# ADDENDUM TO THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT OF LIGHT RAIL TRANSIT PROJECT (JICA)

**Submitted by**
**Project Management Unit**
**Light Rail Transit Project**
**Ministry of Megapolis and Western Development**

**18th July 2018**

# Table of Contents

*(Referred to Final EIA Report)*



**Annexures**

1. Noise Barriers
2. Spread sheet for noise
3. Spread sheet for vibration
4. Responses for Public Comments
5. Responses for TEC Comments
6. Extended Cost Benefit Analysis (revised version)
7. Annexure 7

# CHAPTER 3 – Description of the Existing Environment

## 3.1.1 Noise and Vibration

### (1) Noise

Noise measurements were carried out at selected locations mainly aiming sample noise sensitive receptors such as temples, schools, residential areas etc. Noise measurements were carried out by ITI. Noise levels were measured at strategic locations during week days and weekend. Locations for noise levels measurements have been indicated in 3.3.

Sample average noise levels day, evening and night during a weekday are presented in 3-4 below. In addition, 15-minute interval noise measurements for these locations for 24 hours are available. All the baseline noise levels are indicated in Annex D.(EIA Report)

**Table 3-5 Vibration Level Results**

| Location | Run time (min) | Vibration level | |
|---|---|---|---|
| | | Frequency Range (Hz) | Vibration in ppv (mm/sec) |
| Interim Standard for Vibration Levels by the CEA (Type 3 structures, made of lightweight materials) | | 0-10<br>10-50<br>over 50 | 2.0<br>4.0<br>8.0 |
| 1<br>Colombo fort | 0-15min | 10-50 | 0.19 |
| | 15-30min | 10-50 | 0.30 |
| | 30-45min | 10-50 | 0.38 |
| | 45-50min | 10-50 | 0.29 |
| 2<br>National Hospital | 0-15min | 0-10 | 0.22 |
| | 15-30min | 10-50 | 0.14 |
| | 30-45min | 0-10 | 0.14 |
| | 45-50min | 0-10 | 0.16 |
| 3<br>Borella | 0-15min | 0-10 | 0.22 |
| | 15-30min | 0-10 | 0.21 |
| | 30-45min | 0-10 | 0.18 |
| | 45-50min | 0-10 | 0.25 |
| 4<br>Divawanna | 0-15min | 0-10 | 0.21 |
| | 15-30min | 0-10 | 0.36 |
| | 30-45min | 0-10 | 0.34 |
| | 45-50min | 0-10 | 0.26 |
| 5<br>Lumbini Temple | 0-15min | 10-50 | 0.07 |
| | 15-30min | 10-50 | 0.07 |
| | 30-45min | 10-50 | 0.09 |
| | 45-50min | 10-50 | 0.08 |
| 6<br>Malabe- Boys School | 0-15min | 10-50 | 0.10 |
| | 15-30min | 10-50 | 0.20 |
| | 30-45min | 10-50 | 0.21 |
| | 45-50min | 10-50 | 0.16 |

Note: Measurement has carried out at single story buildings

## Vibration Measurement Locations

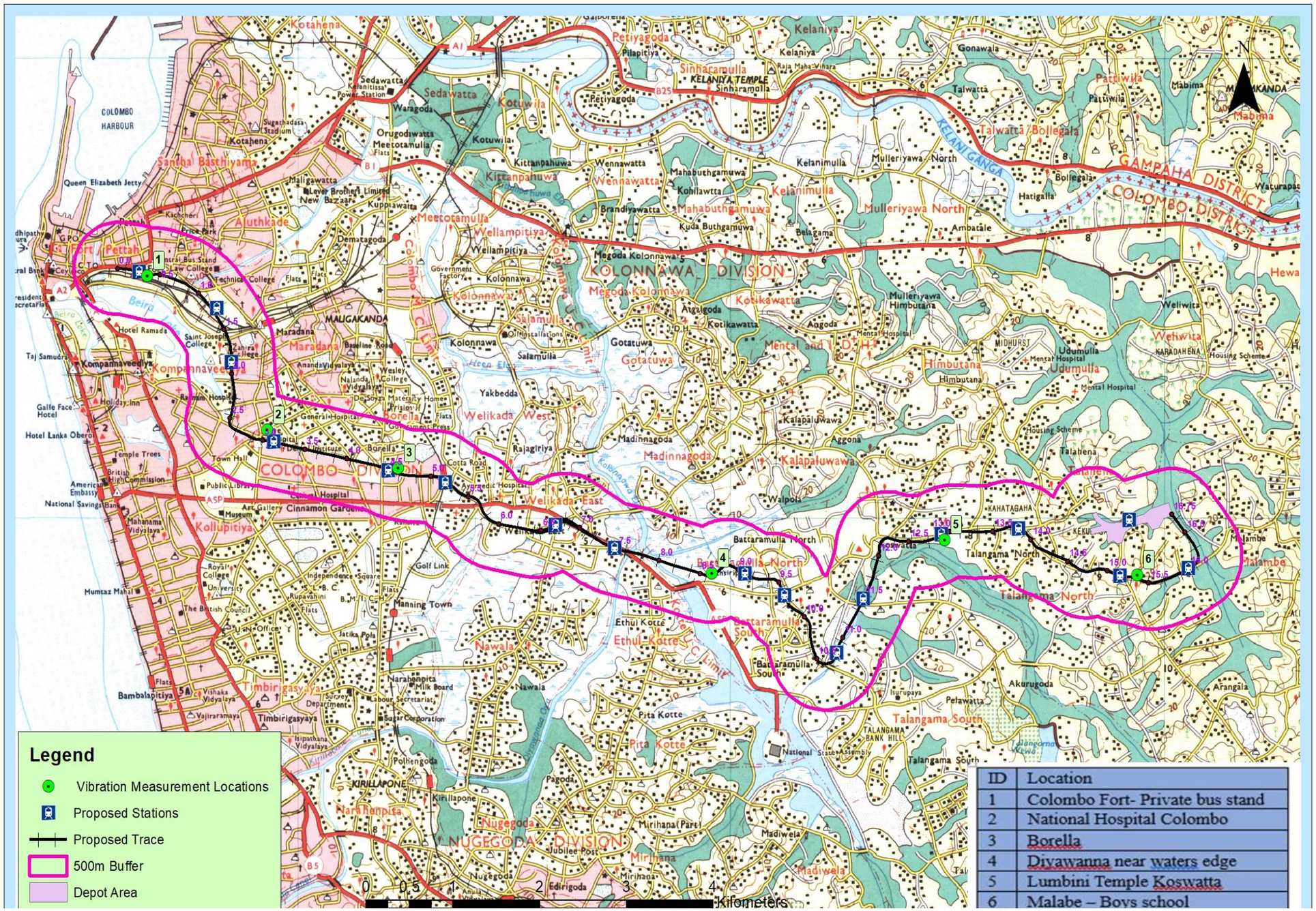



**Figure 3.3**

# CHAPTER 4 – Impact Assessment

## 4.1 Noise and Vibration

### 4.1.1 Noise Impacts

#### (2) Construction stage

Construction of railway structure and station

During construction, noise levels would increase in the vicinity of the construction site. The major sources of noise pollution during construction are the noise generating activities at the construction site, including pilling, excavation or compaction. Although the noise from construction activities will be significant, the effect would be temporary. 4.1 presents noise level of construction activities.

**Table4.1 noise levels of construction equipment**

| Construction equipment | Noise level (dB(A)) |
|---|---|
| Excavator | 113 |
| Earth driller | 97 |
| Crawler Crane | 98 |
| Truck Crane | 110 |
| Bulldozer | 104 |
| Backhoe | 107 |
| Tractor shovel | 107 |
| Clamshell | 97 |
| Macadam roller | 100 |
| Tire roller | 94 |
| Asphalt paver | 102 |
| Concrete mixer | 101 |
| Concrete pump car | 105 |

Source: JICA study team

Using the values given in**,** noise levels generated from the equipment in construction works were calculated. Noise levels experienced in the vicinity of working places (noise source) is given by the following equation and predicted noise level generated from construction work is shown in Table 4.2.

$$L = Lw - 20\log(r) - 8dB(A)$$

Where,
L = Noise level at a distance of r (m) from the noise sources (dB (A))
Lw = Noise power level of noise source (dB (A))
8dB(A)= Noise level at l m from the noise source

In addition, the combined noise level generated from the operation of several construction machineries is given by the following equation;

$$L = 10\log(\frac{10^{L1}}{10} + \frac{10^{L2}}{10} + \cdots + \frac{10^{Ln}}{10})$$

Where,
L = Combined noise level (dB (A))

L1, L2,…, Ln=Noise level of each equipment (dB (A))

**Table 4.2 Predicted noise level generated from construction works**

| Construction type | Major Tasks | Activity | Equipment | Noise power level (dB(A)) | Predicted noise at Project boundary | Cumulative noise level (dB(A)) | With Noise Barrier Fence Type 1 (Assuming 10dB reduction) | With Noise Barrier Fence Type 2 |
|---|---|---|---|---|---|---|---|---|
| LRT general elevated structure /station | Structure construction | Concrete placement | Concrete pump car | 105 | 77.0 | 78.5 | 68.5 | ** |
| | | | Concrete mixer | 101 | 73.0 | | | ** |
| | | Pilling | Crawler Crane | 98 | 70.0 | 85.0 | 75.0 | ** |
| | | | Excavator | 113 | 85.0 | | | ** |
| | | Temporal work/sheet pile | Crawler Crane | 98 | 70.0 | 82.5 | 72.5 | ** |
| | | | Truck Crane | 110 | 82.0 | | | ** |
| | | | Earth driller | 97 | 69.0 | | | ** |
| | | excavation/filling | Backhoe | 107 | 79.0 | 82.0 | 72.0 | ** |
| | | | Tractor shovel | 107 | 79.0 | | | ** |
| | Road work | clearance/excavation | Bulldozer | 104 | 76.0 | 77.8 | 67.8 | ** |
| | | | Macadam roller | 100 | 72.0 | | | ** |
| | | | Tire roller | 94 | 66.0 | | | ** |
| | | Roadbed work | Macadam roller | 100 | 72.0 | 73.0 | 63.0 | ** |
| | | | Tire roller | 94 | 66.0 | | | ** |
| | | Pavement | Macadam roller | 100 | 72.0 | 76.5 | 66.5 | ** |
| | | | Tire roller | 94 | 66.0 | | | ** |
| | | | Asphalt paver | 102 | 74.0 | | | ** |
| LRT crossing over reservoir | Temporal bridge | Construction road/temporary bridge placement | Bulldozer | 104 | 76.0 | 86.5 | 76.5 | 75 |
| | | | Tractor shovel | 107 | 79.0 | | | |
| | | | Crawler Crane | 98 | 70.0 | | | |
| | | | Excavator | 113 | 85.0 | | | |
| | Base structure | temporal work | Excavator | 113 | 85.0 | 86.2 | 76.2 | 75 |
| | | | Crawler Crane | 98 | 70.0 | | | |
| | | | Backhoe | 107 | 79.0 | | | |
| | | | Clamshell | 97 | 69.0 | | | |
| | Upper structure | Concrete placement | Truck Crane | 110 | 82.0 | 83.6 | 73.6 | ** |
| | | | Concrete pump car | 105 | 77.0 | | | ** |
| | | | Concrete mixer | 101 | 73.0 | | | ** |
| | | Pavemement | Macadam roller | 100 | 72.0 | 76.1 | 66.1 | ** |
| | | | Asphalt paver | 102 | 74.0 | | | ** |
| Depot | Depot | Leveling/excavation | Backhoe | 107 | 79.0 | 83.0 | 73.0 | ** |
| | | | Tractor shovel | 107 | 79.0 | | | ** |
| | | | Bulldozer | 104 | 76.0 | | | ** |
| | | Pilling | Crawler Crane | 98 | 70.0 | 85.0 | 75.0 | ** |

| Construction type | Major Tasks | Activity | Equipment | Noise power level (dB(A)) | Predicted noise at Project boundary | Cumulative noise level (dB(A)) | With Noise Barrier Fence Type 1 (Assuming 10dB reduction) | With Noise Barrier Fence Type 2 |
|---|---|---|---|---|---|---|---|---|
| | | | Excavator | 113 | 85.0 | | | ** |
| | | structure construction | Concrete pump car | 105 | 77.0 | 78.5 | 68.5 | ** |
| | | | Concrete mixer | 101 | 73.0 | | | ** |
| | | levelling/ pavement | Bulldozer | 104 | 76.0 | 79.3 | 69.3 | ** |
| | | | Macadam roller | 100 | 72.0 | | | ** |
| | | | Tire roller | 94 | 66.0 | | | ** |
| | | | Asphalt paver | 102 | 74.0 | | | ** |

Source: JICA study team

Noise associated with construction works will be high when several equipment and machineries are used at the same time. Thus, during construction works, surrounding communities may be disturbed since noise levels tend to exceed the permissible day time limit (75dB (A)), stipulated in Sri Lanka's noise regulation. With the use of noise barriers fence (3m height), noise level can be reduced by up to 10 dB. Therefore, by using the noise barrier fence, noise levels from most of the construction activities can be managed to meet noise standards.

Two types of noise barriers are suggested i.e. Type 1 and Type 2. Details of the height and the types of material included in these barriers are as follows.;

**Table 4.2A A Details of proposed noise barriers**

| Noise Barrier Type | Height | Material Types used for Sound Insulation | Remarks |
|---|---|---|---|
| Type 1 | 3m | Timber and fibre cement sheeting. | Can reduce 5-10dB |
| Type 2 | >3m | Glass fibre reinforced cement sheets | Can reduce at-least 15dB by adjusting the height and the material type |

Ref; A Guide to the reduction of Traffic Noise, Australia, Reprint 2003, relevant pages in Annexure 01

Conceptual designs for Type 1 and Type 2 noise barriers given below

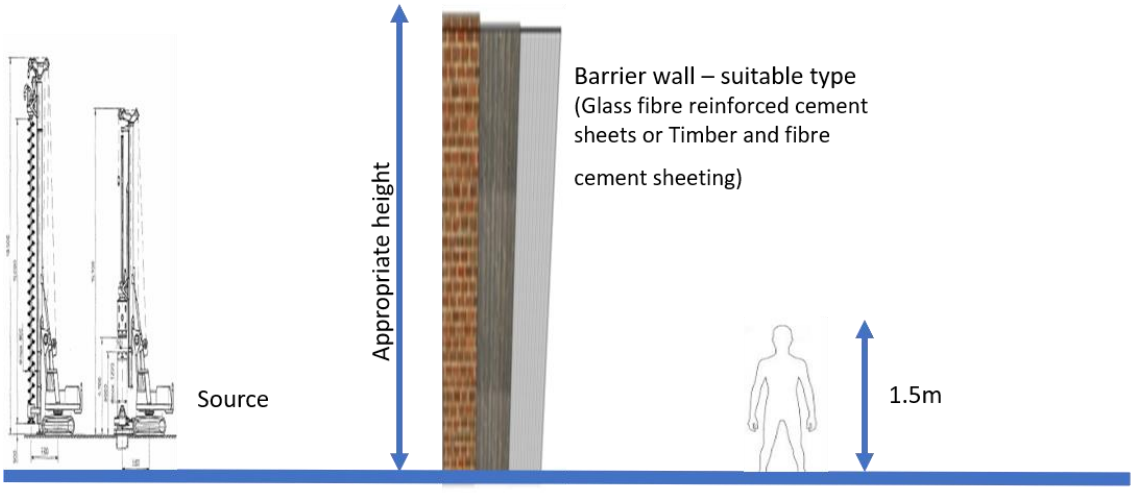
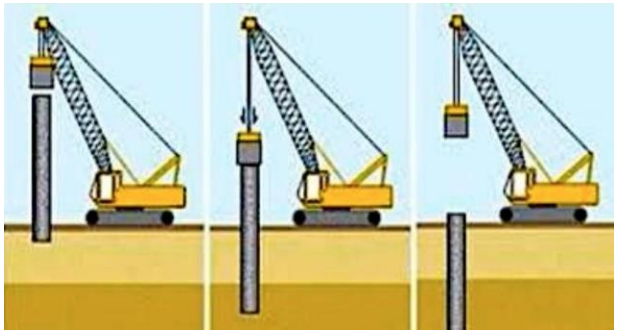



**Figure 4.1 A Conceptual design of noise barrier**

Construction of Depot

The Depot will be an elevated structure consisting of slab and pile foundation. Several piling activities will be conducted simultaneously, which would create cumulative noise impact. The pilling activities will be carried out using a drop hammer with crawler crane. In hammer piling, a hammer, with approximately the weight of the pile, is raised a suitable height in a guide and released to strike the pile head (refer to Figure 4.1).



Source: The Constructor Civil Engineering Home

**Figure 4.1 Hammer piling**

The elevated structure will be composed of 120 units. Each unit has a dimension of 50m x 20m. As an estimate, there will be 4 to 5 contractors, which will construct the Depot area simultaneously and each contractor will work at each unit. Therefore, 4 to 5 piling activities will be conducted simultaneously to construct each 50 x 20 unit. A total of 65 pilings is required per unit and approximately 7,800 pilings are required for whole Depot area.

For noise prediction for the construction at Depot area, assumptions are listed in Table 4.3 below.

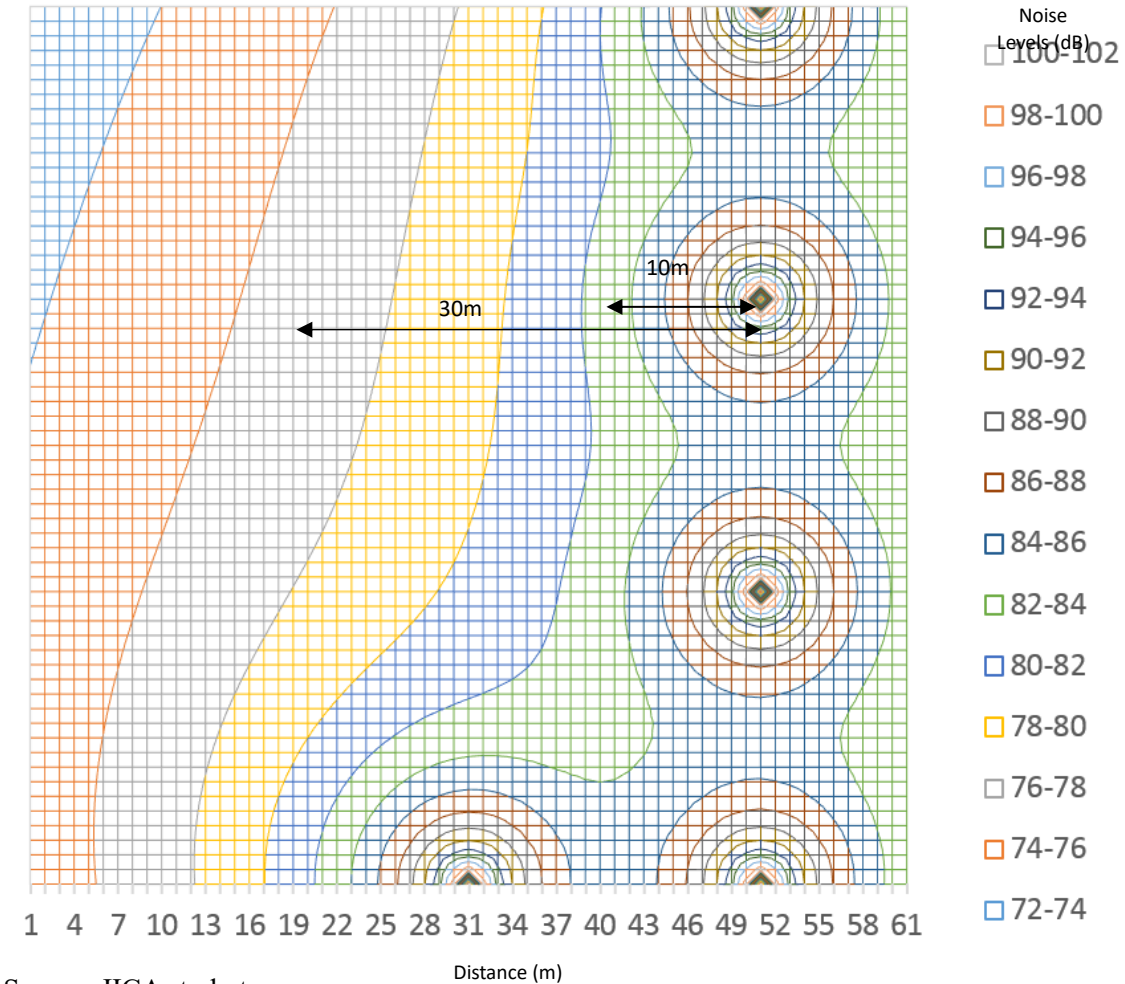
**Table 4.3Assumptions for Modelling of Cumulative Noise Impacts**

| Item | Unit |
|---|---|
| Maximum noise level from piling activity | 97.9dB[1] |
| Number of piling per day | 3 piles |
| Number of hit per piling | 80 times |
| 5 piling activities are conducted simultaneously | - |

Source: JICA Study Team

The cumulative noise level is calculated using same formula used in above calculation. The noise contour of cumulative noise level is shown in Figure 4.2 for maximum noise level and in Figure 4.3 for average noise level.

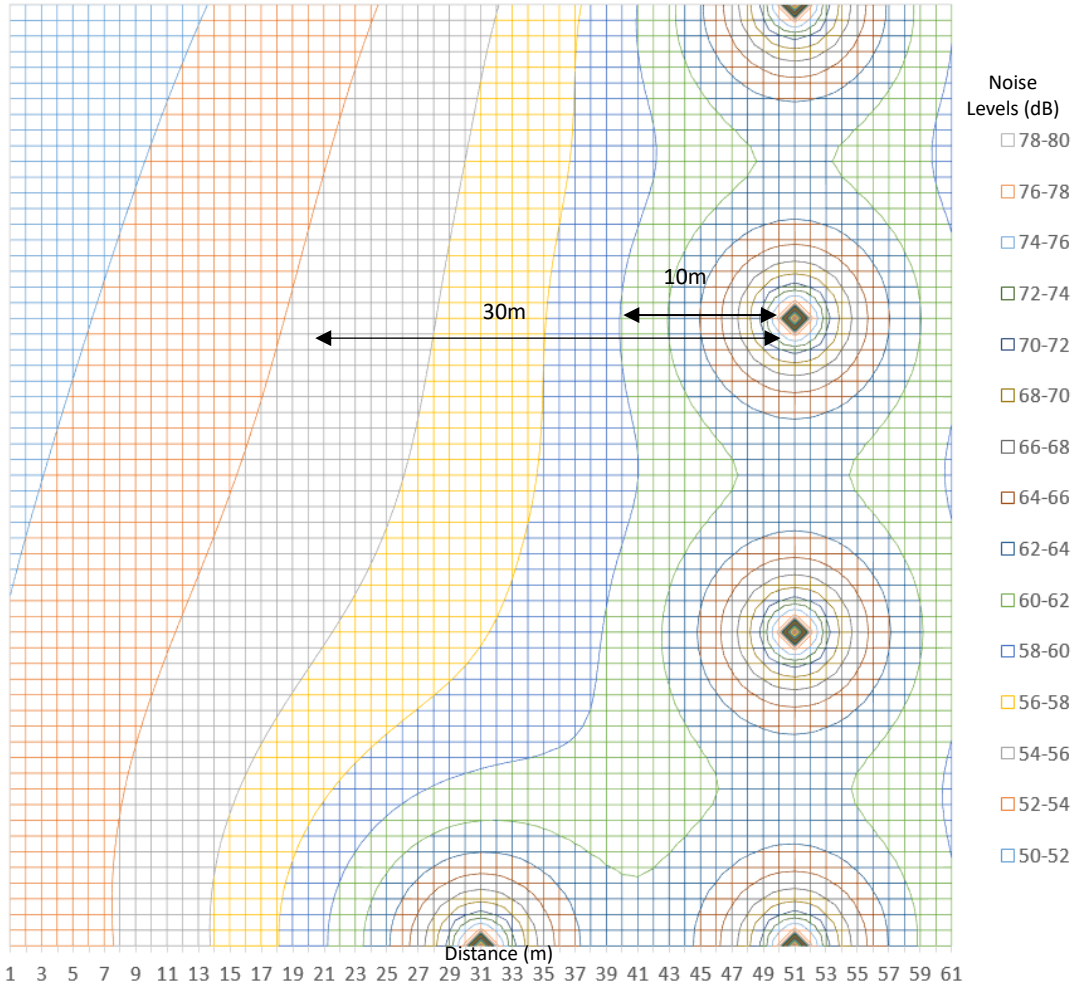
Calculations were done in a spreadsheet and the details are provided in Annexure 02




Source: JICA study team

**Figure 4.2 Cumulative maximum noise level (Lamax)at Depot area**

[1] Investigation on characteristics of noise generated by pilling activity, K.M. Lisan (ICSBE 2016)




Source: JICA study team

**Figure 4.3 Cumulative average noise level (Laeq)at Depot area**

Noise level at the closest residential area, which is about 10m from the noise source, is expected to be around 61dB for average noise level (Laeq) 61dB (average of 12 hours in day time) and about 84dB for maximum noise level (Lamax). The expected average noise level of 61 dB (Laeq) is below CEA standard for construction activity at daytime 75dB (A). there is no limit stipulated for Lamax in Sri Lanka.

It is important to consider that the duration of construction work at each unit will be approximately 1 month (no work during night time and weekend). Thus, exposure such noise level at a certain area will be 1~2 months. As the construction moves forward from one zone to the next one, noise level at a certain area will be reduced. Considering that the working unit is 20 m x 50m, the noise source will move at least 20m far away after the completion of piling activity at one unit. This means that after completion of the first unit and the piling activity will move forward by 20m, the noise level at the closest residential area will be 77dB for maximum noise level and 55dB for average noise level.

Although the noise level from the construction activity at Depot area will the noise limit (Laeq), appropriate mitigation measures will be implemented to minimize the disturbance to the residence around thee area. The mitigation measures are described in thee mitigation chapter (Chapter 5).

4.1.2 **Vibration Impacts**

**(3) Construction stage**

Depending on construction methods and activities employed by the prospective Contractor, there could be vibration impacts especially on the buildings adjacent to the LRT route. Vibration could be generated through the following activities:

- boring the road surface to excavate the trench for the pillars,
- vibrators used to compact concrete and
- construction equipment travelling, launching of beams/girders.

In general, ground vibration from construction activities very rarely reach the level that can damage structures but can reach levels that are audible and can be felt by humans close to the construction site.

A standard description about both these aspects which also includes a description as to how the decibel values are converted to PPV values are given in Annexure 03

1) Human exposure

***Prediction method***

The prediction model for human exposure developed in the Technical Handbook for Environmental Impact Assessment of Roads (2007) is applied. Vibration transmits from a source to a receiving point according to the following formula:

$$L_{(r)} = L_{r_o} - 15log_{10}\frac{r}{r_o} - 8.68\alpha(r - r_o)$$

Where,
$L_{(r)}$ = Vibration level at receiving point (dB)
$L_{(ro)}$ = Vibration level at reference point (dB)
r = Distance from a source (e.g. construction machinery) to receiving point (m)
$r_o$ = Distance of reference point (=5m)
$\boldsymbol{\alpha}$ = Internal damping ratio

Vibration level at reference point

The power levels of main construction machinery are shown in Table 4.14.

**Table4.14 Vibration Level of Construction Machinery and Damping Ratio**

| Construction machinery | Vibration level at reference point (dB) | Internal Damping Ratio |
|---|---|---|
| Pile drivers (hydraulic pile hammer) | 81 | 0.01 |
| Rock drilling (soft rock) | 64 | 0.001 |
| Slope surface splay | 48 | 0.01 |
| Alphalt pavement | 59 | 0.01 |

Source: JICA study team

Location of vibration source and receiving point

The construction machinery is assumed to be set on the center of the track. During the construction temporary wall (3.0m) will be set at the edge of the ROW (construction limit). The height of the receiving point is 1.2m.

***Results of the prediction and evaluation***

The projected vibration levels during construction were calculated based on the formula above. The results are shown in Table 4.15. In Sri Lanka, there is no standard for human perspective threshold.

**Table4.15 Vibration Level of Construction Machinery and Damping Ratio**

| Construction work | | Distance from the edge of the ROW to Receiving point (m) | | | | | Perspective threshold of vibration for human (dB)[2] |
|---|---|---|---|---|---|---|---|
| Activity[1] | Vibration level (dB) | 0 | 5 | 10 | 15 | 20 | |
| Pile drivers | 81 | 77.6 | 75.0 | 72.3 | 70.1 | 68.3 | 55 |
| Rock drilling (soft rock) | 64 | 60.9 | 58.5 | 56.2 | 54.4 | 53.0 | |
| Slope surface splay | 48 | 44.6 | 42.0 | 39.3 | 37.1 | 35.3 | |
| Alphalt pavement | 59 | 55.6 | 53.0 | 50.3 | 48.1 | 46.2 | |

Source: : JICA Study team

1 Technical Handbook for Environmental Impact Assessment of Roads, 2007

2 Technology and Laws Regulation for pollution control, 2000"Japan Environmental Management Association for Industry"

It is predicted that vibration from the operation of pile driver and rock drilling may be felt at areas close to the construction site as these exceed the human perspective threshold.

All calculations were done in an Excel spreadsheet and the results are presented in Annexure 03. The results indicate the decibel values which denote the human exposure impact and PPV values which denote building content impacts.

2) Vibration effects on building contents

Construction of railway structure and station

In Sri Lanka, the maximum permissible vibration levels for different type of structure are regulated by the Central Environmental Authority. In general, transportation and construction sources generate vibration levels within the range of 10-30Hz, normally close to 15Hz. [2] Applying this range in an intermittent method, the applicable vibration permissible limits for different types of structures, are shown in the table below.

The potential vibration impacts (at different points away from the source) from major construction activities with relatively high vibration levels (e.g. piling and rock drilling), have been identified through secondary sources. These estimates are also presented in Table 4.16 below to compare with the applicable vibration standards.

**Table 4.16 Vibration levels of construction activities**

| Construction activity | Predicted vibration level (mm/s) | Maximum permissible vibration level (mm/sec) [3] | | | |
|---|---|---|---|---|---|
| | | Structure type (see below reference) | | | |
| | | Type1 | Type2 | Type3 | Type4 |
| Pile Driver[1] | 8.5mm/s at 5m<br>4.5mm/s at 10m<br>1~3mm/s at 15~20m | 15.0 | 8.0 | 4.0 | 1.0 |
| Rock drilling[2] | 4.5mm/s at 5m<br>1.30mm/s at 10m | | | | |

[2] California Department of Transportation 2013, Transportation and Construction Vibration Guidance Manual, Sacramento, CA, p. 17. Referring to: Hendriks, R 2002. *Transportation related earthborne vibration (Caltrans experience)*. California Department of Transportation. Sacramento, CA.

| | | | | | |
|---|---|---|---|---|---|
| | 0.4mm/s at 20m | | | | |
| | | | | | |
| Type1 | Multi story buildings of reinforced concrete or structural steel, with filling panels of block work, brick work or precast units not designed to resist earthquakes | | | | |
| Type2 | Two-storey domestic houses and buildings constructed of made of reinforced block work, precast units, and reinforced floor & roof construction, or wholly of reinforced concepts or similar, not designed to resist earthquakes. | | | | |
| Type3 | Single and two storey houses and buildings made of lighter construction, using lightweight materials such as bricks, cement blocks etc, not designed to resist earthquakes. | | | | |
| Type4 | Structures that, because of their sensitivity to vibration, do not correspond to those listed above 1,2 & 3, & declared as archeologically preserved structures by the Department of Archaeology | | | | |

Source: CEA
1 comparison between ground vibrations induced by impact piling and boing piling (ICSBE2016-231)
2 EIA report for Northern Expressway Environmental Impact Assessment Report
3 Maximum Permissible interim Vibration levels (Intermittent, Vibration Frequency at 10-50Hz), CEA

Considering that construction activities that may cause vibration, will be conducted at the center of roads, the distance of the vibration source to the structures is more than 10m. Based on the results in Table 4.16, rock drilling will not have significant impact on all Types of structures (except Type 4). However, piling activities my impact Type 3 and 4 structures. For some sections, such as Malabe area where road width is narrow, the distance could be around 8m. Based on Table 4.16, it is predicted that vibration levels from construction activities will exceed the maximum permissible limit for Type 3 and 4 structures and potentially for Type 2.

Overall, special care must be taken for old, fragile buildings located along the LRT route, which may have cultural/historical significance (preserved structure by the Department of Archaeology).

Construction of Depot

As mentioned in the Noise section, several piling activities will be conducted to construct the numerous columns that would support the elevated depot structure. This means around 4-5 pile drivers may be operated at the same time. Similar to noise impact, simultaneous piling activities may generate vibration impacts that may affect humans and surrounding built structures.

In order to estimate the vibration impacts on surrounding areas of simultaneous piling activities, modelling has been conducted. Cumulative vibration impact was calculated with the following assumptions (refer to Table 4.17 below).

**Table 4.17 Assumptions for Modelling of Cumulative Vibration Impacts**

| Item | Unit |
|---|---|
| Vibration level at point source (e.g. pile driver) | 90dB |
| Distance of nearest receptor | 10m |
| Internal damping ratio | 0.01 |
| Five machineries (e.g. pile driver) operate at the same time | - |

Note: Internal damping ration is 0.01-0.02 for clay; 0.02-0.03 for sand-silt
Source: JICA Study Team

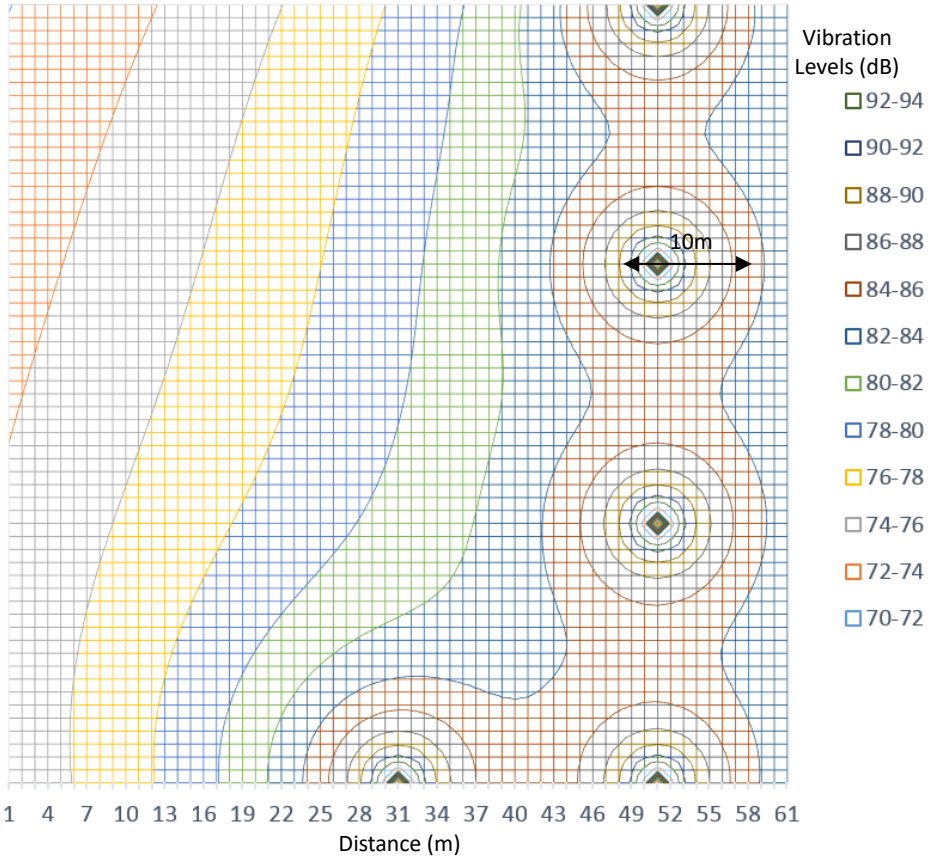
The following equation was used to calculate the cumulative vibration level (similar to combined noise level):

$$L = 10\log(\frac{10^{L1}}{10} + \frac{10^{L2}}{10} + \cdots + \frac{10^{Ln}}{10})$$

Where,
$L_{(sum)}$ = Combined vibration level (dB)
L1, L2,…, Ln = Vibration level of each equipment (dB)

The modelling results are presented in Figure 4.15. The Figure maps out vibration levels of surrounding areas, assuming that five pile drivers operate at the same time. It is assumed that piling activity would create 90dB vibration at 10m from the source for a conservative approach[3]. However, the vibration acceleration values had to be adjusted to remove human perception intrinsic in the measurement methods.

Based on the results, vibration level at 10m away from the vibration source (middle of circle), is expected to be approximately 82-84dB (refer to Figure 4.15). This result reflects the combined impact from the other piling activities. This range is higher than the human perceivable vibration level.

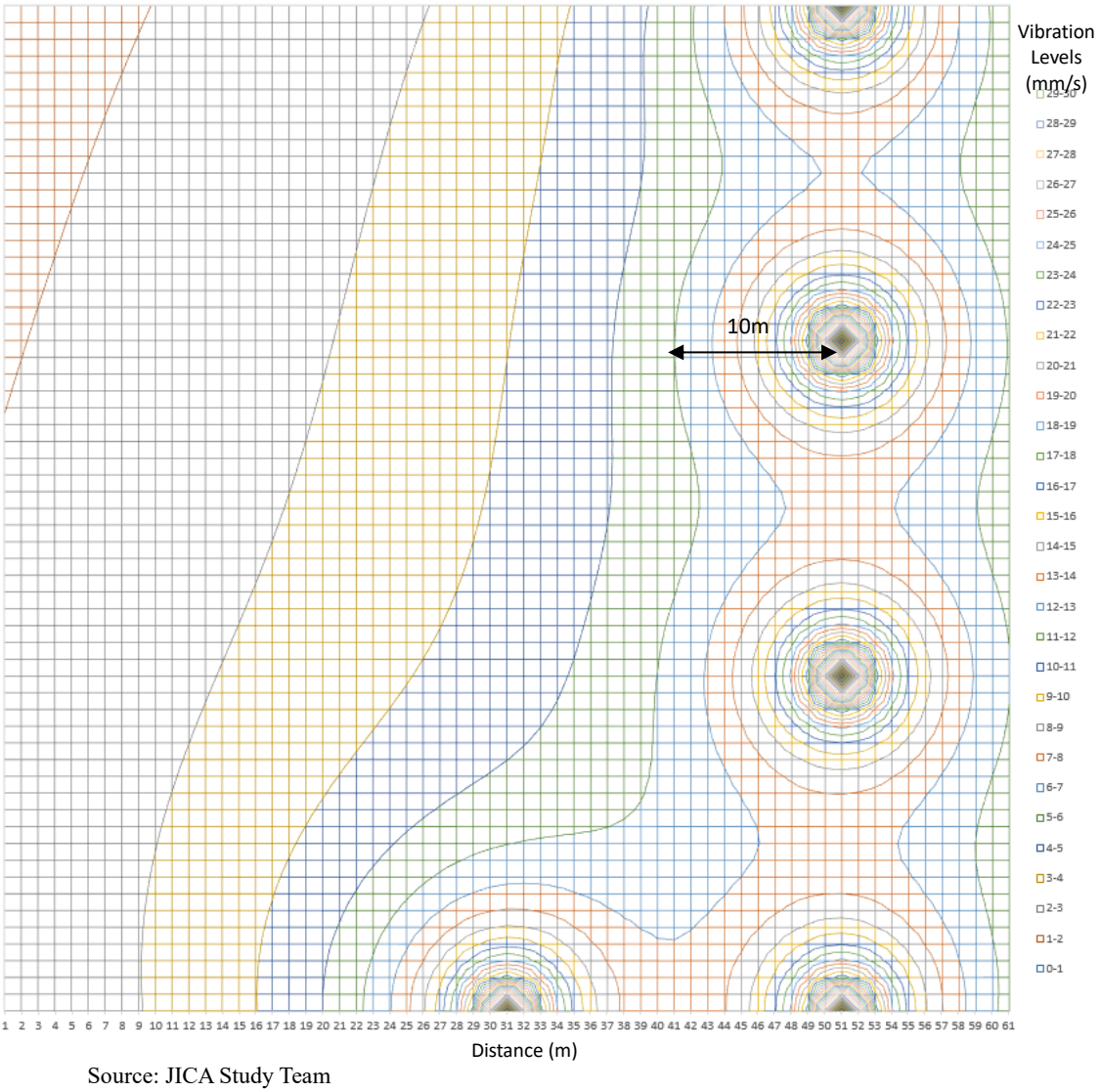



Source: JICA Study Team

**Figure 4.15 Cumulative vibration level (dB) at Depot area**

[3] This vibration level is set at a higher value compared to 81dB (Table 4.17), in order to take a conservative approach in the calculations.

It is important to note that vibration limits stipulated in the Sri Lankan regulation is in terms of peak particle velocity (PPV) in the unit mm/s (millimetre per second). This measurement takes into account movement of particles in the ground and the potential impacts on built structures. The modelling results have been converted into PPV unit (mm/s)[4] in Figure 4.16. According to the results, vibration levels at a distance of 10m from the vibration source (both in the left and right side of the source in the Figure) is estimated at approximately 5-7 mm/s, depending on the location.




