Environmental Impact Assessment

Project Number: 53376-001
October 2020

IND: DBL Highway Project
Noise Impact Assessment

Prepared by AECOM India Private Limited.

FINAL REPORT

Noise Impact Analysis for Road Asset

Anandapuram-Pendurthi-Anakapalli NH-16 Road

Dilip Buildcon Limited

Project number: 60629407

October 13th 2020

Quality information

Prepared by	Checked by	Verified by	Approved by
			
Mr. Shahezan Issani Mr. Bhupesh Mohapatra	Ms. Poonam Singh	Mr. Bhupesh Mohapatra	Mr. Chetan Zaveri

Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	19 April 2020	First Report on Noise assessment	Yes	Chetan Zaveri	Executive Director
02	30 April 2020	Noise Report with primary data	Yes	Chetan Zaveri	Executive Director
03	20 July 2020	Addressed ADB comments – round 1	Yes	Chetan Zaveri	Executive Director
04	7 August 2020	Revised noise assessment – new assessment	Yes	Chetan Zaveri	Executive Director
05	18 September 2020	Revised noise assessment – new assessment with ADB comments – round 2	Yes	Chetan Zaveri	Executive Director
06	13 October 2020	Revised noise assessment – new assessment with ADB comments – round 2	Yes	Chetan Zaveri	Executive Director

Distribution List

# Hard Copies	PDF Required	Association / Company Name
N	Y	DBL

Prepared for:

Dilip Buildcon Limited

Prepared by:

Shahezan Issani

AECOM India Private Limited
19th Floor
Building No.5
Tower C
Cyber City
Gurgaon 122002
Haryana
India

CIN: U74210KA2005PTC037770

T: +91 124 4682700/800
aecom.com

Table of Contents

Figures

Tables

1. Introduction

AECOM India Private Limited (hereinafter referred as 'AECOM') has been appointed by M/s Dilip Buildcon Limited (hereinafter referred to as 'DBL' or the 'Client') as an independent consultant to undertake an Environment and Social Impact Assessment (ESIA) including Noise Impact Assessment (NIA) of its six laning of National Highway (NH) number 16 (NH 16) (old NH 5) from Anandapuram-Pendurthi- Anakapalli section from kilometre (km) 681.000 (existing km 681.000) to km 731.780 (existing km 742.400) in the State of Andhra Pradesh (hereinafter referred to as 'Project'). The Project has been conceived by National Highways Authority of India (NHAI) under the Bharatmala Pariyojana and is executed as per the Hybrid Annuity Mode (HAM) model of NHAI. The Project is being developed by DBL though it's Special Purpose Vehicle (SPV), M/s Anandapuram Anakapalli Highway Private Limited (AAHPL) a wholly owned subsidiary of DBL.

The Project is a 50.8 km stretch of NH 16 starting at village Anandapuram and concluding at Anakapalli, both falling within Vishakhapatnam district. NH 16 connects Kolkata and Chennai and runs along east coast of India. Presently, the Project is under construction with approximately fifty percent (50%) work is completed till date.

This report presents noise monitoring and noise modelling results to assess the impact of the Project on sensitive, residential and commercial receptors along its alignment. Further, an implementable mitigation measures and noise monitoring plan has been provided at the end of the report as part of risk mitigation strategy for the Project.

1.1 Background

Anandapuram Anakapalli Highways Private Limited (AAHPL) a wholly owned subsidiary of DBL has been appointed by National Highway Authority of India (NHAI) for undertaking the six laning of the Anandapuram- Anakapalli section of NH-16 from 681.000 km to 731.780 km in the State of Andhra Pradesh on Build-Operate- Transfer and Hybrid Annuity Mode (BOT-HAM). Concession Agreement for the project has been signed between DBL-AAHPL i.e. the Concessionaire and NHAI in April 2018.

AECOM understands that the international multilateral development institution, the Asian Development Bank (ADB) is in the process of evaluating a potential debt investment in the Project. As part of its investment process, an independent Noise monitoring and Impact Assessment of the project (hereinafter referred to as this "assignment" or "study") is required to be undertaken to ascertain the international and national regulatory compliance and risks of Project against the Applicable Reference Framework as mentioned in **Section 2** of this report.

The Project road extends from 17°41'21.48"N 83°1'50.34"E to 17°54'2.51"N 83°23'38.72"E. It starts at Anandapuram (existing km 681.000) in Visakhapatnam district and ends at Anakapalli (existing km 742.400) in Visakhapatnam district. The entire stretch passes through Visakhapatnam district with a length of 50.80 km out of which 34.95 km is existing road and rest 15.85 km is bypass and realigned section. The 50.80 km long stretch is characterized by two lane carriageways with earthen shoulders. The general terrain along the road is plain. Most of the land use pattern falls under agricultural and built-up areas. Location Map of the Project, ROW alignment and land use is depicted in Figure 1-1.

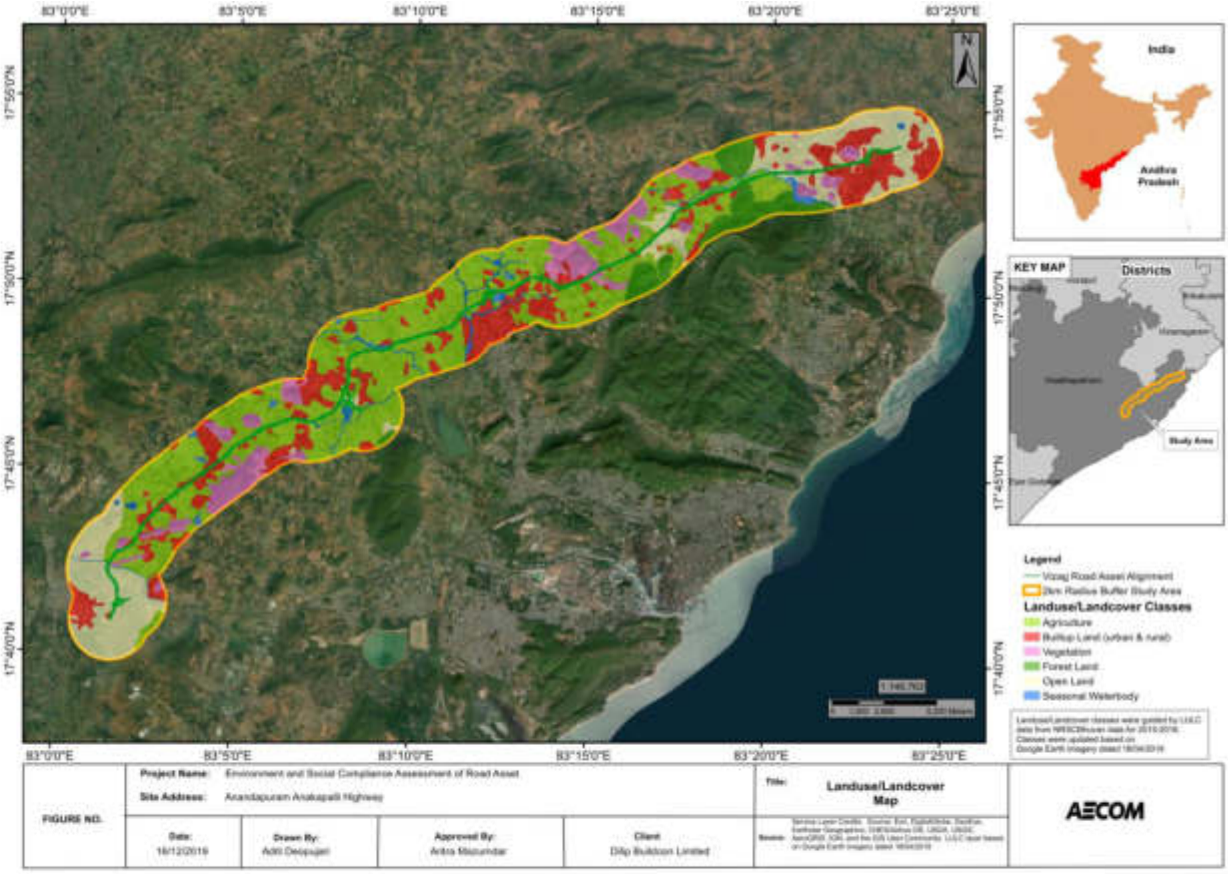


Figure 1-1: Location Map of the Project

1.2 Objectives and Scope of Work

The overall objective of the study is to determine the anticipated impacts of the proposed Project with respect to noise on sensitive and non-sensitive receptors during construction and operation phases and to recommend mitigation measures to reduce the adverse impacts, within applicable guidelines and standards. More specifically, the scope of work for this assignment entails:

- Complete an initial survey to establish baseline noise conditions along the Project site (i.e. along the road and nearby sources);
- Carrying out baseline level of noise measurement at sensitive receptors which may be affected by both construction and operation activities in the area of influence of the Project road.
- Modelling the projected noise impacts of the Project will be conducted using commercial noise modelling software. The model will assess potential impacts both during construction and operation stages of the Project, including the worst case and other relevant scenarios. As worst-case scenario has been considered for noise modelling, hence the highest noise value (Lmax) has been considered as the base value to run the model so as to receive the highest value that would impact a particular receptor at any time.
- The noise model would incorporate ground topography data sufficient to cover the anticipate impact area, meteorological data, and traffic data (including fleet composition).
- Carrying out noise modelling to predict future noise levels from the proposed Project on sensitive receptors.
- Suggest practical mitigation options for areas that do not comply with the requirements with associated cost estimates.
- Verify the effectivity of the proposed mitigation measures to achieve compliance with requirements through an updated model.

1.3 Approach and Methodology

The following Approach and Methodology was adopted by AECOM to carry out this assignment.

- Identification of noise sampling receptors covering entire corridor. In total, sixteen (16) locations were identified based on sensitivity and the sources of noise along the alignment. The locations identified and justification for the same has been provided in Table 2-4.
- The noise measurements were carried out for 48 hours (24 hours for weekend and 24 hours for weekday) and comply with ISO 1996-2 standards for outdoor noise measurements. Monitoring receptor height and the distance from the carriageway considering its proposed impacts. The Leq values for day and nighttime and the corresponding standards an interval of 15 minutes.
- **Federal Highway Administration's Traffic Noise Model (FHWA TNM)** software is used for modelling highway traffic noise prediction and analysis.

a) FHWA TNM establishes existing noise levels to make substantial increase determinations as part of the impact assessment for the proposed highway Project. Establishing existing sound levels with general information about the noise source origin can help determining the effectiveness of a Project's mitigation design.

b) FHWA TNM validates measurements of traffic noise levels to predict existing and future worst-case scenario (worst-hour sound levels) to determine the impact assessment for the proposed highway.

c) FHWA TNM computes incremental highway traffic noise at nearby receivers. It includes noise emission levels for the following:

  - Automobiles: all vehicles with two axles and four tyre - primarily designed to carry nine or fewer people (passenger cars, vans) or cargo (vans, light trucks)
  - Medium trucks, heavy trucks, buses and motorcycles
  - List of instruments/ machineries/ vehicles/ DG sets with its daily working time and locations in project area during construction and operation phase.

1.4 Layout of the Report

This report has been presented as per following sections.

- **Section 1 (this section):** Introduction
- **Section 2:** Overview of Applicable Reference Framework
- **Section 3:** Baseline Noise Levels
- **Section 4:** Noise Modelling
- **Section 5:** Conclusion

2. Overview of Applicable Reference Framework

The present assessment has been undertaken against the following reference framework:

- ADB Safeguard Policy Statement, 2009;
- Guidelines for Community Noise by World Health Organization (WHO), 1999;
- The International Finance Corporation (IFC) and World Bank Guidelines on Noise standards;
- Noise Pollution (Regulation and Control) Rules, 2000,;
- Central Pollution Control Board (CPCB) guidelines on noise; and
- ISO 1996-2:2017(en) Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of sound pressure levels.

2.1 Guidelines for Community Noise WHO 1999

According to the WHO, the community noise (also called environmental noise, residential noise or domestic noise) is defined as noise emitted from all sources except noise at the industrial workplace. Main sources of community noise include road, rail and air traffic; industries; construction and public work; and the neighbourhood. Noise-induce hearing impairment; interference with speech communication; disturbance of rest and sleep; psychophysiological, mental-health and performance effects; effects on residential behaviour and annoyance; and interference with intended activities. Hence it become pivotal to access the impact of noise during all facets of the project cycle.

2.1.1 Sources of road noise

Noise associated with road development has four main sources: a) vehicles; b) friction between vehicles and the road surface; c) driver behaviour; and d) construction and maintenance.

a) **Construction and maintenance**: Road construction generally require the use of heavy machinery, and although these activities may be intermittent and localized, they nevertheless contribute tremendous amount of sustained noise during equipment operation and maintenance activities. Activities such as operation of stone crushers, RMC plant, DG sets, rotating equipment such as grinding machine, pumps and compressors etc. along with the heavy machineries contribute the noise for construction and maintenance of the road.

b) **Vehicle noise**: Vehicle noise comes from the engine, transmission, exhaust, and suspension, and is greatest during acceleration, on upgrades, during engine braking, on rough roads, and in stop-and-go traffic conditions. Poor vehicle maintenance is a contributing factor to this noise source.

c) **Road noise**: Frictional noise from the contact between tyre and pavement contributes significantly to overall traffic noise. The level depends on the type and condition of tyre and pavement. Frictional noise is generally greatest at high speed and during quick braking.

d) **Driver behaviour**: Drivers contribute to road noise by using their vehicles' horns, by playing loud music, by shouting at each other, and by causing their tyre to squeal as a result of sudden braking or acceleration.

2.1.2 Road noise impacts

Noise associated with road development affects the environment through which roads pass by affecting human welfare, by sonically vibration and disturbance.

Human welfare: Even when it is not perceived consciously chronic exposure to road noise can affect human welfare in varying degrees, both physiologically and psychologically. Chronic noise exposure can be a source of annoyance, creating communication problems and leading to elevated stress levels as well as associated behavioural and health effects. It can cause auditory fatigue, temporary and permanent disability of hearing ability, sleep disorders and can even contribute to learning problems in children.

Vibration: The vibration induced by the resonance of traffic noise can have a detrimental effect on structures standing near the road. This is of particular concern in the case of cultural heritage sites, which may have been standing for many centuries, but which were not designed to withstand such vibration. Makeshift or lightly constructed buildings may be the first to succumb to vibration damage.

Wildlife disturbance: Noise may prevent many animal species from approaching or crossing road corridors because they are afraid. As a result, road corridors become barriers to regular wildlife travel routes, effectively rendering roadside habitat areas inaccessible to some species. Such disturbance reduces the success of these species and contributes to ecological alteration.

2.1.3 Guidelines Values for Community Noise

A noise measure based only on energy summation and expressed as the conventional equivalent measure, LAeq, is not enough to characterize most noise environments. It is equally important to measure the maximum values of noise fluctuations, preferably combined with a measure of the number of noise events. The WHO has issued guideline values for community noises in specific environment which are explained in Table 2-1.

Table 2-1: Guideline values for community noise in specific environments (WHO 1999)

Specific environment	Critical health effect(s)	LA_{eq} [dB(A)]	Time base [hours]	LA_{max} fast [dB]
Outdoor living area	• Serious annoyance, daytime and evening • Moderate annoyance, daytime and evening	• 55 • 50	• 16 • 16	- -
Dwelling, indoors Inside bedrooms	• Speech intelligibility & moderate annoyance, daytime & evening • Sleep disturbance, night-time	• 35 • 30	• 16 • 8	- 45
Outside bedrooms	• Sleep disturbance, window open (outdoor values)	• 45	• 8	60
School classrooms & pre-schools, indoors	• Speech intelligibility, • disturbance of information extraction, • message communication	• 35	During class	-
Pre-school bedrooms, indoor	• Sleep disturbance	• 30	sleeping time	45
School, playground outdoor	• Annoyance (external source)	• 55	During play	-
Hospital, ward rooms, indoors	• Sleep disturbance, night-time • Sleep disturbance, daytime and evenings	• 30 • 30	• 8 • 16	40
Hospitals, treatment rooms, indoors	• Interference with rest and recovery	• #1[1]	-	-
Industrial, commercial shopping and traffic areas, indoors and outdoors	• Hearing impairment	• 70	• 24	110
Ceremonies, festivals and entertainment events	• Hearing impairment (patrons:<5 times/year)	• 100	• 4	• 110
Public addresses, indoors and outdoors	• Hearing impairment	• 85	• 1	• 110
Music and other sounds through headphones/ earphones	• Hearing impairment (free-field value)	• 85 #4	• 1	• 110
Impulse sounds from toys, fireworks and firearms	• Hearing impairment (adults) • Hearing impairment (children)	-	-	• 140 • #2 • 120 • #2
Outdoors in parkland and conservations Areas	• Disruption of tranquility	• #3		

Source: Guidelines for Community Noise- WHO 1999

2.2 IFC and World Bank Guidelines

The IFC-WB (2007) provides guideline values on noise, which apply beyond the property boundary of facilities (please refer Table 2-2). The noise emitted beyond the property of facility (RoW) should not exceed the values provided in Table 2-2 or result to increase of 3 dBA from the background noise of the nearest receptor. IFC-WB (2007) guideline values on noise were based on the World Health Organization (WHO), 1999.

Table 2-2: IFC-World Bank Group noise level Guidelines

Receptor	One Hour (L_{Aeq}) (dBA)	
	Day time	Nighttime
Residential; institutional; educational	55	45
Industrial; Commercial	70	70

Note: Noise impacts should not result in a maximum increase in background levels of 3 dBA at the nearest receptor location off-site.

Source: IFC-WB, 2007

2.3 National Regulations for Noise Impact

Guidelines by the Central Pollution Control Board (CPCB), New Delhi, India suggest that noise levels should not exceed 75 dB in daytime and 70 dB during night in industrial areas, while the corresponding levels for commercial area stands at 65 dB in day and 55 dB at night. In residential areas noise levels should not exceed 55 dB in day and 45 dB at night; and the corresponding values for silence zones in daytime is 50 dB and 40 dB at night respectively.

Table 2-3 shows the noise standards as enforced by the Central Pollution Control Board (CPCB) under the Noise Pollution (Regulation and Control) Rules, 2000.

Table 2-3: Ambient Noise Quality standards

Area Code	Category of area zone	Limits in dB(A)L_{eq}	
		Day time	Night time
A.	Industrial area	75	70
B.	Commercial area	65	55
C.	Residential area	55	45
D.	Silence Zone	50	40

Source: Noise Pollution Regulations in India CPCB

2.4 Noise Baseline Monitoring Carried out by AECOM

2.4.1 Noise Monitoring and Analysis Methodology

A two (2) member team of Environment, Health and Safety (EHS) expert from AECOM along with Netel (India) Limited, a NABET accredited laboratory carried out environmental monitoring including baseline noise assessment and meteorological assessment along Project corridor. The baseline noise monitoring was conducted at sixteen (16) locations over a period of 48 hours, split between weekends (Saturday and Sunday) and weekdays (Monday and Tuesday) between 29th February and 4th March 2020. The team further assessed the classified traffic volume count at the Project site from 5th March to 6th March 2020 at four locations simultaneously.

