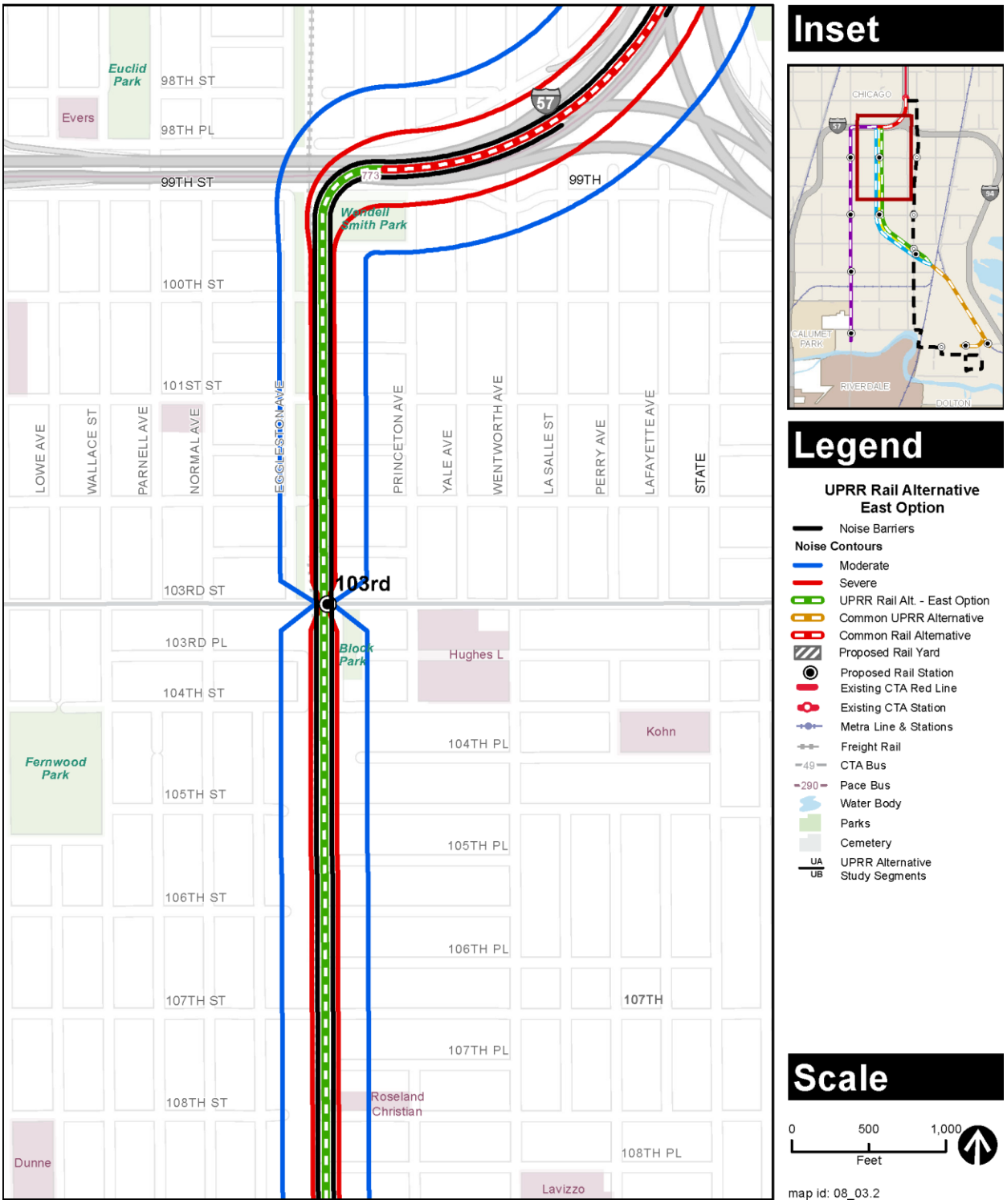

Figure 5-2b: Union Pacific Railroad Rail Alternative - East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

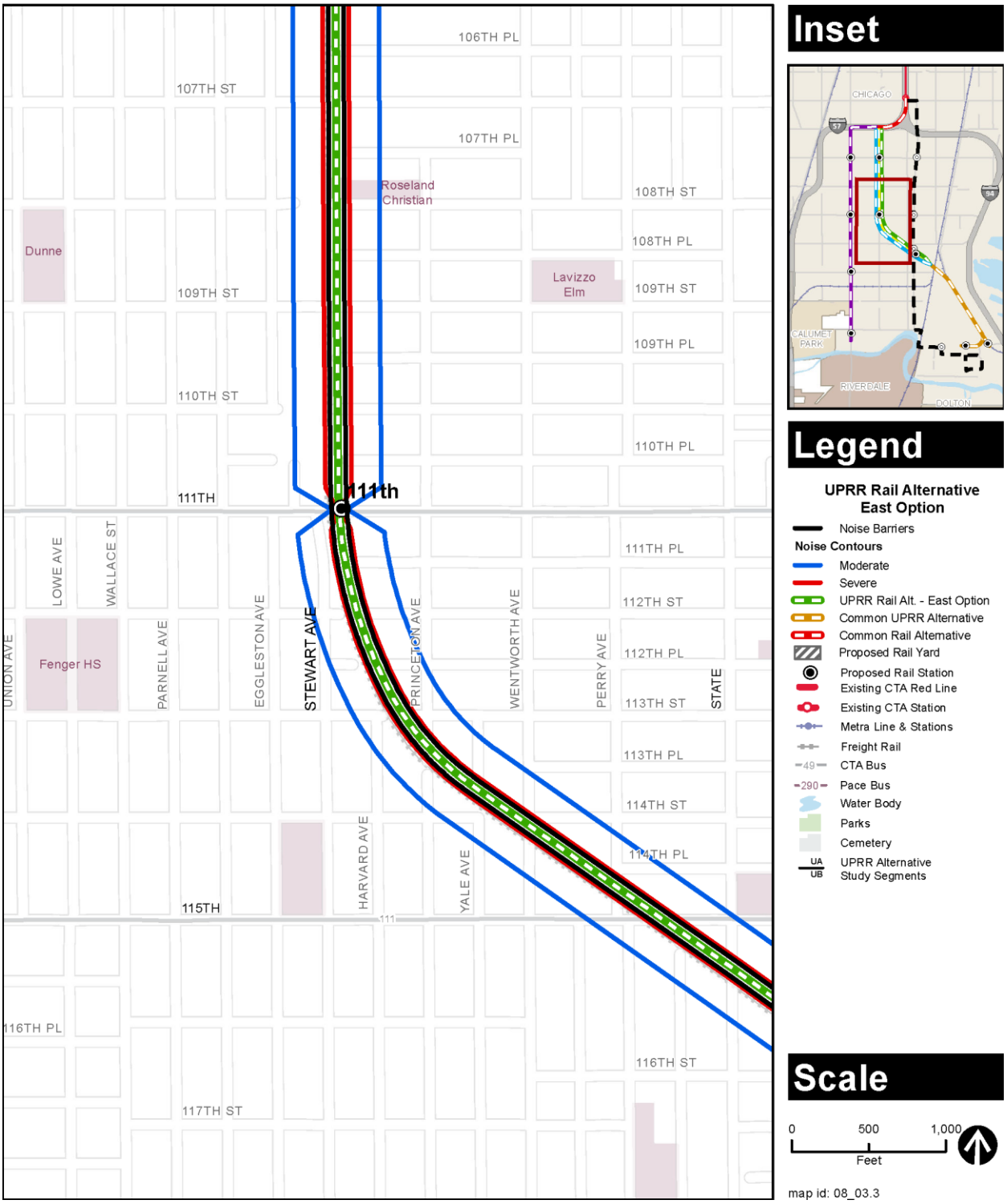

Figure 5-2c Union Pacific Railroad Rail Alternative – East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

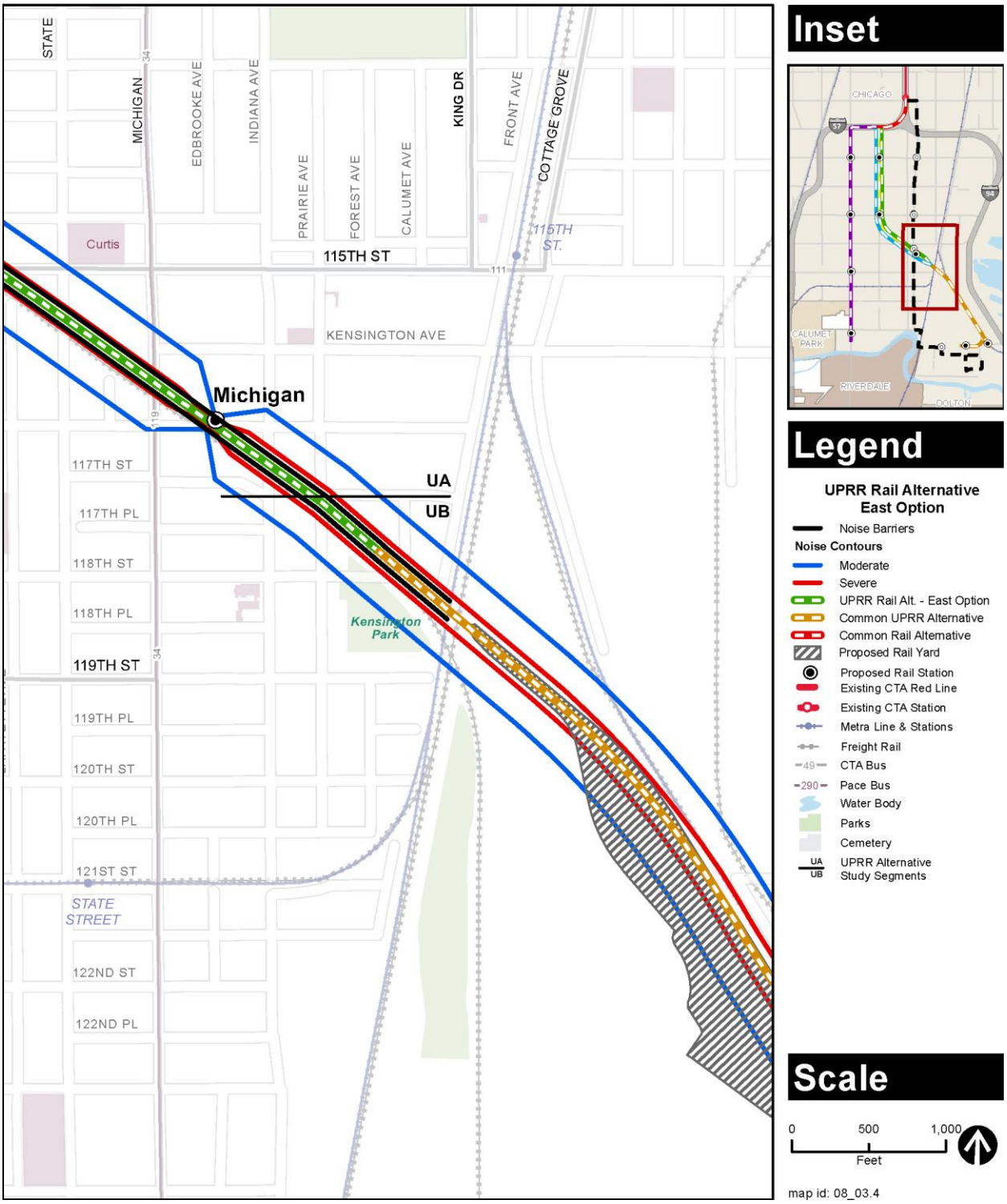

Figure 5-2d: Union Pacific Railroad Rail Alternative - East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

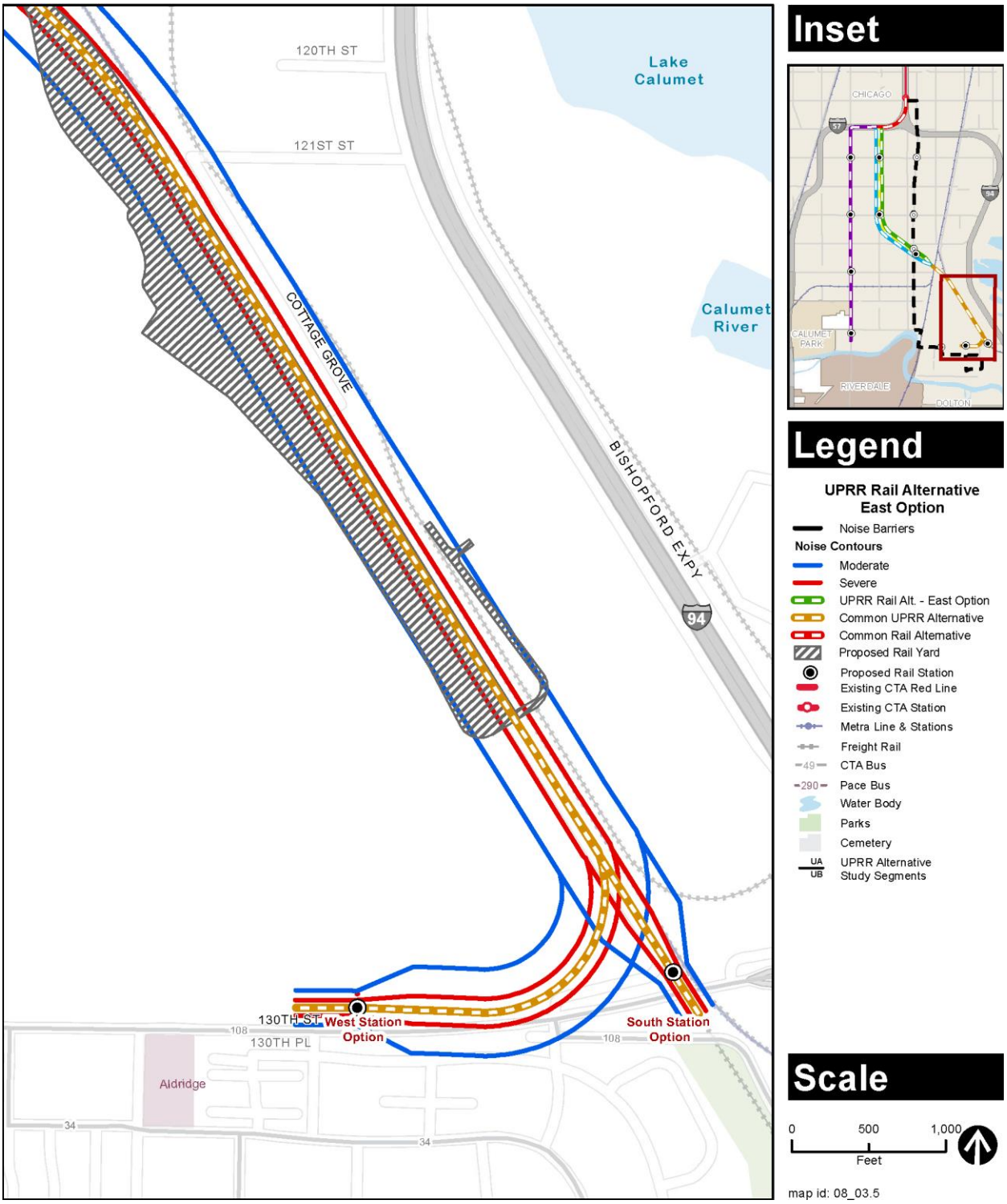

Figure 5-2e: Union Pacific Railroad Rail Alternative - East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

5.4.1.1 Segment UA

Segment UA of the UPRR Rail Alternative is north of Michigan Avenue. As shown in Figure 5-2, there would be a substantial number of affected receptors along this section of the rail corridor where the train speeds reach 55 mph.

