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Magnitude and Impact Analysis of Road Traffic Noise Pollution at Port City Chittagong, Bangladesh

I. B. Muhit[1,*], S. Tasneem Chowdhury[2]

[1]Department of Civil Engineering, Chittagong University of Engineering & Technology, Chittagong, 4349, Bangladesh
[2]Shaheed Ziaur Rahman Medical College, Bogra, 5800, Bangladesh

Abstract Chittagong is the biggest and only port city of Bangladesh. Though Dhaka is the capital but heavy traffic noise pollution is a common phenomenon in port city Chittagong, as it is the commercial capital of Bangladesh. This study provides road traffic noise pollution analysis of Chittagong as well its effects on inhabitants of the city. For computing the magnitude of the traffic noise this big city is divided into 11 segments according to the pressure and magnitude of vehicle based on past 10 year experience. Statistical noise index L_{10} (18 hour) was measured and computed at these 11 segments which consist of 12 stations. The average of two nearby stations is taken as the noise levels of particular segment. British standard of Calculation of Road Traffic Noise (CRTN) method was used to finalize the present and future noise levels at these 12 stations. CRTN method is very effective for predicting noise levels in Chittagong because the CRTN emphasizes those factors which are very much related to this city. Studies showed that Chittagong is environmentally polluted with noise continuously and the ranges of noise levels are 75.29 to 90.12 dB (A) which exceeds the maximum allowable limit of 65 dB (A). By CRTN method future noise levels also predicted and which is undoubtedly higher than the present. To evaluate the impacts on community and inhabitants, a social survey was carried and from the survey it was evident that the community, who lives in Chittagong city, is very much worried about this noise pollution as many of them live beside the main roads. Noise pollution is an important factor for transformation of city dwellers to any quieter areas.

Keywords Allowable Maximum Limit, CRTN Method, Impacts on Community, Magnitude of Vehicle, Road Traffic Noise Pollution

1. Introduction

Noise Pollution is a common point of problem for alldeveloped and developing countries and it polluted urban societies and communities. Excessive noise pollution can cause hearing impairment, hypertension, ischemic heart disease, annoyance as well as sleep disturbance. Noiseexpos ure also creates birth defects and changes in immune system (Passchier-Vermeer W and Passchier WF, 2000). Not only human disease like cardiovascular problem but alsonoise pollution increase workplace accident rates,stimulating aggr ession, anti social behaviour (Kryter, Karl D. 1994). That's why every year huge amount of USD lossesthroughout the world.

After air and water pollution, according to the World Health Organization (WHO) noise is considered as the third hazardous environmental pollutant. But it is true that, city noise pollution is not a highly concentrated issue in developing countries like Bangladesh, because of those two pollutions and budget also packed for air, water as well as soil pollution whether noise pollution is almost neglected. The reason of this ignorance consists of several valid causes: effect of noise pollution is almost subjective and its effects are vary from community to community, noise pollution supposed to be short period impacts whether air and water pollution's effects is highly visible, lack of knowledge about magnitude and impacts of traffic noise pollution (Davis and Masten, 2004). According to Bangladesh Bureau of Statistics (BBS) the total adjusted population of Bangladesh was 149772364 in 2011. At their projected data it can be said that at present the population is almost 155050000. As Chittagong is the port city of Bangladesh, many more heavy industry is established and people from different rural area of Bangladesh come to this city in search of work. At present the total population at the port city approximately 6.5 million according to Chittagong City Corporation. The city area is around 155 Sq. Km. so it is easily understandable that Chittagong is a densely populated area with lots of heavy industries and heavy traffics (Chittagong City Corporation Database). Chittagong is experiencing rapid growth in infrastructural development as well as volume of traffic. That's why automatically pressure of noise pollution also increasing. Many residential areas, residential apartments,

* Corresponding author:
imrose_cuet@live.com (I. B. Muhit)
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commercial cum residential apartments, schools, hospitals, parks are developed on main roads due to faulty urban plan ning of Chittagong without taking any pragmatic measures to prevent sound pollution. So a massive portion of the city dwellers are affected from unbearable noise pollution and a long term impact arises. That's why a noise pollution study is necessary at this city to help the city planners and urban developer to take necessary actions for controlling the noise. For highway development and improvement project, analysis and evaluation of road traffic noise pollution consists of environmental impact assessment is necessary. The aim and purpose of this traffic noise pollution study is to analyse the magnitude and impacts to city inhabitants.

2. Method and Approach

2.1. Equipment

Using "Bruel & Kjaer (Type 2215) Precision Sound Level Meter With 1/1- Octave Filters" road traffic noise levels were recorded. From 1.0 meter away from the curb of road the microphone of sound level meter was positioned. The height from road surface of the microphone was 1.2 meter. Figure 1 shows the picture of sound level meter.

2.2. Data Collection

From 12 stations road traffic noise was measured and distributed in 11 segments in the port city Chittagong.

The locations of the station were selected from last 10 years experience of traffic propagation. The station started from 'Kaptai Rastar Matha' ('B' in the figure 2) as it is the last point of city and finished at 'City Gate' ('A' in the figure 2) which is the starting of city. But road length was selected through the city to cover all the main busiest points. Selected road pattern is shown in Figure 2 by blue line. The selected stations, distance of each station from previous station and cumulative distances are showed to clear the total road length of the all station at Table 1. From 6 a.m. to 12 midnight (18 hour period), 10 noise level readings were recorded hourly at each monitoring station at a frequency of 125 Hz. All data were collected in working days and weather conditions were ideal (no excessive wind or rain). To predict future noise levels and to calculate the present data the British Calculation of Road Traffic Noise (CRTN) prediction method was used and this method allows the prediction of L_{10}(18 hr).

Figure 1. Bruel & Kjaer (Type 2215) Precision Sound Level Meter

Table 1. Station Location and Their Respective Distance

Station Location Name	Distance From Previous Station (meter)	Cumulative Distance (meter)
Kaptai Rastar Matha (S1)	0	0
Bahaddarhat Circle (S2)	4000	4000
2 No. Gate (S3)	2200	6200
GEC Circle (S4)	950	7150
WASA Circle (S5)	850	8000
Tiger-pass Circle (S6)	1500	9500
Agrabad Circle (S7)	1700	11200
Barek Building Circle (S8)	900	12100
Bissho Road Matha (S9)	1300	13400
Boropol (S10)	2100	15500
A.K Khan Circle (S11)	4000	19500
City Gate (S12)	1800	21300