The noise monitoring methodology followed at the site is given below:

- Determine the exact point to place the microphone prior to setting up for data collection. Evaluate the presence or likelihood of localized noise sources (e.g., habitation, machineries, vehicles etc.) and adjust the location accordingly.
- Placing the sound level instrument to the tripod and make sure that the tripod is levelled and secured.
- Checked all equipment settings, including use of the A-weighting filter network and measurement of Leq. If the integrating sound level meter can sample in discrete, repetitive intervals, then a one-minute interval duration is recommended. Synchronize the time clocks on the instruments to each other and to all operators' time-keeping devices. Also, Netel team has checked the battery strength and ensured that the machine runs for 48 hours continuously.
- Calibrate the entire acoustical instrumentation system.
- Set up the meteorological station and confirm its settings. Proper documentation of meteorological condition was of paramount importance. AECOM and Netel team documented wind speed, wind direction, temperature, humidity, and cloud cover prior to surveys.
- Wind data are site-specific and contemporaneous with the sound level measurements. For model validation measurements, the wind should be calm. Discontinue or pause sampling when the wind is not calm (or mark those one-minute periods as contaminated for post-measurement deletion).
- Temperature and humidity can be determined though online weather sites or applications on mobile devices. Historical data were also made available online for documentation of the conditions during the measurements. It was made sure that data from online sources is from stations near to the measurement site and that weather conditions from the online source match conditions observed in the field.
- Temperature lapse rate can have a major effect on measured sound levels by refraction, especially at larger distances from the source. For model validation purposes, the ideal conditions are calm, overcast days. Observing the cloud cover, can be useful in assessing the potential for temperature refraction effects. Lapse rate information is not knowable from online weather sites by comparison of data from different stations.
- Obtained latitude and longitude coordinates from a GPS unit; Make documentation complete enough so that another person can return to the site at another time and set up at the same measurement point.
- Measure sound levels for the needed duration.
- If the integrating sound level meter can sample in one-minute intervals, then intervals with bad data (e.g., during periods of non-calm winds or operator activity) or unrepresentative events that might skew the measurement can be deleted during post-measurement data reduction. If it is suspected or known that certain unrepresentative minutes' data will need to be eliminated from the result, then extend the data collection for the same number of additional minutes.
- Deploy qualified and trained enumerators for classified volume count.
- Vehicle count for vehicles are grouped into five acoustically significant types (i.e., vehicles within each type exhibit statistically similar acoustical characteristics). These vehicle types are defined as follows:
  - **Automobiles (A)**: All vehicles with two axles and four tyres and designated primarily for transportation of nine or fewer passengers or for transportation of cargo; this vehicle type includes light trucks. Generally, the gross vehicle weight is less than 9,900 lb (4,500 kg).
  - **Medium trucks (MT)**: All cargo vehicles with two axles and six tyres. Generally, the gross vehicle weight is greater than 9,900 lb (4,500 kg) but less than 26,400 lb (12,000 kg).
  - **Heavy trucks (HT)**: All cargo vehicles with three or more axles. Generally, the gross vehicle weight is greater than 26,400 lb (12,000 kg).
  - **Buses (B)**: All vehicles with two or three axles and designated for transportation of nine or more passengers.

  - **Motorcycles (MC)**: All vehicles with no more than two or three tires with an open-air driver or passenger compartment.
  - **Non-motorised vehicles**: Vehicles without any motor driven facility, which includes cycles, manual rickshaws, animal driven carts.
  - Make classification counts (i.e., by vehicle type) by direction, ideally for the same interval duration as the sound level meter (e.g., one-minute), in case sound level data needs to be edited out.
- After sampling is done, record the result(s) on the field data sheet. For many sound level analysers, data needs to be saved to a file and download to a computer; do this either on site or after completing the day's measurements. Most analysers allow multiple files to be downloaded and saved with unique names. Use the file naming protocols developed during measurement planning. All precautions were taken to record files names on the data sheets.
- Analyse any data files associated with the traffic counts or speeds to a computer either on site or after completing the day's measurements. Include unique and descriptive file names, including type of file, site, time of day, and date. Be sure to record the files names on the data sheets.
- Next, recheck the sound level instrument's calibration. If this final calibration differs from the initial calibration by less than 0.4 dB, then no adjustment to the data is necessary unless such adjustment is needed to bring the measurement within the needed validation tolerance. If the final calibration differs from the initial calibration by 0.4 dB to 0.5 dB, then adjust all data measured with that system during the time between calibrations as described in operation manual. If the final calibration differs from the initial calibration by more than 0.5 dB, then discard all data measured with that system during the time between calibrations. Repeat the measurement(s) after the instrumentation has been thoroughly checked by the manufacturer or a repair/ calibration facility.

Finally, before taking down the equipment and leaving the site, be sure to record all needed information on the data sheet and take any needed site photographs.

2.4.2 Monitoring Equipment and Data Analysis

For model validation measurements, the key instrumentation and accessories include the following:

- Integrating sound level meter or analyser, including microphone and preamplifier
- Calibrator.
- Windscreen.
- Tripod.
- Anemometer or handheld wind speed and direction instrument (online weather sites and mobile phone applications can also provide data on temperature and humidity data).
- Data sheets, clipboard, pen or pencil, or electronic data-logging device.
- Traffic-counting forms.

There are sixteen (16) units of Sound Level Meters (SLM). The noise monitoring station were mounted on a tripod at some places and at a few places where it was not feasible to place the SLM on a tripod due to safety reasons, it was placed in such a way that the height was maintained at ~ 1.5m..

Typical data analysis and reporting procedures include these steps:

- Download the data file(s) to a computer and import into a spreadsheet.
- **Eliminating bad data**: Examine data collected in one-minute intervals using the field notes and eliminate and label (reason for elimination) any bad, contaminated, or unrepresentative one-minute intervals in the spreadsheet. Compute the measurement's Leq in the spreadsheet using this formula:

Equation 2-1: Formula for Leq

$$L_{eq} = 10 \log_{10}\left\{\left[\sum_{i=1}^{n} 10^{(L_i/10)}\right] / n\right\}(dB)$$

where Li is Ith good minute's L_{eq} and n is the total number of good minutes.

- **Calibration adjustment**: If needed, adjust the Leq to account for a shift in calibration (CAL) level from before to after the measurement:
  - If the final calibration of the sound level meter or analyser differs from the initial calibration by less than 0.4 dB, then no adjustment to the data is necessary unless such adjustment is needed to bring the measurement within the needed validation tolerance.

- If the final calibration of the sound level meter or analyser differs from the initial calibration by 0.4 dB to 0.5 dB, then adjust all data measured with that system during the time between calibrations by arithmetically adding to the data the following CAL adjustment:

CAL adjustment = Reference level - [(CALINITIAL + CALFINAL) / 2]

For example, if:

Reference level (manufacturer's calibration level) = 114.0 dB

Initial calibration level = 114.0 dB

Final calibration level = 114.4 dB

Then:

CAL adjustment = 114.0 - [(114.0 + 114.4)/2] = -0.2 dB

In this example, adjust the measured Leq downward by 0.2 dB, with a note that it has been adjusted.

- If the final calibration of the sound level meter/analyser differs from the initial calibration by greater than 0.5 dB, then discard all data measured with that system during the time between calibrations and repeat all measurements after the instrumentation has been thoroughly checked.

- **Background adjustment**: The total measured Leq is a combination of the source Leq and the background Leq. If the total measured level exceeds the background level by greater than 10 dB, then the background contribution to the total measured level is less than 0.5 dB and no adjustment of the total measured level is necessary to determine the source-only level. If the total measured level does not exceed the background level by 5 dB or more, then the source-only level cannot be accurately determined; omit those data from data analysis. If the noise source is continuous traffic, then it is not possible to determine the background Leq and whether the background noise is increasing the total measured level. If the total measured level exceeds the background level by between 5 and 10 dB, then adjust the measured level for background noise to obtain the source-only level as follows:

Equation 2-2: Formula for Adjusting Leq for Background

$$L_{adj} = 10\log_{10}\left[10^{(0.1L_c)} - 10^{(0.1L_b)}\right]\,(dB)$$

where: L_{adj} is the background-adjusted measured level;

L_c is the total measured level with source and background combined; and

L_b is the background level alone.

For example, if:

L_c = 55.0 dB

L_b = 47.0 dB

Then:

Equation 2-3: Example of Background Adjustment

$$\boldsymbol{L_{adj} = 10\log_{10}\left[10^{(0.1\,x\,55.0)} - 10^{(0.1\,x\,47.0)}\right]} = 54.3\ dB$$

IFC-WB (2007) involves continuous monitoring using an SLM capable of measuring noise levels at very short interval. This is to derive the one-hour equivalent noise level (LAeq), which is the energy average sound level represented by the following equation.

$$L_{Aeq} = 10log_{10}\left[\frac{1}{N}\sum_{i=1}^{n} 10^{\frac{Li}{10}}\right]$$

where,

L_{Aeq} = equivalent noise level,

Li = instantaneous noise level, and

N = total number of noise data

In addition, the following statistical noise levels were computed based on the one-hour data collected per time slice or period.

- L10 level - sound level that exceeded 10% of the time. This relates to the peaks of noise levels over a certain monitoring period; and
- L90 level – the sound level exceeded 90% of time. This is sometimes referred to as the residual or background noise level,

SLM provided continuous noise data (every 1 sec) per station per sampling period (1 hour per sampling period), the summary of results is shown below (Table 2-6 and Table 2-7), which were extracted from SLM.

The measured sound level data are compiled in a noise study report table including site number, site address, date, time duration, Leq etc. Meteorological conditions (data) have also been recorded. A map locating the measurement points is also illustrated in Figure 2-2.

A graph of the Leq variation at different location is useful if the site was measured for a number of places for help in identifying the worst noise areas. The noise representative graphs have been provided in Figure 2-7, Figure 2-8, Figure 2-9 and Figure 2-10.

2.4.3 Noise Monitoring Locations

This section presents the locations of the sampling stations, monitoring equipment, methodology, and results of the background monitoring for noise in vicinities of the alignment.

During site visit, chainage wise sensitive areas for the stretch of the project road were identified based on sensitive receptors categorised as per Guidelines on Community Noise WHO 1999 such as group of dwellings, schools and preschools, hospitals, parkland and conservation areas etc. The sensitive receptors located along the project road is illustrated in Figure 2-1.

The monitoring locations along with its justification is provided in Table 2-4 and represented in Figure 2-2. Further Figure 2-3, Figure 2-4, Figure 2-5 and Figure 2-6 illustrates the noise monitoring location along with sensitive receptors in detail.

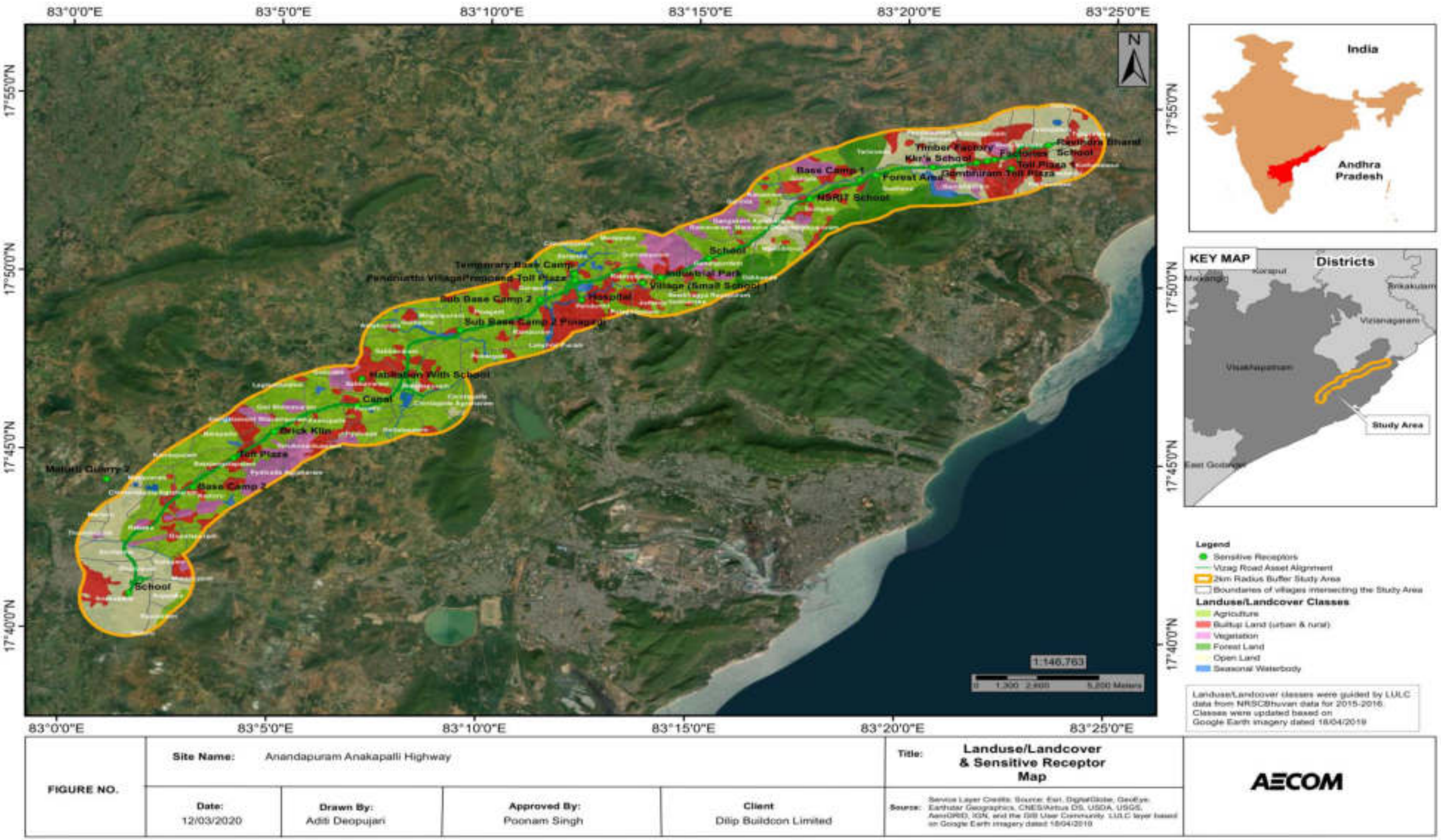


Figure 2-1: Sensitive receptors along the project alignment

Table 2-4: Noise Monitoring Location- Site section

Sl. No	Noise Quality Location	Location Name	Chainage	Coordinates	Surrounding Land use	Type of Receptor	Justification for site selection
1)	NQ 1	Ravindra Bharat School	681+400 (LHS)	17°53'56.44"N 83°23'24.58"E	Open land use and Residential	Silence Zone	This area is near Vellanki village near start of Project road. Though the broad land-use is residential and open area, there is a school located on LHS. This location covers Ravindra Bharat School which represents a sensitive receptor. The school boundary is located about 33 m from the road centerline and actual school is approximately 90m from centerline. The site was selected for air and noise monitoring as this represents sensitive receptor and access to power supply for air sampler. Monitoring was conducted on boundary and main gate of the school at a distance of about 35m from road centerline.
2)	NQ 2	Anandapuram Village	682+900 (RHS)	17°53'44.63"N 83°22'39.11"E	Commercial and Residential	Residential	This is a major commercial cum residential establishment along the Project road, which is Anandapuram village. The first row of houses on ground floor represents commercial activities while the first floor is put to residential use. AECOM also observed that informal daily market (haat) happens in morning (7 AM to 12 PM) in addition to usual business activities in and around the village. The Project road will be at grade with height of approximately 5-6m. The site was selected for air and noise monitoring as this represents commercial land use and access to power supply for air sampler. Monitoring was conducted on first floor (12 feet) of a house on first row just after the RoW at a distance of about 35m from road centerline.
3)	NQ 3	KKR Gautham school	684+800 (RHS)	17°53'27.91"N 83°21'41.54"E	Residential cum commercial	Silence Zone	This area is near proposed Gambhiram toll plaza and represents open area with two small factories. The area has KKR Gautham school is located near the road. The school boundary is located about 30 m from the road centerline and actual school is approximately 50m from centerline. The site was selected for noise monitoring as this represents a varied land use including a sensitive receptor. Monitoring was conducted on school KKR boundary at a distance of about 30m from road centerline. Also, air monitoring was conducted as power supply was made available.
4)	NQ 4	Near Kambalakonda forest/ Wildlife Sanctuary	689 (LHS)	17°53'2.92"N 83°19'20.28"E	Open Land	Silence Zone	This is an open area, no close by receptors (near forest area). A hillock present on left hand side of road which is Kambalakonda forest and Wildlife Sanctuary at a distance of beyond 40m. It is open area with a small hillock on left hand side. The forest is not traversed by the Project road. Though there are no human receptors, noise monitoring was conducted beyond RoW at a distance of about 35 m to record the baseline data.

Sl. No	Noise Quality Location	Location Name	Chainage	Coordinates	Surrounding Land use	Type of Receptor	Justification for site selection
5)	NQ 5	NSRIT School	691+900 (RHS)	17°52'27.80"N 83°17'52.80"E	Residential	Silence Zone	This area is primarily a scattered residential area and NSRIT School boundary is located along the highway at a distance of about 35m and actual school is approximately 110m from centerline.
6)	NQ 6	Gandigundam Village	697+500 (LHS)	17°50'38.46"N 83°15'26.14"E	Residential	Residential	This location is Gandigundam village located next to ROW. There are scattered houses and a village school was seen nearby. Noise monitoring was conducted at a distance of approximately 35m from centerline and represents residential zone.
7)	NQ 7	Mudapaka Village (Bypass)	700+600 (LHS)	17°50'10.99"N 83°13'50.18"E	Residential	Residential	This location is Akkiredi (Mudapaka) on Pendhurthi Bypass. Presently the bypass construction work is progress and the bypass is not operational. On LHS there are many houses and on RHS tree plantations. There were no major noises sources on day of monitoring. This area represents a residential zone and noise monitoring was conducted at a distance of about 35m from centerline after RoW.
8)	NQ 8	Pendhurthi Village	704+000 (LHS)	17°49'43.47"N 83°12'9.63"E	Commercial	Commercial	Pendhurthi represents extremely heavy habitation with all kinds of receptors including residences, hospitals, market, schools etc. in the main town. A bypass is proposed adjacent to the town. Noise monitoring was conducted at a marketplace above first floor of market complex. The monitoring location and the surrounding 200m were observed to be commercial area and hence this location has been categorized as commercial area and not mix land use. The proposed bypass would intercept the crossroad at the monitoring location. The Project road will be at grade with height of more than 6m above the crossroad. This noise and air monitoring location represents commercial zone with lots of varied activities.
9)	NQ 9	Asakapalli Village	716+400 (RHS)	17°46'22.29"N 83° 6'52.93"E	Residential	Residential	This location is Asakapalli village located after ROW. There are scattered houses located approximately 50-150 m from road centerline. Noise monitoring was conducted at a distance of approximately 35m from centerline and represents residential zone.
10)	NQ 10	Batajangpalem (Pallavanipalem Village)	721+500 (RHS)	17°45'4.56"N 83° 4'24.52"E	Residential	Residential	This location is Batajangpalem (also known as Pallavanipalem village) village. The houses are located approximately 50-100 m from road centerline. Noise monitoring was conducted at a distance of approximately 35m from centerline and represents residential zone.

