ENIVIRONMENTAL PROTECTION DEPARTMENT

Agreement No. NP 00-138/1

Developing Data Exchange Protocol for Traffic Noise Assessment

Final Report

September 2003

Approved By	T. J. Camp
	(Director)

REMARKS:

The information supplied and contained within this report is, to the best of our knowledge, correct at the time of printing.

MEMCL accepts no responsibility for changes made to this report by third parties.

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Addendum to Section 3.5 SoundPLAN ver 4.2

3.5.4 In order to reduce discrepancy in noise prediction between SoundPLAN and other software, it is recommended to avoid using the berm structure to model the cantilevered noise barrier. It should be modelled as a cantilever on elevated structure.

3.5.5 Since facade correction is applied only to receivers located 1m from the building facade in SoundPLAN, input of the building facade should be carried out preciously.

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1 INTRODUCTION

1.1 Background

1.1.1 The Calculation of Road Traffic Noise (CRTN) developed by the UK Department of Transport is the traffic noise prediction methodology recommended in the Hong Kong Standards Planning and Guidelines (HKPSG) and the Technical Memorandum on Environmental Impact Assessment Process.

1.1.2 Currently, there are various commercial or in-house softwares adopting the CRTN methodology for traffic noise prediction. However, as different softwares have different input data formats, it is difficult for the relevant parities to exchange the input data.

1.1.3 The Traffic Noise Modelling Standard Data Exchange (TNMSDX) protocol was thus developed to provide guidelines for the preparation of input data in a standard ASCII format. A software was developed for conversion of input data formats from those of road traffic noise computation models commonly used in Hong Kong to the standard format according to the TNMSDX protocol.

1.1.4 The TNMSDX protocol offers the following benefits:

(i) Providing a good quality input data for future reference
Consultants involved in detailed design and review stages should be benefited from having a good quality input data prepared previously during preliminary or feasibility stages for reference.

(ii) Minimizing resources for transferring data
It is no longer necessary to rebuild the input data due to incompatible data definition of various computation models.

(iii) Facilitating the vetting of road traffic noise model input data from various computation models
With the protocol and conversion software, the vetting of road traffic noise model input data could be achieved by directly examining the data file in the format of the proposed protocol.

1.2 Objective and Structure of the Report

1.2.1 This report is to propose a standard format for the TNMSDX protocol. The traffic noise prediction methodologies in the CRTN will be reviewed and the required input data will be identified first. In addition, a sample data format of the TNMSDX protocol will be provided.

1.2.2 This report has been written in four sections with this section providing an introduction and

Section 2 reviews the CRTN methodologies, identifies the necessary input data for the CRTN methodologies and proposes the format of the TNMSDX protocol,

Section 3 reviews the data structure of the input data files of various traffic noise software, and

Section 4 summarises key issues.

2 PROPOSED TNMSDX

2.1 Review of CRTN

CRTN Methodologies

2.1.1 "Calculation of Road Traffic Noise", published by the Department of Transport of Welsh Office U.K., is a memorandum describing the procedures for calculating road traffic noise. The CRTN methodologies are widely used in Hong Kong and are accepted by EPD as the basis for road traffic noise prediction.

2.1.2 In general, the memorandum is divided into three sections of procedures for calculation.

Section I

2.1.3 This section presents the general procedures for road traffic noise prediction. The first step is to divide the road scheme into segments treating each of them as a separate road source.

2.1.4 The basic noise level for each road segment is then calculated taking into account the following parameters:

- Traffic flow,
- Vehicle speed,
- Percentage of heavy vehicles,
- Road gradient; and
- Road surface.

2.1.5 Subsequent to the calculation of basic noise levels for a road segment at the reception point, corrections of distance attenuation, ground cover for an unobstructed propagation or barrier effect and shielding effect from buildings and topographical features of an obstructed propagation would be made.

2.1.6 Having corrected the basic noise level for propagation, the effect from certain site layout features shall also be considered. This includes the reflection effect from buildings and other hard rigid surfaces, propagation down side roads and corrections for size of segment.

2.1.7 The final predicted noise level would be the combination of noise level contributions from all source segments.

Section II

2.1.8 This section provides additional procedures for special road traffic conditions, including low traffic flow, end of the road scheme, curved roads and multiple roads including roads road junctions. Screening effects given by a uniform row of houses facing a major road and multiple barriers are also considered.

Section III

2.1.9 This section outlines the procedures and requirements to be met by the measurement method, and is thus not relevant to the development of the proposed TNMSDX protocol.

2.2 Key Inputs of CRTN Methodologies

Traffic Noise Source

2.2.1 The dominant factors contributing to the noise levels are traffic flow, speed and characteristics of all the road segments considered in the assessment. The parameters for each road segment to be considered for traffic noise source include:

- East (X), north (Y) and height above datum (Z) (H_S = 0 if the road segment is at grade) of the starting and ending points of the centre-line of the road segment, i.e. the 3D co-ordinates of the two spatial points (see Figures 1 and 3),
- Width of the road segment (see Figure 1),
- Width of central divider if the road is a dual carriageway (see Figure 2),
- Height of the road surface (H_S) above the ground (above Z) if the road segment is a section of a bridge or a flyover,
- Traffic flow, traffic speed, and percentage of heavy vehicles,
- One way or two way flow, and flow direction if it is one way flow,
- Type of ground surface between the road and the noise sensitive receivers, and;
- Road surface type, texture depth of the surface, impervious or pervious to surface water.