5.4.1.2 Segment UB

Segment UB of the UPRR Rail Alternative is south of Michigan Avenue. Although there would be affected receptors between Michigan Avenue and the Metra Electric District Rail Corridor, there would be no affected receptors south of the Metra Electric District Rail Corridor. This area of the rail corridor consists primarily of industrial land use.

5.4.2 Construction Impacts and Mitigations – Union Pacific Railroad Rail Alternative - East Option

As it would be for the UPRR ROW Option, this alternative would include the construction of an aerial structure, stations, and parking facilities at the stations. Construction noise impacts would be the same as for the UPRR ROW Option. Construction noise levels are not expected to exceed the FTA recommended construction noise limits. As a result, construction noise mitigation measures were not considered. This analysis assumes that the same noise-reducing construction practices described for the UPRR ROW Option would be used for the East Option.

As with the UPRR ROW Option, no vibration impacts are anticipated from construction. The impact threshold distances were calculated for vibration and it was determined from the analysis that most of the equipment can be operated without risk of damage at distances of 15 feet or greater from non-engineered timber and masonry buildings or at distances of 8 feet or greater from reinforced concrete buildings. Pile-driving activities would be avoided in the vicinity of the historic Roseland Pumping Station.

5.4.3 120th Street Yard and Shop

Because there are no sensitive receptors in the vicinity of the 120th Street yard and shop and because of the much lower amount of train activity in and out of the facility and the lower train speeds compared to other parts of the project corridor, the noise levels generated in this area are anticipated to be lower than the noise levels generated along other parts of the project corridor even with noise generated by maintenance activities conducted at the yard and shop. As a result, the noise generated at the 120th Street yard and shop would not exceed the FTA impact criteria at the nearest sensitive receptors. Therefore, noise mitigation was not considered at the 120th Street yard and shop. In addition, because of the distance from the nearest noise sensitive receptors, there would be no construction noise impacts.

5.5 Union Pacific Railroad Rail Alternative - West Option

The results of the noise assessment for the UPRR Rail Alternative West Option are identical to the analysis results for the UPRR Rail Alternative East Option discussed in Section 5.4. The same moderate and severe noise impact contour distances would be applied to the West Option alignment. See Table 5-4 for the impact criteria and impact distances.

For the West Option, the aerial structure for the trains would be located along the west side of the UPRR rail corridor. See Table 5-5 for the moderate and severe impact distances for the UPRR Rail Alternative East Option, which would be the same for the West Option. Likewise, the moderate and severe impact distances from the idling trains at the station would be the same as for the East Option, as shown in Table 5-6.

5.5.1 Permanent Impacts and Mitigations – Union Pacific Railroad Rail Alternative - West Option

Using the impact distances from Tables 5-4 and 5-5, noise contours were developed for the UPRR Rail Alternative West Option to show the areas of moderate and severe impact along the project corridor. Figures 5-3a through 5-3e show the West Option with both the moderate and severe noise impact contours. From I-57 to the Metra Electric District rail corridor, the moderate noise impact distance would be 280 feet from the centerline of the RLE aerial structure. Near the proposed stations, the moderate noise impact distance would be 50 feet. For the 130th Street station options, however, the moderate noise impact distance would be 110 feet because of the lower measured noise levels near this station location. Residential receptors within these noise contours would be affected by noise. In addition, there is a transition zone that extends for a distance of approximately 200 feet north and south of the station platforms where the trains decelerate and accelerate as they enter and leave the station area. Residential receptors within the noise contours shown in Figure 5-3 in the transition zones north and south of the stations would be affected by noise.

From I-57 to 103rd Street, the severe noise impact distance would be 75 feet. From 103rd Street to 111th Street, the severe noise impact distance would be 85 feet. From 111th Street to the Michigan Avenue station, the severe noise impact distance would be 65 feet. From the Michigan Avenue station to the Metra Electric District rail corridor, the severe noise impact distance would be 90 feet. Near the proposed stations, the severe noise impact distance would be approximately 15 feet. For the 130th Street station options, however, the severe noise impact distance would be 50 feet.

Figures 5-3a through 5-3e show the UPRR Rail Alternative West Option with both the moderate and severe noise impact contours. Mitigation measures for noise-affected residential receptors along the project corridor were considered. The moderate impact noise contours shown in Figures 5-3a through 5-3d extend into the residential areas along both sides of the rail corridor. As a result, noise barriers were considered along both sides of the aerial structure from the 95th Street Terminal to the Metra Electric District Rail Corridor. Noise barriers would not be required south of the Metra Electric District Rail Corridor because this area is primarily industrial land use. A noise barrier approximately 4 feet in height installed along the outer tracks of the aerial structure would reduce the wheel/rail noise that would propagate into the surrounding community. A noise barrier approximately 4 feet in height would provide a 7 to 10-dBA reduction in noise level in the surrounding community. A noise barrier approximately 4 feet in height on the aerial structure that would provide a 10-dBA reduction could result in no impacts remaining after mitigation. Figures 5-3a through 5-3e show the location of the proposed noise barriers for the UPRR Rail Alternative West Option.

With regard to vibration, no mitigation measures are proposed. The new aerial structure with continuously welded rail could result in vibration levels that would be below the FTA impact criterion of 72 VdB at noise sensitive receptors along the project corridor.

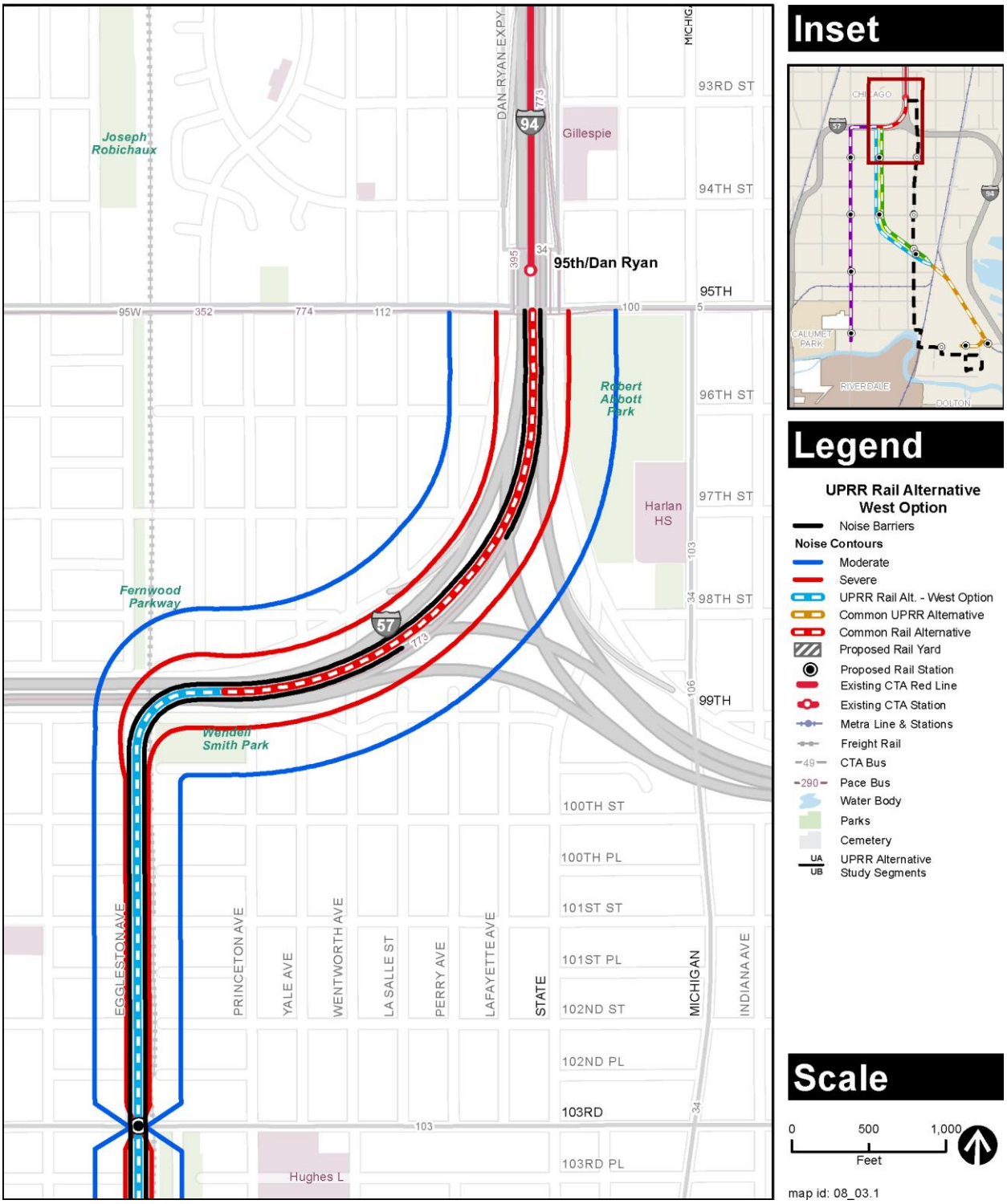

Figure 5-3a: Union Pacific Railroad Rail Alternative - West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

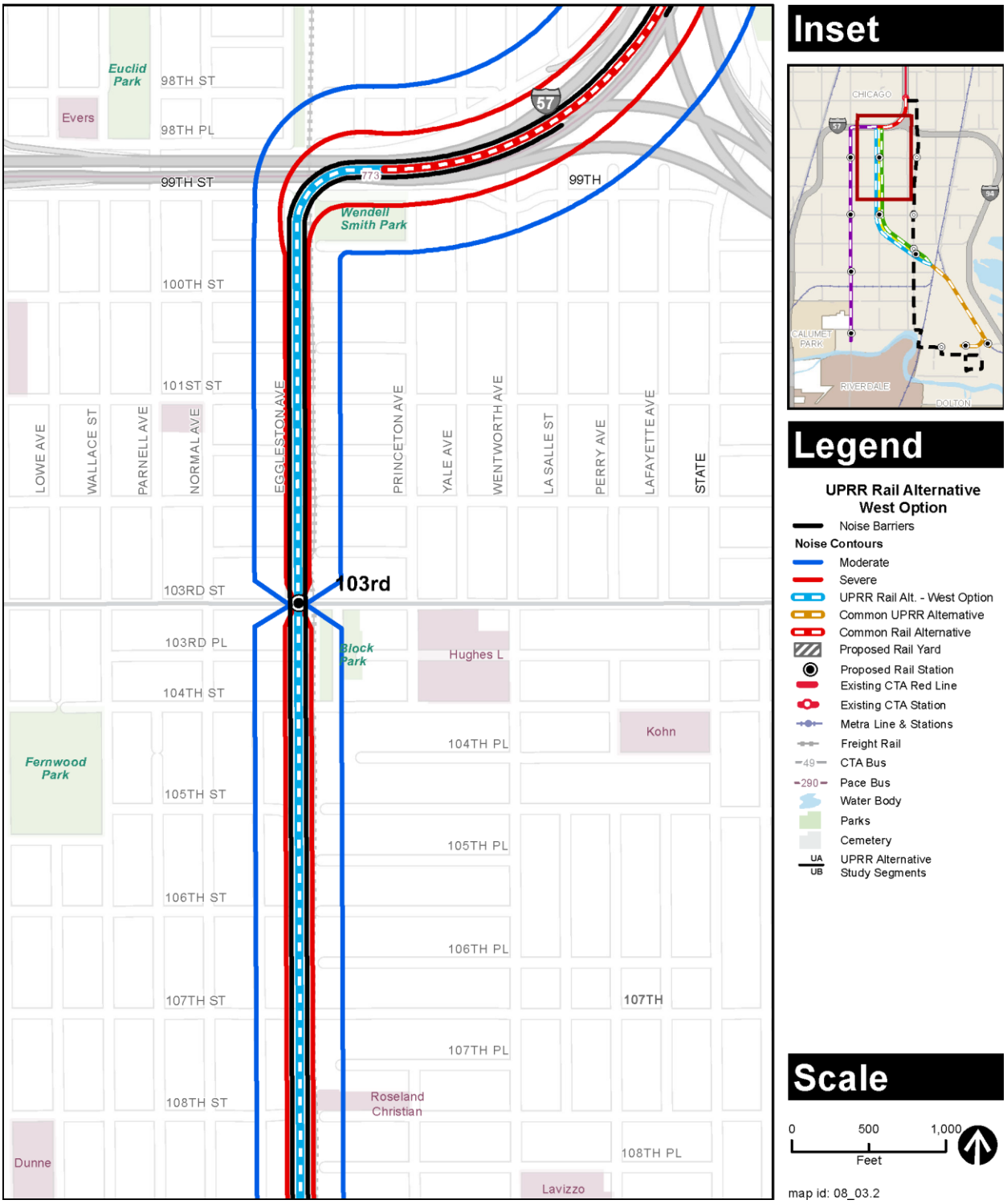

Figure 5-3b: Union Pacific Railroad Rail Alternative - West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

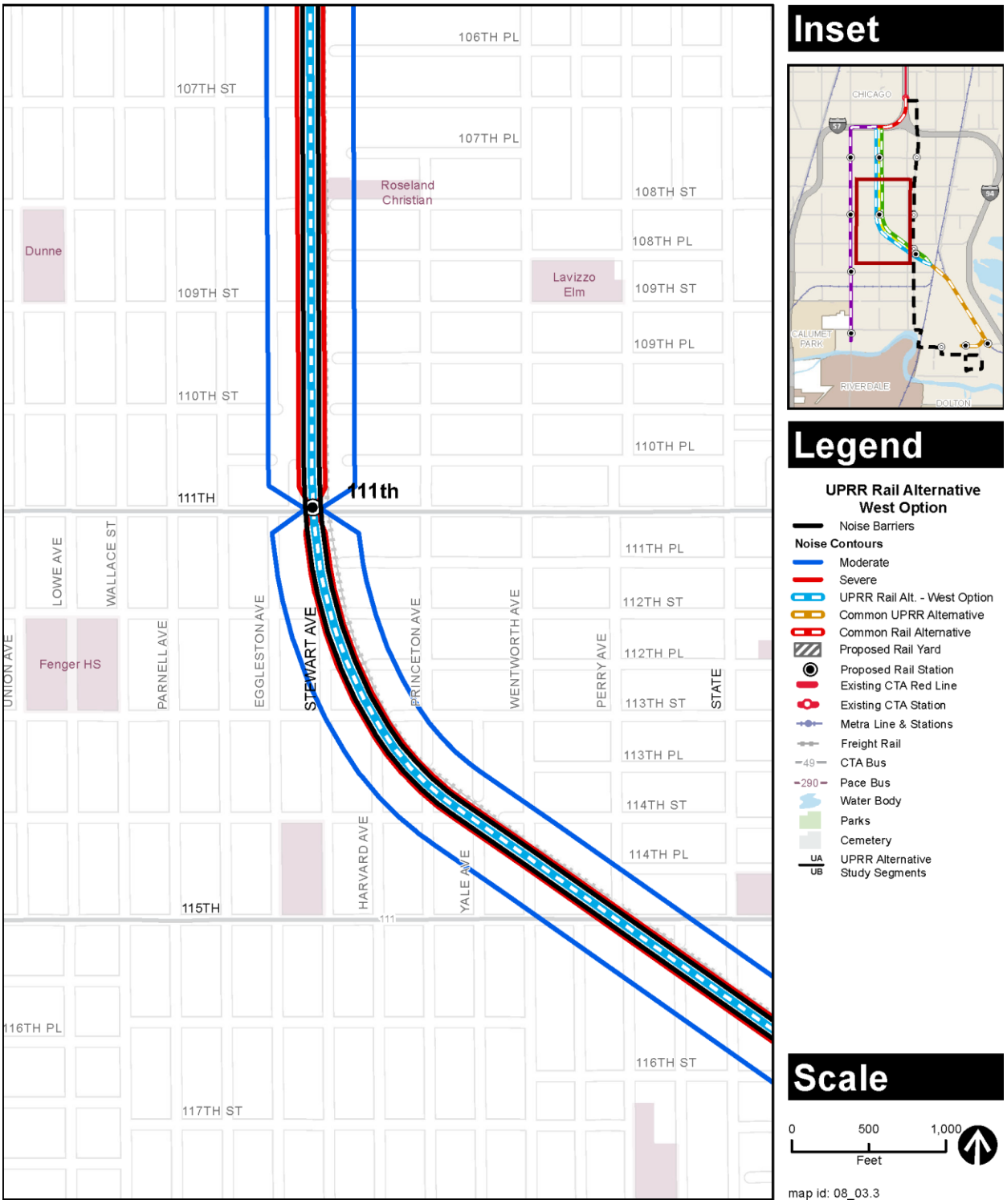

Figure 5-3c: Union Pacific Railroad Rail Alternative – West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

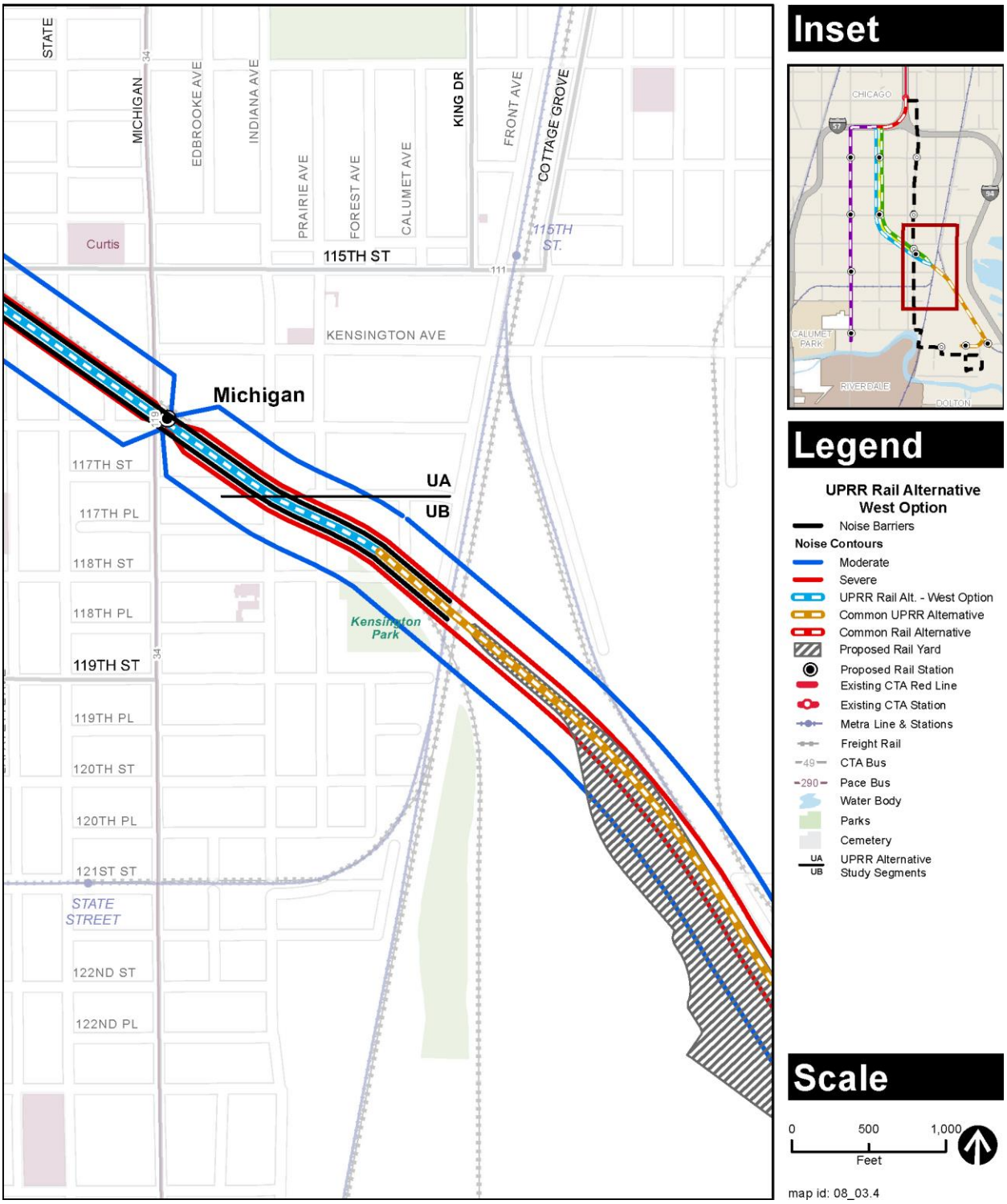

Figure 5-3d: Union Pacific Railroad Rail Alternative – West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

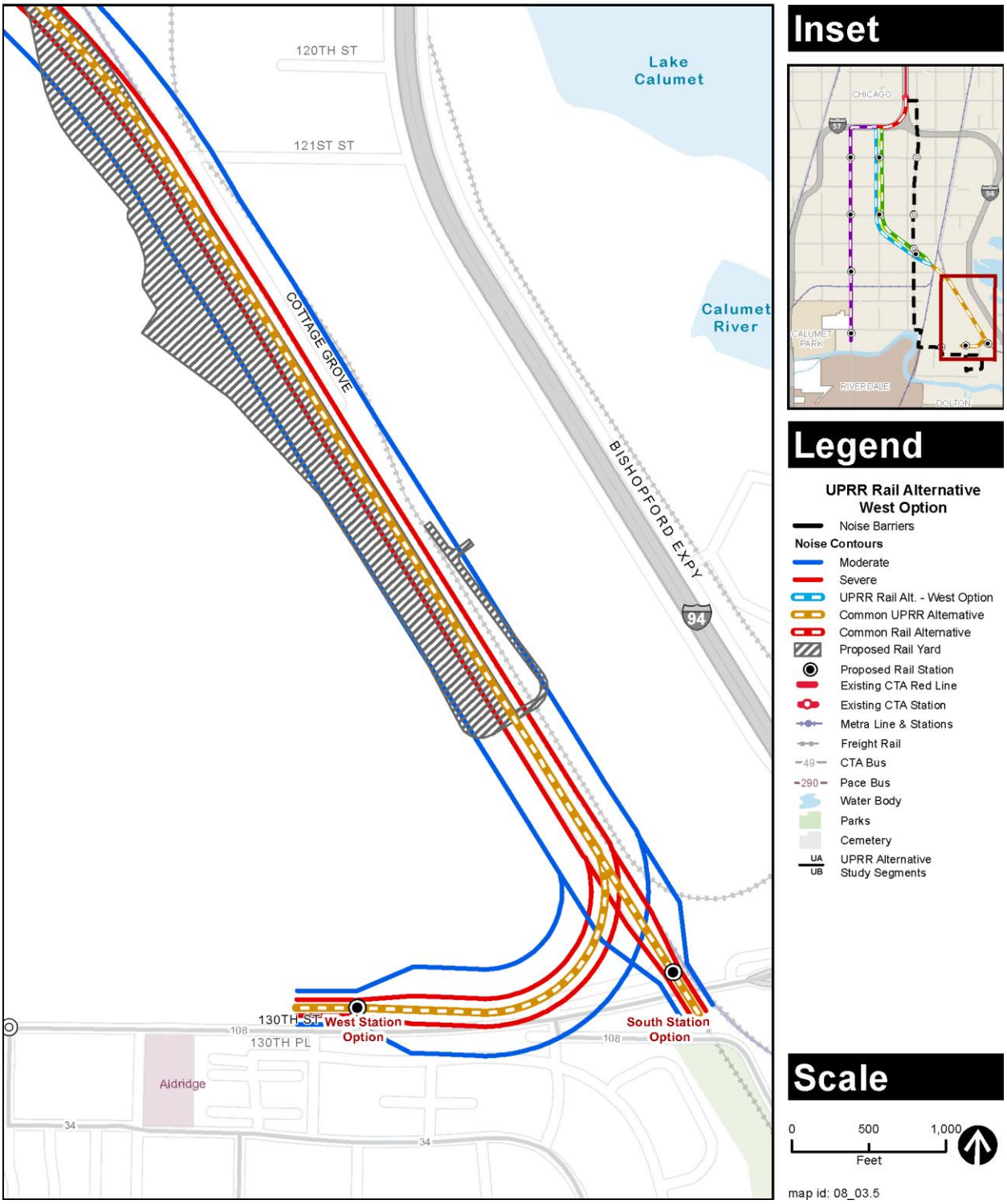

Figure 5-3e: Union Pacific Railroad Rail Alternative – West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

5.5.1.1 Segment UA

Segment UA of the UPRR Rail Alternative is north of Michigan Avenue. As shown in Figure 5-2, there would be a substantial number of affected receptors along this section of the rail corridor where the train speeds reach 55 mph.

5.5.1.2 Segment UB

Segment UB of the UPRR Rail Alternative is south of Michigan Avenue. Although there would be affected receptors between Michigan Avenue and the Metra Electric District Rail Corridor, there would be no affected receptors south of the Metra Electric District Rail Corridor. This area of the rail corridor consists primarily of industrial land use.

5.5.2 Construction Impacts and Mitigations – Union Pacific Railroad Rail Alternative - West Option

As it would be for the UPRR ROW and East Options, this alternative would include the construction of an aerial structure, stations, and parking facilities at the stations. Construction noise impacts would be the same as for the UPRR ROW and East Options. Construction noise levels are not expected to exceed the FTA recommended construction noise limits. As a result, construction noise mitigation measures were not considered. This analysis assumes that the same noise-reducing construction practices described for the UPRR ROW Option would be used for the West Option.

As with the UPRR ROW and East Options, no vibration impacts are anticipated from construction. The impact threshold distances were calculated for vibration and it was determined from the analysis that most of the equipment can be operated without risk of damage at distances of 15 feet or greater from non-engineered timber and masonry buildings or at distances of 8 feet or greater from reinforced concrete buildings. Pile-driving activities would be avoided in the vicinity of the historic Roseland Pumping Station.

5.5.3 120th Street Yard and Shop

Because there are no sensitive receptors in the vicinity of the 120th Street yard and shop site and because of the much lower amount of train activity in and out of the facility and the lower train speeds compared to other parts of the project corridor, the noise levels generated in this area are anticipated to be lower than the noise levels generated along other parts of the project corridor even with noise generated by maintenance activities conducted at the yard and shop. As a result, the noise generated at the 120th Street yard and shop would not exceed the FTA impact criteria at the nearest sensitive receptors. Therefore, noise mitigation was not considered at the 120th Street yard and shop. In addition, because of the distance from the nearest noise sensitive receptors, there would be no construction noise impacts.

5.6 Halsted Rail Alternative

In accordance with FTA guidance, for residential receptors, the L_{dn} measurements are used to determine the FTA moderate and severe impact criteria for the Halsted Rail Alternative using the curves in Figure 3-1. Table 5-7 shows the measured L_{dn} at each of the six measurement locations

along the Halsted Rail Alternative, along with the corresponding FTA moderate and severe noise impact criteria.

Table 5-7: Federal Transit Administration Moderate and Severe Impact Criteria for the Halsted Rail Alternative

Location Number	Receptor Description	Measured Noise Level (L_{dn})	FTA Moderate Impact Criterion	FTA Severe Impact Criterion
1	Residence at 9901 S. Emerald Avenue	65.0 dBA	60.8 dBA	66.2 dBA
2	Residence at 10229 S. Halsted Street	64.2 dBA	60.3 dBA	65.7 dBA
3	Residence at 11005 S. Halsted Street	60.5 dBA	58.1 dBA	63.7 dBA
4	Residence along 119th Street	58.6 dBA	57.0 dBA	62.7 dBA
5	Residence at 12125 S. Halsted Street	63.7 dBA	60.0 dBA	65.4 dBA
6	Residence at 12412 S. Halsted Street	61.6 dBA	58.7 dBA	64.2 dBA

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibels

For the Halsted Rail Alternative, the trains would operate on an aerial structure with continuous welded rail. For the Halsted Rail Alternative, the aerial structure would be located down the middle of Halsted Street. Based on the headway times shown in Table 5-3, the total number of northbound and southbound trains over a 24-hour period would be 378 (286 daytime trains between 7 AM and 10 PM, and 92 nighttime trains between 10 PM and 7 AM). Based on the number of daytime and nighttime trains traveling at a speed of 55 mph, the 24-hour L_{dn} would be 76.3 dBA at a distance of 50 feet. Extrapolating this noise level using the distance attenuation methodology described in the FTA guidance manual results in the impact distances within which moderate and severe noise impacts are expected to occur for the Halsted Rail Alternative. Table 5-8 lists the moderate and severe impact distances for the Halsted Rail Alternative for the trains traveling at 55 mph. The impact distances shown in Table 5-8 are substantially greater than the impact distances for the UPRR Rail Alternatives because of the lower measured L_{dn} noise levels along Halsted Street. These lower measured noise levels result in lower moderate and severe impact criteria based on the FTA curves in Figure 3-1. As a result, the impact distances for moderate and severe impact for the Halsted Rail Alternative are substantially greater than the impact distances for the UPRR Rail Alternatives, even though the noise generated by the trains would be the same.

