ATTACHMENT 18

COPY OF THE NOISE TRAFFIC IMPACT STUDY PERFORMED FOR SECTION V (AC-100076)

PUERTO RICO
HIGHWAYS &
TRANSPORTATION
AUTHORITY

May 26, 2023

Puerto Rico Department of Housing
PO Box 21365
San Juan, PR 00928-1365

RE: Certification of the Validity of the Noise Level Calculations
Sections II, III, IV and V
PR-10
Adjuntas to Utuado, Puerto Rico

Dear Sirs:

This letter is intended to certify the validity of the noise level calculations performed during the environmental planning stage of the above referenced project. After reviewing the traffic noise impact report prepared for the project (Section V), it shall be noted that:

1- The noise level calculations were performed for the closest receiver to the proposed PR-10.
2- The information about the spatial locations between the nearest receivers and the proposed roadway was obtained from the project constriction drawings.
3- Existing noise levels were measured at the nearest locations.
4- No change in the land use pattern of the proposed project corridor has occurred based on a review of the aerial photographs for the area.
5- Predicted noise calculations were performed using the Traffic Noise Model (TNM) version 2.5 developed by the Federal Highway Administration (FHWA) for this purpose. This is the model required to be used by the agency for noise impacts planning purposes.
6- The predicted noise level (Leq = 58.6 dBA) at the nearest receiver was calculated for a horizon of 20 years, which is 2032. This receiver is located within Section V of the proposed roadway.
7- The predicted noise level is well below the 67 dBA established by the FHWA in its Noise Abatement Criteria (NAC) for a residential land use. Therefore, consideration of noise abatement measures is not required for the project.
8- Since the assessment considered the condition of the closest noise receiver in Section V, and the closest receivers identified within Sections II, III and IV are located at greater distances from the proposed roadway, it is reasonable to conclude that predicted noise levels shall be lower.

Based on the previous observations, it is my opinion that the validity of the conclusions of the report remain valid.

If there is a need to provide additional information, please contact the undersigned.

Cordially,

Luis E. Rodríguez Rosa
Sub - Director
Programming and Special Studies Area
(787) 721-8787, Ext. 51503

TRAFFIC NOISE IMPACTS ANALYSIS
CONSTRUCTION OF SECTION V OF PR-10
AC-100076

ADJUNTAS, PUERTO RICO

Prepared for:

Puerto Rico Highway and Transportation Authority
San Juan, Puerto Rico

Prepared by:

Moreno Associates
Environmental and Engineering Consultants

SEPTEMBER 2012

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1.0 INTRODUCTION

This report is intended to provide a summary of the results of the analysis of the traffic noise impacts that can be predicted to affect communities located along the corridor of the proposed construction of Section V of PR-10 (between civil stations 91+51.73 and 109+80.00), in the northwest side of the municipality of Adjuntas. This project will joint project AC-100065 which is presently under construction. **Figure 1** illustrates the project location in a topographic quadrangle published by the **U.S. Geological Survey (USGS)**. This project is being planned by the **Puerto Rico Highway and Transportation Authority** (**PRHTA**), local agency whose responsibility is to plan, construct and maintain the terrestrial network of highways and roads of Puerto Rico. The project constitutes one of the final sections of the relocation of state road **PR-10** who's **Final Environmental Impact Statement (FEIS)** was approved and adopted by the **Federal Highway Administration (FHWA)** on March 31, 1979. The analysis is focused in the assessment of the existing noise environment and the impacts that will result from the construction and operation of the new section of highway with an estimated total length of 1,823.23 meters. The project considers the construction of a two (2) lane roadway, of 3.65 meters width each and paved lateral shoulders of 3.0 meters. The roadway will traverse through vacant spaces with the presence of scattered residential uses. The area shoes an intricate topography that has resulted in a severe constraint for its development. Therefore, the report is intended to provide the reader with an understanding of the methods that are commonly used to collect data on the existing noise levels at different locations within the corridor of the proposed highway project, prediction of future noise levels generated by the operation of the improved highway, the assessment of the impacts that such operation will cause in the affected communities and the development of mitigation measures, if required. The analysis of noise impacts resulting from a transportation project like the one subject of this report is guided by the criteria contained in the **Puerto Rico Department of Transportation and Public Works** (**DTPW**) and the **Puerto Rico Highway and Transportation Authority** (**PRHTA**) **Policy in the Development and Operation of Transportation Projects**. This policy was submitted and approved by the **Federal Highway Administration** (**FHWA**). Said policy establishes that:

> "It is the policy of the **PRDTPW** to design and build highway projects taking into full consideration the potential noise impacts of each alternative, to conduct sufficient studies and analysis to determine these impacts and to provide for reasonable and feasible abatement measures."

The mentioned policy was intended to comply with the requirements set forth in **Title 23**, **Part 772** of the **U.S. Code of Federal Regulations** and the noise related requirements of the **National Environmental Policy Act** (**NEPA**). It is also important to know that the **Puerto Rico Environmental Quality Board** (**EQB**) has adopted the Noise Abatement Criteria (NAC) established by the FHWA in their revised **Regulation for the Control of Noise Pollution** (adopted on May 5, 2011). A said criterion was incorporated in Rule 31 of the mentioned regulation. In addition to the mentioned noise criteria, the EQB has developed specific ruling pertaining to the use and proper maintenance of noise reduction equipment installed on vehicles, the operation of heavy trucks on parking areas close to residential zones and the noise caused by construction activities. It has been the policy of this agency to rely on the knowledge and expertise that federal agencies have developed for this specific type of projects. Noise generated by highway traffic can reach levels which have undesirable effects on nearby activities such as residential areas, schools, churches and hospitals. Federal regulations require conformance with noise standards which include:

- Noise abatement criteria
- Noise prediction
- Informing local officials

This document deals with the first two (2) elements.

