LYNX Blue Line Extension
(Northeast Corridor)
Light Rail Project
Contract #: 08-477
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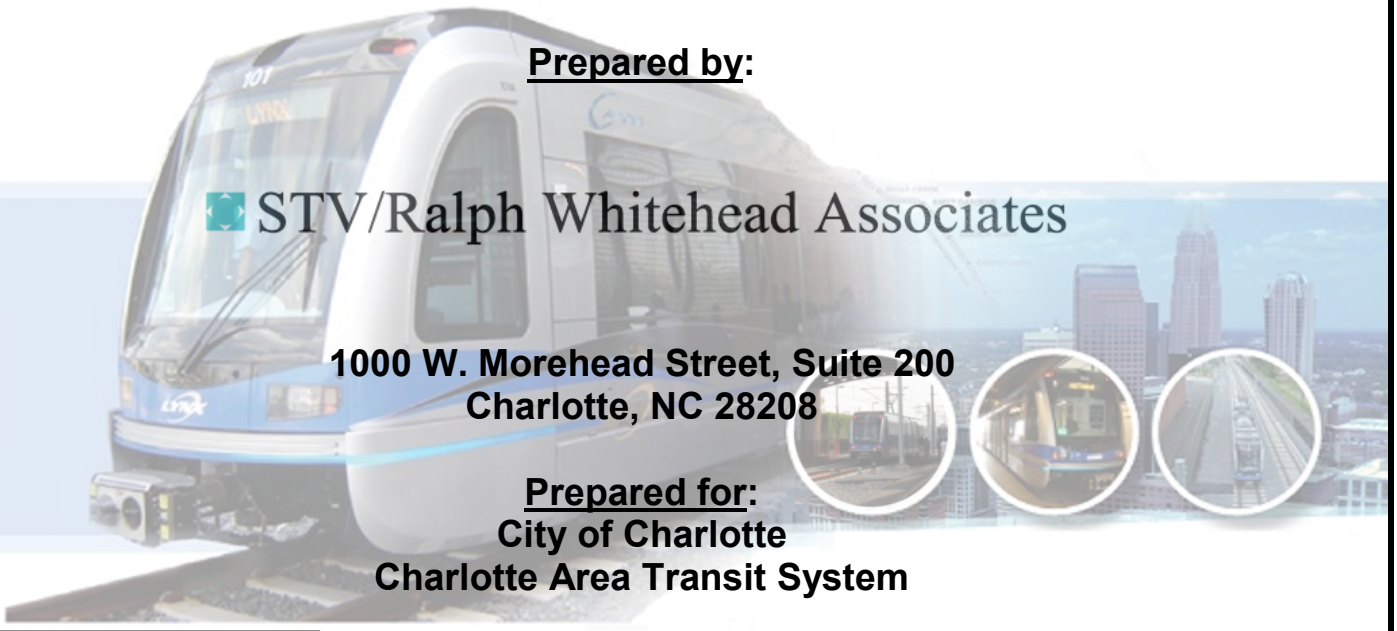
Noise and Vibration Technical Report



Prepared by:

STV/Ralph Whitehead Associates

1000 W. Morehead Street, Suite 200
Charlotte, NC 28208

Prepared for:
City of Charlotte
Charlotte Area Transit System

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1.0 INTRODUCTION AND SUMMARY

This section describes the potential noise and vibration impacts resulting from the construction and operation of the proposed LYNX Blue Line Extension Northeast Corridor Light Rail Project (LYNX BLE). This section will assess long-term changes in the noise and vibration environment based on the operation of light rail service and short-term effects resulting from construction of proposed improvements and support facilities. The focus of the analysis is on the effects of the Light Rail Alternative and the Light Rail Alternative – Sugar Creek Design Option. As such, the Light Rail Alternative and its design option were compared to existing conditions in the immediate vicinity of the proposed improvements. Mitigation measures are discussed where noise or vibration impacts are predicted.

1.1 Project – Light Rail Alternative

The proposed project would extend the existing LYNX Blue Line light rail system by approximately 10.6 miles and provide 13 transit stations, including six walk-up stations and seven park-and-ride facilities. The proposed Light Rail Alternative alignment, shown in Figure 1, would begin at the LYNX 7th Street Station and travel along CATS-owned right-of-way until approximately 12th Street where it would cross over the CSX rail tracks and then enter the existing Norfolk Southern and North Carolina Railroad (railroad) rights-of-way to the middle of the alignment, near Old Concord Road, where it would then transition into the median of North Tryon Street/US-29. The line would remain in the median until north of W.T. Harris Boulevard, where it would turn east crossing under the existing travel lanes of North Tryon Street/US-29, entering the UNC Charlotte campus before returning to the east side of North Tryon Street/US-29 to a terminus just south of I-485.

The project would be designed to accommodate two light rail tracks, one for northbound service and one for southbound service. In general, the tracks would be located at-grade. Some portions would be elevated to go over existing freight tracks, water features or roads. The proposed Light Rail Alternative would include the depression of 36th Street under the existing railroad freight tracks and the proposed light rail tracks. A depression of the light rail tracks under the existing northbound travel lanes of North Tryon Street/US-29 would also occur where the alignment turns southeast to enter the UNC Charlotte campus. Sugar Creek Road would be depressed under the existing railroad tracks as planned and undertaken as a separate project by the railroad. A structure specifically for light rail use would be constructed over a depressed Sugar Creek Road.

The proposed project would include local, neighborhood circulator and express bus services to connect the light rail service with the CATS regional bus system, as well as any ancillary facilities such as traction power substations, signal houses, and crossing cases. CATS is evaluating alternatives for a maintenance and storage facility for the project, including the potential use of the existing South Boulevard Light Rail Facility.

Along North Tryon Street/US-29 north of Old Concord Road, where the proposed alignment would be in the median, station platforms would be located in the median with pedestrian access via crosswalks. All stations would include facilities for bicyclists, such as bike racks or bike lockers. All stations would include shelters, lighting, benches, garbage cans, self-serve ticket-vending machines and CATS customer information, such as maps and schedules for the light rail line and connecting bus routes. Seven stations would include park-and-ride facilities,

providing over 4,000 parking spaces. The park-and-ride facility at the terminal station located at I-485 would include a five-story parking garage.

A design option for the proposed Light Rail Alternative, called the Light Rail Alternative – Sugar Creek Design Option, is also being studied in the Draft EIS and is discussed in this technical report. This optional alignment enters the median of North Tryon Street/US-29 in the vicinity of Sugar Creek Road approximately 500 feet before the Light Rail Alternative alignment as shown in Figure 2. This design option includes park-and-ride facilities at a Sugar Creek Station and an Old Concord Road Station that are in different locations than those proposed for the Light Rail Alternative.

1.2 Project Summary of Results

1.2.1 Noise Impact Assessment

Utilizing FTA noise criteria, the results of the noise study indicate that both moderate and severe noise impacts would occur at several locations along the proposed Light Rail Alternative and the Sugar Creek Design Option. For the Light Rail Alternative, impacts were predicted at four separate impact locations along the alignment. At the Pines Mobile Home Park, a total of 26 individual residential building properties would be moderately impacted. At the Mallard Creek Apartments, six individual residential building properties would be moderately impacted while two individual residential building properties would be severely impacted. The remaining two impact locations would be moderately impacted. They include the InTown Suites Hotel building and one area of noise-sensitive parkland at the Kirk Farm Fields Viewing Area. In addition to the predicted noise impacts, the potential for wheel squeal noise was identified at two locations along the alignment; the UNC Charlotte – Laurel Hall Student Residence and the Kirk Farm Fields Viewing Area.

For the Sugar Creek Design Option, impacts were predicted at two separate impact locations along the extent of the design option. One moderate impact would be predicted at an individual residence along US-29/North Tryon Street. At the Pines Mobile Home Park, a total of 26 individual residential building properties would be moderately impacted.

Mitigation options considered would include:

Rail Vehicle Skirts – Depending upon the exact level of effectiveness, the modification of light rail vehicle skirts from a simple aesthetic use to one that would result in noise attenuation would eliminate or significantly reduce many of the impacts projected for the Light Rail Alternative and the Sugar Creek Design Option.

Sound Barriers – Sound barriers can either be located close to the source, at the affected receptor or somewhere in between. Noise barriers would be effective in eliminating severe and moderate impacts for many of the affected properties.

For the two locations, the UNC Charlotte Laurel Hall and Kirk Farm Fields, that would be affected by wheel squeal, barriers located very close to the track would significantly reduce the level of wheel squeal by as much as 15 decibels (dB).

Resilient or Damped Wheels – Resilient wheels are extremely efficient at attenuating wheel squeal. For the locations at UNC Charlotte Laurel Hall and Kirk Farm Fields, the noise impact

from wheel squeal would likely be eliminated with reductions ranging from 10 to 20 dB depending upon the frequency characteristics of the squeal noise.

Building Sound Insulation – Building sound insulation most typically involves caulking and sealing gaps in the building envelope and installation of specially designed windows and solid-core doors. Depending on the quality of the original windows, such treatments can provide noise reductions as much as five to 10 or more dB to building interiors. One or more of the apartment buildings at Mallard Creek would benefit from sound insulation.

Permanent Roadway Closures – Eliminating unnecessary roadway-rail grade crossings can remove the need for light rail horn use. The importance of individual crossings is a function of through traffic, community circulation and emergency vehicle requirements and limitations. The only grade crossing near an impacted property where closing could be considered is Stetson Drive. The closing of this roadway would eliminate the moderate noise impact at the InTown Suites Hotel.

Relocate or Insulate Substation - For impacts to the InTown Suites Hotel property and the private residence at 5234 North Tryon Street, relocating or using a sound proof enclosure for nearby project substations would reduce the level of noise impact.

1.2.2 Vibration Impact Assessment

Utilizing FTA vibration criteria, the results of the vibration study indicate that one vibration impact would occur along the Light Rail Alternative for a private residence at 342 St. Anne Place. No vibration impacts would occur along the Sugar Creek Design Option. As described in the FTA manual, mitigation options considered could include:

- High Resilience Rail Fasteners;
- Ballast Mats;
- Floating Slab Track Bed; and,
- Resiliently Supported Ties.

Several buildings within the UNC Charlotte campus were identified that could potentially be affected by project rail vibration from the Light Rail Alternative. Because of the sensitive nature of the research at these affected buildings, it was determined that a more detailed review of the rail vibration and building sensitivity is required. This type of review is usually performed during the Detailed Analysis associated with the final design phase of a project and not as part of the Draft Environmental Impact Statement (Draft EIS) due to the increased level of specificity needed in the engineering design to properly assess the proposed impacts. As such, the need for a more detailed analysis along with continuing coordination with the Charlotte Research Institute (CRI) is acknowledged and affirmed.

2.0 FUNDAMENTALS OF NOISE AND VIBRATION

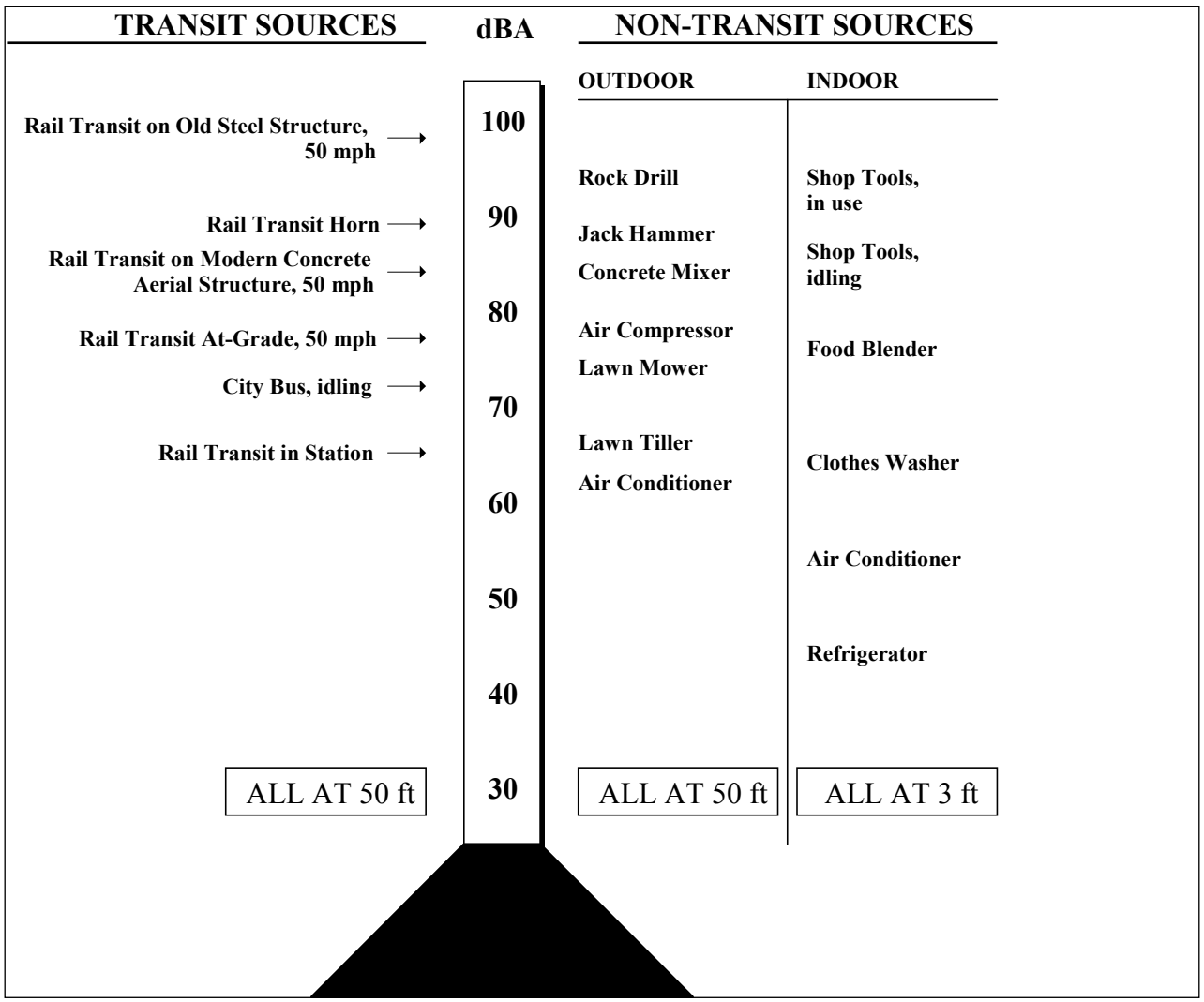
2.1 Noise

Noise, otherwise known as unwanted sound, is a fluctuating disturbance of the air caused by the propagation of sound pressure waves. Sound is measured using a logarithmic unit called a decibel (dB). Noises contain sound energy at different frequencies whose range depends on the individual noise source. Human hearing does not register the sound levels of all noise

frequencies equally and reduces the impression of high and low-pitched sounds. To replicate the response of the human ear to noise, the noise levels at different frequencies must be adjusted using a process referred to as A-weighting. Under such a process, the resulting level is said to be an A-weighted sound level and is commonly expressed as dBA.

Noise levels relate the magnitude of the sound pressure to a standard reference value. Normally encountered sounds lie in the range of 40 to 120 dBA. A sample of common transit-related and other noise sources expressed in A-weighted decibels is shown on Figure 3.

Figure 3
Common Indoor and Outdoor Noise Levels



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006.

Noise levels from human activities at a specific location can vary widely over time. The equivalent noise level (Leq) represents the time-varying noise levels produced over a specified period of time as a single number. This represents the equivalent steady noise level, which, over a given period, contains the same energy as the time-varying noise during the same period. The most common time period is one hour, represented as Leq (h). This descriptor is

commonly used to express the results from noise monitoring, predictions and impact assessments at sensitive receptors where sleep is not an issue. At sensitive receptors where sleep is essential, such as residences and hospitals, the descriptor most often used in noise analyses is the day-night average sound level or Ldn. Ldn is defined as the cumulative noise exposure from all events over a 24-hour period, but with a 10 dB penalty imposed on noise occurring between 10 p.m. to 7 a.m. as people tend to be more sensitive to noises during these hours. Typical ranges for Ldn for community noise are shown in Table 1.

Table 1
Typical Range of Ldn in Populated Areas

Area- Category	Ldn, dBA
Downtown City	75–85
"Very Noisy" Urban Residential Areas	65-75
"Quiet" Urban Residential Areas	60-65
Suburban Residential Areas	55-60
Small Town Residential Areas	45-55

Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment,* May 2006.

The following general relationships may be helpful in understanding the decibel scale:

- An increase of 1 dBA cannot be perceived by the human ear.
- A 3 dBA increase is normally the smallest change in sound levels that is perceptible to the human ear.
- A 10 dBA increase in noise level corresponds to tenfold increase in noise energy; however a listener would only judge a 10 dBA increase as being twice as loud.
- A 20 dBA increase would result in a dramatic change in how a listener would perceive the sound.

Light rail noise, as perceived by an individual at a given location and time, is a function of several factors, including; the distance from the noise source to the receptor, intervening terrain between a receptor and a noise source. Noises sources associated with light rail are typically generated from the following system elements:

- *Horns and crossing gate bells (at and approaching grade crossings)* – Probably the major source of noise related impacts. For the LYNX BLE, it was assumed that the horn would blow for five second duration prior to and after approaching a grade crossing. The sound of the horn ranges from that of a sick seagull to a pure tone with increasing volume. In addition, the bells on the grade crossing gates would sound for a total duration of approximately 30 seconds for each train passing. Noise levels for specific grade crossings vary from location to location.
- *Wheel/rail interaction (a function of the condition of wheels and type (e.g., welded or jointed, truck suspension and condition of the rails)* - Noise levels typically increase with increasing speed of the train. Other factors that increase levels of wheel/rail noise are wheel squeal on tight radius curves, wheel impact at rail joints and poor condition of the wheel or rail operating surface. Wheel squeal results from the rubbing and sliding action between the wheels and rails in short radius curves (< 450 feet). Often can be eliminated with resilient wheels.

- *Substations* – Could be very problematic if located very close to a sensitive noise receptor in combination with the other light rail noise sources. These structures are usually the size of a small house and emit a pure tone that is very obtrusive to the human ear over long periods of time.
- *Structures, such as steel trestles, that may amplify sound* – These structures may cause an increase in noise due to the excitation of the light weight construction elements such as girders and plates.
- *Traction Motor / Auxiliary equipment* – relative to the other noise sources is a relatively minor insignificant part of the overall noise stage. However, noise is typically audible during slow movement or during train stops and starts.

2.2 Vibration

An important consideration for rail transit projects is vibration that is transmitted from rail movement on the tracks through the ground to adjacent vibration sensitive buildings. The vibration is caused by the interaction of the wheels and rails and may be perceived by building occupants as “feel able" vibration. Ground-borne vibration can cause windows, pictures on walls or items on shelves to rattle. Although the perceived vibration from light rail vehicle passbys can be intrusive to building occupants, the vibration is almost never of sufficient magnitude to cause even minor cosmetic damage to buildings.

When evaluating human response, ground-borne vibration is usually expressed in terms of root mean square (RMS) vibration velocity. RMS is defined as the average of the squared amplitude of the vibration signal. To avoid confusion with sound decibels, the abbreviation VdB is used for vibration decibels. Vibration levels (VdB) in this report are all referenced to one micro-inch per second. Figure 4 shows typical vibration levels from rail and non-rail sources as well as the human and structure response to such levels.

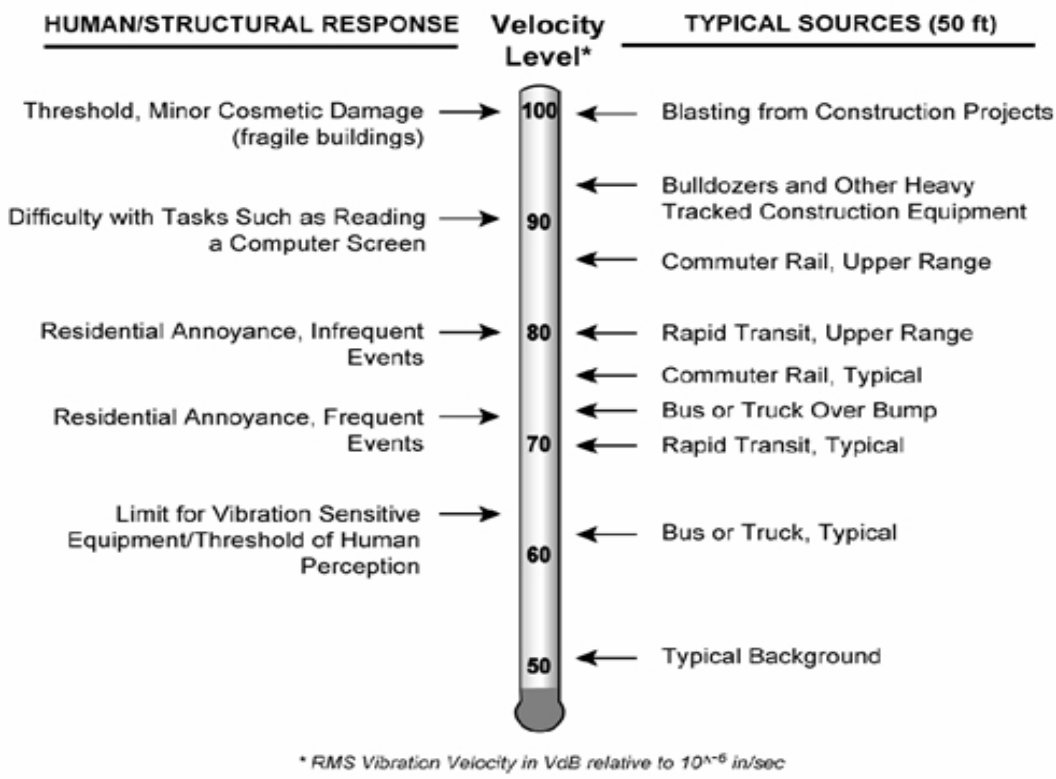
Unlike airborne noise, most common ground-borne vibration levels are imperceptible. However, human annoyance from vibration levels often occurs when vibration exceeds the threshold of perception by only a small margin. Common sources of perceptible ground-borne vibration include steel wheel/steel rail trains, construction equipment, and some industrial processes.