Source: JICA Study Team

**Figure 4.16 Cumulative vibration level (mm/s) at Depot area**

As mentioned earlier, transportation and construction sources generate vibration levels within the range of 10-30Hz, normally close to 15Hz.[5] Thus, the same regulatory limits (Intermittent,

[4] Conversion was calculated by using the acceleration of vibration [$L=20\log(a/a_o)$] (unit in dB), converting this into velocity [$V=(GA)/(2\pi F)$] (unit in mm/s), and correcting the value by multiplying RMS (root mean square) for waveforms.

[5] California Department of Transportation 2013, Transportation and Construction Vibration Guidance Manual, Sacramento,

Vibration Frequency at 10-50Hz) apply (Refer to Table 4.18). As a result, it is estimated that simultaneous piling activities will not have significant impacts on Type 1 and 2 structures that are located within 10m from the piling activities. However, these activities may affect Type 3 and 4 structures located within the 10m boundary.

**Table 4.18 Vibration levels of simultaneous piling activities**

| Construction activity | Predicted vibration level (mm/s) | Maximum permissible vibration level (mm/sec) | | | |
|---|---|---|---|---|---|
| | | Structure type (see below reference) | | | |
| | | Type1 | Type2 | Type3 | Type4 |
| Simultaneous piling activities | 9mm/s at 5m<br>6mm/s at 10m<br>3~5mm/s at 15~20m | 15.0 | 8.0 | 4.0 | 1.0 |
| | | | | | |
| Type1 | Multi story buildings of reinforced concrete or structural steel, with filling panels of block work, brick work or precast units not designed to resist earthquakes | | | | |
| Type2 | Two-storey domestic houses and buildings constructed of made of reinforced block work, precast units, and reinforced floor & roof construction, or wholly of reinforced concepts or similar, not designed to resist earthquakes. | | | | |
| Type3 | Single and two storey houses and buildings made of lighter construction, using lightweight materials such as bricks, cement blocks etc, not designed to resist earthquakes. | | | | |
| Type4 | Structures that, because of their sensitivity to vibration, do not correspond to those listed above 1,2 & 3, & declared as archeologically preserved structures by the Department of Archaeology | | | | |

Source: Maximum Permissible interim Vibration levels (Intermittent, Vibration Frequency at 10-50Hz), CEA

Overall, special care must be taken for old, fragile buildings located close to the boundaries of the proposed depot, particularly those structures made of lightweight materials.

CA, p. 17. Referring to: Hendriks, R 2002. *Transportation related earthborne vibration (Caltrans experience)*. California Department of Transportation. Sacramento, CA.

# CHAPTER 5 Proposed Mitigation Measures

## 5.1 Mitigation Measures for Noise and Vibration

### 5.1.1 Mitigation measures due to Impacts on Noise

*Construction stage*

All construction equipment will be used in good service condition and low noise/vibration generating construction equipment will be used. Heavy noise/vibration generating construction work are not expected. There could be some noise during trench excavation for foundations and the placement of steel beams on columns etc. Such noise or vibration will be minimum and limited to the construction stage and such impacts are not continuous but sporadic. No noise generating night work will be allowed especially in the areas where there are residences (e.g. Ward Place etc.).

Noise and vibration nuisance would be significant only during the construction stage where a piling operations and structure construction works would commence. Therefore, noise levels will be well monitored during the construction stage. If ambient levels are far higher than the stipulated level of 75 dB (A) for daytime construction and 50 dB (A) for night time, mitigation measure given below will be implemented. The impact of noise and vibration nuisance could be minimized through the following measures;

3) Fitting of exhaust baffles and maintaining construction vehicle and machinery in a high operable condition,
4) Use the noise, low-vibration type machine and/or vehicles,
5) The construction site is separated with Type 1 and Type 2 Noise barriers material especially at locations near noise sensitive receptors.
6) Scheduling of construction work that cause high noise and vibration must be within authorized construction embodiment times with the least inconvenience to the public,
7) Avoid construction work on Poya days and days of other religious and/ or cultural importance,
8) Avoid high noise construction activities during the night time.
9) Establishing a complaint mechanism and implementing a procedure to effectively deal with any issue raised by the community.
10) Inform surrounding community of the construction schedule and proposed activity in advance

For the construction activity at Depot, following mitigation measures will be implemented.

1) Conduct a test piling activity and check the noise level generated from the piling activity at Depot area.
2) Consider changing the height of hammer drop or weight of hammer to be used, depending on the result of test piling
3) Install a noise reduction equipment with piling hammer

*Operational stage*

During the operation of LRT project, noise level from LRT will meet the noise level standard for railway both Peak noise level (LAmax) and Equivalent noise level (LAeq) of Japanese/Australian standards. However, noise level would be gradually increased up to the 13m height. In addition, there would be a disturbance especially around noise sensitive areas as identified in Chapter 3.3.3, including hospitals such as General hospital and Ayurweda hospital, schools and education institutes. Therefore, following mitigation measure will be implemented.

11) For section along noise sensitive areas, implementation of noise mitigation measures such as noise barriers or double pane windows shall be considered during detail design stage as well as operational stage.

12) Carry out noise monitoring along LRT routes at the location conducted for noise measurement survey (total 7 locations). Additional monitoring point will be added based on comments raised from stakeholders along LRT route.

13) Standard maintenance of trains, structure and tracks

14) Regular reconditioning of train and its components, such as suspension system, brakes and wheels.

15) Establishing a complaint mechanism and implementing a procedure to effectively deal with any issue raised by the community.

### 5.1.2 Mitigation Measures for Vibration

*Construction stage*

Mitigation will include the following actions;

16) Identification of type of building structure (Type 3 and Type 4). For Type 4 structure, the consultation with Department of Archaeology is required.

17) Carry out a property condition survey (crack survey) of nearby structures and record the present condition of the structure, to accurately assess any damage to these structures during the construction stage.

18) Vibration monitoring at selected area around the construction activities.

19) Regularly communicate with surrounding communities to inform the construction schedule.

20) Use of lower vibration generating device/machinery.

21) Scheduling of construction work that cause high vibration must be within authorized construction embodiment times,

22) Minimization of piling energy (e.g. reduced hammer drop distance) as necessary depending on receptor distance.

23) Establishing a complaint mechanism and implementing a procedure to effectively deal with any issue raised by the community.

24) Provide 3m wide temporary peripheral canal in order to break the vibration transmission

# 6 Extended Cost Benefit Analysis

## 6.1 Introduction

This chapter presents the Extended Cost-Benefit analysis (ECBA) of the proposed LRT line for Malabe traffic corridor from the Fort station to Depot station. The purpose of ECBA is to assess the economic viability of the project once the environmental/social costs reported in the EIA of the project incorporated into the cost benefit analysis. The EIA of the project has identified environmental and social impacts that could lead to benefits and costs, i.e. positive or negative effects to the economy. The ECBA is based on the principles of discounted cash flow analysis. The standard investment assessment criteria of Net Present Value (NPV), Cost-Benefit Ratio (CBR) and Internal Rates of Return (IRR) were used as, the decision rules of the analysis.

## 6.2 Nature of the Investment and Economic Contribution of the Project

The project involves investments leading to establishment of a new mode of transport, currently not available in the multi-modal transport network in the Colombo Metropolitan Region (CMR). The necessity of an LRT network has been identified in the Western Region Megapolis Transport Master Plan (WRMTMP) published in 2016, as a rapid transit system (RTS), to ease the peak hour traffic congestion and resultant passenger difficulties, especially in Central Business District (CBD) areas. The plan has proposed a network of seven RTS routes (RTS1-RTS7) that connects CBD as well as suburban areas, based on a comprehensive methodology that has taken, major trip generation points, major trip attraction points and a minimum spanning tree, into consideration. The project involves substantial cost of capital investments on civil works for construction of the LRT line including stations and depot area, cost of acquiring rolling stocks as well as operational costs of running the system.

The WRMTMP has carried out a detailed economic evaluation for the entire Plan based on the output parameters of a comprehensive demand forecast modelling exercise that covered the whole system of multi-modal transport network using a scenario based approach. However, the WRMTMP recommended undertaking detailed economic analysis during the project feasibility studies, to ascertain true economic value of each individual project implemented under the Western Region Megapolis Transport Master Plan.

The proposed LRT line for the Malabe traffic corridor from the Fort Railway Station to the Malabe Depot station combines certain sections of RTS 1 and RTS 4 thereby connecting CBD with suburban areas. Out of seven major traffic corridors that enter the Colombo city, Malabe corridor has the largest volume of traffic among all corridors and the lowest travel speed at peak hours which was estimated at 13.8 km/h. Shifting and expansion of government office complexes in Battaramulla, Malabe and Akuregoda areas cause further increases in the demand for transport facilities in this corridor at a rapid rate and no rail-based public transport connection is currently available for this traffic corridor.

The LRT opens a new mode of transport for passengers in this corridor in an elevated track that can operate on regular basis without being obstructed by traffic conditions in the existing road transport facilities. It will increase the capacity of the total transit system while simultaneously reducing the burden of overloading the existing transit facilities by attracting passengers especially from modes of private transport such as cars, motor cycles and three wheelers. Hence, the project offers a modal choice for passengers with faster connectivity, low travel time, increased safety and comfort to their destinations.

The LRT was selected as a mode of environmental sustainable transport, one of the four major principles considered in the preparation of WRMTMP. The LRT is an electric-powered system with no or minimum emissions during its operations. Simultaneously, reduced use of emission-intensive private transport modes and decreased traffic congestions can be expected to generate further reductions in emissions that can be considered as a major environmental benefit of the project.

## 6.3 Methodology of the ECBA

### 6.3.1 General

This section describes the general methodology adopted in undertaking the ECBA. It discusses data sources used, key steps of evaluation, standards/assumptions and decision criteria used for the evaluation.

### 6.3.2 Data sources of ECBA

The key data sources used for the ECBA are draft final report of the Feasibility Study[6] prepared by the expert team of Oriental Consultants Global Co., Japan, draft final report of EIA Study[7] and Resettlement Action Plan (RAP)[8] prepared by the Consulting Engineers and Architects Associated (Pvt) Ltd., Sri Lanka. The feasibility study team has undertaken an economic evaluation of the project using output parameters of the demand forecast modelling study and other relevant economic data from secondary sources. Even though this evaluation has not considered all environmental and social impacts identified in the EIA, the experts have also estimated emission reduction benefits of the project. The EIA and RAP studies have identified environmental and social impacts of the project during construction and implementation phases. The ECBA is mainly based on information from these study reports. In addition, key members of expert teams were consulted from time-to-time for clarifications and further information.

## 6.4 Key Steps of ECBA

Key steps of the ECBA of KHRP included the following steps:

- **Extracting the required base data on project costs and benefits from the demand forecast analysis and the feasibility study**
- **Identifying environmental social impacts reported from the current EIA and SIA and determining whether they represent cost (negative impacts) or benefits (positive impacts)**
- **Acquiring required information on economically measurable impacts (costs and benefits) from experts of EIA and SIA teams and evaluating costs and benefits of environmental and social impacts using appropriate methods**
- **Carrying out ECBA, incorporating extended cost and benefits identified in EIA and SIA to estimate standard project evaluation parameters —i.e. NPV, CBR and IRR**
- **Undertaking sensitivity analysis of CBA taking alternative scenarios of benefits and costs in to consideration**

[6] ***Preparatory Study on the Project for Establishment of New Rail Transit System in Colombo*** **submitted for approval of the JICA**

[7] ***Environmental Impact Assessment for Colombo Light Rail Transit (LRT) Project*** **prepared for submission of CEA.**

[8] ***Resettlement Action Plan for Colombo Light Rail Transit (LRT) Project*** **(unpublished)**

## 6.5 Standards and Assumptions used in ECBA

The list of assumptions and standards adopted in the ECBA is given in the Table 6.1 below.

Table 6.1: Major assumptions and standards used in the extended cost-benefit analysis

| Parameter | Standard/Assumption | Remarks |
|---|---|---|
| Discount rate | **12**% | This is the standard rate used in CBA **of the project feasibility study** and ECBA of many similar projects and is based on the historical movement of the interest rates in the country. |
| Evaluation period | Seven years **(2018-2024)** for construction and 30 years **(2025-2054)** for operations | Cost estimates for the construction were available for given number of years and they are consistent with the usual standards applied for similar projects. |
| Price year | 2017 constant prices | This is a new trace and EIA for it will be completed in early 2018 |
| Prices | Shadow prices were used. | Standard practice adopted in economic analysis. Shadow conversion factors used in the **CBA of the project feasibility study** were applied |
| Numeraire currency | LKR | Standard used in the CBA and ECBA of previous traces |
| Treatment of inflation | Constant prices excluding inflation were used | A Standard practice adopted in economic analysis |

## 6.6 Decision Criteria

### 6.6.1 General

The three decision criteria considered in the ECBA are:

- Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

### 6.6.2 Net Present Value

The Net Present Value (NPV) measures the actual or real net economic benefit of the project. The NPV is calculated by subtracting the discounted costs from the discounted benefits. All projects with a positive NPV provide a net economic benefit and are economically justified. The NPV should be used when comparing mutually exclusive project options. The option with the highest NPV is the economically preferred option.

The formula applied for calculating NPV is as follows:

$$NPV = \sum_{i=1}^{n} \frac{(B_i - C_i)}{(1+r)^i}$$

B= Net annual benefits
C = Net annual costs
r = discount rate

### 6.6.3 Benefit Cost Ratio (BCR)

The Benefit Cost Ratio (BCR) is the ratio of the present value of benefits to the present value of costs and measures the relative net gain of the proposed expenditure. The BCR will be greater than 1 whenever discounted benefits exceed discounted costs. A project with a BCR above 1, provides a net economic gain and is therefore it is economically justified. In a budget constrained environment, projects should be prioritized according to their BCRs. The project with the higher BCR is expected to provide the greatest benefit per dollar invested and hence it should receive priority in the allocation of funding. This will ensure the efficient allocation of scarce resources.

The formula applied for computing BCR is as follows:

$$BCR = \sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \Big/ \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}$$

### 6.6.4 Internal Rate of the Return (IRR)

Internal Rate of Return (IRR) is the discount rate at which the present value of benefits equals the present value of costs (where NPV equals zero). It measures the rate of return of benefits to costs. If the IRR is greater than the interest rate that would otherwise be the rate of return for the funds invested in the project concerned and it is considered as a sound investment.

## 6.7 Costs and Benefits of the Project

### 6.7.1 General

In the feasibility study, major components of the project costs and benefits have been identified and estimated. The project cost estimates were prepared according to the final trace and engineering design of the project. Key project benefits were estimated using information generated in demand forecast study and other secondary information.

### 6.7.2 Construction/Procurement and Operational Costs of the Project

Preliminary cost estimates of the project have been prepared in the feasibility study. Cost items have been identified under the following major categories:

***Cost of construction/procurement***: This includes all estimated capital cost items of construction phase of the LRT project including pre-construction costs. Pre-construction costs include cost of feasibility, detailed design and land acquisition. Construction/procurement cost includes: Rolling stock cost, depot construction and mainline construction. Engineering construction and project management costs are to be expended within the first eight years (2017-2024) of the project life and the LRT will be commissioned in 2025.

***Operating costs and replacement costs***: Operating costs of LRT system were estimated for a period of 30 years after commissioning of the LRT line from 2025 to 2054. Estimates cover costs concerning

operation of train services and maintenance and rehabilitation of the line for the period concerned. Details about construction and operational costs are given in the Tables 6.2 and 6.3.

***Replacement costs***: Costs of replacement identified for every five year after commencing operations. The cumulative total for the 30 years was estimated at 83.7 billion LKR. The original estimates of the project costs were financial estimates and they were converted to economic costs by using standard conversion factor that has been calculated as 0.92 by the feasibility study team.

Table 6.2: Cost of construction and pre-construction activities

(Source: Feasibility Study Report)

| **Item** | | Total | | | |
|---|---|---|---|---|---|
| **Item** | | Value of Foreign Currency component | Local currency | Total financial Cost | Total Economic Cost |
| | | (million LKR) | (million LKR) | (million LKR) | (million LKR) |
| **A. ELIGIBLE PORTION** | | | | | |
| I) Procurement/Construction | | 149,008 | 105,570 | 254,578 | 234,211 |
| | Base Cost | 124,123 | 82,334 | 206,457 | 189,940 |
| | Price Escalation | 11,338 | 13,639 | 24,977 | 22,979 |
| | Physical Contingency | 13,546 | 9,597 | 23,143 | 21,292 |
| II) Consulting Services | | 17,500 | 5,332 | 22,832 | 21,006 |
| | Base Cost | 15,438 | 4,438 | 19,876 | 18,286 |
| | Price Escalation | 1,228 | 640 | 1,868 | 1,719 |
| | Physical Contingency | 833 | 254 | 1,087 | 1,000 |
| Total (I+II) | | 166,508 | 110,902 | 277,410 | 255,217 |
| **B. NON ELIGIBLE PORTION** | | | | | |
| a | Land Acquisition | 0 | 6,212 | 6,212 | 190 |
| B | Administration Cost | 0 | 14,181 | 14,181 | 13,047 |
| C | VAT | 0 | 42,543 | 42,543 | 0 |
| Total (a+b+c) | | 0 | 62,936 | 62,936 | 13,237 |
| **TOTAL (A+B)** | | 166,508 | 173,838 | 340,346 | 268,454 |

Table 6.3: Cost of operation and maintenance activities

| Description | | Cost (million LKR) | |
|---|---|---|---|
| | | 2025 | 2035 |
| Human Cost | | 953.94 | 953.94 |
| Outsourcing & Parts Cost | Operation | 637.21 | 955.82 |
| | Maintenance of Rolling stocks | 404.52 | 606.78 |
| | Maintenance of Infrastructure & Tracks | 415.92 | 415.92 |
| | Maintenance of Electrical Equipment | 499.11 | 499.11 |
| Power Cost | | 573.64 | 860.46 |
| Admission cost | | 95.40 | 95.40 |
| **Total** | | 3,579.74 | 4,387.42 |

(Source: Feasibility Study Report)

## 6.8 Environmental and Social Costs of the Project

Besides the above-mentioned project related costs, the EIA study has identified number of negative environmental and socio-economic impacts that can be considered as environmental costs of the projects. Summary of these environmental and socio-economic impacts are given table 6.4. These include impacts during the construction stage and operation stage of the project. However, majority of impacts are connected to construction phase and therefore they can be considered as temporary. Impacts relating to noise, vibration, water quality and safety are likely to persist in the implementation stage too. Also, some environmental conditions are likely to be improved due to project after construction phase. An example is the improved air quality due to reduction of emissions. (Economic benefits of emission reductions are discussed in Section on 'Environmental Benefits of the Project'). Details given in the EIA study report suggest that the impacts identified are scattered and can largely be managed using appropriate mitigation and monitoring measures. However, some significant impacts can also be identified in the depot area during the construction as well as implementation phases. The proposed depot is located in a flood prone area and therefore it has been designed as elevated structure supported by pillars. This can disturb the wetland environment in the depot area. Significant amount of waste generated in the depot during operation stage has to be managed to avoid pollution of water sources. Also, the Project requires removal of some number of trees along the Denzil Kobbekaduwa Road (Palan Thuna Junction area).

Table 6.4: Environmental and socio-economic impacts of the project

| Area of Impact | Stage | Key impacts | Cost of mitigation |
|---|---|---|---|
| **Environmental Impacts** | | | |
| Traffic | construction | Traffic congestion | Included in EPC Contractor's service fee |
| Noise | construction | Noise pollution | Included in EPC Contractor's service fee |
| | Implementation | Noise pollution from the operation of LRT | To be included in the project cost at the detailed design stage |
| Vibration | construction | Damage to adjacent buildings | Included in EPC Contractor's service fee |
| | Implementation | Vibration impact from the operation of LRT | Included in the project cost |
| Air quality | construction | Dust and emissions | Included in EPC Contractor's service fee |
| Water course | construction | Bridge crossing and impacts on flood plains | Included in EPC Contractor's service fee |
| Water and soil quality | construction | Soil erosion, improper discharge of sewage from depots and sites and discharge of oil from vehicles | Included in EPC Contractor's service fee |
| | Implementation | Spillage, leakage and accidental leakage | Included in the project cost |
| | | Waste water from depots | To be included in the project cost at the detailed design stage |
| | | Waste water from stations | Included in the project cost |
| Solid waste | construction | Nuisance to pedestrians and road users | Included in EPC Contractor's service fee |
| | Implementation | Waste from depots | Included in the project cost |
| | | Waste from stations | Included in the project cost |
| Flora and Fauna | construction | Removal of trees and trimming of branches | Included in EPC Contractor's service fee |
| | | Loss of green area ( appox. 1 ha) | 20 million |
| Landscape | construction | Impact on aesthetic view of sensitive areas | To be included in the project cost at the detailed design stage |
| **Socio-economic impacts** | | | |
| land | construction | Land acquisition and resettlement | Included in the project cost |
| Livelihood | construction | Disturbances to livelihood and economic Activities | Included in the project cost |
| | Implementation | Disturbances to livelihood and economic Activities | |

| Area of Impact | Stage | Key impacts | Cost of mitigation |
|---|---|---|---|
| **Environmental Impacts** | | | |
| Safety | construction | Occupational Health and safety | Included in EPC Contractor's service fee |
| | Implementation | Occupational Health and safety | Included in the project cost |
| Religious & culture | construction | Impacts on religious & Culturally important locations | Included in EPC Contractor's service fee |
| Government properties | construction | Impacts on Government properties | Management cost |
| Utilities | construction | Disturbances to utility supply lines | Included in the project cost |

(Source: EIA Study Report)

Given the scattered nature of impacts, limited availability of data and time constraints, estimation of the value of these environmental costs was not practical. However, the EIA team has identified mitigation measures to minimize all these impacts. These mitigation measures have been taken into consideration in the preparation of the project costs. Experts of project feasibility team confirmed that number of mitigation measures have already been included in the project costs as shown in the final column of Table 6.4. They can be considered as proxy values of environmental costs of the project estimated through 'preventive expenditure' approach. For instance project cost covers the cost of installing the wastewater treatment plant of LKR 68 million.

The RAP has identified quantitative details of certain socio-economic impacts together with compensation schemes and income restoration measures. A summary of the impacts identified in RAP is given in Annex Table 3.

## 6.10 Benefits of the Project

### 6.10.1 General

The project generates both transport and environmental benefits to the national economy. The LRT project being a transport sector project, transport benefits can naturally be considered as the most important category of the benefits.

### 6.10.2 Transport Related Benefits of the Project

In the Project Feasibility Study, the following transport system benefits have been identified as the key benefits of the project.

- **Vehicle operation cost savings**
- **Travel time cost savings**
- **Savings of accident costs**

Vehicle Operations Cost Savings

Vehicle operating costs (VOC) are the costs associated with the running of a motor vehicle such as fuel, oil, tires, repair and maintenance and depreciation costs. Smooth vehicle running conditions created due to operation of LRT against the base case situation of the existing road network can be expected generate VOC savings as main economic benefit. General formula for estimating Vehicle Operating Cost Savings can be given as follows.

$$VOC\ savings\ = Total\ VKT\ by\ vehicle\ class \times \Delta\ unit\ OC\ per\ vehicle\ km\ by\ vehicle\ class$$

VKT = Vehicle km travelled

Δ Unit OC = Difference in unit operating cost between base case and LRT

The unit vehicle operating costs (VOC) were derived based on *'Assessing Public Investment in the Transport Sector 2001'* by the Department of National Planning, Ministry of Finance and Planning, Sri Lanka. The price was converted to 2017 price based on the Colombo Consumer Price Index (CPI) of the transport sector. Unit vehicle operating cost estimated by the representative vehicles and operating speed in 2017 prices is shown in Annex Table 6.

Travel Time Savings

Savings in travel time is a primary economic benefit sought from many transport sector projects. These savings are enjoyed by passengers as well as freight consignees. A main benefit predicted by traffic demand models for users of LRT is travel time savings. The general formula used for estimating travel time savings is as follows.

$$TT\ savings\ = \Delta\ VHT\ by\ vehicle\ class\ \times\ VT\ per\ vehicle\ hour\ by\ vehicle\ class$$

ΔVHT = Difference in vehicle hours travelled between the base case and KHRP

VT = Value of time per vehicle hour by vehicle class

Hourly travel time value of passengers was estimated for three income groups based on the results of the Home Visit Survey (HVS 2013) conducted in 2013 at the CoMTrans Project and the Household Income and Expenditure Survey 2012 (HIES 2012) by the Department of Census and Statistics. Income categories were identified by the HVS considering vehicle ownership and mode choice characteristics. The mean household income was estimated by the HIES 2012. It is assumed that the future value of time by income class is consistent throughout the analysis period. The following table presents the time value of workers average trip for three income categories in 2017 prices.

Table 6.5: Hourly value of time by income group

| Income Level (LKR) | Mean Household Monthly Income | Avg. No. of Workers in household | Time Value of Work Trip (LKR/h) | Work Trip Ratio | Avg. Time Value (LKR/h) |
|---|---|---|---|---|---|
| >80,000 | 231076 | 1.9 | 1129 | 23% | 572 |
| 40,000-79,999 | 70516 | 1.72 | 381 | 16% | 169 |
| <40,000 | 29802 | 1.2 | 231 | 15% | 100 |
| All | 87343 | 1.36 | 596 | 16% | 265 |

Savings of Accident Costs

Compared with situation of the existing road network (base case), reduced number of accidents is another advantage of the LRT. This results in the economic benefit of accident cost savings. The

accident loss was estimated by the method proposed in '*Assessing Public Investment in the Transport Sector 2001*' by the Ministry of Finance and Planning. Assumptions on the accident loss estimation are shown in Annex Table 7. The unit accident cost per vehicle-kilometre in 1999 was converted to the 2017 value. It is assumed that traffic accidents will decline 4% every year.

## 6.11 Environmental Benefits of the Project

### 6.11.1 General

The major environmental benefit that can be expected from the LRT project is reduction of emissions due to modal shift from private vehicles to LRT and low traffic congestion. This could lead to improved public health and climate change mitigation due to reduction of GHG emissions.

### 6.11.2 Reduction of $CO_2$ Emissions

For the analysis, assessment year was set at 2035 to evaluate the potential GHG emission reduction, covering both construction and operation phases. Project activities considered in the analysis and the corresponding quantification methods employed are summarized in Table 6.6.

**Table 6.6 Analysis Scope and Quantification Methods**

| Project Phase | Activities | Quantification Method |
|---|---|---|
| **Construction** | **Carbon loss from disturbance on grassland by construction of depot area** | **Estimated by multiplying total biomass (including above- and belowground biomass in Depot construction site) and carbon fraction value to convert dry matter to carbon** |
| **Operation** | **Decrease of fossil fuel consumption by modal shift of passenger from existing transportation modes (e.g. buses, private car, taxi, motorbike) to LRT (Light Rail Transit)** | **Determined as the difference between the GHG emission of baseline activity (existing mode of transportation, e.g. buses, private car, taxi, motorbike) and project activity (e.g. LRT.).** |
| | **Increase of electricity consumption in the operation of LRT** | **Estimated by multiplying annual electricity consumption associated with the operation of the LRT and $CO_2$ emission factor of the grid electricity.** |

(Source: JICA Study Team)

Parameters considered, and conversion factors used for the analysis are summarized in Annex Tables 2, 4 and 5. Results indicate that during construction phase, carbon loss from disturbance on grassland by depot construction is estimated to be 436.8 t-$CO_2$e. On the other hand, during operation phase, $CO_2$ reduction in year 2035 is estimated to be 53,184 t-$CO_2$e/y. In order to convert the estimated GHG emission data into monetary value, carbon emission reduction credit value under the Clean Development Mechanism (CDM) has been adopted. As of October 20, 2018, the credit value is 0.19 Euro/t -$CO_2$e. Therefore, the Project will incur cost of approximately 83EUR (approximately LKR 14,850[9]) due to GHG emission during construction; and will yield savings (positive) equivalent to approximately 14,665 EUR (approximately LKR Million 2.768) in 2035 due to GHG emission reduction. These values were incorporated in the Project's Cost and Benefit Analysis.

According to the above estimates, the LRT project can be expected to generate LKR Billion 3,920.51 of total undiscounted benefits over 30 years period (Table 6.7). The highest share of benefits is due to travel time savings which amounts to 67% of the total benefits. The lowest share of benefits is due to reduction of emissions.

Table 6.7: Summary of the projected benefits of LRT project

| Benefits | Total undiscounted value for the project evaluation period ( LKR Billion) |
|---|---|
| Travel time savings | 2,617.1 |
| Vehicle operating cost savings | 1,290.4 |
| Saving of accident costs | 12.9 |
| Emission reduction benefits | 0.1136 |
| **Total** | 3,920.51 |

## 6.12 Other Unquantified Benefits

In addition, following benefits can be expected due to establishment of LRT. However, they were not included in the cost benefit analysis due to lack of data for making reliable estimates.

Table 6.8: Unquantified benefits expected from project

[9] **Conversion rate for Euro to Sri Lankan Rupee is 178.89, according to the Central Bank of Sri Lanka (as of 1 December 2017).**

| Benefits | Remarks |
|---|---|
| Benefits during construction period | |
| Employment (direct + indirect)<br>Direct<br>Indirect | LRT project is a large scale construction project and during the construction period it is expected that a significant number of employment opportunities (direct + indirect) will be created. |
| Benefits after implementation of the project | |
| Real estate market value gains | It is expected that commissioning of LRT will bring in an upward push to real estate prices located along the route and surrounding areas. |
| Employment benefits<br>Direct<br>Indirect | LRT will generate additional employment opportunities after commissioning of the road for management and maintenance of the system |

## 6.13 Calculation of Benefit Cost Ratios (BCR), NPV and IRR

BCR, ENPV and EIRR were calculated applying the assumptions mentioned in Table 6.1. The Discount Rate used in the analysis was 12%. As in the usual case of large-scale infrastructure projects, capital investment of the LRT project is high at the initial stage (construction period 2017-2024). Thereafter, the project starts generating transport and environmental benefits to the national economy. The estimated BCR, ENPV and EIRR values are given in Table 6.9.

Table 6.9: ECBA Results

| Decision Criteria | |
|---|---|
| BCR | **2.2** |
| ENPV (Billion LKR) | **174.3** |
| EIRR (%) | **20.2 %** |

Estimated ENPV was 174.3 billion LKR. The values of EIRR and BCR were 20.2% and 2.2, respectively. Since the project records a positive ENPV together with EIRR exceeding the discount rate of 12% and BCR over 1, the project can be identified as an economically viable project.

## 6.14 Sensitivity Testing

A sensitivity testing was carried out under three adverse scenarios.

- **Scenario 1: Benefits are reduced by 10%**
- **Scenario 2: Costs are increased by 10%**
- **Scenario 3: Costs are increased by 10% and benefits are reduced by 10%**

The estimated BCR, ENPV and EIRR values are given in Table 6.10. It indicates economic feasibility under selected scenarios thereby confirming the resilience of the project under adverse economic conditions.

Table 6.10: Sensitivity analysis

| **Parameter** | **Base Case** | **Benefit -10%** | **Cost +10%** | **Benefit -10% Cost +10%** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| EIRR | 20.2% | 18.9% | 19.1% | 17.9% |
| ENVP (Billion LKR) | 174.3 | 142.4 | 159.9 | 128.0 |
| BCR | 2.2 | 2.0 | 1.98 | 1.80 |

## 6.15 Conclusion

Tables 6.9 and 6.10 show that the ENPV, EIRR and BCR values of the project under the base case and three selected adverse scenarios. It indicates that even under the worst scenario of 10 % cost escalation plus 10% benefit reductions; the BCR values are greater than 1.80. The resulted EIRR value (17.9%) is higher than the discount rate and the project reports a positive ENPV of LKR Billion 128.0. Therefore, the proposed LRT project for Malabe traffic corridor can be considered as an economically viable project that can be recommended for implementation.

# ANNEXURE 01

**Noise Barrier**

# 8. Noise Barriers Principles

A noise barrier is an obstacle placed between a noise source and a receiver which interrupts the path of the noise. Barriers can reduce noise levels in outdoor living areas by about 5 to 10 dB(A). However, they are not as effective as insulation at reducing indoor noise levels. Barriers may take the form of earth mounds or fences made of various materials including concrete blocks, bricks, timber and fibre cement sheeting.

The choice of a particular alternative depends upon consideration of space, cost, aesthetics and the desired level of

appreciate that shielding from passers-by can make an unattended home more prone to burglary.

## Materials

Bricks and concrete blocks have the best sound reducing properties. However, lighter materials are generally sufficient for a fence because the limiting consideration is that noise passing through the barriers should be negligible compared to that which will pass over the barrier and around the ends.

In a simple suburban situation where the ground is level, the traffic noise could be reduced by up to 10 decibels if negligible sound came through the barrier.

Page 8

For such a situation the barrier material should be dense enough to reduce the transmitted sound by at least 15 dB(A). The material should weigh at least 10 kilograms per square metre. Glass fibre Reinforced Cement (GRC) sheets and 20mm pine planking are dense enough to meet this requirement. The material must also be strong enough to meet the construction requirements set out in the next section.

## Construction

Fences must be solidly built to be effective as noise barriers. There must be no clearance gap under the fence, and planks or sheets must be tight fitting so there are no cracks. Consideration must also be given to the ageing and warping of timber, and fences should be designed to avoid gaps developing due to warping over time.

Hints for building solid timber noise

(ii) use three horizontal support rails on a vertical timber fence or cement sheet fence. Alternatively, use two rails with closer post interval, say 2 metres;

(iii) overlap horizontal or vertical planks by 35mm;

(iv) use galvanised bolts and nails, the former for preference. Where nails are used, drill holes to prevent cracking;

(v) if necessary bolt a support strip to planks between posts to pull planks together;

(vi) bury the bottom of the barrier; and

(vii) use treated timber or apply a preservative, (environmentally friendly materials is preferable).

The driveway must be effectively blocked off, too, if the benefit of the fence is not to be lost. Solidly built gates, of the same height as the fence, with rebated meeting edges

Page 9

Source; https://www.vicroads.vic.gov.au/~/.../aguidetoreductionoftrafficnoise2003.pdf?la=en