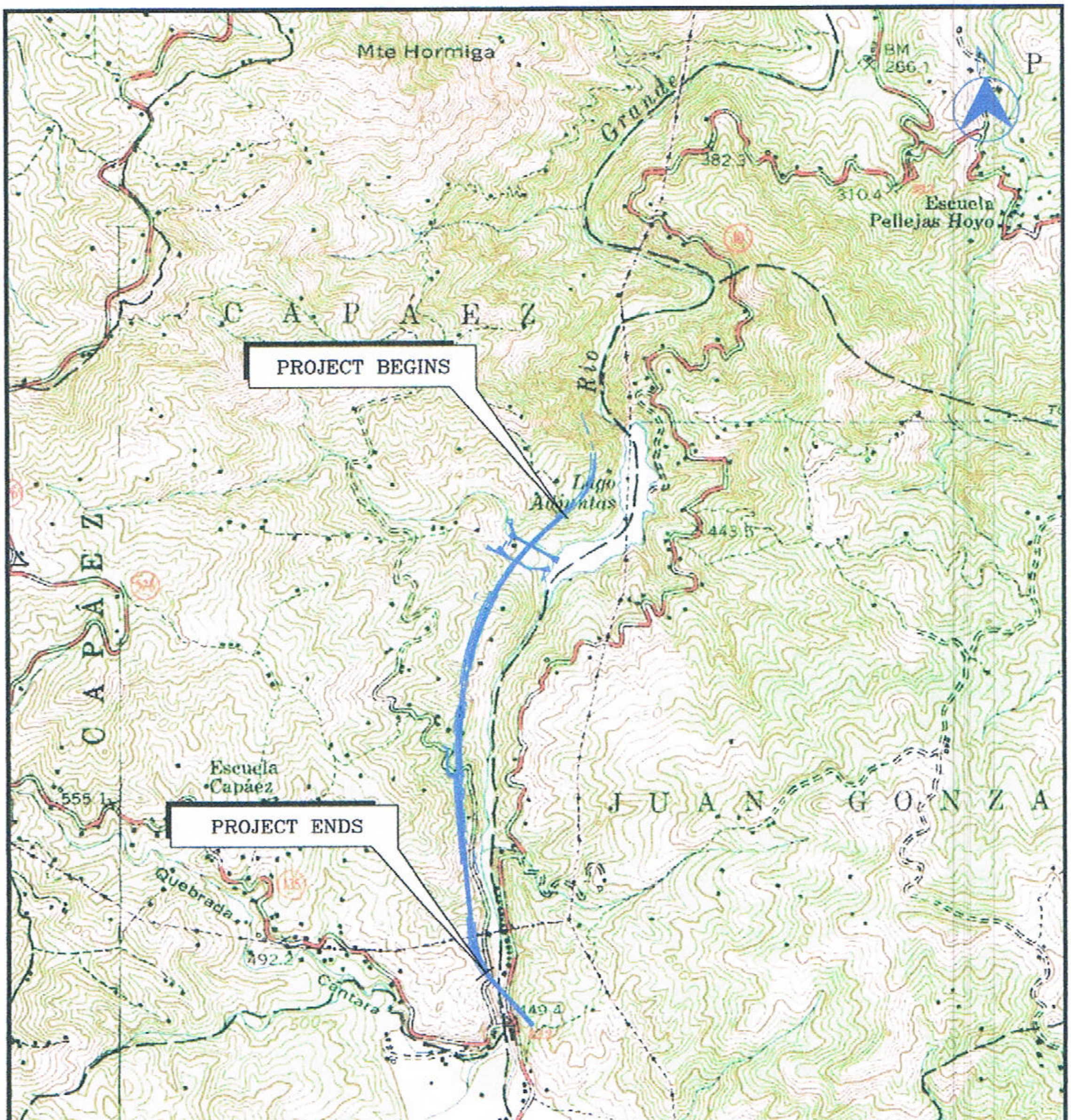


Figure 1: Project Location Map

2.0 PROJECT DESCRIPTION

The project being planned by the **PRHTA** consists of construction of a new highway with an approximate length of 1.822 kilometers (equivalent to 1.14 miles). The purpose of the project is to complete the construction of the relocation of PR-10, which constitutes the main terrestrial interconnection between the north and south parts of the Island that exist in this part of the Island. The total length of the project is 58 kilometers of which approximately 51 have been already constructed. The old PR-10 was a two (2) lane road whose construction started early in the 20 century and exhibited severely geometric and safety issues that prompted the need to built a safer and more efficient roadway. The planning efforts for the construction of the new roadway stared in the 1960's and the FEIS completed in 1979. Since that date the construction of the highway has been taken place at a slow pace resulting from the high costs and rugged conditions. However, most of it has been already built and there is a small portion comprised between the municipalities of Adjuntas and Utuado that still remain to be constructed. Section V (AC-100076) is one of the remaining segments whose construction is being planned for this FY. Once constructed and functional, the new highway will provide its users with a safer and efficient terrestrial access. The typical proposed roadway cross section is of 7.30 meters. Variable median and lateral paved shoulders of 3.0 meters are also considered for this project.

A typical cross section of the proposed project is illustrated in F**igure 2**.

In order to establish future highway operating conditions, the **FEIS** noise section was revised as a source of information. This document provides details of the methodology followed to generate the traffic noise levels that were used to define noise impacts. This information was developed with the techniques and policies available at that time and therefore, they don't reflect the change policies that have been approved afterward. However, there are some general assumptions that are still valid and that will be used as part of this updated analysis. A review of the environmental setting along the corridor of the proposed project was also conducted to note any changes in the land use pattern that may have resulted from the elapsed time. This review disclosed the fact that land uses for the area remain basically the same as a result of the severe constraints for development that exhibit the zone, in particular the rugged topography. To that end, it may be indicated that the proposed project corridor is almost vacant except for three (3) small areas where some scattered residential uses may be observed. The original EIS document stated that for the purposes of the analysis, it was assumed that approximately 80% of the vehicular traffic along **PR-10** would be diverted to the new roadway and the remaining 20% will continue the use of old **PR-10** (which was renumbered as **PR-123** to differentiate it from the new **PR-10**). This means that as new segments of the highway are built they will be numbered as PR-10 while the old route will remain in use but renamed as **PR-123**. Therefore, it is understood that old PR-10 will continue to operate for local traffic. It is our understanding that this assumption is a reasonable one.

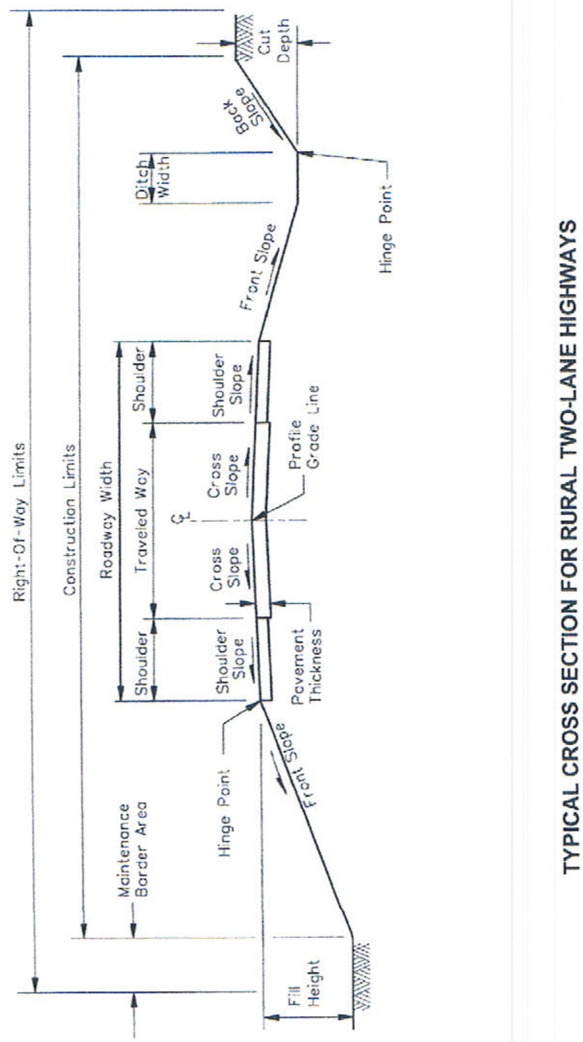


Figure 2

Typical Section of the proposed PR-10

(Sections vary depending upon site specific conditions, for illustrative purposes only)

In order to develop adequate vehicular traffic volumes for the analysis, the data Collection Division of the PRHTA was visited. Since the proposed project will substitute part of the existing PR-123 between the municipalities of Adjuntas and Utuado, data from this specific section was obtained. The obtained records show that at kilometer 38 of PR-123 the Average Annual Daily Traffic (AADT) for year 2006 was 4,817 vehicles. The next step to consider was to establish an adequate growth rate for this vehicular traffic volume. Since this information was not available for this location it was obtained from another station located to the north of the previous one but within the same area. At kilometer 45 of PR-123, for years 2004 and 1999 the AADT was of 3,100 and 2,400 respectively. From this information and using the following equation, the growth rate was obtained for the roadway.

$$I = (F/E)^{1/n} - 1$$

Where:

I = annual traffic growth rate
F= Future AADT (Most recent vehicular traffic volume value)
E = Existing ADDT (Oldest traffic volume value)
n = number of years

Then:

$$I = (3{,}100/2{,}400)^{1/5} - 1$$
$$= (1.29167)^{1/5} - 1$$
$$I = 5.20\ \%$$

Now, to estimate the vehicular traffic volume for year 2032 (which constitutes a 20 year horizon):

$$AADT_{2032} = AADT_{2006}\ (1 + i)^{n}$$
$$= 4{,}817(1 + 0.052)^{26}$$
$$= 4{,}817\ (3.73)$$
$$= 17{,}968 \text{ vehicles}$$

Therefore, for year 2032 the AADT for the proposed roadway will be 14, 374 (which corresponds to an 80 % of the vehicular traffic volume of PR-123). This means that the $AADT_{2032}$ for **PR-123** will be 3,594.

