CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004

CONTENTS
A. General description of project activity
B. Application of a baseline methodology
C. Duration of the project activity / Crediting period
D. Application of a monitoring methodology and plan
E. Estimation of GHG emissions by sources
F. Environmental impacts
G. Stakeholders’ comments

ANNEXES
1: Contact information on participants in the project activity
2: Information regarding public funding
3: Baseline information
4 Monitoring Plan
5 Other Information
  5.1 Main transport sector issues in the MCMA
  5.2 Un-optimized Field Measurement Program
  5.3 Un-optimized components and leakages
  5.4 Referenced Documents
  5.5 Initial Field Calibration Data
  5.6 Details of each component and leakage
  5.7 Sensitivity Analysis of the methods of determining speed-specific fuel consumption
SECTION A. General description of project activity

A.1 Title of the project activity:
Mexico, Insurgentes Avenue Bus Rapid Transit Pilot Project.

Document version: 1.7
Document date: 4-Jan 06

A.2. Description of the project activity:

In order to improve bus-based services in Mexico City’s Metropolitan Area (MCMA), the city government has designed a pilot corridor with exclusive bus lanes on Insurgentes Avenue. The “Insurgentes BRT\(^1\) Corridor” will be implemented along 19.3 of the 34 km of Insurgentes Avenue, starting in Indios Verdes in the north, and ending in Doctor Galvez, Rectoria in the south. This corridor will improve transport conditions for the 250,900 trips per day made by commuters accessing the commercial and service areas along Insurgentes and will make an important contribution to sustainable development.

The project is also intended to reduce local airborne pollutants and to demonstrate and develop the tools required to measure and monitor carbon emission reductions from the transport sector. Whilst the operation of one single corridor does not result in large emission reductions, the project will enable the application of these tools and procedures on an already envisaged network of 33 corridors in the MCMA. The availability of certified emission reductions is expected to accelerate this process. Further, the project will demonstrate that a high-quality bus corridor approach with associated traffic management measures is a viable alternative for promoting modal shift providing a blueprint for other corridors in the city and elsewhere which would bring about a much higher overall impact. Annex 4 discusses the main transport issues in the MCMA and those major sector issues that will be addressed by this project.

The pilot BRT system will be built using the center two lanes and will include 34 stations distributed approximately 450 meters apart along a 19.3-kilometre stretch of Insurgentes. Eighty (80) diesel-fuelled high-capacity articulated autobuses\(^2\), will replace the current fleet of around 350 buses and microbuses.

The principal characteristics of this modern, high-quality bus corridor are:

- Exclusive bus lane in the center of the avenue.
- Elevated stations with a modular, uniform design that provide obstacle-free waiting areas and level access to high-platform articulated buses.
- Access ramps for mobility-impaired passengers and bicycle parking & storage facilities at selected stations.
- Fare pre-payment using rechargeable electronic cards to streamline the boarding process. Validation equipment and turnstiles at the entrance to each station will deduct the corresponding fare.

\(^{1}\) Bus Rapid Transit
\(^{2}\) including 10% as a reserve, for regulation and maintenance
• Centralized coordinated fleet control providing monitoring and communications to schedule services and real-time response to contingencies.

• Traffic-flow improvement measures including bus-priority traffic lights, elimination of left turns, continuity given to right-turns, relocation of valet parking and improved sign-posting.

The high-capacity transport corridor will be the result of a public-private partnership (PPP), in which the public sector will be responsible for the investment to deploy the required infrastructure (segregated lanes, stations, terminals, etc.) and part of the equipment (25% of the trunk bus fleet), while the private sector will be responsible for the investment of most of the trunk fleet (75% of the buses) and the ticket selling and validating system, and for the operation of the trunk and feeder services.

The cross-references to the New Monitoring Methodology (NMM) made in this document are necessary for the purpose of facilitating the reader to understand and follow the emission reductions estimation concept explained throughout the document. Moreover the Annexes have been summarized in a complementary document named “PDD_Insurgentes_Annexes_v1.6, so the reader can find additional and more detailed information on the methodology key points easing in this way the reading process of the PDD.

A.3. Project participants:

<table>
<thead>
<tr>
<th>Name of Party involved (*)</th>
<th>Private and/or public entity(ies) project participants (*)</th>
<th>Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Republic of México (host) (Comisión Intersecretarial de Cambio Climático )</td>
<td>Metrobus</td>
<td>No</td>
</tr>
<tr>
<td>Spanish Government</td>
<td>World Bank</td>
<td>No</td>
</tr>
</tbody>
</table>

The project design was led by the Secretary of the Environment of the City of Mexico (SMA), in coordination with the Secretary of Transport (SETRAVI) and Urban Development (SEDUVI) while METROBUS was being organized. Now that METROBUS is constituted, it will manage the system.

The public organism, METROBUS, is the project manager. It is a decentralized public entity, with independent legal status and independent management, inside the Secretary of Transport. It is responsible for monitoring its performance and assisting in the replication of the experience.

The World Bank (Spanish Carbon Fund (SCF)); a CDM project facility. IBRD is the Trustee of the WB SCF and purchases verified emissions reductions on behalf of and for the SCF.

A.4. Technical description of the project activity:
A.4.1. Location of the project activity:

A.4.1.1. Host Party (ies):
The Republic of Mexico

A.4.1.2. Region/State/Province etc.:
The Federal District

A.4.1.3. City/Town/Community etc.:
Mexico City

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):
The “Insurgentes BRT Corridor” will be implemented along 19.3 of the 34 km of Insurgentes Avenue, starting in “Indios Verdes” in the north, and ending in Doctor Galvez, Rectoria in the south (see blue line on Figure 1).

Insurgentes is an important route for the MCMA completely crossing the city from North to South. The route begins on the northern side of the Mexico-Pachuca Freeway, close to the “Anillo Periférico” and at the border between the State of Mexico and the Federal District. It is an important access route to the Federal District from poor and middle-income areas in the State of Mexico. It has the name of “Avenida Insurgentes Norte” at the crossing with “Avenida Acueducto”, passes “Indios Verdes” and continues as “Autopista Urbana Viaducto” until it crosses the “Circuito Interior” at “La Raza” Monument. The route is called “Insurgentes Norte” as far as the Buenavista station, (at the crossing with Eje 1 North - José Antonio Alzate/Mosqueta), where it becomes “Avenida Insurgentes Centro” This designation is kept to the Insurgentes roundabout, where it becomes “Avenida Insurgentes Sur”. The route crosses the central area of the city where it contains a commercial zone; crosses the “Viaduct Miguel Alemán” passing through an important extension of offices and restaurants and again crosses the “Circuito Interior” (Rio Mixcoac) leaving the central area of the city at Doctor Galvez, Rectoria where the National Autonomous University Campus starts. At the other side of the University Campus it again crosses the “Anillo Periférico” at the Perisur Shopping Mall, entering Tlalpan. It continues with the same designation (Av. Insurgentes Sur) until it reached the “Viaducto Tlalpan” highway where it becomes the Mexico-Cuernavaca Freeway.

The route is principally three lanes in either direction with a central divider, although some sections have more lanes. The southern end is characterized by a mixture of high density, high-income residential development and up-market retail. Insurgentes has pervasive congestion in both directions during both morning and afternoon peak periods and is generally congested throughout the day. Microbuses and regular diesel buses serve Insurgentes. It intersects with four Metro lines and with other microbus and regular bus routes. During the last three decades, there have not been relevant infrastructure improvements and a transportation policy that favored small vehicles (microbuses), combined with a lack of enforcement of traffic laws and irregular occupation of public space, have contributed to road congestion and urban degradation.
A.4.2. Category (ies) of project activity:

Sectoral scope number 7: Transport

There is no category of project activity defined for this type of project. It is proposed that it be assigned to “Urban mass-transit corridors”
A.4.3. Technology to be employed by the project activity:

The project is based on the successful experience of BRT systems in Bogotá (Colombia) and Curitiba (Brazil). BRT gained prominence with its successful application in Curitiba beginning 1974. In the recently closed Bogotá Urban Transport Project (1996-2002), the World Bank was closely involved in the design and implementation of the successful Transmilenio bus system. Important aspects of this experience will be replicated in and adapted to the MCMA transport system. The project strategy was developed by interdisciplinary groups coordinated by the implementation agency; these included Metro, Sistema de Transportes Eléctricos, Red de Transporte de Pasajeros, Secretaría de Transporte y Vialidad, Secretaría de Desarrollo Urbano y Vivienda y la Secretaría de Medio Ambiente. METROBUS is also assisted by the Center for Sustainable Transport (CST) in the project activity design and implementation. Both CST and the World Bank will transfer the important lessons learnt in these other cities including project structure, stakeholder involvement and regulatory reforms. The basic characteristics of the project activity are shown in Table 1.

<table>
<thead>
<tr>
<th><strong>Table 1</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Length:</strong></td>
</tr>
<tr>
<td><strong>Terminals:</strong></td>
</tr>
<tr>
<td><strong>Stations:</strong></td>
</tr>
<tr>
<td><strong>Demand:</strong></td>
</tr>
<tr>
<td><strong>Maximum capacity:</strong></td>
</tr>
<tr>
<td><strong>Routes:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Equipment required:</strong></td>
</tr>
<tr>
<td><strong>Bus capacity:</strong></td>
</tr>
<tr>
<td><strong>Capacity:</strong></td>
</tr>
<tr>
<td><strong>Speed of service:</strong></td>
</tr>
<tr>
<td><strong>Intervals of stops during AM rush hour:</strong></td>
</tr>
<tr>
<td><strong>Trip time:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Hours of service:</strong></td>
</tr>
</tbody>
</table>
Fixed infrastructure will consist of 33 bus stations and three terminals serving an exclusive separated bus lane in the center of the avenue in each direction. Each station will have a modular design to ensure uniformity of the Corridor’s image with obstacle-free waiting areas and elevated level-access to articulated buses with a high platform. All stations will have access ramps for mobility-impaired passengers and selected stations will have bicycle parking and storage facilities to promote the use of NMT.

Traffic flow improvement measures will be introduced including bus-priority traffic lights, elimination of left turns on Insurgentes, continuity given to right turns, relocation of valet parking and improved sign-posting.

The new buses will be high capacity, diesel fuelled, EPA’98 compliant, state-of-the-art low pollutant articulated units within the limitations placed by current fuel availability.

The Development Assistance System (DAS) will provide monitoring and communications to allow centralized fleet control allowing coordinated scheduling of service. Satellite technology will allow METROBUS to pinpoint in real-time the location of each unit in the system compared to its planned itinerary. The two-way communications system will allow adjustments to be made and contingencies handled. The DAS will continually generate operating information to monitor the system and improve efficiency and quality of service. It will be complemented by on-route inspectors.

Pre-payment technology will be introduced using electronic replenishable fare-cards. Validation turnstiles at the entrance to each station will detect each electronic ticket and will deduct the corresponding fare. This will streamline the boarding process, allow drivers to concentrate on bus operation and will play a key role in optimizing operations. Fare-card payment machines will be installed at the stations.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GhG) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The reduction in anthropogenic emissions of greenhouse gas (GhG) by sources due to the proposed CDM project activity will be caused by:

1. The improvement in operating conditions for buses. Confined, segregated bus lanes together with bus-priority traffic signals will allow buses on the route to operate more efficiently and without interference from other traffic reducing journey time and congested-idle; both of which will result in lower fuel consumption and lower GhG and local emissions.

2. The improvement in bus technology and capacity. The use of modern high-capacity, 160 passenger diesel buses in place of approximately 350, old, small and mid-sized, gasoline, gas and non-motorized transport

4 when ultra-low-sulfur fuel is made available, the buses may be fitted with Diesel Particle Traps

5 on the old buses, drivers collect fares which slows the boarding process considerably

6 the Project activity will have 80 buses of which approximately 10% will be held in reserve for maintenance and contingencies

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diesel powered units will also result in lower overall fuel consumption and lower GhG and local emissions.

3. The introduction of fare pre-payment technology. Fare prepayment will streamline the boarding process and reduce journey and bus-idle time thus reducing fuel consumption and GhG and local emissions.

4. The use of centralized bus fleet control. Will allow a coordinated scheduling of bus services that dynamically adjusts bus frequency with demand to result in fewer buses scheduled in off-peak hours. This will reduce bus fuel consumption and GhG and local emissions.

5. Traffic improvements for the other vehicles on the route. Reduced journey time for other (non-bus) vehicles that use the route due to the elimination of multi-lane interference from buses competing for passengers together with the flow improvement schemes will reduce fuel consumption and GhG and local emissions.

6. The creation and demonstration of a sustainable business environment for public transport which pioneers the adoption of organizational measures and incentives to a regulatory framework under which the GhG emissions-efficient services can be provided.

7. The introduction and demonstration of a trunk-feeder concept that reduces the number of bus-kilometers because small buses are only used to transport passengers to and from trunk stations and high-capacity buses transport the passengers longer distances between the trunk stations.

8. The provision of a gradual alternative to the building of additional highways that will result in a better use of public space through the active promotion of increasing transit share which will enhance these benefits by further reducing congestion and travel cost, emissions and urban degradation.

These changes can only be brought about once the barriers (described in section B.3 and Annex 5.1) caused by national and/or sectoral policies and circumstances have been eliminated.

The crediting period selected for the project is 7 years renewable twice for a maximum of 21 years, beginning 22/8/2005. It is proposed that the GhG reduction be verified and certified in the first period in years 1, 4 and 7 and subsequently on a three-yearly basis.

The emissions totals of CO₂ equivalent (CO₂ eq) that will be reduced through this project in the first 7 year period will be of the order of 181,000 tons.

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7 mainly Liquid Petroleum Gas (LPG) but some Compressed Natural Gas (CNG) vehicles are in operation
8 currently all the buses operate continually all-day even though the passenger demand drops outside peak-hours.
9 Traffic-flow improvement measures including bus-priority traffic lights, elimination of left turns, continuity given to right turns, relocation of valet parking and improved sign-posting
**A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:**

The expected emissions reductions per year over this initial period are shown in table 2:

<table>
<thead>
<tr>
<th>Years</th>
<th>Mean Annual estimation of emission reductions in tonnes of CO₂ e</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>25,415</td>
</tr>
<tr>
<td>2007</td>
<td>27,688</td>
</tr>
<tr>
<td>2008</td>
<td>26,849</td>
</tr>
<tr>
<td>2009</td>
<td>25,989</td>
</tr>
<tr>
<td>2010</td>
<td>25,521</td>
</tr>
<tr>
<td>2011</td>
<td>24,949</td>
</tr>
<tr>
<td>2012</td>
<td>24,401</td>
</tr>
<tr>
<td>Total estimated reductions (tonnes of CO₂ e)</td>
<td>181,209</td>
</tr>
<tr>
<td>Total number of crediting years</td>
<td>7</td>
</tr>
<tr>
<td>Annual average over the crediting period of estimated reductions (tonnes of CO₂ e)</td>
<td>25,887</td>
</tr>
</tbody>
</table>

Note: The mean annual estimation of emission reductions presented above in table 2 corresponds to the lower 95th Confidence Interval.

**A.4.5. Public funding of the project activity:**

There is no public funding involved from Annex I Parties for this project. Public funding for the project is in the form of budgetary contributions from the annual expenditure plan by the City's assembly. Funding provisions are the result of tax revenues and excise taxes and do not include any official development assistance and is not counted towards the financial obligations of Annex 1 parties. The government has financed the entire infrastructure, through a budgetary allocation from the City Assembly.
SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

There is no methodology approved by the UNFCCC to evaluate this type of project. It is proposed to use a new baseline methodology entitled “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” with its corresponding monitoring methodology.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The chosen methodology has been developed for rolling-stock and infrastructure projects that affect the operation of vehicles on relatively well-defined routes within an urban environment. It has been designed to apply to evaluating and verifying the impact of Bus Rapid Transit (BRT) corridors amongst others.

The chosen methodology is applicable to projects that are not city-wide\(^{10}\) in their application. It can be applied in metropolitan areas with good existing data and also in urban areas where information is less-readily available or currently non-existent. It is applicable to any geographic region.

This project meets every condition stated in the proposed methodology; moreover, since the present project is a pilot for an already envisaged network of 33 corridors in the MCMA, the chosen methodology may also be applied to the following, more extensive stages of this network.

B.2. Description of how the methodology is applied in the context of the project activity:

This section contains:

- B.2.1 Assumptions
- B.2.2 Key Methodological Steps
- B.2.3 Key information and data used to determine the baseline scenario

B.2.1 Assumptions

The basic assumptions of the baseline methodology for the Insurgentes BRT corridor in the context of project activity are:

Project impact on overall travel patterns

i) That the 19.3 km Insurgentes BRT corridor project is too small, within the overall MCMA context\(^{11}\), to affect or modify the overall travel patterns or degree of motorization within the city. The

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\(^{10}\) the chosen methodology cannot easily manage projects that cause extensive changes in land use and degree of motorization over an entire metropolitan area.
methodology takes into account the modal split of trips but is not responsible for any new trip creation other than new trips directly on the project BRT corridor itself.

ii) The number of baseline vehicles, apart from buses (cars, taxis, motorcycles and commercial) in future years will be calculated from measured flows prior to start-up modified by the overall increase in in-use vehicles within the urban metropolitan area. The difference between this figure and the measured with-project flows, discounting modal shift, will be a rebound effect.

Change in emissions from baseline buses over the project timeframe due to repair & replacement practices

iii) Public transport baseline fuel consumption per vehicle-km will depend on the business-as-usual (BAU) repair, replacement or conversion (RRC) assumptions that are used. The assumptions for the baseline vehicles of the Insurgentes BRT corridor project are:

a. The investment foreseen without the project is the annual renovation of 10% of the fleet. For the Insurgentes BRT corridor project, the BAU public transport consists of 113 large diesel buses operated by RTP12 and 243 privately owned units operating on Ruta 2. This implies the following:

i. RTP

Each year 11 buses will be replaced with units of a similar capacity using engine technology current in the year of introduction. Thus if the pre-project RTP buses have a fuel economy13 of 1.530 km/l, at year one, 11 would be substituted with units having a fuel economy of, say, 1.927 km/l giving a new combined fleet fuel economy of 

\[
\frac{(102 \times 1.530) + (11 \times 1.927)}{113} = 1.569 \text{ km/l.}
\]

If the new buses introduced in the second year have the same fuel efficiency, the new (year 2) combined fleet fuel economy will be 

\[
\frac{(102 \times 1.569) + (11 \times 1.927)}{113} = 1.604 \text{ km/l.}
\]

ii. Ruta 2

The Federal District’s transport plan 2002-200614 calls for the substitution of 2000 Microbuses for larger diesel buses at an exchange rate of 2 x 1 where the removed microbuses will be scrapped15. Whilst this program was terminated prior to the Insurgentes BRT corridor project and serious doubts exist on the number of Microbuses that really were scrapped, the BAU scenario assumes that in the absence of the project this substitution could have been continued for the remaining Microbuses in Ruta 2. For the larger buses, a renovation program at 1x 1 would have followed. Thus the baseline assumption for the substitution of Ruta 2 vehicles is as shown in table 3.

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11 which has an extension of 1500 sq. km.
12 “Red de Transporte de Pasajeros” operated by the government
13 the fuel economies used in the calculation will be determined in ex-post fleet measurements. The numbers presented are ex-ante estimations.
14 published in the official gazette on Nov. 1, 2002
15 Oficial Gazette publication, section 4.4.3 Sustitución de microbuses por autobuses.
As with RTP, the new buses introduced will use engine technology current in the year of introduction, thus a fuel economy improvement will be seen over the project timeframe for the baseline activity buses.

Table 3 – Impact of repair, replacement and conversion assumptions on the Ruta 2 baseline bus fleet assuming zero growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Existing Buses (diesel)</th>
<th>Existing Microbuses (gasoline, LPG &amp; CNG)</th>
<th>New buses (diesel)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 0</td>
<td>156</td>
<td>87</td>
<td>0</td>
<td>243</td>
</tr>
<tr>
<td>Year 1</td>
<td>156</td>
<td>87 – 24 = 63</td>
<td>12</td>
<td>231</td>
</tr>
<tr>
<td>Year 2</td>
<td>156</td>
<td>63 – 24 = 39</td>
<td>12 + 12 = 24</td>
<td>219</td>
</tr>
<tr>
<td>Year 3</td>
<td>156</td>
<td>39 – 24 = 15</td>
<td>24 + 12 = 36</td>
<td>207</td>
</tr>
<tr>
<td>Year 4</td>
<td>156 – 16 = 140</td>
<td>15 – 15 = 0</td>
<td>36 + 16 + 8 = 60</td>
<td>200</td>
</tr>
<tr>
<td>Year 5</td>
<td>140 – 20 = 120</td>
<td>0</td>
<td>60 + 20 = 80</td>
<td>200</td>
</tr>
<tr>
<td>Year 6</td>
<td>120 – 20 = 100</td>
<td>0</td>
<td>80 + 20 = 100</td>
<td>200</td>
</tr>
<tr>
<td>Year 7</td>
<td>100 – 20 = 80</td>
<td>0</td>
<td>100 + 20 = 120</td>
<td>200</td>
</tr>
</tbody>
</table>

Memo:

Fuel Efficiency

| 1.530 km/l | 1.950 km/l | 1.927 km/l |

b. For the RTP and Ruta 2 buses that are not replaced, it is assumed that BAU maintenance practices would have maintained their fuel consumption per bus-km over the project timeframe; neither letting the buses become less fuel-efficient nor improving consumption over time.

The vehicle fleet (other than buses) will modernize over the project timeframe

iv) The emissions characteristics of the in-use vehicle fleet will change between each validation point in time. Thus the validation protocol will be based on the in-use fleet data obtained from the obligatory emissions test records at the date of validation; not on the 2004 fleet characteristics.

v) The private-vehicle baseline fuel consumption per vehicle-km in future years will be calculated using the vehicle fleet and fuel efficiency characteristics at that (future) point in time (year “n”) based on the vehicle make, model and model-year mix from the obligatory emissions test data. The vehicle mix on the route will be assumed to be similar to the overall vehicle make, model and model-year mix within the urban area.

The project is not a motor for decentralization

vi) The corridor is not a motor for decentralization. The existence of the corridor will not substantially change the Origin-Destination profiles and whilst the passenger-km-traveled (PKT) demand will change over time it is not a function of the corridor operation.

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16 project startup condition
17 the obligatory vehicle emissions test in the MCMA is conducted every 6 months on all except the newest vehicles for which a two year waiver is given after their initial test.
Average traffic speeds for vehicles will not vary considerably

vii) The average traffic speeds with and without the project will not vary substantially. The measurable differences can be expressed in terms of congestion time which is the additional time that each journey takes (in minutes per kilometer). In congested traffic, this additional time is spent idling in queues, whilst in free-flow traffic it is seen as a reduction in average traffic speed.

Displaced baseline buses

viii) The authorities have committed to take the required actions to ensure that the displaced baseline buses do not continue to operate on these or competing routes. They have also committed to prohibit the creation or growth of competing routes.

Modal shift

ix) The project activity includes the creation of a BRT corridor with improved bus service. For this reason, it can be assumed that there will not be any significant modal shift caused by the project activity, from the buses to other forms of transport.

x) The existence of an improved transportation corridor could cause car owners to use corridor-buses but is not likely to cause bus-users to shift to a different mass transit route (such as the Metro). There will not be any measurable or significant modal shift from buses to cars that is caused by the project activity.

xi) The GhG emissions from the Metro will not change due to any modal shift from Metro to buses.

xii) Even though a survey may reveal a modal shift from taxis to buses, these taxis will continue to be in operation and thus will not reduce their GhG emissions.

Vehicle Occupancy levels

xiii) Public transport baseline vehicle occupancy levels will remain a constant. Thus changes in the number of annual passenger-km. will cause proportional changes in the number of baseline vehicles over the project timeframe to handle this change in demand.

xiv) Private vehicle baseline occupancy levels in any future year will be the same as those measured in the project activity case (for that same year) unless occupancy restrictions or incentives, due to the project have been applied on the route, in which case a different parallel route should be chosen as a surrogate. Such occupancy restrictions or incentives are not planned for the Insurgentes BRT corridor.

Distance from the route

xv) The baseline ignores the possibility of emissions changes from vehicles operating far from the Insurgentes BRT corridor because the large number of transport-related projects conducted in the MCMA over the project timeframe would not permit such changes, should they occur, to be associated exclusively with one, remote project.
xvi) The baseline deals with possible emissions changes from vehicles on other routes close to, or intersecting, the Insurgentes BRT corridor by using logic of conservatism; the methodology reasonably demonstrates that any un-accounted-for increases in emissions are more than cancelled out by un-accounted-for emissions reductions.

Vehicle Population and use

xvii) The creation of the Insurgentes BRT corridor will not modify car purchase or usage patterns other than an expected modal shift from private vehicles to the new corridor-buses.

Bus rider-ship

xviii) Since reliable records for current bus rider-ship do not exist it will be assumed that the baseline rider-ship prior to project startup (year 0) will be the same as the rider-ship on the new buses 6-8 weeks after start of stable operation. This will be measured from ticketing records taking into account non-fare-paying passengers.

