TECHNICAL SUPPLEMENT 4: NOISE AND VIBRATION

Albuquerque Rapid Transit Project

Prepared for:

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1.0 Introduction and Project Description

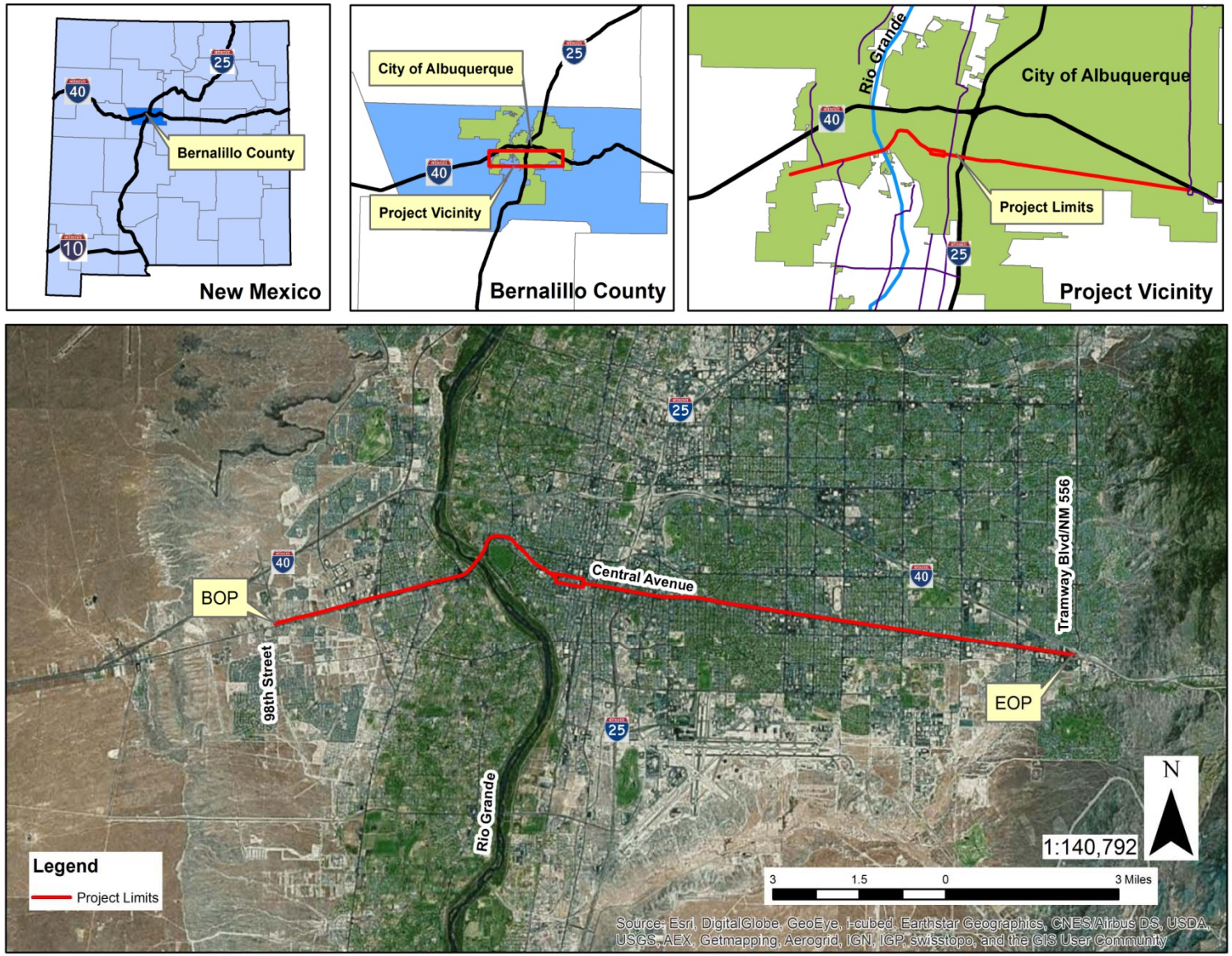
The City of Albuquerque Transit Department (ABQ RIDE), in cooperation with the Federal Transit Administration (FTA), is proposing a Bus Rapid Transit (BRT) project along Central Avenue in Albuquerque, New Mexico. This project is referred to as the Albuquerque Rapid Transit (ART) Project. While the elements of BRT systems are highly variable and depend on the needs of each specific area, the primary features proposed for the ART include: (1) modern articulated rapid vehicles; (2) rapid vehicle lanes (lanes reserved for buses only), as described below; (3) rapid vehicle stations, as described below, spaced at approximately ½ to 1 mile intervals and with off-board fare collection; and, (4) modifications to the traffic signal system to provide rapid vehicle priority.

The proposed project will extend from 98th Street on the west side of the Albuquerque metropolitan area to Tramway Boulevard on the east side (See Figure 1). The overall route length is approximately 15 miles and generally follows the alignment of Central Avenue, except through Downtown Albuquerque. In the Downtown area, the route will split with westbound service located on Copper Avenue between 10th Street and 1st Street, and eastbound service following Gold Avenue from 1st Street to 8th Street.

The major design and operational features of the proposed project include:

- Construction of two dedicated rapid vehicle lanes within the existing operational right-of-way of Central Avenue from Coors Boulevard east to Louisiana Boulevard (approximately 8.75 miles). In general, the rapid vehicle lanes will occupy the existing median of the street and will include one westbound lane and one eastbound lane. This concept will be used in all locations except as follows:
    - From San Pasquale Avenue to 10th Street (0.75 miles), the rapid vehicles will operate in a single reversible lane with the rapid vehicle operating in the off-peak direction traveling in mixed flow traffic lanes.
    - In the Albuquerque Downtown area, the rapid vehicles will operate in mixed flow traffic on Copper Avenue (westbound from 1st Street to 10th Street), Gold Avenue (eastbound from 8th Street to 1st Street), and Central Avenue from Broadway Boulevard to 1st Street. No major reconstruction to the streets will occur in this area.
- Rapid vehicles will operate in the inside traffic lane in mixed flow from 98th Street to Coors Boulevard, and from Louisiana Boulevard to Tramway Boulevard. Queue jumps will be provided at signalized intersections in these segments.
- Construction of stations within the roadway median and/or street curbside. Stations will consist of concrete platforms approximately 65 feet long and 10 to 14 feet wide. The platforms will be elevated 6 to 14 inches above the pavement to allow for level boarding from the ART station to the rapid vehicle. In addition to the platform, stations will include a ticket vending machine and an overhead canopy to shield passengers from sun and precipitation. Other passenger amenities such as benches, an information kiosk, trash receptacles, and security lighting may also be provided.
- Rapid vehicles will operate at approximate 5 to 10 minute headways depending on time of day. Hours of operation have not been determined but are likely to be from 5:00 am until midnight.