Knowing the AADT for year 2032, the next step is to calculate the vehicles per hour (VPH) to perform the analysis. Historical data allow observing that the peak in traffic volume constitutes about an 8.1% of the AADT. Therefore, the VPH was calculated multiplying the AADT by the 8.1 %. This calculation allowed reaching to 1,164 as the VPH to be used for the analysis. The vehicular traffic composition was assigned as follows (for typical rural roadways like **PR-10**):

Automobiles	= 93% of AADT
Medium Trucks	= 2% of AADT
Heavy Trucks	= 5% of AADT

It is important to note that the percentage of trucks using this roadway is higher than in normal rural areas where the observed value is approximately 5%. The directional split of vehicular flow used for the analysis was 55% in the southbound lane, which results in a more critical condition for the analysis. The velocity used for the analysis was 45 Miles per hour (MPH). This corresponds to the vehicular traffic speed posted in other sections of **PR-10** in operation.

3.0 GENERAL NOISE CONCEPTS

Prior to start to discuss the different elements of the noise study, it is important to briefly explain some concepts and basic theory that will help to better understand the report. Noise is defined as a sound which causes annoyance to the person that perceives it. Sound is generated by some sort of vibration and requires of media for its dispersion. This means that in the space, sound can't be transmitted due to the lack of such media. In our environment, sound is transmitted by the air molecules and the ground until they reach our ears.

In order to measure sound, an instrument known as sound level meter is used. This equipment is provided with a microphone, capable of receiving the vibrations and translating them into meaningful pieces of data. Depending on the purpose of the sound analysis, different scales have been developed. For most common uses, scale "A" is the one used due to the fact that it reassembles the way in which the human ear responds to the noise. It is a logarithmic scale in which the unit of measurement is known as "decibel", whose abbreviation is dB. When scale A is used, measurements are referred to as dB (A). A dB is a unit of measurement of sound level calculated as ten times the base 10 logarithm of the square of the ratio of the mean-square sound pressure and base reference mean-square sound pressure of 20 µ Pa (which is the threshold of the human hearing).

Based on the **Federal Transportation Administration (FTA)** studies, it has been found that an increase in sound level of three (3) dBA or less is barely perceived, while an increase of around five (5) dBA is perceived as a moderate increase. An increase of 10 dBA or more is perceived as a significant increase and is felt as doubling of volume, regardless of the new noise level. Environmental noise varies constantly as a function of the activities that occur nearby a receiver. There will be moments of relatively low noise levels followed by intense levels such as when a truck passes nearby a person. Even when we are inside our houses, there are different sources of noise that we perceive such as other persons conversation, the TV sets, radios, refrigerators, air conditioning units, screaming boys, etc. Numerous studies have been conducted to identify what are considered as typical noise levels. **Table 1** presents a summary of diverse noise sources and their effects developed by the Department of Civil/Environmental Engineering of the University of Temple. As such, they are presented only as approximations of typical noise levels in our environment. This table is offered only as a way to define the typical or normal noise level environment of a specific location. It shall be noted that the best way to be more specific on this levels at a particular location, is by measuring it with a sound level meter.

Table 1: Noise Sources and Their Effects

Noise Source	Decibel Level (dBA)	Noise Effect
Jet take-off (at 25 meters)	150	Eardrum rupture
Jet take-off (at 100 meters)	140	Earphones at high level
Thunderclap, live rock music, chain saw	130	Earphones at high level
Steel mill, riveting, auto horn at 1 meter	120	Human pain threshold
Jet take-off (at 305 meters), outboard motor, power lawn mower, motorcycle, farm tractor, jackhammer, garbage truck	110	Serious hearing damage
Busy urban street, diesel truck, food blender	90	Hearing damage
Garbage disposal, dishwasher, average factory, freight train (at 15 meters)	80	Possible hearing damage
Freeway traffic (at 15 meters), vacuum cleaner	70	Annoying
Conversation in restaurant, office, background music	60	Quiet
Quiet suburb, conversation at home	50	Quiet
Library	40	Quiet
Quiet rural area	30	Very quiet
Whisper, rustling leaves	20	Very quiet
Breathing	10	Very quiet

Due to the mentioned noise fluctuations as a function of time, a noise descriptor was developed to enable the development of simpler ways to analyze data. There are different types of noise descriptors that may be utilized, depending on the analysis requirements. On this case, the **FHWA** uses a noise descriptor identified as L_{eq} or L_{10}. The first one is defined as the level sound which is equivalent to a constant sound level that is verified on a predetermined time frame. It is widely used to define the noise in a community, but it has to be clarified that there other noise descriptors that may also be used to represent the noise level at a particular location. The second noise descriptor used by the **FHWA** is the L_{10}. This descriptor is used to represent the level of noise that is exceeded on a 10 percent of the measurement time. Both noise descriptors are useful but only one can be used at a time.

4.0 METHODOLOGY

The first step in analyzing the noise effect of a particular transportation related project is to identify the location of the land uses that exists along the corridor of the proposed highway project. For the purpose of the policy, the study zone is defined as the area found approximately 500 feet back from the edge of the highway project. The **FHWA** has published data that indicates that traffic noise is not a serious problem for people who live more than 500 feet from a heavily travelled freeways or more than 100 to 200 feet from lightly traveled roads.

Once the locations are identified, the existing noise levels are measured using a calibrated sound level meter. The **PRHTA** policy defines existing noise level as resulting from the natural and mechanical sources and human activity, considered to be usually present in a particular area. The noise levels are expressed in Leq, which is the equivalent steady state sound level, which in a stated period of time, contains the same acoustic energy as a time-varying sound level during the same time period. The recorded levels, serve to characterize the sound environment of the particular area. Noise measurements are to be collected for minimum time of 30 minutes but not more than 1 hour, at each location. This data will be used to quantify the extent of impacts, based upon the extent of increase when compared against the **Noise Abatement Criteria (NAC)**. Those levels are detailed in T**able 2**.

Table 2: Noise Abatement Criteria (NAC)

Activity Category	Activity Criteria[1] $L_{eq}(h)$	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B_2	67	Exterior	Residential
C_2	67	Exterior	Active sports areas, amphitheaters, auditoriums, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E_2	72	Exterior	Hotels, motels, offices, restaurants/bars/ and other developed lands, properties and activities not included in A-D or F
F	--	--	Agricultures, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	Undeveloped lands that are not permitted

Notes:

1. The L_{eq} (h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
2. Includes undeveloped lands permitted for this activity category.

5.0 ASSESSMENT OF IMPACTS

The policy defines that a traffic noise impact is one that occurs when the predicted noise levels approach or exceed the **NAC**, or when the predicted traffic noise levels substantially exceed the existing noise levels. The noise level prediction is performed using a **FHWA** approved model for traffic noise prediction known as **Traffic Noise Model (TNM)**. The model is newer and improved software which substituted the previous one that was known as **Stamina 2.0.** The new model takes advantage of the faster microprocessors and the improved model algorithm is more complex than the previous one, producing more accurate results. This noise prediction model, computes a predicted noise level through a series of adjustments to a reference sound level. On this model, the reference level is Vehicle Noise Emission Level, which refers to the maximum sound emitted by a vehicle pass-by at a reference distance of 15 meters (50 feet). Adjustments are then made to the emission level to account for traffic flow, distance and shielding. These factors are related by the following equation:

$$L_{Aeq1h} = El_i + A_{trff(i)} + A_d + A_s$$

Where EL_i represents the vehicle noise emission level for the i^{th} vehicle type and:

- $A_{trff(i)}$ represents the adjustment for traffic flow, the vehicle volume and the speed of the i^{th} vehicle type
- A_d represents the adjustment for distance between the roadway and the receiver for the length of roadway
- A_s represents the adjustment for all shielding and ground effects between the roadway and the receiver

The **TNM** is based on a three dimensional coordinate system and is designed to run on personal computers.