Sl. No	Noise Quality Location	Location Name	Chainage	Coordinates	Surrounding Land use	Type of Receptor	Justification for site selection
11)	NQ 11	Rampuram Village	707+000 (LHS)	17°48'50.03"N 83°10'46.22"E	Residential	Residential	This location is Rampuram village. Noise monitoring was conducted at a distance of approximately 35m from centerline and represents residential zone.
12)	NQ 12	Base Camp 2	724+500 (LHS)	17°44'0.34"N 83° 3'8.05"E	Open land	Industrial	The Base Camp 2 houses crusher plant, batching plant, construction equipment's etc. and the second campsite with labor facilities, construction work and material stockyard. There is no residential houses located close by. A village is located beyond base camp 2 at a distance of about 100m. This base camp will continue to function till end of construction period and after that it will be decommissioned. Noise monitoring was conducted to capture baseline data and represents industrial land use[1].
13)	NQ 13	Maturu Quarry	-	17°44'9.14"N 83° 1'3.58"E	Industrial	Industrial	Maturu quarry area is about 3-4 km away from the Project road and is a source of construction material for the Project. the quarry area is located approximately 250-350 m from Maturu Village. This is a secluded area. The site was selected for air and noise monitoring as this represents industrial receptor. This also depended on the access to power supply to run the High Volume Air sampler instrument to sample the ambient air. Noise monitoring was conducted to capture baseline data and represents industrial land use.
14)	NQ 14	Anakapalle Village	730+800 (LHS)	17°41'20.00"N 83° 1'48.96"E	Industrial	Silence Zone	The location represents lot of developments in and around the area with primarily mixed land use along with few small industries, parking of vehicles and end of Project road. Near Anakapalle one educational institution, Dadi Institute of Engineering and Technology located about 700 m from road (boundary wall at 40m from centerline). This site represents mixed land use.
15)	NQ 15	Base Camp 1	689+800 (RHS)	17°52'55.47"N 83°18'54.31"E	Open land	Industrial	The Base Camp 1 houses crusher plant, batching plant, construction equipment's, and the second campsite with labor facilities, construction work and material stockyard. There are no residential houses located close by. This base camp will continue to function till end of construction period and after that it will be decommissioned. Noise and air monitoring was conducted to capture baseline data and represents industrial land use[2].

[1] OHS considerations for the worker accommodations will be assessed as part of the ESIA.
[2] OHS considerations for the worker accommodations will be assessed as part of the ESIA.

Sl. No	Noise Quality Location	Location Name	Chainage	Coordinates	Surrounding Land use	Type of Receptor	Justification for site selection
16)	NQ 16	Vavilpadu Quarry labor Camp	-	18° 0'9.27"N 83° 1'45.19"E	Industrial	Residential	Vavilpadu quarry area is more than 30 km away from the Project road and is a source of construction material for the Project. The labor camp is located approximately 850 m from the quarry area and noise sample was taken at labour camp area. The site was selected for air and noise monitoring as this represents industrial receptor, and also depended on the access to power supply to run the High Volume Air sampler instrument to sample the ambient air.

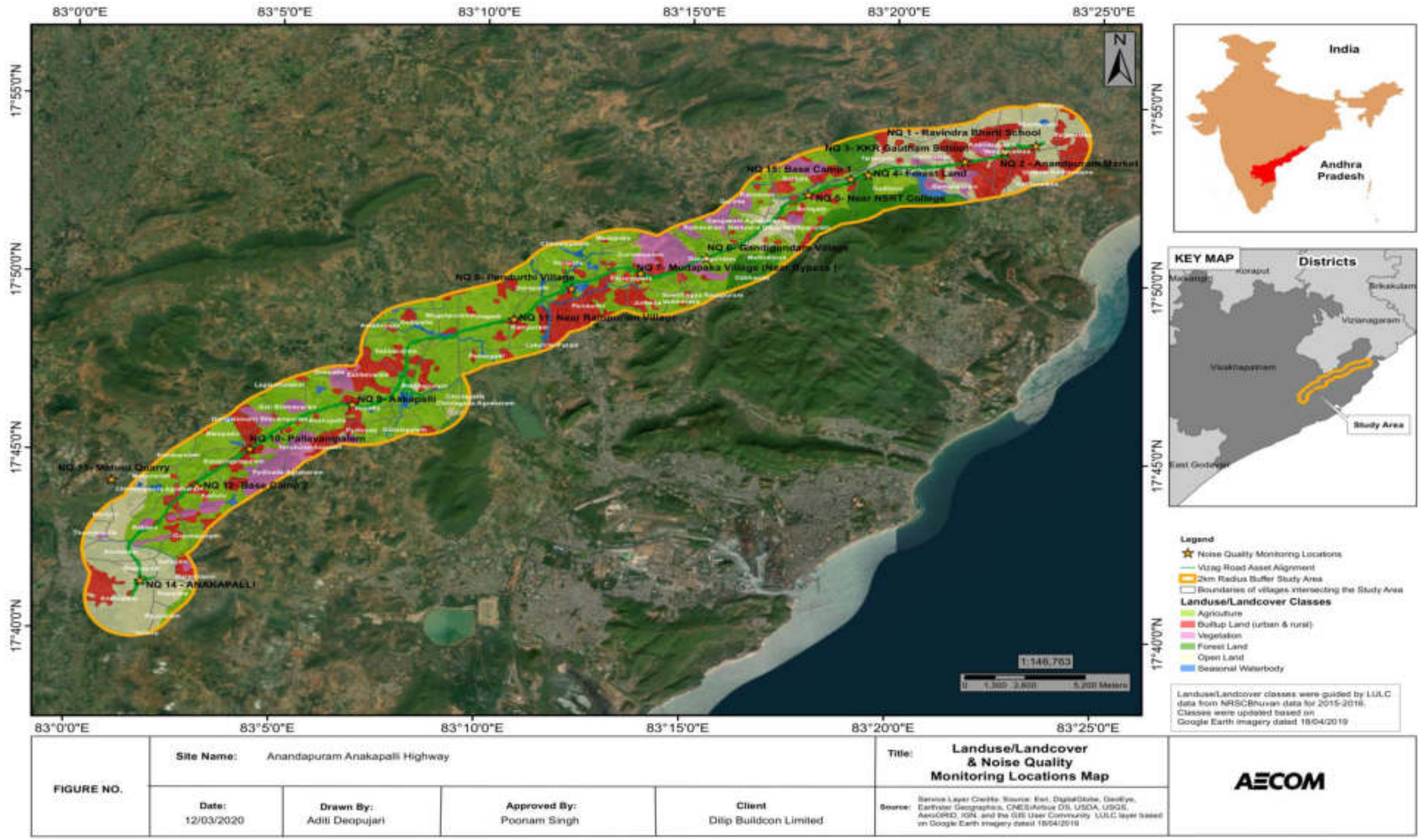


Figure 2-2: Noise Monitoring Location Map

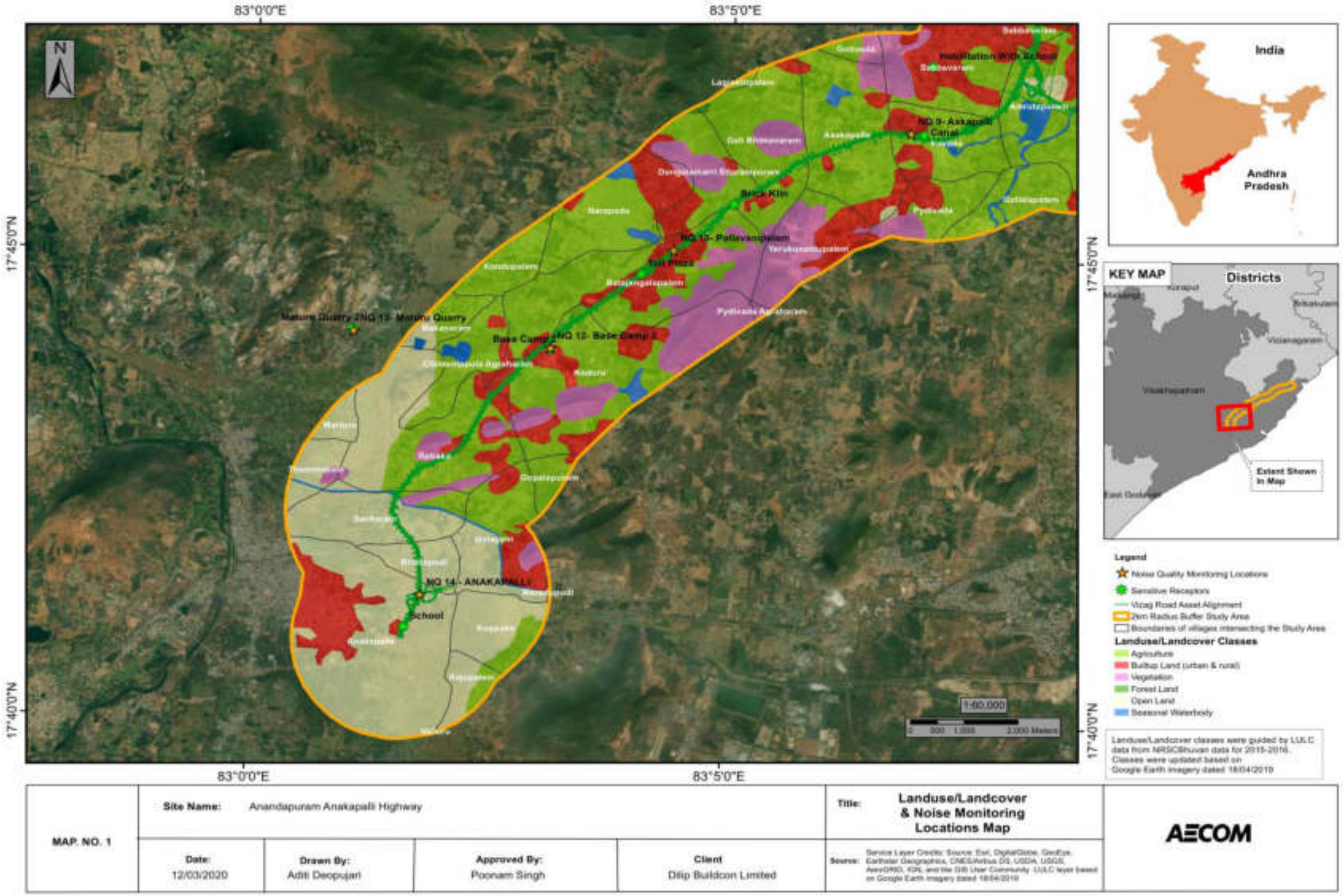


Figure 2-3: Monitoring Location Section 1

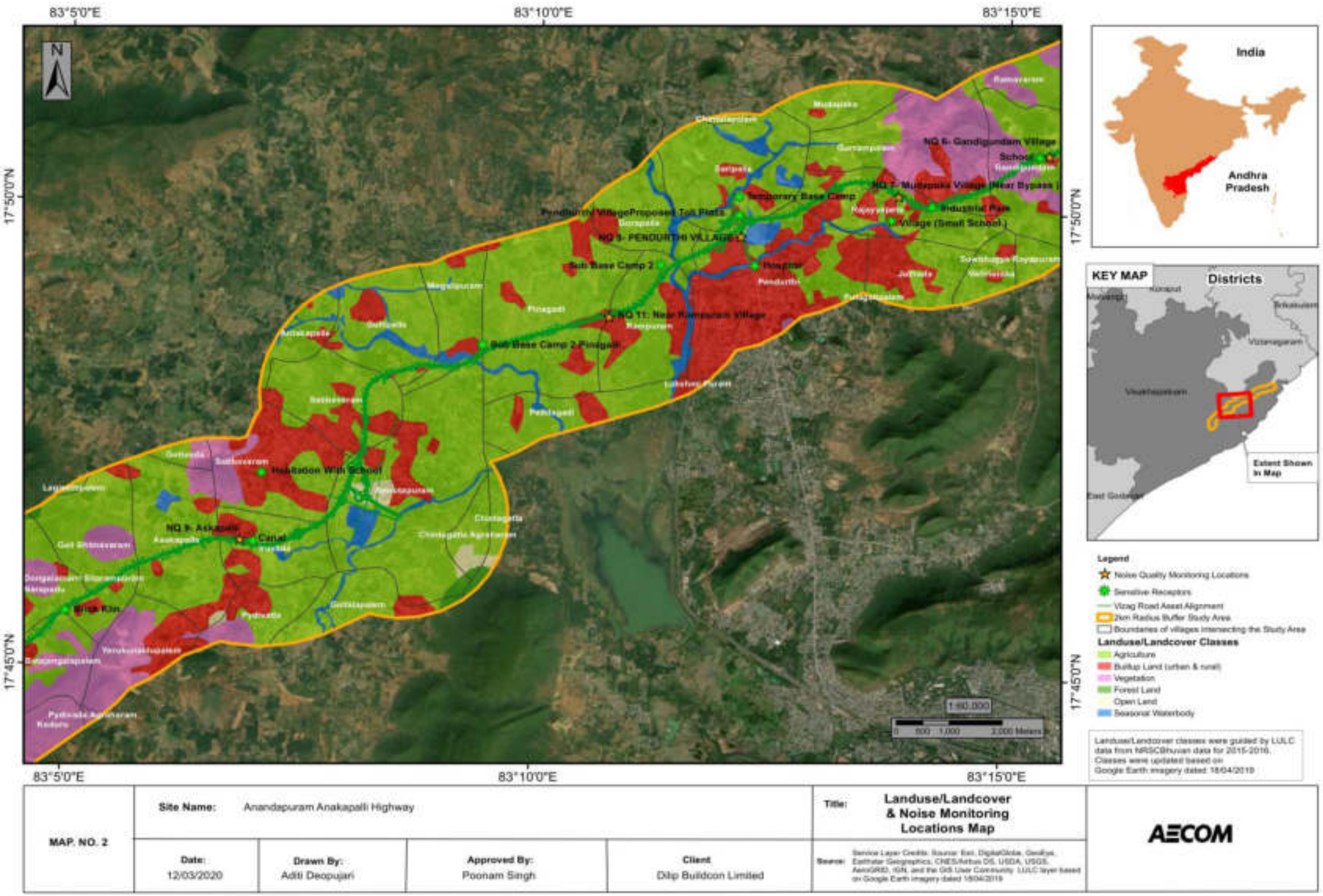


Figure 2-4: Monitoring Location Section 2

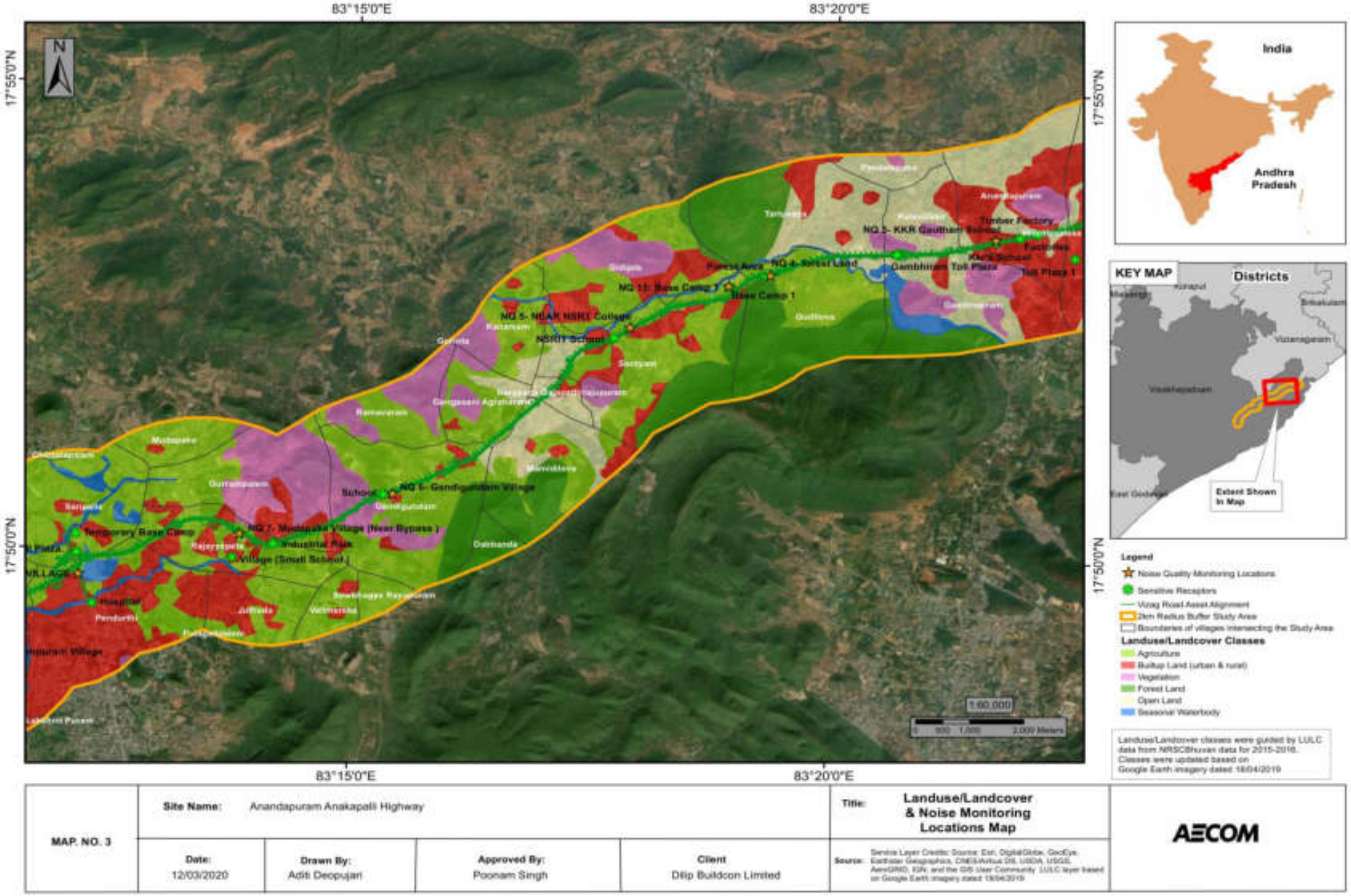


Figure 2-5: Monitoring location Section 3

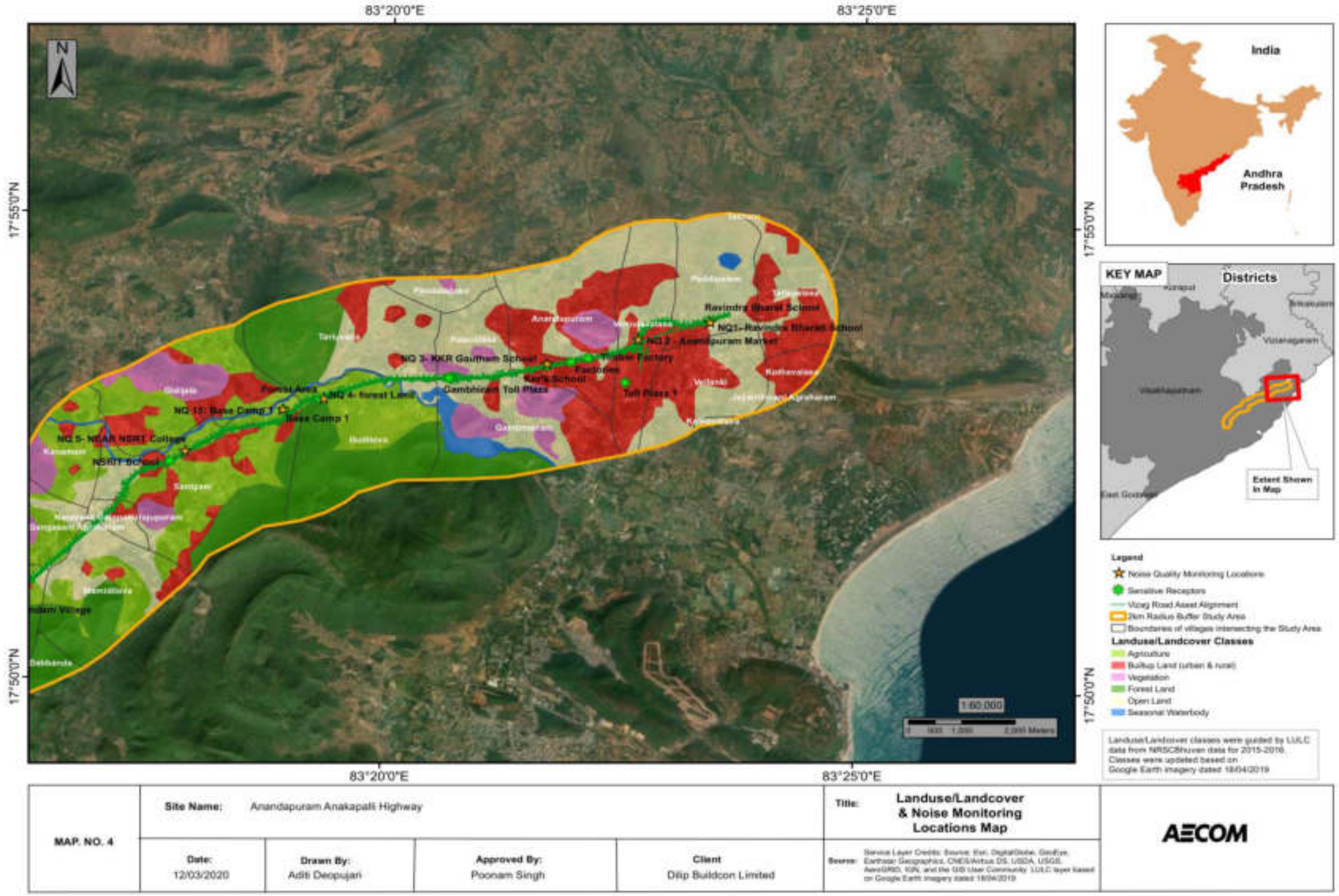


Figure 2-6: Monitoring location Section 4

2.4.4 Noise Monitoring Results

AECOM had appointed Netel (India) Limited to conduct baseline environmental monitoring along the Project road. Netel had conducted ambient noise monitoring at sixteen (16) locations in vicinity of the Project alignment from February 29, 2020 to March 5, 2020. At each of the noise sampling location, noise monitoring was conducted for 48 hours (24 hours during the weekend and 24 hours during the weekdays). The results for noise monitoring for the weekend and weekdays are provided in in Table 2-6 and Table 2-7 respectively.