Figure 1 – Project Vicinity



Project Improvements that May Impact Noise Levels

The proposed BRT service will replace Routes 766 and 777 of the existing service along the corridor and will be supported by the existing local bus network. Route 66 bus service will remain at the current level of service. For the purposes of the noise analysis, bus headways are assumed as 6 minutes during peak travel periods and 12 minutes during off-peak periods for weekdays and 15 minute headways on weekends.

Table 1 provides a summary of the existing transit service along the Central Boulevard corridor and the proposed BRT service.

Table 1 – Existing and Proposed Service

Operational Characteristic		Existing Transit Service	Proposed BRT Service
Route		66, 766 and 777	*BRT
Weekdays	Frequency	Route 66 - 15 minutes Route 766 – 15 minutes Route 777 – 15 minutes	6 minutes between 7:00 am and 9:00 am, 12:00 pm to 6:00 pm 12 minutes 9:00 am. to 12:00 pm and 6:00 pm to 2:00 am
	Span of Service	Route 66 – 5:30 am to 12:45 am Route 766 –5:30 am to 9:30 pm Route 766 –5:30 am to 9:30 pm	
Weekends	Frequency	Route 66 - 15 minutes Route 66 Late Night – 30 minutes Route 766 – 30 minutes Route 777 – 30 minutes	15 minutes 7:00 a.m. to 8:30 p.m. 30 minutes 8:30 p.m. to 12:00 a.m.
	Span of Service	Route 66 – 6:00 am to 7:30 pm Route 66 Late Night (Fri. – Sat.) 12:00 am to 1:30 am Route 766 –6:00 am to 9:20 pm Sat. Route 766 –5:30 am to 9:20 pm - Sat. 6:25 am to 7:00 pm - Sun.	
Stop/Station spacing		¼ mile	½-1 mile
Vehicle		40 foot buses with combination of diesel and diesel-hybrid propulsion.	60 foot, New Flyer: articulated, diesel-hybrid bus with doors on both sides

**Final frequency and span of service to be determined as design advances*

2.0 Methods

The study area for the assessment of noise is defined as 250 feet from the proposed Central Avenue BRT alignment centerline. The study area for this project was chosen according to the FTA screening procedures provided in Chapter 4 of the FTA *Transit Noise and Vibration Impact Assessment*, May 2006. This screening process will also identify areas where the project may cause long-term or temporary noise impact and require a more detailed assessment as described in Chapter 5 of the FTA *Transit Noise and Vibration Impact Assessment*.

The screening review for this project utilized Geographical Informational Systems (GIS) data of the project alignment and City of Albuquerque land use parcel mapping overlaid on detailed 2012 aerial photographs. Parcels within 250 feet of the project centerline were queried as to land uses to identify potential Noise-Sensitive properties.

A reconnaissance survey of land uses immediately adjacent to the project corridor was performed to verify the accuracy of the GIS data and to identify additional potential Noise-Sensitive properties. The field survey was performed on June 25, 2014 and was limited to viewing areas readily observable from the project corridor.

Existing noise levels at four sites along the corridor were measured on June 25 and 26, 2014. These measurements were used to establish base line noise levels prior to determining impacts.

A General Assessment as defined by the FTA Transit Noise and Vibration Impact Assessment was conducted to identify the location and estimated severity of noise impacts.

The screening methodologies used for the noise assessments, including descriptions of the noise metrics, are described in the following section.

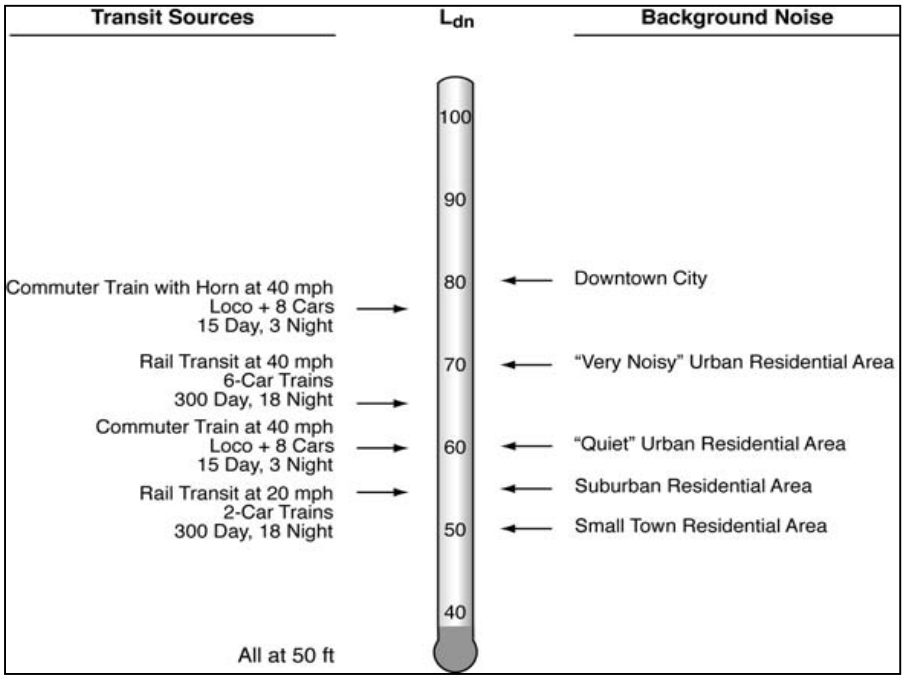
2.1 Noise Fundamentals

The basic unit of measurement for noise is the decibel (dB), which is a logarithmic measure of sound energy that tracks closely with human perception of loudness. To better account for human hearing sensitivity to different frequencies contained in sound (or "unwanted sound" called noise), noise is quantified in units of decibels on an "A-weighted scale" (dBA). The "A" scale approximates the average human ear's sensitivity to sounds comprised of many different frequencies. The terms "sound" and "noise" are used interchangeably in this report.

