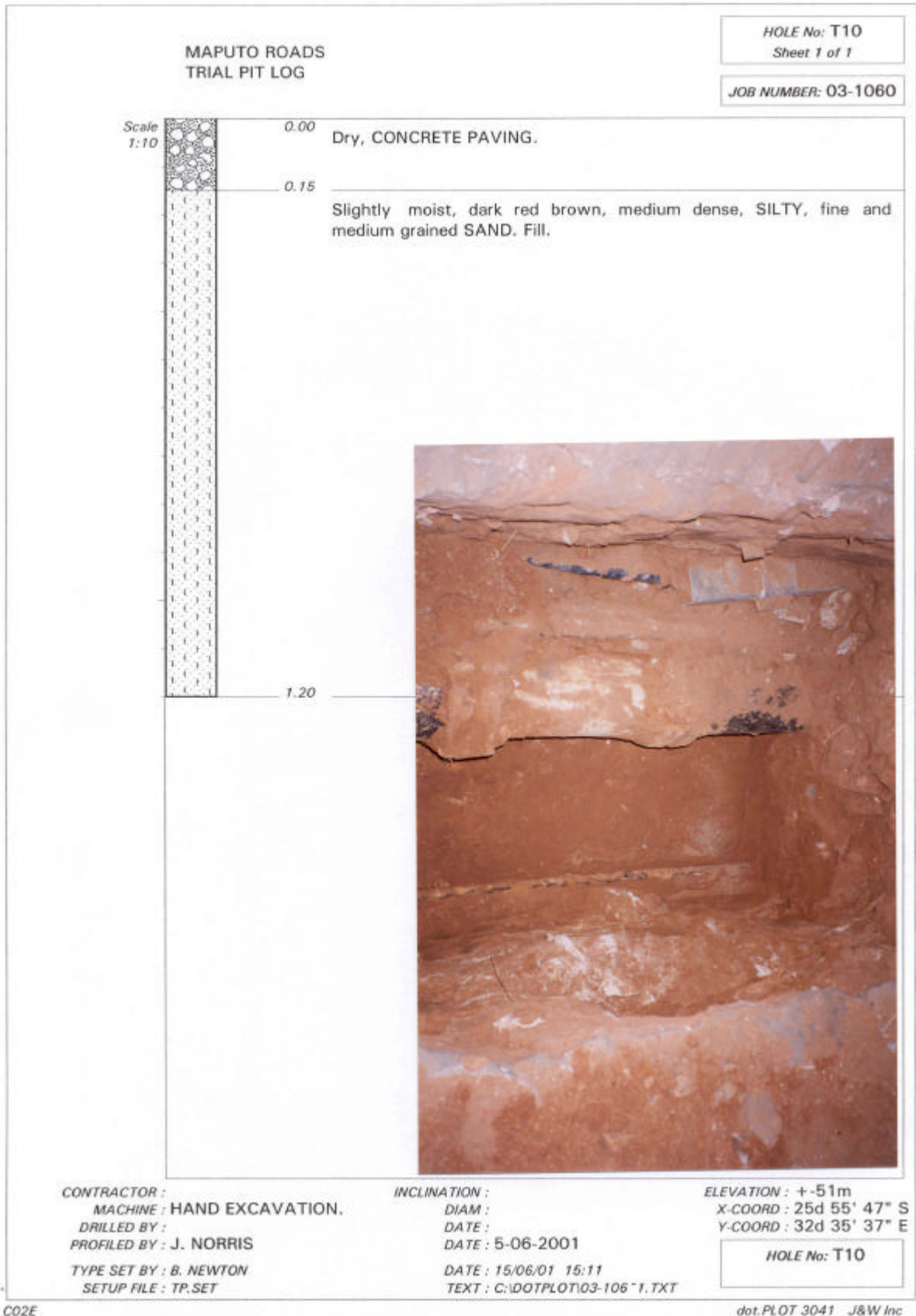


C02E

dot.PLOT 3041 J&W Inc



HOLE No: T10

### 15.3.2 Pavement Structure Survey

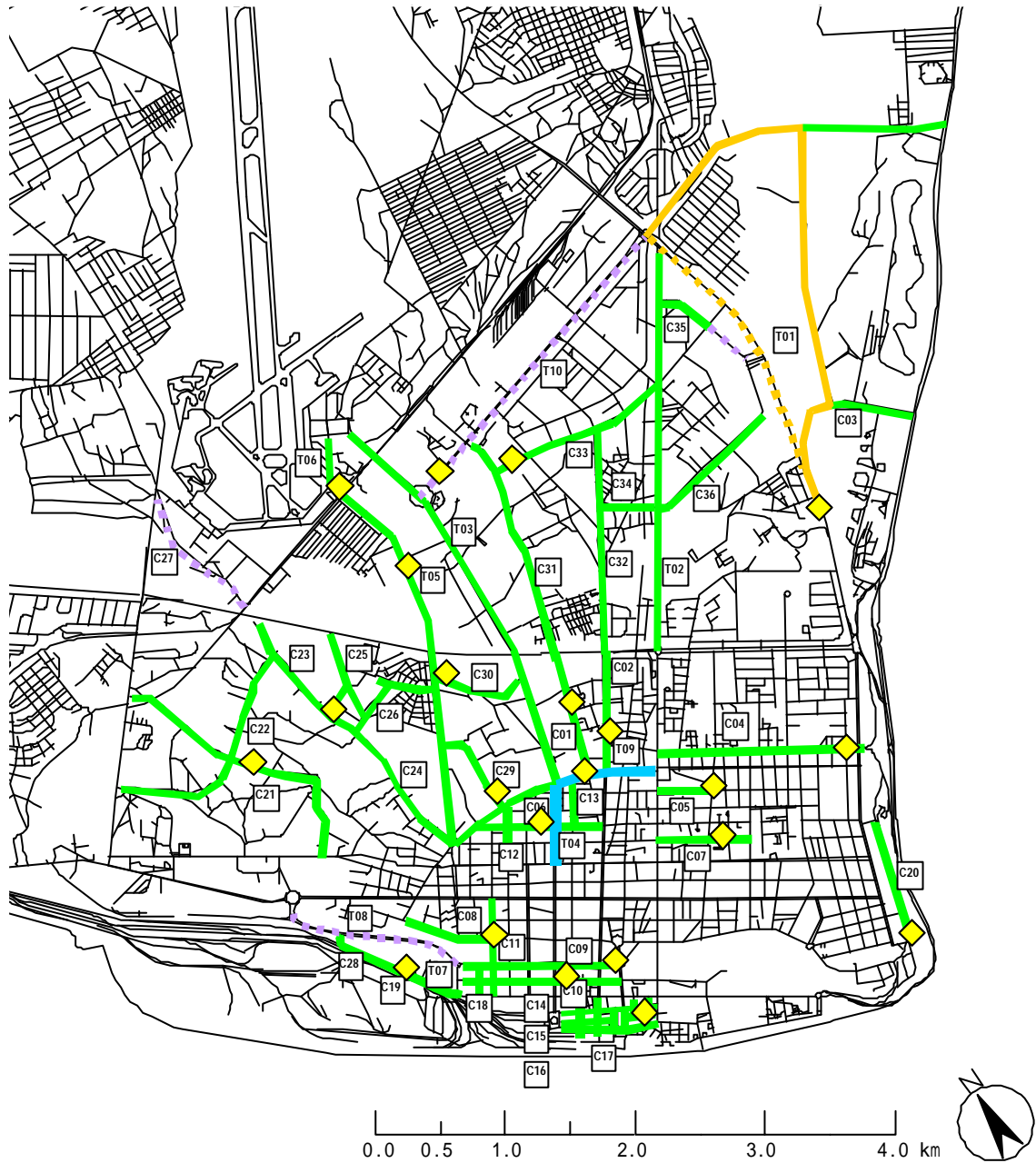


Figure Survey location for thickness of existing pavement

Table Summary of Existing Condition of Pavement

| Road Name      |  | Survey length (km)                                      | Thickness of Asphalt Concrete (cm) | Thickness of Gravel Layer (cm) | Maximum Diameter of Gravel |    |
|----------------|--|---|------------------------------------|--------------------------------|----------------------------|----|
| Trunk Road     | T01) New Construction of Av. Julius Nyerere (incl. Rua 3867, 4500, 4683, 4685) | 5.50  | No pot hole at 4500                |                                |                            |    |
|                | T01) Av. Julius Nyerere (existing route)                                       | 2.80  | 3                                  | 15                             | 3                          |    |
|                | T02) Av. Vladimir Lenine   | 3.20  |                                    |                                |                            |    |
|                | T03) Av. Acordos do Lusaka   | 2.85  | No pot hole                        |                                |                            |    |
|                | T04) Av. Guerra Popular  | 0.70  | No pot hole                        |                                |                            |    |
|                | T05) Av. da Angola   | 3.10  | 5                                  | 15                             | 7                          |    |
|                | T06) Rua S. Cabral / Largo de Deta   | 0.60  | 7                                  | 0                              | -                          |    |
|                | T07) Rua Paulino Santos Gil  | -   |                                    |                                |                            |    |
|                | T08) Av. da ONU  | -   |                                    |                                |                            |    |
|                | T09) Av. Marien Ngouabi  | 0.90  | 8                                  | 14                             | 15                         |    |
|                | T10) Av. da FPLM   | 2.85  | 5                                  | 15                             | 5                          |    |
| Collector Road | District 1   | C01) Av. Milagre Mabote(1369)                           | 1.00                               | 4                              | 12                         | 5  |
|                |  | C02) Av. da Malhangalene(1357)                          | 0.94                               | 6                              | 0                          | -  |
|                |  | C03) Av. Para O Palmar(1426)                            | 1.40                               | No pot hole                    |                            |    |
|                |  | C04) Av. Kawame Nkrumah(1250)                           | 1.61                               | 4                              | 12                         | 5  |
|                |  | C05) Av. Paulo Samuel Kankhomba(1152)                   | 0.55                               | 2                              | 16                         | 10 |
|                |  | C06) Av. Emilia Dausse(1138)                            | 0.85                               | 3                              | 15                         | 10 |
|                |  | C07) Av. de Maguiguana(1130)                            | 0.75                               | 2                              | 12                         | 8  |
|                |  | C08) Av. Josina Michel(1070)                            | 0.90                               | See C11)                       |                            |    |
|                |  | C09) Av. Fernao de Magalhaes(1038)                      | 1.30                               | 3                              | 16                         | 7  |
|                |  | C10) Av. Zedequias Manganhela(1034)                     | 1.30                               | 3                              | 20                         | 10 |
|                |  | C11) Av. Mohamed Siad Barre(1203)                       | 0.85                               | 4                              | 22                         | 10 |
|                |  | C12) Av. RomaoFernandes(1199)                           | 0.85                               | See C06)                       |                            |    |
|                |  | C13) Av. Filipe Samuel Magaia(1183)                     | 0.40                               | See C06)                       |                            |    |
|                |  | C14) R. Consiglieri Pedroso(1022)/R. Joaquim Lapa(1020) | 0.80                               | See C15)                       |                            |    |
|                |  | C15) R. do Bagamayo(1016)/R. de Timor Leste(1014)       | 0.80                               | 2                              | 20                         | 7  |
|                |  | C16) Av. Martires de Inhaminga(1006)                    | 0.80                               | See C15)                       |                            |    |
|                |  | C17) Port Area(6 roads)                                 | 1.50                               | See C15)                       |                            |    |
|                |  | C18) Rua 1229   | 0.25                               | See C15)                       |                            |    |
|                |  | C19) Av. das Estancias(1030)                            | 0.58                               | 3                              | 14                         | 7  |
|                |  | C20) Av. Friedrich Engels(1009)                         | 1.20                               | 2                              | 14                         | 5  |
|                | District 2   | C21) Rua 2282/2265                                      | 2.36                               | 1                              | 18                         | 3  |
|                |  | C22) Rua 2275   | 2.01                               | No pavement                    |                            |    |
|                |  | C23) Rua de Xipamanine(2291)                            | 1.13                               | No pavement                    |                            |    |
|                |  | C24) Rua dos Imaos Roby(2289)                           | 1.3                                | 4                              | 0                          | 0  |
|                |  | C25) Rua 2315/2313                                      | 0.7                                | No pavement                    |                            |    |
|                |  | C26) Rua 2309/2324                                      | 1                                  | No pavement                    |                            |    |
|                |  | C27) Rua 2522   | 1.25                               | No pavement                    |                            |    |
|                |  | C28) Av. das Estancias(2000)                            | 0.49                               | See C19)                       |                            |    |
|                | District 3   | C29) Rua da Goa(3027)                                   | 0.8                                | 1                              | 2                          | 3  |
|                |  | C30) Rua da Lixeira(3030)                               | 0.79                               | 1                              | 5                          | 3  |
|                |  | C31) Av. Milagre Mabote(3001)                           | 1.98                               | See C01)                       |                            |    |
|                |  | C32) Av. da Malhangalene(3259)                          | 1.83                               | See C02)                       |                            |    |
|                |  | C33) Rua 1 de Maio(3374)                                | 1.49                               | 5                              | 15                         | 5  |
|                |  | C34) Rua 3306   | 0.49                               | No pavement                    |                            |    |
|                |  | C35) Rua 3523   | 1                                  | No pavement                    |                            |    |
|                |  | C36) Rua 3576   | 1.1                                | No pavement                    |                            |    |

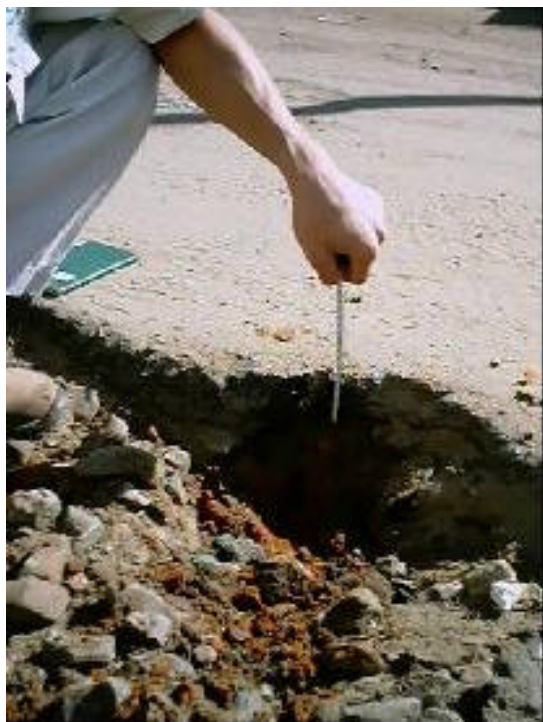


Photo Existing Pavement Thickness



**Photo Trial pitting, encountered with Cables and Groundwater**

## Appendix 15.4 Soil Test Results

### 15.4.1 Borehole Sampling

**Table 1 Laboratory Soil Tests Results for Boreholes (1/2)**

|  |   | 1            | 2          | 3                              | 4          | 5          | 6           |    |
|--|---|--------------|------------|--------------------------------|------------|------------|-------------|----|
| Laboratory Number                                |   | 1595         | 1596       | 1597                           | 1598       | 1599       | 1600        |    |
| Km. / Position                                   |   | Borehole 1   | Borehole 1 | Borehole 1                     | Borehole 2 | Borehole 2 | Borehole 2  |    |
| Depth (m)  |   | 0 - 1.0      | 6 - 7.0    | 13 - 14                        | 5 - 6      | 12 - 13    | 17 - 18     |    |
| Sample   |   | Lt.O.Br.Sand | Lt.Br.Sand | Lt.Br.Coarse                   | Dk.R.Br.   | Dk.R.O.    | Lt.R.O.Sand |    |
| Description                                      |   |              |            | Sand                           | Sand       | Sand       | & Gravel    |    |
| Grain size Analysis                              | Gravel                                    | 63.00        |            |                                |            |            |             |    |
|  |   | 53.00        | 100        | 100                            | 100        | 100        | 100         |    |
|  |   | 37.50        | 100        | 100                            | 100        | 100        | 100         |    |
|  |   | 26.50        | 100        | 100                            | 100        | 100        | 100         |    |
|  |   | 19.00        | 96         | 100                            | 100        | 100        | 100         |    |
|  | Sand                                      | 13.20        | 96         | 100                            | 100        | 100        | 100         | 98 |
|  |   | 4.75         | 95         | 100                            | 100        | 100        | 100         | 97 |
|  |   | 2.00         | 94         | 100                            | 100        | 100        | 100         | 85 |
|  |   | 0.425        | 85         | 53                             | 90         | 82         | 82          | 61 |
|  |   | Clay-Silt    | 0.075      | 6                              | 1          | 24         | 9           | 10 |
|  | 0.060                                     |              |            |                                |            |            |             |    |
|  | 0.050                                     |              |            |                                |            |            |             |    |
|  | 0.026                                     |              |            |                                |            |            |             |    |
|  | 0.015                                     |              |            |                                |            |            |             |    |
|  | 0.010                                     |              |            |                                |            |            |             |    |
|  | 0.0074                                    |              |            |                                |            |            |             |    |
|  | 0.005                                     |              |            |                                |            |            |             |    |
|  | 0.0036                                    |              |            |                                |            |            |             |    |
|  | 0.0020                                    |              |            |                                |            |            |             |    |
|  | 0.0015                                    |              |            |                                |            |            |             |    |
| Gravel Content                                   |   | 5            | 0          | 0                              | 0          | 0          | 3           |    |
| Sand Content                                     |   | 89           | 99         | 76                             | 91         | 90         | 87          |    |
| Silt Content                                     |   | 6            | 1          | 24                             | 9          | 10         | 10          |    |
| Clay Content                                     |   | 0            | 0          | 0                              | 0          | 0          | 0           |    |
| Grading Modulus                                  |   | 1.15         | 1.47       | 0.87                           | 1.09       | 1.09       | 1.44        |    |
| % passing  | 2.00mm                                    | 94           | 100        | 100                            | 100        | 100        | 85          |    |
|  | 0.425mm                                   | 85           | 53         | 90                             | 82         | 82         | 61          |    |
|  | 0.075mm                                   | 6            | 1          | 24                             | 9          | 10         | 10          |    |
| LL&PL  | Liquid Limit                              | NP           | NP         | NP                             | NP         | SP         | SP          |    |
|  | Plasticity Index                          | 0.0          | 0.0        | 0.0                            | 0.0        | 0.0        | 0.5         |    |
|  | Linear Shrinkage                          |              |            |                                |            |            |             |    |
|  | Equivalent PI                             |              |            |                                |            |            |             |    |
| Classification                                   |   | A-3          | A-3        | A-2-4                          | A-3        | A-3        | A-3         |    |
| Usual types of significant constituent materials |   | Fine sand    | Fine sand  | Silty or claye gravel and sand | Fine sand  | Fine sand  | Fine sand   |    |
| General ratings as subgrad                       |   |              |            |                                |            |            |             |    |
| Specific gravity                                 |   | 2635         | 2656       | 2599                           | 2543       | 2543       | 2551        |    |
| Natural Water Content                            |   |              |            |                                |            |            |             |    |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) |              |            |                                |            |            |             |    |
|  | Optimum Moisture Content (%)              |              |            |                                |            |            |             |    |
| CBR  | Average California Bearing Ratio          |              |            |                                |            |            |             |    |
|  | Maximum Swell (%) after 4 days            |              |            |                                |            |            |             |    |
| Direct shear testing                             | Cohesion<br>kN/m <sup>2</sup>             | 80% of MDD   |            |                                |            |            |             |    |
|  |   | 90% of MDD   |            |                                |            |            |             |    |
|  |   | 100% of MDD  |            |                                |            |            |             |    |
|  | Friction<br>angle, °                      | 80% of MDD   |            |                                |            |            |             |    |
|  |   | 90% of MDD   |            |                                |            |            |             |    |
|  |   | 100% of MDD  |            |                                |            |            |             |    |

**Table 2 Laboratory Soil Tests Results for Boreholes (2/2)**

|  |   | 7                              | 8                              | 9          |     |  |  |
|--|---|--------------------------------|--------------------------------|------------|-----|--|--|
| Laboratory Number                                |   | 1601                           | 1602                           | 1603       |     |  |  |
| Km. / Position                                   |   | Borehole 3                     | Borehole 3                     | Borehole 3 |     |  |  |
| Depth (m)  |   | 6 - 7                          | 8 - 9                          | 14 - 15    |     |  |  |
| Sample   |   | Dk.R.Sand                      | Dk.R.Br.Sand                   | Lt.Br.Sand |     |  |  |
| Description                                      |   |                                | & Gravel                       | & Gravel   |     |  |  |
| Grain size Analysis                              | Gravel                                    | 63.00                          |                                |            |     |  |  |
|  |   | 53.00                          | 100                            | 100        | 100 |  |  |
|  |   | 37.50                          | 100                            | 100        | 100 |  |  |
|  |   | 26.50                          | 100                            | 100        | 100 |  |  |
|  |   | 19.00                          | 100                            | 100        | 96  |  |  |
|  |   | 13.20                          | 100                            | 100        | 93  |  |  |
|  | Sand                                      | 4.75                           | 100                            | 100        | 89  |  |  |
|  |   | 2.00                           | 100                            | 100        | 87  |  |  |
|  |   | 0.425                          | 97                             | 95         | 44  |  |  |
|  |   | 0.075                          | 27                             | 29         | 5   |  |  |
|  | Clay -Silt                                | 0.060                          |                                |            |     |  |  |
|  |   | 0.050                          |                                |            |     |  |  |
|  |   | 0.026                          |                                |            |     |  |  |
|  |   | 0.015                          |                                |            |     |  |  |
|  |   | 0.010                          |                                |            |     |  |  |
|  |   | 0.0074                         |                                |            |     |  |  |
|  |   | 0.005                          |                                |            |     |  |  |
|  |   | 0.0036                         |                                |            |     |  |  |
|  |   | 0.0020                         |                                |            |     |  |  |
|  |   | 0.0015                         |                                |            |     |  |  |
| Gravel Content                                   |   | 0                              | 0                              | 11         |     |  |  |
| Sand Content                                     |   | 73                             | 71                             | 84         |     |  |  |
| Silt Content                                     |   | 27                             | 29                             | 5          |     |  |  |
| Clay Content                                     |   | 0                              | 0                              | 0          |     |  |  |
| Grading Modulus                                  |   | 0.76                           | 0.76                           | 1.64       |     |  |  |
| % passing  | 2.00mm                                    | 100                            | 100                            | 87         |     |  |  |
|  | 0.425mm                                   | 97                             | 95                             | 44         |     |  |  |
|  | 0.075mm                                   | 27                             | 29                             | 5          |     |  |  |
| LL&PL  | Liquid Limit                              | NP                             | SP                             | NP         |     |  |  |
|  | Plasticity Index                          | 0.0                            | 0.5                            | 0.0        |     |  |  |
|  | Linear Shrinkage                          |                                |                                |            |     |  |  |
|  | Equivalent PI                             |                                |                                |            |     |  |  |
| Classification                                   |   | A-2-4                          | A-2-4                          | A-3        |     |  |  |
| Usual types of significant constituent materials |   | Silty or claye gravel and sand | Silty or claye gravel and sand | Fine sand  |     |  |  |
| General ratings as subgrad                       |   |                                |                                |            |     |  |  |
| Specific gravity                                 |   |                                | 2591                           | 2568       |     |  |  |
| Natural Water Content                            |   |                                |                                |            |     |  |  |
| Compa-ction                                      | Maximum Dry Density ( kg/m <sup>3</sup> ) |                                |                                |            |     |  |  |
|  | Optimum Moisture Content (%)              |                                |                                |            |     |  |  |
| CBR  | Average California Bearing Ratio          |                                |                                |            |     |  |  |
|  | Maximum Swell (%) after 4 days            |                                |                                |            |     |  |  |
| Direct shear testing                             | Cohesion, kN/m <sup>2</sup>               | 80% of MDD                     |                                |            |     |  |  |
|  |   | 90% of MDD                     |                                |            |     |  |  |
|  |   | 100% of MDD                    |                                |            |     |  |  |
|  | Friction angle, °                         | 80% of MDD                     |                                |            |     |  |  |
|  |   | 90% of MDD                     |                                |            |     |  |  |
|  |   | 100% of MDD                    |                                |            |     |  |  |



15.4.2 CBR Sampling

Table 1 Laboratory Soil Tests Results for Test Pits (1/6)

|  |   | 1                    | 2                                 | 3                    | 4                      | 5                    | 6                    |     |
|--|---|----------------------|-----------------------------------|----------------------|------------------------|----------------------|----------------------|-----|
| Laboratory Number                                |   | 1570                 | 1591                              | 1563                 | 1584                   | 1588                 | 1587                 |     |
| Km. / Position                                   |   | Av. 24               | Ave. 25                           | C04                  | C07                    | C10                  | C11                  |     |
| Depth (m)  |   | De Julho             | De Setembro                       |                      |                        |                      |                      |     |
| Sample   |   | Lt.Y.O.Sand          | Dk.Br.Lt.O.G.                     | Dk.R.Br.             | Dk.Br.Lt.<br>R.Br.Sand | Lt.R.O.              | Lt.Br.Sand           |     |
| Description                                      |   |                      | Sand & Gravel                     | Sand                 | & Gravel               | Sand                 |                      |     |
| Grain size Analysis                              | Gravel                                    | 63.00                | 100                               | 100                  | 100                    | 100                  | 100                  |     |
|  |   | 53.00                | 100                               | 100                  | 100                    | 100                  | 100                  |     |
|  |   | 37.50                | 100                               | 100                  | 100                    | 100                  | 100                  |     |
|  |   | 26.50                | 100                               | 100                  | 100                    | 100                  | 100                  |     |
|  |   | 19.00                | 100                               | 100                  | 100                    | 100                  | 100                  |     |
|  | Sand                                      | 13.20                | 98                                | 98                   | 100                    | 99                   | 100                  | 100 |
|  |   | 4.75                 | 97                                | 97                   | 100                    | 94                   | 99                   | 100 |
|  |   | 2.00                 | 96                                | 96                   | 100                    | 90                   | 99                   | 100 |
|  | Clay • Silt                               | 0.425                | 89                                | 89                   | 90                     | 79                   | 84                   | 65  |
|  |   | 0.075                | 11                                | 12                   | 11                     | 9                    | 7                    | 1   |
|  |   | 0.060                | 6                                 | 7                    | 11                     | 8                    | 7                    | 1   |
|  |   | 0.050                | 6                                 | 7                    | 10                     | 7                    | 5                    | 1   |
|  |   | 0.026                | 5                                 | 6                    | 8                      | 6                    | 4                    | 1   |
|  |   | 0.015                | 4                                 | 5                    | 6                      | 6                    | 3                    | 0   |
|  |   | 0.010                | 0                                 | 4                    | 5                      | 5                    | 3                    | 0   |
|  |   | 0.0074               | 0                                 | 3                    | 4                      | 4                    | 2                    | 0   |
|  |   | 0.005                | 0                                 | 2                    | 3                      | 3                    | 2                    | 0   |
|  |   | 0.0036               | 0                                 | 1                    | 1                      | 2                    | 1                    | 0   |
|  | 0.0020                                    | 0                    | 0                                 | 0                    | 0                      | 0                    | 0                    |     |
|  | 0.0015                                    | 0                    | 0                                 | 0                    | 0                      | 0                    | 0                    |     |
| Gravel Content                                   |   | 3                    | 3                                 | 0                    | 6                      | 1                    | 0                    |     |
| Sand Content                                     |   | 86                   | 85                                | 89                   | 85                     | 92                   | 99                   |     |
| Silt Content                                     |   | 11                   | 12                                | 11                   | 9                      | 7                    | 1                    |     |
| Clay Content                                     |   | 0                    | 0                                 | 0                    | 0                      | 0                    | 0                    |     |
| Grading Modulus                                  |   | 1.03                 | 1.03                              | 1.01                 | 1.22                   | 1.10                 | 1.37                 |     |
| % passing  | 2.00mm                                    | 96                   | 96                                | 100                  | 90                     | 99                   | 100                  |     |
|  | 0.425mm                                   | 89                   | 89                                | 90                   | 79                     | 84                   | 65                   |     |
|  | 0.075mm                                   | 11                   | 12                                | 11                   | 9                      | 7                    | 1                    |     |
| LL&PL  | Liquid Limit                              | -                    | -                                 | -                    | -                      | -                    | -                    |     |
|  | Plasticity Index                          | NP                   | NP                                | NP                   | NP                     | NP                   | NP                   |     |
|  | Linear Shrinkage                          | 0.0                  | 0.0                               | 0.0                  | 0.0                    | 0.0                  | 0.0                  |     |
|  | Equivalent PI                             | 0                    | 0                                 | 0                    | 0                      | 0                    | 0                    |     |
| Classification                                   |   | A-3                  | A-2-4                             | A-3                  | A-3                    | A-3                  | A-3                  |     |
| Usual types of significant constituent materials |   | Fine sand            | Silty or claye<br>gravel and sand | Fine sand            | Fine sand              | Fine sand            | Fine sand            |     |
| General ratings as subgrad                       |   | Excellent to<br>good | Excellent to<br>good              | Excellent to<br>good | Excellent to<br>good   | Excellent to<br>good | Excellent to<br>good |     |
| Specific gravity                                 |   |                      |                                   |                      |                        |                      |                      |     |
| Natural Water Content                            |   |                      |                                   |                      |                        |                      |                      |     |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1836                 | 1834                              | 1816                 | 1807                   | 1722                 | 1606                 |     |
|  | Optimum Moisture Content (%)              | 9.4                  | 9.6                               | 9.4                  | 11.9                   | 6.9                  | 6.2                  |     |
| CBR  | Average California Bearing Ratio          | 35                   | 25                                | 27                   | 22                     | 18                   | 23                   |     |
|  | Maximum Swell (%) after 4 days            | 0.00                 | 0.00                              | 0.00                 | 0.00                   | 0.00                 | 0.00                 |     |
| Direct shear testing                             | Cohesion<br>kN/m <sup>2</sup>             | 80% of MDD           |                                   |                      |                        |                      |                      |     |
|  |   | 90% of MDD           |                                   |                      |                        |                      |                      |     |
|  |   | 100% of MDD          |                                   |                      |                        |                      |                      |     |
|  | Friction<br>angle, °                      | 80% of MDD           |                                   |                      |                        |                      |                      |     |
|  |   | 90% of MDD           |                                   |                      |                        |                      |                      |     |
|  |   | 100% of MDD          |                                   |                      |                        |                      |                      |     |

**Table 1 Laboratory Soil Tests Results for Test Pits (2/6)**

|  |   | 7                 | 8                 | 9                              | 10                | 11                | 12          |
|--|---|-------------------|-------------------|--------------------------------|-------------------|-------------------|-------------|
| Laboratory Number                                |   | 1577              | 1573              | 1562                           | 1578              | 1556              | 1566        |
| Km. / Position                                   |   | C16 / 1           | C16/2             | C20                            | C21/1             | C21/2             | C22         |
| Depth (m)  |   |                   |                   |                                |                   |                   |             |
| Sample   |   | Dk.R.O.Sand       | Dk.R.Br.Sand      | Dk.R.Br.Sand                   | Lt.Br.Lt.G.       | Lt.Y.O.Sand       | Lt.Y.O.Sand |
| Description                                      |   | & Gravel          | & Gravel          | & Gravel                       | Sand              |                   |             |
| Grain size Analysis                              | Gravel                                    | 63.00             | 100               | 100                            | 100               | 100               | 100         |
|  |   | 53.00             | 100               | 100                            | 100               | 100               | 100         |
|  |   | 37.50             | 100               | 100                            | 100               | 100               | 100         |
|  |   | 26.50             | 100               | 100                            | 100               | 100               | 100         |
|  |   | 19.00             | 100               | 100                            | 99                | 100               | 100         |
|  |   | 13.20             | 100               | 97                             | 98                | 100               | 100         |
|  | Sand                                      | 4.75              | 99                | 90                             | 95                | 100               | 100         |
|  |   | 2.00              | 98                | 87                             | 94                | 99                | 100         |
|  |   | 0.425             | 89                | 77                             | 81                | 96                | 97          |
|  |   | 0.075             | 9                 | 10                             | 11                | 7                 | 9           |
|  | Clay +Silt                                | 0.060             | 5                 | 3                              | 11                | 6                 | 9           |
|  |   | 0.050             | 5                 | 3                              | 10                | 6                 | 7           |
|  |   | 0.026             | 5                 | 2                              | 9                 | 6                 | 6           |
|  |   | 0.015             | 5                 | 2                              | 8                 | 5                 | 4           |
|  |   | 0.010             | 4                 | 2                              | 6                 | 4                 | 2           |
|  |   | 0.0074            | 4                 | 2                              | 4                 | 2                 | 0           |
|  |   | 0.005             | 2                 | 1                              | 3                 | 1                 | 0           |
|  |   | 0.0036            | 1                 | 0                              | 2                 | 0                 | 0           |
|  |   | 0.0020            | 0                 | 0                              | 0                 | 0                 | 0           |
|  |   | 0.0015            | 0                 | 0                              | 0                 | 0                 | 0           |
| Gravel Content                                   |   | 1                 | 10                | 5                              | 0                 | 0                 |             |
| Sand Content                                     |   | 90                | 80                | 84                             | 93                | 91                |             |
| Silt Content                                     |   | 9                 | 10                | 11                             | 7                 | 9                 |             |
| Clay Content                                     |   | 0                 | 0                 | 0                              | 0                 | 0                 |             |
| Grading Modulus                                  |   | 1.03              | 1.26              | 1.14                           | 0.98              | 0.95              |             |
| % passing  | 2.00mm                                    | 98                | 87                | 94                             | 99                | 100               |             |
|  | 0.425mm                                   | 89                | 77                | 81                             | 96                | 97                |             |
|  | 0.075mm                                   | 9                 | 10                | 11                             | 7                 | 9                 |             |
| LL&PL  | Liquid Limit                              | -                 | -                 | -                              | -                 | -                 |             |
|  | Plasticity Index                          | NP                | NP                | NP                             | NP                | NP                |             |
|  | Linear Shrinkage                          | 0.0               | 0.0               | 0.0                            | 0.0               | 0.0               |             |
|  | Equivalent PI                             | 0                 | 0                 | 0                              | 0                 | 0                 |             |
| Classification                                   |   | A-3               | A-3               | A-2-4                          | A-3               | A-3               |             |
| Usual types of significant constituent materials |   | Fine sand         | Fine sand         | Silty or claye gravel and sand | Fine sand         | Fine sand         |             |
| General ratings as subgrad                       |   | Excellent to good | Excellent to good | Excellent to good              | Excellent to good | Excellent to good |             |
| Specific gravity                                 |   |                   |                   |                                |                   |                   |             |
| Natural Water Content                            |   |                   |                   |                                |                   |                   |             |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1757              | 1890              | 1868                           | 1713              | 1735              |             |
|  | Optimum Moisture Content (%)              | 9.3               | 8.5               | 6.9                            | 10.7              | 5.9               |             |
| CBR  | Average California Bearing Ratio          | 32                | 41                | 41                             | 21                | 24                |             |
|  | Maximum Swell (%) after 4 days            | 0.00              | 0.01              | 0.00                           | 0.00              | 0.00              |             |
| Direct shear testing                             | Cohesion, kN/m <sup>2</sup>               | 80% of MDD        |                   |                                |                   |                   |             |
|  |   | 90% of MDD        |                   |                                |                   |                   |             |
|  |   | 100% of MDD       |                   |                                |                   |                   |             |
|  | Friction angle, °                         | 80% of MDD        |                   |                                |                   |                   |             |
|  |   | 90% of MDD        |                   |                                |                   |                   |             |
|  |   | 100% of MDD       |                   |                                |                   |                   |             |

Table 1 Laboratory Soil Tests Results for Test Pits (3/6)

|  |   | 13                             | 14                | 15                | 16                | 17                | 18                |    |
|--|---|--------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|----|
| Laboratory Number                                |   | 1589                           | 1579              | 1569              | 1559              | 1575              | 1571              |    |
| Km. / Position                                   |   | C23                            | C24               | C25               | C27               | C27               | C30               |    |
| Depth (m)  |   |                                |                   |                   | 0.30 - 1.20       | 0.0-0.30          |                   |    |
| Sample   |   | Lt.Br.Lt.R.O.                  | Lt.O.Br.Sand      | Lt.Br.Sand        | Lt.Y.Br. Lt.Y.O.  | Dk.Y.Br.          | Dk.Br.Sand        |    |
| Description                                      |   | Sand & Gravel                  |                   |                   | Sand              | Sand & Gravel     | & Gravel          |    |
| Grain size Analysis                              | Gravel                                    | 63.00                          | 100               | 100               | 100               | 100               | 100               |    |
|  |   | 53.00                          | 100               | 100               | 100               | 100               | 100               |    |
|  |   | 37.50                          | 100               | 100               | 100               | 100               | 100               | 87 |
|  |   | 26.50                          | 100               | 100               | 100               | 86                | 100               | 84 |
|  |   | 19.00                          | 100               | 100               | 100               | 75                | 100               | 82 |
|  |   | 13.20                          | 100               | 100               | 100               | 73                | 100               | 79 |
|  | Sand                                      | 4.75                           | 100               | 100               | 96                | 70                | 99                | 76 |
|  |   | 2.00                           | 100               | 100               | 94                | 68                | 98                | 74 |
|  |   | 0.425                          | 95                | 98                | 87                | 62                | 94                | 67 |
|  |   | 0.075                          | 13                | 5                 | 8                 | 6                 | 8                 | 7  |
|  | Clay -Silt                                | 0.060                          | 12                | 5                 | 6                 | 6                 | 4                 | 6  |
|  |   | 0.050                          | 10                | 4                 | 5                 | 5                 | 3                 | 5  |
|  |   | 0.026                          | 8                 | 4                 | 4                 | 4                 | 3                 | 4  |
|  |   | 0.015                          | 6                 | 3                 | 4                 | 2                 | 3                 | 4  |
|  |   | 0.010                          | 5                 | 3                 | 4                 | 1                 | 3                 | 3  |
|  |   | 0.0074                         | 4                 | 2                 | 2                 | 0                 | 3                 | 3  |
|  |   | 0.005                          | 3                 | 0                 | 2                 | 0                 | 3                 | 1  |
|  |   | 0.0036                         | 1                 | 0                 | 0                 | 0                 | 2                 | 0  |
|  |   | 0.0020                         | 0                 | 0                 | 0                 | 0                 | 0                 | 0  |
|  |   | 0.0015                         | 0                 | 0                 | 0                 | 0                 | 0                 | 0  |
| Gravel Content                                   |   | 0                              | 0                 | 4                 | 30                | 1                 | 24                |    |
| Sand Content                                     |   | 87                             | 95                | 88                | 64                | 91                | 69                |    |
| Silt Content                                     |   | 13                             | 5                 | 8                 | 6                 | 8                 | 7                 |    |
| Clay Content                                     |   | 0                              | 0                 | 0                 | 0                 | 0                 | 0                 |    |
| Grading Modulus                                  |   | 0.92                           | 0.97              | 1.11              | 1.64              | 0.99              | 1.52              |    |
| % passing  | 2.00mm                                    | 100                            | 100               | 94                | 68                | 98                | 74                |    |
|  | 0.425mm                                   | 95                             | 98                | 87                | 62                | 94                | 67                |    |
|  | 0.075mm                                   | 13                             | 5                 | 8                 | 6                 | 8                 | 7                 |    |
| LL&PL  | Liquid Limit                              | -                              | -                 | -                 | -                 | -                 | -                 |    |
|  | Plasticity Index                          | NP                             | NP                | NP                | NP                | NP                | NP                |    |
|  | Linear Shrinkage                          | 0.0                            | 0.0               | 0.0               | 0.0               | 0.0               | 0.0               |    |
|  | Equivalent PI                             | 0                              | 0                 | 0                 | 0                 | 0                 | 0                 |    |
| Classification                                   |   | A-2-4                          | A-3               | A-3               | A-3               | A-3               | A-3               |    |
| Usual types of significant constituent materials |   | Silly or claye gravel and sand | Fine sand         | Fine sand         | Fine sand         | Fine sand         | Fine sand         |    |
| General ratings as subgrad                       |   | Excellent to good              | Excellent to good | Excellent to good | Excellent to good | Excellent to good | Excellent to good |    |
| Specific gravity                                 |   |                                |                   |                   |                   |                   |                   |    |
| Natural Water Content                            |   |                                |                   |                   |                   |                   |                   |    |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1866                           | 1675              | 1735              | 1781              | 1761              | 1796              |    |
|  | Optimum Moisture Content (%)              | 9.2                            | 7.2               | 7.0               | 7.3               | 8.2               | 10.5              |    |
| CBR  | Average California Bearing Ratio          | 32                             | 19                | 16                | 31                | 23                | 16                |    |
|  | Maximum Swell (%) after 4 days            | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00              | 0.00              |    |
| Direct shear testing                             | Cohesion, kN/m <sup>2</sup>               | 80% of MDD                     |                   |                   |                   | 0                 |                   |    |
|  |   | 90% of MDD                     |                   |                   |                   | 2                 |                   |    |
|  |   | 100% of MDD                    |                   |                   |                   | 8                 |                   |    |
|  | Friction angle, °                         | 80% of MDD                     |                   |                   |                   |                   | 33                |    |
|  |   | 90% of MDD                     |                   |                   |                   |                   | 33                |    |
|  |   | 100% of MDD                    |                   |                   |                   |                   | 37                |    |

**Table 1 Laboratory Soil Tests Results for Test Pits (4/6)**

|  |   | 19                | 20                | 21                | 22                             | 23                             | 24                |     |   |
|--|---|-------------------|-------------------|-------------------|--------------------------------|--------------------------------|-------------------|-----|---|
| Laboratory Number                                |   | 1583              | 1580              | 1585              | 1582                           | 1593                           | 1565              |     |   |
| Km. / Position                                   |   | C31 / 1           | C31 / 2           | C33               | T01/1                          | T01/2                          | T01/3             |     |   |
| Depth (m)  |   |                   |                   |                   |                                | Dk.R.Br.                       |                   |     |   |
| Sample   |   | Lt.Y.O.Lt.R.      | Lt.Br.Sand        | Dk.R.O.Sand       | Dk.Br.Lt.G.Sand                | Sand                           | Dk.R.Br.Silty     |     |   |
| Description                                      |   | O.Sand            |                   | & Gravel          | & Gravel                       |                                | Sand              |     |   |
| Grain size Analysis                              | Gravel                                    | 63.00             | 100               | 100               | 100                            | 100                            | 100               |     |   |
|  |   | 53.00             | 100               | 100               | 100                            | 100                            | 100               |     |   |
|  |   | 37.50             | 100               | 100               | 100                            | 94                             | 100               | 100 |   |
|  |   | 26.50             | 100               | 100               | 100                            | 91                             | 100               | 100 |   |
|  |   | 19.00             | 100               | 100               | 100                            | 87                             | 100               | 100 |   |
|  |   | 13.20             | 100               | 100               | 100                            | 78                             | 100               | 100 |   |
|  | Sand                                      | 4.75              | 100               | 100               | 100                            | 75                             | 99                | 100 |   |
|  |   | 2.00              | 100               | 100               | 100                            | 74                             | 99                | 99  |   |
|  |   | 0.425             | 94                | 98                | 77                             | 60                             | 93                | 88  |   |
|  |   | Clay • Silt       | 0.075             | 5                 | 8                              | 2                              | 11                | 11  | 9 |
|  |   |                   | 0.060             | 5                 | 5                              | 2                              | 8                 | 10  | 9 |
|  |   |                   | 0.050             | 4                 | 4                              | 2                              | 7                 | 9   | 7 |
|  |   |                   | 0.026             | 3                 | 3                              | 2                              | 6                 | 8   | 6 |
|  |   |                   | 0.015             | 2                 | 3                              | 2                              | 5                 | 6   | 5 |
|  |   |                   | 0.010             | 2                 | 3                              | 1                              | 4                 | 4   | 4 |
|  |   |                   | 0.0074            | 2                 | 2                              | 1                              | 3                 | 3   | 3 |
|  |   |                   | 0.005             | 1                 | 1                              | 1                              | 2                 | 2   | 2 |
|  |   |                   | 0.0036            | 0                 | 1                              | 0                              | 1                 | 1   | 1 |
|  |   |                   | 0.0020            | 0                 | 0                              | 0                              | 0                 | 0   | 0 |
|  |   | 0.0015            | 0                 | 0                 | 0                              | 0                              | 0                 | 0   |   |
| Gravel Content                                   |   | 0                 | 0                 | 0                 | 25                             | 1                              | 0                 |     |   |
| Sand Content                                     |   | 95                | 92                | 98                | 64                             | 88                             | 91                |     |   |
| Silt Content                                     |   | 5                 | 8                 | 2                 | 11                             | 11                             | 9                 |     |   |
| Clay Content                                     |   | 0                 | 0                 | 0                 | 0                              | 0                              | 0                 |     |   |
| Grading Modulus                                  |   | 1.01              | 0.94              | 1.22              | 1.56                           | 0.96                           | 1.04              |     |   |
| % passing  | 2.00mm                                    | 100               | 100               | 100               | 74                             | 99                             | 99                |     |   |
|  | 0.425mm                                   | 94                | 98                | 77                | 60                             | 93                             | 88                |     |   |
|  | 0.075mm                                   | 5                 | 8                 | 2                 | 11                             | 11                             | 9                 |     |   |
| LL&PL  | Liquid Limit                              | -                 | -                 | -                 | -                              | -                              | -                 |     |   |
|  | Plasticity Index                          | NP                | NP                | NP                | NP                             | NP                             | NP                |     |   |
|  | Linear Shrinkage                          | 0.0               | 0.0               | 0.0               | 0.0                            | 0.0                            | 0.0               |     |   |
|  | Equivalent PI                             | 0                 | 0                 | 0                 | 0                              | 0                              | 0                 |     |   |
| Classification                                   |   | A-3               | A-3               | A-3               | A-2-4                          | A-2-4                          | A-3               |     |   |
| Usual types of significant constituent materials |   | Fine sand         | Fine sand         | Fine sand         | Silty or claye gravel and sand | Silty or claye gravel and sand | Fine sand         |     |   |
| General ratings as subgrad                       |   | Excellent to good | Excellent to good | Excellent to good | Excellent to good              | Excellent to good              | Excellent to good |     |   |
| Specific gravity                                 |   |                   |                   |                   |                                |                                |                   |     |   |
| Natural Water Content                            |   |                   |                   |                   |                                |                                |                   |     |   |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1658              | 1815              | 1649              | 1872                           | 1831                           | 1799              |     |   |
|  | Optimum Moisture Content (%)              | 7.8               | 7.0               | 8.9               | 11.1                           | 9.5                            | 7.5               |     |   |
| CBR  | Average California Bearing Ratio          | 18                | 29                | 22                | 44                             | 34                             | 30                |     |   |
|  | Maximum Swell (%) after 4 days            | 0.02              | 0.00              | 0.00              | 0.00                           | 0.00                           | 0.00              |     |   |
| Direct shear testing                             | Cohesion<br>kN/m <sup>2</sup>             | 80% of MDD        |                   |                   |                                |                                |                   |     |   |
|  |   | 90% of MDD        |                   |                   |                                |                                |                   |     |   |
|  |   | 100% of MDD       |                   |                   |                                |                                |                   |     |   |
|  | Friction<br>angle, °                      | 80% of MDD        |                   |                   |                                |                                |                   |     |   |
|  |   | 90% of MDD        |                   |                   |                                |                                |                   |     |   |
|  |   | 100% of MDD       |                   |                   |                                |                                |                   |     |   |

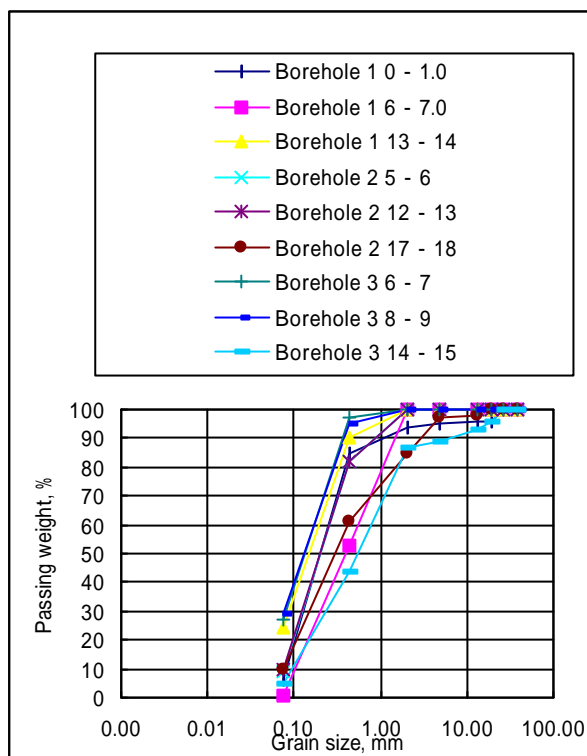
**Table 1 Laboratory Soil Tests Results for Test Pits (5/6)**

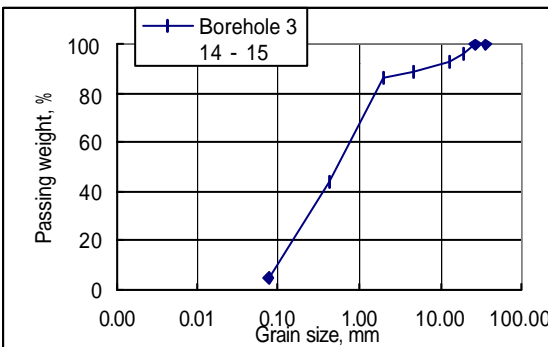
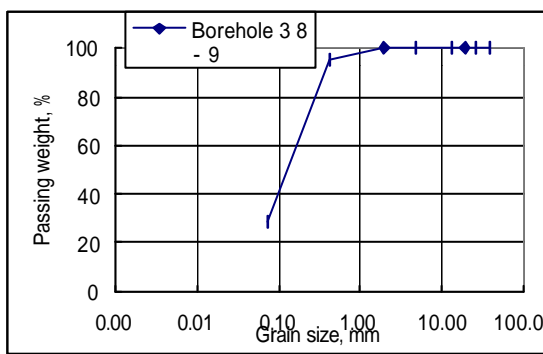
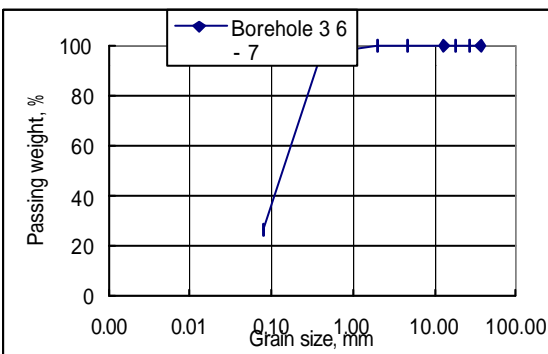
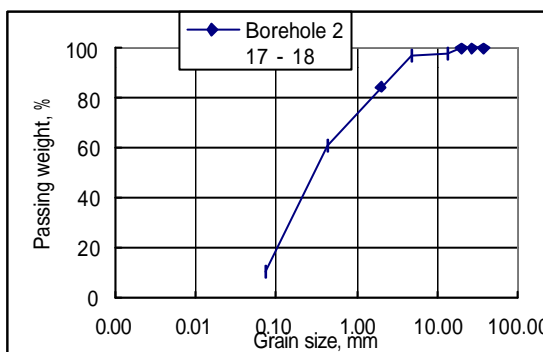
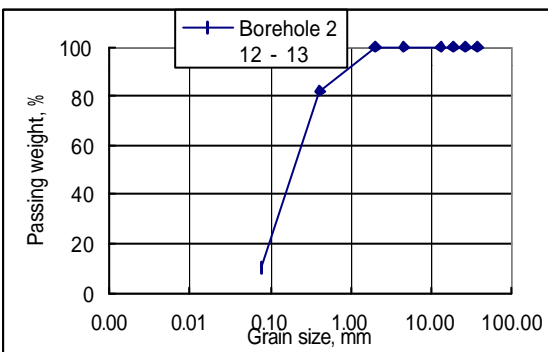
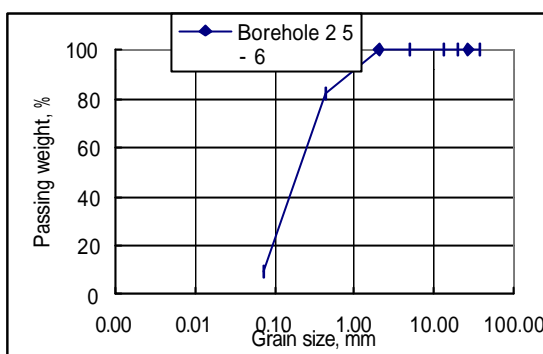
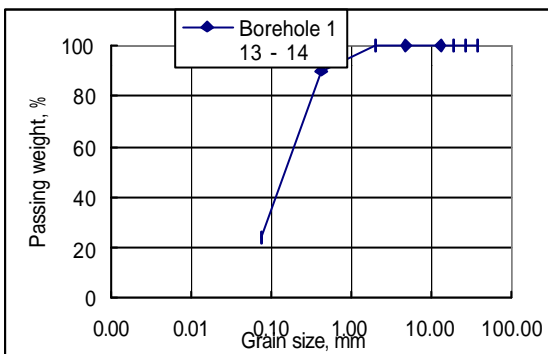
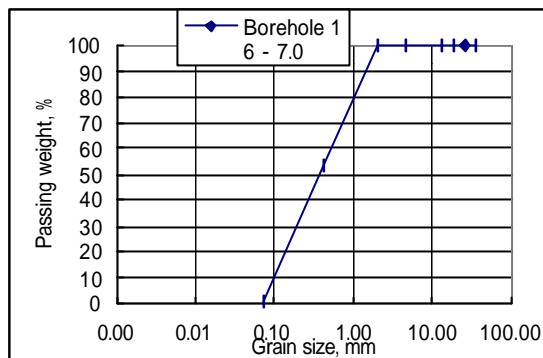
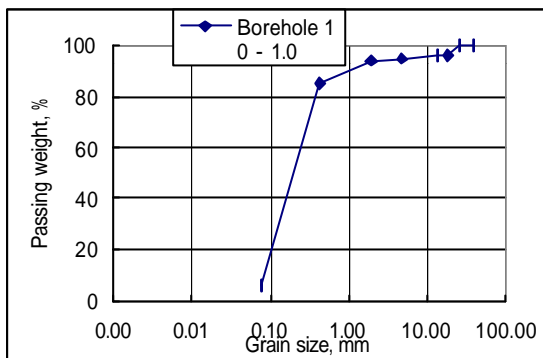
|  |   | 25                              | 26                | 27                             | 28                | 29                | 30                             |     |
|--|---|---------------------------------|-------------------|--------------------------------|-------------------|-------------------|--------------------------------|-----|
| Laboratory Number                                |   | 1561                            | 1581              | 1574                           | 1586              | 1592              | 1572                           |     |
| Km. / Position                                   |   | T01/4                           | T01/5             | T01/6                          | T01/7             | T03               | T04                            |     |
| Depth (m)  |   |                                 |                   |                                |                   |                   |                                |     |
| Sample   |   | Dk.R.Br.Silty                   | Lt.R.Br.Sand      | Lt.R.Br.                       | Dk.R.Br.Sand      | Dk.Br.G.Sand      | Lt.R.O.Sand                    |     |
| Description                                      |   | Sand                            |                   | Sand                           | & Gravel          | & Gravel          | & Gravel                       |     |
| Grain size Analysis                              | Gravel                                    | 63.00                           | 100               | 100                            | 100               | 100               | 100                            |     |
|  |   | 53.00                           | 100               | 100                            | 100               | 100               | 100                            |     |
|  |   | 37.50                           | 100               | 100                            | 100               | 91                | 100                            | 100 |
|  |   | 26.50                           | 100               | 100                            | 100               | 88                | 100                            | 100 |
|  |   | 19.00                           | 100               | 100                            | 100               | 86                | 100                            | 100 |
|  |   | 13.20                           | 100               | 100                            | 100               | 82                | 99                             | 96  |
|  | Sand                                      | 4.75                            | 99                | 100                            | 100               | 78                | 94                             | 93  |
|  |   | 2.00                            | 98                | 100                            | 100               | 76                | 91                             | 92  |
|  |   | 0.425                           | 41                | 94                             | 94                | 68                | 83                             | 84  |
|  |   | 0.075                           | 10                | 9                              | 12                | 6                 | 5                              | 11  |
|  |   | 0.060                           | 4                 | 6                              | 9                 | 6                 | 4                              | 8   |
|  |   | 0.050                           | 3                 | 4                              | 6                 | 5                 | 3                              | 7   |
|  | Clay -Silt                                | 0.026                           | 3                 | 3                              | 5                 | 4                 | 2                              | 5   |
|  |   | 0.015                           | 2                 | 3                              | 4                 | 3                 | 2                              | 5   |
|  |   | 0.010                           | 2                 | 3                              | 4                 | 3                 | 1                              | 3   |
|  |   | 0.0074                          | 2                 | 2                              | 2                 | 3                 | 1                              | 3   |
|  |   | 0.005                           | 1                 | 2                              | 1                 | 2                 | 1                              | 2   |
|  |   | 0.0036                          | 0                 | 1                              | 0                 | 0                 | 0                              | 1   |
|  |   | 0.0020                          | 0                 | 0                              | 0                 | 0                 | 0                              | 0   |
|  |   | 0.0015                          | 0                 | 0                              | 0                 | 0                 | 0                              | 0   |
| Gravel Content                                   |   | 1                               | 0                 | 0                              | 22                | 6                 | 7                              |     |
| Sand Content                                     |   | 89                              | 91                | 88                             | 72                | 89                | 82                             |     |
| Silt Content                                     |   | 10                              | 9                 | 12                             | 6                 | 5                 | 11                             |     |
| Clay Content                                     |   | 0                               | 0                 | 0                              | 0                 | 0                 | 0                              |     |
| Grading Modulus                                  |   | 1.01                            | 0.96              | 0.94                           | 1.50              | 1.21              | 1.13                           |     |
| % passing  | 2.00mm                                    | 98                              | 100               | 100                            | 76                | 91                | 92                             |     |
|  | 0.425mm                                   | 41                              | 94                | 94                             | 68                | 83                | 84                             |     |
|  | 0.075mm                                   | 10                              | 9                 | 12                             | 6                 | 5                 | 11                             |     |
| LL&PL  | Liquid Limit                              | -                               | -                 | -                              | -                 | -                 | -                              |     |
|  | Plasticity Index                          | NP                              | NP                | NP                             | NP                | NP                | NP                             |     |
|  | Linear Shrinkage                          | 0.0                             | 0.0               | 0.0                            | 0.0               | 0.0               | 0.0                            |     |
|  | Equivalent PI                             | 0                               | 0                 | 0                              | 0                 | 0                 | 0                              |     |
| Classification                                   |   | A-1-b                           | A-3               | A-2-4                          | A-3               | A-3               | A-2-4                          |     |
| Usual types of significant constituent materials |   | Stone fragment, gravel and sand | Fine sand         | Silty or claye gravel and sand | Fine sand         | Fine sand         | Silty or claye gravel and sand |     |
| General ratings as subgrad                       |   | Excellent to good               | Excellent to good | Excellent to good              | Excellent to good | Excellent to good | Excellent to good              |     |
| Specific gravity                                 |   |                                 |                   |                                |                   |                   |                                |     |
| Natural Water Content                            |   |                                 |                   |                                |                   |                   |                                |     |
| Compa-ction                                      | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1865                            | 1792              | 1766                           | 1809              | 1698              | 1781                           |     |
|  | Optimum Moisture Content (%)              | 8.7                             | 6.4               | 7.3                            | 7.0               | 8.6               | 9.8                            |     |
| CBR  | Average California Bearing Ratio          | 48                              | 23                | 23                             | 27                | 22                | 32                             |     |
|  | Maximum Swell (%) after 4 days            | 0.00                            | 0.00              | 0.00                           | 0.00              | 0.00              | 0.01                           |     |
| Direct shear testing                             | Cohesion, kN/m <sup>2</sup>               | 80% of MDD                      |                   | 2                              |                   |                   |                                |     |
|  |   | 90% of MDD                      |                   | 2                              |                   |                   |                                |     |
|  |   | 100% of MDD                     |                   | 7                              |                   |                   |                                |     |
|  | Friction angle, °                         | 80% of MDD                      |                   | 28                             |                   |                   |                                |     |
|  |   | 90% of MDD                      |                   | 30                             |                   |                   |                                |     |
|  |   | 100% of MDD                     |                   | 35                             |                   |                   |                                |     |

**Table 1 Laboratory Soil Tests Results for Test Pits (6/6)**

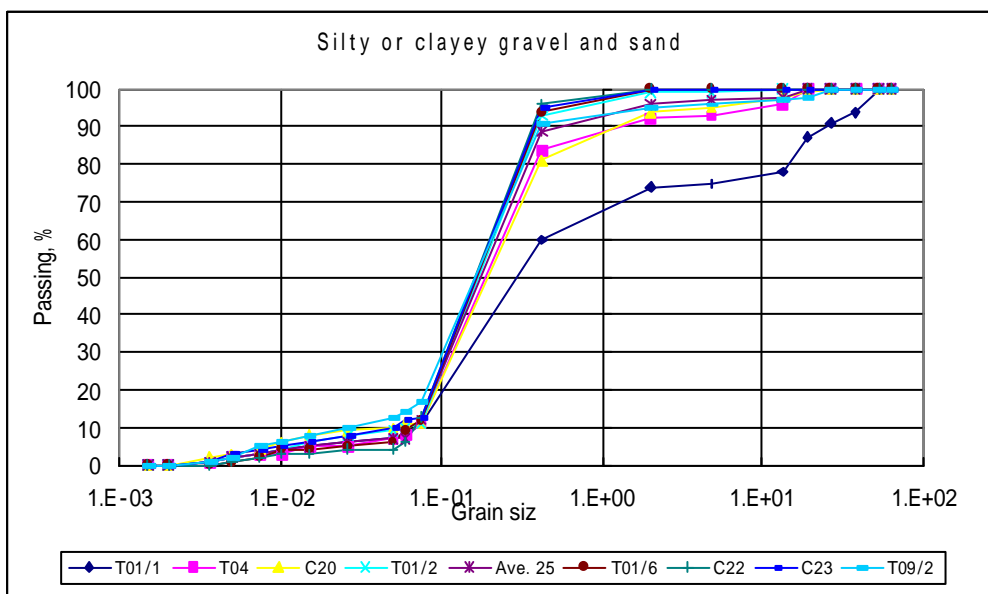
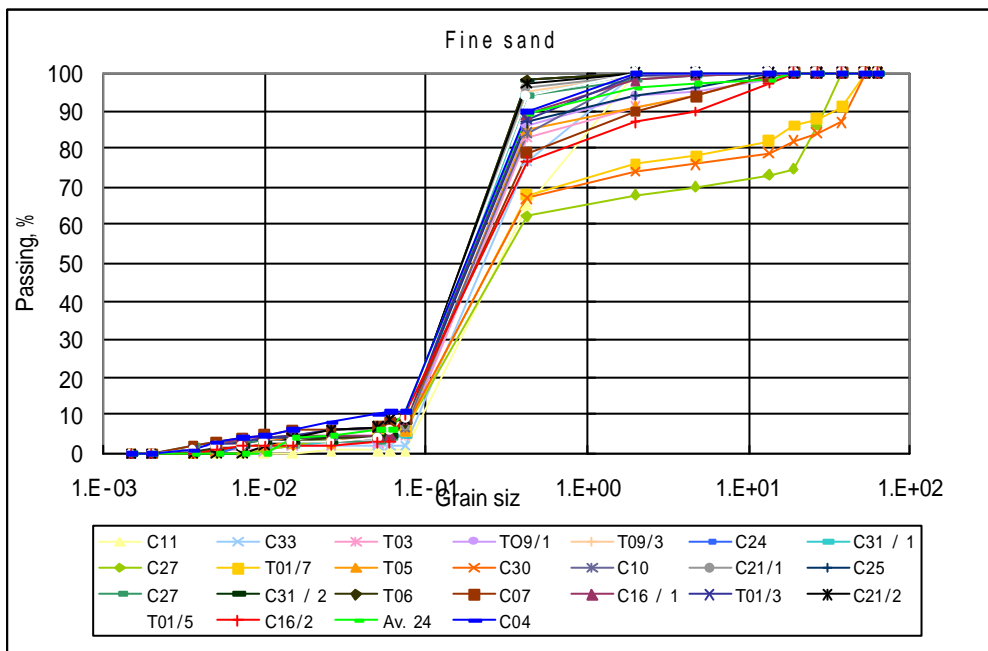
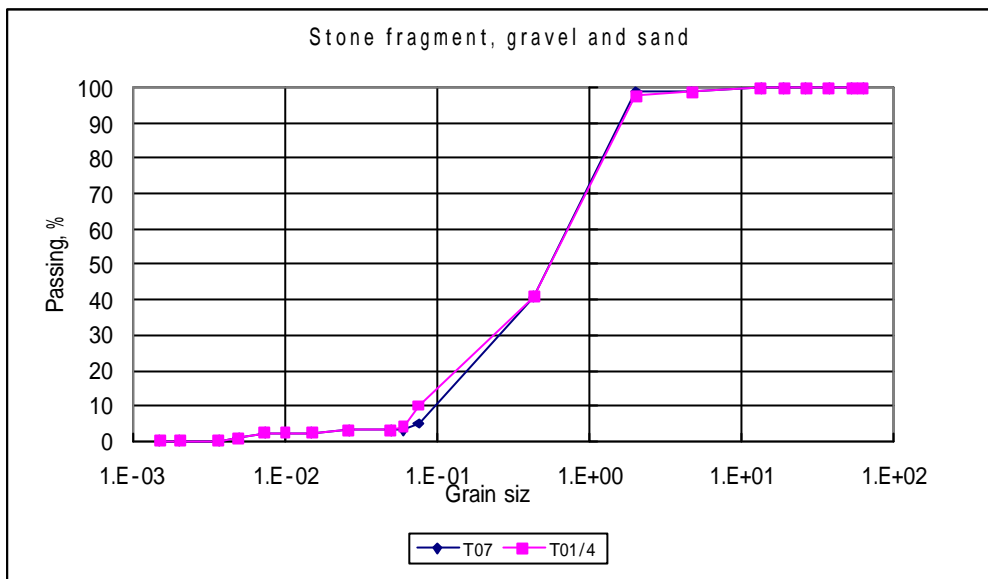
|  |   | 31                   | 32                   | 33                                    | 34                                | 35                   | 36                   |    |
|--|---|----------------------|----------------------|---------------------------------------|-----------------------------------|----------------------|----------------------|----|
| Laboratory Number                                |   | 1568                 | 1567                 | 1560                                  | 1564                              | 1558                 | 1590                 |    |
| Km. / Position                                   |   | T05                  | T06                  | T07                                   | T09/2                             | T09/3                | T09/1                |    |
| Depth (m)  |   |                      |                      |                                       |                                   |                      |                      |    |
| Sample   |   | Dk.Br.Lt.Y.Br.       | Lt.Y.O.Sand          | Lt.Br.Sand                            | Lt.R.O.Sand                       | Lt.Br.Sand           | Dk.Br.Br.Sand        |    |
| Description                                      |   | Sand + Gravel        |                      |                                       | & Gravel                          |                      | & Gravel             |    |
| Grain size Analysis                              | Gravel                                    | 63.00                | 100                  | 100                                   | 100                               | 100                  | 100                  |    |
|  |   | 53.00                | 100                  | 100                                   | 100                               | 100                  | 100                  |    |
|  |   | 37.50                | 100                  | 100                                   | 100                               | 100                  | 100                  |    |
|  |   | 26.50                | 100                  | 100                                   | 100                               | 100                  | 100                  |    |
|  |   | 19.00                | 100                  | 100                                   | 100                               | 98                   | 100                  |    |
|  |   | 13.20                | 99                   | 100                                   | 100                               | 97                   | 100                  |    |
|  | Sand                                      | Clay +Silt           | 4.75                 | 94                                    | 100                               | 99                   | 96                   | 99 |
|  |   |                      | 2.00                 | 91                                    | 100                               | 99                   | 95                   | 99 |
|  |   |                      | 0.425                | 85                                    | 98                                | 41                   | 91                   | 95 |
|  |   |                      | 0.075                | 6                                     | 8                                 | 5                    | 17                   | 5  |
|  |   |                      | 0.060                | 6                                     | 4                                 | 3                    | 14                   | 5  |
|  |   |                      | 0.050                | 5                                     | 4                                 | 3                    | 13                   | 4  |
|  |   |                      | 0.026                | 3                                     | 4                                 | 3                    | 10                   | 4  |
|  |   |                      | 0.015                | 3                                     | 3                                 | 2                    | 8                    | 3  |
|  |   |                      | 0.010                | 2                                     | 3                                 | 2                    | 6                    | 3  |
|  |   |                      | 0.0074               | 2                                     | 2                                 | 2                    | 5                    | 2  |
|  |   |                      | 0.005                | 1                                     | 1                                 | 1                    | 2                    | 1  |
|  |   |                      | 0.0036               | 0                                     | 1                                 | 0                    | 1                    | 0  |
|  |   |                      | 0.0020               | 0                                     | 0                                 | 0                    | 0                    | 0  |
|  |   |                      | 0.0015               | 0                                     | 0                                 | 0                    | 0                    | 0  |
| Gravel Content                                   |   | 6                    | 0                    | 1                                     | 4                                 | 1                    | 5                    |    |
| Sand Content                                     |   | 88                   | 92                   | 94                                    | 79                                | 94                   | 90                   |    |
| Silt Content                                     |   | 6                    | 8                    | 5                                     | 17                                | 5                    | 5                    |    |
| Clay Content                                     |   | 0                    | 0                    | 0                                     | 0                                 | 0                    | 0                    |    |
| Grading Modulus                                  |   | 1.18                 | 0.94                 | 1.05                                  | 0.97                              | 1.02                 | 1.15                 |    |
| % passing  | 2.00mm                                    | 91                   | 100                  | 99                                    | 95                                | 99                   | 94                   |    |
|  | 0.425mm                                   | 85                   | 98                   | 41                                    | 91                                | 95                   | 86                   |    |
|  | 0.075mm                                   | 6                    | 8                    | 5                                     | 17                                | 5                    | 5                    |    |
| LL&PL  | Liquid Limit                              | -                    | -                    | -                                     | -                                 | CBD                  | -                    |    |
|  | Plasticity Index                          | NP                   | NP                   | NP                                    | NP                                | NP                   | NP                   |    |
|  | Linear Shrinkage                          | 0.0                  | 0.0                  | 0.0                                   | 0.0                               | 0.0                  | 0.0                  |    |
|  | Equivalent PI                             | 0                    | 0                    | 0                                     | 0                                 | 0                    | 0                    |    |
| Classification                                   |   | A-3                  | A-3                  | A-1-b                                 | A-2-4                             | A-3                  | A-3                  |    |
| Usual types of significant constituent materials |   | Fine sand            | Fine sand            | Stone<br>fragment,<br>gravel and sand | Silty or claye<br>gravel and sand | Fine sand            | Fine sand            |    |
| General ratings as subgrad                       |   | Excellent to<br>good | Excellent to<br>good | Excellent to<br>good                  | Excellent to<br>good              | Excellent to<br>good | Excellent to<br>good |    |
| Specific gravity                                 |   |                      |                      |                                       |                                   |                      |                      |    |
| Natural Water Content                            |   |                      |                      |                                       |                                   |                      |                      |    |
| Compaction                                       | Maximum Dry Density ( kg/m <sup>3</sup> ) | 1879                 | 1716                 | 1682                                  | 1768                              | 1697                 | 1731                 |    |
|  | Optimum Moisture Content (%)              | 8.3                  | 5.6                  | 6.9                                   | 10.8                              | 13.3                 | 5.1                  |    |
| CBR  | Average California Bearing Ratio          | 34                   | 17                   | 24                                    | 22                                | 21                   | 24                   |    |
|  | Maximum Swell (%) after 4 days            | 0.00                 | 0.00                 | 0.00                                  | 0.00                              | 0.00                 | 0.00                 |    |
| Direct shear testing                             | Cohesion,<br>kN/m <sup>2</sup>            | 80% of MDD           |                      |                                       |                                   |                      |                      |    |
|  |   | 90% of MDD           |                      |                                       |                                   |                      |                      |    |
|  |   | 100% of MDD          |                      |                                       |                                   |                      |                      |    |
|  | Friction<br>angle, °                      | 80% of MDD           |                      |                                       |                                   |                      |                      |    |
|  |   | 90% of MDD           |                      |                                       |                                   |                      |                      |    |
|  |   | 100% of MDD          |                      |                                       |                                   |                      |                      |    |

### 15.4.3 Grain size Analysis

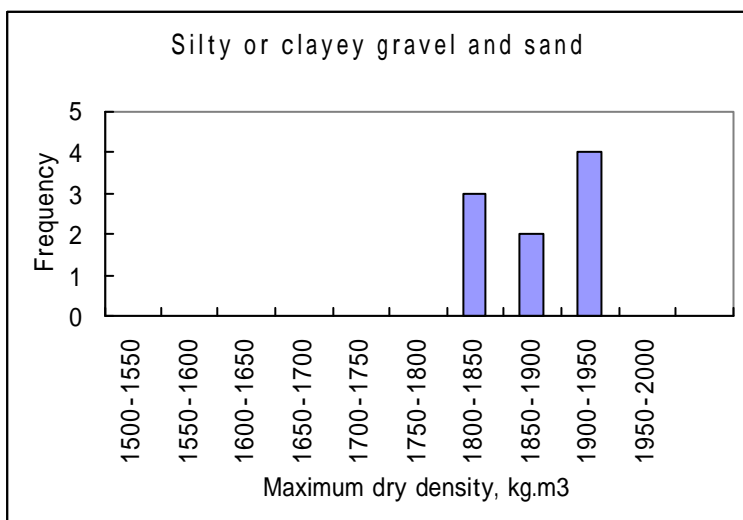
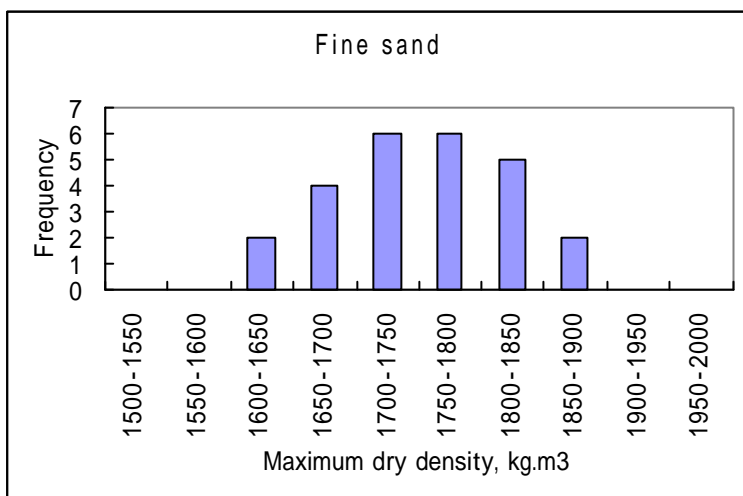
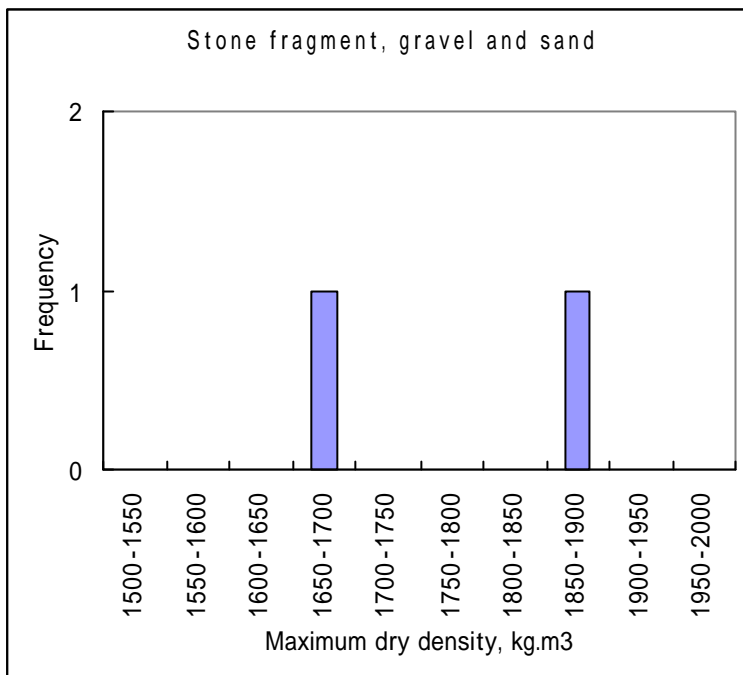




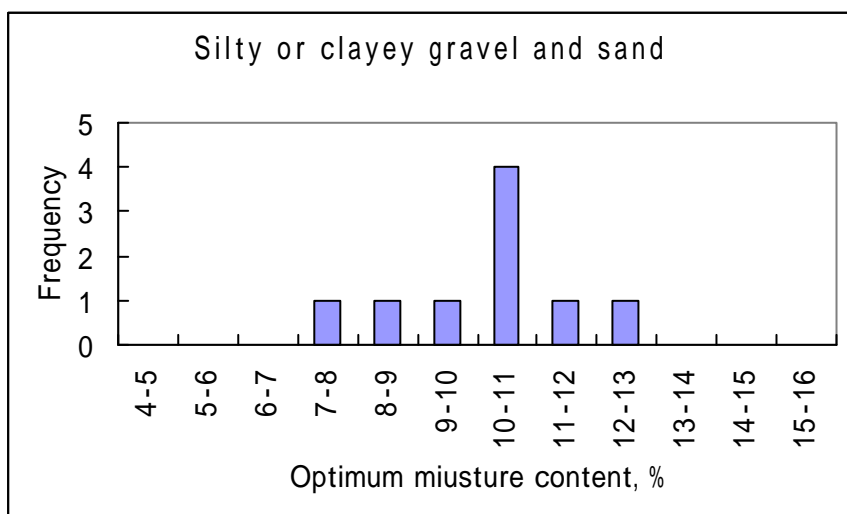
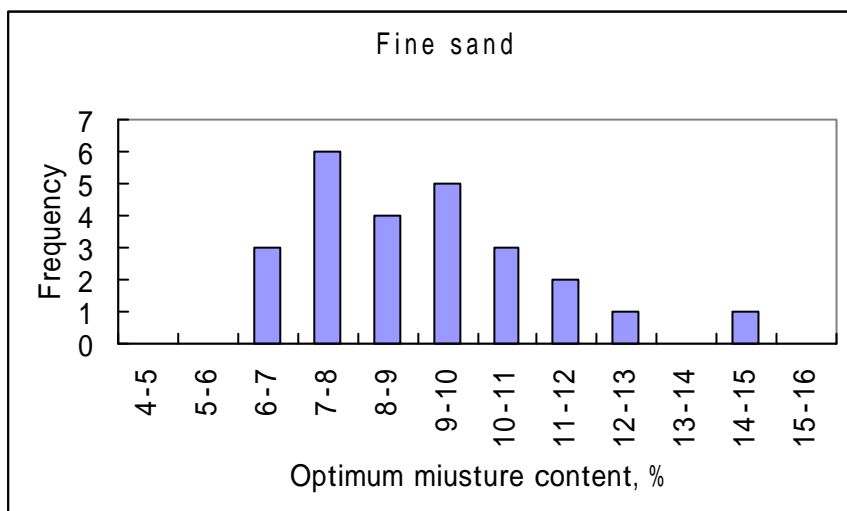
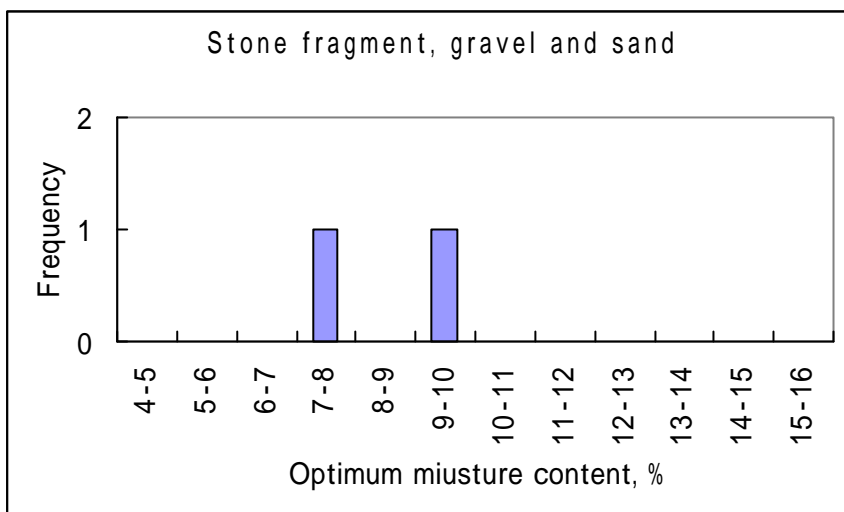




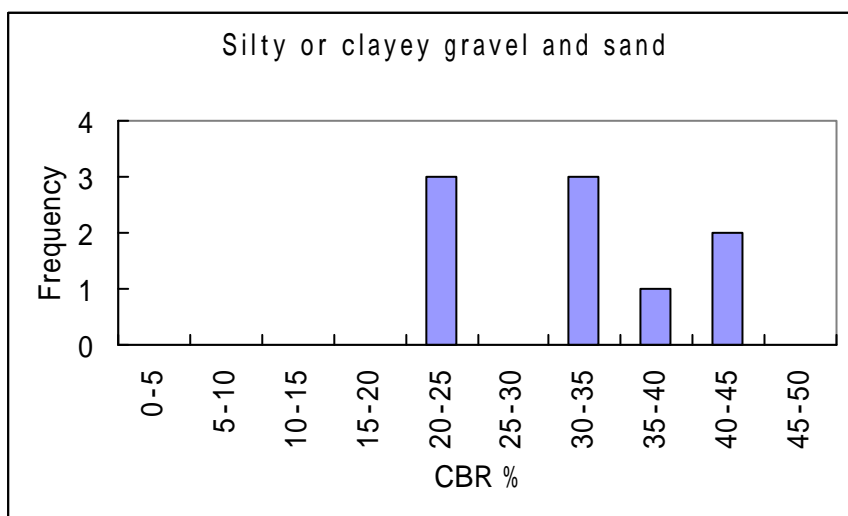
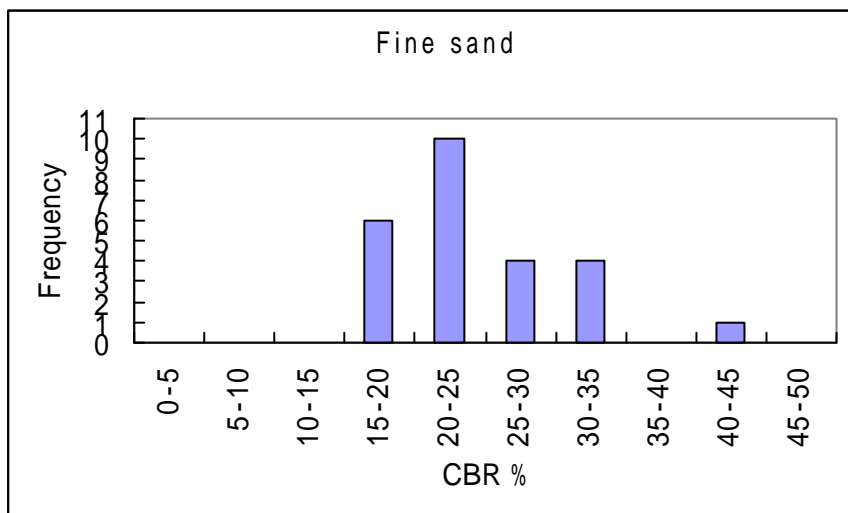
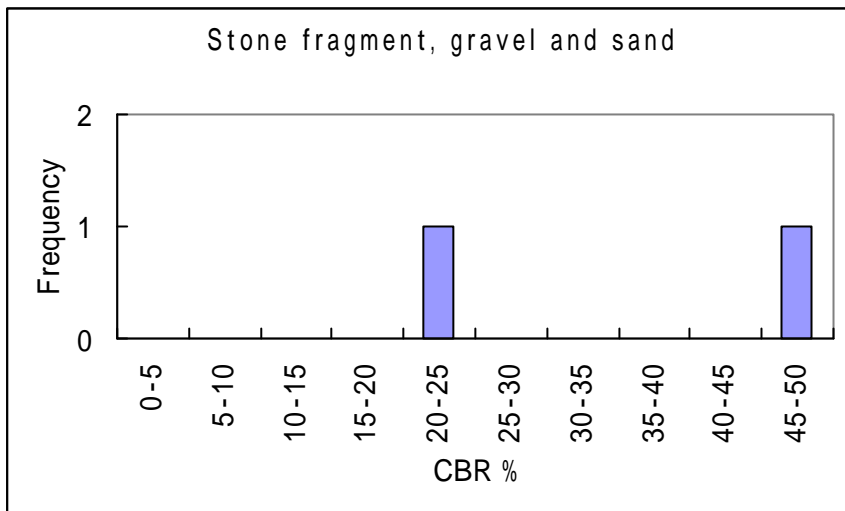
15.4.4 Distribution of Maximum Dry Density



15.4.5 Distribution of Optimum Moisture Content



15.4.6 Distribution of CBR



## Chapter 16 Appendix

### **Environmental Survey**

- 16.1 Departments and Associated People Consulted
- 16.2 Results of Survey on Buildings
- 16.3 Result of Public Facilities Survey

**Appendix 16.1 Departments and associated people consulted**

| <b>Department/Organization</b>                 | <b>Contact Person</b>                 | <b>Reason</b>   |
|--|---------------------------------------|---|
| ◆ Department of Finance and Industry           |                                       | <ul style="list-style-type: none"> <li>▪ Obtain any financial information regarding business activities for the target roads, especially Priority 3 roads</li> <li>▪ Needed in order to calculate compensation costs</li> </ul>   |
| ◆ Department of Marketing                      | Mr. Barradas                          | <ul style="list-style-type: none"> <li>▪ Obtain a list of businesses and any financial information relating to those businesses along the Priority 3 roads</li> </ul>   |
| ◆ Department of Engineering                    | MR. Badura                            | <ul style="list-style-type: none"> <li>▪ Contact person in the Maputo Council in charge of the project</li> </ul>   |
| ◆ Department of Statistics                     | Ms.                                   | <ul style="list-style-type: none"> <li>▪ Collect any available information regarding financial statistics for the city</li> <li>▪ Meteorological data</li> <li>▪ Population census data</li> <li>▪ Land use data</li> </ul>   |
| ◆ Department of Environment, Parks and Gardens | Mr. Cossa                             | <ul style="list-style-type: none"> <li>▪ Provide relevant information regarding Environmental issues</li> <li>▪ Provided the Structure Development Master Plan for Maputo and Matola for future development and zonation of the City.</li> </ul>  |
| ◆ MICOA –                                      | Director of Environmental Management  | <ul style="list-style-type: none"> <li>▪ Provide information regarding the Environmental Policies and Plans for Maputo.</li> <li>▪ Provide the Regulations regarding Environmental Assessments in accordance with Mozambiquan Law</li> <li>▪ Provide administrators names for the registration of the Project with the Department for the final EIA.</li> </ul> |
| ◆ Associaçao Comercial de Mozambique           | Mr. Jaruk Jassat                      | <ul style="list-style-type: none"> <li>▪ Provide useful information regarding the present and future development of businesses along the target roads</li> </ul>  |
| ◆ CPI  |                                       | <ul style="list-style-type: none"> <li>▪ Obtain general information on commercial and industrial development in Maputo.</li> </ul>  |
| ◆ Surveyor General's Department                |                                       | <ul style="list-style-type: none"> <li>▪ Provide topographic or ortho-photo maps of Maputo</li> <li>▪ Provide aerial photographs of Maputo and surrounds</li> </ul>   |
| ◆ CONCOR                                       | Mr. Thys Maree                        | <ul style="list-style-type: none"> <li>▪ Possible information regarding the building costs of constructing new dwellings for relocation</li> </ul>  |
| ◆ COTOP –                                      | Mr. Marcellino Zongo (Civil Engineer) | <ul style="list-style-type: none"> <li>▪ Worked on the Maputo Corridor (N4)</li> <li>▪ Knowledge of similar contacts for this project</li> </ul>  |

## Appendix 16.2 Results of survey on buildings

### (1) Result of survey on buildings along Av. Guerra Popular

| Building No | Type                                   | Name  | Number of floors | Area(m <sup>2</sup> ) | Structure       |
|-------------|--|---|------------------|-----------------------|-----------------|
| 1           | Restaurant                             | <i>Ponto Final</i>  | 1                | 480                   | brick           |
| 2           | Flats                                  | <i>Pensao finata</i>  | 3                | 375                   | brick           |
| 3           | flats                                  |   | 3                | 300                   | brick           |
| 4           | flats                                  |   | 2                | 500                   | brick           |
| 5           | parking                                |   |                  |                       |                 |
| 6           | house                                  |   | 1                | 300                   | brick           |
| 7           | motor car parts shop                   | <i>MRA Trading LDA</i>  |                  |                       | brick           |
|             | Lighting shop                          | <i>National Centre</i>  |                  |                       | brick           |
|             | Flats                                  |   | 2                | 500                   | brick           |
| 8           | Hairdresser                            | <i>Salao de Cabeleireiro Prariso</i>                          | 1                |                       |                 |
|             | Tobacconist                            | <i>Sociedade Distribuidora</i>                                |                  |                       |                 |
|             | General Dealer                         |   |                  |                       |                 |
|             | Computer Shop                          | <i>Mediabit</i>   |                  |                       |                 |
|             | Flats                                  |   | 2                | 525                   |                 |
| 9           | House                                  |   |                  | 64                    | corrugated iron |
| 10          | Plot                                   |   |                  |                       |                 |
| 11          | Flats                                  |   | 3                | 500                   | brick           |
| 12          | Flats                                  |   | 3                | 400                   | brick           |
| 13          | Shop (abandoned)                       |   | 1                | 100                   | brick           |
| 14          | School                                 | <i>Escola Secundara Estrela Vermelha (&gt; 20m from road)</i> | double           |                       | brick           |
| 15          | Flats (semi-detached)                  |   | double           | 600                   | brick           |
| 16          | House (> 20m from road)                |   | 1                |                       |                 |
| 17          | House (semi-detached, > 20m from road) |   |                  |                       |                 |
| 18          | House (> 20m from road)                |   |                  |                       |                 |
| 19          | Flats                                  |   | 2                | 800                   | brick           |
| 20          | House (> 20m from road)                |   |                  |                       |                 |
| 21          | House                                  |   | 1                | 100                   | brick           |
| 22          | Bus Rank                               |   | 3                | 2400                  | brick           |
| 23          | Butchery                               |   |                  |                       |                 |
|             | Flats                                  |   | 2                | 375                   | brick           |
| 24          | House                                  |   | double           | 150                   | brick           |
| 25          | House                                  |   | double           | 150                   | brick           |
| 26          | House                                  |   | double           | 200                   | brick           |
| 27          | Vehicle Repair Garage                  |   | 1                | 100                   | brick           |
| 28          | Supermarket                            | <i>Mohammed &amp; Co LTD.</i>                                 |                  |                       |                 |
|             | Flats                                  |   | 3                | 200                   | brick           |
| 29          | House                                  |   | 1                | 120                   | brick           |
| 30          | Flats                                  |   | double           | 225                   | brick           |
| 31          | Flats                                  |   | 3                | 300                   | brick           |
| 32          | Flats                                  |   | double           | 300                   | brick           |
| 33          | House                                  |   | 1                | 300                   | brick           |
| 34          | House                                  |   | 1                | 225                   | brick           |
| 35          | Flats                                  |   | 2                | 400                   | brick           |
| 36          | Grocery Stall                          | <i>Gelateria Amir Hamza Barraka</i>                           | 1                | 12                    | wood            |
| 37          | Hardware                               | <i>Inagrico</i>   |                  |                       |                 |
|             | Clothing Store                         | <i>A Feira</i>  |                  |                       |                 |
|             | Flats                                  |   | 3                | 750                   | brick           |

(2) Result of survey on buildings along Av. Marien Nguoubi

| Building No | Type                        | Name   | Number of floors | Area(m <sup>2</sup> ) | Structure |
|-------------|-----------------------------|--|------------------|-----------------------|-----------|
| 1           | General Dealer              | <i>Rosa Oriental</i>                                     | 1                | 480                   | brick     |
|             | Fashion shop                | <i>Cassa Tutu</i>  |                  |                       |           |
|             | Flats                       |  | 2                | 500                   | brick     |
| 2           | Construction Office         | <i>Tecnobra LDA</i>                                      | double           | 225                   | brick     |
| 3           | House                       |  | 1                | 225                   | brick     |
| 4           | House                       |  | 1                | 225                   | brick     |
| 5           | Open Plot                   |  |                  |                       |           |
| 6           | House (semi-detached)       |  | double           | 400                   | brick     |
| 7           | Flats                       | <i>MRA Trading LDA</i>                                   | double           | 400                   | brick     |
| 8           | Flats                       |  | double           | 400                   |           |
| 9           | Flats                       |  | double           | 600                   | brick     |
| 10          | Flats                       |  | double           | 400                   | brick     |
| 11          | Flats                       |  | 3                | 800                   | brick     |
| 12          | School (> 20m from road)    |  | 1                |                       | brick     |
| 13          | Pharmacy                    | <i>Farmacia Malhangalene</i>                             | 1                |                       | brick     |
|             | Haberdashery                | <i>Casa Haffejee</i>                                     |                  |                       |           |
|             | Flats                       |  | 3                | 1200                  | brick     |
| 14          | Flats                       |  | 10               | 600                   | brick     |
| 15          | Electrical Repair Shop      | <i>Servizores Mozambique LDA</i>                         | 1                |                       | brick     |
|             | House (semi-detached)       |  | 1                | 200                   | brick     |
| 16          | Flats                       |  | double           | 600                   | brick     |
| 17          | House                       |  | 1                | 625                   | brick     |
| 18          | Flats                       |  | double           | 400                   | brick     |
| 19          | Flats                       |  | double           | 401                   | brick     |
| 20          | Flats                       |  | double           | 402                   | brick     |
| 21          | Flats                       |  | 2                | 800                   | brick     |
| 22          | House                       |  | 1                | 600                   | brick     |
| 23          | House                       |  | 1                | 300                   | brick     |
| 24          | Bottle Store                |  | 1                | 225                   | brick     |
| 25          | flats                       |  | double           | 800                   | brick     |
| 26          | Police station              |  | single           | 225                   | brick     |
| 27          | Art Supply Shop             | <i>Cooperativa de Producao<br/>Artsanal Arte-makonde</i> | 1                | 450                   | brick     |
| 28          | Second hand car sales       | <i>Auto Lagoa</i>  | 1                | 625                   | brick     |
| 29          | Second hand car sales       | <i>Trafalga LDA</i>                                      | plot             |                       |           |
| 30          | House                       |  | 1                | 600                   | brick     |
| 31          | Second hand car sales       | <i>Pazas</i>   | plot             | 120                   | brick     |
| 32          | House                       |  | 1                | 180                   | brick     |
| 33          | House (semi-detached)       |  | 1                | 800                   | brick     |
| 34          | House                       |  | 1                | 400                   | brick     |
| 35          | Building/Repair Yard        |  | plot             |                       |           |
| 36          | Plot                        | <i>Hortokruticola</i>                                    |                  |                       |           |
| 37          | Flats                       |  | double           | 450                   | brick     |
| 38          | Second Hand Shop            | <i>Vive Commerce General<br/>Limitade</i>                | 1                | 600                   | brick     |
| 39          | Flats                       |  | 2                | 300                   | brick     |
| 40          | Flats                       |  | double           | 400                   | brick     |
| 41          | Flats                       |  | double           | 600                   | brick     |
| 42          | Security Firm               | <i>Omega</i>   |                  |                       |           |
|             | House (semi-detached)       |  | 1                | 700                   | brick     |
| 43          | House                       |  | 1                | 225                   | brick     |
| 44          | Flats                       |  | double           | 400                   | brick     |
| 45          | Furniture shop              |  | 1                | 600                   | brick     |
| 46          | flats                       |  | double           | 400                   | brick     |
| 47          | Flats                       |  | double           | 500                   | brick     |
| 48          | Security Firm               | <i>Delta (plot and house &gt; 20m<br/>from road)</i>     |                  |                       |           |
|             | offices                     | <i>Delta</i>   | double           | 624                   | brick     |
| 49          | House                       |  | 1                | 300                   | brick     |
| 50          | Building under construction |  |                  |                       |           |
| 51          | Security Firm               | <i>Agua</i>  | double           | 625                   | brick     |
| 52          | Flats                       |  | double           | 750                   | brick     |
| 53          | House                       |  | 1                | 400                   | brick     |
| 54          | Clinic                      |  | 1                | 400                   | brick     |
| 55          | clothing store              |  |                  |                       |           |
|             | electrical Appliances       |  |                  |                       |           |
|             | Electrical Repair Shop      |  |                  |                       |           |
|             | Take Aways<br>Flats         |  | 3                | 1350                  | brick     |



**Appendix 16.3 Result of public facilities survey**

| Classification      |                            | Road Name         |                  |                        |                |              |                      |                     |                       |                 |                 |                   |                     |           |           |
|---------------------|----------------------------|-------------------|------------------|------------------------|----------------|--------------|----------------------|---------------------|-----------------------|-----------------|-----------------|-------------------|---------------------|-----------|-----------|
|                     |                            | Ave. Emily Dausse | Rua. Timor Leste | Rua. Consiglieu Pedros | Workers Circle | Joaquim Lapa | Zedequias Manganhala | Fermas de Magalhaes | Martines de Inhaminga | Rua de Bagamoya | Ave. Said Barra | Ave de Mozambique | Rua dos Irmaos Roby | Rua 2.522 | Rua 2.282 |
| Market              | official                   |                   |                  |                        |                |              |                      |                     |                       |                 |                 |                   |                     |           |           |
|                     | unofficial                 | 1                 |                  |                        |                |              |                      |                     |                       |                 | 1               | 1                 | 1                   |           |           |
| Medical             | Public Health Care Center  |                   |                  |                        |                | 1            | 1                    |                     |                       |                 |                 |                   |                     |           |           |
|                     |                            | 1                 |                  |                        |                |              |                      |                     |                       |                 |                 |                   |                     |           |           |
| Educational         | Primary & Secondary school | 2                 |                  |                        |                |              |                      |                     |                       | 1               |                 | 1                 |                     |           | 1         |
| Cultural Facilities | Museum                     | 1(Fort)           | 1                |                        |                |              |                      |                     |                       |                 |                 |                   |                     |           |           |
|                     | Monument                   |                   |                  |                        | 1              |              |                      |                     |                       |                 |                 |                   |                     |           |           |
|                     | cinema                     |                   |                  |                        |                |              |                      |                     | 1                     | 1               |                 |                   |                     |           |           |

## Chapter 19 Appendix

# Construction Plan and Cost Estimate

19 Construction Plan and Cost Estimate

**Construction Plan and Cost Estimate**

| AV. J. NYERERE           |                             |                   | MATER PLAN PLAN4(Full Filling) |           | PLAN4(Bridge) |            | REMARK     |            |                |                   |  |
|--------------------------|-----------------------------|-------------------|--------------------------------|-----------|---------------|------------|------------|------------|----------------|-------------------|--|
| TOTAL LENGTH(km)         |                             |                   | 5.6                            |           | 3.1           |            | 3.1        |            |                |                   |  |
| NUMBER OF LANE           |                             |                   | 2                              |           | 2             |            | 2          |            |                |                   |  |
| WIDTH OF CARRIAGE WAY(m) |                             |                   | 3.25                           |           | 3.25          |            | 3.25       |            |                |                   |  |
| WIDTH OF SHOULDER(m)     |                             |                   | 1.25                           |           | 1.25          |            | 1.25       |            |                |                   |  |
| WIDTH OF MEDIAN STRIP(m) |                             |                   | -                              |           | -             |            | -          |            |                |                   |  |
| WIDTH OF SIDEWALK(m)     |                             |                   | 2.5~4                          |           | 2.5~4         |            | 2.5~4      |            |                |                   |  |
| NUMBER OF INTERSECTION   |                             |                   | 2                              |           | 2             |            | 2          |            |                |                   |  |
| MAXIMUM GRADIENT(%)      |                             |                   | 3.46                           |           | 1.67          |            | 1.67       |            |                |                   |  |
| MINIMUM GRADIENT(%)      |                             |                   | 0.17                           |           | 0.43          |            | 0.43       |            |                |                   |  |
| MINIMUM RADIUS(m)        |                             |                   | 143.25                         |           | 1000          |            | 1000       |            |                |                   |  |
| Construction item        |                             | Unit price        | Quantity                       | Amount    | Quantity      | Amount     | Quantity   | Amount     | REMARK         |                   |  |
| EARTH WORK               | Embankment(cu.m)            | 5 47,33.0         | 80,000                         | 437,261   | 320,000       | 10,560,000 | 0          | 0          |                |                   |  |
|                          | Cut(cu.m)                   | 1.96              | 82,000                         | 160,770   | 0             | 0          | 0          | 0          |                |                   |  |
|                          | Cut slope(sq.m)             | 3.26              | 9,000                          | 29,347    | 0             | 0          | 0          | 0          |                |                   |  |
|                          | Slope Countermeasure(sq.m)  | 198.45            | 1,820                          | 361,179   | 0             | 0          | 22,680     | 4,500,846  |                |                   |  |
|                          | Fill slope(sq.m)            | 2.21              | 29,100                         | 64,276    | 1,000         | 2,209      | 4,350      | 9,608      |                |                   |  |
|                          | Slope protection(sq.m)      | 8.00              | 36,280                         | 290,240   | 1,000         | 8,000      | 29,550     | 236,400    |                |                   |  |
|                          | REMOVAL EXISTING PAV        | AS t=0.05 (sq.m)  | 0.50                           | 9,000     | 4,500         | 9,000      | 4,500      | 9,000      | 4,500          |                   |  |
|                          | sub total                   |                   |                                |           | 1,347,574     |            | 10,574,709 |            | 4,751,354      |                   |  |
|                          | PAVEMENT WORK               | SURFACE COURSE    | AS t=0.03 (sq.m)               | 9.19      | 38,310        | 352,192    | 19,830     | 182,302    | 14,073         | 129,375           |  |
|                          |                             | SEMI FLEXIBLE PAV |                                | 10        | 1,900         | 19,000     | 1,900      | 19,000     | 1,348          | 13,484            |  |
| SURFACE COURSE           |                             | AS t=0.05 (sq.m)  | 14.54                          | 6,780     | 98,564        | 6,900      | 100,309    | 4,897      | 71,187         |                   |  |
| BINDER COURSE            |                             | AS t=0.04 (sq.m)  | 12.32                          | 40,210    | 495,350       | 21,730     | 267,693    | 15,421     | 189,976        |                   |  |
| BASE COURSE              |                             | GCS t=0.100(sq.m) | 5.65                           | 39,230    | 221,593       | 20,750     | 117,208    | 14,726     | 83,180         |                   |  |
| BASE COURSE              |                             | SM t=0.100(sq.m)  | 4.36                           | 6,780     | 29,561        | 6,900      | 30,084     | 4,897      | 21,350         |                   |  |
| SUBBASE COURSE           |                             | SM t=0.100(sq.m)  | 4.36                           | 54,590    | 238,012       | 29,550     | 128,838    | 20,971     | 91,433         |                   |  |
| COMPACTED SUBGR          |                             | (sq.m)            | 1.13                           | 61,370    | 69,177        | 36,450     | 41,087     | 25,868     | 29,158         |                   |  |
| SHOULDER SURFAC          |                             | DBST (sq.m)       | 3.75                           | 14,380    | 53,905        | 7,810      | 29,277     | 5,543      | 20,777         |                   |  |
| SIDEWALK SURFAC          |                             | DBST (sq.m)       | 3.75                           | 44,490    | 166,777       | 18,150     | 68,038     | 12,881     | 48,285         |                   |  |
| SIDEWALK BASECO          |                             | SM t=0.10(sq.m)   | 4.36                           | 44,490    | 193,976       | 18,150     | 79,134     | 12,881     | 56,160         |                   |  |
| sub total                |                             |                   |                                | 1,938,109 |               | 1,062,969  |            | 754,365    |                |                   |  |
| DRAINAGE WORK            |                             | U-SHAPE DRAIN     | B1.0-H1.1 (m)                  | 441.69    | 480           | 212,009    | 0          | 0          | 0              | 0                 |  |
|                          | OPEN DRAIN (Stone Pitching) | B1.2-H0.9 (m)     | 99.12                          | 0         | 0             | 0          | 470        | 46,586     |                |                   |  |
|                          | OPEN DRAIN (Stone Pitching) | B0.9-H0.9 (m)     | 59.40                          | 0         | 0             | 470        | 27,918     | 570        | 33,858         |                   |  |
|                          | OPEN DRAIN (Stone Pitching) | B0.8-H0.6(m)      | 57.78                          | 1,200     | 69,335        | 830        | 47,956     | 830        | 47,956         |                   |  |
|                          | OPEN DRAIN (Stone Pitching) | B0.4-H0.4(m)      | 40.10                          |           |               | 870        | 34,887     | 870        | 34,887         |                   |  |
|                          | OPEN DRAIN (Stone Pitching) | B0.3-H0.4(m)      | 36.66                          | 7,252     | 265,844       | 0          | 0          | 0          | 0              |                   |  |
|                          | L-SHAPE DRAIN               | W-0.5(m)          | 16                             | 1,748     | 27,974        | 1,748      | 27,968     | 1,748      | 27,968         |                   |  |
|                          | EARTH DRAIN                 | B0.4-H0.4(m)      | 4.67                           | 3,520     | 16,084        | 2,170      | 9,915      | 2,170      | 9,915          |                   |  |
|                          | CATCH PIT                   | L=1.2(set)        | 30                             | 179       | 5,370         | 93         | 2,790      | 93         | 2,790          |                   |  |
|                          | PIPE CULVERT                | D600              | 178.15                         |           |               |            | 0          |            | 0              |                   |  |
|                          | COLLECTING CONDU            | D300(m)           | 100                            | 2,490     | 249,000       | 810        | 81,000     | 810        | 81,000         |                   |  |
| sub total                |                             |                   |                                | 845,616   |               | 232,435    |            | 284,961    |                |                   |  |
| OTHER WORK               | KERB STONE                  | B0.15-H0.3(m)     | 12                             | 5,015     | 60,180        | 2,170      | 26,040     | 1,540      | 18,480         |                   |  |
|                          | BOUNDARY BLOCK              | B0.15-H0.21(m)    | 12                             | 1,390     | 16,680        | 2,095      | 25,140     | 1,487      | 17,841         |                   |  |
|                          | TREE BLOCK                  | (m)               | 12                             | 2,521     | 30,251        | 398        | 4,776      | 282        | 3,389          |                   |  |
|                          | TREE                        | (set)             | 10                             | 552       | 5,520         | 310        | 3,100      | 220        | 2,200          |                   |  |
|                          | STREET LIGHT                | (set)             | 3000                           | 56        | 168,000       | 310        | 930,000    | 310        | 930,000        |                   |  |
|                          | MARKING                     | WHITE LINE(m)     | 3                              | 3,290     | 9,870         | 2,125      | 6,375      | 2,125      | 6,375          |                   |  |
|                          | GABION                      | (cu.m)            | 200                            | 460       | 92,000        | 460        | 92,000     | 460        | 92,000         | E. MONDELENE UNIV |  |
|                          | VERTICAL DRAINAG            | (m)               | 61.68                          | 250       | 15,421        | 480        | 29,608     | 480        | 29,608         |                   |  |
|                          | REMOVAL KERBSTON            | (m)               | 6.00                           | 930       | 5,580         | 930        | 5,580      | 930        | 5,580          |                   |  |
|                          | REMOVAL BOUNDARY Bloc       | (m)               | 6.00                           | 930       | 5,580         | 930        | 5,580      | 930        | 5,580          |                   |  |
|                          | REMOVAL GANBION             | (cu.m)            | 200                            |           |               | 11,300     | 2,260,000  | 11,300     | 2,260,000      |                   |  |
|                          | sub total                   |                   |                                |           | 430,139       |            | 3,388,199  |            | 3,371,054      |                   |  |
|                          | OUTLET                      | BLOCK PITCHING    | (sq.m)                         | 12.4      | 3,846         | 47,690     | 0          | 0          | 0              | 0                 |  |
| CONSTRUCTION             | sodding                     | (sq.m)            | 8.13                           | 7,480     | 60,812        |            |            |            | 0              |                   |  |
|                          | excavation & filling        | (cu.m)            | 4.97                           | 5,100     | 25,359        |            |            |            | 0              |                   |  |
|                          | BOX CULVERT                 | B5.0-H5.0(m)      | 3,829.02                       | 30        | 114,871       | 30         | 114,871    | 30         | 114,871        |                   |  |
|                          | BOX CULVERT                 | B4.0-H4.0(m)      | 2,673.71                       |           |               | 50         | 133,686    |            | 0              |                   |  |
|                          | BOX CULVERT                 | B3.5-H3.5(m)      | 2,301.50                       |           |               | 100        | 230,150    |            | 0              |                   |  |
|                          | BOX CULVERT                 | B3.0-H3.0(m)      | 1,910.81                       | 50        | 95,541        |            |            |            | 0              |                   |  |
|                          | BOX CULVERT                 | B2.5-H2.5(m)      | 1,530.32                       |           |               | 50         | 76,516     |            | 0              |                   |  |
|                          | BOX CULVERT                 | B3.5-H2.0(m)*2    | 2,899.24                       | 50        | 144,962       |            |            |            | 0              |                   |  |
|                          | sub total                   |                   |                                |           | 489,235       |            | 555,223    |            | 114,871        |                   |  |
| BRIDGE CONSTRUCTION      | PC 1 type (Ø30m)            | (sq.m)            | 5,000.00                       | 0         | 0             |            | 5,850      | 29,250,000 | W-6.5m, L=900m |                   |  |
| sub total                |                             |                   |                                | 0         |               | 0          |            | 29,250,000 |                |                   |  |
| Total                    |                             |                   |                                | 5,050,673 |               | 15,813,535 |            | 38,526,605 |                |                   |  |

## Chapter 20 Appendix

# Environmental Impact Assessment

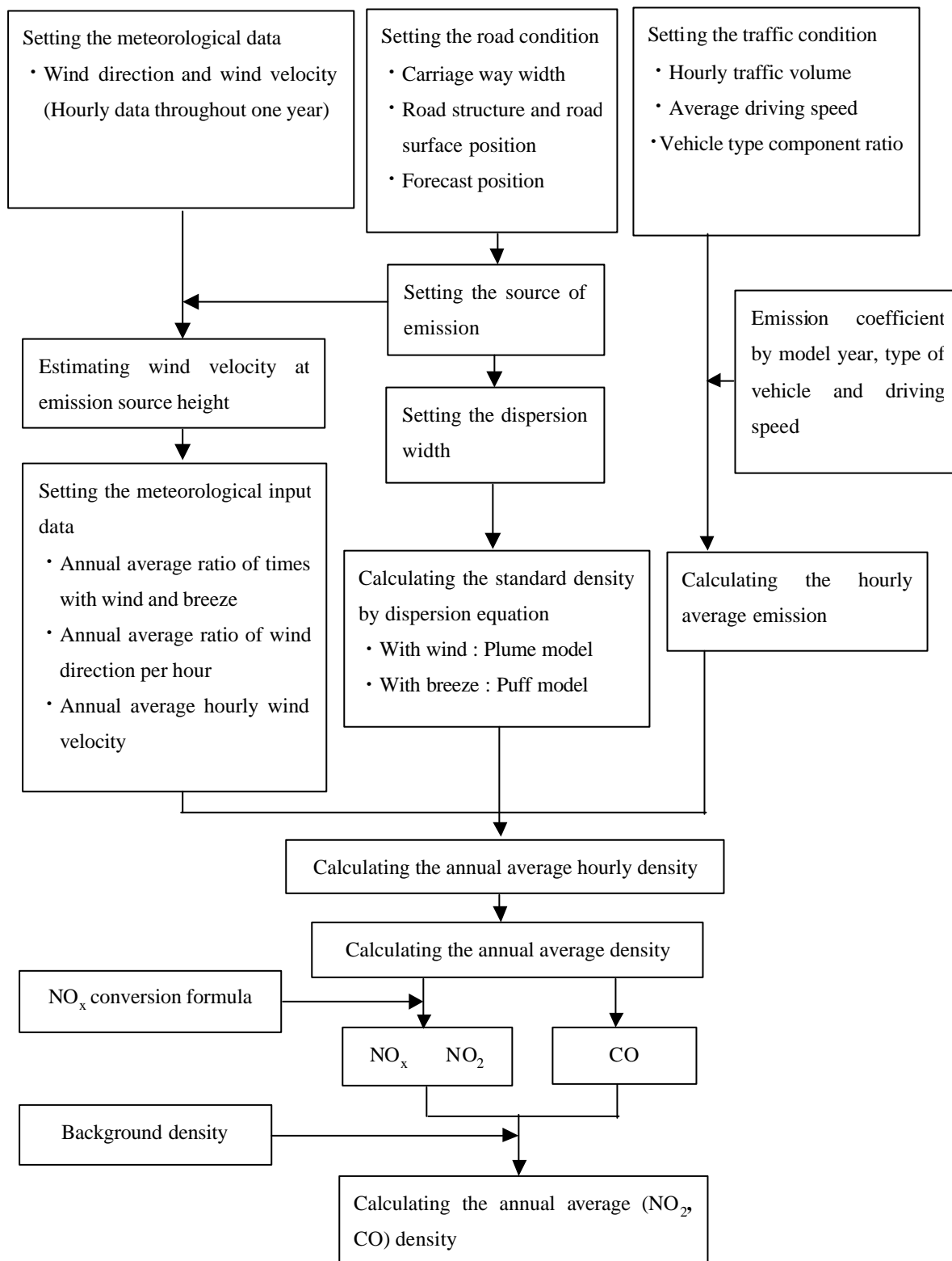
- 20.1 Criteria for Ranking Severity of Environmental Impacts
- 20.2 Detailed Forecast of Air Pollution
- 20.3 Detailed Forecast of Noise
- 20.4 Detailed Forecast of Vibration

**Appendix 20.1 Criteria for ranking severity of environmental impacts**

| RANK     |                | CRITERIA   |
|----------|----------------|--|
| NEGATIVE | H <sup>-</sup> | <ul style="list-style-type: none"> <li>• Substantial, Measurable deterioration, Death, illness or injury</li> <li>• Recommended level always exceeded</li> <li>• Widespread complaints from community</li> <li>• Complete loss of land capability</li> <li>• Soil alteration resulting in a high level impact in one of the other environments</li> <li>• Disturbance to areas that are pristine, have conservation value or are an important resource to humans</li> <li>• Destruction of rare or endangered species</li> <li>• Deterioration of water quality/quantity, resulting in a high negative impact on one of the other environments</li> <li>• Is difficult to manage</li> <li>• Will probably require an alternative course of action</li> <li>• May affect the viability of the project</li> </ul>            |
|          | M <sup>-</sup> | <ul style="list-style-type: none"> <li>• Moderate, measurable deterioration and discomfort</li> <li>• Recommended level will occasionally be violated</li> <li>• Widespread complaints from community</li> <li>• Partial loss of land capability</li> <li>• Soil alteration resulting in a moderate impact on one of the other environments</li> <li>• Disturbance of areas that have some conservation value or are of some potential use to humans</li> <li>• Complete change in species variety or prevalence</li> <li>• Deterioration of water quality/quantity, resulting in a moderate negative impact on one of the other environments</li> <li>• May be managed</li> <li>• Is low or medium only if managed according to a management programme</li> <li>• Does not affect the viability of the project</li> </ul> |
|          | L <sup>-</sup> | <ul style="list-style-type: none"> <li>• Minor, deterioration, nuisance or minor irritation. Change not measurable</li> <li>• Recommended level will never be violated</li> <li>• Sporadic community complaints</li> <li>• Minor deterioration in land capability</li> <li>• Disturbance of areas that are degraded, have little value or are unimportant to humans as a resource</li> <li>• Minor changes in species variety or prevalence</li> <li>• Deterioration of water quality/quantity, resulting in a low negative impact on one of the other environments</li> </ul>   |
| POSITIVE | L <sup>+</sup> | <ul style="list-style-type: none"> <li>• Minor improvement in quality</li> <li>• Change not measurable</li> <li>• Sporadic complaints</li> </ul>   |
|          | M <sup>+</sup> | <ul style="list-style-type: none"> <li>• Moderate improvements</li> <li>• Measurable improvements</li> <li>• Will be within or better than recommended level</li> <li>• No observed reaction from public</li> </ul>  |
|          | H <sup>+</sup> | <ul style="list-style-type: none"> <li>• Substantial improvements</li> <li>• Measurable improvements</li> <li>• Will be within or better than recommended level</li> <li>• Favourable publicity</li> </ul>   |

## Appendix 20.2 Detailed forecast of air pollution

### (1) Calculation procedure for nitrogen dioxide (NO<sub>2</sub>) and carbon monoxide (CO) forecast



## (2) Forecast formula

### (a) Plume model

The following Plume model is used when it is blowing (wind velocity of over 1 m/sec.)

$$C(X,Y,Z) = \frac{Q}{2 \mathbf{p} \cdot u \cdot \mathbf{s}_Y \cdot \mathbf{s}_Z} \exp\left(-\frac{Y^2}{2\mathbf{s}_Y^2}\right) \left[ \exp\left\{-\frac{(Z-H)^2}{2\mathbf{s}_Z^2}\right\} + \exp\left\{-\frac{(Z+H)^2}{2\mathbf{s}_Z^2}\right\} \right]$$

Where,

$C(X,Y,Z)$  : Density (ppm) at points (  $X,Y,Z$  )

$Q$  : Emission strength (ml/s)

$u$  : Average wind velocity (m/s)

$H$  : Height of emission source (m)

$\mathbf{s}_Y \cdot \mathbf{s}_Z$  : Diffusion width in horizontal (y) and perpendicular (z)

$X$  : Leeward distance in wind direction (m)

$Y$  : Horizontal distance at a right angle to x-axis (m)

$Z$  : Perpendicular distance at a right angle to x-axis (m)

### (b) Puff model

The following Puff model is used when it is breezing (wind velocity of 1 m/s or less.)

$$C(X,Y,Z) = \frac{Q}{2 \mathbf{p}^{3/2} \cdot \mathbf{s}^2 \cdot \mathbf{g}} \left[ \frac{1 - \exp\left(-\frac{l}{t_0^2}\right)}{2l} + \frac{1 - \exp\left(-\frac{m}{t_0^2}\right)}{2m} \right]$$

Where,

$$l = \frac{1}{2} \left[ \frac{x^2 + y^2}{\mathbf{a}^2} + \frac{(z-H)^2}{\mathbf{g}^2} \right], \quad m = \frac{1}{2} \left[ \frac{x^2 + y^2}{\mathbf{a}^2} + \frac{(z+H)^2}{\mathbf{g}^2} \right]$$

$t_0$  : Time corresponds to initial diffusion width (s)

$\mathbf{a} \cdot \mathbf{g}$ : Coefficient of diffusion width

**(c) Diffusion width**

- Diffusion width used when it is blowing ( $U > 1.0$  m/s)

- Diffusion width in the perpendicular direction ( $z$ )

$$z = 1.5 + 0.31 \cdot L^{0.83}$$

Where,

L : Distance from the carriage way end ( $L = X - W/2$ )

X : Leeward distance in wind direction (m)

W : Carriage way width

Note that  $z = 1.5$  when  $X < W/2$

- Diffusion width in the horizontal direction ( $y$ )

$$y = W/2 + 0.46 \cdot L^{0.81}$$

Note that  $y = 2$  when  $X < W/2$

- Diffusion width used when it is breezing ( $U < 1.0$  m/s)

- Time corresponds to initial diffusion width ( $t_0$ )

$$t_0 = W/2 \cdot$$

Where,

W : Carriage way width (m)

: Coefficient of diffusion width show below

Coefficient of diffusion width ( , )

$$= 0.3$$

$$= 0.18 \text{ (in the daytime)}$$

$$= 0.09 \text{ (at night)}$$



**(d) Convert NO<sub>x</sub> into NO<sub>2</sub>**

$$[\text{NO}_2] = 0.0587[\text{NO}_x]^{0.416} (1 - [\text{NO}_x]_{\text{BG}} / [\text{NO}_x]_{\text{T}})^{0.630}$$

Where,

$[\text{NO}_x]$  : Calculating NO<sub>x</sub> density (ppm)

$[\text{NO}_2]$  : Calculating NO<sub>2</sub> density (ppm)

$[\text{NO}_x]_{\text{BG}}$  : Background NO<sub>x</sub> density (ppm)

$[\text{NO}_x]_{\text{T}}$  : The total of Background NO<sub>x</sub> density and Calculating NO<sub>x</sub> density  
(ppm)

### (3) Traffic conditions

#### (a) Hourly traffic density of each cross section (2010)

| Time<br>(Hour<br>Beginning) | 1.Missing Link on Av. Julius<br>Nyerere |                  |        | 2.Restoration of original<br>Av.Julius Nyerere |                  |        | 3.Av.Vladimir Lenine (S) |                  |        | 4.Av.Vladimir Lenine (N) |                  |        | 5.Av. Acordos de Lusaka |                  |        | 6.Av. Guerra Popular |                  |        | 7.Av. de Angola (S) |                  |        | 8.Av. de Angola (N) |                  |       |
|-----------------------------|---|------------------|--------|--|------------------|--------|--------------------------|------------------|--------|--------------------------|------------------|--------|-------------------------|------------------|--------|----------------------|------------------|--------|---------------------|------------------|--------|---------------------|------------------|-------|
|                             | Small<br>vehicle                        | Large<br>vehicle | Total  | Small<br>vehicle                               | Large<br>vehicle | Total  | Small<br>vehicle         | Large<br>vehicle | Total  | Small<br>vehicle         | Large<br>vehicle | Total  | Small<br>vehicle        | Large<br>vehicle | Total  | Small<br>vehicle     | Large<br>vehicle | Total  | Small<br>vehicle    | Large<br>vehicle | Total  | Small<br>vehicle    | Large<br>vehicle | Total |
| 7                           | 942                                     | 17               | 959    | 1,634  | 30               | 1,663  | 1,193                    | 30               | 1,224  | 1,078                    | 27               | 1,105  | 1,423                   | 60               | 1,483  | 2,089                | 72               | 2,160  | 1,612               | 60               | 1,672  | 596                 | 22               | 618   |
| 8                           | 1,111                                   | 22               | 1,132  | 1,926  | 38               | 1,964  | 1,366                    | 28               | 1,395  | 1,234                    | 25               | 1,260  | 1,549                   | 55               | 1,604  | 2,334                | 70               | 2,403  | 1,778               | 55               | 1,833  | 657                 | 20               | 677   |
| 9                           | 1,137                                   | 11               | 1,148  | 1,972  | 19               | 1,991  | 1,424                    | 18               | 1,441  | 1,286                    | 16               | 1,302  | 1,672                   | 34               | 1,706  | 2,475                | 42               | 2,517  | 1,901               | 35               | 1,936  | 702                 | 13               | 715   |
| 10                          | 1,050                                   | 17               | 1,067  | 1,820  | 29               | 1,849  | 1,311                    | 28               | 1,338  | 1,184                    | 25               | 1,209  | 1,490                   | 54               | 1,544  | 2,233                | 65               | 2,298  | 1,711               | 54               | 1,766  | 632                 | 20               | 652   |
| 11                          | 957                                     | 22               | 979    | 1,657  | 38               | 1,695  | 1,243                    | 31               | 1,274  | 1,123                    | 28               | 1,151  | 1,454                   | 61               | 1,515  | 2,133                | 76               | 2,208  | 1,660               | 61               | 1,721  | 613                 | 22               | 636   |
| 12                          | 1,142                                   | 9                | 1,151  | 1,980  | 16               | 1,996  | 1,379                    | 23               | 1,402  | 1,245                    | 21               | 1,267  | 1,501                   | 46               | 1,547  | 2,308                | 53               | 2,360  | 1,742               | 47               | 1,790  | 644                 | 17               | 661   |
| 13                          | 926                                     | 8                | 933    | 1,606  | 12               | 1,618  | 1,099                    | 30               | 1,129  | 993                      | 27               | 1,020  | 1,155                   | 60               | 1,215  | 1,809                | 66               | 1,875  | 1,354               | 62               | 1,416  | 500                 | 23               | 523   |
| 14                          | 1,061                                   | 7                | 1,067  | 1,841  | 11               | 1,852  | 1,229                    | 20               | 1,249  | 1,110                    | 18               | 1,128  | 1,283                   | 40               | 1,323  | 2,031                | 45               | 2,076  | 1,504               | 41               | 1,545  | 556                 | 15               | 571   |
| 15                          | 1,015                                   | 22               | 1,038  | 1,763  | 39               | 1,802  | 1,194                    | 37               | 1,231  | 1,079                    | 33               | 1,112  | 1,306                   | 72               | 1,378  | 2,022                | 88               | 2,110  | 1,510               | 73               | 1,583  | 558                 | 27               | 585   |
| 16                          | 1,140                                   | 10               | 1,149  | 1,979  | 16               | 1,995  | 1,332                    | 27               | 1,359  | 1,203                    | 24               | 1,228  | 1,442                   | 53               | 1,495  | 2,246                | 60               | 2,306  | 1,672               | 54               | 1,726  | 618                 | 20               | 638   |
| 17                          | 1,203                                   | 4                | 1,207  | 2,087  | 7                | 2,094  | 1,412                    | 22               | 1,435  | 1,276                    | 20               | 1,296  | 1,491                   | 44               | 1,535  | 2,340                | 47               | 2,388  | 1,744               | 45               | 1,789  | 644                 | 17               | 661   |
| 18                          | 1,100                                   | 10               | 1,110  | 1,910  | 17               | 1,927  | 1,294                    | 33               | 1,327  | 1,169                    | 30               | 1,199  | 1,415                   | 65               | 1,480  | 2,190                | 73               | 2,263  | 1,636               | 67               | 1,703  | 604                 | 25               | 629   |
| 19                          | 866                                     | 1                | 867    | 1,502  | 2                | 1,503  | 1,018                    | 13               | 1,030  | 919                      | 12               | 931    | 1,064                   | 25               | 1,089  | 1,675                | 26               | 1,701  | 1,248               | 26               | 1,275  | 461                 | 10               | 471   |
| 20                          | 640                                     | 4                | 644    | 1,109  | 7                | 1,116  | 770                      | 20               | 790    | 695                      | 18               | 714    | 796                     | 40               | 836    | 1,249                | 44               | 1,293  | 940                 | 42               | 981    | 347                 | 15               | 363   |
| 21                          | 557                                     | 4                | 561    | 965  | 7                | 972    | 654                      | 22               | 675    | 590                      | 20               | 610    | 677                     | 42               | 720    | 1,071                | 46               | 1,117  | 797                 | 44               | 841    | 294                 | 16               | 311   |
| 22                          | 370                                     | 2                | 372    | 641  | 3                | 643    | 445                      | 20               | 465    | 402                      | 18               | 420    | 444                     | 39               | 483    | 707                  | 41               | 748    | 531                 | 41               | 572    | 196                 | 15               | 211   |
| 23                          | 295                                     | 1                | 296    | 513  | 1                | 514    | 334                      | 12               | 346    | 302                      | 11               | 312    | 339                     | 23               | 362    | 547                  | 24               | 571    | 400                 | 24               | 424    | 148                 | 9                | 157   |
| 24                          | 117                                     | 0                | 118    | 204  | 0                | 204    | 127                      | 1                | 127    | 115                      | 1                | 115    | 114                     | 1                | 115    | 197                  | 1                | 198    | 140                 | 1                | 141    | 52                  | 0                | 52    |
| 1                           | 72                                      | 0                | 72     | 126  | 0                | 126    | 77                       | 0                | 77     | 70                       | 0                | 70     | 75                      | 0                | 75     | 126                  | 0                | 126    | 90                  | 0                | 90     | 33                  | 0                | 33    |
| 2                           | 42                                      | 0                | 42     | 73   | 0                | 73     | 44                       | 0                | 44     | 40                       | 0                | 40     | 37                      | 0                | 37     | 67                   | 0                | 67     | 47                  | 0                | 47     | 17                  | 0                | 17    |
| 3                           | 43                                      | 0                | 43     | 74   | 0                | 74     | 45                       | 0                | 45     | 40                       | 0                | 40     | 38                      | 0                | 38     | 68                   | 0                | 68     | 47                  | 0                | 47     | 17                  | 0                | 17    |
| 4                           | 70                                      | 1                | 70     | 121  | 1                | 122    | 85                       | 6                | 91     | 77                       | 5                | 82     | 107                     | 11               | 118    | 156                  | 12               | 168    | 119                 | 12               | 131    | 44                  | 4                | 48    |
| 5                           | 120                                     | 2                | 122    | 206  | 2                | 208    | 218                      | 19               | 237    | 197                      | 17               | 214    | 307                     | 37               | 344    | 394                  | 38               | 432    | 339                 | 38               | 377    | 125                 | 14               | 139   |
| 6                           | 422                                     | 4                | 426    | 731  | 7                | 737    | 620                      | 18               | 637    | 560                      | 16               | 576    | 871                     | 34               | 906    | 1,171                | 38               | 1,208  | 950                 | 36               | 986    | 351                 | 13               | 364   |
| Total                       | 16,396                                  | 177              | 16,574 | 28,437   | 303              | 28,740 | 19,914                   | 457              | 20,371 | 17,987                   | 413              | 18,400 | 22,052                  | 897              | 22,949 | 33,637               | 1,025            | 34,662 | 25,473              | 920              | 26,392 | 9,412               | 340              | 9,751 |

| Time (Hour<br>Beginning) | 9.Av. Marien Ngouabi (E) |                  |        | 10.Av. Marien Ngouabi (W) |                  |        | 11.Av. Josina Michel |                  |        | 12. Av. Martires de Inhaminga |                  |        | 13.Av. Milagre Mabote |                  |        | 14.Av. Da Mahangalene |                  |        | 15.Av. Kwame Nkrumah |                  |       | 16.Rua dos Imaos Roby |                  |        |
|--------------------------|--------------------------|------------------|--------|---------------------------|------------------|--------|----------------------|------------------|--------|-------------------------------|------------------|--------|-----------------------|------------------|--------|-----------------------|------------------|--------|----------------------|------------------|-------|-----------------------|------------------|--------|
|                          | Small<br>vehicle         | Large<br>vehicle | Total  | Small<br>vehicle          | Large<br>vehicle | Total  | Small<br>vehicle     | Large<br>vehicle | Total  | Small<br>vehicle              | Large<br>vehicle | Total  | Small<br>vehicle      | Large<br>vehicle | Total  | Small<br>vehicle      | Large<br>vehicle | Total  | Small<br>vehicle     | Large<br>vehicle | Total | Small<br>vehicle      | Large<br>vehicle | Total  |
| 7                        | 887                      | 14               | 901    | 694                       | 24               | 718    | 667                  | 90               | 757    | 743                           | 53               | 796    | 750                   | 20               | 769    | 589                   | 15               | 604    | 507                  | 4                | 511   | 812                   | 14               | 826    |
| 8                        | 1,051                    | 17               | 1,068  | 776                       | 25               | 801    | 750                  | 108              | 859    | 887                           | 67               | 954    | 857                   | 19               | 876    | 681                   | 19               | 701    | 614                  | 5                | 619   | 893                   | 19               | 911    |
| 9                        | 1,071                    | 9                | 1,080  | 823                       | 15               | 838    | 797                  | 57               | 854    | 902                           | 35               | 936    | 894                   | 12               | 906    | 707                   | 10               | 717    | 616                  | 2                | 619   | 936                   | 9                | 945    |
| 10                       | 997                      | 13               | 1,010  | 739                       | 23               | 761    | 730                  | 87               | 817    | 851                           | 52               | 904    | 820                   | 18               | 838    | 640                   | 15               | 655    | 584                  | 4                | 588   | 860                   | 14               | 874    |
| 11                       | 911                      | 17               | 928    | 699                       | 27               | 726    | 709                  | 111              | 820    | 789                           | 68               | 857    | 775                   | 21               | 795    | 583                   | 20               | 602    | 531                  | 5                | 536   | 823                   | 19               | 842    |
| 12                       | 1,086                    | 8                | 1,094  | 767                       | 17               | 784    | 745                  | 52               | 797    | 921                           | 29               | 951    | 863                   | 15               | 878    | 690                   | 8                | 698    | 645                  | 2                | 647   | 862                   | 7                | 869    |
| 13                       | 883                      | 7                | 890    | 601                       | 20               | 621    | 586                  | 48               | 634    | 753                           | 24               | 776    | 687                   | 18               | 706    | 553                   | 6                | 559    | 531                  | 1                | 533   | 672                   | 5                | 677    |
| 14                       | 1,007                    | 6                | 1,013  | 681                       | 14               | 695    | 643                  | 39               | 683    | 845                           | 21               | 865    | 772                   | 13               | 785    | 640                   | 6                | 645    | 603                  | 1                | 605   | 754                   | 5                | 759    |
| 15                       | 958                      | 18               | 976    | 679                       | 30               | 710    | 631                  | 116              | 747    | 793                           | 70               | 863    | 753                   | 24               | 777    | 624                   | 20               | 644    | 564                  | 5                | 568   | 742                   | 19               | 761    |
| 16                       | 1,076                    | 8                | 1,085  | 755                       | 19               | 774    | 703                  | 56               | 758    | 893                           | 30               | 923    | 840                   | 17               | 856    | 698                   | 8                | 707    | 635                  | 2                | 637   | 817                   | 7                | 824    |
| 17                       | 1,143                    | 4                | 1,148  | 782                       | 14               | 796    | 745                  | 31               | 775    | 962                           | 14               | 976    | 886                   | 13               | 899    | 724                   | 4                | 728    | 684                  | 1                | 685   | 843                   | 2                | 845    |
| 18                       | 1,038                    | 9                | 1,047  | 736                       | 23               | 759    | 678                  | 61               | 740    | 856                           | 32               | 888    | 815                   | 20               | 836    | 676                   | 9                | 684    | 611                  | 2                | 612   | 822                   | 7                | 829    |
| 19                       | 825                      | 2                | 826    | 558                       | 7                | 566    | 536                  | 12               | 548    | 698                           | 4                | 702    | 637                   | 7                | 645    | 518                   | 1                | 519    | 496                  | 0                | 496   | 624                   | 0                | 624    |
| 20                       | 615                      | 4                | 619    | 412                       | 13               | 425    | 412                  | 29               | 441    | 532                           | 14               | 545    | 479                   | 12               | 491    | 376                   | 3                | 379    | 374                  | 1                | 375   | 469                   | 2                | 472    |
| 21                       | 531                      | 4                | 535    | 356                       | 14               | 370    | 342                  | 30               | 372    | 450                           | 14               | 464    | 409                   | 13               | 422    | 332                   | 4                | 335    | 321                  | 1                | 321   | 399                   | 2                | 401    |
| 22                       | 358                      | 2                | 361    | 231                       | 11               | 243    | 241                  | 18               | 259    | 317                           | 6                | 323    | 276                   | 11               | 287    | 213                   | 1                | 214    | 222                  | 0                | 222   | 259                   | 0                | 259    |
| 23                       | 280                      | 1                | 282    | 184                       | 7                | 191    | 172                  | 11               | 182    | 234                           | 4                | 238    | 210                   | 7                | 217    | 177                   | 1                | 178    | 169                  | 0                | 169   | 202                   | 0                | 202    |
| 24                       | 113                      | 0                | 113    | 66                        | 0                | 67     | 62                   | 1                | 62     | 95                            | 0                | 95     | 80                    | 0                | 80     | 68                    | 0                | 68     | 70                   | 0                | 70    | 70                    | 0                | 71     |
| 1                        | 68                       | 0                | 68     | 43                        | 0                | 43     | 38                   | 0                | 38     | 55                            | 0                | 55     | 49                    | 0                | 49     | 44                    | 0                | 44     | 41                   | 0                | 41    | 46                    | 0                | 46     |
| 2                        | 40                       | 0                | 40     | 23                        | 0                | 23     | 21                   | 0                | 21     | 34                            | 0                | 34     | 28                    | 0                | 28     | 24                    | 0                | 24     | 25                   | 0                | 25    | 24                    | 0                | 24     |
| 3                        | 41                       | 0                | 41     | 23                        | 0                | 23     | 22                   | 0                | 22     | 35                            | 0                | 35     | 28                    | 0                | 28     | 24                    | 0                | 24     | 26                   | 0                | 26    | 24                    | 0                | 24     |
| 4                        | 64                       | 1                | 65     | 53                        | 3                | 56     | 46                   | 5                | 52     | 51                            | 2                | 52     | 54                    | 3                | 58     | 46                    | 0                | 46     | 35                   | 0                | 35    | 60                    | 0                | 60     |
| 5                        | 118                      | 2                | 120    | 122                       | 11               | 132    | 149                  | 17               | 166    | 118                           | 6                | 123    | 132                   | 11               | 143    | 72                    | 1                | 73     | 65                   | 0                | 65    | 167                   | 0                | 168    |
| 6                        | 391                      | 4                | 395    | 384                       | 11               | 395    | 378                  | 26               | 404    | 327                           | 13               | 340    | 389                   | 10               | 399    | 280                   | 3                | 284    | 204                  | 1                | 205   | 472                   | 2                | 475    |
| Total                    | 15,553                   | 152              | 15,705 | 11,188                    | 327              | 11,515 | 10,802               | 1,006            | 11,808 | 13,140                        | 556              | 13,696 | 12,484                | 285              | 12,769 | 9,981                 | 154              | 10,134 | 9,174                | 35               | 9,210 | 12,651                | 137              | 12,788 |

**(b) Emission coefficient for nitrogen oxides (NO<sub>x</sub>) and carbon monoxide (CO)**

| Driving speed (km/hr) | Pollutant   |               |                                      |               |
|-----------------------|---|---------------|--------------------------------------|---------------|
|                       | Nitrogen oxides<br>NO <sub>x</sub> (g/km vehicle) |               | Carbon monoxide<br>CO (g/km vehicle) |               |
|                       | Small vehicle                                     | Large vehicle | Small vehicle                        | Large vehicle |
| 30                    | 0.51  | 4.23          | 3.28                                 | 2.29          |
| 40                    | 0.51  | 4.17          | 2.41                                 | 1.97          |
| 50                    | 0.51  | 4.05          | 1.83                                 | 1.77          |
| 60                    | 0.49  | 3.82          | 1.40                                 | 1.64          |

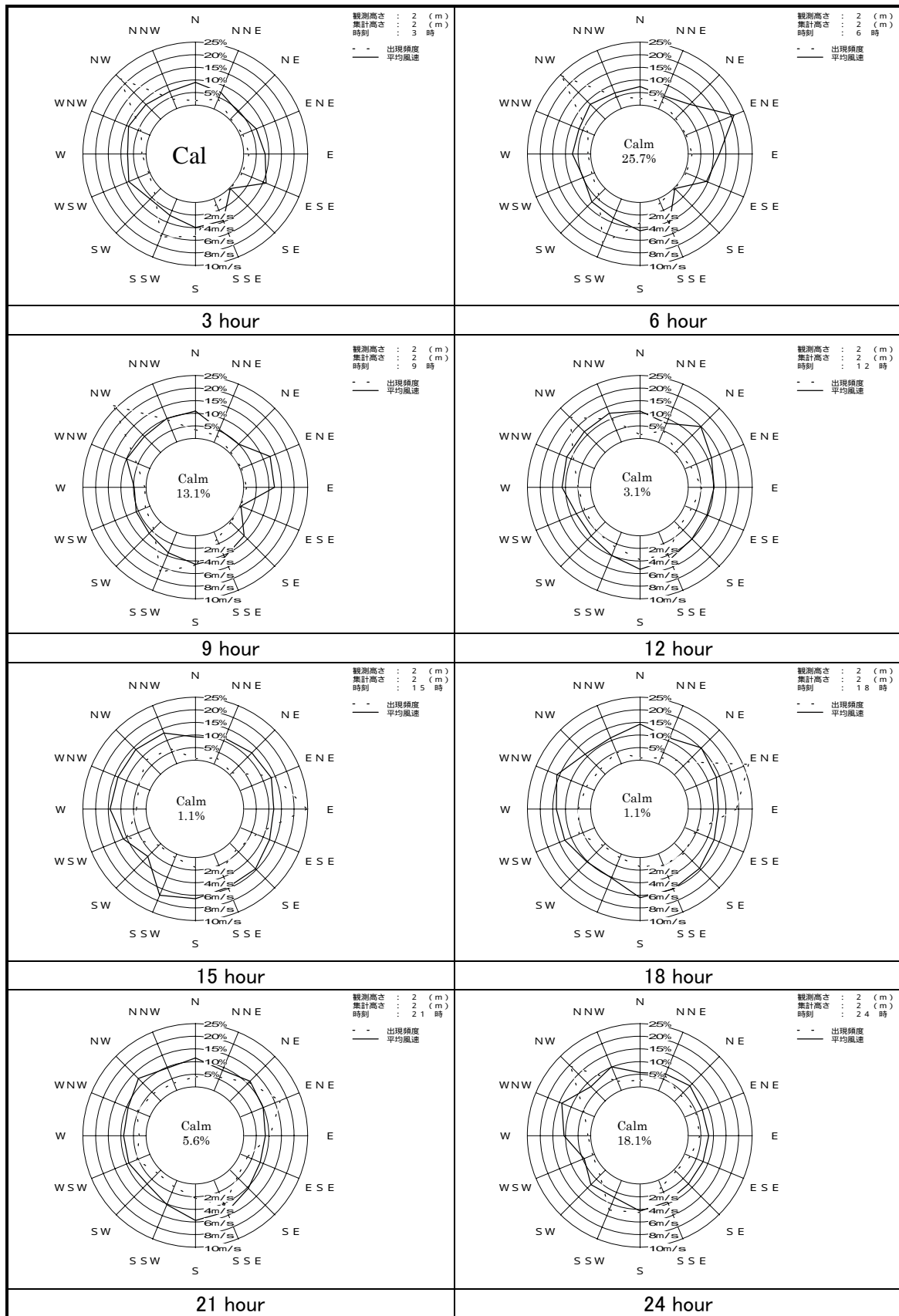
Source: The Construction Ministry

**(4) The hourly wind direction and velocity throughout the year based on the data observed in the year 2000 at Maputo.**

(a) Table Frequency and Average wind velocity throughout the year

| Time | Item      | Unit Frequency (%) \ Average wind velocity (m/s) |     |      |      |      |     |     |      |      |      |     |     |     |     |      |      | calm(%) |
|------|-----------|--|-----|------|------|------|-----|-----|------|------|------|-----|-----|-----|-----|------|------|---------|
|      |           | N  | NNE | NE   | ENE  | E    | ESE | SE  | SSE  | S    | SSW  | SW  | WSW | W   | WNW | NW   | NNW  |         |
| 1    | Frequency | 2.6  | 3.8 | 1.7  | 2.9  | 3.5  | 0.0 | 0.3 | 2.0  | 10.1 | 11.9 | 2.6 | 2.0 | 1.2 | 4.3 | 23.5 | 4.3  | 23.2    |
|      | Velocity  | 2.3  | 2.8 | 3.3  | 2.7  | 3.0  | 0.0 | 4.2 | 5.1  | 3.5  | 2.8  | 2.6 | 2.9 | 1.4 | 3.7 | 3.7  | 3.0  |         |
| 2    | Frequency | 2.0  | 4.3 | 0.6  | 2.0  | 1.5  | 0.6 | 0.3 | 1.7  | 13.6 | 13.9 | 2.3 | 0.9 | 0.6 | 3.5 | 24.6 | 3.2  | 24.6    |
|      | Velocity  | 2.5  | 3.2 | 4.6  | 2.9  | 2.6  | 1.4 | 5.0 | 3.8  | 4.1  | 3.3  | 2.6 | 1.8 | 1.4 | 4.2 | 3.1  | 3.1  |         |
| 3    | Frequency | 1.7  | 4.0 | 0.3  | 0.9  | 1.7  | 0.6 | 0.0 | 2.0  | 13.3 | 16.1 | 3.2 | 0.6 | 1.7 | 3.8 | 22.8 | 4.0  | 23.3    |
|      | Velocity  | 3.6  | 2.8 | 1.7  | 2.6  | 3.3  | 4.3 | 0.0 | 3.7  | 3.9  | 2.8  | 2.3 | 3.7 | 3.0 | 3.7 | 3.3  | 2.9  |         |
| 4    | Frequency | 1.4  | 3.7 | 0.3  | 0.9  | 1.1  | 0.3 | 0.3 | 1.4  | 13.1 | 17.7 | 3.1 | 1.1 | 0.9 | 4.0 | 23.7 | 2.9  | 24.0    |
|      | Velocity  | 2.5  | 3.2 | 1.9  | 2.5  | 2.5  | 6.1 | 2.5 | 3.2  | 4.3  | 2.9  | 3.0 | 3.0 | 3.8 | 4.1 | 3.2  | 3.1  |         |
| 5    | Frequency | 2.9  | 2.9 | 1.7  | 0.9  | 0.6  | 0.9 | 0.0 | 0.6  | 10.1 | 17.8 | 2.3 | 0.3 | 0.9 | 5.5 | 25.0 | 4.0  | 23.9    |
|      | Velocity  | 2.4  | 1.6 | 3.5  | 2.0  | 4.9  | 4.5 | 0.0 | 5.2  | 4.1  | 3.4  | 1.9 | 3.1 | 4.1 | 3.0 | 3.2  | 3.0  |         |
| 6    | Frequency | 2.5  | 3.1 | 0.6  | 0.3  | 1.1  | 0.3 | 0.0 | 1.4  | 7.9  | 18.9 | 3.7 | 1.1 | 1.1 | 2.8 | 24.3 | 5.1  | 25.7    |
|      | Velocity  | 2.9  | 2.2 | 3.3  | 8.3  | 4.8  | 3.6 | 0.0 | 4.3  | 4.4  | 3.2  | 3.0 | 2.0 | 2.9 | 2.7 | 3.3  | 2.7  |         |
| 7    | Frequency | 3.4  | 3.4 | 0.0  | 1.1  | 2.0  | 0.0 | 0.0 | 1.7  | 11.1 | 16.5 | 2.8 | 0.6 | 1.1 | 4.8 | 22.2 | 7.7  | 21.6    |
|      | Velocity  | 3.0  | 1.9 | 0.0  | 2.8  | 2.8  | 0.0 | 0.0 | 4.0  | 3.7  | 3.1  | 3.4 | 4.8 | 1.3 | 3.8 | 3.3  | 2.7  |         |
| 8    | Frequency | 2.9  | 2.9 | 0.0  | 0.6  | 1.1  | 0.0 | 0.0 | 1.4  | 9.5  | 17.0 | 3.7 | 1.1 | 1.1 | 3.7 | 24.1 | 9.8  | 21.0    |
|      | Velocity  | 2.7  | 2.7 | 0.0  | 4.1  | 4.7  | 0.0 | 0.0 | 4.1  | 4.3  | 3.1  | 3.0 | 1.8 | 2.0 | 2.9 | 3.7  | 3.3  |         |
| 9    | Frequency | 3.3  | 2.8 | 0.3  | 0.3  | 0.8  | 0.0 | 0.3 | 2.8  | 11.4 | 16.9 | 3.9 | 1.9 | 0.6 | 5.8 | 26.4 | 9.4  | 13.1    |
|      | Velocity  | 4.3  | 2.1 | 1.9  | 5.0  | 4.7  | 0.0 | 3.1 | 4.2  | 4.5  | 3.5  | 2.6 | 2.4 | 1.9 | 4.0 | 3.7  | 4.0  |         |
| 10   | Frequency | 1.1  | 8.4 | 0.6  | 1.1  | 1.1  | 0.3 | 0.9 | 4.2  | 10.7 | 12.7 | 3.9 | 2.0 | 2.0 | 6.2 | 29.6 | 9.6  | 5.6     |
|      | Velocity  | 3.5  | 2.7 | 2.0  | 3.3  | 3.1  | 1.9 | 3.6 | 4.5  | 5.2  | 3.6  | 3.7 | 4.6 | 3.5 | 4.6 | 4.3  | 4.4  |         |
| 11   | Frequency | 2.3  | 6.2 | 0.0  | 1.4  | 3.1  | 0.8 | 1.1 | 6.7  | 12.6 | 10.4 | 3.1 | 2.8 | 4.2 | 6.5 | 23.6 | 10.4 | 4.8     |
|      | Velocity  | 4.3  | 2.9 | 0.0  | 3.3  | 4.0  | 3.0 | 3.6 | 5.4  | 5.0  | 4.3  | 3.6 | 3.4 | 3.4 | 4.2 | 4.7  | 4.3  |         |
| 12   | Frequency | 1.4  | 4.8 | 0.8  | 2.3  | 5.1  | 2.5 | 2.5 | 9.3  | 9.3  | 6.2  | 5.1 | 4.2 | 5.1 | 9.0 | 19.7 | 9.8  | 3.1     |
|      | Velocity  | 4.3  | 3.2 | 5.8  | 4.5  | 3.9  | 3.7 | 3.8 | 4.6  | 5.2  | 3.9  | 3.2 | 3.1 | 4.6 | 4.8 | 4.7  | 4.9  |         |
| 13   | Frequency | 2.0  | 3.6 | 1.4  | 4.5  | 12.0 | 4.8 | 5.6 | 8.7  | 8.7  | 3.9  | 2.5 | 5.3 | 3.4 | 5.9 | 17.9 | 7.8  | 2.0     |
|      | Velocity  | 5.5  | 4.4 | 4.2  | 4.0  | 3.7  | 4.0 | 4.7 | 5.3  | 5.3  | 4.7  | 4.4 | 4.2 | 4.6 | 4.9 | 4.7  | 4.7  |         |
| 14   | Frequency | 2.5  | 3.6 | 1.4  | 10.0 | 18.6 | 5.3 | 5.0 | 6.1  | 4.2  | 3.3  | 1.9 | 8.3 | 4.2 | 6.1 | 11.4 | 5.8  | 2.2     |
|      | Velocity  | 4.1  | 3.8 | 5.1  | 4.7  | 4.1  | 4.5 | 4.8 | 6.2  | 6.0  | 3.1  | 3.8 | 4.5 | 4.2 | 5.4 | 5.0  | 5.4  |         |
| 15   | Frequency | 0.6  | 2.5 | 0.8  | 14.5 | 24.6 | 6.7 | 3.3 | 7.0  | 3.6  | 1.4  | 0.8 | 9.8 | 3.9 | 4.8 | 8.1  | 6.4  | 1.1     |
|      | Velocity  | 3.7  | 4.4 | 4.8  | 5.2  | 4.6  | 4.9 | 5.6 | 5.7  | 6.4  | 7.0  | 2.9 | 4.6 | 5.7 | 5.5 | 5.6  | 5.3  |         |
| 16   | Frequency | 1.7  | 2.2 | 0.8  | 19.5 | 26.5 | 7.0 | 3.9 | 6.1  | 4.5  | 1.1  | 0.6 | 5.8 | 3.3 | 4.7 | 7.2  | 4.2  | 0.8     |
|      | Velocity  | 4.2  | 4.2 | 6.0  | 5.9  | 4.6  | 5.6 | 4.5 | 6.3  | 6.2  | 2.2  | 6.1 | 6.0 | 5.5 | 6.5 | 5.6  | 5.1  |         |
| 17   | Frequency | 1.4  | 1.4 | 2.5  | 27.9 | 21.5 | 7.5 | 3.3 | 5.0  | 5.0  | 0.8  | 0.6 | 6.7 | 3.9 | 3.6 | 3.9  | 3.9  | 0.8     |
|      | Velocity  | 5.7  | 6.0 | 6.1  | 5.7  | 4.7  | 5.2 | 4.6 | 6.3  | 6.3  | 3.7  | 5.7 | 5.7 | 7.1 | 5.6 | 4.5  | 5.2  |         |
| 18   | Frequency | 0.8  | 2.5 | 6.9  | 26.9 | 18.6 | 4.2 | 5.3 | 4.7  | 3.3  | 1.4  | 1.1 | 6.7 | 5.0 | 3.6 | 2.8  | 5.0  | 1.1     |
|      | Velocity  | 5.7  | 4.4 | 5.9  | 5.3  | 4.6  | 4.9 | 5.5 | 6.0  | 6.3  | 4.0  | 4.1 | 5.1 | 5.5 | 6.5 | 4.5  | 4.4  |         |
| 19   | Frequency | 2.2  | 4.2 | 7.5  | 28.4 | 14.2 | 3.3 | 4.2 | 6.4  | 3.3  | 1.4  | 4.5 | 6.7 | 5.6 | 2.2 | 3.9  | 1.1  | 0.8     |
|      | Velocity  | 4.8  | 3.9 | 5.2  | 5.3  | 4.3  | 4.0 | 5.2 | 5.8  | 4.5  | 3.8  | 3.3 | 4.4 | 6.0 | 5.4 | 9.3  | 3.8  |         |
| 20   | Frequency | 2.8  | 6.2 | 7.8  | 22.4 | 12.0 | 3.9 | 4.5 | 8.1  | 5.6  | 1.1  | 3.1 | 5.0 | 4.8 | 3.4 | 2.8  | 1.7  | 4.8     |
|      | Velocity  | 4.2  | 3.7 | 4.6  | 4.0  | 3.8  | 3.5 | 4.7 | 5.7  | 5.1  | 6.9  | 3.6 | 3.7 | 5.0 | 4.2 | 4.6  | 3.7  |         |
| 21   | Frequency | 3.9  | 5.6 | 10.3 | 16.8 | 10.1 | 2.8 | 3.9 | 10.3 | 5.3  | 2.5  | 1.7 | 5.6 | 2.8 | 5.6 | 4.2  | 3.1  | 5.6     |
|      | Velocity  | 4.5  | 3.4 | 4.4  | 3.8  | 3.3  | 3.3 | 4.0 | 5.3  | 5.7  | 4.1  | 3.0 | 3.6 | 3.6 | 3.8 | 5.0  | 3.8  |         |
| 22   | Frequency | 3.2  | 6.9 | 6.9  | 14.4 | 5.8  | 1.1 | 2.6 | 7.2  | 8.9  | 2.3  | 3.7 | 5.2 | 2.3 | 6.9 | 9.8  | 3.7  | 9.2     |
|      | Velocity  | 4.1  | 3.8 | 3.6  | 3.5  | 3.0  | 3.7 | 3.7 | 4.8  | 4.6  | 4.1  | 2.3 | 3.4 | 4.3 | 4.1 | 4.0  | 4.6  |         |
| 23   | Frequency | 2.3  | 8.4 | 4.1  | 7.6  | 6.4  | 1.8 | 2.3 | 5.3  | 11.9 | 7.6  | 2.6 | 2.3 | 2.0 | 5.0 | 11.9 | 5.0  | 13.4    |
|      | Velocity  | 3.7  | 3.3 | 4.0  | 3.2  | 3.0  | 3.2 | 3.8 | 4.3  | 4.5  | 3.3  | 2.2 | 3.7 | 2.1 | 5.0 | 3.4  | 4.0  |         |
| 24   | Frequency | 2.4  | 6.2 | 3.3  | 4.4  | 4.2  | 2.1 | 0.6 | 2.7  | 11.0 | 12.5 | 3.0 | 0.9 | 1.2 | 4.4 | 19.3 | 3.9  | 18.1    |
|      | Velocity  | 2.2  | 2.8 | 3.4  | 2.9  | 3.1  | 3.0 | 3.0 | 3.6  | 4.2  | 2.8  | 3.2 | 1.8 | 4.3 | 5.6 | 3.2  | 4.0  |         |
| Year | Frequency | 2.2  | 4.3 | 2.5  | 8.9  | 8.3  | 2.4 | 2.1 | 4.7  | 8.6  | 8.9  | 2.7 | 3.7 | 2.6 | 4.8 | 16.3 | 5.5  | 11.3    |
|      | Velocity  | 3.7  | 3.2 | 4.6  | 4.7  | 4.1  | 4.4 | 4.6 | 5.2  | 4.6  | 3.3  | 3.1 | 4.2 | 4.5 | 4.5 | 3.9  | 4.1  |         |

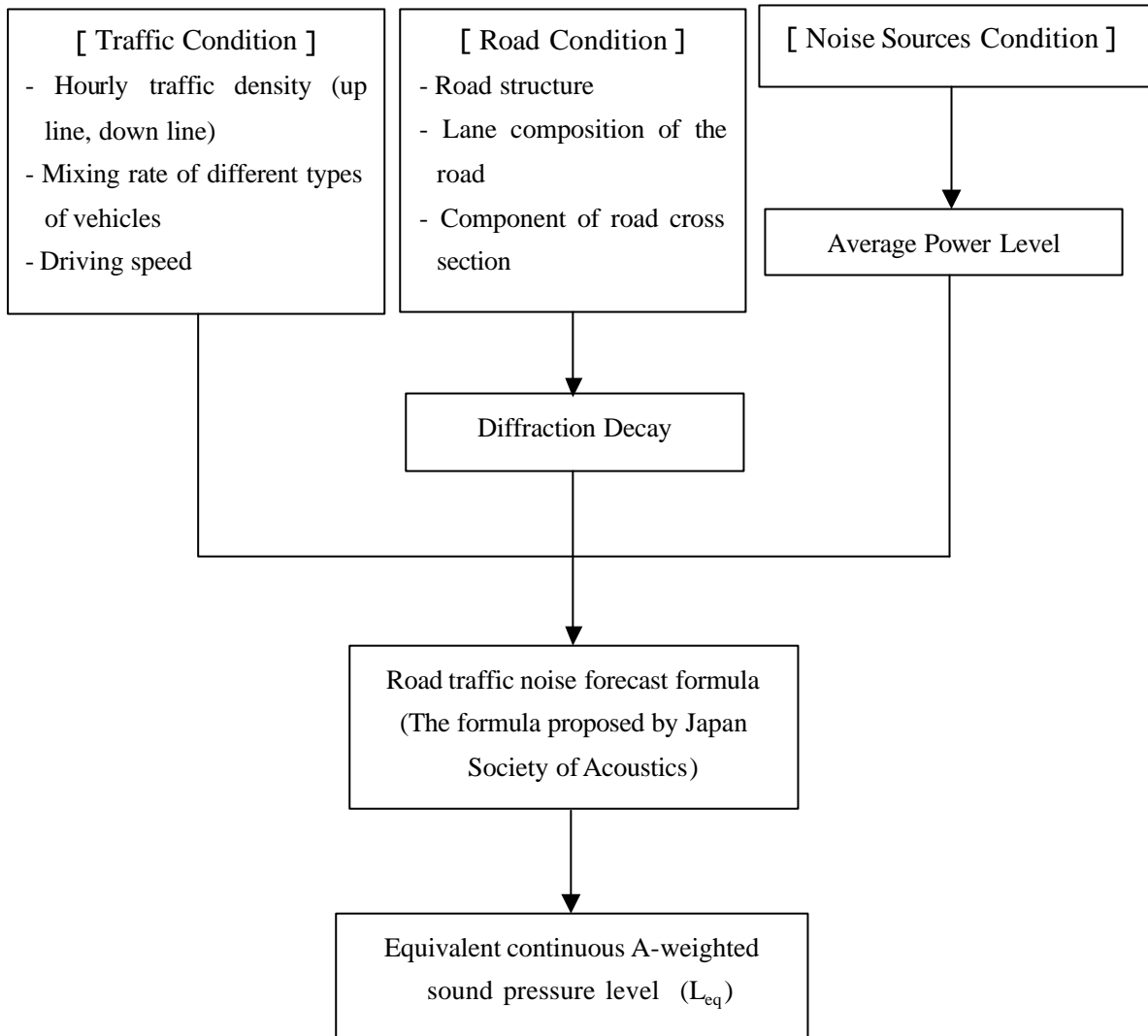
(b) Figure The hourly wind direction and velocity throughout the year



-----:Frequency(%), ———:Average wind velocity (m/s)、High:2m

### Appendix 20.3 Detailed forecast of noise

#### (1) Road traffic noise level forecast procedure



## (2) Road traffic noise forecast

### (a) Forecast formula

Following formula that is named ASJ Model 1998 was used. It is proposed by the Japan Society of Acoustics in 1998.

$$L_{PA,i} = L_w - 8 - 20 \log_{10} r + L_d + L_g$$

Where,

- $L_{PA,i}$  : A-weighted sound pressure level (dB)
- $L_w$  : Average power level produced from each vehicle (dB)
- $r$  : Distance from the noise source to the noise receiving point (m)
- $L_d$  : Correction value for diffraction decay (dB)
- $L_g$  : Correction value for road surface (dB)

Note: The predictive formula shown below is based on the one-row interval equi-power model formulated by the Japan Society of Acoustics.

### (b) Average power level: $L_w$

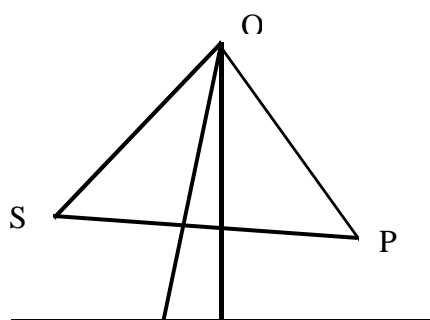
Large vehicle :  $L_w = 53.2 + 30 \log_{10} V$

Small vehicle :  $L_w = 46.7 + 30 \log_{10} V$

Where,

- $L_w$  : Average power level (dB)
- $V$  : Average driving speed (km/hr)

### (c) Correction value for diffraction decay: $L_d$



- O : Apex of the acoustic obstacle
- P : Position of noise receiving point
- S : Noise source

$$L_d = SO + OP - SP$$



$$L_d = \begin{cases} -20 - 10 \log_{10} \mathbf{d} & \mathbf{d} \geq 1 \\ -5 \pm \frac{-15}{\ln(1 + \sqrt{2})} \cdot \sinh^{-1} \left( \left| \mathbf{d} \right|^{0.414} \right) & -0.0537 \leq \mathbf{d} < 1 \\ 0 & \mathbf{d} < -0.0537 \end{cases}$$

Where,

$\pm$  :  $>0$ : +,  $<0$ : -

$$\sinh^{-1} : \sinh^{-1} x = \ln \left( x + (x^2 + 1)^{1/2} \right)$$

**(d) Correction value for road surface:  $L_g$**

$$L_g = L_{g,i}$$

$$L_{g,i} = \begin{cases} -K_i \log_{10} \left( \frac{r_i}{r_{0,i}} \right) & r_i \geq r_{0,i} \\ 0 & r_i < r_{0,i} \end{cases}$$

Where,

$L_{g,i}$ : Correction value for road surface of No.i (dB)

$K_i$ : Coefficient of over decay on road surface of No.i

$r_i$ : Propagation distance on road surface of No.i (m)

$r_{0,i}$ : Distance that over decay occur on road surface of No.i (m)

**(e) Equivalent continuous A-weighted sound pressure level of No. n lane:  $L_{eq,n}$**

$$L_{AE} = 10 \log_{10} \left[ \left( \frac{1}{T_0} \right) \cdot \sum 10^{L_{PA,i}/10} \cdot \Delta t_i \right]$$

$$L_{eq,n} = L_{AE} + 10 \log_{10} N - 10 \log_{10} 3600$$

Where,

$N$ : Hourly traffic density (vehicles/hour)

$t_i$ : Noise source interval (m) / Average speed (meter/second)

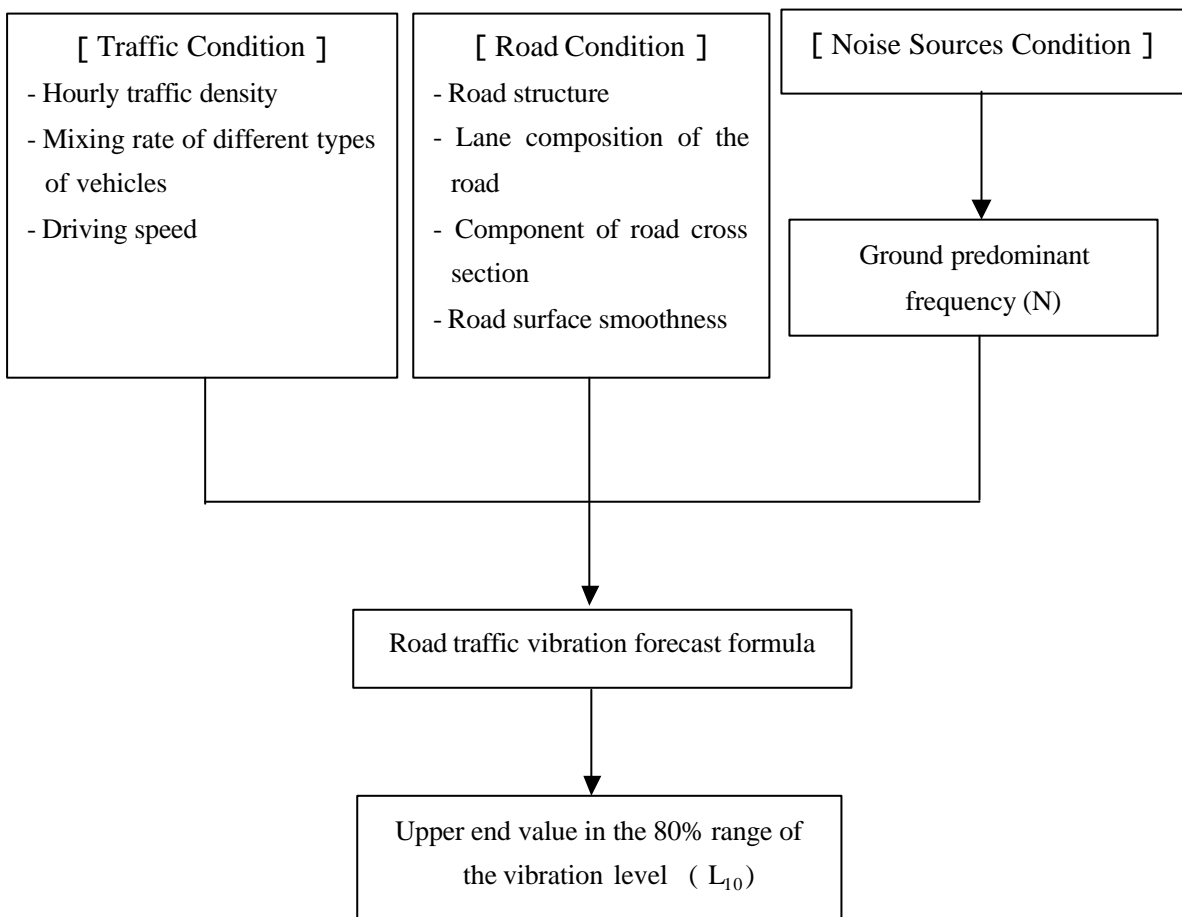
$T_0$  : Time (3600 second)

**(f) Equivalent continuous A-weighted sound pressure level :  $L_{eq}$**

$$L_{eq} = 10 \log_{10} \sum 10^{L_{eq,n}/10}$$

**Appendix 20.4 Detailed forecast of vibration**

**(1) Road traffic vibration level forecast procedure**



## (2) Road traffic vibration forecast

### (a) Forecast formula

Following formula was utilized. It is proposed by the Public Works Research Institute of the Ministry of Land, Infrastructure and Transport of Japan.

$$L_{10} = a \log_{10} (\log_{10} Q^*) + b \log_{10} V + c \log_{10} M + d + f + s - 1$$

Where,

$L_{10}$  : Forecast upper end value in the 80% range of the vibration level ( dB )

$Q^*$  :Equivalent traffic density per 500 second per lane  
( number of vehicles / 500 sec. / lane)

$$Q^* = \frac{500}{3600} \times \frac{1}{M} (Q_1 + 13Q_2)$$

$Q_1$  : Hourly traffic density of small vehicles (number of small vehicles / hour)

$Q_2$  : Hourly traffic density of large vehicles (number of large vehicles / hour)

$V$  : Average driving speed (km/hour)

$M$  : Total number of up and down lines

$d$  : Correction value for road surface smoothness (dB )

$f$  : Correction value for ground predominant frequency (dB )

$s$  : Correction value for road structure (dB )

$1$  : Decay by distance (dB )

a, b, c, d: Fixed numbers

### Coefficient for road traffic vibration forecast formula

| Road structure | Fixed number |    |     |      |
|----------------|--------------|----|-----|------|
|                | a            | b  | c   | d    |
| Flat road      | 47           | 12 | 3.5 | 27.3 |

**(b) Correction value for road surface smoothness:**

**Correction value for road surface smoothness**

| Road structure | Pavement | Coefficient                                  | Correction value |
|----------------|----------|--|------------------|
| Flat road      | Blacktop | Roughness in the longitudinal direction (mm) | $8.2 \log_{10}$  |
|                | Concrete |  | $19.4 \log_{10}$ |

**(c) Correction value for ground predominant frequency:  $f_g$**

$$f_g = -17.3 \log_{10} f$$

When,  $f = 8$  Hz

$f$  : Ground predominant frequency (Hz)

$$f_g = 8.4 N^{1/3}$$

Where,

$N$  : Average value for  $N$  (from the surface to 10 m under the ground)

**(d) Correction value for road structure:  $s$**

$$s = 0 \text{ (flat road)}$$

**(e) Decay by distance:  $d_1$**

$$d_1 = b \frac{\log_{10}(r/5 + 1)}{\log_{10} 2}$$

Where,

$r$  : Distance from the control point (m)

$b$  : Vibration level decay per double distance (dB)

$$b = 0.130 L_{10}^* - 3.9 \text{ (Sandy land)}$$

Note:  $L_{10}^*$  : Vibration level at control point (dB)

$$L_{10}^* = a \log_{10}(\log_{10} Q^*) + b \log_{10} V + c \log_{10} M + d + f + s$$

## Chapter 22 Appendix

### **Project Evaluation**

## Appendix 22 Economic Evaluations

Economic Evaluation for Alternative Route of J.Nyrere "Off-Line" (BasePlan)

|     |        |             |
|-----|--------|-------------|
| B/C | 2.9    | million USD |
| NPV | 53.7   |             |
| IRR | 29.10% |             |

Discout rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 16.5               | 0.0                   | -16.5                | 89.3%            | 14.7               | 0.0                   | -14.7                |
| 2003  | 9.9                | 0.0                   | -9.9                 | 79.7%            | 7.9                | 0.0                   | -7.9                 |
| 2004  | 6.6                | 0.0                   | -6.6                 | 71.2%            | 4.7                | 0.0                   | -4.7                 |
| 2005  | 0.2                | 6.8                   | 6.6                  | 63.6%            | 0.1                | 4.3                   | 4.2                  |
| 2006  | 0.2                | 14.2                  | 14.0                 | 56.7%            | 0.1                | 8.0                   | 7.9                  |
| 2007  | 0.2                | 14.8                  | 14.6                 | 50.7%            | 0.1                | 7.5                   | 7.4                  |
| 2008  | 0.2                | 15.4                  | 15.2                 | 45.2%            | 0.1                | 7.0                   | 6.9                  |
| 2009  | 0.2                | 16.0                  | 15.8                 | 40.4%            | 0.1                | 6.5                   | 6.4                  |
| 2010  | 0.2                | 16.7                  | 16.5                 | 36.1%            | 0.1                | 6.0                   | 6.0                  |
| 2011  | 0.2                | 17.3                  | 17.1                 | 32.2%            | 0.1                | 5.6                   | 5.5                  |
| 2012  | 0.2                | 17.9                  | 17.7                 | 28.7%            | 0.1                | 5.1                   | 5.1                  |
| 2013  | 0.2                | 18.5                  | 18.3                 | 25.7%            | 0.1                | 4.7                   | 4.7                  |
| 2014  | 0.2                | 19.1                  | 18.9                 | 22.9%            | 0.0                | 4.4                   | 4.3                  |
| 2015  | 0.2                | 19.7                  | 19.5                 | 20.5%            | 0.0                | 4.0                   | 4.0                  |
| 2016  | 0.2                | 20.4                  | 20.2                 | 18.3%            | 0.0                | 3.7                   | 3.7                  |
| 2017  | 0.2                | 21.1                  | 23.1                 | 16.3%            | 0.0                | 3.4                   | 3.8                  |
| 2018  | 0.2                | 21.8                  | 21.6                 | 14.6%            | 0.0                | 3.2                   | 3.2                  |
| 2019  | 0.2                | 22.6                  | 22.4                 | 13.0%            | 0.0                | 2.9                   | 2.9                  |
| 2020  | 0.2                | 23.3                  | 23.1                 | 11.6%            | 0.0                | 2.7                   | 2.7                  |
| 2021  | 0.2                | 24.1                  | 23.9                 | 10.4%            | 0.0                | 2.5                   | 2.5                  |
| Total | 36.2               | 285.6                 | 251.6                | -                | 28.4               | 81.7                  | 53.7                 |

**Summary of Inputs for ANE's VOC Model**

**Meticas In 1998 Price**

| Economic Costs          | Cars           | Pickups      | Minibuses    | Buses          | 2-3 axle trucks   | 4 axle trucks | Artics        |
|-------------------------|----------------|--------------|--------------|----------------|-------------------|---------------|---------------|
| Typical Model           | Toyota Corolla | Toyota Hilux | Toyota Hiace | Toyota Coaster | Mitsubishi Canter | Hino 8 tonne  | Mercedes 2024 |
| Tyre Size               | 165/13         | 185/14       | 165/13       | 315-80 R22.5   | 650-16            | 1000-20       | 1000-20       |
| New Vehicle Price       | 176,101,852    | 197,926,440  | 261,895,062  | 813,105,967    | 410,083,333       | 650,000,000   | 715,000,000   |
| Tyre Cost               | 390,432        | 556,790      | 390,432      | 3,394,383      | 706,173           | 2,237,346     | 2,237,346     |
| Maintenance Labour Cost | 6,875          | 13,021       | 6,875        | 21,875         | 21,875            | 21,875        | 21,875        |
| Operating Overheads     | 8,558,875      | 9,603,479    | 12,665,250   | 43,348,208     | 16,103,250        | 25,460,000    | 32,870,000    |
| Crew Cost               | 10,417         | 31,250       | 51,708       | 51,708         | 41,938            | 41,938        | 41,938        |
| Passenger Time Value    | 8,778          | 15,015       | 568          | 568            | 1,746             | 1,746         | 1,746         |

| Basic Characteristics         | Cars | Pickups | Minibuses | Buses | 2-3 axle trucks | 4 axle trucks | Artics |
|-------------------------------|------|---------|-----------|-------|-----------------|---------------|--------|
| Gross Vehicle Weight (tonnes) | 1.5  | 2       | 2         | 12    | 12              | 24            | 40     |
| No of Axles                   | 2    | 2       | 2         | 2     | 2               | 4             | 6      |
| No of Tyres                   | 4    | 4       | 4         | 6     | 6               | 14            | 22     |
| Equivalent Standard Axles     | 0    | 0       | 0         | 1.25  | 2.2             | 3             | 4.4    |
| No of Passengers              | 3    | 3       | 12        | 50    | 1               | 1             | 1      |

| Vehicle Utilisation Data | Cars   | Pickups | Minibuses | Buses  | 2-3 axle trucks | 4 axle trucks | Artics |
|--------------------------|--------|---------|-----------|--------|-----------------|---------------|--------|
| Service Life (vrs)       | 8      | 6       | 7         | 7      | 8               | 8             | 8      |
| Hours Driven per Year    | 300    | 350     | 2000      | 2000   | 700             | 900           | 900    |
| Kms Driven per Year      | 20000  | 25000   | 100000    | 130000 | 40000           | 55000         | 55000  |
| Hourly Utilisation Ratio | 0.6    | 0.5     | 0.7       | 0.7    | 0.5             | 0.5           | 0.5    |
| Annual Interest Rate %   | 21.55% | 21.55%  | 21.55%    | 21.55% | 21.55%          | 21.55%        | 21.55% |

| Fuel Information | Cars   | Pickups | Minibuses | Buses  | 2-3 axle trucks | 4 axle trucks | Artics |
|------------------|--------|---------|-----------|--------|-----------------|---------------|--------|
| Fuel Type Used   | Petrol | Diesel  | Petrol    | Diesel | Diesel          | Diesel        | Diesel |

| Fuel Costs (Economic) | Petrol | Diesel | Lubricants |
|-----------------------|--------|--------|------------|
| Cost per litre        | 4,173  | 2,425  | 22,082     |

Source: ANE (2000)

**VOC Input Data of Costs of New Vehicles**

|                    | Cars           | Pickups      | Minibuses    | Buses         | 2-3 axle trucks | 4 axle trucks | Artics        |
|--------------------|----------------|--------------|--------------|---------------|-----------------|---------------|---------------|
| Typical Model      | Toyota Corolla | Toyota Hilux | Toyota Hiace |               | Mitsubishi Cant | Hino 8 tonne  | Mercedes 2024 |
| Tyre Size          | 165/13         | 185/14       | 165/13       | 315-80 R22.5  | 650-16          | 1000-20       | 1000-20       |
| Retail Price       | 259,350,000    | 291,491,667  | 385,700,000  | 1,197,483,333 | 492,100,000     | 780,000,000   | 936,000,000   |
| Retailers Margin % | 10%            | 10%          | 10%          | 10%           | 10%             | 10%           | 10%           |
| Margin Amount      | 16,009,259     | 17,993,313   | 23,808,642   | 73,918,724    | 37,280,303      | 59,090,909    | 65,000,000    |
| IVA%               | 17.0%          | 17.0%        | 17.0%        | 17.0%         | 17.0%           | 17.0%         | 17.0%         |
| IVA Amount         | 27,215,741     | 30,588,632   | 40,474,691   | 125,661,831   | 63,376,515      | 100,454,545   | 110,500,000   |
| Import Duty %      | 35%            | 35%          | 35%          | 35%           | 5%              | 5%            | 17%           |
| Import Duty Amount | 56,032,407     | 62,976,595   | 83,330,247   | 258,715,535   | 18,640,152      | 29,545,455    | 110,500,000   |
| cif Price          | 160,092,593    | 179,933,128  | 238,086,420  | 739,187,243   | 372,803,030     | 590,909,091   | 650,000,000   |
| Economic Price     | 176,101,852    | 197,926,440  | 261,895,062  | 813,105,967   | 410,083,333     | 650,000,000   | 715,000,000   |
| Economic:Financial | 0.68           | 0.68         | 0.68         | 0.68          | 0.83            | 0.83          | 0.76          |

Source: ANE (2000)

**VOC Input Data of Retail Tyre Costs**

| New Tyres          | Cars    | Pickups | Minibuses | Buses      | 2-3 axle trucks | 4 axle trucks | Artics    |
|--------------------|---------|---------|-----------|------------|-----------------|---------------|-----------|
| Size of Tyre       | 165/13  | 185/14  | 165/13    | 315-80 R22 | 650-16          | 1000-20       | 1000-20   |
| Retail Price       | 575,000 | 820,000 | 575,000   | 4,999,000  | 1,040,000       | 3,295,000     | 3,295,000 |
| Retailers Margin % | 10%     | 10%     | 10%       | 10%        | 10%             | 10%           | 10%       |
| Margin Amount      | 35,494  | 50,617  | 35,494    | 308,580    | 64,198          | 203,395       | 203,395   |
| IVA %              | 17.0%   | 17.0%   | 17.0%     | 17.0%      | 17.0%           | 17.0%         | 17.0%     |
| IVA Amount         | 60,340  | 86,049  | 60,340    | 524,586    | 109,136         | 345,772       | 345,772   |
| Import Duty %      | 35%     | 35%     | 35%       | 35%        | 35%             | 35%           | 35%       |
| Import Duty Amount | 124,228 | 177,160 | 124,228   | 1,080,031  | 224,691         | 711,883       | 711,883   |
| cif Price          | 354,938 | 506,173 | 354,938   | 3,085,802  | 641,975         | 2,033,951     | 2,033,951 |
| Economic Price     | 390,432 | 556,790 | 390,432   | 3,394,383  | 706,173         | 2,237,346     | 2,237,346 |
| Economic:Financial | 0.68    | 0.68    | 0.68      | 0.68       | 0.68            | 0.68          | 0.68      |

| Retread Tyres      | Cars     | Pickups  | Minibuses | Buses      | 2-3 axle trucks | 4 axle trucks | Artics  |
|--------------------|----------|----------|-----------|------------|-----------------|---------------|---------|
| Tyre Size          | 165/13   | 185/14   | 165/13    | 315-80 R22 | 650-16          | 1000-20       | 1000-20 |
| Retail Price       | 90,000   | 110,000  | 90,000    | -          | 150,000         | -             | -       |
| Retailers Margin % | 10%      | 10%      | 10%       | 10%        | 10%             | 10%           | 10%     |
| Margin Amount      | 8,182    | 10,000   | 8,182     | -          | 13,636          | -             | -       |
| IVA %              | 17%      | 17%      | 17%       | 17%        | 17%             | 17%           | 0%      |
| IVA Amount         | 13,076.9 | 15,982.9 | 13,076.9  | -          | 21,794.9        | -             | -       |
| Import Duty %      | 35%      | 35%      | 35%       | 35%        | 35%             | 35%           | 35%     |
| Import Duty Amount | 23,333   | 28,519   | 23,333    | -          | 38,889          | -             | -       |
| cif Price          | 55,556   | 67,901   | 55,556    | -          | 92,593          | -             | -       |
| Economic Price     | 63,737   | 77,901   | 63,737    | -          | 106,229         | -             | -       |
| Retread Cost       | 16.32%   | 13.99%   | 16.32%    | 0.00%      | 15.04%          | 0.00%         | 0.00%   |
| Assumed average    |          |          |           |            |                 |               | 15%     |

Source: ANE (2000)

**VOC Input Data of Maintenance Labour Costs**

| Wage per hour                   | Cars   | Pickups | Minibuses | Buses  | 2-3 axle trucks | 4 axle trucks | Artics | Tractor Trailers | Tractors |
|---------------------------------|--------|---------|-----------|--------|-----------------|---------------|--------|------------------|----------|
| Supervisor                      | 35,417 | 35,417  | 35,417    | 35,417 | 35,417          | 35,417        | 35,417 | 35,417           | 35,417   |
| Mechanic                        | 8,333  | 8,333   | 8,333     | 8,333  | 8,333           | 8,333         | 8,333  | 8,333            | 8,333    |
| Owner                           | 0      | 0       | 0         | 0      | 0               | 0             | 0      | 0                | 0        |
| <b>Proportion of time</b>       |        |         |           |        |                 |               |        |                  |          |
| Supervisor                      | 10%    | 25%     | 10%       | 50%    | 50%             | 50%           | 50%    | 10%              | 10%      |
| Mechanic                        | 40%    | 50%     | 40%       | 50%    | 50%             | 50%           | 50%    | 40%              | 40%      |
| Owner                           | 50%    | 25%     | 50%       | 0%     | 0%              | 0%            | 0%     | 50%              | 50%      |
| Average hourly rate for service | 6,875  | 13,021  | 6,875     | 21,875 | 21,875          | 21,875        | 21,875 | 6,875            | 6,875    |
| Shadow Wage Rate Factor         | 1.00   | 1.00    | 1.00      | 1.00   | 1.00            | 1.00          | 1.00   | 1.00             | 1.00     |
| Economic Hourly Rate            | 6,875  | 13,021  | 6,875     | 21,875 | 21,875          | 21,875        | 21,875 | 6,875            | 6,875    |

**Wage calculations**

|             |         |             |         |
|-------------|---------|-------------|---------|
| Supervisor  |         | Mechanic    |         |
| Per month   | 8500000 | Per month   | 2000000 |
| No of Hours | 240     | No of Hours | 240     |
| Per hour    | 35417   | Per hour    | 8333    |

Source: ANE (2000)



**VOC Input Data of Vehicle Overheads**

**Annual Registration Fees**

|                 |           |
|-----------------|-----------|
| Cars            | 130,000   |
| Pickups         | 130,000   |
| Minibuses       | 130,000   |
| Buses           | 4,430,000 |
| 2-3 axle trucks | 110,000   |
| 4 axle trucks   | 110,000   |
| Artics          | 110,000   |

**Insurance Costs**      Third Party Fire and Theft Only

|                 | Cost per annum | Average Value of Vehicle | Cost % per value |
|-----------------|----------------|--------------------------|------------------|
| Cars            | 8,428,875      | 129,675,000              | 7%               |
| Pickups         | 9,473,479      | 145,745,833              | 7%               |
| Minibuses       | 12,535,250     | 192,850,000              | 7%               |
| Buses           | 38,918,208     | 598,741,667              | 7%               |
| 2-3 axle trucks | 15,993,250     | 246,050,000              | 7%               |
| 4 axle trucks   | 25,350,000     | 390,000,000              | 7%               |
| Artics          | 32,760,000     | 468,000,000              | 7%               |

**Total Overheads**

|                 | Registration Fee | Insurance  | Total      |
|-----------------|------------------|------------|------------|
| Cars            | 130,000          | 8,428,875  | 8,558,875  |
| Pickups         | 130,000          | 9,473,479  | 9,603,479  |
| Minibuses       | 130,000          | 12,535,250 | 12,665,250 |
| Buses           | 4,430,000        | 38,918,208 | 43,348,208 |
| 2-3 axle trucks | 110,000          | 15,993,250 | 16,103,250 |
| 4 axle trucks   | 110,000          | 25,350,000 | 25,460,000 |
| Artics          | 110,000          | 32,760,000 | 32,870,000 |

Source: ANE (2000)

**VOC Input Data of Crew Cost**

|                                      | Cars   | Pickups | Minibuses | Buses  | 2-3 axle trucks | 4 axle trucks | Artics | Tractor Trailers | Tractors |
|--------------------------------------|--------|---------|-----------|--------|-----------------|---------------|--------|------------------|----------|
| No of Drivers                        | 0.25   | 0.75    | 1         | 1      | 1               | 1             | 1      | 1                | 1        |
| Average Wage Rate per Hour           | 41,667 | 41,667  | 41,667    | 41,667 | 41,667          | 41,667        | 41,667 | 41,667           | 41,667   |
| Driver Costs                         | 10,417 | 31,250  | 41,667    | 41,667 | 41,667          | 41,667        | 41,667 | 41,667           | 41,667   |
| Shadow Wage Rate Factor Semi-skilled | 1.00   | 1.00    | 1.00      | 1.00   | 1.00            | 1.00          | 1.00   | 1.00             | 1.00     |
| Economic Driver Costs                | 10,417 | 31,250  | 41,667    | 41,667 | 41,667          | 41,667        | 41,667 | 41,667           | 41,667   |
| No of Helpers/Turnboy                | 0      | 0       | 1         | 1      | 1               | 1             | 1      | 1                | 1        |
| Average Wage Rate per Hour           | 20,833 | 562     | 20,833    | 20,833 | 562             | 562           | 562    | 562              | 562      |
| Helper/Turnboy Costs                 | 0      | 0       | 20,833    | 20,833 | 562             | 562           | 562    | 562              | 562      |
| Shadow Wage Rate Factor Unskilled    | 0.48   | 0.48    | 0.48      | 0.48   | 0.48            | 0.48          | 0.48   | 0.48             | 0.48     |
| Economic Driver Costs                | 0      | 0       | 10,041    | 10,041 | 271             | 271           | 271    | 271              | 271      |
| Total Economic Cost                  | 10,417 | 31,250  | 51,708    | 51,708 | 41,938          | 41,938        | 41,938 | 41,938           | 41,938   |

**Driver Wages**

|             |            |
|-------------|------------|
| Per month   | 10,000,000 |
| No of hours | 240        |
| Per hour    | 41,667     |

Source: ANE (2000)

**Steward/Turnboy wages**

|             |           |
|-------------|-----------|
| Per month   | 5,000,000 |
| No of hours | 240       |
| Per hour    | 20,833    |

**Labourer wages**

|             |         |
|-------------|---------|
| Per month   | 134,950 |
| No of hours | 240     |
| Per hour    | 562     |

**VOC Input Data of the Value of Passenger Time Savings**

**For Cars and Pickups**

|                                     |            |
|-------------------------------------|------------|
| Average Annual Salary Professionals | 23,699,520 |
| Allowances/Benefits                 | 14,400,000 |
| Employers Contributions             | 0          |
| Total Remuneration                  | 38,099,520 |
| Number of Hours Worked              | 2000       |
| Average Hourly Rate                 | 19049.76   |
| Non Work Time as % of Work Time     | 0.25       |
| Value of Non Work Time              | 4762       |

Salary class 74 scale 4 (Primeiro Oficial de radio) 1974960 per month  
Car worth say 100 USD per month

**For Trucks and Buses**

|                                     |           |
|-------------------------------------|-----------|
| Average Annual Earnings All Sectors | 5,400,000 |
| Number of Hours Worked              | 3000      |
| Average Hourly Rate                 | 1800      |
| Non Work Time as % of Work Time     | 0.25      |
| Value of Non Work Time              | 450       |

Minimum Govt salary Salary class 1U scale 1 MT 450000 per month

**Calculation of Average Value of Time by Vehicle Type**

|                                  | Cars   | Pickups | Minibuses | Buses | 2-3 axle trucks | 4 axle trucks | Artics | Tractor Trailers | Tractors |
|----------------------------------|--------|---------|-----------|-------|-----------------|---------------|--------|------------------|----------|
| Value of Work Time               | 19,050 | 19,050  | 1,800     | 1,800 | 1,800           | 1,800         | 1,800  | 1,800            | 1,800    |
| Proportion of Trips for Work     | 0.3    | 0.75    | 0.1       | 0.1   | 1               | 1             | 1      | 1                | 1        |
| Value of Non Work Time           | 4,762  | 4,762   | 450       | 450   | 450             | 450           | 450    | 450              | 450      |
| Proportion of Trips for Non Work | 0.7    | 0.25    | 0.9       | 0.9   | 0               | 0             | 0      | 0                | 0        |
| Average Value of Time            | 9,049  | 15,478  | 585       | 585   | 1,800           | 1,800         | 1,800  | 1,800            | 1,800    |
| Standard Conversion Factor       | 0.97   | 0.97    | 0.97      | 0.97  | 0.97            | 0.97          | 0.97   | 0.97             | 0.97     |
| Economic Value of Time           | 8,778  | 15,015  | 568       | 568   | 1,746           | 1,746         | 1,746  | 1,746            | 1,746    |

Source: ANE (2000)

**VOC Input Data of Fuel and Lubricants Costs**

|                    | <b>Petrol</b> | <b>Diesel</b> | <b>Lubricants</b> |
|--------------------|---------------|---------------|-------------------|
| Retail Price       | 6,620         | 4,340         | 27,000            |
| Retailers Margin % | 10.0%         | 10.0%         | 10.0%             |
| Margin Amount      | 379.39        | 220.45        | 2,007.43          |
| IVA %              | 17.0%         | 17.0%         | 17.0%             |
| IVA Amount         | 644.97        | 374.77        | 3,412.64          |
| Excise Duty Amount | 1,612.00      | 1,430.00      | 0.00              |
| Import Duty %      | 5.0%          | 5.0%          | 7.5%              |
| Import Duty Amount | 189.70        | 110.23        | 1,505.58          |
| cif Price          | 3,793.94      | 2,204.55      | 20,074.35         |
| Economic Price     | 4,173.33      | 2,425.00      | 22,081.78         |
| Economic:Financial | 0.63          | 0.56          | 0.82              |

**Assessment of Average Prices**

|                           | <b>Petrol</b> | <b>Diesel</b> | <b>Lubricants</b> |
|---------------------------|---------------|---------------|-------------------|
| Garagem Tomareense        | 6620          | 4340          | Petromoc 24600    |
| Garagem Tomareense        |               |               | BP 33600          |
| Auto Car                  |               |               | Shell 28800       |
| Auto Car                  |               |               | Valvoline 21000   |
| Petromoc Av de Mocambique | 6620          | 4340          |                   |
| Average                   | 6620          | 4340          | 27000             |

Source: ANE (2000)

**Import Duty Amounts**

From Boletim Da Republica, 3rd Supplement, 29 September 1998

| Code        | Description            |
|-------------|------------------------|
| <b>2710</b> | Petroleum Oils         |
| 2710 10     | Gasolines              |
| 2710 11     | For industrial use     |
| 2710 19     | Other uses             |
| 2710 70     | Lubricating Oils       |
| 2710 71     |                        |
| 2710 72     |                        |
| 2710 73     |                        |
| 2710 79     | Other lubricating oils |
| 2710 90     | Heavy Fuel Oils        |
| 2710 91     | Diesel                 |

**Calculation of HDM III Input Data**

**VOC Input Data of Shadow Wage Rate Factor**

|                                      | Skilled | Semi-skilled | Unskilled |
|--------------------------------------|---------|--------------|-----------|
| Index                                | 1       | 1            | 1         |
| Income Tax Rate                      | 0%      | 0%           | 0%        |
| Other Taxes Rate                     | 0%      | 0%           | 0%        |
| Average Agricultural Production Loss | 0%      | 0%           | 52%       |
| Shadow Wage Rate Factor              | 1.00    | 1.00         | 0.48      |

**Average Agricultural Production Rate Calculations**

(from EN103 Colomue - Tete Design Report, CPP Ltd, May 1999)

**Value of Family Production**

| Product  | Requiremen Price | Total      |
|--|------------------|------------|
| Maize  | 660              | 495 326700 |
| Beans  | 345              | 828 285660 |
| Vegetables   | 330              | 598 197340 |
| Total Meticaais                                      |                  | 809700     |
| US Dollar Exchange Rate                              | 5400             |            |
| Total Dollars  |                  | 150        |
| Project Wage (50,000 + 90,000 food basket) per month |                  | 140000     |
| Project Wage Dollars                                 |                  | 311        |
| Shadow Wage Rate Factor                              |                  | 0.48       |

Source: ANE (2000)

VOC Input Data of Standard Conversion Factor Calculation

| ITEM   | VARIABLES/EQUATIONS                  | Meticais Million |           |
|--|--------------------------------------|------------------|-----------|
|  |                                      | 1997             | 1998      |
| <b>IMPORTS</b>                                   |                                      |                  |           |
| Total Imports                                    | TQM                                  | 8,662,513        | 8,844,412 |
| Special Transactions (Items for re-export)       | SM                                   | -                | -         |
| Government and Quasi-government Imports          | NM                                   | -                | -         |
| Net Imports                                      | QM=TQM-SM-NM                         | 8,662,513        | 8,844,412 |
| <b>EXPORTS</b>                                   |                                      |                  |           |
| Total Exports                                    | TQX                                  | 2,621,636        | 2,915,067 |
| Re-exports                                       | RXX                                  | -                | -         |
| Net Exports                                      | OX=TOX-RXX                           | 2,621,636        | 2,915,067 |
| <b>BALANCE OF TRADE</b>                          |                                      |                  |           |
| Trade Deficit                                    | dQ=QM-QX                             | 6,040,877        | 5,929,345 |
| <b>IMPORT DUTIES</b>                             |                                      |                  |           |
| Total Import Duties                              | ITI                                  | 11,292           | 13,840    |
| Relevant Import Duties (excl quasi-govt imports) | IT                                   | 9,255            | 11,273    |
| Import Excise Duties                             | TR                                   | 2,037            | 2,567     |
| Import Tariff Rate                               | tm=(IT-TR)/QM                        | 0.001            | 0.002     |
| Total Duties and Taxes on Imports                | T=ITI-TR                             | 9,255            | 11,273    |
| <b>EXPORT DUTIES</b>                             |                                      |                  |           |
| Total Duties and Taxes on Exports                | E                                    | -                | -         |
| Export Tax Rate                                  | tx                                   | 0.000            | 0.000     |
| <b>ELASTICITIES AND WEIGHTS</b>                  |                                      |                  |           |
| Elasticity of Supply                             | es                                   | 1                | 1         |
| Elasticity of Demand                             | nd                                   | -2               | -2        |
| Weight on Supply                                 | Ws=es/(es-(nd*(QM/OX)))              | 0.131            | 0.141     |
| Weight on Demand                                 | Wd=(nd*(OM/OX))/(es-(nd*(OM/OX)))    | 0.869            | 0.859     |
| <b>OFFICIAL EXCHANGE RATE</b>                    |                                      |                  |           |
|  | OER                                  | 11,395           | 11,853    |
| <b>BALANCED TRADE</b>                            |                                      |                  |           |
| Shadow Exchange Rate                             | SER=Ws*(OER(1-tx)+Wd*OER*(1+tm))     | 11,408           | 11,869    |
| Shadow Exchange Rate Factor                      | SERF=SER/OER                         | 1.001            | 1.001     |
| Standard Conversion Factor                       | SCF=OER/SER                          | 0.999            | 0.999     |
| <b>UNBALANCED TRADE (if 100% unsustainable)</b>  |                                      |                  |           |
| Equilibrium Nominal Exchange Rate                | ERR=OER*(1+(dQ/(es*QX-nd*QM)))       | 14,846           | 15,264    |
| Shadow Exchange Rate                             | SER=ERR*(Ws*(1-tx)+Wd*(1+tm))        | 14,863           | 15,285    |
| Shadow Exchange Rate Factor                      | SERF=SER/OER                         | 1.304            | 1.290     |
| Standard Conversion Factor                       | SCF=OER/SER                          | 0.767            | 0.775     |
| <b>UNBALANCED TRADE (if partly sustainable)</b>  |                                      |                  |           |
| Fraction of Current BOP Deficit Sustainable      | F                                    | 90%              | 90%       |
| Equilibrium Nominal Exchange Rate                | ERR=OER*(1+((1-F)*dQ)/(es*QX-nd*QM)) | 11,740           | 12,194    |
| Shadow Exchange Rate                             | SER=ERR*(Ws*(1-tx)+Wd*(1+tm))        | 11,753           | 12,210    |
| Shadow Exchange Rate Factor                      | SERF=SER/OER                         | 1.031            | 1.030     |
| Standard Conversion Factor                       | SCF=OER/SER                          | 0.970            | 0.971     |
| <b>SIMPLIFIED LITTLE AND MIRRLEES FORMULA</b>    |                                      |                  |           |
| Standard Conversion Factor                       | SCF=(TQM+TQX)/((TQM-T)+(TQX-E))      | 0.999            | 0.999     |
| Shadow Exchange Rate Factor                      | SEFR=1/SCF                           | 1.001            | 1.001     |

Source: ANE (2000)

## Comparison of Traffic Assignment Indicator and Benefit Lost

Base Year : 2005

| Code No. | Project Package   | PCU-Km    | PCU-Hour | VOC per day<br>(US Dollar) | Benefit from<br>Base Case | Benefit Lost<br>by undoing the<br>target project |
|----------|---|-----------|----------|----------------------------|---------------------------|--|
| Do Min   | Do Minimum (Base Case)                                  | 2,257,108 | 74,537   | 560,114                    | 0                         |  |
| Full     | Full Projects   | 2,262,846 | 66,621   | 518,851                    | 41,263                    |  |
| P-1      | Construction of missing link on Av. Julius Nyerere      | 2,243,454 | 68,575   | 526,402                    | 33,712                    | -7,552   |
| P-2      | Improvement of Av. Vladinir Lenine                      | 2,260,994 | 67,395   | 519,075                    | 41,039                    | -224   |
| P-3      | Rehabilitation and Improvement of Av. Acordos de Lusaka | 2,272,272 | 67,388   | 522,733                    | 37,380                    | -3,883   |
| P-4      | Rehabilitation and Improvement of Av. Angola            | 2,263,176 | 66,730   | 519,727                    | 40,387                    | -876   |
| P-5      | Rehabilitation and Improvement of Av. Marien Ngouabi    | 2,267,668 | 66,898   | 520,307                    | 39,807                    | -1,456   |
| P-6      | Rehabilitation of Industrial and Commercial Area Roads  | 2,265,143 | 66,949   | 520,457                    | 39,657                    | -1,606   |
| P-7      | Rehabilitation of Port Area Roads                       | 2,266,792 | 66,986   | 520,375                    | 39,738                    | -1,525   |
| P-8      | Rehabilitation of District 1 Area Roads                 | 2,266,830 | 67,074   | 520,591                    | 39,522                    | -1,741   |
| P-9      | Rehabilitation of District 2 Area Roads                 | 2,260,027 | 66,905   | 520,943                    | 39,171                    | -2,092   |
| P-10     | Rehabilitation of District 3 Area Roads                 | 2,278,666 | 67,664   | 523,395                    | 36,719                    | -4,544   |
| P-11     | Rehabilitation of Improvement of Traffic Management     | 2,262,846 | 67,000   | 519,428                    | 40,686                    | -1,669   |

**Cost Estimates in Financial Price and Economic Price**

**Financial Cost**

Unit: mil. US\$

| Phase                          | 1 st. year          |             |             |             | 2 nd. Year           |             |             |             | 3 rd. year           |             |             |             | 4 th. Year          |             |             |             | 5 th. Year          |             |             |             | Grand Total                |             |             |             |
|--------------------------------|---------------------|-------------|-------------|-------------|----------------------|-------------|-------------|-------------|----------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|----------------------------|-------------|-------------|-------------|
|                                | 2002                |             |             |             | 2003                 |             |             |             | 2004                 |             |             |             | 2005                |             |             |             | 2006                |             |             |             |                            |             |             |             |
|                                | C/C                 | U/R         | H/C         | Other       | C/C                  | U/R         | H/C         | Other       | C/C                  | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                        | U/R         | H/C         | Other       |
| - Av. J. Nyerere               | 0.00                | 0.02        | 0.26        | 0.02        | 0.00                 | 0.02        | 0.26        | 0.00        | 4.04                 | 0.00        | 0.00        | 0.89        | 1.01                | 0.00        | 0.00        | 0.22        | 0.00                | 0.00        | 0.00        | 0.00        | 5.05                       | 0.04        | 0.53        | 1.13        |
| - Av. V. Lenine                | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.10                 | 0.00        | 0.00        | 0.02        | 0.03                | 0.00        | 0.00        | 0.01        | 0.00                | 0.00        | 0.00        | 0.00        | 0.13                       | 0.00        | 0.00        | 0.05        |
| - Av. A. Lusaka                | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.00        | 0.00        | 0.00        | 1.41                 | 0.00        | 0.00        | 0.31        | 0.35                | 0.00        | 0.00        | 0.08        | 0.00                | 0.00        | 0.00        | 0.00        | 1.76                       | 0.00        | 0.00        | 0.40        |
| - Av. Angola                   | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.82                | 0.00        | 0.00        | 0.18        | 1.23                | 0.00        | 0.00        | 0.19        | 2.05                       | 0.00        | 0.00        | 0.39        |
| - Av. M. Nougouabi             | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.06        | 0.00        | 0.00        | 0.00                 | 0.06        | 0.00        | 0.00        | 0.57                | 0.00        | 0.00        | 0.13        | 0.86                | 0.00        | 0.00        | 0.13        | 1.43                       | 0.12        | 0.00        | 0.28        |
| - Industrial/ Commercial Area  | 0.00                | 0.00        | 0.00        | 0.02        | 2.29                 | 0.00        | 0.00        | 0.55        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 2.29                       | 0.00        | 0.00        | 0.57        |
| - Port Area                    | 0.00                | 0.00        | 0.00        | 0.02        | 1.53                 | 0.00        | 0.00        | 0.37        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 1.53                       | 0.00        | 0.00        | 0.39        |
| - District 1 Roads             | 0.00                | 0.00        | 0.00        | 0.02        | 3.61                 | 0.00        | 0.00        | 0.87        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 3.61                       | 0.00        | 0.00        | 0.89        |
| - District 2 Roads             | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.21        | 0.00        | 0.00        | 0.00                 | 0.21        | 0.08        | 0.00        | 1.45                | 0.00        | 0.00        | 0.32        | 2.17                | 0.00        | 0.00        | 0.33        | 3.62                       | 0.42        | 0.08        | 0.67        |
| - District 3 Roads             | 0.00                | 0.07        | 0.00        | 0.02        | 0.00                 | 0.07        | 0.05        | 0.00        | 3.42                 | 0.00        | 0.00        | 0.75        | 0.86                | 0.00        | 0.00        | 0.19        | 0.00                | 0.00        | 0.00        | 0.00        | 4.28                       | 0.13        | 0.05        | 0.96        |
| - Traffic Management Facilitie | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                 | 0.00        | 0.00        | 0.00        | 1.12                | 0.00        | 0.00        | 0.25        | 1.68                | 0.00        | 0.00        | 0.26        | 2.80                       | 0.00        | 0.00        | 0.52        |
| - Bus Stops and terminals      | 0.00                | 0.00        | 0.14        | 0.02        | 0.56                 | 0.00        | 0.00        | 0.14        | 0.00                 | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.56                       | 0.00        | 0.14        | 0.15        |
| <b>Total</b>                   | <b>0.00</b>         | <b>0.09</b> | <b>0.40</b> | <b>0.20</b> | <b>8.00</b>          | <b>0.36</b> | <b>0.32</b> | <b>1.93</b> | <b>8.98</b>          | <b>0.27</b> | <b>0.08</b> | <b>1.97</b> | <b>6.20</b>         | <b>0.00</b> | <b>0.00</b> | <b>1.38</b> | <b>5.94</b>         | <b>0.00</b> | <b>0.00</b> | <b>0.91</b> | <b>29.12</b>               | <b>0.71</b> | <b>0.80</b> | <b>6.38</b> |
|                                | <b>Total = 0.69</b> |             |             |             | <b>Total = 10.60</b> |             |             |             | <b>Total = 11.29</b> |             |             |             | <b>Total = 7.58</b> |             |             |             | <b>Total = 6.85</b> |             |             |             | <b>Grand Total = 37.01</b> |             |             |             |

C/C: Construction Cost    U/R: Utilitiv Relocation Cost    H/C: House Compensation    Other: Consultant Fee. Administration Fee

**Economic Cost**

| Phase                          | 1 st. year          |             |             |             | 2 nd. Year          |             |             |             | 3 rd. year          |             |             |             | 4 th. Year          |             |             |             | 5 th. Year          |             |             |             | Grand Total                |             |             |             |
|--------------------------------|---------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|---------------------|-------------|-------------|-------------|----------------------------|-------------|-------------|-------------|
|                                | 2002                |             |             |             | 2003                |             |             |             | 2004                |             |             |             | 2005                |             |             |             | 2006                |             |             |             |                            |             |             |             |
|                                | C/C                 | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                 | U/R         | H/C         | Other       | C/C                        | U/R         | H/C         | Other       |
| Conversion Factor              | 0.85                | 0.85        | 1.00        | 1.00        | 0.85                | 0.85        | 1.00        | 1.00        | 0.85                | 0.85        | 1.00        | 1.00        | 0.85                | 0.85        | 1.00        | 1.00        | 0.85                | 0.85        | 1.00        | 1.00        | 0.85                       | 0.85        | 1.00        | 1.00        |
| - Av. J. Nyerere               | 0.00                | 0.02        | 0.26        | 0.02        | 0.00                | 0.02        | 0.26        | 0.00        | 3.43                | 0.00        | 0.00        | 0.89        | 0.86                | 0.00        | 0.00        | 0.22        | 0.00                | 0.00        | 0.00        | 0.00        | 4.29                       | 0.04        | 0.53        | 1.13        |
| - Av. V. Lenine                | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.00        | 0.00        | 0.00        | 0.09                | 0.00        | 0.00        | 0.02        | 0.02                | 0.00        | 0.00        | 0.01        | 0.00                | 0.00        | 0.00        | 0.00        | 0.11                       | 0.00        | 0.00        | 0.05        |
| - Av. A. Lusaka                | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.00        | 0.00        | 0.00        | 1.20                | 0.00        | 0.00        | 0.31        | 0.30                | 0.00        | 0.00        | 0.08        | 0.00                | 0.00        | 0.00        | 0.00        | 1.50                       | 0.00        | 0.00        | 0.40        |
| - Av. Angola                   | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.70                | 0.00        | 0.00        | 0.18        | 1.05                | 0.00        | 0.00        | 0.19        | 1.74                       | 0.00        | 0.00        | 0.39        |
| - Av. M. Nougouabi             | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.05        | 0.00        | 0.00        | 0.00                | 0.05        | 0.00        | 0.00        | 0.49                | 0.00        | 0.00        | 0.13        | 0.73                | 0.00        | 0.00        | 0.13        | 1.22                       | 0.10        | 0.00        | 0.28        |
| - Industrial/ Commercial Area  | 0.00                | 0.00        | 0.00        | 0.02        | 1.95                | 0.00        | 0.00        | 0.55        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 1.95                       | 0.00        | 0.00        | 0.57        |
| - Port Area                    | 0.00                | 0.00        | 0.00        | 0.02        | 1.30                | 0.00        | 0.00        | 0.37        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 1.30                       | 0.00        | 0.00        | 0.39        |
| - District 1 Roads             | 0.00                | 0.00        | 0.00        | 0.02        | 3.07                | 0.00        | 0.00        | 0.87        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 3.07                       | 0.00        | 0.00        | 0.89        |
| - District 2 Roads             | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.18        | 0.00        | 0.00        | 0.00                | 0.18        | 0.08        | 0.00        | 1.23                | 0.00        | 0.00        | 0.32        | 1.85                | 0.00        | 0.00        | 0.33        | 3.08                       | 0.36        | 0.08        | 0.67        |
| - District 3 Roads             | 0.00                | 0.06        | 0.00        | 0.02        | 0.00                | 0.06        | 0.05        | 0.00        | 2.91                | 0.00        | 0.00        | 0.75        | 0.73                | 0.00        | 0.00        | 0.19        | 0.00                | 0.00        | 0.00        | 0.00        | 3.64                       | 0.11        | 0.05        | 0.96        |
| - Traffic Management Facilitie | 0.00                | 0.00        | 0.00        | 0.02        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.95                | 0.00        | 0.00        | 0.25        | 1.43                | 0.00        | 0.00        | 0.26        | 2.38                       | 0.00        | 0.00        | 0.52        |
| - Bus Stops and terminals      | 0.00                | 0.00        | 0.14        | 0.02        | 0.48                | 0.00        | 0.00        | 0.14        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.00                | 0.00        | 0.00        | 0.00        | 0.48                       | 0.00        | 0.14        | 0.15        |
| <b>Total</b>                   | <b>0.00</b>         | <b>0.07</b> | <b>0.40</b> | <b>0.20</b> | <b>6.80</b>         | <b>0.30</b> | <b>0.32</b> | <b>1.93</b> | <b>7.63</b>         | <b>0.23</b> | <b>0.08</b> | <b>1.97</b> | <b>5.27</b>         | <b>0.00</b> | <b>0.00</b> | <b>1.38</b> | <b>5.05</b>         | <b>0.00</b> | <b>0.00</b> | <b>0.91</b> | <b>24.75</b>               | <b>0.61</b> | <b>0.80</b> | <b>6.38</b> |
|                                | <b>Total = 0.68</b> |             |             |             | <b>Total = 9.34</b> |             |             |             | <b>Total = 9.91</b> |             |             |             | <b>Total = 6.65</b> |             |             |             | <b>Total = 5.96</b> |             |             |             | <b>Grand Total = 32.54</b> |             |             |             |

C/C: Construction Cost    U/R: Utilitiv Relocation Cost    H/C: House Compensation    Other: Consultant Fee. Administration Fee