Topographic Barrier

2.2.2 Topographic barriers including buildings, podiums, purpose-built noise barriers, retaining walls and natural terrains all provide screening effect to the noise source. The relevant data required for each barrier segment to be considered in the prediction of road traffic noise include:

- East (X), north (Y) and height above datum (Z) (the base of barrier) of the starting and ending points of the barrier segment, i.e. the 3D co-ordinates of the two spatial points (see Figure 4),
- Height of the noise barrier (H_B),
- Inclined angle of the noise barrier, the leaning direction is determined by the sign of the value (see Figure 4), and;
- Acoustic properties of the barrier, i.e. reflective or absorptive.

2.2.3 For topographic screening effect provided by a uniform row of houses, the row of the houses can be treated as a single barrier segment but additional parameters are required (see Figure 5). The relevant data are:

- Mean length of building, and;
- Mean opening between buildings.

Noise Sensitive Receivers

2.2.4 The location and relevant attributes of noise sensitive receivers (NSRs) are also significant to the predicted results. The input parameters considered for a NSR include:

- East (X), north (Y) and height above datum (Z) of the noise reception point, i.e. the 3D co-ordinates of the spatial point,
- Height of the receiver above ground surface (H_R) (see Figure 3),
- Angle of view from the NSR (see Figure 6); and,
- With or without facade correction.

Model Setup Parameters

2.2.5 Other than the information of roads, barriers and receivers, some parameters affecting the noise prediction have to be set by the user or defaulted by the prediction software. The information of these parameters is also required to be included in the data exchange protocol. These parameters are:

- Multiple screening effect of barriers (with or without);
- Opposite facade effect given by barriers (with or without);
- Cut-off angle (if the angle of view of a road segment is less than the specified value, the road segment would not be taken into account in noise prediction);
- Cut-off distance (if the slant distance between a receiver and a road segment is greater than the specified value, the road segment would not be taken into account in noise prediction); and
- Cut-off distance for reflection from barrier (if the distance between a road segment and a barrier beyond is greater than the specified value, the reflection from that barrier would not be taken into account in noise prediction).

2.2.6 For some traffic noise prediction software, an association between a road and a particular noise barrier could be defined such that the associated noise barrier would only provide noise screening effect to that road. This information is also required to be included in the data exchange protocol.

2.2.7 It is recommended that the HK1980 Grid coordinate system should be adopted for the preparation of the input data such that a common reference could be made by the others.

2.3 Proposed Format of TNMSDX

2.3.1 Taking all relevant parameters into consideration, a format of the TNMSDX protocol is proposed. The protocol is divided into four main sections:

- Header section – contains information of the consultant who carried out the noise assessment, project title, date and time of the data file, coordinate system adopted, year of traffic flow used and model setup parameters mentioned in paragraph 2.2.5;
- Road links section – contains information of all road source including the parameters mentioned in paragraphs 2.2.1 and 2.2.6;
- Barrier links section – contains information of all topographic barriers including the parameters mentioned in paragraphs 2.2.2, 2.2.3 and 2.2.6; and
- Noise sensitive receivers section – contains information of all noise sensitive receivers including the parameters mentioned in paragraph 2.2.4.

2.3.2 The proposed format of the TNMSDX protocol is as follows:

```
Name of Consultant:  aaaaa[1]
Telephone Number:    xxxx xxxx[2]
Fax Number:          xxxx xxxx
Email:               aaaaa@aaaaa.com

Project Title:       aaaaa
Date:                xx/xx/xxxx       Time:   xx:xx

Coordinate System used:     aaaaa
Year of Traffic Flow used:  xxxx

Options for Corrections:
Multiple Screening Effect:  Yes/No
Opposite Façade Effect:     Yes/No
Cut-off Angle:     x.x deg.
Cut-off Distance:  xxxx.x m
Cut-off Distance for Reflection from Barrier:  xx.x m

Road Link(s):

Link No.:     xxxx
Link ID:      aaaaa
Category:     (1)New/(2)Existing/(3)Other
Flow:         xxxxx veh/hr
Speed:        xxx.x km/h     Speed Corrected for Gradient: Yes/No
%Heavy Vehicle:    xxx.x
Flow Direction:    One Way/Two Way
Dual Carriageway:  Yes/No
Width of Central Divider: xx.x       Vertical Separation[3]: xx.x
Elevated Road:     Yes/No
Surface Type:      Concrete/Bituminous/Pervious/Surface Corr.
Texture Depth:     xx.x mm
Associated Barrier Link No.: xxx
Seg From                          To                             Width  Ground Type[4]
No. X        Y        Z     H     X        Y        Z     H             Left   Right
1   xxxxxx.x xxxxxx.x xxx.x xxx.x xxxxxx.x xxxxxx.x xxx.x xxx.x xxx.x  xxx.x  xxx.x
2   xxxxxx.x xxxxxx.x xxx.x xxx.x xxxxxx.x xxxxxx.x xxx.x xxx.x xxx.x  xxx.x  xxx.x
.
.

Barrier Link(s):

Link No.:     xxxx
Link ID:      aaaaa
Type:   Absorptive/Reflective
Level:  Grade/Elevated
Associated Road Link No.: xxx
Seg From                          To                             Inclined  Mean    Mean    FOA[7]  Width
No. X        Y        Z     H     X        Y        Z     H        angle[5]  Length[6] Opening[6]
1   xxxxxx.x xxxxxx.x xxx.x xxx.x xxxxxx.x xxxxxx.x xxx.x xxx.x   xx.x    xxx.x   xx.x    x.x   xx.x
2   xxxxxx.x xxxxxx.x xxx.x xxx.x xxxxxx.x xxxxxx.x xxx.x xxx.x   xx.x    xxx.x   xx.x    x.x   xx.x
.
.

Receiver(s):

No.[8] NSR ID              X        Y        Z     H        View Angle Bearing[9]    Facade
                                                              Left    Right      Correction
1    aaaaa               xxxxxx.x xxxxxx.x xxx.x xxx.x      xxx.x   xxx.x         Yes/No
2    aaaaa               xxxxxx.x xxxxxx.x xxx.x xxx.x      xxx.x   xxx.x         Yes/No
```

Remarks:

(1) aaaaa are alphabetical and/or numerical data.

