

Environmental Assessment Report

Summary Environmental Impact Assessment
Project Number: 40075
April 2007

Proposed Multitranche Financing Facility Pakistan: National Trade Corridor Highway Investment Program Tranche I: M4 (Motorway between Faisalabad and Khanewal)

Prepared by the National Highway Authority for the Asian Development Bank (ADB).

The summary environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

CURRENCY EQUIVALENTS

(as of 2 April 2007)

Currency Unit	–	Pakistan rupee/s (PRe/PRs)
PRe1.00	=	\$0. 0164
\$1.00	=	PRs60.73

ABBREVIATIONS

ADB	–	Asian Development Bank
CO	–	carbon monoxide
DC	–	design consultant
EIA	–	environmental impact assessment
EMP	–	environmental management plan
EPA	–	Environmental Protection Agency
IEE	–	initial environmental examination
MFF	–	multitranches financing facility
NEQS	–	national environmental quality standard
NESPAK	–	National Engineering Services Pakistan (Pvt.) Limited
NHA	–	National Highway Authority
NHMP	–	National Highway and Motorway Police
NTCHIP	–	National Trade Corridor Highway Investment Program
ROW	–	right-of-way
SC	–	supervision consultant
SEIA	–	summary environmental impact assessment
USEPA	–	United States Environmental Protection Agency
WHO	–	World Health Organization

WEIGHTS AND MEASURES

dB(A)	–	decibel
km	–	kilometer
ha	–	hectare
m	–	meter
mm	–	millimeter
PM ₁₀	–	particulates less than 10 micrometers in diameter
ppm	–	parts per million
µg/m ³	–	micrograms per cubic meter of air

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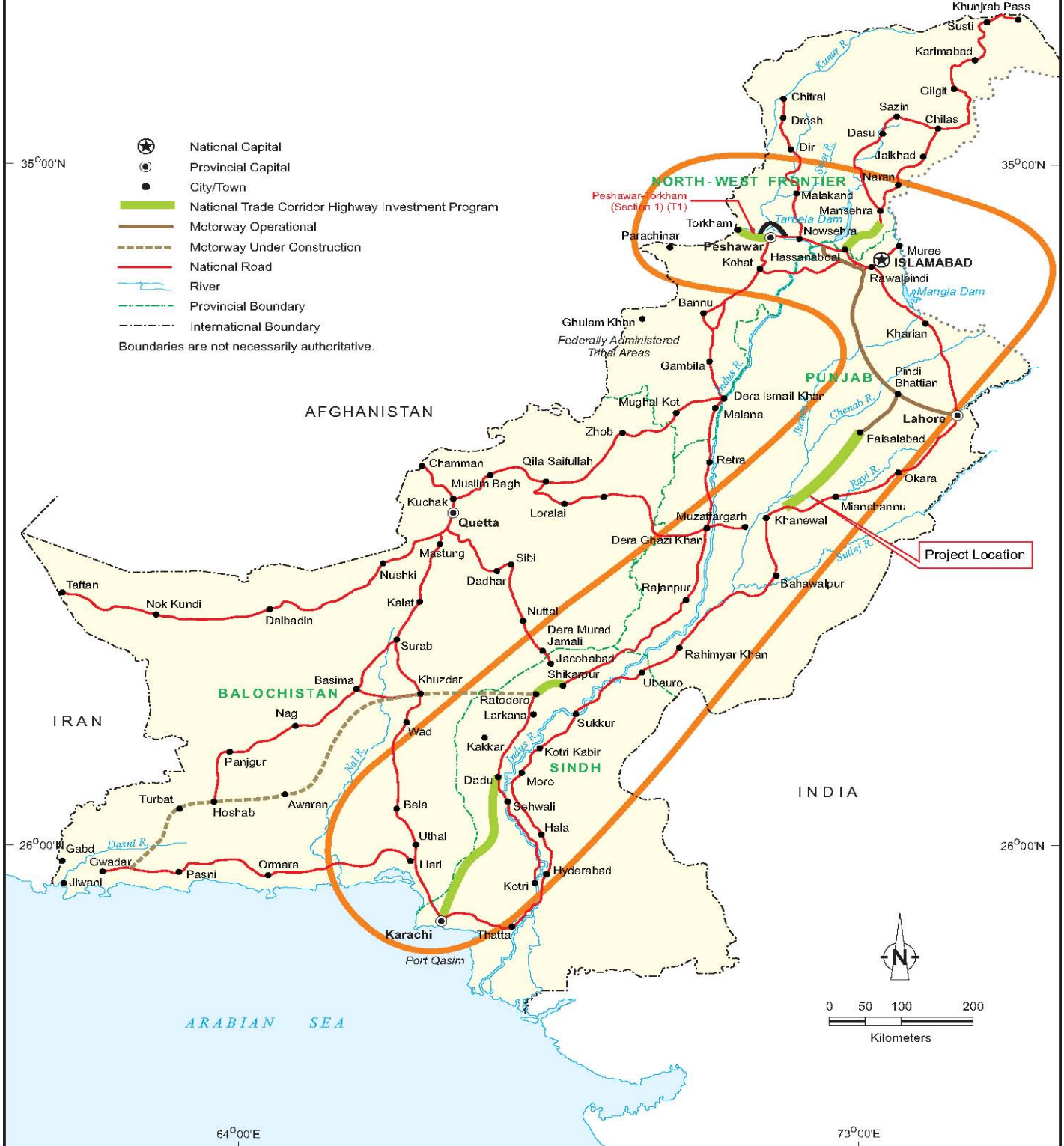
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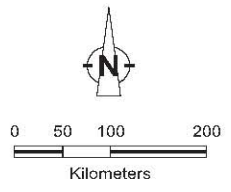
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PAKISTAN

NATIONAL TRADE CORRIDOR HIGHWAY INVESTMENT PROGRAM TRANCHE I: M4 (MOTORWAY BETWEEN FAISALABAD AND KHANEWAL)



Project Location



I. INTRODUCTION

1. This summary environmental impact assessment (SEIA) is based on the environmental impact assessment (EIA) prepared for the proposed construction of the Faisalabad-Khanewal Motorway (M4; the Project) under the National Trade Corridor Highway Investment Program (NTCHIP) Multitranchise Financing Facility (MFF). The EIA was prepared by the National Engineering Services Pakistan (Pvt.) Limited (NESPAK), contracted by the Project's executing agency, the National Highway Authority (NHA). The EIA was prepared consistent with the environmental assessment requirements of the Government of Pakistan,¹ and with the *Environmental Policy* (2002) and *Environmental Assessment Guidelines* (2003) of the Asian Development Bank (ADB).

2. The Project has been classified as category A (OM Section F1)² in accordance with ADB's *Environmental Assessment Guidelines*. Based on the Pakistan Environment Protection Agency Regulations (2000),³ the proposed Project falls under Schedule II,⁴ i.e., projects requiring an EIA. NHA plans to submit the EIA to the provincial Environmental Protection Agency (EPA) in April 2007. EPA's decision on the application for environmental approval is expected 3 months from EIA submission.

3. This SEIA briefly describes the Project, existing environmental conditions in the project area, anticipated environmental impacts and corresponding mitigation measures, public consultation process, and environmental management and monitoring plan.