Economic Evaluation for With Program (including all projects)

|     |       |             |
|-----|-------|-------------|
| B/C | 2.7   | million USD |
| NPV | 41.5  |             |
| IRR | 27.9% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.7                | 0.0                   | -0.7                 | 89.3%            | 0.6                | 0.0                   | -0.6                 |
| 2003  | 9.3                | 0.0                   | -9.3                 | 79.7%            | 7.4                | 0.0                   | -7.4                 |
| 2004  | 9.9                | 0.0                   | -9.9                 | 71.2%            | 7.1                | 0.0                   | -7.1                 |
| 2005  | 6.6                | 0.0                   | -6.6                 | 63.6%            | 4.2                | 0.0                   | -4.2                 |
| 2006  | 6.0                | 0.0                   | -6.0                 | 56.7%            | 3.4                | 0.0                   | -3.4                 |
| 2007  | 0.2                | 7.4                   | 7.2                  | 50.7%            | 0.1                | 3.7                   | 3.6                  |
| 2008  | 0.2                | 15.4                  | 15.2                 | 45.2%            | 0.1                | 7.0                   | 6.9                  |
| 2009  | 0.2                | 16.0                  | 15.8                 | 40.4%            | 0.1                | 6.5                   | 6.4                  |
| 2010  | 0.2                | 16.7                  | 16.5                 | 36.1%            | 0.1                | 6.0                   | 5.9                  |
| 2011  | 0.2                | 17.3                  | 17.0                 | 32.2%            | 0.1                | 5.6                   | 5.5                  |
| 2012  | 0.2                | 17.9                  | 17.6                 | 28.7%            | 0.1                | 5.1                   | 5.1                  |
| 2013  | 0.2                | 18.5                  | 18.2                 | 25.7%            | 0.1                | 4.7                   | 4.7                  |
| 2014  | 0.2                | 19.1                  | 18.9                 | 22.9%            | 0.1                | 4.4                   | 4.3                  |
| 2015  | 0.2                | 19.7                  | 19.5                 | 20.5%            | 0.0                | 4.0                   | 4.0                  |
| 2016  | 2.7                | 20.4                  | 17.7                 | 18.3%            | 0.5                | 3.7                   | 3.2                  |
| 2017  | 0.2                | 21.1                  | 20.9                 | 16.3%            | 0.0                | 3.4                   | 3.4                  |
| 2018  | 0.2                | 21.8                  | 21.6                 | 14.6%            | 0.0                | 3.2                   | 3.1                  |
| 2019  | 0.2                | 22.6                  | 22.3                 | 13.0%            | 0.0                | 2.9                   | 2.9                  |
| 2020  | 0.2                | 23.3                  | 23.1                 | 11.6%            | 0.0                | 2.7                   | 2.7                  |
| 2021  | 0.2                | 24.1                  | 23.9                 | 10.4%            | 0.0                | 2.5                   | 2.5                  |
| Total | 38.4               | 281.4                 | 243.0                | -                | 24.0               | 65.6                  | 41.5                 |



Economic Evaluation for Project 1  
Construction of missing link on Av. Julius Nyerere

|     |        |             |
|-----|--------|-------------|
| B/C | 3.0    | million USD |
| NPV | 9.0    |             |
| IRR | 32.00% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.3                | 0.0                   | -0.3                 | 89.3%            | 0.3                | 0.0                   | -0.3                 |
| 2003  | 0.3                | 0.0                   | -0.3                 | 79.7%            | 0.2                | 0.0                   | -0.2                 |
| 2004  | 4.3                | 0.0                   | -4.3                 | 71.2%            | 3.1                | 0.0                   | -3.1                 |
| 2005  | 1.1                | 0.0                   | -1.1                 | 63.6%            | 0.7                | 1.6                   | -0.7                 |
| 2006  | 0.0                | 1.3                   | 1.3                  | 56.7%            | 0.0                | 0.7                   | 0.7                  |
| 2007  | 0.0                | 2.7                   | 2.7                  | 50.7%            | 0.0                | 1.4                   | 1.4                  |
| 2008  | 0.0                | 2.8                   | 2.8                  | 45.2%            | 0.0                | 1.3                   | 1.3                  |
| 2009  | 0.0                | 2.9                   | 2.9                  | 40.4%            | 0.0                | 1.2                   | 1.2                  |
| 2010  | 0.0                | 3.1                   | 3.0                  | 36.1%            | 0.0                | 1.1                   | 1.1                  |
| 2011  | 0.0                | 3.2                   | 3.1                  | 32.2%            | 0.0                | 1.0                   | 1.0                  |
| 2012  | 0.0                | 3.3                   | 3.2                  | 28.7%            | 0.0                | 0.9                   | 0.9                  |
| 2013  | 0.0                | 3.4                   | 3.3                  | 25.7%            | 0.0                | 0.9                   | 0.9                  |
| 2014  | 0.0                | 3.5                   | 3.5                  | 22.9%            | 0.0                | 0.8                   | 0.8                  |
| 2015  | 0.0                | 3.6                   | 3.6                  | 20.5%            | 0.0                | 0.7                   | 0.7                  |
| 2016  | 0.5                | 3.7                   | 3.3                  | 18.3%            | 0.1                | 0.7                   | 0.6                  |
| 2017  | 0.0                | 3.9                   | 4.2                  | 16.3%            | 0.0                | 0.6                   | 0.7                  |
| 2018  | 0.0                | 4.0                   | 4.0                  | 14.6%            | 0.0                | 0.6                   | 0.6                  |
| 2019  | 0.0                | 4.1                   | 4.1                  | 13.0%            | 0.0                | 0.5                   | 0.5                  |
| 2020  | 0.0                | 4.3                   | 4.2                  | 11.6%            | 0.0                | 0.5                   | 0.5                  |
| 2021  | 0.0                | 4.4                   | 4.4                  | 10.4%            | 0.0                | 0.5                   | 0.5                  |
| Total | 7.0                | 54.1                  | 47.5                 | -                | 4.5                | 15.0                  | 9.0                  |

Economic Evaluation for Project 2  
Improvement of Av. Vladinir Lenine

|     |        |             |
|-----|--------|-------------|
| B/C | 3.4    | million USD |
| NPV | 0.3    |             |
| IRR | 34.56% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.0                | 0.0                   | 0.0                  | 79.7%            | 0.0                | 0.0                   | 0.0                  |
| 2004  | 0.1                | 0.0                   | -0.1                 | 71.2%            | 0.1                | 0.0                   | -0.1                 |
| 2005  | 0.0                | 0.0                   | -0.0                 | 63.6%            | 0.0                | 0.0                   | -0.0                 |
| 2006  | 0.0                | 0.0                   | 0.0                  | 56.7%            | 0.0                | 0.0                   | 0.0                  |
| 2007  | 0.0                | 0.1                   | 0.1                  | 50.7%            | 0.0                | 0.0                   | 0.0                  |
| 2008  | 0.0                | 0.1                   | 0.1                  | 45.2%            | 0.0                | 0.0                   | 0.0                  |
| 2009  | 0.0                | 0.1                   | 0.1                  | 40.4%            | 0.0                | 0.0                   | 0.0                  |
| 2010  | 0.0                | 0.1                   | 0.1                  | 36.1%            | 0.0                | 0.0                   | 0.0                  |
| 2011  | 0.0                | 0.1                   | 0.1                  | 32.2%            | 0.0                | 0.0                   | 0.0                  |
| 2012  | 0.0                | 0.1                   | 0.1                  | 28.7%            | 0.0                | 0.0                   | 0.0                  |
| 2013  | 0.0                | 0.1                   | 0.1                  | 25.7%            | 0.0                | 0.0                   | 0.0                  |
| 2014  | 0.0                | 0.1                   | 0.1                  | 22.9%            | 0.0                | 0.0                   | 0.0                  |
| 2015  | 0.0                | 0.1                   | 0.1                  | 20.5%            | 0.0                | 0.0                   | 0.0                  |
| 2016  | 0.0                | 0.1                   | 0.1                  | 18.3%            | 0.0                | 0.0                   | 0.0                  |
| 2017  | 0.0                | 0.1                   | 0.1                  | 16.3%            | 0.0                | 0.0                   | 0.0                  |
| 2018  | 0.0                | 0.1                   | 0.1                  | 14.6%            | 0.0                | 0.0                   | 0.0                  |
| 2019  | 0.0                | 0.1                   | 0.1                  | 13.0%            | 0.0                | 0.0                   | 0.0                  |
| 2020  | 0.0                | 0.1                   | 0.1                  | 11.6%            | 0.0                | 0.0                   | 0.0                  |
| 2021  | 0.0                | 0.1                   | 0.1                  | 10.4%            | 0.0                | 0.0                   | 0.0                  |
| Total | 0.2                | 1.6                   | 1.4                  | -                | 0.1                | 0.4                   | 0.3                  |

Economic Evaluation for Project 3  
Rehabilitation and Improvement of Av. Acordos de Lusaka

|     |        |             |
|-----|--------|-------------|
| B/C | 4.9    | million USD |
| NPV | 5.5    |             |
| IRR | 46.69% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.0                | 0.0                   | 0.0                  | 79.7%            | 0.0                | 0.0                   | 0.0                  |
| 2004  | 1.5                | 0.0                   | -1.5                 | 71.2%            | 1.1                | 0.0                   | -1.1                 |
| 2005  | 0.4                | 0.0                   | -0.4                 | 63.6%            | 0.2                | 0.8                   | -0.2                 |
| 2006  | 0.0                | 0.7                   | 0.7                  | 56.7%            | 0.0                | 0.4                   | 0.4                  |
| 2007  | 0.0                | 1.4                   | 1.4                  | 50.7%            | 0.0                | 0.7                   | 0.7                  |
| 2008  | 0.0                | 1.4                   | 1.4                  | 45.2%            | 0.0                | 0.7                   | 0.6                  |
| 2009  | 0.0                | 1.5                   | 1.5                  | 40.4%            | 0.0                | 0.6                   | 0.6                  |
| 2010  | 0.0                | 1.6                   | 1.6                  | 36.1%            | 0.0                | 0.6                   | 0.6                  |
| 2011  | 0.0                | 1.6                   | 1.6                  | 32.2%            | 0.0                | 0.5                   | 0.5                  |
| 2012  | 0.0                | 1.7                   | 1.7                  | 28.7%            | 0.0                | 0.5                   | 0.5                  |
| 2013  | 0.0                | 1.7                   | 1.7                  | 25.7%            | 0.0                | 0.4                   | 0.4                  |
| 2014  | 0.0                | 1.8                   | 1.8                  | 22.9%            | 0.0                | 0.4                   | 0.4                  |
| 2015  | 0.0                | 1.9                   | 1.8                  | 20.5%            | 0.0                | 0.4                   | 0.4                  |
| 2016  | 0.2                | 1.9                   | 1.8                  | 18.3%            | 0.0                | 0.4                   | 0.3                  |
| 2017  | 0.0                | 2.0                   | 2.2                  | 16.3%            | 0.0                | 0.3                   | 0.4                  |
| 2018  | 0.0                | 2.1                   | 2.0                  | 14.6%            | 0.0                | 0.3                   | 0.3                  |
| 2019  | 0.0                | 2.1                   | 2.1                  | 13.0%            | 0.0                | 0.3                   | 0.3                  |
| 2020  | 0.0                | 2.2                   | 2.2                  | 11.6%            | 0.0                | 0.3                   | 0.3                  |
| 2021  | 0.0                | 2.3                   | 2.3                  | 10.4%            | 0.0                | 0.2                   | 0.2                  |
| Total | 2.3                | 27.8                  | 25.8                 | -                | 1.4                | 7.7                   | 5.5                  |

Economic Evaluation for Project 4  
Rehabilitation and Improvement of Av. Angola

|     |        |             |
|-----|--------|-------------|
| B/C | 1.0    | million USD |
| NPV | 0.0    |             |
| IRR | 12.37% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.0                | 0.0                   | 0.0                  | 79.7%            | 0.0                | 0.0                   | 0.0                  |
| 2004  | 0.0                | 0.0                   | 0.0                  | 71.2%            | 0.0                | 0.0                   | 0.0                  |
| 2005  | 0.9                | 0.0                   | -0.9                 | 63.6%            | 0.6                | 0.2                   | -0.6                 |
| 2006  | 1.2                | 0.0                   | -1.2                 | 56.7%            | 0.7                | 0.0                   | -0.7                 |
| 2007  | 0.0                | 0.2                   | 0.1                  | 50.7%            | 0.0                | 0.1                   | 0.1                  |
| 2008  | 0.0                | 0.3                   | 0.3                  | 45.2%            | 0.0                | 0.1                   | 0.1                  |
| 2009  | 0.0                | 0.3                   | 0.3                  | 40.4%            | 0.0                | 0.1                   | 0.1                  |
| 2010  | 0.0                | 0.4                   | 0.3                  | 36.1%            | 0.0                | 0.1                   | 0.1                  |
| 2011  | 0.0                | 0.4                   | 0.4                  | 32.2%            | 0.0                | 0.1                   | 0.1                  |
| 2012  | 0.0                | 0.4                   | 0.4                  | 28.7%            | 0.0                | 0.1                   | 0.1                  |
| 2013  | 0.0                | 0.4                   | 0.4                  | 25.7%            | 0.0                | 0.1                   | 0.1                  |
| 2014  | 0.0                | 0.4                   | 0.4                  | 22.9%            | 0.0                | 0.1                   | 0.1                  |
| 2015  | 0.0                | 0.4                   | 0.4                  | 20.5%            | 0.0                | 0.1                   | 0.1                  |
| 2016  | 0.2                | 0.4                   | 0.2                  | 18.3%            | 0.0                | 0.1                   | 0.0                  |
| 2017  | 0.0                | 0.4                   | 0.5                  | 16.3%            | 0.0                | 0.1                   | 0.1                  |
| 2018  | 0.0                | 0.5                   | 0.4                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 0.5                   | 0.5                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 0.5                   | 0.5                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 0.5                   | 0.5                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 2.5                | 6.0                   | 3.5                  | -                | 1.4                | 1.6                   | 0.0                  |

Economic Evaluation for Project 5  
Rehabilitation and Improvement of Av. Marien Ngouabi

|     |        |             |
|-----|--------|-------------|
| B/C | 2.2    | million USD |
| NPV | 1.3    |             |
| IRR | 27.23% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.1                | 0.0                   | -0.1                 | 79.7%            | 0.0                | 0.0                   | -0.0                 |
| 2004  | 0.1                | 0.0                   | -0.1                 | 71.2%            | 0.0                | 0.0                   | -0.0                 |
| 2005  | 0.6                | 0.0                   | -0.6                 | 63.6%            | 0.4                | 0.3                   | -0.4                 |
| 2006  | 0.9                | 0.0                   | -0.9                 | 56.7%            | 0.5                | 0.0                   | -0.5                 |
| 2007  | 0.0                | 0.3                   | 0.2                  | 50.7%            | 0.0                | 0.1                   | 0.1                  |
| 2008  | 0.0                | 0.5                   | 0.5                  | 45.2%            | 0.0                | 0.2                   | 0.2                  |
| 2009  | 0.0                | 0.6                   | 0.6                  | 40.4%            | 0.0                | 0.2                   | 0.2                  |
| 2010  | 0.0                | 0.6                   | 0.6                  | 36.1%            | 0.0                | 0.2                   | 0.2                  |
| 2011  | 0.0                | 0.6                   | 0.6                  | 32.2%            | 0.0                | 0.2                   | 0.2                  |
| 2012  | 0.0                | 0.6                   | 0.6                  | 28.7%            | 0.0                | 0.2                   | 0.2                  |
| 2013  | 0.0                | 0.7                   | 0.6                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 0.7                   | 0.7                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 0.7                   | 0.7                  | 20.5%            | 0.0                | 0.1                   | 0.1                  |
| 2016  | 0.1                | 0.7                   | 0.6                  | 18.3%            | 0.0                | 0.1                   | 0.1                  |
| 2017  | 0.0                | 0.7                   | 0.8                  | 16.3%            | 0.0                | 0.1                   | 0.1                  |
| 2018  | 0.0                | 0.8                   | 0.8                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 0.8                   | 0.8                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 0.8                   | 0.8                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 0.9                   | 0.8                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 1.9                | 9.9                   | 8.1                  | -                | 1.0                | 2.6                   | 1.3                  |

Economic Evaluation for Project 6  
Rehabilitation of Industrial and Commercial Area Roads

|     |        |             |
|-----|--------|-------------|
| B/C | 1.7    | million USD |
| NPV | 1.4    |             |
| IRR | 21.03% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 2.5                | 0.0                   | -2.5                 | 79.7%            | 2.0                | 0.0                   | -2.0                 |
| 2004  | 0.0                | 0.3                   | 0.3                  | 71.2%            | 0.0                | 0.2                   | 0.2                  |
| 2005  | 0.0                | 0.5                   | 0.5                  | 63.6%            | 0.0                | 0.3                   | 0.3                  |
| 2006  | 0.0                | 0.6                   | 0.6                  | 56.7%            | 0.0                | 0.3                   | 0.3                  |
| 2007  | 0.0                | 0.6                   | 0.6                  | 50.7%            | 0.0                | 0.3                   | 0.3                  |
| 2008  | 0.0                | 0.6                   | 0.6                  | 45.2%            | 0.0                | 0.3                   | 0.3                  |
| 2009  | 0.0                | 0.6                   | 0.6                  | 40.4%            | 0.0                | 0.3                   | 0.2                  |
| 2010  | 0.0                | 0.7                   | 0.6                  | 36.1%            | 0.0                | 0.2                   | 0.2                  |
| 2011  | 0.0                | 0.7                   | 0.7                  | 32.2%            | 0.0                | 0.2                   | 0.2                  |
| 2012  | 0.0                | 0.7                   | 0.7                  | 28.7%            | 0.0                | 0.2                   | 0.2                  |
| 2013  | 0.0                | 0.7                   | 0.7                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 0.7                   | 0.7                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 0.8                   | 0.8                  | 20.5%            | 0.0                | 0.2                   | 0.2                  |
| 2016  | 0.2                | 0.8                   | 0.6                  | 18.3%            | 0.0                | 0.1                   | 0.1                  |
| 2017  | 0.0                | 0.8                   | 0.9                  | 16.3%            | 0.0                | 0.1                   | 0.1                  |
| 2018  | 0.0                | 0.8                   | 0.8                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 0.9                   | 0.9                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 0.9                   | 0.9                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 0.9                   | 0.9                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 3.0                | 12.6                  | 9.7                  | -                | 2.1                | 3.5                   | 1.4                  |

Economic Evaluation for Project 7  
Rehabilitation of Port Area Roads

|     |        |             |
|-----|--------|-------------|
| B/C | 2.4    | million USD |
| NPV | 1.9    |             |
| IRR | 28.85% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 1.7                | 0.0                   | -1.7                 | 79.7%            | 1.3                | 0.0                   | -1.3                 |
| 2004  | 0.0                | 0.2                   | 0.2                  | 71.2%            | 0.0                | 0.2                   | 0.2                  |
| 2005  | 0.0                | 0.5                   | 0.5                  | 63.6%            | 0.0                | 0.3                   | 0.3                  |
| 2006  | 0.0                | 0.5                   | 0.5                  | 56.7%            | 0.0                | 0.3                   | 0.3                  |
| 2007  | 0.0                | 0.5                   | 0.5                  | 50.7%            | 0.0                | 0.3                   | 0.3                  |
| 2008  | 0.0                | 0.6                   | 0.6                  | 45.2%            | 0.0                | 0.3                   | 0.3                  |
| 2009  | 0.0                | 0.6                   | 0.6                  | 40.4%            | 0.0                | 0.2                   | 0.2                  |
| 2010  | 0.0                | 0.6                   | 0.6                  | 36.1%            | 0.0                | 0.2                   | 0.2                  |
| 2011  | 0.0                | 0.6                   | 0.6                  | 32.2%            | 0.0                | 0.2                   | 0.2                  |
| 2012  | 0.0                | 0.7                   | 0.6                  | 28.7%            | 0.0                | 0.2                   | 0.2                  |
| 2013  | 0.0                | 0.7                   | 0.7                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 0.7                   | 0.7                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 0.7                   | 0.7                  | 20.5%            | 0.0                | 0.1                   | 0.1                  |
| 2016  | 0.1                | 0.8                   | 0.6                  | 18.3%            | 0.0                | 0.1                   | 0.1                  |
| 2017  | 0.0                | 0.8                   | 0.9                  | 16.3%            | 0.0                | 0.1                   | 0.1                  |
| 2018  | 0.0                | 0.8                   | 0.8                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 0.8                   | 0.8                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 0.9                   | 0.9                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 0.9                   | 0.9                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 2.0                | 11.9                  | 10.0                 | -                | 1.4                | 3.4                   | 1.9                  |

Economic Evaluation for Project 8  
Rehabilitation of District 1 Area Roads

|     |        |             |
|-----|--------|-------------|
| B/C | 1.2    | million USD |
| NPV | 0.5    |             |
| IRR | 14.31% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 3.9                | 0.0                   | -3.9                 | 79.7%            | 3.1                | 0.0                   | -3.1                 |
| 2004  | 0.0                | 0.3                   | 0.3                  | 71.2%            | 0.0                | 0.2                   | 0.2                  |
| 2005  | 0.0                | 0.6                   | 0.6                  | 63.6%            | 0.0                | 0.4                   | 0.4                  |
| 2006  | 0.0                | 0.6                   | 0.6                  | 56.7%            | 0.0                | 0.3                   | 0.3                  |
| 2007  | 0.0                | 0.6                   | 0.6                  | 50.7%            | 0.0                | 0.3                   | 0.3                  |
| 2008  | 0.0                | 0.6                   | 0.6                  | 45.2%            | 0.0                | 0.3                   | 0.3                  |
| 2009  | 0.0                | 0.7                   | 0.6                  | 40.4%            | 0.0                | 0.3                   | 0.3                  |
| 2010  | 0.0                | 0.7                   | 0.7                  | 36.1%            | 0.0                | 0.3                   | 0.2                  |
| 2011  | 0.0                | 0.7                   | 0.7                  | 32.2%            | 0.0                | 0.2                   | 0.2                  |
| 2012  | 0.0                | 0.8                   | 0.7                  | 28.7%            | 0.0                | 0.2                   | 0.2                  |
| 2013  | 0.0                | 0.8                   | 0.8                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 0.8                   | 0.8                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 0.8                   | 0.8                  | 20.5%            | 0.0                | 0.2                   | 0.2                  |
| 2016  | 0.3                | 0.9                   | 0.5                  | 18.3%            | 0.1                | 0.2                   | 0.1                  |
| 2017  | 0.0                | 0.9                   | 1.0                  | 16.3%            | 0.0                | 0.1                   | 0.2                  |
| 2018  | 0.0                | 0.9                   | 0.9                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 1.0                   | 0.9                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 1.0                   | 1.0                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 1.0                   | 1.0                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 4.7                | 13.6                  | 9.0                  | -                | 3.3                | 3.8                   | 0.5                  |



Economic Evaluation for Project 9  
Rehabilitation of District 2 Area Roads

|     |        |             |
|-----|--------|-------------|
| B/C | 1.2    | million USD |
| NPV | 0.6    |             |
| IRR | 15.31% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.2                | 0.0                   | -0.2                 | 79.7%            | 0.1                | 0.0                   | -0.1                 |
| 2004  | 0.3                | 0.0                   | -0.3                 | 71.2%            | 0.2                | 0.0                   | -0.2                 |
| 2005  | 1.6                | 0.0                   | -1.6                 | 63.6%            | 1.0                | 0.4                   | -1.0                 |
| 2006  | 2.2                | 0.0                   | -2.2                 | 56.7%            | 1.2                | 0.0                   | -1.2                 |
| 2007  | 0.0                | 0.4                   | 0.3                  | 50.7%            | 0.0                | 0.2                   | 0.2                  |
| 2008  | 0.0                | 0.8                   | 0.8                  | 45.2%            | 0.0                | 0.4                   | 0.3                  |
| 2009  | 0.0                | 0.8                   | 0.8                  | 40.4%            | 0.0                | 0.3                   | 0.3                  |
| 2010  | 0.0                | 0.8                   | 0.8                  | 36.1%            | 0.0                | 0.3                   | 0.3                  |
| 2011  | 0.0                | 0.9                   | 0.8                  | 32.2%            | 0.0                | 0.3                   | 0.3                  |
| 2012  | 0.0                | 0.9                   | 0.9                  | 28.7%            | 0.0                | 0.3                   | 0.3                  |
| 2013  | 0.0                | 0.9                   | 0.9                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 1.0                   | 0.9                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 1.0                   | 1.0                  | 20.5%            | 0.0                | 0.2                   | 0.2                  |
| 2016  | 0.3                | 1.0                   | 0.7                  | 18.3%            | 0.1                | 0.2                   | 0.1                  |
| 2017  | 0.0                | 1.1                   | 1.2                  | 16.3%            | 0.0                | 0.2                   | 0.2                  |
| 2018  | 0.0                | 1.1                   | 1.1                  | 14.6%            | 0.0                | 0.2                   | 0.2                  |
| 2019  | 0.0                | 1.1                   | 1.1                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 1.2                   | 1.2                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 1.2                   | 1.2                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 4.9                | 14.3                  | 9.5                  | -                | 2.7                | 3.8                   | 0.6                  |

Economic Evaluation for Project 10  
Rehabilitation of District 3 Area Roads

|     |        |             |
|-----|--------|-------------|
| B/C | 2.3    | million USD |
| NPV | 4.6    |             |
| IRR | 26.56% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.1                | 0.0                   | -0.1                 | 89.3%            | 0.1                | 0.0                   | -0.1                 |
| 2003  | 0.1                | 0.0                   | -0.1                 | 79.7%            | 0.1                | 0.0                   | -0.1                 |
| 2004  | 3.7                | 0.0                   | -3.7                 | 71.2%            | 2.6                | 0.0                   | -2.6                 |
| 2005  | 0.9                | 0.0                   | -0.9                 | 63.6%            | 0.6                | 1.0                   | -0.6                 |
| 2006  | 0.0                | 0.8                   | 0.8                  | 56.7%            | 0.0                | 0.4                   | 0.4                  |
| 2007  | 0.0                | 1.6                   | 1.6                  | 50.7%            | 0.0                | 0.8                   | 0.8                  |
| 2008  | 0.0                | 1.7                   | 1.7                  | 45.2%            | 0.0                | 0.8                   | 0.8                  |
| 2009  | 0.0                | 1.8                   | 1.7                  | 40.4%            | 0.0                | 0.7                   | 0.7                  |
| 2010  | 0.0                | 1.8                   | 1.8                  | 36.1%            | 0.0                | 0.7                   | 0.7                  |
| 2011  | 0.0                | 1.9                   | 1.9                  | 32.2%            | 0.0                | 0.6                   | 0.6                  |
| 2012  | 0.0                | 2.0                   | 1.9                  | 28.7%            | 0.0                | 0.6                   | 0.6                  |
| 2013  | 0.0                | 2.0                   | 2.0                  | 25.7%            | 0.0                | 0.5                   | 0.5                  |
| 2014  | 0.0                | 2.1                   | 2.1                  | 22.9%            | 0.0                | 0.5                   | 0.5                  |
| 2015  | 0.0                | 2.2                   | 2.1                  | 20.5%            | 0.0                | 0.4                   | 0.4                  |
| 2016  | 0.4                | 2.2                   | 1.9                  | 18.3%            | 0.1                | 0.4                   | 0.3                  |
| 2017  | 0.0                | 2.3                   | 2.5                  | 16.3%            | 0.0                | 0.4                   | 0.4                  |
| 2018  | 0.0                | 2.4                   | 2.4                  | 14.6%            | 0.0                | 0.4                   | 0.3                  |
| 2019  | 0.0                | 2.5                   | 2.5                  | 13.0%            | 0.0                | 0.3                   | 0.3                  |
| 2020  | 0.0                | 2.6                   | 2.5                  | 11.6%            | 0.0                | 0.3                   | 0.3                  |
| 2021  | 0.0                | 2.7                   | 2.6                  | 10.4%            | 0.0                | 0.3                   | 0.3                  |
| Total | 5.6                | 32.6                  | 27.2                 | -                | 3.5                | 9.0                   | 4.6                  |

Economic Evaluation for Project 11  
Rehabilitation of Improvement of Traffic Management

|     |        |             |
|-----|--------|-------------|
| B/C | 1.4    | million USD |
| NPV | 0.8    |             |
| IRR | 18.37% |             |

Discount rate = 12.0% Unit: million USD

|       | 2001 price<br>Cost | 2001 price<br>Benefit | 2001 price<br>Profit | Discount<br>Rate | Discounted<br>Cost | Discounted<br>Benefit | Discounted<br>Profit |
|-------|--------------------|-----------------------|----------------------|------------------|--------------------|-----------------------|----------------------|
| 2002  | 0.0                | 0.0                   | -0.0                 | 89.3%            | 0.0                | 0.0                   | -0.0                 |
| 2003  | 0.0                | 0.0                   | 0.0                  | 79.7%            | 0.0                | 0.0                   | 0.0                  |
| 2004  | 0.0                | 0.0                   | 0.0                  | 71.2%            | 0.0                | 0.0                   | 0.0                  |
| 2005  | 1.2                | 0.0                   | -1.2                 | 63.6%            | 0.8                | 0.4                   | -0.8                 |
| 2006  | 1.7                | 0.0                   | -1.7                 | 56.7%            | 1.0                | 0.0                   | -1.0                 |
| 2007  | 0.0                | 0.3                   | 0.3                  | 50.7%            | 0.0                | 0.2                   | 0.1                  |
| 2008  | 0.0                | 0.6                   | 0.6                  | 45.2%            | 0.0                | 0.3                   | 0.3                  |
| 2009  | 0.0                | 0.6                   | 0.6                  | 40.4%            | 0.0                | 0.3                   | 0.3                  |
| 2010  | 0.0                | 0.7                   | 0.7                  | 36.1%            | 0.0                | 0.2                   | 0.2                  |
| 2011  | 0.0                | 0.7                   | 0.7                  | 32.2%            | 0.0                | 0.2                   | 0.2                  |
| 2012  | 0.0                | 0.7                   | 0.7                  | 28.7%            | 0.0                | 0.2                   | 0.2                  |
| 2013  | 0.0                | 0.7                   | 0.7                  | 25.7%            | 0.0                | 0.2                   | 0.2                  |
| 2014  | 0.0                | 0.8                   | 0.8                  | 22.9%            | 0.0                | 0.2                   | 0.2                  |
| 2015  | 0.0                | 0.8                   | 0.8                  | 20.5%            | 0.0                | 0.2                   | 0.2                  |
| 2016  | 0.3                | 0.8                   | 0.6                  | 18.3%            | 0.0                | 0.2                   | 0.1                  |
| 2017  | 0.0                | 0.9                   | 0.9                  | 16.3%            | 0.0                | 0.1                   | 0.2                  |
| 2018  | 0.0                | 0.9                   | 0.9                  | 14.6%            | 0.0                | 0.1                   | 0.1                  |
| 2019  | 0.0                | 0.9                   | 0.9                  | 13.0%            | 0.0                | 0.1                   | 0.1                  |
| 2020  | 0.0                | 0.9                   | 0.9                  | 11.6%            | 0.0                | 0.1                   | 0.1                  |
| 2021  | 0.0                | 1.0                   | 1.0                  | 10.4%            | 0.0                | 0.1                   | 0.1                  |
| Total | 3.5                | 11.4                  | 8.0                  | -                | 1.9                | 3.0                   | 0.8                  |