# CLIMATE CHANGE ASSESSMENT

## I. Basic Project Information

| |
|---|
| **Project Title:** MFF CAREC corridor Development Investment Program, Tranche 1 Project |
| **Project Budget:** $195 million |
| **Location:** Petaro, Sehwan, Ratodero, and Shikarpur in Sindh Province; and Dara Adamkhel and Peshawar in Khyber Pakhtunkhwa Province, Pakistan |
| **Sector:** road transport (non-urban) |
| **Theme:** Inclusive economic growth and regional cooperation |
| **Brief Description**<br>The proposed MFF will enhance regional connectivity and trade via the CAREC Corridors in Pakistan by improving the efficiency for road traffic along the CAREC Corridors. For the purpose, the proposed MFF will rehabilitate and upgrade the road network of 747 km constituting the CAREC Corridors mainly in Sindh, Punjab, and Khyber Pakhtunkhwa.<br>Tranche 1 Project will (i) build an additional 2-lane carriageway for 66 km of Petaro–Sehwan road and for43 km of Ratodero–Shikarpur road; (ii) rehabilitate the existing 34 km 4-lane carriageway of Dara Adamkhel–Peshawar road; and (iii) develop NHA's capacity through due diligence advisory services and assistance with project implementation. Project 1 is estimated to cost $195 million.<br>In case of building an additional two-lane carriageway for Petaro–Sehwan and Ratodero–Shikarpur roads, the additional carriageway will be 7.3 m wide with 3.0 m outer shoulder and 1.0 m inner shoulder with the design speed of 100 km/h, separated from the existing carriageway through New Jersey barrier. The additional carriageway including the shoulders will be benched into the existing width and pavement layers constructed and compacted as per the NHA's technical specifications after checking the soil properties of pavement and shoulder. The pavement construction will consist of embankment filling, granular subbase, aggregate base and asphaltic layers. As for rehabilitation of the existing four-lane carriageway for Dara Adamkhel–Peshawar road, the existing carriageway of 14.6 m wide with 2.0 m outer shoulder and 1.0 m inner shoulder will be upgraded with the design speed of 100 km/h. Drainage system will consist of bridges, culverts and cross drainage structures. Majority of the pipe culverts will be replaced by box culverts to make the structures resilient to cater for the current hydrology, seismic zone and climate change. Following the experience of the floods of 2009–2011 in Pakistan, NHA has strengthened its design standards to make road assets more resilient to climate change. Climate proofing road design has been adopted which includes protective structure for reducing vulnerability to water rise, floods, and/or landslides. |

## II. Summary of Climate Risk Screening and Assessment

**A. Sensitivity of Project Component(s) to Climate/Weather Conditions and Sea Level**

Heavy rainfall may affect the optimal number of bridges and culverts and the adequacy of bridge and culvert design. A large discrepancy between the high and low temperatures in summer and winter may affect the adequacy of road pavement materials.

| Project component | Sensitivity to climate/weather conditions |
|---|---|
| • Construction of bridges and culverts<br>• Construction of asphaltic road pavement | • High summer temperature at times<br>• Intensity and frequency of heavy rainfall |

**B. Climate Risk Screening**

| Risk topic | Description of the risk |
|---|---|
| • Flood | |

| | |
|---|---|
| | • The alignments for Petaro–Sehwan and Ratodero–Shikarpur roads fall in arid region with average annual rainfall of 200–250 mm. The long-term rainfall analysis shows that in case of Petaro–Sehwan road, there is no general trend of unstable up and down of rainfall. The flood inundation analysis, especially looking at the mega historical flood of 2010 shows no major threat to the road although the flood water crossed through the XC-drainage structures while remaining below the entire road alignment.<br>• The alignment for Dara Adamkhel–Peshawar road falls in the high rainfall zone with average rainfall up to 600 mm. The long-term rainfall trends indicate a slight decrease on long-term average. The historical pattern of alternating dry and wet years shows that wet years were dominant with no extremes, though. The flood hazard analysis especially with reference to major historical flood of 2010 shows no major hazard to the road. A small stream of Bara River (Km 0+050), which is a tributary of the Kabul River and crosses the alignment, experienced flooding in 2010; however, no threat to the bridge was reported except for some damages in the areas located upstream and downstream to the bridge due encroachment to its bed. |
| Climate Risk Classification: *Medium* | |

**C. Climate Risk Assessment**

GIS analysis indicates that some regions of the project areas may be at moderate risk to flooding. Based on the design standards adopted by NHA for detailed designs for project roads, it is expected that national highway design parameters can mitigate climate variability-related impacts.