(2) xxxxx are numerical data.

(3) The level difference between two carriageways. This value is used by RoadNoise in defining a dual carriageway with a centre line segment.

(4) The proportion of absorbing ground cover between the road segment and the NSR. The value is 1.0 for total absorbing ground and 0.0 for non-absorbing ground. The value between 0.0 and 1.0 represents the intervening ground cover is partially of an absorbent nature.

(5) The inclined angle of the barrier is measured from the vertical. A positive value represents a barrier leaning to the right and vice versa when looking from the starting point to the ending point (see Figure 4).

(6) For the use of defining a uniform row of buildings (see Figure 5).

(7) Fractional Open Area: proportion of open area of the barrier, e.g. 0.2 represents 20% of the barrier length is open. This value is used by RoadNoise in defining a noise barrier.

(8) The NSRs with the same X-Y co-ordinates at various height levels would be grouped together, i.e. they would be listed one by one.

(9) See Figure 6 for definition of the right and left bearing of the angle of view.

(10) "N/A" should be put in fields which is not used in particular prediction software.

2.4 Sample Data Format of TNMSDX

2.4.1 A sample data format of the proposed TNMSDX is given in Appendix A.

3 REVIEW OF DATA STRUCTURE OF AVAILABLE TRAFFIC NOISE SOFTWARE

3.1 Review of Projects in EIAO registry

3.1.1 Registered EIA projects of the last 3 years have been reviewed for what traffic noise prediction software have been adopted. Five traffic noise prediction software have been identified, namely HFANoise, HFCNoise, WS Atkins RoadNoise 2000, SoundPLAN and TNIA.

3.2 HFANoise ver 1.10

3.2.1 Node numbers are given to start and end points of each road segment, start and end points of each barrier segment and receiver points. Each node contains a set of values of easting, northing, mPD level and height. The type of additional attributes/features of a node depends on what object it is representing, i.e. road, barrier, terrain or receiver.

3.2.2 The input data files for HFANoise are binary coded, and can only be retrieved by the software. The file extension is **.DAT**. The input data can be exported to a file in ASCII format such that the input parameters could be read by text editor, except information of the view angle bearings of receivers, layout barriers and cut-off distance for reflection from barrier.

3.2.3 As the format of the binary coding is not available, a conversion software has been developed to convert the ASCII export file to a TNMSDX format file. However, information of the receivers' view angle is missing in the ASCII file, the values for the "Left View Angle Bearing' and the "Right View Angle Bearing' are defaulted to 0° and 360° respectively. The missing information should be incorporated to the converted file by the user, i.e. to complete the conversion manually.

3.2.4 A type of noise barrier could be defined in HFANoise such that the barrier would provide screening effect to only a road with a designated layout number. This type of noise barrier is called layout barrier. The information of layout barriers is also missing in the text output file mentioned in 3.2.2. Hence an ASCII file containing the information of the layout barrier is required when using the conversion software. The format of the file is as follows:

```
Layout      Lpd   Lbh   Lba   Rpd   Rbh   Rba
------      ---   ---   ---   ---   ---   ---
10          2.0   3.0   0.0   0.0   0.0   0.0
18          0.0   0.0   0.0   2.0   5.0   -15.0
20          2.0   3.0   0.0   2.0   5.0   0.0
```

where `Lpd/Rpd` represents the perpendicular distance of the layout barrier from the left/right kerb
`Lbh/Rbh` represents the height of the left/right layout barrier
`Lba/Rba` represents the inclined angle of the left/right layout barrier

3.2.5 For the example shown in paragraph 3.2.4, the first layout barrier defined for layout number 10 is a barrier at a perpendicular distance of 2.0m from the left kerb of 3.0m high with an inclined angle 0.0° to the vertical. The second layout barrier defined for layout number 18 is a barrier at a perpendicular distance of 2.0m from the right kerb of 5.0m in high with an inclined angle of –15.0°. The third layout barrier defined for layout number 20 are two vertical barriers: one at a perpendicular distance of 2.0m from the left kerb of 3.0m high and one at a perpendicular distance of 2.0m from the right kerb of 5.0m high.

3.2.6 In HFANoise, the default *cut-off distance for reflection from barrier* is 40m which could be changed by the user. As this value is missing in the text output file (see Section 3.2.2), the default value will be adopted when converting the HFANoise data to a TNMSDX format file by the conversion software. If a value other than 40m was used when setting up a HFANoise model, the value in the TNMSDX format file should be amended manually after conversion.

3.3 HFCNoise ver 3.5

3.3.1 The input data files for HFCNoise are in ASCII format. All input parameters are viewed and edited by text editing program. The file extension is **.DAT**.

3.3.2 The data file is divided into four sections: (i) global parameters, (ii) road and traffic information, (iii) barrier information which includes buildings, terrain and purpose built barriers and (iv) receiver information.

3.4 WS Atkins RoadNoise 2000

3.4.1 A set of data files would be generated after each model setup. Each data file contains attributes of one of these objects: roads, barriers, contours, receivers and traffic flow data. Different object files are distinguished by the file extension name. A master file contains a list of these object files will also be generated. All these data files are in ASCII format. Although these files could be edited by a text editor, it is recommended that users should use the software's interface to set up a model and edit the input data.