Growth in VKT over the project timeframe

xix) The future growth in private vehicle-km-traveled (VKT) which forms part of the dynamic baseline will be proportional to the growth in the VKT of the vehicles operating in the urban metropolitan area.

Rebound

xx) The total growth of VKT on the Insurgentes route will be measured and the difference between what is measured and what is determined from Assumption (xix) above will be assigned to rebound. We will not be able to separate-out within the rebound, what is due to induced journeys and what is due to vehicle trips that have shifted from other routes.

xxi) If the traffic flow on the Insurgentes route is better in the project-activity than in the dynamic baseline it will attract vehicles from other avenues. If it is worse, some vehicles that used to use the route will change to other avenues, and this will continue until a new equilibrium condition is reached.18

*The Insurgentes BRT corridor may cause a net shift of traffic from other routes* if it offers a faster and more consistent journey time than that previously experienced. Thus for these vehicles the shift to the route represents a reduction in journey time, fuel consumption and GhG emissions. Also the fact that these vehicles are no longer operating on the alternative avenue will reduce traffic loading and in turn reduce the generation of GhG emissions from the vehicles that continue to use the alternative.

*Or the Insurgentes BRT corridor may generate a net shift of traffic to other avenues* if they offer a faster journey time than that experienced on the route. Thus for these vehicles the shift from the route represents a reduction in journey time, fuel consumption and GhG emissions and also will reduce traffic loading and the generation of GhG emissions from the vehicles that continue to use the route.

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18 the methodology assumes that the project is too small to create new trips for cars, even though it may create new trips on the faster public transport service. The project design assumes that traffic on the route will have shorter journey times than previously experienced.
In the first case, the increased emissions on Insurgentes due to extra traffic that previously used other routes will be handled as rebound. In the second case the reduced emissions on Insurgentes due to traffic that changed to other routes cannot be used in the calculations because it will be offset by a rebound effect on the other routes outside the project boundary. Thus in either case the rebound effects are offset and can be excluded. In the case of doubt, values that generate a lower baseline projection or a higher project activity value shall be used. Each variable shall be determined in such a way that CERs cannot be earned due to force majeure.

**Vehicle Fleet mix**

xxii) In the southern end of Insurgentes, that involves up-market neighborhoods, the vehicle fleet that actively uses the route may have a higher percentage of newer cars than in other areas. The converse is true for the northern end of Insurgentes that communicates with poorer areas. However, for this project it will be assumed that the vehicle mix on the whole route is the same as the average vehicle mix in the MCMA.

xxiii) Similarly, it has been widely found that newer cars have higher annual usage than older cars. Due to the high cost of determining the actual VKT mix of vehicles using Insurgentes it will be assumed that the VKT mix by model year on Insurgentes is the same as the average VKT mix by model year in the MCMA.

**Trickle-down effect**

xxiv) Not all the removed buses from Insurgentes will be scrapped directly. The permit for new vehicles (large capacity buses) to operate on the new corridor is provided against a corresponding scrapping certificate. This applies to ¾ of the vehicles being replaced on Insurgentes. The reminder will substitute highly polluting vehicles outside the corridor. The verification and validation procedures with regard to the emission reductions will monitor the scrapping arrangements throughout the project implementation. The scrapping of the replaced vehicles will not lead to an increase in bus traffic on other avenues because the transport ministry of Mexico City (SETRAVI) has frozen the issuance of concessions for bus route operations city-wide.

xxv) Scrappage certificates from other routes outside the project boundary will be accepted where buses that have been removed from Insurgentes have replaced other highly polluting vehicles. Providing the trickle-down process is adequately documented and a destruction, recycling or dismantling certificate is obtained for the ultimate vehicle removed, the leakage mechanisms in the methodology will be evoked to account for this movement.

**Pedestrian Cross-traffic**

xxvi) It is assumed that pedestrian cross traffic to and from the stations located on the central divider will not affect traffic flow of other vehicles on the route because traffic lights will be placed on the same cycle as that used for the bus priority cycle. The impact of this, however, will be directly measured by the methodology.

**GhG emissions due to construction activities**

xxvii) The funding for this project comes from the Annual Budget for the City of Mexico, 2005. If this project had not been selected, the City Government would have allocated these funds to a different project with the intention of alleviating some other social, economic or transport need within the City. The city’s current administration was unable to finish its much heralded signature project; the
Periferico upper deck (Segundo piso) due to lack of funds. Had the Insurgentes BRT corridor project not gone ahead, its funding would almost certainly have been assigned to the Segundo piso. Since these funds would have been spent, in any case, on some construction project, the construction orientated emissions impact should be assigned to the BAU case as well as to the project-activity case. The GhG-emissions due to construction activities are thus project-neutral and should not be included in the CDM calculations.

B.2.2 Key Methodological Steps

The New Methodology Baseline (NMB) defines seven key methodological steps that have to be followed in determining the baseline scenario for the Insurgentes BRT corridor project. These are:

B.2.2.1) Characterize the project.
B.2.2.2) Determine the baseline scenario
B.2.2.3) Demonstrate additionality.
B.2.2.4) Define a field measurement and data collection program
B.2.2.5) Calculate the ex-ante value of the emissions reductions
B.2.2.6) Optimize to achieve the best net financial benefit (emissions reductions less measurement costs)
B.2.2.7) Establish responsibilities and QA/QC procedures

These will be discussed in the following sections.

B.2.2.1 Characterize the project and all emissions reductions and probable leakages

The identification of this project is described in A.4.1.4 and the technology used in A.4.3. It is apparent that the project consists of only one main route on which a BRT corridor is to be constructed; currently without any feeder routes but with intersecting streets.

The BRT transportation project strategic design documents are an important source for the data required to characterize this CDM project although some pre-measurements were required to estimate vehicle fuel economy, etc.

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19 This is performed to visualize the scope of the project, identify which avenues and streets have vehicle flows that will be impacted by the project activity and to generate a first estimation of the magnitudes and an idea of the variability involved. Data sources include the transportation project design documents, pre-measurements, expert opinion and experiences in similar projects. Since the dynamic baseline will be constructed around the most attractive alternative option identified in the additionality analysis (B.2.2.2 and B.2.2.3), this may involve changes to the historic business-as-usual scenario at the beginning of the project or systematically over the project timeframe. The methodology uses a route-based approach to sub-divide any multi-route project into multiple individual routes. It identifies the extension of each route and how traffic on this and other streets may be affected by project activity and identifies all significant sources that can be reasonably attributed to the project activity. The possible Components and Leakages in tables 4 & 5 are evaluated.

20 see figure 3 for the project boundary.
Within this methodological framework, each of the possible components and leakages indicated in tables 4 & 5 are analyzed.

### Table 4 – Possible Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on each main route within the project boundary (Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>Buses (fuel consumption measured directly)</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption change determined from difference in travel time)</td>
</tr>
<tr>
<td>3</td>
<td>Vehicles on each main route within the project boundary (Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>Buses (fuel consumption measured as above)</td>
</tr>
<tr>
<td>4</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption measured as above)</td>
</tr>
<tr>
<td>5</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction in use of private cars</td>
</tr>
<tr>
<td>6</td>
<td>Increased bus service to cover extra demand</td>
<td>Increased bus service to cover extra demand</td>
</tr>
<tr>
<td>7</td>
<td>Elimination of left turns on main routes</td>
<td>All vehicles have to travel extra distance to go “round-the-block” to the right to make left turn</td>
</tr>
<tr>
<td>8</td>
<td>Elimination of crossing points on main routes</td>
<td>All vehicles travel extra distance to use a different crossing point</td>
</tr>
<tr>
<td>9</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles have increased travel time due to crossing the routes</td>
</tr>
<tr>
<td>10</td>
<td>Traffic delays due to construction activity</td>
<td>All vehicles on the routes have increased travel time due to additional congestion</td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to construction activity plus upstream construction material emissions</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5 – Possible Sources of Leakage

<table>
<thead>
<tr>
<th>Leakage</th>
<th>Activity</th>
<th>Vehicles affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smelting removed vehicles</td>
<td>Buses</td>
</tr>
<tr>
<td>2</td>
<td>Transferring buses from a different service or route</td>
<td>Buses</td>
</tr>
<tr>
<td>3</td>
<td>Displaced buses are not scrapped</td>
<td>Buses</td>
</tr>
<tr>
<td>4</td>
<td>Buses have to dead-head to reach route</td>
<td>Buses</td>
</tr>
<tr>
<td>5</td>
<td>Competing buses on alternative routes</td>
<td>Buses</td>
</tr>
</tbody>
</table>
Leakage | Activity | Vehicles affected
--- | --- | ---
6 | Modal shift from buses to other modes | Buses, cars, taxis
7 | Shift from transport outside the project boundary to the buses | Buses, cars, taxis
8 | Additional delay to cross the route affects several blocks | All vehicles crossing the route
9 | Vehicles change to alternative routes outside the project boundary | All vehicles on the route except buses
10 | Feeder route improvements adversely affect crossing traffic | All vehicles crossing the feeder route
11 | Vehiches that used routes outside the project boundary transfer to the main route | All vehicles on the route except buses
12 | Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions | Vehicles under the control of the project participants

All the data shown in this section consists of ex-ante values for the initial characterization of the project. The data was obtained from the Insurgentes BRT corridor transportation project strategic design documents reinforced with pre-measurements as necessary. Section E of this document details the most recent ex-ante values; which can be seen in many cases to be different to these initial estimates.

The calculations in all of the following components and leakages will determine ex-ante initial values of the difference in annual fuel consumption (in liters) between the baseline and project activities. This difference (in liters of fuel consumed by fuel type) is converted to tons of CO₂ equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).

Component 1 – Operating condition improvements and/or the substitution of the number and technology of buses that operate on Insurgentes

The project activity involves the creation of a 19.3 km BRT corridor on Insurgentes. Project design documents call for the introduction of 80 high capacity buses on a confined exclusive bus-lane in substitution of approximately 350 diesel, gasoline, LPG and CNG buses.

Table 6 – buses to be introduced

<table>
<thead>
<tr>
<th>Concept / Fuel</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Active buses</td>
<td>70</td>
</tr>
</tbody>
</table>

except component 11 and leakages 1 & 12
including a reserve for maintenance etc
The expected CO₂eqiv reduction per year from Component 1 is approx:\(^23\): 18,000 tons/yr

Component 2 – vehicles on the route other than buses

The project is expected to ease the flow of other vehicles that operate on Insurgentes because of operating condition improvements. An improvement in travel time of approx 20 seconds per km is expected.

The expected CO₂eqiv reduction per year from Component 2 is approx:\(^23\): 15,000 tons/yr

\(^{23}\) calculated from the difference in fuel consumption using UNFCCC factors and procedures
Component 3 - Operating condition improvements and/or the substitution of the number and technology of buses that operate on feeder routes.

No feeder routes are currently included in the project.

The expected CO$_{2}$ equiv reduction per year from Component 3 is approx: 0 tons/yr

Component 4 - Improving the operating conditions for other vehicles operating on the feeder routes.

No feeder routes are currently included in the project.

The expected CO$_{2}$ equiv reduction per year from Component 4 is approx: 0 tons/yr

Component 5 - Modal shift from cars on the route to buses.

Since the project is expected to deliver a much-improved bus service, it is expected that some people that previously used cars will change to the new buses. An initial estimate of 1% of cars will be affected according to the project design documents.

Table 9 – modal shift from cars to buses

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route length</td>
<td>19.3 km</td>
</tr>
<tr>
<td>Vehicles/day on the route</td>
<td>60,000</td>
</tr>
<tr>
<td>Modal shift %</td>
<td>1%</td>
</tr>
<tr>
<td>Average passengers/car</td>
<td>1.5</td>
</tr>
<tr>
<td>Principal fuel</td>
<td>gasoline</td>
</tr>
<tr>
<td>Average fuel consumption</td>
<td>7 km/l</td>
</tr>
<tr>
<td>Days per year</td>
<td>365</td>
</tr>
</tbody>
</table>

The expected CO$_{2}$ equiv reduction per year from Component 5 is approx: 1,300 tons/yr

Component 6 - Extra buses required due to Modal shift.

Since the modal shift from cars will place an extra burden on the bus system it is necessary to see if more buses could be required to cover this extra demand.

Table 10 – extra demand on the buses

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average passenger trip length</td>
<td>4 km</td>
</tr>
<tr>
<td>Additional passengers</td>
<td>900</td>
</tr>
<tr>
<td>Additional passenger-km</td>
<td>3600</td>
</tr>
<tr>
<td>Total passengers</td>
<td>250,900</td>
</tr>
</tbody>
</table>
Component 7 - Elimination of left turns on the corridor

Insurgentes has a total of 19 crossings with large avenues and 47 with small/medium streets. Of these, 13 have left turns from Insurgentes that were permitted in the baseline but will be eliminated with the project activity. If we assume that each large crossing equates to 10 small crossings and that 40% of the traffic will turn left\(^2\), the no-left-turn rule can be expected to affect \(13/(19+4.7)*40\% = 22\%\) of vehicles

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles/day on the route</td>
<td>60,000</td>
</tr>
<tr>
<td>Percent affected</td>
<td>22%</td>
</tr>
<tr>
<td>Additional distance</td>
<td>400 mt</td>
</tr>
<tr>
<td>Days per year</td>
<td>365</td>
</tr>
<tr>
<td>Principal fuel</td>
<td>gasoline</td>
</tr>
<tr>
<td>average fuel consumption</td>
<td>7 km/l</td>
</tr>
</tbody>
</table>

The expected CO\(_{2}\)equiv increase per year from Component 7 is approx:  600 tons/yr

Component 8 - Longer distance required for vehicles to cross the corridor due to the elimination of crossing points

The elimination of crossing points is not planned for the Insurgentes project.

The expected CO\(_{2}\)equiv increase per year from Component 8 is approx:  0 tons/yr

\(^2\) the number is rounded down to the nearest integer. Buses are added to service in discreet numbers; fractional increases in occupancy are allowed (0.26 extra buses equates to less than one additional person per bus)

\(^2\) this assumes that 20\% of traffic flows continue to the end of the route and the rest is equally distributed between left and right turns.
Component 9 - Longer time required for vehicles to cross the route or BRT corridor due to traffic signal timing altered giving priority to buses

The Insurgentes BRT corridor project includes traffic flow improvements for the corridor (including bus-priority traffic lights) that are expected to increase the time per vehicle to cross the corridor in approximately 30 seconds.

### Table 12 – Traffic crossing the route

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles/day crossing the route</td>
<td>25,000</td>
</tr>
<tr>
<td>Additional time to cross</td>
<td>30 sec</td>
</tr>
<tr>
<td>Days per year</td>
<td>365</td>
</tr>
<tr>
<td>Principal fuel</td>
<td>gasoline</td>
</tr>
<tr>
<td>Idle fuel consumption</td>
<td>3.2 l/hr</td>
</tr>
</tbody>
</table>

The expected CO$_{2}$equiv increase per year from Component 9 is approx: 540 tons/yr

Component 10 - Traffic delays during construction

The project is expected to cause delays during the construction period for all the vehicles that operate on Insurgentes. This will affect the first-year results only.

Since the construction process should not cause traffic delays on the entire corridor all the time, it has been estimated that approximately 7.5 km will be affected over a period of 105 days causing a delay of approx. 25 sec/km.

### Table 13 – Traffic delay due to construction

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route length</td>
<td>7.5 km</td>
</tr>
<tr>
<td>Vehicles/day on the route</td>
<td>60,000</td>
</tr>
<tr>
<td>Additional travel time</td>
<td>25 sec/km</td>
</tr>
<tr>
<td>Principal vehicle type</td>
<td>car</td>
</tr>
<tr>
<td>Principal fuel</td>
<td>gasoline</td>
</tr>
<tr>
<td>Idle fuel consumption</td>
<td>3.2 l/hr</td>
</tr>
<tr>
<td>Days of construction</td>
<td>105</td>
</tr>
</tbody>
</table>

The expected CO$_{2}$equiv increase (first year) from Component 10 is approx: 2,300 tons
Component 11 - GhG emissions due to construction activities

The funding for this project comes from the Annual Budget for the City of Mexico, 2005. If this project had not been selected, the City Government would have allocated these funds to some different project with the intention of alleviating some other social, economic or transport need within the City. The city’s current administration was unable to finish its much heralded signature project; the Periferico upper deck (Segundo piso) due to lack of funds. Had the Insurgentes BRT corridor project not gone ahead, its funding would almost certainly have been assigned to the Segundo piso. Since these funds would have been spent, in any case, on some construction project, the construction-orientated emissions impact should be assigned to the BAU case as well as to the project-activity case. The project construction activities are thus GhG-emissions neutral.

The NMB shows the GhG emissions due to construction activities and upstream manufacture of construction materials to be calculated from the project cost. If this were to be taken into account it would have affected the first year results only.

Table 14 – emissions due to construction activities

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost (million USD)</td>
<td>13</td>
</tr>
<tr>
<td>Life Cycle Factor</td>
<td>2756.76</td>
</tr>
</tbody>
</table>

The expected CO₂eqv increase (first year) from Component 11 is approx: 35,800 tons

This should not be considered in the emissions reduction calculation

Leakages

The only leakage that was expected to affect the Insurgentes project is:

Leakage 1 - Smelting removed vehicles

The buses removed from Insurgentes will be scrapped. This will affect the first year results only.

Table 15 – Smelting of removed vehicles

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Buses</td>
<td>350</td>
</tr>
<tr>
<td>Weight per bus</td>
<td>1.5 ton</td>
</tr>
<tr>
<td>liters of diesel per ton</td>
<td>65.1053627</td>
</tr>
</tbody>
</table>

26 at the time of the initial characterization, it was expected that all the buses on Insurgentes would be scrapped. Later it became apparent that 25% of the buses would “trickle-down” through other routes outside the project boundary. Also, in the initial characterization, the need to dead-head the buses was not considered. In section E the mechanisms in Leakages 3 & 4 have been evoked to include these effects.
The expected CO$_2$eqiv increase (first year) from Leakage 1 is approx: 176 tons

Total Characterization

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year emissions reduction</td>
<td>30,645 tons</td>
</tr>
<tr>
<td>All other years</td>
<td>33,136 tons</td>
</tr>
</tbody>
</table>

This is an initial ex-ante value that does not take measurement uncertainties into account. Section E of this document details the most recent ex-ante values, which can be seen in many cases to be different from these initial estimates.

**B.2.2.2 Determine the baseline scenario**

1) **Identification of the relevant decision makers on potential alternative projects**

   The possible decision makers on potential alternative projects are:
   - The Mexico City Government
   - The RTP\textsuperscript{27} bus line
   - Ruta 2 concessionaires
   - Any combination of the above three.

   It would be impossible for any other party to be involved in potential alternative projects without the agreement of these current stakeholders.

2) **Identification of relevant possible alternatives for the decision makers**

   Several alternative options to the project activity have been analyzed:
   a. The implementation of "light" corridors was considered as an option (corridors with minimal additional infrastructure).
   b. Another alternative considered, was a programmatic approach for the development of an entire set of corridors, at a metropolitan scale.
   c. The option to expand the metro was also considered.

   Other alternative courses of action, structured around a BAU model that does not require the structural policy and regulatory reforms were also analyzed. These are:
   d. The adoption of traffic measures.
   e. An enhanced BAU scenario whereby 10% of the bus fleet is renewed yearly, eliminating the Microbuses in Ruta 2 and getting their current operators to replace them (at a substitution rate of 2 x 1) for larger, more efficient diesel powered buses.

\textsuperscript{27} “Red de Transporte de Pasajeros” operated by the government
3) **Check if the possible alternatives are in compliance with the existing regulations**

All the options are in compliance with local regulations.

4) **Check that the possible alternatives to the project-activity are:**

- economically or financially more attractive than the current project without the revenue from the sale of certified emission reductions (CERs); and/or
- not subject to the same barriers to implementation as the current project.

a. The implementation of "light" corridors was rejected because of its potentially weak impact on improving traffic congestion as well as difficulties in enforcing the dedicated character of the exclusive bus lanes. This approach, where applied, has not resulted in significant improvements in modal shift nor on emission reductions. The same can be said for the implementation of temporary corridors that open depending on a fixed timetable during the day. This would be subject to the same barriers to implementation as the project.

b. The programmatic approach for the development of an entire set of corridors, at a metropolitan scale was not pursued as the authorities considered important the catalytic effect of initiating the program in stages, and learning from the operation of Insurgentes, before embarking on an expansion of the program. This approach also would have required additional budgetary resources that were not available at the moment.
c. The option to expand the metro is considerably more expensive than the considered alternative and while it may provide more capacity, it is doubtful that under the current fiscal situation it can be implemented in a meaningful manner.

d. The adoption of traffic measures are part of the solution but such measures are not seen as an exclusive alternative to the corridors in that they do not offer a substantially better or more sustainable mass transit model. They are being made part of the corridor program.

e. An enhanced BAU scenario whereby 10% of the bus fleet is renewed yearly, eliminating the Microbuses in Ruta 2 and getting their current operators to replace them (at a substitution rate of 2 x 1) for larger, more efficient diesel powered buses.

5) Selection of the most plausible baseline scenario
The most plausible baseline scenario is the enhanced BAU scenario whereby 10% of the bus fleet is renewed yearly, eliminating the Microbuses in Ruta 2 and getting their current operators to replace them (at a substitution rate of 2 x 1) for larger, more efficient diesel powered buses.

6) Determine if the overall methodology is applicable to the selected baseline scenario
The overall methodology is applicable to the selected baseline scenario.

B.2.2.3 Demonstrate additionality
Section B.3 demonstrates how the additionality tool is used for the Insurgentes BRT corridor project.

In the case of this project the additionality analysis showed the most attractive alternative option to the project activity was to continue the present style of operation and invest in a yearly replacement of 10% of the bus fleet.

This would phase-out over a number of years the remaining 87, gasoline and gas fuelled Microbuses to replace them with larger diesel fuelled buses at a substitution rate of 2 x 1. The removed microbuses would be taken out of service. Although there is not an exchange mechanism in force at this time, this has been done in the past; and has resulted in the current Insurgentes Ruta-2 bus fleet containing 175 larger diesel units.

The 44 diesel buses that the baseline introduces in substitution of 28 gasoline, 57 LPG and 7 CNG Microbuses will be included in the baseline bus fleet using the current diesel technology at the time of introduction. The larger diesel fuelled buses would be replaced at a substitution rate of 1 x 1. The details of this renovation process are shown in B.2.1 (iii - a).

Any changes in the baseline due to the demonstration of additionality have to be fed back into step 1 (Characterization of the project).
B.2.2.4 Define a Field Measurement and Data Collection Program

The limited scale of this project (less than 40,000 tons per year of CO$_2$eq) dictates that the measurement costs are kept to a minimum and thus manual on-route surveys are proposed for use wherever the data requirements cannot be met from fleet or official records.

This Field Measurement and Data collection program must be defined in accordance with the Monitoring Methodology contained in the NMM titled “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed”. It must comply with the recommendations made in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories: see http://www.ipcc-nggip.iges.or.jp/public/gp/english/.

Annex 5.2 shows the 23 distinct data collection activities have been defined for the Insurgentes BRT corridor project together with the forecast sampling fixed and variable costs, ex-ante measurement standard deviation, the variables generated and where these are used in the baseline (NMB) and monitoring (NMM) methodologies.

B.2.2.5 Calculate an ex-ante value of emissions reductions

Using the ex-ante measurement Standard Deviations in Annex 5.2 (step 3 of this procedure) which are based on the chosen monitoring plan together with the initial estimates of emissions changes from the characterization of the project (step 1 of this procedure), the expected carbon savings are calculated by developing the ex-ante value of the expanded uncertainty associated with each emissions reduction component and leakage taking into account each vehicle$^{30}$ and fuel type$^{31}$.

Table 16 shows the initial ex-ante value of the emissions reductions, whose details are to be found in Annex 5.3. It is important to note that these numbers will change in section E due to (i) a more detailed ex-ante value being used$^{32}$ and; (ii) the results of the optimization process.

Section E shows the detailed calculation method for each component and leakage and the ex-ante values after optimization.

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$^{28}$ To obtain the required data both for defining and updating the baseline and for measuring the project activity. Determine the field measurement and data collection activities required and estimate the fixed and variable cost components of each activity. Estimate the measurement uncertainties associated with each parameter according to the selected activity. These can be obtained from a preliminary set of measurements, and/or from literature. Define the assumptions and measurements that will be required before project start-up and those that will be required to continually update the baseline and measure project activity over the project’s timeframe.

$^{29}$ Carbon emissions reduction = (Baseline emissions – Project Activity emissions) – Leakage – Expanded Measurement Uncertainty

$^{30}$ Vehicle types include: Cars, Taxis, Pickups and Light Duty Commercial, Heavy Duty Commercial, Microbuses and Buses since each of these categories can be readily identified when conducting a traffic count.

$^{31}$ Fuel types include diesel, gasoline, LPG and CNG. Where a vehicle’s fuel type cannot be readily identified in a field survey, regional fuel-type distribution for each vehicle type is to be used.