Table 2-5: Represents the Monitoring Pictures






Table 2-6: Noise Monitoring Results for Weekend

Location Code	Location	Zone	IFC and World Bank Guidelines		WHO 1999 Standards[3] LAeq dB(A)	NAAQS		day Time dBA (Leq)[4]	Night Time dBA (Leq)[5]	Lmin	Lmax	Leq
			Day Time	Night-time		Daytime (Ldn) dB (A)	Night-time dBA (Leq)					
NQ 1	Ravindra Bharat School	Silence Zone	55	45	55[6]	50	40	**61.4**	**59.6**	58.2	63.2	60.9
NQ 2	Anandapuram Village	Residential	55	45	55[7]	55	45	**60.4**	**55.3**	52.1	63.4	59.4
NQ 3	KKR Gautham school	Silence Zone	55	45	55	50	40	51.3	**46.3**	45.2	54.3	50.3
NQ 4	Near Kambalakonda Wildlife Sanctuary	Silence Zone	55	45	-[8]	50	40	53.9	**50.7**	39.5	59.9	53.2
NQ 5	NSRIT School	Silence Zone	55	45	55	50	40	53.3	**49.9**	45.2	58.2	52.6
NQ 6	Gandigundam Village	Residential	55	45	55	55	45	**65.9**	**63.1**	59.4	69.6	65.2
NQ 7	Mudapaka Village (Bypass)	Residential	55	45	55	55	45	50.3	44.5	37.5	56.0	49.2
NQ 8	Pendhurthi Village	Commercial	70	70	70[9]	65	55	**72.7**	68.1	62.5	79.7	71.7
NQ 9	Asakapalli Village	Residential	55	45	55	55	45	**57.5**	**47.9**	43.1	63.7	56.2
NQ 10	Pallavanipalem Village	Residential	55	45	55	55	45	**58.6**	**56.7**	52.4	62.1	58.1
NQ 11	Rampuram Village	Residential	55	45	55	55	45	**61.6**	**56.2**	54.4	64.5	60.6
NQ 12	Basecamp 2	Industrial	70	70	70	75	70	63.0	56.5	48.5	69.1	61.9
NQ 13	Maturu Quarry	Industrial	70	70	70	75	70	60.1	58.0	49.7	67.0	59.6
NQ 14	Anakapalle Village	Silence Zone	50	40	55	50	40	**57.1**	**55.6**	46.9	60.9	56.7
NQ 15	Base Camp 1	Industrial	70	70	70	75	70	53.9	51.5	46.9	60.6	53.4
NQ 16	Vavilpadu Quarry labor Camp	Residential	55	45	55	55	45	**66.9**	**61.9**	59.3	75.5	66.0

[3] https://www.who.int/docstore/peh/noise/Comnoise-4.pdf
[4] Figures in bold indicate exceedances of the relevant IFC EHS Guidelines
[5] Figures in bold indicate exceedances of the relevant IFC EHS Guidelines
[6] As per WHO specific Environment: School, playground outdoor
[7] As per WHO specific Environment: Outdoor living area
[8] As per WHO specific Environment: Background noise should be maintained.
[9] As per WHO specific Environment: Industrial, commercial, shopping and traffic areas, indoors and Outdoors

Noise Analysis for weekend

Table 2-6 shows the measured noise levels at each of the monitoring stations during the weekends. The plots of noise levels against the National Ambient Air Quality Standards (NAAQS) in respect of noise for Day and Night are shown in Figure 2-7 and Figure 2-8 respectively. The major inferences are drawn below:

- During day time the measured noise levels at a few sampling stations were higher than the prescribed NAAQS noise limit. These include a considerable exceedance of noise guidelines at NQ 1, NQ 6 and NQ 8;
- During day time at locations NQ 2, NQ 3, NQ 4, NQ 5, NQ 9, NQ 10, NQ 11, NQ 14 and NQ 16 the noise levels is higher than the compared to NAAQS but comparatively minimal.
- During day time apart from this. Levels at NQ 7, NQ 12, NQ 13 and , NQ 15 were within the NAAQS permissible limits.
- During night time the measured noise levels at a few sampling stations were higher than the prescribed NAAQS noise limit. These include locations at NQ 1, NQ 2, NQ 3, NQ 4, NQ 5 NQ 6, NQ8, NQ 9, NQ 10, NQ 11, NQ 14 and NQ 16. While the other location such as NQ 7, NQ 12, NQ 13 and NQ 15 were within the NAAQS limits.
- Intermittent high noise levels greater than the ambient standards were primarily due to due to passing vehicles, construction machineries, habitation noise etc. and from other noise sources (playing of children and other background noise).
- The measurements were done at locations adjacent to roads wherein noise from vehicles were the significant sources along with other sources such as base camps (housing crusher, RMC plant, DG set etc.) and quarry area etc.
- In accordance with the IFC and World Bank Guidelines during day time NQ1, NQ2, NQ 6, NQ8, NQ9, NQ10, NQ11, NQ14 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ3, NQ 4, NQ5, NQ 7, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- In accordance with the IFC and World Bank Guidelines during night time NQ1, NQ2, NQ 3, NQ 4, NQ5, NQ 6, NQ9, NQ10, NQ11, NQ14 and NQ 16. were observed to be higher than the prescribed limits. Whereas NQ 7, NQ8, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- Whereas as per WHO 1999 Standards during day time NQ1, NQ2, NQ 6, NQ8, NQ9, NQ10, NQ11, NQ14 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ3, NQ 4, NQ5, NQ 7, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- Whereas as per WHO 1999 Standards during night time NQ1, NQ 6, NQ10, NQ11, NQ14 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ2, NQ3, NQ 4, NQ5, NQ 7, NQ 8, NQ9, NQ 12, NQ 13 and NQ 15 were within permissible limits

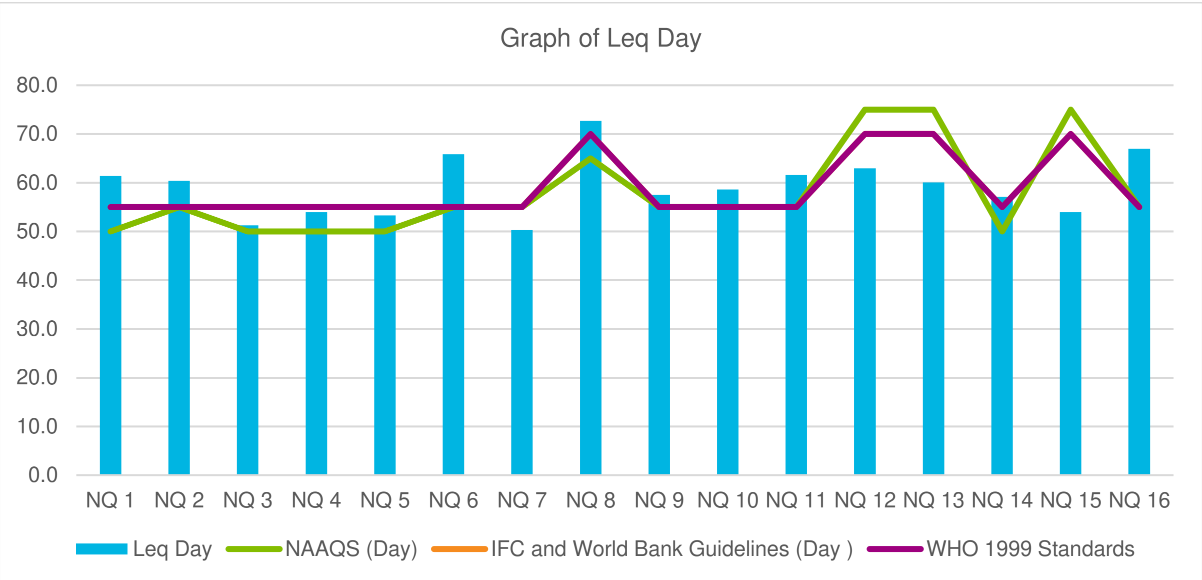


Figure 2-7: Noise Monitoring Results for L_{eq} Day Weekend

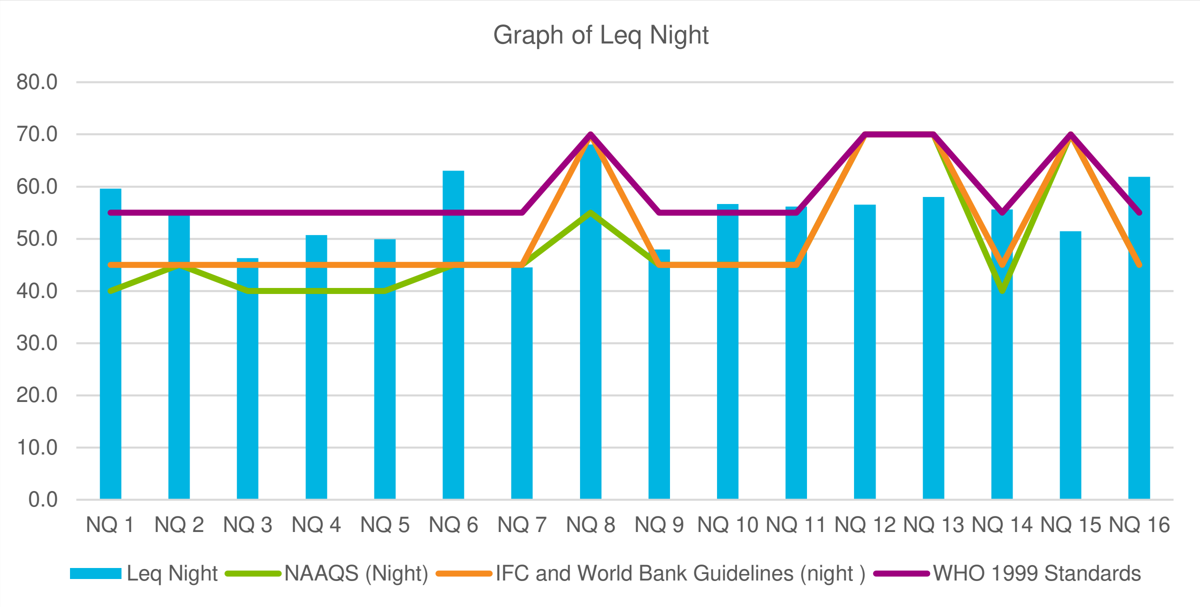


Figure 2-8: Noise Monitoring Results for L_{eq} Night Weekend

Table 2-7: Noise Monitoring Results for Weekday

Location Code	Location	Zone	IFC and World Bank Guidelines		WHO 1999 Standards	NAAQS		Daytime dB(A)[10]	Night times dB(A)[11]	Lmin	Lmax	Leq
			Day Time	Night-time	LAeq dB(A)	Daytime (Ldn) dB (A)	Night-time dBA (Leq)					
NQ 1	Ravindra Bharat School	Silence Zone	55	45	55	50	40	**67.2**	**65.1**	62.5	69.9	66.7
NQ 2	Anandapuram Village	Residential	55	45	55	55	45	**61.2**	**59.9**	56.2	64.7	60.9
NQ 3	KKR Gautham school	Silence Zone	55	45	55	50	40	**58.0**	**53.1**	43.7	68.8	57.0
NQ 4	Near Kambalakonda Wildlife Sanctuary	Silence Zone	55	45	55	50	40	53.0	**50.4**	45.8	58.3	52.4
NQ 5	NSRIT School	Silence Zone	55	45	55	50	40	49.5	44.5	42.6	51.3	48.5
NQ 6	Gandigundam Village	Residential	55	45	55	55	45	**66.5**	**61.6**	57.3	69.4	65.5
NQ 7	Mudapaka Village (Bypass)	Residential	55	45	55	55	45	52.3	**49.0**	40.6	55.6	51.6
NQ 8	Pendhurthi Village	Commercial	70	70	70	65	55	**73.5**	68.7	57.9	77.2	72.6
NQ 9	Asakapalli Village	Residential	55	45	55	55	45	**57.6**	**53.5**	49.8	60.1	56.7
NQ 10	Pallavanipalem Village	Residential	55	45	55	55	45	**57.0**	**46.6**	37.1	63.5	55.7
NQ 11	Rampuram Village	Residential	55	45	55	55	45	**61.2**	**52.5**	49.0	65.7	60.0
NQ 12	Basecamp 2	Industrial	70	70	70	75	70	62.6	55.4	48.5	68.3	61.4
NQ 13	Maturu Quarry	Industrial	70	70	70	75	70	60.0	60.2	53.2	65.3	60.1
NQ 14	Anakapalle Village	Silence Zone	50	40	55	50	40	**57.0**	**49.7**	42.6	59.9	55.9
NQ 15	Base Camp 1	Industrial	70	70	70	75	70	57.0	56.4	47.9	61.2	56.8
NQ 16	Vavilpadu Quarry labor Camp	Residential	55	45	55	55	45	**62.1**	**60.1**	59.3	68.0	61.6

[10] Figures in bold indicate exceedances of the relevant IFC EHS Guidelines
[11] Figures in bold indicate exceedances of the relevant IFC EHS Guidelines

Noise Analysis for weekday

Table 2-7 shows the measured noise levels at each of the monitoring stations during the weekdays. The plots of noise levels against the NAAQS standards for Day and Night are shown in Figure 2-9 and Figure 2-10 respectively. The major inferences are drawn below:

- During day time the measured noise levels at a few sampling stations were higher than the NAAQS prescribed limit of ambient Noise. These include a considerable noise levels at NQ 1, NQ 6 and NQ 8,
- During day time at locations NQ 2, NQ 3, NQ 4, NQ 9, NQ 10, NQ 11, NQ 14 and NQ 16 the difference in noise level is higher than the compared to NAAQS but comparatively minimal.
- During day time apart from this, all other locations such as, NQ 5, NQ 7, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- During night time the measured noise levels at a few sampling stations were higher than the prescribed NAAQS noise limit. These include locations at NQ 1, NQ 2, NQ 3, NQ 4, NQ 5 NQ 6, NQ8, NQ 9, NQ 10, NQ 11, NQ 14 and NQ 16. While the other location such as NQ 7, NQ 12, NQ 13 and NQ 15 were within the NAAQS limits.
- Intermittent high noise levels greater than the ambient standards were due to passing vehicles, construction machineries, habitation noise etc. and from other noise sources. Measurements were done at locations adjacent to roads wherein noise from vehicles were the significant sources along with other sources such as Base camps (Containing Crusher, RMC plant, DG set etc.) quarry etc.
- In accordance with the IFC and World Bank Guidelines during day time NQ1, NQ2, NQ 3, NQ 6, NQ8, NQ9, NQ10, NQ11, NQ14 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ 4, NQ5, NQ 7, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- In accordance with the IFC and World Bank Guidelines during night time NQ1, NQ2, NQ 3, NQ 4, NQ 6, NQ 7, NQ9, NQ10, NQ11, NQ14 and NQ 16. were observed to be higher than the prescribed limits. Whereas NQ5, NQ8, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- Whereas as per WHO 1999 Standards during day time NQ1, NQ2, NQ 3, NQ 4, NQ 6, NQ 7, NQ9, NQ14 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ5, NQ8, NQ 12, NQ 13 and NQ 15 were within permissible limits.
- Whereas as per WHO 1999 Standards during night time NQ1, NQ2, NQ 6 and NQ 16 were observed to be higher than the prescribed limits. Whereas NQ3, NQ 4, NQ5, NQ 7, NQ 8, NQ9, NQ10, NQ11, NQ 12, NQ 13, NQ 14 and NQ 15 were within permissible limits

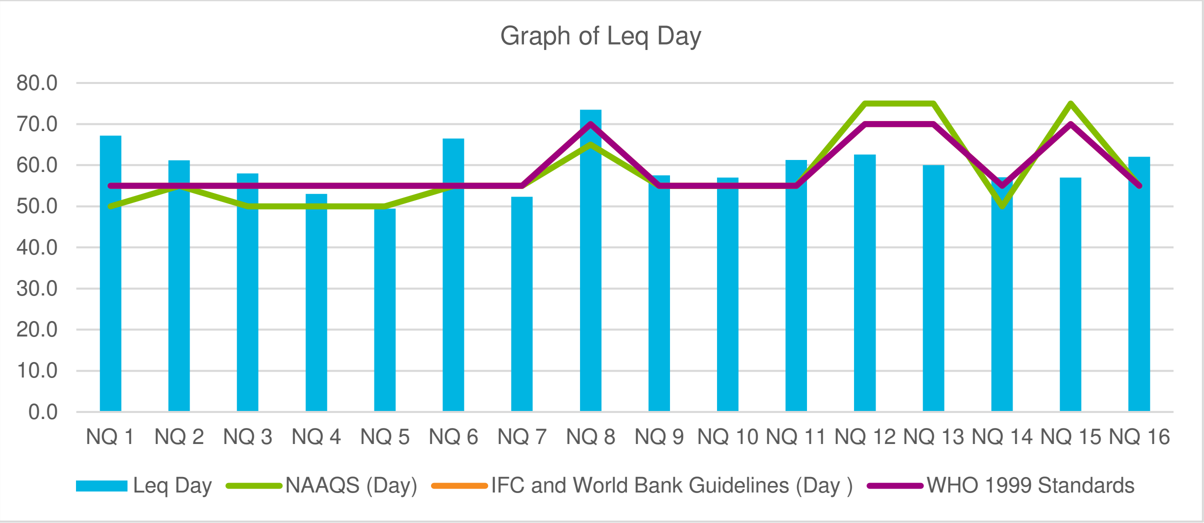


Figure 2-9: Noise Monitoring Results for L_{eq} Day Weekday

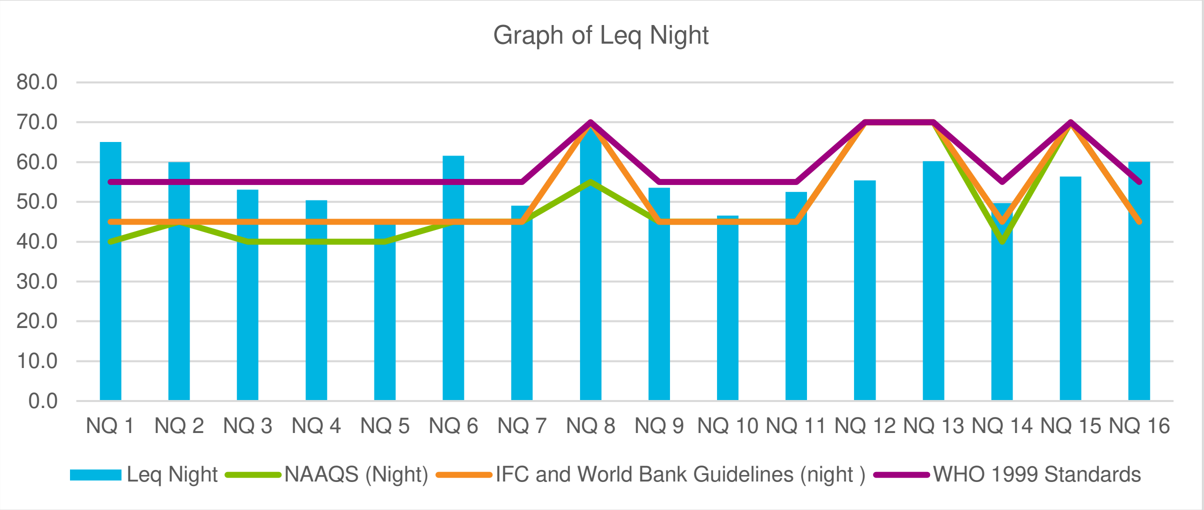


Figure 2-10: Noise Monitoring Results for L_{eq} Day Weekday

3. Noise Modelling

The highway traffic noise levels are expressed in terms of the hourly, A-weighted equivalent sound level in decibels (dBA). A sound level represents the level of the rapid air pressure fluctuations caused by sources, such as traffic, that are heard as noise. A decibel is a unit that relates the sound pressure of a noise to the faintest sound the young human ear can hear. The A-weighting refers to the amplification or attenuation of the different frequencies of the sound (subjectively, the pitch) to correspond to the way the human ear "hears" these frequencies. Generally, when the sound level exceeds the mid-60 dBA range, outdoor conversation in normal tones at a distance of three feet (0.9 meters) becomes difficult. About 9- 10 dB increase in sound level is typically judged to be twice as loud as the original sound, while a 9-10 dB reduction is half as loud. Doubling the number of sources (i.e., vehicles) increases the hourly equivalent sound level (Leq) by approximately 3 dB, which is usually the smallest change that people can detect without specifically listening for the change.