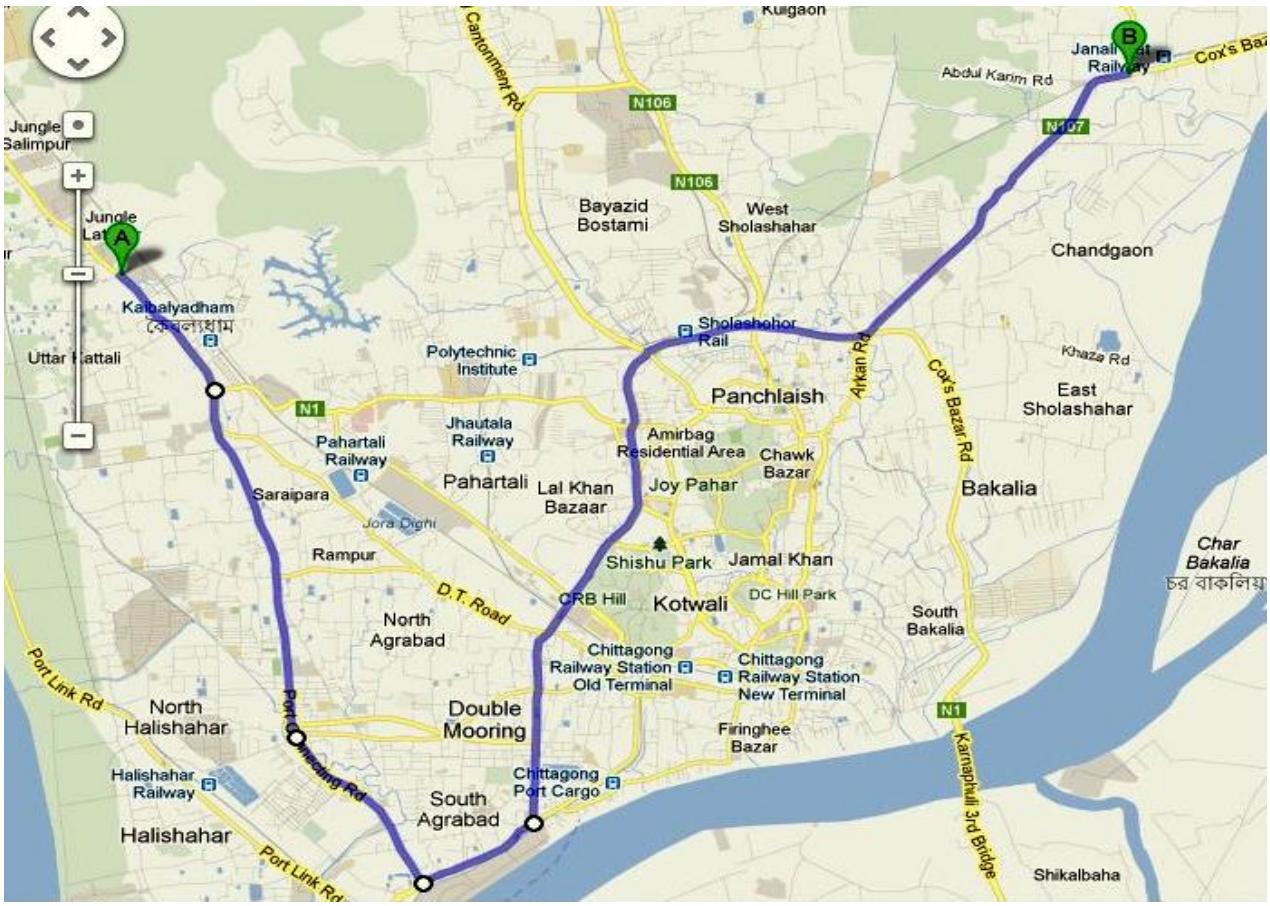


Figure 2. Total road length of all stations

2.3. Social Survey

A social survey conducted among 200 residents of Chittagong who lives around the selected sites to identify reaction by asking some predesigned questionnaire. The question involves presence of awareness of noise pollution, annoyance effects on his/her daily life, disease feeling etc. This data were taken during the working days and it was a parallel survey along with experiment.

3. Results and Discussions

3.1. Present Noise Levels

Present noise level is shown in Table 2 which was measured from 12 stations around the city. These 12 stations data represents the whole Chittagong city in this sense that the main and heavy vehicle run on this route. From Table 2 it is very much clear that almost all the stations exceeds the allowable limit of 65 dB(A) which was taken as new standard for Bangladesh. The lowest and highest traffic noise levels were 75.29 dB (A) and 90.12 dB (A) at S9 and S4 respectively. Average traffic noise level throughout the city was 83.16 dB (A). Figure 3 shows the fluctuations and magnitude of noise level of these 12 stations.

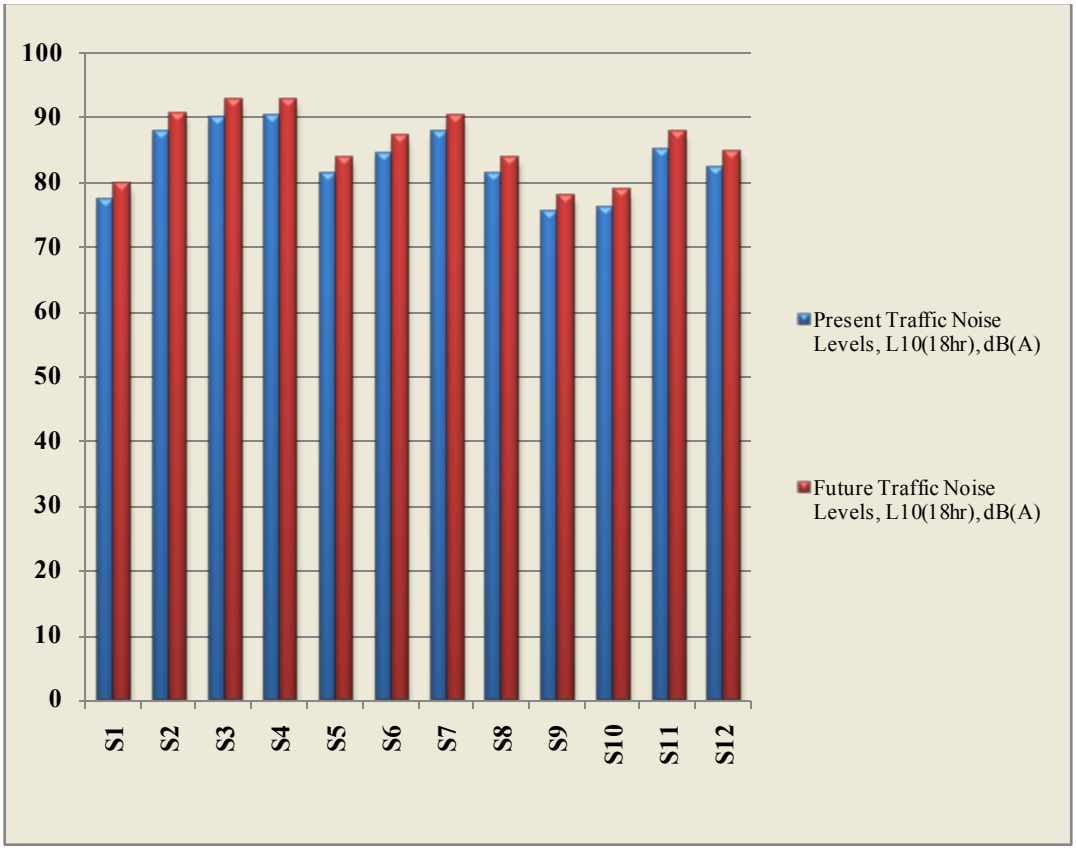


Figure 3. Magnitude and fluctuation of traffic noise level at present and future

Table 2. Present and Future Traffic Noise Levels at Different Stations

Station Name	Present Traffic Noise Levels L_{10}(18hr), dB(A)	Future Traffic Noise Levels L_{10}(18hr), dB(A)
S1	77.11	79.71
S2	87.89	90.52
S3	90.01	92.63
S4	90.12	92.73
S5	81.19	83.83
S6	84.44	87.04
S7	87.67	90.28
S8	81.10	83.73
S9	75.29	77.92
S10	76.00	78.63
S11	84.99	87.63
S12	82.09	84.71

3.2. Future Noise Levels

Using the CRTN method the future noise levels at all stations were predicted and calculated. The year 2023 was selected for the future prediction (n=10 years). The British Calculation of Road Traffic Noise (CRTN) prediction method was used to predict future noise levels at the selected sites and stations. The method allows the prediction of L_{10}(18 hr). The input data for the CRTN method include traffic volume, speed, percentage of heavy vehicles, type of road surface, road gradient, road obstructions meaning that whether the source line of the road is obstructed or unobstructed, distance between reception point and the edge of the nearside carriageway, noise path, intervening ground and effects of shielding. The traffic volume, percent of heavy vehicles and road gradient data for each selected site were collected from the Traffic Department of Chittagong City Corporation and Roads & Highways Department of Bangladesh. Future traffic volume is predicted from the following formula,

$$F = P(1+i)^n$$

Where, F is future traffic volume, P is present traffic volume, i is rate of growth and n is the number of years.

All the input data for calculation of future noise level, assumed to be same as like present 2013. Traffic growth rate is assumed to be 6% by analyzing many more traffic data of Chittagong city. Table 2 shows the future (after 10 years) noise level and from this table it can be said that in all stations noise level will be increases. Average, highest and lowest future noise level is 85.78 dB (A), 92.73 dB (A) and 77.29 dB (A) respectively.

3.3. Segment-Wise Noise Levels

Whole road length was divided into 11 segments. One segment is the distance between two nearby stations and the noise levels for each segment was calculated by taking average of two nearby station's noise levels. From Table 3 to Table 13 shows the present and future noise levels as well as segment location map. This segment noise levels is an indicator for the urban and regional planner for considering the traffic noise level effects in urban planning for both residential areas and transportation development.