# ANNEXURE 02

**Spread Sheet for Noise**

**Combined LEQ all source**

Lmax Max 600 dB Min 0 dB

| Y/X | 600 | 590 | 580 | 570 | 560 | 550 | 540 | 530 | 520 | 510 | 500 | 490 | 480 | 470 | 460 | 450 | 440 | 430 | 420 | 410 | 400 | 390 | 380 | 370 | 360 | 350 | 340 | 330 | 320 | 310 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 600 | 48.15 | 48.36 | 48.59 | 48.82 | 49.06 | 49.31 | 49.57 | 49.85 | 50.13 | 50.44 | 50.76 | 51.09 | 51.45 | 51.83 | 52.24 | 52.68 | 53.15 | 53.67 | 54.23 | 54.86 | 55.55 | 56.33 | 57.22 | 58.24 | 59.45 | 60.91 | 62.72 | 65.10 | 68.49 | 74.29 |
| 590 | 48.17 | 48.39 | 48.61 | 48.84 | 49.08 | 49.33 | 49.59 | 49.87 | 50.15 | 50.45 | 50.77 | 51.11 | 51.46 | 51.84 | 52.25 | 52.68 | 53.16 | 53.67 | 54.23 | 54.84 | 55.53 | 56.30 | 57.17 | 58.18 | 59.35 | 60.76 | 62.48 | 64.66 | 67.55 | 71.40 |
| 580 | 48.19 | 48.40 | 48.62 | 48.86 | 49.09 | 49.34 | 49.60 | 49.88 | 50.16 | 50.46 | 50.77 | 51.11 | 51.46 | 51.84 | 52.24 | 52.67 | 53.13 | 53.63 | 54.18 | 54.78 | 55.44 | 56.19 | 57.02 | 57.97 | 59.06 | 60.33 | 61.83 | 63.59 | 65.60 | 67.56 |
| 570 | 48.20 | 48.41 | 48.63 | 48.86 | 49.10 | 49.35 | 49.61 | 49.88 | 50.16 | 50.45 | 50.77 | 51.09 | 51.44 | 51.81 | 52.20 | 52.62 | 53.07 | 53.56 | 54.09 | 54.67 | 55.30 | 56.00 | 56.78 | 57.65 | 58.62 | 59.72 | 60.94 | 62.27 | 63.61 | 64.69 |
| 560 | 48.20 | 48.42 | 48.64 | 48.86 | 49.10 | 49.35 | 49.60 | 49.87 | 50.15 | 50.44 | 50.74 | 51.07 | 51.41 | 51.77 | 52.15 | 52.55 | 52.99 | 53.46 | 53.96 | 54.51 | 55.11 | 55.75 | 56.46 | 57.24 | 58.09 | 59.01 | 59.99 | 60.97 | 61.88 | 62.54 |
| 550 | 48.21 | 48.42 | 48.63 | 48.86 | 49.09 | 49.34 | 49.59 | 49.85 | 50.12 | 50.41 | 50.71 | 51.02 | 51.36 | 51.71 | 52.08 | 52.47 | 52.89 | 53.33 | 53.81 | 54.32 | 54.88 | 55.47 | 56.11 | 56.79 | 57.52 | 58.28 | 59.05 | 59.79 | 60.43 | 60.88 |
| 540 | 48.20 | 48.41 | 48.63 | 48.85 | 49.08 | 49.32 | 49.57 | 49.83 | 50.09 | 50.37 | 50.67 | 50.97 | 51.30 | 51.63 | 51.99 | 52.37 | 52.77 | 53.19 | 53.64 | 54.11 | 54.62 | 55.16 | 55.73 | 56.33 | 56.95 | 57.57 | 58.19 | 58.76 | 59.23 | 59.56 |
| 530 | 48.19 | 48.40 | 48.61 | 48.83 | 49.06 | 49.30 | 49.54 | 49.79 | 50.06 | 50.33 | 50.61 | 50.91 | 51.22 | 51.55 | 51.89 | 52.25 | 52.63 | 53.03 | 53.45 | 53.89 | 54.35 | 54.84 | 55.34 | 55.86 | 56.39 | 56.91 | 57.41 | 57.86 | 58.23 | 58.48 |
| 520 | 48.18 | 48.39 | 48.60 | 48.81 | 49.04 | 49.27 | 49.51 | 49.76 | 50.01 | 50.28 | 50.56 | 50.84 | 51.14 | 51.46 | 51.78 | 52.13 | 52.48 | 52.86 | 53.25 | 53.65 | 54.08 | 54.51 | 54.96 | 55.42 | 55.87 | 56.31 | 56.72 | 57.09 | 57.38 | 57.60 |
| 510 | 48.17 | 48.37 | 48.58 | 48.79 | 49.01 | 49.24 | 49.47 | 49.71 | 49.96 | 50.22 | 50.49 | 50.77 | 51.06 | 51.36 | 51.67 | 51.99 | 52.33 | 52.68 | 53.04 | 53.42 | 53.80 | 54.20 | 54.60 | 55.00 | 55.39 | 55.77 | 56.11 | 56.42 | 56.67 | 56.87 |
| 500 | 48.15 | 48.35 | 48.55 | 48.76 | 48.98 | 49.20 | 49.43 | 49.66 | 49.91 | 50.16 | 50.42 | 50.69 | 50.97 | 51.25 | 51.55 | 51.86 | 52.18 | 52.50 | 52.84 | 53.19 | 53.54 | 53.90 | 54.25 | 54.61 | 54.95 | 55.28 | 55.58 | 55.85 | 56.07 | 56.25 |
| 490 | 48.13 | 48.32 | 48.52 | 48.73 | 48.94 | 49.16 | 49.38 | 49.61 | 49.85 | 50.09 | 50.34 | 50.60 | 50.87 | 51.15 | 51.43 | 51.72 | 52.02 | 52.33 | 52.64 | 52.96 | 53.28 | 53.61 | 53.93 | 54.25 | 54.56 | 54.85 | 55.12 | 55.36 | 55.56 | 55.73 |
| 480 | 48.10 | 48.29 | 48.49 | 48.69 | 48.90 | 49.11 | 49.33 | 49.56 | 49.79 | 50.02 | 50.27 | 50.52 | 50.77 | 51.04 | 51.31 | 51.58 | 51.87 | 52.15 | 52.45 | 52.74 | 53.04 | 53.34 | 53.64 | 53.92 | 54.20 | 54.47 | 54.71 | 54.93 | 55.13 | 55.29 |
| 470 | 48.07 | 48.26 | 48.46 | 48.66 | 48.86 | 49.07 | 49.28 | 49.50 | 49.72 | 49.95 | 50.19 | 50.43 | 50.67 | 50.93 | 51.18 | 51.45 | 51.72 | 51.99 | 52.26 | 52.54 | 52.82 | 53.09 | 53.36 | 53.63 | 53.88 | 54.13 | 54.35 | 54.56 | 54.75 | 54.92 |
| 460 | 48.04 | 48.23 | 48.42 | 48.61 | 48.81 | 49.02 | 49.23 | 49.44 | 49.66 | 49.88 | 50.11 | 50.34 | 50.58 | 50.82 | 51.06 | 51.32 | 51.57 | 51.83 | 52.09 | 52.35 | 52.60 | 52.86 | 53.12 | 53.36 | 53.60 | 53.83 | 54.04 | 54.25 | 54.43 | 54.60 |
| 450 | 48.01 | 48.19 | 48.38 | 48.57 | 48.77 | 48.97 | 49.17 | 49.38 | 49.59 | 49.81 | 50.03 | 50.25 | 50.48 | 50.71 | 50.95 | 51.19 | 51.43 | 51.67 | 51.92 | 52.16 | 52.41 | 52.65 | 52.89 | 53.12 | 53.35 | 53.56 | 53.77 | 53.97 | 54.15 | 54.33 |
| 440 | 47.98 | 48.16 | 48.34 | 48.53 | 48.72 | 48.91 | 49.11 | 49.32 | 49.52 | 49.73 | 49.94 | 50.16 | 50.38 | 50.61 | 50.83 | 51.06 | 51.29 | 51.53 | 51.76 | 51.99 | 52.23 | 52.46 | 52.68 | 52.91 | 53.12 | 53.33 | 53.53 | 53.73 | 53.91 | 54.10 |
| 430 | 47.94 | 48.12 | 48.30 | 48.48 | 48.67 | 48.86 | 49.06 | 49.25 | 49.45 | 49.66 | 49.87 | 50.08 | 50.29 | 50.51 | 50.72 | 50.94 | 51.17 | 51.39 | 51.61 | 51.84 | 52.06 | 52.28 | 52.50 | 52.71 | 52.92 | 53.12 | 53.32 | 53.52 | 53.71 | 53.89 |
| 420 | 47.91 | 48.08 | 48.26 | 48.44 | 48.62 | 48.81 | 49.00 | 49.19 | 49.39 | 49.59 | 49.79 | 49.99 | 50.20 | 50.41 | 50.62 | 50.83 | 51.05 | 51.26 | 51.48 | 51.69 | 51.90 | 52.12 | 52.33 | 52.53 | 52.74 | 52.94 | 53.14 | 53.33 | 53.52 | 53.71 |
| 410 | 47.87 | 48.04 | 48.21 | 48.39 | 48.57 | 48.75 | 48.94 | 49.13 | 49.32 | 49.51 | 49.71 | 49.91 | 50.11 | 50.31 | 50.52 | 50.72 | 50.93 | 51.14 | 51.35 | 51.55 | 51.76 | 51.97 | 52.17 | 52.37 | 52.58 | 52.77 | 52.97 | 53.17 | 53.36 | 53.56 |
| 400 | 47.83 | 48.00 | 48.17 | 48.34 | 48.52 | 48.70 | 48.88 | 49.07 | 49.25 | 49.44 | 49.63 | 49.83 | 50.02 | 50.22 | 50.42 | 50.62 | 50.82 | 51.02 | 51.23 | 51.43 | 51.63 | 51.83 | 52.03 | 52.23 | 52.43 | 52.63 | 52.82 | 53.02 | 53.22 | 53.42 |
| 390 | 47.79 | 47.96 | 48.13 | 48.30 | 48.47 | 48.65 | 48.82 | 49.01 | 49.19 | 49.37 | 49.56 | 49.75 | 49.94 | 50.13 | 50.33 | 50.52 | 50.72 | 50.92 | 51.11 | 51.31 | 51.51 | 51.71 | 51.90 | 52.10 | 52.30 | 52.49 | 52.69 | 52.89 | 53.09 | 53.30 |
| 380 | 47.75 | 47.91 | 48.08 | 48.25 | 48.42 | 48.59 | 48.77 | 48.95 | 49.12 | 49.31 | 49.49 | 49.67 | 49.86 | 50.05 | 50.24 | 50.43 | 50.62 | 50.82 | 51.01 | 51.20 | 51.40 | 51.59 | 51.79 | 51.98 | 52.18 | 52.37 | 52.57 | 52.77 | 52.98 | 53.19 |
| 370 | 47.71 | 47.87 | 48.04 | 48.20 | 48.37 | 48.54 | 48.71 | 48.89 | 49.06 | 49.24 | 49.42 | 49.60 | 49.79 | 49.97 | 50.16 | 50.34 | 50.53 | 50.72 | 50.91 | 51.10 | 51.29 | 51.48 | 51.68 | 51.87 | 52.07 | 52.26 | 52.46 | 52.67 | 52.87 | 53.08 |
| 360 | 47.67 | 47.83 | 47.99 | 48.15 | 48.32 | 48.49 | 48.66 | 48.83 | 49.00 | 49.18 | 49.35 | 49.53 | 49.71 | 49.89 | 50.08 | 50.26 | 50.44 | 50.63 | 50.82 | 51.01 | 51.20 | 51.39 | 51.58 | 51.77 | 51.97 | 52.17 | 52.37 | 52.57 | 52.78 | 52.99 |
| 350 | 47.63 | 47.79 | 47.95 | 48.11 | 48.27 | 48.43 | 48.60 | 48.77 | 48.94 | 49.11 | 49.29 | 49.46 | 49.64 | 49.82 | 50.00 | 50.18 | 50.36 | 50.55 | 50.73 | 50.92 | 51.11 | 51.30 | 51.49 | 51.68 | 51.88 | 52.07 | 52.28 | 52.48 | 52.69 | 52.91 |
| 340 | 47.59 | 47.74 | 47.90 | 48.06 | 48.22 | 48.38 | 48.55 | 48.71 | 48.88 | 49.05 | 49.22 | 49.40 | 49.57 | 49.75 | 49.93 | 50.11 | 50.29 | 50.47 | 50.65 | 50.84 | 51.02 | 51.21 | 51.40 | 51.60 | 51.79 | 51.99 | 52.19 | 52.40 | 52.61 | 52.83 |
| 330 | 47.55 | 47.70 | 47.85 | 48.01 | 48.17 | 48.33 | 48.49 | 48.66 | 48.83 | 48.99 | 49.16 | 49.33 | 49.51 | 49.68 | 49.86 | 50.03 | 50.21 | 50.39 | 50.58 | 50.76 | 50.95 | 51.13 | 51.32 | 51.52 | 51.71 | 51.91 | 52.12 | 52.33 | 52.54 | 52.76 |
| 320 | 47.50 | 47.66 | 47.81 | 47.97 | 48.12 | 48.28 | 48.44 | 48.61 | 48.77 | 48.94 | 49.10 | 49.27 | 49.44 | 49.62 | 49.79 | 49.97 | 50.14 | 50.32 | 50.50 | 50.69 | 50.87 | 51.06 | 51.25 | 51.45 | 51.64 | 51.84 | 52.05 | 52.26 | 52.48 | 52.70 |
| 310 | 47.46 | 47.61 | 47.76 | 47.92 | 48.07 | 48.23 | 48.39 | 48.55 | 48.71 | 48.88 | 49.04 | 49.21 | 49.38 | 49.55 | 49.73 | 49.90 | 50.08 | 50.25 | 50.44 | 50.62 | 50.80 | 50.99 | 51.18 | 51.38 | 51.58 | 51.78 | 51.99 | 52.20 | 52.42 | 52.64 |
| 300 | 47.42 | 47.57 | 47.72 | 47.87 | 48.03 | 48.18 | 48.34 | 48.50 | 48.66 | 48.82 | 48.99 | 49.15 | 49.32 | 49.49 | 49.66 | 49.84 | 50.01 | 50.19 | 50.37 | 50.55 | 50.74 | 50.93 | 51.12 | 51.31 | 51.51 | 51.72 | 51.93 | 52.14 | 52.36 | 52.59 |
| 290 | 47.38 | 47.53 | 47.68 | 47.83 | 47.98 | 48.13 | 48.29 | 48.45 | 48.61 | 48.77 | 48.93 | 49.10 | 49.26 | 49.43 | 49.60 | 49.78 | 49.95 | 50.13 | 50.31 | 50.49 | 50.68 | 50.87 | 51.06 | 51.25 | 51.45 | 51.66 | 51.87 | 52.09 | 52.31 | 52.54 |
| 280 | 47.34 | 47.48 | 47.63 | 47.78 | 47.93 | 48.09 | 48.24 | 48.40 | 48.56 | 48.72 | 48.88 | 49.04 | 49.21 | 49.38 | 49.55 | 49.72 | 49.89 | 50.07 | 50.25 | 50.43 | 50.62 | 50.81 | 51.00 | 51.20 | 51.40 | 51.61 | 51.82 | 52.04 | 52.26 | 52.50 |
| 270 | 47.29 | 47.44 | 47.59 | 47.73 | 47.89 | 48.04 | 48.19 | 48.35 | 48.50 | 48.66 | 48.82 | 48.99 | 49.15 | 49.32 | 49.49 | 49.66 | 49.84 | 50.01 | 50.19 | 50.38 | 50.56 | 50.75 | 50.95 | 51.14 | 51.35 | 51.56 | 51.77 | 51.99 | 52.22 | 52.45 |
| 260 | 47.25 | 47.40 | 47.54 | 47.69 | 47.84 | 47.99 | 48.14 | 48.30 | 48.45 | 48.61 | 48.77 | 48.94 | 49.10 | 49.27 | 49.44 | 49.61 | 49.78 | 49.96 | 50.14 | 50.32 | 50.51 | 50.70 | 50.89 | 51.09 | 51.30 | 51.51 | 51.72 | 51.95 | 52.18 | 52.42 |
| 250 | 47.21 | 47.35 | 47.50 | 47.64 | 47.79 | 47.94 | 48.09 | 48.25 | 48.40 | 48.56 | 48.72 | 48.88 | 49.05 | 49.21 | 49.38 | 49.55 | 49.73 | 49.90 | 50.08 | 50.27 | 50.46 | 50.65 | 50.84 | 51.04 | 51.25 | 51.46 | 51.68 | 51.90 | 52.14 | 52.38 |
| 240 | 47.17 | 47.31 | 47.45 | 47.60 | 47.75 | 47.90 | 48.05 | 48.20 | 48.35 | 48.51 | 48.67 | 48.83 | 49.00 | 49.16 | 49.33 | 49.50 | 49.67 | 49.85 | 50.03 | 50.22 | 50.40 | 50.60 | 50.79 | 50.99 | 51.20 | 51.42 | 51.64 | 51.86 | 52.10 | 52.34 |
| 230 | 47.12 | 47.26 | 47.41 | 47.55 | 47.70 | 47.85 | 48.00 | 48.15 | 48.31 | 48.46 | 48.62 | 48.78 | 48.94 | 49.11 | 49.28 | 49.45 | 49.62 | 49.80 | 49.98 | 50.17 | 50.35 | 50.55 | 50.74 | 50.95 | 51.16 | 51.37 | 51.59 | 51.82 | 52.06 | 52.31 |
| 220 | 47.08 | 47.22 | 47.36 | 47.51 | 47.65 | 47.80 | 47.95 | 48.10 | 48.26 | 48.41 | 48.57 | 48.73 | 48.89 | 49.06 | 49.23 | 49.40 | 49.57 | 49.75 | 49.93 | 50.12 | 50.31 | 50.50 | 50.70 | 50.90 | 51.11 | 51.33 | 51.55 | 51.78 | 52.02 | 52.27 |
| 210 | 47.04 | 47.18 | 47.32 | 47.46 | 47.61 | 47.75 | 47.90 | 48.05 | 48.21 | 48.36 | 48.52 | 48.68 | 48.84 | 49.01 | 49.18 | 49.35 | 49.52 | 49.70 | 49.88 | 50.07 | 50.26 | 50.45 | 50.65 | 50.86 | 51.07 | 51.28 | 51.51 | 51.74 | 51.99 | 52.24 |
| 200 | 46.99 | 47.13 | 47.27 | 47.42 | 47.56 | 47.71 | 47.86 | 48.01 | 48.16 | 48.31 | 48.47 | 48.63 | 48.79 | 48.96 | 49.13 | 49.30 | 49.47 | 49.65 | 49.83 | 50.02 | 50.21 | 50.40 | 50.60 | 50.81 | 51.02 | 51.24 | 51.47 | 51.70 | 51.95 | 52.20 |
| 190 | 46.95 | 47.09 | 47.23 | 47.37 | 47.51 | 47.66 | 47.81 | 47.96 | 48.11 | 48.26 | 48.42 | 48.58 | 48.74 | 48.91 | 49.08 | 49.25 | 49.42 | 49.60 | 49.78 | 49.97 | 50.16 | 50.36 | 50.56 | 50.76 | 50.98 | 51.20 | 51.42 | 51.66 | 51.91 | 52.16 |
| 180 | 46.90 | 47.04 | 47.18 | 47.32 | 47.47 | 47.61 | 47.76 | 47.91 | 48.06 | 48.22 | 48.37 | 48.53 | 48.69 | 48.86 | 49.03 | 49.20 | 49.37 | 49.55 | 49.73 | 49.92 | 50.11 | 50.31 | 50.51 | 50.72 | 50.93 | 51.15 | 51.38 | 51.62 | 51.86 | 52.12 |
| 170 | 46.86 | 47.00 | 47.14 | 47.28 | 47.42 | 47.56 | 47.71 | 47.86 | 48.01 | 48.17 | 48.32 | 48.48 | 48.64 | 48.81 | 48.98 | 49.15 | 49.32 | 49.50 | 49.68 | 49.87 | 50.06 | 50.26 | 50.46 | 50.67 | 50.89 | 51.11 | 51.34 | 51.57 | 51.82 | 52.08 |
| 160 | 46.81 | 46.95 | 47.09 | 47.23 | 47.37 | 47.52 | 47.66 | 47.81 | 47.96 | 48.12 | 48.27 | 48.43 | 48.59 | 48.76 | 48.92 | 49.10 | 49.27 | 49.45 | 49.63 | 49.82 | 50.01 | 50.21 | 50.41 | 50.62 | 50.84 | 51.06 | 51.29 | 51.53 | 51.78 | 52.03 |
| 150 | 46.77 | 46.90 | 47.04 | 47.18 | 47.32 | 47.47 | 47.61 | 47.76 | 47.91 | 48.07 | 48.22 | 48.38 | 48.54 | 48.71 | 48.87 | 49.05 | 49.22 | 49.40 | 49.58 | 49.77 | 49.96 | 50.16 | 50.36 | 50.57 | 50.79 | 51.01 | 51.24 | 51.48 | 51.73 | 51.99 |
| 140 | 46.72 | 46.86 | 46.99 | 47.13 | 47.27 | 47.42 | 47.56 | 47.71 | 47.86 | 48.01 | 48.17 | 48.33 | 48.49 | 48.65 | 48.82 | 48.99 | 49.17 | 49.35 | 49.53 | 49.72 | 49.91 | 50.11 | 50.31 | 50.52 | 50.74 | 50.96 | 51.20 | 51.43 | 51.68 | 51.94 |
| 130 | 46.67 | 46.81 | 46.94 | 47.08 | 47.22 | 47.37 | 47.51 | 47.66 | 47.81 | 47.96 | 48.12 | 48.28 | 48.44 | 48.60 | 48.77 | 48.94 | 49.12 | 49.30 | 49.48 | 49.67 | 49.86 | 50.06 | 50.26 | 50.47 | 50.69 | 50.91 | 51.15 | 51.39 | 51.63 | 51.89 |
| 120 | 46.63 | 46.76 | 46.90 | 47.03 | 47.17 | 47.32 | 47.46 | 47.61 | 47.76 | 47.91 | 48.06 | 48.22 | 48.38 | 48.55 | 48.72 | 48.89 | 49.06 | 49.24 | 49.43 | 49.61 | 49.81 | 50.01 | 50.21 | 50.42 | 50.64 | 50.86 | 51.10 | 51.34 | 51.58 | 51.84 |
| 110 | 46.58 | 46.71 | 46.85 | 46.98 | 47.12 | 47.27 | 47.41 | 47.56 | 47.71 | 47.86 | 48.01 | 48.17 | 48.33 | 48.49 | 48.66 | 48.83 | 49.01 | 49.19 | 49.37 | 49.56 | 49.75 | 49.95 | 50.16 | 50.37 | 50.59 | 50.81 | 51.04 | 51.29 | 51.53 | 51.79 |
| 100 | 46.53 | 46.66 | 46.80 | 46.93 | 47.07 | 47.21 | 47.36 | 47.50 | 47.65 | 47.80 | 47.96 | 48.11 | 48.27 | 48.44 | 48.61 | 48.78 | 48.95 | 49.13 | 49.31 | 49.50 | 49.70 | 49.90 | 50.10 | 50.31 | 50.53 | 50.76 | 50.99 | 51.23 | 51.48 | 51.74 |
| 90 | 46.48 | 46.61 | 46.74 | 46.88 | 47.02 | 47.16 | 47.30 | 47.45 | 47.60 | 47.75 | 47.90 | 48.06 | 48.22 | 48.38 | 48.55 | 48.72 | 48.89 | 49.07 | 49.26 | 49.45 | 49.64 | 49.84 | 50.05 | 50.26 | 50.48 | 50.70 | 50.94 | 51.18 | 51.43 | 51.69 |
| 80 | 46.43 | 46.56 | 46.69 | 46.83 | 46.97 | 47.11 | 47.25 | 47.39 | 47.54 | 47.69 | 47.84 | 48.00 | 48.16 | 48.32 | 48.49 | 48.66 | 48.84 | 49.01 | 49.20 | 49.39 | 49.58 | 49.78 | 49.99 | 50.20 | 50.42 | 50.65 | 50.88 | 51.12 | 51.38 | 51.64 |
| 70 | 46.37 | 46.51 | 46.64 | 46.77 | 46.91 | 47.05 | 47.19 | 47.34 | 47.48 | 47.63 | 47.79 | 47.94 | 48.10 | 48.26 | 48.43 | 48.60 | 48.78 | 48.95 | 49.14 | 49.33 | 49.52 | 49.72 | 49.93 | 50.14 | 50.36 | 50.59 | 50.82 | 51.07 | 51.32 | 51.58 |
| 60 | 46.32 | 46.45 | 46.58 | 46.72 | 46.86 | 46.99 | 47.14 | 47.28 | 47.43 | 47.58 | 47.73 | 47.88 | 48.04 | 48.20 | 48.37 | 48.54 | 48.71 | 48.89 | 49.08 | 49.26 | 49.46 | 49.66 | 49.86 | 50.08 | 50.30 | 50.53 | 50.76 | 51.01 | 51.26 | 51.53 |
| 50 | 46.27 | 46.40 | 46.53 | 46.66 | 46.80 | 46.94 | 47.08 | 47.22 | 47.37 | 47.52 | 47.67 | 47.82 | 47.98 | 48.14 | 48.31 | 48.48 | 48.65 | 48.83 | 49.01 | 49.20 | 49.39 | 49.59 | 49.80 | 50.01 | 50.23 | 50.46 | 50.70 | 50.94 | 51.20 | 51.47 |
| 40 | 46.21 | 46.34 | 46.47 | 46.61 | 46.74 | 46.88 | 47.02 | 47.16 | 47.31 | 47.45 | 47.61 | 47.76 | 47.92 | 48.08 | 48.24 | 48.41 | 48.58 | 48.76 | 48.94 | 49.13 | 49.33 | 49.53 | 49.73 | 49.94 | 50.17 | 50.39 | 50.63 | 50.88 | 51.14 | 51.41 |
| 30 | 46.16 | 46.29 | 46.42 | 46.55 | 46.68 | 46.82 | 46.96 | 47.10 | 47.25 | 47.39 | 47.54 | 47.70 | 47.85 | 48.01 | 48.18 | 48.34 | 48.52 | 48.69 | 48.88 | 49.06 | 49.26 | 49.46 | 49.66 | 49.87 | 50.09 | 50.32 | 50.56 | 50.81 | 51.07 | 51.34 |
| 20 | 46.10 | 46.23 | 46.36 | 46.49 | 46.62 | 46.76 | 46.90 | 47.04 | 47.18 | 47.33 | 47.48 | 47.63 | 47.79 | 47.95 | 48.11 | 48.28 | 48.45 | 48.62 | 48.80 | 48.99 | 49.18 | 49.38 | 49.59 | 49.80 | 50.02 | 50.25 | 50.49 | 50.73 | 50.99 | 51.27 |
| 10 | 46.04 | 46.17 | 46.30 | 46.43 | 46.56 | 46.70 | 46.84 | 46.97 | 47.12 | 47.26 | 47.41 | 47.56 | 47.72 | 47.88 | 48.04 | 48.20 | 48.38 | 48.55 | 48.73 | 48.92 | 49.11 | 49.31 | 49.51 | 49.72 | 49.94 | 50.17 | 50.41 | 50.65 | 50.91 | 51.19 |
| 0 | 45.99 | 46.11 | 46.24 | 46.37 | 46.50 | 46.63 | 46.77 | 46.91 | 47.05 | 47.20 | 47.34 | 47.49 | 47.65 | 47.81 | 47.97 | 48.13 | 48.30 | 48.48 | 48.65 | 48.84 | 49.03 | 49.23 | 49.43 | 49.64 | 49.86 | 50.09 | 50.32 | 50.57 | 50.83 | 51.10 |

**Combined LEQ all source**

| Y/X | 300 | 290 | 280 | 270 | 260 | 250 | 240 | 230 | 220 | 210 | 200 | 190 | 180 | 170 | 160 | 150 | 140 | 130 | 120 | 110 | 100 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 600 | 102.59 | 74.29 | 68.51 | 65.17 | 62.90 | 61.26 | 60.05 | 59.18 | 58.60 | 58.26 | 58.17 | 58.30 | 58.66 | 59.26 | 60.13 | 61.33 | 62.96 | 65.22 | 68.53 | 74.30 | 102.59 | 74.30 | 68.51 | 65.16 | 62.82 | 61.06 | 59.67 | 58.53 | 57.57 | 56.75 | 56.03 |
| 590 | 74.29 | 71.40 | 67.58 | 64.75 | 62.67 | 61.12 | 59.97 | 59.14 | 58.58 | 58.26 | 58.17 | 58.30 | 58.65 | 59.23 | 60.07 | 61.22 | 62.75 | 64.80 | 67.61 | 71.42 | 74.30 | 71.41 | 67.59 | 64.74 | 62.60 | 60.94 | 59.60 | 58.50 | 57.57 | 56.77 | 56.07 |
| 580 | 68.50 | 67.58 | 65.65 | 63.70 | 62.05 | 60.74 | 59.72 | 58.98 | 58.47 | 58.18 | 58.11 | 58.23 | 58.55 | 59.09 | 59.85 | 60.86 | 62.16 | 63.78 | 65.70 | 67.62 | 68.53 | 67.61 | 65.67 | 63.70 | 61.99 | 60.56 | 59.36 | 58.35 | 57.48 | 56.72 | 56.05 |
| 570 | 65.14 | 64.72 | 63.68 | 62.43 | 61.22 | 60.19 | 59.35 | 58.72 | 58.29 | 58.04 | 57.98 | 58.10 | 58.39 | 58.86 | 59.51 | 60.34 | 61.37 | 62.55 | 63.78 | 64.81 | 65.22 | 64.79 | 63.73 | 62.44 | 61.18 | 60.02 | 59.00 | 58.11 | 57.32 | 56.62 | 55.99 |
| 560 | 62.81 | 62.59 | 61.99 | 61.18 | 60.33 | 59.56 | 58.90 | 58.40 | 58.05 | 57.86 | 57.82 | 57.93 | 58.18 | 58.58 | 59.11 | 59.77 | 60.54 | 61.37 | 62.17 | 62.76 | 62.98 | 62.73 | 62.09 | 61.24 | 60.32 | 59.42 | 58.58 | 57.81 | 57.11 | 56.48 | 55.90 |
| 550 | 61.06 | 60.95 | 60.59 | 60.06 | 59.48 | 58.92 | 58.43 | 58.05 | 57.78 | 57.64 | 57.62 | 57.73 | 57.95 | 58.27 | 58.70 | 59.21 | 59.78 | 60.36 | 60.87 | 61.24 | 61.36 | 61.19 | 60.78 | 60.20 | 59.52 | 58.83 | 58.15 | 57.50 | 56.89 | 56.33 | 55.80 |
| 540 | 59.70 | 59.65 | 59.43 | 59.09 | 58.70 | 58.31 | 57.96 | 57.69 | 57.50 | 57.41 | 57.42 | 57.52 | 57.71 | 57.98 | 58.32 | 58.71 | 59.13 | 59.53 | 59.88 | 60.10 | 60.17 | 60.05 | 59.77 | 59.35 | 58.85 | 58.31 | 57.75 | 57.21 | 56.68 | 56.18 | 55.70 |
| 530 | 58.61 | 58.60 | 58.48 | 58.27 | 58.02 | 57.76 | 57.52 | 57.34 | 57.23 | 57.18 | 57.21 | 57.32 | 57.49 | 57.72 | 58.00 | 58.30 | 58.61 | 58.90 | 59.13 | 59.28 | 59.31 | 59.22 | 59.01 | 58.70 | 58.31 | 57.88 | 57.43 | 56.96 | 56.50 | 56.05 | 55.61 |
| 520 | 57.72 | 57.75 | 57.69 | 57.57 | 57.42 | 57.26 | 57.12 | 57.02 | 56.96 | 56.97 | 57.03 | 57.14 | 57.30 | 57.51 | 57.74 | 57.99 | 58.23 | 58.45 | 58.62 | 58.72 | 58.74 | 58.66 | 58.49 | 58.24 | 57.93 | 57.57 | 57.19 | 56.78 | 56.37 | 55.96 | 55.55 |
| 510 | 56.99 | 57.04 | 57.03 | 56.99 | 56.91 | 56.83 | 56.77 | 56.73 | 56.73 | 56.77 | 56.86 | 56.99 | 57.16 | 57.36 | 57.57 | 57.79 | 58.00 | 58.18 | 58.32 | 58.39 | 58.40 | 58.33 | 58.19 | 57.97 | 57.70 | 57.39 | 57.04 | 56.67 | 56.29 | 55.90 | 55.52 |
| 500 | 56.38 | 56.45 | 56.49 | 56.49 | 56.48 | 56.46 | 56.46 | 56.48 | 56.53 | 56.61 | 56.73 | 56.89 | 57.07 | 57.28 | 57.49 | 57.71 | 57.91 | 58.09 | 58.21 | 58.29 | 58.29 | 58.23 | 58.09 | 57.89 | 57.64 | 57.34 | 57.00 | 56.65 | 56.27 | 55.90 | 55.52 |
| 490 | 55.86 | 55.96 | 56.03 | 56.07 | 56.11 | 56.15 | 56.20 | 56.26 | 56.36 | 56.48 | 56.64 | 56.82 | 57.04 | 57.27 | 57.51 | 57.75 | 57.97 | 58.16 | 58.31 | 58.39 | 58.40 | 58.34 | 58.20 | 57.99 | 57.72 | 57.41 | 57.07 | 56.70 | 56.32 | 55.94 | 55.55 |
| 480 | 55.43 | 55.55 | 55.64 | 55.73 | 55.80 | 55.88 | 55.98 | 56.09 | 56.22 | 56.39 | 56.58 | 56.81 | 57.06 | 57.34 | 57.62 | 57.91 | 58.18 | 58.42 | 58.61 | 58.72 | 58.74 | 58.67 | 58.51 | 58.27 | 57.97 | 57.62 | 57.23 | 56.84 | 56.43 | 56.03 | 55.63 |
| 470 | 55.07 | 55.20 | 55.32 | 55.43 | 55.54 | 55.66 | 55.79 | 55.95 | 56.12 | 56.33 | 56.57 | 56.84 | 57.15 | 57.48 | 57.83 | 58.19 | 58.54 | 58.86 | 59.12 | 59.28 | 59.33 | 59.24 | 59.04 | 58.74 | 58.36 | 57.94 | 57.50 | 57.04 | 56.59 | 56.15 | 55.73 |
| 460 | 54.76 | 54.91 | 55.05 | 55.19 | 55.33 | 55.48 | 55.64 | 55.83 | 56.05 | 56.30 | 56.59 | 56.91 | 57.28 | 57.68 | 58.12 | 58.59 | 59.05 | 59.49 | 59.86 | 60.11 | 60.18 | 60.08 | 59.80 | 59.40 | 58.91 | 58.38 | 57.84 | 57.31 | 56.80 | 56.32 | 55.85 |
| 450 | 54.50 | 54.66 | 54.82 | 54.98 | 55.14 | 55.32 | 55.52 | 55.75 | 56.00 | 56.29 | 56.63 | 57.01 | 57.44 | 57.94 | 58.48 | 59.08 | 59.71 | 60.32 | 60.86 | 61.24 | 61.37 | 61.22 | 60.82 | 60.25 | 59.59 | 58.91 | 58.25 | 57.63 | 57.04 | 56.49 | 55.99 |
| 440 | 54.27 | 54.44 | 54.62 | 54.80 | 54.99 | 55.20 | 55.42 | 55.68 | 55.97 | 56.30 | 56.68 | 57.12 | 57.63 | 58.22 | 58.89 | 59.64 | 60.48 | 61.35 | 62.16 | 62.77 | 62.99 | 62.75 | 62.13 | 61.29 | 60.39 | 59.51 | 58.70 | 57.96 | 57.28 | 56.68 | 56.13 |
| 430 | 54.08 | 54.26 | 54.45 | 54.65 | 54.86 | 55.09 | 55.34 | 55.62 | 55.94 | 56.31 | 56.74 | 57.23 | 57.81 | 58.49 | 59.29 | 60.23 | 61.31 | 62.53 | 63.78 | 64.82 | 65.24 | 64.81 | 63.77 | 62.50 | 61.25 | 60.12 | 59.14 | 58.27 | 57.52 | 56.85 | 56.25 |
| 420 | 53.91 | 54.10 | 54.30 | 54.52 | 54.74 | 54.99 | 55.27 | 55.57 | 55.92 | 56.32 | 56.78 | 57.32 | 57.96 | 58.72 | 59.64 | 60.75 | 62.12 | 63.77 | 65.71 | 67.62 | 68.54 | 67.62 | 65.70 | 63.75 | 62.07 | 60.67 | 59.51 | 58.54 | 57.70 | 56.99 | 56.36 |
| 410 | 53.76 | 53.96 | 54.18 | 54.40 | 54.64 | 54.90 | 55.19 | 55.52 | 55.89 | 56.31 | 56.80 | 57.37 | 58.05 | 58.87 | 59.88 | 61.13 | 62.72 | 64.80 | 67.62 | 71.42 | 74.30 | 71.42 | 67.62 | 64.79 | 62.68 | 61.06 | 59.77 | 58.71 | 57.83 | 57.08 | 56.42 |
| 400 | 53.63 | 53.84 | 54.06 | 54.30 | 54.55 | 54.82 | 55.12 | 55.46 | 55.84 | 56.28 | 56.78 | 57.37 | 58.07 | 58.92 | 59.96 | 61.26 | 62.95 | 65.22 | 68.54 | 74.30 | 102.59 | 74.30 | 68.54 | 65.21 | 62.92 | 61.20 | 59.86 | 58.78 | 57.87 | 57.11 | 56.45 |
| 390 | 53.51 | 53.73 | 53.96 | 54.20 | 54.46 | 54.74 | 55.05 | 55.40 | 55.78 | 56.22 | 56.73 | 57.32 | 58.01 | 58.84 | 59.86 | 61.12 | 62.71 | 64.80 | 67.62 | 71.42 | 74.30 | 71.42 | 67.61 | 64.78 | 62.68 | 61.06 | 59.77 | 58.71 | 57.83 | 57.08 | 56.42 |
| 380 | 53.40 | 53.62 | 53.86 | 54.11 | 54.37 | 54.66 | 54.98 | 55.32 | 55.71 | 56.14 | 56.64 | 57.21 | 57.87 | 58.66 | 59.59 | 60.72 | 62.10 | 63.76 | 65.70 | 67.62 | 68.54 | 67.62 | 65.69 | 63.74 | 62.07 | 60.67 | 59.51 | 58.54 | 57.71 | 56.99 | 56.36 |
| 370 | 53.30 | 53.53 | 53.77 | 54.02 | 54.29 | 54.58 | 54.90 | 55.24 | 55.62 | 56.04 | 56.52 | 57.06 | 57.67 | 58.39 | 59.21 | 60.17 | 61.28 | 62.51 | 63.77 | 64.81 | 65.23 | 64.80 | 63.76 | 62.49 | 61.24 | 60.12 | 59.13 | 58.27 | 57.52 | 56.85 | 56.26 |
| 360 | 53.22 | 53.45 | 53.69 | 53.94 | 54.21 | 54.50 | 54.81 | 55.15 | 55.52 | 55.93 | 56.38 | 56.88 | 57.44 | 58.07 | 58.78 | 59.56 | 60.42 | 61.31 | 62.13 | 62.75 | 62.98 | 62.74 | 62.12 | 61.28 | 60.38 | 59.51 | 58.69 | 57.95 | 57.29 | 56.68 | 56.14 |
| 350 | 53.13 | 53.37 | 53.61 | 53.87 | 54.14 | 54.43 | 54.73 | 55.06 | 55.42 | 55.81 | 56.23 | 56.68 | 57.19 | 57.74 | 58.33 | 58.96 | 59.62 | 60.26 | 60.82 | 61.21 | 61.35 | 61.20 | 60.80 | 60.23 | 59.58 | 58.90 | 58.25 | 57.62 | 57.04 | 56.50 | 56.00 |
| 340 | 53.06 | 53.30 | 53.54 | 53.80 | 54.07 | 54.35 | 54.66 | 54.98 | 55.32 | 55.69 | 56.08 | 56.50 | 56.95 | 57.42 | 57.92 | 58.43 | 58.93 | 59.40 | 59.79 | 60.05 | 60.14 | 60.04 | 59.77 | 59.37 | 58.89 | 58.37 | 57.84 | 57.31 | 56.81 | 56.33 | 55.87 |
| 330 | 52.99 | 53.23 | 53.48 | 53.73 | 54.00 | 54.29 | 54.59 | 54.90 | 55.23 | 55.58 | 55.95 | 56.33 | 56.74 | 57.15 | 57.57 | 57.99 | 58.39 | 58.74 | 59.02 | 59.21 | 59.27 | 59.20 | 59.00 | 58.71 | 58.34 | 57.93 | 57.49 | 57.05 | 56.61 | 56.17 | 55.76 |
| 320 | 52.93 | 53.17 | 53.42 | 53.68 | 53.95 | 54.23 | 54.52 | 54.83 | 55.16 | 55.49 | 55.84 | 56.20 | 56.57 | 56.94 | 57.31 | 57.66 | 57.99 | 58.27 | 58.49 | 58.62 | 58.67 | 58.61 | 58.47 | 58.24 | 57.94 | 57.60 | 57.23 | 56.84 | 56.45 | 56.05 | 55.66 |
| 310 | 52.87 | 53.12 | 53.37 | 53.63 | 53.90 | 54.18 | 54.47 | 54.78 | 55.10 | 55.43 | 55.77 | 56.11 | 56.46 | 56.81 | 57.14 | 57.46 | 57.74 | 57.98 | 58.17 | 58.28 | 58.31 | 58.27 | 58.15 | 57.95 | 57.70 | 57.40 | 57.07 | 56.71 | 56.35 | 55.97 | 55.60 |
| 300 | 52.82 | 53.07 | 53.32 | 53.58 | 53.86 | 54.14 | 54.44 | 54.74 | 55.06 | 55.39 | 55.73 | 56.07 | 56.41 | 56.75 | 57.08 | 57.38 | 57.65 | 57.88 | 58.05 | 58.16 | 58.19 | 58.15 | 58.04 | 57.85 | 57.61 | 57.33 | 57.01 | 56.66 | 56.31 | 55.94 | 55.58 |
| 290 | 52.78 | 53.02 | 53.28 | 53.55 | 53.82 | 54.11 | 54.41 | 54.73 | 55.05 | 55.38 | 55.73 | 56.08 | 56.43 | 56.78 | 57.12 | 57.44 | 57.72 | 57.97 | 58.15 | 58.26 | 58.30 | 58.26 | 58.13 | 57.94 | 57.69 | 57.39 | 57.05 | 56.70 | 56.33 | 55.96 | 55.59 |
| 280 | 52.74 | 52.99 | 53.25 | 53.52 | 53.80 | 54.09 | 54.40 | 54.72 | 55.06 | 55.40 | 55.76 | 56.13 | 56.51 | 56.89 | 57.26 | 57.62 | 57.95 | 58.24 | 58.46 | 58.60 | 58.64 | 58.59 | 58.44 | 58.21 | 57.92 | 57.58 | 57.21 | 56.82 | 56.42 | 56.03 | 55.64 |
| 270 | 52.70 | 52.95 | 53.22 | 53.49 | 53.78 | 54.08 | 54.40 | 54.73 | 55.08 | 55.45 | 55.83 | 56.23 | 56.65 | 57.07 | 57.51 | 57.93 | 58.34 | 58.70 | 58.98 | 59.17 | 59.24 | 59.17 | 58.97 | 58.68 | 58.31 | 57.90 | 57.46 | 57.01 | 56.57 | 56.14 | 55.72 |
| 260 | 52.66 | 52.92 | 53.19 | 53.47 | 53.77 | 54.08 | 54.41 | 54.75 | 55.12 | 55.51 | 55.93 | 56.37 | 56.83 | 57.32 | 57.84 | 58.36 | 58.88 | 59.35 | 59.75 | 60.01 | 60.11 | 60.01 | 59.74 | 59.34 | 58.85 | 58.33 | 57.80 | 57.27 | 56.77 | 56.28 | 55.83 |
| 250 | 52.63 | 52.89 | 53.17 | 53.46 | 53.76 | 54.08 | 54.42 | 54.78 | 55.17 | 55.59 | 56.04 | 56.52 | 57.05 | 57.62 | 58.23 | 58.89 | 59.56 | 60.21 | 60.78 | 61.17 | 61.31 | 61.17 | 60.77 | 60.20 | 59.54 | 58.86 | 58.20 | 57.57 | 56.99 | 56.45 | 55.95 |
| 240 | 52.60 | 52.87 | 53.15 | 53.44 | 53.75 | 54.08 | 54.43 | 54.81 | 55.22 | 55.66 | 56.15 | 56.68 | 57.28 | 57.94 | 58.67 | 59.48 | 60.36 | 61.26 | 62.10 | 62.72 | 62.95 | 62.71 | 62.09 | 61.25 | 60.34 | 59.46 | 58.64 | 57.90 | 57.23 | 56.62 | 56.07 |
| 230 | 52.57 | 52.84 | 53.12 | 53.42 | 53.74 | 54.08 | 54.45 | 54.84 | 55.27 | 55.74 | 56.26 | 56.84 | 57.49 | 58.24 | 59.10 | 60.09 | 61.22 | 62.47 | 63.74 | 64.79 | 65.21 | 64.78 | 63.74 | 62.46 | 61.21 | 60.07 | 59.08 | 58.21 | 57.45 | 56.78 | 56.18 |
| 220 | 52.54 | 52.81 | 53.10 | 53.40 | 53.73 | 54.08 | 54.45 | 54.85 | 55.30 | 55.79 | 56.34 | 56.96 | 57.67 | 58.50 | 59.47 | 60.64 | 62.04 | 63.72 | 65.68 | 67.61 | 68.53 | 67.61 | 65.68 | 63.72 | 62.03 | 60.62 | 59.45 | 58.47 | 57.63 | 56.91 | 56.27 |
| 210 | 52.50 | 52.78 | 53.07 | 53.38 | 53.71 | 54.06 | 54.44 | 54.86 | 55.31 | 55.82 | 56.39 | 57.04 | 57.79 | 58.67 | 59.73 | 61.02 | 62.65 | 64.76 | 67.60 | 71.41 | 74.30 | 71.41 | 67.60 | 64.76 | 62.65 | 61.01 | 59.71 | 58.64 | 57.75 | 56.99 | 56.33 |
| 200 | 52.47 | 52.75 | 53.04 | 53.35 | 53.68 | 54.04 | 54.42 | 54.84 | 55.30 | 55.82 | 56.39 | 57.05 | 57.82 | 58.72 | 59.81 | 61.16 | 62.88 | 65.19 | 68.53 | 74.30 | 102.59 | 74.30 | 68.52 | 65.19 | 62.88 | 61.15 | 59.80 | 58.70 | 57.79 | 57.01 | 56.34 |
| 190 | 52.43 | 52.71 | 53.01 | 53.32 | 53.65 | 54.01 | 54.39 | 54.81 | 55.27 | 55.78 | 56.35 | 57.01 | 57.76 | 58.65 | 59.71 | 61.01 | 62.65 | 64.76 | 67.60 | 71.41 | 74.30 | 71.41 | 67.60 | 64.76 | 62.64 | 61.00 | 59.70 | 58.63 | 57.73 | 56.97 | 56.30 |
| 180 | 52.39 | 52.67 | 52.97 | 53.28 | 53.61 | 53.97 | 54.35 | 54.76 | 55.22 | 55.72 | 56.27 | 56.90 | 57.62 | 58.46 | 59.44 | 60.61 | 62.02 | 63.71 | 65.67 | 67.60 | 68.53 | 67.60 | 65.67 | 63.71 | 62.02 | 60.60 | 59.43 | 58.44 | 57.60 | 56.87 | 56.23 |
| 170 | 52.35 | 52.63 | 52.92 | 53.24 | 53.57 | 53.92 | 54.29 | 54.70 | 55.14 | 55.62 | 56.15 | 56.75 | 57.42 | 58.18 | 59.05 | 60.05 | 61.19 | 62.44 | 63.72 | 64.77 | 65.20 | 64.77 | 63.72 | 62.44 | 61.18 | 60.04 | 59.04 | 58.16 | 57.39 | 56.71 | 56.11 |
| 160 | 52.30 | 52.58 | 52.88 | 53.19 | 53.51 | 53.86 | 54.23 | 54.62 | 55.05 | 55.51 | 56.01 | 56.56 | 57.17 | 57.85 | 58.59 | 59.42 | 60.31 | 61.22 | 62.06 | 62.69 | 62.92 | 62.69 | 62.06 | 61.21 | 60.30 | 59.41 | 58.58 | 57.83 | 57.14 | 56.53 | 55.97 |
| 150 | 52.26 | 52.54 | 52.83 | 53.14 | 53.46 | 53.80 | 54.16 | 54.54 | 54.95 | 55.39 | 55.85 | 56.36 | 56.91 | 57.50 | 58.13 | 58.80 | 59.48 | 60.14 | 60.72 | 61.12 | 61.26 | 61.12 | 60.72 | 60.14 | 59.47 | 58.78 | 58.11 | 57.47 | 56.88 | 56.33 | 55.81 |
| 140 | 52.21 | 52.49 | 52.78 | 53.08 | 53.40 | 53.74 | 54.09 | 54.46 | 54.85 | 55.26 | 55.70 | 56.16 | 56.65 | 57.16 | 57.69 | 58.23 | 58.77 | 59.26 | 59.66 | 59.93 | 60.03 | 59.93 | 59.66 | 59.25 | 58.76 | 58.22 | 57.68 | 57.14 | 56.62 | 56.13 | 55.66 |
| 130 | 52.16 | 52.44 | 52.73 | 53.03 | 53.34 | 53.67 | 54.02 | 54.38 | 54.75 | 55.15 | 55.56 | 55.98 | 56.42 | 56.87 | 57.32 | 57.77 | 58.19 | 58.56 | 58.86 | 59.05 | 59.12 | 59.05 | 58.86 | 58.56 | 58.18 | 57.76 | 57.31 | 56.85 | 56.39 | 55.95 | 55.52 |
| 120 | 52.11 | 52.39 | 52.68 | 52.98 | 53.29 | 53.62 | 53.95 | 54.31 | 54.67 | 55.05 | 55.44 | 55.83 | 56.24 | 56.64 | 57.04 | 57.41 | 57.76 | 58.06 | 58.29 | 58.44 | 58.49 | 58.44 | 58.29 | 58.05 | 57.75 | 57.40 | 57.02 | 56.62 | 56.21 | 55.80 | 55.40 |
| 110 | 52.06 | 52.34 | 52.63 | 52.93 | 53.24 | 53.56 | 53.90 | 54.25 | 54.60 | 54.97 | 55.35 | 55.73 | 56.11 | 56.49 | 56.85 | 57.19 | 57.49 | 57.75 | 57.95 | 58.07 | 58.11 | 58.07 | 57.94 | 57.74 | 57.48 | 57.18 | 56.83 | 56.47 | 56.08 | 55.70 | 55.31 |
| 100 | 52.01 | 52.29 | 52.58 | 52.88 | 53.19 | 53.52 | 53.85 | 54.20 | 54.56 | 54.92 | 55.29 | 55.67 | 56.05 | 56.41 | 56.77 | 57.10 | 57.39 | 57.63 | 57.82 | 57.93 | 57.97 | 57.93 | 57.81 | 57.63 | 57.38 | 57.08 | 56.75 | 56.40 | 56.02 | 55.64 | 55.26 |
| 90 | 51.96 | 52.24 | 52.53 | 52.84 | 53.15 | 53.48 | 53.82 | 54.17 | 54.53 | 54.90 | 55.28 | 55.67 | 56.05 | 56.43 | 56.80 | 57.14 | 57.45 | 57.71 | 57.91 | 58.03 | 58.07 | 58.03 | 57.90 | 57.70 | 57.44 | 57.13 | 56.78 | 56.41 | 56.03 | 55.64 | 55.25 |
| 80 | 51.91 | 52.19 | 52.49 | 52.79 | 53.11 | 53.45 | 53.79 | 54.15 | 54.52 | 54.91 | 55.30 | 55.71 | 56.12 | 56.53 | 56.94 | 57.32 | 57.68 | 57.98 | 58.22 | 58.37 | 58.42 | 58.37 | 58.21 | 57.98 | 57.67 | 57.31 | 56.93 | 56.52 | 56.10 | 55.69 | 55.28 |
| 70 | 51.86 | 52.14 | 52.44 | 52.75 | 53.08 | 53.42 | 53.77 | 54.15 | 54.53 | 54.94 | 55.36 | 55.80 | 56.25 | 56.72 | 57.18 | 57.64 | 58.07 | 58.45 | 58.76 | 58.96 | 59.02 | 58.96 | 58.76 | 58.45 | 58.06 | 57.63 | 57.17 | 56.70 | 56.24 | 55.78 | 55.34 |
| 60 | 51.80 | 52.09 | 52.40 | 52.71 | 53.04 | 53.39 | 53.76 | 54.15 | 54.56 | 54.99 | 55.45 | 55.93 | 56.44 | 56.97 | 57.52 | 58.08 | 58.63 | 59.13 | 59.55 | 59.83 | 59.92 | 59.82 | 59.54 | 59.13 | 58.62 | 58.07 | 57.51 | 56.96 | 56.42 | 55.91 | 55.42 |
| 50 | 51.75 | 52.04 | 52.35 | 52.67 | 53.01 | 53.37 | 53.75 | 54.15 | 54.59 | 55.05 | 55.54 | 56.08 | 56.65 | 57.27 | 57.93 | 58.62 | 59.33 | 60.01 | 60.60 | 61.01 | 61.16 | 61.01 | 60.60 | 60.01 | 59.33 | 58.62 | 57.92 | 57.26 | 56.64 | 56.06 | 55.52 |
| 40 | 51.69 | 51.98 | 52.30 | 52.62 | 52.97 | 53.34 | 53.74 | 54.16 | 54.61 | 55.11 | 55.64 | 56.23 | 56.88 | 57.59 | 58.37 | 59.23 | 60.15 | 61.09 | 61.96 | 62.60 | 62.84 | 62.60 | 61.96 | 61.09 | 60.15 | 59.23 | 58.37 | 57.58 | 56.86 | 56.21 | 55.62 |
| 30 | 51.62 | 51.92 | 52.24 | 52.57 | 52.93 | 53.31 | 53.71 | 54.15 | 54.63 | 55.15 | 55.73 | 56.37 | 57.09 | 57.89 | 58.81 | 59.86 | 61.04 | 62.33 | 63.64 | 64.71 | 65.14 | 64.71 | 63.64 | 62.33 | 61.04 | 59.85 | 58.81 | 57.89 | 57.07 | 56.35 | 55.71 |
| 20 | 51.55 | 51.85 | 52.17 | 52.51 | 52.87 | 53.26 | 53.68 | 54.13 | 54.63 | 55.18 | 55.79 | 56.47 | 57.25 | 58.15 | 59.19 | 60.42 | 61.88 | 63.61 | 65.61 | 67.56 | 68.49 | 67.56 | 65.61 | 63.61 | 61.88 | 60.41 | 59.18 | 58.14 | 57.24 | 56.46 | 55.77 |
| 10 | 51.47 | 51.78 | 52.10 | 52.44 | 52.81 | 53.20 | 53.63 | 54.09 | 54.60 | 55.17 | 55.80 | 56.52 | 57.34 | 58.30 | 59.44 | 60.81 | 62.50 | 64.67 | 67.55 | 71.39 | 74.29 | 71.39 | 67.55 | 64.67 | 62.50 | 60.80 | 59.43 | 58.29 | 57.33 | 56.51 | 55.78 |
| 0 | 51.39 | 51.69 | 52.01 | 52.36 | 52.72 | 53.12 | 53.55 | 54.02 | 54.54 | 55.12 | 55.76 | 56.50 | 57.34 | 58.33 | 59.50 | 60.93 | 62.73 | 65.09 | 68.48 | 74.29 | 102.59 | 74.29 | 68.48 | 65.09 | 62.73 | 60.93 | 59.50 | 58.32 | 57.33 | 56.48 | 55.75 |

# ANNEXURE 03

**Spread Sheet for Vibration**

| Computed Noise level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lmax | | | Max | 105.8721 | dB | | Min | 1 | dB | | | | | | | | | | | | | | | | | | | | | |
| Y/X | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 |
| 60 | 83.71558 | 83.96809 | 84.22656 | 84.49145 | 84.76333 | 85.04279 | 85.33052 | 85.62733 | 85.93411 | 86.25189 | 86.58189 | 86.92551 | 87.28439 | 87.66048 | 88.05611 | 88.47408 | 88.91782 | 89.39154 | 89.90052 | 90.45147 | 91.0531 | 91.71691 | 92.4586 | 93.30025 | 94.27424 | 95.43085 | 96.85415 | 98.70128 | 101.3235 | 105.8353 | |
| 59 | 83.74037 | 83.99264 | 84.25081 | 84.51536 | 84.78683 | 85.06581 | 85.353 | 85.64916 | 85.95518 | 86.27209 | 86.60107 | 86.9435 | 87.30099 | 87.67545 | 88.06916 | 88.48484 | 88.92584 | 89.39623 | 89.90112 | 90.44695 | 91.04202 | 91.69725 | 92.42729 | 93.25242 | 94.20169 | 95.31842 | 96.67051 | 98.37021 | 100.6062 | 103.5808 | 105.8404 |
| 58 | 83.75892 | 84.01055 | 84.26798 | 84.53169 | 84.80219 | 85.08007 | 85.36598 | 85.66068 | 85.96501 | 86.27997 | 86.60668 | 86.94645 | 87.30083 | 87.6716 | 88.06091 | 88.47131 | 88.90588 | 89.36834 | 89.86332 | 90.39654 | 90.97522 | 91.60858 | 92.30856 | 93.0908 | 93.97593 | 94.99101 | 96.16958 | 97.54407 | 99.10304 | 100.6217 | 101.351 |
| 57 | 83.77138 | 84.02198 | 84.27825 | 84.54065 | 84.80965 | 85.08582 | 85.36978 | 85.66224 | 85.964 | 86.27599 | 86.59926 | 86.93502 | 87.28467 | 87.64987 | 88.03252 | 88.43492 | 88.85974 | 89.31022 | 89.79023 | 90.30446 | 90.85858 | 91.4595 | 92.11553 | 92.83643 | 93.63307 | 94.51554 | 95.48767 | 96.53176 | 97.57264 | 98.41953 | 98.77297 |
| 56 | 83.77793 | 84.02715 | 84.28186 | 84.54249 | 84.8095 | 85.0834 | 85.36478 | 85.6543 | 85.95269 | 86.26079 | 86.57955 | 86.91007 | 87.25358 | 87.61153 | 87.98559 | 88.37766 | 88.78999 | 89.22518 | 89.68623 | 90.17664 | 90.70038 | 91.26186 | 91.86573 | 92.51631 | 93.21624 | 93.96359 | 94.74598 | 95.5297 | 96.2443 | 96.77459 | 96.99294 |
| 55 | 83.7788 | 84.0263 | 84.27908 | 84.53754 | 84.8021 | 85.07324 | 85.35148 | 85.63742 | 85.93172 | 86.23512 | 86.54846 | 86.87269 | 87.20886 | 87.5582 | 87.92206 | 88.30199 | 88.69972 | 89.11719 | 89.55653 | 90.02003 | 90.51003 | 91.02871 | 91.57764 | 92.15698 | 92.76397 | 93.39039 | 94.01851 | 94.61581 | 95.13103 | 95.4985 | 95.65916 |
| 54 | 83.77424 | 84.01972 | 84.27025 | 84.52618 | 84.78789 | 85.05581 | 85.33042 | 85.61224 | 85.90184 | 86.19986 | 86.50702 | 86.82411 | 87.152 | 87.49167 | 87.84416 | 88.21064 | 88.59235 | 88.9906 | 89.40669 | 89.84183 | 90.297 | 90.77259 | 91.26796 | 91.78062 | 92.30502 | 92.83082 | 93.34073 | 93.80874 | 94.20041 | 94.47822 | 94.6131 |
| 53 | 83.76454 | 84.00774 | 84.25572 | 84.5088 | 84.76732 | 85.03166 | 85.30222 | 85.57946 | 85.86386 | 86.15597 | 86.45636 | 86.76567 | 87.08459 | 87.41384 | 87.75419 | 88.10644 | 88.47137 | 88.84973 | 89.24212 | 89.64888 | 90.06993 | 90.50441 | 90.95029 | 91.40373 | 91.85825 | 92.30373 | 92.72558 | 93.10451 | 93.41804 | 93.64442 | 93.76886 |
| 52 | 83.75 | 83.99069 | 84.23587 | 84.48584 | 84.74089 | 85.00133 | 85.26752 | 85.53983 | 85.81866 | 86.10445 | 86.39765 | 86.69876 | 87.00825 | 87.32666 | 87.65448 | 87.99218 | 88.34017 | 88.6987 | 89.06783 | 89.44726 | 89.83616 | 90.23292 | 90.6348 | 91.03752 | 91.43474 | 91.81763 | 92.17469 | 92.49219 | 92.75556 | 92.95207 | 93.07422 |
| 51 | 83.73094 | 83.96892 | 84.21112 | 84.45776 | 84.7091 | 84.96542 | 85.22698 | 85.49411 | 85.76711 | 86.04632 | 86.33208 | 86.62473 | 86.92461 | 87.23204 | 87.54727 | 87.87052 | 88.20187 | 88.54121 | 88.88819 | 89.24208 | 89.6016 | 89.96475 | 90.32859 | 90.68893 | 91.04013 | 91.37495 | 91.68469 | 91.95976 | 92.19078 | 92.37033 | 92.49479 |
| 50 | 83.70769 | 83.94282 | 84.18187 | 84.42503 | 84.6725 | 84.92452 | 85.1813 | 85.44307 | 85.71009 | 85.98259 | 86.2608 | 86.54495 | 86.83521 | 87.13175 | 87.43464 | 87.74386 | 88.05926 | 88.38047 | 88.70687 | 89.03745 | 89.37073 | 89.70462 | 90.03623 | 90.3618 | 90.67658 | 90.97485 | 91.25021 | 91.49606 | 91.70643 | 91.87708 | 92.00656 |
| 49 | 83.68058 | 83.91276 | 84.14854 | 84.3881 | 84.63161 | 84.87922 | 85.13112 | 85.38748 | 85.64847 | 85.91424 | 86.18493 | 86.46065 | 86.74149 | 87.02744 | 87.31844 | 87.61431 | 87.91472 | 88.21914 | 88.52678 | 88.83651 | 89.14681 | 89.45564 | 89.76039 | 90.05783 | 90.3441 | 90.61483 | 90.86539 | 91.09132 | 91.2889 | 91.45587 | 91.592 |
| 48 | 83.64996 | 83.8791 | 84.11155 | 84.34746 | 84.58693 | 84.83011 | 85.07711 | 85.32805 | 85.58304 | 85.84217 | 86.10548 | 86.37302 | 86.64475 | 86.92057 | 87.20032 | 87.4837 | 87.77026 | 88.05937 | 88.35019 | 88.64157 | 88.93203 | 89.21972 | 89.50237 | 89.7773 | 90.04148 | 90.29164 | 90.52451 | 90.73715 | 90.92734 | 91.09407 | 91.23782 |
| 47 | 83.61615 | 83.84222 | 84.07131 | 84.30353 | 84.53898 | 84.77773 | 85.01987 | 85.26548 | 85.51459 | 85.76724 | 86.02342 | 86.28309 | 86.54615 | 86.81243 | 87.08167 | 87.35351 | 87.62745 | 87.90283 | 88.17877 | 88.45419 | 88.72775 | 88.99781 | 89.26247 | 89.51959 | 89.76683 | 90.00181 | 90.22228 | 90.42639 | 90.61295 | 90.78172 | 90.93363 |
| 46 | 83.57948 | 83.80246 | 84.0282 | 84.25676 | 84.48822 | 84.72261 | 84.95999 | 85.20039 | 85.44381 | 85.69022 | 85.93958 | 86.19179 | 86.4467 | 86.70408 | 86.96364 | 87.22497 | 87.48755 | 87.75073 | 88.01368 | 88.2754 | 88.53471 | 88.79022 | 89.0404 | 89.28355 | 89.51794 | 89.74189 | 89.95392 | 90.15294 | 90.33846 | 90.51077 | 90.67106 |
| 45 | 83.54026 | 83.76018 | 83.9826 | 84.20756 | 84.4351 | 84.66524 | 84.898 | 85.13337 | 85.37133 | 85.6118 | 85.85471 | 86.09992 | 86.34725 | 86.59643 | 86.84716 | 87.09901 | 87.35149 | 87.60395 | 87.85566 | 88.10573 | 88.35314 | 88.59678 | 88.8354 | 89.06773 | 89.29252 | 89.50862 | 89.71514 | 89.91155 | 90.09784 | 90.27463 | 90.44328 |
| 44 | 83.49879 | 83.71569 | 83.93485 | 84.15629 | 84.38003 | 84.60606 | 84.83438 | 85.06495 | 85.29771 | 85.53258 | 85.76945 | 86.00816 | 86.2485 | 86.4902 | 86.73295 | 86.97635 | 87.2199 | 87.46305 | 87.70513 | 87.94538 | 88.18297 | 88.41698 | 88.64648 | 88.87053 | 89.08826 | 89.29896 | 89.50216 | 89.69772 | 89.88597 | 90.06777 | 90.24456 |
| 43 | 83.45533 | 83.66929 | 83.88528 | 84.10332 | 84.32339 | 84.54548 | 84.76956 | 84.99558 | 85.22345 | 85.45308 | 85.68434 | 85.91706 | 86.15102 | 86.38596 | 86.62157 | 86.85748 | 87.09324 | 87.32835 | 87.56225 | 87.7943 | 88.02384 | 88.25014 | 88.47253 | 88.69033 | 88.903 | 89.11015 | 89.31161 | 89.50755 | 89.69853 | 89.88554 | 90.07009 |
| 42 | 83.41015 | 83.62126 | 83.83419 | 84.04895 | 84.26552 | 84.48386 | 84.70393 | 84.92566 | 85.14897 | 85.37373 | 85.59983 | 85.82707 | 86.05525 | 86.28412 | 86.5134 | 86.74273 | 86.97174 | 87.19998 | 87.42699 | 87.65225 | 87.87525 | 88.09544 | 88.31235 | 88.52553 | 88.73469 | 88.93967 | 89.14056 | 89.33771 | 89.53184 | 89.72404 | 89.91582 |
| 41 | 83.36349 | 83.57184 | 83.78185 | 83.99348 | 84.20672 | 84.42152 | 84.63782 | 84.85555 | 85.07461 | 85.2949 | 85.51627 | 85.73854 | 85.96153 | 86.18501 | 86.4087 | 86.6323 | 86.85549 | 87.07791 | 87.29916 | 87.51886 | 87.73659 | 87.952 | 88.16476 | 88.37461 | 88.58145 | 88.7853 | 88.98642 | 89.18531 | 89.38277 | 89.57993 | 89.77831 |
| 40 | 83.31556 | 83.52128 | 83.72849 | 83.93715 | 84.14725 | 84.35872 | 84.5715 | 84.78552 | 85.00068 | 85.21687 | 85.43394 | 85.65175 | 85.87011 | 86.0888 | 86.30761 | 86.52626 | 86.7445 | 86.96201 | 87.17849 | 87.39366 | 87.60722 | 87.81894 | 88.02861 | 88.23615 | 88.44158 | 88.64506 | 88.84696 | 89.04788 | 89.24867 | 89.45047 | 89.65474 |
| 39 | 83.26656 | 83.46977 | 83.67432 | 83.88019 | 84.08734 | 84.2957 | 84.50522 | 84.71582 | 84.92741 | 85.13986 | 85.35307 | 85.56688 | 85.78113 | 85.99563 | 86.2102 | 86.4246 | 86.63863 | 86.85205 | 87.06463 | 87.27616 | 87.48645 | 87.69537 | 87.90283 | 88.10885 | 88.31355 | 88.51721 | 88.72026 | 88.92335 | 89.12734 | 89.33335 | 89.54279 |
| 38 | 83.21665 | 83.41749 | 83.61954 | 83.82279 | 84.02718 | 84.23267 | 84.43918 | 84.64664 | 84.85497 | 85.06406 | 85.2738 | 85.48405 | 85.69468 | 85.90553 | 86.11644 | 86.32723 | 86.53773 | 86.74777 | 86.95718 | 87.16583 | 87.37361 | 87.58046 | 87.7864 | 87.99152 | 88.19602 | 88.40024 | 88.60466 | 88.80994 | 89.01694 | 89.22673 | 89.44062 |
| 37 | 83.166 | 83.36459 | 83.5643 | 83.7651 | 83.96694 | 84.16976 | 84.37351 | 84.57812 | 84.7835 | 84.98957 | 85.19622 | 85.40333 | 85.6108 | 85.81849 | 86.02627 | 86.23401 | 86.44158 | 86.64885 | 86.85573 | 87.06213 | 87.26803 | 87.47342 | 87.67839 | 87.88309 | 88.08778 | 88.29284 | 88.49876 | 88.7062 | 88.91599 | 89.12912 | 89.3468 |
| 36 | 83.11472 | 83.31121 | 83.50874 | 83.70726 | 83.90674 | 84.10712 | 84.30835 | 84.51037 | 84.7131 | 84.91647 | 85.12038 | 85.32474 | 85.52947 | 85.73444 | 85.93957 | 86.14476 | 86.34991 | 86.55496 | 86.75985 | 86.96455 | 87.16908 | 87.37351 | 87.57795 | 87.78262 | 87.9878 | 88.19388 | 88.40138 | 88.61092 | 88.82327 | 89.03936 | 89.26027 |
| 35 | 83.06293 | 83.25746 | 83.45295 | 83.64937 | 83.84668 | 84.04483 | 84.24378 | 84.44347 | 84.64383 | 84.8448 | 85.0463 | 85.24827 | 85.45062 | 85.65329 | 85.85619 | 86.05927 | 86.26247 | 86.46575 | 86.66912 | 86.87257 | 87.07617 | 87.28003 | 87.48432 | 87.68925 | 87.89515 | 88.10241 | 88.31152 | 88.52309 | 88.73784 | 88.95658 | 89.18028 |
| 34 | 83.01073 | 83.20343 | 83.39704 | 83.59152 | 83.78684 | 83.98297 | 84.17985 | 84.37745 | 84.5757 | 84.77455 | 84.97396 | 85.17385 | 85.37418 | 85.5749 | 85.77595 | 85.97731 | 86.17895 | 86.38088 | 86.58311 | 86.7857 | 86.98874 | 87.19237 | 87.39679 | 87.60223 | 87.80903 | 88.01758 | 88.22835 | 88.44191 | 88.65892 | 88.8801 | 89.1063 |
| 33 | 82.95817 | 83.14918 | 83.34106 | 83.53377 | 83.72728 | 83.92158 | 84.1166 | 84.31233 | 84.50872 | 84.70572 | 84.9033 | 85.10141 | 85.30003 | 85.49912 | 85.69866 | 85.89864 | 86.09908 | 86.29999 | 86.50143 | 86.70348 | 86.90627 | 87.10995 | 87.31473 | 87.52089 | 87.72875 | 87.93868 | 88.15116 | 88.36669 | 88.58589 | 88.80939 | 89.03794 |
| 32 | 82.90534 | 83.09478 | 83.28506 | 83.47615 | 83.66803 | 83.86067 | 84.05404 | 84.24811 | 84.44285 | 84.63824 | 84.83425 | 85.03086 | 85.22804 | 85.42579 | 85.62411 | 85.82302 | 86.02254 | 86.22273 | 86.42367 | 86.62546 | 86.82825 | 87.03221 | 87.23758 | 87.44462 | 87.65366 | 87.86508 | 88.07931 | 88.29685 | 88.51822 | 88.74404 | 88.97491 |
| 31 | 82.85225 | 83.04026 | 83.22909 | 83.4187 | 83.6091 | 83.80026 | 83.99215 | 84.18476 | 84.37807 | 84.57207 | 84.76673 | 84.96206 | 85.15806 | 85.35473 | 85.55209 | 85.75018 | 85.94905 | 86.14878 | 86.34946 | 86.55123 | 86.75423 | 86.95868 | 87.16479 | 87.37286 | 87.58321 | 87.7962 | 88.01226 | 88.23185 | 88.45546 | 88.68364 | 88.91694 |
| 30 | 82.79896 | 82.98565 | 83.17314 | 83.36143 | 83.55049 | 83.74032 | 83.9309 | 84.12223 | 84.3143 | 84.5071 | 84.70063 | 84.89491 | 85.08994 | 85.28575 | 85.48238 | 85.67988 | 85.87833 | 86.07781 | 86.27844 | 86.48038 | 86.68378 | 86.88887 | 87.09588 | 87.3051 | 87.51686 | 87.73152 | 87.94948 | 88.1712 | 88.39714 | 88.62781 | 88.86373 |
| 29 | 82.74547 | 82.93095 | 83.11723 | 83.30431 | 83.49218 | 83.68083 | 83.87027 | 84.06048 | 84.25147 | 84.44325 | 84.63584 | 84.82925 | 85.0235 | 85.21865 | 85.41475 | 85.61186 | 85.81007 | 86.00949 | 86.21026 | 86.41253 | 86.61649 | 86.82235 | 87.03038 | 87.24086 | 87.45412 | 87.67053 | 87.89048 | 88.11441 | 88.3428 | 88.57613 | 88.8149 |
| 28 | 82.69178 | 82.87616 | 83.06135 | 83.24734 | 83.43414 | 83.62175 | 83.81018 | 83.99942 | 84.1895 | 84.38042 | 84.57223 | 84.76493 | 84.95859 | 85.15325 | 85.34898 | 85.54587 | 85.74401 | 85.94353 | 86.14458 | 86.34732 | 86.55195 | 86.75871 | 86.96785 | 87.17968 | 87.39452 | 87.61275 | 87.83476 | 88.06101 | 88.29195 | 88.5281 | 88.76997 |
| 27 | 82.6379 | 82.82128 | 83.00547 | 83.19049 | 83.37634 | 83.56303 | 83.75058 | 83.93898 | 84.12828 | 84.3185 | 84.50966 | 84.70182 | 84.89503 | 85.08935 | 85.28486 | 85.48167 | 85.67988 | 85.87963 | 86.08107 | 86.28439 | 86.4898 | 86.69754 | 86.90787 | 87.12111 | 87.33759 | 87.5577 | 87.78184 | 88.01046 | 88.24407 | 88.48318 | 88.72836 |
| 26 | 82.58381 | 82.76627 | 82.94957 | 83.13372 | 83.31873 | 83.50461 | 83.69139 | 83.87908 | 84.06772 | 84.25735 | 84.44801 | 84.63975 | 84.83263 | 85.02674 | 85.22216 | 85.41901 | 85.6174 | 85.81748 | 86.01943 | 86.22342 | 86.42968 | 86.63847 | 86.85005 | 87.06474 | 87.2829 | 87.50491 | 87.73121 | 87.96226 | 88.19858 | 88.44074 | 88.68937 |
| 25 | 82.52948 | 82.71112 | 82.89361 | 83.07698 | 83.26124 | 83.44642 | 83.63253 | 83.81962 | 84.00772 | 84.19687 | 84.38713 | 84.57856 | 84.77123 | 84.96524 | 85.16067 | 85.35766 | 85.55633 | 85.75683 | 85.95935 | 86.16408 | 86.37125 | 86.58113 | 86.79399 | 87.01016 | 87.23001 | 87.45393 | 87.68238 | 87.91585 | 88.15489 | 88.40013 | 88.65226 |
| 24 | 82.47489 | 82.65578 | 82.83754 | 83.02022 | 83.20382 | 83.38838 | 83.57392 | 83.7605 | 83.94815 | 84.13692 | 84.32688 | 84.5181 | 84.71066 | 84.90465 | 85.10018 | 85.29739 | 85.49641 | 85.6974 | 85.90055 | 86.10607 | 86.31419 | 86.52517 | 86.73933 | 86.95698 | 87.1785 | 87.4043 | 87.63486 | 87.8707 | 88.11241 | 88.36066 | 88.61621 |
| 23 | 82.42001 | 82.60021 | 82.78132 | 82.96337 | 83.14639 | 83.33041 | 83.51547 | 83.70162 | 83.8889 | 84.07738 | 84.26712 | 84.45821 | 84.65073 | 84.84478 | 85.04049 | 85.23798 | 85.4374 | 85.63893 | 85.84275 | 86.04908 | 86.25817 | 86.47028 | 86.68571 | 86.90481 | 87.12796 | 87.35559 | 87.58819 | 87.82629 | 88.07054 | 88.32165 | 88.58044 |
| 22 | 82.36479 | 82.54437 | 82.72489 | 82.90639 | 83.08889 | 83.27244 | 83.45709 | 83.64287 | 83.82986 | 84.01811 | 84.20771 | 84.39873 | 84.59127 | 84.78545 | 84.98138 | 85.1792 | 85.37908 | 85.58118 | 85.7857 | 85.99286 | 86.20291 | 86.41612 | 86.63281 | 86.85332 | 87.07803 | 87.3074 | 87.54191 | 87.78214 | 88.02874 | 88.28245 | 88.54418 |
| 21 | 82.30919 | 82.4882 | 82.66819 | 82.84919 | 83.03124 | 83.21438 | 83.39867 | 83.58416 | 83.77091 | 83.95899 | 84.1485 | 84.33951 | 84.53213 | 84.72648 | 84.92267 | 85.12087 | 85.32122 | 85.52391 | 85.72914 | 85.93713 | 86.14813 | 86.36242 | 86.58032 | 86.80217 | 87.02836 | 87.25935 | 87.49564 | 87.7378 | 87.9865 | 88.24252 | 88.50678 |
| 20 | 82.25316 | 82.43165 | 82.61115 | 82.79171 | 82.97335 | 83.15614 | 83.34012 | 83.52536 | 83.71193 | 83.8999 | 84.08936 | 84.2804 | 84.47314 | 84.66769 | 84.86418 | 85.06277 | 85.26362 | 85.46691 | 85.67284 | 85.88165 | 86.09358 | 86.30891 | 86.52796 | 86.75107 | 86.97865 | 87.21112 | 87.44901 | 87.69289 | 87.94342 | 88.2014 | 88.46773 |
| 19 | 82.19665 | 82.37466 | 82.55372 | 82.73387 | 82.91515 | 83.09762 | 83.28134 | 83.46638 | 83.6528 | 83.84069 | 84.03014 | 84.22125 | 84.41413 | 84.60891 | 84.80572 | 85.00472 | 85.20607 | 85.40995 | 85.61658 | 85.82618 | 86.03901 | 86.25533 | 86.47547 | 86.69976 | 86.92861 | 87.16244 | 87.40175 | 87.64711 | 87.89919 | 88.15874 | 88.42666 |
| 18 | 82.1396 | 82.31717 | 82.49582 | 82.6756 | 82.85656 | 83.03875 | 83.22224 | 83.4071 | 83.59341 | 83.78125 | 83.97071 | 84.16191 | 84.35496 | 84.54998 | 84.74712 | 84.94652 | 85.14837 | 85.35285 | 85.56015 | 85.77052 | 85.9842 | 86.20146 | 86.42262 | 86.64801 | 86.87802 | 87.11306 | 87.35362 | 87.60025 | 87.85358 | 88.11434 | 88.38339 |
| 17 | 82.08196 | 82.25912 | 82.43739 | 82.61683 | 82.79748 | 82.97942 | 83.16271 | 83.34742 | 83.53364 | 83.72144 | 83.91094 | 84.10225 | 84.29547 | 84.49074 | 84.6882 | 84.88802 | 85.09035 | 85.2954 | 85.50336 | 85.71446 | 85.92895 | 86.1471 | 86.36921 | 86.59561 | 86.82667 | 87.0628 | 87.30445 | 87.55215 | 87.80649 | 88.06814 | 88.3379 |
| 16 | 82.02367 | 82.20044 | 82.37835 | 82.55747 | 82.73785 | 82.91955 | 83.10266 | 83.28723 | 83.47337 | 83.66116 | 83.8507 | 84.04211 | 84.23551 | 84.43103 | 84.62882 | 84.82903 | 85.03183 | 85.23743 | 85.44601 | 85.65781 | 85.87307 | 86.09205 | 86.31505 | 86.54238 | 86.77441 | 87.01151 | 87.25412 | 87.50273 | 87.75787 | 88.02016 | 88.29031 |
| 15 | 81.96467 | 82.14106 | 82.31864 | 82.49745 | 82.67757 | 82.85905 | 83.04198 | 83.22643 | 83.4125 | 83.60027 | 83.78986 | 83.98138 | 84.17495 | 84.37071 | 84.5688 | 84.76939 | 84.97265 | 85.17876 | 85.38794 | 85.60039 | 85.81638 | 86.03614 | 86.25997 | 86.48817 | 86.72109 | 86.95908 | 87.20255 | 87.45195 | 87.70776 | 87.97053 | 88.24087 |
| 14 | 81.90491 | 82.08093 | 82.25818 | 82.4367 | 82.61655 | 82.79783 | 82.98058 | 83.16491 | 83.35091 | 83.53867 | 83.72829 | 83.91991 | 84.11364 | 84.30962 | 84.508 | 84.70894 | 84.91262 | 85.11923 | 85.32896 | 85.54204 | 85.7587 | 85.9792 | 86.20381 | 86.43284 | 86.66659 | 86.90541 | 87.14969 | 87.39982 | 87.65624 | 87.91942 | 88.1899 |
| 13 | 81.84431 | 82.01998 | 82.1969 | 82.37513 | 82.55473 | 82.73579 | 82.91837 | 83.10258 | 83.28849 | 83.47622 | 83.66588 | 83.85757 | 84.05144 | 84.24763 | 84.44627 | 84.64754 | 84.85161 | 85.05867 | 85.26892 | 85.48258 | 85.69988 | 85.92108 | 86.14643 | 86.37623 | 86.61079 | 86.85042 | 87.09548 | 87.34633 | 87.60337 | 87.86702 | 88.1377 |
| 12 | 81.78283 | 81.95815 | 82.13474 | 82.31267 | 82.49202 | 82.67285 | 82.85526 | 83.03932 | 83.22515 | 83.41283 | 83.60249 | 83.79425 | 83.98824 | 84.18459 | 84.38347 | 84.58503 | 84.78945 | 84.99693 | 85.20766 | 85.42186 | 85.63976 | 85.86161 | 86.08767 | 86.31822 | 86.55356 | 86.79399 | 87.03986 | 87.29149 | 87.54924 | 87.81348 | 88.08458 |
| 11 | 81.72041 | 81.89536 | 82.07162 | 82.24925 | 82.42833 | 82.60893 | 82.79114 | 82.97505 | 83.16076 | 83.34838 | 83.53803 | 83.72981 | 83.92388 | 84.12037 | 84.31944 | 84.52126 | 84.72599 | 84.93384 | 85.145 | 85.3597 | 85.57816 | 85.80063 | 86.02736 | 86.25865 | 86.49477 | 86.73603 | 86.98274 | 87.23523 | 87.49384 | 87.75889 | 88.03071 |
| 10 | 81.65698 | 81.83156 | 82.00748 | 82.18479 | 82.36358 | 82.54394 | 82.72593 | 82.90967 | 83.09524 | 83.28277 | 83.47236 | 83.66414 | 83.85826 | 84.05484 | 84.25406 | 84.45608 | 84.66108 | 84.86925 | 85.0808 | 85.29594 | 85.51492 | 85.73796 | 85.96535 | 86.19735 | 86.43425 | 86.67636 | 86.92399 | 87.17746 | 87.43709 | 87.70322 | 87.97615 |
| 9 | 81.59249 | 81.76669 | 81.94224 | 82.11923 | 82.29772 | 82.47779 | 82.65955 | 82.84308 | 83.02849 | 83.21588 | 83.40538 | 83.59712 | 83.79123 | 83.98787 | 84.18719 | 84.38936 | 84.59457 | 84.80301 | 85.01488 | 85.23042 | 85.44985 | 85.67344 | 85.90144 | 86.13413 | 86.37182 | 86.61481 | 86.86342 | 87.11799 | 87.37885 | 87.64634 | 87.92078 |
| 8 | 81.52689 | 81.70068 | 81.87586 | 82.05248 | 82.23064 | 82.41042 | 82.59191 | 82.77519 | 82.96039 | 83.14762 | 83.33699 | 83.52863 | 83.7227 | 83.91933 | 84.11869 | 84.32095 | 84.5263 | 84.73494 | 84.94708 | 85.16295 | 85.38279 | 85.60685 | 85.83542 | 86.06878 | 86.30725 | 86.55114 | 86.80079 | 87.05656 | 87.31882 | 87.58794 | 87.8643 |
| 7 | 81.46011 | 81.63348 | 81.80825 | 81.9845 | 82.1623 | 82.34174 | 82.52292 | 82.70593 | 82.89088 | 83.07788 | 83.26707 | 83.45857 | 83.65252 | 83.84908 | 84.04842 | 84.25071 | 84.45613 | 84.6649 | 84.87723 | 85.09336 | 85.31352 | 85.53801 | 85.76708 | 86.00106 | 86.24027 | 86.48505 | 86.73577 | 86.99283 | 87.25662 | 87.5276 | 87.8062 |
| 6 | 81.39211 | 81.56503 | 81.73937 | 81.9152 | 82.09261 | 82.27168 | 82.45251 | 82.63519 | 82.81985 | 83.00658 | 83.19553 | 83.38682 | 83.5806 | 83.77702 | 83.97626 | 84.17849 | 84.38391 | 84.59272 | 84.80516 | 85.02145 | 85.24186 | 85.46667 | 85.69618 | 85.9307 | 86.1706 | 86.41623 | 86.668 | 86.92636 | 87.19176 | 87.46472 | 87.74579 |
| 5 | 81.32284 | 81.49528 | 81.66916 | 81.84454 | 82.02152 | 82.20017 | 82.3806 | 82.56292 | 82.74722 | 82.93362 | 83.12226 | 83.31328 | 83.50681 | 83.70302 | 83.90208 | 84.10417 | 84.30949 | 84.51825 | 84.73069 | 84.94705 | 85.1676 | 85.39263 | 85.62246 | 85.85743 | 86.09791 | 86.3443 | 86.59706 | 86.85666 | 87.12366 | 87.39863 | 87.68224 |
| 4 | 81.25225 | 81.42418 | 81.59755 | 81.77245 | 81.94895 | 82.12714 | 82.30713 | 82.48901 | 82.6729 | 82.85892 | 83.04719 | 83.23785 | 83.43106 | 83.62697 | 83.82575 | 84.02761 | 84.23273 | 84.44133 | 84.65366 | 84.86996 | 85.09052 | 85.31565 | 85.54566 | 85.78094 | 86.02186 | 86.26888 | 86.52248 | 86.7832 | 87.05166 | 87.32853 | 87.61459 |
| 3 | 81.1803 | 81.35168 | 81.52451 | 81.69887 | 81.87485 | 82.05254 | 82.23202 | 82.41342 | 82.59683 | 82.78238 | 82.97021 | 83.16044 | 83.35324 | 83.54875 | 83.74717 | 83.94868 | 84.15348 | 84.36181 | 84.57389 | 84.79001 | 85.01043 | 85.23549 | 85.46553 | 85.70093 | 85.94212 | 86.18956 | 86.4438 | 86.70541 | 86.97509 | 87.2536 | 87.54183 |
| 2 | 81.10694 | 81.27773 | 81.44998 | 81.62376 | 81.79917 | 81.97629 | 82.15522 | 82.33606 | 82.51893 | 82.70395 | 82.89125 | 83.08096 | 83.27325 | 83.46828 | 83.66622 | 83.86727 | 84.07163 | 84.27954 | 84.49124 | 84.707 | 84.92713 | 85.15194 | 85.3818 | 85.61712 | 85.85833 | 86.10595 | 86.36053 | 86.62272 | 86.89327 | 87.17301 | 87.46295 |
| 1 | 81.03213 | 81.20229 | 81.37391 | 81.54707 | 81.72186 | 81.89835 | 82.07666 | 82.25688 | 82.43914 | 82.62354 | 82.81023 | 82.99934 | 83.19102 | 83.38545 | 83.5828 | 83.78326 | 83.98705 | 84.1944 | 84.40555 | 84.62079 | 84.84043 | 85.06478 | 85.29424 | 85.52922 | 85.77018 | 86.01765 | 86.27223 | 86.53459 | 86.80554 | 87.08598 | 87.37698 |
| 0 | 80.95584 | 81.12533 | 81.29628 | 81.46876 | 81.64286 | 81.81867 | 81.9963 | 82.17583 | 82.35739 | 82.5411 | 82.72708 | 82.91549 | 83.10647 | 83.30018 | 83.49681 | 83.69656 | 83.89963 | 84.10625 | 84.31669 | 84.53122 | 84.75015 | 84.97383 | 85.20263 | 85.43698 | 85.67736 | 85.92432 | 86.17848 | 86.44054 | 86.71133 | 86.99179 | 87.28307 |