As most environmental noise fluctuates from moment to moment, it is standard practice to condense data into a single level called the equivalent sound level (Leq). The Leq is a steady sound level that would contain the same amount of sound energy as the actual time varying sound evaluated over the same time period. The Leq averages the louder and quieter moments but gives much more weight to the louder moments in the averaging. For traffic noise studies, Leq is typically evaluated over the worst one-hour period and is defined as Leq.

The term Insertion Loss (IL) is generally used to describe the reduction in Leq (1h) at a location after a noise barrier is constructed. For example, if the Leq (1h) at a residence before a barrier is constructed is 75 dBA and the Leq (1h) after a barrier constructed is 65 dBA, then the insertion loss would be 10 dB. Noise studies may use the terms "receptor" and "receiver" that are similar but distinct. Receptors represent noise-sensitive locations, such as a backyard or an outdoor seating area at a restaurant. Receivers are discreet TNM modelling points that represent receptors. A TNM receiver can represent a single receptor or a group of receptors, such as using one TNM receiver to represent a group of residences with similar sound levels.

This section represents noise modelling for the construction and operation of the proposed project. The noise model, noise emission source inputs and other model inputs, and the results and discussions are provided for each phase of the project.

3.1 The Noise Model and Noise Calculation Standard

The Federal Highway Administration's Traffic Noise Model (FHWA TNM) is used in this study to simulate the propagation of construction equipment noise levels to help predict construction operational impacts, where the levels would be implemented in construction noise prediction models or methods. Also, existing noise levels are established during construction; this would help to establish noise levels during the construction phase, particularly for receivers that may be highly noise sensitive.

Noise impact is determined by comparing predicted future noise levels with the Project:

1) to a set of Noise Abatement Criteria (NAC) for a land use activity category, and

2) to existing noise levels.

Measurement methods applicable to determining operational noise impacts for highway operation. Existing noise measurements should be conducted for these types of projects for two primary reasons:

1) To establish existing noise levels; and

2) To validate the FHWA Traffic Noise Model (FHWA TNM).

Measurement of noise sources other than roadways/highways may be necessary for noise-sensitive areas that are exposed to multimodal noise sources such as trains and aircraft; screening estimates or prediction methods may suffice for consideration of these noise sources. Measurement of the influence of pavement on noise in areas adjacent to roadways/highways may be helpful for validating the noise model and for understanding pavement's influence on the project.

3.1.1 Noise Emission Sources

Construction of the proposed project will involve use of numerous types of construction equipment that are mobile and with high intermittent noise emissions. Owing to the variability of construction noise and the length of the project route which extends more than 50 km, simulations were performed only for a specific location or site adjacent residential areas, as shown in Figure 2-2. Apart from that there would be other outdoor sources of noise that would form accumulative emission source with the construction equipment's. Figure 3-1 shows some common indoor and outdoor sound levels

Figure 3-1:Common Outdoor Noises

3.2 Model Inputs and Methodology

Following considerations were used in noise modelling.

3.2.1 Environmental Considerations

The model inputs were the meteorological parameters (air temperature, humidity, and atmospheric pressure) and simulations were also performed on scenarios with and without noise barrier. Elevation points were derived from the Shuttle Radar Topography Mission (SRTM) data, which were extracted and processed using AERMAP View, a terrain pre-processor of AERMOD View Air Dispersion Modelling. Elevation points (x, y, z) were then imported in AutoCAD and converted to *.dxf (AutoCAD format). The annual average meteorological parameters used in the simulations are given below.

- Air temperature = 28 °C,
- Relative Humidity = 70%; and
- Atmospheric pressure = 1009 mb

Satellite imageries from Google Earth covering the modelling domains were imported in AutoCAD and used as base maps. Houses, commercial buildings, and roads within the modelling domain were digitized in AutoCAD and converted to *.dxf format, which were then imported in FHWA TNM.

3.2.2 Traffic Considerations

Five classes of vehicle are used in this FHWA model for prediction of noise in the future; they are automobiles, medium trucks, heavy trucks, buses and motorcycles. The five TNM vehicle types are defined as follows:

1. Automobiles: all vehicles with two axles and four tires
2. Medium trucks: all cargo vehicles with two axles and six tires
3. Heavy trucks: all cargo vehicles with three or more axles
4. Buses: all vehicles designed to carry more than nine passengers; and
5. Motorcycles: all vehicles with two or three tires and an open-air driver/passenger compartment.

Vehicle Speed Consideration

- 4-Wheeler: 60 kmph
- LCV: 60 kmph
- 2-Wheeler: 60 kmph
- Medium sized vehicles: 50 kmph
- Multi axle vehicles: 45 kmph

3.2.3 Other Considerations

One of the regional aspects considered during noise assessment is land use zoning regulations near Project corridor among the published sources and consultation with local people and with the client. Though some parts of Project area (Pendurthi) falls in Greater Visakhapatnam Municipal Corporation limit, however, specific and localised land use zoning close to Project highway (within 100 meters) is not evident. Moreover, the Project road being a National Highway, the RoW is protected and minimum width of 60m is considered. Also, during site visit no such major developments were evident.

Other parameters considered are:

- Width of Road: 21m (main CW)
- RoW considered is 60m
- Type of pavement: Average: An average pavement is a pavement type consisting of Reference Energy Mean Emission Levels (REMEL) data measured on Dense-graded asphalt concrete (DGAC) and Portland cement concrete (PCC) pavements combined.
- Noise reduction Goal: 8dB to 15dB
- Height of receiver above ground level: 1.5m (average)
- Height of barrier: 3m for analysis purpose and 8m for comparison
- Length of Barrier: 150m along the road
- Barrier type: Wall
- Default Ground type: Field Grass

As worst-case scenario has been considered for noise modelling, hence the highest noise value (Lmax) has been considered as the base value to run the model so as to receive the highest value that would impact a particular receptor at any time.

Table 3-1: Annual Traffic Volume Growth rate

Year	Pvt. Car/Jeep/Mini LCV	Three Wheeler	Two wheeler	Mini Bus	School Bus	LCV	2-axle Truck	3-axle Truck	MAV(4 -6 axle)	Tractor	Tractor with Trailor	Cycle	Cycle-Rickshaw	Hand - Cart	Animal-Drawn
2020	7.6	7.6	8.5	6.6	6.6	5.5	5.5	6.0	5.8	5.5	3.0	3.0	3.0	0.0	0.0
2021	7.6	7.6	8.5	6.6	6.6	5.5	5.5	6.0	5.8	5.5	3.0	3.0	3.0	0.0	0.0
2022	7.6	7.6	8.5	6.6	6.6	5.5	5.5	6.0	5.8	5.5	3.0	3.0	3.0	0.0	0.0
2023	6.6	6.6	8.2	6.3	6.3	5.4	5.4	5.8	5.6	5.4	3.0	3.0	3.0	0.0	0.0
2024	6.6	6.6	8.2	6.3	6.3	5.4	5.4	5.8	5.6	5.4	3.0	3.0	3.0	0.0	0.0
2025	6.6	6.6	8.2	6.3	6.3	5.4	5.4	5.8	5.6	5.4	3.0	3.0	3.0	0.0	0.0
2026	6.6	6.6	8.2	6.3	6.3	5.4	5.4	5.8	5.6	5.4	3.0	3.0	3.0	0.0	0.0
2027	6.6	6.6	8.2	6.3	6.3	5.4	5.4	5.8	5.6	5.4	3.0	3.0	3.0	0.0	0.0
2028	6.3	6.3	8.0	6.0	6.0	5.3	5.2	5.7	5.5	5.2	3.0	3.0	3.0	0.0	0.0
2029	6.3	6.3	8.0	6.0	6.0	5.3	5.2	5.7	5.5	5.2	3.0	3.0	3.0	0.0	0.0
2030	6.3	6.3	8.0	6.0	6.0	5.3	5.2	5.7	5.5	5.2	3.0	3.0	3.0	0.0	0.0
2031	6.3	6.3	8.0	6.0	6.0	5.3	5.2	5.7	5.5	5.2	3.0	3.0	3.0	0.0	0.0
2032	6.3	6.3	8.0	6.0	6.0	5.3	5.2	5.7	5.5	5.2	3.0	3.0	3.0	0.0	0.0
2033	5.9	5.9	7.7	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2034	5.9	5.9	7.7	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2035	5.9	5.9	7.7	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2036	5.9	5.9	7.7	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2037	5.9	5.9	7.7	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2038	5.9	5.9	7.5	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2039	5.9	5.9	7.5	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0
2040	5.9	5.9	7.5	5.6	5.6	5.2	5.1	5.5	5.3	5.1	3.0	3.0	3.0	0.0	0.0

3.3 Results and Discussion

The summary of the results of the simulations are presented in Table 3-2. The simulations for the noise levels are done for years 2025, 2030, 2035 and 2040, these stimulations are done without noise barriers as well as with noise barriers of about 3m height and 150 m in length to understand the reduction in noise levels.

The noise exceedance values are highlighted in red font at respective places. There are three schools (NQ1, NQ3 and NQ5) situated approximately 90 m from the central line of the highway. Hence, the noise modelling for NQ1, NQ3 and NQ 5 has been conducted for 90m as well as 30m distance from road centreline. The noise level values predicted at 30m from centreline has been provided in the table and the values predicted at the 90m from the centreline has been provided in the footnotes.

Table 3-2: Noise Modelling Results

Location	Place	Type of Receptor	NAAQS	Baseline Weekday Noise Level	Baseline Weekend Noise Level	Predicted Weekday Noise Level (dBA) Without Barrier @30m from C/L				Predicted Noise Level (dBA) with Barrier_3m height @ 30m from C/L				Noise Reduction (dBA) with Barrier 3m height @30m from C/L				Peak Hour Traffic Considered for Noise Modelling				
				2020	2020	2025	2030	2035	2040	2025	2030	2035	2040	2025	2030	2035	2040	2020	2025	2030	2035	2040
NQ 1	Ravindra Bharati School	Silence Zone	50	69.9	63.2	72.1[12]	**73.5**	**74.9**	**76.2**	63	64.5	65.9	**67.2**	9.1	9	9	9	2,556	3,537	4,831	6,536	8,803
NQ 2	Anandpuram Village (near Surya Traders) (Flyover proposed)	Residential	55	64.7	63.4	**74.4**	**75.8**	**77.2**	**78.5**	65	66.4	67.8	**69.2**	9.4	9.4	9.4	9.3	2,556	3,537	4,831	6,536	8,803
NQ 3	Opposite Dr. KKRS Gowtham School[13]	Silence Zone	50	68.8	54.3	69.4	70.3	71.6	**73**	61.8	62.8	64 .2	65.5	7.6	7.5	7.4	7.5	2,556	3,537	4,831	6,536	8,803
NQ 4	Labour hutment beside (Forest area)	Silence Zone	50	58.3	59.9	**67.6**	**69.1**	**70.4**	**71.8**	61.8	63.2	**64.7**	**66**	5.8	5.9	5.8	5.9	2,556	3,537	4,831	6,536	8,803
NQ 5	Gommidivanipalem Village (NSRIT College[14])	Silence Zone	50	51.3	58.2	**70.9**	**72.3**	**73.7**	**75**	**63.4**	**64.9**	**66.3**	**67.6**	9.6	7.4	7.4	7.4	2,556	3,537	4,831	6,536	8,803

[12] Noise level values predicted at 90m from centreline without noise barrier is 2025: 66.0 dBA, 20230: 67.5 dBA, 2035: 68.8 dBA, 2040: 70.2 dBA.
Noise level values predicted at 90m from centreline without noise barrier with height of 3m is 2025: 62.3 dBA, 2030: 63.8 dBA, 2035: 65.2 dBA, 2040: 66.5 dBA.

[13] Noise level values predicted at 90m from centreline without noise barrier is 2025: 64.1 dBA, 20230: 65.6 dBA, 2035: 67.0 dBA, 2040: 68.3 dBA.
Noise level values predicted at 90m from centreline with noise barrier with height of 3m is 2025: 61.7 dBA, 2030: 63.2 dBA, 2035: 64.6 dBA, 2040: 65.9 dBA.

[14] Noise level values predicted at 90m from centreline without noise barrier is 2025: 66.4 dBA, 2030: 67.9 dBA, 2035: 69.3 dBA, 2040: 70.6 dBA.
Noise level values predicted at 90m from centreline with noise barrier with height of 3m is 2025: **61.3** dBA, 2030: **62.8** dBA, 2035: **64.1** dBA, 2040: **65.5** dBA.
Noise level values predicted at 90m from centreline with noise barrier with height of 8m is 2025: 60.6 dBA, 2030: **62.0** dBA, 2035: **63.4** dBA, 2040: **64.7** dBA.

Location	Place	Type of Receptor	NAAQS	Baseline Weekday Noise Level	Baseline Weekend Noise Level	Predicted Weekday Noise Level (dBA) Without Barrier @30m from C/L				Predicted Noise Level (dBA) with Barrier_3m height @ 30m from C/L				Noise Reduction (dBA) with Barrier 3m height @30m from C/L				Peak Hour Traffic Considered for Noise Modelling				
				2020	2020	2025	2030	2035	2040	2025	2030	2035	2040	2025	2030	2035	2040	2020	2025	2030	2035	2040
NQ 6	Godigundam village (Light Vehicular Underpass (LVUP) @ 697+840)	Residential	55	69.4	69.6	61.3	62.7	64.1	65.5	58.6	60.1	61.5	62.8	2.6	2.6	2.6	2.7	2,556	3,537	4,831	6,536	8,803
NQ 7	Akkiredi (Mudapaka) on Bypass (LVUP @ 700+800)	Residential	55	55.6	56	52.9	54.3	55.6	56.9	51.2	52.6	53.9	55.2	1.7	1.7	1.7	1.7	1,300	1,791	2,445	3,312	4,470
NQ 8	Pendarthi (Bypass is at grade above the existing road)	Commercial	65	77.2	79.7	58.5	59.9	61.2	62.5	57.2	58.6	59.9	61.2	1.3	1.3	1.3	1.3	1,300	1,791	2,445	3,312	4,470
NQ 9	Askapali village (LVUP @716+400)	Residential	55	60.1	63.7	59.8	61.2	62.5	63.8	58.6	60	61.3	62.6	1.2	1.2	1.2	1.2	1,300	1,791	2,445	3,312	4,470
NQ 10	Batajangpalem	Residential	55	63.5	62.1	**67.6**	**69**	**70.3**	**71.5**	60	61.3	62.6	63.9	7.6	7.7	7.7	7.6	945	1,294	1,756	2,365	3,175
NQ 11	Ramapuram	Residential	55	65.7	64.5	**69.3**	**70.7**	**72**	**73.3**	60.9	62.3	63.6	64.9	8.4	8.4	8.4	8.4	1,300	1,791	2,445	3,312	4,470
NQ 12	Base Camp 2	Industrial	75	68.3	69.1	68.3[15]	61.9	63.2	64.5	58.5	59.8	61.1	62.4	9.8	2.1	2.1	2.1	945	1,294	1,756	2,365	3,175
NQ 13	Maturu Mining (Crusher)	Industrial	75	65.3	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NQ 14	Ankapale	Silence Zone	50	59.9	60.9	**72.7**	**74.1**	**75.5**	**76.9**	60.5	61.9	63.3	64.6	12.6	12.6	12.6	12.7	945	1,294	1,756	2,365	3,175
NQ 15	Base Camp 1	Industrial	75	61.2	60.6	64[16]	**65.5**	**67.4**	**68.2**	62.6	**64.1**	**66**	**66.8**	1.4	1.4	1.4	1.4	2,556	3,537	4,831	6,536	8,803
NQ 16	Vavilapada	Residential	55	68	75.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[15] For 2025 the noise level has been considered as baseline noise level. Since the campsite would be decommissioned by end of 2021, the background noise level generated from construction campsite no longer affect the site.
[16] For 2025 the noise level has been considered as baseline noise level. Since the campsite would be decommissioned by end of 2021, the background noise level generated from construction campsite no longer affect the site.

Table 3-2 shows the baseline noise levels arising from the simulations with and without the noise barriers. Few of the locations predicted noise levels are greater than the permissible ambient standards set for residential areas, sensitive areas like schools/ colleges, forest area, commercial areas etc. With noise barriers, there were substantial reduction of modelled noise levels depending on the height of the walls. The proposed heights of the noise barrier have been set to 3m and the length has been considered as 150m, in most cases. Assuming use of noise barrier walls that blocked the construction noise (i.e., retractable noise barriers) with the nearest households, there would be considerable reduction of predicted noise levels at the facades of houses or buildings fronting the equipment. With the addition of noise barriers there have been reduction ranging of noise level ranging from 1.3 dBA at Pendurthi to 13.6 dBA at Akkiredi village. This study referred to the IFC-WB (2007) noise guidelines that specifies limit of +3dBA from the background noise of the nearest receptor. Noise locations where the predicted noise levels are higher the +3dBA from the background noise have been highlighted.