The most commonly used noise metric (also called a "noise descriptor") is the Equivalent Noise Level (L_{eq}), which is the energy sum of all the sound that occurs during a measurement period. Another descriptor known as Average Day-Night Noise Level (L_{dn}), is nearly universally used to evaluate noise in areas with noise-sensitive uses that include sleeping quarters such as residential areas. The L_{dn} is a 24-hour L_{eq} with a 10-dB penalty added to noise occurring from 10 p.m. to 7 a.m. The effect of this penalty is that, in the calculation of L_{dn}, any sound (or noise event) during nighttime hours is equivalent to 10 identical events occurring during daytime hours. This strongly weights L_{dn} toward nighttime noise to reflect that most people are more easily annoyed by noise during nighttime hours when background sounds may be lower and most people are sleeping.

A rural area with no major roads nearby would have a typical L_{dn} of around 40 dBA; a noisy urban residential area close to a major arterial highway would average around 70 dBA L_{dn}. Most residential areas in the study corridor fall within the range of 60 to 75 dBA L_{dn}. Figure 2 provides typical L_{dn} values experienced in a range of residential and urban areas.

Figure 2 – Typical L_{dn} Values



Source: FTA, 2006

2.2 Noise Impact Criteria

FTA has developed standards and criteria for assessing noise impacts related to transit projects. The standards outlined in the FTA guidance manual *Transit Noise and Vibration Impact Assessment* (FTA, 2006) are based on community reaction to noise.

These standards evaluate changes in existing noise conditions using a sliding scale. The higher the level of existing noise, the less room there is for a project to contribute additional noise.

Some land use activities are more sensitive to noise than others; for example, churches, and residences are more noise-sensitive than industrial and commercial areas. The Noise Impact Criteria group sensitive land uses into the following three categories:

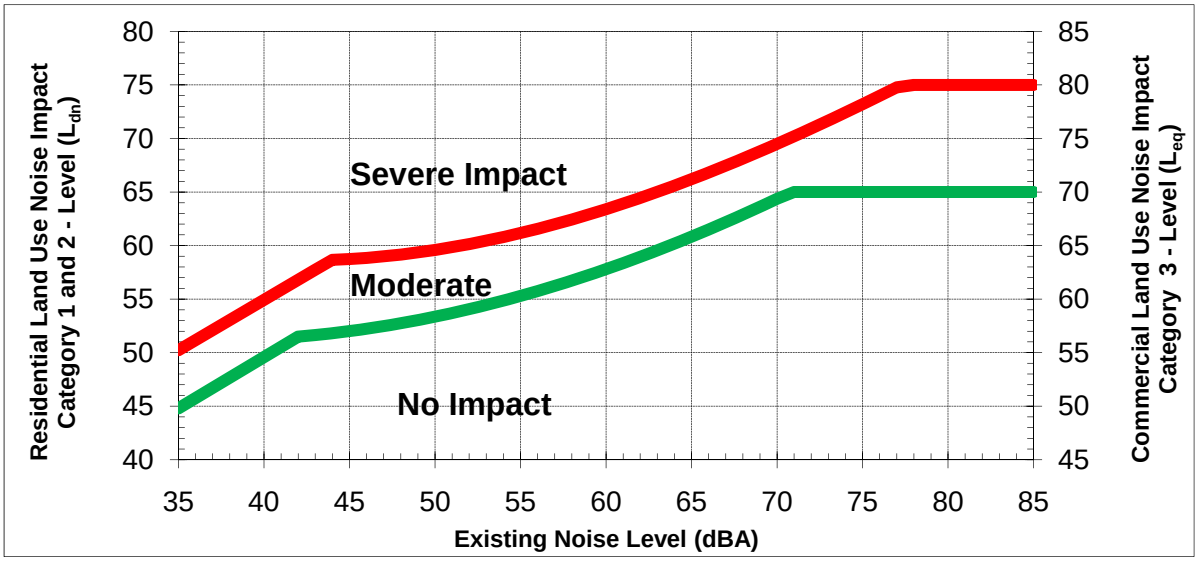
- **Category 1**: Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as national historic landmarks with significant outdoor use. Also included are recording studios and concert halls.
- **Category 2**: Residences and buildings where people normally sleep. This includes residences, hospitals, and hotels, where nighttime sensitivity is assumed to be of utmost importance.
- **Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with activities such as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

L_{dn} is used to characterize noise exposure for residential areas (Category 2), and maximum one-hour L_{eq} (during the period that the facility is in use) is used for other noise-sensitive land uses such as school buildings (Categories 1 and 3).

Figure 3 shows the levels of impact included in the noise impact criteria. The FTA noise criteria are delineated into two categories: impact and severe impact. The impact threshold defines areas where the change in noise is noticeable but may 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 new noise levels. The level of impact at any specific location can be established by comparing the predicted Project noise level at the site to the existing noise level at the site.

For this assessment, the FTA screening distance of 250 feet for BRT operations was applied to the Central Avenue ART Project alignment to determine potential noise impact locations for further assessment.

Figure 3 – Noise Impact Criteria for Transit Projects



3.0 Existing Conditions

Land uses along the Central Avenue Corridor and within the 250 foot offset study area are a mix of residential, commercial, industrial, public institutional uses (such as schools, parks, and churches), and quasi public institutions (such as hospitals).