II. DESCRIPTION OF THE PROJECT

4. The Government of Pakistan, through NHA, intends to construct M4 as part of NTCHIP. The prime objective of M4 is to improve trade flows and lower transit costs and travel time by providing a high speed, safe, and reliable access controlled motorway system. M4 will facilitate transportation of goods between Central Asia and China to the ports of Karachi and Gawadar, and will provide easy access for residents of Faisalabad, Toba Tek Sing, Khanewal, and Multan districts to Islamabad, Rawalpindi, and Lahore.

5. The Project falls under the administrative jurisdiction of Faisalabad, Toba Tek Sing, Jhang, and Khanewal districts. The road alignment starts at the end point of M-3 near Faisalabad and extends for 184 kilometers (km) to N-5 near Khanewal. M4 will include construction of a two-lane dual carriageway and construction of nine interchanges at road crossings. Two bridges will also be constructed, one at Sadhnai Spill channel and the other across Ravi River. The proposed carriageways will include inner and outer paved shoulders. The two carriageways will be separated by a median nine meters (m) in width. This median, will be provided with vegetation cover, and will allow for the construction of a 3.65 m lane on both carriageways, should future road expansion be undertaken. Total road width is 31.8 m. The

¹ The Pakistan Environmental Protection Act (1997); the Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations (2000); and Guidelines for the Preparation and Review of Environmental Reports, Government of Pakistan (November 1997).

² Projects with potential for significant adverse environmental impacts. An environmental impact assessment (EIA) is required to address significant impacts.

³ These regulations provide the following: (i) list of projects requiring IEE and EIA, (ii) rate of review fees, and (iii) process for filing and review of IEE and EIA.

⁴ Schedule II requires preparation of an EIA for federal or provincial highways or major roads that will cost more than 50 million PRs.

interchanges will have two lanes, each having a width of 3.5 m and a 1 m shoulder at its outer edge. About 350 culverts will be installed to maintain proper drainage. The new road will have a 100 m right-of-way (ROW). At the location of the proposed interchanges, the ROW widens to 300 m.

6. Strips of land—250 m wide and 700 m long—will be reserved along the M4 for service areas, where restaurants and petrol pumps will be located. There will also be provisions for 150 m wide x 200 m long rest areas on both sides of the motorway.

7. The construction is expected to employ more than 400 people for approximately 300 days per year over a 3-year period. Commencement of site works is expected in early 2008, with an estimated completion date of late 2010.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Environment

1. Meteorology

8. The climate of the project area is characterized by hot summers, which extend from April to October, and mild winters, which begin in November and continue until March. The hottest months are from May to July and the coldest are from December to February. The mean minimum and maximum temperatures are 4°C and 41°C, respectively. The project area has very low rainfall. The bulk of the monsoon precipitation occurs in July and August, with monthly averages of 115 and almost 90 millimeters (mm), respectively. The month with the least rainfall is November (3 mm).

2. Topography and Soils

9. The project area is composed predominantly of flat alluvial plains formed by the Chenab and Ravi Rivers; the predominant land use is agricultural. Soils are fertile alluvial loam. Sand, which is abundant in the Ravi and Chenab riverbeds, is ideal for use as a building material.

3. Surface and Groundwater Quality

10. The main water sources in the project area are the Ravi and Chenab rivers. The system of canals and watercourses that carries water from these rivers is the main source of irrigation. The Jhang, Guggera, and Burala branches are the major irrigation system for the project area, particularly for Faisalabad, Jhang, and Toba Tek Singh districts. Khanewal district is irrigated through the Sadhnai canal and Abdul Hakeem distributary. The proposed road will cross Ravi River and Sadhnai Canal, where two bridges are proposed to be constructed. Agricultural land is also irrigated by tube wells. Small-scale waterlogging and groundwater salinity problems were observed in the project area in Khanewal district. Waterlogged areas are located more than 1 km from the ROW. Local inhabitants use ground and surface water for drinking and other needs. The same sources will also be used for construction works. Filtered water will be provided to workers.

11. Ground and surface water samples from the project area were collected and analyzed. Groundwater test results showed that most of the samples did not meet World Health Organization (WHO) guidelines for drinking water parameters such as total dissolved solids,

chloride and sodium, and total coliform. Surface water conformed to limits prescribed by the national environmental quality standards (NEQs), with the exception of fecal coliform.

4. Air Quality

12. Agriculture is the dominant land use along the project corridor, and air quality can be considered good due to the absence of significant pollutant sources. Dust emission does occur, however, on sections of the proposed alignment traversed by existing roads and on exposed dry fields. In areas where interchanges and overpasses are proposed, large amounts of suspended particulate matter are generated when vehicles overtake other vehicles on unpaved shoulders.

13. To determine baseline ambient air quality conditions, seven monitoring sites were established near existing roads, as well as on agricultural fields that will be traversed by the proposed alignment. Sampling was conducted over a 24-hour period at the downwind side, about 5 to 10 m from the edge of the road. United States Environmental Protection Agency (USEPA) standards were used, as ambient air quality standards have not yet been developed in Pakistan. The peak recorded values for carbon monoxide (3 parts per million [ppm]), sulfur dioxide (0.02 micrograms per cubic meter of air [$\mu\text{g}/\text{m}^3$]), and nitrogen dioxide (0.02 $\mu\text{g}/\text{m}^3$) were well below the respective USEPA limits of 35 ppm, 180 $\mu\text{g}/\text{m}^3$, and 70 $\mu\text{g}/\text{m}^3$. Values for all particulates were below the 150 $\mu\text{g}/\text{m}^3$ USEPA limit, with the exception of particulates less than 10 micrometers (PM_{10}) in diameter, for which a peak concentration of 225.80 $\mu\text{g}/\text{m}^3$ was recorded at the starting point of the alignment in Faisalabad.

5. Noise

14. Much of the proposed road alignment will be in agricultural fields, so current noise levels are expected to be very low. Noise measurements were undertaken for a 24-hour period at the edge of the road (about 7.5 m from the source) where interchanges will be constructed. Average noise levels recorded along the road were between 40 and 70 decibels (dB)(A). Relatively high noise levels are generated only along those sections of the proposed alignment traversed by existing roads; the highest noise level recorded was 100 dB(A). The average noise level along the road crossings is close to NEQS and WHO limits; noise levels are expected to exceed these limits during the construction and operational phases. The average values for the section are all well within the NEQSs limit of 85 dB(A) and WHO guideline of 70 dB(A).

B. Ecological Environment

1. Flora and Fauna

15. Vegetation cover in the project area consists of major crops such as wheat, oilseeds, fodder, sugar cane, maize, rice, and cotton. Vegetables are grown near the towns. Citrus and guava orchards are common towards the northeastern section of the alignment, while mango orchards are found at the southwestern end. There are no natural forests in the area, but various tree species have been planted along field borders and water channels and patches of trees are found on crop fields. Dominant species are shisham or Indian rosewood (*Dalbergia sissoo*) and kikar (*Acacia nilotica*). Some of the species also noted include eucalypts (*Eucalyptus camaldulensis*), cotton tree (*Bombax ceiba*), Chinaberry (*Melia azedarac*), jamun or Java plum (*Syzigium cumini*), sukh chain (*Pongamia glabra*), mulberry (*Morus alba*), Indian jujube or Chinese apple (*Ziziphus mauritiana*) and date palm (*Phoenix dactylifera*).