Vibration from trains is caused by the wheels interaction on the rail when moving. The forces caused by the interaction of the wheels and rails causes vibration in the ground that propagates away from the track. When the vibration reaches building foundations, it interacts with the building structure and can cause floors, walls and ceilings in living spaces to vibrate.

Although there has been relatively little research into human and building response to ground-borne vibration, there is substantial experience with vibration from rail systems. In general, this collective experience indicates that:

- It is rare that ground-borne vibration from transit systems results in building damage, even minor cosmetic damage as noted above. The primary consideration therefore is whether vibration will be intrusive to building occupants or will interfere with interior activities or machinery;
- The threshold for human perception is approximately 65 VdB. Vibration levels in the range of 70 to 75 VdB are often noticeable but acceptable. Beyond 80 VdB, vibration levels are often considered unacceptable; and,

Figure 4
Typical Vibration Levels



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006.

- For human annoyance, there is a relationship between the number of daily events and the degree of annoyance caused by ground-borne vibration. The FTA guidance manual includes a higher and a lower impact threshold depending upon the number of events per day. The higher impact threshold is for the infrequent events criteria and is based on project having fewer than 70 events per day. However, the low impact threshold (which is eight VdB lower than the high impact threshold) for the frequent events criteria is applicable to the LYNX BLE light rail project as there would be more than 70 events.

3.0 CRITERIA

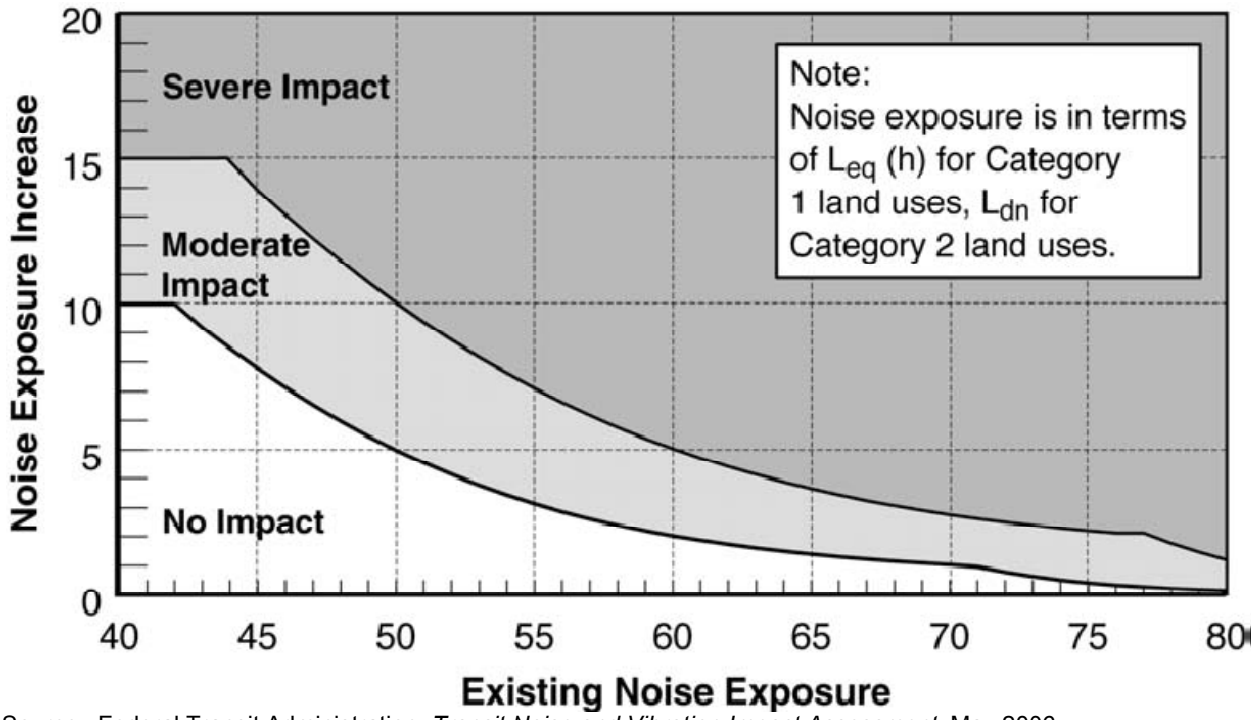
3.1 Noise

With respect to rail noise, the FTA has established criteria, shown on Figure 5, to assess potential impacts of transit projects. These criteria group noise sensitive land uses into the following three categories:

Category 1: Buildings or parks where quiet is an essential element of their intended purpose. This category includes National Historic landmarks with significant outdoor usage as well as 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 such activities as speech, meditation and concentration on reading material.

Figure 5
Allowable Transit Noise Increases



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006.

Noise impacts resulting from a proposed project are determined by comparing the existing and future project-related outdoor noise levels as illustrated in the graph provided in Figure 5. As the existing level of ambient noise increases, the allowable level of transit noise also increases, but the total amount, by which that community's noise can increase, without an impact, is reduced. Noise level increases, defined by the FTA guidance as "moderate impacts" or "severe impacts", occur when the existing levels are surpassed by more than the allowable increase by the project-related noise.

The terms no impact, moderate impact and severe impact are defined as follows:

- No Impact: The project, on average, will result in an insignificant increase in the number of people "highly annoyed" by new noise.
- Moderate Impact: The change in cumulative noise is noticeable to most people, but may not be sufficient to cause strong, adverse community reactions.
- Severe Impact: A significant percentage of people would be highly annoyed by the noise, perhaps resulting in vigorous community reaction and possibly attended by litigation.

For land use categories 1 and 3, the Leq noise descriptor is used while land use category 2 properties are assessed utilizing the Ldn descriptor. These criteria do not generally apply to industrial or commercial areas since they are generally compatible with high noise levels. The

criteria for assessing impacts were developed based on numerous studies of human annoyance due to cumulative increases in noise. Table 2 shows several examples of moderate and severe noise impact criteria levels as they relate to the existing noise level.

Table 2
FTA Noise Impact Criteria

Existing Noise Exposure Leq or Ldn (1)	Project Noise Exposure Impact Thresholds, Ldn or Leq,(1) dBA			
	Category 1 or 2 Sites		Category 3 Sites	
	Moderate Impact	Severe Impact	Moderate Impact	Severe Impact
<43	Amb.+10	Amb.+15	Amb.+15	Amb.+20
43	52	59	57	64
44	52	59	57	64
45	52	59	57	64
46	52	59	57	64
47	52	59	57	64
48	53	59	58	64
49	53	59	58	64
50	53	60	58	65
51	54	60	59	65
52	54	60	59	65
53	54	60	59	65
54	55	61	60	66
55	55	61	60	66
56	56	62	61	67
57	56	62	61	67
58	57	62	62	67
59	57	63	62	68
60	58	63	63	68
61	58	64	63	69
62	59	64	64	69
63	60	65	65	70
64	60	66	65	71
65	61	66	66	71
66	61	67	66	72
67	62	67	67	72
68	63	68	68	73
69	64	69	69	74
70	64	69	69	74
71	65	70	70	75
72	65	71	70	76
73	65	72	70	77
74	65	72	70	77
75	65	73	70	78
76	65	74	70	79
77	65	75	70	80
>77	65	75	70	80

Note: (1) Ldn is used for land uses where nighttime sensitivity is a factor; maximum 1-hour Leq is used for land use involving only daytime activities.
Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006.

3.2 Vibration

The FTA vibration criteria are based on the maximum ground vibration caused by a typical light rail vehicle passby. As noted in the preceding text, the frequent events criteria are applicable to the LYNX BLE project as the number of rail events per day would be greater than 70.

Similar to the FTA noise criteria, the FTA vibration criteria are based on three land use categories, although the categories are somewhat different. One important difference is that outdoor spaces are not included in category 3 for vibration. This is because human annoyance from ground-borne vibration requires the interaction of the ground vibration with a building structure. Consequently, the criteria apply to indoor spaces only and there are no vibration impact thresholds for outdoor spaces such as parks.

Table 3 shows FTA impact criteria for ground-borne vibration from rail transit systems. For residential buildings (category 2), the threshold applicable to this project is 72 VdB. The applicable threshold for schools and churches (category 3) is 75 VdB.

Table 3 includes separate FTA criteria for ground-borne noise, or the "rumble" that can be radiated from the motion of room surfaces in buildings due to ground-borne vibration. Although expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are set significantly lower than for airborne noise to account for the annoying low-frequency character of ground-borne noise. Because airborne noise often masks ground-borne noise for above ground (i.e. at-grade or elevated) transit systems, ground-borne noise criteria are primarily applied to subway operations.

Table 3
Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re: 1 micro-inch / sec)			GBN Impact Levels (dB re: 20 micro Pascals/ sec)		
	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB	65 VdB	65 VdB	N/A [4]	N/A [4]	N/A [4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primary daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

[1] "Frequent Events" is defined as more than 70 vibration events per day.
[2] "Occasional Events" is defined as between 30 and 70 vibration events per day.
[3] "Infrequent Events" is defined as less than 30 vibration events per day.
[4] N/A means "not applicable". Vibration-sensitive equipment is not sensitive to ground-borne noise.
Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006.

4.0 EXISTING CONDITIONS

Noise and vibration-sensitive land use was identified by screening GIS data for buildings with residential or institutional uses nearby the proposed alignment. For rail traffic from a light rail project such as the BLE, the FTA-defined noise screening distance for locations with unobstructed views is 350 feet. The screening distance when intervening buildings are present is 175 feet. Vibration screening distances are 450, 150 and 100 feet for vibration category 1, 2 and 3 land uses, respectively. Field observations were made to identify and confirm sensitive land use locations within the larger study area to ensure that the maximum screening distance of 450 feet for vibration was captured.

4.1 Locations of Noise and Vibration Sensitive Receptors

The following are descriptions of noise and vibration-sensitive land uses along the proposed alignment and the associated design option.

- Near the southern project terminus at 7th Street, there are several category 3 locations (institutional land uses), approximately 300 feet from the proposed alignment. These include the Museum of the New South, the United Presbyterian Church and the County's Medical Examiner Office. Further east, past I-277 near 12th Street, the Alpha Mill Apartments multi-family residential units are approximately 100 feet from the proposed alignment.
- Along Parkwood Avenue, one multi-family and several single-family residences are located between 17th Street and Brevard Street.
- On Brevard Street near Parkwood Avenue, there is one single-family residence approximately 80 feet from the proposed alignment and three single-family residences approximately 225 feet from the proposed alignment. On 21st Street, there are 2 single-family residences approximately 225 feet from the proposed alignment.
- On Brevard Street near the 30th Street overpass, there are four single-family residences approximately 100 feet from the proposed alignment and other single-family residences further from the alignment on Charles Avenue and Faison Avenue. The GDR Holiness Church is also located on Brevard Street approximately 100 feet from the proposed alignment.
- On North Davidson Street near Mallory Street, there is a building comprised of 90 multi-family loft units known as the Highland Lofts. The residential units range between approximately 300 to 900 feet away from the proposed alignment.
- On North Davidson Street and East 37th Street, there are four single-family residences approximately 250 to 300 feet from the proposed alignment.
- At North Davidson Street and Patterson Street, the Colony has mixed-use commercial (1st floor) and residential (2nd floor). There are four single-family residences on North Davidson Street near Herrin Avenue approximately 110 feet from the proposed alignment and nine single-family residences 150 to 250 feet from the proposed alignment. The Renaissance Apartments have 43 multi-family units located approximately 235 feet from the proposed alignment, near the Craighead Road grade crossing.
- There are eight single-family residences on Bearwood Avenue approximately 125 feet from the proposed alignment and approximately 60 feet from the existing Norfolk-Southern rail line. These residences are 100 to 650 feet away from the grade crossing at Sugar Creek Road. Eleven single-family residences on Bearwood Avenue are near the proposed alignment approximately 150 to 250 feet away. Eight single-family residences

on the south side of Bearwood Avenue are approximately 240 to 280 feet away from the proposed alignment. East of Bearwood Avenue on Galax Drive, Clintwood Drive, Barrymore Drive and St. Anne Place, there are 50 single-family residences within 300 feet of the proposed alignment. The Vietnamese Baptist Church on Howie Circle is located approximately 160 feet from the proposed light rail tracks.

- On North Tryon Street/US-29 between Old Concord Road and the merge of Route 29 Bypass near the "weave", there are 32 mobile homes within 300 feet of the proposed alignment at the Pines Mobile Homes Park. The Star Motel and Holiday Motel are approximately 115 feet north of the proposed alignment. The Kings City La Fuente Church and Eagle Chiropractic Medical Office are approximately 100 feet south of the proposed alignment. The Relax Inn and Fairyland Learning Center are approximately 150 feet south of the proposed alignment.
- On North Tryon Street/US-29, in the "weave" with Route 29 Bypass, The InTown Suites are approximately 200 feet from the proposed alignment. The Camino Del Rey church is 40 feet from the University City Parking lot access road.
- On North Tryon Street/US-29, between the Route 29 Bypass "weave" and W.T. Harris Boulevard, two single-family residences and the Extended Stay America Motel are located approximately 150 feet north of the proposed alignment. One single-family residence is approximately 300 feet from the proposed alignment. The Microtel, Homewood Suites, Hampton Inn, Residence Inn and Sleep Inn motels are 100 to 300 feet away from the proposed alignment. The University Radiation Oncology Medical Office is approximately 170 feet north of the proposed alignment.
- On North Tryon Street/US-29 between W.T. Harris Boulevard and Mallard Creek Church Road, the Carolinas Medical Center-University is approximately 250 feet away from the proposed alignment. Several multi-family residences at the Grove Mallard Lake Apartments and the Summit Green Apartments are 140 to 160 feet north of the proposed alignment at the bottom of an embankment. To the northeast of the hospital is a passive recreation area near a pond near the planned Toby Creek Greenway Connector.
- The Charlotte Research Institute's Bioinformatics building is approximately 165 feet away as the alignment enters the UNC Charlotte campus property. The UNC Charlotte campus housing building at Laurel Hall is approximately 235 feet away from the alignment as the track curves sharply towards Mallard Creek Church Road. As the alignment turns toward Mallard Creek Church Road, the closest of the Mallard Creek Apartments would be approximately 100 feet south of the alignment.
- On North Tryon Street/US-29 between Mallard Creek Church Road and I-485, as the alignment approaches North Tryon Street/US-29, there are five multi-family residential buildings at the Hunt Club Apartments approximately 300 feet north of the proposed alignment on an embankment.
- Kirk Farm Fields Wetland Viewing Area is approximately 150 feet from the alignment and is considered a passive recreational area. It is located 160 feet north of East Mallard Creek Church Road. It is also within approximately 400 feet of the beginning of a sharp track curve as the alignment heads toward North Tryon Street. A soccer field is to the immediate west of the viewing area.
- On North Tryon Street/US-29 between I-485 and the northern terminus of the proposed project, the Queen's Grant Mobile Home Park exists approximately 400 feet to the south of the alignment.
- For the Light Rail Alternative – Sugar Creek Design Option, on North Tryon Street/US-29 between Mellow Drive and Old Concord Road, there is a medical dialysis office 180 feet away from the proposed alignment. There is one single-family residence north of the

alignment approximately 80 feet away and the Elmore Mobile Home Park setback approximately 300 feet from the alignment. Crossroads Charter High School is approximately 110 feet south of the proposed alignment. Several churches (Greater Love Baptist Church, Resurrection Church and Sacrifice of Praise Ministry) also exist in this area from 150 to 260 feet from the alignment.

4.2 Existing Conditions of Noise and Vibration Sensitive Receptors

Noise

Two noise monitoring programs have been undertaken for the LYNX BLE project and their results are summarized here. An initial noise monitoring program was conducted in 2005 by Harris Miller and Hanson Incorporated (HMMH). Because of the approximately three-year intervening period since the initial noise and vibration studies and because there have been some alignment and station refinements, an additional monitoring program was conducted in 2008 to expand and update the previous program.

The LYNX BLE noise monitoring program was conducted to obtain existing ambient noise levels along the study corridor at selected sensitive receptors. The monitoring sites were selected on the basis of several factors, the most important of which was the site's potential sensitivity to changes in noise or vibration levels. For the 2005 monitoring, nine noise sensitive sites were monitored along the project corridor during the month of October. In 2008, an additional sixteen noise monitoring sites were selected and monitored during the months of October and December. For both monitoring programs, each site selected was either representative of a unique noise environment or that of similarly situated receptors nearby. While the majority of the selected sensitive receptors are residential in nature, because the alignment would primarily traverse residential and commercial districts, several category 3 land uses are also identified as receptors; these included schools, churches and medical offices. Non-sensitive commercial or industrial land uses were not chosen as monitoring sites as they are not represented by an FTA land-use category. However, the historic nature of several residences in the area primarily south of the alignment from approximately 30th Street to Craighead Road within the North Charlotte Historic District was also taken into consideration during the selection of noise receptors. Both long-term (24-hour) and short-term monitoring was conducted at numerous sites along the proposed alignment.

A tabulation of the existing noise levels measured in 2005 is provided in Table 4. Monitoring locations for the 2005 monitoring programs are shown on Figures 6a and 6b.
Following are brief definitions of the terms used in Table 1:

A-weighted Decibels (dBA): Sound varies in intensity by over one million times within the range of human hearing. The logarithmic decibel scale is used in acoustics to compress this to a more manageable range. In addition, community noise is almost always described using "A-weighting", which approximates the frequency response of human hearing.

Equivalent Sound Level (Leq): Leq is a descriptor used to characterize loudness of fluctuating noise. Leq represents a constant sound that, over the specified period, has the same sound energy as the fluctuating sound.

Day-Night Sound Level (Ldn): Ldn, also abbreviated as DNL, is used to characterize community noise over a 24-hour period. It is basically a 24-hour Leq with an adjustment to account for the greater sensitivity of most people to noises during the nighttime hours. Nighttime

is defined as 10 p.m. to 7 a.m. The effect of the adjustment is that events that occur in the nighttime hours are equivalent to 10 of the same events occurring during the daytime hours.

In accordance with FTA procedures, monitored noise levels resulting in an equivalent hourly noise level (Leq) were, according to the time of day they were monitored, adjusted to obtain the resulting Ldn noise level for category 2 receptors. No adjustments were required for monitored noise levels at category 3 receptors, because Leq is the appropriate noise descriptor.

Table 4
2005 Noise Monitoring Results

Site#	Monitoring Location Description	Date	Duration	Existing Noise Exposure	
				Ldn	Leq
LT1A	House, 405 19th Street	10/3/2005	24	69	69
LT2A	The Colony - Mixed-use, 3440 North Davidson Street (1st floor commercial, 2nd floor residential)	10/3/2005	24	69	71
LT3A	House, 4031 Bearwood Avenue	10/3/2005	24	76	67
LT4A	Holiday Motel, 6001 North Tryon Street/US-29	10/3/2005	24	70	68
LT5A	Summit Green Apartments, 209 Barton Creek Drive	10/3/2005	24	62	61
ST1A	Hunt Club Apartments, 208 Northbend Drive	10/4/2005	1	63	65
ST2A	InTown Suites, 110 Rocky River Road	10/4/2005	1	62	64
ST3A	GDR Holiness Church, 2604 North Brevard Street	10/4/2005	1	59	61
ST4A	United Presbyterian Church, 201 East 7th Street	10/4/2005	1	61	63

ST – Short-term, LT – Long-term. Source: Harris Miller and Hanson Incorporated, 2005

A tabulation of the existing noise levels measured in 2008 is provided below in Table 5. Monitoring locations for the 2008 monitoring programs are shown on Figures 6a and 6b.

Table 5
2008 Noise Monitoring Results

Site #	Monitoring Location Description	Date	Duration	Existing Noise Exposure	
				Ldn	Leq
ST1B	Alpha Mill Apartments, 220 Alpha Mill Lane	10/01/2008	1	71.0	59.1
ST2B	House, 234 Parkwood Avenue	10/01/2008	1	72.7	73.9
ST3B	House, 423 East 22nd Street	10/01/2008	1	60.1	56.0
ST4B	Highland Mill Residential Apartments, 2901 North Davidson Street	10/01/2008	1	63.1	61.3
LT1B	House, 342 St. Anne Place	12/15/2008	24	71.4	58.8
ST5B	Crossroads Charter High School, 5500 North Tryon Street/US-29	10/02/2008	1	69.6	71.8
ST6B	Harbor Baptist Church, 5801 Old Concord Road	10/02/2008	1	59.8	62.0

Table 5 (continued)
2008 Noise Monitoring Results

Site #	Monitoring Location Description	Date	Duration	Existing Noise Exposure	
				Ldn	Leq
ST7B	Pines Mobile Home Park, 5635 North Tryon Street	10/02/2008	1	54.0	50.8
ST8B	Elmore Mobile Home Park, 4832 North Tryon Street	10/02/2008	1	53.8	50.2
LT2B	House, 201 Kingview Drive	10/08/2008	24	63.6	66.4
ST9B	Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman Dr	10/06/2008	1	66.1	66.4
ST10B	Carolinas Medical Center-University, 8800 North Tryon Street	10/06/2008	1	58.1	60.1
ST11B	UNC Charlotte Duke Centennial Hall	10/06/2008	1	63.3	65.3
LT3B	Residence, UNC Charlotte Laurel Hall	10/08/2008	24	62.1	55.3
ST12B	Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	10/07/2008	1	50.5	52.5
ST13B	Queen's Grant Mobile Homes, 124 Carnival Street	10/06/2008	1	55.4	52.5

ST – Short-term, LT – Long-term. Source: STV Incorporated, 2008

Below are descriptions for the overall noise measurement program conducted for the proposed project.