3.4.2 In WS Atkins RoadNoise 2000, all noise barriers are reflective by default. The noise barriers could be only defined as vertical barriers, i.e. no cantilevered type or inclined barrier is allowed.

3.5 SoundPLAN ver 4.2

3.5.1 For this version of SoundPLAN, several data files will be generated after setting up a traffic noise model. These data files are called geo-database files which are binary coded, and can only be retrieved by the software.

3.5.2 Each geo-database data file contains attributes of one of these objects: roads with traffic data, barriers, contours and receivers, etc.

3.5.3 The conversion software developed can readily convert these binary coded geo-database files into a TNMSDX format file.

3.6 TNIA ver 2.0

3.6.1 The input data file is in MS Excel's worksheet format. Separate worksheets are used to store the information of different attributes: (i) coordinates and heights of all the objects, (ii) road and traffic information, (iii) barrier information, (iv) building blocks information, (iv) receiver information. Model parameters are input and edited in MS Excel.

4 CONCLUSION

4.1 TNMSDX Protocol

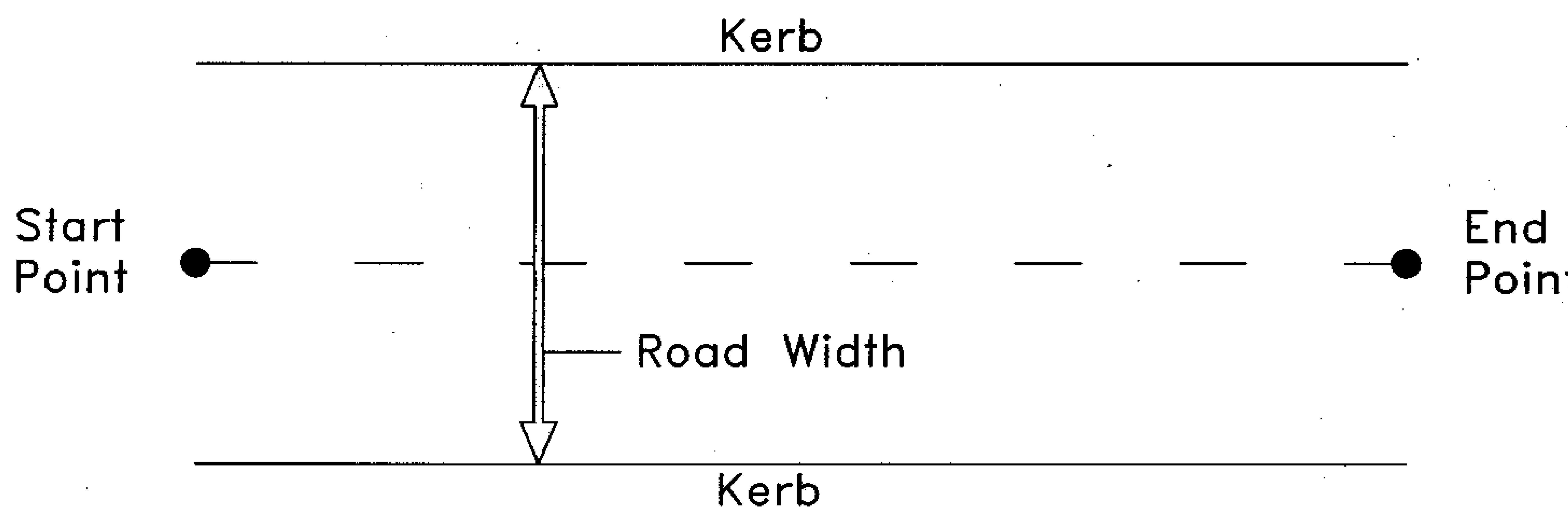
4.1.1 The CRTN methodologies have been reviewed and the essential parameters for the prediction of the road traffic noise level have been identified. A format of the TNMSDX protocol is proposed based on these parameters.

4.1.2 Registered EIA projects of the last 3 years have been reviewed for what traffic noise prediction software have been adopted. Five traffic noise prediction software have been identified, namely HFANoise, HFCNoise, WS Atkins RoadNoise 2000, SoundPLAN and TNIA.

4.2 Conversion Software

4.2.1 A conversion software has been developed to perform the task of converting the input data files of the five identified traffic noise prediction software to files in a standardized format of the proposed TNMSDX protocol.

Figures



Title	Developing Data Exchange Protocal for Traffic Noise Assessment Single Carriageway Road Segment Definition	Scale N.T.S.	Project No. M09201	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
		Date Nov 2001	Figure No. 1	

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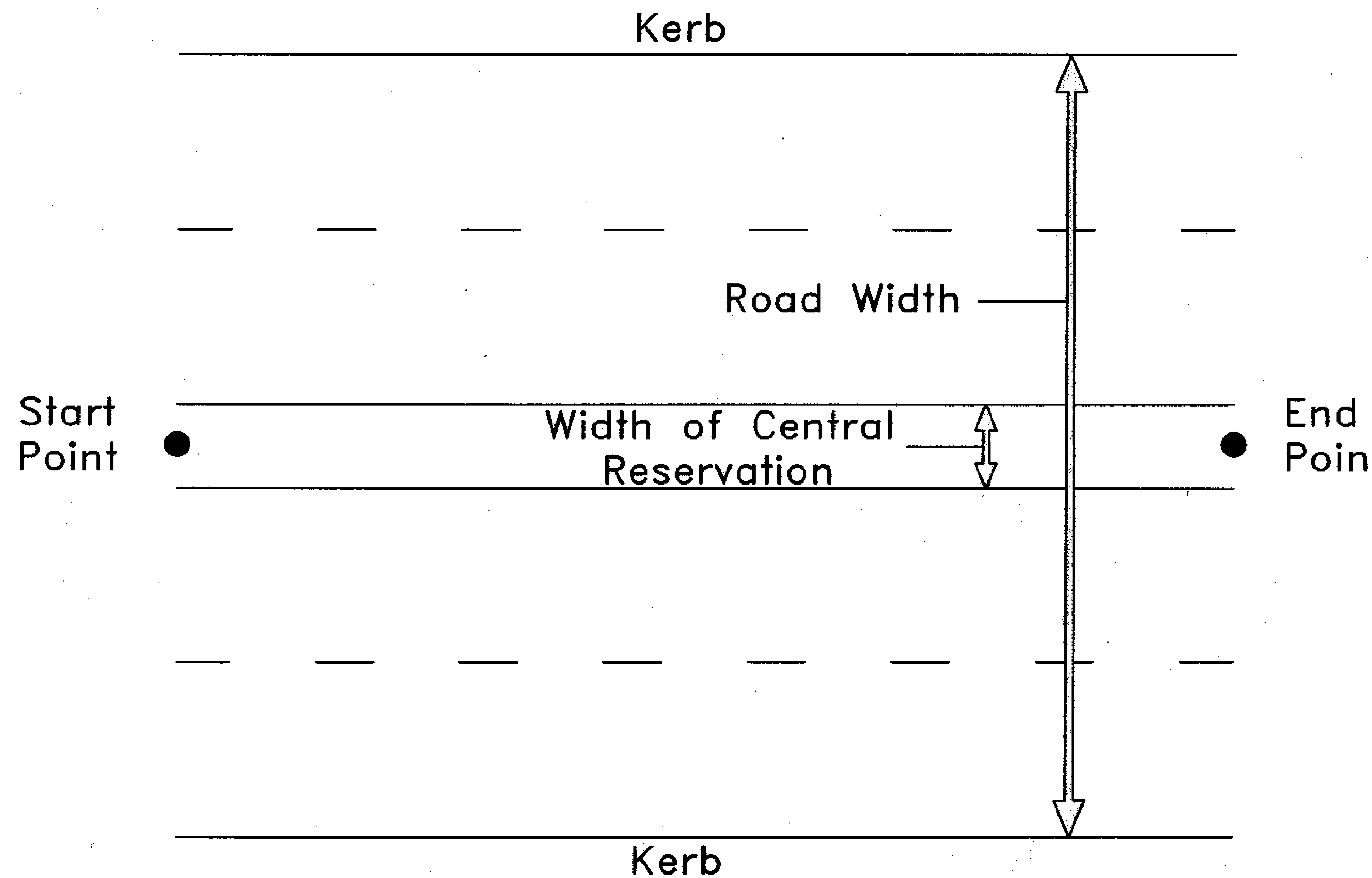

Title		Scale		Project No.	
Developing Data Exchange Protocal for Traffic Noise Assessment Dual Carriageway Road Segment Definition		Scale	N.T.S.	Project No.	M09201
		Date	Nov 2001	Figure No.	2

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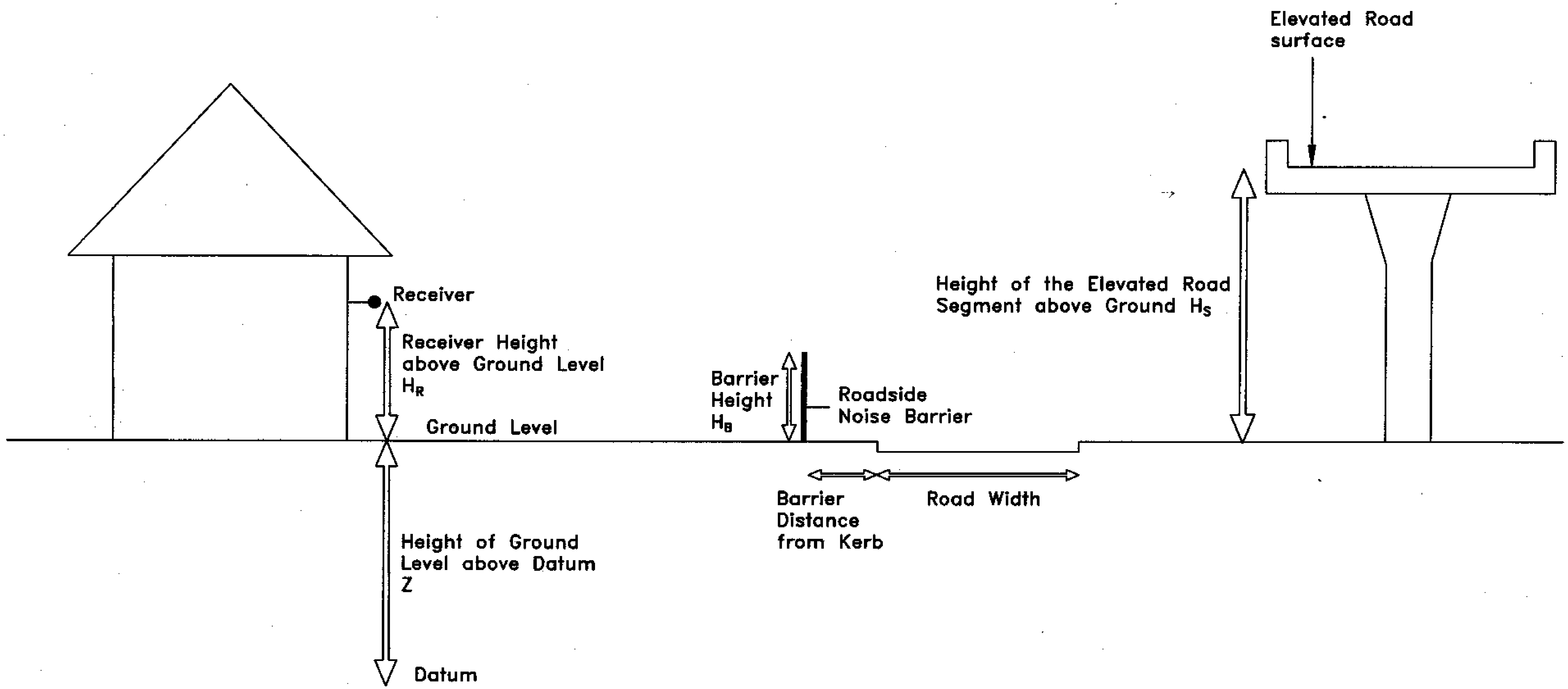
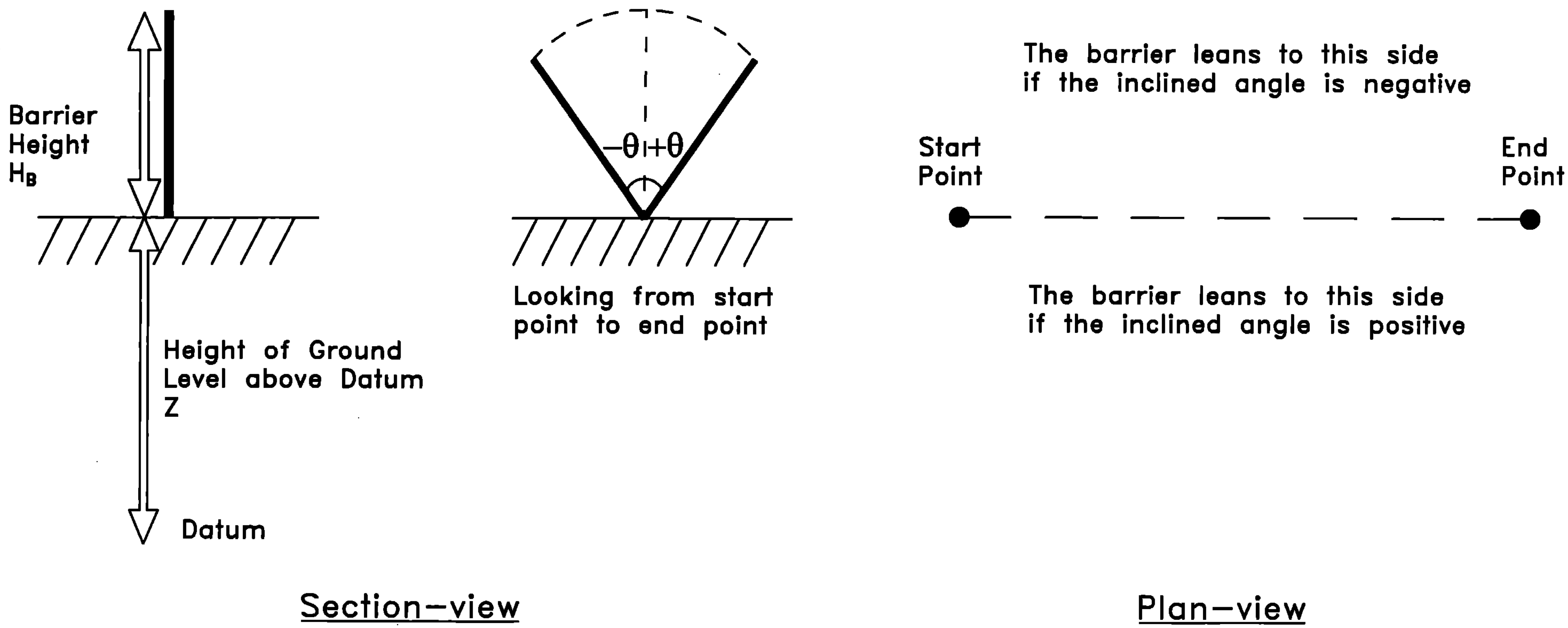


Title		Scale	Project No.	
Developing Data Exchange Protocal for Traffic Noise Assessment Road Layout Cross-section		N.T.S.	M09201	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
		Date: Nov 2001	Figure No. 3	

k:\Projects\M09201\Drawing\Fig3.dwg



Title			
Developing Data Exchange Protocal for Traffic Noise Assessment Barrier Segment Definition	Scale: N.T.S.	Project No. M09201	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date: Feb 2003	Figure No. 4	

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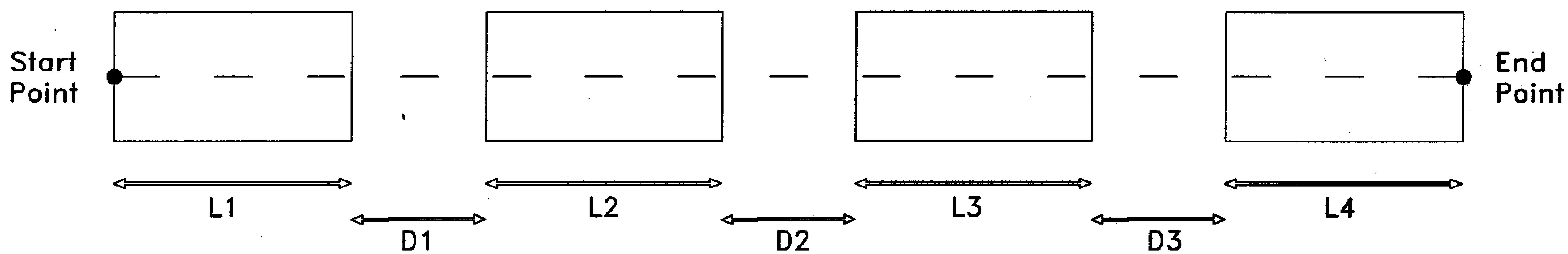

$$\text{Mean Length} = \frac{L1+L2+L3+L4}{4}$$

$$\text{Mean Opening} = \frac{D1+D2+D3}{3}$$

Title: Developing Data Exchange Protocal for Traffic Noise Assessment	Scale: N.T.S.	Project No.: M09201	Maunsell — MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
Building Definition	Date: Nov 2001	Figure No.: 5	