$^{32}$ the results in tables 17 & 18 are based on the data used in the initial characterization in B.2.2.1
Table 16 – Total emissions reductions

<table>
<thead>
<tr>
<th></th>
<th>MEAN CO2 equiv tons/year</th>
<th>Expanded Uncertainty (lower 95% bound)</th>
<th>LOWER 95th CONFIDENCE LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total components &amp; Leakages per year</td>
<td>33,136</td>
<td>3,117</td>
<td>30,018</td>
</tr>
<tr>
<td>Total components &amp; Leakages for the first year</td>
<td>30,645</td>
<td>3,092</td>
<td>27,563</td>
</tr>
</tbody>
</table>

**B.2.2.6 Optimize to achieve the best net financial benefit**

The optimization process (as shown in the NMB sections F.1 and I.3.2) looks to maximize the value of the carbon emissions reductions (at market value) that can be generated, after subtraction of the measurement and verification costs. All components and leakages are optimized individually, using a grid search method, where possible combinations of measurement/verification effort are evaluated for the associated measurement uncertainty, the monetary value of the emissions reduction or leakage at the lower 95% confidence level and the monetary cost of conducting the verification.

The optimization process looks to detect the minimum possible value of the sum of the cost of the uncertainties\(^{33}\) plus the measurement cost on a per-annum basis.

The annual cost of measurements depends on the number of years in the crediting period and the number of verifications and measurements to be conducted over this timeframe (which in this case consists of a crediting period of 7 years with 3 verifications at years 1, 4 & 7). The cost of baseline measurements performed only once (at project startup) is proportionally distributed across the project timeframe (one seventh of its cost assigned per year), and the cost of each project activity verification is proportioned on a per-annum basis (one seventh of the total cost of 3 verifications assigned per year). Any start-up emissions increases or leakages are assigned to the first year only.

The optimized number of measurements depends principally on their Standard Deviation and the cost of measurement. The initial numbers used in the characterization of the project are refined at this time to generate the final ex-ante value of emissions reductions as shown in Section E.

The optimization process is carried out in the planning phase (using ex-ante data) and at each verification period; using ex-post data from the previous period to define that period’s measurement plan.

Using the numbers and the measurement standard deviations and measurement costs shown in Annex 5.2 as referred in B.2.2.4 above, the optimized measurement plan is developed. Table 17 shows, as an example, the ex-ante standard deviations and measurement costs for the component 1 baseline buses, however this process is followed for all components and leakages.

---

\(^{33}\) uncertainties expressed as tons of CO\(_{2}\text{equiv}\) per year at the market value in $USD/ton
Table 17 – Component 1 baseline buses

<table>
<thead>
<tr>
<th>Type of Bus</th>
<th>Baseline Fuel consumption measurement sample size for buses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diesel buses</td>
</tr>
<tr>
<td>Standard Deviation of Measurements</td>
<td>0.45</td>
</tr>
<tr>
<td>Measurement Costs ($USD)</td>
<td></td>
</tr>
<tr>
<td>Fixed Cost ($USD)</td>
<td>510</td>
</tr>
<tr>
<td>Variable Cost ($USD per bus)</td>
<td>96</td>
</tr>
</tbody>
</table>

Considering a market value for carbon of $US 5 per ton, table 18 shows a partial set of results caused by evaluating different sample sizes for the Component 1 baseline buses. It can be seen that increasing the sample size reduces the measurement uncertainty but increases the sampling cost. The lowest dollar sum value of (uncertainty + measurement cost) occurs with a sample of 105 diesel buses, 5 gasoline buses, 22 LPG buses and 5 CNG buses.

This results in a Component 1 baseline uncertainty of 791.5 tons of CO₂equiv per year worth $3,957.58 and a per-annum measuring cost of $2,384.57, considering that the crediting period is 7 years. This process is similarly conducted for the baseline and project-activities of all components and leakages.

Table 18 – Effect of changes in Sample Size for component 1 baseline

<table>
<thead>
<tr>
<th>Diesel buses</th>
<th>Gasoline buses</th>
<th>LPG buses</th>
<th>CNG buses</th>
<th>Uncertainty (t)</th>
<th>Uncertainty ($USD)</th>
<th>Measurement Cost ($US)</th>
<th>Sum (Uncert + MC) $USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>826.9</td>
<td>4134.372</td>
<td>2220</td>
<td>6354.372</td>
</tr>
<tr>
<td>95</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>823.9</td>
<td>4119.287</td>
<td>2233.714</td>
<td>6353.002</td>
</tr>
<tr>
<td>95</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>821.1</td>
<td>4105.526</td>
<td>2247.429</td>
<td>6352.955</td>
</tr>
<tr>
<td>96</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>823.7</td>
<td>4118.562</td>
<td>2233.714</td>
<td>6352.276</td>
</tr>
<tr>
<td>96</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>820.7</td>
<td>4103.42</td>
<td>2247.429</td>
<td>6350.848</td>
</tr>
<tr>
<td>96</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>817.9</td>
<td>4089.605</td>
<td>2261.143</td>
<td>6350.748</td>
</tr>
<tr>
<td>97</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>820.6</td>
<td>4103.019</td>
<td>2247.429</td>
<td>6350.448</td>
</tr>
<tr>
<td>97</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>817.6</td>
<td>4087.819</td>
<td>2261.143</td>
<td>6348.962</td>
</tr>
<tr>
<td>97</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>814.8</td>
<td>4073.952</td>
<td>2274.857</td>
<td>6348.809</td>
</tr>
<tr>
<td>98</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>814.5</td>
<td>4072.479</td>
<td>2274.857</td>
<td>6347.336</td>
</tr>
<tr>
<td>98</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>811.7</td>
<td>4058.559</td>
<td>2288.571</td>
<td>6347.131</td>
</tr>
<tr>
<td>99</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>811.5</td>
<td>4057.393</td>
<td>2288.571</td>
<td>6345.965</td>
</tr>
<tr>
<td>99</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>808.7</td>
<td>4043.421</td>
<td>2302.286</td>
<td>6345.570</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>808.5</td>
<td>4042.554</td>
<td>2302.286</td>
<td>6344.844</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>22</td>
<td>5</td>
<td>805.7</td>
<td>4028.531</td>
<td>2316</td>
<td>6344.531</td>
</tr>
<tr>
<td>101</td>
<td>5</td>
<td>21</td>
<td>5</td>
<td>805.6</td>
<td>4027.956</td>
<td>2316</td>
<td>6343.956</td>
</tr>
</tbody>
</table>
The optimization process requires this calculation to be performed for every component and leakage to
determine the optimum sample size for each variable. Where measurement costs are high, accepting a high
level of uncertainty can produce optimal results due to the reduction in these measurement costs.

### B.2.2.7 Establish responsibilities and QA/QC procedures

METROBUS has the responsibility for carrying out the monitoring methodology and continually revising
the inventory of uncertainties to make adjustments to the monitoring program as necessary.

METROBUS is responsible for establishing, monitoring and conducting all the QA/QC procedures.
Its organic responsibility is detailed in section D.4 and the QA/QC activities it should include are specified
in D.3.

### B.2.3 Key information and data used to determine the baseline scenario

The Key information and data sources used to determine the baseline scenario can be found in Annex 3. Ex-
ante values of the data are to be found in section E and in B.2.2.

### B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below
those that would have occurred in the absence of the registered CDM project activity:

The chosen baseline methodology uses direct source measurement over the project timeframe to create a
dynamic baseline that automatically accounts for changes in the natural growth of passenger-trips per year
on Insurgentes due to an expanding urban population; and the renovation, growth and change in technology
and fuel efficiency of the active vehicle fleet over the project timeframe\(^\text{34}\). The dynamic baseline
incorporates the most attractive alternative option to the project activity identified in this section. This

\(^{34}\) see the NMB sections F, G, and I.1 for a discussion on how the methodology creates the dynamic baseline, measures
the project activity and evaluates the reduction
involves re-activating a program to substitute Microbuses with larger diesel buses\(^{35}\) which would phase out over a number of years the remaining 87 gasoline and gas\(^{36}\) fuelled Microbuses and replaces them with larger diesel fuelled buses at a substitution rate of 2 x 1. The removed microbuses would be scrapped.

The 44 diesel buses that this program introduces to the baseline fleet in substitution of 28 gasoline, 57 LPG and 7 CNG Microbuses will use diesel technology current at the time of introduction.

An investment program would be maintained to replace 10% of the remaining bus fleet (both public and privately owned) per year.

The project activity is as described in A.2 and table 1.

To demonstrate that the Insurgentes BRT corridor project activity is not the baseline and is, therefore, additional, the methodology requires that the UNFCCC/CCNUCC approved tool for the demonstration and assessment of additionality be used. It is to be found at: [http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf](http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf). This tool provides for a step-wise approach to demonstrate and assess additionality. The steps include:

- Identification of alternatives to the project activity;
- Investment analysis to determine that the proposed project activity is not the most economically or financially attractive; or
- Barriers analysis;
- Common practice analysis; and
- Impact of registration of the proposed project activity as a CDM project activity.

**Step 0. Preliminary screening based on the starting date of the project activity**

The Marrakech Accords and decision 18/CP.9 provide guidance on the eligibility of a proposed CDM project activity which started before registration. This CDM project has an expected effectiveness date of: 22/8/2005 which is before the registration date of 30/12/2005.

The project is being formulated under the guidelines of the Clean Development Mechanism (CDM) and is intended to generate Carbon Emission Reduction.

From a climate change perspective, efforts to promote a modal shift are anticipated to result in reductions of greenhouse gas emissions per passenger-km. Carbon Finance (CF) support provided to the proposed project however is not expected to compete neither with the GEF’s long-term operational program nor with their short-term response measures. Rather, the GEF resources complement CF intervention by enabling the development of a regulatory framework for the introduction of a modal shift. The CF contributes to the development of transport corridors as a preferred option for this modal shift.

The project is consistent with, and was prepared pursuant to guidance from the United Nations Framework Convention on Climate Change (UNFCCC) and the guidelines of the World Bank's Carbon Funds (CF). The global common objective of the project is to contribute to the reduction of global carbon emissions from the passenger transport sector in the Mexico City Metropolitan Area to be achieved through a modal shift towards low polluting, space efficient transport corridors with exclusive bus-ways and traffic management measures.

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\(^{35}\) Microbus substitution and scrappage program published in the official gazette on Nov. 1, 2002

\(^{36}\) most are LPG fuelled although a small percentage use CNG
The project was initially submitted to the Carbon Finance Unit of the World Bank for consideration of carbon emissions reductions at the earliest stages of consideration by the City Government. The Project Idea Note (first document to request inclusion in the portfolio of CF at the World Bank) was issued by the City and received by the Bank on July 2003 (see copy in Annex 5.4, reference 1). The PIN requested a potential purchase of carbon emission reductions. A PCN (later renamed CFD, carbon finance document) was submitted by the City on November 2004 and later updated (see copy in Annex 5.4, references 6 and 7). The CFD again requested carbon reductions purchases from CF and requested assistance in the removal of barriers that were obstacles to the implementation of the project. As a response, CF at the World Bank allocated resources, including trust fund resources to assist in the identification and removal of barriers. In coordination with the GEF resources were allocated to address institutional issues, business model development and identification in regulatory gaps.

The terms of reference for the feasibility assessment included the quantification of global environmental benefits. These terms of reference were dated September 2003.

In parallel, the City addressed a formal written letter to the World Bank director for Mexico (dated March 2004), (see copy in Annex 5.4, reference 8) where it requested assistance for ensuring the purchase of carbon emission reductions, indicating: "the sale of carbon emission reduction is essential for ensuring project viability".

A quality enhance review was undertaken at the World Bank on March 2005, where a green light was provided to the project concept focused on the generation of emission reductions, which were then valued at US$2.0 million during the first 14 years of operation.

**Step 1. Identification of alternatives to the project activity consistent with current laws and regulations**

**Sub-step 1a. Define alternatives to the project activity:**

The alternatives to the project activity are:

a. The business-as-usual scenario in which mass transit services are proportioned by dispersed, inefficient and predatory operations, due to the barriers against change.

b. The most plausible baseline scenario selected in the determination of the baseline scenario in B.2.2.2 which consists of an enhanced BAU scenario whereby 10% of the bus fleet is renewed yearly, eliminating the Microbuses in Ruta 2 and getting their current operators to replace them (at a substitution rate of 2 x 1) for larger, more efficient diesel powered buses.

c. The project activity without the CDM component.

**Sub-step 1b. Enforcement of applicable laws and regulations:**

All of the above options comply with all the applicable legal and regulatory requirements

Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis).

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37 even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution. Where poor compliance with existing transport regulations currently exists, it can be shown that this state of affairs had been accepted for many years making it ipso facto part of the BAU structure.
Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:

The CDM activity was involved in the removal of barriers to the implementation of the project. Barriers present at the start of the activity included:

\textit{a) lack of an institutional framework.}

The CDM activity using resources provided by CF at the Bank, reviewed options for an institutional structure that could manage a corridor transport system and created an independent institution (METROBUS), to be partially funded by emission reductions revenues that would operate and manage the corridor. The institution is an independently managed public entity with own management and accounts. The creation of METROBUS was critical for the viability and sustainability of the project.

\textit{b) lack of a business model.}

The baseline business model for the transport sector in the City consisted of independently owned and operated small transport companies or individuals, managing a few vehicles without standards for performance, safety nor health and fringe benefits for the drivers. This multitude of operators created a chaotic operational condition on Insurgentes Avenues.

As part of the CDM activity, a business model was developed for the grouping of the small operators under a single company with business statutes, performance indicators, modern financial and safety standards and clear operational rules. The company is now a concessionaire of the public space created under the transport corridor project. Concession contracts were drafted and agreed with the newly formed company. The operation of the corridor as a business under strict performance standards enables the delivery of emission reductions.

\textit{c) lack of a regulatory framework.}

In the absence of the project, public space was not regulated, nor confinement for public transport was allowed for. There were no rules on the use of the bus lanes and no disincentives for the use of bus lanes by other modes of transport.

Under the CMD activity, the transport regulations were modified and new transport rules were issued that created the figure of lanes of exclusive use by public transport. The efficient allocation of public space permitted the improvement in mobility that is central to the design of the project.

\textit{d) lack of incentives for scrapping of old buses.}

With carbon finance assistance a dialogue was carried out to ensure that strict scrapping rules would be in effect by the time the project initiated activities. Scrapping of old rolling equipment was a requirement to the creation of the carbon asset. Furthermore, part of the future revenues from carbon emission reductions will be used to partially finance scrapping of old vehicles.

These barriers were solved with the support of the CDM activity. The city communicated to the Bank in September 2004, that the project would not be implemented were not for the CDM involvement's assistance in addressing these barriers (see copy in Annex 5.4, reference 8).

Annex 5.4 contains documented references prepared by the project developer, contractors and project partners (World Bank) in the context of the proposed project activity that clearly demonstrate:
i. The existence of these barriers
ii. That the barriers were resolved with the support of the CDM activity
iii. That the project would not be implemented were not for the CDM involvement's assistance in addressing these barriers

These identified barriers would have prevented the implementation of the project activity without the CDM component.

**Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):**

The barriers discussed above would not have prevented, under the existing institutional and regulatory framework a continuation of the BAU scenario (option “a” in sub-step 1a) or option “b” in sub-step 1a that consists of the phasing out over a number of years of the remaining 87 gasoline- and gas-38 fuelled Microbuses and replacing them with larger more-fuel-efficient diesel fuelled buses at a substitution rate of 2 x 1. The removed microbuses would be removed from service. Although there is not an exchange mechanism in force at this time, this has been done in the past; resulting in the current Insurgentes Ruta-2 bus fleet containing 175 larger diesel units; however the removed units were not scrapped.

The 44 diesel buses that the baseline introduces in substitution of the 28 gasoline, 57 LPG and 7 CNG Microbuses will be introduced into the baseline bus fleet using the diesel technology current at the time of introduction.

The most attractive of these two options is option “b” from sub-step 1a.

**Step 4. Common practice analysis**

**Sub-step 4a. Analyze other activities similar to the proposed project activity:**

No other activities similar to the proposed project activity have been implemented previously or are currently underway in Mexico City.

The use of sectoral policies for improving the quality of public transportation services is not new however; several cities in Latin America are improving their public transport services through the use of BRT corridors. The leaders in this field are Curitiba (Brazil) and Bogotá (Colombia) that have focused their attention on improved bus service management, large-capacity buses, segregated exclusive lanes, and bus and station design that allows rapid boarding. Santiago (Chile) and Mexico have based their designs mainly around the Columbian Transmilenio experience which involved a comprehensive overhaul of the city’s public transport system that started in 2000.

Transmilenio has introduced 65 km of segregated bus-way39 with an additional 330 km planned by 2016. The system currently has 78 stations and 628 buses.

The consumer-oriented nature of BRT has contributed to an apparent reduction in private car and taxi use, and significant increases in public transit passenger trips. By May 2005 Transmilenio has transported over 926 million passenger-trips substantially cutting travel-times, traffic accidents and pollution.

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38 most are LPG fuelled although a small percentage use CNG
39 including the Calle 92 to Calle 8 sur trunk route opened on July 1 2005
Similar to TranSantiago and Mexico, Transmilenio is planning to add a CDM project to their initiative—project developers are currently seeking approval for the methodology.

The above-mentioned barriers faced in the implementation of the Insurgentes BRT corridor project were not experienced in the same restrictive degree in these other cities (and countries).

**Sub-step 4b. Discuss any similar options that are occurring:**

It is imperative that BRT systems are properly designed not only from a physical perspective but also from an institutional and legal perspective in order to ensure they are financially sustainable. Any BRT corridor with transit demand over 8,000 passengers per peak hour per direction can be made financially self-sufficient\(^{*}\), but that is no guarantee that it will be. Simply building exclusive bus lanes will by no means guarantee financial sustainability. In Curitiba, for example, the system and tariffs are structured so that each concessionaire gets a 12 percent return on investment\(^{**}\), assuming they comply with the terms of their contract but at the cost of very high fares (US$0.70) which would be socially impossible to implement in Mexico. TransJakarta at this point is financed largely by government subsidies. Quito’s electric trolley bus line has yet to achieve full financial sustainability. Bogota’s TransMilenio achieved full financial sustainability not only by constructing exclusive bus lanes, but by re-routing regional transit systems to create a quasi-monopoly out of the trunk line operators, then contracting this monopoly concession out to multiple bidders through competitive tender. It is institutionally and legally complex to ensure that the private sector invests in the rolling stock and continues to invest in the maintenance of the rolling stock.

In the MCMA the bus tariff could not be fixed at a level measurably higher than that which the passengers had been previously paying, nor could regional transit systems be rerouted to increase income or subsidized operation be allowed; thus carbon funding became essential to permit the structured operation that is a keystone to breaking down the barriers; which involves additional planning and monitoring costs that can only work with carbon funding.

**Step 5. Impact of CDM registration**

The City government has committed as budgetary resources all the funding required for the construction of the infrastructure. The government has already established Metrobus, an independent public entity that will manage the operation of the corridor. The carbon finance resources will directly contribute to the sustainability of the corridors program by addressing monitoring and planning functions at Metrobus. The project is intended to demonstrate and develop the tools required to measure and monitor carbon emission reductions from the transport sector. While the operation of one single corridor does not result in large emission reductions, the project will eventually enable the application of the tools and procedures developed, on a larger scale, which is already envisaged, as a follow up to this operation. The availability of certified emission reductions is expected to accelerate this process.

The CDM component of this project has been politically sufficiently strong and desirable for politicians and local authorities to build the consensus and levels of interest that could allow these above mentioned barriers to be torn-down. Without this the project could not have succeeded.

\(^{*}\) see “Reducing Greenhouse Gas Emissions with Bus Rapid Transit”: a GEF Medium-sized Project Brief 14 July 2004

\(^{**}\) The Opportunities for Sustainable Urban Transportation in Medium-Sized Cities in Latin American and the Caribbean, Deborah Bleviss, November 2004
B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary defined in the chosen methodology encompasses all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the project activity. It achieves this by dividing any multi-route project into a collection of individual routes, including each of these within the project boundary.

In the case of the Insurgentes BRT corridor the project consists of only one 19.3 km route as defined in A.4.1.4. On this route, the methodology monitors all project activity; direct, and dependant changes in vehicle fuel consumption that can be identified and measured with statistical validity. The methodology includes within the project boundary and measures changes in fuel consumption from:

A. Vehicles on the 19.3 km Insurgentes BRT corridor route: buses [1] and other vehicles [2].

B. Vehicles on feeder routes: buses and other vehicles. – These are not included in this project’s current implementation.

Whilst the project participants have looked at the possibility of including feeder routes at the southern end of the Insurgentes BRT corridor, no feeder routes have yet been defined. When these plans are implemented the feeder routes may be included within the project activity.

C. Modal shift [5] to buses from private cars and other forms of transport.

D. Vehicles that are affected by the elimination of:
   - left turns [6];- 13 left turns have been eliminated by the project activity;
   - crossing points;- no crossing points have been eliminated in the project design
   - vehicles that suffer increased delay in crossing the main route or BRT corridor [8].

E. The methodology adds to the above, within the project boundary, other temporal identifiable GhG emissions changes:
   - delays during project defined construction activities and
   - GhG emissions due to construction activities and upstream manufacture of material for construction; - Should not be considered in this project.

The funding for this project comes from the Annual Budget for the City of Mexico, 2005. If this project had not been selected, the City Government would have allocated these funds to some different construction project within the City. Since these funds would have been spent, in any case, on construction, the GhG emissions impact should be assigned to the BAU case as well as to the project-activity case making the project construction-neutral.

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42 the numbers in [ ] refer to the elements in Figure 3 that apply to the Insurgentes project. Elements [3], [4] and [7] are not included in this project.
B.5. Details of baseline information, including the date of completion of the baseline study and the name of person(s)/entity(ies) determining the baseline:

Annex 3 contains the key elements used to determine the baseline for the project activity including elements such as variables, parameters and data sources.

The person(s)/entity(ies) responsible for determining the baseline and constantly updating it throughout the project timeframe is METROBUS, who is a project participant listed in Annex 1.

The date of completion of the initial baseline analysis is 30/10/2005; however the baseline data (and analyses) will be dynamically updated at each verification period throughout the projects timeframe.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

Thirty (30) years zero (0) months
C.1.1. Starting date of the project activity:
The project started full operation on 19/6/2005.

C.1.2. Expected operational lifetime of the project activity:
The operational lifetime of the BRT corridor is estimated as Fourteen (14) years, zero (0) months

C.2 Choice of the crediting period and related information:
The project activity will use a renewable crediting period.

C.2.1. Renewable crediting period
The project seeks a Seven (7) years renewable crediting period with up to two renewals, (provided that a designated operational entity determines and informs the Executive Board that the original project baseline is still valid or has been updated taking account of new data where applicable)

C.2.1.1. Starting date of the first crediting period:
The first crediting period is expected to start on: 01/11/2005

C.2.1.2. Length of the first crediting period:
Seven (7) years, zero (0) months

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

C.2.2.2. Length:

SECTION D. Application of a monitoring methodology and plan
At the time of the creation of this PDD, there were no UNFCCC approved methodologies to monitor urban transportation projects. For this reason a new monitoring and verification methodology has been submitted to the UNFCCC titled “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed”.

This new monitoring methodology uses the new baseline methodology of the same name.

The project seeks to verify and certify the emissions reduction resultant from this Insurgentes BRT corridor project on three occasions within the initial, renewable crediting period; after 1, 4 and 7 years of operation.
The new methodology; monitoring (NMM) defines the following key methodological steps (shown in figure 1 in the NMM) that have to be followed in determining the measurement plan for the Insurgentes BRT corridor project. These are:

A. Define data collection activities required to continually update the baseline and project activity
B. Optimize data collection activities
C. Collect monitored data and GhG parameters
D. Receive and verify data
E. Analyze data
F. Update uncertainty and sampling cost calculations
G. Verify if the net monetary value could be improved\(^43\); if so return to step (A).
H. Archive data

The project participants have designated METROBUS as the institution responsible for making the monitoring measurements and calculations over the project timeframe and as such, METROBUS is the agency that is responsible for carrying out all of these activities (see B.2.2.7).

During all these activities, the project participants must also ensure that Metrobus\(^44\) carries out adequate QA/QC procedures\(^45\) to guarantee the validity of the data and results and the integrity of its storage. QA/QC audits should be conducted on a periodic basis that may not be greater than the validation period.

The application of quality auditing techniques at each stage of the process is integral to the monitoring methodology. Additionally, visual inspections of vehicle operation on the main route, feeder routes, alternative avenues and intersecting streets shall be conducted on a periodic basis as a reality check to ensure that changes have not occurred that are not recognized, included and evaluated within the measurement plan.

A. Define data collection activities required to continually update the baseline and project activity

The methodology first requires that the project participants identify monitoring requirements based on the ex-ante determination in the baseline methodology\(^46\). From this, the initial monitoring requirements are identified. The formulae and algorithms that determine the GhG emissions are obtained from the baseline methodology “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed”.

At each verification period, this process is repeated using the data available at that time\(^47\); to continually revise the data collection activities ensuring that sufficient data is being collected to meet the monitoring goals.

\(^{43}\) By statistically optimizing to achieve a minimum (uncertainty cost plus measurement cost) where the uncertainty cost is derived from the expanded combined uncertainty in tons/yr of CO\(_{2equiv}\) at the 95\(^{th}\) percentile lower level considering the market value per ton of CO\(_{2equiv}\).