Table 3. Segment-I (From Station S1 to S2)

Average Present Traffic Noise Level, dB (A)	82.8
Average Future Traffic Noise Level, dB (A)	85.12

Segment Route Map

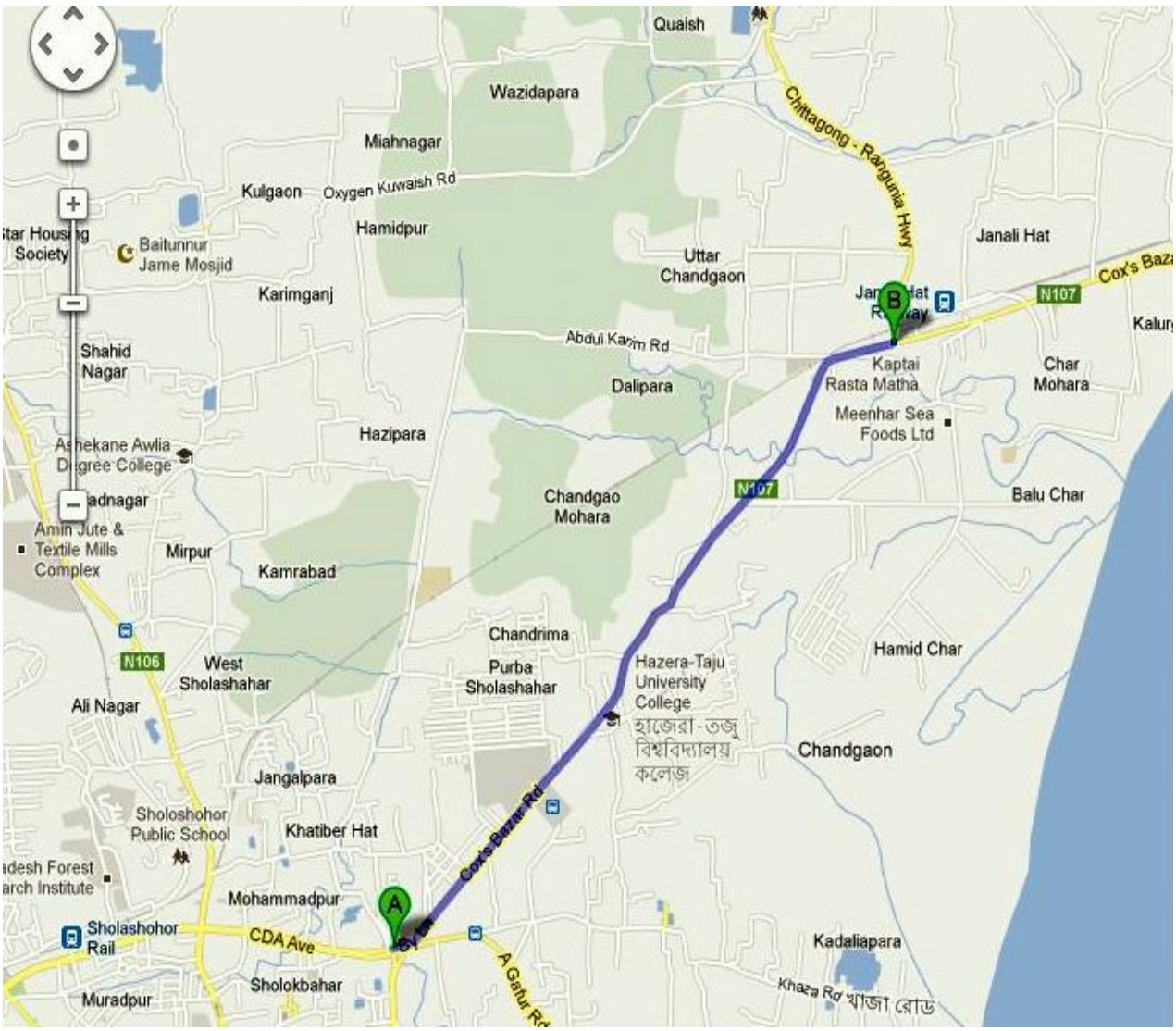


Table 4. Segment-II (From Station S2 to S3)

Average Present Traffic Noise Level, dB (A)	88.95
Average Future Traffic Noise Level, dB (A)	91.575

Segment Route Map

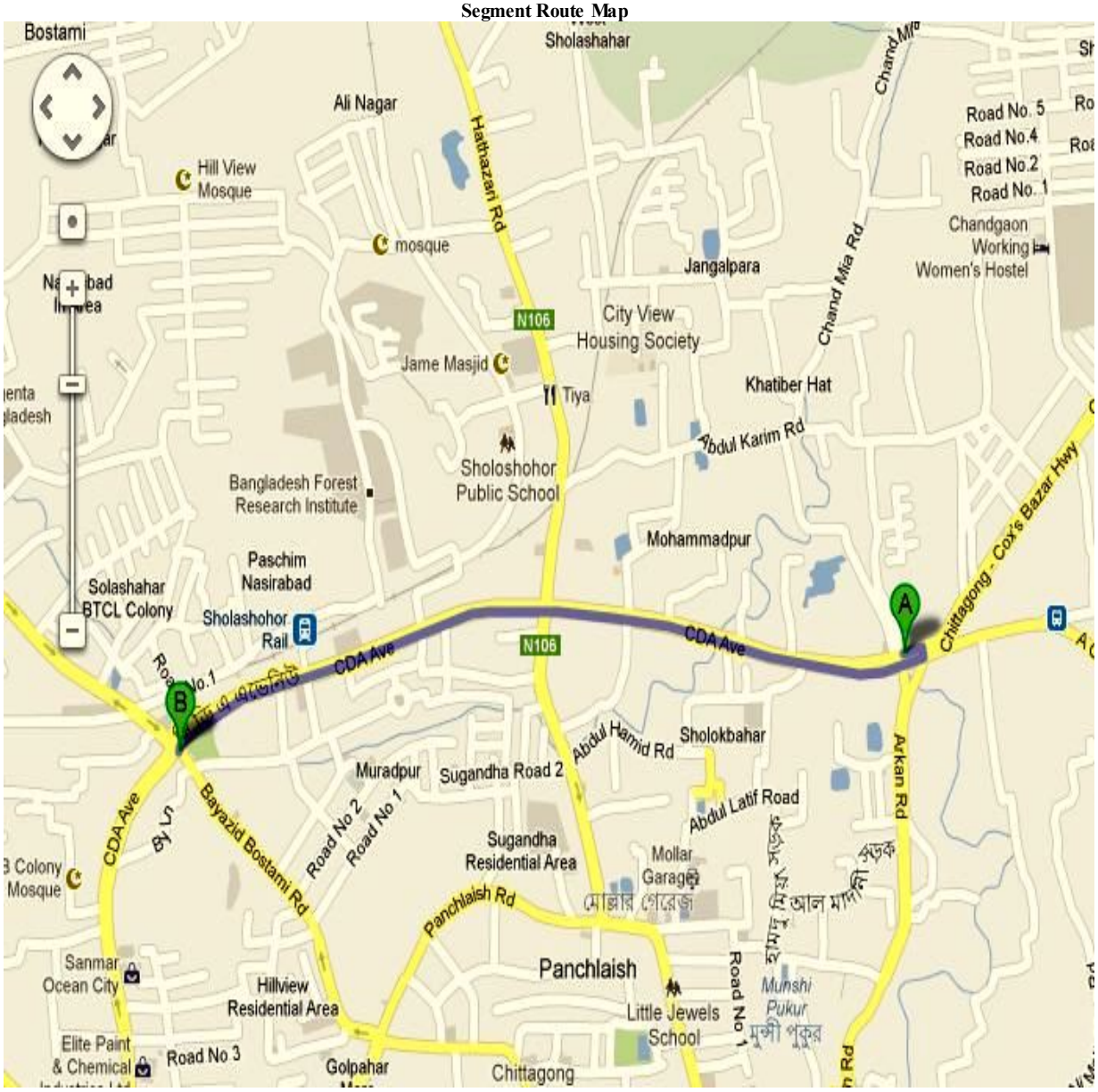


Table 5. Segment-III (From Station S3 to S4)

Average Present Traffic Noise Level, dB (A)	90.07
Average Future Traffic Noise Level, dB (A)	92.68

Segment Route Map

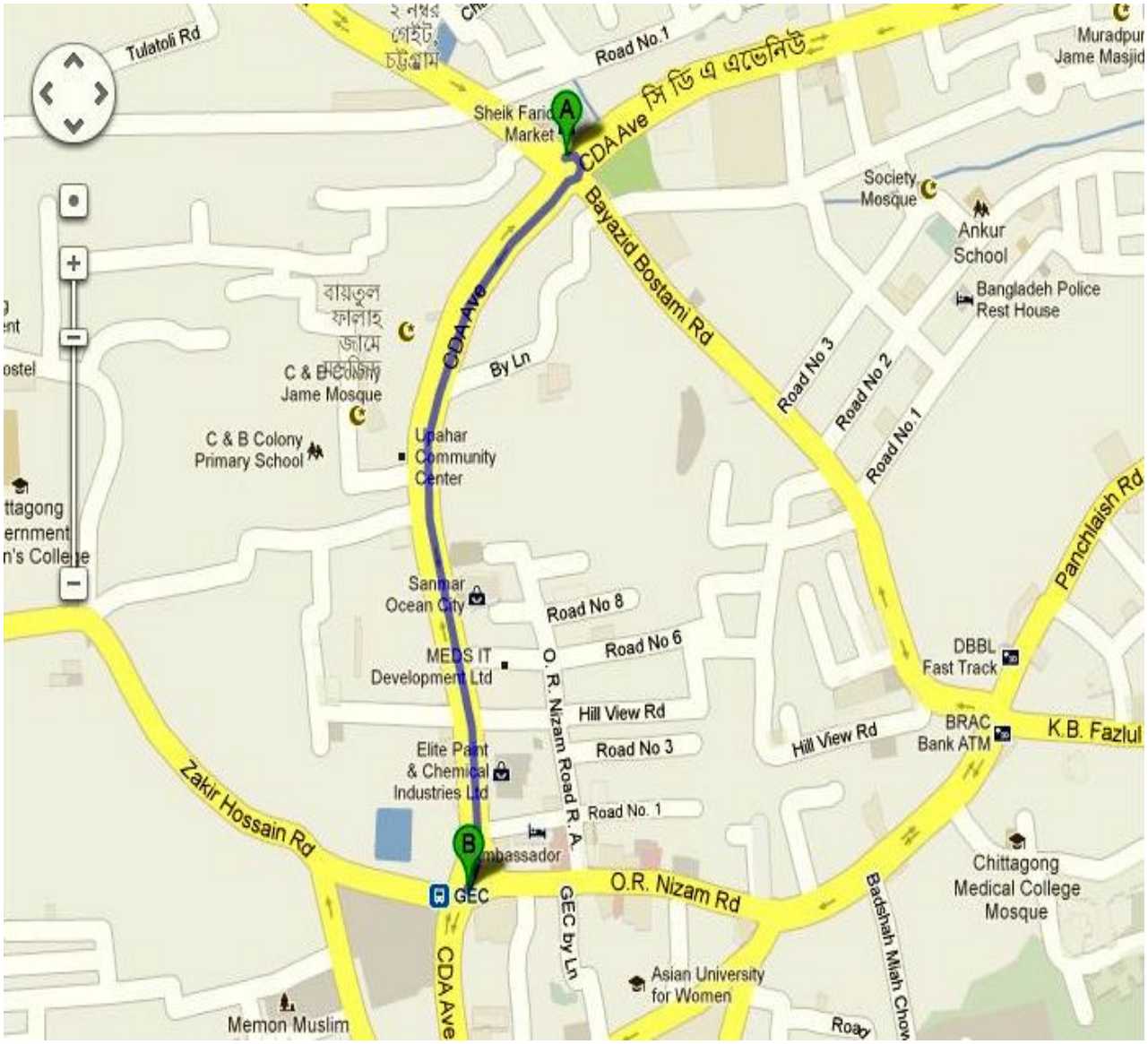


Table 6. Segment-IV (From Station S4 to S5)

Average Present Traffic Noise Level, dB (A)	85.66
Average Future Traffic Noise Level, dB (A)	88.28

Segment Route Map

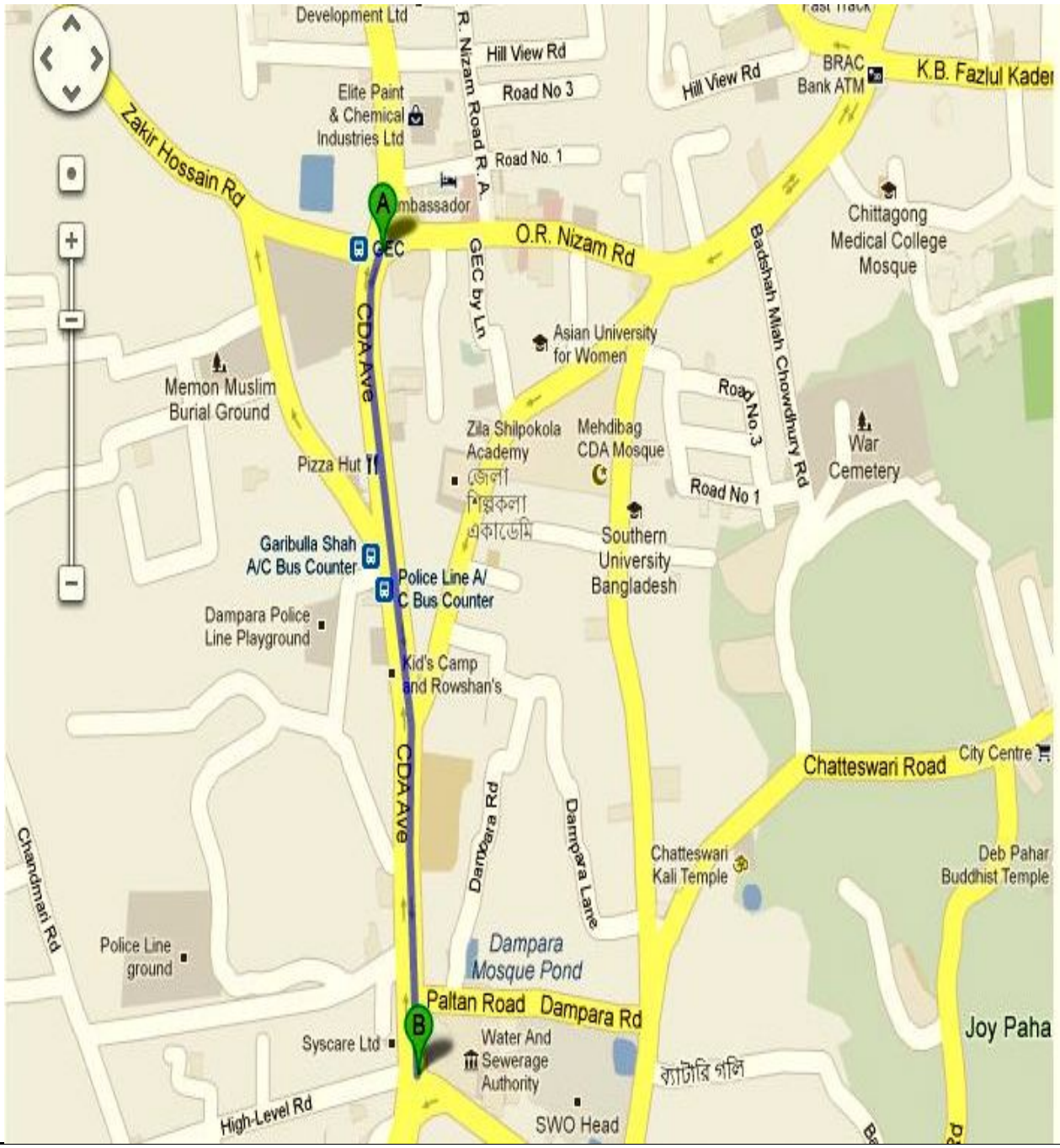


Table 7. Segment-V (From Station S5 to S6)

Average Present Traffic Noise Level, dB (A)	82.82
Average Future Traffic Noise Level, dB (A)	85.44

Segment Route Map

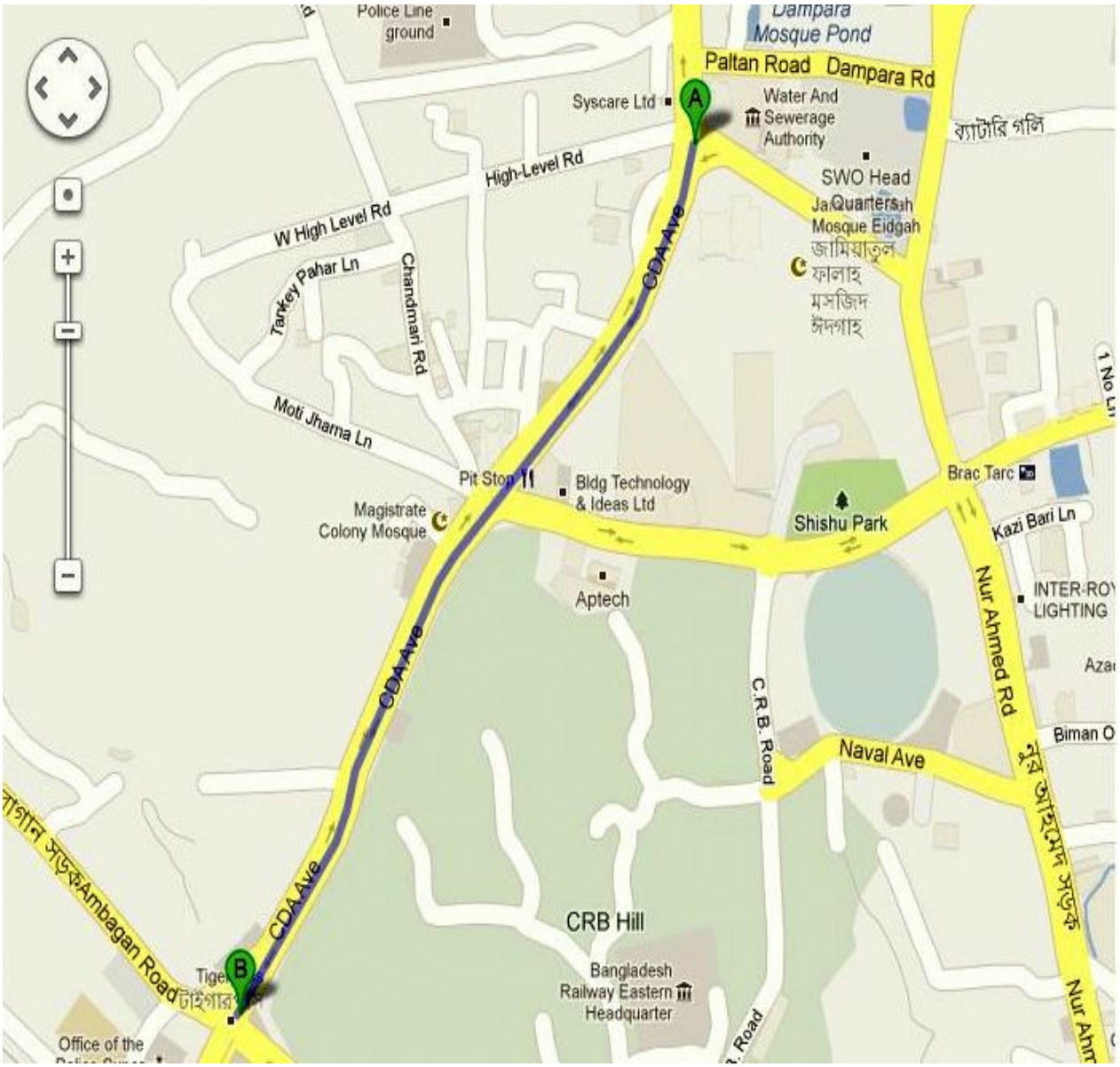


Table 8. Segment-VI (From Station S6 to S7)

Average Present Traffic Noise Level, dB (A)	86.06
Average Future Traffic Noise Level, dB (A)	88.66

Segment Route Map

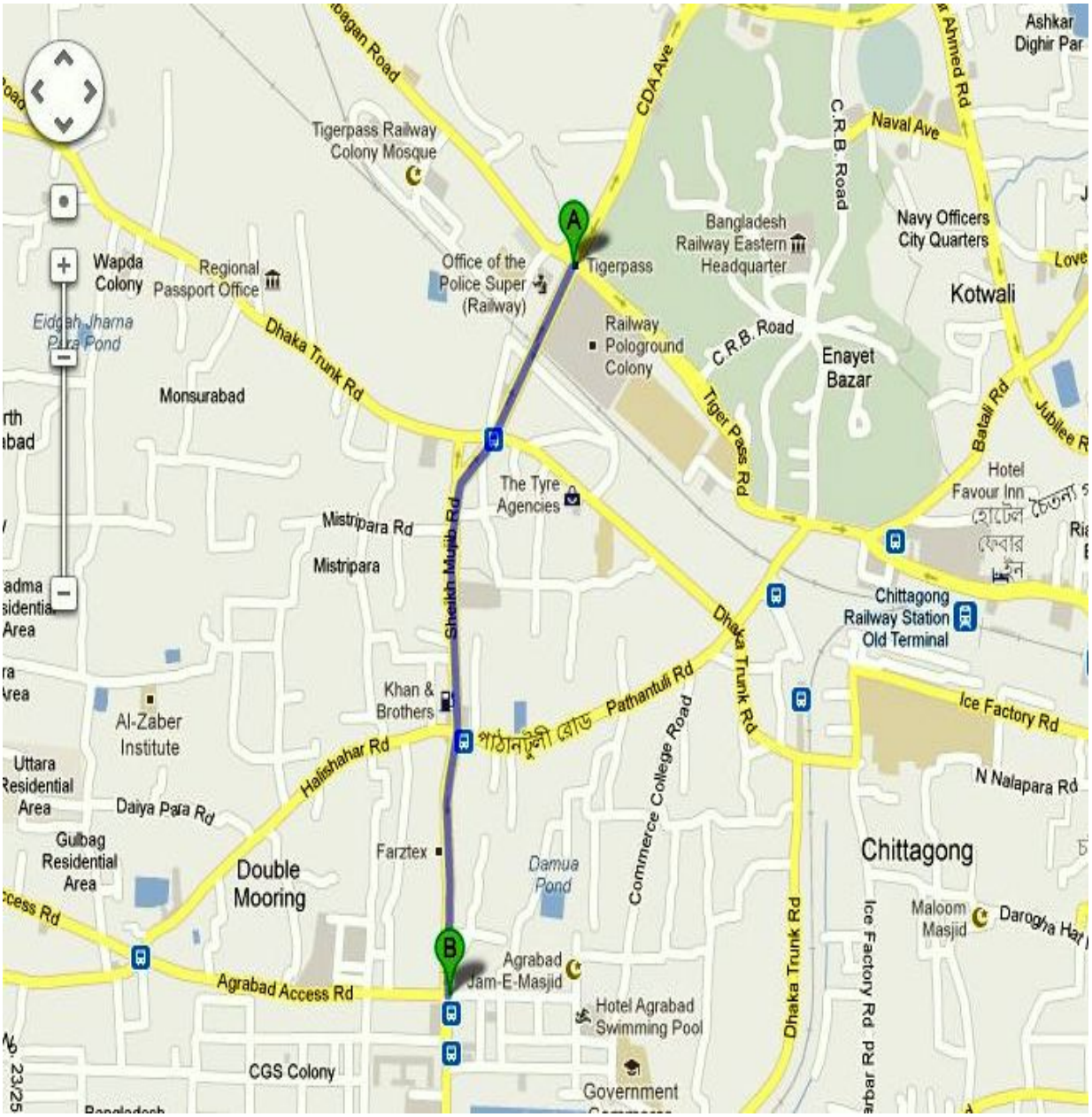


Table 9. Segment-VII (From Station S7 to S8)

Average Present Traffic Noise Level, dB (A)	84.39
Average Future Traffic Noise Level, dB (A)	87.01

Segment Route Map

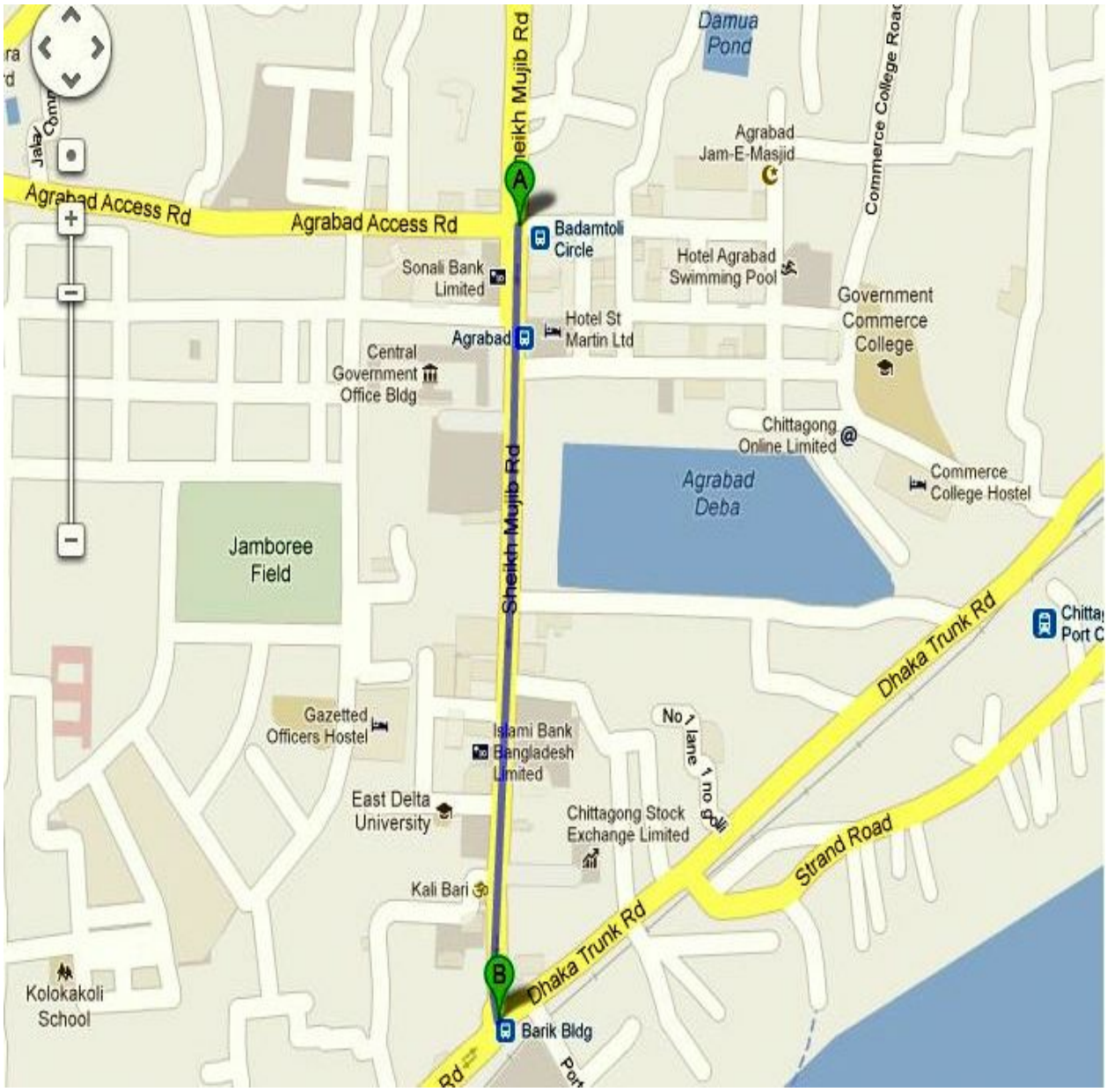


Table 10. Segment-VIII (From Station S8 to S9)

Average Present Traffic Noise Level, dB (A)	78.20
Average Future Traffic Noise Level, dB (A)	80.83

Segment Route Map

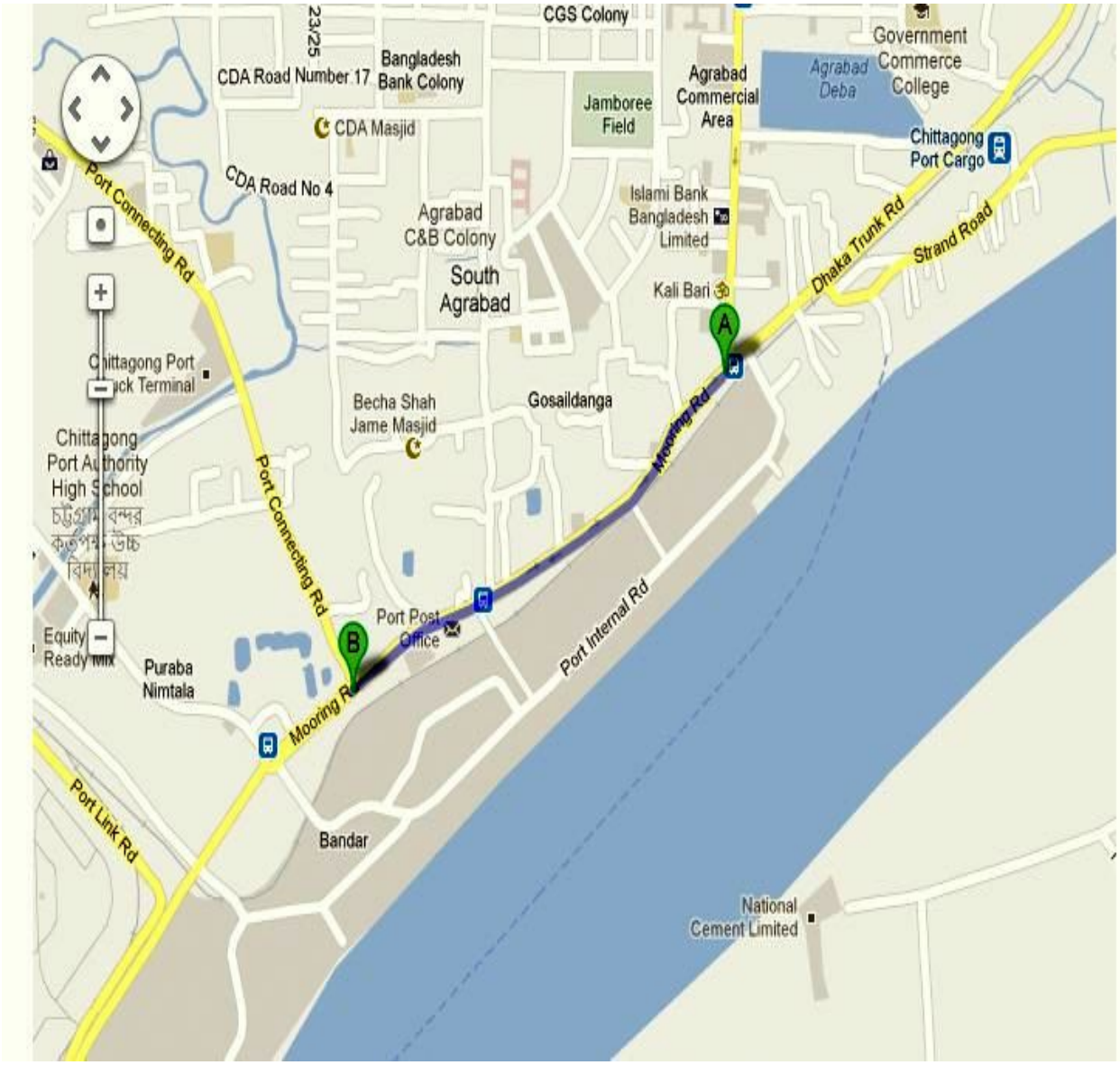


Table 11. Segment-IX (From Station S9 to S10)

Average Present Traffic Noise Level, dB (A)	75.65
Average Future Traffic Noise Level, dB (A)	78.28

Segment Route Map

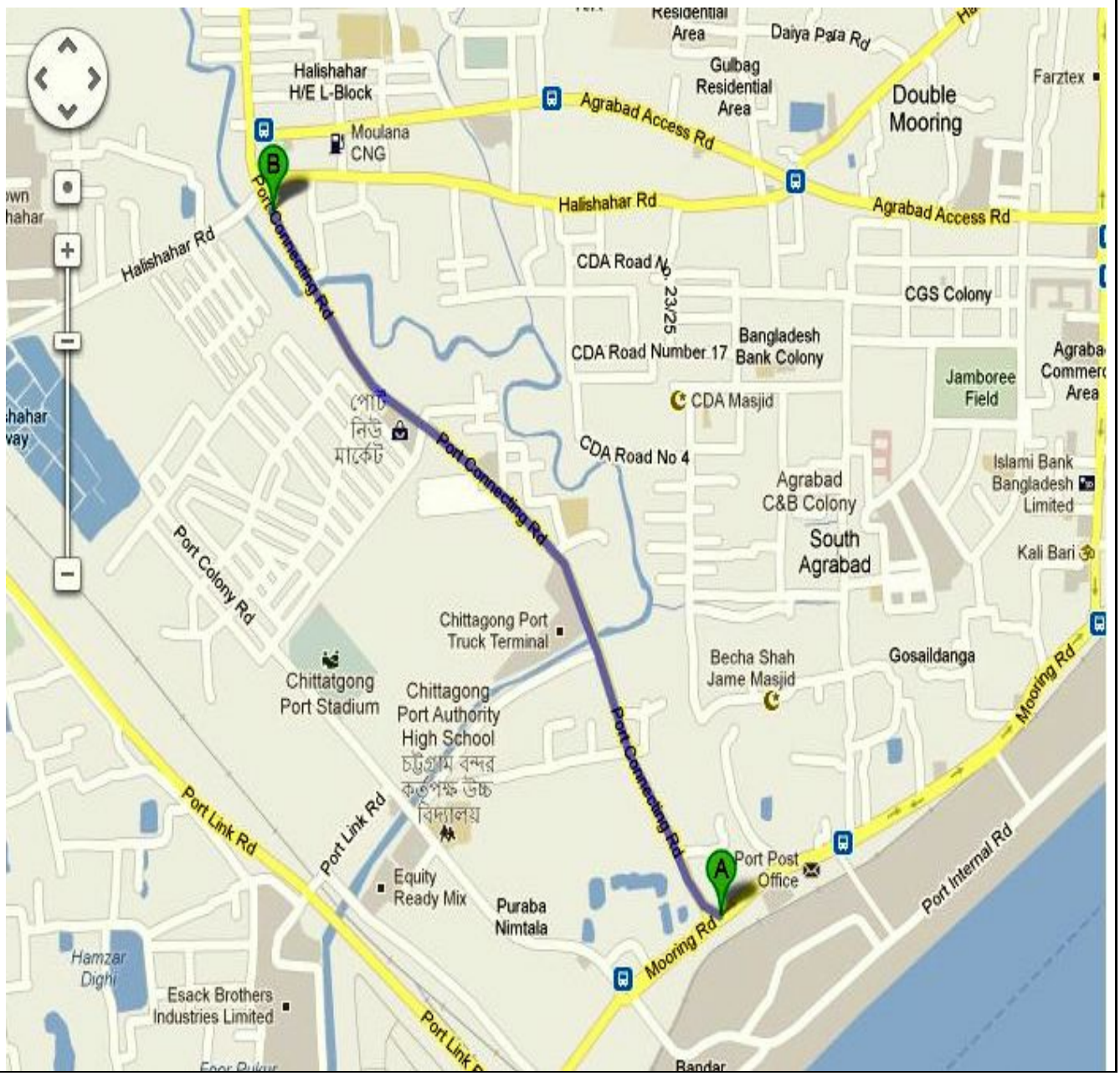


Table 12. Segment-X (From Station S10 to S11)

Average Present Traffic Noise Level, dB (A)	80.50
Average Future Traffic Noise Level, dB (A)	83.13

Segment Route Map

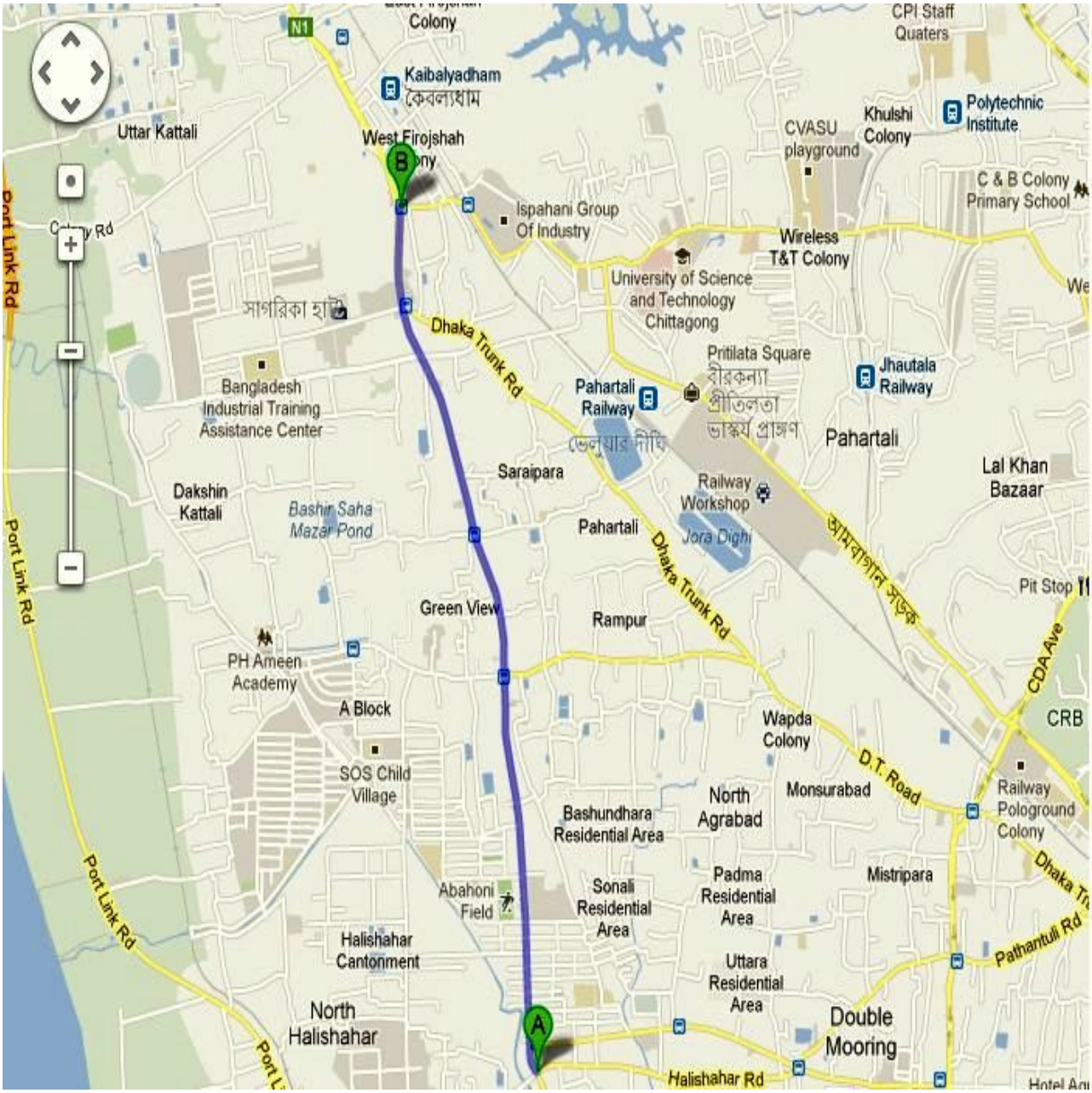
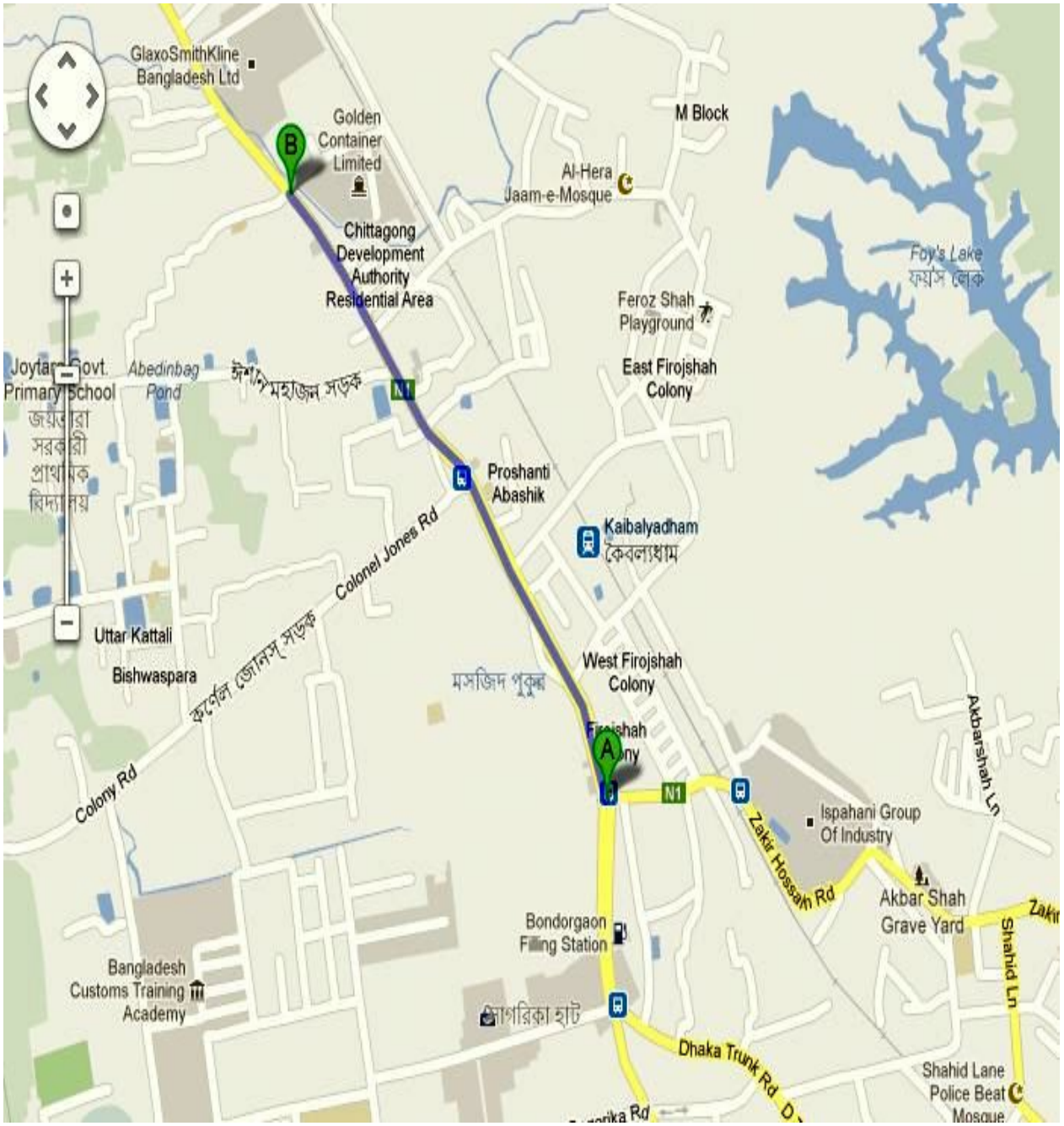


Table 13. Segment-XI (From Station S11 to S12)

Average Present Traffic Noise Level, dB (A)	83.54
Average Future Traffic Noise Level, dB (A)	86.17

Segment Route Map



3.3. Social Survey Results

Social survey consists of the seriousness and consciousness of the road traffic noise pollution in Chittagong city to 200 residents who gave multiple answers for each question. This was revealed from survey that about 86% of the respondents thought that it is a public health problem. About 71% of the respondents considered that migration from their existing place is the final solution. About 92% agreed that noise pollution really effects on their body and mind. Community seriousness is shown in Figure 4. From perceived noise impacts points of view it was observed that many city dwellers were feeling problem during their daily activities, but it was also true that some residents claimed that they were used to with that type of noise. About 33% respondents said that they were facing disturbance in sleeps, 67% were

lose concentration during study, 79% feeling headache after returning home, 77% were forced to close windows. This is shown in Figure 5.

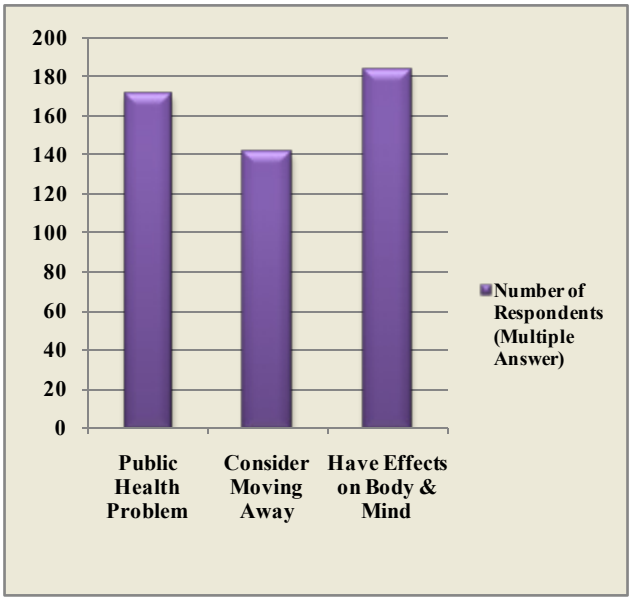


Figure 4. Public Response about Seriousness of Noise Pollution

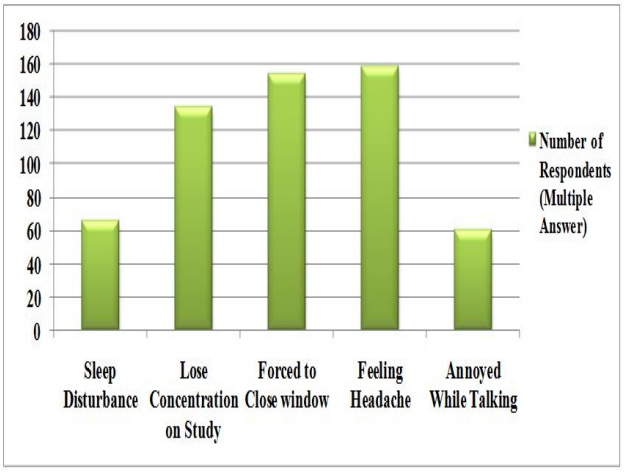


Figure 5. Public response to perceived noise impacts

4. Conclusions

This study mainly covered the magnitude determination and impacts evaluation among the community of traffic noise pollution in port city Chittagong. On the basis of this study some key findings and planning are as follows:

- The British Calculation of Road Traffic Noise (CRTN) method was used to identify the future noise level in selected sites of Chittagong and it is successfully use previously in many more research in United Kingdom, Jordan, Italy, India, Hong Kong, Brazil, Netherland etc.
- At each segments it was visible that, the noise level was beyond the maximum allowable limit of 65 dB (A). In Segment-III (from S3 to S4) it was almost 90.07 dB (A) which was in alarming condition and in future it will be approximately 92.68 dB (A). So some noise attenuation measures should be taken to control this pollution.
- From Segment-wise road traffic noise analysis, urban & regional planner can take message about the city planning for ensuring a satisfied community.
- From social survey it is evident that, community was in a dangerous situation and many types of long term effect was acting on them. Community was not satisfied with this condition and they failed to conduct their daily activities due to this type of pollution.
- Further study of this research will cover the exact source of total traffic noise pollution to quantify the contribution in sound pollution. Further study also involves some preventive measures like noise barriers and its satisfactory height or any other alternative environment friendly attenuation measures for controlling the traffic noise pollution in the port city Chittagong

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