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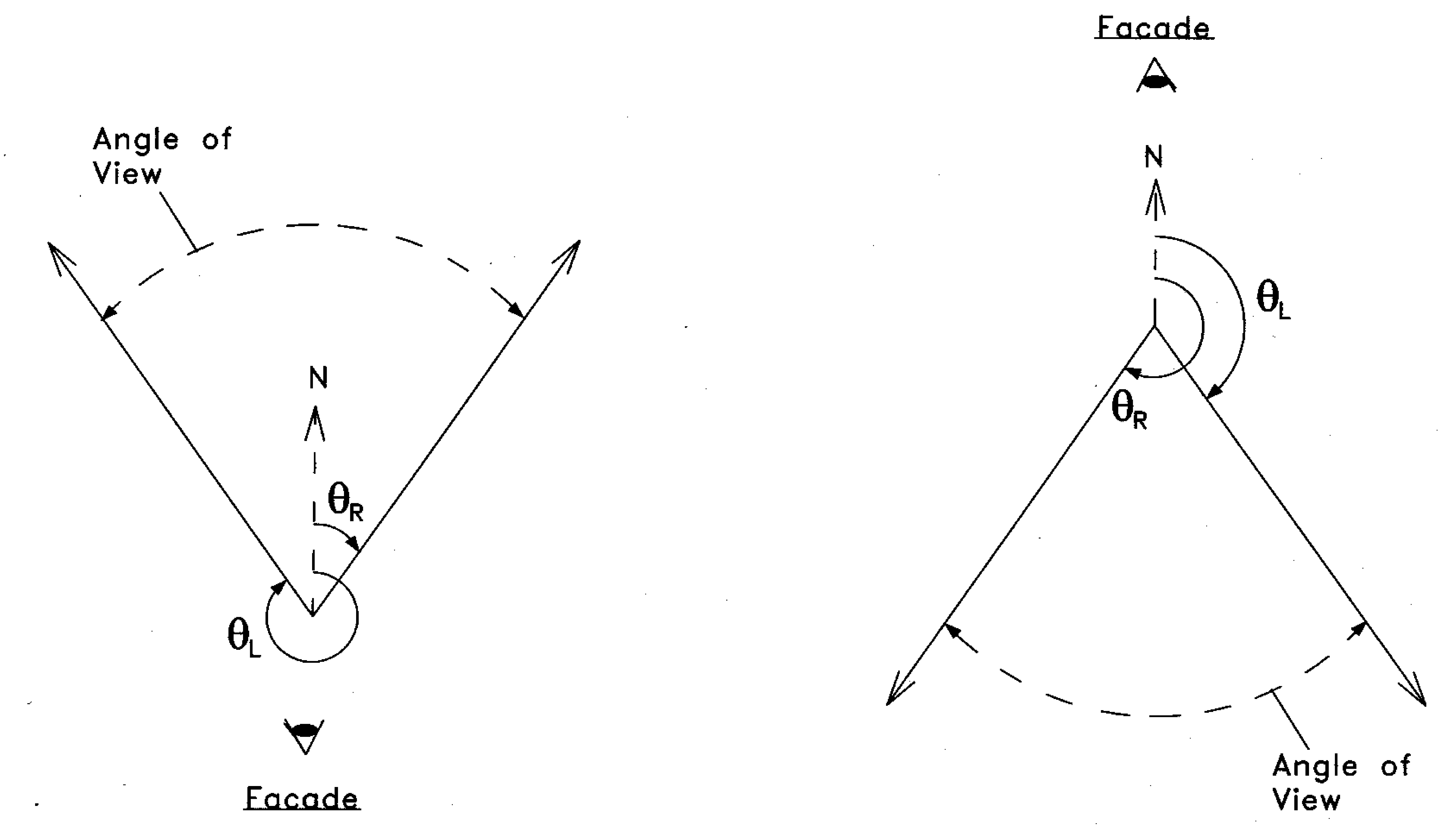

θ_R : Right View Angle Bearing

θ_L : Left View Angle Bearing

Title			
Developing Data Exchange Protocal for Traffic Noise Assessment Angle of View Definition	Scale N.T.S.	Project No. M09201	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date Nov 2001	Figure No. 6	

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Appendix A

Name of Consultant: Maunsell Environmental Management Consultants Limited
Telephone Number: 2893 1551
Fax Number: 2891 0305
Email: mem@maunsell.com.hk

Project Title: EIA Study for Lam Tin Estate Redevelopment
Date: 20/10/2001 Time: 14:34

Coordinate System used: HK1980 Grid
Year of Traffic Flow used: 2018

Options for Corrections:
Multiple Screening Effect: No
Opposite Façade Effect: Yes
Cut-off Angle: 1.5 deg
Cut-off distance: N/A
Cut-off distance for reflection from barrier: 20.0 m

Road Link(s):