16. There are no rare, threatened or endangered species of fauna in the project area as a result of removal of the natural forests for agricultural purposes. Jackal, mongoose, jungle cat, hedgehog, squirrel, and porcupine commonly occur. Small mammals such as a bandicoot or Indian mole rat, soft furred rat, field mouse, Indian gerbil, and house shrew are the common pests of agricultural crops. Domestic livestock include buffalo, cattle, goats, donkeys and sheep. Some farmers are also engaged in horse breeding. Camel may be found occasionally. Different species of reptiles and amphibians such as snakes, lizards, frogs and turtles are also found; various avian species known to occur in the area include partridges, egret, heron, myna, bulbul, babbler, crow, and sparrow. Common quail (*Coturnix coturnix*) visit the area during their spring and winter migration.

2. Fisheries and Aquatic Biology

17. Fish comprise the primary aquatic fauna reported from the rivers and canals in the project area, including various species of carp (*Cirrhinus mrigala*, *Catla catla*, *Labeo rohita*, *Hypophthalmichthys molitrix*, *Cyprinus carpio*, *Ctenopharyngodon idella*), catfish *Wallago attu*, *Rita rita*, *Bagarius bagarius*, *Mystus seenghala*), and exotic tilapia (*Tilapia mozambica*, *T. nilotica*). Aquatic flora consists of species usually found in the standing water along the canals and fish ponds including *Typha angustata*, *Polygonum flaccidum*, *Vallisneria spiralis*, *Potamogeton graminea*, *P. crispus*, *Hydrilla verticillata*, *Monochoria vaginalis*. No rare or endangered aquatic species occur in the project area.

3. Protected Areas

18. The nearest protected areas to the project area are Shorkot and Khanewal irrigated forest plantations, located eight and ten km, respectively, from the M4 alignment. Indian rosewood or *shisham* and eucalyptus are grown as commercial crops. Both plantations have been declared wildlife sanctuaries.

C. Sociocultural Environment

1. Areas of Cultural, Historical, or Archaeological Sites

19. Except for one Jamia mosque in Shorkot subdistrict, there are no known sites of cultural, historical or archaeological importance that will be affected by the Project.

2. Social Profile

20. The proposed alignment will pass through rural areas of the Punjab. The sociocultural conditions of all districts are similar. The total population of the *tehsils* or subdistricts (Faisalabad, Gojra, Toba Tek Sing, Shorkot, Kabirwala, and Khanewal) to be traversed by the Project is 3,366,208, based on 1998 census. Punjabi is the mother tongue and Saraiki is also spoken in some areas. *Shalwar kameez* and *dothi kurta* are the common garments of males and females. People belong to different races but due to frequent intermarriages, castes have intermingled and are now difficult to distinguish.

21. The majority of the inhabitants of the project area are Muslims, with Christians making up less than 1% of the population. Cultural festivals are mostly related to traditional religious events. Visits to shrines (*ziarat*) are common among the local inhabitants.

22. To establish a socioeconomic baseline for the Project, a survey of 100 males and 100 females from various areas in the vicinity of the alignment was conducted from January to February 2007. Of the 200 respondents, 142 were literate; of these 30% had primary level education, 28% had education up to secondary level, 24% reached the intermediate level, and 18% had either graduate or postgraduate education. As documented during the field survey, educational facilities (in about 103 villages in the vicinity of the project area) consist of 88 government schools for boys, 98 schools for girls, and 92 private schools. About 95% of the respondents had electrical connections and 15% had a water supply in their homes. Over half (53%) had open drain sewerage facilities, 23% had telephones (land line), and 9% had gas supplies in their homes. Farmers accounted for the largest group (29%); 16% were engaged in business, 10% were laborers, 17% were involved in allied agriculture professions (e.g., cattle farming, milk retail), 7% were employed in the service sector, while 17% were unemployed. The majority of the respondents (83%) had small land holdings of less than 10 acres. Only 2% had landholdings of more than 20 acres.

IV. ALTERNATIVES

23. **No Action Alternative.** Based on the traffic projection survey, approximately 14,561 vehicles per year will use the proposed Project at its commissioning in 2010. By 2020, this will increase to about 27,067 vehicles. The traffic volume was estimated using both diverted and generated traffic.

24. The “no project” alternative will result in traffic congestion along the existing Faisalabad to Khanewal road. The proposed Project is designed for high speed travel over a smooth surface and will be able to carry a larger traffic volume with shorter travel times.

25. **Alternate Transport Mode.** The alternate transport modes include railways, air travel and other access roads. Air access from Faisalabad to the other parts of the country is already available. Railways presently connect the project area with other parts of the country but travel by railway cannot be considered a viable alternative, in view of traffic patterns and poor connectivity with surrounding areas.

26. **Alternative Alignments.** The preferred alignment was selected because of the following advantages, in comparison with the other alternative alignments: (i) shorter distance; (ii) lower land acquisition and resettlement impacts; (iii) less disruption to graveyards and other community structures; (iv) less earth works, and therefore, reduced associated impacts due to extraction of materials, spoils disposal, dust emission, etc.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES

27. This section identifies the overall impacts of construction and operation activities on the physical, biological, and socioeconomic environment of the project area. Detailed mitigation measures are provided in Appendix 1 (Environmental Management Plan [EMP]).

A. Soil Erosion and Contamination

28. The proposed Project will be constructed on agricultural land, and soil fertility will be reduced if topsoil is not stripped, stored, and reused properly. Soil erosion generally takes place where ground cover is removed and inadequately reestablished. Due to construction of the proposed Project, soil erosion and contamination may take place around borrow pits, road

cuttings, embankments, construction camps, workshop areas, equipment washing yards, asphalt plants, batching plants, and fuel and chemical storage areas. Soil erosion may (i) affect road stability, (ii) increase flooding risk due to more rapid and higher levels of runoff and silting of water bodies, (iii) reduce landscape values, and (iv) may reduce the economic productivity of the land.

29. Impacts caused by soil erosion and contamination will be minimized by limiting, as much as possible, extraction of borrow materials to non-productive land areas and slopes with the least erosion potential, and by observing appropriate excavation depths. If borrow materials need to be extracted from fertile land, proper management of topsoil will prevent loss of soil fertility. Provision of fast-growing vegetation on road embankments will prevent scouring and encourage stabilization. Soil contamination by bitumen, fuel, and chemical storages shall be minimized by siting these facilities on an impervious base, within a bunded area, and secured by fencing. The base and walls of the embankment shall be impermeable and of sufficient capacity to contain 110% of the total volume of stored fuels and chemicals.

30. The disposal of waste asphalt shall be made in approved locations such as borrow pits or natural depressions and shall not be within the ROW. When necessary, impervious liners including walls and capping will be provided to prevent water from percolating through the waste materials and leaching toxic chemicals into the soil and groundwater.

31. Soil stabilization measures such as riprap or stone pitching at overpasses, bridges, culverts, and down drains will minimize soil erosion during the operational phase.