In general, the performance of the noise analysis involves:

- Using projected traffic on a horizon of 20 years into the future of the proposed highway
- Detailed traffic distribution (i.e.; automobiles, medium trucks, heavy trucks.)
- Information about highway operational conditions (such as operating speed in MPH)
- Directional distribution is assigned
- Highway sloping conditions
- Distance between receivers and the highway lanes.
- Relative difference in elevations between receiver and lane

TNM version 2.5 was the one used for this analysis since it is the most up to date version.

Once the predicted noise levels or a substantial increase in noise level indicates that an impact results, then, appropriate noise abatement mitigation measures have to be considered. As such, any measure criteria will be designed to achieve a substantial noise reduction, not the noise abatement criteria that when implemented, results in a reduction of at least 5 dBA are considered as an effective abatement measure. Among the most commonly considered alternatives are:

- ✓ Highway velocity restriction (imposing velocity limits that results in lowered traffic noise emission levels).
- ✓ Noise barriers
- ✓ Buffer zones
- ✓ Strips of Vegetation (only effective when strip is of about 50 meters wide)

The magnitude of noise impacts can be further described based upon the comparison between the existing and projected noise levels. An increase of 3 dBA or less is barely noticeable, while an increase of 10 dBA or more is considered as significant. Therefore, an impacted receiver is one which has a loudest hour L_{eq} that approaches (within 1.0 dBA), or exceeds the **NAC** for the corresponding land use or exceeds the existing noise levels by 10 dBA or more.

Whenever an impacted receiver is identified, noise abatement measures shall be considered. Among the aspects that have to be considered in this analysis are:

- ✓ **Amount of noise reduction provided by the selected measure**

  Efforts shall be directed toward the goal of achieving a substantial noise reduction. A substantial noise reduction is a reduction of at least 7 dBA for benefited receivers. Benefited receivers include all the residences that receive a reduction of 5 dBA or more, regardless of the fact that they are not impacted.

- ✓ **Cost of abatement**

  Abatement costing $42,244.00 per affected unit or less is deemed to be reasonable for cost.

- ✓ **Number of people protected**

  The method to count residences will include all dwelling units that are benefited by the proposed abatement, regardless of whether or not they were identified as impacted. The threshold which determines a "benefited" residence is 5 dBA.

6.0 EXISTING NOISE LEVELS

Existing noise levels along the proposed project corridor were measured during August 20, 2012, after reviewing aerial photographs, conceptual project drawings and site visits. Noise levels were measured using a Quest Model 2900 sound level meter with data logger (see calibration certificate on **Appendix 1**). Measurements were collected during 30 minutes at each location. Noise surveys were conducted at three (3) different locations that met the location criteria previously described. Photographs of each site location have been included in **Appendix 2.** The equipment calibration was checked prior to the surveying efforts, as recommended by the manufacturer of the sound level meter. The equipment was installed in a tripod at each location, once it was defined.

A description of each of the monitoring locations has been included in **Table 3** while **Table 4** provides a summary of the noise survey results. The location of the noise monitoring stations is included in **Figure 3**.

It is important to note from **Table 4** that all of the surveyed areas, area presently experiencing noise levels below the **FHWA** maximum levels for **Land Use B** Category, which constitutes the critical land use that is potentially affected by the proposed project. Along the proposed highway corridor, residential areas are observed only at three (3) discrete locations. On most of the cases, residences are scattered along the area with no concentrations, except for the ones considered as part of this study. They are specifically:

- Residential area #1 comprises approximately five (5) residences located near the project start, close to the end of project AC-100076 and its continuation with project AC-100065 (presently under construction). Two (2) of them are closer to the proposed project alignment. Recorded noise level at this location (L_{eq} of 50.2 dBA) is typical of those observed in rural or suburban areas.

- Residential area #2 is located farther to the northwest side of the proposed project alignment. A recorded noise level (Leq of 48.9 dBA) is approximately 1.3 dBA lower than the ones recorded at residential area #1. There are three (3) residences ate this location. The closest ones will be acquired since the construction activities will directly affect them as part of the cut and fill operations.

- Residential area #3 is the father one located toward the northwest boundary of the proposed project alignment. The lowest Leq noise levels were recorded at this location (45.8 dBA). This is lower than the previous sites in a range between 3.1 and 4.4 dBA. Therefore, this is the location where the lowest existing noise level among the three areas was recorded.

Table 3: Identification of noise monitoring locations and brief area description

Monitoring station description	Comments
Station #1	This noise monitoring location was located to the west side of station 109+80.00, at an approximate distance of 60 meters from the proposed highway . It is located nearby an existing group of residences identified as area #1. The station was located close to a group of about six (6) residences located at the top of a hill.
Station #2:	This noise monitoring location was established to the west side of the proposed project alignment at an approximate distance of 115 meters from the highway centerline at station 100+20.00. There are about three (3) residences located nearby the location.
Station #3:	This noise monitoring location was established at station 94+00.00. It was placed nearby two (2) residential structures. It was located at about 140 meters measured from the border of the proposed highway.

Table 4: Summary of measured noise levels

Noise monitoring station ID	Measured noise level in dBA (Leq-hr)	FHWA Standard in dBA for Land Use category B (Leq)
1. Residences	50.2	67.0
2. Residences	48.9	67.0
3. Residences	45.8	67.0

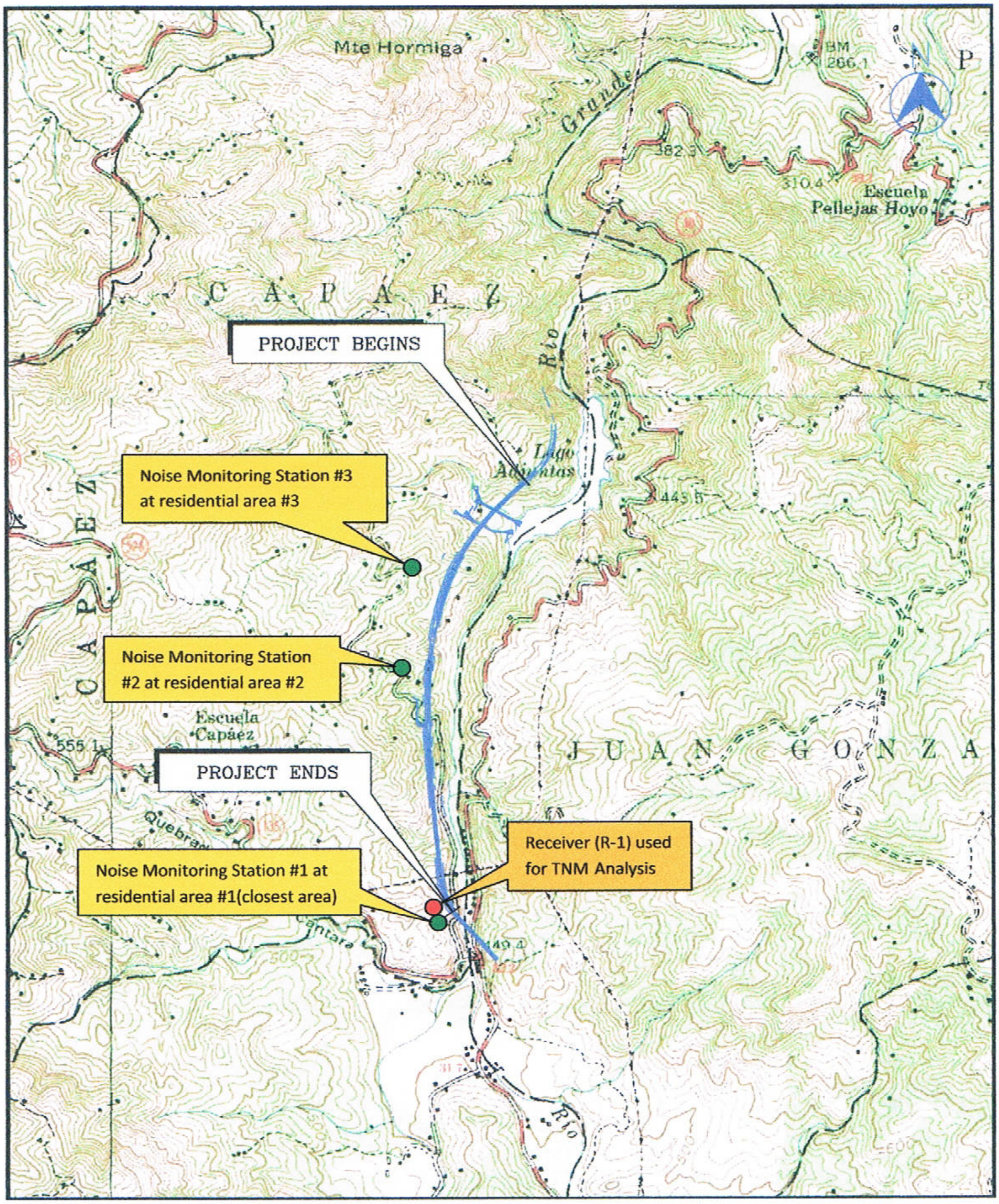


Figure 3: Noise monitoring stations and receivers locations

The results of this survey will be used to help to establish impacts on nearby communities based on its comparison with the predicted noise levels.

7.0 DISCUSSION OF TNM RESULTS

Using the project drawings , the closest residential area to the proposed highway alignment was analyzed using **TNM**. The reason for this lies in the fact that the other two (2) residential areas are located are located farther to the back of the proposed project alignment, resulting unreasonable their affectation by the proposed project operation. If, modeling of the closer receiver indicates that the applicable NAC or a substantial increase in noise levels are predicted, then the remaining two (2) areas would be incorporated in the analysis. However, conclusions of the **FEIS** as well as experience with already operational segments of **PR-10** do not support this possibility. Highway lane coordinates and elevations were obtained from the drawings, as well as the coordinates of the receivers defined for the analysis. The receiver location was also obtained from project drawings where nearby structures (including residences and other uses) are incorporated. As earlier indicated the model is a three (3) dimensional one that requires providing X, Y, Z coordinates for each point of both the roadway and the receivers. Average Daily Traffic for year 2032 (horizon for the noise analysis) volume as well as other model input parameters used for the model was those detailed in section 2.0 of this report.

Once the spatial highway information was obtained from project drawings, it was entered into the **TNM** for calculation. In **Appendix 3** we have included a copy of the project drawings illustrating the location of the receiver chosen to perform the **TNM** runs. The most critical receiver location resulting from its relatively close distance to the proposed project alignment was analyzed. The information obtained as a result of this analysis will also serve to establish appropriate buffer distances from the new road arrangement. The receiver has been identified as **R-1**. A brief description of the receiver characteristics has been summarized in **Table 5**. It is important to indicate that the model performs an input check prior to each run, and warns the user of an input inconsistency. After all issues were solved, then the model run was performed. One feature that results in an improvement over the previous models, is that **TNM** allows to visually checking the coordinates. If some entry was wrong, it was relatively easy to detect and correct. The described procedures were repeated for all the proposed highway alignments. A copy of the program output is included in **Appendix 4** of this report.

The predicted noise levels, impacted receptors, type of impacts and need to mitigate have been summarized in **Table 6**. Said table makes easier to analyze the collected data and to reach to specific recommendations regarding to the need to provide mitigation measures.

Table 5: Receivers used for TNM Modeling Description

Receiver ID	General Description
R-1	This receiver corresponds to a one level residential structure located to the west of the proposed alignment of PR-10. It is located close to the project ending. The area shows has residential characteristics with no commercial uses.

Table 6: Summary of TNM results, impacts and identification of mitigation needs

Receiver ID/# of affected units	Distance to road (mts.)	Existing noise level (in dBA)	Predicted noise level (in dBA) Without barrier	Noise level increase (in dBA)	FHWA Criteria for Land Use- L_{eq} (in dBA)	Type of Impact	Exceeds FHWA NAC	Requires mitigation consideration and/or acquisition of structure
R-1/2	60	50.2	58.6	8.4	67	Moderate	N	N

Notes to table:

1- Impacts assessment was performed by considering that an increase from 1 to 3 dBA is a Low Impact, from 3.1 to 9.9 dBA increases as Moderate, and 10.0 dBA or more is a High Impact.

2- Even though the FHWA criteria for a Type B Land Use as the one being analyzed is established as 67 dBA, from a planning perspective, any predicted noise value of 66 dBA or more is considered as a condition that merits consideration of abatement measures.

8.0 ASSESSMENT OF IMPACTS

8.1 CONSTRUCTION IMPACTS

The highway construction activities will result in the temporary increase in the area noise levels. The increase resulting from these activities will end as soon as the construction of the project is completed. The main source of the noise is constituted by the use of heavy equipment and trucks that are required for earthwork activities. Those equipment use engines that when accelerated result in high emission of noise to their surroundings. The degree or magnitude of the impact will depend on the type and condition of the equipment being used at a particular time, distance to the receptor and type of activity. As an example, earth moving equipment such as backhoes and graders, emit their highest noise levels when performing excavations or earthwork related activities, and not while moving from one site of the project to another. The **FHWA** has measured those levels and published information about the typical values. Table 7 summarizes those values, measured at a distance of 15 meters (50 feet).

These impacts, although unavoidable, can be minimized or mitigated by means of the following practices.

- Limit the use of these equipments to day time schedules as required by the **EQB Regulation for the Control of Noise Contamination**. Night time noise levels are 10 dBA lower than comparable day time levels, therefore it is more difficult to comply with and besides that the practice is protective of neighborhood that needs to rest.
- Request the contractor to always maintain in good condition the noise reduction devices of their equipments. A faulty noise attenuator can be very annoying to local residents, even though the equipment might be used during day time.
- Request the contractor to maintain in good working condition the moving parts of the dozers and in general any equipment that is mounted on tracks. This practice will also help to minimize excessive noise.
- Locate project staging areas and project entry/exit far from residential zones

As earlier mentioned, these impacts will cease to occur once the earthwork activities and major project earth disturbing phases are completed. After construction is finished, noise impacts associated with this phase of the project will also cease. The new noise impacts will be associated with the operation of the highway and caused by the vehicular traffic flow along the highway. Those impacts are discussed in the following section.

Table 7: Typical Noise Levels Generated by Construction Equipment

Type of Equipment	Range of Noise Level (dBA at a distance of 50 feet)
Earthmoving Equipment	
Front loaders	72 - 84
Backhoes	72 - 93
Tractors, Dozers	67 - 96
Scrapers, Graders	80 93
Pavers	86 - 88
Trucks	82 - 94
Material Handling Equipment	
Concrete mixers	75 - 88
Concrete pumps	81 - 83
Cranes (movable)	75 - 86
Forklift	76 - 82
Stationary Equipment	
Pumps	69 -71
Generators	71 - 82
Compressors	74 - 82

8.2 HIGHWAY OPERATION IMPACTS

A careful review of the predicted noise levels that were summarized in **Table 6**, allow reaching the following conclusions:

- The traffic noise to be generated by the new highway will result in higher noise levels for those areas that are closely located near the proposed highway. Based on the analysis, the closest residential receptor located in residential area 31 will perceive an increase in L_{eq} noise levels estimated in 8.4 dBA. The predicted L_{eq} noise level for this receptor (R-1) is of 58.6 dBA. This level is well below the **NAC** applicable to a residential land use category B, and does not approach the 66 dBA established in the Noise Policy that triggers consideration of noise abatement measures. In general, **TNM** results support the fact that receivers that are located at distances of 60 meters of the highway borders will not experience noise levels that will result in an exceedance of the **NAC**.

- A moderate noise impact assessment can be made for receiver **R-1**. This noise results from a combination of a relatively wide separation between the emission source (the proposed highway) and the receiver (residential area). Also, the relatively low vehicular traffic volume consistent with a rural area, and the operating velocity of the highway help to project a moderately increase in noise levels for the areas.

- Notwithstanding the above mentioned findings, also it has to be noted that land uses within the project corridor are scattered and the area is not densely populated. Therefore, any impact will be limited to discrete areas where residential or other sensitive land uses are observed. This observation can be noted both from project drawings and aerial photographs.

- The project area shows extensive open areas whose development for residential uses has been precluded by their abrupt topography.

9.0 CONCLUSION AND/OR RECOMMENDATIONS

The use of **TNM** to analyze noise impacts on residential areas located nearby the proposed construction of Section V of **PR-10** (**AC-100076**) in Adjuntas, Puerto Rico have resulted in the prediction of moderate noise levels along nearby areas when the project is in operation in a horizon of 20 years. However, the predicted L_{eq} noise levels are below the applicable **NAC** and do not meet the substantial increase criteria that merits consideration of noise abatement measures as dictated by the Noise Policy. Therefore, no consideration of mitigation measures is required for the project. These results help to validate the findings of the approved **FEIS** prepared for **PR-10**.

APPENDIX

APPENDIX 1

CALIBRATION CERTIFICATE OF SOUND LEVEL METER

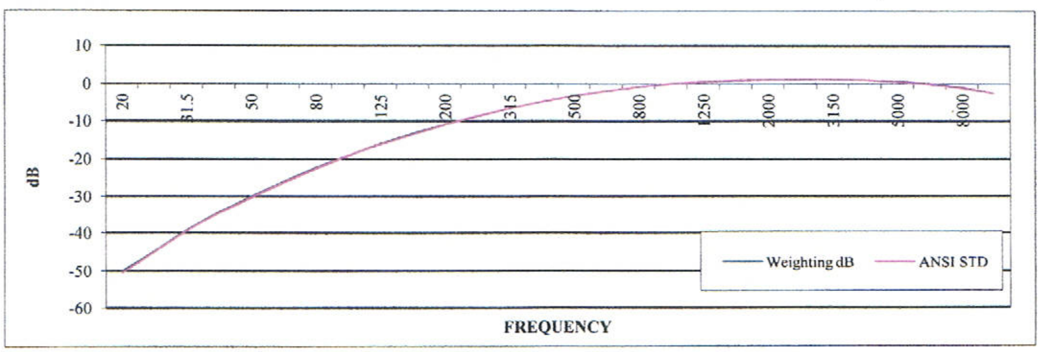
CIH EQUIPMENT COMPANY, INC.

CERTIFICATE OF CALIBRATION

Sound Level Meter Type 2

Manufacturer:	Quest	**Calibration Date:**	December 12, 2011
Model Number:	2900	**Date Due:**	December 12, 2012
Serial Number:	CDA080024	**Temperature:**	77.2 °F
Service Order:	10148	**Relative Humidity:**	54 %
Reference Number:	10148-2900-CDA080024	**Barometric Pressure:**	30.11

Frequency (HZ)	Meter Actual Display (dB)	Meter Weighting dB	ANSI STD	Tolerance	Relative Difference
20	64.0	-50.0	-50.5	± 3	0.5
25	69.5	-44.5	-44.7	± 3	0.2
31.5	74.8	-39.2	-39.4	± 3	0.2
40	79.7	-34.3	-34.6	± 2	0.3
50	84.0	-30.0	-30.2	± 2	0.2
63	88.0	-26.0	-26.2	± 2	0.2
80	91.8	-22.2	-22.5	± 2	0.3
100	95.0	-19.0	-19.1	± 1.5	0.1
125	98.0	-16.0	-16.1	± 1.5	0.1
160	100.9	-13.1	-13.4	± 1.5	0.3
200	103.2	-10.8	-10.9	± 1.5	0.1
250	105.3	-8.7	-8.6	± 1.5	-0.1
315	107.4	-6.6	-6.6	± 1.5	0.0
400	109.2	-4.8	-4.8	± 1.5	0.0
500	110.8	-3.2	-3.2	± 1.5	0.0
630	112.1	-1.9	-1.9	± 1.5	0.0
800	113.2	-0.8	-0.8	± 1.5	0.0
1000	114.0	0.0	0.0	± 1.5	0.0
1250	114.5	0.5	0.6	± 1.5	-0.1
1600	114.9	0.9	1.0	± 2	-0.1
2000	115.1	1.1	1.2	± 2	-0.1
2500	115.2	1.2	1.3	± 2.5	-0.1
3150	115.2	1.2	1.2	± 2.5	0.0
4000	115.0	1.0	1.0	± 3	0.0
5000	114.6	0.6	0.5	± 3.5	0.1
6300	114.0	0.0	-0.1	± 4.5	0.1
8000	113.0	-1.0	-1.1	± 5	0.1
10000	111.5	-2.5	-2.5	+ 5 to -µ	0.0



CIHE Calibration Laboratory certifies that the instrument specified above meets the manufacturer's specifications and was calibrated using standards and instruments also listed below where the accuracy is traceable to National Institute of Standards and Technology (NIST), and the calibration systems and records are in compliance to ANSI S1.4-1983

The reported uncertainty of measurement is stated as the combined standard uncertainty multiplied by a coverage factor k = 2. The measured value and the associated expanded uncertainty represent the interval (y±U), which contains the value of the measured quantity with a probability of approximately a 95% confidence interval. The uncertainty was estimated following the guidelines of the ISO 17025 and the GUM. U = ±0.37dB

STANDARDS

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
Quest	Sound Calibrator	CA-22	J7110005	18120-2	3/4/2012
Stanford Research	Function Generator	DS360	33001	A797607	9/8/2012
Fluke	Multimeter	8840A/AF	AF407041	A797616	9/8/2012
GRAS	Microphone	40AE	18833	18120-3	3/4/2012
LinearX	RTA Analyzer	PCRTA	159383	N/A	1/28/2012

Calibrated By: [signature] Date: 12/12/11

107-G Dunbar Avenue • Oldsmar, FL 34677 USA • PH: (813) 891-6830 • FX: (813) 854-1544
Toll Free: (888) 873-2443 • Website: www.cihequipment.com

CIH EQUIPMENT COMPANY, INC.

CERTIFICATE OF CALIBRATION

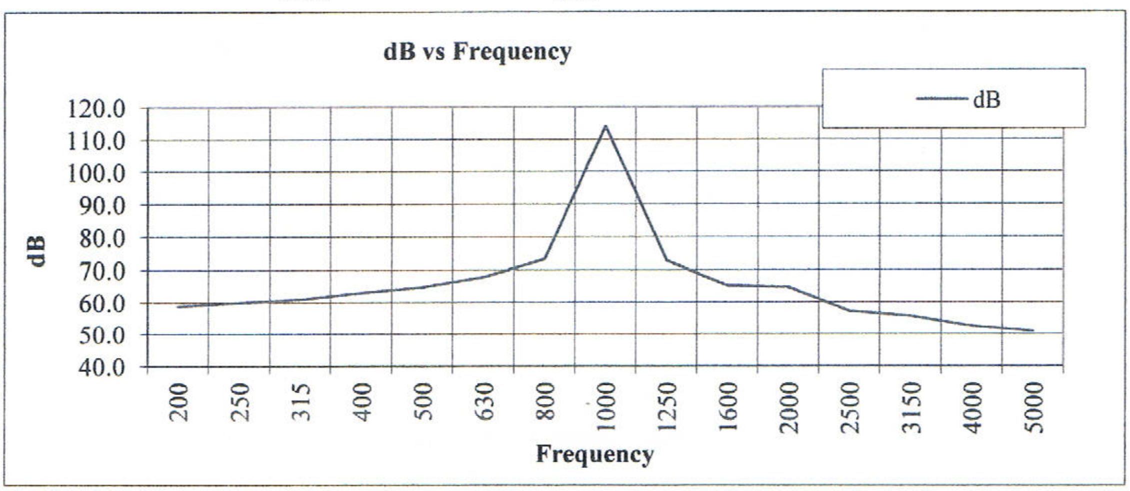
Acoustical Calibrator

Manufacturer:	Quest	**Calibration Date:**	December 12, 2011
Model Number:	QC-10	**Date Due:**	December 12, 2012
Serial Number:	QIA080187	**Temperature:**	77.2 °F
Service Order:	10148	**Relative Humidity:**	55 %
Reference Number:	10148-QC10-QIA080187	**Barometric Pressure:**	30.11