Link No.: 1
Link ID: LKR
Category: (1)New
Flow: 1000 veh/hr
Speed: 50.0 km/h Speed Corrected for Gradient: Yes
%Heavy Vehicle: 20.5
Flow Direction: One Way
Dual Carriageway: No
Width of Central Divider: 0 Vertical Separation: 0
Elevated Road: No
Surface Type: Concrete
Texture Depth: 1.5 mm
Associated Barrier Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Width	Ground Type Left	Right
1	819423.2	842599.1	13.0	0.0	819448.3	842634.7	15.3	0.0	11.0	1.0	0.0
2	819448.3	842634.7	15.3	0.0	819489.1	842675.2	17.1	0.0	11.0	1.0	0.0
3	819489.1	842675.2	17.1	0.0	819458.3	842642.3	18.4	0.0	11.0	1.0	0.0

Link No.: 2
Link ID: LLR
Category: (2)Existing
Flow: 3500 veh/hr
Speed: 70.0 km/h Speed Corrected for Gradient: Yes
%Heavy Vehicle: 12.2
Flow Direction: Two Way
Dual Carriageway: Yes
Width of Central Divider: 0 Vertical Separation: 0
Elevated Road: Yes
Surface Type: Pervious
Texture Depth: 1.5 mm
Associated Barrier Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Width	Ground Type Left	Right
1	819425.2	842580.1	8.9	0.0	819450.3	842655.8	9.6	5.0	28.0	0.0	0.0
2	819450.3	842655.8	9.6	0.0	819488.7	842685.5	10.4	6.0	28.0	0.0	0.0
3	819488.7	842685.5	10.4	0.0	819510.3	842715.3	11.4	6.5	28.0	0.0	0.0
4	819510.3	842715.3	11.4	0.0	819531.4	842725.5	11.8	6.0	28.0	0.0	0.0

Barrier Link(s):

Link No.: 1
Link ID: B1
Type: Absorptive
Level: Grade
Associated Road Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Inclined angle	Mean Length	Mean Opening	FOA	Width
1	818858.9	842363.0	6.0	5.5	818851.6	842458.6	8.5	5.5	25.0	0.0	0.0	0.0	0.0
2	818851.6	842458.6	8.5	5.5	818847.2	842520.0	9.6	5.5	25.0	0.0	0.0	0.0	0.0
3	818847.2	842520.0	9.6	5.5	818854.3	842525.1	10.5	5.5	25.0	0.0	0.0	0.0	0.0

Link No.: 2
Link ID: Topo1
Type: Absorptive
Level: Grade
Associated Road Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Inclined angle	Mean Length	Mean Opening	FOA	Width

1	818972.6	842569.9	10.5	0.0	818993.6	842610.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0
2	818993.6	842610.0	12.5	0.0	819000.0	842624.9	12.8	0.0	0.0	0.0	0.0	0.0	0.0
3	819000.0	842624.9	12.8	0.0	819010.0	842625.9	13.0	0.0	0.0	0.0	0.0	0.0	0.0
4	819010.0	842625.9	13.0	0.0	819033.0	842622.6	12.5	0.0	0.0	0.0	0.0	0.0	0.0
5	819033.0	842622.6	12.5	0.0	819040.1	842637.2	12.8	0.0	0.0	0.0	0.0	0.0	0.0

Link No.: 3
Link ID: Topo2
Type: Reflective
Level: Grade
Associated Road Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Inclined angle	Mean Length	Mean Opening	FOA	Width
1	818970.5	842669.9	5.0	0.0	818995.6	842600.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0
2	818995.6	842600.0	8.5	0.0	819052.0	842625.8	12.8	0.0	0.0	0.0	0.0	0.0	0.0
3	819052.0	842625.8	12.8	0.0	819000.0	842624.9	13.0	0.0	0.0	0.0	0.0	0.0	0.0

Link No.: 4
Link ID: Houses
Type: Reflective
Level: Elevated
Associated Road Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Inclined angle	Mean Length	Mean Opening	FOA	Width
1	818860.9	842364.0	12.5	5.5	818852.6	842468.8	13.0	5.5	0.0	9.0	2.5	0.0	0.0

Link No.: 5
Link ID: Podium
Type: Reflective
Level: Grade
Associated Road Link No.: N/A

Seg No.	From X	Y	Z	H	To X	Y	Z	H	Inclined angle	Mean Length	Mean Opening	FOA	Width
1	818858.9	842363.0	6.0	8.0	818851.6	842458.6	8.5	8.0	0.0	9.0	2.5	0.0	0.0
2	818851.6	842458.6	8.5	5.5	818847.2	842520.0	9.6	5.5	0.0	9.0	2.5	0.0	0.0
3	818847.2	842520.0	9.6	5.5	818854.3	842525.1	10.5	5.5	0.0	9.0	2.5	0.0	0.0

Receiver(s):

No.	NSR ID	X	Y	Z	H	View Angle Bearing Left	Right	Facade Correction
1	N1-1	819096.6	842403.7	12.5	10.2	301.8	99.3	Yes
2	N1-5	819096.6	842403.7	12.5	21.4	301.8	99.3	Yes
3	N1-10	819096.6	842403.7	12.5	35.4	301.8	99.3	Yes
4	N1-15	819096.6	842403.7	12.5	49.4	301.8	99.3	Yes
5	N1-20	819096.6	842403.7	12.5	63.4	301.8	99.3	Yes
6	N2	819096.9	842392.5	12.5	10.2	302.2	15.2	Yes
7	N3	819091.4	842389.2	12.5	13.0	298.1	27.3	Yes
8	N4	819093.3	842397.3	12.5	15.0	312.2	25.2	Yes