\(^{44}\) Whose organic responsibility is detailed in section D.4

\(^{45}\) as specified in section D.3

\(^{46}\) see B.2.2.4

\(^{47}\) ex-post data from the previous verification stage
B. Optimize data collection activities

The measurement techniques used to monitor the identified parameters are selected taking into account the availability of data-gathering technology at that time and information available within the MCMA. The measurement uncertainties associated with each monitored variable must be determined taking into account the methodology used, variance and sample sizes as applicable. The calculation of measurement uncertainties must be adequately documented and accompany the measurements themselves.

This monitoring methodology allows different intervals between measurements to be used for different variables and parameters. The underlying principal of this methodology is that in case of uncertainty regarding values of variables or parameters, or the interval between verification periods, the methodology will be considered conservative providing that it does not lead to an overestimation of emission reductions attributable to the CDM project activity. In the case of doubt, values that generate a lower baseline projection or a higher project activity value shall be used. Each variable shall be determined in such a way that CERs cannot be earned due to force majeure. The optimized activities must abide by the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (found at http://www.ipcc-nggip.iges.or.jp/public/gp/english/).

C. Collect monitored data and GhG parameters

The optimized data collection activities defined at each verification period (as shown in Annex 5.2 for the ex-ante values) are put into practice to obtain the required data for every monitored variable and parameter.

D. Receive and verify data

The data is received, registered and validated before analysis. The correct application of the QA/QC procedures (see D.3) is verified. Any unconformities should be documented.

E. Analyze data

The data is analyzed in accordance with the methodologies specified in sections D.2.1, D.2.3, D.2.4 and section E. The calculation of measurement uncertainties must be adequately documented and accompany the measurements themselves.

F. Update uncertainty and sampling cost calculations

The emissions reduction at market value [Emissions Reductions – (Emissions Increases + Leakages + measurement uncertainties) – verification cost] is calculated.

G. Verify if the value of the emissions reduction could be improved; if so return to step (A).

Using the ex-post measurement uncertainty and cost figures, the measurement plan is re-evaluated to ensure that the optimum net monetary value of the emissions reductions is being generated. If adjustments are required, those that can be made for the current verification period are put into effect immediately. Those that cannot be adjusted for the current period are modified to improve the benefits in the following verification period.

H. Archive data
All monitored data, parameters and calculations are recorded and archived as described in NMM tables B.2.1, B.2.3 and B.4.1. All monitored data and parameters will be securely stored for a minimum of 2 years after the end of the crediting period or receipt of last payment, whichever occurs last.

The data that is to be collected in accordance with the monitoring methodology is specified in D.2.1 (project activity), D.2.1.3 (baseline) and D.2.3.1 (leakages). D.3 describes the QA/QC procedures that must be observed by METROBUS in these activities.

**D.1. Name and reference of approved monitoring methodology applied to the project activity:**

NMM titled: “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed”.

**D.2. Justification of the choice of the methodology and why it is applicable to the project activity:**

The chosen methodology has been developed for rolling-stock and infrastructure projects that affect the operation of vehicles on relatively well-defined routes within an urban environment. It can be applied to evaluating and verifying the impact of Bus Rapid Transit (BRT) corridors, only replacement of old buses by new buses, traffic light synchronization schemes, traffic restriction measures, a bridge or tunnel over a barrier, a road pricing scheme, changes in fuel type or other change in the "terms of trade" of local transport and similar projects. The methodology can be applied in metropolitan areas with good existing data and also in urban areas where information is less-readily available or currently non-existent. It can make extensive use of data-gathering technology where it exists (such as automatic license plate readers) or in its absence obtain all the data required for the methodology through the cost effective application of human-based field measurement campaigns. It is applicable to any geographic region. It is not designed for city-wide projects that substantially modify general metropolitan-area indicators such as degree-of-motorization or land utilization.

This project consists of a BRT corridor on a single route with, at present, no feeder routes. The chosen methodology fits the requirements of the Insurgentes BRT corridor project within the MCMA. Section A.2 describes the project activity and A.4.1.4 explains the boundaries of the Insurgentes BRT corridor project. Whilst Mexico City has generally good data availability, the limited size of this project requires that manual field measurement surveys be used to collect much of the specific data. The extension of this project will not substantially modify general metropolitan-area indicators such as degree-of-motorization or land utilization.

**D.2.1 Option 1: Monitoring of the emissions in the project scenario and the baseline scenario**

**D.2.1.1. Data to be collected in order to monitor emissions from the project activity; and how this data will be archived:**

Section B.2.1 of the NMM “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” shows the data that is to be
collected in the Insurgentes BRT corridor project in order to monitor emissions from the project activity, and how this data will be archived. Data shall be securely archived for a minimum of 2 years after the end of the crediting period or receipt of last payment, whichever occurs last.

**D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO2 eq.)**

The formulae and algorithms used to estimate project emissions in the Insurgentes BRT corridor project are obtained from the baseline methodology (NMB) “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” section G and Annexes.

Section I of the NMB describes the formulae used to determine the difference in CO₂ equivalent emissions between the baseline and project activity. Table 19 shows the sections where the information can be found in the NMB for the formulae used to monitor the project activity components of each section/activity. The column “C” refers to the project boundary definition shown in figure 3.

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>NMB Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on each main route within the project boundary (Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>Buses (fuel consumption measured directly)</td>
<td>[1]</td>
<td>G.1</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>Buses (fuel consumption measured as above)</td>
<td>[3]</td>
<td>G.1</td>
</tr>
<tr>
<td>3</td>
<td>Vehicles on feeder routes within the project boundary</td>
<td>All vehicles except buses (fuel consumption change determined from difference in travel time)</td>
<td>[2]</td>
<td>G.2</td>
</tr>
<tr>
<td>4</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction in use of private cars</td>
<td>[5]</td>
<td>G.3</td>
</tr>
<tr>
<td>5</td>
<td>Increased delay in crossing the main route</td>
<td>Increased bus service to cover extra demand</td>
<td>[4]</td>
<td>G.2</td>
</tr>
<tr>
<td>6</td>
<td>Elimination of left turns on main routes</td>
<td>All vehicles have to travel extra distance to go “round-the-block” to the right to make left turn</td>
<td>[6]</td>
<td>G.5</td>
</tr>
<tr>
<td>7</td>
<td>Elimination of crossing points on main routes</td>
<td>All vehicles travel extra distance to use a different crossing point</td>
<td>[7]</td>
<td>G.6</td>
</tr>
<tr>
<td>8</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles have increased travel time due to crossing the routes</td>
<td>[8]</td>
<td>G.7</td>
</tr>
<tr>
<td>9</td>
<td>Traffic delays due to construction activity</td>
<td>All vehicles on the routes have increased travel time due to additional congestion</td>
<td>G.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Emissions due to construction activity plus upstream construction material emissions</td>
<td></td>
<td>G.9</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1) Components 10 & 11 refer specifically to the main route or corridor within the project boundary.
D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GhG within the project boundary and how such data will be collected and archived:

Section B.2.3 of the NMM “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” shows the data that is to be collected in the Insurgentes BRT corridor project in order to determine the baseline of anthropogenic emissions by sources of GhG within the project boundary and how such data will be collected and archived. Data shall be securely archived for a minimum of 2 years after the end of the crediting period or receipt of last payment, whichever occurs last.

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

The formulae and algorithms that estimate baseline emissions in the Insurgentes BRT corridor project are obtained from the baseline methodology (NMB) “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” section F and Annexes.

Section I of the NMB describes the formulae used to determine the difference in CO2 equivalent emissions between the baseline and project activity.

Table 20 shows the sections where the information can be found in the NMB for the formulae used to monitor the baseline components for each section/activity. The column “C” refers to the project boundary definition shown in figure 3.
Table 20 – Baseline formulae in the sections of the NMB

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>NMB Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on each main route within the project boundary (Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>Buses (fuel consumption measured directly)</td>
<td>[1]</td>
<td>F.2.1</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption change determined from difference in travel time)</td>
<td>[2]</td>
<td>F.2.2</td>
</tr>
<tr>
<td>3</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>Buses (fuel consumption measured as above)</td>
<td>[3]</td>
<td>F.2.1</td>
</tr>
<tr>
<td>4</td>
<td>Vehicles on feeder routes within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption measured as above)</td>
<td>[4]</td>
<td>F.2.2</td>
</tr>
<tr>
<td>5</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction in use of private cars</td>
<td>[5]</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>Increased bus service to cover extra demand</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>Elimination of left turns on main routes</td>
<td>All vehicles have to travel extra distance to go “round-the-block” to the right to make left turn</td>
<td>[6]</td>
<td>F.2.3</td>
</tr>
<tr>
<td>8</td>
<td>Elimination of crossing points on main routes</td>
<td>All vehicles travel extra distance to use a different crossing point</td>
<td>[7]</td>
<td>F.2.4</td>
</tr>
<tr>
<td>9</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles have increased travel time due to crossing the routes</td>
<td>[8]</td>
<td>F.2.5</td>
</tr>
<tr>
<td>10</td>
<td>Traffic delays due to construction activity</td>
<td>All vehicles on the routes have increased travel time due to additional congestion</td>
<td></td>
<td>F.2.2</td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to construction activity plus upstream construction material emissions</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Notes: 1) There is no baseline component for the boxes marked “*”; the baseline value is zero
2) Components 10 & 11 refer specifically to the main route or corridor within the project boundary

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

This section is left blank on purpose.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity; and how this data will be archived:

This section is left blank on purpose.

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithim, emissions units of CO2 equ.):

This section is left blank on purpose.
D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

Section B.4.1 of the NMM “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” shows the data that is to be collected in the Insurgentes BRT corridor project in order to monitor the possible leakage effects of the project activity and how such data will be collected and archived. Data shall be securely archived for a minimum of 2 years after the end of the crediting period or receipt of last payment, whichever occurs last.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

The formulae and algorithms that estimate leakage in the Insurgentes BRT corridor project from each possible source of leakage are obtained from the baseline methodology (NMB) “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed”: see section H and Annexes.

Table 21 shows the sections where the information can be found in the NMB for the formulae used to monitor the leakage for each section/activity.
### Table 21 – Leakage formulae in the sections of the NMB

<table>
<thead>
<tr>
<th>Leakage</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>NMB Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smelting removed vehicles</td>
<td>Buses</td>
<td>H.1</td>
</tr>
<tr>
<td>2</td>
<td>Transferring buses from a different service or route</td>
<td>Buses</td>
<td>H.2</td>
</tr>
<tr>
<td>3</td>
<td>Displaced buses are not scrapped</td>
<td>Buses</td>
<td>H.3</td>
</tr>
<tr>
<td>4</td>
<td>Buses have to dead-head to reach route</td>
<td>Buses</td>
<td>H.4</td>
</tr>
<tr>
<td>5</td>
<td>Competing buses on alternative routes</td>
<td>Buses</td>
<td>H.5</td>
</tr>
<tr>
<td>6</td>
<td>Modal shift from buses to other modes</td>
<td>Buses, cars, taxis</td>
<td>H.6</td>
</tr>
<tr>
<td>7</td>
<td>Shift from transport outside the project boundary to the buses</td>
<td>Buses, cars, taxis</td>
<td>H.7</td>
</tr>
<tr>
<td>8</td>
<td>Additional delay to cross the route affects several blocks</td>
<td>All vehicles crossing the route</td>
<td>H.8</td>
</tr>
<tr>
<td>9</td>
<td>Vehicles change to alternative routes outside the project boundary</td>
<td>All vehicles on the route except buses</td>
<td>H.9</td>
</tr>
<tr>
<td>10</td>
<td>Feeder route improvements adversely affect crossing traffic</td>
<td>All vehicles crossing the feeder route</td>
<td>H.10</td>
</tr>
<tr>
<td>11</td>
<td>Vehicles that used routes outside the project boundary transfer to the main route</td>
<td>All vehicles on the route except buses</td>
<td>H.11</td>
</tr>
<tr>
<td>12</td>
<td>Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions</td>
<td>Buses</td>
<td>H.12</td>
</tr>
</tbody>
</table>

### D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

The formulae and algorithms that estimate emissions reductions in the Insurgentes BRT corridor project are obtained from the baseline methodology (NMB) “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” section I and Annexes.

Table 22 shows the sections where the information can be found in the NMB for the formulae used to determine the emissions reductions of each of these components for each section/activity. The column “C” refers to the project boundary definition shown in figure 3.
Table 22 – Emissions reductions formulae in the sections of the NMB

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>NMB Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on the route</td>
<td>Buses</td>
<td>[1]</td>
<td>I.1.1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>All vehicles except buses</td>
<td>[2]</td>
<td>I.1.2</td>
</tr>
<tr>
<td>3</td>
<td>Vehicles on feeder routes</td>
<td>Buses</td>
<td>[3]</td>
<td>I.1.3</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>All vehicles except buses</td>
<td>[4]</td>
<td>I.1.4</td>
</tr>
<tr>
<td>5</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction of emissions from private cars</td>
<td>[5]</td>
<td>I.1.5</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Increased bus service to cover extra demand</td>
<td></td>
<td>I.1.6</td>
</tr>
<tr>
<td>7</td>
<td>Elimination of Left Turns</td>
<td>All vehicles that have to go “round-the-block” to the right to make left turn</td>
<td>[6]</td>
<td>I.1.7</td>
</tr>
<tr>
<td>8</td>
<td>Elimination of Crossing Points</td>
<td>All vehicles that have to use a different crossing point</td>
<td>[7]</td>
<td>I.1.8</td>
</tr>
<tr>
<td>9</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles crossing the route</td>
<td>[8]</td>
<td>I.1.9</td>
</tr>
<tr>
<td>10</td>
<td>Traffic Delays due to construction activity</td>
<td>All vehicles on the route</td>
<td></td>
<td>I.1.10</td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to Construction</td>
<td></td>
<td></td>
<td>I.1.11</td>
</tr>
</tbody>
</table>

Notes: 1) Components 10 & 11 refer specifically to the Insurgentes corridor within the project boundary

D.2.4.1 Conversion of fuel consumed to CO2 equivalent

The emissions factors used based on lower heating values are from IPCC, 1996 adjusted for the heating values of specifically available local fuels following the procedures and references laid-out in the NMB section I.4.1.

The factors in table 23 are for the fuel available in Mexico City and have been developed from the above criterion taking into account the local lower heating values and any legal fuel blending requirements together with the local mix of engine types and the distribution of installed control technologies.

Table 18 – Emissions Factors for fuel in Mexico City

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Kg CO2/l</th>
<th>Kg CH4/l</th>
<th>Kg N2O/lt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>2.1796</td>
<td>6.29E-04</td>
<td>1.89E-05</td>
</tr>
<tr>
<td>Diesel</td>
<td>2.5648</td>
<td>1.73E-04</td>
<td>2.08E-05</td>
</tr>
<tr>
<td>CNG (gaseous)</td>
<td>0.0019</td>
<td>1.72E-06</td>
<td>3.44E-09</td>
</tr>
<tr>
<td>LPG (liquid)</td>
<td>1.4738</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalence to CO2 (100 year Global Warming Potential)</td>
<td>1</td>
<td>21</td>
<td>310</td>
</tr>
</tbody>
</table>

source SMA, 2005
D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

The application of quality auditing techniques at each stage of the process is integral to the monitoring methodology. The QA/QC procedures used must be specified in accordance with the monitoring techniques that have been selected for each variable.

Sections B.2.1, B.2.3 and B.4.1 of the monitoring methodology (NMM) “GhG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed” show the data that must be monitored for project-activities, baseline and possible leakages respectively as referenced in this PDD in sections D.2.1.1, D.2.1.3 and D.2.3.1.

Section B.7 of the monitoring methodology (NMM) shows the quality control (QC) and quality assurance (QA) procedures and level of uncertainty of the data for each of the items monitored in the above cited sections.

The specific QA/QC procedures on data collection activities and calculations for the Insurgentes BRT corridor project are to include:

Where the sample is obtained from a video of traffic flow.

i) The original video sequences are to be stored for a minimum of 2 years after completion of the CDM project activity timeframe on DVDs in a format that can be viewed on any commercial DVD player and television. Each DVD will be uniquely identified with reference to the sequences it contains. Each sequence will be labeled with a sequence number, location, date and time of the filming.

ii) Each traffic count or other information obtained from the filmed sequence will be registered together with the DVD and sequence identifiers and the time-marks between which the count was performed.

iii) All analyzed data will be stored in electronic form using commercially available software and formats.

iv) A representative sample of counts and subsequent calculations will be re-analyzed (audited) by QA/QC personnel and the results compared to the original samples. If differences are found, all intervening samples must be re-analyzed. All audits will be documented.

Where the sample or survey is performed directly in the field.

v) The original survey documents are to be stored for a minimum of 2 years after completion of the CDM project activity timeframe. Each document will state the date, time and location of the field-work and the interviewee’s ID.

vi) The field work will be performed by more than one interviewer. QA/QC audits will be performed analyzing the statistical differences in replies obtained by each interviewer. All such QA/QC audits will be documented. Significant unexplained differences will cause the field-work to be repeated.

vii) All analyzed data will be stored in electronic form using commercially available software and formats.
Where data is obtained from official or fleet sources or is obtained from corridor design documents and maps

viii) A copy of all source documents and references will be stored for a minimum of 2 years after completion of the CDM project activity timeframe.

ix) All analyzed data will be stored in electronic form using commercially available software and formats.

x) The analyzed data is to be checked for changes at each verification period. If intermediate data is available, this will be used as part of a QA/QC reality check on an audited sub-sample of data.

When calculations or analyses are performed on the data.

xi) If the calculations involve spreadsheets, databases and or other electronic means, a validation check will be performed by calculating one set of results by hand or using a separate methodology and comparing with the program results. This manual audit must be documented.

Measurement uncertainty calculations.

xii) Measurement uncertainty calculations will be performed on the data and parameters; both measured or derived via calculation. The uncertainty calculations will be adequately documented and stored together with their associated data.

Activity data check

xiii) The agency responsible for QA/QC should review the source of the activity data to ensure applicability and relevance to the project. Where possible, the agency should compare the data to historical activity data to look for anomalies. The QA/QC agency should ensure the reliability of activity data.

External review

xiv) The QA/QC agency should perform an independent, objective review of the calculations, assumptions, and documentation of the emissions calculations and results. A peer review should be performed by expert(s) who are familiar with the source category and who understand the data requirements and the evaluation of the associated measurement uncertainties.

Data storage

xv) The agency responsible for QA/QC will be responsible for reviewing the methods and procedures that have been established for safeguarding the data and calculations to ensure that they are securely and safely stored and protected from loss (tampering, corruption, force majeure, etc.).
D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The public organism, Metrobus, was created for the management, monitoring and planning of transport corridors within the Policy, Institutional and Regulatory Framework reform caused by the Transport Corridors Program. It is a decentralized public entity, with independent legal status and independent management, inside the secretary of Transport. It will manage the corridor operation and is responsible for monitoring its performance and assisting in the replication of the experience. It will be assisted by the Center for Sustainable Transport (an NGO).

Within its responsibilities, METROBUS has been directly assigned full responsibility for:

a) Monitoring the environmental and operational performance of the system.

b) All data collection activities including fleet and official records, surveys and independent studies required to maintain the databases and information needed to monitor the CDM activity\(^49\) in accordance with the procedures and requirements specified in the designated NMB and NMM and this present document.

c) All data analysis required as specified in the designated NMB and NMM documents.

d) Determining the measurement uncertainties associated with the data.

e) Establishing quality assurance and quality control (QA/QC) procedures to ensure the validity and representative nature of the data obtained and analyses as specified in the NMM.

f) Conducting and documenting all QA/QC activity in accordance with the established procedures.

g) Safely and securely storing all data and analysis results for a minimum period of 2 years after the CDM project activity ceases.

h) Performing the analyses required at each verification interval to satisfactorily demonstrate to the certification agency the CDM emissions reduction generated per year.

METROBUS will assign these responsibilities to functional areas within its structure. The area responsible for all QA/QC activities will report directly to the Managing Director.

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\(^{49}\) which includes project-activity, dynamic baseline activity and leakages.
D.5 Name of person/entity determining the monitoring methodology:

Metrobus, which is a project participant listed in Annex 1, is responsible for determining the monitoring methodology.

The baseline and monitoring methodologies were designed and developed by:

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John Rogers and Senes Consultants were working under contract with the World Bank, with the support and assistance of an extended team of people. John Rogers is the author of this present PDD and of the baseline and monitoring methodologies.
SECTION E.  Estimation of GHG emissions by sources

The crediting period selected for the project is 7 years renewable twice for a maximum of 21 years, beginning 22/8/2005. It is proposed that the GHG reduction be verified and certified in the first period in years 1, 4 and 7 and subsequently on a three-yearly basis.

The emissions totals of CO2 equivalent (CO2 eq) that will be reduced through this project in the first 7 year period will be of the order of 181,000 tons.

This section walks the reader through each step of the calculation process; discussing the sources of ex-post data and using ex-ante values to demonstrate the use of each formula.

Section E.1 discusses how the project activity is monitored and calculated in terms of fuel consumed, together with its associated uncertainties.

Section E.2 evaluates the possible sources of Leakage; its values and uncertainties.

Section E.4 looks at how the dynamic baseline is updated, monitored and calculated in terms of fuel consumed, (together with its associated uncertainties); and

Section E.5 generates the emissions reduction of the project activity in terms of tons of CO2 equiv per annum by taking into account the baseline, project-activity and leakage measurements in the previous sections.

E.1. Estimate of GHG emissions by sources:

The objective of this section is to demonstrate how the yearly fuel consumption in liters is calculated from each element of the project activity of the Insurgentes BRT corridor project by using the formulae contained in section G and annexes of the baseline methodology (NMB) "GHG emissions reductions in urban transportation projects that affect specific routes or bus corridors or fleets of buses including where fuel usage is changed"^50. 

In section E.5 the differences in project-activity fuel consumed and baseline fuel consumed are converted to CO2 equivalent emissions (in tons per year) following IPCC rules.

The calculations do not pretend to measure all the emissions in the project-activity scenario; they are designed to determine the real differences between the project activity (plus leakages) and the dynamic baseline^50.

All the figures presented in this section are ex-ante and for the whole corridor. When ex-post data is obtained and used to calculate verifiable emissions reductions, the corridor must be divided into sub-corridors of homogeneous traffic and the calculations performed on each one separately; and subsequently combined. When ex-post data is used, the standard deviations (SD) will be determined directly from the data obtained; following the procedures specified in section I.2 of the NMB, however with ex-ante data the SD have been determined from pre-measurements or estimations.

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^50 this important distinction is illustrated in the case of an emissions reduction that is generated by a reduction of idle time between the baseline and project-activity. Clearly the total project-activity journey time multiplied by idle fuel consumption bears no relationship to the amount of fuel really consumed by the vehicle; however the difference in the baseline and project-activity idle times multiplied by idle fuel consumption produces a significant result that can be converted to a GHG emissions change measured in tons of CO2 equiv per annum.
Table 24 indicates in which section of this document each project activity component can be found. The column “C” refers to the project boundary definition shown in figure 3.

Table 19 – Project Activity component index

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on each main route within the project boundary</td>
<td>Buses (fuel consumption measured directly)</td>
<td>[1]</td>
<td>E.1.1</td>
</tr>
<tr>
<td>2</td>
<td>(Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>All vehicles except buses (fuel consumption change determined from difference in travel time)</td>
<td>[2]</td>
<td>E.1.2</td>
</tr>
<tr>
<td>3</td>
<td>Vessels on feeder routes within the project boundary</td>
<td>Buses (fuel consumption measured as above)</td>
<td>[3]</td>
<td>E.1.1</td>
</tr>
<tr>
<td>4</td>
<td>(Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption measured as above)</td>
<td>[4]</td>
<td>E.1.2</td>
</tr>
<tr>
<td>5</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction in use of private cars</td>
<td>[5]</td>
<td>E.1.3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Increased bus service to cover extra demand</td>
<td></td>
<td>E.1.4</td>
</tr>
<tr>
<td>7</td>
<td>Elimination of left turns on main routes</td>
<td>All vehicles have to travel extra distance to go “round-the-block” to the right to make left turn</td>
<td>[6]</td>
<td>E.1.5</td>
</tr>
<tr>
<td>8</td>
<td>Elimination of crossing points on main routes</td>
<td>All vehicles travel extra distance to use a different crossing point</td>
<td>[7]</td>
<td>E.1.6</td>
</tr>
<tr>
<td>9</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles have increased travel time due to crossing the routes</td>
<td>[8]</td>
<td>E.1.7</td>
</tr>
<tr>
<td>10</td>
<td>Traffic delays due to construction activity</td>
<td>All vehicles on the routes have increased travel time due to additional congestion</td>
<td></td>
<td>E.1.8</td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to construction activity plus upstream construction material emissions</td>
<td></td>
<td></td>
<td>E.1.9</td>
</tr>
</tbody>
</table>

Notes: 1) Components 10 & 11 refer specifically to the main route or corridor within the project boundary.