## III. Climate Risk Management Response within the Project

Climate change risks and mitigation measures were considered in the project design. The road embankment is sufficiently high to withstand sheet flows of highest floods. The design provides adequate cross drainage structures and hydraulic structures, based on 100-year recurrence-interval flood discharges, adopted by NHA after the 2010 mega-flood. The impact of temperature on asphaltic pavement layers has been mitigated by adopting pavement specifications suitable for the climate in the project areas.

Design measures that have been taken to address climate change risks are:

- Sufficiently high embankments to facilitate drainage crossings
- Drainage ditch as required along the roads
- Increased clearance of bridges
- Putting additional culverts and expanding the capacity of culverts by replacing pipe culverts with box culverts.
- Giving 0.2 to 0.3 freeboard (about 20%) margin in culvert design to mitigate the risk of overland flow.

For the project roads under the MFF, a total of about 1.73% ($14.5 million of the civil works cost of $838.0 million) will be spent on addressing (adaptation) climate change risks.

Attachments: 1. Project Location and GIS Analysis
2. Estimated Cost for Adapting Climate Change Risks

## Project Location and GIS Analysis

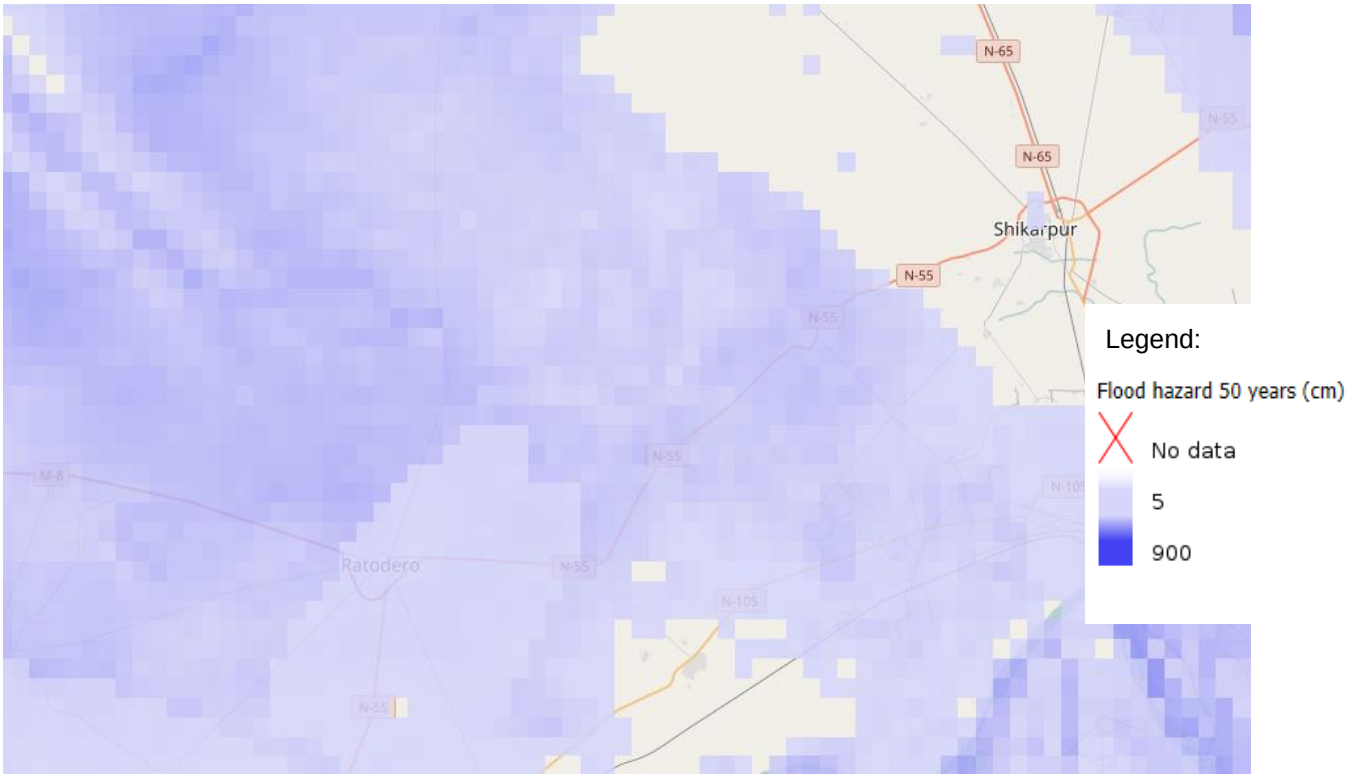



**Figure 1: GIS Analysis of Ratodero–Shikarpur Section**

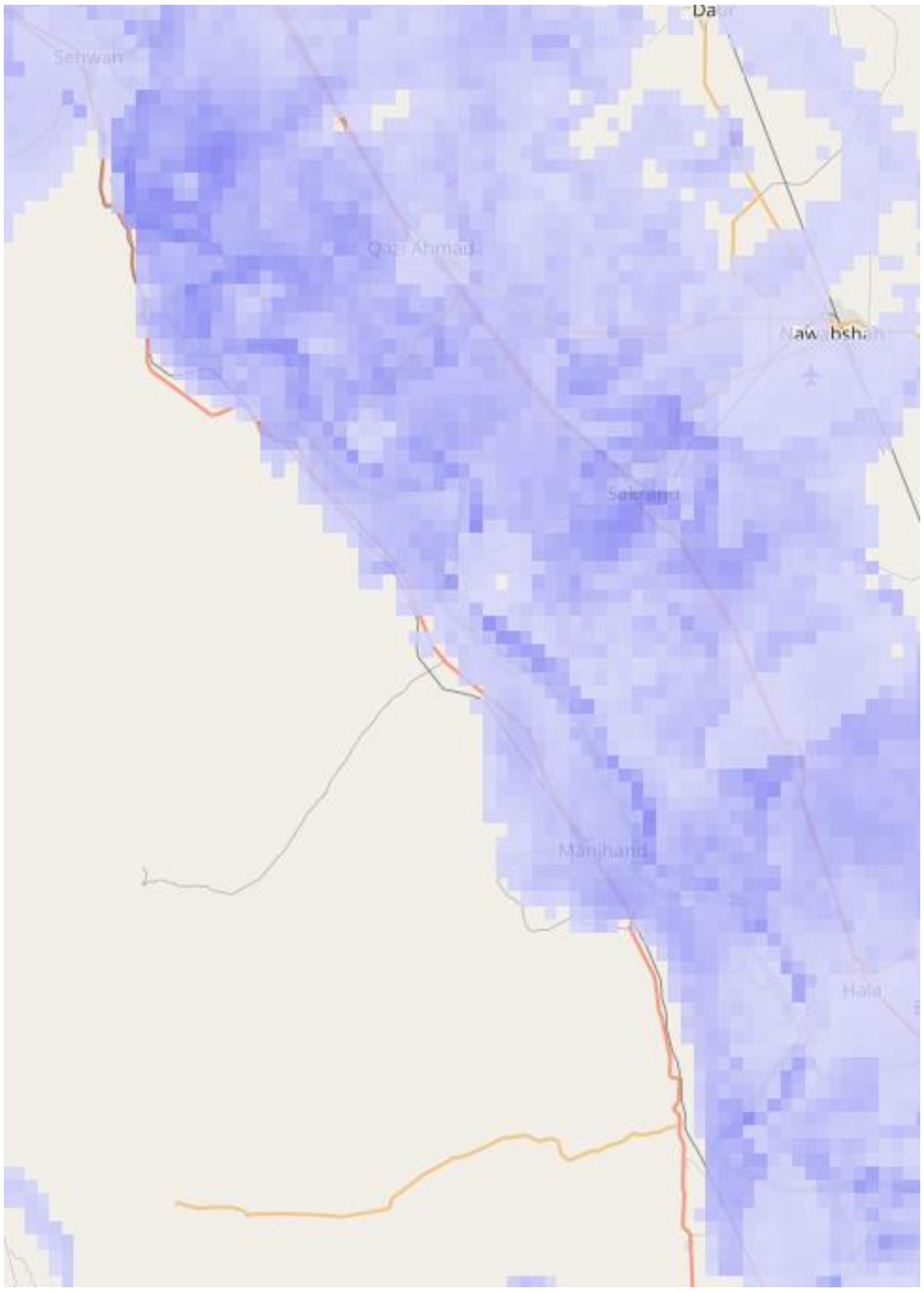
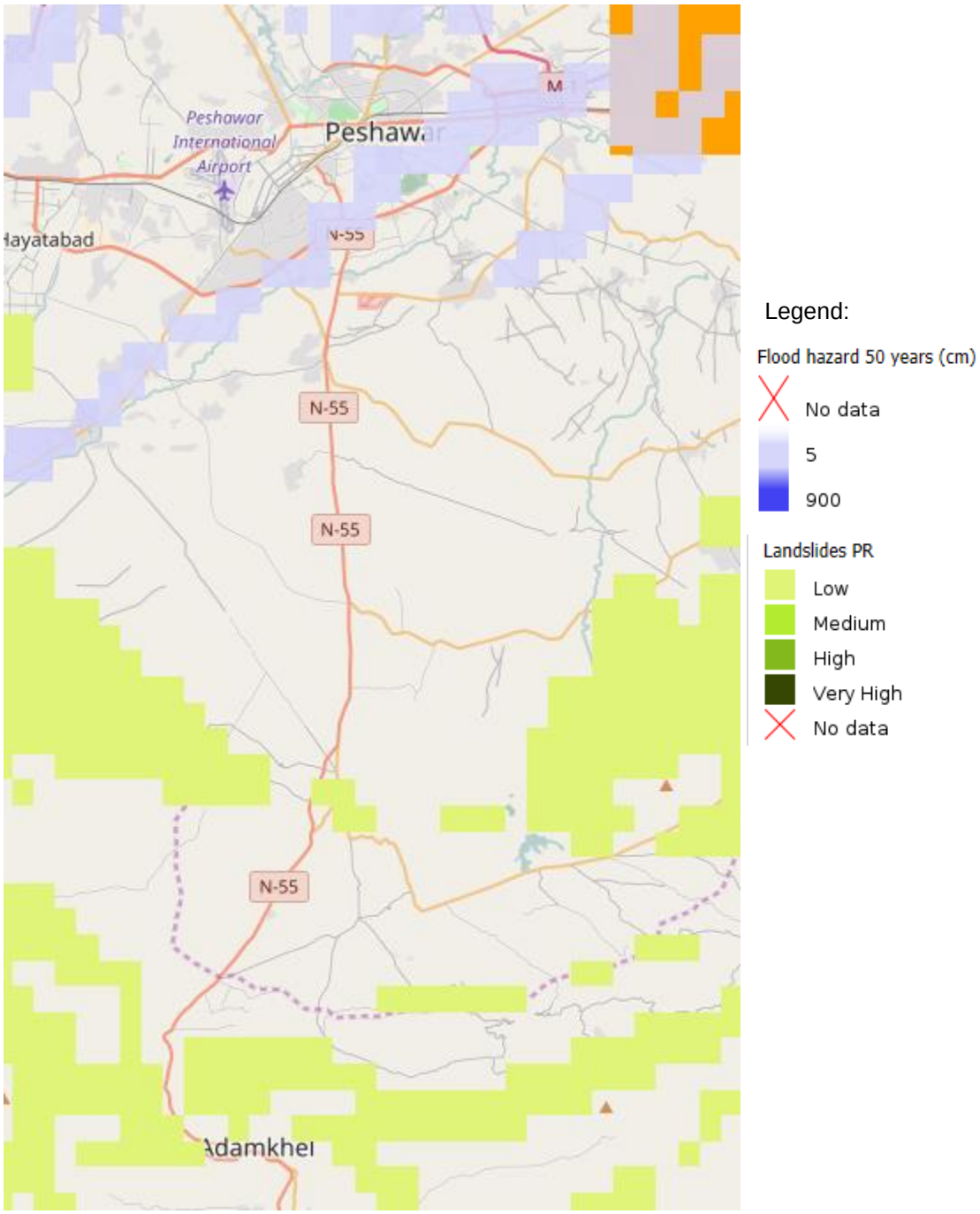