- **NQ 1**: At NQ 1, Ravindra Bharat School the baseline noise levels arising from the simulations showed that the noise levels were above the prescribed standard at all years until 2040. As per the IFC-WB (2007) Guidelines +3dBA from the background noise has been found to exceed only after the year 2030. Since the school is observed to be at 90m away from the noise monitoring stations (end of RoW), this is expected to reduce even further. With a noise barrier, a reduction of approximately 9 dBA was observed. It is understood that to provide additional wall/ barrier, the permission of NHAI is required as this would be out of scope of concession agreement. It is recommended to modify the existing boundary wall of the school to make it a continuous wall with a minimum 3m height. In this regard, AAHPL will need to have a discussion with the school authorities and decide. at the predicted noise levels in 2040 the noise level (with the noise barrier) will be above +3dBA from the baseline noise level. It is assumed that at 2040, the concession period will be over, and the impact of noise may have to be assessed again by the new concessionaire. If required, the noise barrier will be refurbished along with increasing the height of barrier.
- **NQ 2**: At NQ 2, Anadpuram Village which is a marketplace along with residential area. As per the IFC-WB (2007) Guidelines +3dBA from the background noise has been found to exceed from the year 2025 itself. However, simulation with Noise barrier have shown a reduction of 9.4 dBA for the year 2025 and 2030. It is recommended that a High-Density Acoustical Material Noise barrier of 3m height be constructed (on the Flyover). After 2035 monitoring of noise level needs to be carried out to access the noise levels and appropriate refurbishing of the noise barrier needs to be validated.
- **NQ 3**: At NQ 3, KKR Gautham School, the baseline noise levels arising from the simulations showed that the noise levels were below +3dBA from the background noise as per the IFC-WB (2007) Guidelines at all years until 2035. However, with the noise barrier, a reduction of approximately 7.5dBA was observed for all years upto 2040. As the ambient noise level is observed within +3 dBA for all years till 2035, hence noise barrier is not proposed. As part of annual noise monitoring, DBL would monitor the ambient noise level and if require would implement adequate mitigation measures in case the noise level goes beyond +3 dBA of present level after 2035.
- **NQ 4**: NQ 4 is an open area without human receptors and includes a forest area, which is a sensitive zone. The baseline noise levels arising from the simulations shows that the noise levels were above the +3dBA from the background noise as per the IFC-WB (2007) guidelines at all years from 2025. Increase in noise levels could have adverse impacts on the biodiversity present in the area by altering predator or prey detection and avoidance, interfere with reproduction and navigation, and contribute to hearing loss. However, as the site is at the edge of the protected area and a hillock of approximately 25 m is adjacent to the road, it is considered that the hillock will act as a natural noise barrier, limiting the noise impacts on the wider forest area. Signage to inform users that the area is a no honking zone and other mitigation measures, such as the use of rumble strips leading up to the area and afforestation, will be deployed in the area to further minimize potential noise impacts.
- **NQ 5**: At NQ 5, NSRIT college, the baseline noise levels arising from the simulation shows that the noise levels were above the +3dBA from the background noise as per the IFC-WB (2007) Guidelines at all years from 2025. A proposal to thicken the compound wall of the school along with increasing the height (3 m) would act as the noise barriers. However, monitoring will be conducted to ascertain the exceedance of noise levels from 2030 and appropriate mitigation measures to be adopted.
- **NQ 6**: At NQ 6, Godigundam village, is a residential area with a small number of habitations. There is a proposed vehicular underpass at this location. The simulation for prediction of noise level is carried out keeping in mind the road above the proposed underpass, hence, the reduction in predicted noise levels noise levels as compared to the current baseline noise levels. The baseline noise levels arising from the simulations shows that the noise levels were below the +3dBA from the background noise as per the IFC-WB (2007) Guidelines at all years until 2040. Hence no noise barrier is proposed.
- **NQ 7**: At NQ 7, Akkiredi is a village located on proposed bypass and the baseline noise levels confirms to present accepted noise level stipulated by CPCB. The noise level prediction till 2040 have shown a steady rise in levels. The proposed alignment is at grade above the existing road. However, the noise levels have been found to be below the +3dBA from the background noise has been as per the IFC-WB (2007) Guidelines at all years from 2025. Hence no noise barrier is proposed.

- **NQ 8**: At NQ 8, Pendurthi Village, which is a commercial area and hence the baseline for 2020 has been observed to be higher than the prescribed limits. However, the proposed bypass is above the existing road, and owing to this the height difference, would play a major part in dissipating the noise levels. Hence, the baseline noise levels arising from the simulations from 2025-2040 will be within the +3dBA from the background noise has been as per the IFC-WB (2007) Guidelines and so no noise barrier is proposed.
- **NQ 9**: At NQ 9, At Askapali there is a proposed vehicular underpass. The simulation for prediction of noise is carried out keeping in mind the noise at above the proposed underpass. Therefore, the reduction in predicted noise levels as compared to the current baseline noise levels would be less. Hence no noise barrier is proposed.
- **NQ 10**: At NQ 10, Batajangpalem is a dense habitation and the baseline noise levels arising from the simulations showed that the noise levels will be above +3dBA from the background noise as per the IFC-WB (2007) Guidelines at all years from 2025. The simulation with noise barrier, a reduction of 7.7 dBA was observed. Keeping in mind, the Batajangpalem being a large habitation and close to proposed toll plaza, a proposal high-density acoustical material noise barrier of 3m height is recommended.
- **NQ 11**: At NQ 11, Ramapuram village, is a small village and the predicted noise levels arising from the simulations shows that the noise levels will be above the +3dBA from the background noise as per the IFC-WB (2007) Guidelines at all years from 2025. With adoption of noise barrier, a reduction of 8.4 dBA can be achieved. A proposal for high-density acoustical material noise barrier of 3m height is recommended. Since Ramapuram is a small habitation the noise barrier should be placed in such a way that only the impacted receptors are protected.
- **NQ 12**: At NQ 12, Base camp 2, is an area which houses crusher, batching plant, WMM plant etc and hence considered as industrial area as per the CPCB. The base camp will be decommissioned within 1.5 to 2 years. Post decommissioning, the land would be handed over to the owner and put to normal usage (may be open stockyard). There is no immediate receiver within 100m of basecamp and, therefore, the impact of noise will not be evident. The noise levels arising from the simulations shows that the incremental noise for all years until 2040 would not be evident and impact any receiver. Though noise barrier is not provisioned at this place, however, as per the conditions of Consent for Operation (CFO) cladding and kirby sheets of 20 feet height needs to be fenced all around the suspected fugitive periphery around the RMC, HMM, stone crusher etc. This is to be enforced immediately. After the decommissioning of the Base Camp, the land would be returned back to the owner in its original form. As the future land use has not been decided at present, AAHPL will have to re-access its noise levels against the changed land use. If the noise levels go beyond the standards along with a threshold limit of 3dBA as prescribed by IFC, appropriate mitigations would need to be adopted by AAHPL. After decommissioning of the base camp, the change in land use could vary from an industrial use (the owner could give it for the purpose of an industry) or could be used for residential purposes. If the land continues to be under industrial zone then the mitigation measure would remain unchanged but if the area comes under residential use then there would be further mitigations measures required.
- **NQ 14**: At NQ 14, Anakapalli is end of Project road and a major junction. This junction would not be at grade. Ankapalli village lies about 700m away from the actual alignment. The broad landuse of the area along the alignment was observed to be industrial. The noise level arising from the simulations predicts that the noise levels would be above the +3dBA from the background noise has been as per the IFC-WB (2007) Guidelines for all years until 2040. However, the proposed bypass is above the existing road, owing to this height difference, would play a major part in dissipating the noise levels. As the background noise level is found to be within stipulated standard for industrial area, noise barrier is not required at this place (flyover). At end of the Project corridor a school is located on RHS and to minimize noise impacts on the school, it is proposed that the existing boundary wall of the school will be raised at least by 3 m height to minimise the noise impacts.
- **NQ 15**: At NQ 15 Base camp I, is an area which includes crusher, batching plant, WMM etc. and hence considered as industrial area as per the CPCB. The base camp will be decommissioned within 1.5 to 2 years. Post decommissioning, the land would be handed over to the owner and put to normal usage (may be open stockyard). The noise levels arising from the simulations shows that the noise levels will be 64dBA by 2025 without barrier. Though noise barrier is not provisioned at this location, however, as per the conditions of Consent for Operation (CFO) cladding and kirby sheets of 20 feet height needs to be fenced all around the suspected fugitive periphery around the RMC, HMM, stone crusher etc. This is to be enforced immediately. After the decommissioning of the Base Camp, the land would be returned back to the owner. As the future land use has not been decided at present, AAHPL will have to re-access its noise levels against the changed land use. If the noise levels go beyond the standards along with a threshold limit of 3dBA as prescribed by IFC, appropriate mitigations would need to be adopted by AAHPL. After decommissioning of the base camp, the change in land use could vary from an industrial use (the owner could give it for the purpose of an industry) or could be used for residential purposes. If the land continues to be under industrial zone then the mitigation measure would remain unchanged but if the area comes under residential use then there would be further mitigations measures required.
- **NQ 13 and NQ 16**: For NQ 13 and NQ 16 (Maturu and Vavilipadu quarry areas respectively), noise modelling has not been carried out, as these sites are presently on lease from third parties and will be abandoned immediately once the construction materials are sourced. As informed by DBL, the quarry areas

will be closed within six months and hence would not require further predictions for the same. However, the baseline was observed to be within the prescribed limits against industrial standards.

High noise generating sources during construction, options may be exercised to reduce noise using temporary noise barriers (i.e., temporary cladding sheets) could significantly reduce noise levels, though it may not be able to reduce noise at levels within ambient noise standards. For noise barriers located at the middle of the source and the receiver, a reduction of about a maximum of 13.6 dBA could be attained with a 3 m high noise barrier (at NQ 7), as shown in Figure 3-2. Positioning of the noise barrier closer to the source, and partially enclosing noise source could further reduce noise levels at the receivers.

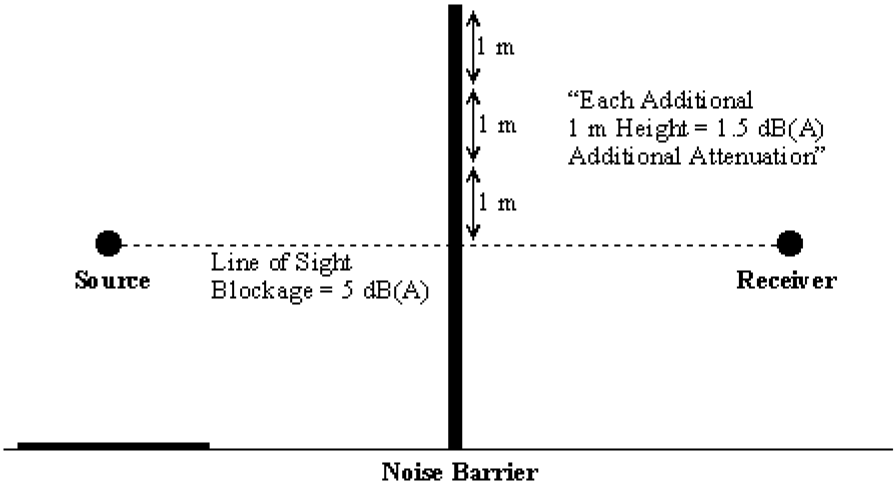


Figure 3-2: Relationship of line-of-sight and noise barrier

Source: https://www.fhwa.dot.gov/ENVIRONMENT/noise/noise_barriers/design_construction/design/design03.cfm

3.4 Proposed Mitigation Measures for Construction Phase

A part of abatement design includes understanding noise sources other than those from the Project highway. These sources include nearby arterial roads, industrial noise, noise emanating from residential/ commercial areas. Establishing existing sound levels with general information about the noise sources originate can help in determining the effectiveness of a Project's mitigation design. Construction noise mitigation might involve use of temporary noise barriers or building sound insulation. While noise impacts during construction are temporary in nature, adequate mitigation measures should be implemented to ensure that it would not affect noise sensitive receptors adjacent to the alignment. The following mitigation measures are proposed for abetting construction noise.

- Provide Noise Protection walls that can block the construction equipment, i.e., retractable noise barriers, within the nearest households.
- **Buffer Zones:** Buffer zones are undeveloped, open spaces which border a highway. Buffer zones are created when the highway agency (NHAI) purchase land or development rights, in addition to the normal right-of-way, so that future dwellings cannot be constructed close to the highway. This prevents the possibility of constructing dwellings that would otherwise have an excessive noise level from nearby highway traffic. An additional benefit of buffer zones is that they often improve the roadside appearance. In accordance with the Project, some areas along the alignment are observed to which can accommodate roadside vegetation/ avenue plantation or empty spaces which would act as buffer zones.
- Operate high noise emitting equipment during daytime or only until early evening, as possible. If construction works using high impact noise equipment need to be extended or done during night-time, DBL should provide adequate noise control measures. Adequate measures would include partial enclosure of high impact noise equipment with retractable noise barriers. This would also apply for other areas along the Project route, such as adjacent or near schools, hospitals, and other noise sensitive receptors (if any).
- **Storage Areas**: During the planning and design stages of a project, storage areas may be able to be designated in locations removed from sensitive receptors. Where this is not possible, the storage of waste materials, earth, and other supplies may able to be positioned in a manner that will function as a noise barrier.
- **Haul Roads**: Haul roads can be designated in locations where the noise impacts caused by truck traffic need to be reduced.
- **Detours:** Increased noise generated by temporarily rerouting traffic during construction is considered as part of construction noise. It is essential to consider efforts to reduce the impact from such changes during the design phases of the project.
- **Shields**: Employing shields that are physically attached to the particular piece of equipment is effective, particularly for stationary equipment and where considerable noise reduction is required. Provide DG sets and compressors with total enclosures to minimize high noise emissions needs to be considered.
- **Dampeners**: Equipment modifications, such as dampening of metal surfaces, is effective in reducing noise due to vibration. Another possibility is the redesign of a particular piece of equipment to achieve quieter noise levels.
- **Maintenance Programs:** Poor maintenance of equipment typically causes excessive noise levels. Faulty or damaged mufflers and loose engine parts such as screws, bolts, or metal plates contribute to increased noise levels. Removal of noise-reducing attachments and devices such as mufflers, silencers, covers, guards, vibration isolators, etc., will, to varying degrees, increase noise emission levels. Old equipment may be made quieter by simple modifications, such as adding new mufflers or sound absorbing materials. Loose and worn parts should be fixed as soon as possible.
- **Equipment Operation Training:** Careless or improper operation or inappropriate use of equipment can increase noise levels. Poor loading, unloading, excavation, and hauling techniques are examples of how lack of adequate guidance and training may lead to increased noise levels.
- Imposing speed limits at construction sites and access roads;
- Ensure that each of the heavy equipment is provided with effective noise mufflers to reduce noise.
- Conduct regular noise monitoring to check compliance with applicable noise regulations.
- Provision of avenue plantations near habitation.
- Inclusion of incentives and/or disincentives in the contract specifications to encourage contractors to participate in the mitigation program and to make the contractors more accountable for impacts.
- Mandatory for contractors to participate in training programs related to project-specific noise requirements, specifications, and/or equipment operations. Such training may be provided by specialized agency or project management personnel, and/or equipment manufacturers or suppliers. The contractor may also receive onsite training related to noise-specific issues and noise-critical areas and sites adjacent to the project.
- It is recommended that DBL may formulate a grievance redressal mechanism and complaint resolution procedure for the local community so that any issues or concerns associated with noise impact are reported and ensure that appropriate and timely action is taken in case of receipt of such complaints. In case of complaints of higher noise levels and uncomforting received from the inhabitants of nearby settlements the provision of noise barriers near to the receptor need to be considered.

3.5 Proposed Mitigation Measures for Operation Phase

Noise impacts during operation are permanent until the project lasts, adequate mitigation measures should be implemented to ensure it will not affect noise sensitive receptors adjacent to the alignment. The following are the proposed mitigation measures

Noise impacts during operation are permanent until the Project lasts. Adequate mitigation measures should be implemented to ensure that it would not affect noise sensitive receptors adjacent to the alignment. The following mitigation measures are proposed for the Project during operational phase.

- **Noise Barriers:** Noise barriers are solid obstructions built between the highway and the receptors (houses/ schools, shops or any other receiving units) along the highway. An effective noise barrier can reduce noise levels by 10 to 15 decibels, cutting the loudness of traffic noise almost by half. Barriers can be formed from earth mounds along the road (usually called earth berms) and vertical walls. Noise walls can be built out of wood, concrete, masonry, metal, and other materials. The material chosen should be rigid and of sufficient density to provide a transmission loss of 10 dBA greater than the expected reduction in the noise diffracted over the top of the barrier.
- **Steel sheet pile** walls often combine two functions: retaining wall and noise barrier, with the advantage that it requires a very small footprint along the roads. The efficiency of the noise barrier can be improved by installing the sheet piles with a small batter angle. Steel sheet piles reflect the sound waves, but due to their geometry, the result of the reflections is quite different compared to a pure smooth flat surface. In some cases, additional panels have been fixed on the sheets to absorb part of the sound. In case steel sheet piles act only as a sound barrier, then some of the piles can be shorter than the others and are designed in a similar way to a combined wall system.
- **Vegetation:** Vegetation, if it is high enough, wide enough, and dense enough that it cannot be seen through, can decrease highway traffic noise. The FHWA traffic noise analysis and abatement policy guidance notes of advocates that a 61-meter width of dense vegetation can reduce noise by 10 decibels, which cuts in half the loudness of traffic noise. However, it is usually impossible to plant enough vegetation along a road to achieve such reductions.

Figure 3-3: Vegetation and Noise Reduction

- **Traffic Management:** Controlling traffic can sometimes reduce noise problems. For example, trucks can be prohibited from certain streets and roads, or they can be permitted to use certain streets and roads only during daylight hours. Traffic lights can be changed to smooth out the flow of traffic and to eliminate the need for frequent stops and starts. Speed limits can be reduced; however, about a 33 kilometre-per-hour reduction in speed is necessary for a noticeable decrease in noise levels.
- **Building Insulation:** Insulating buildings can greatly reduce highway traffic noise, especially when windows are sealed, and cracks and other openings are filled. Sometimes noise-absorbing material can be placed in the walls of new buildings during construction. Noise insulation is normally limited to public use structures such as schools and hospitals.

4. Cost Implications

Highway noise barriers are an effective means of noise reduction because they interrupt the propagation path between the noise sources and nearby receptors. The current approach to addressing noise levels along proposed highways is to construct sound barrier walls in residential areas to protect residents from excessive noise levels as measured at the property line adjacent to RoW. However, noise barriers are expensive, and residents often consider them an eyesore because they obstruct views. Hence for the construction phase there could be other mitigation measures provided in Section 3.4 to be implemented. Figure 4-1 provides an exemplary view of difficulties in implementation different types of noise mitigation measures and its difficulty in implications.

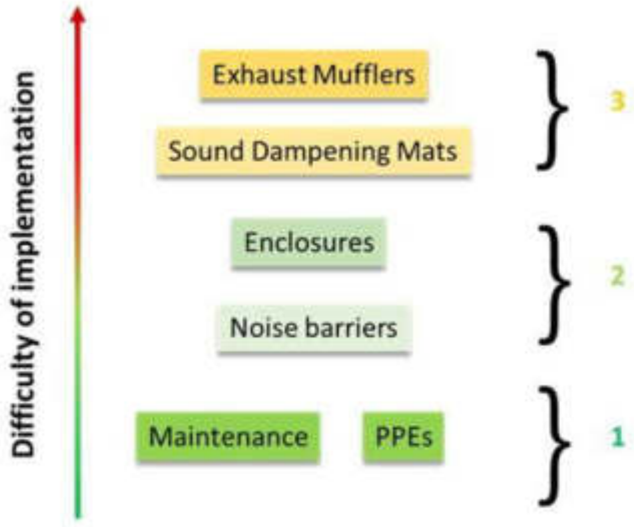


Figure 4-1: Difficulty of Implementation

The proposed noise barriers suggested comprising high density acoustical Material, which is moisture resistant and non-corrosive in nature to counter the natural atmospheric conditions on the wall. The wall proposes to achieve a reduction of 20-25 dB. The cost of the noise barrier is varying from INR 9000 to INR 14000 per sq meter. As per the inference provided in section 3.3 the following are the cost implications for a Noise Barrier of height 3m and length 150m. Apart from that at a few locations, modification of existing retaining walls have been proposed where habitation is not so dense, and impact is minimised, but this could not be validated with the modelling software. Table 4-1 provides year wise cost towards noise implications to achieve desired noise standards. The total cost is estimated at INR 3,19,68,000 (USD 546,686).