Each project activity variable has an associated measurement uncertainty; these are evaluated as shown in section I.2 of the NMB and the expanded uncertainty for the project activity is determined. Section I.1 of the NMB explains the formulae/algorithms used to combine the project activity formulae (in this section E.1) with the dynamic baseline formulae in E.4 and leakage formulae in E.2 to determine the emissions reduction accruing from the project.
E.1.1 Project activity components 1 & 3

Operating condition improvements and/or the substitution of the number and technology of buses that operate on the main route or BRT corridor (Component 1) or any feeder route (Component 3)

This procedure is used to define the project activity fuel consumption from bus services on the route or BRT corridor or on any feeder route where bus operation is created or substantially modified by the project design. In the case of the Insurgentes BRT corridor project, no feeder routes are currently considered thus the component 3 can be ignored until such time that feeder routes are incorporated.

For the fleets of buses that operate regular services on the Insurgentes route, the number of vehicles, their per-unit annual kilometers and fuel economy are determined from fleet records every verification period and used to calculate their yearly fuel consumption.

The fuel consumed by these project-activity bus services is given by equation (9) in the NMB:

\[ \text{NNVA}_n \times \text{AKTN}_n / \text{FEN}_n \]

Equation 9 generates an ex-ante yearly consumption of 4,073,917 liters of diesel with a standard error of 98,188 liters.

The source of data for each term in equation 9 is discussed below:

\text{NNVA}_n \ - \ number of new vehicles added to service in year “n” (used in equation 9)

The Insurgentes BRT corridor project will introduce 80 high-capacity, modern-technology, diesel-fuelled buses. However not all will be put into simultaneous service; METROBUS proposes using 70 on weekdays, 39 on Saturdays and 24 on Sundays and holidays. For the calculations, 70 units will be used and a weighed ex-ante average daily km calculated (see table 25). The Standard Deviation associated with the number of vehicles in service is estimated to be 1.

Ex-post data will be obtained from fleet records and the SD will be determined from the data that is collected.

\text{AKTN}_n \ - \ annual kilometers traveled by new vehicles in year “n” (used in equation 9)

The weighted ex-ante average km in service for buses on the Insurgentes BRT corridor per day based on 70 buses and according to METROBUS is as shown in table 25. The annual

---

51 see G.1 in the NMB for the formulae used.

52 If buses were transferred that were previously in service on a different route outside the project boundary (see leakage 2) then equation 25 should be used in place of equation 9. If Buses have to dead-head to reach their route (see leakage 4) then these additional kilometers must be included in AKTN.
kilometers traveled per bus are $243 \times 365 = 88,595$ km. The Standard Deviation associated with the daily km per vehicle is estimated to be 1.

Ex-post data will be obtained from fleet records and the SD will be determined from the data that is collected.

Table 20 – Weighted number of buses and daily km

<table>
<thead>
<tr>
<th>Units in service</th>
<th>Total km on route per day</th>
<th>Total Dead-head km / day (empty)</th>
<th>Total km</th>
<th>Km per unit / day</th>
<th>Days per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>70</td>
<td>18923</td>
<td>1167</td>
<td>20090</td>
<td>287</td>
</tr>
<tr>
<td>Saturday</td>
<td>39</td>
<td>11261</td>
<td>829</td>
<td>12090</td>
<td>310</td>
</tr>
<tr>
<td>Sunday + holidays</td>
<td>24</td>
<td>7450</td>
<td>192</td>
<td>7642</td>
<td>318</td>
</tr>
<tr>
<td>Buses added</td>
<td>70</td>
<td>weighted Average</td>
<td>243.0</td>
<td></td>
<td>365</td>
</tr>
</tbody>
</table>

Please note that the dead-head km form part of Leakage 4 which is to be found in section E.2.

\[ FEN_n \] - fuel efficiency of new vehicles in year “n” (used in equation 9)

The ex-ante fuel efficiency of the new vehicles was measured by WVU\(^{53}\) under different drive cycles and reported by Senes Consultants. The average fuel economy of the Scania articulated, new-technology buses on the 3 cycles used was 1.524 km/l with a SD of 0.252.

Ex-post data will be obtained from fleet records and the SD will be determined from the data that is collected.

E.1.2 Project activity components 2 & 4

*Improving the operating conditions for all vehicles on the main route*\(^{54}\) (Component 2) or any feeder route (Component 4)

In the case of the Insurgentes BRT corridor project, no feeder routes are currently considered thus the component 4 can be ignored until such time that feeder routes are incorporated.

The total number of vehicles using the Insurgentes BRT corridor in the with-project scenario in future years (PTTC\(_n\)) can be directly measured. This number however consists of 2 distinct groups of vehicles:

1. The natural project-activity traffic flow (POTC\(_n\))

\(^{53}\) West Virginia University under Component 3 of the Insurgentes BRT corridor project

\(^{54}\) apart from buses which are included in E.1.1
The rebound effect of vehicles that would otherwise have used a different avenue and now use that route. (A basic assumption is that the project-activity will not cause new trip creation for private cars).

For these vehicles that run on the Insurgentes BRT corridor the measurement proposal needed to define the project activity fuel consumption is given by equation (10) in the NMB.

\[ AKTC_n \times POTC_n \times \frac{WTTC_n}{60} \times VFC_n \]

Equation 10 generates an ex-ante yearly consumption of:
- 7,873 liters of diesel with a standard error of 5,118,918 liters,
- 69,662,325 liters of gasoline with a standard error of 12,513,280 liters;
- 1,201,615 liters of LPG with a standard error of 4,444,608 liters and
- 186,824 liters of CNG with a standard error of 4,439,711 liters.

The source of data for each term in equation 10 is discussed below:

**AKTC** \(_n\) - kilometers traveled per vehicle on the route per year in year “n” (used in equation 10)
This is dependant on the project design. With ex-post data, the Insurgentes BRT corridor will be divided into sections, in both directions, such that the traffic flow and pattern within each section is consistent and homogeneous.

The sum of the lengths of each section must match the overall length of the corridor which is 19.3 km according to the design documents and communicated by the SMA. This figure is used for the ex-ante calculation.

The kilometers traveled per vehicle per year is equal to the length of each section of the route (kilometers) multiplied by the number of travel days in a year which is taken to be 365. For the ex-ante calculation, a SD associated with the daily km per vehicle is estimated to be 6 and for the number of days per year a SD of 1 is assumed.

Ex-post data for the length of each section of the corridor will be verified at each verification period.

**WTTC** \(_n\) - with-project travel time on route in minutes per kilometer in year “n” (used in equation 10)

The ex-post with-project travel time on the Insurgentes BRT corridor will be directly measured at each verification period by using a Moving Car Observer survey. The ex-ante

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55 the equation numbering conforms to the NMB numbering sequence for ease of reference
56 it is important to note that the emissions reduction calculated in E.5.1 between the baseline and project activity is determined from a measured difference in travel time, not from subtracting the fuel consumed in the project activity from the baseline fuel consumed. This radically changes the standard error calculation.
57 Secretaría del Medio Ambiente del Distrito Federal
value prepared by Senes Consultants is 2.245 min/km. A SD of 0.36 was determined by Senes Consultants based on pre-measurements.

POTC\textsubscript{n} - number of vehicles due to natural project-activity traffic flow in year “n” (used in equation 10)

The natural project-activity traffic flow in year “n” is given by equation (11) in the NMB:

$$\text{POTC}_n = \text{NOTC}_n - \frac{\text{NPSV}_n}{\text{APPV}_n}$$

This generates an ex-ante natural project-activity traffic flow per day for year 1 (POTC\textsubscript{1}) as shown in table 29.

where

\text{NOTC}_n = the baseline number of vehicles using the route in year “n” (used in equation 11)

is determined from equation (4) of the NMB. The ex-ante value for Year 1 (NOTC\textsubscript{1}) as calculated using this equation is shown in table 28.

$$\text{NOTC}_n = \text{NOTC}_0 \times \frac{\text{PL}_n}{\text{PL}_0}$$

Senes Consultants determined the ex-ante SD for Motorcycles and Cars to be 4000, for Taxis, 200 and for LD & HD commercial to be 1000.

The ex-post values of NOTC\textsubscript{n} will be determined from measured values of NOTC\textsubscript{0}, PL\textsubscript{0} and PL\textsubscript{n}.

The source of data for each term in equation 4 is discussed below:

\text{NOTC}_0 = the number of vehicles measured before project startup (used in equation 4)

The ex-ante value for NOTC\textsubscript{0} from METROBUS prior to project activity (Year 0) is shown in table 26; ex-post values will be measured.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-cycles</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cars</td>
<td>62616</td>
<td></td>
<td></td>
<td></td>
<td>62616</td>
</tr>
<tr>
<td>Taxis</td>
<td>11226</td>
<td></td>
<td></td>
<td></td>
<td>11226</td>
</tr>
<tr>
<td>LD Commercial</td>
<td>1274</td>
<td>4</td>
<td>537</td>
<td>84</td>
<td>1899</td>
</tr>
<tr>
<td>HD Commercial</td>
<td>227</td>
<td>1</td>
<td>96</td>
<td>15</td>
<td>338</td>
</tr>
<tr>
<td>Total</td>
<td>75343</td>
<td>4</td>
<td>633</td>
<td>98</td>
<td>76079</td>
</tr>
</tbody>
</table>

\text{PL}_0 = urban population of that category of vehicle before project start-up (used in equation 4)
Table 27 shows the ex-ante value of the number of each category of vehicle prior to project startup and their estimated per vehicle daily km. The vehicle numbers shown are from the obligatory emissions test programs in the MCMA\textsuperscript{58} in 2004 and their average daily km were determined in 2004 from a field survey performed by Senes Consultants.

At the end of 2006, ex-post calculations should use January 2006 data from the obligatory emissions test programs in the MCMA for both the number of vehicles and their average daily km.

<table>
<thead>
<tr>
<th>Vehicle Category</th>
<th>Number</th>
<th>km/day</th>
<th>VKT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td>115,858</td>
<td>79</td>
<td>9,152,782</td>
</tr>
<tr>
<td>Private cars</td>
<td>2,909,146</td>
<td>36</td>
<td>174,548,760</td>
</tr>
<tr>
<td>Taxis</td>
<td>118,634</td>
<td>132</td>
<td>15,659,688</td>
</tr>
<tr>
<td>Pick Up</td>
<td>124,637</td>
<td>65</td>
<td>8,101,405</td>
</tr>
<tr>
<td>L.D. Commercial</td>
<td>187,117</td>
<td>62</td>
<td>11,601,254</td>
</tr>
<tr>
<td>H.D. Commercial</td>
<td>133,301</td>
<td>47</td>
<td>6,265,147</td>
</tr>
<tr>
<td>Combis</td>
<td>19,485</td>
<td>237</td>
<td>4,617,945</td>
</tr>
<tr>
<td>Microbuses</td>
<td>29,973</td>
<td>123</td>
<td>3,686,679</td>
</tr>
<tr>
<td>Autobuses</td>
<td>32,073</td>
<td>132</td>
<td>4,233,636</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3,670,224</strong></td>
<td><strong>237,867,296</strong></td>
<td></td>
</tr>
</tbody>
</table>

\[PL_n = \text{urban population of that category of vehicle in year “n” (used in equation 4)}\]

At each verification period, the ex-post calculations should use the most current data from the obligatory emissions test programs in the MCMA for both the number of vehicles and their average daily km as in table 27.

To demonstrate the use of equation 4, an ex-ante value of a 6% growth in number of vehicles and 0% growth in daily km will be used for all vehicle categories.

Thus the ex-ante values from METROBUS for NOTC\textsubscript{0} after one year of project activity (NOTC\textsubscript{1} in Year 1) would be that shown in table 28.

\textsuperscript{58} Mexico City Federal District and surrounding municipalities in the State of Mexico
Table 28 - ex-ante values for NOTC$_1$ in Year 1

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-cycles</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cars</td>
<td>66373</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>66373</td>
</tr>
<tr>
<td>Taxis</td>
<td>11900</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11900</td>
</tr>
<tr>
<td>LD Commercial</td>
<td>1350</td>
<td>4</td>
<td>569</td>
<td>89</td>
<td>2012</td>
</tr>
<tr>
<td>HD Commercial</td>
<td>241</td>
<td>1</td>
<td>102</td>
<td>16</td>
<td>360</td>
</tr>
<tr>
<td>Total</td>
<td>79864</td>
<td>5</td>
<td>671</td>
<td>105</td>
<td>80645</td>
</tr>
</tbody>
</table>

The source of data for the other terms in equation 11 is discussed below:

**APPV$_n$** = average number of people per private vehicle in year “n” in the project activity (used in equation 11)

Determined from the on-board rider-ship survey of passengers on the new buses in future years at each verification period (where hired drivers are discounted) will allow the ex-post number to be determined. The ex-ante value of 1.5 persons per private vehicle as determined by Senes Consultants is used in these calculations.

**NPSV$_n$** = number of people shifting from private vehicles to mass-transit in year “n” in the project activity (used in equation 11)

At each verification period, an on-board survey on the BRT buses combined with ticketing information from the fleet will allow the ex-post number of people shifting from private vehicles to mass-transit to be determined.

The annualized number of passengers on the new buses is given by PKD (used in equation 14) which will be determined from fleet records (ticketing information and passes for non-fare-paying passengers) at each verification period. The ex-ante value prepared by METROBUS is 250,900 passengers per day generating approximately 73 million passenger-trips per year.

The ex-post modal shift percentage from cars will be determined from the on-board rider-ship survey of passengers on the new buses on the Insurgentes BRT corridor in future years. The ex-ante value prepared by Senes Consultants is equivalent to 1% of private cars. Thus the ex-ante value of the number of people shifting from private vehicles to mass-transit in Year 1 (NPSV$_1$) is 66373 x 1.5 x 0.01 = 996 persons. (approximately 270,000 passenger-trips annually). A SD of 285 (on daily trips) was estimated by Senes Consultants based on pre-measurements.

Thus the ex-ante value for POTC$_1$ is as shown in table 29.
Table 29 - ex-ante values for POTC_{1} in Year 1

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-cycles</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cars</td>
<td>66373</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>65709</td>
</tr>
<tr>
<td>Taxis</td>
<td>11900</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11900</td>
</tr>
<tr>
<td>LD Commercial</td>
<td>1350</td>
<td>4</td>
<td>569</td>
<td>89</td>
<td>2012</td>
</tr>
<tr>
<td>HD Commercial</td>
<td>241</td>
<td>1</td>
<td>102</td>
<td>16</td>
<td>360</td>
</tr>
<tr>
<td>Total</td>
<td>79864</td>
<td>5</td>
<td>671</td>
<td>105</td>
<td>79981</td>
</tr>
</tbody>
</table>

VFC_{n} - fuel efficiency of vehicles (liters/hour) in year “n” (used in equation 10)

The project-activity fuel consumption for these vehicles will be calculated as follows:\(^{59}\):

The MOBILE6 emissions factor model that is often used for emissions inventories contains a file “MPG.csv” that allows the user to provide their own vehicle fuel economy performance estimates by vehicle class and model year or to use the default values. For each of 28 vehicle classes, the file specifies the fuel economy performance in MPG\(^{60}\) for model years 1952 thru 2050. Table 30 shows the Vehicle classifications and how each is reclassified, within the context of the MCMA.

Table 30 - Complete MOBILE6 Vehicle Classifications\(^{61}\)

<table>
<thead>
<tr>
<th>Class</th>
<th>MCMA Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cars + Taxis</td>
<td>Light-Duty Gasoline Vehicles (Passenger Cars)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>LD Commercial</td>
<td>Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>LD Commercial</td>
<td>Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>LD Commercial</td>
<td>Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>LD Commercial</td>
<td>Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>LD Commercial</td>
<td>Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>HD Commercial</td>
<td>Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>HD Commercial</td>
<td>Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)</td>
</tr>
<tr>
<td></td>
<td>Gasoline &amp; Gas</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>HD Commercial</td>
<td>Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)</td>
</tr>
</tbody>
</table>

\(^{59}\) the complete procedure is shown in NMB section F.3.1 and Annex 2 “Determining the fuel consumption”.

\(^{60}\) miles per gallon

\(^{61}\) colors show grouping
<table>
<thead>
<tr>
<th>Class</th>
<th>MCMA Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>HD Commercial Gasoline &amp; Gas</td>
<td>Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)</td>
</tr>
<tr>
<td>11</td>
<td>HD Commercial Gasoline &amp; Gas</td>
<td>Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)</td>
</tr>
<tr>
<td>12</td>
<td>HD Commercial Gasoline &amp; Gas</td>
<td>Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)</td>
</tr>
<tr>
<td>13</td>
<td>HD Commercial Gasoline &amp; Gas</td>
<td>Class 8b Heavy-Duty Gasoline Vehicles (&gt;60,000 lbs. GVWR)</td>
</tr>
<tr>
<td>14</td>
<td>Cars &amp; Taxis Diesel</td>
<td>Light-Duty Diesel Vehicles (Passenger Cars)</td>
</tr>
<tr>
<td>15</td>
<td>LD Commercial Diesel</td>
<td>Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)</td>
</tr>
<tr>
<td>16</td>
<td>LD Commercial Diesel</td>
<td>Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)</td>
</tr>
<tr>
<td>17</td>
<td>HD Commercial Diesel</td>
<td>Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)</td>
</tr>
<tr>
<td>18</td>
<td>HD Commercial Diesel</td>
<td>Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)</td>
</tr>
<tr>
<td>19</td>
<td>HD Commercial Diesel</td>
<td>Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)</td>
</tr>
<tr>
<td>20</td>
<td>HD Commercial Diesel</td>
<td>Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)</td>
</tr>
<tr>
<td>21</td>
<td>HD Commercial Diesel</td>
<td>Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)</td>
</tr>
<tr>
<td>22</td>
<td>HD Commercial Diesel</td>
<td>Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)</td>
</tr>
<tr>
<td>23</td>
<td>HD Commercial Diesel</td>
<td>Class 8b Heavy-Duty Diesel Vehicles (&gt;60,000 lbs. GVWR)</td>
</tr>
<tr>
<td>24</td>
<td>Motorcycles</td>
<td>Motorcycles (Gasoline)</td>
</tr>
<tr>
<td>25</td>
<td>LD Commercial Gasoline &amp; Gas</td>
<td>Gasoline Buses (School, Transit and Urban)</td>
</tr>
<tr>
<td>26</td>
<td>HD Commercial Diesel</td>
<td>Diesel Transit and Urban Buses</td>
</tr>
<tr>
<td>27</td>
<td>HD Commercial Diesel</td>
<td>Diesel School Buses</td>
</tr>
<tr>
<td>28</td>
<td>LD Commercial Diesel</td>
<td>Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)</td>
</tr>
</tbody>
</table>

This data is corrected and updated for model- and model-year-mix and vehicle kilometers traveled (VKT\(^{62}\)) within the MCMA from the obligatory vehicle emissions verification program database.

To improve readability, the following tables will show only a partial dataset (consisting of gasoline cars & taxis from 1975 to 2004), however the full vehicle class and model-year mix\(^{63}\) should be used in the calculations. If the EMFAC2000 or COPERT III methods are

---

\(^{62}\) The VKT adjustment is necessary because recent model year vehicles tend to have higher annual mileages than older vehicles and some vehicles (like taxis) have substantially higher usage than the rest of the vehicle population

\(^{63}\) consisting of the 28 classes from 1952 to date
used, the technology of each class and model-year of vehicles must also be identified\(^{64}\). An example for EMFAC2000 is shown ex-ante in table 31.

Table 31 – partial ex-ante model-year table for Class 1 (cars & taxis)

<table>
<thead>
<tr>
<th>Model-year</th>
<th>MPG</th>
<th>Km/l</th>
<th>Technology(^{65})</th>
<th>Population</th>
<th>km/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>13.4</td>
<td>5.7</td>
<td>1</td>
<td>12106</td>
<td>20</td>
</tr>
<tr>
<td>1976</td>
<td>14.8</td>
<td>6.3</td>
<td>1</td>
<td>12633</td>
<td>20</td>
</tr>
<tr>
<td>1977</td>
<td>15.5</td>
<td>6.6</td>
<td>1</td>
<td>13159</td>
<td>20</td>
</tr>
<tr>
<td>1978</td>
<td>16.8</td>
<td>7.1</td>
<td>1</td>
<td>13685</td>
<td>20</td>
</tr>
<tr>
<td>1979</td>
<td>17.1</td>
<td>7.3</td>
<td>1</td>
<td>14212</td>
<td>20</td>
</tr>
<tr>
<td>1980</td>
<td>19.8</td>
<td>8.4</td>
<td>1</td>
<td>245036</td>
<td>20</td>
</tr>
<tr>
<td>1981</td>
<td>21.2</td>
<td>9.0</td>
<td>1</td>
<td>52745</td>
<td>20</td>
</tr>
<tr>
<td>1982</td>
<td>22.0</td>
<td>9.4</td>
<td>1</td>
<td>52557</td>
<td>20</td>
</tr>
<tr>
<td>1983</td>
<td>21.9</td>
<td>9.3</td>
<td>1</td>
<td>30907</td>
<td>20</td>
</tr>
<tr>
<td>1984</td>
<td>22.2</td>
<td>9.4</td>
<td>1</td>
<td>37853</td>
<td>20</td>
</tr>
<tr>
<td>1985</td>
<td>22.9</td>
<td>9.7</td>
<td>1</td>
<td>47117</td>
<td>20</td>
</tr>
<tr>
<td>1986</td>
<td>23.7</td>
<td>10.1</td>
<td>1</td>
<td>44676</td>
<td>20</td>
</tr>
<tr>
<td>1987</td>
<td>23.8</td>
<td>10.1</td>
<td>1</td>
<td>33441</td>
<td>25</td>
</tr>
<tr>
<td>1988</td>
<td>24.3</td>
<td>10.3</td>
<td>1</td>
<td>48491</td>
<td>25</td>
</tr>
<tr>
<td>1989</td>
<td>23.9</td>
<td>10.2</td>
<td>1</td>
<td>70230</td>
<td>25</td>
</tr>
<tr>
<td>1990</td>
<td>23.6</td>
<td>10.0</td>
<td>1</td>
<td>89539</td>
<td>25</td>
</tr>
<tr>
<td>1991</td>
<td>23.8</td>
<td>10.1</td>
<td>2</td>
<td>102757</td>
<td>25</td>
</tr>
<tr>
<td>1992</td>
<td>23.5</td>
<td>10.0</td>
<td>2</td>
<td>112666</td>
<td>25</td>
</tr>
<tr>
<td>1993</td>
<td>24.0</td>
<td>10.2</td>
<td>3</td>
<td>111876</td>
<td>40</td>
</tr>
<tr>
<td>1994</td>
<td>23.9</td>
<td>10.2</td>
<td>3</td>
<td>109309</td>
<td>40</td>
</tr>
<tr>
<td>1995</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>68432</td>
<td>40</td>
</tr>
<tr>
<td>1996</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>47865</td>
<td>40</td>
</tr>
<tr>
<td>1997</td>
<td>24.2</td>
<td>10.3</td>
<td>3</td>
<td>90581</td>
<td>40</td>
</tr>
<tr>
<td>1998</td>
<td>24.3</td>
<td>10.3</td>
<td>3</td>
<td>162900</td>
<td>40</td>
</tr>
<tr>
<td>1999</td>
<td>24.0</td>
<td>10.2</td>
<td>3</td>
<td>146270</td>
<td>40</td>
</tr>
<tr>
<td>2000</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>195234</td>
<td>40</td>
</tr>
<tr>
<td>2001</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>244357</td>
<td>40</td>
</tr>
<tr>
<td>2002</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>238210</td>
<td>40</td>
</tr>
<tr>
<td>2003</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>276229</td>
<td>40</td>
</tr>
<tr>
<td>2004</td>
<td>24.1</td>
<td>10.2</td>
<td>3</td>
<td>175056</td>
<td>40</td>
</tr>
</tbody>
</table>

The ex-post data is also corrected at each verification period by calibration factors derived from field-testing a representative sample of vehicles via driver logs in which fuel

\(^{64}\) an analysis of the difference in results between the three methods can be found in Annex 5.7.

\(^{65}\) 1=carbureted, 2= throttle body fuel injection and oxidation catalyst, 3= multipoint fuel injection and 3-way cat.
consumed and kilometers operated are recorded for a group of vehicles that often use the route on a day-to-day basis\textsuperscript{66}. This is performed separately for each class of vehicle.

In this example the EMFAC2000 method is used to calibrate the fuel economy data in table 31\textsuperscript{67}.

The formula A-1 of the NMB-Annex 2 is used to calculate the forecast fuel economy for each sampled vehicle at its measured average speed.

The average of the percentile differences between the measured fuel economy and the forecast fuel economy for each vehicle in this representative sample is used to correct the fuel economy figures illustrated in table 31.

The resultant factor is used to adjust the table 31 data to the Insurgentes BRT corridor project operating conditions. In this limited example, table 32 shows that the forecast fuel economy should be divided by 0.689\textsuperscript{68} to adjust to local conditions. The standard deviation of this calculation is 0.467. Increasing the sample size and the use of an initially-better-calibrated MPG file will reduce the standard deviation.