Table 5-8: Federal Transit Administration Moderate and Severe Impact Distances for the Halsted Rail Alternative (at 55 miles per hour)

Location Number	Receptor Description/(Area of Impact)	Measured Noise Level (L_{dn})	FTA Moderate Impact Distance	FTA Severe Impact Distance
1	Residence at 9901 S. Emerald Avenue/ (along I-57)	65.0 dBA	540 feet	235 feet
2	Residence at 10229 S. Halsted Street/ (from I-57 to 103rd Street)	64.2 dBA	590 feet	255 feet
3	Residence at 11005 S. Halsted Street/ (from 103rd Street to 119th Street)	60.5 dBA	810 feet	345 feet
4	Residence along 119th Street/ (along 119th Street)	58.6 dBA	73 feet	20 feet
5	Residence at 12125 S. Halsted Street/ (from 119th Street to 124th Street)	63.7 dBA	610 feet	265 feet
6	Residence at 12412 S. Halsted Street/ (from 124th Street to 128th Street)	61.6 dBA	740 feet	320 feet

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibels

Near the stations, where the trains would decelerate and accelerate as they enter and leave the station area, the trains were assumed to decelerate from a speed of 55 mph within a distance of approximately 200 feet from the train station, as a conservative estimate. A 200-foot distance was also assumed for the train acceleration to 55 mph when leaving the station. As a result, the noise contours narrow near the stations. At the stations, where the trains would be idling, the 24-hour L_{dn} would be 65.0 dBA. Extrapolating this noise level using the distance attenuation methodology described in the FTA guidance manual results in the impact distances within which moderate and severe noise impacts are expected to occur for the Halsted Rail Alternative. Table 5-9 indicates the moderate and severe impact distances for the Halsted Rail Alternative within a distance of approximately 200 feet north and south of the station platforms.

Table 5-9: Federal Transit Administration Moderate and Severe Impact Distances for the Halsted Rail Alternative (near the stations)

Location Number	Receptor Description/(Station Location)	Measured Noise Level (L_{dn})	FTA Moderate Impact Distance	FTA Severe Impact Distance
2	Residence at 10229 S. Halsted Street/ (103rd Street station)	64.2 dBA	105 feet	45 feet
3	Residence at 11005 S. Halsted Street/ (111th Street station)	60.5 dBA	145 feet	41 feet
5	Residence at 12125 S. Halsted Street/ (119th Street station)	63.7 dBA	110 feet	53 feet
6	Residence at 12412 S. Halsted Street/ (Vermont station)	61.6 dBA	130 feet	44 feet

Notes: L_{dn} = day-night average sound level, FTA = Federal Transit Administration, dBA = A-weighted decibels

Using the impact distances from Tables 5-8 and 5-9, noise contours were developed for the Halsted Rail Alternative to show the areas of moderate and severe impact along the project corridor. Figures 5-4a through 5-4e show the Halsted Rail Alternative with both the moderate and severe noise impact contours. Along I-57, the moderate noise impact distance would be 540 feet from the centerline of the RLE aerial structure. From I-57 to 103rd Street, the moderate noise impact distance would be 590 feet. From 103rd Street to 119th Street, the moderate noise impact distance would be 810 feet. From 119th Street to 128th Street, the moderate noise impact distance would be 740 feet. At the 103rd Street station, the moderate noise impact distance would be 105 feet. At the 111th Street station, the moderate noise impact distance would be 145 feet. At the 119th Street station, the moderate noise impact distance would be 110 feet. At the Vermont Street station, the moderate noise impact distance would be 130 feet. Approximately 200 feet north and south of the stations would be a transition zone where the trains decelerate and accelerate as they enter and leave the station area.

Along I-57, the severe noise impact distance would be 235 feet. From I-57 to 103rd Street, the severe noise impact distance would be 255 feet. From 103rd Street to 119th Street, the severe noise impact distance would be 345 feet. From 119th Street to 128th Street, the severe noise impact distance would be 320 feet. At the 103rd Street station, the severe noise impact distance would be 45 feet. At the 111th Street station, the severe noise impact distance would be 41 feet. At the 119th Street station, the severe noise impact distance would be 53 feet. At the Vermont Street station, the severe noise impact distance would be 44 feet.

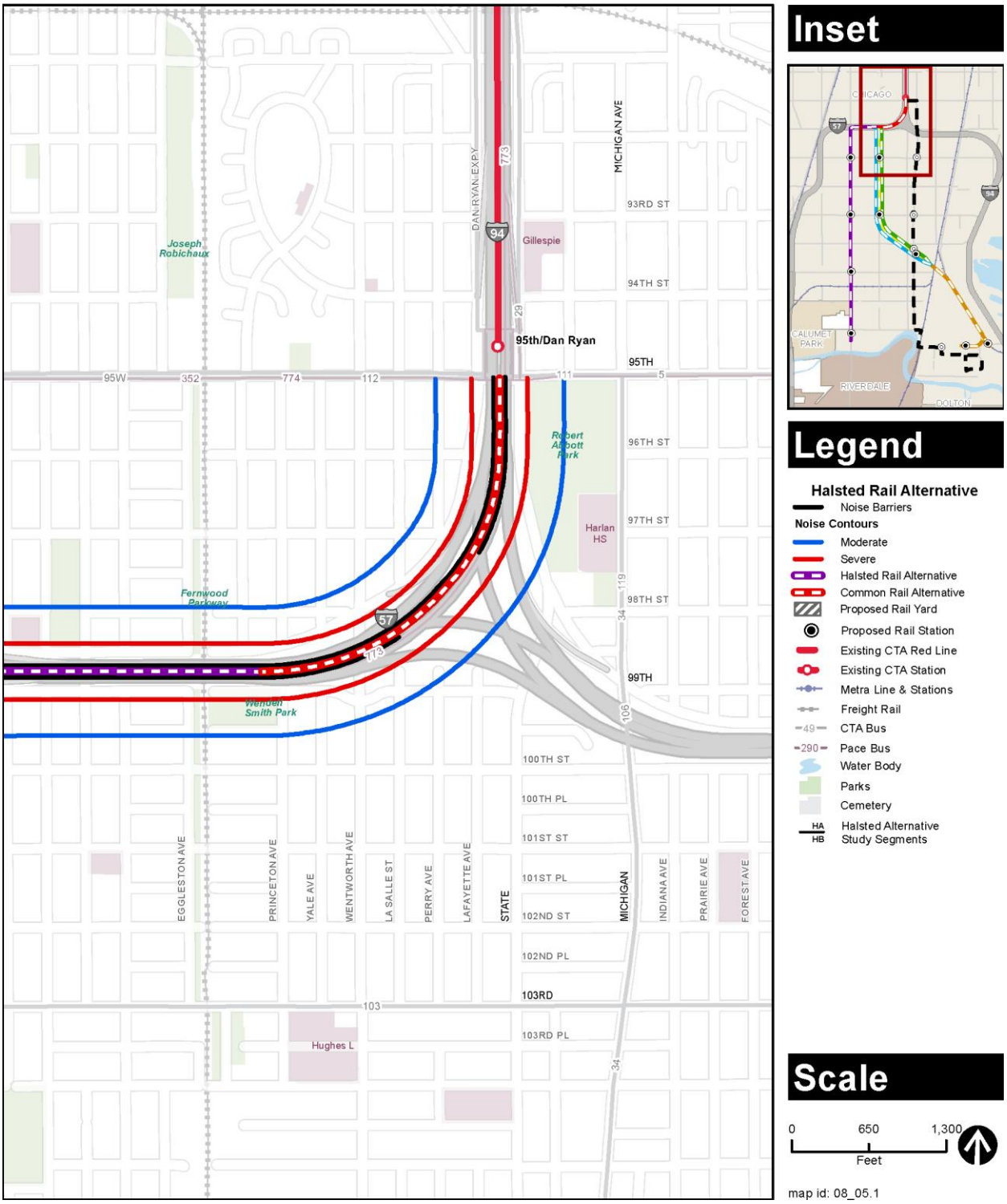

Figure 5-4a: Halsted Rail Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

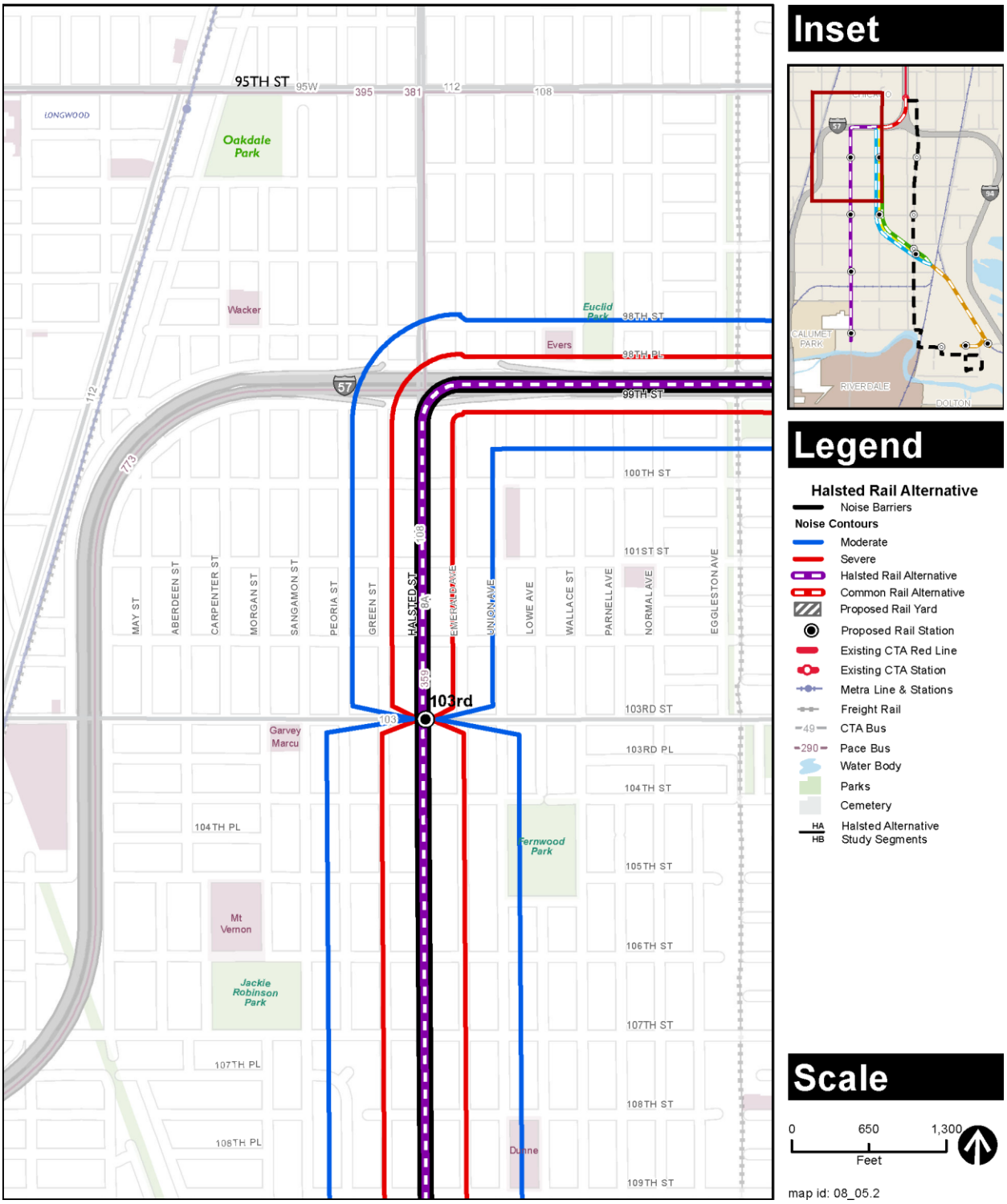

Figure 5-4b: Halsted Rail Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

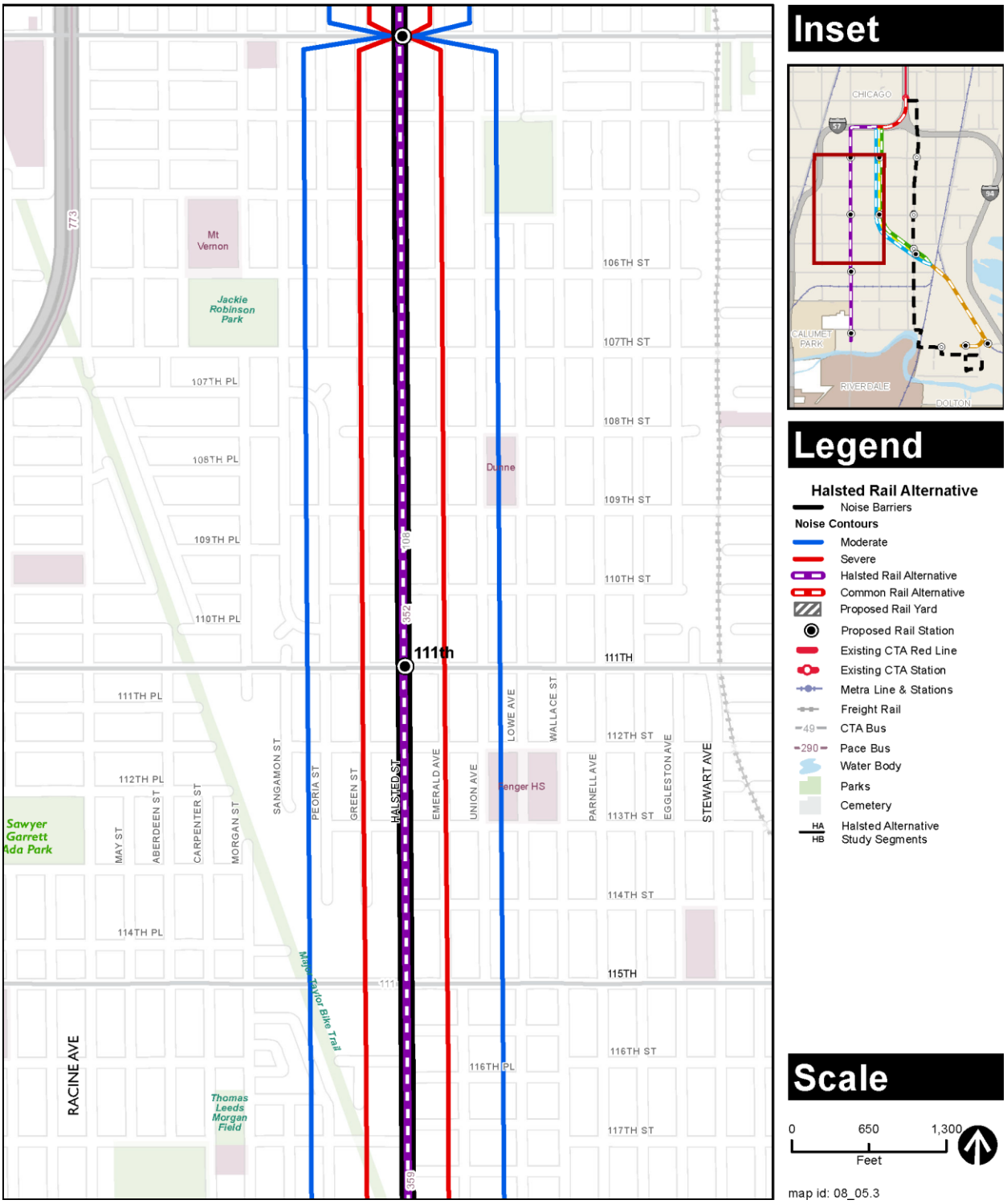

Figure 5-4c: Halsted Rail Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

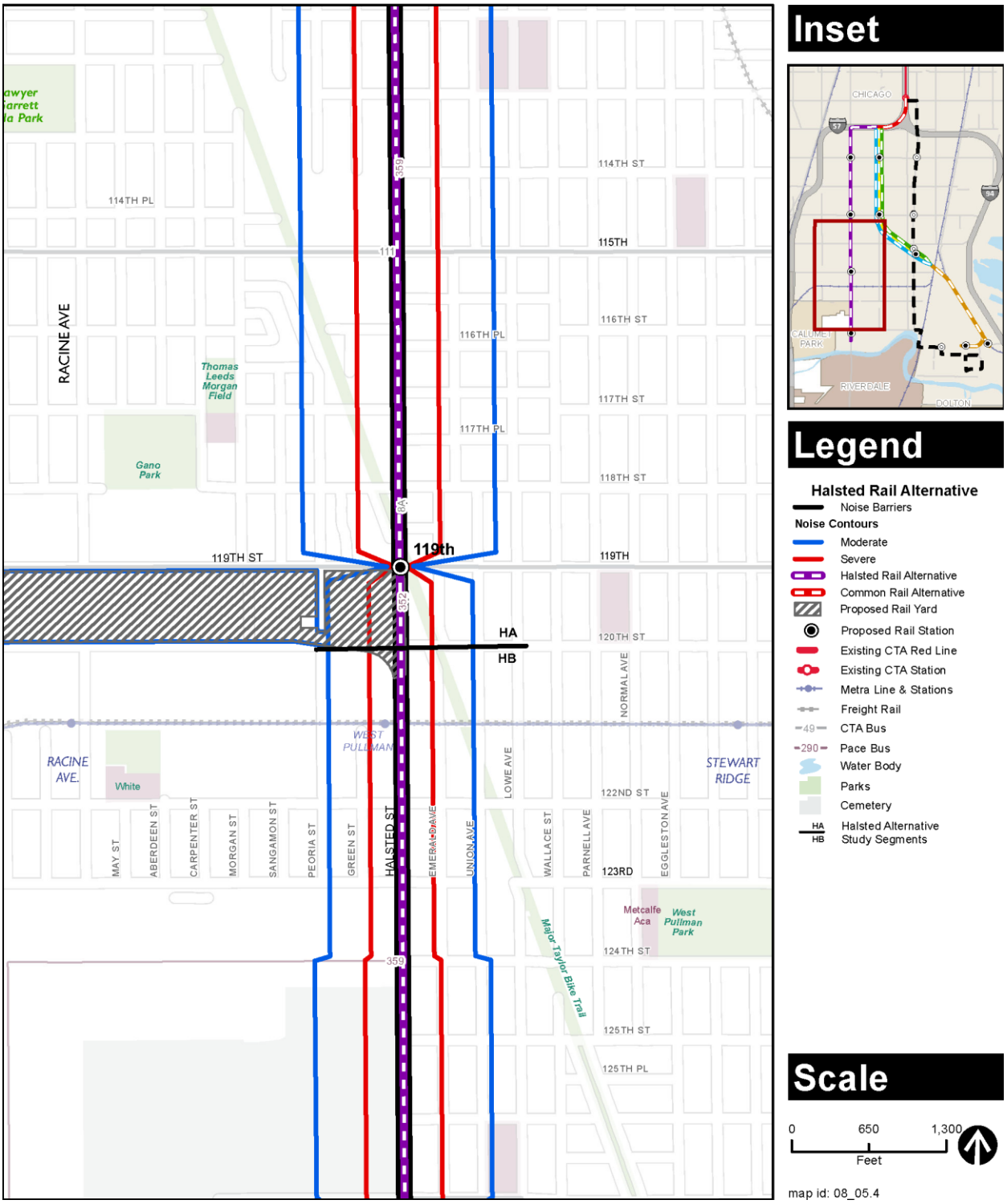

Figure 5-4d: Halsted Rail Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

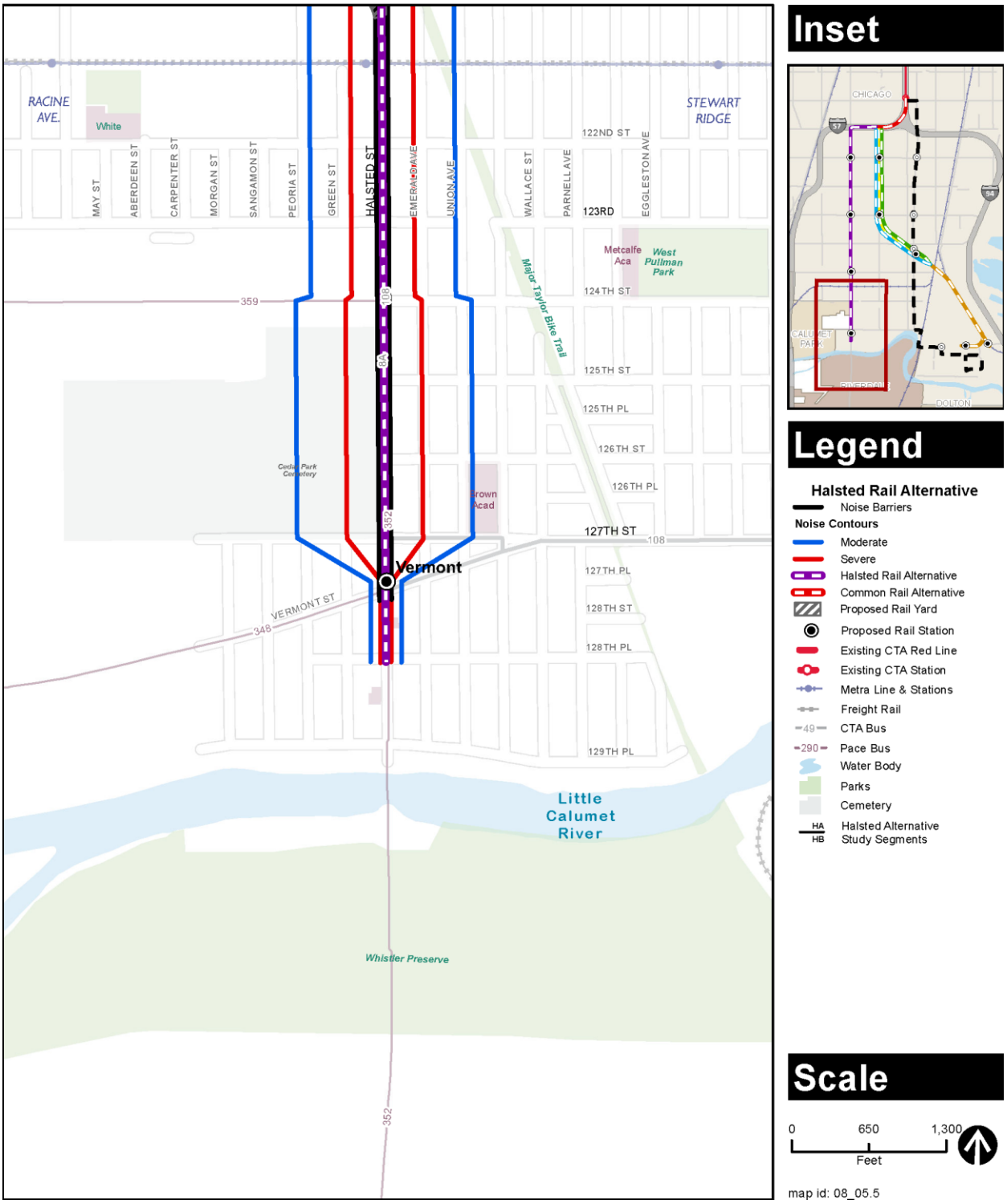

Figure 5-4e: Halsted Rail Alternative with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

5.6.1 Permanent Impacts and Mitigations – Halsted Rail Alternative

Figures 5-4a through 5-4e show the Halsted Rail Alternative with both the moderate and severe noise impact contours. Mitigation measures for noise-affected residential receptors along the project corridor were considered. A noise barrier approximately 4 feet in height installed along the outer tracks of the aerial structure could reduce the wheel/rail noise that would propagate into the surrounding community. A noise barrier approximately 4 feet in height could provide a 10-dBA reduction in noise level in the surrounding community. Figures 5-4a through 5-4e show the location of the proposed noise barriers for the Halsted Rail Alternative.

With regard to vibration, no mitigation measures are proposed. The aerial structure with continuously welded rail could result in vibration levels that would be below the FTA impact criterion of 72 VdB at the residential receptors along the project corridor.

5.6.1.1 Segment HA

Segment HA of the Halsted Rail Alternative is north of 119th Street. As shown in Figure 5-4, there would be a substantial number of affected receptors along this section of the rail corridor in areas where the train speeds reach 55 mph.

5.6.1.2 Segment HB

Segment HB of the Halsted Rail Alternative is south of 119th Street. As shown in Figure 5-4, there would be a substantial number of affected receptors along this section of the rail corridor in areas where the train speeds reach 55 mph.

5.6.2 Construction Impacts and Mitigations – Halsted Rail Alternative

As it would be for the other build alternatives, this alternative would include the construction of an aerial structure, stations, and parking facilities at the stations. Construction noise impacts would be the same as for the other build alternatives. Construction noise levels are not expected to exceed the FTA recommended construction noise limits. As a result, construction noise mitigation measures were not considered. This analysis assumes that the same noise-reducing construction practices described for the UPRR ROW Option would be used for all of the build alternatives, including the Halsted Rail Alternative.

As with the UPRR ROW Option, no vibration impacts are anticipated from construction. The impact threshold distances were calculated for vibration and it was determined from the analysis that most of the equipment can be operated without risk of damage at distances of 15 feet or greater from non-engineered timber and masonry buildings or at distances of 8 feet or greater from reinforced concrete buildings.

5.6.3 119th Street Yard and Shop

Because of the much lower amount of train activity in and out of the 119th Street yard and shop and the lower train speeds compared to other parts of the project corridor, the noise levels generated in this area (an L_{dn} of 58 dBA at a distance of 50 feet) are anticipated to be lower than the noise levels generated along other parts of the project corridor even with noise generated by

maintenance activities conducted at the yard and shop. . The Kroc Center is located more than 135 feet to the northwest of the yard and shop site and is not within the noise impact contours. As a result, the noise generated at the 119th Street yard and shop would have no impact noise sensitive receptors along 119th Street.

5.6.3.1 Permanent Impacts and Mitigations

The noise generated at the 119th Street yard and shop would have no impact on noise sensitive receptors along 119th Street. As a result, noise mitigation was not considered for the 119th Street yard and shop.

5.6.3.2 Construction Impacts and Mitigations

Construction noise levels are not expected to exceed the FTA recommended construction noise limits described in Table 3-3. As a result, construction noise mitigation measures were not considered. Construction activities would, however, be restricted to daytime hours, and all construction equipment exhaust mufflers would be kept in a state of good repair. To the maximum extent possible, vehicles that are not in use would not remain idling on the construction site.

Section 6
Impacts Remaining After Mitigation

6.1 No Build Alternative

The No Build Alternative assumes no change in the existing conditions and therefore no change to the existing noise and vibration levels would occur within the project area. As a result, the No Build Alternative could result in no impact, and therefore no mitigation was considered.

6.2 Bus Rapid Transit Alternative

There would be noise impacts associated with the BRT Alternative as shown in Figure 5-1. Noise mitigation would not be feasible because the buses would travel along local streets that have small blocks, numerous cross streets, and driveways.

6.3 Union Pacific Railroad Rail Alternative – Right-of-Way Option

The UPRR Rail Alternative ROW Option would only occur if the freight relocation project were implemented prior to RLE Project implementation. As a result, the noise levels along the rail corridor would decrease by 5 to 7 dBA due to the removal of the freight operations. Because of the reduction in noise level, noise mitigation was not considered for the UPRR Rail Alternative ROW Option.

The aerial structure with continuous welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB for residential receptors along the project corridor. As a result, vibration mitigation measures are not proposed.

6.4 Union Pacific Railroad Rail Alternative – East Option

A noise barrier approximately 4 feet in height on the aerial structure would provide a 7 to 10-dBA reduction in the projected noise level in the surrounding community. Based on a noise reduction of 10 dBA, the moderate noise impact distance for trains traveling at 55 mph would decrease from 280 feet without mitigation to 60 feet from the centerline of the tracks with mitigation. The severe noise impact distance would be less than 20 feet with mitigation. A noise barrier approximately 4 feet in height on the aerial structure that would provide a 10-dBA reduction could result in no affected receptors remaining after mitigation.

The aerial structure with continuous welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB for residential receptors along the project corridor. As a result, vibration mitigation measures are not proposed.

6.5 Union Pacific Railroad Rail Alternative – West Option

Noise impacts remaining after mitigation would be the same as for the East Option, but would apply to distances from the centerline of the West Option alignment.

The aerial structure with continuous welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB for residential receptors along the project corridor. As a result, vibration mitigation measures are not proposed.

6.6 Halsted Rail Alternative

A noise barrier approximately 4 feet in height on the aerial structure would provide a 7 to 10-dBA reduction in projected noise level in the surrounding community. Based on a noise reduction of 10 dBA, the moderate noise impact distance for trains traveling at 55 mph would decrease from the distances shown in Table 5-8, to distances ranging from 115 feet to 180 feet from the centerline of the aerial structure. The severe noise impact distance would be less than 45 feet with mitigation. As a result, the Halsted Rail Alternative after mitigation (i.e., including a noise barrier approximately 4 feet in height on the aerial structure) would still result in moderate noise impacts along Halsted Street. No severely affected receptors would remain after mitigation.

The aerial structure with continuous welded rail could result in vibration levels that are below the FTA impact criterion of 72 VdB for residential receptors along the project corridor. As a result, vibration mitigation measures are not proposed.

6.6.1 119th Street Yard and Shop

The noise generated at the 119th Street yard and shop would have no impact to noise sensitive receptors along 119th Street. As a result, noise mitigation was not considered for the 119th Street yard and shop.

Because of the slow speed of the trains entering and leaving the 119th Street yard and shop, vibration levels would be below the FTA impact criterion of 72 VdB for residential receptors. As a result, vibration mitigation measures are not proposed.

Section 7
References Cited

Chicago Transit Authority (CTA). 2012. Personal Communication - Email from Chicago Transit Authority (Sonali Tandon, Red Line Extension Project Manager) regarding RLE Track Structure Assumptions for noise and vibration analysis (aerial structure with closed deck and continuous welded rail), dated 3 October 2012.

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Federal Transit Administration (FTA). 2006. Transit Noise and Vibration Impact Assessment, Department of Transportation, Federal Transit Administration, Report No. FTA-VA-90-1003-06, May 2006.

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Appendix A
2014-2015 Red Line Extension Project Update

2014–2015 Red Line Extension Project Update

From 2012–2014, CTA evaluated benefits and impacts of four alternatives: the No Build Alternative, the Bus Rapid Transit Alternative (along Michigan Avenue), the Union Pacific Railroad (UPRR) Rail Alternative, and the Halsted Alternative. CTA evaluated three options of the UPRR Rail Alternative: Right-of-Way Option, East Option, and West Option. CTA also evaluated two options of the UPRR Rail Alternative 130th Street station: a South Station Option and a West Station Option. Based on the project description provided in Section 2 of this technical memorandum, CTA analyzed the impacts of these alternatives and station options. The benefits and impacts are included in the technical memoranda prepared in 2012–2014.

In August 2014, based on the technical analysis and public input, CTA announced the NEPA Preferred Alternative—the UPRR Rail Alternative. Additional conceptual engineering was conducted on the UPRR Rail Alternative to refine the East and West Option alignments. In addition, CTA is considering only the South Station Option of the 130th Street Station.

In late 2014 and early 2015, CTA conducted additional engineering and revised assumptions on the East and West Options to refine the alignments. The refinement of the East and West Options consisted of the following items:

- For the segment of the alignment along I-57, CTA shifted the proposed alignment from the median of I-57 to the north side of I-57 within the existing expressway right-of-way. The construction would be less complex, safer for construction workers, and have a shorter duration. The shift would also allow for fewer impacts to Wendell Smith Park for the East Option, and would allow for no permanent impacts to Wendell Smith Park for the West Option.

- CTA modified the curve speeds as the alignment heads south from I-57 along the UPRR tracks. The curve speed for both the East and West Options would be 35 mph.

- CTA shifted the East Option alignment near 103rd Street station to minimize impacts to Block Park and the Roseland Pumping Station.

- CTA modified the curves south of 103rd Street for both the East and West Options to 55 mph to maximize the train speed.

- CTA refined the layout of the 120th Street yard and shop to optimize yard operations. The refined layout of the yard would accommodate 340 train cars.

The refinement of the East and West Option alignments minimizes potential impacts to parks while providing flexibility for future design phases. The Draft Environmental Impact Statement contains the benefits and impacts of the refined East and West Option alignments and supersedes information presented in other chapters of this technical memorandum

Noise and Vibration

In early 2015, CTA refined the general assessment that was conducted in 2012-2013. CTA identified individual noise-sensitive receivers within the moderate and severe impact contours and conducted a field verification of noise-sensitive receiver locations on March 5, 2015. Residential noise-sensitive receivers within the moderate and severe impact contours were counted unless identified as potentially displaced properties. The land use in the vicinity of the corridor is predominantly residential (Category 2). Three parks, six schools, and four churches (Category 3) are near the corridor and were assessed for impacts. During the field verification, numerous uninhabited residences were identified scattered throughout the area. Although they are not occupied and are not likely to be occupied, these properties are included in the counts of noise-sensitive receivers because they are not contiguous and are adjacent to occupied homes. The land use in the area is expected to continue to be residential, and it is possible that these properties may be resold for residential development. The majority of these houses were between 105th Street and 115th Street on the east side of the corridor and along Eggleston Avenue from 107th Street south on the west side of the corridor. Although these areas would be affected and there are noise-sensitive receivers in the area, the overall impacts would likely be less because the properties are not in use. The identified affected noise-sensitive receivers were counted individually but mapped as sensitive receiver clusters because of the small size of the individual parcels. The clusters of receivers were determined to be similar distances from the proposed tracks and where the CTA operating conditions, such as train speed, were determined to be similar.

The revised alignment along I-57 would result in different permanent noise impacts for both the East and West Options than what was presented previously.

Operating assumptions are based on the operating plan for 95th Street Station because service frequency on the proposed service is anticipated to be the same as for the Red Line. March 2016 average daytime headway at 95th Street Station is 6.1 minutes, which is consistent with the daytime average headway used for noise modeling. Service frequency varies by the time of day and by line; therefore, CTA provides frequency ranges in public schedules. The service frequency would be adjusted to accommodate demand once the proposed project service has been implemented.

Table 1 and **Figures 1a through 1e** summarize the sensitive receivers within the moderate and severe noise impact contours for the East Option.

Table 1: Sensitive Receivers within Moderate and Severe Noise Impact Contours - Union Pacific Railroad Alternative East Option

Area of Impact	West of Track Structure	East of Track Structure	Total
95th Street to 103rd Street	167 Moderate 25 Severe	108 Moderate 22 Severe	275 Moderate 47 Severe
103rd Street to 111th Street	1 Moderate 0 Severe	107 Moderate 25 Severe	108 Moderate 25 Severe
111th Street to Michigan Avenue at 116th Street	37 Moderate 0 Severe	98 Moderate 4 Severe	135 Moderate 4 Severe
Michigan Avenue to CN/ME Rail Corridor	16 Moderate 0 Severe	40 Moderate 7 Severe	56 Moderate 7 Severe
Total	**221 Moderate 25 Severe**	**353 Moderate 58 Severe**	**574 Moderate 83 Severe**

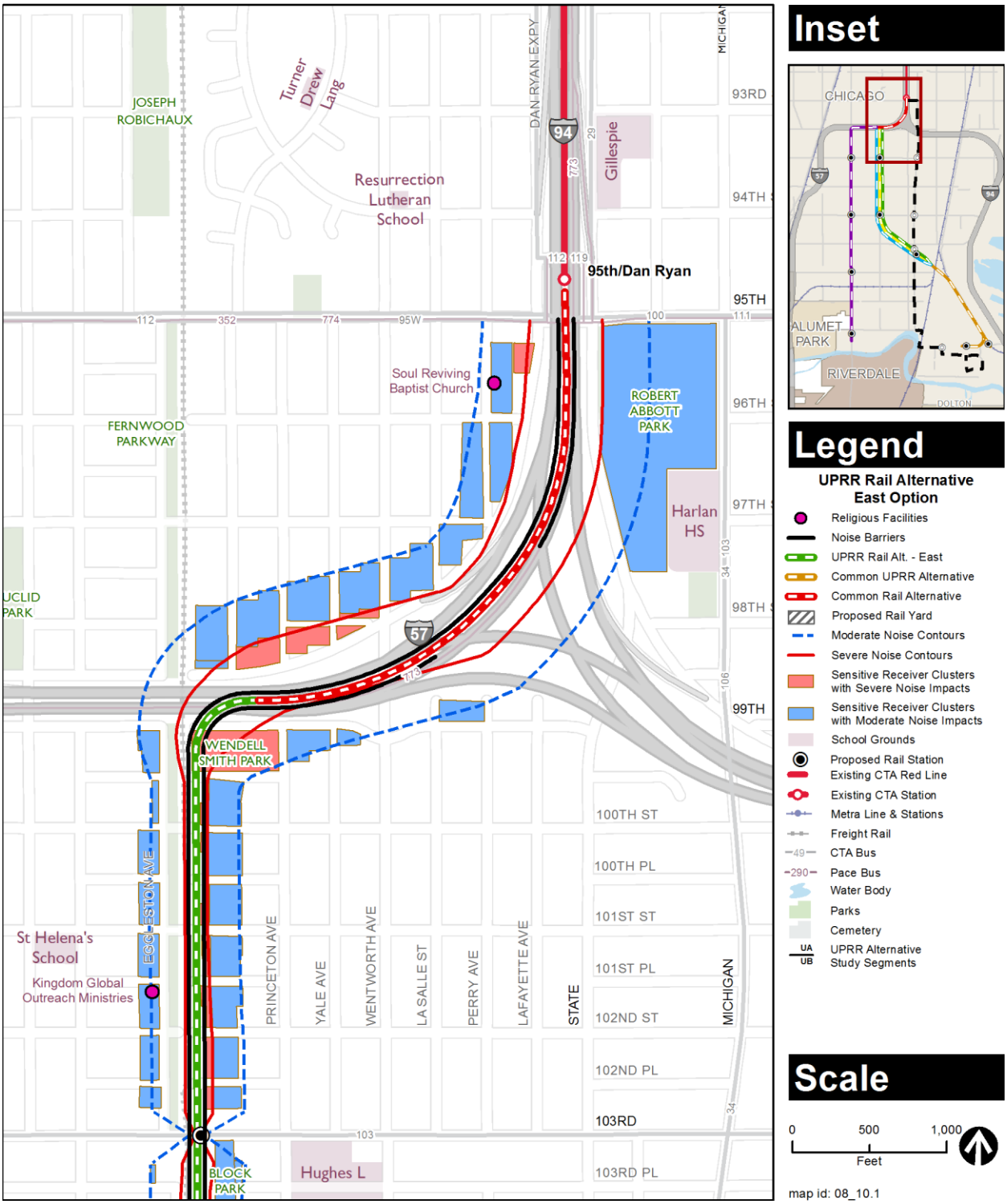

Figure 1a: Union Pacific Railroad Alternative East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

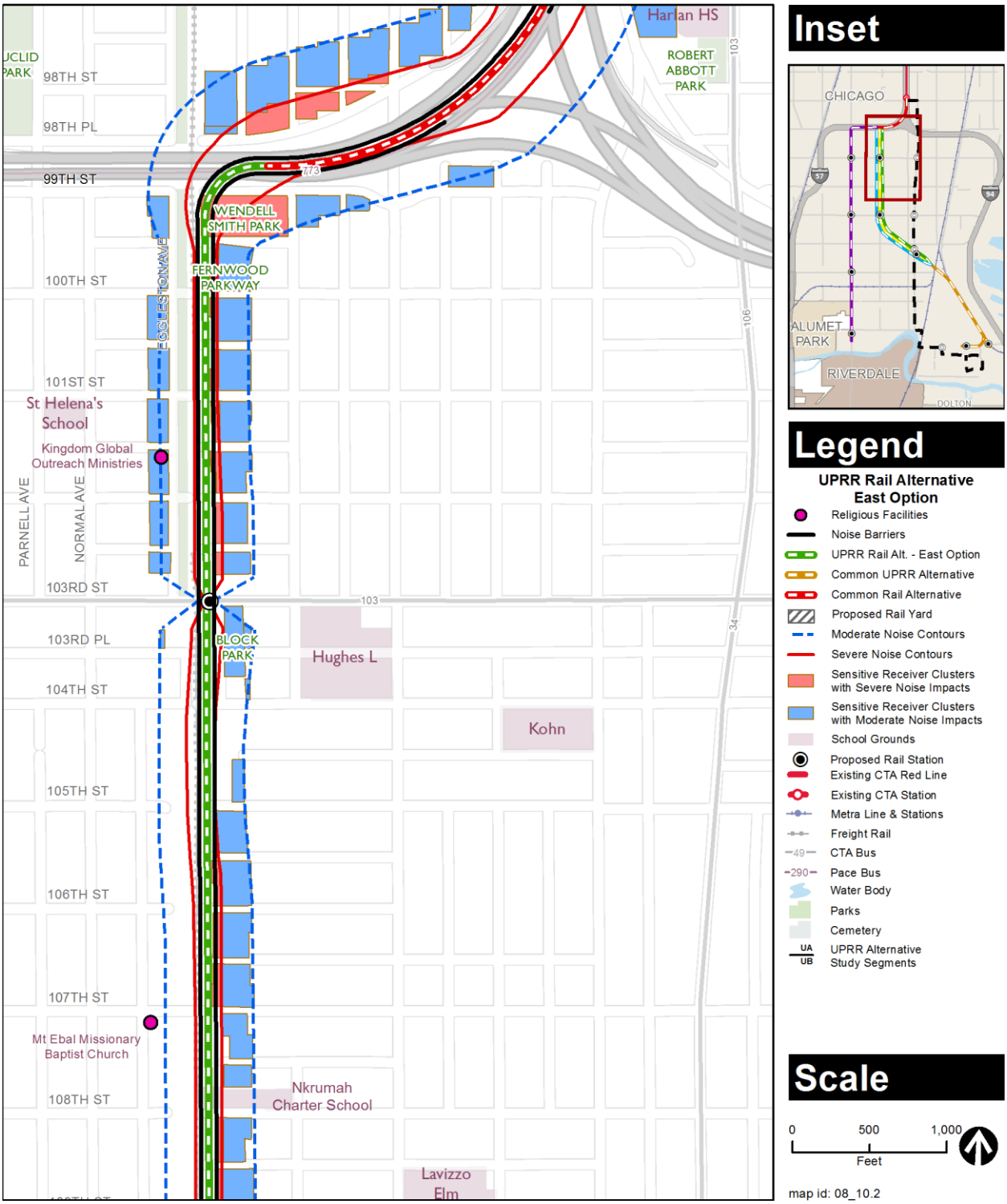

Figure 1b: Union Pacific Railroad Alternative East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

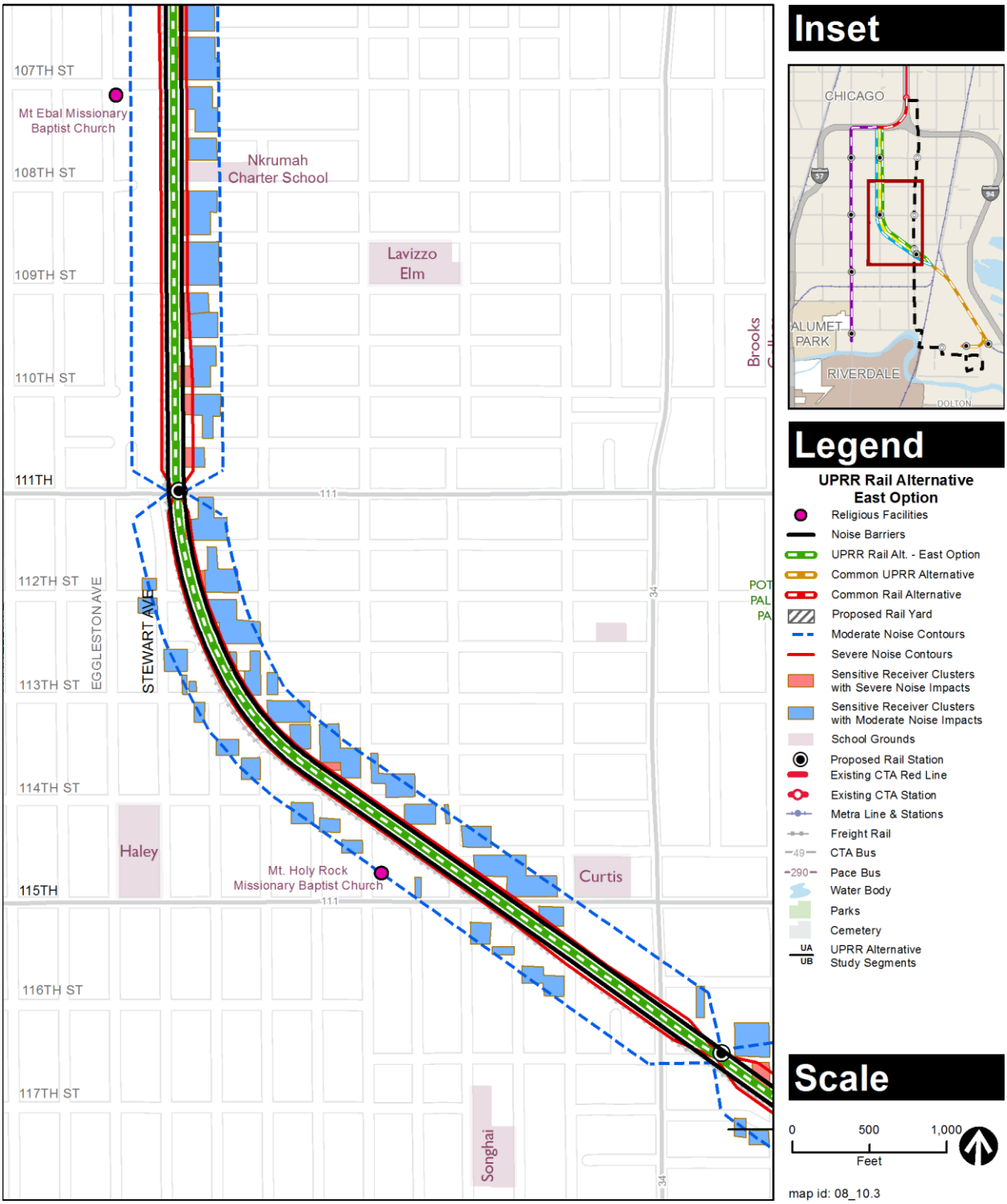

Figure 1c: Union Pacific Railroad Alternative East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

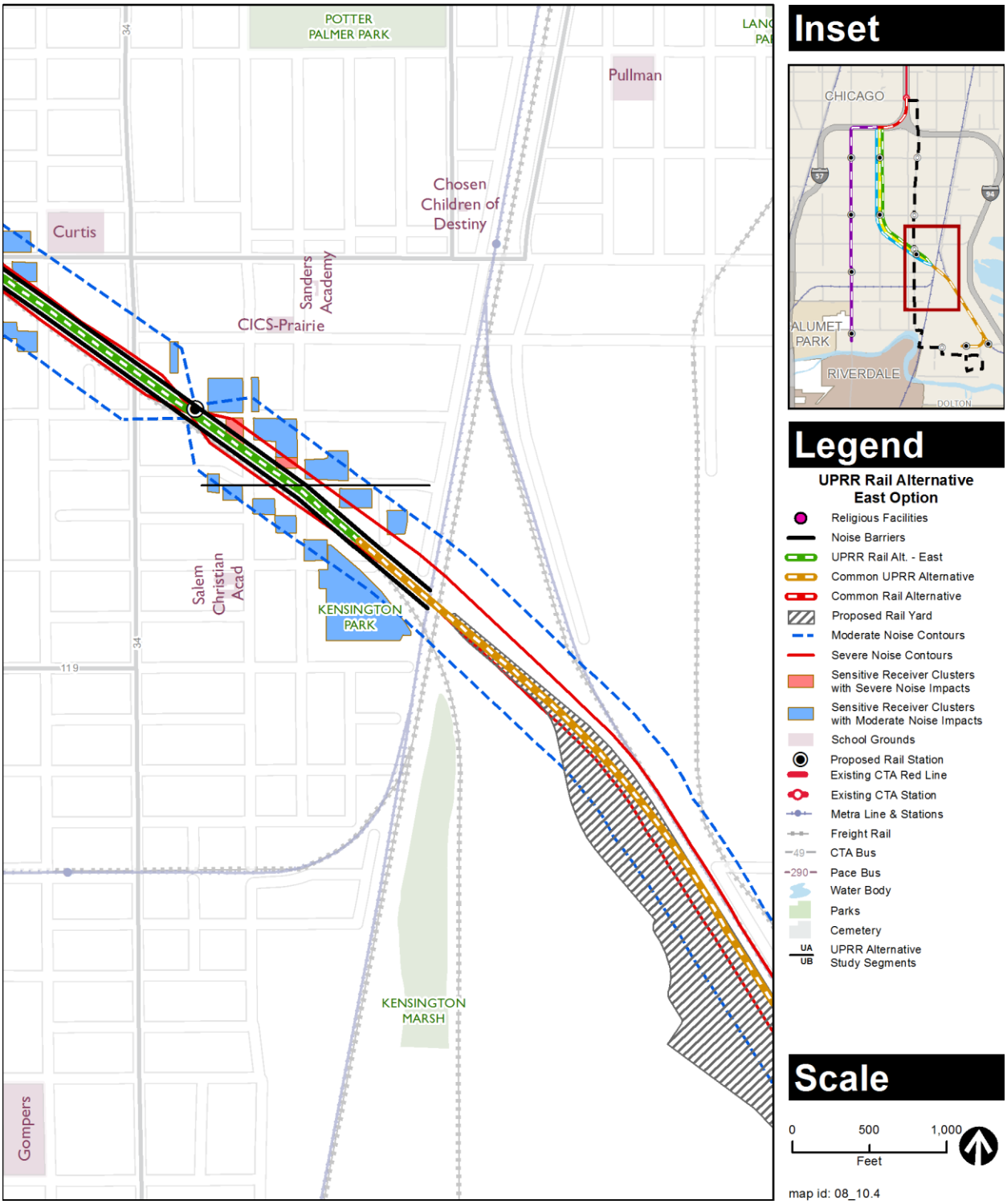

Figure 1d: Union Pacific Railroad Alternative East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

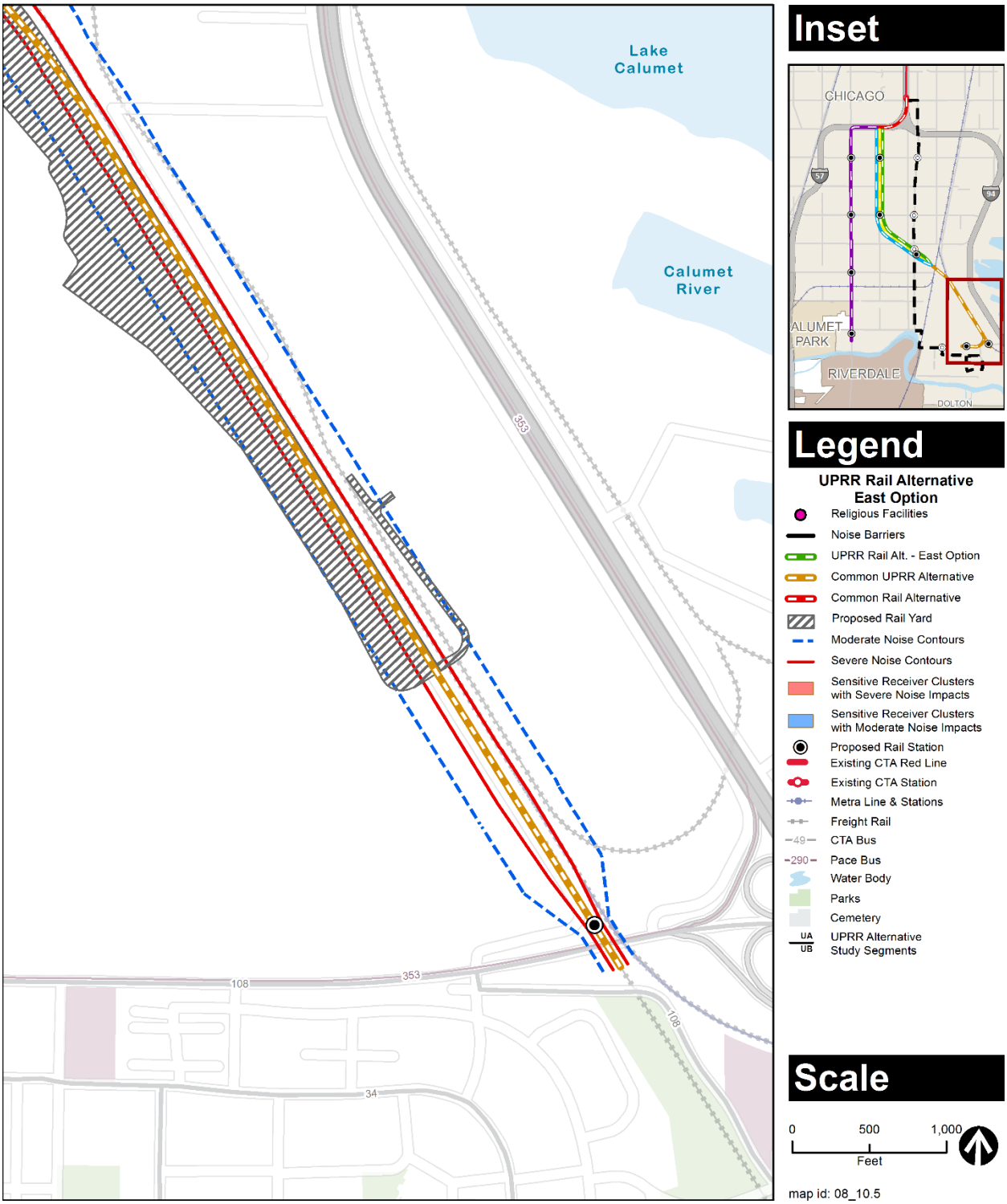

Figure 1e: Union Pacific Railroad Alternative East Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

Table 2 and **Figures 2a through 2e** summarize the sensitive receivers within the moderate and severe noise impact contours for the West Option.

Table 2: Sensitive Receivers within Moderate and Severe Noise Impact Contours – Union Pacific Railroad Alternative West Option

Area of Impact	West of Track Structure	East of Track Structure	Total
95th Street to 103rd Street	209 Moderate 32 Severe	81 Moderate 1 Severe	290 Moderate 33 Severe
103rd Street to 111th Street	125 Moderate 0 Severe	62 Moderate 0 Severe	187 Moderate 0 Severe
111th Street to Michigan Avenue at 116th Street	145 Moderate 9 Severe	47 Moderate 0 Severe	192 Moderate 9 Severe
Michigan Avenue to CN/ME Rail Corridor	41 Moderate 7 Severe	28 Moderate 0 Severe	69 Moderate 7 Severe
Total	**520 Moderate 48 Severe**	**218 Moderate 1 Severe**	**738 Moderate 49 Severe**

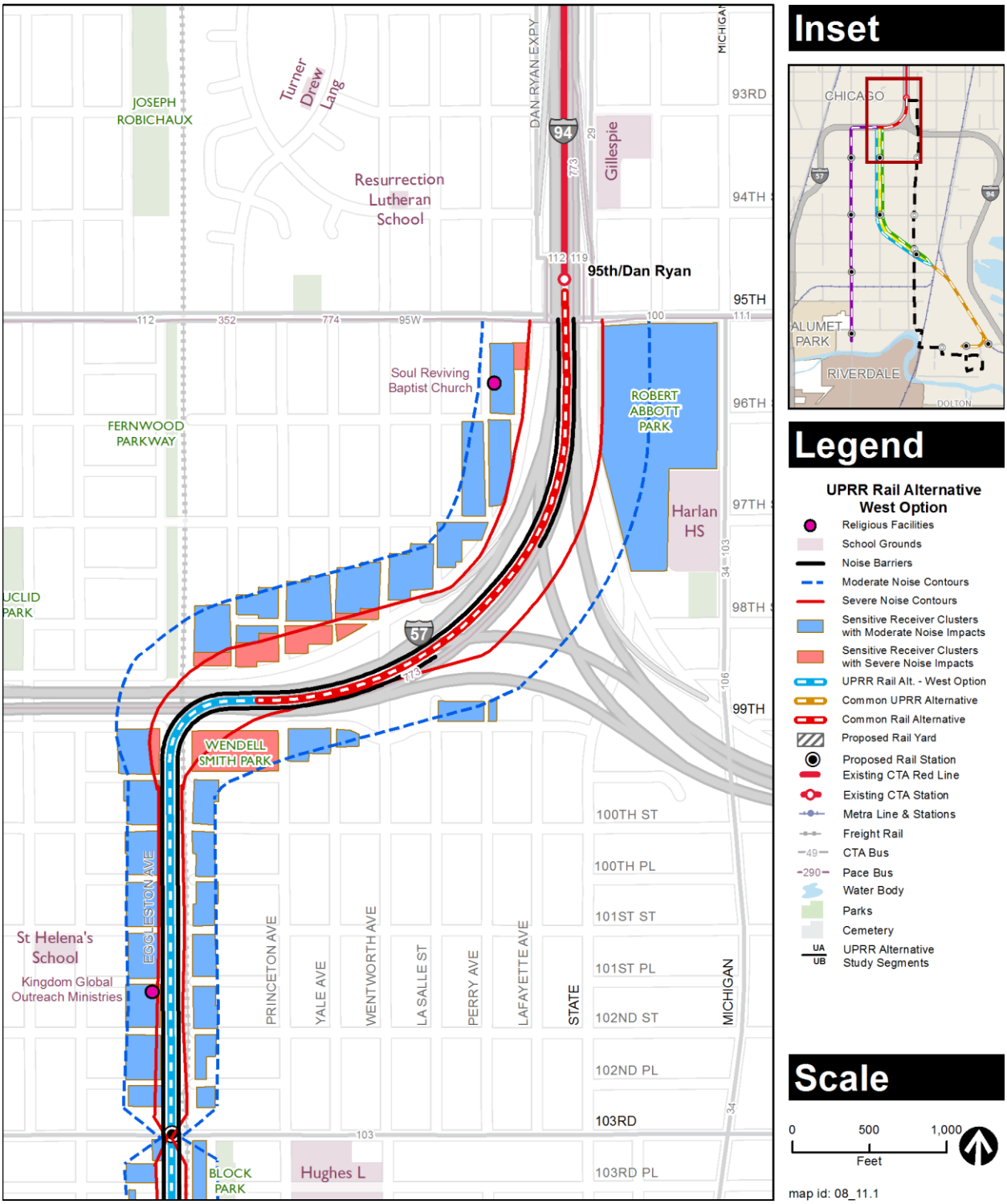

Figure 2a: Union Pacific Railroad Alternative West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

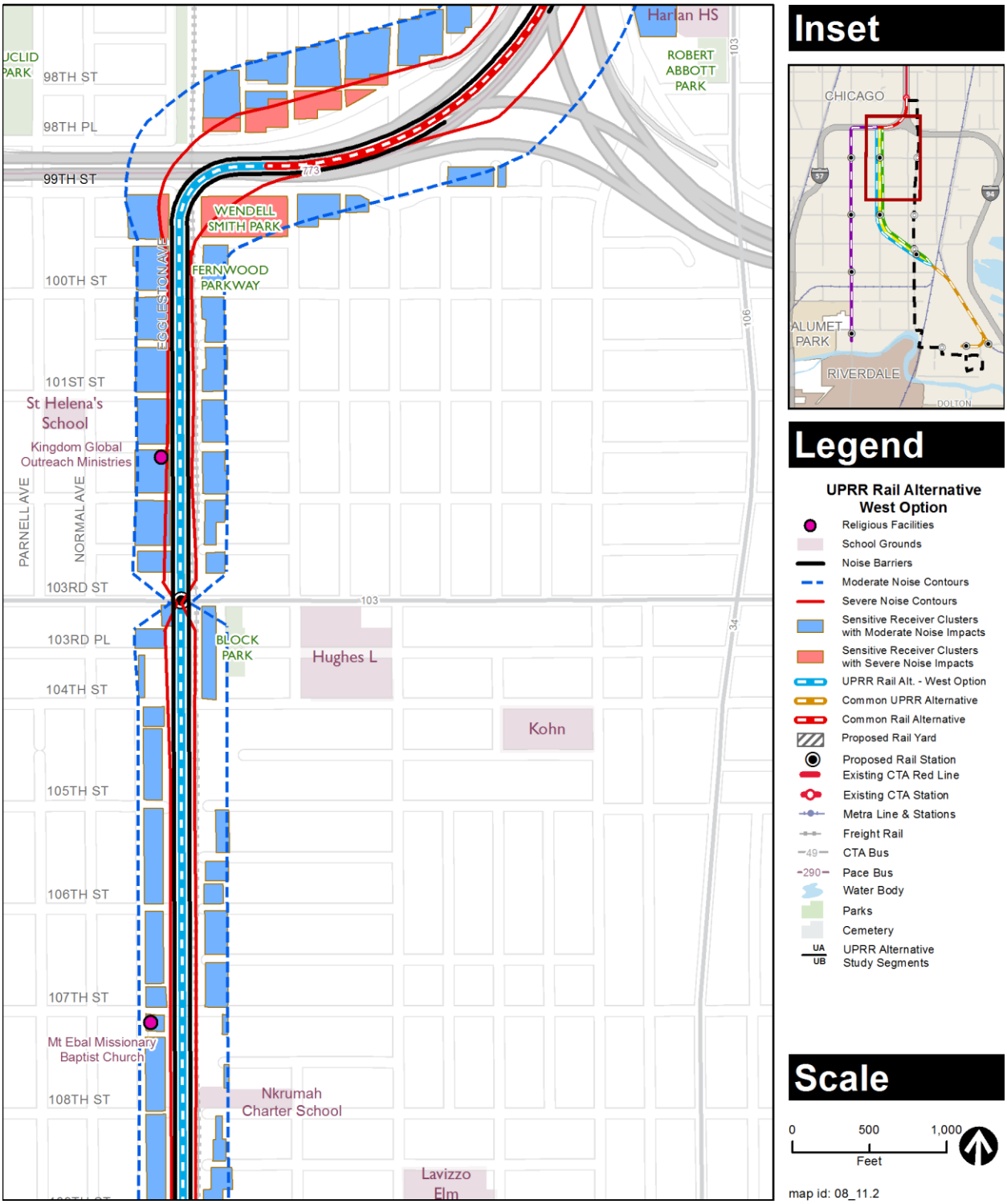

Figure 2b: Union Pacific Railroad Alternative West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

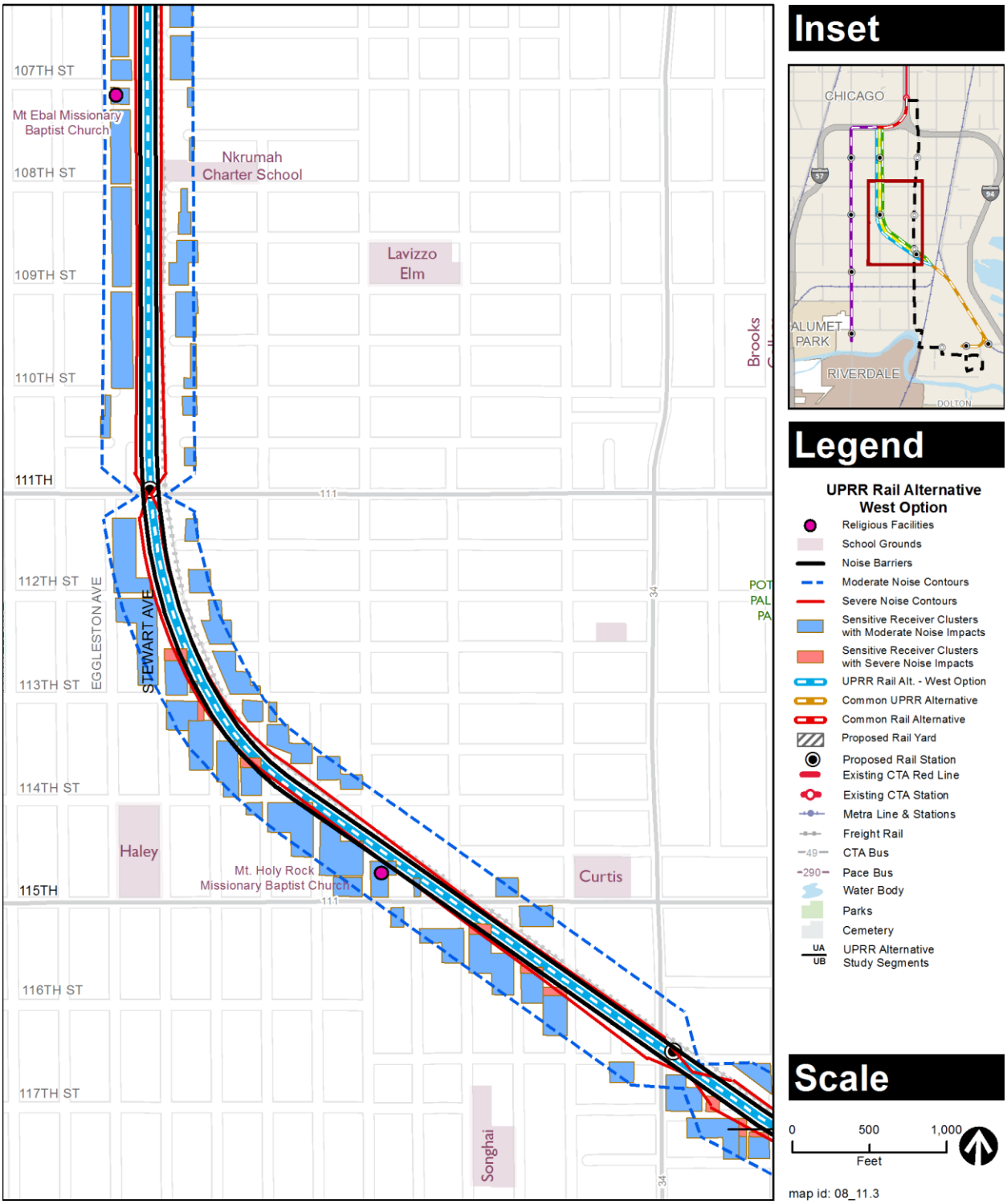

Figure 2c: Union Pacific Railroad Alternative West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

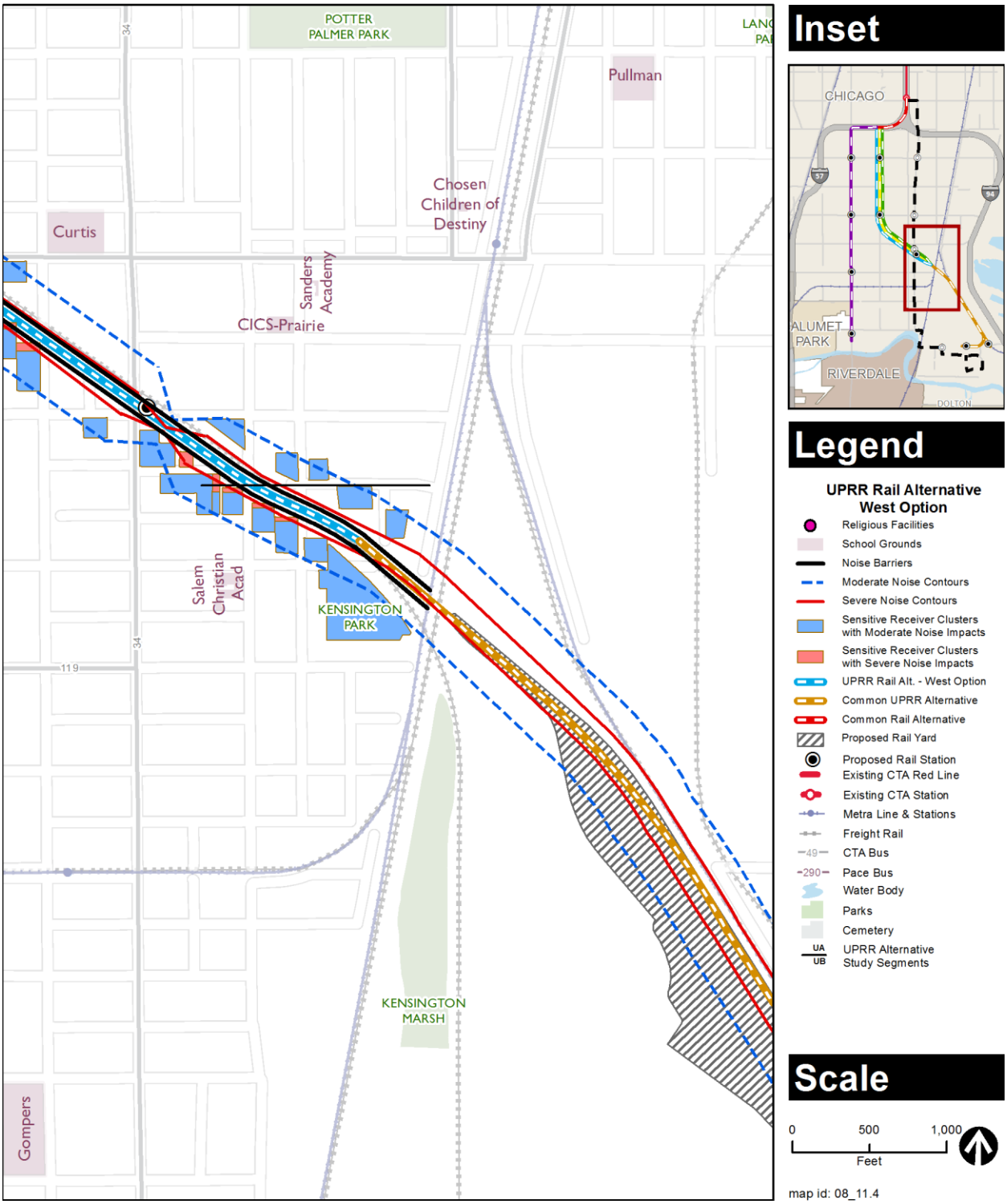

Figure 2d: Union Pacific Railroad Alternative West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours

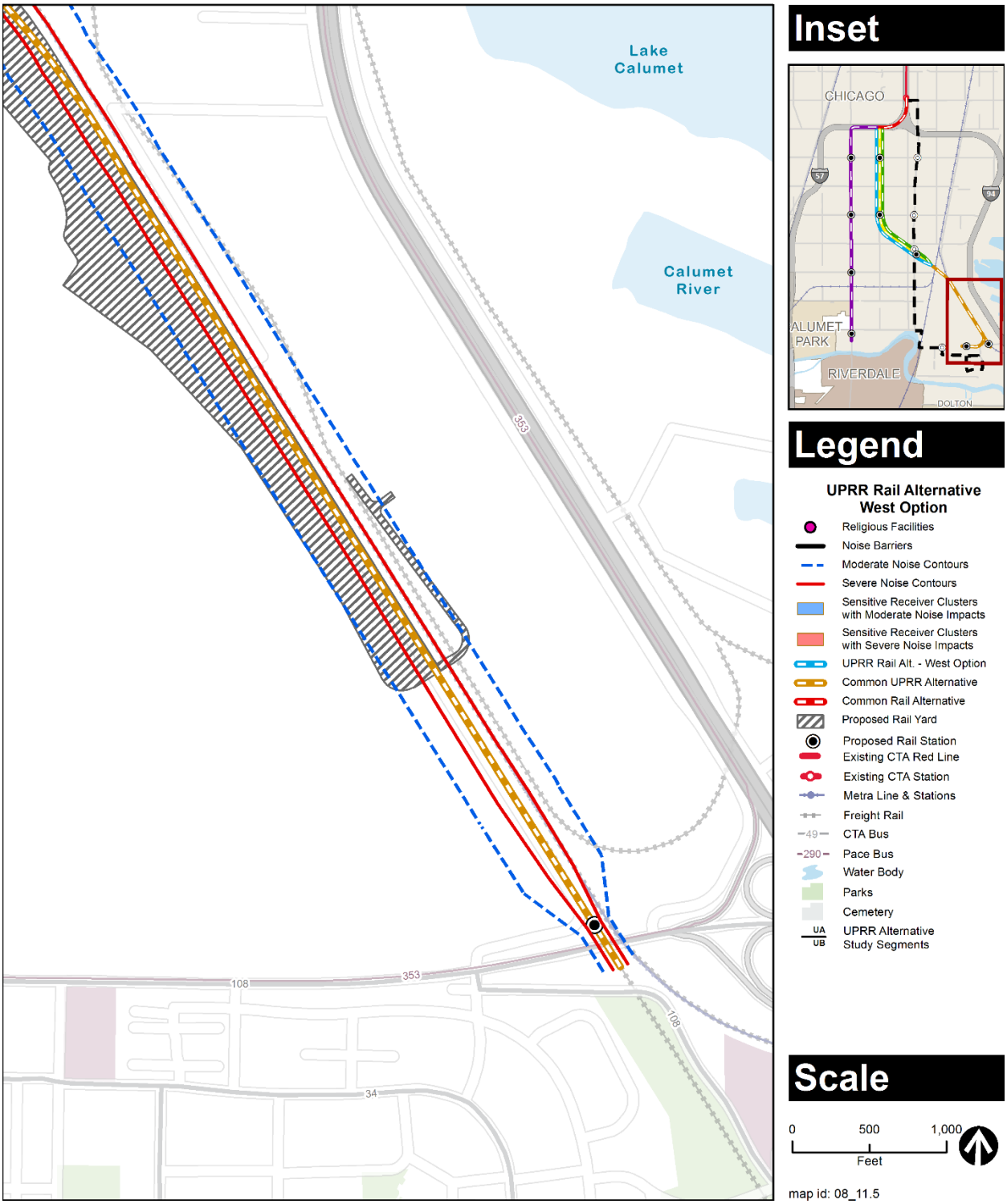

Figure 2e: Union Pacific Railroad Alternative West Option with Moderate (in Blue) and Severe (in Red) Impact Noise Contours