

# Border Environment Cooperation Commission Comprehensive Road Rehabilitation Project Tijuana, Baja California

## 1. General Criteria

### 1.a Project Type

**Project Name:** Comprehensive Road Rehabilitation Project for Tijuana, Baja California.

**Project Sector:** Air Quality

### 1.b Project Category

**Category:** Community environmental infrastructure project – Community-wide impact.

### 1.c Project Location and Community Profile

**Communities:** Tijuana, B.C.

**Location:** Located in the northwestern part of the state of Baja California, within the municipality of Tijuana.

**Location within the border:** Within the 100 km border area.

Figure 1 shows the location of Tijuana, in the northeastern part of the state of Baja California.



Figure 1. Location of Tijuana in the State of Baja California.

### Demographics

<b>Current population:</b>	1,540,072 (CONAPO 2008)
<b>Growth rate:</b>	3.00 %
Reference:	INEGI Year: 2005/CONAPO 2008
<b>Economically active population:</b>	561,002
Reference:	National Municipal Information System ( <i>Sistema Nacional de información Municipal, SNIM</i> )
<b>Median per capita income:</b>	\$ 2,902 pesos
Reference:	BECC estimation based on statistics by INEGI and the National Commission on Minimum Wages
<b>Primary economic activities:</b>	Manufacturing industry, tourism, trade, and services
<b>Marginalization Rate:</b>	-1.9000, Very Low (CONAPO)

### Services

#### Water System

Water coverage:	93%
Water supply source:	Río Colorado
Connections:	475,022

#### Wastewater Collection System

Wastewater coverage:	79.2 %
Domestic hookups:	413,942

#### Wastewater Treatment

Wastewater treatment coverage:	90 %
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#### Solid Waste

Solid waste collection coverage:	99%
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#### Street Paving

Street paving coverage:	60%
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### 1.d Legal Authority

<b>Project applicant:</b>	CEMEX Concretos, S.A. de C.V.
<b>Joint applicant:</b>	Municipality of Tijuana, Baja California.
<b>Legal instrument to demonstrate legal authority:</b>	The City of Tijuana, pursuant to the authority conferred by Articles 1, 3, 5, 6, 24, Section I; Art. 33 Section I; and Art. 34 and 36 of the Baja California Public Works, Utilities and Related Services Act ( <i>Ley de Obras Públicas, Equipamiento, Suministros y Servicios Relacionados</i> ), opened a public bid process

and granted a contract to CEMEX Concretos SA de CV for the construction of the tasks included in the Comprehensive Road Rehabilitation Program (PIRE). The above process was completed with the issuance of a Contract Award letter on September 25, 2008. Contract Number: AYTO-TIJ-2008-LP-001.

**Date of instrument:**

October 27, 2008

**Compliance with Agreements:**

- 1983 La Paz Agreement, or Border Environment Agreement
- 1990 Integrated Border Environmental Plan (IBEP)
- 1994 North American Free Trade Agreement (NAFTA)
- Border 2012 Program

### **1.e. Project Summary**

**Project Description and Scope:**

The Comprehensive Road Rehabilitation Project for Tijuana, Baja California is a key component to upgrade the existing damaged road infrastructure network in Tijuana by implementing tasks to preserve and maintain the city's main roadways through their partial or total rehabilitation using hydraulic concrete. The purpose of the project is to minimize traffic congestion and bottlenecks and overall, to streamline the vehicle flow in the city's main roadways. In addition, the project will result in various environmental benefits, as it will enhance the local infrastructure and urban image, and the quality of life of area residents.

The main objective of the project that proposes repaving primary roadways in Tijuana, B.C. is to enhance urban mobility, in addition to improving the air quality in the Tijuana-San Diego County common binational airshed.

**Components:**

Paving

The project is as follows:

- Repaving 160 km of primary roadways in Tijuana, which make up the city's 17 main traffic corridors. The 17 traffic corridors are divided into 42 boulevards with an average age of 30 years.

- The project intends to increase the city's hydraulic concrete pavement coverage from 30.2% to 40.7%. The project cost is estimated to be 1,704.96 million pesos.
- The project will be executed over a period of two years, with construction tasks beginning in November 2008.

Pursuant to studies developed in the project area and strategic locations within the city during the last few years (2000-2008), street paving has been repetitive in the same primary boulevards, an action that has inadequately channeled grant funding to roadway rehabilitation and maintenance tasks, including pothole repairs. Within the last four years, an average of \$94.8 million pesos has been spent annually on actions that failed to address even the minimal maintenance needs of local boulevards and roadways; year after year, the same roads and boulevards have to be repaved after the rainy season.

Additionally, studies have been developed to create various diverse traffic behavior tools that help generate traffic volume and vehicle composition data for pavement design purposes, as well as information on the load capacity of different types of pavement to determine their viability.

**Population Benefited:**

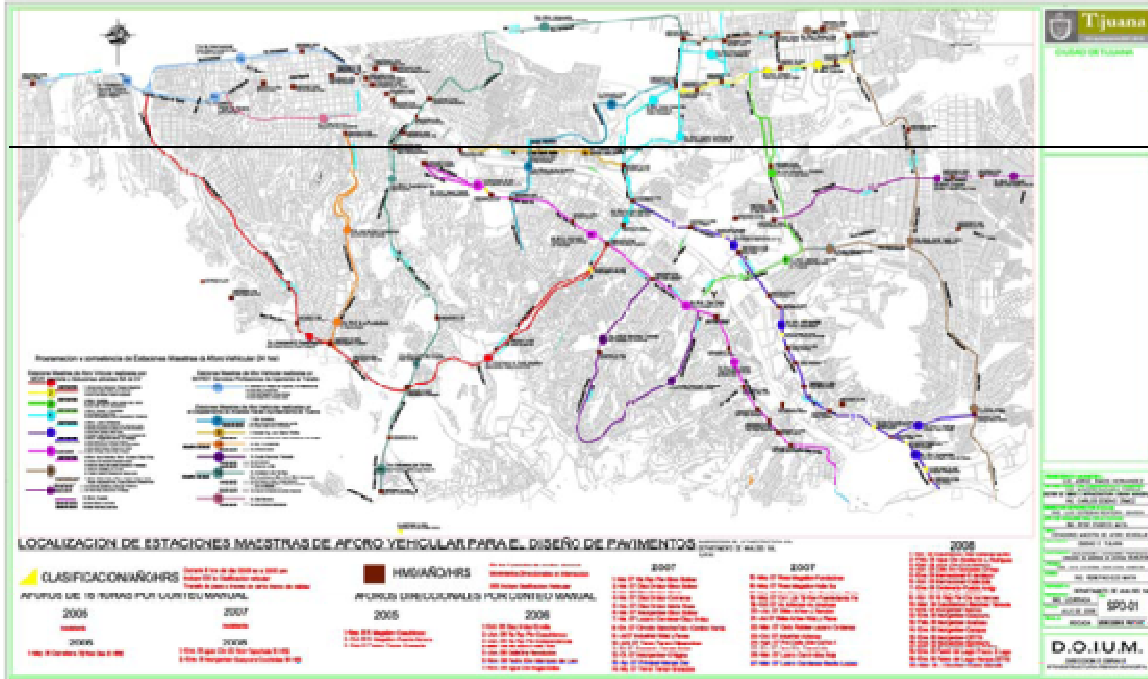
1,540,072 residents

**Project Cost:**

\$1,704.96 million pesos

**Project Map:**

The following figures show the main sectors of the city that have been included in the street paving program.



**Figure 1. Location of roadways proposed for repaving in Tijuana, Baja California**



**Figure 2. Location of roadways proposed for repaving in Tijuana, Baja California**

**Project Justification:**

The project is needed to reduce the concentration of contaminant air emissions (such as VOC, NO<sub>x</sub> y CO) in the Tijuana-San Diego airshed, by reducing the time required for travel by the average vehicle in the urban area and by eliminating the intensive use of asphalt on the maintenance and reposition of the thoroughfares included in the Project. In particular the health benefits from the Project include:

- Amelioration of the incidence of illnesses associated with air-borne pollutants by improving air quality;
- Mitigation of carbon and nitrogen oxides emissions into the atmosphere by facilitating traffic flows and by reducing the current pothole repair program to a minimum;
- Reduction in volatile organic compound emissions from: a) eliminating constant pothole repairs using hot asphalt mix; b) the repair and maintenance required by any asphalt surface as compared with a cement concrete surface; and c) improved traffic flow;<sup>1</sup>
- Decrease in Particulate Matter emissions by renovating road surfaces and eliminating potholes and cracks.

**Project need or consequences of the No Action Alternative:**

- The City of Tijuana, Baja California faces a severe air pollution problem caused by suspended particles and contaminant emissions associated to the use of vehicles on damaged roadways, a condition that is exacerbated by the use of old and contaminating vehicles that have exceeded their standard life cycle, more than 85 percent of which lack emission control systems.
- The no-action alternative means that the problem associated with dispersion of pollutants into the atmosphere will be aggravated, a situation that may pose respiratory health problems to area residents, inasmuch as sustained exposure to particulate matter that originates from vehicular fuel combustion may cause eye and nose irritation and an increase in respiratory problems. Street paving is the only proven and viable alternative to reduce fugitive dust produced by vehicle traffic.

<sup>1</sup> The recurrent application of asphalt overlays required to maintain the road surface in standard conditions can generate more than 90,000 tons of VOC emissions over the project life cycle of the Project.

- During the rainy season, the poor condition of the pavement results in rain water pools forming on the surface of local roadways, which also become sources of infections, primarily due to direct human contact with contaminated water.

**Prioritization Process Category:** N/A

**Pending Issues:**

None

**Criterion Summary:**

The Project consists of paving roadways in Tijuana, Baja California with hydraulic pavement, using the White Topping technique. The project is defined as an air quality improvement effort and it is located within the 100 km border area.

## 2. Human Health and Environment

### 2.a Compliance with Applicable Environmental and Cultural Resource Laws and Regulations

**Environmental and Public Health needs addressed by the proposed project:**

The impacts to human health associated to air pollution are determined by the concentration of pollutants, the type of pollutants present in the atmosphere, exposure time, and temporary fluctuations in pollutant concentrations, as well as recipients' individual sensitivities and the synergy between the different pollutants.

Beneficial environmental impacts that will result from the project's implementation include a reduction in pollutant emissions and the concentration of PM<sub>10</sub> particles in the Tijuana-San Diego airshed. Failure to implement the project will continue aggravating the problem of pollutants being dispersed into the atmosphere.

**The project meets the following applicable environmental laws and regulations:**

The implementation of the proposed project will contribute to achieve full compliance with the following standards:

Official Mexican Norm NOM-025-SSA1-1993

Establishes the maximum limits of PM<sub>10</sub> concentration in the environment, necessary to protect public health.

Official Mexican Norm NOM-020-SSA1-1993

Establishes criteria for evaluating the quality of environmental air with respect to ozone (O<sub>3</sub>).

Official Mexican Norm NOM-021-SSA1-1993

Establishes criteria for evaluating the quality of environmental air with respect to carbon monoxide (CO).

Official Mexican Norm NOM-022-SSA1-1993

Establishes criteria for evaluating the quality of environmental air with respect to sulfur dioxide (SO<sub>2</sub>).

Official Mexican Norm NOM-023-SSA1-1993

Establishes criteria for evaluating the quality of environmental air with respect to nitrogen dioxide.

Since these projects will be carried out within existing urban areas and roadways, a consultation with the National Anthropology and History Institute (INAH) is not required. Disturbances of any cultural or historical resources are not anticipated; however, should any cultural resources be found, construction tasks will be deferred until an assessment is performed by the INAH.



## 2.b Human Health and Environmental Impacts

### Human Health Impacts

#### Direct and indirect benefits to human health:

It is well known that whenever the speed of vehicles transiting through congested and badly preserved streets increases, the level of combustion gas emission decreases.

For the city of Tijuana, it is estimated that the rehabilitation of the streets under this project will allow vehicles to increase their speed from between 8 to 16 km/h (5 to 10 mph); thus, decreasing the emission of pollutants into the atmosphere such as: volatile organic compounds (VOC), nitrogen oxides (NO<sub>x</sub>), and carbon monoxide (CO).

The results given by the *Mobile6.2* model indicate that with an increase in speed from 32 to 40 Km/h (20 to 25 mph) the VOC, CO and NO<sub>x</sub> emissions will be reduced 6%, 3% and 4% respectively from their current levels, which equals 117 metric tons (MT) per year of VOC, 637 TM per year of CO and 118 TM per year of NO<sub>x</sub>. With an increase in speed from 32 to 48 Km/h (20 to 30 mph) the VOC, CO y NO<sub>x</sub> emissions will be reduced 10%, 5% and 7% respectively from their current levels, which equals 192 MT per year of VOC, 965 MT per year of CO and 185 MT per year of NO<sub>x</sub>.

Regarding the dispersion and emission of particulate material through vehicular traffic on the present streets, it was calculated based on the AP-42 indicators that each year 28 MT of PM<sub>10</sub> and 4.2 MT of PM<sub>2.5</sub> are emitted, with maximum current concentrations of 10 and 0.8 µg/m<sup>3</sup> in 24 hours estimated with *Aeromod*. Even though the modeled particulate material concentrations do not overpass the applicable limits for atmospheric quality (150 and 35 µg/m<sup>3</sup> within and average period of 24 hours for PM<sub>10</sub> and PM<sub>2.5</sub>), the percentage decrease this paving project will generate is significant.

Moreover, the traditional materials employed for street paving and their further maintenance, such as asphalt, are characterized for their high VOC emissions during their application and first year of operation. These emissions might be a risk for the public health of the people living nearby these streets.

Modeling of the emissions dispersion for VOC with *Aeromod* indicates applying asphalt might generate an hourly maximum concentration of 356 µg/m<sup>3</sup>, and a maximum concentration of 77 µg/m<sup>3</sup> in 24 hours during the first year of operation of the paved streets, which would affect people living nearby. This

estimation is based on the application of an emission factor<sup>2</sup> of 1.07 kgVOC/m<sup>2</sup> for paving with an asphalt layer of 6 cm of asphalt.

Within the area that would be affected by the VOC emissions generated by the repaving project, in case asphalt was used in the process, the figure for potential affected population goes up to 255,000 inhabitants,<sup>3</sup> and this would happen 4 to 6 times in a lapse of 30 years.

Based on the latter, it can be asserted that the use of alternative materials other than asphalt for paving, like hydraulic concrete, is an alternative that practically eliminates the polluting VOC emissions, and it is preferable in case it is actually economically feasible for the community.

The participation of the North American Development Bank (NADB) would allow the city of Tijuana the repaving of the streets using hydraulic concrete and obtain the indicated environmental benefits in behalf of its inhabitants.

Further additional benefits from the paving of the main streets at Tijuana using hydraulic concrete include the possibility to help decrease the heat isle effect within urban areas, the possibility to diminish the energy consumption by the lighting of the streets and the decrease in construction residues produced that would end up in the municipal landfill in case the paving is done using asphalt.

The *Mobile6.2* computer model estimates emission factors for HC, CO, NO<sub>x</sub>, exhaust particulate matter (PM), tire wear particulate matter, brake wear particulate matter, sulfur dioxide (SO<sub>2</sub>), ammonia (NH<sub>3</sub>), six hazardous air pollutants (HAPs), and carbon dioxide (CO<sub>2</sub>). These emission factors are modeled for gasoline-fueled and diesel vehicles, as well as specialized vehicles such as natural-gas-fueled or totally electric vehicles that may eventually replace the vehicles used at the present time (U.S. EPA, 2003).

In order to present a general quantification of emission reductions expected as a result of higher average speeds on local roadways –assuming an average speed increase of 20 km/hr–, a first step was using the *Mobile6.2* model as a tool for the development of this type of study.

*Mobile6.2* is a model used by EPA to estimate speed-dependent vehicle emissions from arteries and highways, as

<sup>2</sup> AP-42, Fifth Edition, Volume I, Chapter 13: *Miscellaneous sources*

<sup>3</sup> Resident population by AGEBS, Population Count 2005, INEGI.

well as non-speed dependent vehicle emissions from ramps and local roadways (Dowling, et al, 2005). Emissions estimated by *Mobile6.2* depend upon conditions such as ambient temperatures, travel speeds, operating modes, fuel volatility, and mileage accrual rates. Many of the variables that have an impact on vehicle emissions may be specified by the user. The model is used to estimate emission factors for vehicle years 1952 to 2050 (U.S. EPA, 2004).

*Aeromod* is a model employed to estimate concentrations of air pollutants from multiple sources: point, flare, area, line, and volume. This model is unique in that it is capable of estimating air pollutant concentrations based on turbulence expected from the planetary boundary layer (PBL), taking into account plume rise, downwash, urban and rural dispersion parameters, irregular shaped areas and, limited complex terrain (Franco, 2006).

**Health statistics:**

The air quality within the atmospheric basin for Tijuana-San Diego has been a concern for the last few years, for Mexico as well as the United States, since it is frequently compromised due to the congested and crowded local vehicular traffic.

The most recent morbidity statistics for the city of Tijuana<sup>4</sup> indicate that during 2006 there were 162,568 cases of acute respiratory infections (ARI), giving a rate of 1,091 cases out of 10,000 inhabitants. The ARIs were the 59.7% from all the reported diseases to the health department within the same year.

In that regard, every project helping to improve the air quality, however moderate its contribution might be, contributes in decreasing the ARIs incidences within the Tijuana-San Diego area.

In general, the Comprehensive Road Rehabilitation Project (PIRE) will reduce pollution in the Tijuana-San Diego airshed, particularly air pollutants that are currently estimated to exceed NAAQS levels and Official Mexican Norm NOM-021-SSA1-1993.

Residents of areas adjacent to deteriorated roadways are more exposed to air pollution, as they inhale higher pollutant concentrations than the average resident. Some of the short time effects of exposure include eye, nose, and throat irritation, as well as upper respiratory tract infections such as bronchitis and pneumonia. Long time effects may include chronic respiratory diseases, lung cancer, heart disease, and

<sup>4</sup> Secretary of Health for the State of Baja California, Medical Services Division No. 2, Tijuana, BC, 2006

even brain, nervous, liver, or kidney damage. Morbidity and mortality associated with air pollution episodes have also been observed in the area (Shen, et al, 2002; Nemmar, et al, 2004; Desantes, et al, 2005; Peters, 2006; Wilson, et al, 2006).

The following table shows health impacts resulting from exposure to such pollutants.

**Summary of Impacts resulting from Exposure to Air Pollutants**

Pollutant	Impact
Carbon Monoxide	Interferes with the blood's ability to transport oxygen to the brain, the heart, and other tissues. Unborn or newborn babies and people with heart disease are at a higher risk of being affected by this contaminant, but even healthy individuals may experience headaches, fatigue, and reduced reflexes as a result of CO exposure.
Nitrogen Oxides	The effect of NO <sub>x</sub> exposure on the respiratory system is similar to the effect of ozone and sulfur dioxide exposure. Negative health impacts include breathing difficulties and respiratory problems, lung tissue damage, and even premature death. Minute particles penetrate the most sensitive areas of the lungs and cause or aggravate respiratory diseases, such as lung emphysema or bronchitis, and also aggravate heart diseases.
VOCs	Air pollutants such as benzene and formaldehyde are substances found in vehicle emissions that are known or suspected to cause cancer, genetic mutations, birth defects, or other serious diseases in people subjected even to relatively low levels.

**Environmental Impacts**

**Direct and Indirect Benefits:** The proposed tasks will immediately reduce combustion particle emission times by reducing the amount of time required by average vehicles for travel in the urban area. These improvements, without a doubt, will help reduce respiratory system illnesses and allergies, which are rather common in the region.

In addition to the direct benefit of reducing air pollutants, the project will also have a secondary effect by reducing the amount of airborne PM<sub>10</sub> particles.

The project's most significant impacts will occur during the development of paving tasks, due to the use of heavy machinery, which may cause considerable dispersion of PM<sub>10</sub> particles in the atmosphere. This impact will be temporary; once the streets are paved a reduction of airborne PM<sub>10</sub> particles will be achieved.

It is important to mention that the area affected by the project is located within the urban zone and therefore, no significant

biotic impacts are anticipated, as there are no sensitive habitats or ecosystems within the project area.

Potential benefits to be obtained by the implementation of the proposed project are as follows:

***Reduction*** of air pollutants

Vehicle fuel consumption and corresponding emissions will decrease, inasmuch as the new roadways will help reduce the time that vehicles spend idling or traveling at low speeds due to the condition of the pavement. In average a reduction between 1% and 7% may be obtained on concrete pavement, depending on the type of vehicles and average speeds<sup>5</sup>. Additionally, lower emissions will result in improved air quality for the region.

***Reduction*** of water ponding on the surface of existing roadways.

The City of Tijuana has been seriously impacted by the volume of water that flows through its streams, streets, avenues, and even through buildings, as it has caused significant material and human losses.

The existing infrastructure in the higher part of the sub-basins is minimal, inasmuch as it is limited to some drains, overpasses, and small sections of channeled streams. Water runoffs usually run along roadways and natural courses. In most of the cases, the existing infrastructure is insufficient, even in relatively low return periods, as established by the "Diagnostic Assessment of the Current Status of the Storm Drain System and Proposed Conceptual Solution for Flood Control in Tijuana, B.C."<sup>6</sup>

In the Tijuana main streets repaving project the additional benefits for using hydraulic concrete are only defined conceptually and include the reduction of heat isles, improvement regarding rain water and water quality from the Tijuana river basin.

Nonetheless urban heat isles can be identified measuring the temperature from the surface of the earth, and that it has an indirect but decisive influence upon air temperature, in practice it is quite difficult for the border communities in Mexico to

<sup>5</sup> American Concrete Pavement Association (ACPA), *Environmentally and Economically Sustainable Concrete Pavements*

<sup>6</sup> Diagnóstico de la situación actual del drenaje pluvial y propuesta de solución conceptual para el control de inundaciones en la ciudad de Tijuana, B.C, CNA, 1993

calculate the costs and benefits of a heat isles mitigation program. As a reference, some of the strategies for heat isles reduction, including urban reforestation, vertical gardens, reflecting roofs, and cold pavement have been implemented in such cities as Los Angeles, Sacramento, Salt Lake City, Honolulu, Chicago, Miami and Atlanta.<sup>7</sup>

The municipality of Tijuana encompasses a 123,863 hectare surface area; the urban area covers 63,314 hectares; the area proposed to be repaved under the PIRE project is 381 hectares. It has been established that with the implementation of the proposed program, the increase in the runoff coefficient as result of the change from asphalt to concrete will be minimal.

#### ***Reduction*** of PM<sub>10</sub> particle emissions

The wear and breakdown of pavement surfaces is known to be a major source of particle emissions. The condition of pavement surfaces that have exceeded their mean life, have had deficient maintenance, or support traffic loads heavier than their design specifications, becomes a significant factor for the release of PM<sub>10</sub> on paved roads. Cracks, potholes, and the lack of curbs result in the accumulation of sediment on paved surfaces. "In extreme cases, a road may capture such level of sediment deposits on its paved surface that it is better characterized as unpaved in nature."<sup>8</sup>

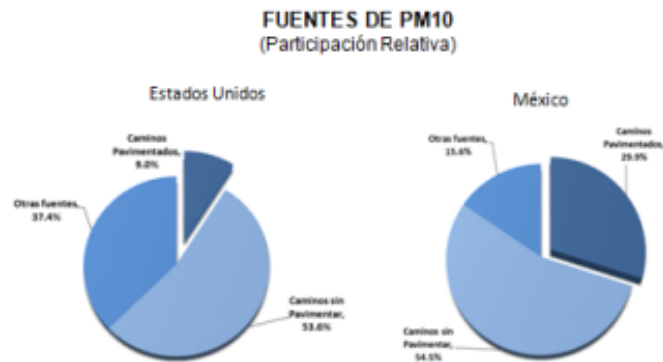
The poor condition of street pavement in Mexico is one of the main causes of PM<sub>10</sub> releases in this country, as compared with the United States. The inventory of emissions for the northern border has established that in Tijuana and Ciudad Juarez, paved roadways are the second most important source of airborne dust and particularly PM<sub>10</sub>.<sup>9</sup> Said inventory reflects the following PM<sub>10</sub> sources for the United States-Mexico border:

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<sup>7</sup> U.S. Climate Change Technology Program – *Technology Options for the Near and Long Term*, November 2003 – Page 30

<sup>8</sup> EPA, Control of Open Fugitive Dust Sources”, September 1988, EPA-450/3-88-008, p. 2-1:  
[http://www.epa.gov/ttn/chief/old/ap42/ch13/s025/reference/ref\\_10c13s025\\_1995.pdf](http://www.epa.gov/ttn/chief/old/ap42/ch13/s025/reference/ref_10c13s025_1995.pdf)

<sup>9</sup> Paula Fields, Marty Wolf (2004) Border 2012 Baseline Emissions Inventory Technical Memorandum – Final, p7.



Fuente: Paul Fields, Marty Wolf [2004] Border 2012 Baseline Emissions Inventory Technical Memorandum – Final, Apéndice B, gráficos B-5 y B-12

In the particular case of Fugitive Dust released by paved roads, control techniques exist to prevent the accumulation of sediments on the surface (preventive measures) or to remove deposits (mitigating measures). Preventive measures include a direct and immediate method: covering roadways with non-erosionable materials.<sup>10</sup> This method is the most appropriate when the degree of pavement deterioration is such that the use of mitigating measures is ineffective or costly.

One of the most common techniques for covering paved roads with non-erosionable materials is the use of hydraulic concrete. Because of its extended life cycle and surface properties, hydraulic concrete is a material that minimizes sediment deposits. In the particular case of Tijuana, the site's terrain, the features of vehicles that travel on the city's main roadways, and the local climate, make the use of hydraulic concrete pavement the most appropriate option to minimize fugitive dust emissions.

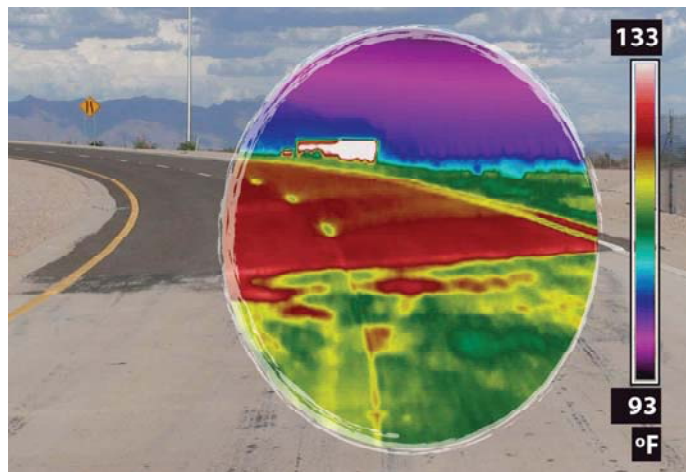
**Reduction** of lighting requirements in major thoroughfares, inasmuch as White Topping hydraulic concrete has a higher light reflection rate; therefore, a lower number of street lamps will be required to provide the same lighting effect on concrete pavement than would be required for asphalt pavement. This action is estimated to create 24% savings in lighting over the original power requirement (ACPA, et al).

<sup>10</sup> Watson, J.G. and Chow, J.C. "Reconciling Urban Fugitive Dust Emissions Inventory and Ambient Source Contribution Estimates", University of Nevada, May, 2000, Table 3-1



Tijuana has implemented a Lighting Program for the city's main boulevards for the 2009-2010 period. The program will begin in February 2009 and is expected to be completed in 2 years.

**Reduction** of pavement surface temperature to prevent global warming and heat island effects.



When exposed to sunlight, concrete reaches a temperature of about 21° F (12° C), which is lower than the temperature of asphalt.

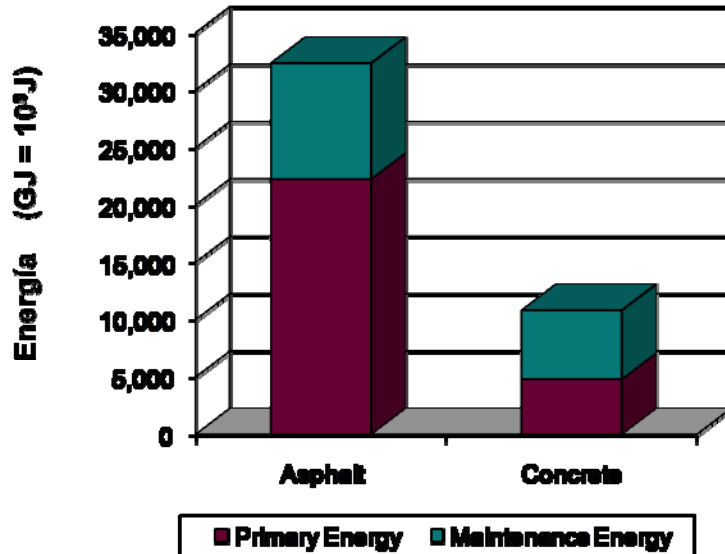
**Reduction** of the Carbon Footprint

A 50-year study<sup>11</sup> was conducted in Canada to document the amount of energy required for asphalt and concrete pavements, from their extraction, production, and transportation, to their maintenance on 2-lane, 1 km long stretches.

<sup>11</sup> A Lifecycle Perspective on Concrete and Asphalt Roadways: Embodied Primary Energy and Global Warming Potential, Athenea Institute



The results showed that asphalt requires from two to five times as much energy as the equivalent concrete pavement.



Greater energy requirements are directly related to pollution rates, given that the use of more energy to build and maintain a road results in more pollution from the increased energy requirements.

**Mitigation Measures:**

During the implementation of the project, measures will be taken to mitigate these temporary effects by introducing the preventive actions described below:

**Air Quality.** Air emissions levels must be minimized in order to offset adverse ambient air impacts during the construction phase. The above may be achieved by implementing the usual operational and emission control measures, such as following equipment manufacturers' emission control suggestions or requirements. Fugitive dust will be kept to a minimum by damping exposed areas with water at least twice a day, and this will be increased as the wind speed increases. Stockpiles will be covered, watered at least twice daily, and/or treated with non-toxic binders. During the construction phases, traffic speeds will be restricted on all unpaved surfaces to a maximum of 30 km/h. Temporary affected areas will be re-vegetated, paved or landscaped. The equipment will be kept appropriately maintained, and idling will be kept to a minimum while equipment is not in use.

**Noise.** Noise from the construction site will be intermittent and its intensity will vary. Contractors will be required to comply with any County or City noise ordinances. The contractor will be required to use appropriately maintained equipment and ensure that all equipment utilizes the manufacturers' recommended noise abatement measures.

**Traffic.** Traffic control plans will be developed, such that temporary signage will be placed around the construction site, trenches will be covered when construction is not active. The site will be fenced during construction; additionally, perimeter lighting will be placed to illuminate the equipment and supplies. One road lane will remain open at all times, which will establish safe passage through the construction zone and facilitate access to any existing residential, commercial, agricultural and public facilities within and adjacent to project vicinity.

**Energy Use.** Construction equipment will be inspected regularly to ensure efficiency in order to conserve energy.

**Other Green Building Efforts.** Native vegetation will be used for landscaping boulevards. For the disposal of waste pavement, temporary storage sites will be properly identified and waste disposal will be in accordance with applicable regulations. Accumulated material will be handled using best practices, and storage sites and requirements will be properly determined. Cutting and filling activities must be minimized, or materials available in the vicinity of the construction site must be used. Additionally, in accordance with green building practices, recycled water will be used for dust control.

**Impacts:**

The environmental impact resulting from the project will be positive overall, inasmuch as:

The project will reduce environmental pollution and will improve the quality of life of local residents by reducing the emission of air pollutants.

**Transboundary Impacts:**

Negative transboundary impacts are not anticipated by the implementation this project. In fact, it is anticipated that the project will have a beneficial impact, as a result of the foreseen improvement in air quality in the Tijuana, Baja California and San Diego, California common airshed.

**Formal Environmental Authorization**

**Environmental Authorization:**

Pursuant to the provisions of the General Law on Ecological Equilibrium and Environmental Protection regarding Environmental Impact Assessments, which is generally observed throughout the national territory and is regulated by the Executive Power through the Secretariat of the Environment and Natural Resources (SEMARNAT), the agency has determined that the project is not required to submit an environmental impact statement, as per Chapter II, Article 5, Sections A through V.

Road rehabilitation projects will be conducted on Tijuana's main roadways. No significant environmental impacts or imbalances are anticipated. The project will not impact environmental components in an irreversible or relevant manner, inasmuch as the project does not require the removal of vegetation for the completion of road paving tasks, and the proposed construction area has already been impacted by anthropogenic activities.

The Secretariat of Urban Development, through its Office of Environmental Protection in Tijuana, issued Official Communication DPA-DAA-0047-09 to establish that the type of tasks proposed by this project do not require the submission of an environmental impact study.

**Pending Issues:**

None

**Criterion Summary:**

The project addresses a major human health and environmental issue by reducing the emission of pollutants into the atmosphere, which has an effect on the increased respiratory disease rates among area residents. The applicable environmental authorizations have been obtained.

## 3. Technical Feasibility

### 3.a Technical Aspects

#### Project Development Criteria

**Design Criteria:**

The project was designed following standard engineering practices and complies with the applicable Municipal Code. There are standard street paving designs available that will be used as the basis for developing the final designs for selected streets. The project will use a technique called "White Topping," consisting of the construction of a hydraulic concrete layer over existing pavement.

**Project Components:**

**Hydraulic Concrete Pavement**

Covering asphalt pavement with concrete is a technique that has been long used successfully.

Given the particular design features of this technique, which considers binding flexible pavement to concrete, the construction procedure must take into account certain critical aspects to ensure the appropriate behavior of compound pavement surfaces.

**Thickness**

The thickness of toppings must range between 16 cm and 25 cm; conventional toppings are to be used when more concrete thickness is desired.

The need to consider adequate bonding and maintenance requirements are critical factors that strongly condition the design and construction of this type of road covering.

**Joint Spacing**

Spaces between joints, both across and along the surface, must be appropriate for the thickness of the topping; as currently established, approximately 10 to 15 times the thickness established. The construction of small slabs reduces tangential stress and warping in the interface, contributing thus to maintain adherence.

**Surface Preparation**

The removal of the existing layer of asphalt pavement may be achieved by different methods, but the need to provide a rough surface to enhance adherence must be considered. Experience has shown that the texture obtained by milling the surface, without any other treatment but surface clean up, provides adequate bonding to the interface.

After surface milling, the underlying asphalt pavement layer must be more than 7.5 cm thick, so as to make the design feasible, considering adherence requirements. Otherwise, the option must be dismissed and the project must be redesigned with a non-adhering, thicker topping.

### **Basic Characteristics of Concrete**

Concrete used for ultrathin toppings must conform to thickness requirements; consequently, the maximum size must not exceed 1/3, or preferably 1/4 of the thickness of the slab. Settling rates used are those typical for available equipment, with a range between 16 and 25 cm.

Typically, the concrete has to have good resistance. Cement unit contents are relatively high (360-450 kg/m<sup>3</sup>) and the water/cement ratio is low, being under 0.42.

The use of steel or synthetic fibers may contribute to control initial contraction, although satisfactory results have been reported without the use of fibers. Accordingly, fibers are not considered essential for the technique.

### **Project Construction**

Concrete application and compaction may be achieved by conventional methods, using vibrating rammers and immersion vibrators to compact edges when the use of a rammer is not effective.

Surface texturing does not involve any difficulties; however, once the concrete becomes rigid, it will be difficult to obtain the appropriate texture, or even efficient compaction.

### **Protection and Curing**

Concrete curing must be effective and performed immediately after texturing to reduce the potential for surface fissures. The use of chemical membranes suitable to be applied to the wet concrete surface is advisable.

If a wide temperature range is desired, or if the concrete is applied in cold temperature conditions, the use of insulation blankets is essential to reduce temperature variations in the concrete. This protective sheeting will also contribute to increase concrete curing speed, supporting thus a rapid evolution to full resistance and early completion.

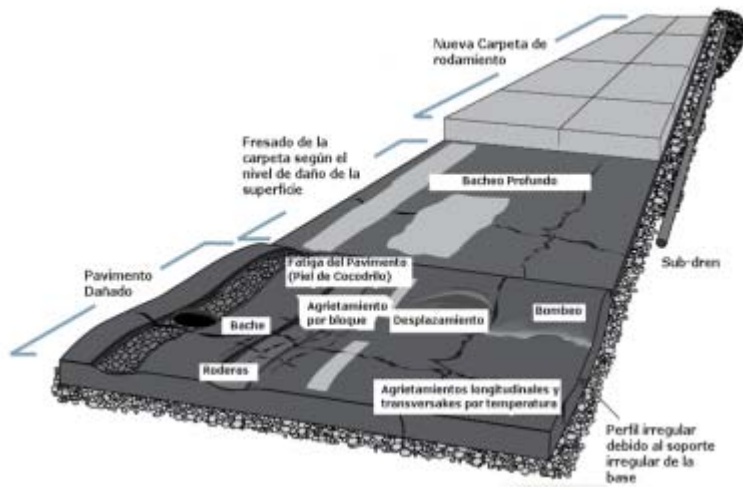
The removal of the protective blankets must be scheduled so as to reduce initial temperature gradients; thus, removal is recommended at times when the temperature is at its highest or

during the hours of sunlight, if operations are performed during the winter season. Insulation membranes may be counterproductive under warm weather conditions.

**Opening to Traffic Criteria**

Traditionally, the criterion for opening roads paved with bonded topping to traffic has been the same as the criterion for non-bonded toppings.

Hence, the most essential factor is not reaching a high compression resistance but rather, sufficient bonding stress to validate the "bonding" assumption.



**Other Design Criteria** N/A

**Appropriate Technology**

**Assessment of Alternatives:**

Roadways were selected for pavement rehabilitation based on traffic and vehicle flow study developed in the area and strategic locations throughout the city during the last few years (2000-2008). Various tools to assess vehicle flow have been developed using the following criteria:

- Roadways with higher traffic
- Major roadways in the city
- Access roads to strategic points of the city

Hydraulic concrete was selected to repave the city's main arteries with heavy traffic flow, in order to reduce maintenance and extend the surface life cycle. Additionally, based on a study developed by the city, a choice was made to either use the existing pavement as the base for the new covering, or to replace

the base with new pavement, as established by the final design for each roadway on a case-by-case basis.

The project applicant has established coordination with the State Commission for Public Services in Tijuana (*Comisión Estatal de Servicios Públicos de Tijuana*, CESPT) to ensure that water and wastewater collection infrastructure has been introduced in streets selected for paving. The final design outlines the proposed paving schedule is available.

### **Property and Right-of-Way Requirements**

#### **Requirements:**

Inasmuch as the proposed street paving project will be developed within the urban area and existing rights-of-way, no additional land or rights-of-way need to be purchased by the City, which has municipal jurisdiction over the project. Additionally, no land use changes will be made in the areas required for the project.

During the project's implementation, the City of Tijuana, through its Department of Public Works, will oversee the execution of the proposed construction tasks.

The City expects to complete the construction of this project within twenty-eight months, with tasks scheduled to begin in September 2008.

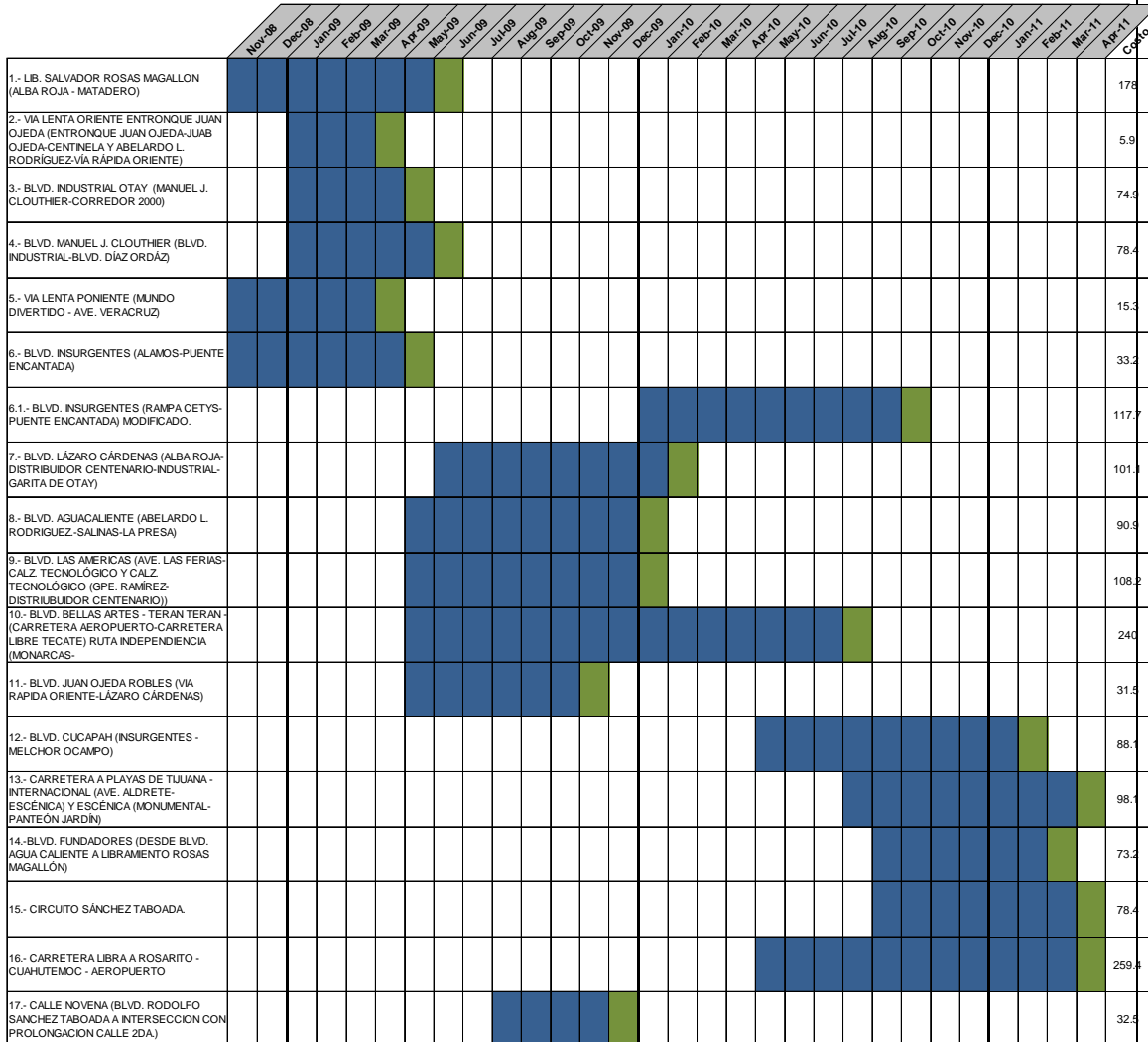
## Project Tasks and Timelines

### Project Timeline:

The figure shows the proposed project task schedule.



Programa de Obra proyecto "PIRE"



\*(Montos en millones de Pesos con IVA)

■ IMPLEMENTACIÓN ■ PAGO/ENTREGA DE PAGARE

Conforme al Apartado III.E.5. de las Políticas y Procedimientos de Crédito del BDAN , los periodos de gracia son negociables y pueden abarcar las etapas previstas para la construcción y puesta en marcha de los proyectos. En el caso del presente proyecto, el periodo de construcción es mayor a 24 meses, razón por la cual se está solicitando un periodo de gracia equivalente.

### Project Task Schedule



### 3.b Management and Operations

#### Project Management

**Resources:** According to the Internal Code of Municipal Public Administration and other applicable agreements and provisions, the City of Tijuana is empowered to provide maintenance to existing roadways by patching up potholes and carrying out other engineering tasks as required for the proper operation of the road infrastructure. The City of Tijuana, through the Department of Public Works, will be the agency responsible for implementing preventive and corrective maintenance, as well as for future mobility studies required by the city. Operation and maintenance costs will be considered as part of the city's operating budget.

#### Operation and Maintenance

**Organization:** The Tijuana Department of Public Works has a Director, Deputy Director, Unit Managers, and trained personnel to operate and maintain the system. Additionally, the city has available specialized personnel to provide technical support.

**Operation Plan:** The Services and Public Works Law requires the Department of Public Works to have an Operations Manual to provide maintenance to existing and future paved streets. A specific Operation and Maintenance Plan will be developed prior to the completion of paving tasks. The manual will include future corrective and preventive maintenance required by concrete structures throughout their life cycle.

**Permits, licenses, and other regulatory requirements:** The project was designed following standard engineering practices for concrete paving designs. There are standard street paving designs available that will be used as the basis for developing the final designs for selected streets. As previously mentioned, hydraulic concrete with the White Topping technique will be used for the project.

The project applicant has the following documentation available:

- Municipal Environmental Authorization, Official Communication DPA-DDA/0047/09, January 15, 2009.

**Reviewing Agencies:**

- CEMEX
- City of Tijuana, 2008-2010 Administration
- NADB
- BECC

**Pending Issues:**

None

**Criterion Summary:**

The Project for Tijuana will be built using the "White Topping" technique, which consists of the construction of a hydraulic concrete overlay on existing pavement. The project was designed following standard engineering practices to extend the surface life cycle and reduce maintenance requirements.

## 4. Financial Feasibility

<b>4.a Verification of Financial Feasibility</b>			
<b>Financial Conditions</b>			
<b>Information Presented:</b>	Municipality's Financial Statements.		
<b>Summary of Financial Analysis:</b>	Municipality has enough revenues to service the proposed debt.		
<b>Project total cost, financial structure and other capital investment plans</b>			
<b>Concept:</b>			
<b>Construction costs, management, supervision and contingency costs:</b>			
	\$1,704.96 millions of pesos		
<b>Total Cost:</b>	\$1,704.96 millions of pesos		
<b>Financial Structure:</b>			
		<b>Amount (Millions of Pesos)</b>	<b>%</b>
CEMEX	Equity / Loan	\$1,093.41	64
NADB	Loan	611.55	36
<b>Total:</b>		\$1,704.96	100
<b>Dedicated Revenue Source</b>			
<b>Revenue Source:</b>	Municipality's Federal Tax Revenues.		
<b>4.b Legal Considerations</b>			
<b>Project Administration:</b>	The project will be managed by CEMEX and the Municipality of Tijuana, who have adequate staff to oversee the construction.		
<b>Financing status:</b>	Loan contract to be signed once project is certified.		

**Pending Issues:**

None
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## 5. Public Participation

<b>5.a Community Environmental Infrastructure Projects – Community-wide impact</b>							
<b>Steering Committee</b>							
<b>Date of establishment:</b>	The Steering Committee was formally installed on January 14, 2009 at a meeting held in the Tijuana City Hall.						
<b>Steering Committee members:</b>	<p>At this meeting, a Board of Directors was elected, comprised of the following individuals:</p> <p>Chairman: Oscar Lepe-Peralta                      Secretary: Sebastián Lanz                      Alternates: Margarita Díaz, Emma Aguirre and Bruno Soto</p>						
<b>Date of approval of Public Participation Plan:</b>	The Comprehensive Community Participation Plan developed by the Steering Committee was approved by the BECC on January 15, 2009.						
<b>Public access to project information:</b>	<p>The project's technical and financial information was made available to the public for review.</p> <p>Project information was available at the following locations:</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr style="background-color: #cccccc;"> <th style="padding: 5px;">Location</th> <th style="padding: 5px;">Contact / Tel.</th> <th style="padding: 5px;">Address / City</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">Mayor's Office</td> <td style="padding: 5px;">664-973-7000</td> <td style="padding: 5px;">Independencia No. 1350, Zona Rio, Tijuana, B.C.</td> </tr> </tbody> </table>	Location	Contact / Tel.	Address / City	Mayor's Office	664-973-7000	Independencia No. 1350, Zona Rio, Tijuana, B.C.
Location	Contact / Tel.	Address / City					
Mayor's Office	664-973-7000	Independencia No. 1350, Zona Rio, Tijuana, B.C.					
<b>Additional outreach activities:</b>	<p>Additionally, the project's technical and financial information was made available on the following website: <a href="http://www.tijuana.gob.mx">www.tijuana.gob.mx</a></p> <p>Local organizations that represent community interests contacted to present them the project and request their support. The list of organizations contacted is as follows:</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr style="background-color: #cccccc;"> <th style="padding: 5px;">ORGANIZATION</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">Colegio de Ingenieros Civiles de Tijuana.</td> </tr> <tr> <td style="padding: 5px;">Colegio de Arquitectos de Tijuana</td> </tr> <tr> <td style="padding: 5px;">Cámara Mexicana de la Industria de la Construcción de Tijuana</td> </tr> <tr> <td style="padding: 5px;">Asociación de Constructores de Tijuana</td> </tr> </tbody> </table>	ORGANIZATION	Colegio de Ingenieros Civiles de Tijuana.	Colegio de Arquitectos de Tijuana	Cámara Mexicana de la Industria de la Construcción de Tijuana	Asociación de Constructores de Tijuana	
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Asociación de Constructores de Tijuana							

A project factsheet was developed and distributed.

On July 31, 2008 the State Congress approved the Comprehensive Roadway Rehabilitation Plan. As part of this plan, State Representatives unanimously approved the project's proposed funding scheme.

Radio and TV spots, flyers, and the print media will be used to provide the public information about road closures, re-openings, and detours related to the construction work in process, so as to coordinate actions and prevent traffic congestions. These outreach actions will be targeted to the general public during the week, and 1 to 2 weeks prior to each occurrence. About 1,000 informational spots were broadcasted during the first two months of the project.

Additionally, the City of Tijuana, through the Divisional Subcommittee on Urban Development headed by the Secretary of Urban Development, will present project status reports to City Council members, trade chambers, business organizations, and the community at large, to provide monitoring and follow up to the PIRE program.

**First Public Meeting:** The public meeting was held by the city council on July 25, 2008 to present the project to the public.

**Second Public Meeting:** N/A

#### **Final Public Participation Report**

**Final Report:** The Steering Committee and the applicant prepared the Final Public Participation Report to demonstrate that the proposed objectives were fully met to BECC's satisfaction.

#### **Post-Certification Public Participation Activities**

**Post-Certification Activities:** The project applicant, in coordination with the Steering Committee, will provide a general description of public participation activities that may be carried out after the project's certification to support its implementation and long-term feasibility.

#### **Pending Issues:**

None

**Criterion Summary:**

The project has support from local residents
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## 6. Sustainable Development

### 6.a Human and Institutional Capacity Building

**Project Operation and Maintenance:**

The project applicant will be the agency responsible for operating and maintaining the system through the Secretariat of Urban Development.

The applicant has the basic institutional and human capacity to operate and maintain the project through the use of:

- Trained personnel
- Training program
- Operations Manual for roadway maintenance

**Human and Institutional Capacity Building:**

Actions considered by the project will strengthen the City of Tijuana by increasing its management capabilities over its roadway systems due to a reduction of the maintenance needs.

### 6.b Conformance to applicable Local, State, and Regional Regulations and Conservation and Development Plans

**Local and Regional Plans addressed by the project:**

The proposed project conforms to applicable plans and actions described in the following documents:

- 2008- 2013 State Development Plan
- 2008- 2010 Municipal Development Plan
- The project adheres to the U.S.-Mexico Border 2012 Environmental Program by meeting Goal 1 –Reduce air emissions as much as possible, towards the attainment of each country's national ambient air quality standards, and reduces exposure to contaminants in the border region.

**Laws and Regulations addressed by the project:**

The project meets applicable municipal regulations pursuant to road operations within the city.

### 6.c Natural Resource Conservation

- The final design will include the implementation of green building practices as part of the technical construction specifications.
- The purpose of the project is to improve the quality of air in the Tijuana air basin, and benefit the health of residents of the border region without deteriorating the environment.

- The project contributes to reduce environmental deterioration by facilitating traffic flow on the existing roadway system and by reducing the waste generation from the deterioration of roads.

#### **6.d Community Development**

The project will promote community development by reducing the incidence of respiratory illnesses in the region. Direct benefits to the community are foreseen, and include an improved quality of life of the population by reducing pollution levels; reducing travel times; promoting quick access to emergency, security and other public services; fostering economic development, and increasing the value of properties located adjacent to the project site.

#### **Pending Issues:**

None.

#### **Criterion Summary:**

The project complies with all sustainable development principles.



**Available Project Documentation:**

- Final Design of Paving Construction Project, developed by the Department of Public Works, 2008.
- Environmental Impact Finding from the Municipal Directorate of Ecology, Official Communication DPA-DAA-0047-09, January 15, 2009.
- Public Participation Plan and Final Public Participation Report (pending).