Frequency (HZ)	Linear dB
200	58.7
250	59.9
315	61.0
400	63.0
500	64.7
630	67.8
800	73.2
1000	114.0
1250	72.7
1600	65.1
2000	64.6
2500	57.2
3150	55.7
4000	52.6
5000	50.9

Center Frequency
1009.2 Hz

THD
0.003 %



STANDARDS

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
Quest	Sound Calibrator	CA-22	J7110005	18120-2	3/4/2012
Stanford Research	Function Generator	DS360	33001	A797607	9/8/2012
Fluke	Multimeter	8840A/AF	AF407041	A797616	9/8/2012
GRAS	Microphone	40AE	18833	18120-3	3/4/2012
E-MU	DAQ	EM8740A	8740050000648H	18120-3	11/15/2012
Virtins Technology	Spectrum Analyzer	Pro v3.2	B0D1DD6C	N/A	11/8/2012

CIHE Calibration Laboratory certifies that the instrument specified above meets the manufacturer's specifications and was calibrated using standards and instruments listed below where the accuracy is traceable to National Institute of Standards and Technology (NIST), and the calibration systems and records are in compliance to ANSI S1.40-1984

Calibrated By: Thomas Oakm[signature] Date: 12/12/11

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APPENDIX 2

PHOTOGRAPHS OF THE NOISE MONITORING STATIONS

VIEW OF THE PROJECT END AND JUNCTION WITH AC-100065 (UNDER CONSTRUCTION)

PHOTOGRAPH OF RESIDENTIAL AREA #1(ILLUSTRATES SOUND LEVEL METER LOCATION)

PHOTOGRAPH OF RESIDENTIAL AREA #2

PHOTOGRAPH OF RESIDENTIAL AREA # 3

PHOTOGRAPH ILLUSTRATING TYPICAL SECTION OF RURAL ROADS OF THE AREA

PHOTOGRAPH ILLUSTRATING EXISTING PROJECT CORRIDOR PREVAILING CONDITIONS

PHOTOGRAPH OF RESIDENTIAL STRUCTURE LOCATED IN RESIDENTIAL AREA #1 WHICH IS CLOSER TO THE PROPOSED PROJECT ALIGNMENT BUT HAS BEEN ACQUIRED

(A NEIGHBOR USES IT AS PARKING SPACE)