B. Water Quality

32. Wastewater from workshops at the construction and temporary camp sites will be treated using gravel and/or sand beds to remove oil and grease before it is discharged into natural streams. The work force will be trained on proper storage and handling of materials and chemicals. Work camps will be provided with toilets and septic tanks to handle sewage. Construction wastes will not be dumped into the river and canals.

33. Bridges and culverts will be constructed across irrigation canals and the Ravi River. To ensure unobstructed flow, the contractor shall ensure that construction wastes are not dumped into the river, canals, and drainage ditches. Work on irrigation canals will be kept to a minimum to avoid disrupting water supplies to crop lands; protective walls will either be constructed or repaired, as necessary.

C. Flooding

34. The proposed alignment will not pass through any flood-prone areas, and changes in the hydrological regime are unlikely. Proper design of bridges across Ravi River and Sadhnai canal will ensure that there will be no change in flow pattern. Provision of appropriately sized culverts and drains will prevent floods. About 3 to 5% of the land in the vicinity of the proposed project corridor is waterlogged and has salinity problems, but such areas are located more than 1 km from the proposed motorway, and are unlikely to be affected by the Project. However, to ensure that the Project will not aggravate the situation, drainage culverts will be provided at suitable locations. During operation, flooding will be avoided through proper maintenance of drainage facilities.

D. Air Quality

35. Emissions during construction will come from (i) dust due to transport of construction materials, aggregate preparation, extraction of borrow materials, and various site works; (ii) construction machinery and vehicles; (iii) asphalt plants; and (iv) uncontrolled burning of construction waste. Air pollutants may be carried over long distances depending upon the wind speed, direction, temperature of the surrounding air, and atmospheric stability, and may cause health impacts, e.g., coughing and eye irritation.

36. Mitigation measures will include (i) provision of dust control systems such as fabric filters or wet scrubbers for asphalt, hot mix, and batching plants; (ii) surface treatment or overlaying of diversion and haul routes with shingle and sprinkling water during dry periods, particularly in the vicinity of villages; (iii) ensuring that haul trucks carrying aggregate fill materials are kept covered; and (iv) enforcing the NEQS applicable to gaseous emissions for construction vehicles, equipment, and machinery.

37. During operation, maintenance of tree-lined strips of land on both sides of the road will help reduce the amount of particulate matter that may reach roadside settlements. A smooth road surface will also contribute to more efficient combustion and lower fuel consumption. Currently, heavy dust emission occurs at road crossings due to unpaved shoulders. The Project is not anticipated to cause dust problems because road shoulders will be paved.

E. Noise

38. To minimize noise generation during construction, heavy equipment and/or vehicles will be provided with mufflers. Activities that will generate excessive noise will be limited to daytime hours, as much as possible, particularly near settlements. Crushing plants will be located at least 500 m from critical receptors.

39. Increased noise levels during operation will be mitigated by providing adequate noise barriers, such as indigenous tree species, on both sides of the road and by increasing the wall heights of schools, mosques and other sensitive receptors. Coordination with local authorities may also be undertaken to enforce a ban on the use of horns in the vicinity of schools, mosques, hospitals, and residential areas.

40. The project area consists primarily of agricultural fields and some road crossings, and noise is a serious issue only at the road crossings. The average value of noise along the road crossings is close to NEQS and WHO limits, and is expected to exceed these limits during the construction and operational phases. Roadside noise levels were measured from the edge of the road (about 7.5 m from the source). The average noise level along the road is between 40 and 67 dB(A), whereas the peak noise level is between 61 and 100 dB(A). Average values for the entire section are all well within the NEQS standard of 85 dB(A).

F. Solid Waste

41. Solid wastes generated during construction will be safely disposed in an approved waste disposal sites. Prior to site works, the contractor will prepare a solid waste management plan, to be approved by NHA, which details garbage collection and disposal and promotes composting and recycling.

G. Siting of Construction Camps and Other Facilities

42. The precise location of construction camps and other facilities such as workshops, equipment washing yards, borrow pits, quarries, crushing plants, asphalt plants, batching plants, construction material storage areas, haul routes, and disposal sites for construction wastes will be determined by NHA in consultation with the contractors. It is recognized that these facilities may cause vegetation loss and permanent physical and visual impacts, and pose pollution risks. The following mitigation measures will be implemented to minimize such impacts: (i) construction camps, workshops, and crushing plants shall not be located within 500 m of critical receptors such as settlements, while asphalt hot mix and batching plants shall not be located within 1,000 m of settlements, schools, health facilities, and similar sites; (ii) locations with minimal vegetation shall be considered when selecting sites for construction camps and other facilities; (iii) sites for borrow pits shall be selected on the basis of type of soil strata, depth of water table, ground topography, prevalent vegetation state, and shall not be located within 100 m of the proposed project ROW; (iv) the contractor shall ensure that borrow pits are left in a tidy state with stable side slopes and proper drainage in order to avoid creation of stagnant water bodies, and that sites for temporary camps and other facilities are cleaned up and restored upon completion of site works.

H. Ecological Resources

43. It is estimated that a total of 18,000 trees, found in agricultural fields throughout the project area, will be cut. A tree-cutting permit shall be secured by the contractor prior to removal of vegetation. For every tree felled, four trees will be planted to compensate for the loss in vegetation. Planting shall be undertaken on a 25 m strip of land on both sides of the road. Selection of appropriate species and the design of the planting and maintenance program shall be carried out by the contractor in close consultation with the Forestry Department. The raised road median shall be planted with grasses and shrubs. Workers shall be prohibited from cutting trees for fuel. The project area has low faunal diversity; nonetheless, workers shall be prohibited from trapping or hunting wildlife.

44. An awareness campaign targeting neighborhood farmers will be conducted to promote tree planting. Organic farming will also be encouraged to minimize the use of chemical fertilizers and pesticides. Organic fertilizer (cow dung) is available in large amounts at minimum cost in the surrounding villages.

I. Land Acquisition and Resettlement

45. The proposed Project will be constructed on a new alignment for which about 1,940 hectares (ha) of land will be acquired; about 200 mud or brick structures will need to be demolished. There will also be losses due to removal of other infrastructure such as farmhouses, tube wells, and poultry farms. Mitigation measures will involve timely and fair compensation, to be paid to project-affected persons based on the Land Acquisition and Resettlement Plan.

J. Cultural Relics

46. Only one Jamia mosque, adjacent to a farmhouse in Shorkot *tehsil*, requires relocation. No other structures or sites of religious, archaeological or historical significance will be affected by the Project.

K. Social Conflicts

47. Workers will be encouraged to be sensitive to local customs and traditions, in order to minimize social friction. Good relations with local communities will be promoted by encouraging contractors to provide opportunities for skilled and unskilled employment to locals, as well as on-the-job training in construction for young people.

L. Public Utilities

48. Public utilities will be affected by the proposed project, disrupting public services and causing inconvenience. This impact will be temporary and will be mitigated by relocating affected utilities (e.g. water pipes, power and telephone lines) well ahead of the actual commencement of construction. This activity will be done in coordination with the concerned departments.

M. Road Safety and Traffic Management

49. Construction activities may result in traffic jams and inconvenience people passing through the road crossings where interchanges will be constructed. This impact is temporary and will be mitigated by providing alternate traffic routes during construction. Adequate warning signs in both directions will be provided at the approaches to road crossings.