Table 32 – Field-survey vehicles used to calibrate fuel economy tables

<table>
<thead>
<tr>
<th>Vehicle Model</th>
<th>Model-year</th>
<th>Average trip speed (km/h)</th>
<th>Measured Fuel Economy (km/l)</th>
<th>Forecast Fuel Economy (km/l)</th>
<th>Dif (%) Measured to Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEVY, GMC 2000</td>
<td>2000</td>
<td>21.87</td>
<td>6.54</td>
<td>6.17</td>
<td>5.9%</td>
</tr>
<tr>
<td>CHEVY POP 1999</td>
<td>1999</td>
<td>20.41</td>
<td>5.80</td>
<td>5.89</td>
<td>-1.4%</td>
</tr>
<tr>
<td>VW SEDAN 1996</td>
<td>1996</td>
<td>18.24</td>
<td>7.65</td>
<td>5.53</td>
<td>38.4%</td>
</tr>
<tr>
<td>CIRRUS, CHRYSLER 1997</td>
<td>1997</td>
<td>26.31</td>
<td>3.64</td>
<td>7.02</td>
<td>-48.1%</td>
</tr>
<tr>
<td>ASTRA, GMC 2001</td>
<td>2001</td>
<td>23.2</td>
<td>11.99</td>
<td>6.41</td>
<td>87.0%</td>
</tr>
<tr>
<td>CAVALIER, GMC 2000</td>
<td>2000</td>
<td>22.85</td>
<td>9.70</td>
<td>6.35</td>
<td>52.8%</td>
</tr>
<tr>
<td>RENAUL CLIO 2002</td>
<td>2002</td>
<td>19.45</td>
<td>5.42</td>
<td>5.74</td>
<td>-5.6%</td>
</tr>
<tr>
<td>CORDOBA, SEAT 2003</td>
<td>2003</td>
<td>23.45</td>
<td>12.41</td>
<td>6.46</td>
<td>92.2%</td>
</tr>
<tr>
<td>ALMERA, NISSAN 2002</td>
<td>2002</td>
<td>29.86</td>
<td>12.16</td>
<td>7.65</td>
<td>58.9%</td>
</tr>
</tbody>
</table>

Average difference (%) 31.1%

Standard Deviation 0.467

\textsuperscript{66} See Annex 5.3 Initial Field Calibration Data of Fuel Consumption by Vehicle Type for an example of the data used

\textsuperscript{67} see NMB section F.3.1 and NMB Annex 2 “Determining the fuel consumption” for details of the procedure and other techniques that can be used for calculating the speed sensitive fuel consumption.

\textsuperscript{68} (1 – 0.311) = 0.689. This calibration factor is high because the default sea-level file “MPG.csv” is being used in this example as a basis for Mexico City high-altitude fuel consumptions.
Table 33 shows the partial model-year table for Class 1 (cars & taxis) calibrated data set that is obtained by applying this calibration factor.

Table 33 – Calibrated fuel economy data for partial model-year table for Class 1 (cars & taxis)

<table>
<thead>
<tr>
<th>Model-year</th>
<th>km/l</th>
<th>Technology</th>
<th>Population</th>
<th>km/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>8.3</td>
<td>1</td>
<td>12106</td>
<td>20</td>
</tr>
<tr>
<td>1976</td>
<td>9.1</td>
<td>1</td>
<td>12633</td>
<td>20</td>
</tr>
<tr>
<td>1977</td>
<td>9.6</td>
<td>1</td>
<td>13159</td>
<td>20</td>
</tr>
<tr>
<td>1978</td>
<td>10.4</td>
<td>1</td>
<td>13685</td>
<td>20</td>
</tr>
<tr>
<td>1979</td>
<td>10.6</td>
<td>1</td>
<td>14212</td>
<td>20</td>
</tr>
<tr>
<td>1980</td>
<td>12.2</td>
<td>1</td>
<td>245036</td>
<td>20</td>
</tr>
<tr>
<td>1981</td>
<td>13.1</td>
<td>1</td>
<td>52745</td>
<td>20</td>
</tr>
<tr>
<td>1982</td>
<td>13.6</td>
<td>1</td>
<td>52557</td>
<td>20</td>
</tr>
<tr>
<td>1983</td>
<td>13.5</td>
<td>1</td>
<td>30907</td>
<td>20</td>
</tr>
<tr>
<td>1984</td>
<td>13.7</td>
<td>1</td>
<td>37853</td>
<td>20</td>
</tr>
<tr>
<td>1985</td>
<td>14.1</td>
<td>1</td>
<td>47117</td>
<td>20</td>
</tr>
<tr>
<td>1986</td>
<td>14.6</td>
<td>1</td>
<td>44676</td>
<td>20</td>
</tr>
<tr>
<td>1987</td>
<td>14.7</td>
<td>1</td>
<td>33441</td>
<td>25</td>
</tr>
<tr>
<td>1988</td>
<td>15.0</td>
<td>1</td>
<td>48491</td>
<td>25</td>
</tr>
<tr>
<td>1989</td>
<td>14.7</td>
<td>1</td>
<td>70230</td>
<td>25</td>
</tr>
<tr>
<td>1990</td>
<td>14.6</td>
<td>1</td>
<td>89539</td>
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<td>1991</td>
<td>14.7</td>
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<td>1992</td>
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<tr>
<td>1993</td>
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<td>1995</td>
<td>14.9</td>
<td>3</td>
<td>68432</td>
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</tr>
<tr>
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<td>14.9</td>
<td>3</td>
<td>47865</td>
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<tr>
<td>1997</td>
<td>14.9</td>
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<tr>
<td>1998</td>
<td>15.0</td>
<td>3</td>
<td>162900</td>
<td>36</td>
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<tr>
<td>1999</td>
<td>14.8</td>
<td>3</td>
<td>146270</td>
<td>36</td>
</tr>
<tr>
<td>2000</td>
<td>14.9</td>
<td>3</td>
<td>195234</td>
<td>36</td>
</tr>
<tr>
<td>2001</td>
<td>14.9</td>
<td>3</td>
<td>244357</td>
<td>36</td>
</tr>
<tr>
<td>2002</td>
<td>14.9</td>
<td>3</td>
<td>238210</td>
<td>36</td>
</tr>
<tr>
<td>2003</td>
<td>14.9</td>
<td>3</td>
<td>276229</td>
<td>36</td>
</tr>
<tr>
<td>2004</td>
<td>14.9</td>
<td>3</td>
<td>175056</td>
<td>36</td>
</tr>
</tbody>
</table>

This calibrated data set is then used as the baseline fuel consumption to which the speed-sensitive correction factors calculated in equation A-1 of Annex 2 of the NMB are applied.

The calculation is performed separately for each class of vehicle by applying the calculation to each model year according to its technology level, its relative participation in the total population of vehicles and its average kilometers per day.
Figure 4 shows the ex-ante speed-sensitive fuel-economy correction factors (CCF) which are to be used for comparing fuel consumption differences over relatively small speed-difference ranges.

Using these curves, VFC, the fuel efficiency of vehicles is determined under two different conditions:

i. **Free-flow Traffic**

In un-congested traffic conditions the CCFs are used to determine the difference in fuel consumption (km/l) at different speeds, which is applied to the difference in average speed of the vehicles over the route.

An ex-ante journey time of 2.245 min/km is an average speed of 26.72 km/hr (16.60 mph). At this speed, equation A-1 generates correction factors (CCF) as follows:

- Carbureted without converter \( \text{CCF} = 1.336 \)
- Throttle-body with an oxidation catalyst \( \text{CCF} = 1.361 \)
- Fuel Injection with 3-way catalytic converter \( \text{CCF} = 1.416 \)

The fleet average fuel economy for each vehicle class is calculated from:

\[
\text{Total daily fuel consumed} / \text{Total daily km traveled}
\]

**Where:**

\[69\] WTTC is directly measured with a Moving Car Observer survey at each verification period.
**Total daily fuel consumed**

\[ = \text{sum of fuel consumed per day per model year at that average speed (population x km/day ÷ km/l x CCF)}^{70}\]

**Total daily km traveled**

\[ = \text{sum of km traveled daily per model year according to official emissions verification database analysis. (population x km/day)}\]

This procedure generates the ex-ante weighed average fuel economy for cars to be 6.402 km/l.

**ii. Congested Traffic**

In congested traffic conditions the difference between the with-project travel time (see WTTC above) and the baseline travel time (in min/km) is used with the idle fuel consumption\(^{71}\) (liters/hour) to determine the difference in fuel consumed using the same procedure.

The project activity element of this difference for the Insurgentes BRT corridor considering the ex-ante value of 2.245 min/km for cars is 3.162 l/hr.

The ex-ante value of the vehicle-weighed percentage of travel under congested traffic conditions is 60% and the percentage of travel under un-congested, free-flow traffic conditions is 40%. The ex-post value will be determined from the traffic flow rate measurements at each verification period.

**Rebound effects in project-activity traffic flow**

The total number of vehicles using the Insurgentes corridor in the with-project scenario in future years (PTTC\(_n\)) can be directly measured by counting vehicles per hour from a video of the traffic over a statistically significant number of days to determine the average daily and annual vehicle flow.

The rebound effect of vehicles that would otherwise have used a different avenue and now use the route will be the difference between this measured number and the calculated number of vehicles due to natural project-activity traffic flow as given by equation (12) in the NMB.

Any increase in project-activity traffic flow on the route due to rebound will increase the project activity emissions. The impact in fuel consumption on the route of the rebound effect of vehicles that would otherwise have used a different avenue and now use the route (or vice-a-versa) is given by:

\[ AKTC_n * (PTTC_n – POTC_n) * [WTTC_n/60] * VFC_n \]

Equation 12 generates an ex-ante yearly consumption increase of:

- 394 liters of diesel,
- 348,312 liters of gasoline,
- 60,081 liters of LPG
- 9,341 liters of CNG.

---

\(^{70}\) according to the technology of vehicles in each model-year

\(^{71}\) calculated at a speed of 2.5 mph
The source of data for the remaining term\textsuperscript{72} in equation 12 is discussed below:

\[ PTTC_n = \text{measured number of total vehicles using the route per year in year “n”} \]

The ex-post measured number of vehicles using the Insurgentes BRT corridor will be directly measured at each verification period. Ex-ante value for year 1 is a 5% increase over POTC for all vehicle categories. Table 34 shows the ex-ante figures for PTTC\textsubscript{1}.

The SD associated with each figure is assumed to be (ex-ante) the same as POTC.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-cycles</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cars</td>
<td>69692</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>69692</td>
</tr>
<tr>
<td>Taxis</td>
<td>12495</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12495</td>
</tr>
<tr>
<td>LD Commercial</td>
<td>1418</td>
<td>4</td>
<td>597</td>
<td>93</td>
<td>2112</td>
</tr>
<tr>
<td>HD Commercial</td>
<td>253</td>
<td>1</td>
<td>107</td>
<td>17</td>
<td>378</td>
</tr>
<tr>
<td>Total</td>
<td>83858</td>
<td>5</td>
<td>704</td>
<td>110</td>
<td>84677</td>
</tr>
</tbody>
</table>

\textbf{Table 34 - ex-ante values for PTTC\textsubscript{1} in year 1}

E.1.3 Project activity component 5

\textit{Effect of Modal shift from cars on the route to buses}

Modal shift creates reduction when passengers shift from private vehicles to mass-transit and these private vehicles are not put to another use. There are two elements to be considered: Component 5 calculates the savings due to the elimination of private-vehicle trips and component 6 looks at the necessity of adding buses to carry these extra passengers (due to modal shift, rebound and new trip creation on the buses). The reduction in fuel consumed (in liters) due to modal shift from those private vehicles are not put to another use is given by equation (13) of the NMB:

\[ \frac{(NPSV_n / APPV_n) \times AKAV_n}{VFCU_n} \]

Equation 13 generates an ex-ante yearly reduction in consumption of 633,289 liters of gasoline with a standard error of 213,623 liters.

\textsuperscript{72} AKTC, POTC, WTTC and VFC are calculated in E.1.2 equation 10 above.

\textsuperscript{73} If Project activity causes modal shift away from the buses (see Leakage 6) then equation 31 should be used instead of equation 13
The source of data for each new term in equation 13 is discussed below:

\[ \text{AKAV}_n \] - Annual kilometers per vehicle avoided by private vehicles whose users switched to mass-transit in year “n” (used in equation 13)

This data is determined ex-post from the on-board rider-ship survey of passengers on the new buses in future years. The ex-ante value is the length of the Insurgentes BRT corridor (19.3 km) multiplied by the 365 days per year. The SD estimated for the length considering gasoline vehicles is 6.0 and the SD for days/yr is 1.

\[ \text{VFCU}_n \] - vehicle fuel efficiency in km/L in year “n” (used in equation 13)

The fuel consumption for these passenger cars will be considered the same as the free-flow condition project activity on the Insurgentes BRT corridor calculated as above. (ex-ante value of 6.963 km/l for cars).

E.1.4 Project activity component 6

Extra buses required due to Modal shift from cars, Metro or other more-fuel-efficient-transport to buses on the BRT corridor plus rebound and new trip creation on the buses

If modal shift from private vehicles together with rebound and new trips creation on the buses is a substantial number, the Insurgentes BRT bus service would have to expand to cover this additional demand.

This is combined with Component 5 to calculate the overall savings from modal shift due to the elimination of private vehicle-trips due to rebound and new trip creation on the buses.

The calculation assumes that the level of occupancy of the buses should not increase due to modal shift, rebound and new trip creation; to do so would not be conservative, and thus increased ridership for any of these reasons will require an increase in bus-trips (rounded down to the nearest integer additional bus).

Rebound and new trip creation

Rebound caused by passengers shifting from another route or mode (other than private cars) to the new buses; and new trips created on the buses by this more favorable means of transport are included directly in the calculation of bus operation in NMB section G.1.

The number of passengers on the buses due to these causes in year “n” is given by equation (14) in the NMB:

\[ MSN_n = PKD_n \times (Mm_n + N_n) \]

The source of data for each term in equation 14 is discussed below:

74 NPSV and APPV appear in equation 11

75 Component 5 shows the impact of eliminating cars due to modal shift, however these additional passengers on the buses may require additional buses or trips; which is considered here

76 a calculated result of 0.9 buses equates to 144 additional passengers accommodated on the 70 buses in service on weekdays is only 2.1 additional passengers per bus.

77 Rebound is the increase in trips on the buses due to a better bus service having been established. The creation of a more desirable form of transport induces trips and promotes modal shift from other modes.
PKDₙ - annualized number of passengers on the new buses in year “n” (used in equation 14)

The ex-post annualized number of passengers on the new buses on the Insurgentes BRT corridor will be determined from fleet records (ticketing information and passes for non-fare-paying passengers) at each verification period. The ex-ante value prepared by METROBUS is 250,900 passengers per day generating approximately 73 million passenger-trips per year.

Mmₙ - Modal Shift percentage from a less polluting form of transport in year “n” (used in equation 14)

The ex-post modal shift percentage from a less polluting form of transport (such as non-motorized or Metro) will be determined from the on-board rider-ship survey of passengers on the new buses on the Insurgentes BRT corridor in future years. The ex-ante value is 100 passenger-trips per day or approximately 29,000 passenger-trips annually (Mm = 0.04%). A SD of 285 (on daily trips) is estimated.

Nₙ - New passenger-trips percentage created by the new service in year “n” (used in equation 14)

The ex-post number of new passenger-trips will be determined from the on-board rider-ship survey of passengers on the new buses on the Insurgentes BRT corridor in future years. The ex-ante value is similar to the above modal shift number accounting for approximately 29,000 passenger-trips annually (N = 0.04%).

The increase in fuel consumption that this causes is given by equation (15) in the NMB:

\[
\frac{(NPSVₙ + MSNₙ) \times TLSVₙ}{PKDₙ} \times ANNBₙ \times AKTNₙ \div FENₙ
\]

Equation 15 does not in this case, generate an ex-ante yearly increase in fuel consumption because the additional buses required to handle these extra passengers is less than one; the average passengers per bus increases but no additional trips are implemented.

The source of data for each new term in equation 15 is discussed below:

TLSVₙ - average trip length for people shifting from private vehicles to mass-transit in year “n” (used in equation 15)

The ex-post average trip length for people shifting from private vehicles to mass-transit will be determined from the on-board rider-ship survey of passengers on the new buses by asking their boarding and descent points. The ex-ante value is 8.0 km based on data from Metrobus.

ANNBₙ - annualized average number of new buses in service in year “n” (used in equation 15)

The ex-post annualized average number of new buses in service will be determined from fleet data in future years. The ex-ante value is 70 as shown in table 25.
E.1.5 Project activity component 7

Elimination of left turns on the route or BRT corridor generates increased travel time and distance for those vehicles that now have to go-round-the-block

The elimination of left turns will require those vehicles wishing to turn left in the project-activity case to go-round-the-block to the right to accomplish this maneuver. This will cause a certain quantity of fuel to be consumed per year, which is given by equation (16) in the NMB:

\[ \text{PDT}_n \times \frac{\text{NOLT}_n}{\text{VFU}_n} \]

Equation 16 generates an ex-ante yearly consumption of:

- 38 liters of diesel with a standard error of 2,820 liters,
- 309,556 liters of gasoline with a standard error of 32,670 liters;
- 6,297 liters of LPG with a standard error of 2,475 liters and
- 979 liters of CNG with a standard error of 2,385 liters.

The source of data for each term in equation 16 is discussed below:

\[ \text{PDT}_n \rightarrow \text{project-activity distance traveled to make turn in year “n” (used in equation 16)} \]

The distance for those wishing to turn left that have to go round-the-block on those crossings where left-turns have been eliminated by the project will be defined by project design documents and measured on large scale maps. In future years, an in-field revision will be conducted to ensure that any changes are adequately documented and included. The ex-ante value of the additional distance per turn is 0.346 km with a standard error of 0.041.

\[ \text{NOLT}_n \rightarrow \text{number of vehicles per year making left turn in year “n” (used in equation 16)} \]

The number of each category of vehicle (and fuel type) making a left turn is measured at the start of the project (year 0).

The number of each category of vehicle (and fuel type) turning left in future years will be the initial baseline year 0 count proportionally increased in accordance with equation 17:

\[ NOLT_n = NOLT_0 \times \frac{PL_n}{PL_0} \]

Care must be taken not to exceed the maximum carrying capacity of the road in question; which is the ceiling value for this result. Also the value of NOLT_n shall never be less than NOLT_0 for any year “n” within the project timeframe.

NOLT_0 prior to project activity (Year 0) is 22% of the traffic on the Insurgentes BRT corridor based on the number of left turns that are eliminated vs. the number turns that already required “going round the block” prior to this project. This is shown in table 35.

---

78 see equation 4 for details
Table 35 - ex-ante values for NOLT₀ (year 0)

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-cycles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Cars</td>
<td>13776</td>
<td></td>
<td></td>
<td></td>
<td>13776</td>
</tr>
<tr>
<td>Taxis</td>
<td>2470</td>
<td></td>
<td></td>
<td></td>
<td>2470</td>
</tr>
<tr>
<td>LD Commercial</td>
<td>280</td>
<td>1</td>
<td>118</td>
<td>18</td>
<td>418</td>
</tr>
<tr>
<td>HD Commercial</td>
<td>50</td>
<td>21</td>
<td>3</td>
<td></td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>16576</td>
<td>1</td>
<td>138</td>
<td>21</td>
<td>16736</td>
</tr>
</tbody>
</table>

VFUn - vehicle fuel efficiency in km/L in year “n” (used in equation 16)

Using the average speed of the vehicles “going round the block” measured ex-post at each verification, or if the number of these vehicles is small using a conservative average-speed measured on one surrogate route at that time, the fuel efficiency for these vehicles is calculated as shown in E.1.2 for VFC. The ex-ante value for the average speed of the vehicles “going round the block” is 26.7 km/h with a SD of 0.500 according to Senes Consultants pre-measurements.

E.1.6 Project activity component 8

**Longer distance required for vehicles to cross the route or BRT corridor due to the elimination of crossing points in the with-project case.**

The elimination of crossings on the BRT corridor in the project-activity case would require traffic wishing to cross to travel an extra distance to reach the nearest available crossing point that is functional and then back to their preferred route.

No crossing points were eliminated in the Insurgentes BRT corridor project thus this term does not participate.

E.1.7 Project activity component 9

**Longer time required for vehicles to cross the route or BRT corridor due to traffic signal timing altered giving priority to buses.**

The effect of a reduced green-light time on the vehicles wishing to cross the route in the project-activity case can be expressed as a number of additional minutes per vehicle, on average, of idle time per crossing between the baseline and the with-project cases.

The project-activity fuel consumed is given by equation 20 in the NMB:
Equation 20 generates an ex-ante yearly consumption of: 983,319 liters of gasoline with a standard error of 148,688 liters;

The source of data for each term in equation 20 is discussed below:

\( \text{NOCT}_n \) - number of vehicles crossing the route in year “\( n \)” (used in equation 20)

The number of each category of vehicle (and fuel type) crossing the route is measured at the start of the project (year 0).

The number of each category of vehicle (and fuel type) crossing in future years will be the initial baseline year 0 count proportionally increased in accordance with equation 21. 

Care must be taken not to exceed the maximum carrying capacity of the road in question; which is the ceiling value for this result. Also the value of \( \text{NOCT}_n \) shall never be less than \( \text{NOCT}_0 \) for any year “\( n \)” within the project timeframe.

\[ \text{NOCT}_n = \text{NOCT}_0 \times \frac{PL_n}{PL_0} \]

The ex-ante value for \( \text{NOCT}_0 \) prior to project activity (Year 0) is 25,560 gasoline cars per day according to Senes Consultants pre-measurements with a SD of 1,278.

The carrying capacity of the road is established as being that flow rate (veh/hr) for which any increase in journey time (min/km) is not directly related to an increase in flow rate; which may remain constant or diminish. This relationship can be established where highly congested traffic exists or is projected, by measurements. It can be safely assumed that whilst the traffic flow is free-flow, the carrying capacity of the road has not been reached.

\( \text{VIFC}_n \) - fuel consumption of these vehicles (liters/hour) in year “\( n \)” (used in equation 20)

The project-activity idle fuel consumption for these vehicles will be calculated as shown in E.1.2 (VFC). The SD is estimated in 0.158.

\( \text{PDCT}_n \) - project-activity delay in crossing time expressed as average minutes/crossing in year “\( n \)” (used in equation 20)

The ex-post average project-activity time to cross will be measured using a statistically representative sample of vehicles and crossings on all sections of the route at each future verification point in time. The ex-ante value for \( \text{PDCT}_0 \) prior to project activity (Year 0) is 2.0 minutes per crossing according to Senes Consultants pre-measurements with a SD of 0.5.

---

79 section G.6 in the NMB contained equation 18 & 19 which are not used in the Insurgentes BRT corridor project. The equation numbering system is kept consistent with the NMB for ease of reference.

80 see equation 4 for details
**Project Startup**

Different calculation mechanisms are required to measure GhG emissions from start-up activities.

**E.1.8 Project activity component 10**

*Increase in fuel consumption during construction due to traffic delays on all vehicles that use the route*

The construction period can cause additional traffic delays and congestion. These must be quantified using the methodology laid out above in E.1.2 where the project activity fuel consumption from traffic on the route during the construction period will be given by equation 22 in the NMB:

\[
CVKT \times NDC \times \left[\frac{CTTC}{60}\right] \times POTC \times VFC
\]

Equation 22\(^8\) generates an ex-ante consumption of: 14,831,128 liters of gasoline in the first year with a standard error of 4,451,469 liters;

*The source of data for each new term in equation 22 is discussed below:*

- **CVKT** - daily kilometers traveled per vehicle on the route during the construction period (used in equation 22)
  
  This is determined ex-post from measurements made during the construction period and may not affect the whole of the route at any one time. The ex-ante value obtained by METROBUS is 7.5 km to which a SD of 6.0 has been assigned.

- **NDC** - number of days of construction (used in equation 22)
  
  This is also determined ex-post from measurements made during the construction period and may not cover the whole of the construction period. The ex-ante value from METROBUS is 105 days with a SD of 1.

- **CTTC** - with-project travel time on the route in minutes per kilometer during the construction period (used in equation 22)
  
  This is determined ex-post using a Moving Car Observer program at each verification period as shown in E.1.2. The ex-ante value obtained Senes Consultants is 2.945 min/km with a SD of 0.360.

  The ex-ante value of the vehicle-weighed percentage of travel under congested traffic conditions is 60% and the percentage of travel under un-congested, free-flow traffic conditions is 40%.

---

\(^8\) it is important to note that the emissions reduction calculated in E.5.1 between the baseline and project activity is determined from a measured difference in travel time, not from subtracting the fuel consumed in the project activity from the baseline fuel consumed. This radically changes the standard error calculation.
E.1.9 Project activity component 11

*Greenhouse gas emissions due to construction activities of the project and energy used to produce the construction materials*

This does not generate an ex-ante increase in GhG emissions because in the absence of this project the Mexico City government would have invested in a similar construction activity\(^2\).

E.2. Estimated leakage:

Leakage, which is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary and which is measurable and attributable to the CDM project activity, can occur. Sources of possible leakage that have been identified are enumerated below, however it is expected that most projects will be affected by no more than 2 or 3 of these leakage concepts.

This exhaustive check-list shown in table 36 has been included to enable the project participants to adequately identify possible sources of leakage that could affect their specific projects and take actions accordingly.