| Lmax | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y/X | 105.8436 | 101.3706 | 98.83146 | 97.1213 | 95.89687 | 95.0077 | 94.37557 | 93.95574 | 93.72162 | 93.6581 | 93.75879 | 94.02546 | 94.46922 | 95.11386 | 96.00289 | 97.2151 | 98.90337 | 101.4151 | 105.8609 | | 105.8546 | 101.3799 | 98.80661 | 97.01689 | 95.65684 | 94.56705 | 93.66153 | 92.88849 | 92.2143 | 91.61596 |
| 60 | 103.5951 | 100.6629 | 98.51326 | 96.95399 | 95.80429 | 94.95833 | 94.35362 | 93.95182 | 93.72903 | 93.67116 | 93.77188 | 94.03234 | 94.46214 | 95.08202 | 95.92894 | 97.06608 | 98.60212 | 100.7229 | 103.6282 | 105.8615 | 103.6178 | 100.6818 | 98.49884 | 96.86186 | 95.57869 | 94.53436 | 93.65874 | 92.90676 | 92.24806 | 91.66142 |
| 59 | 100.6502 | 99.18419 | 97.71894 | 96.4906 | 95.51873 | 94.77707 | 94.23699 | 93.87565 | 93.67652 | 93.62876 | 93.72681 | 93.97057 | 94.36598 | 94.92613 | 95.67243 | 96.63442 | 97.8418 | 99.28111 | 100.725 | 101.4186 | 100.7051 | 99.22452 | 97.72029 | 96.41181 | 95.30621 | 94.36767 | 93.56002 | 92.85422 | 92.22821 | 91.66534 |
| 58 | 98.46734 | 97.68885 | 96.75354 | 95.86413 | 95.10425 | 94.49767 | 94.04497 | 93.7394 | 93.57299 | 93.53898 | 93.63294 | 93.85328 | 94.20154 | 94.68205 | 95.30011 | 96.05626 | 96.93068 | 97.84636 | 98.60943 | 98.91313 | 98.57762 | 97.76925 | 96.78395 | 95.80755 | 94.91062 | 94.10701 | 93.38992 | 92.74702 | 92.16591 | 91.63581 |
| 57 | 96.8448 | 96.40251 | 95.809 | 95.19126 | 94.62827 | 94.15964 | 93.80172 | 93.55894 | 93.43029 | 93.41268 | 93.50271 | 93.6975 | 93.9947 | 94.39157 | 94.88217 | 95.45141 | 96.06379 | 96.647 | 97.08241 | 97.23519 | 97.03853 | 96.54834 | 95.88994 | 95.17439 | 94.46762 | 93.79937 | 93.17886 | 92.60566 | 92.07553 | 91.58315 |
| 56 | 95.59297 | 95.33544 | 94.95941 | 94.54165 | 94.14165 | 93.79759 | 93.53069 | 93.35095 | 93.26163 | 93.26217 | 93.34997 | 93.52121 | 93.77089 | 94.09187 | 94.47257 | 94.89295 | 95.31883 | 95.69706 | 95.95852 | 96.0376 | 95.90383 | 95.57888 | 95.12034 | 94.59046 | 94.03643 | 93.48695 | 92.95663 | 92.45138 | 91.97241 | 91.51866 |
| 55 | 94.5979 | 94.45324 | 94.22045 | 93.94719 | 93.67557 | 93.43689 | 93.25145 | 93.13078 | 93.08001 | 93.09995 | 93.18849 | 93.34128 | 93.55191 | 93.81123 | 94.10599 | 94.41678 | 94.71587 | 94.96689 | 95.12899 | 95.16732 | 95.06581 | 94.83343 | 94.49841 | 94.09557 | 93.65589 | 93.20201 | 92.7484 | 92.30335 | 91.87106 | 91.4533 |
| 54 | 93.78959 | 93.72013 | 93.58607 | 93.41825 | 93.24618 | 93.09391 | 92.97869 | 92.9113 | 92.89721 | 92.93771 | 93.0309 | 93.17229 | 93.35496 | 93.56935 | 93.80262 | 94.03795 | 94.25415 | 94.42654 | 94.5301 | 94.54486 | 94.4614 | 94.28341 | 94.02541 | 93.70726 | 93.34881 | 92.96671 | 92.57334 | 92.17723 | 91.78391 | 91.3968 |
| 53 | 93.1226 | 93.10686 | 93.04398 | 92.9548 | 92.86017 | 92.77817 | 92.72258 | 92.7026 | 92.72318 | 92.7856 | 92.88806 | 93.02613 | 93.19298 | 93.37941 | 93.57377 | 93.76194 | 93.92769 | 94.05374 | 94.12385 | 94.12557 | 94.05286 | 93.90712 | 93.69622 | 93.43203 | 93.12761 | 92.79513 | 92.44482 | 92.08468 | 91.72065 | 91.35698 |
| 52 | 92.56581 | 92.59069 | 92.58136 | 92.55246 | 92.51899 | 92.49446 | 92.48964 | 92.51201 | 92.56573 | 92.65186 | 92.76869 | 92.91201 | 93.07536 | 93.25017 | 93.42596 | 93.59063 | 93.73106 | 93.83409 | 93.888 | 93.88408 | 93.81792 | 93.69004 | 93.50528 | 93.2716 | 92.99848 | 92.69548 | 92.37137 | 92.03357 | 91.68807 | 91.33949 |
| 51 | 92.09697 | 92.15406 | 92.18663 | 92.20533 | 92.22123 | 92.24452 | 92.28357 | 92.3444 | 92.43043 | 92.54255 | 92.6792 | 92.83652 | 93.00856 | 93.18736 | 93.36324 | 93.52512 | 93.66121 | 93.75991 | 93.81107 | 93.80727 | 93.74474 | 93.62383 | 93.4486 | 93.22587 | 92.96403 | 92.67183 | 92.35751 | 92.02827 | 91.6901 | 91.34769 |
| 50 | 91.69955 | 91.78322 | 91.84977 | 91.90724 | 91.96402 | 92.02801 | 92.10582 | 92.20238 | 92.32062 | 92.46141 | 92.62351 | 92.80362 | 92.99637 | 93.19434 | 93.38816 | 93.56676 | 93.71792 | 93.82927 | 93.88974 | 93.89112 | 93.82945 | 93.70554 | 93.52446 | 93.29431 | 93.02465 | 92.7251 | 92.40442 | 92.07003 | 91.72789 | 91.38261 |
| 49 | 91.36087 | 91.46719 | 91.56218 | 91.65215 | 91.74372 | 91.8432 | 91.95605 | 92.08652 | 92.23736 | 92.40971 | 92.60291 | 92.81446 | 93.0398 | 93.27208 | 93.50191 | 93.71724 | 93.90369 | 94.04558 | 94.12801 | 94.13969 | 94.07542 | 93.93727 | 93.73353 | 93.47635 | 93.17892 | 92.85346 | 92.51019 | 92.15705 | 91.79994 | 91.44303 |
| 48 | 91.0709 | 91.19701 | 91.31642 | 91.43433 | 91.55619 | 91.68729 | 91.83242 | 91.99554 | 92.17957 | 92.38623 | 92.61584 | 92.8671 | 93.13668 | 93.41866 | 93.70365 | 93.97801 | 94.22337 | 94.41758 | 94.53782 | 94.5659 | 94.49387 | 94.32643 | 94.07876 | 93.77105 | 93.42329 | 93.05207 | 92.66969 | 92.28456 | 91.90206 | 91.52549 |
| 47 | 90.8215 | 90.96518 | 91.10599 | 91.24836 | 91.39702 | 91.55669 | 91.73184 | 91.9265 | 92.14407 | 92.38723 | 92.65772 | 92.95603 | 93.28084 | 93.62803 | 93.98904 | 94.34877 | 94.68341 | 94.96013 | 95.14124 | 95.19457 | 95.10621 | 94.88658 | 94.56473 | 94.17584 | 93.75085 | 93.31219 | 92.87408 | 92.44451 | 92.02746 | 91.62448 |
| 46 | 90.6059 | 90.76534 | 90.92508 | 91.08909 | 91.26166 | 91.44722 | 91.65024 | 91.87504 | 92.12584 | 92.40657 | 92.72089 | 93.07182 | 93.46118 | 93.8883 | 94.34758 | 94.82445 | 95.28976 | 95.69506 | 95.97554 | 96.06939 | 95.94912 | 95.63841 | 95.19578 | 94.68365 | 94.14888 | 93.61965 | 93.11004 | 92.62547 | 92.16676 | 91.73256 |
| 45 | 90.41841 | 90.592 | 90.76853 | 90.95168 | 91.1455 | 91.35436 | 91.58284 | 91.83579 | 92.11836 | 92.43606 | 92.79482 | 93.20097 | 93.66082 | 94.17956 | 94.75849 | 95.38913 | 96.04215 | 96.65116 | 97.10315 | 97.2685 | 97.08456 | 96.60975 | 95.97029 | 95.27695 | 94.59486 | 93.95278 | 93.35904 | 92.81249 | 92.30831 | 91.8408 |
| 44 | 90.2542 | 90.4404 | 90.63172 | 90.83165 | 91.04412 | 91.27349 | 91.52458 | 91.80279 | 92.11426 | 92.46612 | 92.86681 | 93.32642 | 93.85693 | 94.472 | 95.18532 | 96.0051 | 96.91876 | 97.8564 | 98.63129 | 98.94367 | 98.61938 | 97.82785 | 96.8654 | 95.91681 | 95.05109 | 94.28059 | 93.59723 | 92.9877 | 92.43887 | 91.93943 |
| 43 | 90.10915 | 90.30646 | 90.51062 | 90.72499 | 90.9534 | 91.20023 | 91.47052 | 91.77012 | 92.10605 | 92.48686 | 92.92329 | 93.42909 | 94.02219 | 94.72616 | 95.57176 | 96.59712 | 97.8401 | 99.29539 | 100.7443 | 101.4413 | 100.7377 | 99.27676 | 97.80091 | 96.52727 | 95.46061 | 94.56311 | 93.79694 | 93.13186 | 92.54489 | 92.01883 |
| 42 | 89.97981 | 90.18672 | 90.4018 | 90.62824 | 90.86978 | 91.13077 | 91.41631 | 91.73255 | 92.08705 | 92.48932 | 92.95174 | 93.49074 | 94.12893 | 94.89828 | 95.84583 | 97.04404 | 98.61048 | 100.74 | 103.6419 | 105.8721 | 103.6388 | 100.7278 | 98.58068 | 96.98687 | 95.75133 | 94.75663 | 93.93071 | 93.22709 | 92.6144 | 92.07077 |
| 41 | 89.86331 | 90.07834 | 90.30242 | 90.53859 | 90.7904 | 91.06206 | 91.35859 | 91.68611 | 92.0523 | 92.46695 | 92.94294 | 93.49771 | 94.15559 | 94.95193 | 95.94066 | 97.21039 | 98.92354 | 101.4371 | 105.8719 | | 105.8702 | 101.4277 | 98.89835 | 97.16048 | 95.85688 | 94.82535 | 93.97771 | 93.26053 | 92.63909 | 92.08969 |
| 40 | 89.75736 | 89.97907 | 90.21033 | 90.45395 | 90.71323 | 90.9921 | 91.2953 | 91.6286 | 91.99928 | 92.41662 | 92.8928 | 93.44417 | 94.09323 | 94.87193 | 95.82732 | 97.03186 | 98.6032 | 100.7362 | 103.6403 | 105.8713 | 103.6377 | 100.7261 | 98.57856 | 96.98465 | 95.74934 | 94.7552 | 93.9301 | 93.22751 | 92.61601 | 92.07368 |
| 39 | 89.66017 | 89.88724 | 90.12399 | 90.37296 | 90.63712 | 90.92 | 91.22583 | 91.55975 | 91.92818 | 92.3392 | 92.80318 | 93.33367 | 93.94845 | 94.67103 | 95.53218 | 96.57009 | 97.8227 | 99.28484 | 100.738 | 101.4368 | 100.7335 | 99.27208 | 97.79589 | 96.52239 | 95.45645 | 94.56022 | 93.79581 | 93.13287 | 92.54832 | 92.02489 |
| 38 | 89.57044 | 89.80169 | 90.04246 | 90.29497 | 90.56179 | 90.84593 | 91.15096 | 91.48118 | 91.84179 | 92.2392 | 92.68134 | 93.17796 | 93.74087 | 94.38367 | 95.12011 | 95.95852 | 96.88649 | 97.83441 | 98.61592 | 98.9319 | 98.60915 | 97.81819 | 96.85624 | 95.90861 | 95.04449 | 94.27628 | 93.59581 | 92.98965 | 92.44455 | 91.94911 |
| 37 | 89.48725 | 89.72173 | 89.96534 | 90.21995 | 90.48769 | 90.77099 | 91.07268 | 91.39605 | 91.74497 | 92.12397 | 92.53831 | 92.99391 | 93.49689 | 94.05244 | 94.66201 | 95.31736 | 95.98953 | 96.61258 | 97.0742 | 97.24566 | 97.06541 | 96.59303 | 95.95569 | 95.26476 | 94.58565 | 93.94721 | 93.35773 | 92.81594 | 92.31692 | 91.85483 |
| 36 | 89.41003 | 89.64702 | 89.89263 | 90.14835 | 90.41585 | 90.69698 | 90.99381 | 91.3086 | 91.64388 | 92.00238 | 92.3869 | 92.80001 | 93.24342 | 93.71655 | 94.21411 | 94.72198 | 95.21161 | 95.63527 | 95.92907 | 96.03228 | 95.91865 | 95.61298 | 95.17477 | 94.66708 | 94.13713 | 93.61324 | 93.10949 | 92.63124 | 92.17921 | 91.75192 |
| 35 | 89.33843 | 89.57751 | 89.82462 | 90.08092 | 90.34765 | 90.62611 | 90.91762 | 91.22353 | 91.54516 | 91.88366 | 92.2398 | 92.61365 | 93.00387 | 93.4066 | 93.81386 | 94.21123 | 94.57581 | 94.87575 | 95.07449 | 95.14112 | 95.06294 | 94.85156 | 94.53697 | 94.15501 | 93.73704 | 93.3057 | 92.87526 | 92.4537 | 92.04492 | 91.65038 |
| 34 | 89.27229 | 89.51328 | 89.76176 | 90.01859 | 90.28462 | 90.56066 | 90.84743 | 91.1455 | 91.45518 | 91.77638 | 92.10838 | 92.44951 | 92.79658 | 93.14422 | 93.4839 | 93.80302 | 94.08439 | 94.30716 | 94.44981 | 94.49553 | 94.43765 | 94.28203 | 94.04476 | 93.74675 | 93.40843 | 93.04667 | 92.67389 | 92.29852 | 91.92594 | 91.55937 |
| 33 | 89.2115 | 89.45448 | 89.70452 | 89.96222 | 90.22816 | 90.50275 | 90.78625 | 91.07863 | 91.37946 | 91.68779 | 92.00189 | 92.31899 | 92.63494 | 92.94378 | 93.23735 | 93.50502 | 93.73394 | 93.91 | 94.01986 | 94.05367 | 94.00761 | 93.88489 | 93.69477 | 93.45009 | 93.16456 | 92.85073 | 92.519 | 92.17741 | 91.83186 | 91.48652 |
| 32 | 89.15594 | 89.4012 | 89.65324 | 89.91253 | 90.17942 | 90.45408 | 90.73646 | 91.02615 | 91.32229 | 91.62339 | 91.92713 | 92.2302 | 92.52797 | 92.81434 | 93.0816 | 93.32053 | 93.52083 | 93.67202 | 93.7648 | 93.79262 | 93.75295 | 93.64781 | 93.48329 | 93.26824 | 93.01279 | 92.72694 | 92.41968 | 92.09858 | 91.76966 | 91.4375 |
| 31 | 89.10542 | 89.35339 | 89.60808 | 89.86989 | 90.13907 | 90.41569 | 90.69957 | 90.99016 | 91.28641 | 91.58666 | 91.8884 | 92.18811 | 92.48104 | 92.76107 | 93.02068 | 93.25114 | 93.443 | 93.58691 | 93.67481 | 93.70114 | 93.66376 | 93.56436 | 93.40809 | 93.20263 | 92.95699 | 92.68034 | 92.38119 | 92.06693 | 91.74358 | 91.41585 |
| 30 | 89.05963 | 89.31082 | 89.56891 | 89.8343 | 90.10726 | 90.38791 | 90.67611 | 90.97141 | 91.27287 | 91.57897 | 91.88737 | 92.19469 | 92.4963 | 92.78609 | 93.05636 | 93.29787 | 93.50035 | 93.65332 | 93.74753 | 93.77645 | 93.73759 | 93.63302 | 93.46886 | 93.25402 | 92.99865 | 92.71278 | 92.40545 | 92.08423 | 91.75517 | 91.42286 |
| 29 | 89.0181 | 89.27302 | 89.53526 | 89.80528 | 90.08351 | 90.37021 | 90.66552 | 90.96927 | 91.28093 | 91.59946 | 91.92305 | 92.24887 | 92.57272 | 92.88862 | 93.18838 | 93.46138 | 93.69477 | 93.87447 | 93.98718 | 94.02313 | 93.97857 | 93.85681 | 93.66722 | 93.42275 | 93.13718 | 92.82316 | 92.49113 | 92.14918 | 91.80325 | 91.45753 |
| 28 | 88.98019 | 89.23931 | 89.50635 | 89.78194 | 90.06672 | 90.36128 | 90.66615 | 90.98169 | 91.30805 | 91.64502 | 91.99174 | 92.34644 | 92.70588 | 93.06459 | 93.41402 | 93.74151 | 94.02989 | 94.25828 | 94.40522 | 94.454 | 94.39806 | 94.24348 | 94.00655 | 93.70836 | 93.36953 | 93.00706 | 92.63347 | 92.25727 | 91.88388 | 91.51655 |
| 27 | 88.94514 | 89.20878 | 89.48109 | 89.76293 | 90.05525 | 90.35903 | 90.67535 | 91.0053 | 91.34996 | 91.71029 | 92.08692 | 92.47975 | 92.88733 | 93.3057 | 93.72677 | 94.13604 | 94.5105 | 94.81826 | 95.02277 | 95.09319 | 95.01707 | 94.80634 | 94.49135 | 94.1083 | 93.68884 | 93.25584 | 92.82372 | 92.40054 | 91.99027 | 91.5944 |
| 26 | 88.91204 | 89.18035 | 89.45817 | 89.74663 | 90.04701 | 90.36078 | 90.68967 | 91.03561 | 91.40086 | 91.78788 | 92.19926 | 92.63741 | 93.10384 | 93.59782 | 94.11388 | 94.63772 | 95.14059 | 95.57457 | 95.87568 | 95.98327 | 95.87139 | 95.56538 | 95.12539 | 94.61505 | 94.08206 | 93.55506 | 93.04834 | 92.56736 | 92.1129 | 91.68349 |
| 25 | 88.87994 | 89.15286 | 89.43614 | 89.73118 | 90.03962 | 90.36345 | 90.70505 | 91.06733 | 91.45379 | 91.86865 | 92.31692 | 92.80427 | 93.3366 | 93.91889 | 94.55232 | 95.22837 | 95.91771 | 96.55404 | 97.02472 | 97.20097 | 97.02169 | 96.5473 | 95.90604 | 95.2102 | 94.52591 | 93.88243 | 93.2883 | 92.74238 | 92.23975 | 91.77458 |
| 24 | 88.84788 | 89.12511 | 89.4135 | 89.71468 | 90.03063 | 90.36382 | 90.71727 | 91.0948 | 91.50118 | 91.94246 | 92.42623 | 92.96195 | 93.56118 | 94.23723 | 95.00353 | 95.868 | 96.81774 | 97.78248 | 98.5752 | 98.89637 | 98.57325 | 97.77781 | 96.80902 | 95.85358 | 94.98164 | 94.20608 | 93.51902 | 92.90709 | 92.35705 | 91.85744 |
| 23 | 88.81495 | 89.09601 | 89.38886 | 89.69534 | 90.01772 | 90.35883 | 90.72226 | 91.11258 | 91.53565 | 91.99913 | 92.51302 | 93.09049 | 93.74903 | 94.51184 | 95.40931 | 96.47917 | 97.75874 | 99.242 | 100.7093 | 101.4139 | 100.7082 | 99.23893 | 97.75228 | 96.46764 | 95.39097 | 94.48494 | 93.71188 | 93.04147 | 92.45061 | 91.9219 |
| 22 | 88.78036 | 89.06458 | 89.36102 | 89.67166 | 89.99893 | 90.34594 | 90.71661 | 91.11604 | 91.55084 | 92.02977 | 92.56455 | 93.17114 | 93.87169 | 94.69781 | 95.69613 | 96.93866 | 98.5424 | 100.7014 | 103.6236 | 105.8619 | 103.6231 | 100.6993 | 98.53743 | 96.9291 | 95.6803 | 94.67406 | 93.83841 | 93.12681 | 92.50774 | 91.95911 |
| 21 | 88.74353 | 89.03011 | 89.32911 | 89.64253 | 89.97287 | 90.32331 | 90.69792 | 91.10195 | 91.54229 | 92.02809 | 92.5717 | 93.19011 | 93.90725 | 94.75806 | 95.7961 | 97.10947 | 98.85997 | 101.4038 | 105.8607 | | 105.8605 | 101.4022 | 98.85571 | 97.101 | 95.78184 | 94.73646 | 93.8768 | 93.1494 | 92.51938 | 91.96288 |
| 20 | 88.70404 | 88.99217 | 89.29262 | 89.60736 | 89.93882 | 90.29009 | 90.66508 | 91.06887 | 91.50809 | 91.99148 | 92.53074 | 93.14182 | 93.84685 | 94.67739 | 95.68002 | 96.92666 | 98.5342 | 100.6964 | 103.6211 | 105.8605 | 103.6207 | 100.6947 | 98.52996 | 96.91851 | 95.6665 | 94.65706 | 93.81834 | 93.10381 | 92.48196 | 91.93074 |
| 19 | 88.66174 | 88.9506 | 89.25146 | 89.56613 | 89.89684 | 90.24641 | 90.61841 | 91.01737 | 91.44918 | 91.92143 | 92.44411 | 93.03036 | 93.69761 | 94.46898 | 95.37473 | 96.45238 | 97.73901 | 99.22815 | 100.6995 | 101.4057 | 100.6987 | 99.22592 | 97.7343 | 96.44397 | 95.36132 | 94.44927 | 93.67034 | 92.99431 | 92.39811 | 91.86436 |
| 18 | 88.61668 | 88.90559 | 89.20594 | 89.51932 | 89.84768 | 90.19344 | 90.55958 | 90.94989 | 91.36911 | 91.82323 | 92.3198 | 92.86823 | 93.47997 | 94.1682 | 94.94614 | 95.82143 | 96.78074 | 97.75322 | 98.55116 | 98.87438 | 98.54995 | 97.75031 | 96.77531 | 95.81244 | 94.93245 | 94.14866 | 93.45344 | 92.83361 | 92.276 | 91.76922 |
| 17 | 88.56913 | 88.85755 | 89.15671 | 89.46792 | 89.79276 | 90.13315 | 90.49142 | 90.87041 | 91.27356 | 91.70503 | 92.16974 | 92.67325 | 93.22136 | 93.81883 | 94.46658 | 95.15573 | 95.85643 | 96.50179 | 96.97849 | 97.15726 | 96.97688 | 96.49821 | 95.85021 | 95.14602 | 94.45243 | 93.79922 | 93.19529 | 92.63971 | 92.12774 | 91.65361 |
| 16 | 88.51947 | 88.80712 | 89.10469 | 89.41323 | 89.73392 | 90.06815 | 90.41753 | 90.78392 | 91.16947 | 91.57654 | 92.0076 | 92.46493 | 92.94984 | 93.4614 | 93.99382 | 94.53239 | 95.04786 | 95.49175 | 95.7995 | 95.91009 | 95.79754 | 95.48756 | 95.04092 | 94.522 | 93.97919 | 93.44166 | 92.92411 | 92.4323 | 91.96718 | 91.52743 |
| 15 | 88.46822 | 88.75502 | 89.05095 | 89.35677 | 89.67328 | 90.00133 | 90.34188 | 90.69587 | 91.06424 | 91.44781 | 91.84705 | 92.26168 | 92.69003 | 93.1279 | 93.56685 | 93.99202 | 94.37993 | 94.69821 | 94.90987 | 94.98383 | 94.90764 | 94.69354 | 94.37242 | 93.98111 | 93.55188 | 93.10813 | 92.66469 | 92.22996 | 91.80813 | 91.40087 |
| 14 | 88.41588 | 88.70201 | 88.99659 | 89.30008 | 89.61295 | 89.93562 | 90.26842 | 90.61155 | 90.96496 | 91.32824 | 91.70034 | 92.07926 | 92.46151 | 92.84137 | 93.20995 | 93.55426 | 93.85675 | 94.09617 | 94.25077 | 94.30366 | 94.24836 | 94.09119 | 93.84889 | 93.54306 | 93.19485 | 92.82176 | 92.43671 | 92.04854 | 91.66295 | 91.28342 |
| 13 | 88.3629 | 88.64879 | 88.94259 | 89.24455 | 89.55487 | 89.87363 | 90.20069 | 90.53567 | 90.87781 | 91.22581 | 91.5776 | 91.93011 | 92.27885 | 92.61757 | 92.93778 | 93.22857 | 93.47678 | 93.6681 | 93.78903 | 93.82974 | 93.78655 | 93.663 | 93.46881 | 93.21735 | 92.92285 | 92.59839 | 92.25482 | 91.90056 | 91.54185 | 91.18314 |
| 12 | 88.30961 | 88.59588 | 88.88972 | 89.19128 | 89.50058 | 89.81745 | 90.14149 | 90.47195 | 90.80762 | 91.14666 | 91.48643 | 91.82326 | 92.15222 | 92.4669 | 92.7593 | 93.01994 | 93.23831 | 93.40376 | 93.50693 | 93.5413 | 93.50447 | 93.39872 | 93.23048 | 93.009 | 92.74484 | 92.44843 | 92.1292 | 91.79509 | 91.45247 | 91.10623 |
| 11 | 88.25617 | 88.54354 | 88.83843 | 89.14095 | 89.45103 | 89.76845 | 90.09268 | 90.42284 | 90.75756 | 91.09481 | 91.43174 | 91.76449 | 92.08796 | 92.39572 | 92.67994 | 92.93162 | 93.14107 | 93.29883 | 93.39674 | 93.42927 | 93.39439 | 93.29403 | 93.13362 | 92.92122 | 92.66623 | 92.37825 | 92.06622 | 91.73791 | 91.39972 | 91.05671 |
| 10 | 88.2025 | 88.49177 | 88.78879 | 89.09372 | 89.40654 | 89.72709 | 90.05494 | 90.3893 | 90.72893 | 91.07195 | 91.41566 | 91.75633 | 92.08897 | 92.40709 | 92.70261 | 92.96597 | 93.18658 | 93.35373 | 93.458 | 93.49283 | 93.45584 | 93.34931 | 93.17971 | 92.95636 | 92.6899 | 92.39086 | 92.06872 | 91.73153 | 91.38572 | 91.03626 |
| 9 | 88.14827 | 88.4402 | 88.74042 | 89.04918 | 89.36666 | 89.69289 | 90.02773 | 90.37073 | 90.72105 | 91.07732 | 91.43738 | 91.79802 | 92.15463 | 92.50078 | 92.82781 | 93.12462 | 93.37786 | 93.57301 | 93.69642 | 93.73816 | 93.69452 | 93.5691 | 93.37174 | 93.11599 | 92.81631 | 92.48597 | 92.13604 | 91.77511 | 91.4096 | 91.04409 |
| 8 | 88.0929 | 88.38817 | 88.6925 | 89.00635 | 89.33018 | 89.66438 | 90.00923 | 90.36488 | 90.73119 | 91.10764 | 91.49304 | 91.88522 | 92.28047 | 92.67281 | 93.05304 | 93.40781 | 93.71914 | 93.96538 | 94.12439 | 94.17904 | 94.12278 | 93.96204 | 93.71386 | 93.40027 | 93.04286 | 92.65954 | 92.26362 | 91.86427 | 91.46745 | 91.07683 |
| 7 | 88.03556 | 88.33466 | 88.6438 | 88.96372 | 89.29522 | 89.63916 | 89.99644 | 90.36796 | 90.75459 | 91.15702 | 91.57554 | 92.00968 | 92.45747 | 92.91432 | 93.37131 | 93.81294 | 94.215 | 94.54431 | 94.76314 | 94.83985 | 94.76184 | 94.54159 | 94.21061 | 93.80653 | 93.36248 | 92.90261 | 92.44237 | 91.99068 | 91.5521 | 91.12858 |
| 6 | 87.97522 | 88.27842 | 88.59275 | 88.91929 | 89.25926 | 89.61406 | 89.98529 | 90.37481 | 90.78468 | 91.21716 | 91.67458 | 92.15893 | 92.6712 | 93.2099 | 93.76857 | 94.33152 | 94.8683 | 95.32904 | 95.64781 | 95.76251 | 95.64682 | 95.32692 | 94.86477 | 94.3262 | 93.76103 | 93.19968 | 92.65777 | 92.14178 | 91.65316 | 91.19095 |
| 5 | 87.91073 | 88.21798 | 88.53752 | 88.87077 | 89.21937 | 89.58531 | 89.97096 | 90.37917 | 90.81338 | 91.27768 | 91.77683 | 92.31614 | 92.90097 | 93.53545 | 94.21956 | 94.94308 | 95.6744 | 96.34441 | 96.83742 | 97.02218 | 96.83672 | 96.34284 | 95.67166 | 94.93877 | 94.21322 | 93.52658 | 92.88906 | 92.30067 | 91.75727 | 91.2535 |
| 4 | 87.84082 | 88.15178 | 88.47615 | 88.81566 | 89.17238 | 89.54884 | 89.94816 | 90.3742 | 90.83174 | 91.32677 | 91.86671 | 92.46073 | 93.11981 | 93.85638 | 94.68251 | 95.60416 | 96.60564 | 97.61293 | 98.43444 | 98.76629 | 98.43399 | 97.61183 | 96.60357 | 95.6007 | 94.67718 | 93.84867 | 93.10921 | 92.44673 | 91.84878 | 91.30439 |
| 3 | 87.76424 | 88.07827 | 88.40668 | 88.75149 | 89.11512 | 89.50058 | 89.91164 | 90.353 | 90.83065 | 91.35225 | 91.92773 | 92.56999 | 93.29598 | 94.12799 | 95.09496 | 96.23248 | 97.5748 | 99.11146 | 100.6165 | 101.3353 | 100.6162 | 99.11074 | 97.57326 | 96.22967 | 95.09041 | 94.12121 | 93.28646 | 92.55721 | 91.91118 | 91.33142 |
| 2 | 87.6798 | 87.99597 | 88.32728 | 88.67594 | 89.04467 | 89.43681 | 89.85658 | 90.30929 | 90.80179 | 91.34294 | 91.94444 | 92.62201 | 93.3973 | 94.30096 | 95.37812 | 96.69857 | 98.37615 | 100.6003 | 103.5722 | 105.8314 | 103.5721 | 100.5999 | 98.37494 | 96.69621 | 95.37413 | 94.29486 | 93.38859 | 92.61018 | 91.92898 | 91.32337 |
| 1 | 87.58647 | 87.9036 | 88.23635 | 88.58706 | 88.95858 | 89.35443 | 89.77905 | 90.23803 | 90.73856 | 91.29 | 91.90472 | 92.5995 | 93.39774 | 94.33337 | 95.45829 | 96.85822 | 98.6916 | 101.3102 | 105.8273 | | 105.8272 | 101.3098 | 98.69055 | 96.85609 | 95.45463 | 94.32769 | 93.38957 | 92.58834 | 91.89009 | 91.27142 |

| Convertd Vibration level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PPV ALL | | | Max | 60 | mm/s | | Min | 0 | mm/s | | PPV | | | | | | | | | | | | | | | | | | | |
| Y/X | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 |
| 60 | 2.301564015 | 2.369456 | 2.441022 | 2.516614 | 2.596631 | 2.681533 | 2.771852 | 2.868206 | 2.971318 | 3.082042 | 3.20139 | 3.330576 | 3.471069 | 3.624664 | 3.79358 | 3.980595 | 4.189237 | 4.42406 | 4.691049 | 4.998246 | 5.356716 | 5.782149 | 6.297583 | 6.938349 | 7.761687 | 8.8672 | 10.44603 | 12.92135 | 17.47497 | 29.37714 |
| 59 | 2.308141742 | 2.376161 | 2.447848 | 2.523551 | 2.603667 | 2.688652 | 2.779033 | 2.875422 | 2.978536 | 3.089217 | 3.208466 | 3.337481 | 3.47771 | 3.630918 | 3.799283 | 3.985529 | 4.193105 | 4.426447 | 4.691369 | 4.995641 | 5.349893 | 5.769077 | 6.27492 | 6.900251 | 7.697121 | 8.753157 | 10.2275 | 12.43811 | 16.08992 | 22.66131 |
| 58 | 2.313076066 | 2.381065 | 2.452692 | 2.528299 | 2.608276 | 2.693068 | 2.78319 | 2.879239 | 2.98191 | 3.09202 | 3.210538 | 3.338617 | 3.477645 | 3.62931 | 3.79568 | 3.979327 | 4.18348 | 4.41226 | 4.671002 | 4.966735 | 5.308905 | 5.710486 | 6.189735 | 6.773043 | 7.499643 | 8.429357 | 9.654348 | 11.3096 | 13.53306 | 16.11863 |
| 57 | 2.316395709 | 2.384201 | 2.455594 | 2.530907 | 2.610515 | 2.69485 | 2.784407 | 2.879757 | 2.981564 | 3.090605 | 3.207797 | 3.334223 | 3.471182 | 3.620238 | 3.783294 | 3.962687 | 4.161319 | 4.382833 | 4.631861 | 4.914358 | 5.238091 | 5.613311 | 6.053691 | 6.577572 | 7.209369 | 7.980332 | 8.925396 | 10.06542 | 11.34686 | 12.50893 |
| 56 | 2.318143626 | 2.385619 | 2.456614 | 2.531444 | 2.61047 | 2.694101 | 2.782807 | 2.877126 | 2.977682 | 3.0852 | 3.200526 | 3.324659 | 3.45878 | 3.604297 | 3.762904 | 3.936651 | 4.128035 | 4.340129 | 4.576731 | 4.84257 | 5.143548 | 5.487024 | 5.882074 | 6.339564 | 6.871565 | 7.488993 | 8.194884 | 8.968682 | 9.737753 | 10.35079 |
| 55 | 2.318375836 | 2.385387 | 2.455829 | 2.530003 | 2.608249 | 2.690951 | 2.778548 | 2.87154 | 2.970501 | 3.076095 | 3.18909 | 3.310382 | 3.441019 | 3.582234 | 3.735486 | 3.902505 | 4.085357 | 4.286507 | 4.5089 | 4.756041 | 5.032058 | 5.341699 | 5.690178 | 6.082649 | 6.522924 | 7.010734 | 7.536496 | 8.072989 | 8.56634 | 8.936531 |
| 54 | 2.317159942 | 2.383582 | 2.453333 | 2.526695 | 2.603984 | 2.685558 | 2.77182 | 2.863227 | 2.9603 | 3.063634 | 3.173912 | 3.291921 | 3.418567 | 3.554898 | 3.702131 | 3.861677 | 4.035167 | 4.224485 | 4.43178 | 4.65946 | 4.910142 | 5.186491 | 5.49088 | 5.824716 | 6.187208 | 6.573319 | 6.970768 | 7.356664 | 7.695988 | 7.946114 |
| 53 | 2.314573414 | 2.380295 | 2.449232 | 2.521644 | 2.597825 | 2.678099 | 2.762834 | 2.852442 | 2.947386 | 3.048192 | 3.155455 | 3.269848 | 3.392137 | 3.523188 | 3.663982 | 3.815626 | 3.979354 | 4.156525 | 4.348602 | 4.557093 | 4.783438 | 5.028798 | 5.293688 | 5.577384 | 5.877009 | 6.186292 | 6.494155 | 6.783743 | 7.033085 | 7.218797 |
| 52 | 2.310701694 | 2.375627 | 2.443642 | 2.514988 | 2.589931 | 2.668764 | 2.751818 | 2.839456 | 2.932087 | 3.030166 | 3.134199 | 3.244753 | 3.362456 | 3.488004 | 3.622163 | 3.765764 | 3.919695 | 4.084876 | 4.262214 | 4.452528 | 4.656415 | 4.874047 | 5.104862 | 5.34712 | 5.597328 | 5.849588 | 6.095069 | 6.321985 | 6.516613 | 6.665728 |
| 51 | 2.305636229 | 2.369682 | 2.436688 | 2.506871 | 2.580472 | 2.657753 | 2.739006 | 2.82455 | 2.914737 | 3.009955 | 3.110627 | 3.217218 | 3.330232 | 3.450211 | 3.577729 | 3.713385 | 3.857778 | 4.011478 | 4.174972 | 4.348583 | 4.532352 | 4.725867 | 4.928031 | 5.136774 | 5.348726 | 5.558932 | 5.760744 | 5.946095 | 6.106369 | 6.233909 |
| 50 | 2.299472489 | 2.362572 | 2.428496 | 2.497441 | 2.569621 | 2.645268 | 2.724637 | 2.808003 | 2.895667 | 2.987951 | 3.085205 | 3.187801 | 3.296131 | 3.410603 | 3.531634 | 3.659627 | 3.794955 | 3.937924 | 4.088718 | 4.247333 | 4.413474 | 4.58643 | 4.764918 | 4.94691 | 5.129473 | 5.308679 | 5.479672 | 5.636984 | 5.775177 | 5.889763 |
| 49 | 2.292308057 | 2.354408 | 2.419196 | 2.486847 | 2.55755 | 2.631509 | 2.708944 | 2.790088 | 2.875194 | 2.964528 | 3.058371 | 3.157014 | 3.260755 | 3.36989 | 3.484704 | 3.60545 | 3.73233 | 3.865458 | 4.004818 | 4.150205 | 4.301148 | 4.456828 | 4.615976 | 4.776782 | 4.936838 | 5.093136 | 5.242196 | 5.380339 | 5.504133 | 5.610961 |
| 48 | 2.284240832 | 2.345302 | 2.408916 | 2.475236 | 2.544429 | 2.616672 | 2.692151 | 2.771064 | 2.85362 | 2.940033 | 3.030527 | 3.125322 | 3.22464 | 3.328684 | 3.437637 | 3.551638 | 3.670766 | 3.795007 | 3.924221 | 4.058095 | 4.196094 | 4.337402 | 4.480868 | 4.624969 | 4.767797 | 4.907109 | 5.040449 | 5.165366 | 5.279722 | 5.382044 |
| 47 | 2.275367415 | 2.335365 | 2.39778 | 2.462751 | 2.53042 | 2.60094 | 2.674469 | 2.751172 | 2.831218 | 2.91478 | 3.002029 | 3.093132 | 3.188242 | 3.287496 | 3.390997 | 3.498803 | 3.610909 | 3.727222 | 3.847534 | 3.971491 | 4.09856 | 4.227994 | 4.358806 | 4.489762 | 4.619396 | 4.74607 | 4.868081 | 4.983832 | 5.092034 | 5.19194 |
| 46 | 2.265781688 | 2.324701 | 2.385909 | 2.449526 | 2.515676 | 2.584488 | 2.656095 | 2.730633 | 2.80824 | 2.889049 | 2.973193 | 3.06079 | 3.151946 | 3.246743 | 3.345229 | 3.447406 | 3.553216 | 3.662523 | 3.775093 | 3.890575 | 4.008475 | 4.128145 | 4.248775 | 4.369396 | 4.488911 | 4.606153 | 4.719975 | 4.829374 | 4.933636 | 5.032486 |
| 45 | 2.255573628 | 2.313412 | 2.373416 | 2.435689 | 2.500338 | 2.567473 | 2.637205 | 2.709646 | 2.784903 | 2.863084 | 2.944283 | 3.028587 | 3.116063 | 3.206753 | 3.300668 | 3.397774 | 3.497986 | 3.601151 | 3.707035 | 3.815313 | 3.925555 | 4.037223 | 4.149672 | 4.262166 | 4.373908 | 4.484095 | 4.591989 | 4.697009 | 4.798835 | 4.89751 |
| 44 | 2.244828337 | 2.301592 | 2.360404 | 2.421355 | 2.484536 | 2.55004 | 2.617959 | 2.688384 | 2.7614 | 2.83709 | 2.915523 | 2.996759 | 3.080837 | 3.167773 | 3.257553 | 3.350127 | 3.445395 | 3.543206 | 3.643345 | 3.745527 | 3.849393 | 3.954513 | 4.060393 | 4.166491 | 4.272254 | 4.377155 | 4.480759 | 4.582788 | 4.683197 | 4.78225 |
| 43 | 2.233625315 | 2.28933 | 2.346973 | 2.406633 | 2.468388 | 2.532317 | 2.598496 | 2.666998 | 2.737892 | 2.811241 | 2.887094 | 2.965492 | 3.046454 | 3.129982 | 3.216047 | 3.304591 | 3.395516 | 3.488683 | 3.583905 | 3.680943 | 3.779511 | 3.879279 | 3.979882 | 4.080942 | 4.182096 | 4.28303 | 4.383533 | 4.483545 | 4.583217 | 4.682967 |
| 42 | 2.222037932 | 2.276705 | 2.333208 | 2.391617 | 2.451997 | 2.514415 | 2.578935 | 2.645617 | 2.714515 | 2.785676 | 2.859138 | 2.934926 | 3.01305 | 3.0935 | 3.176243 | 3.261222 | 3.348349 | 3.437502 | 3.528526 | 3.621234 | 3.715405 | 3.810798 | 3.90716 | 4.004243 | 4.101836 | 4.199788 | 4.298052 | 4.396726 | 4.496099 | 4.596695 |
| 41 | 2.210133113 | 2.26379 | 2.319189 | 2.376391 | 2.435453 | 2.496432 | 2.55938 | 2.624347 | 2.691377 | 2.760507 | 2.831765 | 2.905167 | 2.980716 | 3.058399 | 3.138186 | 3.220023 | 3.303837 | 3.389529 | 3.476979 | 3.566044 | 3.656568 | 3.748384 | 3.841331 | 3.93527 | 4.030104 | 4.125807 | 4.222453 | 4.320254 | 4.419592 | 4.521063 |
| 40 | 2.197971182 | 2.250649 | 2.304985 | 2.361031 | 2.418835 | 2.478448 | 2.539914 | 2.603275 | 2.668566 | 2.735818 | 2.805053 | 2.876282 | 2.949506 | 3.024712 | 3.101875 | 3.180952 | 3.261885 | 3.3446 | 3.429009 | 3.515013 | 3.602509 | 3.691397 | 3.781591 | 3.873036 | 3.965726 | 4.059727 | 4.155202 | 4.252439 | 4.351884 | 4.454175 |
| 39 | 2.185605863 | 2.237341 | 2.290657 | 2.345598 | 2.402209 | 2.460532 | 2.520607 | 2.582469 | 2.646148 | 2.711672 | 2.779057 | 2.848314 | 2.919444 | 2.99244 | 3.067282 | 3.143939 | 3.22237 | 3.302527 | 3.384351 | 3.467783 | 3.552766 | 3.639254 | 3.727224 | 3.816686 | 3.907703 | 4.000409 | 4.095028 | 4.191903 | 4.291516 | 4.394521 |
| 38 | 2.173084404 | 2.223915 | 2.276255 | 2.330147 | 2.385629 | 2.442739 | 2.501513 | 2.561981 | 2.624172 | 2.688109 | 2.753808 | 2.821281 | 2.890533 | 2.96156 | 3.034352 | 3.108891 | 3.185154 | 3.263115 | 3.342743 | 3.424013 | 3.506907 | 3.591426 | 3.677595 | 3.765475 | 3.855182 | 3.946897 | 4.040888 | 4.137528 | 4.237316 | 4.340906 |
| 37 | 2.160447801 | 2.210413 | 2.261825 | 2.314722 | 2.36914 | 2.425113 | 2.482673 | 2.54185 | 2.60267 | 2.665154 | 2.729321 | 2.795185 | 2.862753 | 2.93203 | 3.003015 | 3.075703 | 3.150088 | 3.226164 | 3.303926 | 3.383379 | 3.464537 | 3.547438 | 3.632146 | 3.718762 | 3.807439 | 3.898394 | 3.991919 | 4.088404 | 4.188352 | 4.292396 |
| 36 | 2.147731094 | 2.19687 | 2.247401 | 2.299359 | 2.352776 | 2.407686 | 2.464118 | 2.522101 | 2.58166 | 2.642818 | 2.705596 | 2.770009 | 2.836071 | 2.903795 | 2.973188 | 3.04426 | 3.11702 | 3.191479 | 3.267656 | 3.34558 | 3.425295 | 3.506866 | 3.590388 | 3.675993 | 3.763862 | 3.854232 | 3.947414 | 4.0438 | 4.143882 | 4.24827 |
| 35 | 2.134963722 | 2.183317 | 2.233014 | 2.284086 | 2.336565 | 2.390482 | 2.445868 | 2.502748 | 2.561151 | 2.6211 | 2.682618 | 2.745727 | 2.810444 | 2.87679 | 2.944783 | 3.014444 | 3.085796 | 3.158869 | 3.233699 | 3.310338 | 3.388851 | 3.46933 | 3.551891 | 3.636691 | 3.723927 | 3.813855 | 3.906788 | 4.003119 | 4.103323 | 4.207973 |
| 34 | 2.122169916 | 2.169778 | 2.218685 | 2.268923 | 2.320524 | 2.373517 | 2.427932 | 2.483798 | 2.541141 | 2.599989 | 2.660368 | 2.722302 | 2.785819 | 2.850944 | 2.917705 | 2.986134 | 3.056269 | 3.128152 | 3.201838 | 3.277396 | 3.354911 | 3.434493 | 3.516278 | 3.60044 | 3.68719 | 3.77679 | 3.869559 | 3.96588 | 4.066209 | 4.171083 |
| 33 | 2.109369111 | 2.156269 | 2.204432 | 2.253888 | 2.304667 | 2.3568 | 2.410317 | 2.465247 | 2.52162 | 2.579466 | 2.638814 | 2.699694 | 2.762138 | 2.82618 | 2.891857 | 2.959211 | 3.028291 | 3.099154 | 3.171868 | 3.246518 | 3.323205 | 3.402054 | 3.483218 | 3.56688 | 3.653265 | 3.74264 | 3.835322 | 3.931684 | 4.032164 | 4.137267 |
| 32 | 2.096576367 | 2.142807 | 2.190267 | 2.238987 | 2.288998 | 2.340331 | 2.393017 | 2.447087 | 2.502572 | 2.559506 | 2.617921 | 2.677852 | 2.739339 | 2.802421 | 2.867143 | 2.933558 | 3.001725 | 3.071712 | 3.1436 | 3.217488 | 3.29349 | 3.371744 | 3.452414 | 3.535696 | 3.621821 | 3.71106 | 3.803729 | 3.900194 | 4.000876 | 4.106253 |
| 31 | 2.083802793 | 2.129399 | 2.176197 | 2.224227 | 2.273521 | 2.32411 | 2.376026 | 2.429304 | 2.483976 | 2.540078 | 2.597649 | 2.656728 | 2.717358 | 2.779587 | 2.843468 | 2.909061 | 2.976436 | 3.045671 | 3.116858 | 3.190107 | 3.265544 | 3.343318 | 3.423604 | 3.506606 | 3.592562 | 3.681747 | 3.774478 | 3.871116 | 3.972069 | 4.077798 |
| 30 | 2.071055956 | 2.116052 | 2.162225 | 2.209608 | 2.258231 | 2.308128 | 2.359332 | 2.411879 | 2.465806 | 2.521151 | 2.577956 | 2.636266 | 2.696129 | 2.757599 | 2.820738 | 2.885611 | 2.952298 | 3.020886 | 3.091478 | 3.164191 | 3.239164 | 3.316556 | 3.396549 | 3.479357 | 3.565224 | 3.654431 | 3.747296 | 3.84418 | 3.945489 | 4.051673 |
| 29 | 2.05834028 | 2.102768 | 2.148352 | 2.195126 | 2.243122 | 2.292374 | 2.342918 | 2.394792 | 2.448034 | 2.502687 | 2.558797 | 2.616412 | 2.675587 | 2.736381 | 2.798861 | 2.863102 | 2.929189 | 2.99722 | 3.067305 | 3.139571 | 3.214165 | 3.291254 | 3.371031 | 3.453718 | 3.539565 | 3.62886 | 3.721927 | 3.819131 | 3.920883 | 4.027636 |
| 28 | 2.045657421 | 2.089546 | 2.134574 | 2.180776 | 2.228184 | 2.276835 | 2.326766 | 2.378017 | 2.430629 | 2.484649 | 2.540125 | 2.597111 | 2.655666 | 2.715854 | 2.777749 | 2.841433 | 2.906996 | 2.974545 | 3.044197 | 3.116088 | 3.190372 | 3.267226 | 3.346851 | 3.429475 | 3.51536 | 3.6048 | 3.698128 | 3.79572 | 3.897997 | 4.005427 |
| 27 | 2.033006621 | 2.076384 | 2.120887 | 2.166549 | 2.213406 | 2.261495 | 2.310855 | 2.361528 | 2.413559 | 2.466997 | 2.521894 | 2.578308 | 2.636302 | 2.695946 | 2.757319 | 2.820507 | 2.885611 | 2.952739 | 3.02202 | 3.093595 | 3.167626 | 3.244299 | 3.323821 | 3.40643 | 3.492397 | 3.582026 | 3.675663 | 3.773697 | 3.876566 | 3.984765 |
| 26 | 2.020385044 | 2.063276 | 2.107281 | 2.152434 | 2.198772 | 2.246334 | 2.295161 | 2.345298 | 2.396791 | 2.449692 | 2.504057 | 2.559948 | 2.617432 | 2.676584 | 2.737487 | 2.800234 | 2.864929 | 2.93169 | 3.000649 | 3.071955 | 3.145778 | 3.222309 | 3.301766 | 3.384396 | 3.470476 | 3.560324 | 3.6543 | 3.75281 | 3.856317 | 3.965346 |
| 25 | 2.007788075 | 2.050216 | 2.093748 | 2.138419 | 2.184268 | 2.231334 | 2.279662 | 2.329297 | 2.380289 | 2.432693 | 2.486568 | 2.541978 | 2.598995 | 2.657699 | 2.718176 | 2.780525 | 2.844855 | 2.911289 | 2.979965 | 3.05104 | 3.124687 | 3.201108 | 3.280525 | 3.363195 | 3.449407 | 3.539488 | 3.633815 | 3.732813 | 3.836971 | 3.94685 |
| 24 | 1.995209611 | 2.037195 | 2.080277 | 2.12449 | 2.169875 | 2.216474 | 2.264332 | 2.313496 | 2.36402 | 2.415961 | 2.46938 | 2.524345 | 2.580932 | 2.639224 | 2.699312 | 2.761298 | 2.825297 | 2.891437 | 2.95986 | 3.030729 | 3.104225 | 3.180553 | 3.259945 | 3.342664 | 3.42901 | 3.519322 | 3.61399 | 3.713462 | 3.818251 | 3.928954 |
| 23 | 1.98264231 | 2.024204 | 2.066855 | 2.110632 | 2.155577 | 2.201732 | 2.249145 | 2.297866 | 2.34795 | 2.399456 | 2.452448 | 2.506999 | 2.563186 | 2.621095 | 2.680823 | 2.742475 | 2.806169 | 2.872039 | 2.940231 | 3.010912 | 3.08427 | 3.160514 | 3.239884 | 3.322649 | 3.409118 | 3.499641 | 3.594622 | 3.694525 | 3.79989 | 3.911345 |
| 22 | 1.97007783 | 2.011233 | 2.05347 | 2.09683 | 2.141354 | 2.187087 | 2.234077 | 2.282377 | 2.332044 | 2.38314 | 2.435731 | 2.489891 | 2.545702 | 2.603253 | 2.662643 | 2.723981 | 2.78739 | 2.853007 | 2.920981 | 2.991485 | 3.06471 | 3.140871 | 3.220211 | 3.303009 | 3.389577 | 3.480277 | 3.575522 | 3.675791 | 3.781644 | 3.893736 |
| 21 | 1.957507042 | 1.998269 | 2.040109 | 2.083067 | 2.127187 | 2.172515 | 2.219102 | 2.267001 | 2.31627 | 2.366975 | 2.419184 | 2.472973 | 2.528427 | 2.585638 | 2.644707 | 2.705748 | 2.768885 | 2.834259 | 2.902023 | 2.972353 | 3.045443 | 3.121513 | 3.20081 | 3.283616 | 3.37025 | 3.461078 | 3.556523 | 3.657073 | 3.7633 | 3.875877 |
| 20 | 1.944920221 | 1.985301 | 2.026756 | 2.069327 | 2.113058 | 2.157996 | 2.204194 | 2.251707 | 2.300595 | 2.350924 | 2.402767 | 2.456201 | 2.511312 | 2.568196 | 2.626957 | 2.68771 | 2.750583 | 2.815719 | 2.883274 | 2.953427 | 3.026375 | 3.10234 | 3.181572 | 3.264356 | 3.351014 | 3.441915 | 3.537484 | 3.638214 | 3.744682 | 3.857568 |
| 19 | 1.93230722 | 1.972318 | 2.013399 | 2.055594 | 2.098947 | 2.143508 | 2.189329 | 2.236468 | 2.284987 | 2.334954 | 2.386442 | 2.439531 | 2.49431 | 2.550876 | 2.609336 | 2.669806 | 2.732418 | 2.797316 | 2.86466 | 2.934628 | 3.007421 | 3.083262 | 3.162404 | 3.24513 | 3.331764 | 3.422676 | 3.518288 | 3.619092 | 3.725661 | 3.83867 |
| 18 | 1.919657625 | 1.959307 | 2.000023 | 2.04185 | 2.084835 | 2.129028 | 2.174482 | 2.221257 | 2.269416 | 2.319029 | 2.37017 | 2.422922 | 2.477375 | 2.533628 | 2.59179 | 2.651979 | 2.714329 | 2.778985 | 2.846109 | 2.915882 | 2.988504 | 3.0642 | 3.143221 | 3.225852 | 3.312414 | 3.403273 | 3.498847 | 3.599619 | 3.706151 | 3.819101 |
| 17 | 1.906960894 | 1.946255 | 1.986613 | 2.02808 | 2.070704 | 2.114536 | 2.15963 | 2.206048 | 2.253853 | 2.303117 | 2.353917 | 2.406336 | 2.460465 | 2.516407 | 2.57427 | 2.634176 | 2.696259 | 2.760666 | 2.82756 | 2.897123 | 2.969555 | 3.045081 | 3.123952 | 3.20645 | 3.292891 | 3.383637 | 3.479096 | 3.57974 | 3.68611 | 3.798839 |
| 16 | 1.894206485 | 1.93315 | 1.973156 | 2.014268 | 2.056536 | 2.100011 | 2.14475 | 2.190814 | 2.238269 | 2.287188 | 2.337648 | 2.389734 | 2.44354 | 2.499168 | 2.556729 | 2.616346 | 2.678154 | 2.742302 | 2.808953 | 2.878289 | 2.950511 | 3.025843 | 3.104533 | 3.186861 | 3.273138 | 3.363717 | 3.458996 | 3.559429 | 3.665535 | 3.777914 |
| 15 | 1.881383967 | 1.919981 | 1.959637 | 2.000398 | 2.042312 | 2.085434 | 2.12982 | 2.175532 | 2.222638 | 2.271211 | 2.32133 | 2.373082 | 2.426561 | 2.481871 | 2.539124 | 2.598444 | 2.659967 | 2.723842 | 2.790234 | 2.859325 | 2.931316 | 3.006428 | 3.084909 | 3.167033 | 3.253107 | 3.343474 | 3.43852 | 3.538681 | 3.64445 | 3.756388 |
| 14 | 1.868483122 | 1.906736 | 1.946044 | 1.986455 | 2.028017 | 2.070786 | 2.114818 | 2.160178 | 2.206934 | 2.255159 | 2.304934 | 2.356347 | 2.409493 | 2.464477 | 2.521413 | 2.580424 | 2.641649 | 2.705237 | 2.771354 | 2.84018 | 2.911917 | 2.986785 | 3.065029 | 3.14692 | 3.232758 | 3.322879 | 3.417656 | 3.517505 | 3.622894 | 3.73435 |
| 13 | 1.855494035 | 1.893403 | 1.932364 | 1.972424 | 2.013634 | 2.056048 | 2.099726 | 2.144731 | 2.191132 | 2.239005 | 2.288431 | 2.339498 | 2.392302 | 2.44695 | 2.503557 | 2.562247 | 2.623158 | 2.686442 | 2.752263 | 2.820804 | 2.892265 | 2.966865 | 3.044847 | 3.126479 | 3.212056 | 3.301906 | 3.396391 | 3.495912 | 3.600913 | 3.711888 |
| 12 | 1.842407179 | 1.879971 | 1.918584 | 1.958292 | 1.999147 | 2.041204 | 2.084523 | 2.129169 | 2.17521 | 2.222724 | 2.271792 | 2.322504 | 2.374956 | 2.429256 | 2.485519 | 2.543872 | 2.604453 | 2.667413 | 2.732919 | 2.801152 | 2.872313 | 2.946621 | 3.024317 | 3.105667 | 3.190963 | 3.280527 | 3.374711 | 3.473907 | 3.578539 | 3.689078 |
| 11 | 1.829213491 | 1.866431 | 1.904692 | 1.944045 | 1.984541 | 2.026237 | 2.069192 | 2.113472 | 2.159146 | 2.206292 | 2.254993 | 2.305338 | 2.357425 | 2.411363 | 2.467266 | 2.525264 | 2.585494 | 2.648109 | 2.713276 | 2.781178 | 2.852015 | 2.926006 | 3.003393 | 3.08444 | 3.169438 | 3.258706 | 3.352592 | 3.45148 | 3.555786 | 3.665964 |
| 10 | 1.815904436 | 1.852772 | 1.890678 | 1.929672 | 1.969804 | 2.011132 | 2.053717 | 2.097622 | 2.14292 | 2.189688 | 2.238009 | 2.287974 | 2.339681 | 2.393239 | 2.448765 | 2.506386 | 2.566244 | 2.628491 | 2.693295 | 2.760839 | 2.831325 | 2.904973 | 2.982026 | 3.062749 | 3.147433 | 3.236398 | 3.329993 | 3.4286 | 3.532634 | 3.642545 |
| 9 | 1.802472077 | 1.838986 | 1.876532 | 1.915161 | 1.954923 | 1.995876 | 2.038081 | 2.081603 | 2.126513 | 2.172891 | 2.220818 | 2.270387 | 2.321697 | 2.374857 | 2.429984 | 2.487207 | 2.546668 | 2.60852 | 2.672932 | 2.74009 | 2.810196 | 2.883472 | 2.960164 | 3.040539 | 3.124891 | 3.213545 | 3.306854 | 3.405206 | 3.509024 | 3.618768 |
| 8 | 1.788909124 | 1.825063 | 1.862244 | 1.900501 | 1.939886 | 1.980455 | 2.02227 | 2.065397 | 2.109908 | 2.155881 | 2.203399 | 2.252556 | 2.303449 | 2.356189 | 2.410894 | 2.467694 | 2.526731 | 2.588159 | 2.652149 | 2.718888 | 2.788581 | 2.861453 | 2.937751 | 3.017749 | 3.101746 | 3.190073 | 3.283094 | 3.381209 | 3.484857 | 3.594521 |
| 7 | 1.775208994 | 1.810998 | 1.847807 | 1.885683 | 1.924681 | 1.964857 | 2.006272 | 2.048992 | 2.093089 | 2.138642 | 2.185734 | 2.234458 | 2.284914 | 2.337212 | 2.391469 | 2.447818 | 2.5064 | 2.567373 | 2.630907 | 2.697191 | 2.766433 | 2.838861 | 2.914728 | 2.994312 | 3.07792 | 3.165894 | 3.258611 | 3.356489 | 3.459992 | 3.569635 |
| 6 | 1.761365858 | 1.796783 | 1.833211 | 1.8707 | 1.909301 | 1.949072 | 1.990075 | 2.032374 | 2.076042 | 2.121158 | 2.167805 | 2.216076 | 2.266072 | 2.317901 | 2.371684 | 2.427551 | 2.485646 | 2.546127 | 2.609166 | 2.674955 | 2.743703 | 2.815643 | 2.891031 | 2.970155 | 3.053329 | 3.140908 | 3.233285 | 3.330902 | 3.434251 | 3.543889 |
| 5 | 1.74737468 | 1.782412 | 1.818451 | 1.855542 | 1.893737 | 1.933092 | 1.973668 | 2.015532 | 2.058755 | 2.103415 | 2.149597 | 2.197393 | 2.246903 | 2.298237 | 2.351515 | 2.406868 | 2.46444 | 2.52439 | 2.586892 | 2.652139 | 2.720344 | 2.791743 | 2.866598 | 2.945203 | 3.027883 | 3.115006 | 3.206984 | 3.304282 | 3.407428 | 3.517023 |
| 4 | 1.73323126 | 1.76788 | 1.803522 | 1.840205 | 1.877981 | 1.916907 | 1.957043 | 1.998456 | 2.041216 | 2.085402 | 2.131097 | 2.178394 | 2.227392 | 2.278202 | 2.330943 | 2.385746 | 2.442756 | 2.502133 | 2.564051 | 2.628706 | 2.696312 | 2.767109 | 2.841365 | 2.91938 | 3.00149 | 3.088075 | 3.179567 | 3.276454 | 3.379301 | 3.488753 |
| 3 | 1.718932269 | 1.753185 | 1.788419 | 1.824683 | 1.862029 | 1.900512 | 1.940194 | 1.981138 | 2.023417 | 2.067108 | 2.112294 | 2.159066 | 2.207525 | 2.25778 | 2.309949 | 2.364165 | 2.420572 | 2.47933 | 2.540613 | 2.604619 | 2.671564 | 2.741691 | 2.815272 | 2.892613 | 2.97406 | 3.060004 | 3.150893 | 3.247241 | 3.349641 | 3.458787 |
| 2 | 1.704475274 | 1.738322 | 1.773139 | 1.808973 | 1.845876 | 1.883902 | 1.923113 | 1.963573 | 2.005351 | 2.048525 | 2.093178 | 2.1394 | 2.187291 | 2.236958 | 2.288521 | 2.34211 | 2.397869 | 2.455958 | 2.516552 | 2.579848 | 2.646064 | 2.715445 | 2.788265 | 2.864836 | 2.94551 | 3.030687 | 3.120831 | 3.216473 | 3.318235 | 3.426844 |
| 1 | 1.689858762 | 1.72329 | 1.757679 | 1.793071 | 1.829518 | 1.867074 | 1.905798 | 1.945755 | 1.987013 | 2.029649 | 2.073745 | 2.119389 | 2.166681 | 2.215728 | 2.266646 | 2.319567 | 2.374632 | 2.432001 | 2.491847 | 2.554368 | 2.619782 | 2.688333 | 2.760299 | 2.835991 | 2.915767 | 3.000035 | 3.089265 | 3.184003 | 3.28489 | 3.392678 |
| 0 | 1.675082159 | 1.708089 | 1.742038 | 1.776977 | 1.812954 | 1.850025 | 1.888246 | 1.927682 | 1.9684 | 2.010475 | 2.053989 | 2.099028 | 2.145691 | 2.194082 | 2.244318 | 2.296528 | 2.350851 | 2.407445 | 2.466484 | 2.528162 | 2.592695 | 2.660328 | 2.731337 | 2.806034 | 2.884776 | 2.967974 | 3.056102 | 3.149712 | 3.249452 | 3.35609 |

| Y/X | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | | 29.40526 | 17.57016 | 13.11647 | 10.77231 | 9.355937 | 8.445568 | 7.852759 | 7.482224 | 7.283243 | 7.230178 | 7.31448 | 7.542527 | 7.937891 | 8.549429 | 9.470836 | 10.88927 | 13.2255 | 17.66029 | 29.4637 | | 29.44259 | 17.58888 | 13.07899 | 10.64359 | 9.100928 | 8.027793 | 7.233033 | 6.617109 | 6.122921 | 5.715338 |
| 59 | 29.39447 | 22.69849 | 16.19532 | 12.64465 | 10.5668 | 9.256748 | 8.3977 | 7.832944 | 7.47885 | 7.289462 | 7.241055 | 7.325514 | 7.548504 | 7.931422 | 8.518139 | 9.390544 | 10.70404 | 12.77468 | 16.30757 | 22.78524 | 29.46573 | 22.75807 | 16.23057 | 12.62368 | 10.45531 | 9.019418 | 7.997644 | 7.23071 | 6.631043 | 6.146771 | 5.745327 |
| 58 | 17.53041 | 16.17166 | 13.66008 | 11.53961 | 10.01784 | 8.957362 | 8.224266 | 7.728465 | 7.413551 | 7.245527 | 7.205794 | 7.287599 | 7.495009 | 7.844092 | 8.366627 | 9.117277 | 10.18509 | 11.70399 | 13.81336 | 16.31159 | 17.66738 | 16.27413 | 13.72366 | 11.5414 | 9.927379 | 8.740861 | 7.845619 | 7.148989 | 6.591056 | 6.132735 | 5.747923 |
| 57 | 13.02843 | 12.57798 | 11.49969 | 10.32574 | 9.320743 | 8.539975 | 7.963928 | 7.55949 | 7.298169 | 7.159673 | 7.131698 | 7.209264 | 7.394486 | 7.696992 | 8.134791 | 8.734727 | 9.529211 | 10.53847 | 11.71013 | 12.78543 | 13.24037 | 12.73869 | 11.60664 | 10.36194 | 9.260223 | 8.351699 | 7.613676 | 7.010353 | 6.510207 | 6.088908 | 5.728411 |
| 56 | 10.61428 | 10.43479 | 9.916749 | 9.261771 | 8.625953 | 8.084575 | 7.659947 | 7.350717 | 7.148106 | 7.043014 | 7.028747 | 7.10198 | 7.263045 | 7.515865 | 7.867238 | 8.324389 | 8.888215 | 9.537471 | 10.19986 | 10.72418 | 10.91448 | 10.67015 | 10.08465 | 9.348482 | 8.609207 | 7.936424 | 7.348733 | 6.84206 | 6.405115 | 6.025876 | 5.693789 |
| 55 | 9.103359 | 9.034259 | 8.770331 | 8.398746 | 8.004353 | 7.6441 | 7.347225 | 7.124893 | 6.978973 | 6.907571 | 6.908002 | 6.978183 | 7.117122 | 7.324676 | 7.600415 | 7.94095 | 8.334731 | 8.753573 | 9.143167 | 9.422575 | 9.508763 | 9.363442 | 9.019609 | 8.555801 | 8.049462 | 7.552061 | 7.089108 | 6.669226 | 6.292349 | 5.954761 | 5.651669 |
| 54 | 8.070466 | 8.056357 | 7.9233 | 7.713767 | 7.474866 | 7.244737 | 7.048362 | 6.899483 | 6.80429 | 6.764632 | 6.780184 | 6.849648 | 6.971209 | 7.142323 | 7.358772 | 7.612785 | 7.890107 | 8.166529 | 8.405978 | 8.56433 | 8.602202 | 8.50226 | 8.277813 | 7.964607 | 7.603656 | 7.228337 | 6.86032 | 6.511245 | 6.186021 | 5.885685 | 5.609304 |
| 53 | 7.322964 | 7.340464 | 7.281999 | 7.170463 | 7.033252 | 6.895292 | 6.775469 | 6.686183 | 6.634512 | 6.623755 | 6.65471 | 6.726496 | 6.836889 | 6.982197 | 7.156673 | 7.351478 | 7.553383 | 7.743753 | 7.898977 | 7.993723 | 8.007311 | 7.930739 | 7.769884 | 7.542483 | 7.271209 | 6.977254 | 6.676969 | 6.381323 | 6.096845 | 5.826923 | 5.572932 |
| 52 | 6.760128 | 6.797887 | 6.785575 | 6.736631 | 6.667817 | 6.595574 | 6.533596 | 6.491912 | 6.476997 | 6.492362 | 6.539186 | 6.616782 | 6.722805 | 6.853194 | 7.001874 | 7.160315 | 7.317131 | 7.458105 | 7.567128 | 7.628447 | 7.629961 | 7.566357 | 7.44046 | 7.26198 | 7.044424 | 6.801805 | 6.546366 | 6.2876 | 6.032229 | 5.784637 | 5.547441 |
| 51 | 6.323876 | 6.375796 | 6.394082 | 6.387221 | 6.366002 | 6.34152 | 6.323639 | 6.320129 | 6.336425 | 6.375735 | 6.439274 | 6.526471 | 6.635055 | 6.761016 | 6.898466 | 7.039504 | 7.174233 | 7.291161 | 7.378167 | 7.424105 | 7.420748 | 7.364446 | 7.256809 | 7.104078 | 6.915506 | 6.701433 | 6.471694 | 6.234653 | 5.996837 | 5.762982 | 5.536286 |
| 50 | 5.97822 | 6.040769 | 6.080605 | 6.103451 | 6.116606 | 6.12781 | 6.144262 | 6.17195 | 6.215324 | 6.277195 | 6.358748 | 6.459572 | 6.577638 | 6.709217 | 6.848762 | 6.988854 | 7.12033 | 7.232764 | 7.315419 | 7.35864 | 7.355416 | 7.302658 | 7.201707 | 7.05787 | 6.879192 | 6.674912 | 6.454096 | 6.224711 | 5.993184 | 5.764329 | 5.541515 |
| 49 | 5.699595 | 5.770606 | 5.826461 | 5.871273 | 5.910247 | 5.949015 | 5.993 | 6.046929 | 6.114525 | 6.198331 | 6.299618 | 6.41829 | 6.552769 | 6.699805 | 6.854261 | 7.008933 | 7.154545 | 7.280144 | 7.374076 | 7.425586 | 7.426767 | 7.374228 | 7.269772 | 7.119783 | 6.933611 | 6.721659 | 6.4938 | 6.258421 | 6.022062 | 5.789466 | 5.563839 |
| 48 | 5.471861 | 5.54993 | 5.618281 | 5.680057 | 5.739198 | 5.800024 | 5.866833 | 5.943556 | 6.033507 | 6.139204 | 6.262233 | 6.403086 | 6.560955 | 6.733395 | 6.915888 | 7.101323 | 7.279573 | 7.437523 | 7.560016 | 7.632109 | 7.642374 | 7.586037 | 7.466329 | 7.293241 | 7.08046 | 6.842106 | 6.590477 | 6.335098 | 6.082703 | 5.837685 | 5.602672 |
| 47 | 5.283543 | 5.367711 | 5.446208 | 5.521602 | 5.597068 | 5.676143 | 5.762466 | 5.859558 | 5.97064 | 6.098493 | 6.24533 | 6.412625 | 6.600833 | 6.808917 | 7.033585 | 7.268191 | 7.501431 | 7.716358 | 7.890837 | 8.000824 | 8.026734 | 7.960441 | 7.808462 | 7.588951 | 7.32481 | 7.037334 | 6.742909 | 6.452506 | 6.17265 | 5.906727 | 5.656119 |
| 46 | 5.126217 | 5.215775 | 5.302772 | 5.389437 | 5.478506 | 5.573078 | 5.676472 | 5.792099 | 5.923369 | 6.073619 | 6.246052 | 6.443619 | 6.668762 | 6.922865 | 7.205185 | 7.510966 | 7.828565 | 8.136063 | 8.399437 | 8.576415 | 8.629241 | 8.541896 | 8.328612 | 8.025656 | 7.67425 | 7.307792 | 6.947899 | 6.606141 | 6.287378 | 5.992623 | 5.720946 |
| 45 | 4.993532 | 5.087904 | 5.182162 | 5.278348 | 5.378962 | 5.486897 | 5.605381 | 5.737936 | 5.888383 | 6.06088 | 6.259974 | 6.490652 | 6.758258 | 7.068103 | 7.424357 | 7.827495 | 8.269251 | 8.724327 | 9.141068 | 9.44106 | 9.54362 | 9.412393 | 9.081638 | 8.630442 | 8.136292 | 7.650467 | 7.198244 | 6.788062 | 6.419739 | 6.089507 | 5.792577 |
| 44 | 4.880585 | 4.979258 | 5.079767 | 5.184062 | 5.294534 | 5.414011 | 5.545768 | 5.693583 | 5.861833 | 6.055667 | 6.281261 | 6.546136 | 6.8595 | 7.232443 | 7.677539 | 8.206698 | 8.824712 | 9.513744 | 10.20473 | 10.74982 | 10.95642 | 10.72684 | 10.1562 | 9.435359 | 8.711469 | 8.05354 | 7.479677 | 6.985475 | 6.559463 | 6.189557 | 5.865214 |
| 43 | 4.783531 | 4.886005 | 4.991876 | 5.10305 | 5.221874 | 5.351184 | 5.494373 | 5.655522 | 5.839603 | 6.052809 | 6.303041 | 6.600616 | 6.959287 | 7.39759 | 7.940425 | 8.620047 | 9.473245 | 10.52402 | 11.72367 | 12.81765 | 13.28701 | 12.80009 | 11.68521 | 10.45957 | 9.377442 | 8.487861 | 7.767358 | 7.179689 | 6.693127 | 6.283293 | 5.932196 |
| 42 | 4.699317 | 4.805089 | 4.915489 | 5.032398 | 5.158144 | 5.295586 | 5.448232 | 5.620433 | 5.817682 | 6.047088 | 6.318104 | 6.643671 | 7.042035 | 7.539687 | 8.176211 | 9.012227 | 10.14145 | 11.7017 | 13.83609 | 16.34788 | 17.71361 | 16.33534 | 13.80644 | 11.64902 | 10.06021 | 8.897634 | 8.024155 | 7.346679 | 6.805135 | 6.360459 | 5.986674 |
| 41 | 4.625509 | 4.734064 | 4.848192 | 4.96974 | 5.101008 | 5.244851 | 5.404832 | 5.585463 | 5.79257 | 6.033873 | 6.319898 | 6.665468 | 7.092201 | 7.632916 | 8.339846 | 9.301124 | 10.67691 | 12.78698 | 16.33964 | 22.82128 | 29.50178 | 22.81311 | 16.31681 | 12.74318 | 10.60688 | 9.200482 | 8.20494 | 7.4607 | 6.880157 | 6.411565 | 6.02258 |
| 40 | 4.56017 | 4.670993 | 4.788074 | 4.913206 | 5.048629 | 5.197136 | 5.362247 | 5.548469 | 5.761686 | 6.009786 | 6.303638 | 6.65872 | 7.097888 | 7.656379 | 8.39151 | 9.403227 | 10.88337 | 13.25625 | 17.70515 | 29.50127 | | 29.49552 | 17.68599 | 13.21786 | 10.82101 | 9.312968 | 8.270116 | 7.501177 | 6.906697 | 6.429812 | 6.03571 |
| 39 | 4.501772 | 4.614362 | 4.733664 | 4.86139 | 4.99967 | 5.151165 | 5.319234 | 5.508188 | 5.723663 | 5.973212 | 6.267221 | 6.620397 | 7.054273 | 7.601604 | 8.314584 | 9.281321 | 10.66196 | 12.77626 | 16.33252 | 22.81701 | 29.49904 | 22.81025 | 16.31363 | 12.74007 | 10.60416 | 9.198374 | 8.203585 | 7.460174 | 6.880491 | 6.412754 | 6.024597 |
| 38 | 4.449127 | 4.56302 | 4.683881 | 4.813305 | 4.953269 | 5.106226 | 5.275262 | 5.464309 | 5.678472 | 5.924516 | 6.211602 | 6.552441 | 6.965101 | 7.475949 | 8.124479 | 8.971253 | 10.10993 | 11.67828 | 13.8193 | 16.33597 | 17.70454 | 16.32738 | 13.79901 | 11.64229 | 10.05456 | 8.893372 | 8.021489 | 7.345723 | 6.805925 | 6.362973 | 5.99085 |
| 37 | 4.401328 | 4.516124 | 4.637975 | 4.768339 | 4.908995 | 5.062131 | 5.230466 | 5.417414 | 5.627335 | 5.865882 | 6.140504 | 6.461166 | 6.841349 | 7.299401 | 7.86009 | 8.555578 | 9.422577 | 10.485 | 11.69403 | 12.79499 | 13.26902 | 12.78502 | 11.67222 | 10.44855 | 9.368589 | 8.481418 | 7.763503 | 7.17851 | 6.694627 | 6.287408 | 5.938812 |
| 36 | 4.357702 | 4.473077 | 4.595474 | 4.726188 | 4.866778 | 5.019129 | 5.185534 | 5.368809 | 5.572454 | 5.800861 | 6.059579 | 6.355644 | 6.697908 | 7.09722 | 7.565993 | 8.116041 | 8.752095 | 9.456276 | 10.15952 | 10.71406 | 10.92765 | 10.70322 | 10.13668 | 9.419515 | 8.699246 | 8.045003 | 7.474881 | 6.984417 | 6.562071 | 6.195694 | 5.874698 |
| 35 | 4.317756 | 4.433485 | 4.556118 | 4.686788 | 4.826822 | 4.977787 | 5.141538 | 5.320276 | 5.516631 | 5.733741 | 5.975344 | 6.245808 | 6.55005 | 6.893106 | 7.278996 | 7.708137 | 8.172274 | 8.646181 | 9.078359 | 9.390682 | 9.502941 | 9.379426 | 9.055089 | 8.609591 | 8.120783 | 7.640123 | 7.192933 | 6.787635 | 6.424008 | 6.098239 | 5.805502 |
| 34 | 4.281134 | 4.397092 | 4.519802 | 4.650234 | 4.789498 | 4.938858 | 5.099753 | 5.273812 | 5.462866 | 5.668942 | 5.894224 | 6.140927 | 6.411012 | 6.705594 | 7.023831 | 7.360997 | 7.705585 | 8.035897 | 8.318234 | 8.510764 | 8.576294 | 8.499451 | 8.295103 | 8.000046 | 7.655871 | 7.296187 | 6.942711 | 6.607041 | 6.294032 | 6.004678 | 5.738031 |
| 33 | 4.247572 | 4.363737 | 4.486504 | 4.616702 | 4.755248 | 4.903145 | 5.061471 | 5.23137 | 5.414008 | 5.610516 | 5.821872 | 6.048712 | 6.290994 | 6.547463 | 6.81483 | 7.086617 | 7.351816 | 7.593877 | 7.791152 | 7.920166 | 7.961968 | 7.909085 | 7.768645 | 7.559307 | 7.304348 | 7.025311 | 6.738722 | 6.455627 | 6.182583 | 5.922988 | 5.678224 |
| 32 | 4.216861 | 4.333302 | 4.456234 | 4.586376 | 4.724491 | 4.871379 | 5.027842 | 5.194653 | 5.372486 | 5.56182 | 5.762797 | 5.975003 | 6.197167 | 6.426741 | 6.659367 | 6.888287 | 7.103868 | 7.293583 | 7.44293 | 7.537664 | 7.567067 | 7.527045 | 7.421443 | 7.260761 | 7.059082 | 6.830802 | 6.588405 | 6.341529 | 6.096978 | 5.859183 | 5.630795 |
| 31 | 4.188813 | 4.305672 | 4.428981 | 4.559381 | 4.697539 | 4.844118 | 4.999745 | 5.164958 | 5.340125 | 5.525332 | 5.720225 | 5.923803 | 6.134142 | 6.348077 | 6.560858 | 6.765873 | 6.954573 | 7.116811 | 7.241772 | 7.319541 | 7.343019 | 7.309559 | 7.221616 | 7.086115 | 6.912832 | 6.712486 | 6.495172 | 6.269429 | 6.041893 | 5.81737 | 5.599106 |
| 30 | 4.16323 | 4.280702 | 4.404669 | 4.535739 | 4.674536 | 4.82167 | 4.977698 | 5.14307 | 5.31804 | 5.502555 | 5.69609 | 5.897446 | 6.104492 | 6.313874 | 6.520748 | 6.718588 | 6.899238 | 7.053322 | 7.171158 | 7.244103 | 7.266093 | 7.234889 | 7.152564 | 7.025033 | 6.860813 | 6.669501 | 6.460419 | 6.24171 | 6.019916 | 5.799929 | 5.585168 |
| 29 | 4.139891 | 4.258194 | 4.383133 | 4.515328 | 4.655419 | 4.804044 | 4.961801 | 5.129198 | 5.306574 | 5.493985 | 5.691051 | 5.896742 | 6.109112 | 6.324975 | 6.53956 | 6.746239 | 6.936454 | 7.100048 | 7.226202 | 7.305005 | 7.329365 | 7.29665 | 7.209332 | 7.074357 | 6.901522 | 6.701564 | 6.484594 | 6.259164 | 6.03192 | 5.807675 | 5.589679 |
| 28 | 4.118531 | 4.237882 | 4.364103 | 4.497868 | 4.639894 | 4.790923 | 4.951703 | 5.122946 | 5.305266 | 5.499087 | 5.704492 | 5.921016 | 6.14734 | 6.38087 | 6.617208 | 6.84956 | 7.068262 | 7.260761 | 7.412543 | 7.509359 | 7.540506 | 7.501921 | 7.397493 | 7.237775 | 7.036899 | 6.809308 | 6.567524 | 6.321212 | 6.077193 | 5.839915 | 5.612034 |
| 27 | 4.098847 | 4.219428 | 4.347199 | 4.482922 | 4.627439 | 4.781672 | 4.946613 | 5.123316 | 5.312858 | 5.516284 | 5.734489 | 5.968029 | 6.216789 | 6.479443 | 6.752637 | 7.029827 | 7.299943 | 7.546376 | 7.747433 | 7.879616 | 7.923985 | 7.873123 | 7.734245 | 7.526121 | 7.272133 | 6.993915 | 6.708058 | 6.425656 | 6.15329 | 5.894375 | 5.650301 |
| 26 | 4.080492 | 4.202433 | 4.331944 | 4.469906 | 4.617327 | 4.775362 | 4.945333 | 5.128749 | 5.327321 | 5.542963 | 5.777748 | 6.033786 | 6.312939 | 6.616227 | 6.942711 | 7.287564 | 7.639167 | 7.975704 | 8.263364 | 8.460231 | 8.529101 | 8.454686 | 8.252027 | 7.958134 | 7.614806 | 7.25581 | 6.902971 | 6.567949 | 6.25563 | 5.96702 | 5.701171 |
| 25 | 4.063094 | 4.18645 | 4.317789 | 4.458128 | 4.608668 | 4.770834 | 4.94633 | 5.137208 | 5.345945 | 5.575539 | 5.829587 | 6.112334 | 6.428572 | 6.78322 | 7.18017 | 7.6197 | 8.09338 | 8.575773 | 9.015141 | 9.333143 | 9.449469 | 9.328529 | 9.005605 | 8.560778 | 8.07228 | 7.591833 | 7.144912 | 6.740013 | 6.376935 | 6.051861 | 5.759948 |
| 24 | 4.046267 | 4.171007 | 4.304144 | 4.446834 | 4.600476 | 4.766779 | 4.947849 | 5.146317 | 5.365501 | 5.609616 | 5.884052 | 6.195694 | 6.553257 | 6.967453 | 7.450553 | 8.014198 | 8.662886 | 9.378413 | 10.09127 | 10.65319 | 10.87158 | 10.64948 | 10.08344 | 9.365817 | 8.644779 | 7.989861 | 7.419343 | 6.928816 | 6.506728 | 6.140891 | 5.820669 |
| 23 | 4.029634 | 4.155639 | 4.290418 | 4.435259 | 4.591744 | 4.761847 | 4.948056 | 5.15356 | 5.382496 | 5.640311 | 5.934264 | 6.274154 | 6.673312 | 7.149946 | 7.728683 | 8.441513 | 9.324895 | 10.40233 | 11.62432 | 12.73514 | 13.21485 | 12.73228 | 11.61807 | 10.39189 | 9.309428 | 8.420268 | 7.701017 | 7.115324 | 6.631294 | 6.224385 | 5.876464 |
| 22 | 4.012848 | 4.139913 | 4.276064 | 4.422693 | 4.581534 | 4.754774 | 4.945219 | 5.156524 | 5.393524 | 5.662739 | 5.97311 | 6.33716 | 6.772801 | 7.306267 | 7.976935 | 8.845239 | 10.00466 | 11.5926 | 13.75131 | 16.28201 | 17.65786 | 16.27995 | 13.74645 | 11.58398 | 9.991386 | 8.826575 | 7.952261 | 7.275078 | 6.734688 | 6.291795 | 5.920236 |
| 21 | 3.995609 | 4.123463 | 4.260621 | 4.408542 | 4.569059 | 4.744501 | 4.937884 | 5.153171 | 5.395675 | 5.672648 | 5.994216 | 6.374874 | 6.835984 | 7.410177 | 8.149562 | 9.14219 | 10.54816 | 12.68715 | 16.26717 | 22.7732 | 29.46732 | 22.77184 | 16.26338 | 12.67989 | 10.53656 | 9.125551 | 8.127307 | 7.381838 | 6.801183 | 6.333309 | 5.945648 |
| 20 | 3.977685 | 4.106012 | 4.243748 | 4.392376 | 4.553762 | 4.730286 | 4.925038 | 5.142093 | 5.386929 | 5.667065 | 5.993056 | 6.380123 | 6.850926 | 7.440569 | 8.206294 | 9.248027 | 10.75765 | 13.1596 | 17.63745 | 29.46328 | | 29.46231 | 17.63422 | 13.15314 | 10.74717 | 9.232855 | 8.185907 | 7.414533 | 6.818889 | 6.341804 | 5.94823 |
| 19 | 3.958923 | 4.087388 | 4.225248 | 4.373962 | 4.535363 | 4.711781 | 4.906233 | 5.122687 | 5.366456 | 5.644798 | 5.967847 | 6.350105 | 6.812944 | 7.38901 | 8.130424 | 9.125252 | 10.53361 | 12.67517 | 16.25794 | 22.76669 | 29.46237 | 22.76554 | 16.25472 | 12.66899 | 10.52372 | 9.111055 | 8.111423 | 7.3648 | 6.783193 | 6.314544 | 5.926263 |
| 18 | 3.939249 | 4.067531 | 4.205078 | 4.353284 | 4.513882 | 4.68906 | 4.881625 | 5.095235 | 5.334732 | 5.60664 | 5.919912 | 6.287082 | 6.726076 | 7.263141 | 7.937668 | 8.810088 | 9.973857 | 11.5663 | 13.7294 | 16.26376 | 17.64128 | 16.26226 | 13.72587 | 11.56003 | 9.964204 | 8.796498 | 7.919679 | 7.240374 | 6.698216 | 6.253874 | 5.881148 |
| 17 | 3.918671 | 4.046485 | 4.183343 | 4.330528 | 4.489623 | 4.662598 | 4.851943 | 5.060845 | 5.293446 | 5.555197 | 5.853364 | 6.197751 | 6.601697 | 7.08341 | 7.667505 | 8.385927 | 9.275035 | 10.35811 | 11.58523 | 12.69994 | 13.18144 | 12.69817 | 11.58136 | 10.35164 | 9.265433 | 8.372719 | 7.650276 | 7.06181 | 6.575431 | 6.166575 | 5.817075 |
| 16 | 3.89726 | 4.024391 | 4.160271 | 4.306053 | 4.463131 | 4.633208 | 4.818384 | 5.021287 | 5.245228 | 5.49442 | 5.774247 | 6.09159 | 6.455152 | 6.87562 | 7.365213 | 7.935478 | 8.590737 | 9.312486 | 10.03075 | 10.59664 | 10.817 | 10.59468 | 10.02661 | 9.305819 | 8.581138 | 7.922553 | 7.348604 | 6.855011 | 6.430272 | 6.062207 | 5.740165 |
| 15 | 3.875142 | 4.001452 | 4.136182 | 4.280342 | 4.43512 | 4.601929 | 4.78246 | 4.978749 | 5.19326 | 5.428969 | 5.689456 | 5.978938 | 6.30217 | 6.664016 | 7.06828 | 7.515099 | 7.995828 | 8.48471 | 8.929584 | 9.251638 | 9.370189 | 9.249556 | 8.925278 | 8.47793 | 7.986271 | 7.502451 | 7.052239 | 6.644306 | 6.278545 | 5.95118 | 5.657379 |
| 14 | 3.852465 | 3.97791 | 4.111447 | 4.253942 | 4.406385 | 4.56991 | 4.745813 | 4.935575 | 5.140876 | 5.363594 | 5.605761 | 5.869436 | 6.156416 | 6.467634 | 6.802034 | 7.15462 | 7.513547 | 7.856706 | 8.149935 | 8.350978 | 8.422389 | 8.348839 | 8.145559 | 7.849915 | 7.504114 | 7.142296 | 6.78657 | 6.448792 | 6.133975 | 5.843196 | 5.575544 |
| 13 | 3.829385 | 3.95401 | 4.086434 | 4.227399 | 4.377719 | 4.538282 | 4.710042 | 4.894009 | 5.091212 | 5.302638 | 5.529118 | 5.771131 | 6.028469 | 6.299694 | 6.581308 | 6.866592 | 7.144257 | 7.39744 | 7.604179 | 7.740734 | 7.788016 | 7.738593 | 7.599825 | 7.390745 | 7.135047 | 6.854671 | 6.566469 | 6.281732 | 6.007186 | 5.746344 | 5.500658 |
| 12 | 3.806035 | 3.929966 | 4.061473 | 4.201198 | 4.349821 | 4.508038 | 4.676546 | 4.855995 | 5.046931 | 5.2497 | 5.464296 | 5.690152 | 5.92583 | 6.168599 | 6.413903 | 6.654768 | 6.881326 | 7.080812 | 7.238505 | 7.339991 | 7.374471 | 7.337893 | 7.234256 | 7.074314 | 6.872443 | 6.643339 | 6.399755 | 6.151551 | 5.905706 | 5.666782 | 5.437521 |
| 11 | 3.782503 | 3.905931 | 4.036804 | 4.175705 | 4.323225 | 4.479946 | 4.646398 | 4.823014 | 5.010044 | 5.207447 | 5.414729 | 5.630737 | 5.853382 | 6.079317 | 6.303602 | 6.519419 | 6.718017 | 6.88905 | 7.021533 | 7.105432 | 7.133599 | 7.103417 | 7.017461 | 6.88284 | 6.709556 | 6.508571 | 6.290213 | 6.063228 | 5.83443 | 5.608765 | 5.389587 |
| 10 | 3.758819 | 3.881973 | 4.012554 | 4.151123 | 4.298246 | 4.454466 | 4.620259 | 4.795985 | 4.981795 | 5.177519 | 5.382501 | 5.595397 | 5.81391 | 6.03451 | 6.252157 | 6.460123 | 6.650046 | 6.81236 | 6.937218 | 7.015863 | 7.042182 | 7.013964 | 6.933383 | 6.806517 | 6.642092 | 6.449935 | 6.239594 | 6.019423 | 5.796147 | 5.57481 | 5.358948 |
| 9 | 3.734936 | 3.85806 | 3.988707 | 4.127466 | 4.274937 | 4.431707 | 4.598313 | 4.775192 | 4.962597 | 5.160483 | 5.368355 | 5.585046 | 5.808454 | 6.03521 | 6.260343 | 6.477004 | 6.676399 | 6.84814 | 6.981202 | 7.065515 | 7.093908 | 7.063759 | 6.977653 | 6.842727 | 6.669021 | 6.46754 | 6.248657 | 6.021157 | 5.791889 | 5.565827 | 5.346345 |
| 8 | 3.710727 | 3.834047 | 3.965099 | 4.104543 | 4.253073 | 4.411404 | 4.580243 | 4.760256 | 4.951995 | 5.155806 | 5.371679 | 5.599032 | 5.836397 | 6.081005 | 6.328238 | 6.571046 | 6.799467 | 7.000627 | 7.159692 | 7.262148 | 7.297128 | 7.260556 | 7.156468 | 6.995692 | 6.792716 | 6.562351 | 6.317461 | 6.068003 | 5.821027 | 5.581154 | 5.351164 |
| 7 | 3.685987 | 3.809682 | 3.941416 | 4.08196 | 4.232155 | 4.392918 | 4.565232 | 4.750131 | 4.948662 | 5.161826 | 5.390458 | 5.635023 | 5.895284 | 6.169747 | 6.454824 | 6.743667 | 7.02481 | 7.281169 | 7.490533 | 7.628925 | 7.677081 | 7.627512 | 7.487659 | 7.276744 | 7.018715 | 6.735764 | 6.444968 | 6.157791 | 5.881086 | 5.618447 | 5.371376 |
| 6 | 3.660441 | 3.784615 | 3.917211 | 4.059138 | 4.211431 | 4.37527 | 4.551997 | 4.74314 | 4.95042 | 5.175752 | 5.421191 | 5.688804 | 5.98037 | 6.296766 | 6.636821 | 6.995352 | 7.360224 | 7.708927 | 8.006806 | 8.21109 | 8.283933 | 8.209865 | 8.004297 | 7.705027 | 7.354794 | 6.988241 | 6.627872 | 6.285829 | 5.967301 | 5.67347 | 5.403469 |
| 5 | 3.633756 | 3.758418 | 3.891927 | 4.035351 | 4.189946 | 4.357194 | 4.53886 | 4.737057 | 4.954323 | 5.19371 | 5.45886 | 5.754038 | 6.084016 | 6.453626 | 6.866558 | 7.322715 | 7.813034 | 8.311109 | 8.763873 | 9.09147 | 9.212331 | 9.090437 | 8.761732 | 8.307729 | 7.808257 | 7.316369 | 6.858478 | 6.443655 | 6.072012 | 5.739869 | 5.442409 |
| 4 | 3.605565 | 3.730614 | 3.864939 | 4.009775 | 4.166604 | 4.337229 | 4.523862 | 4.729244 | 4.956811 | 5.210903 | 5.497027 | 5.822175 | 6.195136 | 6.626626 | 7.128802 | 7.712978 | 8.382972 | 9.119353 | 9.850643 | 10.42594 | 10.65008 | 10.42509 | 9.848863 | 9.116474 | 8.37881 | 7.707346 | 7.121526 | 6.617548 | 6.184112 | 5.809079 | 5.481745 |
| 3 | 3.575488 | 3.700708 | 3.835597 | 3.981545 | 4.140253 | 4.313827 | 4.504907 | 4.716848 | 4.953973 | 5.221927 | 5.52818 | 5.882738 | 6.299127 | 6.795699 | 7.397123 | 8.135223 | 9.045907 | 10.1514 | 11.39962 | 12.53043 | 13.01842 | 12.52977 | 11.39818 | 10.14898 | 9.042299 | 8.130228 | 7.390563 | 6.787417 | 6.288982 | 5.870608 | 5.513957 |
| 2 | 3.543164 | 3.668224 | 3.803271 | 3.949827 | 4.109776 | 4.285482 | 4.479948 | 4.697056 | 4.941897 | 5.22127 | 5.544425 | 5.924209 | 6.378866 | 6.934946 | 7.632084 | 8.530837 | 9.724513 | 11.34969 | 13.54619 | 16.10896 | 17.49886 | 16.10848 | 13.54505 | 11.34767 | 9.721371 | 8.526378 | 7.626132 | 6.927347 | 6.369485 | 5.912929 | 5.531142 |
| 1 | 3.508268 | 3.632738 | 3.767404 | 3.913881 | 4.074187 | 4.250864 | 4.447177 | 4.667376 | 4.917095 | 5.203954 | 5.538482 | 5.935615 | 6.417186 | 7.016313 | 7.785592 | 8.813527 | 10.26059 | 12.44662 | 16.07908 | 22.63891 | 29.36385 | 22.63859 | 16.07819 | 12.44489 | 10.2578 | 8.809485 | 7.780126 | 7.009276 | 6.408448 | 5.925064 | 5.526019 |
| 0 | 3.470541 | 3.593912 | 3.727552 | 3.873125 | 4.03271 | 4.208941 | 4.405199 | 4.625901 | 4.876918 | 5.166211 | 5.504828 | 5.908533 | 6.400571 | 7.016666 | 7.814699 | 8.895259 | 10.45093 | 12.90696 | 17.44825 | 29.35001 | | 29.34978 | 17.44748 | 12.9054 | 10.44836 | 8.891505 | 7.809595 | 7.010069 | 6.392358 | 5.898594 | 5.493068 |

# ANNEXURE 04

## Responses for Public Comments

University of Moratuwa

Centre for Environmental Justice

Environmental Foundation Limited

D M K J Dassanayake

G B Gunadasa

B H T Kulasekera

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 1 | **University of Moratuwa** | | |
| 1 | 1. **Inequitable share of right-of way and poor walkability**<br>8.1 From a land use planning perspective, one objective of development is to create great places for walking, for commerce and living. In the segments of wider right-of-way (Wider-street and wider walkways areas, the proposed LRT could have minor impacts but the street width is not sufficient for this nature of development in most of the B Class road segments (Palam Thuna Junction to Koswatta, Rajagiriya HSBC area etc.) so pedestrians may feel compact and entrapped. due to this pedestrian may not have a great walking experience. | It is our concern too. It shall be addressed during detail design stage. Further the width of pedestrian walkways will comply the drawing provided by the RDA. The particular impact identified in Chapter 4.2 of EIA Report under traffic impact and proposed mitigation measures. Further this aspect will also be considered during detail design stage. | For more clarity please refer typical cross section provided by RDA in annex A, EIA Report. Chapter 4.2 of Traffic impact and Landscape impact of chapter 4.3 table 4.3.1 |
| 2 | 8.2 In the location of Rajagiriya Flyover, does it propose to eat up pedestrian space? where there is a large pedestrian gathering? | Most appropriate design will be done to minimize the inconvenience to public. The pedestrian space shall be kept throughout the section. | |
| 3 | 8.3 In such locations, we would recommend to allocate more space for pedestrian ways. | This is also one of our major concerns. It shall be addressed promptly during detailed design stage. | See conceptual station design image in Figure 2.8 |
| 4 | 8.4 Need to ensure walkability, and pedestrian and disability access in and around the deport areas during the operation stage without any social impacts. | A barrier free workshop conducted by the project to integrate the matters during detail design of the structures. It should also be noted that, no any requirement of entering general public to the Depot area and ensured the walkability and disability access at each Station | For more clarity, please refer Appendix 11 - feasibility report found in www.clr.lk |
| 5 | 2. **Lack of concerns on visual impact**<br>2.1 The proposed LRT will block the sensitive views (Diyawanna Lake, the Ceremonial approach in Rajagiriya area etc...) | Sensitive locations will be thoroughly studied in terms of landscape impact during detail design stage in consultation with concerned agencies. Micro level detailing, structures, colors, lighting, planting, trains design and colors like | Chapter 5.3.1 of mitigation measures of landscape and aesthetic degradation |
| 6 | 2.2 Further, proposed LRT will reduce the importance and the visibility of the ceremonial approach in Rajagiriya area as LRT is located on the middle of the road. The Kotte-Sri Jayawardanepura City Plan, the only of its kind in late history and the Sri Lanka's worldly known New National Capital : The ceremonial approach- Sri Jayawardenapura Ceremonial Drive - that will be totally disrupted by ugly concrete structures at its center median and LRT stations shading upon it at several locations. | The particular section has considered with other alternatives and found this is the most appropriate route. Further it has been confirmed with Ministry, and UDA planning committee has given their concern and no objection obtained from relevant authorities. However during detail design the section will be considered to reduce landscape impact. | Chapter 4.3.2, Section 6& 7 in EIA Report and Chapter 3.6.2 D and Table 3.6.8 in Feasibility Report |
| 7 | 2.3 Most of these impacts could be minimized if the proposed transport route moves underground, if other conditions meet. Therefore, the visual impact management plan should be justified with cost-benefit analysis of multi-model alternatives (such as metro, light rail) | The feasibility study has analyzed all three level and found the underground construction cost would be very high (3 times more than elevated option) and less technical familiarity. | For more clarity, please refer Chapter 2.2.2 structure alternative analysis and Table 2.8 of EIA Report |
| 8 | 3. **Lack of technical clarity in the Cost benefit Assessment**<br>3.1 ECBA (ENPV and EIRR) suggest the feasibility of the operation and the project is worth to go ahead. | | |
| 9 | 3.2 It is hard to make precise comments on extended CBA, because annexes on detail calculations not available.Costs of this operation surely embrace in benefits, however, in real terms the benefits are much more if real environmental values are included in the benefits. For example the benefits of CO2 reduction and the reduction of health cost. | The results shows CO2 emission reduction in year 2035 is estimated to be 77,184 t-CO2/y. Savings of accident cost calculated as 12.9 Billion LKR | Annex P of EIA Report and feasibility report (available in web; www.clr.lk) |
| 10 | 3.3 Impact of inflation should be discussed with the EIRR rather than comparing it with discount rate used (12%). For example the discount rate has been increased during past year (2017 to 2018) from 12% to 15% current. | | |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 11 | 3.4 The extended CBA seems to be missed the capital cost of trains. | | |
| 12 | 3.5 Project sensitivity on interest rate fluctuations need to be considered. | | |
| 13 | 3.6 The economic viability of project heavily dependent on two estimates of travel time saving and vehicle operational cost saving values. Any mistake there would create massive difference in the results. | | |
| 14 | 3.7 Assuming all negative impacts of the project has been looked after and all externalities caused by the project has been addressed and included in the expenditure, we can support for the project activities. | | |
| 15 | 4. **Traffic Congestion**<br>4.1 Construction at center median will create heavy disturbances to traffic flows, which is crucial even now. | 1.Traffic impact study has already been conducted. Further during detail design stage detail traffic management plan will be prepared in consultation with all relevant parties including traffic police. 2. Will acquire additional lands from both side to make sure the traffic movement in uninterrupted. | For more clarity, please refer Annex C Traffic Impact Assessment EIA report |
| 16 | 5. **Impact of Vibration**<br>8.1 Mitigation measures for vibration during the operation stage need to be technically decided by considering the contextual differences of surrounding Built form. | Proposed mitigation measures under operational stage has pointed out to establish a complaint mechanism and implementing a procedure to effectively deal with any issue raised by the community. Further the O&M company will have a social team to deal technically for such incidents. Additionally pre crack survey and post crack survey has recommended in the EMP of the EIA report to assess any damage cause to structures. | Refer 5.1.2 of EIA Report Mitigation Measures for Vibration and EMP in Annex Q |
| 17 | 6. **Lack of concerns of already proposed projects**<br>6.1. what will happen to the IT Park of the UDA that was designed and developed with the expectation of all these paddy lands to remain in the vicinity? | Existing view will be impacted. However as mitigation measures to improve the vicinity around the depot area has proposed to create a green buffer zone. | Refer Annex Q of EMP in EIA Report |
| 18 | 7. **Reclamation of Paddy lands**<br>7.1 The large 12 acre concrete slab on a fertile paddy field in Kaduwela. This is while there are enough highlands available in the vicinity. What will be the environment under this large concrete slab? | Currently around 20% of the land under cultivation, rest is abandoned. As a result of the series of discussions had with land owners, it was revealed that most of the land owners are willing to provide their lands to the project at a reasonable compensation package. Department of Agrarian Development given their consent to use the land for Depot construction. Selection of Depot area was done through alternative analysis. Further most of the paddy lands here not been cultivated for many years. | Chapter 2.2.3 of LRT alternative routes, 2.12 Table (Depot area selection) EIA Report Annex B consent letter of DAD |
| 19 | 7.2 This crucial due the adjacent floods, particularly no significant solutions to existing devastated floods are not provided. | Flood modeling study has been done and deck height is to 0.5m above from the 100 years flood level. And the proposed pumping station at Ambatale will protect the area from extreme flooding. | Flood modelling - Annex L- EIA report. Letters from DAD and SLLRDC in Annexure B, EIA Report |
| 20 | 7.3 Therefore, the alternative is to acquire a suitable land in the area, without disturbing the water retention area. | In addition to the solution described above the water retention capacity shall not be restricted with the elevated depot structure. | See conceptual design of depot in Figure 2.12 of EIA report. |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 21 | 8. **Non-optimized route**<br>8.1 Omitting Maradana road, where lots of opportunities for future development and instead taking Ward Place, which has a character of its own, disturbing the primary residential area, and simply to touch Town Hall which is well served by many bus routes.<br>8.2 Therefore, the alternative is to take Maradana Route and avoid disturbing the Town Hall junction. | Borella- Maradana route has also been considered during alternative analysis and it has found the Town Hall route is the most appropriate route and the route has accepted by the Ministry. The decision has arrived through proper study, analysis etc. and have been accepted by the line Ministry. | For more clarity, please refer Chapter 3.6.2; Table 3.6.4 in Feasibility Report and Chapter 2.2.3 and Table 2.9 in EIA Report |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 2 | **Center for Environmental Justice** | | |
| 1 | During the operation of the LRT project, noise level from LRT is expected to meet the noise level standard for railway for both Peak noise level (LAmax) 80 db during day and night time and Equivalent noise level (LAeq ) 60db during day and 55 db during night. LA max is [illegible] along the [illegible] based on the speed of the train. However the speed is not the only factor that needs to be considered. It also depend on other factors such as engine type etc. Therefore this has to be rechecked. | The impact of Noise and Vibration has described in chapter 4.1 and the mitigations measures have been described in chapter 5.1 for construction and operational stage with the modelling results. No noise and vibration standard stipulated for railway in Sri Lanka. However The operational stage noise level is recommended in the report as per Japanese and Australian Standards. | Page 4-6 in table 4.4 in Chapter 4.1 of Vibration impact & 5.1 of mitigation measures of vibration impacts in the EIA Report |
| 2 | Green cover in Colombo is very limited. Therefore cutting 652 trees would have a significant effect whether they are native or exotic trees. Habitats would be destroyed. Animals seem to depend even on invasive plants sometimes. Trying to save trees as much as possible only by trimming is essential. Coordination is very important in this regard. Among the identified trees, there are very valuable trees such as 18 trees of Me (Madhuca longifolia), 1 tree of Hora (*Dipterocarpus zeylanicus*).etc It would take years to grow such trees to the existing size. 89 trees will be removed in Denzil Kobbekaduwua Mawatha. Possibilities on lowering the track to the ground level in that area or looking for an alternative rout might be under consideration. | 652 number of trees have been identified along the trace. Only 89 trees along Denzil Kobbekaduwa Mw will be removed and 14 Bo trees may be trimmed, However a compensatory tree planting will be conducted at depot area. | Refer Chapter 3.4.5 of affecter trees , chapter 5.12.1 of mitigation measures and Annex Q in the EIA Report |
| 3 | Construction activities would create a significant increase in traffic congestion due to the marginalization of the road area. To minimize the effect, construction activities can be carried out section wise so that the extra traffic would be limited to a certain area for a certain time period. People can avoid driving into that area if possible. | 1.Traffic impact study has already been conducted. Further during detail design stage detail traffic management plan will be prepared in consultation with all relevant parties including traffic police. 2. Will acquire additional lands from both side to make sure the traffic movement | Annex C of traffic impact study EIA report |
| 4 | Considered about raw material acquiring, 95000 tons of sand will be required for the project. This quantity is expected to be acquired from river sands. Almost all river beds in the country are already being overexploited for sand. Therefore looking for an alternative such as dredging sand from the sea might be a consideration. | GSMB has already been consulted for obtaining information of licensed material suppliers available in Western Province. However, possibility of looking for an alternative such as dredging sand from the sea would be considered during detail design stage. | |
| 5 | Rain water is naturally discharged into wetlands/lowlands in Colombo. During the construction period water with cement could flow into wetlands causing negative impacts on the flora and fauna. Alkalinity of water could be increased. This could be avoided by directing the waste water generated from the construction site to a silting pit. Eight fish species have been recorded along the LRT rout and out of them two species are endemic. It is estimated that 2500 [illegible] | It is proposed to do quarterly basis water quality in selected 4 points. During construction stage it will closely monitored and site specific management plan shall be implemented. In addition, all precautionary measures would be taken to minimize surface water quality degradation during construction. | Refer Annex Q; EMP & EMoP |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 6 | Area selected for the depot site is a lowland area. Therefore filling the area would increase the flood levels in the area. Therefore the depot should be kept as an elevated structure as proposed and minimum area should be filled for access roads during construction. The report say "For the construction of the Depot and the IT Park Station at Malabe (IT Park Junction) partially abandoned and partially cultivated paddy lands in Kaduwela DS Division may be acquired." May be the selected paddy land for the depot may be justified due to reasons such as close proximity to the LRT tack, Size of the land area. But filling a paddy land for an IT park is not justifiable. | No permanent filling will be carried out other than temporary pilot road construction. The mitigation measures to avoid flood described under EMP. Flood modeling study has been done and deck height is to 0.5m above from the 100 years flood level. And the proposed pumping station at Ambatale will escape the area from extreme flooding. Department of Agrarian Development given their consent to use the land for Depot construction | Refer Annex Q; EMP & EMoP. Flood modelling - Annex L- EIA report. Letters from DAD and SLLRDC in Annexure B, EIA Report |
| 7 | ... but of them two species are endemic. It is estimated that 2500 workforce will be recruited. Priority can be given to the people from affected households/business places in offering these jobs. A total of 66 structures will be partially and fully affected and more than 80% of these are commercial buildings such as groceries, restaurants, vehicle sales, vegetable stalls etc. They may have to find other jobs or will have to face difficulties until the businesses are re-established. | The Resettlement Action Plan (RAP) for project has considered this aspects in detail. | Resettlement Action Plan is available in PMU |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 3 | **Environmental Foundation Limited** | | |
| 1 | **3.2 Physical environment**<br><br>Except for Diyawanna Lake and Palan Thuna, the other sites where water quality testing was carried out has indicated poor water quality with regards to solids. The canal close to the proposed depot (Site 3) and Beira Lake (Site 4) have extremely high Total Suspended Solids exceeding way above the standard, permissible level of 50 mg/L given in the PIWQS. High contents of suspended solids, together with increased turbidity affect ecosystem health by reducing photosynthesis and affecting primary productivity. Care should be taken to not further deteriorate already polluted waterways and regular water quality monitoring is highly advised. | It is proposed to do quarterly basis water quality in selected 4 points. During construction stage it will closely monitored and site specific management plan shall be implemented. In addition, all precautionary measures would be taken to minimize surface water quality degradation during construction. | Refer Annex Q; EMP & EMoP |
| 2 | **4.6 Impacts on the Biological Environment**<br><br>**Section 4.6.1 – Disturbance to Protected area**<br><br>LRT route falls outside of the protected areas, Sri Jayawardhanapura sanctuary and Thalangama Tank, but goes through the buffer zone (100 m) in both locations. While the protected area provides important habitat and breeding grounds for a number of threatened and endemic species, the buffer zones around the conservation site provide important areas for wildlife movement. Further ecosystem services of these areas flow beyond the declared protected area. Hence, it is advised that all essential steps are taken to minimize the negative impacts of LRT project on animal migration, especially to prevent road kills and | Outlined in the EMP&EMOP for fauna monitoring. In addition, regular monitoring of fauna will be considered during operation of LRT | Refer Annex Q Biological Survey; EMP & EMoP |
| 3 | **Section 4.6.2 - Fauna and flora Disturbance**<br><br>Removal of trees on the Denzil Kombbekkaduwa Mawatha will also have a considerable number of impacts. These trees along the side of the road provide shade, retain stormwater and provide aesthetic value to the region. Especially, with increasing urbanization and climate change lead to intense Urban Heat Island (UHI) that will strengthen heat waves and air pollution, impairing community's environment and quality of life. Urban canopy cover and street trees, therefore, immensely assist in mitigating and adapting to heat island effects and reduce the energy use in the cities. The LRT project should implement a rigorous rehabilitation program that will include the replantation of street trees to maintain the green cover in the CMR. Additionally, as stated in the EIA, surveys should be conducted to evaluate impacts of tree felling and development within the buffer zone on bird migration. | Creation of green buffer zone around depot area has proposed under EMP as compensatory planting. Will consider further locations during detail design stage. | Refer Annex Q of EMP & EMoP |
| 4 | Additionally, it is stated that "During the operational stage nearly 50% of the wetland will become shaded due to the elevated structure which will result in loss of species that prefer direct sunlight while shade loving species will benefit from the increased shade" and further goes on to state that "The site does not contain any critical species such as threatened or endemic species and therefore, the proposed activity will not have a significant impact on the overall wetland biodiversity of the region". Although there may be no direct impact on the biota in the paddy land, there can be indirect effects between multiple populations that occasionally exchange individuals through migration. Without a comprehensive biological survey, the full impacts of the proposed building of the depot cannot be evaluated and hence it is recommended that a thorough baseline study of the biodiversity is conducted to identify sensitive species prior to landfilling. | According to the biological survey it has found no such important (endangered or threatened species) species in the abandoned paddy area. However during detail design a biological survey will be carried out and the EMoP included the fauna monitoring throughout the project implementation. It should emphasize that there is no any land filling envisages in Depot area except temporary filling for pilot road construction | Refer Annex Q; EMP & EMoP |
| 5 | **4.10 Impacts due to Solid Waste**<br><br>Lack of appropriate waste collection measures at hubs such as LRT stations, where large masses of crowd gather, can not only reduce the aesthetics of the area but will also pose health hazards. Although the EIA states that "General wastes from administrative buildings in depot area will be segregated", details on how this waste is collected, segregated, disposed and the frequency of it are missing. Given that the country is already experiencing many issues related to chaotic ways of garbage disposal, it is recommended that segregation leading to recycling and composting, as opposed to landfilling, is used and promoted during the construction and operational stages of the LRT. | Systematic segregation system will be implemented by O&M company in consultation with the local authority during operational stage. | Refer 5.10 of solid waste mitigation measures. Annex B of correspondence letter in EIA Report |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 6 | 5.11 Impacts on Surface and Ground Water Quality during Construction<br><br>It is estimated that approximately 100 $m^3$ of wastewater containing oil, grease, detergent and dust is generated from maintenance activities at the depot during operation (Annex, Page 319). Most of the waterways from the stations and deport area transport water to the Ambatale-Kelani River that provides drinking water to a large proportion of Colombo's population. Therefore, it is essential that a wastewater treatment plant is installed and that regular water quality monitoring is conducted to prevent surface and ground water contamination that can affect human health and aquatic habitats. | A waste water treatment facility will be installed in the depot area to treat the water and the treated water will recycled the rest will pump to the public sewer system. In the stations proposed to connect to the public sewer system. This matters were addressed in the chapter 4.13.3 and 5.13.3. | Refer chapter 4.13.3 of disposal of waste water from depot and 5.13.3 for mitigation measures for waster water from depot in EIA Report |
| 7 | **7. Environmental Management and Monitoring Plan**<br><br>Long term monitoring is essential during a project of this nature as it has the potential to cause irreversible damage to the environment and the negative consequences will be detrimental to all living beings. Disturbances to protected areas must be minimized and conversion of wetlands to other landuses should be avoided as much as possible. Water quality monitoring and waste management should be prioritized and the monitoring mechanism outlined in the report (Annex Q) should be strictly adhered to. It is the responsibility of the Ministry of Megapolis and Western Development to ensure smooth functioning of the monitoring programme. | A separate environmental team will be dedicated to implement the EMP and the organization chart of O&M company included the environmental professional to continue the activity for long term. | Please refer the feasibility report available at www.clr.lk |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 4 | **Mr. D M K J Dasanayaka** | | |
| 1 | Table 0.2 While impact on traffic and measures for mitigation are given in Table 0.1, there is no item for " Traffic Impact" in Table 0.2 Summary of expected impact and mitigation measures (Operation Stage)<br><br>It is hard to believe that there will be no Traffic Impact during operation, especially around operations as there will be cars and taxis (3 wheelers) dropping off and picking up passengers. | Transport Demand Model has identified impacts of cars and three wheelers in the corridor which will have positive impacts for road vehicles. However, it is agreed that there will be some impacts such as dropping off and picking up of passengers by cars and three wheelers (private vehicles) which needs to be addressed as part of the design of station areas. Therefore, Conceptual design of Stations has already included an additional areas for parking. | See conceptual design of depot in Figure 2.8 of EIA report. |
| 2 | Section 4.16 Urbanization Impacts<br><br>The report identifies that there will be increased urbanization during the Operational Stage, but only concern stated is the conversion of green areas to , I guess built up areas. | Will have close consultation with the relevant agencies during project implementation to support to develop necessary policies to merge green areas with built up areas while urbanization. | |
| 3 | Section 6.6.4 Other Unquantified Benefits (Table 6.8)<br><br>"Real Estate Market Gain" is stated as a benefit and "Unquantifiable"<br><br>We feel the development of the towns along the route will be the biggest benefit from the project and can easily be quantified in an approximate manner. While the report has quantified the "Vehicle Operation Cost Savings", the high density developments around stations will make this cost zero for those who will live in these high density developments and walk to the stations. Examples can be easily drawn from other countries for prediction and calculation purposes. If this was done, the Benefit Cost Ration will be far higher than the figure given in the report. | | |
| 4 | Another major benefit, which may perhaps be difficult (not impossible) to quantify is the reduction in CO2 gasses and other pollutants from motor vehicles. The direct cost savings as well as indirect savings due to reduction in ill health of passengers and road side dwellers will be significant. | The results shows CO2 emission reduction in year 2035 is estimated to be 77,184 t-CO2/y. | Annex P of Extended cost and benefit analysis and feasibility report (available in web; www.clr.lk |
| 5 | **Mr. G P. Gunadasa** | | |
| 1 | 01. මෙකී ව්‍යාපෘතිය ක්‍රියාත්මක කිරීම සඳහා මේ වන තෙක් කඩුවෙල ප්‍රාදේශිය ලේකම් කොට්ඨාසයේ සියලුම ගොවි ජනතාව සහ ගොවි සංවිධාන රාජ්‍ය නිළධාරීන් හමුවන මසකට වරක් කඩුවෙල ප්‍රාදේශිය ලේකම් කාර්යාලයේ පැවැත්වෙන කඩුවෙල ප්‍රාදේශිය කෘෂිකර්ම කමිටුවේ ලිඛිත අනුමැතියක් ලබාගෙන නොමැති බැවින් අදාළ ව්‍යාපෘති වාර්තාව අනුමත කිරීම නීතිවිරෝධී වේ. | යෝජිත සැහැල්ලු දුම්රිය ව්‍යාපෘතියෙහි දුම්රිය අංගනය ඉදිකිරීම සඳහා කුඹුරු ඉඩම් යොදා ගැනීම සම්බන්ධයෙන් ගොවිජන සංවර්ධන දෙපාර්තමේන්තුවේ විරෝධතාවයක් නොමැති බව 2018.01.12 දිනැති 7/11/17/CO/Dev. 94 අංක දරණ ලිපිය මඟින් දැනුම් දී ඇත. තව ද ඒම ලිපිය කඩුවෙල ප්‍රාදේශීය ලේකම් වෙත ද පිටපත් කර ඇත. | ඇමුණුම B, පරිසර බලපෑම් ඇගයීම් වාර්තාව |
| 2 | 02. යෝජිත දුම්රිය අංගනය ඉදිකිරීමට ආසන්න ප්‍රදේශයෙන් මාදිවෙල අඹතලේ ඇලමාර්ගය ගලාබසින අතර එම ඇලමාර්ගයේ කෙලවර කැලණි ගඟට අඹතලේ ප්‍රදේශයෙන් සම්බන්ධ වේ. එම සම්බන්ධවන ස්ථානය අසළ ජාතික ජලසම්පාදන හා ජලාපවාහන මණ්ඩලයේ අඹතලේ ජල පොම්පාගාරය පිහිටා ඇති අතර එම ජල පොම්පාගාරයෙන් කොළඹ ජනතාවට බීමට ජලය ලබාදෙන අතර මෙම දුම්රිය ව්‍යාපෘතිය අදාළ ස්ථානයේ පිහිටුවීමෙන් ක්‍රියාකාරිත්වයේ දී අධික ලෙස ජනනය වන තෙල්, ග්‍රීස් මිශ්‍ර ජලය මාදිවෙල අඹතලේ ඇලමාර්ගය ඔස්සේ කැලණි ගඟේ අඹතලේ ජල පොම්පාගාරයට ඇතුළු වීමෙන් කොළඹ ජනතාව බීමට ගන්නා ජලය අපිරිසිදු වනු ඇත. ව්‍යාපෘතිය අනුමත කිරීමේ දී මේ පිළිබඳ අවධානය යොමු කරන ලෙස ඉල්ලා සිටිමි. | දුම්රිය අංගනයේ විවිධ කටයුතු නිසා ජනනය වන තෙල්, ග්‍රීස් මිශ්‍ර ජලය, අපජලය පිරිපහදු කිරීමේ පද්ධතියක් මඟින් පිරිපහදු කර, නැවත ප්‍රයෝජනය සඳහා යොදා ගැනීමට ද, අවසාන වශයෙන් පිරිපහදු කරන ලද අපජලය ශ්‍රී ජයවර්ධනපුර කෝට්ටේ ප්‍රදේශයේ ඉදිකිරීමට යෝජිත මල අපවහන පද්ධතිය වෙත මුදා හැරීමට ජල සම්පාදන හා ජලාපවහන මණ්ඩලය මඟින් අනුමැතිය ලබා ගෙන ඇත. ඒබැවින් අපජලය කැලණි ගඟට බැහැර වීම සිදු නොවේ. | පරිසර බලපෑම් ඇගයීම, 5.13.3 පරිච්ඡේදය, |

**Responses for Public Comments**

| No | Comments | Response | Reference |
|---|---|---|---|
| 3 | 03. අදාළ කුඹුරු ඉඩම් අත්පත් කර ගැනීමේ දී අප දන්නා පරිදි කුඹුරු හිමියන්ට සොච්චම් මුදලක් වන්දි වශයෙන් ලබාදෙන අතර අඳ ගොවීන්ට කිසිදු මුදලක් නොලැබීමෙන් ඔවුන්ගේ දෛනික ජන ජීවිතයේ කටයුතු අඩාල වනු ඇත. | කුඹුරු ඉඩම් සඳහා තක්සේරු දෙපාර්තමේන්තුව විසින් ලබා දෙනු ලබන වර්තමාන වෙළඳපොළ වටිනාකම යටතේ වන්දි ගෙවනු ලබයි. ඉඩම් අත්කර ගැනීමේ හා ප්‍රතිස්ථානගත කිරීමේ කම්ටු ක්‍රමය (LARC) මෙම ව්‍යාපෘතිය තුළ ක්‍රියාත්මක වන බැවින් වඩා සහනදායි වන්දි මුදලක් කුඹුරු ඉඩම් හිමියන්ට ද හිමිවනු ඇත. අඳ ගොවීන් සඳහා ද වන්දි ලබා ගැනීමේ හිමිකමක් පවතී. ඒ සඳහා ඔවුන් අඳ ගොවියන් ලෙස කුඹුරු නාම ලේඛනයේ ලියාපදිංචි වී සිටිය යුතු වේ. ඊට අමතරව ව්‍යාපෘතිය මඟින් ආදායම් පුනරුත්ථාපන වැඩසටහනක් ක්‍රියාවට නංවන බැවින්, ආදායම් අහිමිවීමකට ලක්වන කුඹුරු හිමියන් මෙන්ම අඳ ගොවියන් වෙත ද ඒම වැඩපිළිවෙල යටතේ ඔවුන්ගේ අහිමිවන ආදායම් නහා සිටුවීම සඳහා අවශ්‍ය මහ පෙන්වීම සිදු කෙරෙනු ඇත. | |
| 4 | 04. මෙම ව්‍යාපෘතිය සඳහා අත්පත් කර ගැනීමට යෝජිත කුඹුරු යාය සෑම අවුරුද්දකම මැයි මාසයේ සහ දෙසැම්බර් මාසයේ අධික ලෙස ජලයෙන් යටවන අතර (කැලණි ගඟ පිටාර ගැලීමෙන් මෙම ස්ථානයේ ජලයේ උස අඩි 10කටත් වඩා අධික වේ) ඉදිකිරීමට යෝජිත දුම්රිය අංගනය ද ජලයෙන් යට වේ. ව්‍යාපෘතිය අනුමත කිරීමේ දී මේ පිළිබඳ අවධානය යොමු කර නැත.<br>05. මෙම ව්‍යාපෘතිය සම්බන්ධයෙන් මහජන අදහස් යොමුකරන ලෙස දිනමිණ සහ ඩේලි නිවුස් පුවත්පත්වල 2018 මැයි 04 වන දින පමණක් කුඩා දැන්වීමක් පළකර තිබූ අතර මෙම දැන්වීම මෙතෙක් ව්‍යාපෘතියට අත්කර ගන්නා කුඹුරු ඉඩම් අයිතිකරුවන් හෝ අඳ ගොවීන් කිසිවෙකු දැක නැති අතර එම නිසා අදාළ විරෝධතා මෙතෙක් ඔබ ආයතනයට යොමු වී නොමැති වන්නට පුළුවන් වන අතර මෙවන් විශාල ව්‍යාපෘතියක් කිරීමේ දී මහජන අදහස් විමසීම මීට වඩා ජනමාධ්‍යයෙන් පුළුල්ව සිදුකළ යුතු බව මාගේ හැඟීම වන අතර මෙම ව්‍යාපෘතිය හෙවත් දුම්රිය අංගනය මෙම ස්ථානයේ ඉදි කළහොත් අදාළ කුඹුරු යාය අවට පිහිටි ගොඩ ඉඩම් වල පිහිටුවා ඇති සයිටම් වෛද්‍ය පීඨය වැනි අධ්‍යාපන මධ්‍යස්ථාන ද, ආයතන ද, සාමාන්‍ය ජනතාව ජීවත්වන නිවාස ජලයෙන් යට වීමෙන් ජන ජීවිතයේ දෛනික කටයුතු අඩාල වනු ඇත. | දුම්රිය අංගනය ඉහළට නැංවූ ව්‍යුහයන් (Elevated Structure) ලෙස ඉදි කිරීමට යෝජනා කර ඇත්තේ ව්‍යාපෘතිය මඟින් ගංවතුර තත්ත්වයක් ඇතිවීම වලක්වාලීම සඳහා ය. ඊට අමතරව මෙම ප්‍රදේශයේ ගංවතුර ඇතිවීම සම්බන්ධයෙන් විශේෂ ආකෘතියක් මඟින් වර්ෂ 100ක් දක්වා ගංවතුර ඇතිවීම සලකා බලා ඇත. තව ද, කොළඹ අගනගර ආශ්‍රිත සංවර්ධන ව්‍යාපෘතිය මඟින් යෝජිත අඹතලයේ ඉදි කිරීමට නියමිත ජල පොම්පාගාරය මඟින් ද ගංවතුර තත්ත්වය පාලනය කෙරෙනු ඇත. මෙම ව්‍යාපෘතිය පිළිබඳව ගොවීන් දැනුවත් කිරීමේ වැඩසටහන් කිහිපයක් කඩුවෙල ප්‍රාදේශීය ලේකම් කාර්යාලයේ පවත්වා ඇත. | |
| 6 | **Mr. B H T. Kulasekara** | | |
| 1 | Therefore during construction stage as well as operational stage an unexpected road congestion may occur as this vast vehicle movement is not considered while building up the center pilers and foundations.<br><br>Also to cater any future vehicular capacity increase on the road definitely lands in both side of the road may have to be acquired. | 1.Traffic impact study has already been conducted. Further during detail design stage detail traffic management plan will be prepared in consultation with all relevant parties including traffic police. 2. Will acquire additional lands from both side to make sure the traffic movement along with RDAs standards | Annex C of traffic impact assessment of EIA report |

**Responses for commnets from Univerity of Moratuwa on Extended Cost Benefit Analysis (Annexure 6 and Chaper 6 of Addendum)**

| No | Comment | Response |
|---|---|---|
| 1 | It is hard to make precise comments on extended CBA, because annexes on detail calculations not available. Costs of this operation surely embrace in benefits, however, in real terms the benefits are much more if real environmental values are included in the benefits. For example the benefits of $CO_2$ reduction and the reduction of health cost. | Direct value of $CO_2$ reduction was estimated and included in the analysis and details of estimates are given in tables N2, N4 and N5. According to estimates value of benefits are low given the current carbon prices used to value reduced emissions are low in emission markets (Full details of calculations are available in pages 4-157 – 4-161 of the final version of the Project Feasibility Report). Potential indirect benefits due to reduction of health cost due to decreased emissions may also be generated by the project. However, it cannot be quantified and valued due to lack of data. |
| 2 | Impact of inflation should be discussed with the EIRR rather than comparing with discount rate used (12%). For example the discount rate has been increased during past year (2017 to 2018) from 12% to 15%. | The ECBA uses principles of **Economic Analysis** and not the principles of **Financial Analysis**. As a principle, inflation is not considered in **Economic Analysis** and all calculations are based on real values (free of inflation). The major economic principle behind discounting is time preference of money and when selecting discount rates applicable for a given economy, parameters such as opportunity cost of capital together with adjustments for risk are considered. Decision criteria for EIRR is EIRR> MARR (Minimum acceptable rate of returns). There is no hard and fast rule regarding MARR. For instance, ADB uses minimum required discount rate which is 9%. Usually in developed countries, discount rates applicable for project CBAs are prepared and periodically updated by national planning bodies using relevant economic parameters. In the absence of such systematic processes for determining and updating discount rates in developing countries, discount rates in the range of 10-12 % have widely been used by international donor agencies (e.g. World Bank, ADB) in project appraisals which are usually higher than discount rates applied in developed country projects. The JICA feasibility study of the current project has also used 12 % which is in line with discount rates applied for many similar projects in Sri Lanka. |
| 3 | The extended CBA seems to be missed the capital cost of trains | Construction/Procurement Cost given in Table 6.2 covers the cost of rolling stock too. Details of major cost components will be included to the revised ECBA chapter to address this comment. |
| 4 | Project sensitivity on interest rate fluctuations need to be considered | Interest rate fluctuations are not usually considered in sensitivity scenarios of **Economic Analysis** which evaluate the project worth from the perspective of whole society. EIRR values under reduced benefit and increased cost scenarios give an idea about how rate of returns might vary subject to variations in cost and benefits. Interest rates based analyses may be used in **Financial Analysis** undertaken from the perspective of project operators/investors to assess the financial viability of a project. It is not relevant here. |
| 5 | The economic viability of project heavily dependent on two estimates of travel time savings and vehicle operational cost saving values. Any mistake there would create massive difference in the results. | Travel time cost savings, vehicle operating cost savings, savings of accident costs etc. are the major benefits from any transport project to the economy. Hence, estimation of them is a major task of project feasibility studies and methods such as surveys and traffic demand analysis are used for that purpose (see "Assessing Public Investment in the Transport Sector", a handbook published by the National Planning Department with the collaboration of University of Moratuwa for more details). A JICA team has carried out a detailed feasibility study for LRT project and data on transport benefits for the ECBA was obtained directly from this feasibility study team. It is assumed that estimates made in the feasibility study are sufficiently accurate within an acceptable margin of error. |

# ANNEXURE 05

**Responses for TEC Comments**

**Responses for comments of Technical Evaluation Committee**

| No | Comments | Response | Reference |
|---|---|---|---|
| 1 | **National Physical Planning Department** | | |
| 1 | 1. The observable disturbance to the safe Pedestrian Areas because of the location of LRT structures:<br><br>The project proposes to construct the structures (pillars) of the elevated rail occupying part of the pedestrian areas.<br>Eg: at the location the existing elevated highway at Rajagiriya junction.<br>This will undermine the pedestrian safety (which is not more than 01 meter even now).<br><br>This is will detrimental to a large group of pedestrians, unless, the lands on either sides will be acquired and facilitated. But the proposal shows that 'no land acquisition' at these locations.<br><br>The project proposal shall clearly explain how it will be carried out with minimum or no disturbance to the pedestrian areas. | Additional two lanes will be provided from Koswatta Junction to Palampthuna Junction and 2.5m pedestrian walkway will be provided at Rajagiriya HSBC as er RDA proposal | For more clarity please refer typical cross section provided by RDA in annex A, EIA Report |
| 2 | 2. The undermining of the 'Sri Jayawardanepura Ceremonial highway':<br><br>The project proposes an elevated line to run at the Centre-median from Ayurveda Juction to Diyatha Uyana.<br><br>All of us are fully aware that the Sri Jayawardhenapura road has been designated as the Ceremonial Access to the Sri Lanka's New Capital City. Even though there are unwanted developments cropping up along the road, they can be corrected with certain measures. Yet, if the LRT runs at the centre of the said road it will destruct the expected and still remaining scenic beauty and the expected 'Ceremonial' character of the Sri Jayawardenapura highway.<br><br>In that sense, NPPD propose to trace the track along the northern end of the ceremonial drive, which is noted to be open and free of building structures. | A series of discussion held with the UDA and relevant agencies during finalization of the trace and it has agreed to go with the proposed trace by the UDA planning committee meeting held during January 2018 and the trace has accepted by the Ministry. | Please refer the page number 2-41 of chapter 2.2 of section of LRT alternative route in the EIA Report |
| 3 | 3. The unnecessarily extended lengths and large number of stations:<br><br>It could be noted that the LRT line some instances is expended to unnecessary lengths.<br>Eg: From Battaramulla Junction- PalamThuna Junction – Koswatta Junction<br>(there are no commuters in this additional area)<br>and From Borella – Town Hall- Pettah<br>(avoiding Maradana, which has a better present and future catchment)<br><br>It is observed that these lengths will serve for no remarkable achievement other than add costs to the project (It shall be noted that the project is implemented with the support of a loan by JICA) and disturb additional areas.<br><br>The usual practice is to attract commuters in those areas through alternative facility such as integrated bus services, which are less costly and implemented with convenience. | 1. Considering the catchment it was observed most of the government offices situated along Denzil Kobbekaduwa mw and traffic demand analysis shows the particular section has high passenger demand. 2. Considering the additional land acquisition and technical aspects (sharp bends) it was avoided selecting the route from Battaramull Junction to Koswatta Jn. 3. Maradana route also been considered during alternative analysis and it has found the Town Hall route is the most appropriate route and the route has accepted by the Ministry. | Please refer feasibility report for passenger demand analysis. Available at https://www.clr.lk |

**Responses for comments of Technical Evaluation Committee**

| No | Comments | Response | Reference |
|---|---|---|---|
| 4 | 4. The Construction of Depot Area on a fertile paddy land:<br><br>It is noted that the land selected for the proposed Depot is 15 Hectares of cultivated paddy (even though the report hints to be 'abandoned').<br><br>The project also proposes the depot to be built on an elevated structure, just to avoid possible flood threats.<br><br>However, it could be noted that such elevated construction will have highly negative impacts on existing land use pattern and drainage pattern and the 'living paddy fields' in the area, expected by the Information Technology City proposed by the UDA. | Currently around 20% of the land under cultivation, rest is abandoned. As a result of the series of discussions had with land owners, it was revealed that most of the land owners are willing to provide their lands to the project at a reasonable compensation package. Selection of Depot area was done based on a proper analysis. Department of Agrarian Development given their consent to use the land for Depot construction | Refer chapter 2.2.3 of LRT Alternative routes. |
| **2** | **Irrigation Department** | | |
| 1 | 02. However, there should not be any problems regarding drainage pattern, water quality, erosion flooding situation etc from this project during construction period and after construction. | Currently around 20% of the land under cultivation, rest is abundant. As a result of the series of discussions had with land owners, it was revealed that most of the land owners are willing to provide their lands to the project at a reasonable compensation package. Selection of Depot area was done based on a proper analysis. Flood modeling study has been done and deck height is to 0.5m above from the 100 years flood level. And the proposed pumping station at Ambatale will escape the area from extreme flooding. | Chapter 2.2.3 EIA Report. Flood modelling - Annex L- EIA report. Letters from DAD and SLLRDC in Annexure B, EIA Report |
| **3** | **National Water Supply and Drainage Board** | | |
| 1 | **1. Clause 4.13.1, 5.13.1 and 5.13.3**<br>Septic tank combined with soil absorption system or up flow anaerobic filters are to be designed in line with the requirements stipulated in SLS 745 part II; 2009. Soakage pits are only feasible if seasonal high ground water table is below 2.5m while soakage trenches can function if seasonal high ground water table is more than 1.5m. If the seasonal high GWT is less than the above requirement, soil absorption systems are not feasible hence septic tanks should be combined with up flow anaerobic filters and the treated effluent should be discharged in line with CEA regulations. | Septic tank related matters during construction sate will comply the all local standard and the appropriate design will be closely considered during detail design. | |
| 2 | **2. Clause 5.13.3 Wastewater from Administration Building – <u>Rain Water</u>**<br>Rain water can be re used for non potable uses as per UDA regulation. In the event if storm water is discharged to the storm water drainage system, silt trap could be incorporated and maintained prior to discharge.<br>Clause 5.13.3 (1) should be amended as "CEA current standard or its subsequent amendments". | The roof water from admin building could be harvested. However the capacity of holding tank will be determined during detail design stage. The current proposal is to recycle the rolling stock waste water after treatment. This advice will consider closely during depot detail design. | Refer the conceptual design of waste water treatment facility in Chapter 2.1.11 Wastewater Sources |

**Responses for comments of Technical Evaluation Committee**

| No | Comments | Response | Reference |
|---|---|---|---|
| 3 | **3. Clause 5.13.4 Wastewater generated from the administrative building**<br><br>The wastewater from the administrative building will be collected in a septic tank, there after the sewerage will be collected by a gully sucker by a licensed contractor or local authority for final disposal.<br><br>It is not clear whether the facility to be provided are sewage holding tanks or on site treatment comprising septic tank combined with soil absorption system. | It is proposed to have holding tanks to store treated water to reuse the excess water will connect to the public sewer system as permanent measures. The depot area water table is high therefore, no onsite soil absorption system has proposed | |

**Responses for Comments from Transport Specialist Dr. Sivakumar**

| No | Comment | Response |
|---|---|---|
| 1 | The calculation details and assumptions were not complete neither in the report nor annexure | It is not clear what calculation details and assumptions that are been referred to. |
| 2 | The report states about Traffic Management Plan (TMP) during construction. However it lacks mentioning about post construction congestion and related TMP due to permenant capacity reduction. (carriageway reduction due to central concrete columns elevated structure however made to minimum dimension) | The modelling takes into consideration of the capacity of the road in macro level modelling. The post construction congestion is also reduced by the reduction of private vehicles due to the LRT. Also there is no carriage way reduction due to column on the road since standard lane widths are provided . |
| 3 | The loss in speed due to reduction in road space should be considered as a negative benefit and this should also be reflected in the analysis and cost calculation. | There is no reduction in road space due to LRT. The standard lane widths are maintained. Based on Traffic theory, the speeds are not directly reduced with reduction in lane widths. What reduces is the Lane capacity. Speed is a function of vehicle flow which reduces when the V/C gets closer to 1. Since V/C is essentially reduced due to the LRT with mode shift from private vehicle to public, the speed is essentially increased. therefore there is no negative benefit but rather a positive benefit. It is unclear how speed or reduction in lane width is connected with cost as mentioned in the comment. |
| 4 | It must be noted that, LRT could not attract entire existing passengers as well as not able to attract entire automobile users. Thus only a fraction would be expected as LRT patronage. Therefore, travel time saving might be overvalued around 4 times as abenefit in the Cost Benifit Analysis which needs to be revisited. | The actual mode shift form existing public transport passengers and private passengers will be known once the LRT is operational. The comment that "LRT could not attract " is misleading since LRT is not still in place yet. Secondly the comment is not supported by any valid scientific proof. However it should be noted that the feasibility study has completed a comprehensive modelling approach where the mode choice have been scientifically estimated rather than "writing the answer" as in applying percentage of shift from each mode. Therefore the travel time saving are estimated based on scientific method. It is unclear how the "4 times" overvalue is been suggested as in the comment. |
| 5 | It was mentioned at the meeting the calculations were based on line-speed.However, when it comes to public transport, door to door speed must be considered and travel time saving needs to be adjusted accordingly. | The travel times shown using the LRT is based on average operational speed from Origin LRT station to destination LRT station. The door to door travel time varies from one door to the other door therefore cannot be used for comparison. It is agreeable that access and egress times from rail (which is similar to LRT) has not improved for the last 20 years since there has been next to nothing done to improve the bus industry. However, it is shown that the network speed is due to increase because of the LRT introduction therefore the bus industry is to be benefited indirectly. |
| 6 | There were several traffic improvement/transport development are being discussed and implemented namely" Area Traffic Management Systems", "Road User Taxation", "Bus Priority Measures", "Bus Priority Lanes", "Railway Electrification", etc. It was not mentioned in the report whether all these developments were considered in the analysis. | All the Development projects that have been submitted by the line ministries have been included and is available in the feasibility report. Some of the mentioned improvement have not been materialised and some even though implemented have shown that they have been highly over rated. |
| 7 | What will happen to LRT modal share, if there is a competitive bus service (if Sahasarian western province gain bus speed bus speed of 20km/hr) ? What is the EIRR under this scenario ? | There is no scientific proof to say that sahasara will gain the bus speed to 20 km/h. Although there are reports with merely reports opinions it is not proven yet. However it should be noted that, only the committed projects at the time of the feasibility can be considered which has been submitted by the line ministry. The subsequent projects that comes up will need to access the impact separately since all ideas that have been around cannot be accommodated until it is considered by each line ministry |
| 8 | It is noted that the LRT fare must be around 3 times the current bus fare at the indicated passenger demand. What would be the market share at this fare? What will they have to charge if the pessanger over estimation is | The question is unclear. It should be noted that the according to fundamentals of demand modelling, the demand is a function of the fare, not the other way around as in the comment. There is no passenger overestimation. It is the results of a proper modelling exercise. |
| 9 | What if Government imposes a congestion tax and car travel reduces by 50% with travel time reducuing as well. What % of these will come to LRT and by what % will LRT ridership increase? When will capacity be overrun? Will this be viable if road speeds will ebcompetitive with LRT? | Government does not have any plans to introduce congestion pricing in the near future and the pre requisites for such implementation has not still materialised. Even if it get implemented it will be a advantage to the LRT as it will be a more attraction to the public transport therefore a more benefit rather than a disbenefit. The LRT system has enough capacity to accommodate any increase in ridership which will only make the LRT more feasible. It is unclear how the assumption was made of 50% of trips vanishing when according to fundamental of transportation what is likely to happen is that the private trips to shift to a better mode of travel rather than the likelihood of vanishing of the trips. |

**Responses for comments of Technical Evaluation Committee - Dr. Makesh Jayaweera**

| No | Comment | Response | Reference |
|---|---|---|---|
| 1 | Background noise levels measured need not to be compared with permissible noise levels set out in the National Standards meant for industries | Background noise levels were taken (baseline noise measurements) in an area where the project implementation envisages. The area seems to be Urban Residential, but not declared as a zone. Noise level monitoring will be conducted with the commencement of the construction activities as mentioned in the EMoP on quarterly basis and upon receiving public complaints during construction stage. However the comparison of noise levels will be done as per the permissible levels described in Schedule III of the National Environmental (Noise Control) Regulation stipulated in gazzette notification dated 21st May 1996. Noise control measures will be adopted as described in Chapter 5.1 in order to minimize the impact. | |
| 2 | Evening noise levels for background noise are not required and nighttime noise levels should only be measured for maximum 5minutes not 15 minutes | ITI have a SLAB accredicted background noise level measuting method called 'Monitoring of Background Noise Level and Existing Noise Level'. Accoring to that test method background noise level calculated for each and every 15 minutes. This method was developed based on the; NSW industrial noise policy 2000, Environmental criteria for road traffic noise, 2011. | |
| 3 | Locations where vibration levels are measured need to be defined and they are defined only with numerals without clear reference | Table 3.5 and Figure 3.3 was modified with the locations | Table 3.5 and Figure 3.3 in Addendum of EIA Report |
| 4 | At some points, the predicted construction noise levels even with barriers exceed the permissible noise (75dB) and thus, there is high tendency to exceed the standards during both daytime and night time | It has been furhter described in Chapter 4.1.1 by introducing appropriate materials to be used for noise barriers and for the points exceeding the noise levels, it is also considered the to change the material type and height of the noise barriers. | Chaptrer 4.1.1, Table 4.2 and 4.2A in the Addendum of EIA Report |
| 5 | Under the sub section 4.1.1 (page 4-3) stated as " with the use of noise barriers fence (3m height), noise level can be reduced by up to 10dB". However, the implementation may be difficult considering the practical situation. EIA preparers need to give more specific elaborations with the conceptual designs as to how this noise reduction be achieved. | It was elaborated in Table 4.2A and through a conceptual design given for Type 1 and Type 2 noise barriers. | Table 4.2A of Addendum of EIA Report |
| 6 | In the depot area, it is better to use bored piling method instead of drop hammer method in order to minimize the impacts on surrounded houses. It is very unlikely that driven piles be practiced in the middle of the residential areas. Also please give how piling be carried out in terms of number of piles and accordingly, both noise and vibration levels need to be predicted. | It is proposed to construct the Depot as an elevated structure giving special attention to conserve water retaining area underneath. . Drop Hammer method is suggested for piling against Bored Piling by considering time duration for construction of Depot, cost and the number of piling. It is obvious that, only impact would cause due to operation of drop hammer is noise and vibration. Noise and vibration predictions have been described giving special attention the Depot construction in Chapter 4.1 and, as described in Chapter 5.1, the mitigation measures will be adopted to control noise and vibration. Further the EMoP describes the frequent monitoring mechanism of noise and vibration during construction in order to make necessary arrangements for mitigations. However, this matter will further be considered during detai design stage. | |
| 7 | It is necessary to mention the assumptions used for the noise modeling. Modeled figures are not compatible with the calculations. | Assmtions are clearly mentioned in the report under chapter 2.4. Modled figures are comptible with calculations. Report title; Noise Map for proposed Light Ril Transit System in Colombo'. Report No: 'CTS-1708659' | |
| 8 | The equations and model assumptions of noise model should be provided for all calculations used for the noise modeling. | Normally modeling software has many calculation methods. These methods are not visible to the 'End user'. In the EIA report chapter 2.4, it is mention the calculation method as SRM. All equations are included in the calculation method in Annexure. | Refer Annexure 7-Aof the Annexure 7 in the Addendum to the EIA report |
| 9 | Predicted results of noise level from the proposed LRT should be given | Predicted results are given in the Repott CTS-1708659. Please refer 4.1 and 4.2 of the ereport. | |
| 10 | Noise level prediction for day time have to be modeled by taking the calculation of the combined noise level by considering all runs as one by one | This noise model calculate the Laeq values for one hour. It will not produce the noise level for a pass by event. | |
| 11 | It better to provide an enlarged strip noise contour map along the track with only 60dB 65dB contours instead of area map as per the guidelines of NSW, Australia | Develop this kind of noise maps, will take considerable amount of time. However the perticular map can be obtained from ITI with in one month period. | |
| 12 | It is better to build the noise map with horizontal contour instead of vertical contour. It is enough to illustrate operational noise modeling in to 5 levels at 1.2m height from each floor level. | Develop this kind of noise maps, will take considerable amount of time. However the perticular map can be obtained from ITI with in one month period. | |
| 13 | It is necessary to do the ground vibration assessment in ppv, which is completely missed. Measurements, predictions and mitigations for ground vibration (not for air-blast vibration) need to be incorporated. | Be noted that, the Vibration measured for predictions is not air-blast vibration, but ground vibration measured in dB. Conversion to PPV(mm/s) has done using particular formula given in Chapter 4.1.2. Further,the spread sheet in Annexure 3 gives the numerals used for assessment | Chapter 4.1.2 and foot note 4, Annexure 3 of the Addendum to the EIA Report |
| 14 | Mitigations are proposed to have noise and vibration barriers. Hence, need to give a typical conceptual design for such measures with material being used. | Conceptual design for the noise barrier has given in Chapter 4.1.1 and mitigation measures are described in Chapter 5.1.1 and 5.1.2 for Noise and vibration respectively. | Chapter 4.1.1, 5.1.1 and 5.1.2 of the Addendum to the EIA Report |
| 15 | It is necessary to update the conclusions as per the recommended changes. | The project would adhere with the conclusions and the recommendations given in the EIA Report, and with the changes have been done as per the comments received from the Technical Evaluation Committee and from the Public | |

# ANNEXURE 6

## (Referred to Annex P in EIA report)

### Extended Cost Benefit Analysis

Annex P1: Economic costs and benefits of the project

| Year LRT | Years of operation | Economic Cost | | | | Economic Benefits | | | | | Net Benefit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment | | O & M Cost | Total Cost (LKR) | VOC | TTC | $CO_2$ | Accident | Total Benefit | |
| | | LRT Construction | Replacement | | | | | | | | |
| 2018 | | 3.76 | 0.00 | 0.00 | 3.76 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -3.76 |
| 2019 | | 4.23 | 0.00 | 0.00 | 4.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -4.23 |
| 2020 | | 30.63 | 0.00 | 0.00 | 30.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -30.63 |
| 2021 | | 59.33 | 0.00 | 0.00 | 59.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -59.33 |
| 2022 | | 51.29 | 0.00 | 0.00 | 51.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -51.29 |
| 2023 | | 50.64 | 0.00 | 0.00 | 50.64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -50.64 |
| 2024 | | 42.00 | 0.00 | 3.31 | 45.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | -45.21 |
| 2025 | 1 | 11.88 | 0.00 | 3.27 | 15.15 | 13.91 | 24.76 | 0.001 | 0.12 | 38.79 | 23.64 |
| 2026 | 2 | 1.21 | 0.00 | 3.34 | 4.55 | 16.20 | 28.53 | 0.001 | 0.14 | 44.87 | 40.32 |
| 2027 | 3 | 1.09 | 0.00 | 3.41 | 4.50 | 18.85 | 32.88 | 0.001 | 0.16 | 51.89 | 47.39 |
| 2028 | 4 | 0.00 | 0.00 | 3.48 | 3.48 | 21.94 | 37.89 | 0.001 | 0.18 | 60.01 | 56.53 |
| 2029 | 5 | 0.00 | 0.13 | 3.55 | 3.68 | 25.54 | 43.66 | 0.002 | 0.21 | 69.41 | 65.73 |
| 2030 | 6 | 0.00 | 0.00 | 3.62 | 3.62 | 29.72 | 50.31 | 0.002 | 0.25 | 80.28 | 76.66 |
| 2031 | 7 | 0.00 | 0.00 | 3.70 | 3.70 | 34.59 | 57.98 | 0.002 | 0.29 | 92.86 | 89.16 |
| 2032 | 8 | 0.00 | 0.00 | 3.77 | 3.77 | 40.27 | 66.81 | 0.003 | 0.33 | 107.41 | 103.64 |
| 2033 | 9 | 0.00 | 0.00 | 3.85 | 3.85 | 46.87 | 76.99 | 0.003 | 0.38 | 124.24 | 120.39 |
| 2034 | 10 | 0.00 | 6.15 | 3.93 | 10.08 | 54.55 | 88.72 | 0.003 | 0.45 | 143.72 | 133.64 |
| 2035 | 11 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2036 | 12 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2037 | 13 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2038 | 14 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2039 | 15 | 0.00 | 4.47 | 4.01 | 8.48 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 157.77 |
| 2040 | 16 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2041 | 17 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2042 | 18 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2043 | 19 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2044 | 20 | 0.00 | 12.43 | 4.01 | 16.44 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 149.81 |
| 2045 | 21 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2046 | 22 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2047 | 23 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2048 | 24 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2049 | 25 | 0.00 | 0.13 | 4.01 | 4.14 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.11 |
| 2050 | 26 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2051 | 27 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| 2052 | 28 | 0.00 | 0.00 | 4.01 | 4.01 | 63.49 | 102.24 | 0.004 | 0.52 | 166.25 | 162.24 |
| **Total** | | **256.1** | **23.3** | **111.4** | **390.7** | **1445.2** | **2348.9** | **0.1** | **11.8** | **3806.0** | **3415.2** |

(Source: Feasibility Study Report)

Annex P2: Carbon Dioxide Emission Factor by Vehicle Type

| Vehicle Type | Emission Factor ($tCO_2$/passenger-km) |
|---|---|
| Car | 0.0001026 |
| Motorcycle | 0.0001004 |
| Three wheeler | 0.0001067 |
| Bus | 0.0000257 |

(Source: Feasibility Study Report)

Annex P3: Socio economic impacts of the project

| Impact | Type | Quantity |
|---|---|---|
| Land Area (perch) | Agricultural | 7913.8 |
| | Residential | 57 |
| | Commercial | 259.3 |
| Structures (Sq. metres) | Type 1 | 8658.52 |
| | Type 2 | 1111.67 |
| | Type 3 | 2886.17 |
| Structures (number) | Residential | 1 |
| | commercial | 65 |
| Self-relocation (Households) | Municipality area | 28 |
| | Urban council area | 73 |
| Loss of Income (No. of persons) | Business | 100 |
| | Loss of wage/ salary | 455 |
| Affected persons (No. of Persons) | Business owners | 100 |
| | Renters | 73 |
| | Workers | 455 |

(Source: RAP)

**Annex P4: Analysis Parameters of Emission Reductions (Construction Phase)**

| Parameter | Description | | Value | Unit | Source |
|---|---|---|---|---|---|
| **A** | **land area of organic soils** | | **14.8** | **ha** | **JICA team** |
| **$B_{AG}$** | **Aboveground biomass** | **Tropical moist & wet** | **6.2** | **t-dm/ha** | **Table 3.4.2, IPCC GPG-LULUCF** |
| **R** | **Root-to-shoot ratio** | **Tropical moist & wet** | **1.6** | | **Table 3.4.3, IPCC GPG-LULUCF** |
| **CF** | **Carbon fraction of dry matter** | **Default value** | **0.5** | **t-C/t-dm** | **IPCC GPG-LULUCF** |

(Source: JICA Study Team)

**Annex P5: Analysis Parameters of Emission Reductions (Operation Phase – year 2035)**

| Parameter | Description | | Value | Unit | Source |
|---|---|---|---|---|---|
| $P_y$ | Number of passenger of the project activity in year y | | 246,818,475 | passenger/year | = 676,215 passenger/day * 365 JICA team |
| $BPKM_y$ | Passenger transportation volume/activity by the project in year y | | 1,332,819,765 | passenger-km/y | JICA team |
| | | Car | 773,035,464 | passenger-km/y | JICA team |
| | | Motorcycle | 199,922,965 | passenger-km/y | |
| | | 3 Wheeler | 133,281,977 | passenger-km/y | |
| | | Bus | 226,579,360 | passenger-km/y | |
| $EF_{PKM,i}$ | CO2 emission factor per passenger kilometer for transport mode i | Car | 0.0001026 | tCO2/passenger-km | JICA team |
| | | Motorcycle | 0.0001004 | tCO2/passenger-km | |
| | | 3 Wheeler | 0.0001067 | tCO2/passenger-km | |
| | | Bus | 0.0000257 | tCO2/passenger-km | |
| $BTDP_y$ | Average trip distance of the passenger of the project activity in year y | | 5.4 | km | JICA team |
| $MS_{i,y}$ | Share of passengers by transport mode in the baseline scenario in year y | Car | 58 | % | JICA team |
| | | Motorcycle | 15 | % | |
| | | 3 Wheeler | 10 | % | |
| | | Bus | 17 | % | |
| $EC_{PJ,y}$ | Annual electricity consumption associated with the operation of the project activity in year y | | 45,512 | MWh/year | JICA team |
| $EF_{elec}$ | CO2 emission factor of the grid electricity | | 0.9274 | tCO2/MWh | In year 2015, Build Margin, from SLSEA website |

(Source: JICA Study Team)

Annex P6: Unit Vehicle Operating Cost (VOC)

| Velocity (km/h) | Motorcycle | 3 Wheeler | Car & Van | Medium & Large Bus | Medium & Large 2 Axle Lorry | Large 3 Axle Lorry |
|---|---|---|---|---|---|---|
| **10** | 17.20 | 45.03 | 64.70 | 144.88 | 120.46 | 174.60 |
| **15** | 15.01 | 37.05 | 54.44 | 110.39 | 93.10 | 140.60 |
| **20** | 13.97 | 33.16 | 49.50 | 93.01 | 79.33 | 123.50 |
| **25** | 13.40 | 30.78 | 46.65 | 82.65 | 71.06 | 113.24 |
| **30** | 13.02 | 29.17 | 44.75 | 75.81 | 65.65 | 106.50 |
| **35** | 12.83 | 28.12 | 43.42 | 70.97 | 61.94 | 101.75 |
| **40** | 12.64 | 27.27 | 42.56 | 67.45 | 59.19 | 98.33 |
| **45** | 12.45 | 26.60 | 41.90 | 64.89 | 57.19 | 95.86 |
| **50** | 12.54 | 26.32 | 41.71 | 62.99 | 55.77 | 94.05 |
| **55** | 12.64 | 26.13 | 41.52 | 61.47 | 54.63 | 92.82 |
| **60** | 12.64 | 25.94 | 41.52 | 60.52 | 53.96 | 91.87 |
| **65** | 12.73 | 25.84 | 41.52 | 59.76 | 53.39 | 91.39 |
| **70** | 12.83 | 25.75 | 41.52 | 59.28 | 53.20 | 91.20 |
| **75** | 12.92 | 25.65 | 41.61 | 59.09 | 53.11 | 91.30 |
| **80** | 12.92 | 25.65 | 41.71 | 59.19 | 53.30 | 91.68 |
| **85** | 13.02 | 25.65 | 41.80 | 59.38 | 53.68 | 92.34 |
| **90** | 13.11 | 25.65 | 41.99 | 59.85 | 54.25 | 93.29 |
| **95** | 13.21 | 25.65 | 42.18 | 60.52 | 55.01 | 0.00 |
| **100** | 13.30 | 25.65 | 42.37 | 61.37 | 55.86 | 0.00 |

(Source: JICA Study Team)

Annex P7: Accident Loss Savings

| Item | Value | Unit |
|---|---|---|
| Accident Cost (1) | 0.396 | LKR/vehicle-km in 1999 values |
| Accident Cost | 1.46015 | LKR/vehicle-km in 2017 values |
| Annual decline in accident rate (1) | 4% | |
| Accident rate deduction in '35 | 48% | '35/'17 |
| Accident Cost in 2035 | 0.7003 | LKR/vehicle-km in 2017 values |

(Source: JICA Study Team)

# ANNEXURE 7

- Evening noise levels for background noise are not required and night time noise levels should only be measured for maximum of 5 minutes not 15 minutes.

ITI have a SLAB Accredited background noise level measuring method called "Monitoring of Background Noise Level and Existing Noise Level". According to that test method background noise level calculated for each and every 15minutes. This method was developed based on the

*NSW Industrial Noise Policy*. 2000
*Environmental Criteria for Road Traffic Noise*.2011

- It is necessary to mention the assumptions used for the noise modeling. Modeled figures are not compatible with the calculations.

Assumptions are clearly mentioned in the report under chapter 2.4 which is submitted to our customer "Consulting Engineers & Architects Associated (pvt) Ltd. Modeled figures are compatible with calculations. Report title: "Noise Map for Proposed Light Rail Transit System In Colombo". Report No: "CTS – 1708659"

- The equations and model assumptions of noise model should be provided for all calculations used for the noise modeling.

Normally modeling software has many calculation methods. These methods are not visible to the "End User". In the above report under chapter 2.4, it is mention the calculation method as SRM. All equations are included in the calculation method as attached as Annexure 01.

- Predicted results of noise levels from the proposed LRT should be given.

Predicted results are given in the Report CTS –1708659.Please refer 4.1 and 4.2 in the report

- Noise level prediction for day time have to be modeled by taking the calculation of the combined noise level by considering all runs as one by one.

This noise model calculate the $L_{A,eq}$ values for one hour. It will not produce the noise level for a pass by event.

- It is better to provide an enlarged strip Noise Contour Map along the track with only 60dB and 65dB contours instead of area map as per the guidelines of NSW, Australia.

As we have to perform the calculations again to develop above noise maps it will take considerable time. Therefore we are not in a position to provide the maps in this stage. However we can issue the revised report with above maps within 2 weeks time.

- It is better to build the noise map with horizontal contour instead of vertical contour. It is enough to illustrate operational noise modeling into 5 levels at 1.2m height from each floor level.

As we have to perform the calculations again to develop above noise maps it will take considerable time. Therefore we are not in a position to provide the maps in this stage. However we can issue the revised report with above maps within 2 weeks time.

- Railway tracks with adjustable rail fixation (index code bb = 6);
- Railway tracks with adjustable rail fixation and ballast bed (index code bb = 7);
- Railway tracks with poured in railway lines (index code bb = 8);
- Railway tracks with level crossing.

When determining the emission values, distinctions are also made, according to how many track disconnections occur on the emission route concerned:

- jointless rails (fully welded tracks) with or without jointless switches or crossings (index code m = 1);
- rails with joints ( = tracks with joints) or an isolated switch (m = 2);
- switches and crossings with joints, 2 per 100 meters (m = 3);
- more than 2 switches per 100 meters (m = 4);

## 3.3. SPECIFICATIONS

The following specifications are necessary to calculate the emission values per octave band:

| | |
|---|---|
| $Q_c$ | mean number of non-braking trains in the railway vehicle category concerned [$h^{-1}$] |
| $Q_{r,c}$ | mean number of braking trains in the railway vehicle category concerned [$h^{-1}$] |
| $v_c$ | mean speed of passing non-braking railway vehicles [$kmh^{-1}$] |
| $v_{r,c}$ | mean speed of passing braking railway vehicles [$kmh^{-1}$] |
| bb | type of track/condition of the railway tracks [-] |
| m | estimation of the occurrence of track disconnections [-] |
| n | number of points or junctions on the emission route concerned [-] |
| a | length of the emission route in question, at least equivalent to the length of the point or junction [m] |

Trains qualify as braking when the brake gear has been activated.

## 3.4. CALCULATION METHOD

The calculation proceeds as follows[3]:

[3] equations have been modified to correct errors of the RMR1996 method, similar to corrections included in RMR2002.

$$L_{E,i}^{bs} = 10\lg\left(\sum_{c=1}^{8} 10^{E_{bs,nr,i,c}/10} + \sum_{c=1}^{8} 10^{E_{bs,r,i,c}/10}\right) \qquad 3.1a$$

In the calculation model category 9 has no $L_E^{bs}$:

$$L_{E,i}^{as} = 10\lg\left(\sum_{c=1}^{9} 10^{E_{as,r,i,c}/10} + \sum_{c=1}^{9} 10^{E_{as,nr,i,c}/10} + \sum_{c=1}^{9} 10^{E_{brake,i,e}/10} + 10^{E_{motor,i}/10} + 10^{E_{diesel,i}/10}\right) \qquad 3.1b$$

$$L_{E,i}^{2m} = 10\lg\left(10^{E_{2m,i,c}/10}\right) \qquad 3.1c$$

$$L_{E,i}^{4m} = 10\lg\left(10^{E_{4m,i,c}/10}\right) \qquad 3.1d$$

$$L_{E,i}^{5m} = 10\lg\left(10^{E_{5m,i,c}/10}\right) \qquad 3.1e$$

The following applies for categories 1, 2, 3, 6, 7 & 8:

$$E_{bs,nr,i,c} = E_{nr,i,c} - 1$$
$$E_{bs,r,i,c} = E_{r,i,c} - 1$$
$$E_{as,nr,i,c} = E_{nr,i,c} - 7$$
$$E_{as,r,i,c} = E_{r,i,c} - 7$$

The following applies for categories 4 & 5:

$$E_{bs,nr,i,c} = E_{nr,i,c} - 3$$
$$E_{bs,r,i,c} = E_{r,i,c} - 3$$
$$E_{as,nr,i,c} = E_{nr,i,c} - 3$$
$$E_{as,r,i,c} = E_{r,i,c} - 3$$

The following applies for category 9:

$$E_{as,nr,i,c} = E_{nr,i,9-as}$$
$$E_{as,r,i,c} = E_{r,i,9-as}$$
$$E_{2m,i,c} = E_{i,9-2m}$$
$$E_{4m,i,c} = E_{i,9-4m}$$
$$E_{5m,i,c} = E_{i,9-5m}$$

with:

$$E_{nr,i,c} = a_{i,c} + b_{i,c} \lg v_c + 10 \lg Q_c + C_{bb,i,m} \quad 3.2a$$

$$E_{r,i,c} = a_{i,c} + b_{i,c} \lg v_{r,c} + 10 \lg Q_{r,c} + C_{bb,i,m} \quad 3.2b$$

$$E_{brake,i,c} = a_{i,c} + b_{i,c} \lg v_{r,c} + 10 \lg Q_{r,c} + C_{brake,i,c} \quad 3.2c$$

***for c = 5***

$$E_{diesel,i} = 10 \lg \begin{pmatrix} 10^{\left(a_{diesel,i} + b_{diesel,i} \lg v_5 + 10 \lg Q_5\right)/10} \\ + 10^{\left(a_{diesel,i} + b_{diesel,i} \lg v_{r,5} + 10 \lg Q_{r,5}\right)/10} \end{pmatrix} \quad 3.2d$$

***for c = 3 and c = 6***

$$E_{motor,i} = 10 \lg \begin{pmatrix} 10^{\left(a_{motor,i} + b_{motor,i} \lg v_c + 10 \lg Q_c\right)/10} \\ + 10^{\left(a_{motor,i,c} + b_{motor,i} \lg vr_{r,c} + 10 \lg Q_{r,c}\right)/10} \end{pmatrix} \quad 3.2e$$

***for c = 9***

$$E_{9-2m,i} = 10 \lg \begin{pmatrix} 10^{\left(a_{9-2m,i} + b_{9-2m,i} \lg v_9 + 10 \lg Q_9\right)/10} \\ + 10^{\left(a_{9-2m,i} + b_{9-2m,i} \lg v_{r,9} + 10 \lg Q_{r,9}\right)/10} \end{pmatrix} \quad 3.2f$$

$$E_{9-4m,i} = 10 \lg \begin{pmatrix} 10^{\left(a_{9-4m,i} + b_{9-4m,i} \lg v_9 + 10 \lg Q_9\right)/10} \\ + 10^{\left(a_{9-4m,i} + b_{9-4m,i} \lg v_{r,9} + 10 \lg Q_{r,9}\right)/10} \end{pmatrix} \quad 3.2g$$

$$E_{9-5m,i} = 10 \lg \begin{pmatrix} 10^{\left(a_{9-5m,i} + b_{9-5m,i} \lg v_9 + 10 \lg Q_9\right)/10} \\ + 10^{\left(a_{9-5m,i} + b_{9-5m,i} \lg v_{r,9} + 10 \lg Q_{r,9}\right)/10} \end{pmatrix} \quad 3.2h$$

The values for the emission index codes can be taken from tables 3.1 & 3.2.