Table 4-1: Noise Implications per year

Location	Unit Cost (INR)	Noise barrier area (sqm)	Noise barrier Y/N	Type of Barrier	2020	2025	2030	2035	2040	Total Cost
NQ 1	9680	450	Yes	Boundary wall raising			43,56,000			43,56,000
NQ 2	14000	450	Yes	Noise barrier	6,300,000					
NQ 3	9680	450	No							
NQ 4	14000	450	No							
NQ 5	9680	450	Yes	Boundary wall raising	43,56,000					43,56,000
NQ 6	9680	450	No							
NQ 7	14000	450	No							
NQ 8	14000	450	No							
NQ 9	9680	450	No							
NQ 10	9680	450	Yes	Noise barrier	6,300,000					6,300,000

Location	Unit Cost (INR)	Noise barrier area (sqm)	Noise barrier Y/N	Type of Barrier	2020	2025	2030	2035	2040	Total Cost
NQ 11	9680	450	Yes	Noise barrier	6,300,000					6,300,000
NQ 12	14000	450	No							
NQ 13	14000	450	No							
NQ 14	9680	450	Yes	Noise Barrier	43,56,000					43,56,000
NQ 15	14000	450	No							
NQ 16	14000	450	No							
Total Cost (INR)					**2,76,12,000**		**3,56,000**			**3,19,68,000**
Total Cost (USD) (1 USD @ 70 INR)					**394,457**		**62,229**			**456,686**

5. Conclusion

A Noise assessment following the procedures of the Federal Highway Administration's Traffic Noise Model (FHWA TNM) software was performed along the Anandapuram- Anakapalli section of NH-16 from 681.000 km to 731.780 km in the State of Andhra Pradesh. The noise monitoring and its modelling were undertaken at sixteen (16) locations identified based on sensitivity and the sources of noise along the alignment. The baseline noise monitoring was conducted over a period of 48 hours, split between weekends (Saturday and Sunday) and weekdays (Monday and Tuesday).

The Weekend noise levels for a few locations (NQ 1, NQ 2, NQ 3, NQ4, NQ 5, NQ 6, NQ 8, NQ 9, NQ 10 NQ 11, NQ 14 and NQ 16) during day and night-time were found to be higher than the prescribed CPCB limits, apart from that all other locations were observed to be within prescribed limits. The Weekday noise levels for a few locations (NQ 1, NQ 2, NQ 3, NQ4, NQ 6, NQ 8, NQ 9, NQ 10 NQ 11, NQ 14 and NQ 16) during day and including NQ 5 during the night-time were found to be higher than the prescribed CPCB limits, apart from that all other locations were observed to be within prescribed limits.

Intermittent high noise levels greater than the ambient standards were due to passing vehicles, construction machineries, habitation noise etc. and from other noise sources. Measurements were done at locations adjacent to roads wherein noise from vehicles were the significant sources along with other sources such as Base camps (Containing Crusher, RMC plant, DG set etc.) quarry etc.

The Federal Highway Administration's Traffic Noise Model (FHWA TNM) was used in this study to simulate the propagation of construction equipment noise levels to help predict construction and operational impacts. Also, existing noise levels were established at present (during construction) which would help to establish baseline noise levels this would help to establish noise levels during the construction phase, particularly for receivers that may be highly noise sensitive. The modelling was carried out for simulations of “with noise barrier” and “without noise barrier”. The physical parameter input of the wall was considered to be of height 3m and length 150m.

The noise modelling simulation predictions shows that NQ 2, NQ 10 and NQ 11 would require a high-density acoustical wall to achieve a reduction of ~ 9.4 dBA, 7.6 dBA, 8.4 dBA respectively. NQ1, NQ 5 and NQ 14 would require refurbishing of the compound wall by thickening the wall long with increasing the height (3 m) would act as the noise barriers. Rest all the locations were observed to have been within the +3dBA from the background noise as per the IFC-WB (2007) Guidelines and hence no noise barrier wall has been proposed.

The cost implication imposed for the installation of the noise barrier have also been documented in Section 4.

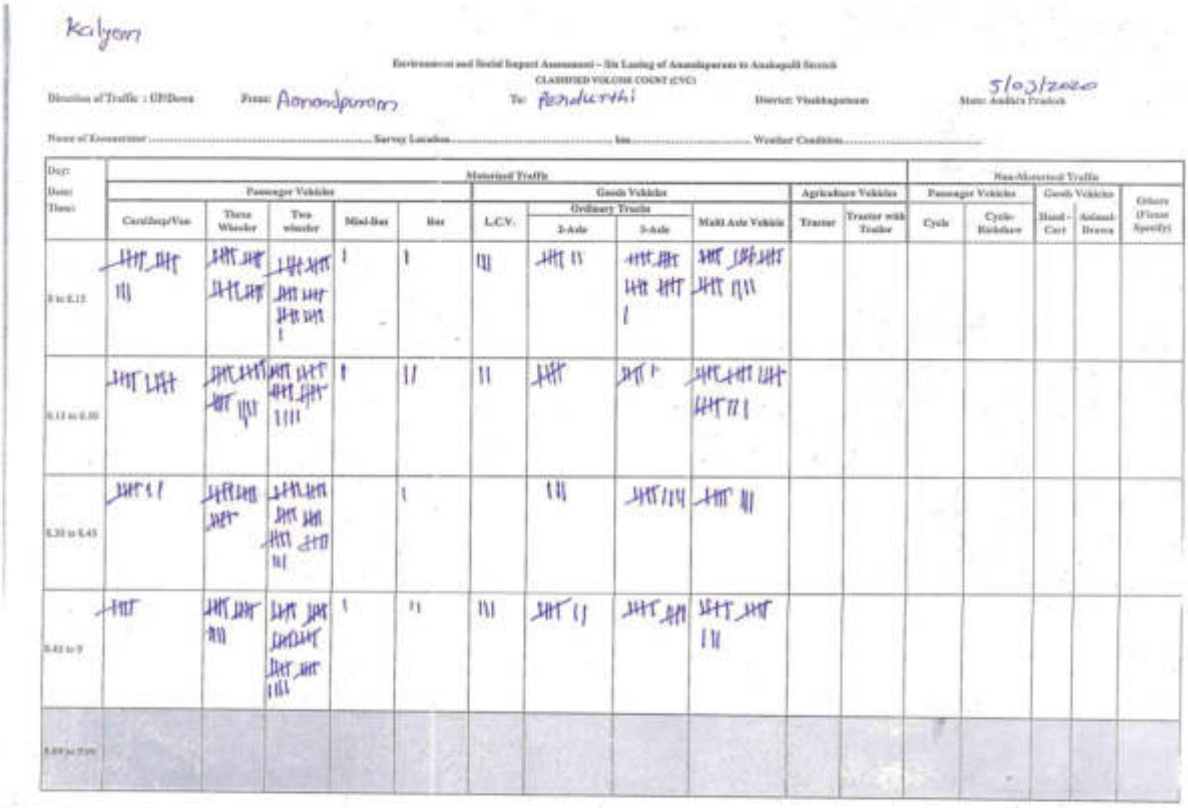
- The Cost implications in the year 2020 would be evident at location NQ 2, NQ 5, NQ 10, NQ11 and NQ 14 where the proposal for high density acoustic barrier and refurbishing the school compound wall to meet the noise barrier specifications have been proposed.
- The Cost implications in the year 2030 would be at NQ 1 where in refurbishing the school compound wall to meet the noise barrier specifications have been proposed.

Appendix A Hourly Noise Data

		Ravindra Bharati School		SRI Surya Traders Anandpuram		Opposite Dr. KKRS Gowtham School		Labour Colony (Forest)		Gommidivanipalem Village (NSRIT College)		Godigundam village		Akkiredi (Mudapaka)		Pendarthi		Askapali village		Batajangpalem		Ramapuram		Base Camp 2		Maturu Mining (Crusher)	
	Date	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/3/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020
S.No	TIME	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)
1	6:00	61.5	66.8	57.7	59.5	47.3	54.6	50.3	51.9	48.4	47.5	63.6	66.7	47.4	48.8	72.3	68.4	52.6	56.1	57.9	42.9	58.2	56.4	59.2	55.0	56.5	58.4
2	7:00	60.6	65.4	56.2	60.8	46.6	68.8	47.0	53.9	48.9	49.3	64.5	65.2	49.9	54.1	71.6	67.8	50.6	54.5	57.0	50.6	59.5	55.9	59.0	60.5	52.0	58.2
3	8:00	61.3	67.3	57.8	61.9	48.7	48.0	43.2	47.0	52.9	51.3	60.4	66.4	49.5	52.3	66.1	71.5	50.7	53.5	61.5	50.7	60.7	56.3	64.5	59.5	49.7	55.8
4	9:00	62.1	64.4	60.1	64.7	49.6	55.2	45.7	50.8	50.9	49.2	63.4	66.4	50.7	48.7	66.5	64.5	58.8	57.8	55.8	51.5	61.3	59.1	64.5	59.3	53.4	60.2
5	10:00	62.9	67.1	60.5	59.5	49.8	51.0	59.9	51.2	55.6	50.2	64.1	67.7	56.0	48.5	69.6	77.2	55.8	57.8	52.4	53.9	61.2	65.7	59.7	64.5	55.9	59.6
6	11:00	61.9	67.4	61.7	57.7	50.7	57.6	52.9	48.8	52.4	49.5	65.5	64.5	51.3	49.0	70.6	75.5	55.6	58.0	53.6	54.5	64.4	63.6	63.1	64.1	60.8	64.9
7	12:00	62.0	67.3	62.8	56.8	53.4	55.8	49.5	46.3	53.1	49.9	64.8	65.8	49.8	44.8	68.6	70.5	57.9	57.4	59.1	52.7	64.5	61.9	62.7	61.6	60.5	65.3
8	13:00	62.4	67.5	63.4	56.2	53.9	50.4	53.6	45.8	56.6	51.2	66.4	64.8	49.4	49.6	74.4	71.2	49.4	55.5	56.8	53.9	61.8	59.9	61.6	59.1	52.0	53.2
9	14:00	61.9	66.9	62.6	58.3	53.8	47.7	59.9	53.7	58.2	49.5	67.1	67.2	47.8	51.1	74.0	72.4	61.6	58.9	60.9	53.0	64.5	61.3	61.3	60.7	52.8	58.0
10	15:00	60.9	66.5	61.6	58.5	54.3	50.9	58.2	55.5	52.9	49.2	69.6	66.4	49.2	51.4	75.9	76.6	63.7	60.1	62.1	53.7	63.2	63.4	61.2	68.3	67.0	59.1
11	16:00	62.4	67.6	61.3	61.3	54.0	53.1	50.1	58.3	51.7	50.5	68.7	69.4	47.8	54.9	69.8	74.1	61.5	58.7	58.1	59.1	62.5	61.9	63.6	65.6	66.2	60.4
12	17:00	63.2	69.9	59.8	63.8	51.7	52.3	48.2	56.2	56.6	50.7	68.0	68.8	49.2	55.1	71.8	75.7	58.2	59.3	57.8	59.3	60.8	61.3	62.1	65.5	59.0	61.0
13	18:00	60.2	69.2	57.8	63.6	50.2	52.1	48.8	54.2	49.6	48.9	65.7	66.3	49.6	55.6	79.7	75.5	57.7	57.0	58.3	63.5	59.8	60.3	62.8	60.6	60.2	58.9
14	19:00	58.4	65.8	58.4	61.9	49.3	46.7	54.3	51.5	53.8	48.4	64.7	68.0	46.9	51.5	71.6	72.3	56.1	59.8	57.7	62.2	59.0	62.5	64.5	61.6	55.7	58.1
15	20:00	59.3	66.0	58.1	59.0	48.9	47.3	50.7	52.3	47.4	47.2	66.0	63.9	46.6	51.3	71.0	68.3	45.1	54.2	57.6	55.4	60.3	59.5	69.1	60.6	59.3	55.7
16	21:00	58.5	67.6	57.7	64.2	48.9	52.7	49.8	51.7	48.3	47.4	63.8	63.1	48.8	52.0	66.4	75.5	45.0	59.1	60.8	57.9	58.6	60.1	55.7	58.0	57.6	56.5
17	22:00	59.8	66.7	60.3	60.8	48.9	54.4	51.3	52.2	47.8	47.9	64.0	64.5	52.5	55.6	66.5	72.4	43.1	51.8	58.0	52.8	58.0	59.1	55.0	57.1	57.1	57.8

		Ravindra Bharati School		SRI Surya Traders Anandpuram		Opposite Dr. KKRS Gowtham School		Labour Colony (Forest)		Gommidivanipalem Village (NSRIT College)		Godigundam village		Akkiredi (Mudapaka)		Pendarthi		Askapali village		Batajangpalem		Ramapuram		Base Camp 2		Maturu Mining (Crusher)	
	Date	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/3/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	2/29/2020	3/4/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020	3/1/2020	3/3/2020
S.No	TIME	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)	dB (A)
18	23:00	60.9	66.6	59.5	59.8	46.7	50.2	53.2	51.5	49.5	45.0	67.5	61.8	50.0	51.9	66.8	72.0	49.6	52.2	56.8	51.8	57.5	55.0	54.0	55.5	57.8	61.5
19	0:00	59.8	65.4	54.2	59.1	46.5	55.8	52.4	51.6	45.2	45.2	60.5	61.9	37.5	53.8	63.0	62.7	45.6	49.8	57.6	50.0	57.3	53.8	52.0	54.7	59.4	62.0
20	1:00	59.6	65.9	53.7	60.7	45.7	55.6	39.5	50.6	49.6	43.1	59.9	60.8	37.6	42.1	74.4	73.6	48.2	50.9	60.4	44.8	55.2	49.0	48.5	54.5	58.9	61.7
21	2:00	58.2	64.7	52.1	60.8	46.7	43.7	52.4	47.4	50.4	43.8	60.4	57.3	38.8	43.7	64.4	69.6	48.3	51.3	55.2	42.6	56.0	52.8	58.8	51.2	58.2	58.7
22	3:00	59.6	64.2	54.6	58.7	45.2	51.7	49.5	50.5	53.0	44.9	59.4	62.4	41.9	40.6	64.9	57.9	48.5	52.1	54.5	37.4	56.0	50.8	57.0	48.5	56.3	58.0
23	4:00	58.3	62.5	53.3	60.2	46.0	53.0	48.6	50.9	51.2	42.6	63.9	61.7	44.5	47.7	62.5	59.4	46.6	57.0	54.8	37.1	54.4	50.4	54.9	59.4	58.2	58.7
24	5:00	60.1	65.1	54.7	59.9	47.0	52.9	50.1	49.2	45.2	46.0	63.1	63.1	45.4	47.2	64.9	59.3	47.7	56.0	52.6	39.1	55.9	52.7	60.4	56.1	56.1	58.7

Appendix B Sample Field data sheets



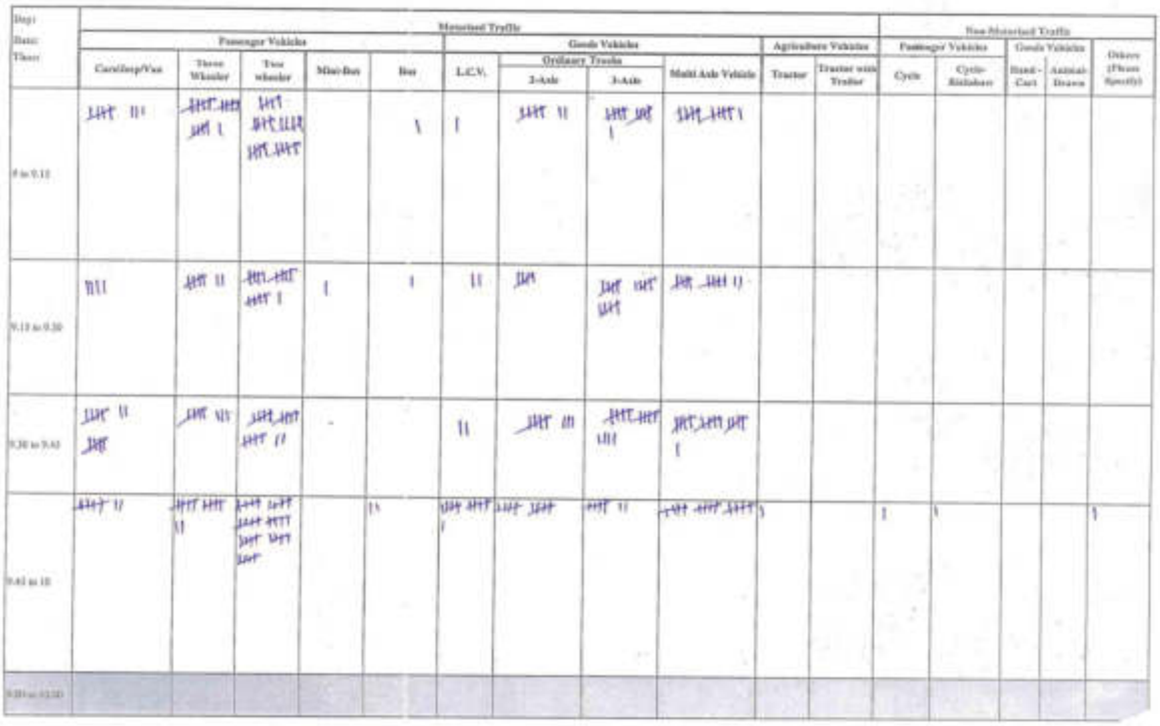
Kalyan

Environmental and Social Impact Assessment – Six Laning of Anandapuram to Anakapalli Stretch
CLASSIFIED VOLUME COUNT (CVC)

Direction of Traffic : UP/Down From: Anandpuram To: Pendurthi District: Visakhapatnam State: Andhra Pradesh 5/03/2020

Name of Enumerator .... Survey Location .... km .... Weather Condition ....