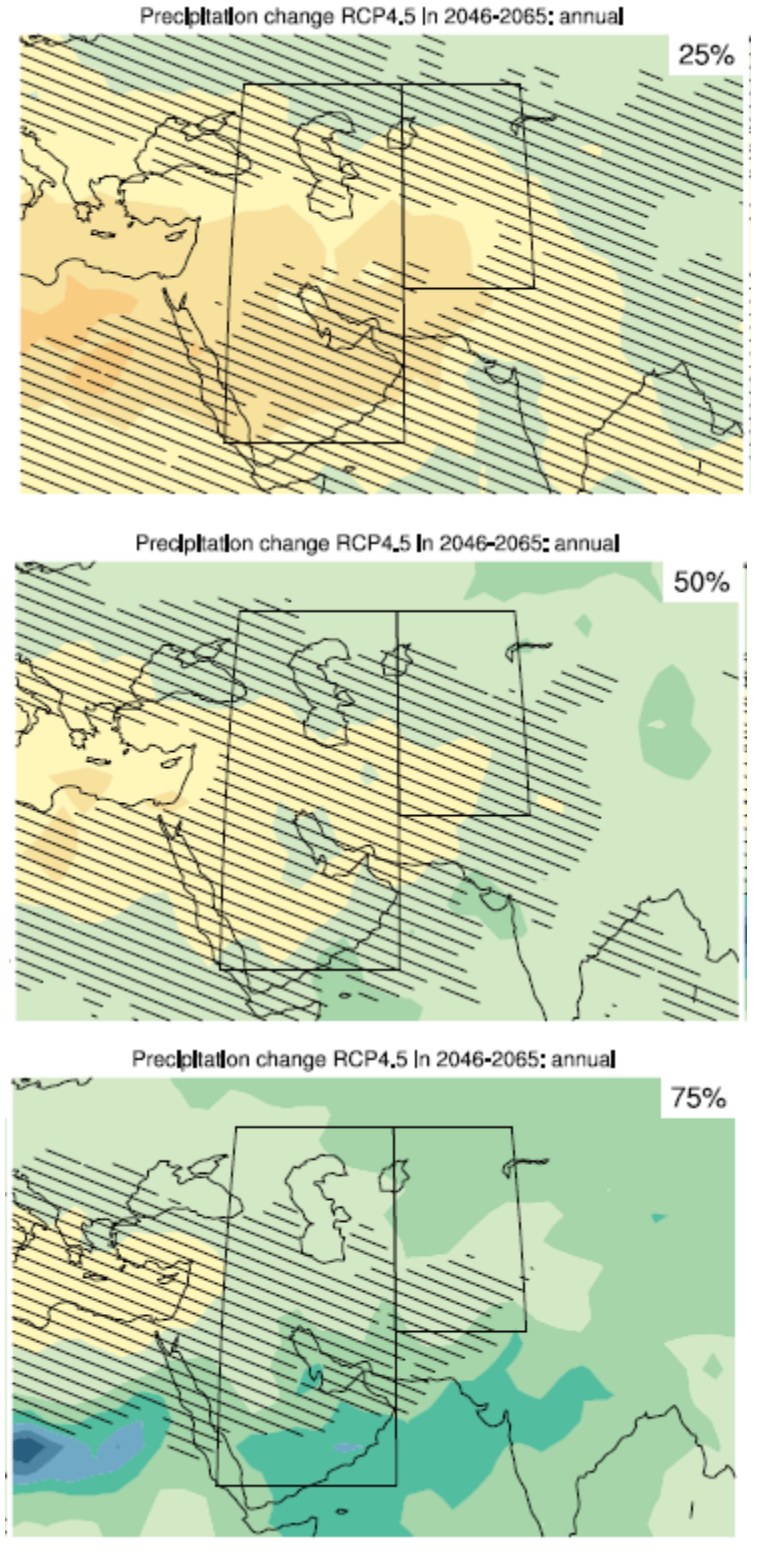

**Figure 2: GIS Analysis of Petaro–Sehwan**

**Figure 3: GIS Analysis of Dar Adamkhel–Peshawar**




Source: UNEP PREVIEW Global Risk Platform.

**Figure 4: Projected Change in Annual Precipitation at 25%, 50%, 75% Percentiles (RCP4.5)**




Source: IPCC (2013) AR5 WG1 Annex I.

## Estimated Cost for Adapting Climate Change Risk

| Road | Unit No. | Description | Unit | Quantity | Rate (Rs) | Amount (Rs) |
|---|---|---|---|---|---|---|
| **Petaro–Sehwan** | 107a | Structure excavation in common material | $m^3$ | 5,348 | 363.27 | 1,942,768 |
| | 107d | Granular backfill | $m^3$ | 4,793 | 1,065.04 | 5,104,737 |
| | 401a3 | Concrete Class “A3” | $m^3$ | 4,663 | 11,238.26 | 52,404,006 |
| | 401f | Lean concrete | $m^3$ | 574 | 5,736.89 | 3,292,975 |
| | SS | Extra over for providing sulphate-resisting cement in concrete works of specified class: | | | | |
| | | for concrete Class “A3” | $m^3$ | 4,663 | 200.00 | 932,600 |
| | | for lean concrete | $m^3$ | 574 | 87.50 | 50,225 |
| | 404b | Reinforcement as per AASHTO M31 Grade 60 | ton | 699 | 115,360.95 | 80,637,304 |
| | 406a | Premoulded joint filler 25 mm thick with bitumen joint | $m^2$ | 75 | 3,033.78 | 227,534 |
| | | **Total** | | | | **144,592,149** |
| **Ratodero–Shikarpur** | 107a | Structure excavation in common material | $m^3$ | 689 | 359.83 | 247,923 |
| | 107d | Granular backfill | $m^3$ | 717 | 1,330.58 | 954,026 |
| | 401a3 | Concrete Class “A3” | $m^3$ | 750 | 11,197.93 | 8,398,448 |
| | 401f | Lean concrete | $m^3$ | 125 | 5,553.91 | 694,239 |
| | SS | Extra over for providing sulphate-resisting cement in concrete works of specified class: | | | | |
| | | for concrete Class “A3” | $m^3$ | 750 | 200.00 | 150,000 |
| | | for lean concrete | $m^3$ | 125 | 87.50 | 10,938 |
| | 404b | Reinforcement as per AASHTO M31 Grade 60 | ton | 112 | 116,134.21 | 13,007,032 |
| | 406a | Premoulded joint filler 25 mm thick with bitumen joint | $m^2$ | 9 | 3,027.72 | 27,249 |
| | | **Total** | | | | **23,489,855** |
| **Dara Adamkhel–Peshawar** | 107a | Structure excavation in common material | $m^3$ | 1,524 | 361.08 | 550,286 |
| | 107d | Granular backfill | $m^3$ | 1,783 | 1,885,98.00 | 3,362,702 |
| | 401a3 | Concrete Class “A3” | $m^3$ | 1,723 | 12,062.90 | 20,784,377 |
| | 401f | Lean concrete | $m^3$ | 290 | 6,370.51 | 1,847,448 |
| | 404b | Reinforcement as per AASHTO M31 Grade 60 | ton | 258 | 116,443.82 | 30,042,506 |
| | 406a | Premoulded joint filler 25 mm thick with bitumen joint | $m^2$ | 22 | 3,063.65 | 67,400 |
| | | **Total** | | | | **56,654,719** |
| **Total** | | | | | | **224,736,723** |
| **Total Civil Works Cost** | | | | | | **12,981,483,000** |
| **Average %** | | | | | | **1.73%** |