50. Operation of the Project will pose serious safety risks to local residents, particularly in rural areas traversed by the new road. The proposed road will be fenced; to ensure the safety of pedestrian and livestock, alternative access routes and underpasses will be provided at short intervals, and at any existing crossing paths. Crossing locations will be determined in consultation with local communities. The smooth road surface will result in faster vehicular speeds and this may lead to road mishaps. The impact on road safety will be mitigated by enforcing speed limits. Rest areas will also be provided and traffic signs installed. The lanes, median, and sharp bends will be reflectorized for better nighttime visibility, and proper lighting will be provided.

VI. CUMULATIVE IMPACTS

51. Implementation of the M4 road project, in conjunction with other subprojects under the National Trade Highway Investment Program and other development activities in the corridor, may result in, among others, the following cumulative impacts, over a longer timeframe and beyond the project area: (i) an increase in air pollutants and green house gas emissions; (ii) land use changes due to improved access and economic growth; (iii) increased demand for and potential contamination of water resources; (iv) overall aesthetic transformation of the landscape; (v) changes in land values; (vi) improved health and sanitation conditions of residents due to better access; (vii) increased HIV/AIDS⁵ and sexually transmitted diseases-related public health risks, and increased drug and arms trafficking; (viii) poverty alleviation through trade promotion; and (vi) other impacts.

52. Potential interventions for the identified cumulative impacts, which are beyond the scope of the EIA for the Project, may be formulated at a strategic and regional level and include: (i) a sectoral and corridor-wide cumulative impact assessment study; (ii) a set of policy

⁵ Human immunodeficiency virus/acquired immunodeficiency syndrome.

recommendations addressing cumulative impacts; (iii) a set of mitigation or response programs with broader temporal and spatial dimensions beyond the Project's construction site and duration; and (iv) comprehensive review of development programs in land use, water resources, air quality, and public health and safety in response to the impacts to ensure the sustainability of the Project.

53. In conclusion, the anticipated cumulative impacts may not be significant unless viewed in a "corridor" perspective and together with other development activities. Considering the projected exponential increase in trade volume in the NTCHIP coverage area up to 2030, policy level, comprehensive consideration of impacts is necessary.

VII. ECONOMIC ASSESSMENT

A. Benefits

54. The economic benefits resulting from implementation of the proposed Project are decreased vehicle operating costs and travel time due to the improved road facility, reduced traffic congestion, uninterrupted and smooth traffic flow between Faisalabad and Khanewal, as well as increased commercial activity in the project area.

B. Costs

55. The total environmental cost has been calculated to be PRs4,057.859 million, including PRs3,960.359 million for resettlement (including training and monitoring) and PRs97.50 million for environmental mitigation. The environmental cost has been added to the project investment cost of PRs23,549.46 million. The total investment costs in financial terms is thus estimated as PRs27,606.46 million (PRs23,549 + 4,057 million); converted into economic terms (using the standard conversion factor of 0.90), this equals PRs24,846.59 million.

56. Annual operations and maintenance costs and overlaying costs have been calculated to be PRs58.874 million and PRs2,980.014 million, respectively; expressed in economic terms these equal PRs52.987 million and PRs2,682.013 million.

C. Economic Analysis of Environmental Impacts

57. It is difficult to quantify (in monetary terms) the environmental benefits arising from implementation of the EMP. Qualitatively, however, these benefits correspond to the following: (i) compensatory planting, i.e., for every tree felled, four will be planted; (ii) fuel efficiency improvement; (iii) air pollution (suspended particulate) abatement; and (iv) raised environmental and safety awareness of workers.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Environmental Management Plan

58. The EMP provides an approach to management and monitoring of environment-related issues and describes the institutional framework for environmental management and resource allocations to be carried out by NHA for mitigating negative impacts of the proposed Project.

59. NHA will ensure that (i) the EMP provisions are incorporated in the project design and specifications; (ii) EIA approval is secured from the Punjab EPA prior to site works; (iii) the

bidding documents include the EMP (i.e., mitigation and monitoring requirements) for implementation by contractors; (iv) EMP implementation is monitored and results are reported regularly; (v) there is coordination among concerned parties to effectively implement the EMP; (vi) additional mitigation measures are implemented as necessary; and (vii) appropriate environmental assessment, along with formulation of mitigation measures and a monitoring program, is undertaken should there be changes in the project design and specifications. NHA will be responsible for the compensatory tree planting program in coordination with the Forest Department, while the local community (especially women) will be encouraged to participate.

60. The contractor shall be responsible for implementing the mitigation measures and monitoring various environmental parameters during the construction phase. NHA shall monitor the contractor's performance with respect to EMP implementation. Prior to any site works, NHA shall require the contractor to develop an aggregate and/or borrow pits management plan, a spoil management plan, a construction camp management plan, a traffic management plan, a waste management plan, and a reinstatement or revegetation management plan. Such plans shall be reviewed and approved by NHA, and their implementation shall be monitored by the supervision consultants and relevant authorities.

61. Should there be any complaints arising from the implementation of the Project, NHA will conduct site inspections and appropriate sampling to validate claims. Based on the findings, mitigation measures during the construction and operational phases will be implemented by the contractor and NHA, respectively.

B. Institutional Capacity to Address Environmental Concerns

62. The Director (Environment, Social and Land/Resettlement) of NHA will have the overall responsibility of ensuring that the EMP is properly implemented. The Deputy Director for Environment, with the assistance of the supervision consultant, will be responsible for directly supervising the contractor in implementing the EMP. The supervision consultant shall: (i) organize periodic environmental training programmes and workshops for the contractors' staff and NHA site staff in consultation with NHA, (ii) develop "good practices" construction guidelines to assist the contractors and NHA staff in implementing the EMP, and (iii) monitor the progress of work and adherence of the contractor to the EMP and Resettlement Action Plan. The contractors shall ensure proper implementation of the EMP, which will be made a part of the contract agreement.

63. Appendix 2 presents the environmental monitoring plan, which has been prepared to guide project staff and other concerned parties in monitoring or assessing (i) actual environmental impacts of the Project on the physical, biological, and socioeconomic environment; (ii) unexpected environmental impacts; (iii) implementation of mitigation measures such as rehabilitation of borrow areas, tree planting, soil stabilizations schemes, etc.; and (iv) effectiveness of mitigation measures. Additional mitigation measures may be recommended as necessary.

IX. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

64. A series of consultations were carried out in January 2007 involving more than 300 local residents and local government representatives at the subdistrict and village levels of the four districts traversed by the Project. The meetings were held at various locations. Generally, people were aware of the need for the Project and indicated their support for its implementation.

The participants expressed that they should be part of a continuous consultation process with other stakeholders at different stages of the Project. During meetings conducted at the subdistricts, the key concerns raised in relation to the design and construction phases were: (i) the need to provide underpasses at shorter intervals; (ii) provision of interchanges at appropriate places to provide access for residents; (iii) minimizing dust emission by providing paved road shoulders; (iv) construction of a road median to enhance road safety; (v) installation of adequate drainage; (vi) planting trees of along the road to reduce noise and air pollution; (vii) implementation of a proper solid waste management plan; (viii) adoption of measures to minimize dust, smoke, and noise pollution, and to control material spillages; (ix) hiring of as much local labor as much as possible to avoid social conflict between migrant workers and local communities; and (x) provision of proper diversions for traffic during construction to avoid traffic congestion, related hazards, and dust emissions. For the operational phase, the participants recommended the (i) installation of warning signs; (ii) regulation or control of the use of loud horns near schools; (iii) addressing of issues pertaining to traffic problems/disorders and violations of traffic regulations; (iv) imposition of speed limits, as necessary; and (v) regular maintenance of drainage structures and collection of accumulated garbage within the ROW.

65. Primary issues raised by participants at the village meetings pertained to compensation for affected properties and crops, relocation of houses and structures, division of agricultural land traversed by the alignment, construction of interchanges and underpasses, safety risks, provision of service roads, and disruption of business activities. The villagers expect that the Project will provide better livelihood opportunities, including employment during construction, improvement of transportation facilities, shorter travel times, and better access to medical facilities and urban areas. It is also expected that the Project will spur economic growth in the rural areas and assist in reducing migration to big cities. These concerns were fully addressed by the EIA and project design.

66. The second round of public consultation was conducted in March 2007 in nine different locations within the project districts. The consultations involved a total of 949 residents from 101 villages. Concerns raised by the participants were related to accessibility to cultural sites (e.g., graveyards and shrines), road crossing facilities for pedestrians and farm equipment, areas where construction works will be undertaken, compensation for fruit trees, irrigation facilities that may be affected by the Project, and borrow areas.

X. CONCLUSIONS

67. As part of the NTCHIP MFF, the proposed Project has been conceived to provide fast and safe access to traffic using the Faisalabad-Khanewal Motorway (M4), which is expected to improve trade flows between Central Asia and China thru Karachi and Gawadar ports. The new road will lower transportation costs, shorten travel times and improve access for residents of Faisalabad, Toba Tek Sing, Khanewal, and Multan districts to Islamabad, Rawalpindi, and Lahore.

68. The supervision consultant to be hired under the Project will conduct training for the contractors and NHA on environmental management. NHA will be assisted by the supervision consultant in monitoring the contractor's EMP implementation performance. Regular monitoring of various environmental parameters will be undertaken to assess effectiveness of environmental controls, so that additional mitigation measures can be formulated and implemented, as necessary.

69. The EIA reveals that no major negative environmental impacts are likely to occur due to construction and normal operations of the proposed Project, provided mitigation measures are implemented and the proposed monitoring program is adequately carried out. The EMP includes measures to minimize project impacts due to soil erosion, air and noise pollution, waste generation, and vegetation clearing. Cumulative impacts of this Project and other related projects undertaken under NTCHIP should be viewed with a “corridor” and regional perspective, and mitigation or response programs formulated at the policy, cross-sectoral level. The M4 project is recommended for implementation, with adequate consideration of the EMP and cumulative impacts.

ENVIRONMENTAL MANAGEMENT PLAN

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
A. Design and Preconstruction Stage				
1. Soil Erosion	Road instability, increased flood risk due to more rapid and higher levels of runoff, silting of water bodies	Vegetation cover and/or stone pitching or riprap shall be provided on embankments and at bridges and overpasses.	DC	NHA
2. Change in Hydrologic Regime	Flooding in waterlogged areas	Culverts and drainage structures shall be installed at suitable locations.	DC	NHA
3. Seismicity	Seismic activities may damage structures	Project structures shall be designed consistent with seismic codes for the area.	DC	NHA
4. Public Utilities	Disruption of public utilities	There shall be provision in the design and budget for the relocation of existing utility infrastructure wherever required.	DC	NHA
5. Noise	Nuisance to adjacent communities	Provision for tree planting shall be included in the project design especially near the communities.	DC	NHA
6. Land Acquisition and Resettlement	Loss of about 1,940 ha of agricultural land and demolition of 200 mud or brick structures	Careful alignment and route selection shall be considered in the design to minimize land acquisition. Prior to site works, payment of fair compensation to affected people based on the Land Acquisition and Resettlement Plan shall be made.	DC Resettlement official at local government level	NHA
7. Loss of Access	Provision of fences on both sides of the road will block access of pedestrians and livestock	Overpasses and underpasses shall be constructed at appropriate intervals to facilitate movement across the project road.	DC	NHA
B. Construction Stage				
1. Borrow/open pits	Land disputes, soil erosion, loss of fertile cropland, loss of vegetation, landscape degradation, and damage to road embankments	Necessary permits from the competent authorities shall be obtained for any borrow pits. An aggregate/borrow pits management plan shall be developed prior to any site works.	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Health hazards due to formation of mosquito breeding grounds	<p>No excavations shall be allowed within 100 m of the ROW.</p> <p>The depth of borrow pits shall be regulated so that the sides of the excavation will have a slope not steeper than 1:4.</p> <p>Soil erosion along the borrow pits shall be regularly checked to prevent/ mitigate impacts on adjacent lands.</p> <p>Borrow pits shall be constructed with proper drainage to prevent the creation of mosquito-breeding sites.</p>		
2. Air Quality	Dust emissions from construction machinery, asphalt plants, and vehicular traffic. Emissions may be carried over long distances depending upon the wind speed, direction, temperature of the surrounding air, etc.	<p>The level of dust will be reduced through dust control, provided by equipping asphalt, hot mix and batching plants with fabric filters or wet scrubbers .</p> <p>Water shall be sprinkled across diversion tracks. Haul trucks carrying asphalt concrete mix and/ or aggregate fill materials shall be kept covered with tarpaulins to help contain transported construction materials.</p> <p>The NEQS applicable to gaseous emissions generated by construction vehicles, equipment and machinery shall be enforced.</p>	CC	NHA and SC
3. Construction waste disposal (wastewater, oil and solid waste etc.)	Contamination of water resources, health risks	<p>A solid and liquid waste management plan shall be developed prior to any site works.</p> <p>Wastewater from contractor's workshops and equipment washing yards will be passed through gravel/sand beds to remove oil/ grease contaminants before it is discharged into natural streams.</p> <p>The work force shall be trained on proper storage and handling of materials and chemicals that can potentially cause soil contamination.</p>	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>Solid waste generated during construction and in campsites will be properly treated and safely disposed of in demarcated waste disposal sites.</p> <p>Debris generated by dismantling of existing pavement structures will be recycled subject to the suitability of the material.</p>		
4. Siting of Construction Camps and Other Facilities	<p>Loss of tree plantations and vegetation, siltation and pollution risks if construction materials are extracted from river beds</p> <p>Conflicts with land owners</p>	<p>A construction camp management plan shall be developed prior to undertaking any site works.</p> <p>Construction camps, workshops, and crushing plants shall not be located within 500 m of critical receptors such as settlements; asphalt hot mix and batching plants shall not be located within 1,000 m of settlements, schools, health facilities and similar sites.</p> <p>Locations with minimal vegetation cover shall be considered when selecting sites for construction camps and other facilities.</p> <p>Materials shall be sourced from licensed quarry/borrow areas operations.</p> <p>Sites for borrow pits shall be selected on the basis of soil type, water table depth, ground topography, prevalent vegetation state, and shall not be located within 100 m of the ROW of the proposed Project. Borrow pits shall be prohibited in areas where they might interfere with the existing or designed drainage pattern.</p> <p>Proper drainage shall be provided to avoid creation of stagnant water bodies.</p> <p>Extraction of sand and gravel materials in river beds shall only be undertaken upon the approval of the concerned authority/agency.</p>	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>When materials such as gravel are removed from riverbanks the depth of extraction shall be kept at a reasonable level to ensure stability and minimal erosion; this activity shall not interrupt river flow or undermine the riverbanks.</p> <p>Construction material storage areas shall not be located adjacent to sensitive (e.g., residential) areas and shall be sheltered.</p> <p>The contractors shall use the selected routes approved by NHA for transport of construction materials. Any cost for repairing damage to these routes caused by overloaded or excessively heavy vehicles shall be borne by the contractor.</p> <p>Landowners shall be compensated according to the terms of lease agreements negotiated with them for constructing camps and other facilities.</p> <p>Upon completion of extraction activities, borrow pits will be left in a tidy state with stable side slopes and proper drainage in order to avoid creation of stagnant water bodies.</p> <p>Temporary camps and other facilities will be cleaned up and restored upon completion of site works.</p>		
5. Soil Erosion and Contamination	Road instability, increased flood risk due to rapid and higher levels of runoff, silting of water bodies, loss of soil fertility	<p>A reinstatement/revegetation management plan shall be developed prior to any site works.</p> <p>Borrow materials shall be sourced from non-productive and barren land in broken terrain, nullahs, and publicly recognized waste lands.</p> <p>The excavation of earth fill shall be limited to an approximate</p>	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>depth of 0.5 to 1 m.</p> <p>If the use of agricultural land is unavoidable, the top 30 cm of the plough layer shall be stripped off and stockpiled. Where deep ditching is to be carried out, the top 1 m layer of the ditching area shall be stripped and stockpiled for redressing the land after the required borrow material has been removed.</p> <p>Drainage interception ditches shall be built around the borrow pits to prevent erosion caused by surface runoff during the rainy season.</p> <p>Denuded ground cover shall be revegetated as soon as possible following fill placement to facilitate regeneration of a stabilizing ground cover.</p> <p>Road embankments and road cuttings shall be vegetated with a fast-growing crop and a native seed mix immediately after fill placement to prevent scour and to encourage stabilization. Stone pitching or riprap shall be used where appropriate, especially at overpasses, bridges, culverts.</p> <p>The down drains/discharge zones of drainage structures shall be furnished with riprap, masonry or concrete to reduce erosion.</p> <p>The gradient of side slopes shall be adjusted as needed to reduce erosion potential; if steeper, they shall be stabilized and covered with riprap or other material to prevent soil erosion.</p> <p>Construction shall be restricted to dry season as much as possible to avoid soil erosion.</p> <p>Siltation to water bodies shall be minimized through provision of</p>		

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>sediment basins, etc.</p> <p>Soil contamination from storage of bitumen, fuel and chemicals shall be minimized by storing these materials on an impervious base, within an embanked area and secured by fencing. The base and walls of the embankment shall be impermeable and of sufficient capacity to contain 110 % of the total volume of stored fuels and chemicals.</p> <p>Waste asphalt shall be disposed of in approved locations, such as borrow pits or natural depressions; these shall not be within the ROW. Unless located in areas with impervious soils, encapsulation with pre-laid impervious liners (including walls and capping) is required, the objective being to prevent water from percolating through the waste materials and leaching toxic chemicals into the surrounding soils. On completion of disposal at the site, the area shall be capped with impermeable soil (compacted thickness at least 0.5 m), covered with at least 200 mm of top soil, and landscaped.</p>		
6. Noise	Nuisance/ disturbance to nearby settlements and critical receptors	<p>Reduced noise levels shall be ensured through use of the latest equipment, with suitable built-in damping equipment and appropriate muffling devices.</p> <p>Activities that generate excessive noise shall be confined to normal daytime working hours.</p> <p>Construction workers shall be provided with suitable hearing protection (e.g. ear plugs or muffs). Nighttime use of heavy machinery (e.g. percussion hammers and pneumatic drills) shall be avoided.</p> <p>Crushers, concrete mixing plants, and material storage yards shall</p>	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		be located at least 500 m from residential areas, schools, hospitals and similar facilities.		
7. Surface and Groundwater Quality	<p>Contamination of surface water due to disposal of construction wastes</p> <p>Contamination of groundwater due to percolation of leachate from wastes</p>	<p>Wastewater from workshops at construction and temporary camp sites will be treated using gravel or sand beds to remove oil and grease before it is discharged into natural streams.</p> <p>The workforce shall be trained on proper storage and handling of materials and chemicals.</p> <p>Work camps shall be provided with toilets and septic tanks to handle sewage.</p> <p>Construction wastes shall not be dumped into the river and canals.</p> <p>Washing of machinery and vehicles in surface waters shall be prohibited. Sealed washing basins shall be provided and wastewater collected into a sedimentation/retention pond.</p>	CC	NHA and SC
8. Irrigation Canals	Disruption of irrigation water supply	<p>Work on irrigation canals shall be kept to a minimum to avoid disruption of water supply to crop lands.</p> <p>Protective walls shall either be constructed or repaired, as necessary.</p>	CC	NHA and SC
9. Flora	Cutting of 18,000 trees within the ROW	<p>A tree-cutting permit shall be secured by the contractor prior to removal of vegetation. For every tree felled, four trees will be planted to compensate for the loss in vegetation. Planting shall be undertaken on a 25 m strip of land on both sides of the road. Selection of appropriate species and the design of the planting and maintenance program shall be carried out by the contractor in close consultation with the Forestry Department.</p> <p>All old and mature trees falling in the proposed 25 m planting strips</p>	NHA	NHA, SC, and Forestry Department

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>must be saved. Efforts shall be made to save as many trees as possible.</p> <p>The raised road median shall be planted with grasses and shrubs.</p> <p>Workers shall be prohibited from cutting trees for fuel.</p> <p>Plants will be properly irrigated and maintained.</p> <p>An awareness campaign targeting neighborhood farmers will be implemented to popularize tree planting, with saplings provided at subsidized cost.</p> <p>Organic farming will be encouraged to minimize the use of chemical fertilizers and pesticides.</p>		
10. Health and Safety of Workers	Health risks due to unsafe working conditions	<p>Basic medical care shall be provided at camp sites.</p> <p>Workers shall be provided with a potable water supply.</p> <p>Appropriate protective equipment shall be provided.</p> <p>Designated staff shall be provided with basic medical training.</p> <p>Work camps shall be provided with facilities to ensure the safety of workers, e.g., fire-fighting equipment, adequate storage for hazardous materials, and contingency measures in case of accidents.</p> <p>Awareness campaigns/ orientation shall be implemented to educate workers on AIDS and other communicable diseases.</p>	CC	NHA and SC
11. Public Safety	Risk of drowning due to presence of water-filled borrow pits	Borrow pits shall be dewatered and fences shall be provided, as appropriate.	CC	NHA and SC

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Safety risks due to construction works	<p>The general public/local residents shall not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation.</p> <p>Work area will be fenced to avoid unauthorized entry.</p>		
12. Socioeconomic and Cultural Issues	<p>Social conflict due to presence of migrant workers</p> <p>Blocked/restricted access to mosques</p>	<p>Workers will be encouraged to be sensitive toward local customs and traditions to minimize social friction.</p> <p>Local labor shall be employed with an agreed ratio (>75%) for construction works. Women will be hired (10-20% of total labor requirements) as unskilled labor; remuneration shall be equal to that of men.</p> <p>Alternate routes will be provided.</p>	CC	NHA and SC
13. Traffic	Construction activities may cause traffic jams and inconvenience to people passing through the road crossings where interchanges will be constructed	<p>Alternative traffic routes shall be provided during construction, and adequate warning signs installed at the approach to road crossings from both directions.</p> <p>Traffic management shall be undertaken in coordination with the local traffic police department.</p>	CC	NHA, SC, and local traffic police department
14. Public Utilities	Site works may cause damage to public utilities thereby disrupting related services	Utilities such as water pipes, power and telephone lines that will be affected by the Project shall be relocated well ahead of the actual commencement of construction. This activity shall be done in coordination with the concerned departments.	CC	NHA, SC, and concerned local departments
C. Operation Stage				
1. Noise	Nuisance due to elevated noise levels	<p>Adequate noise barriers (e.g. indigenous tree species on both sides of the road) shall be provided.</p> <p>Height of walls surrounding schools and mosques may also be increased and other suitable measures may be implemented</p>	NHA	

Aspect	Project Impact	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>based on noise monitoring results.</p> <p>Coordination with local authorities may also be undertaken to enforce a ban on the use of horns in the vicinity of schools, mosques, hospitals and residential areas.</p>		
2. Flooding	Flooding may occur during heavy rains	Drainage facilities shall be regularly cleaned to ensure that these are free from obstruction.	NHA	
3. Road Safety	Occurrence of road accidents	<p>Speed limits shall be imposed.</p> <p>Rest areas shall be provided.</p> <p>Traffic signs shall be provided to warn road users about speed limits, rest areas, eating establishments etc.</p> <p>Lanes, median, and sharp bends shall be reflectorized to improve road visibility at nighttime.</p> <p>An emergency response plan for spills of hazardous materials and oil will be prepared prior to operation.</p> <p>Proper lighting shall be provided along the project road.</p>	NHA	NHMP
4. Air quality	Deterioration of air quality will occur along the project road	Tree-lined strips of land on both sides of the road shall be provided and maintained to help reduce particulate matter and gaseous emissions reaching roadside settlements.	NHA	

AIDS = acquired immunodeficiency syndrome, CC = construction contractors, DC = design consultants, ha = hectare, m = meter, NEQS = national environmental quality standard, NHA = National Highway Authority, NHMP = National Highway and Motorway Police, ROW = right-of-way, SC = supervision consultants.

ENVIRONMENTAL MONITORING PLAN

Parameter	Location	Standards/ Guidelines	No. of Stations	Frequency	Responsibility	Duration	Cost (PRs)
A. Preconstruction Stage							
Air Quality SO _x NO _x CO PM ₁₀	5 m from the edge of pavement downwind at selected sensitive locations (e.g. basic health unit, school, madrassa and residential/ commercial area)	134 ppb 106 ppb 35 ppm 200 µg/m ³	7	Once prior to construction at PRs50,000/location	Contractor	Continuous for 24 hours	350,000
Water Quality <i>E. coli</i>	Community groundwater sources near the edge of the ROW at selected locations along the project alignment	0 cfu/100 mL (WHO guidelines)	7	Once prior to construction at PRs1,500/test	Contractor		10,500
Noise Levels on dB(A) Scale	5 m from the edge of the pavement, at sensitive locations (e.g. basic health unit, school, madrasah and residential/ commercial area)	WHO noise guidelines	7	Once prior to construction at PRs500/source	Contractor	12 hours, readings taken at 15 sec intervals for 15 min every hour and then averaged	3,500
B. Construction Stage							
Air Quality PM ₁₀	35 m from the hot mix plant in downwind direction	200 µg/m ³	10	Once every 6 months during construction phase at PRs5,000/ location	Contractor	Continuous for 12 hours or over 1 full working day	50,000
Air Quality SO _x NO _x PM ₁₀	5 m from edge of the pavement in downwind direction	134 ppb 106 ppb 200 µg/m ³	10	Once every 6 months during construction phase at PRs50,000/ location	Contractor	Continuous for 12 hours or over 1 full working day	500,000

Parameter	Location	Standards/ Guidelines	No. of Stations	Frequency	Responsibility	Duration	Cost (PRs)
<i>E. coli</i>	Community groundwater source near the edge of the ROW at two selected locations on existing/ proposed highway	WHO drinking water quality guidelines	10	Once every 6 months during construction phase at PRs1,500/test	Contractor	-	15,000
Noise Levels on dB(A) scale	7.5 m from the equipment for which the noise level is to be determined	WHO noise guidelines	40	Once every 6 months at PRs500/ source	Contractor	Reading taken at 15 Sec. intervals for 15 min every hour and then averaged	20,000
Noise Levels on dB(A) scale	5 m from edge of the pavement at selected locations where sensitive receptors are found	WHO noise Guidelines	30	Once every 6 months during construction phase at PRs500/source	Contractor	24 hours, readings taken at 15 sec intervals for 15 min every hour and then averaged	15,000
Oil and Grease	Selected locations in contractor's equipment yards, as identified by the supervision consultant	Threshold set by USEPA	8	Once per year in construction phase at 1,000/sample	Contractor	-	8,000
C. Operational Stage							
Air Quality SO _x NO _x CO PM ₁₀	5 m from edge of the pavement; downwind background concentration near a residential area at a sensitive location e.g., hospital or school, taken at selected locations on the highway	134 ppb 106 ppb 35 ppm 200 µg/m ³	8	Twice per year for 3 years at PRs 50,000/ location	NHA	Continuous 24 hours (assuming 3 years past project monitoring)	800,000/year i.e., 2,400,000 (3 years)

Parameter	Location	Standards/ Guidelines	No. of Stations	Frequency	Responsibility	Duration	Cost (PRs)
Water Quality <i>E. coli</i>	Community ground water sources near ROW at selected locations on existing/ proposed highway	WHO drinking water quality guidelines	8	Once per year in summer, just before monsoon season, for 3 years at PRs1,500/test	NHA	-	12,000/ year i.e., 36,000 (3 years)
Noise Levels on dB(A) scale	5 m from the edge of pavement, at sensitive locations	WHO noise guidelines	15	Once per year after start of operation, for 3 years, at PRs500/source	NHA	24 hours, readings taken at 15 sec intervals for 15 min every hour and then averaged	7,500/year i.e., 22,500 for 3 years

CO = carbon monoxide, dB = decibel, m = meter, NHA = National Highway Authority, NO_x = nitrogen oxide, PM₁₀ = particulates less than 10 micrometers in diameter, ppb = parts per billion, ROW = right-of-way, SO_x = sulfur monoxide, USEPA = United States Environmental Protection Agency, µg/m³ = micrograms per cubic meter of air, WHO = World Health Organization.