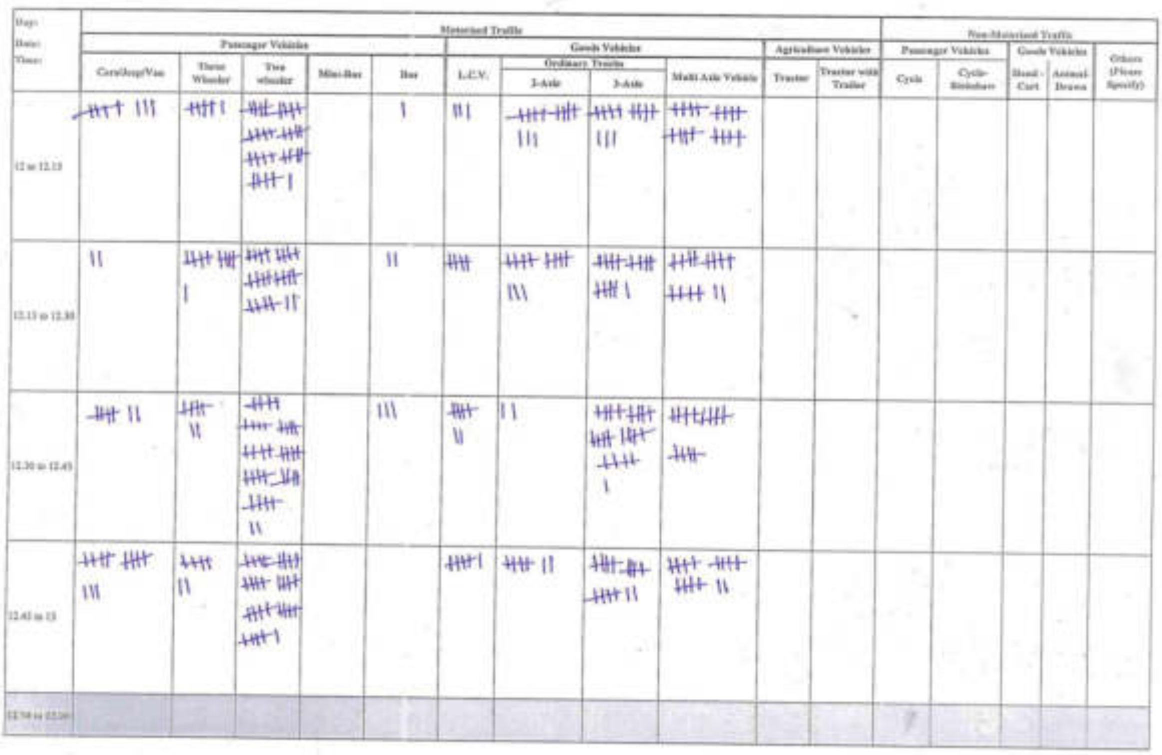
Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
8 to 8.15																
8.15 to 8.30																
8.30 to 8.45																
8.45 to 9																
8.00 to 9.00																

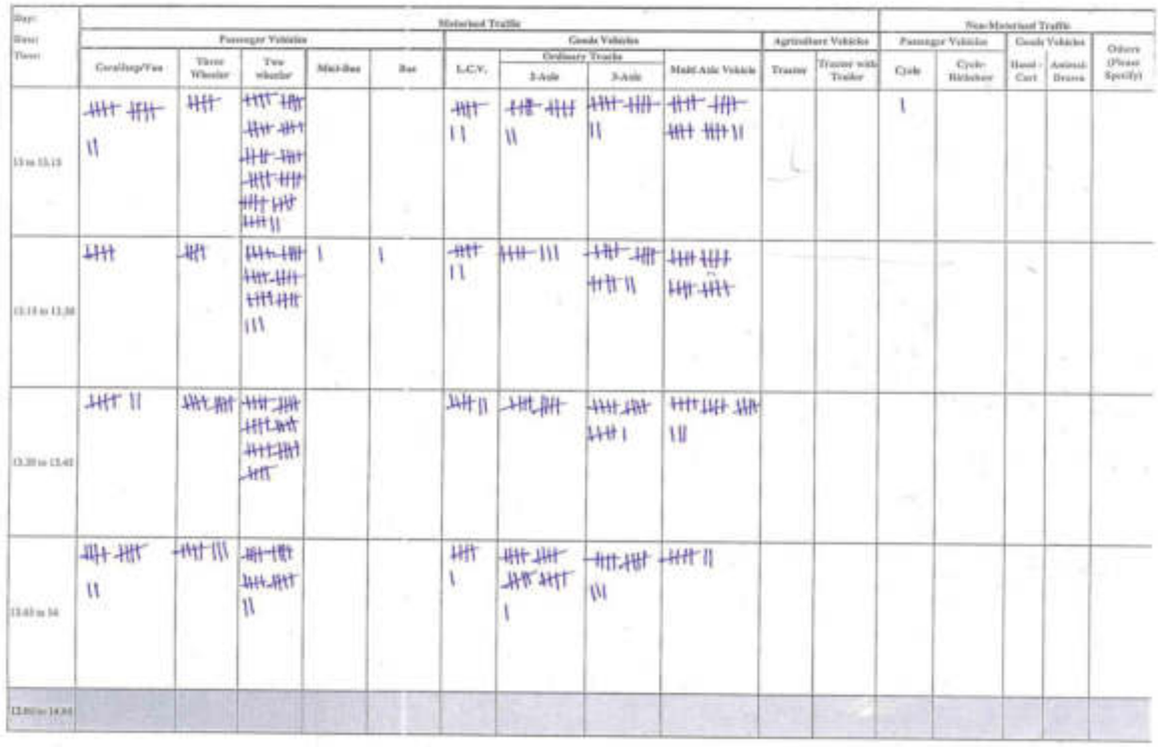


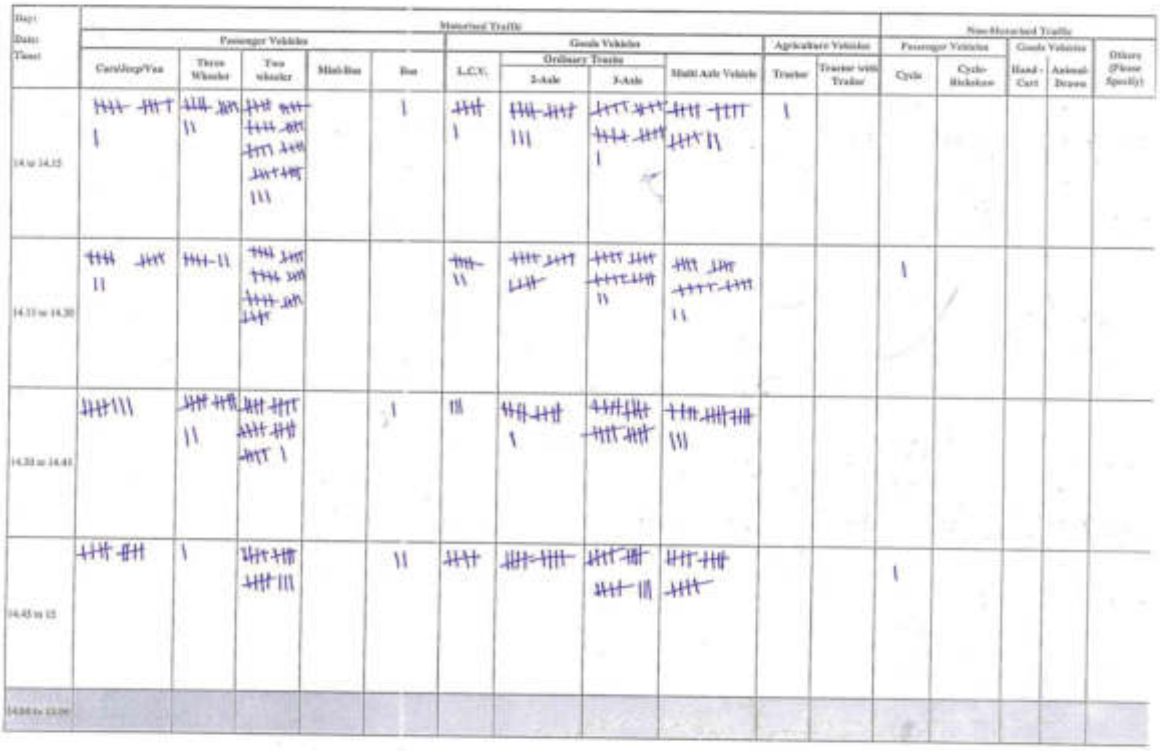
Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
9 to 9.15																
9.15 to 9.30																
9.30 to 9.45																
9.45 to 10																
9.00 to 10.00																

Day: / Date: / Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
10 to 10.15	卌	卌 卌	卌 卌 卌 卌 ||		||	卌 |	卌 ||	卌 卌	卌 卌 ||							
10.15 to 10.3	卌 卌 ||	卌 |||	卌 卌 卌 卌 卌 |||		|||	卌 ||	卌 |	卌 卌	卌 卌 ||							
10.30 to 10.45	卌 卌 卌 卌	卌 |	卌 卌 卌 卌 卌 卌 卌			|||	卌 |	卌 卌 卌 |	卌 卌 卌 ||							
10.45 to 11	卌 卌	卌 卌 卌	卌 卌 卌 卌 卌 卌 卌 ||		||	卌 |	|||	卌 卌 卌 卌 ||	卌 卌 卌 卌							
10.00 to 11.00																

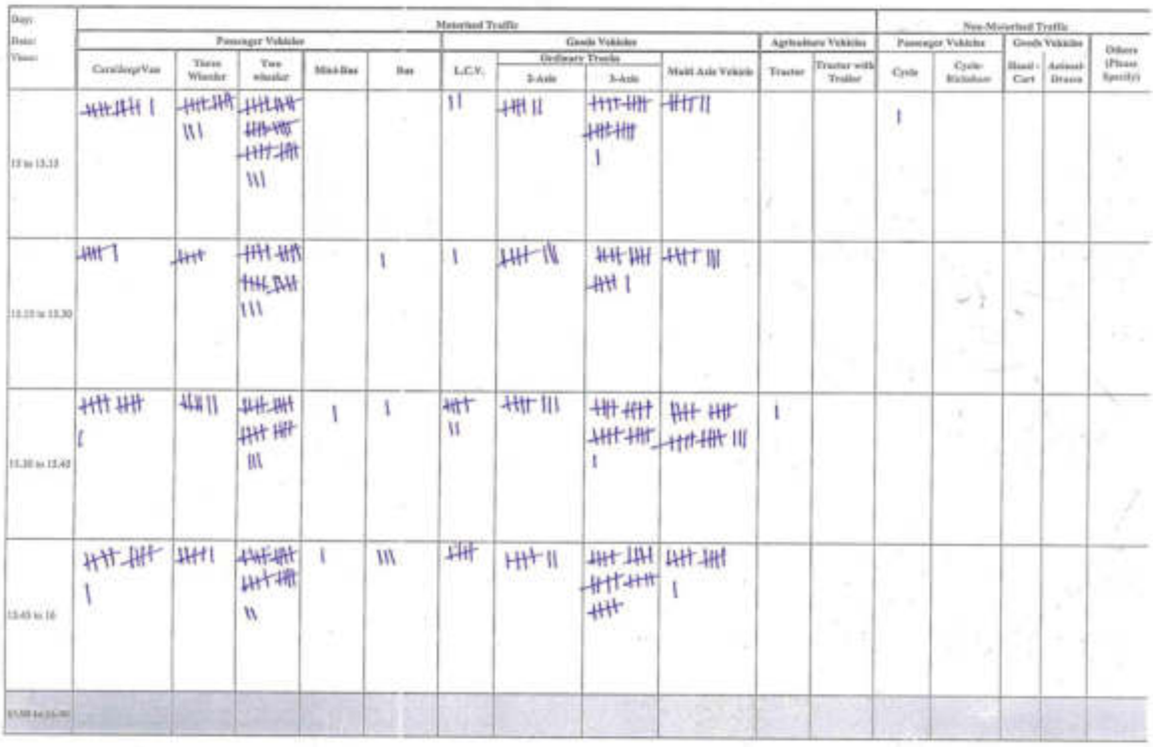
Day: / Date: / Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
11 to 11.15	|||	卌 卌	卌 卌 卌 卌 卌 卌 卌 ||			卌	卌	卌 卌 ||	卌 卌 ||	||		|				
11.15 to 11.30	卌 |	卌 卌	卌 卌 卌 卌 卌 卌 卌 卌 卌		||	|||	|||	卌 卌 卌 |	卌 卌 卌							
11.30 to 11.45	卌 卌 |	卌 卌 卌	卌 卌 卌 卌 |||			|||	卌 |	卌 卌 ||	|||							
11.45 to 12	卌 卌 ||	卌 卌	卌 卌 卌 ||		|	卌 |||	卌 |	卌 卌 卌 ||	卌 卌 ||		|					
11.00 to 12.00																


Day:
Date:
Time:
Motorised Traffic
Passenger Vehicles
Car/Jeep/Van
Three Wheeler
Two wheeler
Mini-Bus
Bus
Goods Vehicles
L.C.V.
Ordinary Trucks
2-Axle
3-Axle
Multi Axle Vehicle
Agriculture Vehicles
Tractor
Tractor with Trailer
Non-Motorised Traffic
Passenger Vehicles
Cycle
Cycle-Rickshaw
Goods Vehicles
Hand-Cart
Animal-Drawn
Others (Please Specify)
12 to 12.15
12.15 to 12.30
12.30 to 12.45
12.45 to 13


Day:
Date:
Time:
Motorised Traffic
Passenger Vehicles
Car/Jeep/Van
Three Wheeler
Two wheeler
Mini-Bus
Bus
Goods Vehicles
L.C.V.
Ordinary Trucks
2-Axle
3-Axle
Multi Axle Vehicle
Agriculture Vehicles
Tractor
Tractor with Trailer
Non-Motorised Traffic
Passenger Vehicles
Cycle
Cycle-Rickshaw
Goods Vehicles
Hand-Cart
Animal-Drawn
Others (Please Specify)
13 to 13.15
13.15 to 13.30
13.30 to 13.45
13.45 to 14



Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
14 to 14.15																
14.15 to 14.30																
14.30 to 14.45																
14.45 to 15																
14.00 to 15.00																



Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
15 to 15.15																
15.15 to 15.30																
15.30 to 15.45																
15.45 to 16																
15.00 to 16.00																

Day/ Date/ Time	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
17 to 17:15																
17:15 to 17:30																
17:30 to 17:45																
17:45 to 18																
17:00 to 18:00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
18 to 18.15	15	16	[illegible]	1		7	11	23	22							
18.15 to 18.30	22	18	[illegible]			1	17	13	12			1				
18.30 to 18.45	17	15	[illegible]	1		5	7	27	17			1				
18.45 to 19	15	5	[illegible]		1	5	6	24	11							
18.00 to 19.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	Ordinary Trucks 2-Axle	Ordinary Trucks 3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
19 to 19.15	11	8	[illegible]	2		3	16	16	11			13				
19.15 to 19.30	7	7	22	2		2	15	15	10			1				
19.30 to 19.45	10	8	28		1	2	5	21	11			1				
19.45 to 20	3	1	17			3	2	2	8							
19.00 to 20.00																

Day: Date: Time:	Motorized Traffic											Non-Motorized Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
20 to 20.15	2		22				3	2	2							
20.15 to 20.30	10	1	13		1	5	17	24	28			1				
20.30 to 20.45	8	4	12		1	2	16	16	14			1				
20.45 to 21	8	3	5			1	14	14	17							
20.00 to 21.00																

Day: Date: Time:	Motorized Traffic											Non-Motorized Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
21 to 21.15	1	2	9			4	10	12	15							
21.15 to 21.30	2	1	7			2	13	16	12						1	
21.30 to 21.45	4		8			4	4	7	9							
21.45 to 22	3	1	4			3	9	9	14							
21.00 to 22.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Cars/Jeep/Van	Three Wheeler	Two wheeler	Mini Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
22 to 22.15	||||		HHT |			|	HHT HHT	HHT HHT HHT |	HHT HHT ||							
22.15 to 22.30	|		HHT ||			|	||||	HHT HHT ||	HHT ||||							
22.30 to 22.45	||		|||			||	||||	HHT HHT ||	HHT |||							
22.45 to 23	|	|||	|||		|||	||	HHT HHT	HHT HHT HHT |||	HHT HHT |							
22.00 to 23.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Cars/Jeep/Van	Three Wheeler	Two wheeler	Mini Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
23 to 23.15			||			|	||||	HHT HHT HHT ||	HHT							
23.15 to 23.30			||||			|||	HHT ||||	HHT ||||	HHT HHT HHT |||							
23.30 to 23.45	|		|||			|	|||	HHT ||||	HHT |||							
23.45 to 24	||					|||	HHT |||	HHT HHT	||||							
23.00 to 24.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
24 to 00.15							6	5	3							
00.15 to 00.30			2				3	3	4							
00.30 to 00.45						2	2	7	4							
00.45 to 01.00							1	1	10							
24.00 to 01.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
01 to 01.15								6	1							
01.15 to 01.30							1	3	5							
01.30 to 01.45		1	4			1	3	8	11							
01.45 to 02.00	1						3	7	4							
01.00 to 02.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
02 to 02.15			I					卌 I	IIII							
02.15 to 02.30			I				I	I	卌							
02.30 to 02.45							II	卌	III		II					
02.45 to 03.00	I						III	卌	III							
02.00 to 03.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
03 to 03.15					I			卌 III	IIII		I					
03.15 to 03.30	I	I						IIIIII I	IIII		II					
03.30 to 03.45	I						III	IIIII II	I							
03.45 to 04.00	I		I				IIIII II	IIIII I	I		I					
03.00 to 04.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
04 to 04.15			|		|		|	𝍸 |								
04.15 to 04.30		|					|||	𝍸	||							
04.30 to 04.45		||	||			|	||	𝍸	||||		||					
04.45 to 05.00		|||	||				||||	|||	𝍸 𝍸 |		|					
04.00 to 05.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
05 to 05.15	|||	|||	𝍸 |			||	|||	𝍸 |||	||		|					
05.15 to 05.30	||	|||	𝍸			|		|||	||							
05.30 to 05.45		𝍸 |||	𝍸 𝍸 𝍸					|||	|							
05.45 to 06.00			|||					𝍸 |	𝍸							
05.00 to 06.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Car/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle Rickshaw	Hand-Cart	Animal-Drawn	
16 to 16.15	卌 |	卌 卌 ||	卌 卌 卌 卌 卌 |||	||	||	卌 ||	卌 卌	卌 卌 卌 卌	卌 卌 卌 卌 |							
16.15 to 16.30	卌 卌 卌 |	卌 卌 |||	卌 卌 卌 卌 卌		||	|||	卌	卌 卌 |||	卌 卌 卌 卌 |||							
16.30 to 16.45	卌 卌	|||	卌 卌 卌 卌 卌 卌 卌 ||	卌	||	卌 |	卌 卌 卌	卌 卌 卌 卌 卌	卌 卌 卌 ||							
16.45 to 17	卌 |	卌 卌 卌	卌 卌 卌 卌 卌 卌 |	卌 |	||	卌	卌 卌	卌 卌 卌 |	卌 卌 卌 卌 |							
16.00 to 17.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Cars/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
06 to 06.15	III	卌	卌			III	卌	卌 IIII	卌 卌 卌 I							
06.15 to 06.30	I	IIII	卌 卌 I			I	III	卌 卌 III	卌 IIII							
06.30 to 06.45	III	卌 III	卌 卌 IIII			II	卌 II	卌 卌 III	卌 卌 IIII							
06.45 to 07.00	IIII	卌 卌 I	卌 卌 卌 I			II	卌 卌 IIII	卌 卌 卌 III	卌 卌 卌 卌 I							
06.00 to 07.00																

Day: Date: Time:	Motorised Traffic											Non-Motorised Traffic				
	Passenger Vehicles					Goods Vehicles				Agriculture Vehicles		Passenger Vehicles		Goods Vehicles		Others (Please Specify)
							Ordinary Trucks									
	Cars/Jeep/Van	Three Wheeler	Two wheeler	Mini-Bus	Bus	L.C.V.	2-Axle	3-Axle	Multi Axle Vehicle	Tractor	Tractor with Trailer	Cycle	Cycle-Rickshaw	Hand-Cart	Animal-Drawn	
07 to 07.15	III	卌 I	卌 卌 卌	I	I	III	卌 卌 III	卌 卌 卌 III	卌 卌 卌 IIII							
07.15 to 07.30	卌 III	卌 II	卌 卌 卌 卌 I	I	I	III	卌 II	卌 卌 卌 I	卌 卌							
07.30 to 07.45	卌	卌 卌 III	卌 卌 卌 卌 卌 I			IIII	卌 卌 卌	卌 卌 卌 II	卌 卌 卌							
07.45 to 08.00	卌 卌	卌 卌 卌 I	卌 卌 卌 卌 卌	I	I	II	卌 卌 卌 I	卌 卌 卌 卌 II	卌 卌 卌		I					
07.00 to 08.00																

aecom.com