- There are no Category 1 Land Use parcels within the study area.
- Category 2 Land Uses occur throughout the corridor and include multi-family residential uses (apartments and condominiums), several motels and hotels, several schools, and a hospital. The majority of the residential areas do not front Central Avenue and are setback from the roadway. However, several apartments and condominium complexes are present and are immediately adjacent to the roadway. These are mostly in the downtown area and Nob Hill area. The hospital is also setback from the roadway.
- Category 3 Land Use parcels are also present including several schools, small parks, churches,

theaters, and a large health care complex. The majority of these uses are setback from the roadway.

Approximately one hundred ninety six Category 2 and Category 3 parcels are within the study area including single or multi-family units, motels and hotels, apartment complexes, one hospital, one low income housing development, and one retirement home. The Category 3 parcels include the University of New Mexico, the Albuquerque Bio-Park Aquarium, the State Fair Grounds and several churches.

Existing noise levels were measured at four sites along the corridor on June 25 and 26, 2014. Sound levels were collected using a calibrated Larson Davis sound level meter (SLM) set to record A-weighted decibels (dBA) at a slow-response setting. Levels were measured for 20 and 30 minute durations. The receiver sites were chosen to represent typical segments of the corridor and to assist in the analysis of noise impacts at Category 2 locations. Measurements were taken at the back of sidewalk or right-of-way line away from the centerline of the corridor. Distances to the centerline ranged from 40 feet to 80 feet. Table 2 lists the measurement results (see Figure 7 for locations).

Table 2 – Measured Noise Levels

Receiver	Time Begin	Time End	Distance to Centerline	LASeq (dBA)	Land Use Category
1	10:43 AM	11:13 AM	45 feet	70	Commercial – No Category
2	9:19 AM	9:50 AM	42 feet	68	Loft Type Apartments – Cat 1
3	12:23 PM	12:43 PM	40 feet	67	Apartment Complex – Cat 2
4	1:12 PM	1:43 PM	80 feet	67	Vacant / Commercial – No Cat.

The levels measured are consistent with Table 5-7 of the FTA *Transit Noise and Vibration Impact Assessment*. In that Table noise exposures are estimated at 70 dBA Leq for the condition identified as "Other Roadways" at 10 to 50 feet away from source and at 65 dBA Leq for distances of 50 to 100 feet.

Figure 7 — Project Maps — show the project alignment, the 250 foot FTA noise screening distance, the location of potential noise sensitive land use parcels, and the existing noise level monitor sites.

4.0 Impacts

Project parameters were input into the FTA-provided Excel Noise Impact Assessment Spreadsheet to analyze the potential project noise impacts for three distinct conditions within the project area. The conditions represent roadway segments with specific right-of-way widths (80 feet, 100 feet, and 120 feet) and different traffic volumes and travel speeds. This approach allowed noise level to be characterized for each major segment of Central Avenue. Eight distinct segments were evaluated, including:

- *98th Street to Coors Boulevard* – The right-of-way in this segment is typically 120 feet wide or more. Land use is primarily large industrial and commercial parcels with one large church and a school present. A small number of residential parcels exist. In all instances, noise sensitive properties are set back 10 feet or more from the edge of right-of-way (70 feet from the roadway centerline).

- *Coors Boulevard to Old Coors Drive* – This segment of the project corridor also has an existing right-of-way width of 120 feet. Land use is predominantly smaller commercial and multi-family residential parcels. Noise sensitive uses are typically set back ten feet or more from the right-of-way, i.e., 70 feet from the roadway centerline.
- *Old Coors Drive to the Rio Grande* – Land use is predominantly a mixture of large and small commercial properties with at least one motel. Existing right-of-way width is 100 feet. Set backs from right-of-way are generally greater than ten feet.
- *Rio Grande to Lomas Boulevard & San Pasquale* – Land use is predominantly small commercial parcels and recreational facilities including the Albuquerque Bio Park Aquarium and a golf course. Existing right-of-way width is 100 feet. The commercial uses are set back from zero to ten feet or more.
- *San Pasquale to 10th Street* – Land use in this segment is predominantly a mixture of small commercial facilities, two schools, and several apartment complexes and motels. Existing right-of-way width is 80 feet with buildings set back zero to ten feet. Because this segment of Central Avenue is limited to a single lane in each travel direction, posted travel speeds are 30 mph and traffic volumes are generally low.
- *Broadway Boulevard to University Boulevard* – This segment is predominantly smaller commercial and residential parcels, and hotels and motels. A large hospital complex (Presbyterian Hospital) is also present. The right-of-way is generally 80 feet or more. Buildings on the small parcels receivers are typically set back zero to ten feet while the larger buildings are set back much further.
- *University Boulevard to San Mateo Boulevard* – Land use is predominantly small commercial development and several apartment/condominiums. The University of New Mexico is also within this segment along with assorted other Category 2 and 3 uses. Right-of-way width is generally 100 feet or more. Set backs on small parcels are zero to ten feet while larger parcel are set back more.
- *San Mateo Boulevard to Tramway Boulevard* – This segment is predominantly a mixture of small and large commercial parcels, the New Mexico State Fair Grounds, churches, schools, motels, mobile home parks and a retirement center. Existing right-of-way width is 100 feet. Building offsets are ten feet or more.

Noise impacts for the above segments were evaluated using the FTA Noise Impact Assessment Spreadsheet, version 7/3/2007. The variable used for the distance to the receiver for each option was one half the width of the right-of-way, i.e., 40, 50 and 60 feet. For the screening analysis, additional distance for building setbacks was not considered. Existing noise levels were assumed as 67 dBA, which was the lowest sound level found during the field measurements. Bus speeds were assumed as 30 mph in the roadway segments with an 80 foot right-of-way and 35 mph for the segments with right-of-way widths of 100 feet or more.

The results of the analysis using the FTA spreadsheet are shown in Figures 4, 5 and 6. The analysis indicates that the increased noise level due to the project is 1 dB. The cumulative noise level, assuming an existing background level of 67 dBA, is estimated at 60 dBA to 61 dBA, a level that is below the moderate impact threshold. Thus, based on the noise screening assessment, the proposed project is not anticipated to result in operational noise impacts.

Figure 4 – Estimated Noise Level at Edge of Right-of-Way for Segments with 80 foot Right-of-Way

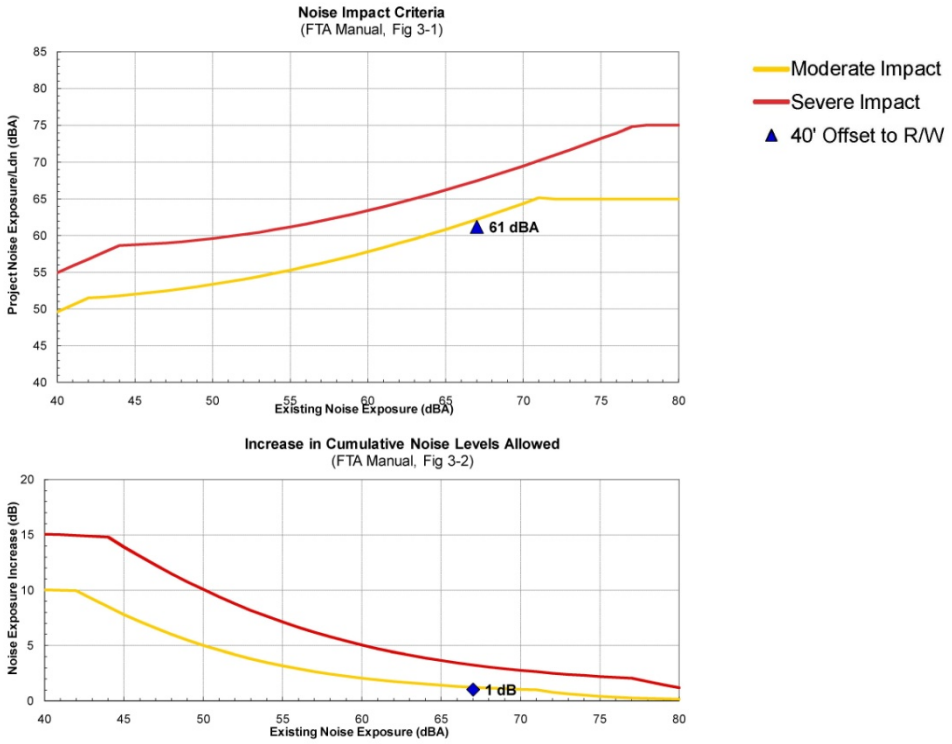


Figure 5 – Estimated Noise Level at Edge of Right-of-Way for Segments with 100 foot Right-of-Way

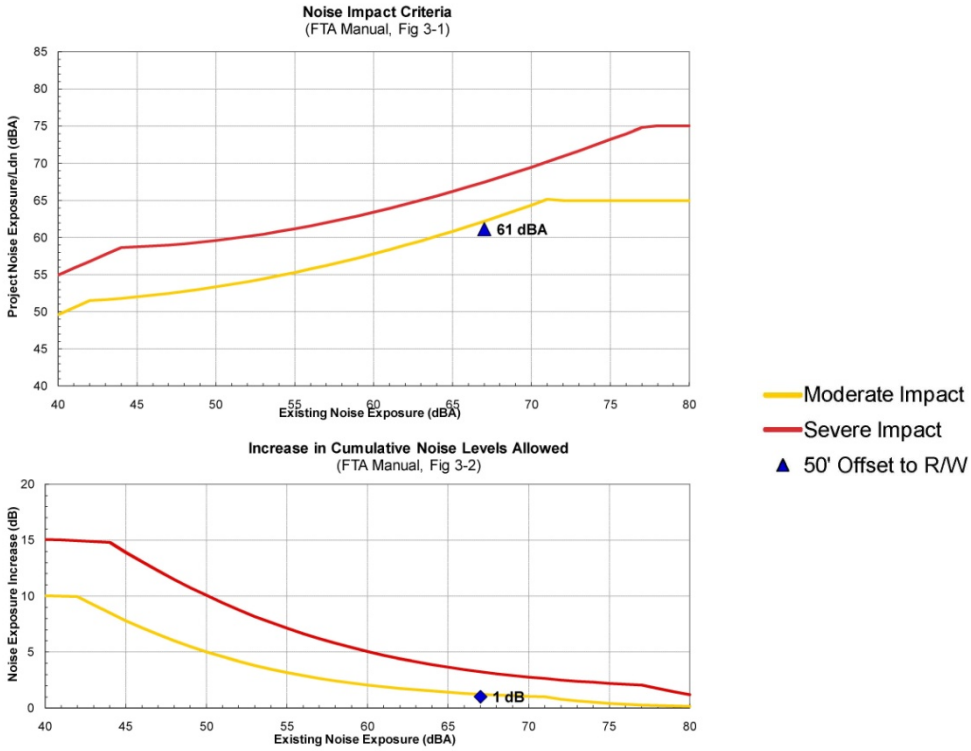
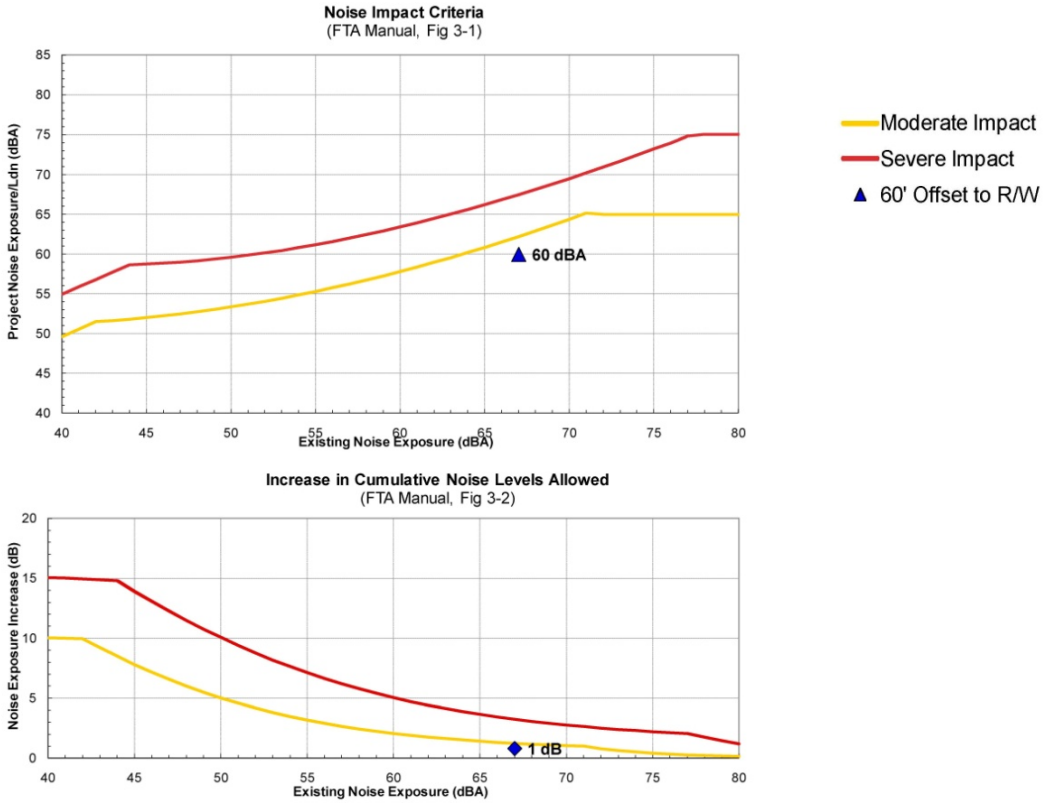


Figure 6 – Estimated Noise Level at Edge of Right-of-Way for Segments with 120 foot Right-of-Way



5.0 Vibration Screening

The FTA vibration screening procedure is designed to identify projects that have little possibility of creating significant vibration impact. If the screening procedure does not identify potential problem areas, further consideration of vibration impacts is not necessary.

Vibration impacts are generally associated with projects involving light rail or commuter rail transit. Because the Central ART project involves rubber-tire vehicles, vibration impact is unlikely. For this type of project, the FTA screening procedure considers three specific factors to determine the potential for vibration impact:

- The use of expansion joints, speed bumps or other design features that result in uneven road surfaces near vibration sensitive buildings? Roadway irregularities can result in perceptible ground-borne vibration at up to 75 feet away.
- Buses operating close to a sensitive building such as research facilities using electron microscopes or manufacturing of computer chips.
- The operation of vehicles inside of or directly underneath buildings that are vibration sensitive.

The Central ART project does not involve any of the three factors listed above. Therefore, vibration impact is unlikely and further consideration of ground-borne vibration impact is unnecessary.

Figure 7 – Project Maps

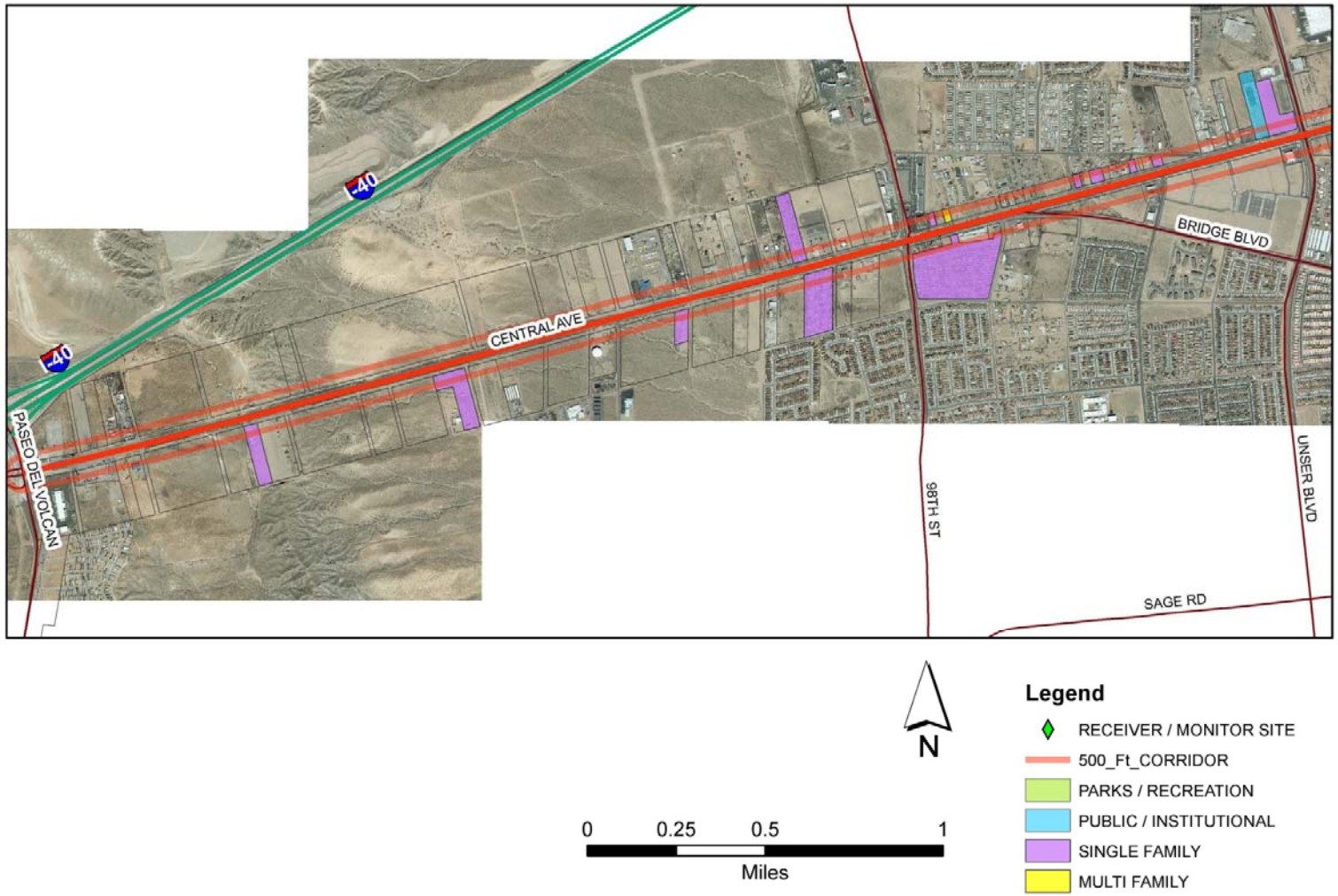


Figure 7 – Project Maps (continued)

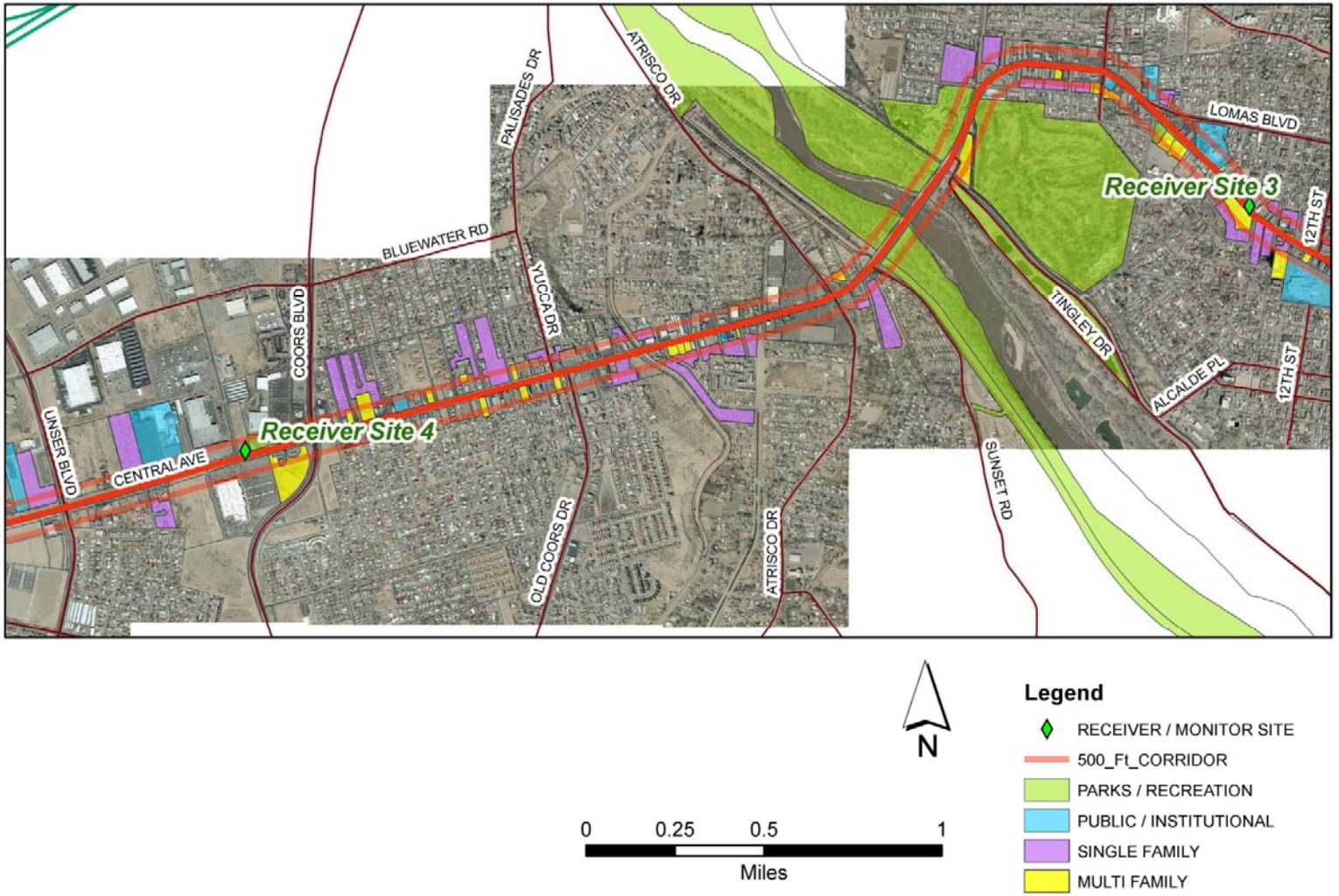


Figure 7 – Project Maps (continued)

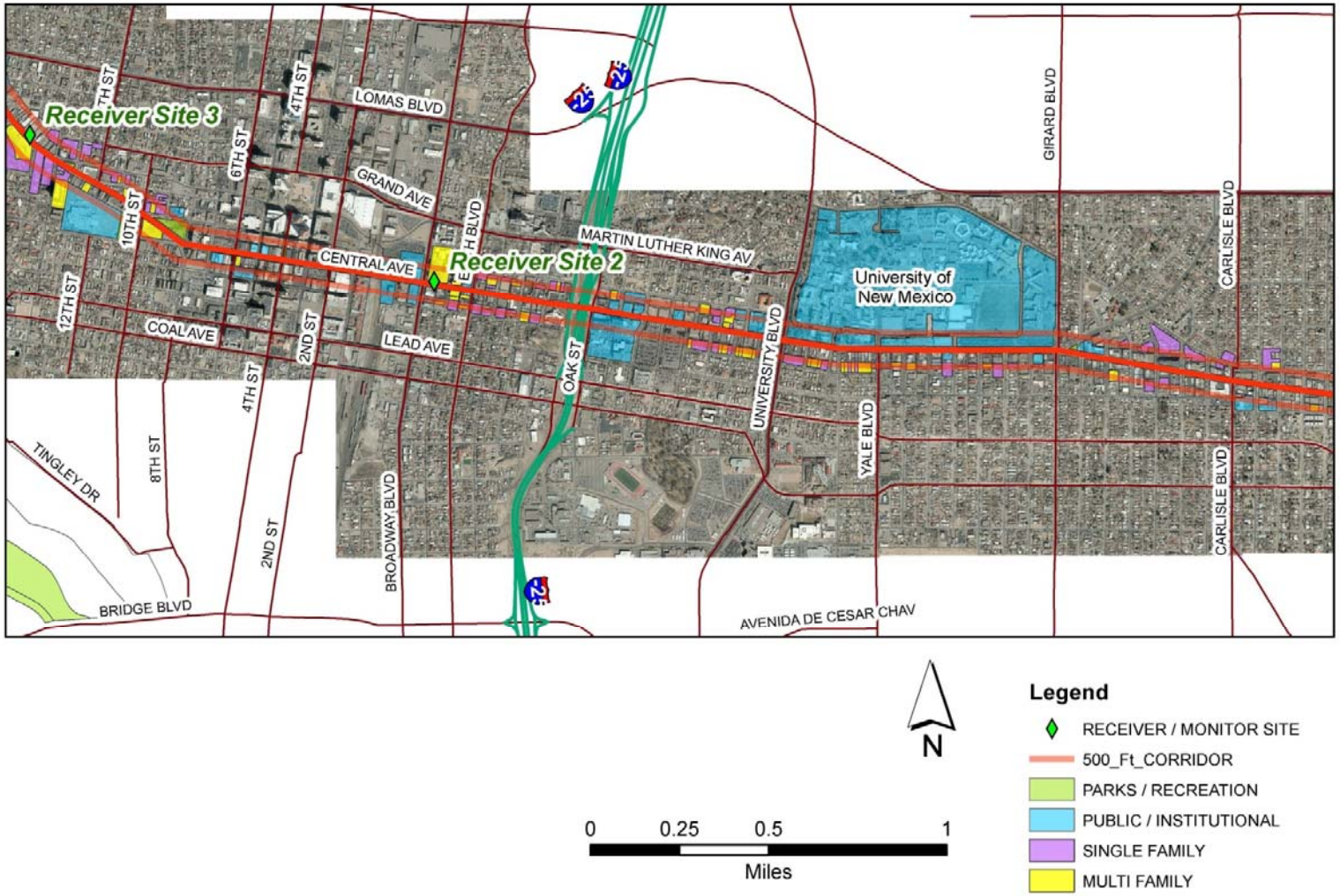


Figure 7 – Project Maps (continued)

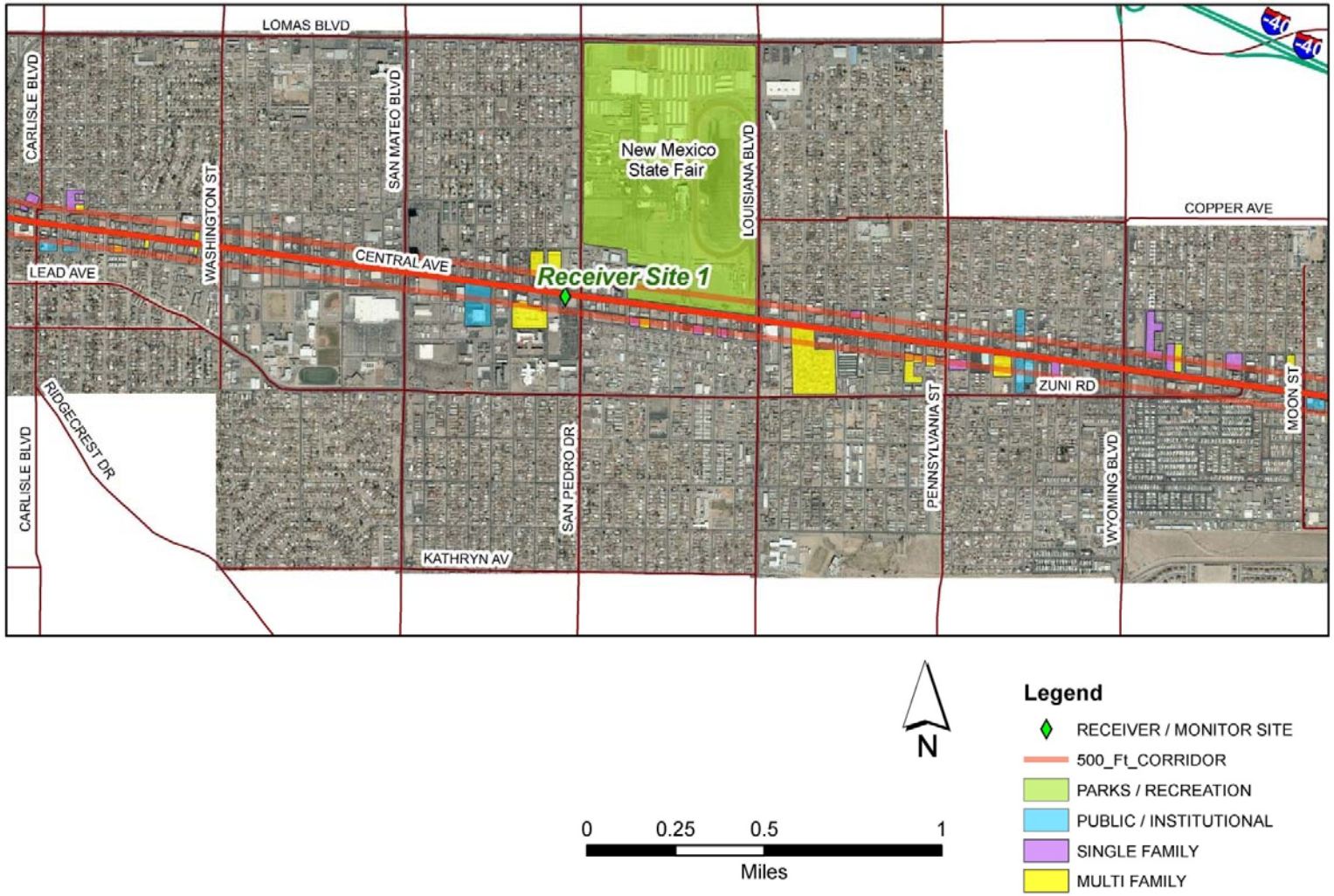


Figure 7 – Project Maps (continued)