<table>
<thead>
<tr>
<th>Leakage</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smelting removed vehicles</td>
<td>Buses</td>
<td>E.2.1</td>
</tr>
<tr>
<td>2</td>
<td>Transferring buses from a different service or route</td>
<td>Buses</td>
<td>E.2.2</td>
</tr>
<tr>
<td>3</td>
<td>Displaced buses are not scrapped</td>
<td>Buses</td>
<td>E.2.3</td>
</tr>
<tr>
<td>4</td>
<td>Buses have to dead-head to reach route</td>
<td>Buses</td>
<td>E.2.4</td>
</tr>
<tr>
<td>5</td>
<td>Competing buses on alternative routes</td>
<td>Buses</td>
<td>E.2.5</td>
</tr>
<tr>
<td>6</td>
<td>Modal shift from buses to other modes</td>
<td>Buses, cars, taxis</td>
<td>E.2.6</td>
</tr>
<tr>
<td>7</td>
<td>Shift from transport outside the project boundary to the buses</td>
<td>Buses, cars, taxis</td>
<td>E.2.7</td>
</tr>
<tr>
<td>8</td>
<td>Additional delay to cross the route affects several blocks</td>
<td>All vehicles crossing the route</td>
<td>E.2.8</td>
</tr>
<tr>
<td>9</td>
<td>Vehicles change to alternative routes outside the project boundary</td>
<td>All vehicles on the route except buses</td>
<td>E.2.9</td>
</tr>
<tr>
<td>10</td>
<td>Feeder route improvements adversely affect crossing traffic</td>
<td>All vehicles crossing the feeder route</td>
<td>E.2.10</td>
</tr>
<tr>
<td>11</td>
<td>Vehicles that used routes outside the project boundary transfer to the main route</td>
<td>All vehicles on the route except buses</td>
<td>E.2.11</td>
</tr>
<tr>
<td>12</td>
<td>Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions</td>
<td>Buses</td>
<td>E.2.12</td>
</tr>
</tbody>
</table>

\(^2\) See B.2.1 xxvii for details
The objective of this section is to demonstrate how the yearly fuel consumption in liters is calculated from each element of the leakages by using the formulae contained in the NMB section H and annexes.

The figures presented in this section are ex-ante and for the whole corridor. When ex-post data is used, the standard deviations (SD) will be determined directly from the data following the procedures specified in section I.2 of the NMB; however with this ex-ante data the SD have been determined from pre-measurements or estimations.

**E.2.1 Leakage 1**

**Greenhouse gas emissions generated whilst smelting the old vehicles removed from service**

If vehicles removed from service due to project activity are smelted, GhG emissions will be generated. The fuel consumed by smelting (in liters of distillate #2 diesel fuel) is given by equation (24) in the NMB:

$$65.1053627 \times NTMS$$

Equation 24 generates an ex-ante consumption of 68,360 liters of diesel with a standard error of 22,764 liters

The source of data for the term in equation 24 is discussed below:

- **NTMS** - number of tons of metal smelted (used in equation 24)
  This will be determined ex-post from official scrappage certificates showing the number of vehicles smelted and the weight per vehicle. The ex-ante value from METROBUS is 350 units at an average weight of 3 tons. The ex-ante SD for vehicle weight is 1 ton and the SD for the number of vehicles is 1.

**E.2.2 Leakage 2**

**Transferring buses to the project activity that were previously in service on a different route**

This leakage concept is not included in the Insurgentes BRT corridor project thus this term does not participate.

**E.2.3 Leakage 3**

**Buses displaced by the project activity are not scrapped**

**Scraping program.** The permit for new vehicles (large capacity buses) to operate on the new corridor is provided against a corresponding scrapping certificate. This applies to ¼ of the vehicles being replaced on
Insurgentes. The reminder will substitute highly polluting vehicles outside the corridor. The verification and validation procedures with regard to the emission reductions will monitor the scrapping arrangements throughout project implementation. The transport ministry of Mexico City (SETRAVI) has frozen the issuance of concessions for bus-route operations city-wide.

The buses displaced (by the project activity) from the main route that are not directly scrapped and are placed into service on a different route outside of the project boundary are taken into account in the calculations. There will be a “trickle down” effect where the bus that is removed from Insurgentes substitutes an older vehicle outside the project boundary leading to the oldest vehicle within the transport system being eventually scrapped.

The fuel used by the vehicle that was finally scrapped is taken into account in equation 28 in the NMB which is used in place of equation 183 in section E.4.1:

\[
AKTOn \times NOVRn / FEOn - AKTNSn \times (NOVNSn / FEOn – NSVNSn / FSVNn)
\]

The ex-ante value of this leakage (terms on a white background in equation 28) is zero due to the assumption that the vehicles finally scrapped from the other route outside the project boundary will equal in number, daily km and fuel economy those vehicles from Insurgentes that were not scrapped and replaced them. With ex-post data this number will almost certainly change.

The source of data for each term in equation 28 is discussed below:

**AKTO**

- Baseline annual kilometers traveled per bus per year on the route in year “n” (used in equation 28)
  
  In the Insurgentes BRT corridor project this baseline parameter is to be determined through a measurement program over a number of days to obtain an average daily number of kilometers traveled multiplied by the number of travel days in a year (the sample size and length of time required will depend on the number of independent data points required to meet a specified uncertainty criterion). The ex-ante value obtained by Senes Consultants is 142 km/day for the diesel buses and 127 km/day for each of the others multiplied by 365 days per year. In all cases a SD of 1 was assigned.

**NOVR**

- Number of buses removed from service in year “n” (used in equation 28)
  
  The annualized number of buses in the baseline would have evolved over time due to changes in passenger-km. within the city. They also would have evolved over time in accordance with the Repair, Replacement and Conversion assumptions shown in B.1.2 (ii). Thus the number of vehicles removed has to adjust over the project timeframe to account for these effects.
  
  The number of buses removed from Insurgentes (NOVRn) at project startup is measured ex-post directly from fleet and official records.

\(^{83}\) The terms in equation 1 are shown in white letters on a green background
The ex-ante value of the 356 buses removed from service on Insurgentes and how many would be directly scrapped, or replace scrapped vehicles on other routes (outside the project boundary) is given in table 37.

Table 37 – ex-ante value of Buses removed from service in year 0 (NOVR₀)

<table>
<thead>
<tr>
<th>Type of Bus</th>
<th>Total Removed from Insurgentes NOVR₀</th>
<th>Number directly Scrapped</th>
<th>Number “swapped” for more scrapped units on other routes NOVNS₀ &amp; NSVNS₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP - Diesel</td>
<td>113</td>
<td>85</td>
<td>28</td>
</tr>
<tr>
<td>Ruta 2 - Diesel</td>
<td>156</td>
<td>117</td>
<td>39</td>
</tr>
<tr>
<td>Ruta 2 - Gasoline</td>
<td>28</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Ruta 2 - LPG</td>
<td>52</td>
<td>39</td>
<td>13</td>
</tr>
<tr>
<td>Ruta 2 - CNG</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

In future years this baseline number of vehicles will change in proportion to the growth of passenger-km. in the project activity case discounting modal shift according to equation 2 in the NMB. Thus:

\[
NOVR_n = NOVR_0 \times \left( \frac{PKD_n \times (1 - [M_n + N_n])}{PKD_0} \right)
\]

To illustrate the calculation, if there were an annualized growth of 3% in the number of passenger-km on the buses in Year 1, and using the values of PKD, M & N in equation 14 then NOVR₁ / NOVR₀ = 1.029 and Table 37 becomes:

Table 38  – ex-ante value of Buses removed from service in year 1 (NOVR₁) without RRC

<table>
<thead>
<tr>
<th>Type of Bus</th>
<th>Total Removed from Insurgentes NOVR₁</th>
<th>Number directly Scrapped</th>
<th>Number “swapped” for more scrapped units on other routes NOVNS₁ &amp; NSVNS₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP - Diesel</td>
<td>116</td>
<td>87</td>
<td>29</td>
</tr>
<tr>
<td>Ruta 2 - Diesel</td>
<td>161</td>
<td>120</td>
<td>40</td>
</tr>
<tr>
<td>Ruta 2 - Gasoline</td>
<td>29</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Ruta 2 - LPG</td>
<td>54</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>Ruta 2 - CNG</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 38 does not include the effects of the selected repair, replacement or conversion assumptions (see table 3). It must be modified to account for the effect of the 10% replacement of vehicles per year. Table 39 shows how this substitution of vehicles in the baseline modifies both the number of vehicles that would have operated in Insurgentes and how many are scrapped.

### Table 39 - ex-ante value of Buses removed from service in year 1 (NOVR₁) with RRC

<table>
<thead>
<tr>
<th>Type of Bus</th>
<th>Total Removed from Insurgentes NOVR₁</th>
<th>Number directly Scrapped NOVNS₁ &amp; NSVNS₁</th>
<th>Number “swapped” for more scrapped units on other routes NOVNS₁ &amp; NSVNS₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP - Diesel</td>
<td>116</td>
<td>87</td>
<td>29</td>
</tr>
<tr>
<td>Ruta 2 - Diesel</td>
<td>161 + 12 = 173</td>
<td>120 +9 = 129</td>
<td>40 + 3 = 43</td>
</tr>
<tr>
<td>Ruta 2 - Gasoline</td>
<td>29 – 24 = 5</td>
<td>22 – 18 = 4</td>
<td>7 – 6 = 1</td>
</tr>
<tr>
<td>Ruta 2 - LPG</td>
<td>54</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>Ruta 2 - CNG</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

**FEOₙ** - Fuel efficiency of removed buses on the route in year “n” (used in equation 28)

In the Insurgentes BRT corridor project this baseline parameter is to be determined through a measurement program in year 0 over a statistically significant number of vehicles to allow an overall accuracy to be achieved.

The repair, replacement or conversion [RRC] assumptions (see B.2.1 (ii) and table 3) require the baseline measured fuel consumption to be modified in future years to account for the introduction on new, more fuel-efficient vehicles.

The combined average fuel consumption of the baseline buses must be recalculated for each route and fuel type on a continuing basis.

The ex-ante values of fuel economy based on Senes Consultants and WVU pre-measurements is shown in table 40. Ex-post data for the current vehicles will be measured prior to project start-up. The fuel economy of the new diesel buses introduced to the fleet under this renovation program will be determined at each verification period for the vehicles to be incorporated at that time.

---

84 buses will be introduced into the baseline fleet using technology current at the date of introduction.
Table 40 – ex-ante value of Fuel Economy of buses

<table>
<thead>
<tr>
<th></th>
<th>Existing diesel buses</th>
<th>Existing gasoline, LPG &amp; CNG buses</th>
<th>New diesel buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Efficiency</td>
<td>1.530 km/l</td>
<td>Gasoline 1.950</td>
<td>1.927 km/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas 1.141 km/l</td>
<td></td>
</tr>
</tbody>
</table>

AKTNS_n - annual kilometers traveled by the vehicles that were not scrapped on their new route in year “n” (used in equation 28)

For the Insurgentes BRT corridor project, the ex-post parameter will be determined in one of two of ways:

- from annual fleet vehicle records for the other route (preferred option85); or
- through a measurement program over a number of days to obtain an average daily number of kilometers traveled multiplied by the number of travel days in a year (the sample size and length of time required will depend on the number of independent data points required to meet a specified uncertainty criterion).

The per-vehicle annual kilometers of buses must be determined for each bus-type, route and fuel combination in each year of project activity.

Whilst the ex-ante value is that 25% of the units in operation on Insurgentes will move to different routes outside the project boundary, no estimates of which routes exist at this time. The current ex-ante assumption is that the new routes will involve the same daily km (and SD) as their previous route on Insurgentes.

NOVNS_n - number of vehicles that were not scrapped in year “n” (used in equation 28)

The number of buses that were not scrapped and were put into operation on a different route outside the project boundary will be directly measured or this data can be obtained from the computerized data system supporting the new vehicle fleet operation. The ex-ante value is shown in table 39. The ex-post number of buses operating must be determined for each bus-type, route and fuel combination in each year of project activity.

NSVNS_n - number of vehicles from the other route that were finally scrapped in year “n” (used in equation 28)

The number of buses that were finally scrapped on the other route outside the project boundary will be directly measured from scrappage certificates. The ex-ante value is that it will be the same number as NOVNS (one-for-one substitution). The number of buses operating must be determined for each bus-type, route and fuel combination in each year of project activity.

---

85 Annual Fleet vehicles records should be kept. This reduces uncertainty and cost in the data collection process.
FSVNₙ = fuel efficiency of the vehicles from the other route that were finally scrapped (km/L) in year “n” (used in equation 28)

The fuel economy of the buses finally scrapped from the other route outside the project boundary will be determined through a measurement program over a number of days to obtain an average daily fuel consumption multiplied by the number of travel days in a year. The ex-ante value is that it will be the same as on the corridor.

**E.2.4 Leakage 4**

*Buses have to dead-head to reach their route*

If the buses displaced or introduced by the project activity have to dead-head from their base or depot to reach their operating route then the additional fuel consumed must be taken into account in the calculations. In the Insurgentes BRT corridor project this number will come from fleet records. The ex-ante value is shown in table 25 for the new vehicles and is included in AKTN in equation 9.

Likewise for the old vehicles, the respective distance is included in AKTO in equation 1.

This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

**E.2.5 Leakage 5**

*Competing buses on alternative routes*

This leakage concept is not included in the Insurgentes BRT corridor project thus this term does not participate.

**E.2.6 Leakage 6**

*Project activity causes modal shift away from the buses*

Questions included in the on-board ridership survey⁸⁶ will indicate the degree of satisfaction with the new service. Statistical analysis must be used to evaluate the ex-post percentage of previous passengers that appear to be highly dissatisfied with the new service. However, the ex-ante value is zero.

The ex-ante value for this leakage is zero.

---

⁸⁶ see E.2.1 and E.2.2 for other variables that use the same source
E.2.7 Leakage 7

**Shift from other modes of transport (outside the project boundary) to the buses**

The additional PKT is automatically included in the rebound and new trip creation components of E.1.3 (equation 14) and in the calculation of the additional buses required to cover this additional demand in equation 15 (see E.1.4).

This is conservative since the reduction in the number of passengers on the other forms of transport outside the project boundary may reduce emissions there.

This leakage is not to be included in the “Leakage” part of equation 38 since it is already accounted-for within the project activity calculations.

E.2.8 Leakage 8

**Additional delay to cross the main route for traffic is so great that it affects several blocks either side of the main route.**

The monitoring methodology must ensure that the total time to cross the corridor for each vehicle is evaluated.

This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

E.2.9 Leakage 9

**Prohibition of left turns, the elimination of crossing-points or other factors force vehicles to change to alternative routes**

Since the baseline number of vehicles in year “n” (NOTC_n) is used in equation 26 to determine the emissions reduction due to improving the operating conditions for vehicles on the main route rather than the project activity number of vehicles (POTC_n in equation 12), this effect is automatically accounted-for in the calculations by artificially inflating the number of vehicles and hence fuel consumed.

This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

E.2.10 Leakage 10

**Feeder route improvements adversely affect traffic flow on their cross-streets**

Feeder routes are not included in the Insurgentes BRT corridor project thus this term does not participate.
E.2.11 Leakage 11

Other vehicles that previously used routes outside the project boundary transfer to the main route

This leakage is not to be included in the “Leakage” part of equation 38 since it is automatically accounted-for within the project activity calculations.

E.2.12 Leakage 12

Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions

Since the Insurgentes BRT corridor project introduces diesel buses in substitution for old, primarily diesel buses this leakage concept is not expected to be significant or measurable.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Neither the dynamic baseline (E.4) nor the project activity and leakage measurements (E.1 & E.2) pretend to measure all the emissions in their respective cases; they look to provide a basis for determining the differences between the dynamic baseline and project-activity plus leakages using the formulae explained in E.5\textsuperscript{87}. A more mathematically-robust treatment of each formula is discussed in the NMB Annex 3, Formulae - a more rigorous presentation.

The methodology laid-out in NMB section I.2 must be used to determine the measurement uncertainties associated with each component and leakage. The importance of determining the GhG emissions reductions from the differences between the baseline and project activity & leakage scenarios (in E.5) derives from the management of measurement uncertainties; if we were to sum E.1 and E.2 and then subtract the total from E.4, the expanded uncertainty would be orders of magnitude larger. Thus the respective sums are not presented in this section.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

This section explains how the fuel consumed is calculated for each element of the dynamic baseline. The methodology determines the difference between the fuel consumption in the dynamic baseline and the project activity at any point in time within the project timeframe. It does not pretend to measure the total fuel consumption in the baseline or in the with-project scenario. The methodology only looks at those elements where changes caused by the project can be identified and measured. It is designed to correctly identify and measure the differences between the baseline and project-activity.

In the Insurgentes BRT corridor project, the total baseline fuel consumed is considerably larger than the expected reduction caused by project activity. Thus the measurement uncertainties associated with any

\textsuperscript{87} a clear example of this is where the emissions reduction is generated by a reduction of idle time. Clearly the total journey time multiplied by idle fuel consumption bears no relationship to the amount of fuel really consumed by the vehicle; however the difference in idle time multiplied by idle fuel consumption produces a significant result.
economically-viable measurement plan would be too-large to reliably prove that reduction has occurred. However by measuring only the differences this problem is circumvented, allowing cost-effective measurements to statistically demonstrate the change between the baseline and project activity cases.

Table 41 indicates in which section of this document each baseline component can be found. The column “C” refers to the project boundary definition shown in figure 3.

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on the route</td>
<td>Buses</td>
<td>[1]</td>
<td>E.4.1</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles on feeder routes</td>
<td>All vehicles except buses</td>
<td>[2]</td>
<td>E.4.2</td>
</tr>
<tr>
<td>3</td>
<td>Buses</td>
<td>[3]</td>
<td>E.4.1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>All vehicles except buses</td>
<td>[4]</td>
<td>E.4.2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Modal shift to buses from private cars and other forms of transport</td>
<td>Reduction of emissions from private cars</td>
<td>[5]</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>Increased bus service to cover extra demand</td>
<td>[9]</td>
<td>E.4.2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Elimination of Left Turns</td>
<td>All vehicles that have to go &quot;round-the-block&quot; to the right to make left turn</td>
<td>[6]</td>
<td>E.4.3</td>
</tr>
<tr>
<td>8</td>
<td>Elimination of Crossing Points</td>
<td>All vehicles that have to use a different crossing point</td>
<td>[7]</td>
<td>E.4.4</td>
</tr>
<tr>
<td>9</td>
<td>Increased delay in crossing the main route</td>
<td>All vehicles crossing the route</td>
<td>[8]</td>
<td>E.4.5</td>
</tr>
<tr>
<td>10</td>
<td>Traffic Delays due to construction activity</td>
<td>All vehicles on the route</td>
<td>E.4.2</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to Construction</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1) There is no baseline component for the boxes marked **; the baseline value is zero**. 2) Components 10 & 11 refer specifically to the main route or corridor within the project boundary.

Each dynamic baseline variable has an associated measurement uncertainty; these are evaluated as shown in NMB section I.2 and the expanded uncertainty for the baseline is determined.

NMB section I.1 explains the formulae/algorithms used to combine the dynamic baseline formulae (in this section) with the project activity formulae in E.1 to determine these emissions reduction accruing from the project.

**E.4.1 Baseline components 1 & 3**

*Operating condition improvements and/or the substitution of the number and technology of buses that operate on the main route or BRT corridor (Component 1) or any feeder route (Component 3)*

In the case of the Insurgentes BRT corridor project, no feeder routes are currently considered thus the Component 3 can be ignored until such time that feeder routes are incorporated.

The annual liters of fuel burnt by these baseline buses are given by equation 1 in the NMB:

---

88 because modal shift is with respect to the baseline and cannot be included in it

89 see Figure 3 for definitions
AKTOₙ * NOVRₙ / FEOₙ

The ex-ante values of these variables, ex-post sources of data and collection methods together with the calculations are shown in section E.2.3 (equation 28 refers).

Equation 1 generates an ex-ante yearly consumption of:
- 9,112,595 liters of diesel with a standard error of 272,584 liters,
- 665,610 liters of gasoline with a standard error of 84,508 liters;
- 2,112,585 liters of LPG with a standard error of 213,850 liters and
- 296,737 liters of CNG with a standard error of 73,867 liters.

E.4.2 Baseline components 2 & 4

Improving the operating conditions for other vehicles on the main route (Component 2) or any feeder route (Component 4)

In the case of the Insurgentes BRT corridor project, no feeder routes are currently considered thus the Component 4 can be ignored until such time that feeder routes are incorporated.

For all the vehicles that run on the Insurgentes BRT corridor (Component 2), apart from buses, the baseline fuel consumption is given by equation 3 of the NMB.

AKTCₙ * NOTCₙ * \[BTTCₙ/60\] * VFCₙ

Equation 3 generates an ex-ante yearly consumption of:
- 8,667 liters of diesel with a standard error of 5,509,338 liters,
- 77,510,150 liters of gasoline with a standard error of 13,654,873 liters;
- 1,324,758 liters of LPG with a standard error of 4,835,529 liters and
- 205,969 liters of CNG with a standard error of 4,830,329 liters.

The source of data for each term in equation 3 is discussed below:

- If all the buses displaced by the project activity are not scrapped then equation 28 (see E.2.3) should be used in place of equation 1. If buses have to dead-head to reach their route (see E.2.4) then these additional kilometers must be included in AKTO.
- all vehicles, apart from the buses
- Note that this number is not representative of the total annual consumption since the fuel efficiency numbers used relate only to the difference in operating conditions.
- it is important to note that the emissions reduction calculated in E.5.1 between the baseline and project activity is determined from a measured difference in travel time, not from subtracting the fuel consumed in the project activity from the baseline fuel consumed. This radically changes the standard error calculation.
AKTCₙ - kilometers traveled per vehicle on the route per year in year “n” (used in equation 3)
This is the same as used in section E.1.2 equation 10.

NOTCₙ - number of vehicles using the route in year “n” (used in equation 3)
This is the same as used in section E.1.2 equation 4.
Care must be taken not to exceed the maximum carrying capacity of the road in question; which is the ceiling value for this result. Also the value of NOTCₙ shall never be less than NOTC₀ for any year “n” within the project timeframe.

BTTCₙ - baseline travel time on route in minutes per kilometer in year “n” (used in equation 3)
A sampling program is required before project start-up to establish the vehicle flow (expressed as vehicles/hour) and travel time (expressed in minutes/km) characteristics of each section of the Insurgentes route over the 24 hour period by using a Moving Car Observer survey with simultaneous traffic loading measurements (vehicles/hour). A large number of measurements is required to develop a travel time vs. flow rate curve that can be used to determine baseline travel times for any future flow-rate on the corridor. This can most efficiently be measured during the morning (and evening) rush-period during which time the traffic volumes will increase from their overnight minimums through to rush-hour peak and settle back to the daytime flows (and vice versa). This generates a “cloud” of data as illustrated in figure 5 from which multiple sub-samples can be extracted at different traffic-loading conditions.
The ex-post baseline vehicle/hour traffic loading in future years is obtained from the measured project-activity traffic flow for each section of Insurgentes by applying the corresponding adjustment for modal shift. The baseline number of vehicles using the route in year “n” (NOTCn) is determined from equation (4) of the NMB as shown in E.1.2.

Travel time samples are extracted from the data cloud at each traffic loading condition. The mean of the sample gives the baseline travel time in min/km at that traffic loading and the SD of the sample is used to calculate measurement uncertainty.

The ex-ante value prepared by Senes Consultants is 2.545 min/km. A SD of 0.36 was determined by Senes Consultants based on pre-measurements.

This procedure is explained in NMB Annex 1 “Calculating the baseline travel time”.

\[ VFC_n \] - vehicle fuel consumption in year “n”

This is the same as used to calculate VFC in section E.1.2 equation 10.
E.4.3 Baseline component 7

Elimination of left turns on the route or BRT corridor generates increased travel time and distance for those vehicles that now have to go-round-the-block

The elimination of left turns on Insurgentes will require those vehicles wishing to turn left in the project-activity case to go-round-the-block to the right to accomplish this maneuver. If the baseline distance to turn left on the corridor were significant, equation 5 from the NMN would be used to determine the quantity of fuel to be consumed per year, in the baseline.

\[ \text{BDT}_n \times \text{NOLT}_n / \text{VFU}_n \]

The ex-ante value for this emissions increase is zero.

The source of data for each new term\textsuperscript{94} in equation 5 is discussed below:

- \text{BDT}_n - baseline distance traveled to make turn in year “n”
  For the Insurgentes BRT corridor project, the distance for those wishing to turn left on those crossings where left-turns are allowed in the baseline but not in the with-project scenario is considered to be zero.

E.4.4 Baseline component 8

Longer distance required for vehicles to cross the route or BRT corridor due to the elimination of crossing points in the with-project case.

No crossing points were eliminated in the Insurgentes BRT corridor project thus this term does not participate.

E.4.5 Baseline component 9

Longer time required for vehicles to cross the route or BRT corridor due to traffic signal timing altered giving priority to buses.