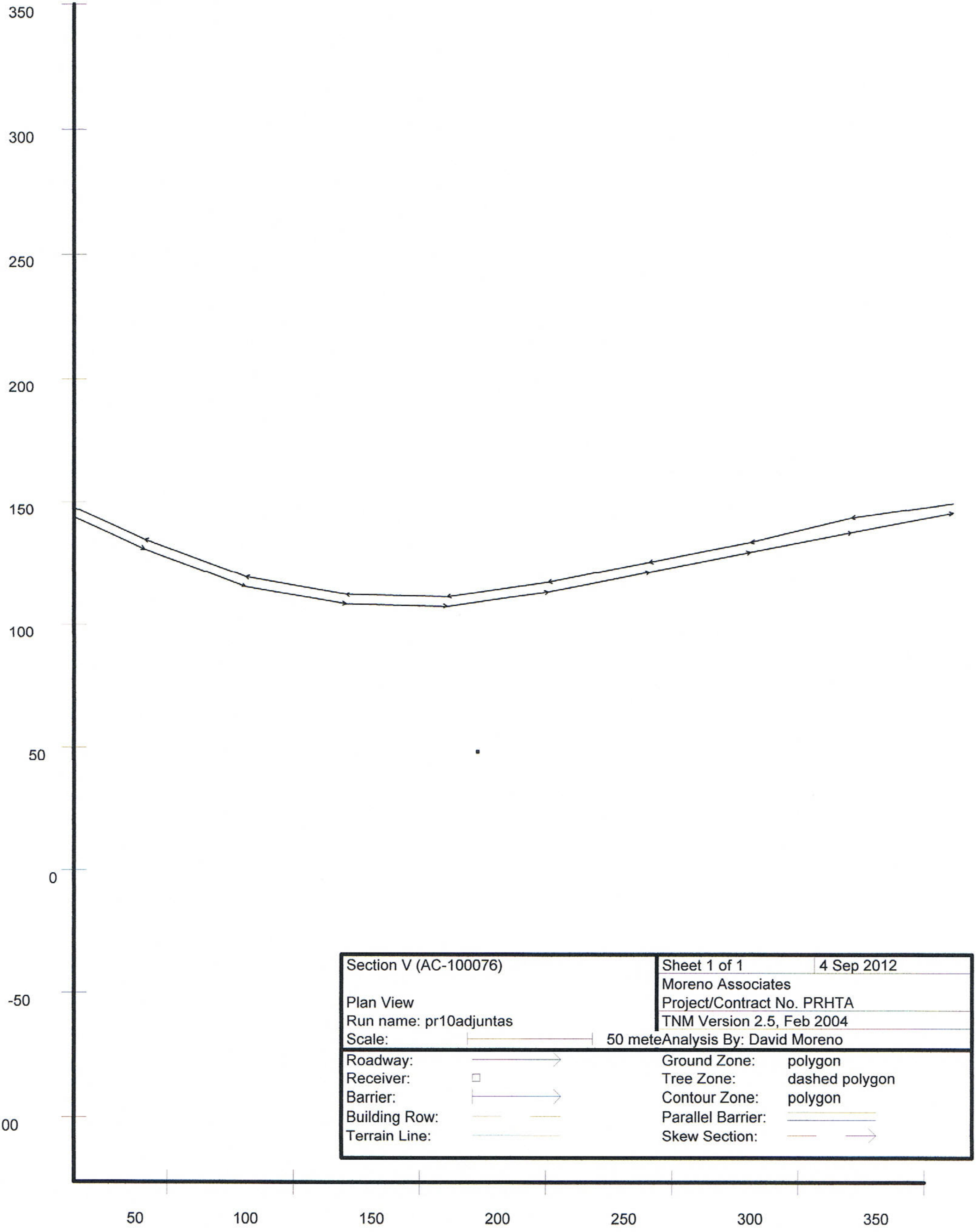
APPENDIX 3

PROJECT DRAWINGS ILLUSTRATING THE LOCATION OF THE RECEIVER USED FOR TNM

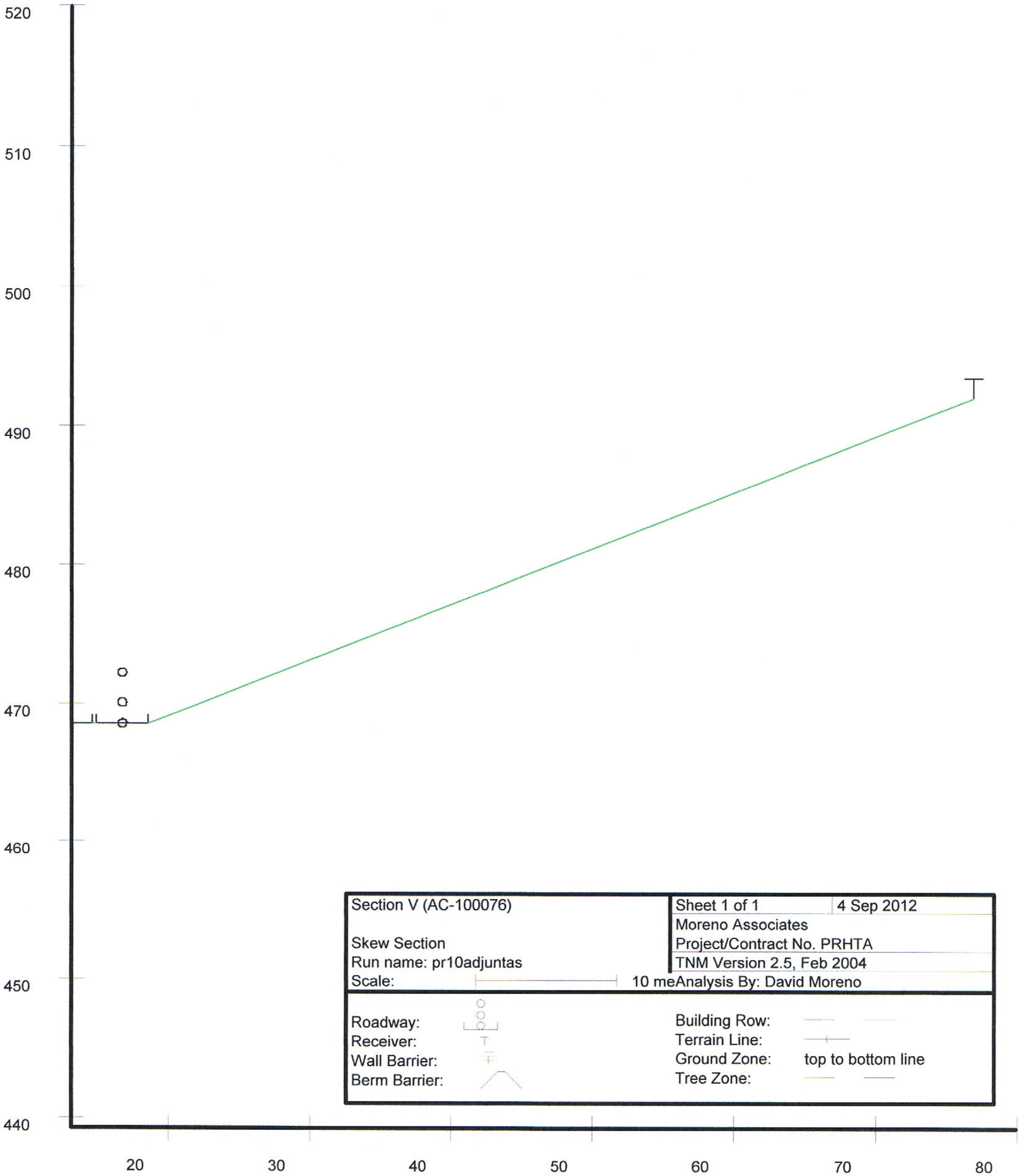
Acquired by PRHTA
450
460
470
97.0 mts
75.0 mts
Acquired by PRHTA
Receiver 1 for Noise Analysis

APPENDIX 4

COPY OF TNM OUTPUT FORMS



350
300
250
200
150
100
50
0
-50
00
50
100
150
200
250
300
350
Section V (AC-100076)
Plan View
Run name: pr10adjuntas
Scale:
50 mete
Sheet 1 of 1
4 Sep 2012
Moreno Associates
Project/Contract No. PRHTA
TNM Version 2.5, Feb 2004
Analysis By: David Moreno
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:


520
510
500
490
480
470
460
450
440
20
30
40
50
60
70
80
Section V (AC-100076)
Skew Section
Run name: pr10adjuntas
Scale:
10 meAnalysis By: David Moreno
Sheet 1 of 1
4 Sep 2012
Moreno Associates
Project/Contract No. PRHTA
TNM Version 2.5, Feb 2004
Roadway:
Receiver:
Wall Barrier:
Berm Barrier:
Building Row:
Terrain Line:
Ground Zone:
top to bottom line
Tree Zone:

Moreno Associates
David Moreno

4 September 2012
TNM 2.5

INPUT: ROADWAYS
PROJECT/CONTRACT: PRHTA
RUN: Section V (AC-100076)

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway		Points									
Name	Width	Name	No.	Coordinates (pavement)			Flow Control			Segment	
				X	Y	Z	Control Device	Speed Constraint	Percent Vehicles Affected	Pvmt Type	On Struct?
	m			m	m	m		km/h	%		
Southbound lane to Adjuntas	3.7	A	10	0.0	150.0	466.50				Average	
		B	9	40.0	131.0	467.10				Average	
		C	8	80.0	116.0	467.60				Average	
		D	7	120.0	109.0	468.20				Average	
		E	6	160.0	108.0	468.60				Average	
		F	5	200.0	114.0	469.10				Average	Y
		G	4	240.0	122.0	469.60				Average	Y
		H	3	280.0	130.0	470.10				Average	Y
		I	2	320.0	138.0	470.70				Average	Y
		G	1	360.0	146.0	471.20					
Northbound lane to Utuado	3.7	J	20	360.0	150.0	471.20				Average	Y
		I	19	320.0	144.0	470.70				Average	Y
		H	18	280.0	134.0	470.10				Average	Y
		G	17	240.0	126.0	469.60				Average	Y
		F	16	200.0	118.0	469.10				Average	Y
		E	15	160.0	112.0	468.60				Average	
		D	14	120.0	113.0	468.20				Average	
		C	13	80.0	120.0	467.10				Average	
		B	12	40.0	135.0	467.10				Average	
		A	11	0.0	154.0	466.60					

Moreno Associates 4 September 2012
David Moreno TNM 2.5

INPUT: TRAFFIC FOR LAeq1h Volumes
PROJECT/CONTRACT: PRHTA
RUN: Section V (AC-100076)

Roadway	Points		Segment									
Name	Name	No.	Autos		MTrucks		HTrucks		Buses		Motorcycles	
			V	S	V	S	V	S	V	S	V	S
			veh/hr	km/h	veh/hr	km/h	veh/hr	km/h	veh/hr	km/h	veh/hr	km/h
Southbound lane to Adjuntas	A	10	595	72	13	72	32	72	0	0	0	0
	B	9	595	72	13	72	32	72	0	0	0	0
	C	8	595	72	13	72	32	72	0	0	0	0
	D	7	595	72	13	72	32	72	0	0	0	0
	E	6	595	72	13	72	32	72	0	0	0	0
	F	5	595	72	13	72	32	72	0	0	0	0
	G	4	595	72	13	72	32	72	0	0	0	0
	H	3	595	72	13	72	32	72	0	0	0	0
	I	2	595	72	13	72	32	72	0	0	0	0
	G	1										
Northbound lane to Utuado	J	20	487	72	11	72	26	72	0	0	0	0
	I	19	487	72	11	72	26	72	0	0	0	0
	H	18	487	72	11	72	26	72	0	0	0	0
	G	17	487	72	11	72	26	72	0	0	0	0
	F	16	487	72	11	72	26	72	0	0	0	0
	E	15	487	72	11	72	26	72	0	0	0	0
	D	14	487	72	11	72	26	72	0	0	0	0
	C	13	487	72	11	72	26	72	0	0	0	0
	B	12	487	72	11	72	26	72	0	0	0	0
	A	11										

Moreno Associates
David Moreno

4 September 2012
TNM 2.5

INPUT: RECEIVERS
PROJECT/CONTRACT: PRHTA
RUN: Section V (AC-100076)

Receiver												
Name	No.	#DUs	Coordinates (ground)			Height above Ground	Input Sound Levels and Criteria				Active in Calc.
			X	Y	Z		Existing LAeq1h	Impact Criteria LAeq1h	Impact Criteria Sub'l	NR Goal	
			m	m	m	m	dBA	dBA	dB	dB	
Receiver1	1	2	172.0	49.0	492.00	1.50	50.20	66	10.0	8.0	Y

Moreno Associates
David Moreno

4 September 2012
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: PRHTA
RUN: Section V (AC-100076)
BARRIER DESIGN: INPUT HEIGHTS

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

ATMOSPHERICS: 20 deg C, 50% RH

Receiver												
Name	No.	#DUs	Existing	No Barrier					With Barrier			
			LAeq1h	LAeq1h		Increase over existing		Type	Calculated	Noise Reduction		
				Calculated	Crit'n	Calculated	Crit'n Sub'l Inc	Impact	LAeq1h	Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	2	50.2	58.6	66	8.4	10	----	58.6	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction		
		Min	Avg	Max
		dB	dB	dB
All Selected	2	0.0	0.0	0.0
All Impacted	0	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0