- Long-term Site 1 (LT-1A) was located along the proposed alignment at a single-family residence at 405 19th Street. The microphone was located in the backyard of this residence. Traffic noise from vehicles on Parkwood Avenue was the dominant noise source. Traffic volumes on Parkwood Avenue were relatively high compared to other nearby roads such as Brevard Street or North Davidson Street. The measured Ldn at this site was 69 dBA. This monitoring location is representative of several first-row single-family residences south of the alignment along Parkwood Avenue.
- Long-term Site 2 (LT-2A) was located along the proposed alignment at 3440 North Davidson Street. The site is a mixed-use building with a commercial first floor and a residential second floor. The microphone was located along the side yard of the building. Traffic noise from North Davidson Street contributed to the noise environment as well as freight train traffic along the Norfolk-Southern rail line grade crossing at Craighead Road. The measured Ldn at this site was 69 dBA. This monitoring location is representative of three single-family residences and several multi-family residential buildings on North Davidson Street between 36th Street and Craighead Road.
- Long-term Site 3 (LT-3A) was located along the proposed alignment at a single-family residence at 4031 Bearwood Avenue. The microphone was located in the backyard of the residence. Contributions to the noise environment included local automobile traffic, nearby freight trains on the Norfolk-Southern rail line and audible warning signals (train horns) from the grade crossing at Sugar Creek Road. The measured Ldn at this site was 76 dBA. This monitoring location was representative of several single-family residences on Bearwood Avenue, Howie Circle, Clintwood Drive, Galax Drive and St. Anne Place and multi-family residences on Eastway Drive.
- Long-term Site 4 (LT-4A) was located along the proposed alignment at the Holiday Motel at 6001 North Tryon Street/US-29. The microphone was located in front of the motel. Traffic on North Tryon dominated the noise environment. The measured Ldn at this site

was 70 dBA. This monitoring location is representative of first-row sensitive land uses along Tryon Street and North Tryon Street/US-29. These land uses include hotels, motels, mobile homes, churches, medical offices, schools, the Carolinas Medical Center-University, single-family residences and multi-family residences.

- Long-term Site 5 (LT-5A) was located along the proposed alignment at the Summit Green Apartments. The microphone was located in the front yard of the apartments at the bottom of a 20-foot embankment below North Tryon Street/US-29. The noise environment was dominated by traffic noise from North Tryon Street/US-29. The measured Ldn at this site was 62 dBA. This monitoring location was representative of several multi-family residences on North Tryon Street/US-29 that are located at the bottom of an embankment.
- Short-term Site 1 (ST-1A) was located along the proposed alignment at Hunt Club Apartments on North Tryon Street/US-29. The microphone was located near the apartments on an embankment approximately 15 feet above North Tryon Street/US-29. Monitoring was conducted for one hour during peak morning traffic conditions between 7:17 a.m. and 8:17 a.m. The measured one-hour Leq at this site was 65 dBA. This monitoring location is representative of multi-family residences in the immediate area also on an embankment. An Ldn of 63 dBA has been calculated from this peak-hour measurement using FTA guidelines.
- Short-term Site 2 (ST-2A) was located along the proposed alignment at the InTown Suites at 110 Rocky River Road. Monitoring was conducted for one hour during peak morning traffic conditions between 8:41 a.m. and 9:41 a.m. The measured one-hour Leq at this site was 64 dBA. This monitoring location is representative of other motels located near the “weave” portion of North Tryon Street/US-29 where North Tryon Street/US-29 and Route 29 Bypass merge. An Ldn of 62 dBA has been calculated from this peak-hour measurement using FTA guidelines.
- Short-term Site 3 (ST-3A) was located along the proposed alignment at the GDR Holiness Church at 2604 Brevard Street. Traffic volumes on Brevard Street were relatively low compared to other nearby roads such as Parkwood Avenue or North Davidson Street. Monitoring was conducted for one hour during peak afternoon traffic conditions between 4:00 p.m. and 5:00 p.m. The measured one-hour Leq at this site was 61 dBA. This monitoring location is representative of several single-family residences on Brevard Street south of the proposed alignment. An Ldn of 59 dBA has been calculated from this peak-hour measurement using FTA guidelines.
- Short-term Site 4 (ST-4A) was located along the proposed alignment at the United Presbyterian Church across from 7th Street Station. Noise sources in this area included vehicles on 7th Street and North College Street, the nearby streetcar trolley and fan noise form a local garage. Monitoring was conducted for one hour during peak afternoon traffic conditions between 17:20 p.m. and 18:20 p.m. This monitoring location is representative of other sensitive land use in the area including the Museum of the New South and a medical office. The measured one-hour Leq at this site was 63 dBA. An Ldn of 61 dBA has been calculated from this peak hour measurement; however, there is no category 1 or 2 land use in this area for which an Ldn would be applied.
- Short-term Site 1 (ST-1B) was located along the proposed alignment at the Alpha Mill Apartment complex located at 220 Alpha Mill Lane, on the corner of East 12th Street and Alpha Mill Lane. The site contains multi-story residential apartments. The microphone was located along the side of the building closest to the rail line. Traffic noise from nearby I-277 significantly contributed to the noise environment. Freight traffic along the CSX RR rail line just east of the apartment complex was audible but not dominant.

Utilizing FTA guidelines, the calculated Ldn at this site was 71.0 dBA. There are no other representative receptors in the vicinity of the complex.

- Short-term Site 2 (ST-2B) was located along the proposed alignment at 234 Parkwood Avenue between 16th and 17th Streets. The site contains a single-family residence. The microphone was located along the front yard of the property. Traffic noise from adjacent Parkwood Avenue contributed heavily to the noise environment as 16th Street is a grade crossing for the Norfolk Southern Railroad tracks. Utilizing FTA guidelines, the calculated Ldn at this site was 72.7 dBA. This monitoring location is representative of the receptors on Parkwood Avenue including three multi-family apartments' buildings and three single-family homes.
- Short-term Site 3 (ST-3B) was located along the proposed alignment at 423 East 22nd Street. The site contains a single-family residence. The microphone was located along the front yard of the property. Traffic noise from adjacent E. 22nd Street is extremely light, but traffic from nearby Parkwood Avenue contributed to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 60.1 dBA. This monitoring location is representative of the row of private homes and along East 22nd Street and East 21st Street nearest to the proposed alignment.
- Short-term Site 4 (ST-4B) was located along the proposed alignment at North Brevard Street. The site contains the Highland Mill multi-family residential complex. The microphone was located along the front edge of the property nearest to the proposed alignment. Traffic noise from the adjacent North Brevard Street was the principal contributor to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 63.1 dBA. This monitoring location is also representative of the several private homes along Faison Avenue nearest to the proposed alignment.
- Long-term Site 1 (LT-1B) was located along the proposed alignment at 341 St. Anne's Place. The site contains a single-family residence. The microphone was located in the back yard of the property. Traffic noise from nearby elevated Eastway Drive and the rail line adjacent to the back edge of the property contributed greatly to the noise environment. The measured Ldn at this site was 71.4 dBA. This monitoring location is representative of the numerous homes abutting the existing rail line right-of-way along Prince Charles Street, St. Anne Place, Barrymore Drive, Clintwood Drive and Leafmore Drive.
- Short-term Site 5 (ST-5B) was located along the proposed alignment at the Crossroads Charter High School at 5500 North Tryon Street/US-29. The site contains a high school building and an adjacent parking lot. The microphone was located in the front yard of the property. Traffic noise from nearby North Tryon Street/US-29 contributed greatly to the noise environment. The measured Leq at this site was 71.8 dBA. Utilizing FTA guidelines, the calculated Ldn at this site was 69.6 dBA. This site was representative of a medical facility and one single-family residence on North Tryon Street/US-29 near Eastway Drive.
- Short-term Site 6 (ST-6B) was located along the proposed alignment at the Harbor Street Baptist Church at 5801 Old Concord Road. The site contains a church building and an adjacent parking lot. The microphone was located in the front yard of the property. Traffic noise from nearby North Tryon Street/US-29 and Old Concord Road contributed greatly to the noise environment. The measured Leq at this site was 62.0 dBA. There are no other representative receptors in the vicinity of the school.
- Short-term Site 7 (ST-7B) was located along the proposed alignment along North Tryon Street/US-29 between Old Concord Road and Orr Road. The site contains a large mobile home community called the Pines Mobile Home Park. The microphone was located on the front edge of the property. Traffic noise from nearby North Tryon

Street/US-29 and Old Concord Road contributed greatly to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 54.0 dBA. This monitoring location is representative of the rows of mobile homes nearest to the proposed alignment setback approximately 185 feet from North Tryon Street/US-29.

- Short-term Site 8 (ST-8B) was located along the proposed alignment along North Tryon Street/US-29 near Bennett Street. The site contains a large mobile home community known as the Elmore Mobile Home Park. The microphone was located in the front edge of the property. Traffic noise from nearby North Tryon Street/US-29 was the main contributor to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 53.8 dBA. This monitoring location is representative of the rows of mobile homes nearest to the proposed alignment setback approximately 200 feet from North Tryon Street/US-29.
- Long-term Site 2 (LT-2) was located along the proposed alignment at 201 Kingview Drive near Tom Hunter Road. The site contains a single-family residence. The microphone was located in the back yard of the property, adjacent to the proposed Tom Hunter park-and-ride lot. Traffic noise from nearby North Tryon Street/US-29 contributed heavily to the noise environment at this location. The measured Ldn at this site was 63.6 dBA. This monitoring location is representative of the row of private homes along Northridge Village Drive and the cul-de-sac at Kingview Drive nearest to the proposed Tom Hunter park-and-ride lot.
- Short-term Site 9 (ST-9B) was located along the proposed alignment at the Residence Inn by Marriott at 8503 North Tryon Street/US-29. The site contains several multi-unit buildings that are a part of the hotel complex. The microphone was located in the front yard of the property along North Tryon Street/US-29. Traffic noise from nearby North Tryon Street/US-29 contributed greatly to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 66.1 dBA. This monitoring location is also representative of a large apartment complex neighboring the site.
- Short-term Site 10 (ST-10B) was located along the proposed alignment at the Carolinas Medical Center-University at 8800 North Tryon Street/US-29 near Harris Boulevard. The site contains a large hospital complex and a parking lot. The microphone was located in the front of the hospital along North Tryon Street/US-29. Traffic noise from nearby North Tryon Street/US-29 and W.T. Harris Boulevard contributed greatly to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 58.1 dBA.
- Short-term Site 11 (ST-11B) was located along the proposed alignment at the Charlotte Research Institute's Duke Centennial Hall. The site contains a multi-story building used for academic classes and a parking lot. The microphone was located along the side of the building along the traveled roadway. Traffic noise from North Tryon Street/US-29 and internal campus roads contributed to the noise environment. The measured Leq at this site was 65.3 dBA. This monitoring location is representative of several other campus buildings such as Grigg Hall and the Bioinformatics Building.
- Long-term Site 3 (LT-3B) was located along the proposed alignment on the UNC Charlotte campus at Laurel Hall. The site contains a multi-story building used for campus housing. The microphone was located along the side of the building along the traveled campus road. Traffic noise from internal campus roads contributed to the noise environment. The measured Ldn at this site was 62.1 dBA.
- Short-term Site 12 (ST-12B) was located along the proposed alignment at the Mallard Creek Apartment complex located at Mallard Creek Church Road and Alexander Glen Drive, at 220 Michelle Linnea Drive. The site contains multi-story residential apartments. The microphone was located along the side of the building closest to the proposed alignment. Traffic noise mainly came from the internal roads of the apartment complex.

Noise from Mallard Creek Church Road was also audible. Utilizing FTA guidelines, the calculated Ldn at this site was 50.5 dBA. The measured Ldn at this site was 52.5 dBA. This monitoring location is representative of the many rows of multi-family residences at this complex as well as the Kirk Farm Fields site on the opposite side of Mallard Creek Church Road.

- Short-term Site 13 (ST-13B) was located along the proposed alignment along North Tryon Street/US-29 near Desire Street. The site contains a large mobile home community known as the Queen's Grant Mobile Home Park. The microphone was located in the front edge of the property. Traffic noise from nearby North Tryon Street/US-29 along with background noise from I-485 contributed to the noise environment. Utilizing FTA guidelines, the calculated Ldn at this site was 55.4 dBA. This monitoring location is representative of the rows of mobile homes nearest to the proposed alignment and parking garage.

Vibration

For a detailed vibration assessment, the specific characterization of the vibration environment is very important. For example, in areas where the proposed Light Rail Alternative traverses along an existing freight line, vibration levels from freight train passbys could be used to help determine vibration propagation characteristics of the soil. However, for this phase of the proposed project where general assessment procedures are used for vibration prediction, the monitoring of baseline vibration levels is not necessary since this information is not a required input for the vibration prediction procedure. However, although no vibration monitoring was conducted, it is expected that existing vibration levels near sensitive receptors in the project study area would primarily be the result of vehicular traffic on local roadways. In the few areas where there is existing rail activity, existing vibration levels may be slightly higher depending upon receptor proximity to the track.

The Light Rail Alternative would traverse through the campus of UNC Charlotte and would come close to several existing research buildings of the Charlotte Research Institute. As a result, the UNC Charlotte faculty have raised concerns over the potential for the proposed project alignment to disturb vibration-sensitive research facilities and equipment contained within several of the nearby existing and future campus buildings. Subsequently, UNC Charlotte provided vibration data that were previously collected at two of their existing academic buildings, Duke Centennial Hall and Grigg Hall. At Duke Centennial Hall, the greatest measured vertical vibration level was approximately 46 VdB (monitored in 2002). At Grigg Hall, the greatest measured vertical vibration level was approximately 43 VdB (monitored in 2007). However, the Duke Centennial Hall monitoring was taken on a pedestal foundation prior to the actual construction of the building while the Grigg Hall monitoring was taken within the buildings existing research facilities. Grigg Hall incorporates the use of a dual vibration isolation system in the form of 1) a central slab mounted on bedrock and isolated from the rest of the building and 2) individual mechanical vibration isolation platforms tailored for the various pieces of sensitive equipment. The specific vibration reading of 43 VdB was taken on a vibration isolation slab within the Metrology Lab. As such, the most accurate measure of existing vibration would be at Duke Centennial Hall as readings were taken on solid ground. While the Grigg Hall monitoring is not representative of a true measure of existing vibration conditions, it does however, serve to demonstrate the effectiveness of the current vibration isolation system within the building.

5.0 NOISE AND VIBRATION PREDICTION METHODOLOGY

The procedures utilized for this LYNX BLE Noise and Vibration Technical Report were based on guidelines contained in the FTA's *Transit Noise and Vibration Impact Assessment* (FTA, May 2006). In general, the approach follows the General Assessment guidelines outlined in the FTA Guidance Manual.

5.1 FTA Approach

This approach is recommended by the FTA for projects in the Draft EIS phase of project development. The FTA approach is as follows:

1. Representative noise- and vibration-sensitive receptors (i.e. residences, schools, churches, medical facilities, and passive use public recreation areas) were identified. Sensitive land uses along the corridor were identified first using aerial photography and subsequent field visits. Sensitive receptors were then grouped together based on their location relative to the tracks, grade crossings and other geographic and LYNX BLE operational factors that might affect noise and vibration levels. Within each grouping, a representative receptor was included in the noise model (see step 3 below).

2. Existing noise and vibration levels were determined. The monitoring of existing noise levels was conducted at a number of locations along the corridor as discussed previously (refer to Tables 4 and 5). Both short-term (1-hour) and long-term (24-hours) noise monitoring was conducted. Twenty-four hour monitoring was conducted at more sensitive, receptors and or locations where, significant variations in hour-to-hour noise levels could occur. Vibration monitoring data previously conducted by the University of North Carolina at Charlotte (UNC Charlotte) was reviewed.

3. FTA's noise and vibration screening procedures were utilized to eliminate noise- and vibration-sensitive receptors at which impacts would be unlikely. For receptors that were not eliminated by the screening process, noise and vibration general assessment procedures were used to predict future noise and vibration levels from proposed LYNX BLE operations. When the required input data was available, the FTA equations for detailed noise analysis were used in the assessment. Noise prediction equations were based on the forecasted number of daily light rail vehicles and the distribution of these vehicles throughout the day (early morning, daytime and nighttime), the distance from the tracks, the vehicle speed and other site-specific conditions such as acoustic shielding, substations, access roads and grade crossings. For the prediction of potential vibration impacts, generalized curves provided in the FTA guidance manual were utilized along with a speed adjustment equation. Special consideration was given to sensitive vibration receptors at UNC Charlotte.

4. Noise and vibration assessments were conducted for the Light Rail Alternative as well as the Light Rail Alternative – Sugar Creek Design Option using noise prediction models, the generalized vibration curve and speed adjustment equations for vibration from the FTA Manual. Assessments for these options were specifically conducted to address receptor locations that would not be affected by, or are affected differently from, the Light Rail Alternative. In addition to these quantitative assessments, sensitive noise locations affected by wheel squeal were identified and assessed qualitatively.

5. Results were compared to applicable FTA impact thresholds to identify potential noise and vibration impacts. See the “Environmental Consequences" section below for a discussion of predicted noise and vibration impacts.

6. Potential noise and vibration mitigation measures were recommended.

5.2 Analysis Assumptions

To perform the general assessment for noise and vibration, the following assumptions related to operational data and methodological approach were included in the analysis. The following serve as a reference for these assumptions

1. The average number of trains per hour during daytime hours (from 7:00 a.m. to 10:00 p.m.) used in the analysis was 12.4. The average number of trains/hour during nighttime hours (from 10:00 p.m. to 7:00 a.m.) used in the analysis was 5.33. The following operating schedule was assumed:

    - Operating hours: service from 5:30 a.m. to 1:00 a.m. weekdays, 6:00 a.m. to 1:00 a.m. Saturdays, 6:30 a.m. to 12:00 a.m. Sundays.
    - Weekday peak-period service: every 6 minutes (6:00 a.m. to 9:30 a.m. and 4:00 p.m. to 7:00 p.m.);
    - Weekday off-peak service: every 15 minutes during the early morning, midday, and evening periods (5:30 a.m. to 6:00 a.m., 9:30 a.m. to 4:00 p.m.), and 15 minutes during the evening/night period (7:00 p.m. to 1:00 a.m.);
    - Saturday service: every 15 minutes from 10:00 a.m. to 5:00 p.m. and every 15 minutes from 7:00 a.m. to 10 a.m. and 5 p.m. to 10:00 p.m.; and, every 15 minutes from 6 a.m. to 7 a.m. and 10:00 p.m. to 1:00 a.m.
    - Sunday service: every 15 minutes from 11:00 a.m. to 5:00 p.m. and every 15 minutes from 9:00 a.m. to 11 a.m. and 5 p.m. to 10:00 p.m.; and, every 15 minutes from 6 a.m. to 9 a.m. and 10:00 p.m. to 1:00 a.m.

2. Light rail vehicles include two 93-foot long cars which will operate during all periods.

3. Speed limits would range from 25 to 55 mph along the corridor (based on maximum speed restrictions due to super elevation, horizontal and vertical geometry as well as anticipated run-times). Speed restrictions of 35 mph were assumed between 9th Street and 12th Street.

4. Noise exposures from rail and other related operations were computed in terms of a source reference Sound Exposure Levels (SEL) of 82 dBA for light rail cars, 81 dBA for light rail vehicle horns (assumed to be the same throughout the entire project alignment), 99 dBA for substations and 109 dBA for at-grade crossing bells. All SELs are based on a source to receptor distance of 50 feet. All SEL’s were obtained from the *FTA Noise and Vibration Impact Assessment* guidance to provide for the most conservative assessment results. The assessment did not include horn or bell noise associated with light rail vehicles approaching and departing stations.

5. In areas of the alignment where retaining walls would act as “noise barriers” (at least three to four feet above the top of rail), a four-decibel noise reduction was assumed.

6. All light rail vehicles approaching roadway-rail grade crossings blow their horn for five seconds prior to reaching a grade crossing. This is the same operational assumption utilized for the analysis of the existing LYNX Blue Line.

7. It is assumed that the Lynx Blue Line light rail vehicle skirt coverings are for aesthetic purposes only and do not result in any appreciable noise attenuation. Therefore, no reduction for attenuation from vehicle skirts was assumed.

8. Wheel squeal, while discussed as a potential noise issue where tight radius curves are designed, was not included in actual noise projections because wheel squeal noise levels are highly variable, thereby making accurate noise projections extremely complex. Two locations of the alignment have tight radius curves that could be a concern for wheel squeal. These locations are Laurel Hall located on the UNC Charlotte campus and the Kirk Farm Fields wetland viewing area. More detailed is provided in Section 8.1.1.3 and shown in Figure 7.

9. Roadway-rail crossings assumed in the analysis included; 7th Street, 8th Street, 9th Street, 12th Street, 16th Street, Arrowhead Drive, Tom Hunter Road, Stetson Drive, Shopping Center Drive, McCollough Drive, J.W. Clay Boulevard, Mallard Creek Church Road, For the Light Rail Alternative – Sugar Creek Design Option, the following roadway-rail crossings were assumed: Lambeth Drive, Eastway Drive, Old Concord Road, and Raleigh Street.

10. Locations of substations, grade crossings and curve radii were obtained from the *LYNX BLE 15% Preliminary Engineering Design Plans*, January 2009.

11. A light rail maintenance and storage facility for this project is under evaluation and is not included in this analysis.

6.0 NOISE PREDICTION

Below are descriptions of the data inputs and equations used to predict noise levels from the relevant project-related noise sources.

6.1 Horn Noise

Federal Railroad Administration (FRA) regulations require that train horns be sounded prior to all public grade crossings unless a quiet zone has been established. The horn is required to produce "… a minimum sound level of 96 dBA (lower horn) and a maximum sound level of 110 dBA (higher horn) at 100 feet forward of the locomotive in its direction of travel." However, for light rail trains the local requirements for the lower and higher horns are usually somewhat less. At the time of the assessment for the project, precise SEL horn noise levels from existing CATS vehicles had not yet been determined. Furthermore, changes to the vehicle and horn specifications during final design and vehicle procurement could occur. Therefore, the reference horn noise SEL contained in the FTA manual was conservatively used. According to the manual, the reference horn SEL at 50 feet for transit cars is 81 dBA. Field observations of the existing LYNX Blue Line light rail fleet revealed that the horns used during grade crossings did not have an intrusively loud sound typical of diesel locomotive horns but sounded more like a mellow chime or whistle. It was assumed that the horns/whistles would be mounted on the front of the rail vehicle. The light rail cars would also have a louder horn but this horn would typically be sounded for emergency purposes or as backup for the horn/whistle. As a result, only the lower horn was used in the assessment. Based

on the existing LYNX Blue Line operations, all light rail vehicles approaching roadway-rail grade crossings were assumed to blow their horn for five seconds prior to reaching a grade crossing. Using the above data, procedures in the FTA Guidance Manual were used to estimate the levels of wheel rail noise. The hourly Leq reference equation for 50 feet is shown below:

$Leq(h) = SEL_{ref} - 10Log(S/50) + 10Log(V) - 35.6$

Where,

S = Train speed, in miles per hour

V = Average hourly train volume, in trains per hour

6.2 Wheel/Rail Noise

Factors that increase levels of wheel/rail noise include wheel impact at rail joints and poor condition of the wheel or rail operating surface. It is assumed for prediction purposes that all rails would be welded and would be kept in good condition through vigorous maintenance protocols. In addition, a +4 dB correction factor was used for areas influenced by the rail cars traveling over aerial structures on a slab track. Based on the FTA manual, a 50 foot reference SEL of 82 dBA was used for wheel/rail noise prediction. This SEL was selected as it is most applicable to the proposed light rail car. The hourly Leq reference equation for 50 feet is shown below:

$Leq(h) = SEL_{ref} + 20Log(S/50) + 10Log(N_{cars}) + 10Log(V) - 35.6$

Where,

S = Train speed, in miles per hour

N_{cars} = Average number of cars per train

V = Average hourly train volume, in trains per hour

6.3 Grade Crossing Bell Noise

Based on the FTA manual, a 50 foot reference SEL of 109 dBA was used for grade crossing bell noise prediction. While informal grade-crossing measurements indicate the actual SEL on the existing LYNX Blue Line may be somewhat less, the FTA reference SEL level was conservatively used in the prediction equation. It was assumed that the grade crossing bells would sound for a total duration of 30 seconds for each train passing. The hourly Leq reference equation for 50 feet is shown below:

$Leq(h) = SEL_{ref} + 10Log(E/3600) + 10Log(N) - 35.6$

Where,

E = Duration of one event in seconds

N = Number of events that occur per hour

6.4 Substation Noise

Based on the FTA manual, a 50 foot reference SEL of 99 dBA was used for substation noise prediction. It was assumed that the substation noise would be constant during the hours of light rail operation. The hourly Leq reference equation for 50 feet is shown below:

$Leq(h) = SEL_{ref} + 10Log(E/3600) + 10Log(N) - 35.6$

Where,

E = Duration of one event in seconds

N = Number of events that occur per hour

6.5 Wheel Squeal Noise

For the purposes of assessment it is assumed that wheel squeal or the sliding of the wheel over the rail head is proportional to W/R where W is the light rail truck wheelbase and R is the track curve radius. Squeal behavior is separated into three ranges: none, intermediate and severe. The boundaries for the squeal categories are about W/R > 0.01 for the onset of intermediate squeal and W/R > 0.03 for the onset of severe squeal. For the proposed project, the truck wheel base would be 4.5 feet. As a result, light rail vehicles for the proposed project may be expected to generate intermediate squeal in turns with radii less than 450 ft and severe squeal in turns with radii less than 150 ft. These criteria were used to identify potential locations of wheel squeal.

7.0 VIBRATION PREDICTION

The FTA Generalized Ground Surface Vibration Curves were utilized to predict vibration impacts along the proposed project alignment and the associated design option. The curves are based on the type of rail vehicle and the receptor to track distance. All curves steel wheel vehicles are based on a reference speed of 50 mph. As a result, adjustments based on train speed were made using the following speed adjustment equation:

$\text{Speed Adjustment (dB)} = 20Log\ (Speed_{actual} / Speed_{ref})$

Where,

$Speed_{actual}$ = Actual speed of train

$Speed_{ref}$ = Reference speed of 50 mph used in the FTA vibration curve

8.0 IMPACT ASSESSMENT

8.1 Noise

The prediction of noise impacts involves a determination of project-related noise levels at several noise sensitive locations and then comparing them to the applicable FTA noise criteria shown on Figure 5 and in Table 2. These locations included single-family residences, multi-family apartment buildings, hotels, schools, churches and medical facilities. When a receptor

would be affected by more than one project-related noise source, the noise levels of the different sources are combined to predict the total noise impact level at that receptor. Impact determinations are shown in Tables 6 through 10. Parks were also evaluated in the noise impact assessment. As per the FTA manual, parks are defined as being used for either active or passive recreation and only park areas designated for passive recreation are considered noise-sensitive and are subsequently assessed here. Those parks not considered for impact assessment are active use parks such as the future Toby Creek Greenway Extension and the future Mallard Creek Greenway Extension.

8.1.1 Light Rail Alternative

To assess the proposed project, the impacts of the Light Rail Alternative were examined using FTA general assessment guidelines. Table 6 shows the resulting impact assessment performed for noise category 1 and 2 land uses (residences, quiet parks). Table 7 shows the resulting impact assessment performed for noise category 3 land uses (schools and churches). Figures 8 through 11 show the locations of each potential impact. Each of the 39 noise sensitive receptors examined could either be uniquely affected by the proposed project or representative of a cluster of potentially impacted noise sensitive properties. The table presents the levels of impact as a function of a site's distance from the track and the light rail vehicle speed.

Table 6
Light Rail Alternative
Noise Impact General Assessment (2009) Category 1 & 2 Land Uses

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Distance to Track (feet)	Impact Thresholds		Project -Related Prediction Ldn (dBA)	Type of Impact	# Impacts*
					Impact	Severe			
Alpha Mill Apartments, 220 Alpha Mill Lane	MFR	71	35	103	65	70	59.1	None	
House, 234 Parkwood Avenue	SFR	73	25	350	65	72	56.1	None	
House, 423 East 22nd Street	SFR	60	35	380	58	63	51.9	None	
Apartments @ Mallory Street & South Brevard	MFR	63	35	310	60	65	52.8	None	
House, 342 St. Anne Place	SFR	71	45	50	65	70	56.9	None	
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	54	35	230	55	61	58.1	Moderate	4-SFU
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	54	35	300	55	61	57.0	Moderate	22-SFU
Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman	Hotel	66	35	112	61	67	57.3	None	
Campus Housing, UNC Charlotte Laurel Hall	School	62	35	218	59	64	54.4	None	
House, 405 19th Street	SFR	69	40	150	64	69	57.3	None	
3440 North Davidson Street (1st floor commercial, 2nd floor residential)	MU	69	35	230	64	69	54.1	None	
House, 4031 Bearwood Avenue	SFR	76	35	145	65	74	56.4	None	
Holiday Motel 600 North Tryon Street @ Orr Street	Hotel	70	40	82	64	69	59.8	None	

Table 6 (continued)
Light Rail Alternative
Noise Impact General Assessment (2009) Category 1 & 2 Land Uses

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Distance to Track (feet)	Impact Thresholds		Project -Related Prediction Ldn (dBA)	Type of Impact	# Impacts*
					Impact	Severe			
Summit Green Apartments, 230 Barton Creek Drive	MFR	62	40	137	59	64	57.5	None	
Hunt Club Apartments, 100 Heritage Ponte Road	MFR	63	40	319	60	65	53.9	None	
InTown Suites, 110 Rocky River Road	Hotel	62	40	220	59	64	60.6	Moderate	1-Hotel
House, 2672 N Brevard Street	SFR	59	35	140	57	63	56.3	None	
House, 410 East 21st Street	SFR	60	35	225	58	63	49.2	None	
Relax Inn, 6426 North Tryon Street	Hotel	70	35	170	64	69	54.2	None	
Carolinas Medical Center-University, 8800 North Tryon Street	Hosp	58	35	245	57	62	54.0	None	
Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	MFR	51	40	105	54	60	60.7	Severe	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	MFR	51	40	240	54	60	58.2	Moderate	1-MFU

Table 6 (continued)
Light Rail Alternative
Noise Impact General Assessment (2009) Category 1 & 2 Land Uses

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Distance to Track (feet)	Impact Thresholds		Project -Related Prediction Ldn (dBA)	Type of Impact	# Impacts*
					Impact	Severe			
Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	MFR	51	40	300	54	60	56.5	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	MFR	51	40	125	54	60	59.6	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	MFR	51	40	310	54	60	54.7	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	MFR	51	40	190	54	60	56.4	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	MFR	51	40	320	54	60	54.2	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	MFR	51	40	100	54	60	63.8	Severe	1-MFU
Kirk Farm Fields Wetland Viewing Area, North Tryon Street/US-29 @Mallard Creek Church Road	Park	52.5	25	150	59	65	59.0	Moderate	1-Park

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit, Hosp = Hospital
Source: STV Incorporated, 2009

Table 7
Light Rail Alternative
Noise Impact General Assessment (2009) Category 3 Land Uses

Description	Land Use	Existing Leq (dBA)	Speed (mph)	Distance to Track (feet)	Impact Thresholds		Project –Related Prediction Leq (dBA)	Type of Impact
					Impact	Severe		
Crossroads Charter High School, 5500 North Tryon Street	School	72	25	100	70	76	54.1	None
Harbor Baptist Church, 5801 Old Concord Road	Church	62	35	340	64	69	53.9	None
Charlotte Research Institute, Duke Centennial Hall	School	65	35	415	66	71	50.3	None
Campus Housing UNC Charlotte Laurel Hall	School	62	35	218	59	64	54.4	None
GDR Holiness Church, 2604 North Brevard Street	Church	61	35	101	63	69	56.3	None
United Presbyterian Church, 406 N College Street	Church	63	30	320	65	70	55.7	None
CMC Northpark Medical Facility, 251 Eastway Drive	Medical Office	59	45	80	62	68	59.5	None
Medical Dialysis Office, 4234 North Tryon Street/US-29	Medical Office	72	45	180	70	76	58.0	None
Charlotte Research Institute, Bioinformatics Building	School	65	35	165	66	71	53.2	None
Charlotte Research Institute,, Future Portal Building	School	65	35	220	66	71	53.0	None

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit
Source: STV Incorporated, 2009

As shown in Table 6, the assessment reveals that noise impacts are likely to occur at 12 category 1 and 2 land uses as a result of the Light Rail Alternative. As shown in Table 7, the assessment reveals that noise impacts would not occur at any category 3 land uses for the Light Rail Alternative.

8.1.1.1 Train Operations / Grade Crossings / Substations

With the proposed project, light rail operations would consist of 234 total train movements per day. These movements represent the number of times a receptor would be exposed to a train passby during a 24-hour period. Procedures in the FTA's *Transit Noise and Vibration Impact Assessment* manual were used to forecast noise levels due to wheel/rail interaction as well as the blowing of light rail horns and grade crossing bells where applicable. The location of stationary noise sources (grade crossings and substations) relative to the location of a noise receptor in question was also taken into consideration. These noise levels were then combined to determine the total noise level for future conditions including the new light rail service.

The InTown Suites Hotel along the proposed alignment would be moderately affected by increased noise levels from project substations. At this location, predicted substation noise levels were also added to those noise levels predicted for the light rail operations and grade crossings.

8.1.1.2 Stations and Park-and-Ride Lots

Noise due to the operation of a light rail station would be primarily associated with automobile and bus traffic entering and exiting station drop-off and parking areas. The noise assessment was based on parking facilities ranging in size from a 100-space lot to an approximately 2000-space, five-level parking garage. The proposed stations would all be in areas where existing roadway vehicle traffic is substantial on nearby streets or freeways, and experience from past modeling shows the small increment in noise arising from additional traffic bound to or from the light rail stations would likely result in negligible noise increases. In addition, most stations are near grade crossings where the light rail vehicles would be required to blow their horn. Consequently, the noise energy related to the blowing of light rail horns would far outweigh any potential impact from noise related to station operations. As a result no additional impacts are anticipated as a result of station noise and an analysis of station noise was not required.

Conversely, a potential for noise impacts from project-related vehicular access roads only, exists at several noise-sensitive receptors. These potential impacts would be related to three proposed Light Rail Alternative stations. Unlike the circumstance described in the above paragraph, at these locations, noise-sensitive receptors would not be affected by project-related rail, horn or substation noise. The only project-related noise source would come from vehicular access roads. Specifically, for the University City Blvd. Station, traffic noise from access roads could impact the Camino Del Rey church. The Tom Hunter Station could result in access road noise impacts to a residence at 201 Kingview Drive. A separate noise assessment was conducted at these locations to account for potential traffic noise impacts resulting from these access roads. Table 8 shows the result of the assessment for the two stations in question. The assessment reveals that noise impacts would not occur at any of the category 2 and 3 land uses as a result of the increase traffic along station access roads.

Table 8
Light Rail Alternative
Noise Impact General Assessment (2009) Category 2 & 3 Land Uses (Access Roads)*

Description	Land Use	Existing Ldn or Leq (dBA)	Speed (mph)	Distance to Access Road (feet)	Impact Thresholds		Project-elated Prediction Ldn or Leq (dBA)	Type of Impact
					Impact	Severe		
House, 201 Kingview Drive	SFR	64	25	50	60	66	54.0	None
Camino Del Rey Church, 133 Stetson Drive	Church	59	25	40	62	68	59.0	None

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit
** Assessment was performed for noise sensitive locations which could be affected by parking area access roads only.*
Source: STV Incorporated, 2009

8.1.1.3 Wheel Squeal

Based on the criteria for wheel squeal described above, two potentially affected locations were identified along the light rail alternative. These locations include the UNC Charlotte Laurel Hall student residence near curve #N-27 and the Kirk Farms Fields Wetland Viewing Area near curve #N-29. Both locations would be located near track curves which could result in intermediate wheel squeal as these curves have a turning radius of less than 450 feet. Both locations are shown on Figure 7.

8.1.1.4 Charlotte Research Institute at the UNC Charlotte

As indicated in Table 7, the noise prediction results at the Charlotte Research Institute (CRI) buildings indicate that future noise levels would not result in impacts at any of the CRI buildings. The Light Rail Alternative would be located in a depressed trackway in the vicinity of these buildings. Therefore, predicted noise levels would be reduced to even lower levels than those identified in Table 7 due to the barrier like effect of the below-grade retaining walls. According to the FTA manual, reductions could range anywhere from six to 15dB.

8.1.2 Light Rail Alternative – Sugar Creek Design Option

Potential impacts of the Light Rail Alternative – Sugar Creek Design Option were examined using FTA general assessment guidelines. Table 9 shows the resulting impact assessment performed for noise category 1 and 2 land uses (residences, quiet parks). Figures 12 and 13 show the locations for potential impacts. Each of the sites examined is either uniquely affected by the Sugar Creek Design Option or is representative of a cluster of potentially impacted noise sensitive properties. The table presents the levels of impact as a function of a sites distance from the track and the light rail vehicle speed. Three additional projected moderate impacts would result if the Sugar Creek Design Option were chosen. The selection of the Light Rail Alternative – Sugar Creek Design Option would not eliminate any of the predicted impacts for the Light Rail Alternative.

Table 9
Light Rail Alternative – Sugar Creek Design Option
Noise Impact General Assessment (2009) Category 1 & 2 Land Uses

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Dist to Track (feet)	Impact Thresholds		Project- Related Prediction Ldn (dBA)	Type of Impact	# Impacts
					Impact	Severe			
Elmore Mobile Home Park (1st Row), 4832 North Tryon Street	SFR	54	25	250	55	61	51.1	None	
House, 5234 North Tryon Street	SFR	70	45	70	64	69	67.4	Moderate	1-SFU
House, 3910 Bearwood Avenue	SFR	76	35	164	65	74	59.1	None	
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	54	35	195	55	61	59.1	Moderate	4-SFU
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	54	35	300	55	61	56.6	Moderate	22-SFU

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit
Source: STV Incorporated, 2009

Table 10
Light Rail Alternative – Sugar Creek Design Option
Noise Impact General Assessment (2009) Category 3 Land Uses

Description	Land Use	Existing Leq (dBA)	Speed (mph)	Dist to Track (feet)	Impact Thresholds		Project- Related Prediction Leq (dBA)	Type of Impact
					Impact	Severe		
Greater Love Baptist Church, 4709 North Tryon Street	Church	69	25	230	69	74	53.8	None
Sacrifice of Praise Ministry, 4801 North Tryon Street	Church	72	25	150	70	76	51.8	None
Resurrection Church, 131 Bennett Street	Church	69	25	260	69	74	50.3	None
Crossroads Charter High School, 5500 North Tryon Street	School	72	25	95	70	76	54.1	None
Harbor Baptist Church, 5801 Old Concord Road	Church	62	35	340	64	69	54.8	None

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit
Source: STV Incorporated, 2009

Potential impacts of the Light Rail Alternative – Sugar Creek Design Option were examined using FTA general assessment guidelines. Table 10 shows the resulting impact assessment performed for noise category 3 land uses (schools and churches). Each of the sites examined is either uniquely affected by the Sugar Creek Design Option or is representative of a cluster of potentially impacted noise sensitive properties. The table presents the levels of impact as a function of a sites' distance from the track and the light rail vehicle speed. No impacts are predicted to occur.

8.1.2.1 Train Operations / Grade Crossings / Substations

A residence located at 5234 North Tryon Street/US-29 along the proposed Light Rail Alternative – Sugar Creek Design Option would be affected by noise levels from project substations. At this location, predicted substation noise levels were also added to those noise levels predicted for the light rail operations and grade crossings.

8.1.2.2 Stations and Park-and-Ride Facilities

The only station that has sensitive noise receptors nearby that could potentially be impacted would be the Old Concord Station - Sugar Creek Design Option. While noise due to the operation of a light rail station would be primarily associated with automobile and bus traffic entering and exiting station drop-off and parking areas, noise energy related to the blowing of light rail horns and crossing bells for the Light Rail Alternative – Sugar Creek Design Option would far outweigh any potential impact from noise related to station operations. However, because this station would include an access road that is very close to a sensitive receptor (approximately 50 feet from the Crossroads Charter High School) its potential noise impact was conservatively included in the total noise impact assessment conducted for the high school. Results concluded that there would be no impact at the school.

8.1.2.3 Wheel Squeal

No sections of the Light Rail Alternative – Sugar Creek Design Option would have a track radius of less than 450 feet. As a result, it is not anticipated that any sensitive noise receptors would be affected by wheel squeal.

8.2 Vibration

As described above in the existing conditions section, for a detailed vibration assessment, the specific characterization of the vibration environment is very important. However, for this phase of the proposed project where general assessment procedures, as described in the noise and vibration methodology section, were used for vibration prediction, the monitoring of baseline vibration levels is not necessary since this information is not required input in the vibration prediction procedure. This includes locations along the Light Rail Alternative which may be affected by existing freight rail.

8.2.1 Light Rail Alternative

Details of the vibration predictions are presented in Table 11 for both residential and institutional land uses (schools and churches). The vibration levels presented have been predicted using the procedure described in the vibration prediction section outlined above. All predictions are based on vibration category 2 and 3 land usage. The results indicate that vibration impacts would occur at one receptor at 342 St. Anne Place, located fifty feet just north of the proposed Light

Rail Alternative alignment. Because the impact at 342 St. Anne Place is within one dB of the vibration criteria level, a more detailed assessment during the final design phase of the project may have to be conducted so that a more accurate determination of actual impact, if any, can be made. While there are other neighboring receptors located along the right-of-way, the next closest vibration-sensitive property would be located 70 feet from the alignment. At this distance and beyond, the assessment indicates that no additional vibration impacts would be projected to occur.

Table 11
Light Rail Alternative
Vibration Impact General Assessment (2009) Category 2 & 3 Land Uses

Description	Land Use*	Land Use Category	Average Train Speed (mph)	Distance To Track (feet)	FTA Threshold (VdB)	Predicted Vibration Level (VdB)	Impact?
Alpha Mill Apartments, 220 Alpha Mill Lane	MFR	2	35	103	72	64	No
House, 342 St. Anne Place	SFR	2	45	50	72	72	Yes
Crossroads Charter High School, 5500 North Tryon Street	School	3	25	100	75	61	No
Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman	Hotel	2	35	112	72	63	No
Mallard Creek Apartments, 420 Michelle Linnea Drive	MFR	2	40	105	72	65	No
House, 405 19th Street	SFR	2	40	150	72	62	No
House, 4031 Bearwood Avenue	SFR	2	35	145	72	61	No
Holiday Motel, 600 North Tryon Street	Hotel	2	40	82	72	68	No
Summit Green Apartments, 230 Barton Creek Drive	MFR	2	40	137	72	61	No
GDR Holiness Church, 2604 North Brevard Street	Church	3	35	101	75	64	No
House, 2672 N Brevard St	SFR	2	35	140	72	61	No
251 Eastway Dr - CMC Northpark Medical Facility	SFR	3	45	80	75	69	No

** SFR = Single-family residential, MFR = Multi-family residential Source: STV Incorporated, 2009*

Charlotte Research Institute at the UNC Charlotte

As described in the FTA manual, screening for sensitive category 1 vibration is based on a distance of 450 feet. Land uses for this category typically include vibration-sensitive research and manufacturing activities, hospitals with vibration-sensitive equipment, and university research operations. However, the degree of sensitivity to vibration is dependent upon the specific equipment that would be affected by the vibration.

CRI personnel indicate that for several existing and future buildings, campus research activities would require vibration limits in the range of 42 – 60 VdB (125 micro-inch per second - 1000 micro-inch per second), which is also described as Vibration Criteria - Level F (VC-F) and VC-C.

These limits are described in the FTA manual and are based on vibration criteria from the International Organizational for Standardization (ISO). To mitigate current vibration on sensitive equipment, several of the existing CRI campus buildings including Grigg Hall and the Bioinformatics Building (which is currently in the process of being constructed) employ the use of a dual vibration isolation system in the form of: 1) a central slab mounted on bedrock and isolated from the rest of the building; and, 2) individual mechanical vibration isolation platforms tailored for the various pieces of sensitive equipment.

The nature of the research in the two existing buildings ranges from sensitive optical analyses to mechanical interaction of molecular level particles using scanning transmission electron microscopes. The Bioinformatics Building will include micro ray and laser scan microscopy technology. Several buildings planned for future construction including the Epic Building and the Portal building will also include vibration sensitive research for which the required vibration limits may be even stricter -- at 36 VdB or VC-F (62.5 micro-inch per second). Based on these strict vibration requirements, the vibration levels for the existing environment (which does not include existing rail activity) described above (approximately 46 VdB) would already require some form of mitigation for much of their research activities. Consequently, the vibration criteria described in Table 3 would be inadequate to properly assess potential impacts from light rail on these buildings.

Because vibration limits for category 1 are based on acceptable vibration levels for moderately vibration-sensitive equipment such as optical microscopes and electron microscopes with vibration isolation systems, defining limits for equipment that is even more sensitive requires a detailed review of the specific equipment involved, the vibration frequencies at which they are sensitive and detailed field measurements of soil vibration characteristics. This type of review is usually performed during the Detailed Analysis associated with the final design phase of a project and not as part of the Draft EIS due to the increased level of specificity needed in the engineering design to properly assess the proposed impacts. The need for a more detailed analysis along with continuing coordination with the Charlotte Research Institute is acknowledged and affirmed.

8.2.2 Light Rail Alternative – Sugar Creek Design Option

Details of the vibration predictions are presented in Table 12 for both residential and institutional land uses (schools and churches) for the Light Rail Alternative – Sugar Creek Design Option. The vibration levels presented have been predicted using the same methodology as for the Light Rail Alternative. All predictions are based on vibration category 2 and 3 land usage. The results indicate that impacts would not be observed at any of the vibration-sensitive receptor locations. In addition, the predicted impact at 342 St. Anne Place for the Light Rail Alternative would not occur since the Light Rail Alternative – Sugar Creek Design Option would not pass by this receptor.

Table 12
Light Rail Alternative – Sugar Creek Design Option
Vibration Impact General Assessment (2009) Category 2 & 3 Land Uses

Description	Land Use	Land Use Category	Average Train Speed (mph)	Distance To Track (feet)	FTA Threshold (VdB)	Predicted Vibration Level (VdB)	Impact?
Crossroads Charter High School, 5500 North Tryon Street	School	3	25	95	75	62	No
Residence, 5234 North Tryon Street	SFR	2	45	70	72	70	No

** SFR = Single-family residential, MFR = Multi-family residential Source: STV Incorporated, 2009*

9.0 MITIGATION

Noise

The FTA states that for moderate impacts, mitigation will be incorporated into the project when it is considered reasonable. For severe impacts, mitigation should be incorporated into a project as long as "the proposed mitigation represents a reasonable public expenditure after considering the impacts of the action and the benefit of the proposed mitigation measures." The goal is to gain substantial reductions in noise level. A list of generalized noise mitigation measures are summarized in Table 13 and is followed by descriptions of the most practical mitigation recommendations for properties impacted by the proposed project. All mitigation measures assume that the rail system would be maintained in its as-new condition.

Specific mitigation measures designed for each impacted property will be proposed for the Final EIS. These measures would be based on more accurate and specific operational engineering and environmental data which will be available for use in a detailed noise assessment. As such, they may differ with those mitigation measures recommended below for the general assessment.

Table 13
Transit Noise Mitigation Measures

Application	Mitigation Measure		Effectiveness
SOURCE	Stringent Vehicle & Equipment Noise Specifications		Varied
	Operational Restrictions		Varied
	Resilient or Damped Wheels *	For Rolling Noise on Tangent Track:	2 dB
		For Wheel Squeal on Curved Track:	10-20 dB
	Vehicle Skirts *		6-10dB
	Under Car Absorption*		5dB
	Spin-slide Control (prevents flats)*		**
	Wheel Truing (eliminates wheel flats)*		**
	Rail Grinding (eliminates corrugations)*		**
	Turn Radii greater than 1,000 feet*		Avoids Squeal
	Rail Lubrication on Sharp Curves*		Reduces Squeal
	Movable-Point Frogs (reduce rail gaps at crossovers)*		(Reduces Impact Noise)
	Engine Compartment Treatments (Buses)		6-10 dB
PATH	Sound Barriers close to Vehicles		6-15 dB
	Sound Barriers at ROW Line		3-10 dB
	Alteration of Horizontal & Vertical.		Alignments Varied
	Acquisition of Buffer Zones		Varied
	Ballast on At-Grade Guideway*		3 dB
	Ballast on Aerial Guideway*		5 dB
	Resilient Track Support on Aerial Guideway		Varied
RECEIVER	Acquisition of Property Rights for Construction of Sound Barriers		5-10 dB
	Building Noise Insulation		5-20 dB

Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment* , May 2006.
* Applies to rail projects only
** These mitigation measures work to maintain a rail system in its as-new condition. Without incorporating them into the system, noise levels could increase up to 10 dB.

9.1.1 Light Rail Alternative

The following section discusses potential mitigation measures that should be considered to mitigate the identified impacts of the project. A matrix of recommended mitigation measures for properties that could experience an increase in predicted noise levels is provided in Table 14. Maps identifying the locations of potentially impacted noise sensitive receptors, where mitigation should be considered, are shown in Figures 8 through 11.

Rail Vehicle Skirts – Depending upon the exact level of effectiveness, the modification of light rail vehicle skirts from a simple aesthetic use present an existing light rail vehicles to one that would result in noise attenuation (as presented in Table 13) would eliminate or significantly reduce many of the impacts projected for the Light Rail Alternative. This assumes a –six to 10 dB range of attenuation for wheel/rail noise. Impacts at the Pines Mobile Home Park would be eliminated. Impacts at the Mallard Creek Apartments would be reduced, but not eliminated.

Sound Barriers – Sound barriers can either be located close to the source, at the affected receptor or somewhere in between. While the most effective option would be to build the barrier as close to the source as possible, the critical element for any barrier effectiveness is ensuring that the line-of–site between the noise source and a receptor is broken. Properly configured sound barriers are capable of reducing noise levels by six to 10 dB. Increasing the height of the barrier along with the use of sound absorbing material on the inner surface of the barrier can further enhance barrier effectiveness. In general, a solid, impervious wall that is sufficiently high to block the direct view of the noise source will typically reduce community noise levels at locations within about 200 feet of the track.

For the LYNX BLE project, noise barriers would be effective in eliminating moderate impacts for the Pines Mobile Home Park. For this property, a barrier close to the alignment would be most effective and most feasible. Utilizing barriers at the Mallard Creek Apartment Complex may significantly reduce the severe noise impacts. However, in order to be effective for second floor windows the barrier would have to be extremely tall, which could make the use of barriers impractical at this location. In addition, barriers close to the alignment in this location would do nothing to reduce impacts from crossing bells at several of the affected buildings. For all potential barrier locations, the use of barriers would also require the simultaneous consideration of visual impacts.

For the two locations, the UNC Charlotte Laurel Hall and Kirk Farm Fields, that would be affected by wheel squeal, barriers located very close to the track would significantly reduce the level of wheel squeal by as much as 15dB.

Resilient or Damped Wheels – While not very efficient at reducing rolling noise; resilient wheels are extremely efficient at attenuating wheel squeal. For the locations at UNC Charlotte Laurel Hall and Kirk Farm Fields, the noise impact from wheel squeal would likely be eliminated with reductions ranging from 10 to 20 dB depending upon the frequency characteristics of the squeal noise.

Building Sound Insulation – Building sound insulation most typically involves caulking and sealing gaps in the building envelope and installation of specially designed windows and solid-core doors. Depending on the quality of the original windows, such treatments can provide noise reductions as much as five to 10 or more dB to building interiors. (Note: Noise impacts have been calculated based on distances to property exteriors). Building sound insulation is effective only so long as a building's windows and doors are sealed. It does not provide any noise attenuation outside of a building. The project sponsors would be responsible for payment of any cost associated with sound insulation. Where sound insulation is the appropriate mitigation measure, it can only be implemented with the permission of the property owner. One or more of the apartment buildings at Mallard Creek could benefit from sound insulation.

Permanent Roadway Closures – Eliminating unnecessary roadway-rail grade crossings can remove the need for light rail horn use. The importance of individual crossings is a function of through traffic, community circulation and emergency vehicle requirements and limitations. Where a grade crossing services an important artery or is essential for community circulation, permanent roadway closures are not normally feasible. In locations where there are a series of grade crossings within short distance of each other, eliminating a few of these crossings (e.g., every other block in a town setting) may not result in noise reduction, due to the requirement for light rail vehicles to sound horns at each active crossing.

The only grade crossing near an impacted property where closing could be considered is Stetson Drive. The closing of this roadway would eliminate the moderate noise impact at the InTown Suites Hotel. An investigation of community concerns as well as consideration of the level of noise impact, traffic safety and access issues would have to be investigated to make a full determination as to the feasibility of this grade crossing closure.

Relocate or Insulate Substation – For the InTown Suites Hotel property, relocating or using a sound proof enclosure for the substation nearby would reduce the level of noise impact.

Table 14
Potential Mitigation Measures for the Light Rail Alternative*

Receptor Description	Land Use	Noise Source to Receptor Distances			Type of Impact	# Impacts	Potential Mitigation
		Distance to Track (feet)	Distance to Grade Crossing (feet)	Distance to Light Rail Substation (feet)			
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	**230**	230	N/A	Moderate	4-SFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	**300**	300	N/A	Moderate	22-SFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
InTown Suites, 110 Rocky River Road	Hotel	220	**625**	**220**	Moderate	1-Hotel	Rail Vehicle Skirts and/or Eliminate crossing at Stetson Drive and/or Move or enclose substation
Kirk Farm Fields Wetland Viewing Area, North Tryon Street/US-29 @Mallard Creek Church Road	Park	150	**225**	N/A	Moderate	1-Park	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	MFR	**105**	**300**	N/A	Severe	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW and/or Sound insulation
Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	MFR	240	**240**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW and/or Sound insulation

Table 14 (continued)
Potential Mitigation Measures for the Light Rail Alternative*

Receptor Description	Land Use	Noise Source to Receptor Distances			Type of Impact	# Impacts	Potential Mitigation
		Distance to Track (feet)	Distance to Grade Crossing (feet)	Distance to Light Rail Substation (feet)			
Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	MFR	300	**390**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	MFR	**125**	**500**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW and/or Sound insulation
Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	MFR	310	**530**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	MFR	190	**650**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	MFR	320	**750**	N/A	Moderate	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	MFR	**100**	**100**	N/A	Severe	1-MFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW and/or Sound insulation

** SFR = Single-family residential, MFR = Multi-family residential* *Source: STV Incorporated, 2009*
*For each property, the source to receptor distances when bolded represents the dominant noise sources affecting that property.

9.1.2 Light Rail Alternative –Sugar Creek Design Option

The following section discusses potential mitigation measures that should be considered to mitigate the identified impacts of the Light Rail Alternative – Sugar Creek Design Option. A matrix of recommended mitigation measures for properties that could experience an increase in predicted noise levels is provided in Table 15. Maps identifying the locations of potentially impacted noise sensitive receptors, where mitigation should be considered, are shown in Figures 12 through 14.

Rail Vehicle Skirts – Depending upon the exact level of effectiveness, the use of vehicle skirts as presented in Table 13 would eliminate many of the impacts projected for the Light Rail Alternative – Sugar Creek Design Option. This assumes a –six to 10 dB range of attenuation. Only slightly moderate impacts would remain at the Pines Mobile Home Park.

Sound Barriers – Noise barriers would be effective in eliminating and moderate impacts for the Pines Mobile Home Park. For this property, a barrier located close to the mobile homes while most affective may not prove the most feasible. A more feasible option would be to locate barriers close to the alignment. However, noise from crossing bells may not be adequately blocked for all receptors. For all potential barrier locations, the use of barriers would require the simultaneous consideration of visual impacts.

Building Sound Insulation – The single-family home at 5234 North Tryon Street/US-29 would benefit from sound insulation as it is the only affected property in the immediate area. Assuming a five to 10 dB reduction, moderate impacts would be eliminated.

Relocate or Insulate Substation – For the single-family home at 5234 North Tryon Street/US-29, relocating or using a sound proof enclosure for the substation nearby would reduce the level of noise impact.

Table 15
Potential Mitigation Measures for the Light Rail Alternative – Sugar Creek Design Option*

Proposed Noise Mitigation for the Light Rail Alternative – Sugar Creek Design Option*Receptor Description	Land Use	Noise Source to Receptor Distances			Type of Impact	# Impacts	Potential Mitigation
		Distance to Track (feet)	Distance to Grade Crossing (feet)	Distance to Light Rail Substation (feet)			
House, 5234 North Tryon Street	SFR	70	409	**85**	Moderate	1-SFU	Rail Vehicle Skirts and/or Enclose or move substation.
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	195	**195**	NA	Moderate	4-SFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	300	**300**	NA	Moderate	22-SFU	Rail Vehicle Skirts and/or Noise Barrier at the ROW

** SFR = Single-family residential, MFR = Multi-family residential Source: STV Incorporated, 2009*
*For each property, the source to receptor distances when bolded represents the dominant noise sources affecting that property.

Vibration

Many vibration impacts can be controlled or eliminated by the use of several general control measures. As described in the FTA manual, these measures include:

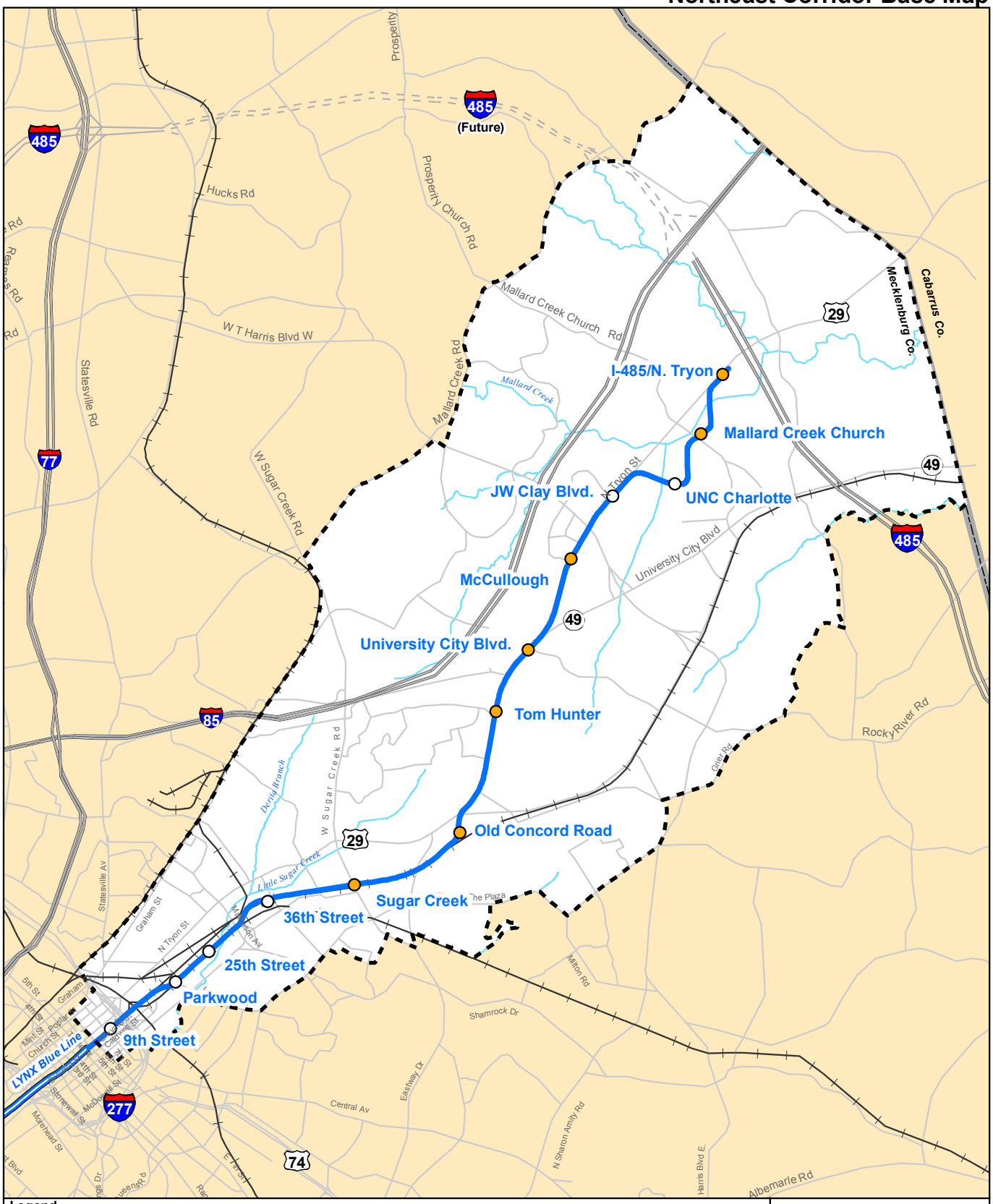
- High Resilience Rail Fasteners – Unlike standard resilient fasteners, these high resilience rail fasteners include a reduced vertical stiffness component.
- Ballast Mats – Consists of thick resilient layers of elastomeric, cork, fiberglass, or rock wool placed under ballast.
- Floating Slab Track Bed – Consist of a concrete slab supported on resilient elements, usually rubber or a similar elastomeric.
- Resiliently Supported Ties – The resilient supported tie system consists of concrete ties supported by rubber pads.

The vibration assessment indicates that only one residence, located at 342 St. Anne Place would potentially be impacted by project-related vibration. A map of the impacted sensitive location for which mitigation would be proposed is shown in Figure 15. However, the projected impact is less than 1 dB over the vibration threshold limit. Consequently, of the control measures listed above, the use of ballast mats would be successful at effectively reducing the predicted vibration level below the FTA threshold.

As with the noise mitigation, vibration mitigation measures assume that regular rail and car maintenance will be strictly enforced. This includes wheel truing and rail grinding to matching profiles.

LYNX Blue Line Extension

Figure 1
Northeast Corridor Base Map



Legend

- Northeast Corridor Limits
- Proposed Light Rail Alternative
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Light Rail Transit
- Highway
- Major Roads
- Highway (Future)
- Streams
- Railroads
- County Line

0 0.5 1
Mile

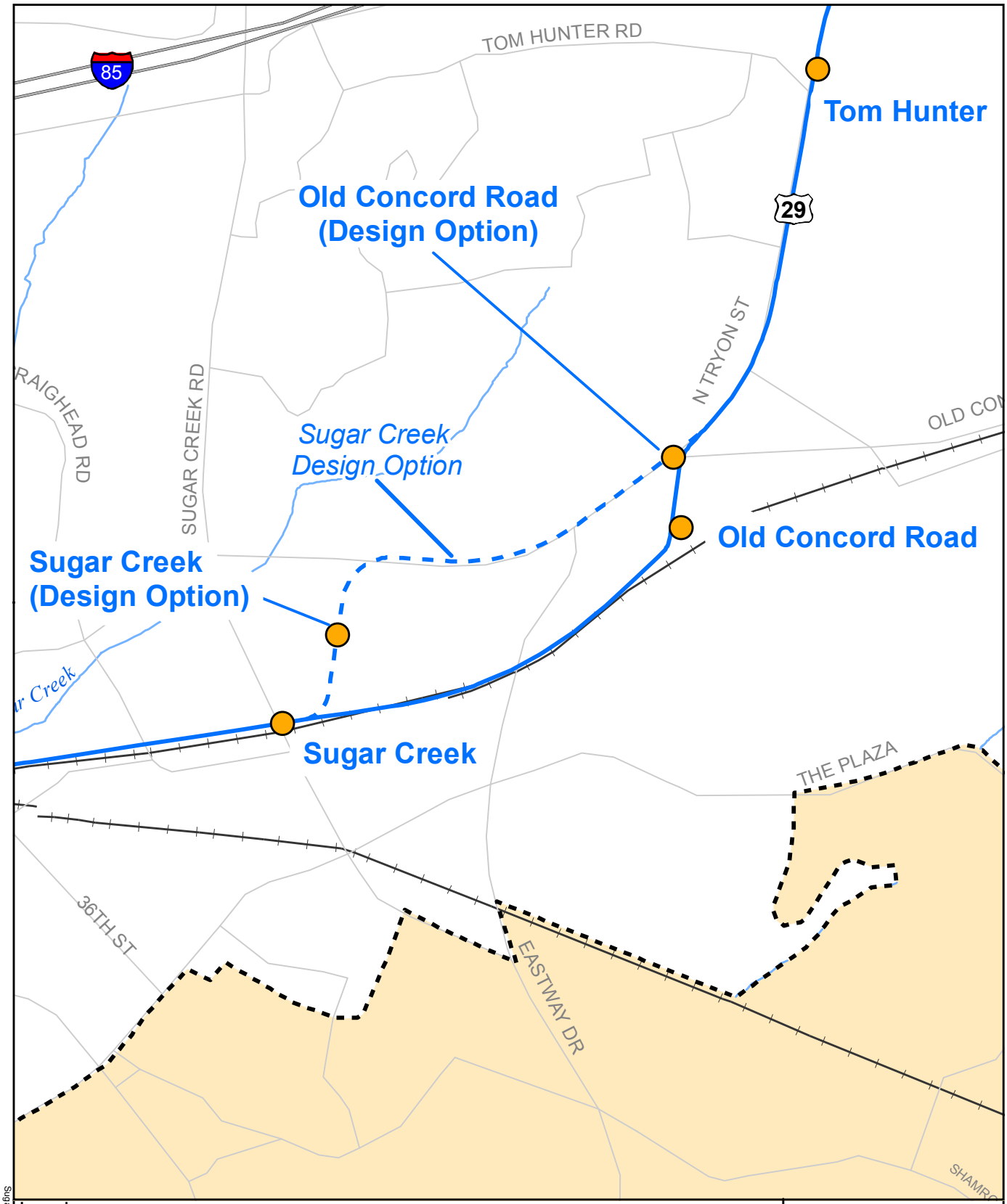
Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS

Corridor_Base_Map_Rev.00.pdf

04.21.09

LYNX Blue Line Extension

Figure 2
Northeast Corridor Light Rail Alternative - Sugar Creek Design Option



Legend

- Northeast Corridor Limits
- Proposed Light Rail Alternative
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Light Rail Transit
- Highway
- Major Roads
- Highway (Future)
- Streams
- Railroads
- County Line

N

0 1,000 2,000 Feet

1 inch equals 2,000 feet

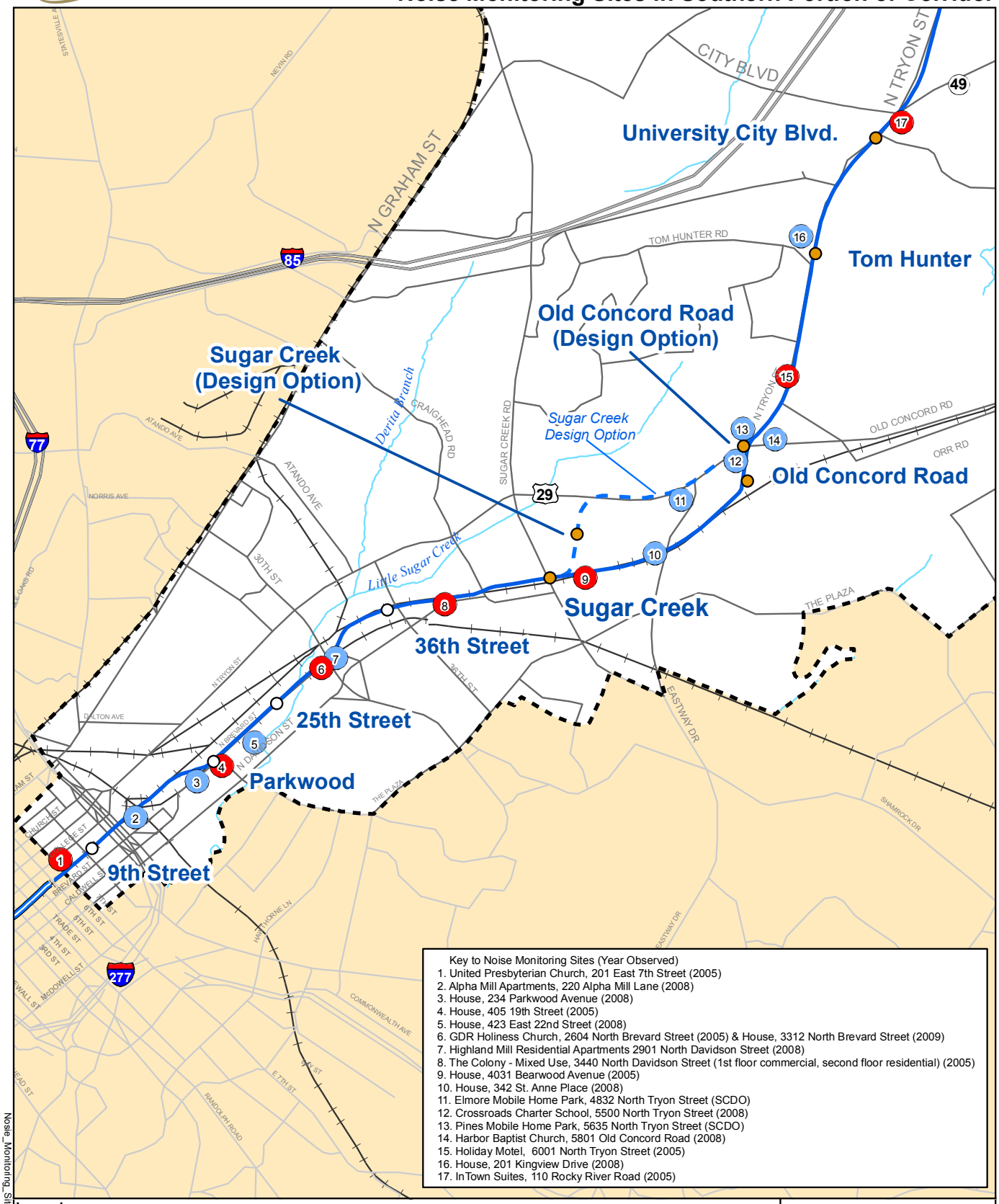
Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS

04.21.09

Sugar Creek Design Option_Map_Rev.00.pdf

LYNX RAPID TRANSIT SERVICES Blue Line Extension

Figure 6a
Noise Monitoring Sites in Southern Portion of Corridor



Legend

- Northeast Corridor Limits
- Light Rail Transit
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Ligh Rail Tranist
- Highway
- Highway (Future)
- Major Roads
- Railroads

Noise Monitoring Sites

- 2005 Noise Monitoring Sites
- 2008 Noise Monitoring Sites

N

0 0.25 0.5
Mile

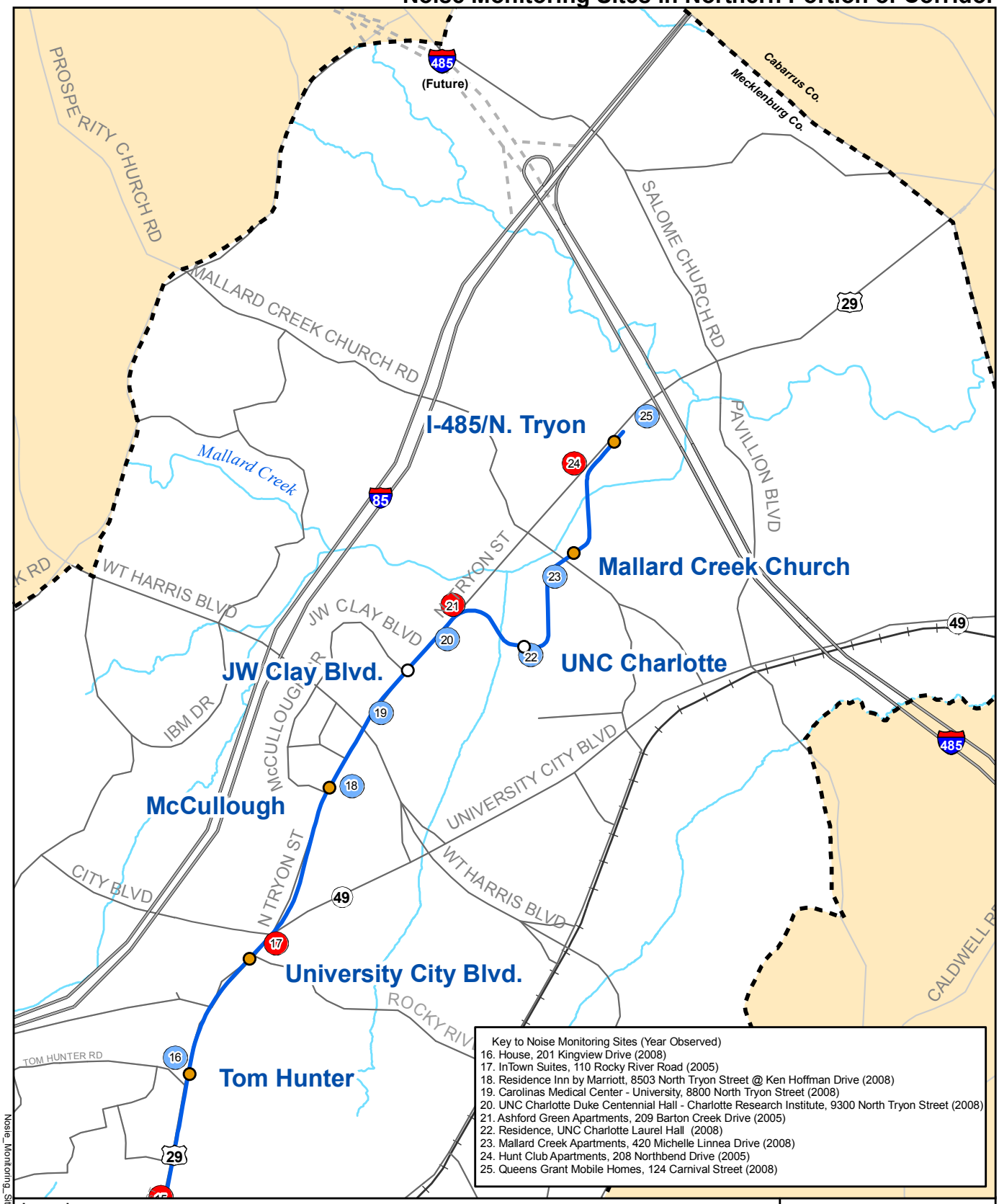
Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS, STV Field Investigation, 2009

11.20.09

Noise_Monitoring_Sites_Southern_Map_Fig.14-4a_Rev.00.pdf

Figure 6b

Noise Monitoring Sites in Northern Portion of Corridor



Key to Noise Monitoring Sites (Year Observed)
16. House, 201 Kingview Drive (2008)
17. InTown Suites, 110 Rocky River Road (2005)
18. Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman Drive (2008)
19. Carolinas Medical Center - University, 8800 North Tryon Street (2008)
20. UNC Charlotte Duke Centennial Hall - Charlotte Research Institute, 9300 North Tryon Street (2008)
21. Ashford Green Apartments, 209 Barton Creek Drive (2005)
22. Residence, UNC Charlotte Laurel Hall (2008)
23. Mallard Creek Apartments, 420 Michelle Linnea Drive (2008)
24. Hunt Club Apartments, 208 Northbend Drive (2005)
25. Queens Grant Mobile Homes, 124 Carnival Street (2008)

Legend

- Northeast Corridor Limits
- Light Rail Transit
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Light Rail Transit
- Highway
- Highway (Future)
- Major Roads
- Railroads

Noise Monitoring Sites

- 2005 Noise Monitoring Sites
- 2008 Noise Monitoring Sites

N

0 0.25 0.5
Mile

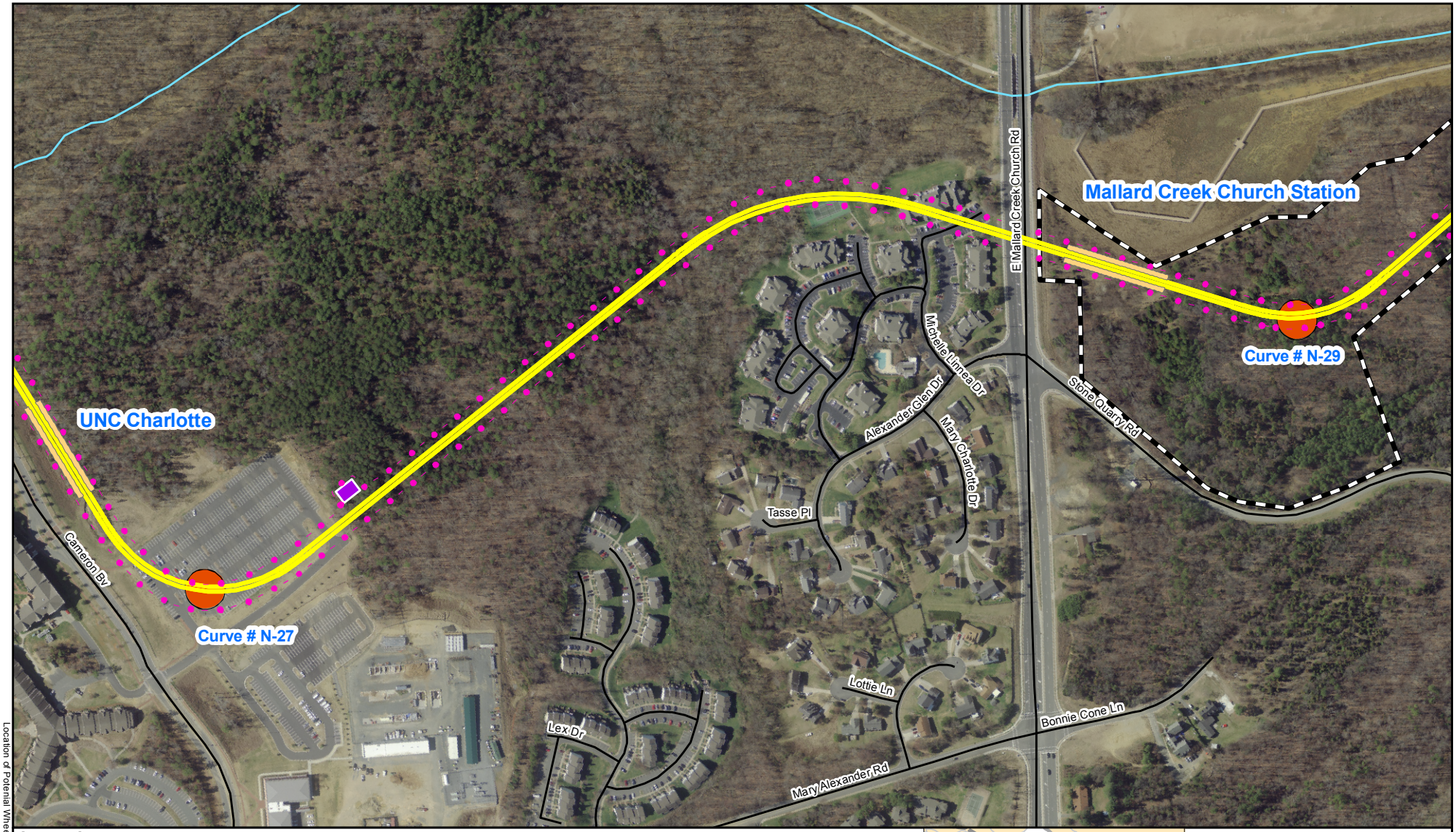
Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS, STV Field Investigation, 2009

Noise_Monitoring_Sites_Northern_Map_Fig.14-4b_Rev.00.pdf

02.02.09

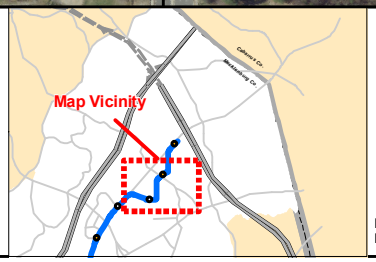
LYNX RAPID TRANSIT SERVICES Blue Line Extension

Figure 7
Locations of Potential Wheel Squeal Noise



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Wheel Squeal Noise Location



0 105 210 420 Feet

Feet

1 inch equals 400 feet

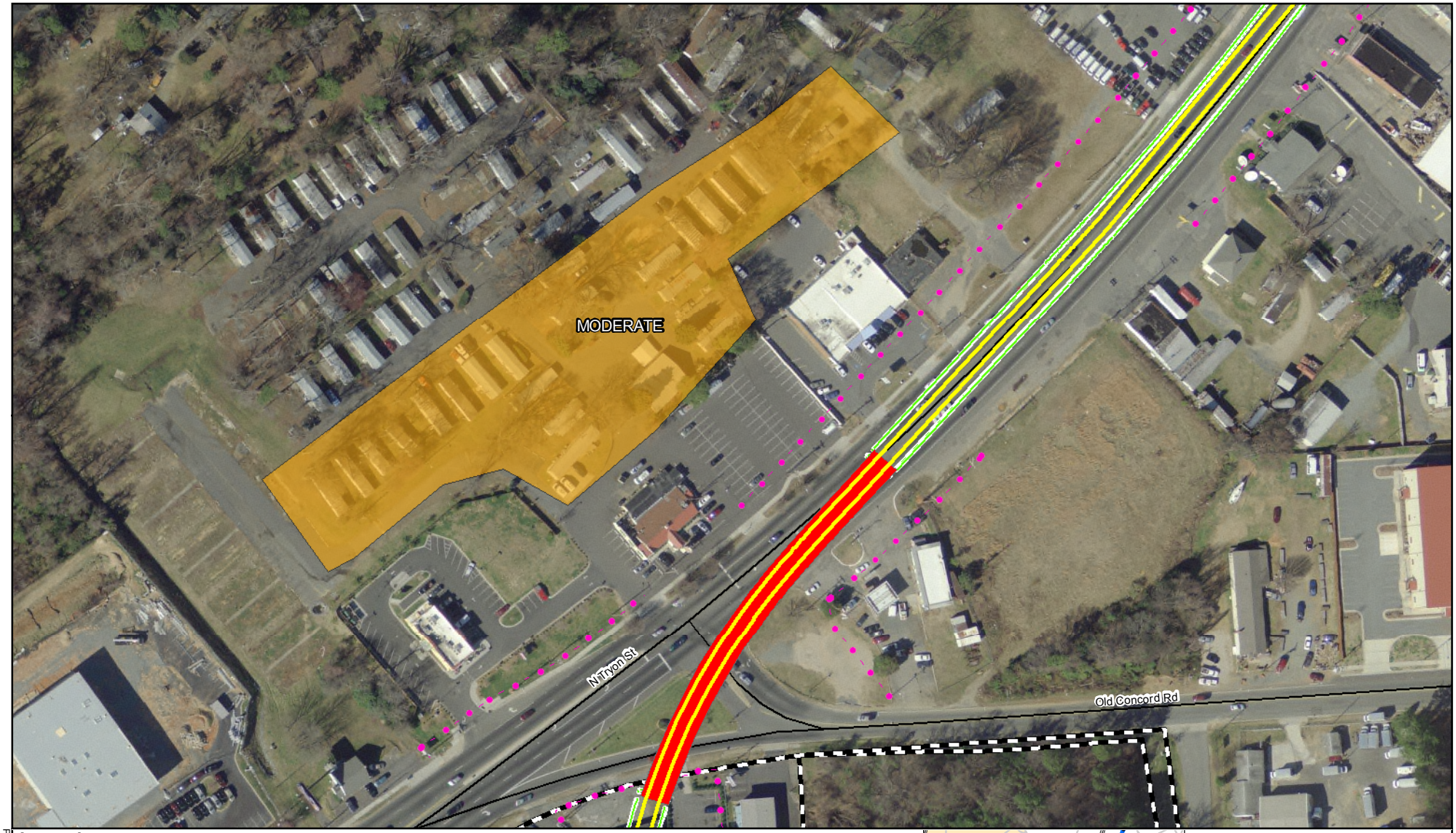
Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

04.13.09

Location of Potential Wheel Squeal Noise Figure 7.REV.00.pdf

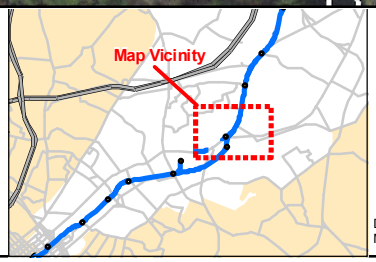
LYNX Blue Line Extension

Figure 8
Pines Mobile Home Park (5635 North Tryon Street/US-29) - Light Rail Alternative SCDO : Noise Impacts



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact



N

75 37.5 0 75

Feet

1 inch = 150 feet

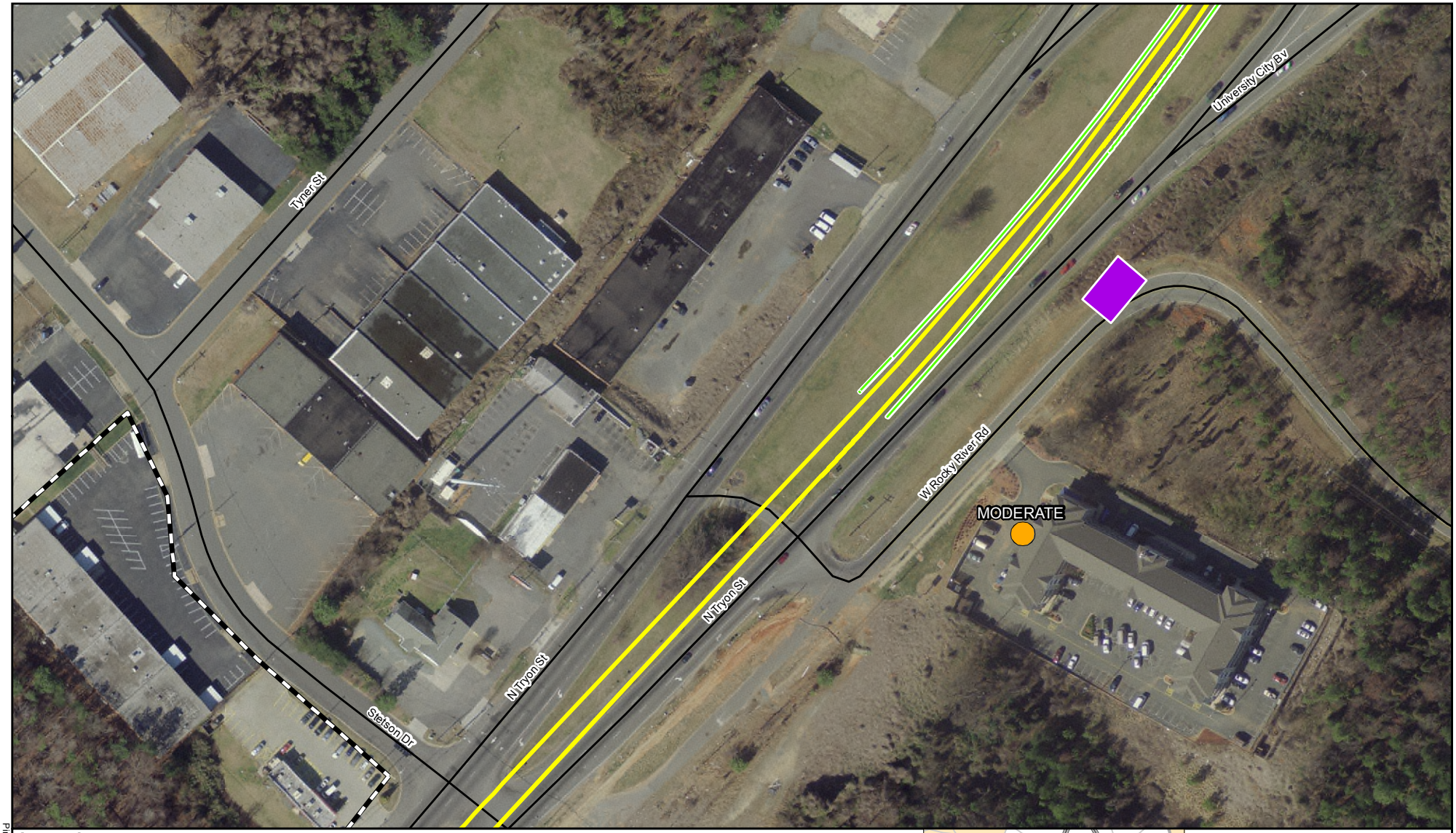
Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

Pines_MHP_N&V_LPA_Map 8.REV00.pdf

10.21.09

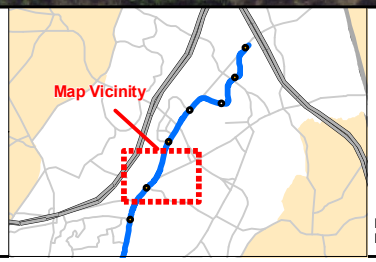
LYNX RAPID TRANSIT SERVICES Blue Line Extension

Figure 9
InTown Suites - Light Rail Alternative : Noise Impact



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact



N

75 37.5 0 75

Feet

1 inch equals 150 feet

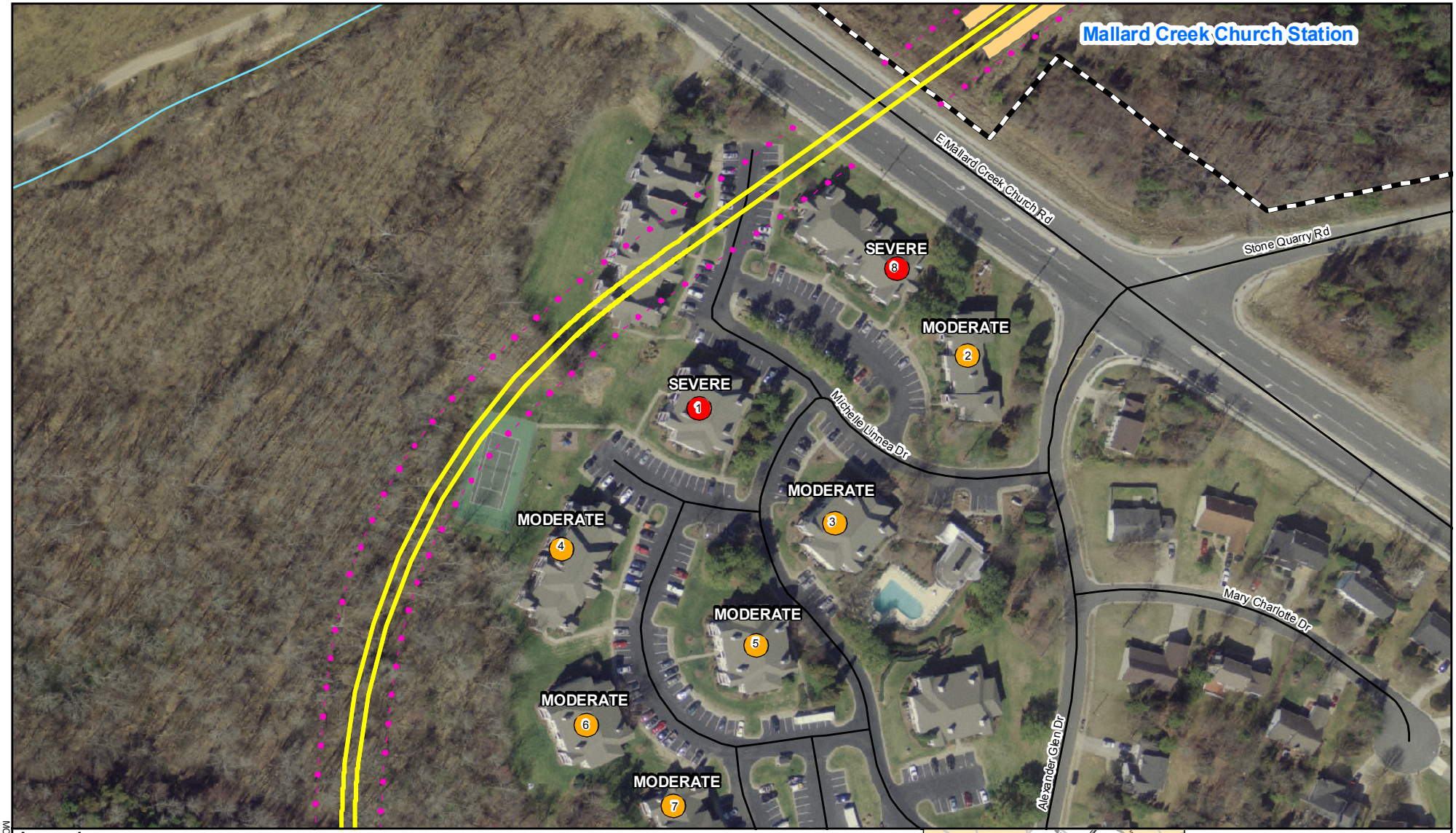
Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

03.19.09

Pines_MHP_N&V_SCDO_Map 9 REV 00.pdf

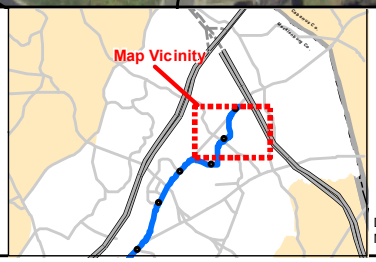
LYNX RAPID TRANSIT SERVICES Blue Line Extension

Figure 10
Mallard Creek Apartments - Light Rail Alternative : Noise Impacts



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact



N

75 37.5 0 75

Feet

1 inch = 150 feet

Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

MCC_Station_N&V_LPA_Map10_REV00.pdf

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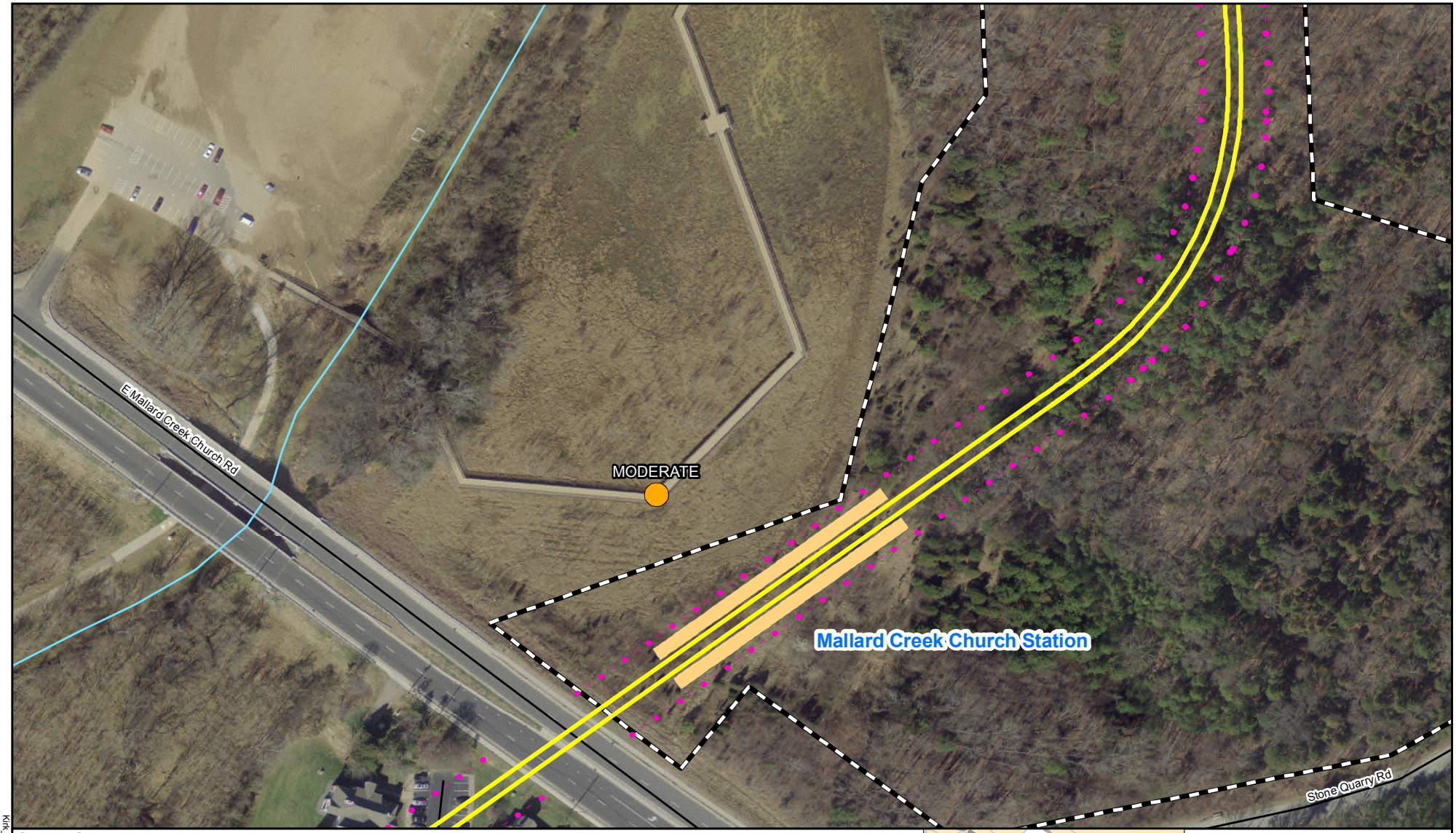
LYNX RAPID TRANSIT SERVICES Blue Line Extension

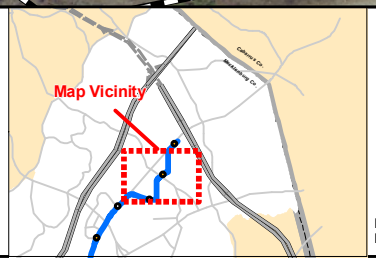
Figure 11

Kirk Farm Fields - Light Rail Alternative : Noise Impacts



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact



N

75 37.5 0 75

Feet

1 inch equals 150 feet

Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

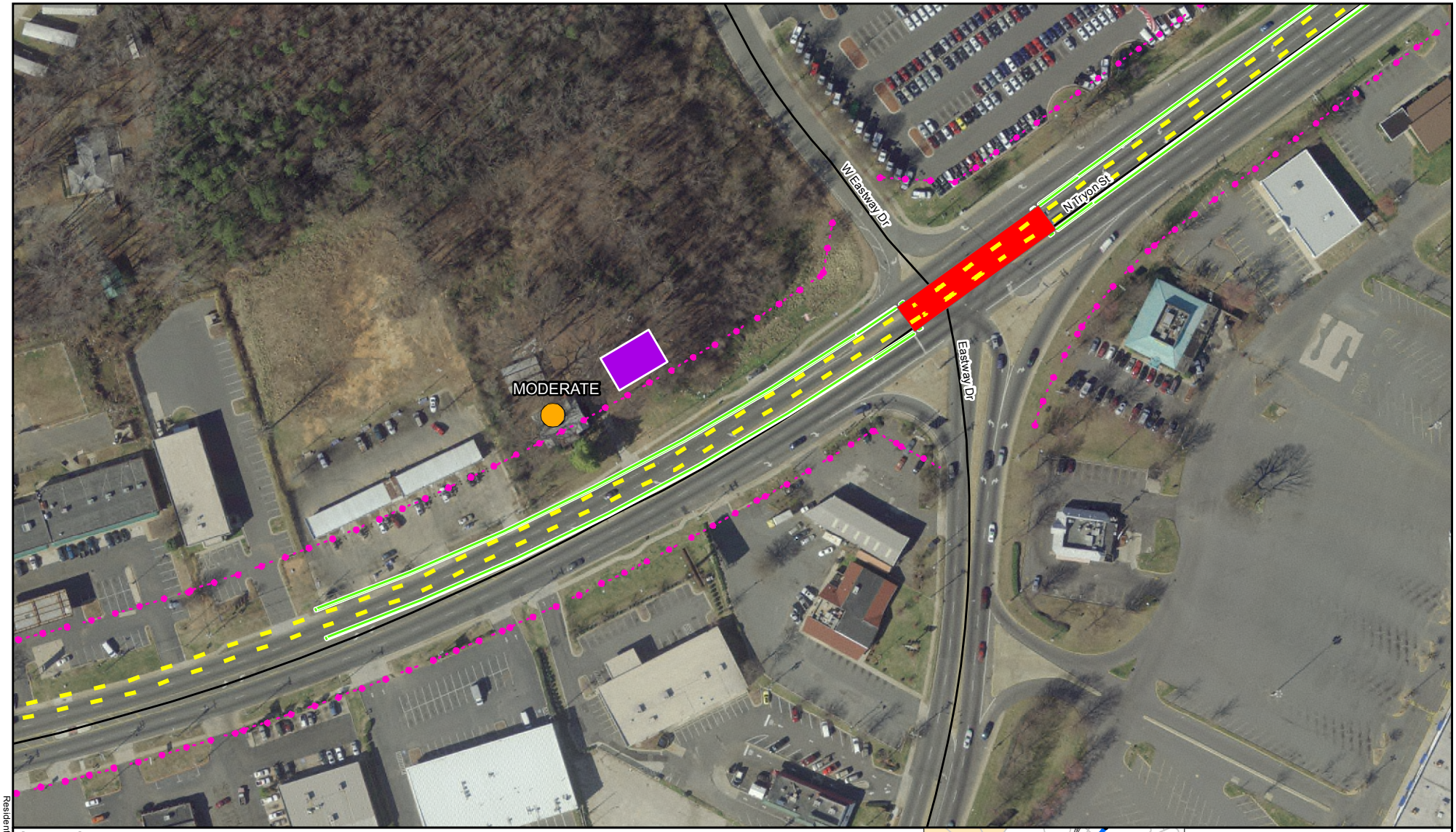
04.13.09

Kirk_Farm_Field_N&V_LPA_Map11.REV.00.pdf

LYNX Blue Line Extension

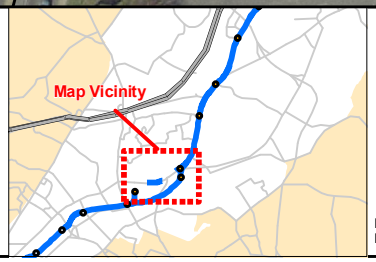
Figure 12

Residential Home (5234 North Tryon Street/US-29) - Light Rail Alternative SCDO : Noise Impacts



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact



N

75 37.5 0 75

Feet

1 inch equals 150 feet

Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

Residential_Home_N&V_SCDO_Map13.REV.00.pdf

04.13.09

Appendix A: Calculation Spreadsheets

Horn Noise Prediction

		Daytime			Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Horn (Ldn) or L(eq)
LPA											
1	Alpha Mills Apartments, 220 Alpha Mill Lane	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	103	**-22.8**
2	House, 234 Parkwood Avenue	59.3	25.0	12.4	55.7	25.0	5.3	81	62.8	350	**54.4**
3	House, 423 East 22nd Street	-22.7	35.0	12.4	-26.8	35.0	5.3	0	-19.5	380	**-28.3**
4	Apartments @ Mallory & South Brevard	-22.4	35.0	12.4	-26.2	35.0	5.3	0	-19.0	310	**-27.0**
5	House, 342 St Anne Place	-24.2	45.0	12.4	-27.9	45.0	5.3	0	-20.7	50	**-20.7**
6	Cross Roads Charter School	-19.6	25.0	20	-210.8	25.0	0.0	0	-19.6	100	**-22.6**
7	Harbor Baptist Church	-21.0	35.0	20	-211.7	35.0	0.0	0	-21.0	340	**-29.4**
8	Mobile Homes @ N Tryon Street & Old Concord Street	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	230	**-26.2**
11	Residence Inn @ North Tryon Road & Ken Hoffman Dr	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	112	**-23.1**
12	Carolinas Medical Center University	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	245	**-26.5**
13	UNC Charlotte Duke Hall	-21.0	35.0	20	-211.7	35.0	0.0	0	-21.0	415	**-30.2**
14	Residence, UNC Charlotte Laurel Hall	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	218	**-26.0**
15	Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	54.3	40.0	6.2	50.6	40.0	2.7	81	57.8	105	**54.6**
LT1	House, 405 19th Street	-23.7	40.0	12.4	-27.4	40.0	5.3	0	-20.2	150	**-25.0**
LT2	3440 North Davidson Street(1st floor commercial, 2nd floor residential)	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	230	**-26.2**
LT3	House, 4031 Bearwood Avenue	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	145	**-24.2**
LT4	Holiday Motel 600 N Tryon Street @ Orr Street	-23.7	40.0	12.4	-27.4	40.0	5.3	0	-20.2	82	**-22.3**
LT5	Summit Green Apartments, N Tryon Street @ Barton Creek Drive	-23.7	40.0	12.4	-27.4	40.0	5.3	0	-20.2	137	**-24.6**
ST1	Hunt Club Apartments, N Tryon Street @ Heritage Ponte Road	-23.7	40.0	12.4	-27.4	40.0	5.3	0	-20.2	319	**-28.2**
ST2	Intown Suites, 110 Rocky River Road	57.3	40.0	12.4	53.6	40.0	5.3	81	60.8	220	**54.4**

Horn Noise Prediction

		Daytime			Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Horn (Ldn) or L(eq)
ST3	GDR Holiness Church, 2604 North Brevard Street	-21.0	35.0	20	-211.7	35.0	0.0	0	-21.0	101	**-24.1**
ST4	United Presbyterian Church, 406 N College Street	60.6	30.0	20	-132.4	30.0	0.0	81	60.6	320	**52.6**
ST3A	House, 2672 N Brevard Street	-23.1	35	12.4	-26.8	35	5.3	0	-19.6	140	**-24.1**
3A	House, 410 East 21st Street	-23.1	35	12.4	-26.8	35	5.3	0	-19.6	225	**-26.1**
5A	CMC Northpark Medical Facility, 251 Eastway Drive	-22.1	45	20	-212.4	45	0.0	0	-22.1	80	**-24.2**
6A	Medical Dialysis Office, 4234 N Tryon Street	58.9	45	20	-134.1	45	0.0	81	58.9	180	**53.3**
6B	House, 5234 N Tryon Street	56.8	45	12.4	53.1	45	5.3	81	60.3	70	**58.8**
LT4B	Relax Inn, North Tryon Street	-26.1	35	6.2	-29.8	35	2.7	0	54.9	170	**49.6**
13A	UNC Charlotte, Bioinformatics Building	-21.0	35.0	20	-211.7	35.0	0.0	0	-21.0	165	**-27.3**
13B	UNC Charlotte, Future Portal Building	-21.0	35.0	20	-211.7	35.0	0.0	0	-21.0	220	**-27.5**
15A	Kirk Farm Fields	61.4	25.0	20	-131.6	25.0	0.0	81	61.4	150	**56.6**
15B	Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	54.3	40.0	6.2	50.6	40.0	2.7	81	57.8	240	**51.0**
15C	Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	54.3	40.0	6.2	50.6	40.0	2.7	81	57.8	300	**50.0**
15D	Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	54.3	40.0	6.2	50.6	40.0	2.7	81	57.8	125	**53.8**
15E	Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	-26.7	40.0	6.2	-30.4	40.0	2.7	0	-23.2	310	**-31.1**
15F	Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	-26.7	40.0	6.2	-30.4	40.0	2.7	0	-23.2	190	**-29.0**
15G	Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	-26.7	40.0	6.2	-30.4	40.0	2.7	0	-23.2	320	**-31.3**
15H	Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	54.3	40.0	6.2	50.6	40.0	2.7	81	57.8	100	**54.8**

Horn Noise Prediction

		Daytime			Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Horn (Ldn) or L(eq)
8A	Mobile Homes @ N Tryon Street & Old Concord Street	-23.1	35.0	12.4	-26.8	35.0	5.3	0	-19.6	300	**-27.4**
SCDO											
6s	Cross Roads Charter School	-19.6	25.0	20	-210.8	25.0	0.0	0	-19.6	95	**-22.4**
7s	Harbor Baptist Church	60.0	35.0	20	-133.1	35.0	0.0	81	60.0	340	**51.6**
8s	Mobile Homes @ N Tryon Street & Old Concord Street	54.9	35.0	6.2	51.2	35.0	2.7	81	58.4	195	**52.5**
9s	Mobile Homes @ N Tryon Street & Bennett Street	-21.7	25.0	12.4	-25.3	25.0	5.3	0	-18.2	250	**-25.1**
LT3s	House, 3910 Bearwood Avenue	57.9	35.0	12.4	54.2	35.0	5.3	81	61.4	164	**56.2**
8As	Mobile Homes @ N Tryon Street & Old Concord Street	54.9	35.0	6.2	51.2	35.0	2.7	81	58.4	300	**50.6**
8Bs	Mobile Homes @ N Tryon Street & Old Concord Street	54.9	35.0	6.2	51.2	35.0	2.7	81	58.4	400	**49.3**
6Cs	Greater Love Baptist Church	-19.6	25.0	20	-210.8	25.0	0.0	0	-19.6	230	**-26.2**
6Ds	Sacrifice of Praise Ministry	-19.6	25.0	20	-210.8	25.0	0.0	0	-19.6	150	**-24.4**
6Es	Resurrection Church	-19.6	25.0	20	-211.7	35.0	0.0	0	-19.6	260	**-26.7**

Rail Car Noise Prediction

		Daytime				Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	# cars	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Car L(dn) or L(eq)
LPA												
1	Alpha Mills Apartments, 220 Alpha Mill Lane	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	103	**57.6**
2	House, 234 Parkwood Avenue	54.3	25.0	12.4	2	50.7	25.0	5.3	82	57.8	350	**49.4**
3	House, 423 East 22nd Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	380	**51.9**
4	Apartments @ Mallory & South Brevard	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	310	**52.8**
5	House, 342 St Anne Place	59.4	45.0	12.4	2	55.8	45.0	5.3	82	62.9	50	**62.9**
6	Cross Roads Charter School	56.4	25.0	20	2	-136.6	25.0	0.0	82	56.4	100	**53.4**
7	Harbor Baptist Church	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	340	**51.0**
8	Mobile Homes @ N Tryon Street & Old Concord Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	230	**58.1**
11	Residence Inn @ North Tryon Road & Ken Hoffman Dr	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	112	**57.2**
12	Carolinas Medical Center University	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	245	**53.8**
13	UNC Charlotte Duke Hall	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	415	**50.1**
14	Residence, UNC Charlotte Laurel Hall	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	218	**54.4**
15	Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	105	**58.7**
LT1	House, 405 19th Street	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	150	**57.1**
LT2	3440 North Davidson Street(1st floor commercial, 2nd floor residential)	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	230	**54.1**
LT3	House, 4031 Bearwood Avenue	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	145	**56.1**
LT4	Holiday Motel 600 N Tryon Street @ Orr Street	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	82	**59.8**

Rail Car Noise Prediction

		Daytime				Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	# cars	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Car L(dn) or L(eq)
LT5	Summit Green Apartments, N Tryon Street @ Barton Creek Drive	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	137	**57.5**
ST1	Hunt Club Apartments, N Tryon Street @ Heritage Ponte Road	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	319	**53.9**
ST2	Intown Suites, 110 Rocky River Road	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	220	**55.5**
ST3	GDR Holiness Church, 2604 North Brevard Street	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	101	**56.3**
ST4	United Presbyterian Church, 406 N College Street	58.0	30.0	20	2	-135.0	30.0	0.0	82	58.0	320	**49.9**
ST3A	House, 2672 N Brevard Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	140	**56.3**
3A	House, 410 East 21st Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	225	**49.2**
5A	CMC Northpark Medical Facility, 251 Eastway Drive	61.5	45.0	20	2	-131.5	45.0	0.0	82	61.5	80	**59.5**
6A	Medical Dialysis Office, 4234 N Tryon Street	61.5	45.0	20	2	-131.5	45.0	0.0	82	61.5	180	**55.9**
6B	House, 5234 N Tryon Street	59.4	45.0	12.4	2	55.8	45.0	5.3	82	62.9	70	**61.5**
LT4B	Relax Inn, North Tryon Street	57.2	35.0	12.4	2	50.6	35.0	2.7	82	58.8	170	**53.5**
13A	UNC Charlotte, Bioinformatics Building	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	165	**53.1**
13B	UNC Charlotte, Future Portal Building	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	220	**52.9**
15A	Kirk Farm Fields	56.4	25.0	20	2	-136.6	25.0	0.0	82	56.4	150	**51.6**
15B	Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	240	**55.1**
15C	Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	300	**54.1**

Rail Car Noise Prediction

		Daytime				Nighttime						
Site	Site Description	Leq (day)	Train Speed	Total Volume	# cars	Leq (Night)	Train Speed	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Car L(dn) or L(eq)
15D	Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	125	**57.9**
15E	Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	310	**54.0**
15F	Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	190	**56.1**
15G	Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	320	**53.8**
15H	Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	58.4	40.0	12.4	2	54.7	40.0	5.3	82	61.9	100	**58.9**
8A	Mobile Homes @ N Tryon Street & Old Concord Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	300	**53.0**
SCDO												
6s	Cross Roads Charter School	56.4	25.0	20	2	-136.6	25.0	0.0	82	56.4	95	**53.6**
7s	Harbor Baptist Church	59.3	35.0	20	2	-133.7	35.0	0.0	82	59.3	340	**51.0**
8s	Mobile Homes @ N Tryon Street & Old Concord Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	195	**54.8**
9s	Mobile Homes @ N Tryon Street & Bennett Street	54.3	25.0	12.4	2	50.7	25.0	5.3	82	57.8	250	**50.8**
LT3s	House, 3910 Bearwood Avenue	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	164	**55.6**
8As	Mobile Homes @ N Tryon Street & Old Concord Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	300	**53.0**
8Bs	Mobile Homes @ N Tryon Street & Old Concord Street	57.2	35.0	12.4	2	53.6	35.0	5.3	82	60.7	400	**51.7**
6Cs	Greater Love Baptist Church	56.4	25.0	20	2	-136.6	25.0	0.0	82	56.4	230	**53.8**
6Ds	Sacrifice of Praise Ministry	56.4	25.0	20	2	-136.6	25.0	0.0	82	56.4	150	**51.6**
6Es	Resurrection Church	56.4	25.0	20	2	-133.7	35.0	0.0	82	56.4	260	**49.2**

Substation Noise Prediction

Site	Site Description	Leq (day)	Leq (Night)	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	SUB L(dn) or L(eq)
LPA							
ST2	Intown Suites, 110 Rocky River Road	63.4	63.4	99	69.8	220	**56.9**
SCDO							
6B	House, 5234 N Tryon Street	63.4	63.4	99	69.8	85	**65.2**

Crossing Signal Noise Prediction

		Daytime			Nighttime					
Site	Site Description	Leq (day)	Total Volume	Duration (sec)	Leq (Night)	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Xing L(dn) or L(eq)
LPA										
1	Alpha Mills Apartments, 220 Alpha Mill Lane	63.5	12.4	30	59.9	5.3	109	67.0	230	**53.8**
2	House, 234 Parkwood Avenue	63.5	12.4	30	59.9	5.3	109	67.0	538	**46.4**
3	House, 423 East 22nd Street	63.5	12.4	30	59.9	5.3	109	67.0	2352	**0.0**
4	Apartments @ Mallory & South Brevard	63.5	12.4	30	59.9	5.3	109	67.0	2000	**0.0**
5	House, 342 St Anne Place	63.5	12.4	30	59.9	5.3	109	67.0	2000	**0.0**
6	Cross Roads Charter School	65.6	20	30	-127.4	0.0	109	65.6	586	**44.2**
7	Harbor Baptist Church	65.6	20	30	-127.4	0.0	109	65.6	580	**44.3**
8	Mobile Homes @ N Tryon Street & Old Concord Street	63.5	12.4	30	59.9	5.3	109	67.0	1639	**0.0**
11	Residence Inn @ North Tryon Road & Ken Hoffman Dr	63.5	12.4	30	59.9	5.3	109	67.0	1294	**38.8**
12	Carolinas Medical Center University	63.5	12.4	30	59.9	5.3	109	67.0	1183	**39.6**
13	UNC Charlotte Duke Hall	65.6	20	30	-127.4	0.0	109	65.6	1335	**37.1**
14	Residence, UNC Charlotte Laurel Hall	63.5	12.4	30	59.9	5.3	109	67.0	2000	**0.0**
15	Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	63.5	12.4	30	59.9	5.3	109	67.0	300	**51.5**
LT1	House, 405 19th Street	63.5	12.4	30	59.9	5.3	109	67.0	934	**41.6**
LT2	3440 North Davidson Street(1st floor commercial, 2nd floor residential)	63.5	12.4	30	59.9	5.3	109	67.0	1287	**0.0**
LT3	House, 4031 Bearwood Avenue	63.5	12.4	30	59.9	5.3	109	67.0	650	**44.8**
LT4	Holiday Motel 600 N Tryon Street @ Orr Street	63.5	12.4	30	59.9	5.3	109	67.0	940	**41.6**
LT5	Summit Green Apartments, N Tryon Street @ Barton Creek Drive	63.5	12.4	30	59.9	5.3	109	67.0	1643	**0.0**
ST1	Hunt Club Apartments, N Tryon Street @ Heritage Ponte Road	63.5	12.4	30	59.9	5.3	109	67.0	2400	**0.0**

Crossing Signal Noise Prediction

		Daytime			Nighttime					
Site	Site Description	Leq (day)	Total Volume	Duration (sec)	Leq (Night)	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Xing L(dn) or L(eq)
ST2	Intown Suites, 110 Rocky River Road	63.5	12.4	30	59.9	5.3	109	67.0	625	**45.1**
ST3	GDR Holiness Church, 2604 North Brevard Street	65.6	20	30	-127.4	0.0	109	65.6	2000	**0.0**
ST4	United Presbyterian Church, 406 N College Street	65.6	20	30	-127.4	0.0	109	65.6	320	**49.5**
ST3A	House, 2672 N Brevard Street	63.5	12.4	30	59.9	5.3	109	67.0	2000	**0.0**
3A	House, 410 East 21st Street	63.5	12.4	30	59.9	5.3	109	67.0	1800	**0.0**
5A	CMC Northpark Medical Facility, 251 Eastway Drive	65.6	20	30	-127.4	0.0	109	65.6	2000	**0.0**
6A	Medical Dialysis Office, 4234 N Tryon Street	65.6	20	30	-127.4	0.0	109	65.6	625	**43.7**
6B	House, 5234 N Tryon Street	63.5	12.4	30	59.9	5.3	109	67.0	409	**48.8**
LT4B	Relax Inn, North Tryon Street	63.5	12.4	30	56.9	2.7	109	65.1	455	**45.9**
13A	UNC Charlotte, Bioinformatics Building	65.6	20	30	-127.4	0.0	109	65.6	1200	**38.0**
13B	UNC Charlotte, Future Portal Building	65.6	20	30	-127.4	0.0	109	65.6	1200	**38.0**
15A	Kirk Farm Fields	65.6	20	30	-127.4	0.0	109	65.6	225	**52.6**
15B	Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	63.5	12.4	30	59.9	5.3	109	67.0	240	**53.4**
15C	Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	63.5	12.4	30	59.9	5.3	109	67.0	390	**49.2**
15D	Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	63.5	12.4	30	59.9	5.3	109	67.0	500	**47.0**
15E	Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	63.5	12.4	30	59.9	5.3	109	67.0	530	**46.5**
15F	Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	63.5	12.4	30	59.9	5.3	109	67.0	650	**44.8**
15G	Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	63.5	12.4	30	59.9	5.3	109	67.0	750	**43.5**

Crossing Signal Noise Prediction

		Daytime			Nighttime					
Site	Site Description	Leq (day)	Total Volume	Duration (sec)	Leq (Night)	Total Volume	SEL (ref)	L(dn)or L(eq) @ 50 feet	Distance To Track CL	Xing L(dn) or L(eq)
15H	Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	63.7	12.4	31	60.0	5.3	109	67.2	100	**61.2**
8A	Mobile Homes @ N Tryon Street & Old Concord Street	63.5	12.4	30	59.9	5.3	109	67.0	1639	**0.0**
SCDO										
6s	Cross Roads Charter School	65.6	20	30	-127.4	0.0	109	65.6	586	**44.2**
7s	Harbor Baptist Church	65.6	20	30	-127.4	0.0	109	65.6	580	**44.3**
8s	Mobile Homes @ N Tryon Street & Old Concord Street	63.5	12.4	30	59.9	5.3	109	67.0	195	**55.2**
9s	Mobile Homes @ N Tryon Street & Bennett Street	63.5	12.4	30	59.9	5.3	109	67.0	1200	**39.4**
LT3s	House, 3910 Bearwood Avenue	63.5	12.4	30	59.9	5.3	109	67.0	650	**44.8**
8As	Mobile Homes @ N Tryon Street & Old Concord Street	63.5	12.4	30	59.9	5.3	109	67.0	300	**51.5**
8Bs	Mobile Homes @ N Tryon Street & Old Concord Street	63.5	12.4	30	59.9	5.3	109	67.0	400	**49.0**
6Cs	Greater Love Baptist Church	65.6	20	30	-127.4	0.0	109	65.6	1700	
6Ds	Sacrifice of Praise Ministry	65.6	20	30	-127.4	0.0	109	65.6	1347	**37.0**
6Es	Resurrection Church	65.6	20	30	-127.4	0.0	109	65.6	633	**43.6**

Notes:

**Some noise results may have been adjusted based on individual terrain, grade and surface characteristics*

***Where applicable, hard ground (G=0) conservatively assumed for calculations*

LYNX Blue Line Extension

Figure 13

Pines Mobile Home Park (5635 North Tryon Street/US-29) - Light Rail Alternative SCDO : Noise Impacts

MODERATE

N Tryon St

Old Concord Rd

Old Concord Road Station
(Sugar Creek Design Option)

Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Moderate Noise Impact
- Severe Noise Impact

Map Vicinity

N

75 37.5 0 75

Feet

1 inch = 150 feet

Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

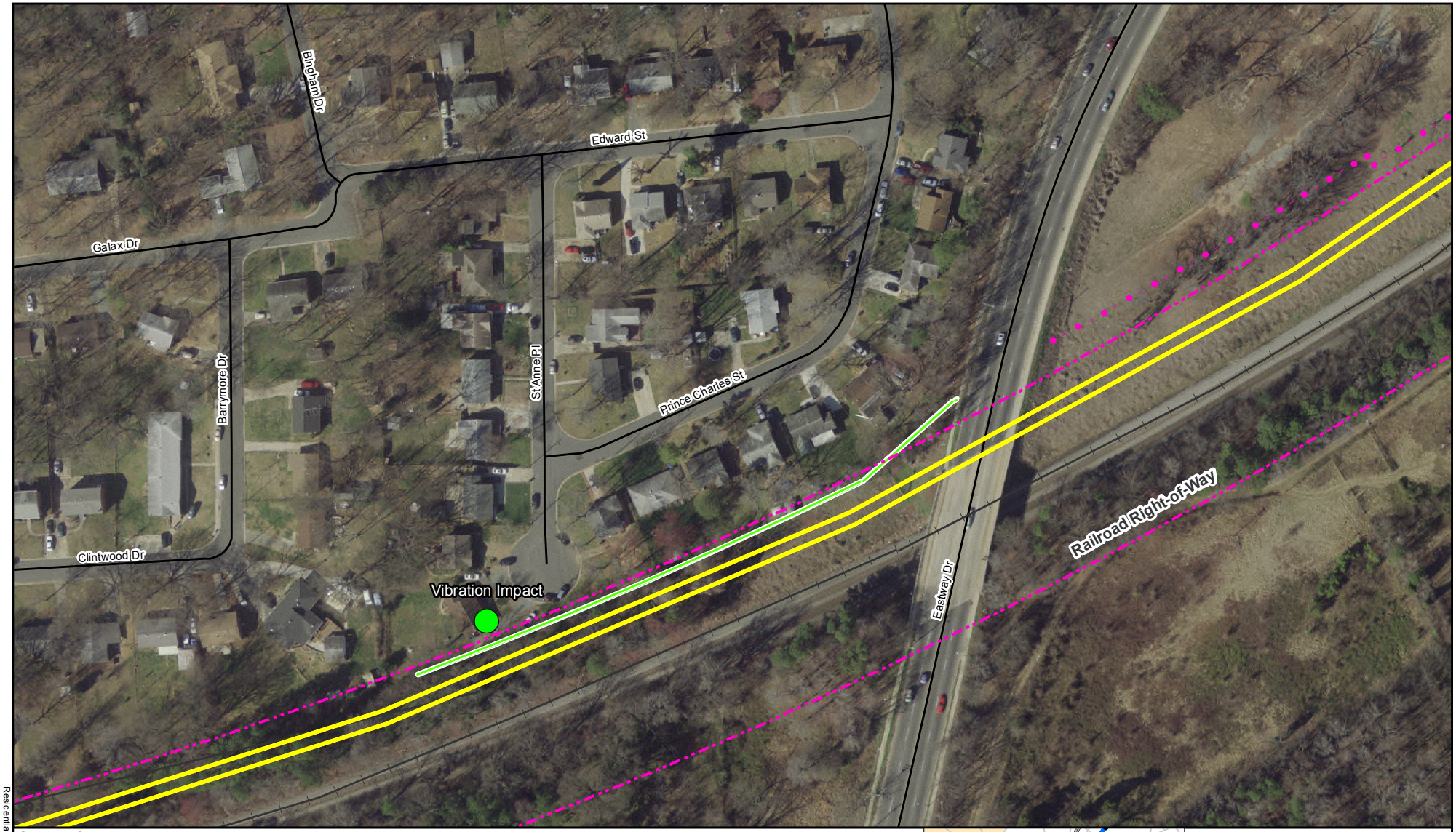
Pines_MHP_N&V_SCDO_Map13.REV.00.pdf

10.21.09

LYNX Blue Line Extension

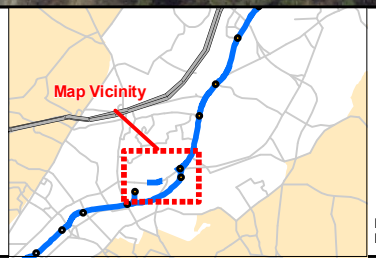
Figure 14

Residential Home (342 St. Anne Place) - Light Rail Alternative : Vibration Impact



Legend

- Proposed Light Rail Alternative
- Design Option
- Proposed Station Platform
- Proposed Retaining Walls
- Proposed ROW
- Railroads
- Proposed Substation
- Proposed Signal Houses
- Roads
- Streams
- Proposed Park-and-Ride Facilities
- Proposed Structures
- Vibration Impact



N

75 37.5 0 75

Feet

1 inch equals 150 feet

Data Source: Charlotte Area Transit System, STV/RWA, Mecklenburg County GIS Aerial (2007)

Residential_Home_Vibration_LPA_Map15.REV.00.pdf

04.13.09