The effect of a reduced green-light time for the vehicles wishing to cross the Insurgentes BRT corridor due to priority being given to vehicles on the route will be an increase in the time required to cross that can be expressed as a number of additional minutes per vehicle, on average, of idle time. This change in idle time can be measured by evaluating the average difference in time to cross between the baseline and the with-project cases.

The baseline fuel consumed is given by equation 8 of the NMB:

\[ \text{NOCT}_n \times \text{VIFC}_n \times [\text{BDCT}_n / 60] \]

\textsuperscript{94} NOLT and VFU are calculated in E.1.5.
Equation 8 generates an ex-ante baseline consumption of: 737,489 liters of gasoline with a standard error of 141,386 liters;

The source of data for each new term\(^95\) in equation 8 is discussed below:

\(\text{BDCT}_n\) - baseline delay in crossing time expressed as average minutes/crossing in year “\(n\)"

The ex-post average baseline time to cross will be measured using a statistically representative sample of vehicles and crossings on all sections of the route before BRT corridor operation starts. The ex-ante value for BDCT prior to project activity (Year 0) is 1.5 minutes per crossing according to Senes Consultants pre-measurements with a SD of 0.5.

### E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

The objective of this section is to elaborate the formulae and explain how the CO\(_2\) equivalent emissions reduction (in tons per year) is calculated from each element of the dynamic baseline (E.4), project activities (E.1) and leakage (E.2). Measurement uncertainties are associated with each component and leakage and used to report a final overall emissions reduction at the lower 95% confidence interval\(^96\).

Section E.5.1 calculates the differences between baseline and project activity;
Section E.5.2 deals with leakages; and
Section E.5.3 calculates the final emissions reduction.

#### E.5.1 Determining the emissions reductions from the project activity

Table 42 indicates in which section of this document the emissions reductions from the project activity calculation for each component can be found. The column “\(C\)” refers to the project boundary definition as shown in figure 3.

---

\(^95\) NOCT and VIFC are calculated in section E.1.7, equation 20

\(^96\) A more mathematically-robust treatment of each formula is discussed in NMB Annex 3, Formulae - a more rigorous presentation.
Table 42 – Emissions reductions index

<table>
<thead>
<tr>
<th>Component</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>C</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicles on each main route within the project boundary (Main routes can substantially modify traffic behavior on intersecting streets)</td>
<td>Buses (fuel consumption measured directly)</td>
<td>[1]</td>
<td>E.5.1.1</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption change determined from difference in travel time)</td>
<td>[2]</td>
<td>E.5.1.2</td>
</tr>
<tr>
<td>3</td>
<td>Buses (fuel consumption measured as above)</td>
<td>Buses (fuel consumption measured as above)</td>
<td>[3]</td>
<td>E.5.1.3</td>
</tr>
<tr>
<td>4</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles except buses (fuel consumption measured as above)</td>
<td>[4]</td>
<td>E.5.1.4</td>
</tr>
<tr>
<td>5</td>
<td>Buses (fuel consumption measured as above)</td>
<td>Reduction in use of private cars</td>
<td>[5]</td>
<td>E.5.1.5</td>
</tr>
<tr>
<td>6</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>Increased bus service to cover extra demand</td>
<td>[6]</td>
<td>E.5.1.6</td>
</tr>
<tr>
<td>7</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles have to travel extra distance to go &quot;round-the-block&quot; to the right to make left turn</td>
<td>[6]</td>
<td>E.5.1.7</td>
</tr>
<tr>
<td>8</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles travel extra distance to use a different crossing point</td>
<td>[7]</td>
<td>E.5.1.8</td>
</tr>
<tr>
<td>9</td>
<td>Vehicles on each main route within the project boundary (Feeder routes do not substantially modify traffic behavior on other streets)</td>
<td>All vehicles have increased travel time due to crossing the routes</td>
<td>[8]</td>
<td>E.5.1.9</td>
</tr>
<tr>
<td>10</td>
<td>Traffic delays due to construction activity</td>
<td>All vehicles on the routes have increased travel time due to additional congestion</td>
<td></td>
<td>E.5.1.10</td>
</tr>
<tr>
<td>11</td>
<td>Emissions due to construction activity plus upstream construction material emissions</td>
<td></td>
<td></td>
<td>E.5.1.11</td>
</tr>
</tbody>
</table>

Notes: 1) Components 10 & 11 refer specifically to Insurgentes

### E.5.1.1 Component 1

**Operating condition improvements and/or the substitution of the number and technology of buses that operate on the main route or BRT corridor.**

Component 1 = burning less fuel by improving operating conditions and replacing old fuel-inefficient technology with modern fuel-efficient technology (tons of CO₂ equiv. per year)

This is given by equation 32 in the NMB:

\[
(NOVR_n * AKTO_n / FEO_n) - (NNVA_n * AKTN_n / FEN_n)
\]

The ex-ante value of Component 1 generates a mean reduction of 17,554 ton/yr of CO₂equiv with an expanded uncertainty (lower 95% bound) of 1,367 ton/yr. The lower 95th Confidence Level is 16,187 ton/yr

If all the buses displaced by the project activity are not scrapped, then equation 29 in the NMB should be used in place of equation 32:
These equations use equation 1 in E.4.1, equation 9 in E.1.1 and equation 28 in E.2.3. The difference in liters of fuel consumed (by fuel type) given by equation 29 or 32 is converted to tons of CO₂ equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1) which contains the emissions factors for the fuel available in Mexico City⁹⁷ and have been developed from the IPCC criterion taking into account the local lower heating values and any legal fuel blending requirements together with the local mix of engine types and the distribution of installed control technologies.

Using these parameters the CO₂eqiv emissions (in tons) are calculated from fuel consumed (FC in liters) using equation 39. in the NMB

\[
CO_{2eqiv} = FC \times \frac{[FCO₂ \times 1] + (FCH₄ \times 21) + (FN₂O \times 310)]}{1000}
\]

Component 1 includes all the effects of rebound and new trip creation on the public transport other than the possible need to increase the bus fleet due to this cause, which is covered in E.5.1.6, component 6.

**E.5.1.2 Component 2**

*Improving the operating conditions for vehicles on Insurgentes⁹⁸.*

Component 2 = burning less fuel by improving the flow of vehicles along a route through decreased travel time per kilometer (tons of CO₂eqiv per year)

This is given by equation 33 in the NMB:

\[
AKTC_n \times VFC_n \times NOTC_n \times \frac{(BTTC_n - WTTC_n)}{60}
\]

The ex-ante value of Component 2 generates a mean reduction of 17,514 ton/yr of CO₂eqiv with an expanded uncertainty (lower 95% bound) of 6,624 ton/yr. The lower 95th Confidence Level is 10,890 ton/yr

This equation uses equation 3 in E.4.2 and equation 10 in E.1.2. The difference in liters of fuel consumed (by fuel type) given by equation 33 is converted to tons of CO₂ equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).

⁹⁷ source SMA, 2005

⁹⁸ apart from buses that are covered in E.5.1.1
E.5.1.3  Component 3

Operating condition improvements and/or the substitution of the number and technology of buses that operate on feeder routes.

No feeder routes have been defined in the Insurgentes BRT corridor project thus this term does not participate in the ex-ante values.

E.5.1.4  Component 4

Improving the operating conditions for vehicles operating on the feeder routes.

No feeder routes have been defined in the Insurgentes BRT corridor project thus this term does not participate in the ex-ante values.

E.5.1.5  Component 5

Effect of Modal shift from cars on the route to buses.

Component 5 = burning less fuel due to modal shift from private vehicles to mass-transit (tons of CO2 equiv. per year)

The ex-ante value of Component 5 generates a mean reduction of 1,399 ton/yr of CO2equiv with an expanded uncertainty (lower 95% bound) of 776 ton/yr. The lower 95th Confidence Level is 623 ton/yr.

This is given by formula 13 in E.1.3 since by definition the baseline value is zero.

Component 5 covers one of the two elements to be considered in Modal shift; the savings due to the elimination of private vehicle-trips. The necessity of adding buses to carry these extra passengers (due to modal shift, rebound and new trip creation on the buses) is contained in component 6.

The on-board revealed preference survey that is used to determine the modal shift of passengers from private transportation to the buses will also reveal the proportion of these modal-shift passengers that are using other buses to and from the Insurgentes corridor. If this number is significant, Component 5 should be modified accordingly to include this additional distance in the calculation.

The number of buses added to cover this additional demand (see E.1.1.6) has to be an integer, and should be rounded down to the nearest bus.

99 apart from buses that are included in E.1.1.3
E.5.1.6 Component 6

**Extra buses required due to Modal shift from cars, Metro or other more-fuel-efficient-transport to buses on the BRT corridor plus rebound and new trip creation on the buses**

Component 6 = burning more fuel because people have switched from cars and metro to new buses - a form of rebound or new trips that do not exist in the baseline (tons of CO2 equiv. per year)

| The ex-ante value of Component 6 is a mean increase of 0 ton/yr of CO2equiv |

This is given by formula 15 in E.1.4 since by definition the baseline value is zero.

E.5.1.7 Component 7

**Elimination of left turns on the route or BRT corridor generates increased travel time and distance for those vehicles that now have to go-round-the-block**

Component 7 = burning more fuel by lengthening the travel time and distance for vehicles that used to turn left across a BRT corridor and are no longer allowed to turn left (tons of CO2 equiv. per year)

This is given by equation 34 in the NMB:

\[ (PDT_n - BDT_n) \times NOLT_n / VFUn \]

| The ex-ante value of Component 7 is a mean increase of 693 ton/yr of CO2equiv with an expanded uncertainty (lower 95% bound) of 119 ton/yr. The lower 95th Confidence Level is 812 ton/yr |

This equation uses equation 5 in E.4.3 and equation 16 in E.1.5. The difference in liters of fuel consumed (by fuel type) given by equation 34 is converted to tons of CO2 equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).

E.5.1.8 Component 8

**Longer distance required for vehicles to cross the route or BRT corridor due to the elimination of crossing points in the with-project case.**

No crossing points have been eliminated in the Insurgentes BRT corridor project thus this term does not participate in the ex-ante values

---

100 Component 5 shows the impact of eliminating cars due to modal shift, however these additional passengers on the buses may require additional buses or trips; which is considered here
E.5.1.9 Component 9

**Longer time required for vehicles to cross the route or BRT corridor due to traffic signal timing altered giving priority to buses.**

Component 9 = burning more fuel by delaying a BRT corridor’s cross flow vehicular traffic by altering traffic signal timing (tons of CO2 eqiv. per year)

This is given by equation 36 in the NMB:

\[
\text{NOCT}_n \times \text{VIFC}_n \times \left[ \text{PDCT}_n - \text{BDCT}_n \right] / 60
\]

The ex-ante value of Component 9 is a mean increase of 543 ton/yr of CO2equiv with an expanded uncertainty (lower 95% bound) of 482 ton/yr. The lower 95th Confidence Level is 1024 ton/yr

This equation uses equation 8 in E.4.5 and equation 20 in E.1.7. The difference in liters of fuel consumed (by fuel type) given by equation 36 is converted to tons of CO2 equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).

The assumption used in this methodology is that the change in crossing time, caused by the design and implementation of the project will remain constant over the life of the project even though the overall traffic flow increases.

It is also assumed that in a congested urban environment, this difference in crossing time can be equated to a difference in idle time for the vehicles waiting for the traffic lights to change since the change in crossing time was caused by a change in green-light duration at the crossing point.

---

E.5.1.10 Component 10

**Increase in fuel consumption during construction due to traffic delays on all vehicles that use the route**

Component 10 = more fuel burned due to traffic delays caused by construction of the new BRT corridor (tons of CO2 eqiv. over the construction period)

This is given by equation 37 in the NMB:

\[
\text{CVKT}_n \times \text{NDC}_n \times \left[ \text{CTTC}_n - \text{BTTC}_n / 60 \right] \times \text{POTC}_n \times \text{VFC}_n
\]

The ex-ante value of Component 10 affects the first year only and generates a mean increase of 2,686 ton/yr of CO2equiv with an expanded uncertainty (lower 95% bound) of 1331 ton/yr. The lower 95th Confidence Level is 4017 ton/yr

This equation uses equation 3 and equation 22 (E.1.8). The difference in liters of fuel consumed (by fuel type) given by equation 37 is converted to tons of CO2 equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).
**E.5.1.11 Component 11**

*Greenhouse gas emissions due to construction activities of the project and energy used to produce the construction materials*

This term is considered emissions neutral because had this project not been realized the Mexico City government would have invested in a construction activity of similar, or greater magnitude.

**E.5.2 Determining the emissions impact from leakages**

Table 43 indicates in which section of this document the emissions change due to leakages can be found.

<table>
<thead>
<tr>
<th>Leakage</th>
<th>Activity</th>
<th>Vehicles affected</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smelting removed vehicles</td>
<td>Buses</td>
<td>E.5.2.1</td>
</tr>
<tr>
<td>2</td>
<td>Transferring buses from a different service or route</td>
<td>Buses</td>
<td>E.5.2.2</td>
</tr>
<tr>
<td>3</td>
<td>Displaced buses are not scrapped</td>
<td>Buses</td>
<td>E.5.2.3</td>
</tr>
<tr>
<td>4</td>
<td>Buses have to dead-head to reach route</td>
<td>Buses</td>
<td>E.5.2.4</td>
</tr>
<tr>
<td>5</td>
<td>Competing buses on alternative routes</td>
<td>Buses</td>
<td>E.5.2.5</td>
</tr>
<tr>
<td>6</td>
<td>Modal shift from buses to other modes</td>
<td>Buses, cars, taxis</td>
<td>E.5.2.6</td>
</tr>
<tr>
<td>7</td>
<td>Shift from transport outside the project boundary to the buses</td>
<td>Buses, cars, taxis</td>
<td>E.5.2.7</td>
</tr>
<tr>
<td>8</td>
<td>Additional delay to cross the route affects several blocks</td>
<td>All vehicles crossing the route</td>
<td>E.5.2.8</td>
</tr>
<tr>
<td>9</td>
<td>Vehicles change to alternative routes outside the project boundary</td>
<td>All vehicles on the route except buses</td>
<td>E.5.2.9</td>
</tr>
<tr>
<td>10</td>
<td>Feeder route improvements adversely affect crossing traffic</td>
<td>All vehicles crossing the feeder route</td>
<td>E.5.2.10</td>
</tr>
<tr>
<td>11</td>
<td>Vehicles that used routes outside the project boundary transfer to the main route</td>
<td>All vehicles on the route except buses</td>
<td>E.5.2.11</td>
</tr>
<tr>
<td>12</td>
<td>Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions</td>
<td>Buses</td>
<td>E.5.2.12</td>
</tr>
</tbody>
</table>

**E.5.2.1 Leakage 1**

*Greenhouse gas emissions generated whilst smelting the old vehicles removed from service*

Leakage 1 = more fuel burned due to smelting the old vehicles removed from service (tons of CO₂<sub>eqiv</sub> over the construction period)

Leakage 1 affects the first year only and generates an ex-ante mean increase of 176 ton/yr of CO₂<sub>eqiv</sub> with an expanded uncertainty (lower 95% bound) of 96 ton/yr. The lower 95th Confidence Level is 272 ton/yr.
This is given by equation 24 in E.2.1. The difference in liters of fuel consumed (by fuel type) given by equation 24 is converted to tons of CO₂ equivalent GhG emissions following IPCC factors and rules by using equation 39 (section E.5.1.1 and NMB section I.4.) and parameters expressed in table 23 (section D.2.4.1).

**E.5.2.2 Leakage 2**

*Transferring buses to the project activity that were previously in service on a different route*

This leakage concept is not included in the Insurgentes BRT corridor project thus this term does not participate.

**E.5.2.3 Leakage 3**

*Buses displaced by the project activity are not scrapped*

The ex-ante value of this leakage (terms on a white background in equation 28) is zero due to the assumption that the vehicles finally scrapped from the other route outside the project boundary will equal in number, daily km and fuel economy those vehicles from Insurgentes that were not scrapped and replaced them. With ex-post data this number will almost certainly change.

**E.5.2.4 Leakage 4**

*Buses have to dead-head to reach their route*

This leakage concept is included in the Insurgentes BRT corridor project and the additional distance and emissions involved is included in Component 1. This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

**E.5.2.5 Leakage 5**

*Competing buses on alternative routes*

This leakage concept is not included in the Insurgentes BRT corridor project thus this term does not participate.
**E.5.2.6  Leakage 6**

*Project activity causes modal shift away from the buses*

The ex-ante value for this leakage is zero.

---

**E.5.2.7  Leakage 7**

*Shift from other modes of transport (outside the project boundary) to the buses*

This leakage concept is included in the Insurgentes BRT corridor project and the additional emissions involved are included in Component 5 and Component 6. This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

---

**E.5.2.8  Leakage 8**

*Additional delay to cross the main route for traffic is so great that it affects several blocks either side of the main route.*

This leakage concept is included in the Insurgentes BRT corridor project and the additional emissions involved are included in Component 9. This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

---

**E.5.2.9  Leakage 9**

*Prohibition of left turns, the elimination of crossing-points or other factors force vehicles to change to alternative routes*

This leakage concept is included in the Insurgentes BRT corridor project. This leakage is not to be included in the “Leakage” part of equation 38 since it is accounted-for within the project activity calculations.

---

**E.5.2.10  Leakage 10**

*Feeder route improvements adversely affect traffic flow on their cross-streets*

Feeder routes are not included in the Insurgentes BRT corridor project thus this term does not participate.
E.5.2.11 Leakage 11

Other vehicles that previously used routes outside the project boundary transfer to the main route

This leakage is not to be included in the “Leakage” part of equation 38 since it is automatically accounted-for within the project activity calculations.

E.5.2.12 Leakage 12

Project activity fuel-use or fuel-handling enhances pilfering or evaporative emissions

This leakage is not considered significant or measurable in the Insurgentes BRT corridor project thus this term does not participate.

E.5.3 Total Emissions Reduction

The total of the CO₂-equivalent emissions reduction attributable to the project activity is given by equation 38 and is shown in table 44 and Annex 5.6.

The methodology laid-out in NMB section I.2 is used to determine the measurement uncertainties associated with each component and leakage. At the selected level of confidence (usually 95%) the expanded combined uncertainty associated with all the components and leakages is determined and subtracted together with the leakages from the difference between the baseline and project activity. It should be noted that Components 10 & 11 apply only to the construction period of the project.

The individual sections of each route are added together with their expanded combined measurement uncertainty.

In a multi-route project the sum of the components and leakages for each individual route is determined together with their expanded combined measurement uncertainty.

\[
\text{Project Emissions Reduction} = (\text{Baseline emissions} – \text{Project Activity emissions}) – \text{Leakage} – \text{Expanded Measurement Uncertainty} \quad (38)
\]

The ex-ante value of the total emissions reduction are shown in section E.6 table 44 and Annex 5.6

where:

(Baseline – Project Activity) is calculated in sections E.5.1 together with their respective measurement uncertainties.

\(^{(101)}\) using a coverage factor \(k = 1.645\) for a one-sided 95% confidence level
Leakage is calculated in sections E.5.2 together with its respective measurement uncertainties. In all cases, the measurement uncertainty is expanded with a coverage factor of \( k = 1.645 \) which corresponds to the lower 95% Confidence Interval.

### E.6. Table providing values obtained when applying formulae above:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>32,194</td>
<td>0</td>
<td>176</td>
<td>25,415</td>
</tr>
<tr>
<td>2007</td>
<td>35,232</td>
<td>723</td>
<td>0</td>
<td>27,688</td>
</tr>
<tr>
<td>2008</td>
<td>35,232</td>
<td>1,574</td>
<td>0</td>
<td>26,849</td>
</tr>
<tr>
<td>2009</td>
<td>35,232</td>
<td>2,440</td>
<td>0</td>
<td>25,989</td>
</tr>
<tr>
<td>2010</td>
<td>35,232</td>
<td>2,913</td>
<td>0</td>
<td>25,521</td>
</tr>
<tr>
<td>2011</td>
<td>35,232</td>
<td>3,494</td>
<td>0</td>
<td>24,949</td>
</tr>
<tr>
<td>2012</td>
<td>35,232</td>
<td>4,049</td>
<td>0</td>
<td>24,401</td>
</tr>
<tr>
<td>Total Tonnes of CO2</td>
<td>243,586</td>
<td>15,193</td>
<td>176</td>
<td>181,209</td>
</tr>
</tbody>
</table>

Annex 5.6 provides details of each component and leakage. Please note that the above figures assume that the vehicle in-use fleet remains constant in vehicle-mix, VKT and fuel economy. Ex-post calculations will take into account the measured changes in these, and all other variables. The final values presented in the fifth column (Estimation of emission reductions) correspond to the lower 95\(^{\text{th}}\) confidence interval.

### SECTION F. Environmental impacts

#### F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

A separate environmental impact assessment (EIA) was conducted for Insurgentes corridor and has been filed with INFOSHOP\(^{102}\). METROBUS has made available the EIA in the City. In the EIA, the environmental impacts of the Project have been analyzed for each of the following phases of the project, and

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\(^{102}\) The InfoShop, The World Bank, 1818 H Street, NW, Washington, D.C. 20433, Tel: (202) 458-5454, Fax: (202) 522-1500, Web: http://www.worldbank.org/infoshop
provisions were included in the project budget to finance the reduction measures. The construction has been largely finalized and the operation has started as of June 19, 2005. The reduction measures implemented included:

**Preparation Phase:** activities prior to construction, including evacuation, expropriation, protection of the area.

**Construction phase:** including activities to prepare the terrain, the removal of vegetation, earthwork, transport, final disposal, improvement of pavement, and activities to build the actual infrastructure, such as stations, pedestrian facilities, barriers for corridor and others.

**Operation Phase:** include the activities that result from the project, including impacts on traffic (change of routes, improved public transport, changes in individual transport) and the maintenance (operation of stations and depots, traffic management systems).

Most environmental impacts are generated during the construction phase of the project. The infrastructure investments will take place within the existing right-of-way of the Corridor and will make use of existing road infrastructure. Investments will focus on strengthening the pavement, bus corridor segregation, construction of stations and access facilities, improvement of sidewalks, and rearrangements of traffic signs and signals. The main impacts include increased levels of air, soil, water and noise pollution, solid waste, limitations on traffic circulation, interruptions in services, damage to existing green areas, energy and fuel use and others. Possible impacts during operation include air, noise, soil and water contamination from the terminals and parking/maintenance areas and increased accidents due to improper design. Possible impacts during operation include air, noise, soil and water contamination from the terminals and parking/maintenance areas.

Environmental benefits predicted by the EIA include a rationalization of the 'collective' transport system, a decrease in travel time, and the reduction of air and noise pollution. Reduction measures during operation of the corridor are included as well in the monitoring program of the Emission Reductions Purchase Agreement.

**Scraping program.** The permit for new vehicles (large capacity buses) to operate on the new corridor is provided against a corresponding scrapping certificate. This applies to ¾ of the vehicles being replaced on Insurgentes. The reminder will substitute highly polluting vehicles outside the corridor. The verification and validation procedures with regard to the emission reductions will monitor the scrapping arrangements throughout project implementation. The scrapping of the replaced vehicles won’t lead to an increase of bus traffic on other avenues given that the transport ministry of Mexico City (SETRAVI) has frozen the issuance of concessions for bus-route operations city-wide. The project will therefore result in a net reduction of vehicular traffic on the Insurgentes Avenue.

**Impacts on cultural heritage.** Although difficult to quantify, the EIA does not expect that the construction or operation of the corridor will have any negative impact on cultural heritage or historic buildings.

**The Monitoring and Reduction Plan** includes measures to address unforeseen impacts. A number of reduction measures are proposed to prevent or minimize environmental impacts or compensate for impacts.

**During the design phase** these include measures to:

- To locate and design bus yards to reduce air pollution and noise impacts on surroundings.
- Minimize impacts on existing corridor, including sidewalks, vegetation and street furniture.
- Minimize impacts on traffic during construction and operation.
• Reduce interruptions in services.
• Improve safety along corridor, stations and stops.

*During the construction phase*, reduction measures include actions to:
• Reduce increase emissions and noise due to construction activities.
• Minimize impacts on urban environment and surroundings of waste storage and disposal.
• Avoid impacts on groundwater.
• Minimize spatial needs.
• Reduce impacts of machinery and equipment on existing road infrastructure.
• Reduce interruptions in services.
• Other reduction measures during construction phase include traffic regulation and landscaping and urban improvements along corridors and the design and construction of bus yards, terminals and stops.

*During the operation phase* reduction measures include measures to:
• Reduce air and noise impacts of the bus operations along corridors.
• Protect groundwater in bus depots.
• Maintain the corridor and associated facilities.
• Control and manage traffic along corridor.

Numerous environmental analyses were completed during project preparation to ensure proper handling of potential impacts, and to ensure that potential environmental benefits are capitalized upon. As described above, the EIA analyzed the environmental impacts of construction of the corridor. Operational guidelines for bus scrapping were developed to ensure proper environmental management of this component. In addition to the required reduction measures, many environmental activities are integrated into the project.

**F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:**
SECTION G. Stakeholders’ comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:
Local Stakeholder consultation process to be completed

G.2. Summary of the comments received:

G.3. Report on how due account was taken of any comments received: