

# **Evaluation Design Report:**

## **Economic Analysis and Evaluation Services of the North-South Road Project in Mongolia**

**Original Submission: August 24, 2018**

**Revision 1: May 6, 2019**

This publication was produced by International Development Group LLC, for review by the Millennium Challenge Corporation.

# Economic Analysis and Evaluation Services of the North-South Road Project in Mongolia

## Final Evaluation Design Report

BPA Number: 95332418A0009  
Contract Number: 95332418F0071

This report was prepared by International Development Group LLC (IDG) with the following contributors: Jens Abraham, Hyosun Bae, Eddy Bynens, Frankie Clogston, Jean-Francois Gautrin, and Goran Mladenovic.

### **DISCLAIMER**

*The views and opinions expressed herein are those of the authors and do not necessarily represent those of MCC or any other U.S. Government entity.*

# TABLE OF CONTENTS

Table of Contents .....	iii
List of Acronyms .....	v
<b>I. Introduction and Background .....</b>	<b>1</b>
1.1 Country Context.....	1
1.2 Objective of the Report.....	1
<b>II. Overview of the Compact and the Intervention(s) Evaluated .....</b>	<b>3</b>
2.1 Overview of the project and implementation plan.....	3
2.2 Theory of Change .....	8
2.3 Cost-benefit Analysis & Beneficiary Analysis .....	11
<b>III. Evaluation Design Overview .....</b>	<b>13</b>
3.1 Evaluation Areas and Questions .....	13
3.2 Evaluation Design Overview .....	15
<b>IV. Evaluation Design – Evaluation Area 0: Engineering Analysis and Economic Model .....</b>	<b>24</b>
4.1 Evaluation Questions .....	24
4.2 Evaluation Approach .....	24
4.3 Challenges.....	25
<b>V. Evaluation Design – Evaluation Area 1: Engineering Analysis and Economic Model .....</b>	<b>26</b>
5.1 Evaluation Questions .....	26
5.2 Evaluation Methodology.....	26
5.3 Challenges.....	44
<b>VI. Evaluation Design – Evaluation Area 2: Maintenance.....</b>	<b>45</b>
6.1 Literature Review.....	45
6.2 Evaluation Questions .....	48
6.3 Evaluation Approach .....	50
6.4 Challenges.....	56
<b>VII. Evaluation Design – Evaluation Area 3: Road Usage Patterns .....</b>	<b>57</b>
7.1 Evaluation Questions .....	57
7.2 Evaluation Approach .....	57
7.3 Challenges.....	65

<b>VIII.</b>	<b>Evaluation Design – Evaluation Area 4: Transportation Market Structure .....</b>	<b>67</b>
8.1	Literature Review.....	67
8.2	Evaluation Questions .....	68
8.3	Evaluation Approach .....	70
8.4	Challenges.....	72
<b>IX.</b>	<b>Administrative.....</b>	<b>73</b>
9.1	Summary of IRB Requirements and Clearances .....	73
9.2	Approval from Local Authorities.....	73
9.3	Data Protection, Access, and Documentation.....	73
9.4	Dissemination Plan .....	74
9.5	Evaluation Team Roles and Responsibilities.....	74
9.6	Evaluation Timeline & Reporting Schedule .....	75
<b>Annex I:</b>	<b>References.....</b>	<b>76</b>
<b>Annex II:</b>	<b>Evaluation Work Plan .....</b>	<b>79</b>
<b>Annex III:</b>	<b>Data Collection Work Plan .....</b>	<b>81</b>
<b>Annex IV:</b>	<b>Illustrative Survey Instrument for Traffic Count.....</b>	<b>88</b>
<b>Annex V:</b>	<b>Rationale For Selecting the Traffic Count Locations .....</b>	<b>89</b>
<b>Annex VI:</b>	<b>Map of Traffic Count Locations .....</b>	<b>91</b>
<b>Annex VII:</b>	<b>Specifications for Video Recording of Road Condition .....</b>	<b>92</b>
<b>Annex VIII:</b>	<b>Evaluation Question 1 Changes In Data Collection .....</b>	<b>95</b>
<b>Annex IX:</b>	<b>Evaluation Question 2C and CHanges to the SOW.....</b>	<b>102</b>
<b>Annex X:</b>	<b>Stakeholder comments and Evaluator responses .....</b>	<b>105</b>
<b>Annex XI:</b>	<b>Evaluation budget .....</b>	<b>106</b>

## **LIST OF ACRONYMS**

AADT	Annual Average Daily Traffic
ADB	Asian Development Bank
ADT	Average Daily Traffic
AZZA	Road Maintenance (Avto Zamin Zasvar Archlalt)
BB	Benkelman Beam
BI	Bump Integrators
CBA	Cost-Benefit Analysis
CBR	California Bearing Ratio
CP	Condition Precedent
DCP	Dynamic Cone Penetrometer
DOR	Department of Roads
EDR	Evaluation Design Report
EMC	Evaluation Management Committee
EMP	Evaluation Management Process
ERR/EIRR	Economic (Internal) Rate of Return
ESAL	Equivalent Standard Axle Load
GOM	Government of Mongolia
GPR	Ground Penetrating Radar
HDM-4	Highway Development and Management
IDG	International Development Group LLC
IRB	Institutional Review Board
IRI	International Roughness Index
KII	Key Informant Interview
LOE	Level of Effort
LTPP	Long-Term Pavement Performance
M&E	Monitoring and Evaluation
MCA-M	Millennium Challenge Account Mongolia
MCC	Millennium Challenge Corporation
MNT	Mongolian TUGrik
MRTCUD	Ministry of Road, Transport, Construction, and Urban Development
MRTD	Ministry of Roads and Transport Development
MTC	Manual Traffic Count
MTZ	Mongolian Railway Company
NPV	Net Present Value
N-S	North-South
O-D	Origin-Destination
ORN	Overseas Road Note
PSR	Present Serviceability Rating
RED	Road Economic Decision
RTD Center	Road and Transport Development Center
RTRRMS	Response Type Road Roughness Measuring System
SN	Structural Number
SOE	State-Owned Enterprise
TA	Technical Assistance

TEU	Twenty-foot Equivalent Unit
ToR	Terms of Reference
TT	Travel Time
UB	Ulaanbaatar
UBTZ	Ulaanbaatar Railway Company
USAID	United States Agency for International Development
VAT	Value-Added Tax
VOC	Vehicle Operating Cost(s)
ZU	Zamyn-Uud

# **I. INTRODUCTION AND BACKGROUND**

## **1.1 COUNTRY CONTEXT**

The Millennium Challenge Corporation (MCC) and the Government of Mongolia (GOM) signed a five-year, \$284.9 million Compact on October 22, 2007. The Compact entered into force on September 17, 2008 which consisted of projects in four different sectors: 1) property rights, 2) health, 3) vocational education, and 4) railway. The Compact goal, as stated in article 1 of the Compact, is to reduce poverty in Mongolia through economic growth.

The objective of the Rail Project (\$188.38 million) was to increase rail traffic and shipping efficiency. However, on April 27, 2009, the GOM notified MCC that they would not be able to proceed with implementing the rail project and requested that MCC consider re-allocating the previously committed railway project funds to both expansion of the remaining projects (health, vocational education, and property rights) and addition of new projects in the fields of road transport, energy, and environment.

MCC accepted the GOM's proposals and subsequently initiated the North-South (N-S) Road Project. While not addressing precisely the same issues as the original rail project, the North-South Road Project focused on the same critical corridor using a different mode of transportation. The Road Project was budgeted at \$79,750,000 of which \$74,775,862 were disbursed at the closure of the project on September 16, 2013.

## **1.2 OBJECTIVE OF THE REPORT**

On September 28, 2017, MCC issued a contract to International Development Group LLC (IDG) to conduct an Economic Analysis and Independent Evaluation Services in Support of the Mongolia North-South Road Project. The evaluation, designed to understand the impact of the MCC-funded N-S Road Project on Mongolia's economic growth, is mainly two-fold: 1) an economic analysis (Evaluation Area 1) to understand the costs and benefits of the MCC-funded roads, and 2) performance evaluations of road maintenance, road usage patterns, and transport market structure to complement and enhance knowledge gained through the economic analysis (Evaluation Area 2, 3, and 4).

The objective of the Evaluation Design Report (EDR) is to allow MCC to review the following areas<sup>1</sup>:

- Prioritize evaluation questions and outcomes that meet demand from key decision-makers;
- Ensure that the program Objective and all key accountability metrics modeled in the cost-benefit analysis are measured or justification is provided as to why they are not;
- Apply the most rigorous evaluation methodology feasible given project design and implementation rules;
- Clearly define the analysis plan to ensure consensus on outcomes – their definitions and measurement;

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<sup>1</sup> MCC Independent Evaluations, Evaluation Management Process (EMP) Version: May 2017.

- Clearly define sample population and sampling strategy that aligns with project target populations;
- Clearly define exposure period that maps data collection timelines with project start date timelines; and
- Update costs as necessary.

In this report, the team will: i) provide an overview of the Compact and the N-S Road Project, ii) present quantitative and qualitative evaluation design for each evaluation question, and iii) summarize administrative issues of the evaluation. The final EDR will incorporate feedback and recommendations from MCC and stakeholders in Mongolia.



## **II. OVERVIEW OF THE COMPACT AND THE INTERVENTION(S) EVALUATED**

### **2.1 OVERVIEW OF THE PROJECT AND IMPLEMENTATION PLAN**

#### **2.1.1 Original Project Description**

The N-S Road Project consisted of three activities as identified in the Amendment to Millennium Challenge Compact.<sup>2</sup> The three activities were: 1) Choir-Sainshand Road Activity, 2) Bayanzurkh Bridge and Road Activity, and 3) Technical Assistance Activity.

##### **Choir-Sainshand Road Activity**

The first activity was designed to “construct an all-weather road from Choir to Sainshand.”<sup>3</sup> The Choir-Sainshand segment of the N-S Road was unpaved, forcing drivers to often detour and take alternate routes to avoid potholes and deep trenches.<sup>4</sup>

MCC funding was intended to support improvement of the N-S corridor road section from the town of Choir to the 35<sup>th</sup> railway crossing outside of Sainshand, totaling 176.4 km in length. This activity is closely linked to an Asian Development Bank’s (ADB) loan (\$37.1 million) which aimed at completing the remaining 428 km section of the N-S corridor from Choir to Zamyn-Uud. Originally, the Korean Government was to provide a concessional loan of \$23.9 million to build the 176.4 km Choir-Sainshand section while the ADB loan was to finance the 252 km section from Sainshand to the Chinese border. During the construction work in 2006-2008, however, significant cost overruns halted the work on the Korean section (Choir-Sainshand) in 2008 with only 13 percent of construction completed.<sup>5</sup> Upon the GOM’s request, MCC designed the first Activity to fund the section of 176.4km from Choir to Sainshand.

##### **Bayanzurkh Bridge and Road Activity**

The second activity was designed to “rehabilitate the existing Bayanzurkh bridge, construct a new bridge near the existing Bayanzurkh bridge, and rehabilitate the road from Ulaanbaatar to Nalaikh.”<sup>6</sup> A major entry point located east of Ulaanbaatar, the Bayanzurkh bridge (242 m) could not be used by heavy vehicles due to rapidly deteriorating conditions. According to MCC’s Investment Memorandum, MCC had plans to rehabilitate the existing bridge and construct a new connecting bridge (260 m).<sup>7</sup> In addition to the Bayanzurkh bridges, the activity included upgrading of the road structure and new surfacing of the Ulaanbaatar – Nalaikh road (17.5 km). Originally constructed in the 1950’s, the road suffered from severe damages, limiting traffic travelling south from Ulaanbaatar.

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<sup>2</sup> Amendment to Millennium Challenge Compact Between the United States of America Acting through the Millennium Challenge Corporation and the Government of Mongolia, January 22, 2010.

<sup>3</sup> *Ibid.*, Annex I – 14.

<sup>4</sup> MCC, Mongolia Compact I Final Result Statements, December 2014. Photos of the road condition prior to MCC’s construction is available on an MCA-M blog post < <http://mcamongolia.blogspot.com/2010/06/on-road.html>>.

<sup>5</sup> MCC, Investment Memorandum on the Reallocation of Mongolia Compact Funding, Part II- New Projects, November 10, 2009.

<sup>6</sup> Amendment to Compact, Annex I – 14.

<sup>7</sup> MCC, Investment Memorandum, page 20.



**Figure 1: Photo of the N-S Road section before MCC’s rehabilitation work began**

### **Technical Assistance Activity**

The third activity was designed to improve road maintenance and consisted of three categories as follows:

1. Project Management and Supervision Consultants: To manage the road project and supervise the construction of the Choir - Sainshand road (176 km).
2. Road Maintenance Improvement Technical Assistance: To provide technical assistance and equipment for road maintenance to the GOM.
3. Bridge Detailed Design and Supervision Consultants: To design the rehabilitation of the Bayanzurkh bridge including the production of the tender documents.

In addition to the road infrastructure improvements, technical assistance (TA) activity was designed to improve GOM’s road maintenance. The TA activity included capacity building and improvements in the operation of state-owned maintenance enterprises (SOEs) “to ensure long-term viability and quality of their work”.<sup>8</sup> The goal was to introduce “policies, produce rules and practices that will encourage private sector participation in road maintenance.”<sup>9</sup> Additionally, according to the Investment Memorandum, the TA would include assistance on road safety, since road maintenance companies partake in safety and emergency response practices.

#### **2.1.2 Project Beneficiaries/Participants**

##### **Choir-Sainshand Road Activity/ Bayanzurkh Bridge and Road Activity**

For both the Choir-Sainshand Road Activity and the Bayanzurkh Bridge and Road Activity, the targeted project beneficiaries were road/bridge users. The road users are individual vehicle owners or transportation service users on the Choir-Sainshand road, the existing and new Bayanzurkh bridges, and the UB-Nalaikh road (details on beneficiaries are available below under Section 2.3.2). As explained above, the road users of these road infrastructures were targeted due to their poor infrastructure quality.

### **Technical Assistance Activity**

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<sup>8</sup> MCC, Supplemental Mongolia Due Diligence Checklist, March 2010.

<sup>9</sup> MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects, November 10, 2009. page. 4, 5.

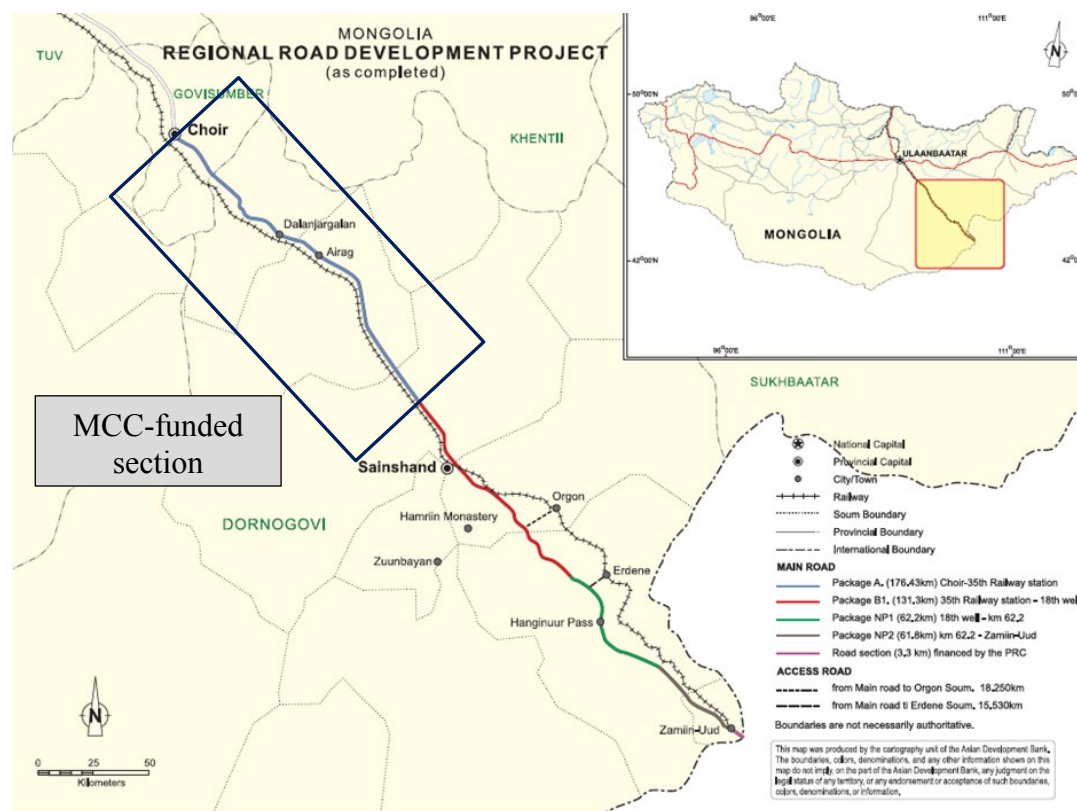
MCC documents are not clear on the exact project participants, defined as those who engage with the intervention but not necessarily experience increase in income, for the Technical Assistance Activity. Yet, based on the initial project design, the main targeted project participants within the GOM were staffs from the Ministry of Road, Transport, Construction, and Urban Development (MRTCUD, now renamed as the Ministry of Roads and Transport Development, MRTD) and the Department of Roads (DOR). MCC intended to build GOM's capacity managing road projects and improving road maintenance practices.

Another major project participant group targeted by the TA Activity was maintenance SOEs (also known as AZZAs<sup>10</sup>). MCC intended to provide TA to the state-owned maintenance enterprises to build capacity in road maintenance and encourage private sector participation.

### 2.1.3 Geographical Coverage

MCC's N-S Road Project was implemented in the south-eastern region of Mongolia as part of the N-S corridor connecting Russia at the northern border (Altanbulag) and China at the southern border (Zamyn-Uud). The MCC-funded Choir-Sainshand road section is shown in the map below:

**Figure 2: Map of Mongolia North-South Road Project Choir-Sainshand Activity<sup>11</sup>**



<sup>10</sup> AZZA is an acronym of “Avto Zamin Zasvar Archlalt” (Авто замын засвар арчлалт) which translates to road (Avto Zam) maintenance (Zasvar Archlalt). This is a commonly used term in Mongolia to refer to road maintenance firms whether they are government owned or private.

<sup>11</sup> ADB. Mongolia: Regional Road Development Project Completion Report. August 2015.

The Bayanzurkh bridge and the UB-Nalaikh road are located close to the nation's capital. The bridge runs over the Tuul river and the UB-Nalaikh road connects the southern exit of the UB to the N-S corridor. The locations are shown in the map below:



**Figure 3: Map of Mongolia North-South Road Project Bayanzurkh Bridge and Road Activity<sup>12</sup>**

### **2.1.4 Description of Implementation to Date**

#### **Choir-Sainshand Road Activity**

In 2010, the Millennium Challenge Account-Mongolia (MCA-M) contracted a joint venture of three firms (Grontmij Carlbro from Denmark, SAI Engineering from India, and Mon Consult from Mongolia) as a Project Consultant<sup>13</sup> and a Korean firm, LIG Engineering and Construction Co., Ltd (LIG), as a construction contractor for the Choir-Sainshand road section. After completing some preparatory works, LIG declared bankruptcy in 2011 and the contract was terminated.<sup>14</sup> MCA-M hired three construction companies (Arj Capital LLC, Green Station LLC, and World Yeruna LLC) that were subcontractors to LIG to continue the preparatory works and, in 2012 February, hired two firms to complete the construction of the Choir-Sainshand road.

The contract was divided into two lots: Lot 1 (KM 0-90) and Lot 2 (KM 90 – 176.4). Lot 1 was contracted with a Korean company, Halla Engineering and Construction Corporation, for \$33.90 million, and Lot 2 was contracted with Jiangxi Water and Hydropower Construction Co. Ltd for

<sup>12</sup> MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects, Annexes, November 10, 2009, page, 3.

<sup>13</sup> Project Management and Construction Supervision Consultant (Project Consultant) refers to a firm contracted by the MCA to supervise the construction performed by another firm and oversee other aspects of the project overall. Project Contractor mainly refers to firms that are contracted by the MCA for the actual construction of the roads. The Project Contractors may often have sub-contracts support the construction of the road.

<sup>14</sup> MCA-M, Project Management and Construction Supervision Consultant for MCA-M Road Project, Final Report, November 2013.



\$31.86 million.<sup>15</sup> The construction of Choir-Sainshand road section was completed by the two contractors in September 2013.

The completed section of the N-S road runs from the town of Choir to the 35<sup>th</sup> railway crossing located outside of Sainshand, totaling 176.4 km in length. It provides for the first time in Mongolia's history the establishment of an all-weather paved road from its northern border with Russia down to its southern with China. As the Due Diligence report indicated, the road complements the railway, which used to be the only major mode facilitating trade between Mongolia, Russia, and China, and provides transportation linkages for economic activities "not as well-suited to rail transport." This includes trips that needed to be completed in a shorter duration of time, trips that necessitate door to door delivery, local trips between major rail stops, and trips for which the cost of rail is prohibitive.

Additionally, two link roads were constructed to link the main Choir-Sainshand road to the Dalanjargalan soum center (1.1 km) and the Airag soum center (1.7 km) before the contract end date.<sup>16</sup>

### **Bayanzurkh Bridge and Road Activity**

MCA-M sought competitive bidding twice for the Bayanzurkh Bridge and Road Activity, in February 2011 and again in August 2011. Similar to the Choir-Sainshand work, MCA-M divided the construction into two lots: Lot 1 for the construction of a four-lane road from Uliastai Junction (close to UB) to Bayanzurkh Tollgate (3.4 km) and the Bayanzurkh bridge (288 m) improvement over the Tuul River, and Lot 2 for the construction of road from Bayanzurkh Tollgate to Terelj Junction (15.9 km). However, the first bidding was cancelled because the successful bidder failed to provide a security guaranteeing its construction performance and the second bidding was cancelled because no bidder met the bidding requirements.<sup>17</sup>

Following the approval of the N-S Road Project, there was more than a 60 percent increase in the cost of works for the Choir-Sainshand segment.<sup>18</sup> The cost over-run and two unsuccessful competitive bidding led MCC to re-allocate Compact funds from the Bayanzurkh bridge and the Ulaanbaatar-Nalaikh road to finance the completion of the Choir-Sainshand segment. The Bayanzurkh Bridge and Road activity was dropped from the N-S Road Project entirely. However, MCA-M had funded a detailed design and drawing of the UB – Nalaikh road and the Bayanzurkh bridge. The designs and cost estimates for construction were handed over to the MRTUD by the MCA-M in September 2012.<sup>19</sup>

### **Technical Assistance Activity**

MCC provided project management and supervision consultants and undertook some efforts to provide Road Maintenance Improvement TA.<sup>20</sup> MCA-Mongolia Road Project team developed a Needs Assessment for Capacity Development in the sector. In addition, MCA-Mongolia developed technical specifications of road repair and maintenance equipment to hand them over to the

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<sup>15</sup> Ibid., page 50.

<sup>16</sup> MCA Completion Report, no page number.

<sup>17</sup> MCA-M, Project Management and Construction Supervision Consultant for MCA-M Road Project, Final Report, November 2013, page 40.

<sup>18</sup> MCC, Mongolia: Road Project, Choir-Sainshand Road Activity ERR. October 17, 2014.

<sup>19</sup> Ibid., page 40.

<sup>20</sup> Conversation with Darren Barry, MCC, November 8, 2017.

Ministry of Road and Transportation to strengthen Mongolia's road repair and maintenance sector. Additionally, MCA-M procured small-capacity repair and maintenance equipment and handed over five sets of equipment comprised of six items (mini excavator, diesel engine mobile concrete mixer, rammer hand compactor/tampering rammer, diesel concrete vibrator, plate compactor, and gasoline asphalt floor saw) to the MRTD in September 2013, near the end of the Compact.<sup>2122</sup>

With respect to the Bridge Detailed Design and Supervision Consultants, since the project was suspended at a later point after tenders were launched, it was decided to cancel this component and thus no supervision was required.

The total funding for the N-S Road Project was \$79.75 million distributed among the two activities as presented in Table 1.<sup>23</sup> Of the total funds allocated to the Project, \$74.77 was disbursed.<sup>24</sup>

**Table 1: Total N-S Road Project Funding**

Activity	Budgeted (US\$M)	Disbursed (US\$M)	% Disbursed
<b>Activity 1: Road Construction and Rehabilitation</b>	<b>\$70.15</b>	<b>\$66.49</b>	<b>95%</b>
Choir-Sainshand Road	\$45.05	\$66.49	148%
Ulaanbaatar-Nalaikh (17.5 km, Uliastai-Bayanzurkh road/bridge)	\$25.10	\$0.00	0%
<b>Activity 2: Technical Support</b>	<b>\$8.90</b>	<b>\$6.59</b>	<b>74%</b>
Project Management and Supervision Consultants	\$5.00	\$6.22	124%
Road Maintenance Improvement TA	\$3.00	\$0.37	12%
Bridge Detailed Design & Supervision Consultants <sup>25</sup>	\$0.90	\$0.00	0%
<b>Miscellaneous</b>	<b>\$0.70</b>	<b>\$1.69</b>	<b>241%</b>
Program Admin Audits, Environment and Social Assessment	\$0.70	\$1.69	241%
<b>Total</b>	<b>\$79.75</b>	<b>\$74.77</b>	<b>94%</b>

## 2.2 THEORY OF CHANGE

### 2.2.1 MCC Theory of Change

The initial Compact identified Rail Project to increase north-south traffic and facilitate trade. The stated objective for the Rail Project was “to increase rail traffic and shipping efficiency.” The Project was designed to impact a large share of the population: 60 percent of the country's population is located along the rail corridor. However, in 2009, MCC and the GOM shifted from the Rail Project to the N-S Road Project after the Russian government, who is a 50 percent owner of the Ulaanbaatar Railway Company (UBTZ), declined to cooperate on Conditions Precedent (CPs) critical to the implementation of the Rail Project.<sup>26</sup>

<sup>21</sup> MCA Completion Report.

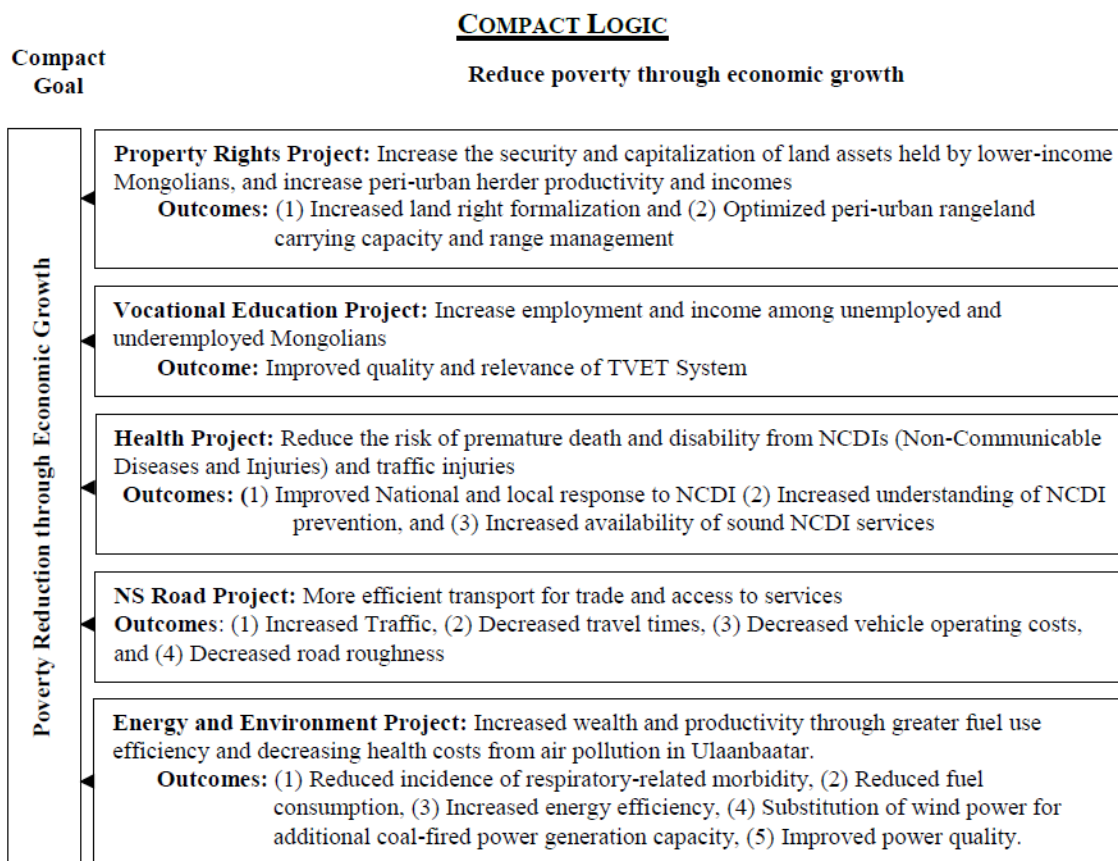
<sup>22</sup> MCA-M, Invitation to Quote, Supply & Delivery of Road Repair and Maintenance Equipment MCA-Mongolia Roads Project, April 22, 2013.

<sup>23</sup> Budget is based on the MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects. November 10, 2009.

<sup>24</sup> Disbursed budget is based on MCC Document Mongolia Funds – as of June 2, 2017.

<sup>25</sup> MCC's Final Report indicates on page 27 that “The Final Design Report for the Detailed Engineering Design for Uliastai Junction to Bayanzurkh Toll Gate Road (3.4 km) Bayanzurkh Bridge (288 m) has been completed and approved by the Client and on 28 September 2012 hand over to Minister of Transportation and Road and Transportation.” However, MCC's Final Project Costs (June 30, 2017) does not record any funds disbursed for the “Bridge Detailed Design and & Supervision Consultant”. It is unclear whether the cost for developing the detailed bridge design is incorporated in other line items.

<sup>26</sup> MCC Mongolia Transaction Team, Mongolia Compact: Lessons of Experience, February 19, 2014.



**Figure 4: MCC Mongolia North-South Project Logic<sup>27</sup>**

The project logic for the N-S Project is shown in Figure 4. The figure presents the Outcomes, Objective, and Compact Goal, as identified in the Post-Compact Monitoring & Evaluation (M&E) Plan (September 2013). The objective of the N-S Road Project is described differently in two different documents; the objective is defined as “more efficient transport for trade and access to services” in the Compact Logic of the Post-Compact M&E Plan (Figure 4) while the Compact Amendment defines the objective as “to reduce the transportation costs along sections of the critical north-south road corridor traversing Mongolia from its northern border with the Russian Federation to China in the south”.<sup>28</sup>

Just as with the Rail Project, it is intended to impact the high population along the N-S corridor. As MCC noted in its Due Diligence Book, the Road Project does “not address precisely the same uses as the original project” but is focused on the same corridor. MCC notes it arguably plays an “even more important role in intra-Mongolia personal and commercial traffic.”<sup>29</sup>

The overall goal of the Compact is “poverty reduction through economic growth.”<sup>30</sup> The causal link between reducing transportation cost on the N-S Road and poverty reduction and economic

<sup>27</sup> MCA-M, Post Compact Monitoring & Evaluation Plan Mongolia September 2013.

<sup>28</sup> MCC, Mongolia Compact Amendment, January 22, 2010.

<sup>29</sup> MCA, Supplemental Mongolia Due Diligence Checklist. November 2009. p. 5.

<sup>30</sup> MCC, Mongolia Compact Amendment, January 22, 2010.

growth in Mongolia is reasonable. There is strong evidence that improvement in road access may be associated with better standards of living.<sup>31</sup> MCC's Result Statement report highlights that "higher maintenance cost of transportation on earthen roads has delayed socio-economic development as the cost would cut into profits of prospective entrepreneurs shipping goods to urban market."<sup>32</sup>

Four outcomes are expected based on the theory of change: 1) increased traffic, 2) decreased travel times, 3) decreased vehicle operating costs, and 4) decreased road roughness. While it is intuitive that the last three outcome lead to the objective of reduced transportation costs, it is not as clear how the first outcome contributes to the objective.

### **2.2.2 Evaluation Team's Modified Theory of Change**

The project logic developed by MCC does not include any outputs or outcomes related to MCC's Technical Assistance Activity. The evaluation team believes that the project logic would improve and MCC's Project Design would be more accurately portrayed with the addition of *training on maintenance state-owned enterprise management* and *road maintenance equipment* as outputs and *improved road maintenance capacity* as a short-term outcome.

MCC's project logic also does not divide the outcomes into short-term outcomes, intermediate outcomes, and long-term outcomes. Providing this differentiation would help to more clearly establish the causal link between the outcomes. Furthermore, MCC's project logic does not provide detailed steps on how the outcomes will lead to the Compact goal of economic growth and poverty reduction. Transport infrastructure, especially for a country with a large geographic area lacking coastline and waterways, plays a crucial role in its economy, linking consumers and producers to domestic and international markets and residents to jobs and social services. Transportation goes hand in hand with trade as a key driver of economic development. Reduced transportation costs lower the prices for businesses and industry to acquire inputs for production and lower distribution costs of products to consumer markets while increased diverted, induced, and generated traffic lead to newer and repeated customer visits. These outcomes lead to opportunities for business and industry growth and thereby expand employment opportunities in businesses and industry. Reduced transportation costs and increased traffic including passenger vehicles for commuters make it easier for labor to reach these employment opportunities. When infrastructure links major industrial and commercial centers to borders with other countries, it also facilitates trade, between Mongolia and its immediate neighbors, including Russia to the North and China to the South, expanding the market for business and industry. Therefore, the evaluation team believes that long-term outcomes, such as improved income from increased economic activities from trade and investment, are helpful to fully explain how the N-S Road Project contributes to the Compact goal.

In addition, MCC's project logic does not clearly depict crucial assumptions that the project is built on. Some major assumptions that should be highlighted include: 1) reduced transportation costs are passed on to the road users, and 2) the N-S road is well maintained to sustain the reduced transportation costs over its lifetime.

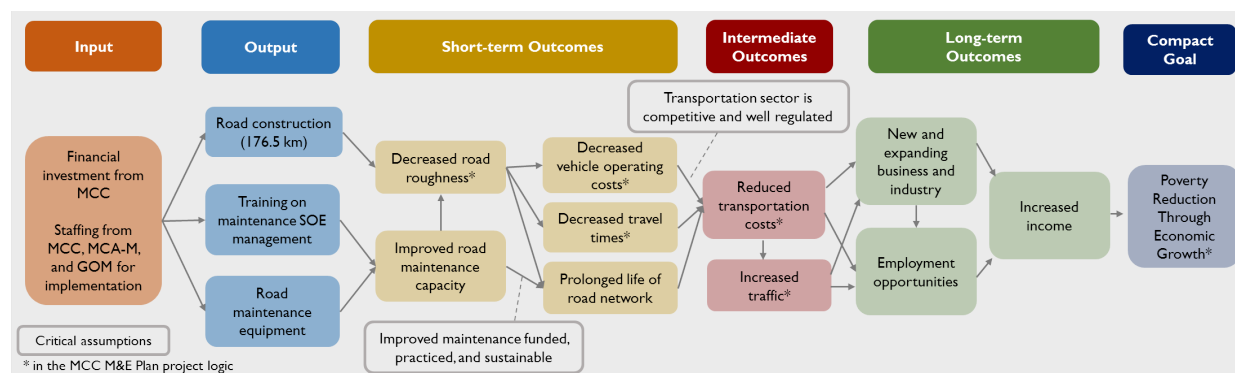
An expanded version of the project logic, drafted by the evaluation team, is shown in Figure 5.

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<sup>31</sup> ADB, TERA Beijing, Technical Assistance Report: "TA 3990 MON – Mongolia Third Roads Development Project Final Report – Supplementary report", Volume 1: Transportation Planning and Economic Issues, January 15, 2004, page 5.

<sup>32</sup> MCC, Final Mongolia Result Statement, December 2014.





**Figure 5: Expanded MCC Mongolia North-South Project Logic by the Evaluation Team**

## 2.3 COST-BENEFIT ANALYSIS & BENEFICIARY ANALYSIS

### 2.3.1 MCC Cost-Benefit Analysis

The economic analysis for the MCC Compact was prepared based on the economic analysis carried out as part of the ADB Feasibility Study of the Choir-Sainshand-Zamyn-Uud Road (Asian Highway 3, Regional Roads Development Project, Loan 2087) in 2003.<sup>33</sup> Review of the ADB Feasibility Study indicates that the analysis used the HDM-4 model to generate a set of unit vehicle operating costs for different road conditions and an average unit vehicle operating cost savings by vehicle type over the project analysis period.

MCC Investment Memo states that MCC’s “analysis estimated returns with and without the planned industrial park based on economic parameters provided in the earlier feasibility report” while updating vehicle operating cost and traffic projection figures. MCC’s economic analysis updated vehicle operating costs from the 2003 level by 10 percent to 2009, without giving a basis for this adjustment. Thus, the analysis used is based on unit rates which have not been updated based on actual cost factors. The MCC Compact economic analysis used traffic projections provided by the GOM. The GOM used the ADB Feasibility Study traffic projections and added the traffic generation for the planned construction of an industrial park in Sainshand.

Using various scenarios of industrial park construction, the Compact economic analysis used an excel spreadsheet to calculate the project net benefit streams using the unit vehicle operating cost savings by vehicle types and the traffic projections over the analysis period. The Economic Internal Rate of Return (EIRR) estimate ranged from 11 to 26 percent under different scenarios of the Sainshand industrial park construction, the lowest assuming no industrial park construction and highest with industrial park construction completed in 2012 as planned.

### 2.3.2 Beneficiary Analysis

The Investment Memorandum Annex 6 indicates that while MCC ordinarily considers the population within a catchment area along the road as the basis for estimating road beneficiaries, “this practice is difficult to apply given the geography of Mongolia and how the population is

<sup>33</sup> Asian Development Bank Technical Assistance Report: “TA 3990 MON – Mongolia Third Roads Development Project; Final Report – Supplementary report Volume 1: Transportation Planning and Economic Issues; prepared by TERA Beijing; January 15, 2004

dispersed within that landscape.”<sup>34</sup> Therefore, based on the origin and destination surveys from the earlier feasibility study, MCC assumed that one third of the road user benefits are retained within the region of the road while the two thirds of the road users reside outside the road segment for the Choir-Sainshand Activity and the UB-Nalaikh Road investment.

According to the M&E Plan (2010) and the Post-Compact M&E Plan (2013), the number of total projected beneficiaries for the Choir-Sainshand Activity was 168,900 and for the UB-Nalaikh road 222,700 over twenty years (2013-2023). There is potential overlap in the number of beneficiaries for the Choir-Sainshand and the UB-Nalaikh Road because they both fall on the same N-S corridor. However, MCC could not determine the overlap between the two beneficiary groups.

For the Bayanzurkh Bridge investment, the number of beneficiaries (166,800) was based on the number of estimated road users, which overlap entirely with the UB-Nalaikh Road beneficiaries. Based on the household socio-economic survey from 2007/2008, MCC determines that that 22-30 percent of beneficiaries are poor (below PPP \$4 per person per day). MCC did not present the beneficiary analysis for the Technical Assistance Activity.

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<sup>34</sup> MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects, Annexes, page. November 10, 2009. Page 46.

### **III. EVALUATION DESIGN OVERVIEW**

#### **3.1 EVALUATION AREAS AND QUESTIONS**

The evaluation will attempt to address the following evaluation areas:

**Evaluation Area 0** examines whether the N-S Road Project was implemented according to plan. The analysis will focus on highlighting any deviations of implementation from the original Compact design to fully understand how the N-S Road Project was implemented.

**Evaluation Area 1** tests the economic viability of MCC-funded roads by conducting a cost-benefit analysis (CBA) to estimate the economic rate of return and net present value (NPV) of the roads. The CBA will employ the HDM-4 model, an analytical tool used to conduct CBA for roads. Post-Compact CBA re-evaluates the validity of the initial assumptions made prior to the Compact. An updated ERR of the MCC-funded roads will inform MCC on the economic viability of large road infrastructure projects.

**Evaluation Area 2** will evaluate the road maintenance regime within Mongolia to test the sustainability of improvement in road infrastructure. The analysis will improve MCC's assumption on post-Compact maintenance and project-life assumptions about its infrastructure investments.

**Evaluation Area 3** is a study of road users, based on origin-destination (O-D) surveys on segments of the MCC-funded roads. The data collected from the O-D surveys will inform the HDM-4 model. Information such as the cost and duration of the trips and value of the goods being transported will be analyzed. The feasibility of surveying public transport users in parallel with the O-D surveys to get a full picture of the users and beneficiaries of the road improvements will also be considered. This evaluation area is intended to understand qualitative information on the road users and their travel patterns. The evaluation area will be also helpful for MCC to understand the type of direct beneficiaries from the Roads Project. Evaluation Area 3B is a study of how road usage patterns have changed since before the infrastructure project. Changes in usage can be obtained as part of O-D surveys.

**Evaluation Area 4** is an analysis of the transportation market structure. This evaluation area will analyze transportation market structure, both formal and informal, to understand how cost savings from road improvements have passed on to transport consumers who do not own their own vehicles. While MCC did not directly work in this area, analysis of the formal and informal institutions of the transportation market will inform whether vehicle operating cost savings were passed on to road users who do not own their own vehicle, such as fisherman and farmers transporting their goods to market and public transportation users.

Below are the key evaluation questions for each evaluation area:

#### **Evaluation Area 0**

- 0) Was the project implemented according to plan?

#### **Evaluation Area 1**

- 1) What is the economic return – calculated in terms of Vehicle Operating Cost (VOC) savings and travel time (TT) savings – of the road investment? [Core]

#### **Evaluation Area 2**

- 2A) What are the relevant road authority's current maintenance practices and what is the likelihood that MCC's investment will remain adequately maintained for the life of the

investment? Based on this assessment, what set of maintenance assumptions should be used in the HDM-4 model to yield the best estimate of the costs and benefits of the road investment? [Core]

- 2B) In cases where MCC invested in improving maintenance practices or included a maintenance Conditions Precedent in the Compact (applicable to Mongolia), what were the effects of those efforts and why? [Core]

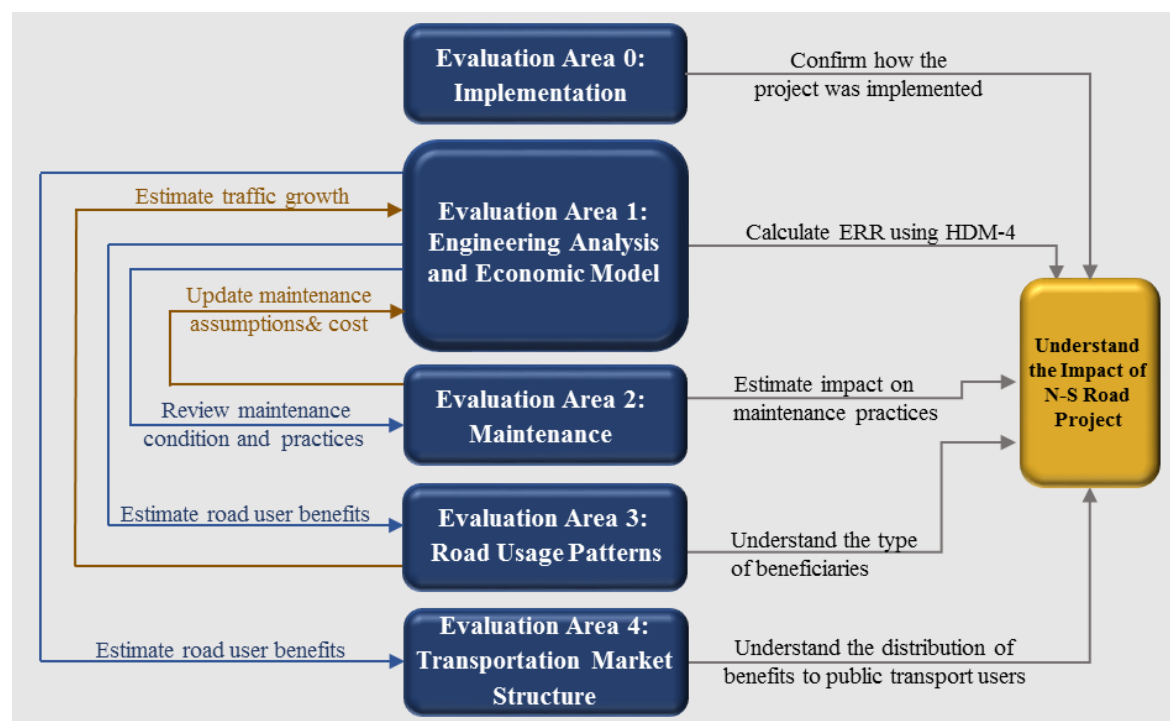
### **Evaluation Area 3**

- 3A) Who is traveling on the road, why, what they are transporting, what they are paying for transport, and how long does it take to move along key routes? [Core]
- 3B) Have road usage patterns changed, in terms of who is traveling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes? [Supplemental]

### **Evaluation Area 4**

- 4) How is the transportation market structured and what is the likelihood that VOC savings will be passed on to consumers of transportation services? [Supplemental]

The team views the individual evaluation areas interwoven as outlined in the figure below. In advance of evaluating the N-S Road Project, the team will investigate how the project was implemented (Evaluation Area 0). With the economic evaluation (Evaluation Area 1) as an instrument to test the project objective of reduced transport cost, the performance evaluation components (Evaluation Area 2, 3, and 4) inform and provide critical nuances to understand the final ERR of the MCC-funded road infrastructure projects. The five evaluation areas, collectively, will inform MCC on its future project design, monitoring, and implementation of roads project and/or other large infrastructure projects.



**Figure 6: Integration of Evaluation Areas**

### **Evaluation Area 0 and Evaluation Area 2, 3, and 4**

Evaluation Area 0 will allow the team to understand how the project was implemented and whether any deviations took place from the original design during the implementation. The information from Evaluation Area 0 will inform the other Evaluation Areas by providing the necessary details of the project for the evaluation.

### **Evaluation Area 1 and Evaluation Area 2**

For Evaluation Area 2, the team will collect data on Mongolia's previous maintenance performed and future maintenance plans and this will contribute to the economic analysis by updating the road maintenance assumptions needed for HDM-4. Furthermore, the engineering studies required for HDM-4 (Road Roughness study) will inform the team on the quality of maintenance conducted on MCC-funded road section for Evaluation Question 2A.

### **Evaluation Area 1 and Evaluation Area 3**

Traffic counts and O-D survey will contribute to the HDM-4 analysis, directly through vehicle number, occupancy, and journey purpose information (the work/non-work in particular) but also indirectly by revealing broader travel patterns and confirming traffic-hierarchy of the MCC section of the road network (Evaluation Question 3A).

### **Evaluation Area 3 and Evaluation Area 4**

The team will interview public transport users and road users at roadside establishments to answer Evaluation Questions 3A and 3B. In addition to addressing Evaluation Area 3, however, the Public Transport User survey and the Roadside Establishment interviews will ask questions to understand the transport market structure and the likelihood of VOC savings being passed on to the consumers of transportation services (Evaluation Area 4). Since no large-scale data collection is intended under Evaluation Area 4, the surveys and the interviews conducted for Evaluation Area 3 will be a major source of information to address Evaluation Area 4.

## **3.2 EVALUATION DESIGN OVERVIEW**

The evaluation team drafted two alternative approaches for the design of the evaluation where relevant:

- Option 1: Comprehensive Approach - a more robust and extensive data collection exercise in which, within time and budgetary constraints, aims for the maximum level of precision; and
- Option 2: Streamlined Approach - a less intensive set of data collection where greater emphasis is placed on the application and adaptation of available data.

Based on the feedback from the stakeholders and MCC, the evaluation team believes that a hybrid of the two approaches - Streamlined and Comprehensive - would be the most cost-effective for MCC. Table 2 below provides a summary of the evaluation design, data collection options where relevant, and the proposed approach for data collection (shaded in light green). Details of the methodology for each data collection effort are provided in sections that follow.

Table 2: Evaluation Design Overview and Data Collection Summary

Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Evaluation Question 0					
List of deviations from original Compact design	MCC Project Documents (Secondary Source Qualitative/Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	IDG will review available sources and interview key stakeholders involved with the implementation of the N-S Road Project to 1) how the project was initially designed. 2) determine how the project was actually implemented, 3) identify any deviations from the original design, and 4) examine the reasons for any changes made. Documents such as the Compact Agreement, Due Diligence reports, and any other documents providing evidence of MCC’s Compact design and implementation will be reviewed. The team will also use the interviews conducted with key stakeholders during the first two visits to Mongolia to verify the information collected and complement additional information that may not have been documented.		
	KIIs with MCA and other stakeholders (Primary Source Qualitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>			
Evaluation Question 1					
Average Annual Daily Traffic of the MCC-funded road section	Traffic Count survey (Primary Source Quantitative)	<ul style="list-style-type: none"><li>• Methodology: US Federal Highway Administration Traffic Monitoring Guide</li><li>• Location: well outside urban areas</li><li>• Adjustment: seasonal traffic variation</li><li>• Survey period: 6am – 8pm</li><li>• Survey days: 2 consecutive market and non-market days</li><li>• Presentation: graphic representation of traffic counting stations, traffic volume, itinerary diagram</li></ul>	<ul style="list-style-type: none"><li>• Location: 2 locations (10km away from Choir/2km from Sainshand )</li><li>• Timing: one time in June</li><li>• Survey period: 6 days-12 hours/1 day-24 hours.</li><li>• Survey days: Saturday – Friday with 24-hour count on mid-week (Tue/Wed/Thu). Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li></ul>	<ul style="list-style-type: none"><li>• Location: 2 locations (10km away from Choir/2km from Sainshand)</li><li>• Timing: one time in June</li><li>• Survey period: 3 days-24 hours.</li><li>• Survey days: Thursday – Saturday. Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li></ul>	<p><b>Deviation from Annex J:</b> Surveying between 6am – 8pm is required by Annex J. However, this will not capture evening traffic and is not aligned with the international standard practice. The US Traffic Monitoring Guide from US Department of Transport states that “a short duration count program is taken from 24, 48, of 72 hours or at times as long as a week.” Based on the observation from the initial trip, the team expects evening traffic will be of significant volume on the N-S road. Therefore, the survey will need to at least include one day of 24-hour data collection (06:00 – 06:00).</p> <p><b>Rationale for Selecting the Option:</b> While 7 days would provide the best result to understand the weekly variation, 3 days would also be sufficient and cost-effective because weekly variations in such a corridor is expected to be low.</p>
<ul style="list-style-type: none"><li>• Vehicle occupancy</li><li>• Trip purpose</li><li>• Passenger time costs (MNT/h)</li><li>• Cargo value (MNT/Ton)</li></ul>	Origin-Destination survey (Primary Source Quantitative)	<ul style="list-style-type: none"><li>• Location: well outside urban areas</li><li>• Survey period: 6am – 8pm</li><li>• Survey days: 2 consecutive market and non-market days</li><li>• Sample rate: 20% of each vehicle type at each site</li><li>• Presentation: graphic representation of O-D stations on aerial imagery and itinerary diagram</li></ul>	<ul style="list-style-type: none"><li>• Location: 2 locations (10km away from Choir/2km from Sainshand)</li><li>• Timing: one time following the traffic count survey</li><li>• Survey period: 2 days-24 hours. Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li><li>• Survey days: Sunday, Monday</li><li>• Sample rate: 20% of each vehicle type at each site</li><li>• Survey length: on average 3-4 minutes</li></ul>	<ul style="list-style-type: none"><li>• Location: 1 location (midway of Lot 2, closer to one of the small towns)</li><li>• Timing: one time following the traffic count survey</li><li>• Survey period: 2 days-24 hours. Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li><li>• Survey days: Sunday, Monday</li><li>• Sample rate: 20% of each vehicle type at each site</li><li>• Survey length: on average 3-4 minutes</li></ul>	<p><b>Deviation from Annex J:</b> Surveying between 6am – 8pm is required by Annex J. However, this will not capture evening traffic. Based on the observation from the initial trip, the team expects evening traffic will be of significant volume on the N-S road. Therefore, the survey will be conducted for 24-hours (06:00 – 06:00).</p> <p><b>Rationale for Selecting the Option:</b> While not significant, there are a number of small towns (e.g. Airag and Eldev coal mine in Dalanjargalan town) along the N-S road. To accurately capture all road users, the team proposes to conduct O-D surveys at 2 locations.</p>



Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Vehicle Operating Cost input parameters for HDM-4	Vehicle Operating Cost survey (Primary Source Quantitative)	<ul style="list-style-type: none"> <li>Sample: transport operators, garages, and sample of private road users from O-D survey</li> </ul>	<u>Conduct new VOC survey</u> <ul style="list-style-type: none"> <li>Sample: Garage shops (Choir/Sainshand), truck companies (UB), vehicle seller (UB), fuel price (secondary if possible)</li> </ul>	<u>Update existing database (2013/2016)</u> <ul style="list-style-type: none"> <li>Adjustment: use inflation rate to update <ul style="list-style-type: none"> <li>Inflation may not accurately reflect fuel price changes</li> </ul> </li> </ul>	<b>Rationale for Selecting the Option:</b> The ADB Project Completion Report provides VOC data for 2013. The ADB Regional Road Development and Maintenance Project also uses VOC data from 2016. The team will conduct a thorough review of the available VOC data and make any adjustments as necessary using secondary sources. The VOC data may be used after review and price adjustment. The cost associated with this will only be in terms of LOE from the HDM-4 Specialist and other team members to review the data for applicability.
Equivalent standard axle loads (ESAL) factor	Axle Load survey (Primary Source Quantitative)	<ul style="list-style-type: none"> <li>Methodology: differentiate between domestic and international traffic</li> <li>Survey period: 6am – 8pm</li> <li>Survey days: one week</li> <li>Adjustment: present both 8.2 ton and 13-ton equivalent factor by vehicle class</li> <li>Presentation: axle weight and heavy weight volume displayed in a tabular format</li> </ul>	<ul style="list-style-type: none"> <li>Sample rate: 30% of all heavy trucks/large buses</li> <li>Location: 1 rest-stop midway of the N-S road</li> <li>Survey period: 48-hours or more based on traffic count/O-D survey results</li> <li>Survey days: 2 days. Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li> </ul>	<ul style="list-style-type: none"> <li>Sample rate: 30% of all heavy trucks/large buses</li> <li>Location: 1 rest-stop midway of the N-S road</li> <li>Survey period: 24-hours or more based on traffic count/O-D survey results</li> <li>Survey days: 1 day. Days selected will be representative days that does not coincide with any public holidays. Survey will not occur during the winter.</li> </ul>	<b>Deviation from Annex J:</b> During the first trip, a number of stakeholders noted that overloading is common on the N-S road. Although Annex J suggests 7 days of data collection, the team believes that a 24-hour survey will be sufficient because weekly variation is expected to be minimal on the N-S road. The team will determine the survey period based on the results from the traffic count and O-D survey.  <b>Rationale for Selecting the Option:</b> The team believes that a 24-hour survey will be sufficient because weekly variation is expected to be minimal on the N-S road.
Unit maintenance costs (MNT)	Maintenance Cost survey (Secondary Source Quantitative)	<ul style="list-style-type: none"> <li>No requirement specified</li> </ul>	The data will be obtained mostly through secondary sources and the costs associated will only be in terms of LOE from the HDM-4 Specialist and the Maintenance Expert to review the data in addition to conducting an additional visual inspection of the road during one of the future trips. The team will collect unit maintenance costs from MRTD for various items such as annual routine maintenance per km, patching per m <sup>2</sup> , crack sealing per m, surface treatment per m <sup>2</sup> , bituminous overlay per m <sup>3</sup> etc. This activity will be paired with other data collection activities to ensure the team is efficiently using their time in-country.		
Road physical parameters for HDM-4	Road Inventory survey (Secondary Source Quantitative)	<ul style="list-style-type: none"> <li>No requirement specified</li> </ul>	No primary data collection is required since the data should be available through secondary sources. The IDG evaluation team will compile and review as-built and design drawings. The costs associated will only be in terms of LOE from the team to review and analyze the data. The team will collect information on roadway width, geometry, drainage and speed reduction factors will be collected from as-built or design drawings and verified during the road condition survey. In case as-built drawings are not available, geometry features will be adopted based on a subjective rating of geometry and HDM-4 defaults.		
International Roughness Index	Road Roughness study (Primary Source Quantitative)	<ul style="list-style-type: none"> <li>Standard: Class 3 or better per ASTM or WB Technical Paper 46</li> <li>Methodology: outer wheel path</li> <li>Interval: 100-meter intervals</li> <li>Presentation: sub-section the road segments into homogenous or dynamic sections</li> </ul>	<u>Private company with UB equipment</u> <ul style="list-style-type: none"> <li>Instrument: Bump Integrator <ul style="list-style-type: none"> <li>Delay due to procurement procedures</li> <li>Better quality control/assurance and conformity to MCC protocol anticipated</li> </ul> </li> <li>Interval: Continuous measure reported every 100-meters</li> </ul>	<u>RTD Center laser-profilometer</u> <ul style="list-style-type: none"> <li>Instrument: Laser-profilometer <ul style="list-style-type: none"> <li>Quality risk due to difference in methodology/standard anticipated</li> <li>RTD Center may not conduct the deflection as initially planned</li> </ul> </li> <li>Interval: Continuous measure reported every 100-meters</li> </ul>	<b>Deviation from Annex J:</b> While Annex J requires 100-m intervals, IRI is a continuous measure and no intervals are required. The IRI data will be reported for every 100-meters to determine homogenous sections.  <b>Rationale for Selecting the Option:</b> The Road and Transport Development (RTD) Center has the capacity and internal plans to measure IRI. Even though it may be more cost-effective to work directly with the RTD Center to collect the deflection data, there is a substantial risk of quality due to differences in methodology/standard used for data collection. The team proposes to collect IRI data with a local engineering company which will ensure higher data quality and conformity to the protocol. IDG will consider options to rent Class 3 or better IRI instruments from the UB Road Department or the RTD Center to be cost-effective.

Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Road condition parameters for HDM-4	Team's assessment based on a drive through (Primary Source Qualitative)	<ul style="list-style-type: none"> <li>Standard: LTPP Distress Identification Manual</li> <li>Analysis: maintenance performed; cause of deterioration</li> <li>Presentation: graphical presentation using color categories</li> </ul>	<u>Road Condition study</u> <ul style="list-style-type: none"> <li>Methodology: Visual inspection of distress</li> <li>Sample: 50m per kilometer</li> <li>Analysis: Determine the cause of deterioration, especially for transverse cracks</li> </ul>	<u>Use of team's subjective assessment</u> <ul style="list-style-type: none"> <li>Surface distress estimated based on a drive through survey by the evaluation team.</li> </ul>	<b>Rationale for Selecting the Option:</b> Based on discussion with MCC, the evaluation team will evaluate the surface distress based on a drive through survey by the evaluation team to be cost-effective. This will limit the understanding of pavement distress and maintenance work conducted on the MCC-funded road section.
<ul style="list-style-type: none"> <li>Deflection (mm)</li> <li>Structural Number (SN)</li> </ul>	MCA-M construction consultant documents (Secondary Source Quantitative)	<ul style="list-style-type: none"> <li>Standard: ASTM</li> <li>Methodology: outer wheel path</li> <li>Timing: during or at the end of the rainy season</li> <li>Interval: 1-kilometer increments</li> <li>Analysis: obtain modulus of every pavement layer and subgrade; obtain pavement layer and determine remaining structural life</li> <li>Adjustment: determine both rainy and dry season deflection</li> <li>Presentation: sub-section the road segments into homogenous or dynamic sections</li> </ul>	<u>Private company with UB equipment</u> <ul style="list-style-type: none"> <li>Instrument: Benkelman Beam</li> <li>Timing: Spring 2019               <ul style="list-style-type: none"> <li>Delay due to procurement procedures</li> <li>Better quality control/assurance and conformity to MCC protocol anticipated</li> </ul> </li> <li>Interval: 500m (staggered)</li> </ul>	<u>Use of existing data</u> <ul style="list-style-type: none"> <li>Assuming that the layer thicknesses are the same as the design thicknesses for Lot 1 and Lot 2, Structural Number estimated based on design thicknesses even though they are not verified with post-Compact data collection.</li> <li>Other structural parameters are estimated from available QC/QA data or using the team's best judgment.</li> </ul>	<b>Rationale for Selecting the Option:</b> Based on discussion with MCC, the evaluation team will estimate the Structural Number of the MCC-funded road based on design thicknesses that are not verified with post-Compact data collection to be cost-effective. This will limit the understanding of pavement structure and the team will be unable to inform homogeneity of the road structure and pavement actual structural performance
<ul style="list-style-type: none"> <li>Adjusted Structural Number</li> <li>Subgrade modulus (psi)</li> <li>California Bearing Ratio (CBR)</li> </ul>	MCA-M construction consultant documents (Secondary Source Quantitative)	<ul style="list-style-type: none"> <li>Standard: ASTM</li> <li>Equipment: Ground Penetrating Radar (GPR)</li> <li>Analysis: determine the subgrade modulus and California Bearing Ratio (CBR); adjusted structural number</li> <li>Presentation: graphical presentation using color categories</li> </ul>	<ul style="list-style-type: none"> <li>Equipment: Dynamic Cone Penetrometer (DCP) (cost estimated at \$2,000) and coring</li> <li>Sample: 43 total - 18 for Lot 1 and 17 for Lot 2, 8 samples where distresses are observed</li> </ul>	<u>Use of existing data</u> <ul style="list-style-type: none"> <li>Assuming that the layer thicknesses are the same as the design thicknesses for Lot 1 and Lot 2, Adjusted Structural Number estimated based on design thicknesses even though they are not verified with post-Compact data collection.</li> <li>Other structural parameters are estimated from available QC/QA data or using the team's best judgment.</li> </ul>	<b>Rationale for Selecting the Option:</b> Based on discussion with MCC, the evaluation team will estimate the Adjusted Structural Number of the MCC-funded road based on design thicknesses that are not verified with post-Compact data collection to be cost-effective. This will limit the understanding of pavement structure and the team will be unable to inform homogeneity of the road structure and pavement actual structural performance. Also, there will be no verification of subgrade CBR and its variability along the section.
<b>Evaluation Question 2A</b>					
Annual maintenance budget requested by MRTD for the N-S road section (2013-2019)	MRTD record of maintenance budget requests to the MOF (Secondary Source Quantitative)	<ul style="list-style-type: none"> <li>No requirement specified</li> </ul>	MRTD's annual budget request to the Ministry of Finance for the maintenance of the MCC-funded N-S road section (2013 to 2019) will be reviewed to examine whether the MRTD is accurately estimating the maintenance needs of the N-S road section.		



Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Annual budget allocated for the maintenance of the N-S road section (2013-2019)	MRTD record of maintenance budget (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	MRTD’s annual budget approved by the Ministry of Finance for the maintenance of the MCC-funded N-S road section (2013 to 2019) will be reviewed to examine whether the Ministry of Finance is funding adequate budget for the maintenance needs of the N-S road section.		
Annual actual maintenance expenditures on the N-S road section (2013-2019)	MRTD record of maintenance expenditure (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	MRTD’s annual budget expenditure on the MCC-funded N-S road section (2013 to 2019) will be reviewed to examine how the maintenance budget is used determine the type of maintenance performed on the N-S road section between 2013 and 2019.		
Quality of emergency and routine maintenance performed on the N-S road section	Team’s assessment based on a drive through (Primary Source Qualitative)	<ul style="list-style-type: none"><li>• As stated above under Evaluation Area 1</li></ul>	Based on the team’s assessment of the road condition, the team will determine the quality of maintenance performed by the maintenance firms on the N-S road section between 2013 and 2019.		
MRTD’s current road maintenance laws, policies, and processes	Mongolia’s laws, MRTD policies and processes	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	Mongolia’s legal documents including laws and decrees pertaining to road maintenance will be reviewed closely. MRTD’s maintenance policies and processes will also be reviewed to compare to international best practices.		
	KIIs with maintenance stakeholders (Primary Source Qualitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	Mainly key informant interviews (KIIs) will be conducted with the relevant maintenance stakeholders. The team will conduct semi-structured interviews. The team will to ask questions and follow-up with relevant inquiry questions to obtain qualitative information on MRTD’s current maintenance practice and its impact on the MCC N-S road section.		
Evaluation Question 2B					
Annual budget allocated for the maintenance all state roads (2013-2019)	MRTD record of maintenance budget (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	The Compact Covenant requested the GOM to maintain a yearly increase in the amount committed to the Road Fund from the amount committed during the prior fiscal year. MRTD’s annual budget approved by the Ministry of Finance for the maintenance of the state roads and the annual budget committed to the Road Fund (2013 to 2019) will be reviewed to examine whether MCC’s Covenant affected Mongolia’s commitment to road maintenance.		
	Road Fund budget (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>			
Annual actual maintenance expenditure for all state roads (2013-2019)	MRTD record of maintenance expenditure (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	MRTD’s annual budget expenditure for all state roads (2013 to 2019) will be reviewed to examine whether the maintenance budget expenditure increased during and after the MCC Compact.		
Number and type of available maintenance equipment owned by the MRTD	MRTD administrative records (Secondary Source Quantitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	As part of the TA Activity, MCC provided seven road maintenance equipment to the MRTD. The team will examine the number and type of maintenance equipment owned by the MRTD to understand whether MCC’s investment in purchasing the equipment were helpful to improve Mongolia’s maintenance practices.		
MRTD’s current road maintenance laws, policies, and processes	Mongolia’s law and decrees, MRTD policies and processes	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	Mongolia’s legal documents including laws and decrees pertaining to road maintenance will be reviewed closely, focusing on any changes that occurred due to MCC’s efforts in improving road maintenance. For instance, MRTD’s maintenance policies and processes will be reviewed to examine whether any changes took place during and after the MCC Compact.		
	KIIs with maintenance stakeholders (Primary Source Qualitative)	<ul style="list-style-type: none"><li>• No requirement specified</li></ul>	KIIs will be conducted with the relevant maintenance stakeholders to understand the effect of MCC’s TA Activity or the Compact Covenant on Mongolia’s road maintenance practices. The team will conduct semi-structured interviews to obtain qualitative information on MCC’s effect on GOM’s maintenance practice.		
Evaluation Question 3A					
Origin-Destination of trips on MCC road section (2019)	Origin-Destination survey (Primary Source Quantitative)	<ul style="list-style-type: none"><li>• As stated above under Evaluation Area 1</li></ul>	In addition to the standard O-D question required for HDM-4 (Origin and Destination, journey purpose, travel time, vehicle classification, passengers per vehicle, number of passengers in employment, number of crew, type and approximate weight of merchandise or goods transported), O-D questionnaire will collect additional elements including fares for transporting goods and people and motivations for the trip. O-D survey will also ask questions on any changes before and after road improvements if relevant to obtain information on Evaluation Area 3B.		
Journey purpose of trips on MCC road section (2019)					
Type of vehicles on MCC road section (2019)					
Number of road users (passengers per vehicle) on MCC road section (2019)					
Type/volume/value of goods transported on MCC road section (2019)					
Travel time from Choir to Sainshand (2019)					
Origin-Destination of public transport users on MCC road section (2019)	Public Transport User survey (Primary Source Qualitative)		Surveys conducted at bus stations: Surveys conducted at Transport Centers in Choir	Surveys conducted on buses: Surveys conducted on public buses leaving from	<b>Rationale for Selecting the Option:</b> On the N-S road, there are two local buses and two international buses daily, and a

Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Journey purpose of public transport users on MCC road section (2019)		<ul style="list-style-type: none"><li>In addition to the tradition questions on travel time and purpose, the Evaluator shall add in questions on fares for goods and people, and motivations for the trip.</li></ul>	and Sainshand, where public buses depart. Survey will interview public transport users on the N-S road and ask questions on travel time, fares, motivation of trip, and any changes before and after the road improvement.	Choir and Sainshand to interview public transport users on the N-S road. Interviewers will board six buses total (four domestic and two international buses) to conduct interviews and ask questions on travel time, fares, motivation of trip, and any changes before and after the road improvement.	bus from the Chinese border to the Russian border two times a month. Conducting surveys on the buses will allow the interviewers sufficient time to ask in-depth questions on the journey and any changes before and after the road improvement for Evaluation Question 3B. The public transport user survey will ask questions relevant for Evaluation Area 3A, 3B, and 4.
Travel time of public transport users from Choir to Sainshand (2019)					
Type/weight/value of goods transported by public transport users on MCC road section (2019)					
Cost of fares for public transportation users from Choir to Sainshand (2019)					
Origin-Destination of trips on MCC road section (2019)	Roadside Establishment Interview (Primary Source Qualitative)	<ul style="list-style-type: none"><li>In addition to the tradition questions on travel time and purpose, the Evaluator shall add in questions on fares for goods and people, and motivations for the trip.</li></ul>	Roadside Establishment Interview: Interviews conducted with residents and commuters at prominent roadside establishments in Choir, Sainshand, and Airag. The interviews will ask questions on any changes before and after the road improvement.	O-D survey: Additional questions will be asked on the O-D survey and the public transport survey to ask questions on any changes before and after the road improvement.	<b>Rationale for Selecting the Option:</b> We believe it may not be possible to get sufficiently detailed answers during the short vehicle intercept O-D survey to fully address questions for Evaluation Area 3, especially Evaluation Area 3B. The team proposes collecting robust information by interviewing residents and commuters at prominent roadside establishments in Choir, Sainshand, and Airag.
Journey purpose of trips on MCC road section (2019)					
Type of vehicles on MCC road section (2019)					
Number of road users (passengers per vehicle) on MCC road section (2019)					
Type/volume/value of goods transported on MCC road section (2019)					
Travel time from Choir to Sainshand (2019)					
Evaluation Question 3B					
Change in Origin-Destination of trips on MCC road section before and after road construction (2019)	Roadside Establishment Interview (Primary Source Qualitative)	<ul style="list-style-type: none"><li>In addition to the tradition questions on travel time and purpose, the Evaluator shall add in questions on fares for goods and people, and motivations for the trip.</li></ul>	In addition to 3A, the Roadside Establishment Interview will ask questions the change in road usage patterns before and after the MCC-road construction. The team expects to gain more detailed information on impacts to beneficiaries who reside in the local area by conducting interviews in Sainshand and Choir. The interviews in Choir, Sainshand, and Airag will particularly ask questions on the change in road usage to understand whether MCC’s road improvements had an effect on the road usage of the MCC road section.		
Change in journey purpose of trips on MCC road section before and after road construction (2019)					
Change in the type of vehicles on MCC road section before and after road construction (2019)					
Change in the number of road users (passengers per vehicle) on MCC road section before and after road construction (2019)					
Change in type/volume /value of goods transported on MCC road section before and after road construction (2019)					
Change in travel time from Choir to Sainshand before and after road construction (2019)					
Change in Origin-Destination of trips on MCC road section before and after road construction (2019)	KIIs with commercial transport service stakeholders (Primary Source Qualitative)	<ul style="list-style-type: none"><li>In addition to the tradition questions on travel time and purpose, the Evaluator shall add in questions on fares for goods and people, and motivations for the trip.</li></ul>	Mainly KIIs will be conducted with the relevant commercial transportation service stakeholders including truck associations, transporter unions, truck operators, and bus operators. The Evaluation Expert will conduct semi-structured interviews, a fairly open framework which allow for focused, conversational, two-way communication. In addition to questions on travel time and purpose, the Evaluator will ask questions on change in transportation fares for goods and people, change in type, weight, and value of goods transported.		
Change in the number of road users (passengers per vehicle) on MCC road section before and after road construction (2019)					
Change in type/volume /value of goods transported on MCC road section before and after road construction (2019)					
Change in travel time from Choir to Sainshand before and after road construction (2019)					

Key Outcome	Data Source (Data Type)	Annex J Requirement	Option 1 – Comprehensive Approach Methodology*	Option 2 – Streamlined Approach Methodology*	Remarks
Change in cost for transporting goods and people from Choir to Sainshand before and after road construction (2019)			<b>Evaluation Question 4</b>		
Change in cost for transporting goods and people from Choir to Sainshand before and after road construction (2019)	Public Transport User survey (Primary Source Qualitative)	<ul style="list-style-type: none"> <li>The Evaluator shall review the country's regulatory structure, formal institutions that impact the sector, and informal institutions that may influence pricing. The primary goal is to understand the market imperfections, and how those imperfections may limit the amount of cost savings that are passed on to users of transport services.</li> </ul>	As noted above, the Public Transport User survey will inform not only Evaluation Question 3B but also Evaluation Question 4. The team will ask question during the Public Transport User interviews to obtain information on VOC savings that are passed on to public transport users. The team will collect information on reported fares for passenger service, such as fares set in the informal market from providers of transport in the informal market and from the roadside establishment interviews and the public bus survey.		
	Roadside Establishment Interview (Primary Source Qualitative)		KIIs will be conducted with transportation service providers, including truck operators at prominent road side establishments in Choir and Sainshand and bus station staffs and operators. The Transport Economist will ask questions if they observed any change in costs for transporting goods and people from Choir to Sainshand before and after the road construction.		
	KIIs with transportation service providers (Primary Source Qualitative)		The team will collect historical data on fares, where available. For example, the team will collect passenger rail fares, but bus fares prior to the Compact are not available because the bus lines did not exist until after the MCC road was completed. The team will collect freight prices from existing associations of drivers (e.g. the Mongol Transport Union) and from independent owner-operated drivers who we have been told by the Chamber of Commerce offer lower prices and have a downward effect on the market price. The team will collect data in the unit available, e.g. container, ton-kilogram, ton-kilogram-meter. It will also be harder to obtain historical pricing data on cargo because few trucks were on the road. (Based on our preliminary interviews, there was very little truck traffic and most cargo came by rail.).		
	Historical records of rail and bus fares from Choir to Sainshand (Primary Source Quantitative)				
Transportation market laws, policies, and processes	Mongolia's laws and MRTD's policies on transport market fares and regulations	<ul style="list-style-type: none"> <li>The Evaluator shall review the country's regulatory structure, formal institutions that impact the sector, and informal institutions that may influence pricing. The primary goal is to understand the market imperfections, and how those imperfections may limit the amount of cost savings that are passed on to users of transport services.</li> </ul>	Mongolia's legal documents including laws and decrees pertaining to road transportation services will be reviewed closely, focusing on any changes that occurred due before and after MCC's road rehabilitation efforts. For instance, MRTD's public bus fares regulations and processes regulating the public transportation or freight forwarding market will be reviewed closely to examine whether the VOC savings are likely to be passed on to consumers of transportation services.		
	KIIs with transportation service providers (Primary Source Qualitative)		KIIs will be conducted with transport ration service providers, including truck operators at prominent road side establishments in Choir and Sainshand and bus station staffs and operators. The Chamber of Commerce has indicated that Zamyn-Uud is the best place to interview independent owner-operated truckers who have had notable effect on the transportation market, exerting downward pressure on prices. The truckers are available in high concentration and make a stop at this location, allowing for interview opportunities. Interviewing taxi drivers and private automobiles providing passenger services in the informal market would allow us to study this sector. However, preliminary findings indicate, that taxis operate primarily locally within Sainshand and Choir and there is a limited number of vehicles in the informal market on the highway. Thus, based on our preliminary findings, the Transport Economist will hold KIIs at Choir and Sainshand. The team will consider options to combine the interviews at roadside establishments.		
	KIIs with transportation service regulators (Primary Source Qualitative)		Mainly KIIs will be conducted with the relevant transport service regulations including the National Transportation Center who sets and/or arbitrates prices and routes. Provincial Transportation Centers will be also interviewed to inform implementation of policies and regulations. The team will conduct semi-structured interviews, a fairly open framework which allow for focused, conversational, two-way communication. The Transport Economist will ask questions developed to answer each evaluation questions and follow-up with relevant inquiry questions to obtain more specific information.		

Note 1: Boxes shaded in light green indicate the final data collection approaches selected by the Evaluation Team for data collection.

Note 2: The vendor costs for the final data collection approaches highlighted in green are based on estimates from vendor responses to RFIs; the approaches not highlighted in green are estimated by the IDG team.

\* The two columns only specify the methodology that are different from Annex J. Otherwise stated, the methodology is the same as described in Annex J.

\*\* The labor costs are based on estimates and may be subject to change if MCC prefers an approach not proposed by IDG (options not highlighted in green).

### 3.2.1 Data Collection and Effect on ERR Estimates

The most sensitive inputs to the HDM model for Economic Rate of Return (ERR) calculation are pavement structural variables (adjusted Structural Number calculated from layer thickness or deflection), traffic volume, and roughness. Based on HDM-4 "A Guide to Calibration and Adaptation - Volume 5", the sensitivity class for these parameters is S-I, which means the impact elasticity is higher than 0.50. For instance, a 10 percent increase in pavement roughness causes 5 percent or more increase in the ERR ceteris paribus. Sensitivity class for data obtained from a surface distress survey used for calibrating cracking initiation factor and cracking progress factor, are either S-II (impact elasticity between 0.2 and 0.5) or S-III (impact elasticity between 0.05 and 0.2), depending on the parameter. Road deterioration inputs obtained from the geotechnical survey, other than the adjusted Structural Number, are S-III.

In order to support the decision making process of the data collection rigor for Evaluation Area 1, the evaluation team estimated the impact of excluding certain data collection efforts on the ERR. The team considered five options, each one providing incrementally greater level of data collection, as follows

- *Option 1:* Includes roughness survey but excludes deflection, surface distress survey, and geotechnical survey.
- *Option 2:* Includes deflection, roughness, and surface distress survey but excludes geotechnical survey.
- *Option 3:* Includes roughness, surface distress survey, and geotechnical survey but excludes deflection.
- *Option 4:* Includes deflection, roughness, and geotechnical survey but excludes surface distress survey.
- *Option 5:* Includes deflection, roughness, geotechnical, and surface distress survey.

The following table presents our estimated level of precision of the ERR for each option.

The estimated ranges of ERR are based on the team's subjective judgment for each option and should not be considered as a rigorous confidence interval. All options estimate the ERR with varying levels of precision based on the rigor of the data collection methodology. Based on the discussion with MCC, Option 1 was selected for the engineering data collection of Evaluation Area 1.



**Table 3: Summary of Results on Estimated Level of ERR Precisions**

Options*	Option 1	Option 2	Option 3	Option 4	Option 5
	Excludes deflection, geotechnical, and surface distress survey	Excludes geotechnical survey	Excludes deflection survey	Excludes surface distress survey	Includes all surveys
Assumptions	<ul style="list-style-type: none"> <li>Assumes layer thicknesses are the same as the design thicknesses for Lot 1 and Lot 2.</li> <li>Structural Number is calculated from design thickness.</li> <li>Other structural parameters are estimated from available QC/QA data or using the team's best judgment.</li> <li>Surface distress estimated based on a drive through survey by the evaluation team.</li> </ul>	<ul style="list-style-type: none"> <li>Assumes layer thicknesses are the same as the design thicknesses for Lot 1 and Lot 2.</li> <li>Structural Number is calculated from design thickness and deflection results.</li> <li>Other structural parameters are estimated from available QC/QA data or using the team's best judgment.</li> </ul>	<ul style="list-style-type: none"> <li>Assumes layer thicknesses are the same as the design thicknesses for Lot 1 and Lot 2.</li> <li>Structural Number is calculated from geotechnical survey results.</li> <li>Other structural parameters are estimated from available QC/QA data or using the team's best judgment.</li> </ul>	<ul style="list-style-type: none"> <li>Structural Number calculated from layer thickness from geotechnical survey and verified by deflection measurement</li> <li>Surface distress estimated based on a drive through survey by the evaluation team.</li> </ul>	N/A
Implications on analysis and interpretation	<ul style="list-style-type: none"> <li>Adjusted Structural Number estimated based on design thicknesses not verified with post-Compact data collection.</li> <li>Unable to inform homogeneity of the road structure and pavement actual structural performance in the field.</li> <li>Less confident estimates of Fatigue curve and remaining life calculations.</li> <li>No geotechnical information available to analyze the cause of transverse cracks.</li> <li>No verification of subgrade CBR in the field and its variability along the section.</li> <li>Limited understanding of pavement distress and maintenance work conducted on the MCC-funded road section limited for Evaluation Area 2.</li> </ul>	<ul style="list-style-type: none"> <li>Deflection survey used to estimate the adjusted Structural Number without verification.</li> <li>No geotechnical information available to analyze the cause of transverse cracks.</li> <li>No verification of subgrade CBR in the field and its variability along the section.</li> </ul>	<ul style="list-style-type: none"> <li>Structural assessment of pavement not possible</li> <li>Unable to inform homogeneity of the road structure and pavement actual structural performance in the field.</li> <li>Less confident estimates of Fatigue curve and remaining life calculations.</li> </ul>	<ul style="list-style-type: none"> <li>Limited understanding of pavement distress and maintenance work conducted on the MCC-funded road section limited for Evaluation Area 2.</li> </ul>	N/A
Estimated range of ERR	<b>+/- 2.5% points</b>	<b>+/- 1.5% points</b>	<b>+/- 1.5% points</b>	<b>+/- 1% points</b>	-

\*All options include roughness survey.

## **IV. EVALUATION DESIGN – EVALUATION AREA 0: ENGINEERING ANALYSIS AND ECONOMIC MODEL**

### **4.1 EVALUATION QUESTIONS**

#### **0) Was the project implemented according to plan?**

This evaluation question is aimed at informing the evaluation as a whole. First, the team will examine how the original MCC Compact was designed and what the intended results and processes were. This helps the team to understand the original plan of the project and whether the team believes that the design was in alignment with the local conditions and international standards. Second, the answer to the question will highlight any deviations made during project implementation from the original Compact design. This will allow the team to understand the changing environment MCC had to manage and adapt to for project implementation. Third, the information obtained to answer the question will provide the team with a clear foundation to assess other evaluation areas.

In particular, the team will address the following sub-questions:

- How did MCC originally design the project?
- Is the original project design supported with evidence?
- How was the MCC project finally implemented?
- What changes and deviations were made during project implementation?
- Are the changes substantiated by evidence?

For instance, IDG will determine whether the initial design or the final structure of the road was applicable for Mongolia and the N-S road. Based on the information gathered, the team will provide recommendations as relevant to inform the future Compact design.

### **4.2 EVALUATION APPROACH**

#### **4.2.1 Summary of Existing Data (refer to Section 2.1.4)**

#### **4.2.2 Evaluation Question 0 Methodology**

##### **Quantitative Approach – Secondary Data Review**

**Description of Methodology:** The evaluation team will continue to review secondary data from various sources to address Evaluation Question 0. The team has reviewed documents provided by the MCC and other stakeholders. IDG will continue to obtain additional secondary data regarding the project and review them to fully understand how the project was implemented. Any deviations from the initial Compact design will be noted and discrepancies between available information will be highlighted to be confirmed during the evaluation.

**Data Processing/Analysis:** When the team is unable to obtain relevant documents in English, the Mongolian document (or at least the executive summary or the relevant sections) will be translated for the purpose of the evaluation. Based on the secondary data collected and the qualitative data collected (details below), the team will evaluate how the N-S Road Project was implemented and

the changes made during the implementation. The team will review the rationale for the initial project design and the changes during implementation made to assess whether the changes made were well supported with evidence. For instance, the team will assess in detail whether MCC's final as-built structure of the road was appropriate and adequate for the objective of the project.

### **Qualitative Approach – KIIs**

**Description of Methodology:** The team has conducted a number of interviews with key stakeholders during the initial trip to Mongolia. Throughout the evaluation process, the team will continue to engage with relevant stakeholders to carry out the other evaluation areas. Based on the interviews already conducted and the additional interviews to be held for the other evaluation areas, the team will gather information that may be helpful to understand the project implementation and the decision-making process that went into changing the original design (see sections under Evaluation Area 2, 3, and 4 for more details on the methodology for conducting KIIs).

#### **Evaluation Area 0 and the Final Analysis**

Evaluation Question 0 will provide the basis for the final analysis by substantiating the evaluation with information on how the N-S Road Project was implemented and the rationale for the changes made.

## **4.3 CHALLENGES**

### ***4.3.1 Limitations of Interpretation of the Results/Risks to the Study Design***

Secondary data sources are essential for answering Evaluation Question 0. There is a risk that these documents may not be available to the evaluation team due to delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Especially given that the project was completed in 2013 and some time has passed since the Compact ended, not all information on the implementation can be retrieved. The team expect that there are a number of documents that could have been misplaced after the project completion. For instance, the as-built drawings for Lot 1 of the N-S road are currently not available for the team. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

## **V. EVALUATION DESIGN – EVALUATION AREA 1: ENGINEERING ANALYSIS AND ECONOMIC MODEL**

### **5.1 EVALUATION QUESTIONS**

#### **1) What is the economic return – calculated in terms of VOC savings and travel time (TT) savings – of the road investment? [Core]**

Economic return refers to a quantitative value that is conventionally expressed in two key indicators: NPV and EIRR. ERR for the evaluation is assessed by comparing the final project capital and recurrent costs (final construction costs and expected maintenance costs) versus the benefits of the project road to its users over the intended project life (determined at appraisal stage, usually 20-30 years).

Prior to an investment, calculating ERR of an infrastructure investment helps to decide on competing infrastructure development priorities within the transport sector and across all sectors under consideration. At an evaluation stage, an assessment of ERR based on actual outcome provides an insight into the original investment decision and provide valuable recommendations, if any, for project design that may improve the economic returns of future projects.

The purpose of determining the N-S Road Project's economic return is to assess whether the investment resulted in an acceptable rate of return on the project investment in terms of the quantifiable social benefits generated by the project. It also helps to compare with the pre-Compact economic rate of return and assess the assumptions made for the investment decisions.

### **5.2 EVALUATION METHODOLOGY**

The approach used for the proposed economic evaluation comprises both primary and secondary data collection efforts followed by rigorous data analysis that utilizes established modeling/analytical tools.

#### **5.2.1 Summary of Existing Evidence**

##### **ERR**

MCC's North-South Road Project in Mongolia between Choir and Sainshand was completed in September 2013. The project was included as part of the larger Mongolia: Regional Road Development Project by ADB and in 2010, MCC took over the financing for the construction of the Choir-Sainshand section. The economic viability of the N-S Road Project was initially evaluated at the appraisal stage in 2003-2004 by ADB. The economic evaluation was updated by ADB twice in 2007 and 2010 incorporating changes (cost increase, traffic growth updates, delay etc.) that occurred during this period. The EIRR estimated by ADB for the N-S road which included the MCC section (Choir- Sainshand) and the ADB section (Sainshand-Zamyn-Uud) was 16.2 percent in 2010. An economic evaluation was conducted by MCC when the road project was included in the Compact and the EIRR estimated by MCC in 2009 was 17.0 percent.

Under the MCC Compact, the Choir-Sainshand section (176 km) of N-S corridor was constructed to a two-lane asphalt concrete surfaced road. Prior to the investment, there were only multiple



earthen tracks used by the traffic.<sup>35</sup> The Feasibility Study report prepared by the ADB in 2003-04 and the design report prepared by the GOM provides information on the project road and traffic data prior to the construction and the project design. Existing data relevant to the current evaluation are listed below:

- ADB Feasibility Study (2004): Provides information on the HDM-4 model used, VOC parameters, traffic pattern. There is only very limited information on the road prior to improvement which is required for developing the without project case in economic analysis.
- Design report prepared by the GOM: Provides details of project road design but there is only limited information on the road prior to improvement.
- ADB Project Completion Report (2015): Provides an economic analysis of the N-S corridor combining the MCC and the ADB sections. This report provides updated VOC parameters used as input to the HDM-4 model which can be adopted for the evaluation. It also provides traffic data for 2013.
- Historical traffic data from MRTD.
- Statistical information on macro-economic indicators, wages, vehicle registration growth, climate are available on the National Statistics Office of Mongolia website<sup>36</sup> which will be useful in the calibration of the HDM-4 model.

MCC documents indicate that MCC used ADB Feasibility Study and GOM's traffic data and projection (MCC didn't independently verified the traffic data) in an excel spreadsheet to calculate the economic rate of return of the project prior to starting the project. The unit VOC rates for vehicles from ADB Feasibility Study were updated to 2009 prices by applying a price adjustment factor of 10 percent.

The GOM traffic forecast assumed that an industrial park will be established in Sainshand by 2012 which will generate substantial traffic on the project road over 1000 vehicles per day. MCC calculated the EIRR assuming various scenarios on industrial park implementation. Without an industrial park, the analysis assumed normal traffic would jump from 161 vehicles per day to 800 vehicles per day on completion of the road section and a 7 percent growth in normal traffic thereafter and estimated to have an ERR of 11 percent. With an industrial park also completing in 2012, the ERR increases to 26 percent. The analysis considered the ERR to fall between 11 and 26 percent based on the likelihood of industrial park implementation and assuming probability for different scenarios of industrial park implementation an expected ERR of 17 percent was estimated.<sup>37</sup>

An update of the economic analysis at closeout by MCC with the increased cost allocation for the project road reduced the expected ERR to 10.5 percent<sup>38</sup> which is below the discount rate of 10 percent.

## **Traffic Forecast**

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<sup>35</sup> MCA Completion Report, no page number.

<sup>36</sup> <http://www.en.nso.mn>

<sup>37</sup> Budget is based on the MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects. November 10, 2009.

<sup>38</sup> Excel file provided by MCC “mcc-err-mongolia CS road\_closeout for webv1+bd”

Since the ADB Feasibility Study in 2004, there has been a series of traffic surveys and traffic forecast with significant divergences. Methods and assumption behind the traffic forecasts have often differed. These divergences are outlined in the table below based on publicly available information<sup>39</sup>.

**Table 4: Traffic Comparison from Different Sources expressed in AADT**

Source	Year	Traffic Type			Total	AAGR (%)*	Assumptions
		Normal	Induced	Generated			
ADB (2004)	2003	114	0	0	114	4.60%	
	2009	149	541	15	705		Induced traffic based on rail conversion
	2014	187	712	19	918	5.40%	
	2017	215	846	22	1083		
	2019	236	934	24	1194		
MRTD (2014)	2004	97			97		
	2010				160	8.70%	Project started in 2010 completed
	2013				762	7% after	In 2013, no industrial park
ADB Project Completion Report RRP (2015)	2010				152		
	2014	187	820	19	1026		
	2017	219	979	22	1220		
	2019	244	1088	24	1356	5.70%	
ADB Project Completion Report Survey Revised (2015)	2014				620		500 in April and 740 in August
	2014	187	494	19	700		Estimated 1,000 at the end of 2014
	2017	219	968	22	1209		
	2019	244	1040	24	1308	4% (2015-23)	Induced traffic rising to 900 in 2015
ADB TA711-MON (Dec 2010)						10% in TEU**	Z-U Logistic Center Study forecast 10% growth TEU on road
MCC-IDG (Jan 2018)	2013				391		Reported from team visit based on interviews with MRTD
	2017				786		

\*AAGR refers to Average Annual Growth Rate

\*\* TEU stands for Twenty-foot Equivalent Unit

Assuming that comparisons from different sources hold, 2017 traffic reported by the MRTD to IDG during the first trip to Mongolia was on average 40 – 50 percent lower than forecasts from ADB in 2004. Large part of the traffic growth reported in the ADB Feasibility Study (and accepted by ADB RRP and PCR) came from conversion from rail traffic and there is high risk in estimating the level of conversion. Traffic annual growth before MCC improvement was in the order of 4-5 percent and roughly growth after improvement has been at the same rate. This will need to be confirmed with new traffic surveys.

### 5.2.2 General Methodology

The general evaluation methodology for calculating the economic rate of return is determined by the magnitude of the impact of road investments on the transport conditions before and after the

<sup>39</sup> During the first trip, MRTD indicated that there is a series of traffic counts on the project road from 2003 to 2017 but this information is not available to the team yet as of June 2018.

project. The project road improvement consists of the construction of a new two-lane asphalt concrete road in place of an existing track, which is passable during dry season for motorized traffic. The main impact of the improvement is estimated to be a substantial reduction in transport costs (VOC and travel time) and contribute to the economic growth of the area served by the road.

In terms of transport economics, road improvement will result in savings to road users and the society as a whole in the form of reduced vehicle operating and time costs for passengers and freight. There will also be reduced costs to the Government in the form of reduced road maintenance costs. These reduced costs, calculated over the project life, are compared with construction costs for the road (including the cost of environmental and social impact mitigation measures).

In order for the project to be considered economically viable, the project road investment has to result in an ERR of at least equal to the opportunity cost of capital in Mongolia, which is set at 10 percent. NPV's are calculated using opportunity cost of capital as the discount rate.

The Road Economic Decision (RED) model or the HDM-4 model are both appropriate tools for establishing the economic evaluation for the project road investment. HDM-4, originally developed by the World Bank, is now accepted as the premier model for the economic evaluation of road rehabilitation and improvement schemes in developing countries. HDM-4 model allows modeling of (1) road deterioration as a factor of road construction and maintenance, traffic loadings, and climatic conditions, and (2) vehicle operating costs as a factor of traffic and roadway factors, road deterioration and subsequent maintenance and rehabilitation/construction, over the analysis period and allows to explore various road construction and maintenance strategies. The RED model is a simplified spreadsheet-based model, which performs a similar function to HDM-4 but uses an average road condition over the analysis period instead of simulating the road condition for the analysis period. The RED model is considered the more appropriate tool when one or more of the following factors are significant:

- Low levels of daily traffic;
- Seasonal interruptions to road operation;
- Road construction is less than fully engineered; or
- Data, particularly engineering data, is limited.

For this evaluation, the road section before construction involved multiple tracks motorable during dry seasons and hardly any engineering data are available on the tracks. With limited information, it is difficult to realistically generate HDM-4 input or use any modelling available in HDM-4 for the “without-project” case. Though the RED model is more appropriate for the “without-project” case, HDM-4 will be used with data to be collected in consultation with MRTD staff familiar with the road condition prior to the MCC road investment.

The HDM-4 model is appropriate to model the “with-project” case of an all-weather asphalt concrete surfaced road and the HDM-4 models the maintenance regime and its impact on the road user cost. The output of the economic evaluation, whether carried out using HDM-4 or RED, consists of measures of economic viability, primarily NPV and EIRR. Basic economic viability is generally considered to be achieved if NPV is positive and EIRR is greater than the specified hurdle rate (opportunity cost of capital), as a percentage.

Based on the above considerations, the team will use the HDM-4 model as the primary analytical tool for the economic evaluation of the N-S Road Project. The analysis will be carried out for a post improvement 20-year appraisal period, the standard application for road cost benefit studies.

### **5.2.3 Timeframe of Exposure**

Realization of impact and benefits of road construction projects depends on the extent of change and economic potential of the project impact area. There is no clear evidence to indicate when to collect data for HDM-4 after a road is completed. In general, “transport experts agree that it is unrealistic to expect to see immediate impacts on high-level outcomes, and that a few years are required for those changes to manifest.”<sup>40</sup> While not in a developing country context, a study of 13 improved roads in England shows that the roads experienced an average of 7 percent increase in traffic, as compared to average background growth, between 3 to 7 years after opening.<sup>41</sup> Based on in this report and other relevant experience, the team believes that improving a congested road will bring out most of the impact within 1-2 years whereas constructing a new road to areas without good access will take 1-2 years to start to see the early impacts and 3-7 years to see larger impacts and 8 or more years to see the full impact.

For the N-S road constructed was completed in September 2013 and the exposure period is around 5 - 6 years assuming the data collection occurs in 2018 and 2019. The team believes that as a new road connectivity, this is an adequate time frame to conduct the economic evaluation for the N-S road.

### **5.2.4 Traffic Count Survey**

**Description of Methodology:** The MRTD reported conducting two rounds of traffic counts in September and November 2013<sup>42</sup>. The traffic counts were conducted for three days (72 hours) between Tuesday and Thursday, which is acceptable standard. The traffic count was conducted 10 km away from Choir, which is also acceptable given that there is no development beyond a few km outside Choir. MRTD had categorized vehicles into six categories (sedan/SUV; heavy trucks; medium or lightweight trucks; normal size buses; minibuses (microbuses); tractor and motorcycles). In the most recent used traffic count form, MRTD had categorized vehicles into eight categories (sedan/SUV; 2-axle vehicle; 3-axle vehicle; 4-axle vehicle; 5-axle vehicle; 6-axle vehicle; bus; motorcycles). While this categorization is acceptable, more detailed classification of vehicle type is preferred for the HDM-4.

The conventional approach to traffic counting is to use the manual paper-based method. In general, this method is the more cost-effective method in comparison to automatic counting procedures as they would involve using costlier high technology instruments, such as piezo or similar sensors embedded in the pavement, or video recording. Ensuring the automatic counting equipment safe and maintained is also a risk to the quality of data collection. In addition, the manual counting method has the advantage of allowing for the recording of as many varieties of vehicle types as required by the evaluation.<sup>43</sup> Depending on the type used, automatic counting methods may be

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<sup>40</sup> MCC, Principles into Practice, Lessons from MCC’s Investments in Roads, November 2017.

<sup>41</sup> Lynn Sloman, Lisa Hopkinson, and Ian Taylor, Campaign to Protect Rural England, The Impact of Road Projects in England, March 2017.

<sup>42</sup> MRTD, *Report on Traffic Count Measurement Made for Choir-Sainshand Road A-102 in 2013*, 2013.

<sup>43</sup> The evaluation team will release an RFP to potential data collection firms in Mongolia to explore the option of conducting Automatic Traffic Counts. When the cost information is available, MCC and the evaluation team will discuss if ATC will be added to the evaluation.

unable to distinguish between numerous vehicle types other than broad categories that are related to the length of each vehicle and the longitudinal spacing between axles. The evaluation team therefore intends to use the manual method (i.e. Manual Traffic Counts, MTC) for this evaluation. When releasing a Request for Proposal to select a data collection firm, the evaluation team will encourage all bidders to consider using electronic hand-held devices for data collection over paper-based surveys.

**Instrument/Equipment:** The manual traffic count is usually performed in 15-minute intervals for each direction of flow. The instrument/equipment used will depend on the availability of competent data collection firms in Mongolia. If the evaluation successfully contracts a firm to use electronic surveying method, hand-held electronic devices, such as tablets or smartphones, will be used to collect data. If not, an A4 or letter size sheet of paper with space for four 15-minute intervals will be used for data collection such that each sheet represents one hour of vehicle movements. Vehicles will generally be recorded in batches of five using the ‘5-bar gate’ configuration as follows:



A sample MTC paper sheet is presented in Annex IV.

**Rounds and Timing:** The MTC will be conducted one time in June 2019. The survey period will be for three days, 24 hours covering representative days of the week (Thursday, Friday, and Saturday) that do not fall during the winter or public holiday period. According to the MRTD, there are no specific days when import/export traffic would be significantly higher or lower.<sup>44</sup>

While Annex J requires traffic count surveys to be conducted between 6:00 am and 8:00 pm, the evaluation team believes that conducting MTC only during this period will not allow the team to capture night traffic on the N-S road. Based on the team’s observations during the initial trip to Mongolia, the team expects a significant volume of night traffic on the MCC-funded road. The US Traffic Monitoring Guide from US Department of Transport also states that “a short duration count program is taken from 24, 48, of 72 hours or at times as long as a week.”<sup>45</sup> Therefore, the survey will at least include one day of 24-hour data collection (06:00 am to 06:00 am). In addition, Annex J requires for two consecutive market and non-market days. While seven days would provide the best results to understand weekly variations, three days would also be efficient and cost-effective as the team expects low weekly variations in this type of road corridor.

**Sample/Data Collection Location<sup>46</sup>:** The sampling unit of the MTC is motorized and non-motorized vehicle observed at the counting station on the N-S road during the survey period.

As part of the ADB Feasibility Study, traffic counts were conducted in 2003 at two locations on the Choir-Sainshand road: 1) near the railway crossing in Choir and 2) 2 km from Sainshand, which both falls outside of the MCC-funded road section. While the evaluation team prefers to conduct the traffic counts at the location where ADB conducted the traffic counts (railway crossing in Choir) to allow comparison over time, the traffic count was conducted within Choir’s center urban area. Therefore, the team will conduct one of the two traffic counts at about 10km away from Choir to allow sufficient comparison over time with the ADB count in 2003 but also avoid

<sup>44</sup> MRTD stated that they are unaware of any unique days to monitor import/export traffic (June 2018).

<sup>45</sup> US Traffic Monitoring Guide, United States Department of Transport, October 2016.

<sup>46</sup> Refer to Annex V for more details on the rationale for selecting the data collection locations.



local developments in Choir. The second traffic count will be located 2 km from Sainshand, which will capture the corridor traffic characteristics between Choir and Sainshand and allow the team to compare with the ADB results from 2003.

Please see Annex VI for illustrative maps that depict the approximate locations of the counting stations on the N-S project road. Consideration will also be given to the availability of some basic facilities such as a café or small shop or filling station to ensure the safety and basic comfort of the traffic counters.

**Staffing:** The evaluation team intends to subcontract the traffic count survey and the team sizes will be determined by the successful bidder based on a competitive procurement process. For inter-urban traffic survey with traffic volumes less than around 1,000 vehicles per day (vpd), manual counts are typically performed by a team of two enumerators for each direction of traffic. The evaluation team will allow bidders to consider conducting the traffic counts with a team of three enumerators (one for each direction and one enumerator to support both directions) to be cost-effective.

**Safety Procedures:** Approximately, two to three meters of space is required inward from the carriageway in order to position tables, chairs, and also umbrellas or a tent-like structure for the enumerators that will provide protection against the sun and rain during data collection. Positioning of the survey location would also need to ensure good visibility in both directions (i.e. road bends or slopes must be avoided). In the evening or other dark times of the day, portable battery powered lamps with suitable back-up batteries, will be placed for the enumerators. The surveyors will also be provided with yellow reflective jackets.

**Data Quality:** Prior to data collection, the subcontractor and the evaluation team will train, pre-test, and pilot the survey to ensure high quality data collection. During data collection, the evaluation team will conduct random checks to ensure the data are recorded correctly and quickly rectify any anomalies. The role of the supervisor is vital in order to consistently check the work of the enumerators. For a paper form survey, supervisors will ensure the vehicle types are properly categorized in the appropriate columns on the traffic count form. Traffic count stations will have a minimum of two personnel at all times and reserves will be in place in case of unexpected emergencies. If using a paper-form, the data collection firm will be required to use data entry software with built-in quality checks for data entry. If this is not possible, data will be entered from paper forms into Excel and will be monitored and randomly checked.

**Data Processing/Analysis:** Data will be checked by the supervisor during the course of the day with a focus on the hourly totals for each vehicle class. At the end of each day, the supervisor will review the paper-form sheets or the data collected on electronic devices for accuracy and consistency. If using a paper-form, the data transferred into an Excel spreadsheet for each counting station. The data collected will be processed in the following sequence:

- i) Formulate the count data by direction, by hour, and by vehicle class for each day of the survey;
- ii) Formulate survey duration by 12-hour totals by direction and by vehicle class for each day of the survey;
- iii) Formulate 24-hour totals by direction and by vehicle class for each day of the survey (by utilizing the 24-hour data to derive the 12:24-hour factors); and
- iv) Formulate bi-directional (two way) traffic flows by vehicle class for each day and calculate the 3-day average to estimate the average daily traffic (ADT).

The ADT data will be converted to annual average daily traffic (AADT) by applying a seasonal correction factor. The team will carefully review the traffic counts conducted by the MRTD (4 times a year) and the monthly fuel consumption data from Mineral Resources and Petroleum Authority of Mongolia. If deemed appropriate and accurate, the team will use either one of the two data to derive seasonal correction factor.

As described in Annex J, the evaluation team will graphically illustrate the traffic volume (AADT and percent trucks) for the entire chainage (kilometers on x-axis, AADT volume on y-axis, and percent of trucks on the other y-axis). The stations and the AADT will be integrated into the itinerary diagrams.

### **5.2.5 Origin-Destination Survey**

**Description of Methodology:** The O-D survey methodology will consist of intercepting vehicles at two locations on the N-S road. Assisted by local police, vehicles will be intercepted at the survey stations and safely directed to the survey areas. An interviewer/enumerator will conduct the survey in-person with vehicle occupants/drivers by soliciting responses verbally. A potential problem with this procedure is that occupants/drivers will be free to withhold information during the roadside interview. To mitigate this risk, the evaluation team will explain the purpose and use of the data and also assure that this data will not be used for any other purpose. As O-D surveys ask for factual information on the trip, the likelihood of biased/wrong reporting is expected to be low. The enumerators will be trained to ask questions in a way that drivers clearly understand the questions and not feel uncomfortable in answering the questions. The survey process will be monitored by the supervisors to ensure reliable data are obtained.

**Instrument/Equipment:** When releasing a Request for Proposal to select a data collection firm, the evaluation team will require all bidders to use electronic hand-held devices for data collection. The instrument/equipment used may depend on the availability of competent data collection firms in Mongolia. If the evaluation successfully contracts a firm to use electronic surveying method, hand-held electronic devices, such as tablets or smartphones, will be used to collect data.

Enumerators will administer a short questionnaire to the vehicle driver and record the information. The survey will record the date of survey (including day of week and time of day), location of the survey, and the name of interviewer/supervisor. The following type of questions will be asked to the drivers: trip origin, trip destination, trip purpose, trip distance, vehicle type and axle configuration, capacity and volume of load, occupancy (including number of occupants and gender), and type of commodity carried (if goods vehicle). Below table indicates the illustrative type of questions that will be asked during the O-D survey depending on the type of drivers:

**Table 5: Illustrative O-D Questions for Each Type of Drivers**

Type of questions asked	Type of Drivers		
	Private car owners	Freight/cargo transporter/ forwarders	Bus drivers
Trip origin	X	X	X
Final trip destination	X	X	X
Vehicle type/axle configuration	X	X	X
Seating capacity of vehicle	X		X
Maximum load (tons)		X	
Current load (tons)		X	
Type of goods carrying (according to classes)		X	

Type of questions asked	Type of Drivers		
	Private car owners	Freight/cargo transporter/ forwarders	Bus drivers
Estimated value of the goods carrying		X	
Average speed when traveling on road section	X	X	X
Estimated traveling time from origin to destination	X	X	X
Purpose of trip	X		
Distance of trip	X	X	X
Number of passengers (by gender)	X		X
Frequency of trips on N-S road per month/year	X	X	X
Question to be asked to drivers and preferably all occupants of cars: Did you travel on road before improvement, before 2009?	X	X	X
If yes, for the same destination, how much time was required to travel on the road section in the past?	X	X	X
Since the improvement, are you making more trips on the road than before the improvement?	X	X	X
Are the types of trips after the improvements different than before? If yes, explain.	X		

**Rounds and Timing:** The O-D survey will be conducted one time in July 2019 and the survey period will be for two days, 24 hours covering representative days of the week (Sunday for weekend, and Monday for weekday) that do not fall during a public holiday period.

Similar to the manual traffic count, Annex J requires O-D survey to be conducted between 6:00 am and 8:00 pm. However, the evaluation team believes that conducting O-D only during this period will not allow the team to capture night traffic. The team has learned that many trucks travel this road segment by night so that they can be at the border crossing (Zamyn-Uud) during the day to handle the customs paperwork. For example, trucks travelling south will leave U-B in the evening to reach the border at night while trucks travelling north will reach the border station in the day time and leave the border station at night, travelling to U-B at night. Therefore, the survey will be conducted for 24-hour periods (06:00 am to 06:00 am).

As required in Annex J, two consecutive market and non-market days will be surveyed. Each O-D questionnaire is expected to take approximately three to four minutes to complete. The team will work with the selected data collection firm to minimize the survey time while ensuring high quality responses. The evaluation team will consider conducting the O-D survey at the same time as the traffic count survey in order to save operational costs.

**Sample/Data Collection Location:** The sampling unit of the O-D survey is vehicle occupants/drivers. A sample rate of 20 percent (i.e. every fifth vehicle) is the target for the O-D survey by vehicle type as indicated in Annex J. The team will review the traffic count survey data to determine whether the sample rate needs to be adjusted to account for either high or low traffic volume per vehicle type.

The O-D survey will be conducted at two locations: one location 10 km from Choir and another location midway of Lot 2 (KM 90 – 176.4). The O-D survey will be conducted at the same location as the traffic counts surveys. The rationale for selection the locations are described in detail under the Traffic Count section above (Section 5.2.4). As required in Annex J, the locations will be placed well outside urban areas. As mentioned above, consideration will also be given to the availability of some basic facilities such as a café or small shop or filling station to ensure the safety and basic comfort of the surveyors while making sure there is sufficient space to safely stop



vehicles in a cordoned off area of the road (there are a number of small towns along the N-S road which will also be considered such as Airag and Eldev coal mine in Dalanjargalan town).

**Staffing:** The evaluation team intends to subcontract the O-D survey and the team sizes will be determined by the successful bidder, based on a competitive procurement process. O-D survey are usually performed by a team of between three and five persons for each direction of traffic.<sup>47</sup> In addition, one supervisor is to oversee both the traffic count and O-D survey on each road (if the O-D survey is conducted in conjunction with one of the MTC rounds).

**Safety Procedures:** Since the survey will involve intercepting vehicles, safety procedures will be supervised by the local traffic police. All personnel will be required to wear high-visibility safety vests at all times. The IDG team will develop traffic control plans to ensure personnel are safe at each survey station. The traffic plans will provide guidance on the position of the traffic delineators and the percentage of the road that needs to be cordoned off with traffic cones to allow for sufficient space to stop and park the vehicle while the surveyors are at work. The traffic plans will include sketches that provide a visual representation of the survey work area and the space to be reserved/cordoned off. The police, supported by appropriate signage, is expected to assist in intercepting vehicles and directing the surveyed vehicle to the secured survey area. In addition, approximately two to three meters of space will be required inward from the carriageway to position equipment (i.e. tables, chairs, umbrellas and/or tents) that will provide protection against the sun and rain and where surveyors can stow survey materials and/or rest during periods of inactivity. If the O-D survey is conducted in conjunction with the MTC, this location will represent the station where the enumerators are standing to observe and count the traffic. Good visibility of the roads in both directions, avoiding road bends/ slopes, will also be ensured in positioning the survey locations. The O-D survey location in each direction will be staggered to avoid congestion.

**Data Quality:** Prior to data collection, the subcontractor and the evaluation team will train, pre-test, and pilot the survey to ensure high quality data collection. During data collection, the evaluation team will conduct random checks at a minimum of 10 percent of responses to ensure the data is recorded correctly and quickly rectify for any anomalies. The role of the supervisor is vital in order to consistently check the work of the surveyors to ensure the survey is conducted properly. The supervisor will closely oversee the O-D survey to ensure that information is complete, and data are not missing.

**Data Processing/Analysis:** Some of these data will subsequently be input into the HDM-4 model and, where necessary, analyses will be required to obtain averages for vehicle occupancy and for determining the percentage of work-related trips. Other information will be used to validate and provide context for the HDM-4 estimates.

### **5.2.6 Vehicle Operating Cost Survey**

**Description of Methodology:** Data on VOC constitutes one of the primary inputs required by the HDM-4 model. Usually, the process of collecting VOC data first involves determining a set of representative types of vehicles for each vehicle class that will be modeled in HDM-4. This determination will be done based on the results of the MTC and O-D surveys, review of historical traffic data, and past studies as well as discussion with the MRTD.

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<sup>47</sup> A work schedule of 1.5 hours followed by a 0.5-hour rest time for each interviewer may be configured.

Once representative vehicles have been set, cost and price data would be obtained from the main vehicle dealerships in Ulaanbaatar with respect to vehicles and tires. In addition, various other information relating to vehicle operation and maintenance would then also be obtained from garage/servicing companies in Choir and Sainshand, bus and road haulage operators, taxi and minibus operators, insurance companies as well as the MRTD.

With that said, the evaluation team understands that 2013 VOC data is already available from the ADB Project Completion Report of the Mongolia Regional Road Development Project. More recently, ADB's 2016 VOC data from the Regional Road Development and Maintenance Project is also available. The same VOC data may be used after review and adjustment with inflation to the year in which all cost data is based. Given that the N-S road construction was completed in September 2013, the evaluation team will utilize most, if not all, of the same VOC data after conducting a thorough review of the available data and price adjustment as required. For the review, vehicle cost data (vehicle price, tire type and price, lubricant price, fuel, maintenance labor costs, vehicle crew costs, overhead costs, interest rates on vehicle loans, and taxes included in these costs) will be collected on a limited scale to verify the reasonableness of the data. If data are found reasonable, they will be adopted. Only when additional data collection is needed, the team will consider conducting a larger sample survey.

**Data Processing/Analysis:** For each of the representative vehicle types, the relevant HDM-4 input data will be formulated in a preparatory Excel file. Certain inputs will require some analysis such as the derivation of the economic price of fuel and the calculation of travel time values. In the case of the former, this analysis will utilize the fuel price structure information from Mineral Resources and Petroleum Authority of Mongolia and in the case of the latter, travel time values will be determined with reference to wage rate information by employment sector and/or GDP per capita data. This will mainly involve reconfirming the 2013/2016 VOC data with limited analysis.

### **5.2.7 Axle Load Survey**

**Description of Methodology:** Axle load surveys are used to estimate damage inflicted on the road pavement from heavy goods vehicle loading. Heavy goods vehicles contribute significantly to the structural damage of the pavement with overloading, shortening the design pavement life, whereas cars and vans only have a very small contribution to pavement damage. During the initial mission to Mongolia, a number of stakeholders noted that overloading is common on the N-S road. Therefore, the evaluation team will conduct an axle load survey will be carried out following the TRL publication Overseas Road Note 40 (ORN 40)<sup>48</sup>.

**Instrument/Equipment:** The evaluation team intends to use portable weighing pads to carry out the axle load survey. The portable weighing pad offers quick installation and low cost. Two portable weighing pads of capacity 25 tons each with sufficient width to cover two wheels to measure the axle will be used. When releasing a Request for Proposal to select a data collection firm, the evaluation team will require all bidders to use electronic hand-held devices for data collection. The instrument/equipment used will depend on the availability of competent data collection firms in Mongolia. If the evaluation successfully contracts a firm to use electronic surveying method, hand-held electronic devices, such as tablets or smartphones, will be used to

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<sup>48</sup> TRL Limited, Overseas Road Note 40, A guide to Axle load surveys and traffic counts for determining traffic loading on pavements, 2004

collect data. In addition to the axle load information, the vehicle's origin and destination and the type of cargo (international or domestic) will be recorded by interviewing the driver.

**Rounds and Timing:** The evaluation team understands that Annex J suggests seven days of data collection, each day from 6:00 am to 08:00 pm. ORN 40 also suggests seven-day surveys as ideal conducted over a period of time.<sup>49</sup> However, these guidelines are more suitable for project design and international practice generally is to conduct one to two days of data collection from cost and survey management consideration. Based on the traffic counts and O-D survey, the team will estimate the weekly variation in axle loads and determine whether the duration of axle load survey needs to be longer than 24-hours. The survey will be conducted in August 2019 and the day of survey will be a representative day that does not coincide with any public holiday period.

**Sample/Data Collection Location:** The sampling unit of axle load survey is heavy trucks and large buses observed on the N-S road during the survey period at the weighing station. A sample rate of 30 percent of all heavy trucks/large buses will be used to collect the data. One out of every three targeted vehicles for survey will be stopped and weighed for the survey. For truck types that are less common, special care will be taken to cover sufficient sample to get a 30 percent sample by all vehicle types.

The weighing pad will be set up in one location at a rest stop at the mid-section of the N-S road (KM 0 – 176.4). While an approximate mid-way position along the N-S road would be preferred, consideration must also be given to the availability of some basic facilities such as a café or small shop or filling station to ensure the safety and basic comfort of the surveyors while making sure there is sufficient space to safely stop vehicles in a cordoned off area of the road.

**Staffing:** The evaluation team intends to subcontract the axle load survey and the team sizes will be determined by the successful bidder, based on a competitive procurement process. Axle load surveys are usually performed by a team of three to four persons who will have differing responsibilities including scale reading, data recording and directing traffic. In addition, one supervisor is required to oversee the survey. The evaluation team will consider conducting the axle load survey in conjunction with the O-D survey in order to save operational costs.

**Safety Procedures:** The safety procedures required for the axle load survey will follow the O-D survey procedures. The team will work closely with the MRTD, the RTD Center, and the local police to administer the survey. See discussion on O-D survey safety procedures above.

**Data Quality:** Axle load survey will be carried out as specified in ORN 40 taking all precautions to ensure data quality and minimum disturbance to traffic. Prior to data collection, the subcontractor and the evaluation team will train and pilot the survey to ensure high quality data collection. During data collection, the evaluation team will have a supervisor to continuously ensure the quality of the data recorded and quickly rectify any anomalies that may be noted. The role of the Supervisor is vital in order to consistently check the work of the surveyors to ensure the survey is conducted properly. The supervisor will closely oversee the axle load survey to ensure that information is complete, and data are not missing. Additional spot checks will be conducted by the Pavement Engineer or the HDM-4/RED Specialist to verify that weighing procedure is carefully followed and to confirm reasonableness of the results based on visual inspection of the survey procedure and results.

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<sup>49</sup> ORN 40 states that axle load survey when conducted continuously reduce truck traffic and especially overloaded trucks as drivers come to know about the survey and avoid overloading for fear of

**Data Processing/Analysis:** The team will use the axle load survey data to derive the equivalent standard axle load (ESAL) factor. The axle load recorded for each axle will be classified by the type of axle (single axle single tire, single axle dual tire). Heavy traffic volume and axle weight data will be presented in a tabular format, showing total two-way traffic volumes for each our counted. The data analysis will be carried out as per ORN 40 guideline and ESAL factor will be calculated for standard axles of 8.16 tons and 13 tons.

#### **5.2.8 Maintenance Cost Survey**

**Description of Methodology:** The information on maintenance cost will be obtained mostly through secondary sources and key informant interviews (KIIs) conducted for Evaluation Area 2 with private and state maintenance contractors, the MRTD, the Road and Transport Development (RTD) Center, and the other main stakeholders. The HDM-4 Specialist and the Maintenance Expert will review the data from MRTD in addition to conducting an additional visual inspection of the road during one of the data collection trips. This activity will be paired with other data collection activities to ensure the team is efficiently using their time in-country.

**Data Processing/Analysis:** The Team Leader/Road Maintenance Expert will coordinate the review of the maintenance data for the HDM-4 modeling. The maintenance cost data will include yearly maintenance costs for routine and emergency maintenance per kilometer for different types of roads and different types of pavement in the country. Routine, emergency, and periodic maintenance costs will be collected as far as possible for each of the last five years. All maintenance costs will be broken down as per the unit rates, such as annual routine maintenance per km, patching per m<sup>2</sup>, crack sealing per m, surface treatment per m<sup>2</sup>, bituminous overlay per m<sup>3</sup> among others. The unit rates will be critically examined and compared with unit rates for new construction and with international unit rates in order to prepare a set of realistic maintenance budget requirements per type of road and pavement and in particular for the MCC-funded section of the N-S road, as compared to the actual expenditures.

#### **5.2.9 Road Inventory Survey**

**Description of Methodology:** Road inventory data for the N-S road will be collected from available secondary sources, such as “as-built” or design drawings and construction records provided by MCC or MRTD. Information to be collected include the following:

- Section length
- Carriageway width
- Shoulder type and width
- Pavement type and structure
- Construction data
- Average horizontal curvature
- Longitudinal profile (rise and fall, and number of rise & falls per km)
- Average altitude
- Super-elevation
- Intersections and traffic diversions
- Drainage types and structures
- Speed limit and speed reduction factors

The evaluation team will compile and review the available as-built drawings and design drawings to collect the above information.<sup>50</sup>

**Data Processing/Analysis:** The Road/Pavement Engineer will 1) compile the needed inventory data from secondary sources, and 2) review and analyze the data to assess the physical elements of the N-S road. Using the compiled data, the Pavement Engineer will calculate the following road characteristics by analysis sections needed for the HDM-4 model: 1) horizontal curvature (degrees/km); 2) rise and fall (m/km); 3) number of rises and falls per km; and 4) super-elevation. The four measures will be calculated according to guidelines provided by the HDM-4 manual.

The horizontal curvature will be calculated as the weighted average of the curvatures of the sub-sections of the road, the weights being the lengths of sub-sections.<sup>51</sup> The rise and fall (m/km) will be calculated as the sum of the absolute values of total vertical rise and total vertical fall of the road profile, in meters, along the road alignments over the road section in either direction divided by the total section length, in km. The number of rise and fall per km represents the number of rises plus the number of falls, as defined on the computation of the rise and fall of a road section, per km of a road section. The average super-elevation will be calculated as the weighted average of the super-elevations of the curvy sections of the road, the weights being the proportion of the lengths of curvy sections.<sup>52</sup>

It is yet to be determined whether the road inventory information of the track prior to the upgrading is available. The information available to date indicates that detailed information is unavailable on the geometry of the road/track existed prior to the construction and shall use subjective estimates in consultation with MRTD staff familiar with the road prior to improvement for the “without-project” case.

#### **5.2.10 Road Roughness Study**

**Description of Methodology:** The roughness of the road surface constitutes the smoothness and the frictional properties of the pavement surface, affecting the ride quality of a vehicle and in turn the safety and comfort of the road user. Roughness not only affects riding quality but also the vehicle operating cost. Roughness is usually quantified by either the present serviceability rating (PSR) or the international roughness index (IRI), with IRI being the most common.

**Instrument/Equipment:** Class 3 or better IRI measuring devices per ASTM or World Bank Technical Paper 46 will be used as indicated in Annex J. Class 3 or better IRI measuring devices include Profilometers (which are very expensive and very complex in usage) and response-type road roughness Measuring System (RTRRMS), which are less expensive and less complex to use. RTRRMS include Bump Integrators (e.g. CRRI Trailer Bump Integrator, ROMDAS Bump Integrator) and Accelerometer Based System (e.g. ARRB Roughometer).

The RTD Center is the only agency which possess a profilometer. To allow other firms to bid, the evaluation team will allow bidding firms to use the Trailer Bump Integrator (a Class 3 measuring

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<sup>50</sup> The evaluation team has located the as-built drawing for Lot 2 but not for Lot 1 from the boxes of documents that the team found during the trip to Mongolia in June 2018.

<sup>51</sup> Sub-sectioning is important because HDM-4 uses average values for each section for the analysis. Therefore, a section should be homogeneous in traffic level, road condition, and pavement structure.

<sup>52</sup> Definitions are taken from the World Bank Guidelines: “World Bank Technical Documentation: HDM-4 Road Use Costs Model Documentation”, World Bank.



device which reports the roughness at intervals of 100 m+ intervals) for data collection since this equipment may be more easily available in Mongolia.

**Rounds and Timing:** Data collection will take place in June 2019.

**Sample/Data Collection Location:** The sampling unit for the road roughness study is the two outer wheel paths of the entire road section of the MCC-funded N-S road (KM 0 – 176.4). While Annex J requires 100-meter interval, IRI is a continuous measure and no intervals are required. A Jeep or other trucks used to carry out the test will drive at a constant speed of about 32 km per hour along the entire road section of the MCC-funded N-S road. The bump counts will be reported at 100-meter intervals and utilized to obtain the roughness of the road. The IRI will be then calculated using a mathematical algorithm.

**Staffing:** The evaluation team intends to subcontract the IRI data collection and the team sizes will be determined by the successful bidder based on a competitive procurement process. Usually two people will be involved in IRI data collection, the driver of the vehicle and one technician.

**Safety Procedures:** IRI is measured at a constant speed and does not require traffic to be diverted. Staffs conducting the survey will remain in the vehicle at all times. Caution signs may be posted at the back of the vehicle to indicate to other drivers that the survey is in progress.

**Data Quality:** It is recommended to maintain survey speed within a certain range or at a constant speed when taking the measurements. The driver and operator will therefore keep this in mind when undertaking the survey. The machine will have to be calibrated either with MERLIN or with a road with known IRI. The Road/Pavement Engineer will be involved in the calibration exercise and assure that the survey firm considers the equipment manufacturer recommendations. The evaluation team will ensure that the survey team follows the appropriate ASTM specifications as well as those mentioned in the World Bank Technical Paper No 46, when carrying out the measurements, analysis, and reporting of results.

**Data Processing/Analysis:** The evaluation team will graphically illustrate the IRI for the entire chainage (kilometers on x-axis, IRI on y-axis). The road segment will then be sub-sectioned into homogeneous sections which will also be illustrated in graphical format.

### **5.2.11 Road Condition Study**

**Description of Methodology:** During the site visit, the evaluation team noticed transverse cracks at a regular interval of between 6m to 10m along the MCC-funded road section. Transverse cracking refers to cracks that are perpendicular to the pavement's centerline.<sup>53</sup> According to the Director of the Dornogobi maintenance company, who also worked on the MCC road project as one of the Highway Engineers and Mr. Ravjir Baljir of RCSC LCC, who in 2010 was the Vice Director in the Project Implementation Unit of MCA-M, the transverse cracks were observed in the stabilized base layer even before the laying of the asphalt concrete on top. In the course of discussion with stakeholders, the evaluation team was also informed that these transverse cracks do also occur in unbound base layers. The stakeholders noted that this is due to the peculiar climatic condition in Mongolia where the temperature varies to the extreme daily and seasonally. The Ulaanbaatar Road and Transport Center engineers noted that the use of geotextiles on top of the

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<sup>53</sup> Pavement Interactive, Pavement Distress, <http://www.pavementinteractive.org/general-guidancepavement-distress/>, accessed: June 6, 2018.



base course prevented cracks from propagating through the asphalt layer to the top of the pavement on some roads in Ulaanbaatar.

There are a number of probable causes of these cracks on the surface. There is literature on types of distress, symptoms, and probable cause.<sup>54</sup> One of the possible causes is cracks in pavement layer underneath, mostly due to low temperature thermal cracking. These are called “bottom-up cracks”, which refer to cracks propagating from the bottom of the pavement to the top.<sup>55</sup> Another potential cause of the transverse cracks is due to shrinkage of the asphalt concrete layer from Mongolia’s cold winter climate. According to the materials report of Lot 1 (2014), the contractor used bitumen with 90/130 penetration grade bitumen (page 39, paragraph 6.1.1).<sup>56</sup> This is the hardest penetration grade bitumen used for roads (other grades are 40/50, 60/70, 80/100), which may lead to cracking in low winter temperatures.

In lieu of conducting a road condition study, the evaluation team will collect information on the road condition based on the evaluation team’s best judgment of the surface distresses and the road condition. Since the data collection will be constrained to subjective assessment of the team member, there will be limited understanding of pavement distress and maintenance work conducted on the MCC-funded road section.

**Data Processing/Analysis:** The Pavement Engineer will estimate the level and extend of the surface distresses by driving through the road. The results of the assessment will be used in the calibration of the HDM-4 model by comparing the model predictions of pavement deterioration at this point in time and modifying the model parameters as needed. The Roads/Pavement Engineer will determine the cause(s) of any pavement distress to the extent possible based on visual inspections. The road segment will then be sub-sectioned into homogeneous sections which will also be illustrated in graphical format. The road distresses as observed by the team will be presented with colors to indicate the severity.

### **5.2.12 Deflection Measurement Study**

**Description of Methodology:** Pavement surface deflection measurements are main means of evaluating the integrity of a pavement structure. Deflection measurements can be used to determine the thickness of overlay required to increase the life of the road or can be used in back-calculation methods to determine the pavement layer stiffnesses and the subgrade modulus.

For the purpose of the evaluation, the team will use existing data from MCA-M contractor documents to estimate the Structural Number (SN) of the MCC-funded road section. It is important

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<sup>54</sup> Asphalt Institute, Pavement Distress Summary, <http://www.asphaltinstitute.org/engineering/maintenance-and-rehabilitation/pavement-distress-summary/>, accessed: June 6, 2018;

Gregory E. Halsted, P.E., Portland Cement Association, Minimizing Reflective Cracking in Cement-Stabilized Pavement Bases, 2010.;

Willway, T, L Baldachin, S Reeves, M McHale and M Nunn. ‘The effects of climate change on highway pavements and how to minimise them: Technical Report’. TRL Published Project Report, PPR 184, Crowthorne, England, 2008.;

Kachroo P N, N G R Raju and L Gambo. ‘Freeze-thaw effects on roadways: approach to pavement design with special reference to roads in Mongolia’;

Otto F, P Liu, Z Zhang, D Wang and M. Oeser. ‘Influence of temperature on the cracking behaviour of asphalt base courses with structural weaknesses’. International Journal of Transportation Sciences and Technology. 2018.

<sup>55</sup> Asphalt Institute, Pavement Distress Summary, <http://www.asphaltinstitute.org/engineering/maintenance-and-rehabilitation/pavement-distress-summary/>, accessed: June 6, 2018.

<sup>56</sup> Ministry of Roads, Transportation Construction, and Urban Development, Halla Engineering and Construction Corporation, Material Report, 2014.

to note that note that this analysis is based on a critical assumption that the layer thicknesses of both lots are the same as the design thicknesses found for Lot 2. There is limited evidence from available documents on the actual thicknesses of both lots. For Lot 1, information on design thicknesses are not available and no as-built drawings were located. For Lot 2, the as-built drawings are available but not reliable because the document doesn't provide any information on how the as-built drawings were verified. This is especially concerning because the as-built drawings are exactly the same as the design drawings, which make the team believe that the as-built drawings are mere copies of the design drawings.

**Data Processing/Analysis:** The Structural Number (SN) will be calculated from design thickness. Other structural parameters will be estimated from available QA/QC data or using the team's best judgment.

### **5.2.13 Geotechnical Study**

**Description of Methodology:** During the second trip to Mongolia (June 2018), the Team Leader located a number of documents which includes the as-built drawing of Lot 2 (provided by Jiangxi Water and Hydropower Construction). This document suggests that the pavement structure is 50mm of asphalt concrete, 200mm of cement treated base, and 200mm of granular sub-base. The team was not able to locate the as-built drawing for Lot 1. However, as noted above, the team believes that the as-built drawings are exactly the same as the design drawings, which suggests that they are most likely copies of the design drawings and not representative of the actual layers.

**Data Processing/Analysis:** Assuming that the layer thicknesses of both lots are the same as the design thicknesses found for Lot 2, the evaluation team will use existing data to calculate the California Bearing Ratio (CBR) values of the layers, the Adjusted Structural Number, and the subgrade modulus. Given that there is no primary data collection to collect the geotechnical data, the Adjusted Structural Number estimated based on design thicknesses not verified with post-Compact data collection. In addition, the team will not be able to verify the subgrade CBR in the field and its variability along the section. Based on the team's analysis, the road segment will then be sub-sectioned into homogeneous sections as appropriate which will also be illustrated in graphical format.

### **5.2.14 Analysis Plan**

#### **Estimation of ERR**

The evaluation team will use HDM-4 model for the estimation of ERR. The Level 1 calibration of HDM-4 model will be undertaken and entering the HDM-4 data inputs, the model will be run. For the "without project" case, data required for road definition and maintenance standard definition will be generated from available information and consultation with MRTD staff.

HDM-4 produces a considerable amount of output and the user selects what is most appropriate for the particular study. The outputs such as roughness progression and predicted speeds will be reviewed. The road agency and road user cost series required for ERR estimation will be brought to an Excel spreadsheet and ERR and NPV will be calculated. In a similar approach, sensitivity test will be carried out testing the data parameters of traffic volumes and traffic growth and maintenance regimes. Other variables can also be tested to reveal their impact on the overall results.

As indicated above, MCC's economic analysis used unit VOC from an ADB report, generated from assumed average IRI and speed. There is no record of additional information collected for the analysis. The main difference between MCC's analysis and the evaluation team's analysis is that the evaluation team will use the HDM-4 model to estimate the VOC over the analysis period, which allows the team to explore scenarios of maintenance assumptions and its impact on EIRR. Another difference between the two analyses is that the analysis conducted by MCC was based on pre-compact traffic forecast assumptions while the evaluation team's analysis will be based on the actual present traffic volume and project traffic volume based on the current situation.

### **Graphic Presentation of Main HDM-4 Data Inputs**

Annex J requires the evaluator to collect "aerial imagery at a resolution of 5cm or better for the constructed works of each road and overlay the collected data in graphical format". Based on the vendor bids received for the MCC Burkina Faso Roads Evaluation, the evaluation team believes that obtaining the aerial images is excessive and not cost-justifiable for drafting the itinerary diagrams. Therefore, in lieu of aerial photography, the team proposes to use post-construction satellite imagery at a resolution of 50 cm or better for graphically presenting data on images of MCC-funded road.

The findings of the traffic count, axle load survey, IRI, and estimated deflection, surface distress, and geotechnical assessments will be overlaid on the satellite image for the itinerary diagram. A sample itinerary diagram will be developed for MCC's review before beginning the work on the itinerary diagrams. Other outputs such as the road condition by section and year (to reveal deterioration), cost inputs by section and year (capital and maintenance) and traffic volumes, by class, section and year will be in the final report.

### **Visualization of MCC-funded Road Quality**

For the purposes of visualizing potential road defects, the team believes the most cost-effective and practical method is to obtain a GPS-linked video of the road using a 360-degree view camera compatible with Google Street View. The team will record a video of the road during one of the data collection trips to capture the details of the road to visualize the road surface defects. The camera will be mounted on top of the vehicle with a protective gear to allow a full 360-degree view of the road.

The video may be recorded in sections due to battery life or storage issue and audio will be removed. The image quality will be 4K at 30 FPS at the minimum. Considering the local condition (weather, traffic), the team will conduct a test-drive to ensure that the basic functions are working accordingly (battery, speed, data management etc.).

#### **Evaluation Area 1 and the Final Analysis**

Evaluation Area 1 will calculate the economic return of MCC's investment on N-S road improvement. The analysis is intended to calculate the benefits (VOC and travel time savings) resulting from the MCC's N-S Road Project. Other evaluation areas will help the team understand whether the benefits are reaching the beneficiaries to lead to economic growth of Mongolia.

If accepted by Google Street View or other similar programs, IDG will upload the video to be shared publicly.<sup>57</sup> GPS coordinates will be overlaid on the video. To ensure privacy, personally identifiable information will be protected by blurring identifiable faces and license plate numbers.

## **5.3 CHALLENGES**

### ***5.3.1 Limitations of Interpretation of the Results***

The pre-compact ERR and ERR estimated as part of the evaluation cannot be directly compared due to the different approaches used. The assumptions and values used in the pre-compact ERR estimation can be assessed based on the HDM-4 model outputs and traffic growth observed. The main difference in the pre-compact assumption and the post compact situation is the traffic realization as some of the pre-compact assumptions have not materialized such as the Industrial park.

### ***5.3.2 Risks to the Study Design***

The results of the economic analysis are dependent upon the quality of the data on which it is based. Therefore, satisfactory data collection of each component is vital to producing an accurate economic evaluation. Surveys need to be thoroughly carried out in order to obtain representative samples of data which can then be carefully processed and analyzed. Traffic data is a significant input data impacting the results, the timing of the traffic counts and their subsequent adjustment to determine the AADT estimates is critical. The MRTD conducts counts four to five times a year and this provides a good historical data to analyze and determine traffic count timing along with consultation with MRTD. The evaluation team will also carefully review the adjustment factors from the monthly fuel consumption data to examine whether they can be used to derive the seasonal variation factors.

Another risk is the relatively little application of HDM-4 in Mongolia for economic analysis. Therefore, there is no established calibration factors for HDM-4 road pavement deterioration prediction models and defaults values will have to be used. It is also likely that the present tools used in this evaluation will be a one-time event and the GOM may not use the tools in the future. This risk will prevail irrespective of the type of software used. This will always be an inherent risk as the GOM does not have a road asset management division mandated to use HDM-4 or RED for road evaluation or planning and lacks staff trained in these areas. This risk can be mitigated only with the GOM's commitment to institutionalize road evaluations and planning.

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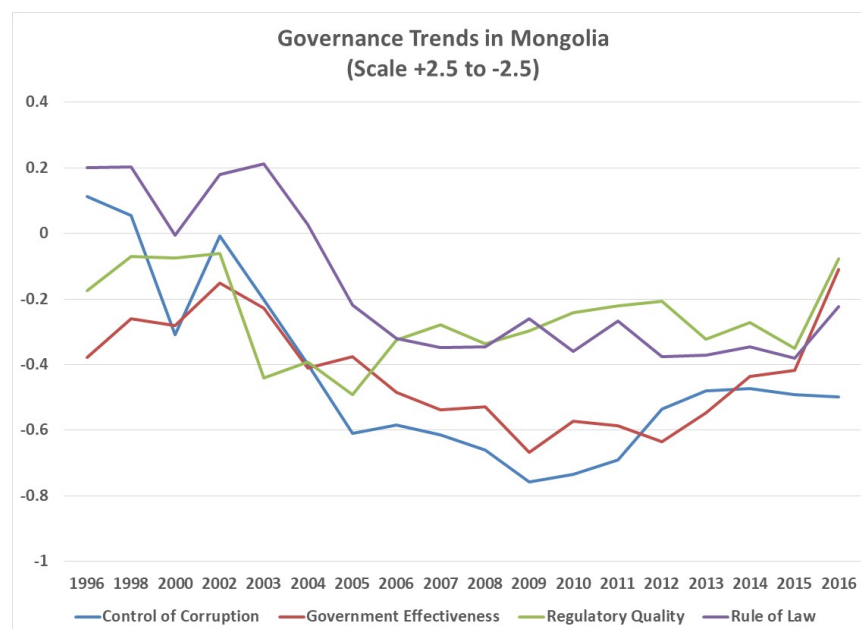
<sup>57</sup> Google Maps ([Google Maps Help](#)) only allows Street View trusted photographers to upload videos which can be converted into Street View or to connect multiple 360 photos. It requires the publisher to have uploaded a certain number (50) of 360 photos that are approved by Google prior to allowing the publisher to use these functions. IDG will explore other software such as Mapillary.

## VI. EVALUATION DESIGN – EVALUATION AREA 2: MAINTENANCE

### 6.1 LITERATURE REVIEW

There exist numerous political economy and institutional challenges to designing and maintaining an efficient road network. This section examines these impediments and progress in road sector reform in Mongolia. Broadly speaking, trends in governance in Mongolia have been deteriorating over the past two decades, although there have been some improvements over the past few years, especially in Government Effectiveness and, to a lesser extent, Control of Corruption.

**Figure 7: World Bank Governance Trends in Mongolia<sup>58</sup>**



Mongolia does not compare very well to East Asia and Pacific peers in these areas, however. Mongolia is far below the East Asia and Pacific averages for corruption and the Rule of Law. The gaps are less pronounced for Government Effectiveness and Regulatory Quality.

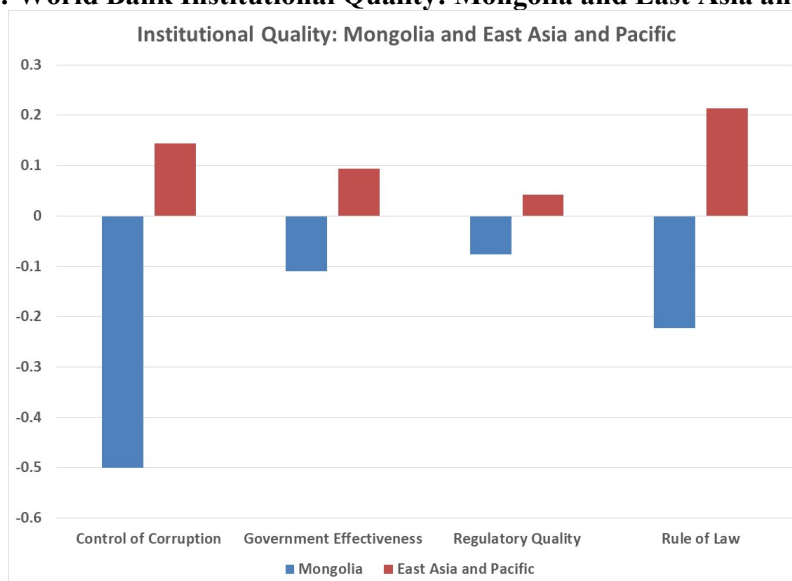
The quality of Mongolia's infrastructure is also low. The World Economic Forum's 2016–2017 Global Competitiveness Report, for example, ranks Mongolia's infrastructure quality at 110 out of 138 countries.<sup>59</sup> Within Asia, only Myanmar and Nepal rate lower than Mongolia in road quality and overall institutional quality (see graph below). Similarly, Mongolia ranks 140<sup>th</sup> out of 160 countries in the infrastructure component of the World Bank's Logistics Performance Index.<sup>60</sup>

<sup>58</sup> Data available at <http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators>

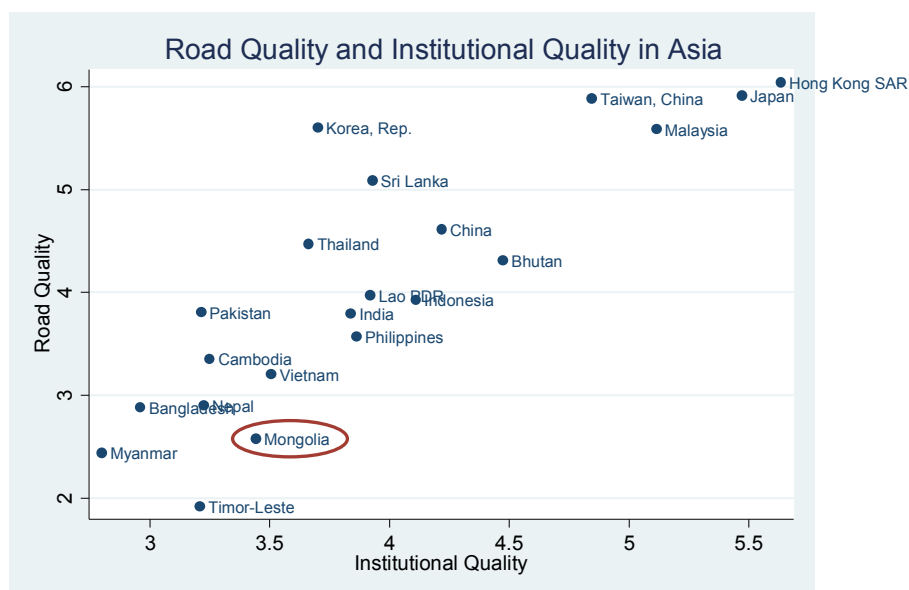
<sup>59</sup> Data available at <http://reports.weforum.org/global-competitiveness-index-2017-2018/>

<sup>60</sup> Data available at <https://lpi.worldbank.org/>

**Figure 8: World Bank Institutional Quality: Mongolia and East Asia and Pacific<sup>61</sup>**



**Figure 9: World Economic Forum Global Competitiveness Index Road Quality and Institutional Quality in Asia<sup>62</sup>**



The GOM has several political economy challenges in developing its road network. A 2011 Technical Assistance Report of the road sector by the ADB identified six key weaknesses in Mongolia's road sector:<sup>63</sup>

1. The existing processes, technology, and organization for road construction and maintenance are not suitable for large-scale operations
2. The planning process is inefficient

<sup>61</sup> Data available at <http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators>

<sup>62</sup> Data available at <http://reports.weforum.org/global-competitiveness-index-2017-2018/>

<sup>63</sup> Asian Development Bank. 2011. *Mongolia: Road Sector Capacity Development*. Manila: Asian Development Bank.



3. Insufficient funds for road maintenance
4. Fragmentation of power and responsibilities across government agencies
5. Insufficient and underqualified staff
6. Lack of private sector capacity to undertake road construction and maintenance

The GOM possesses weaknesses in road planning, management, and supervision. Investment plans tend to lack coherence, prioritization, and reliable estimates of economic benefits. In addition, project management is fragmented across a number of generally understaffed government agencies. Supervision is also problematic.<sup>64</sup> In addition, road maintenance procedures are not aligned with structures to manage Mongolia's large and dispersed road network. Most importantly, GOM budget procedures use historic trends to determine road maintenance allocations, not actual needs. The consequence is that shortfalls cumulate over time. In 2011, the ADB estimated that funds from parliament only cover about 20 percent of maintenance needs. A new Road Law establishing a semi-autonomous road fund with a dedicated source of funding has been drafted, but not yet adopted.

In addition, Parliament is heavily involved in the road sector. It has substantial power over the budget and is taking an increasing larger, but self-serving role in planning. According to Hasnain (2011: 2-3)<sup>65</sup>:

First, MPs [Members of Parliament] have an incentive to over-spend on smaller projects that bring benefits to specific geographical localities, and which, given Mongolia's geography, tend to be uneconomic, and to under-spend on large infrastructure that would bring economic benefits to Mongolia on the whole...

Second, even those projects that are a priori economic are compromised in their implementation through poor planning and appraisal, procurement irregularities, and weak monitoring. The award of contracts to technically unqualified but politically well-connected construction companies is a major political reason for these implementation problems as these contracts provide the avenue for electoral campaign finance.

Third, there is little incentive for political actors to maintain capital assets as evidenced by the chronic under-funding of capital maintenance and repairs, and the resultant deterioration of physical assets.

Road sector institutions generally lack the capacity to undertake sufficient oversight of road maintenance needs and quality of repairs. The MRTD is severely understaffed and lacks the capacity to plan, coordinate with relevant stakeholders, and oversee procurement. The DOR in MRTD faced similar challenges in overseeing road maintenance. The result was slow processes in making decisions, reactive operational decisions, and low levels of accountability. In practice this resulted in the DOR spreading funds thinly across the existing road network, targeting the most immediate needs, and ignoring less costly preventative maintenance leading to more rapid deterioration of the road network. Poor oversight also permits overloading, which is common in Mongolia.<sup>66</sup> Overloaded trucks, especially on poorly maintained roads, accelerate road deterioration and raise the amounts needed for maintenance.

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<sup>64</sup> Asian Development Bank. 2011. *Mongolia: Road Sector Development to 2016*. Manila: Asian Development Bank.

<sup>65</sup> Hasnain, Zahid. 2011. *Incentive Compatible Reforms: The Political Economy of Public Investments in Mongolia*. Policy Research Working Paper 5667. Washington, DC: The World Bank.

<sup>66</sup> Asian Development Bank. 2011. *Mongolia: Road Sector Development to 2016*. Manila: Asian Development Bank.

Frequent changes in institutions and staff turnover further undermine the effectiveness of road maintenance. For example:

- The GOM created the DOR in 1995 to take charge of road maintenance. In 2004, the DOR was reduced to a Road Research and Supervision Center and lost its regulatory powers. It became a department within the Ministry of Infrastructure Development reporting to an understaffed Roads Department. To address this stagnation, the GOM recreated the DOR in 2009 but left procurement within the MRTD.
- The GOM created a Road Board in 2004 and abolished it three years later.
- Turnover in leadership and management is high and is trending towards replacing qualified civil servants with political appointees.

Currently, responsibility for road planning, construction, and maintenance is split across six departments and divisions within the MRTD:

- Policy and Planning Department
- Road Policy Implementation and Coordination Department
- Road Transport Policy Implementation and Coordination Department
- Road and Transport Inspection and Registration Division
- National Road Transport Service Center
- Road and Transport Development Center

The contracting process the GOM employees to execute road maintenance are also problematic. A recent overview of the roads sector in Mongolia by the ADB concluded (ADB 2017:17):<sup>67</sup>

Road maintenance works are mainly conducted by 20 state-owned road maintenance companies and 8 private maintenance companies. These lack sufficient financial resources, road maintenance equipment, up-to-date maintenance technology and qualified staff. With many road maintenance companies and each one assigned to maintain only a relatively small portion of the road network, the present arrangements are fragmented, and the individual companies are under-resourced and unable to invest in upgrading their performance. At the same time, private contractors are unable to bid for routine maintenance works currently performed by the 20 state-owned companies and opportunities for the existing eight private companies are limited.

## **6.2 EVALUATION QUESTIONS**

- A) What are the relevant road authority's current maintenance practices and what is the likelihood that MCC's investment will remain adequately maintained for the life of the investment? Based on this assessment, what set of maintenance assumptions should be used in the HDM-4 model to yield the best estimate of the costs and benefits of the road investment? [Core]**

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<sup>67</sup> Asian Development Bank. 2017. *Mongolia: Regional Road Development and Maintenance Project*. Manila: Asian Development Bank.

The ADB Evaluation study<sup>68</sup> mentions that “In the absence of adequate policies and current insufficient budget allocations to maintenance, the proposed [road] investments could raise fundamental questions on sustainability,” and recommends to “Assist in strengthening of road maintenance regime.”

The purpose of this question is to understand the sustainability of MCC’s road investment and to update assumptions about road maintenance practices into the ERR model in Evaluation Question 1. The analysis will include a descriptive review as well as a technical assessment of the frequency and quality of the RTD Center’s routine, emergency, and periodic maintenance practices. This will be done through a review of administrative records and reports of maintenance resources and activities on the country road network, while targeting relevant comparable and older roads, supplemented by actual field visits to verify or adjust the administrative evidence.

The Evaluation study will assess the maintenance financial needs relative to the actual maintenance expenditures - and the actual condition of the roads – and compare these to assumptions made in the previous ERR models of the investment. The accuracy of MCC’s maintenance assumptions has not yet been formally tested and assessed Post-Compact. Therefore, the analysis will include a discussion on how to improve and update these maintenance assumptions ex-ante for future MCC projects, and will take into account how maintenance needs might change over time.

This question will address the following sub-questions as:

- What was the level of funding of maintenance in the country over the last ten years and was it adequate?
- What maintenance works (routine, emergency and periodic) were conducted over the last ten years on the whole network and in particular on the MCC funded road and other comparable and older roads, and were they in line with the requirements?
- What are the planning procedures for routine and emergency maintenance, and for periodic maintenance?
- What are the procedures for implementation of routine and emergency maintenance, and of periodic maintenance? How is procurement done? What is the capacity of the maintenance companies? How are the maintenance works supervised?
- How did the road conditions change over the last ten years?
- How is the financial planning of maintenance done and how does it compare with the maintenance needs?
- How have recent changes in legislation, institutions, funding impacted on future maintenance. What are expected changes in the near future and how will they impact maintenance?
- What is the probability that the MCC funded road will be adequately maintained over its lifetime: what are the probable budgets that will be allocated for this road and how do they compare with the estimated needs?

**B) In cases where MCC invested in improving maintenance practices or included a maintenance Conditions Precedent in the Compact (applicable to Mongolia), what were the effects of those efforts and why? [Core]**

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<sup>68</sup> ADB Evaluation Study, Operations Evaluation Department, Reference Number: SAP: MON 2008-26, Sector Assistance Program Evaluation, July 2008, Transport and Trade Facilitation–, Potential for Better Synergies in Mongolia.

Mongolia's road maintenance on the national roads is performed by 28 small (20 state-owned and eight private) companies at the aimag level. For many years maintenance was financed by a fuel tax, channeled through state and local Road Fund, but recently this has been replaced by a general budget line which is even less important than before.

Compact Amendment includes a covenant that states:

As an ongoing covenant, the Government will continue to affirm its commitment to the Road Fund by demonstrating a yearly increase in the amount committed to the Road Fund from the amount committed during the prior fiscal year, taking into account inflation and maintenance needs of existing, improved and newly constructed roads, in an amount at least sufficient to provide ongoing maintenance for the roads and bridges constructed and rehabilitated under the North-South Road Project. In addition, the Government will also implement its annual maintenance plan while providing evidence that the amount budgeted for the Road Fund for the previous fiscal year has been expended for the intended purpose, in a manner satisfactory to MCC.

In addition to the Compact Covenant, MCC included a Technical Assistance Activity with the aim of improving road maintenance practices in Mongolia.

The purpose of this evaluation question is to understand whether the road maintenance technical assistance component and/or the covenant included in the revised Compact has been effective in improving road maintenance in Mongolia and in particular on the MCC-funded road. The evaluation team will identify major policy changes associated with the Road Fund, review the road maintenance funding level and source in the last ten years, and examine whether MCC's investments served as an incentive to improve Mongolia's road maintenance practices. In particular, the team will address the following sub-questions:

- Did the GOM increase the amount committed to the Road Fund yearly, per the covenant's requirements? Did this continue after the compact end date? For how long?
- Did the GOM implement its annual maintenance plan, as per the covenant? Did this continue after the compact end date? For how long?
- Have there been any changes to the planning, financing, and implementation process of road maintenance following MCC's assistance?
- Has MCC's assistance in the road sector led to institutional reforms that improved road maintenance in Mongolia? How and why?
- Did MCC's assistance help MTRD design better plans for road maintenance?
- Did MCC's assistance help MTRD design better financial plans for road maintenance?

## **6.3 EVALUATION APPROACH**

### **6.3.1 Summary of Existing Data**

#### **Road Maintenance Fund**

During the meetings with the MRTD and the RTD Center, the team requested a meeting with the staff in charge of managing the Road Fund. However, the MRTD indicated that the Road Fund is only a budget line managed by the MRTD and not an organization with a dedicated team of staff. According to the MRTD, the Road Fund was previously funded from the GOM budget, tax

revenues from import of gasoline and diesel fuel, and roads toll revenue.<sup>69</sup> However, a law was passed in July 2017 to incorporate the fuel taxes as general taxes instead of directly funding the Road Fund.

As of January 2018, the Road Fund is funded from the GOM budget and roads toll revenue. According to information from the RTD Center, the road toll revenue collected from the 19 toll points in Mongolia in 2017 amounted to 372 million Tugrik (approximately USD 156 thousand). A new decree was passed in January 2018 to allocate 20 percent of imported vehicle tax to the Road Fund. However, the Road Fund is not restricted to maintenance but funding new road constructions.

According to the MRTD, the ministry is well aware of the maintenance needs but is unable to convince the Ministry of Finance (and Parliament) to fund routine maintenance fully or any funding for periodic maintenance.

### **Road Maintenance Planning and Management**

According to the MRTD, its staff conduct a visual road inspection every spring, working closely with the RTC Center. The annual inspection includes examining the road degradation and preparing a road maintenance budget for each state road. The budget is in a form of detailed Bill of Quantities, comprising of a line for each type of work required, an estimated quantity, and a unit rate fixed by the MRTD.

The fixed standard unit rates prevent any price competition among the maintenance companies, private or government owned. The only competition is based on the firms' quality of the works completed. Every autumn, an inspection takes place of the maintenance works completed. Only when the work quality is judged inadequate, the contract with the maintenance company is discontinued the following year (this supposedly happens only with private maintenance companies). Selection of new maintenance companies is based on quality and capacity, not on a competitive price. For example, a private maintenance company was contracted to maintain a section of the N-S road during the first two years, which was then replaced by another maintenance company. The current private company has been maintaining a section of the N-S road for four years.

Based on the MRTD's policy, periodic maintenance (referred to as "sub-periodic maintenance in Mongolia") is scheduled to be done every six years. However, the available budget only allows for routine maintenance and no periodic maintenance is conducted. In addition, there is no systematic methodology for determining the periodic maintenance needs. The RTD Center is equipped with instruments to plan for periodic maintenance, such as the laser profilometer for determining the IRI and the Benkelman Beam for determining deflection measurements. However, limited funding for periodic maintenance and lack of incentive hinders any periodic maintenance planning. Currently, the RTD Center uses the equipment to verify the road condition upon completing construction.

### **Road Maintenance on Choir-Sainshand Road**

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<sup>69</sup> MCC Investment Memorandum on the Reallocation of Mongolia Compact Funding Part II – New Projects, Annexes, November 10, 2009.

According to the RTD Center, the maintenance budget which was effectively spent on the MCC road increased regularly each year as follows: 46 million Tugrik (2013), 93.9 million Tugrik (2014), 105.7 million Tugrik (2016), and 208.3 million Tugrik (2017).

According to the authorities in Choir, there has been no major damage on the MCC road and routine maintenance has been focused on filling of cracks with bitumen and repairs on the shoulders. No deformations are observed, and patching and pothole filling were not required. No periodic maintenance has been done on the MCC road. Periodic maintenance may occur in 2019, which is six years after the completion of road rehabilitation, but only if the budget is available.

### **6.3.2 Evaluation Question 2A**

#### **Quantitative Approach – Secondary Data Review**

**Description of Methodology:** The evaluation team will collect a number of secondary data from various sources to address Evaluation Question 2A. The team will mainly collect the documents from the MRTD, the RTD Center, the MCC funded section of the N-S road maintenance firms (1 SOE and 1 private), and the Ministry of Finance. The evaluation will attempt to obtain the following documents as available:

- Laws, regulations, decrees on road maintenance
- Road maintenance policies and processes
- Records of road maintenance budget on the MCC funded section of the N-S road
- Records of road maintenance expenditures on the MCC funded section of the N-S road
- Administrative records on emergency and routine maintenance performed on the N-S road
- Records of periodic road maintenance budget on roads comparable to the N-S road
- Records of periodic road maintenance expenditures on roads comparable to the N-S road
- External assessments (international donors etc.) on Mongolia's maintenance practices

Upon collecting the secondary sources, the team will review and assess the GOM's road maintenance policies in further detail, comparing it to international standards where possible. The maintenance budget allocated to the N-S road and the actual expenditure will be reviewed carefully to estimate whether adequate budget has been allotted and used for the emergency and routine maintenance of the N-S road. Administrative records on all emergency and routine maintenance performed on the N-S road by the two firms will be reviewed for the adequacy and the quality of maintenance work completed on the N-S road. The evaluation will substantiate this data with team's assessment of the road quality and the road roughness study to verify the quality of maintenance work completed. Future maintenance plans and maintenance budget allocation for the N-S road will be reviewed by the team to evaluate whether the budget is adequate, and the work planned is appropriate. As appropriate, the team will examine the methodology used by the RTD Center to determine the maintenance needs and discuss with them the hypothesis and parameters used. If in disagreement with the methodology used, the team will modify the parameters and the hypothesis to come up with what the team determines to be the actual maintenance needs.

Since no periodic maintenance has taken place so far on the Choir-Sainshand road, the team will examine periodic maintenance practice, budgets, and expenditures on a sample of roads comparable and older to the N-S road. Yet, there are no comparable and older roads to the Altanbulag-UB-Zamyn Uud corridor in Mongolia since it was the first such road to be developed in Mongolia. Therefore, IDG will compare the road maintenance of different sections within the



N-S road. For instance, IDG may examine the maintenance of the ADB-funded section of the N-S road between Sainshand and Erdene, which was completed in 2012, or the ADB-funded section between UB and Choir, which was completed in 2005.

**Data Processing/Analysis:** When the team is unable to obtain relevant documents in English, the Mongolian document (or at least the executive summary or the relevant sections) will be translated for the purpose of the evaluation. Based on the secondary data collected and the qualitative data collected (details below), the team will evaluate the GOM's maintenance practices and what the likelihood is that MCC's investment on the N-S road will remain adequately maintained for the life of the investment. Based on this assessment, the team will also update the maintenance assumptions used in the HDM-4 model.

### **Qualitative Approach – KIIs**

**Description of Methodology:** In addition to reviewing the secondary sources, the team will answer Evaluation Question 2A by developing a detailed set of questions, identifying key stakeholders to interview, and conducting KIIs. The Evaluation Team will collect information to triangulate the information available on the secondary sources and to obtain additional information not available from the secondary sources. For instance, the team will ask questions on the MRTD's decision making process, such as the selection procedures and criteria for road maintenance and rehabilitation and the process for deciding the maintenance treatment that should be performed.

**Timeframe of Exposure:** As mentioned above, MRTD's policy mandates a periodic maintenance to be done every six years after rehabilitation/construction of a road. Since the Choir-Sainshand road was completed in 2013, a periodic maintenance may be conducted in 2019 according to the MRTD's policy. The team is aware that the GOM is currently not conducting any periodic maintenance on its road network due to limited budget. However, the team will conduct the KIIs in 2019 towards the end of the data collection period to allow the team to confirm whether the periodic maintenance of the N-S is planned and/or implemented.

**Sample:** Key stakeholders we will interview include relevant officials from the MRTD (e.g., Policy and Planning Department, Road Policy Implementation and Coordination Department, Road and Transport Inspection and Registration Division, and the RTD Center), the Ministry of Finance, road maintenance firms (SOE and private), and donors active in the road sector (e.g., ADB, World Bank).

**Instrument/Equipment:** The team will conduct semi-structured interviews with a fairly open framework which allow for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries questions to obtain more specific information.

**Rounds and Timing:** The KIIs will be conducted to coincide with one of the engineering data collection trips and interviews for addressing evaluation question 2B to maximize the information gathered during interviews.

**Staffing:** The KIIs will be conducted by the evaluation team and no additional staffing is anticipated for this Evaluation area. The Team Leader/Road Maintenance Expert will lead the data collection procedure to conduct KIIs with key stakeholders in Mongolia, supported by the In-Country Coordinator.

**Data Quality:** The team will conduct KIIs in Mongolian with the assistance from an interpreter and in English whenever possible. KIIs will be conducted by the Team Leader/Maintenance Expert, assisted by the In-Country Coordinator. While the Team Leader/Maintenance Expert leads the interviews and takes notes, the In-Country Coordinator will assist the interviews by taking notes that will be used to cross-reference with the notes taken by the Team Leader/Maintenance Expert. The notes will also capture non-verbal information (body language etc.). Prior to data collection, the Evaluation Expert will provide the team members with guidelines for conducting KIIs including detailed instructions on taking notes, transcription, translation, and interpretation.

**Data Processing:** All KIIs will be audio recorded on digital voice recorders and transcribed by the In-Country Coordinator and reviewed by the Team Leader/Maintenance Expert as soon as possible after the interview. The In-Country Coordinator will transcribe the audio recording into Mongolian, which will be then translated into English, and corrected by the Team Leader/Maintenance Expert.

**Data Analysis:** The translated KII transcripts will be coded by the Junior Analyst with the guidance from the Team Leader/Maintenance Expert. Responses will be coded using Microsoft Excel in a consistent manner to identify common themes and trends. Coding will allow the team to consistently categorize information and facilitate the team to reference the information. The team will use the qualitative information gathered to evaluate the GOM's maintenance practices and what the likelihood is that MCC's investment on the N-S road will remain adequately maintained for the life of the investment. Based on this assessment, the team will also update the maintenance assumptions used in the HDM-4 model.

### **6.3.3 Evaluation Question 2B**

#### **Quantitative Approach – Secondary Data Review**

**Description of Methodology:** A number of secondary data will be collected to address Evaluation Question 2B, focusing on the change in Mongolia's maintenance practices due to the TA Activity and the Compact Covenant. The team will review the budget and actual expenditure to examine whether the GOM maintained a yearly increase in the amount committed to the Road Fund from the amount committed during the prior fiscal year (taking into account inflation and maintenance needs) as requested in the Compact Amendment as a covenant. Additionally, the evaluation team will examine whether the repair and maintenance equipment purchased and handed over by MCC in 2013 contributed to improved maintenance practices. The evaluation will attempt to obtain the following documents as available:

- Any change in road maintenance policies and processes before and after the Compact
- Record of road maintenance budget of the Road Fund before and after the Compact
- Record of road maintenance expenditures before and after the Compact
- Administrative records on emergency and routine maintenance performed before and after the Compact
- Administrative records on emergency and routine maintenance equipment owned by the MRTD
- Administrative records on the use of road repair and maintenance equipment purchased by MCC

Upon collecting the secondary sources, the team will review and assess the GOM's road maintenance policies, budget, and expenditure in further detail, comparing to see if there were any changes before and after the Compact.

**Data Processing/Analysis:** Based on the secondary data collected and the qualitative data collected (details below), the team will determine whether MCC's investment in the TA Activity and the Compact's covenant improved the maintenance practices.

### **Qualitative Approach – KIIs**

**Description of Methodology:** In addition to reviewing the secondary sources, the team will answer Evaluation Question 2B by developing a detailed set of questions, identifying key stakeholders to interview, and conducting KIIs. The evaluation team will collect information to triangulate the information available on the secondary sources and to obtain additional information not available from the secondary sources. For instance, the team will ask questions whether MRTD's decision process for determining the Road Fund budget was influenced by MCC's request in the Compact.

**Timeframe of Exposure:** MCC's Compact was completed in September 2013. If MCC's Compact Covenant had any influence on increasing the GOM's commitment to the Road Fund, it would be observed after the Compact Amendment (January 2010) and during the Compact implementation (until September 2013). Any sustainable commitment from the GOM to road maintenance funding would be observed from records after the Compact completion (after September 2013). Reviewing the GOM's road maintenance practices and the Road Fund levels in 2019 would allow the team to understand the full range effect from MCC's efforts to improve road maintenance. The team can observe at least nine years of annual increase or decrease in the Road Fund budget, which covers the Compact period and five years of post-Compact period.

**Sample:** Key stakeholders we will interview include relevant officials from the MTRD (e.g., Policy and Planning Department, Road Policy Implementation and Coordination Department, Road and Transport Inspection and Registration Division, and the RTD Center); maintenance firms (SOE and private), and donors active in the road sector (e.g., ADB, World Bank).

**Instrument/Equipment:** The team will conduct semi-structured interviews with a fairly open framework which allow for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries questions to obtain more specific information to fully understand the effect of MCC's efforts in improving Mongolia's road maintenance practices.

**Rounds and Timing:** The KIIs will be conducted in October – November of 2019 to obtain the latest information available on the status of the road maintenance funding before the analysis period (Option Period II). The data collection will coincide with those of 2A to maximize the information gathered during interviews.

**Staffing:** The KIIs will be conducted by the evaluation team and no additional staffing is anticipated for this evaluation area. The Team Leader/Road Maintenance Expert will lead the data collection procedure to conduct KIIs with key stakeholders in Mongolia, supported by the In-Country Coordinator.

**Data Quality/Processing/Analysis:** The team will follow the same procedure described under Section 5.3.2 to ensure high quality data collection, processing, and analysis. Based on qualitative information collected, the team will determine whether MCC's investment in the TA Activity and the Compact's Covenant improved Mongolia's road maintenance practices.

#### **Evaluation Area 2 and the Final Analysis**

In addition to updating maintenance assumptions used for the economic analysis, Evaluation Areas 2A will examine the overall sustainability of MCC's road investment. Evaluation Area 2B will inform whether or not MCC's efforts in improving maintenance practices were effective. This will add value to the final analysis by illustrating how MCC's road projects can improve maintenance practices in the future projects.

## **6.4 CHALLENGES**

### **6.4.1 Limitations of Interpretation of the Results**

The interviews conducted by the team may be influenced by response bias. The stakeholders often have a strong incentive to hide their nefarious activities, such as corruption. Similarly, stakeholders may be biased to answer in a certain way for social or political incentives. Consequently, they are likely to encounter difficulties in probing and understanding these issues, as well as ascertaining the true interests of the people engaged in such activities. For example, determining that a government agency colluded with a private firm to win certain bids requires documentation of their activities. Such evidence is often difficult, if not dangerous, to obtain. Similarly, if not explained fully prior to the interviews, the Mongolia government staffs may want to provide positive results from the Compact to justify further investments from MCC.

### **6.4.2 Risks to the Study Design**

Secondary data sources and KIIs will be essential for answering Evaluation Questions 2A and 2B. There is a risk that these documents may not be available to the evaluation team due to delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

An additional risk is gathering accurate information from KIIs that we cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to us. To minimize against these risks, we will interview all relevant institutional stakeholders for road maintenance in order to validate the information from multiple perspectives.

## **VII. EVALUATION DESIGN – EVALUATION AREA 3: ROAD USAGE PATTERNS**

### **7.1 EVALUATION QUESTIONS**

#### **A) Who is traveling on the road, why, what they are transporting, what they are paying for transport, and how long does it take to move along key routes? [Core]**

This evaluation question serves several purposes in the overall analysis. First, information gleaned from answering the question will help confirm/validate the identity of the main beneficiaries of the projects (who is traveling on the road, what are they transporting). Second, the answer to the question on why people are traveling on the road (journey purpose) is an important input needed for the HDM-4 analysis in Evaluation Area 1. Third, the information on fares and travel time will help validate the HDM-4 estimates, and could potentially be used in conjunction with the HDM-4 estimates to identify profit/loss margins (which could be an indicator of market competitiveness), and assess whether different operators are charging the same fares for given cargo on given routes.

#### **B) Have road usage patterns changed, in terms of who is traveling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes? [Supplemental]**

This evaluation question will attempt to reveal whether the reasons for using the MCC-funded road, the beneficiaries of the road, the fees, to travel on the road and the duration of the journey have changed to any significant degree because of the Compact investment and, if so, why that may be the case.

### **7.2 EVALUATION APPROACH**

#### **7.2.1 Summary of Existing Data**

The ADB feasibility study provides details and analysis of O-D survey carried out in 2003, and passenger and commodity movement information on the rail corridor running parallel to the N-S road.

As part of the feasibility study, ADB conducted an O-D survey at four locations between Choir and Zamyn-Uud and two of the four locations were located between Choir and Sainshand (near the railway crossing in Choir, 2km from Sainshand). A total of 254 responses were obtained at the four locations with 56 to 71 responses at each location. Cars and jeeps constitute 57.9 percent of the valid responses followed by all trucks and tractors at 36.2 percent and buses at 5.9 percent. The O-D pairs were categorized as local (both origin and destination within Mongolia), external (either the origin or the destination point in an O-D pair is outside Mongolia), and transit (both original and destination are outside Mongolia). The feasibility study reported that:

As expected, local traffic would be the largest share of normal traffic (70.1%). Transit traffic at 4.3% is low, as expected also, since the existing road condition is not suitable for long distance freight or passenger transport. It is interesting to note that of the 65 cases of external traffic, 16 O-D pairs (approximately 25%) has an origin or destination in Erlian Hot [Erenhot] in PRC.

The low share of transit traffic is attributed to the poor road quality. No other information from the O-D survey other than O-D pairs is available in the report. In other words, the results presented include information only on the share of O-D pairs by total vehicles and not by vehicle types or commodity types or by passenger vehicles.

The team expects the MCC-funded road section (Choir – Sainshand) to experience traffic growth in the below types of traffic due to the road improvements:

**Table 4: Type of Traffic Expected on the MCC-funded Road Section**

Type	Traffic Type	Characteristics	Comments
T1	Normal traffic	Traffic which grows according to demand factors not related to road improvements.	Typical traffic of the “without project”, though could also apply to “with project” situation if traffic types described below do not apply. Growth factor is based on macroeconomic index: GDP, GDP/capita.
T2	Diverted road traffic	Traffic transferring to project road from alternative routing because of “price reductions”.	This does not apply for the evaluation, as there was no alternative route to the project road.
T3	Diverted traffic from other transport mode	Increased road traffic carrying transferred freight and passengers from railways. This transfer occurs for a variety of reasons: price, time, comfort etc.	ADB (2004) and ADB (RRP) includes the benefits from this type of traffic in the economic analysis and referred to them as “induced traffic” economic benefits.
T4	Development traffic	Traffic “induced” or “generated” by new economic activities developed because road improvement offers substantial locational advantages.	This type of traffic is difficult to estimate, though it could lead to substantial economic benefits. Isolating the incremental impact of road improvements to the establishment of new economic activities may be difficult.
T5	Generated traffic	Traffic associated with current road users making additional trips because the “net price” of travelling on the improved road has declined.	This type of traffic is relevant and O-D survey will help estimating the volume of generated traffic. This could affect both local and international traffic.

## **7.2.2 Timeframe of Exposure**

By 2018, the N-S Road Project will be five years past completion (September 2013) and the impacts on road usage will be measurable. Those in the resident and transit population will have had ample time to adjust their habits, including travel route and frequency, as a result of the road’s completion. While the impacts of the road will be measurable at any point in the collection period, it will be advantageous to conduct the O-D survey as early as possible in the data collection period since the O-D survey informs multiple Evaluation Areas (the O-D survey provides vehicle occupancy and journey purpose data for Evaluation Area 1, provides data on road users for Evaluation Area 3 and data on prices of journey for Evaluation Area 4).

The Roadside Establishment interviews and the Public Transport User survey measure road usage patterns as set forth in Evaluation area 3A as well as measure changes in road usage as set forth in Evaluation Area 3B. For this reason, questions in these surveys involve respondents to exercise recall and compare factors related to their usage of the road before and after September 2013. This provides another reason that it is advantageous to administer these surveys towards the beginning of the data collection period when the memory of the pre-Compact road conditions is freshest.



### 7.2.3 Evaluation Questions 3A/3B Methodology

#### **Quantitative Approach – O-D Survey**

**Description of Methodology:** The information obtained from the O-D survey will be used to inform the HDM-4 model but also to answer Evaluation Question 3A. The O-D survey methodology is described in detail under Section 5.2.5. Therefore, this section will only highlight areas where the O-D survey is expanded beyond the need of the HDM-4 data requirements for Evaluation Area 3.

**Instrument/Equipment:** In addition to the standard O-D questions required for HDM-4 (origin and destination, journey purpose, travel time, vehicle classification, passengers per vehicle, number of passengers in employment, number of crew, type and approximate weight of merchandise or goods transported), O-D questionnaire will collect additional elements including fares for transporting goods and people and motivations for the trip. These questions will be particularly important in responding to Evaluation Area 3B and 4, providing data to help with the analysis of change in usage patterns and prices in the market for passenger transit and cargo.

Additionally, the O-D survey will tabulate demographic information, including gender and nationality.

**Data Processing/Analysis:** Some of the O-D survey data will subsequently be inputted into the HDM-4 model and, where necessary, analyses will be required to obtain averages for vehicle occupancy and for determining the percentage of work related trips.

In addition to the information required for the HDM-4 modeling, the data will be disaggregated by gender, age, and other social differences and analyzed to see if any significant differences exist between them. For instance, the team will compare the share of road usage by gender and conduct additional analyses with respect to the purpose of usage by gender, including whether that usage is income-generating and what types of goods, if any, are transported by women.<sup>7071</sup> By asking about nationality, the team will disaggregate the population of users and beneficiaries of the road and to what extent they may be Chinese, Russian, or from another foreign country.

Other information will be also used to validate and provide context for the HDM-4 estimates, as well as provide support for Evaluation Area 4. For example, the data could potentially be used in conjunction with the HDM-4 estimates to identify profit/loss margins (which could be an indicator of market competitiveness), assess whether different operators are charging the same fares or cargo rates for given O-D pairs, and determine whether discounts are provided for certain classes of travelers (for example, regular/long-time customers, elderly, women, women with children, etc.)

In the absence of a comprehensive baseline, the comparison between pre- and post-Compact O-D survey data will pertain to available data only. For example, some analysis can be made on the share of O-D pairs by total vehicles in terms of groupings of local (both origin and destination

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<sup>70</sup> For example, as was found in a study in Armenia, while male heads of households were more likely than female heads of household to report using the road for access to market, female heads of household were more likely to report other uses: women reported using the road about one day a month to visit relatives, go shopping and for other activities that were not income-generating. *Evaluation of a Rural Road Rehabilitation Project in Armenia*. March 12, 2015. Mathematica Policy Research. Submitted to Millennium Challenge Corporation.

<sup>71</sup> For example, as found in Ethiopia, women used the road to transport agricultural produce. Bryceson, D. F., Bradbury, A., & Bradbury, T. (2008). Roads to poverty reduction? Exploring rural roads' impact on mobility in Africa and Asia. *Development Policy Review*, 26(4), 459-482.

within Mongolia), external (either the origin or the destination point in an O-D pair is outside Mongolia), and transit (both original and destination are outside Mongolia). However, comparison by vehicle type is not possible because of the absence of baseline data on vehicle type.

### **Qualitative Approach – Roadside Establishment Interviews**

**Description of Methodology:** Roadside Establishment Interviews will be conducted as an extension of the O-D survey. The interviews will be conducted at or outside commercial locations, including gas stations, restaurants and/or convenience stores. At these locations, road users will not be affected by time constraints at a vehicle intercept and the team expect a higher response rate to all the questions on the interviews and more robust responses. Thus, the team will be able to collect more detailed information that will inform our analysis of Evaluation Areas 3A, 3B, and 4. Interviews about road usage have been conducted in the past in addition to O-Ds to provide additional information. In 2013, MCA-M reported that a technical assistance contractor, SE/HPM had interviewed 300 workers about the social-economic growth in the project area and had interviewed 70 selected people including local governors, business men and members of the family that work for the road project.<sup>72</sup> In 2003, a technical consultant conducted interviews of incoming and outgoing passengers at the ZU border post in advance of the completion of the North-South road project.<sup>73</sup> Following completion of the road project, the Chamber of Commerce interviewed residents in Sainshand, Choir, and Zamyn-Uud. These interviews will similarly provide beneficiary feedback beyond what can be provided in the O-D surveys and will be targeted to answer the specific evaluation questions posed by MCC.

Additionally, economic growth in the provinces has been associated with the rehabilitation of the road, according to preliminary meetings the team had with the Offices of the Governor in Gobisumber and Dornogobi. The team expects to gain more detailed information on impacts to beneficiaries who reside in the local area by conducting interviews in Sainshand, Airag, and Choir. These interviews will provide an insight to how economic activities have changed along the road due to the road improvements and provide the team data to inform an analysis of induced demand.

**Instrument/Equipment:** An interviewer will conduct the interviews in-person by soliciting responses verbally as structured interviews. The interviews will ask some of the same questions as the O-D survey regarding trip purposes, trip distances, and type of commodity carried if the respondent carries goods on the road. The Roadside Establishment Interviews will include additional follow-up questions including: purpose of trips beyond just work/leisure differentiation (e.g., commerce and type of commerce, commuting and place of employment, monastery, family) and frequency of trip by type of trip (e.g. work, family, social services). The questions will address whether the changing patterns reveal that the road is a mechanism to income growth and poverty reduction, (e.g. if users buying less expensive consumer goods or less expensive supplies for their businesses by reaching other markets via the road, if they are selling products to new markets opened up by the construction of the road, or if they are using the road to commute to employment).

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<sup>72</sup> MCA-M, Project Management and Construction Supervision Consultant for MCA-M Road Project, Final Report, November 2013., p. 32.

<sup>73</sup> The survey was conducted with assistance from the local government, and yielded a total of 528 responses. However, in 2003, the number of questions was limited by the government. ADB, TERA Beijing, Technical Assistance Report: “TA 3990 MON – Mongolia Third Roads Development Project Final Report – Supplementary report”, Volume 1: Transportation Planning and Economic Issues, January 15, 2004, page 41.

The interviews will also ask questions relevant to Evaluation Area 4 including whether their transport mode has changed (e.g. rail), whether the vehicle class has changed, and whether they have taken vehicles in the informal market before and after the completion of the road.

**Rounds and Timing:** The interviews will be conducted once in each soum for a 12-hour time period (10:00 am -10:00 pm) on a market day in order to capture the maximum number of respondents. The proposed time will sufficiently cover day-time and night-time hours to capture road users who have different schedules: for example, since truckers tend to travel at night, the interview period will need to include night-time hours. The time may be adjusted based on the proposals received from the subcontractors and the team will also consider the operating hours of the establishments where the interviews take place. For the Roadside Establishment Interviews will be conducted during non-winter season from April-September when traffic volume is highest to maximize the number of respondents.

**Sample/Data Collection Location:** The sampling unit for the roadside establishment interviews is individuals over the age of 18 who have used the road. The individuals included in the sample may be local residents or transit road users. The sampling strategy focuses on the segment of the population that are mostly likely to use the road. The sampling strategy will identify high-traffic locations in each of the three soums. Assuming that about 200 people pass through the location over a 12-hour period and that the team will interview every fourth adult who agree to participate and meet the screening requirements, the team assumes a target population of respondents of 30 to 40 in each soum.<sup>74</sup> The team believes this is a sufficient number of respondents to provide information to answer the research questions on road usage and changes in road usage. The sample size and the sampling interval will be finalized once the interview location is finalized.

The strategy will be to approach potential respondents on their way out of the establishment so that they have fulfilled the primary purpose of their journey (e.g. finished their meal or purchased their conveniences) and are more likely to take time to participate in interviews. Based on the sampling interval, interviewers will approach the potential respondents and the first two questions asked will be screening questions to exclude respondents who do not fit the interview frame: 1) Were you 18 in September 2013? and 2) Have you used the N-S road as a driver or a passenger?

With this methodology, it is assumed that the individuals we approach who decline to participate in the interviews are not systematically different than the ones who agree to participate. The interviewers will take notes of the characteristics of those individuals who decline to participate so that the team can identify and analyze any factor that differentiates this population as part of the analysis.

Data will be collected at or outside a commercial location in the soums of Choir, Airag, and Sainshand. The interview locations will be near the road or one that would be frequented by road users, including gas stations, restaurants, or convenience stores. The team may conduct the interviews at more than one location in a soum. The final choice of locations will be proposed by the subcontractor and approved by the evaluation team.

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<sup>74</sup> According to the guidelines of some methodologists, populations of 30 to 50 are often considered a good saturation point for qualitative research beyond which new insights gained from additional respondents are limited (although the saturation point is not a fixed number and could for example be lower in some cases). References used include the following: Morse, Janice M. (1994). Designing funded qualitative research. In Norman K. Denzin & Yvonna S. Lincoln (Eds.), Handbook of qualitative research (2nd ed., pp.220-35). Thousand Oaks, CA: Sage. Creswell, J. W. (1998). Quality inquiry and research design: Choosing among five traditions. Thousand Oaks.

**Staffing:** The roadside establishment interviews will likely be conducted by the team likely with two staff persons to approach potential respondents and oversee their completion of the interviews.

**Safety Procedures:** No additional safety precautions are required for the interviews. However, the team will ensure that the interviewers are safe while collecting information at night.

**Data Quality:** A potential problem with the interview procedure is that respondents will be free to withhold information during the interview. To mitigate this risk, the evaluation team will explain the purpose and use of the data and also assure that this data will not be used for any other purpose. The team will be trained to ask questions in a way that respondents clearly understand the questions and not feel uncomfortable in answering the questions. The interviewers will be paired into groups if possible to allow for one surveyor to lead the discussion while the other takes notes.

Prior to data collection, the Evaluation Expert will provide detailed guidelines for conducting the interviews including detailed instructions on how to conduct interviews, taking notes, and transcription. The evaluation team will conduct random checks to ensure the data is being collected and recorded correctly and quickly rectify for any anomalies. To ensure high quality data collection, the interviews will be conducted in Mongolian and the compiled information will be translated into English.

**Data Processing/Analysis:** The interview data collected in Mongolia will be transcribed into Excel formatted worksheets. The data is intended to understand qualitative information on the road users and their travel patterns. With a target of 120 in the sample (40 each at three locations), some descriptive statistics can be generated related to road use. The interviews will also uniquely inform Evaluation Area 3B by providing information on how the infrastructure project has affected road usage that is not possible to obtain during the O-D survey which prioritizes questions on the cost and duration of the trips and the value of the goods being transported to inform the HDM-4 model.

### **Qualitative Approach – Public Transport User Survey**

**Description of Methodology:** This survey will be conducted as an extension of the O-D survey to collect more detailed information regarding individual journeys including information on fares, discounts, travel times, and preference for specific drivers particularly from public transport users. The survey will be conducted while the interview subjects are aboard buses heading northbound (from Sainshand to Choir) and southbound (from Choir to Sainshand). This survey would capture information from riders between those origin-destination pairs as well as other origin-destination pairs which might include Zamyn-Uud or Chinese destinations for those riding south and UB or Russia for those riding north. The surveyor will board the buses in Sainshand/Choir and administer the survey to all passengers heading north/south, getting off in Choir/Sainshand. Additional passengers boarding the bus between Sainshand and Choir will also be surveyed.

**Instrument/Equipment:** The survey will ask the passengers on public transport vehicles to fill out a short form on paper instead of administering questions verbally by an interviewer. This will mitigate the possibility that passengers may be reluctant to provide information that can be overheard by other passengers and allow for more robust responses. Since the surveyor will be on the bus for an extended period, the team expects a higher response rate as well as more robust responses than from an O-D survey. The interview subjects will have more time to respond to the survey during their journey than at a road-side stop. Interview forms will also be available in Russian, Chinese, and English languages so that responses can be gathered from persons who do not read and write Mongolian but read and write one of these languages.

**Rounds and Timing:** The public transport survey will be administered to passengers on two bus rides heading north and two bus rides heading south on two consecutive market and non-market days, Sunday and Monday, the same days as the O-D surveys, subject to the schedule of the buses. The team confirmed during the trip that there are two domestic buses and one international bus. The interviews will take place on one international bus ride in each direction (for a total of six bus rides altogether).

**Sample/Data Collection Location:** The sampling unit is individual public transport passengers on the N-S road buses leaving from Choir and Sainshand. The public transit survey will be administered to passengers on six buses who were adults (18 or older). The approximate sample size is 194, assuming surveys on six buses, a bus capacity of 40, an occupancy rate 90 percent, and a rate of 90 percent of passengers who are over 18. With this methodology, it is assumed that the individuals we approach who decline to participate in the survey are not systematically different than the ones who agree to participate. The interviewers will take notes of the characteristics of those individuals who decline to participate so that the team can identify and analyze any factor that differentiates this population as part of the analysis.

The interviewers will conduct this survey while aboard buses heading northbound (from Sainshand to Choir) and southbound (from Choir to Sainshand).

**Staffing:** The public transport survey will be conducted by the evaluation team. The team sizes will be two to three interviewers.

**Safety Procedures:** No additional safety precautions are required for this survey.

**Data Quality:** A member of the evaluation team will ride along a bus with an interviewer and conduct a pilot test before the survey is conducted. This will help mitigate the risk that data is not correctly recorded and plan for any anomalies that may be noted so that they can be rectified.

**Data Processing/Analysis:** The information obtained will be transcribed into Excel formatted worksheets. The data is intended to understand qualitative information on the road users and their travel patterns. With a target of 194 in the sample, some descriptive statistics can be generated related to road use. The interviews will also uniquely inform Evaluation Area 3B providing information on how the infrastructure project has affected road usage that is not possible to obtain during the O-D survey which prioritizes questions on the cost and duration of the trips and value of the goods being transported to inform the HDM-4 model.

### **Qualitative Approach – KIIs**

**Description of methodology:** The team will conduct KIIs with representatives from organizations of transportation operators and individual operators of transportation services. Thus, the team will include informants including representatives of bus companies, individual truckers, operators of taxis, and operators of private vehicles transporting passengers or cargo in the informal market. These interviews will help answer questions in Evaluation Area 3 about the passengers and cargo on the road, the prices and the length of journey.

The interviews will also help fulfill the research needs of Evaluation Area 3B and 4. For example, the team will obtain relevant data on pricing and routes both pre- and post- Compact for both cargo (e.g. price per ton-km) and passengers (bus ticket fares). The team will obtain relevant data on how the vehicle fleet composition has changed over time. This will enable us to understand what prices road users are paying, how this price has changed and how the price may differ for passengers and routes.



**Instrument/Equipment:** The team will conduct semi-structured interviews, based on a fairly open framework which will allow for focused, conversational, two-way communication. The evaluation team will ask questions and lead the discussion based on the evaluation questions listed above. Relevant follow-up questions will be asked by the team to obtain more specific information.

**Rounds and Timing:** Data collection will start in the earlier phase of data collection to potentially leverage contacts with individual operators who may be willing to participate in the more in-depth interviews later. When possible, interviews with associations and government stakeholders will be scheduled at the beginning of the KIIs when it is believed that these associations are an important source of information for contacts for further research. For example, vehicle operators such as owner-operated truck drivers or drivers of private vehicles in the informal sector who may be harder to identify. Associations who may have contact information for these stakeholders will be scheduled first.

**Sample/Data Collection Location:** The interviews/meetings will be divided into the following groups based on the different types of information the interviewees can provide. The team will maximize the KIIs by putting in requests price schedules or member lists data which may serve as sources for interview respondents before the team conducts the interviews. In some cases, the evaluation team already met with these members in its first trip. However, the questions will utilize background information obtained from the first trip to focus on asking questions directly related to the evaluation questions that were not provided during the first trip.

The list below is preliminary, and a limited number of additional stakeholders may be added. Since the interviewees will provide information that pertains to not just Evaluation Area 3A but Evaluation Area 3B and Evaluation Area 4, all the projected interviews for these three evaluation areas are listed below. Currently, a total of 25 KIIs are anticipated.

**Table 5: List of Preliminary Stakeholders for KII to address Evaluation Questions 3A, 3B, 4**

#	Type	Interview Group	# of Interviews
1	Truck Operators	Own Vehicle	2 in Sainshand 2 in Choir
2		Private Companies (Mongolian Transport corporation has member companies in local transportation)	2
3	Freight Forwarders	Freight Forwarders (e.g. Mongol Express, SPL, Tushin)	2
4	Bus Operators	Mini Bus Operators	2
5		Large Bus Operators	2 local 2 international
6	Taxi Operators	Regular Taxi and informal sector	3 in Sainshand and Choir, with at least one from each group
7	Transport Regulators	Provincial Governor's Office (Gobisumber)	1
8		Provincial Governor's Office (Dornogobi)	1
9		MTRD	1
10		Customs Zamyn-Uud or Customs Department	1
11	UB Railway	UB Railway	1
12	Transporter Associations	Mongol Transport Union	1
13		Mongolian Transport Association	1
14		NARTAM Road Transporter Association	1



The transport service drivers for cargo and passengers to be interviewed will be identified through the associations that are contacted, through the O-D survey, and through the locations for the expanded road user survey (e.g. gas stations, roadside establishments). Where possible, interviews will be conducted in person at a mutually agreed upon location.

**Staffing:** The evaluation team anticipates the data collection and analysis to be completed by the Evaluation Expert and/or the Transport Economist. No additional staffing is anticipated for the KIIs.

**Rounds and Timing:** The KIIs will be conducted to coincide with one of the engineering data collection trips and interviews for addressing evaluation questions 2B to maximize the information gathered during interviews.

**Data Quality:** The team will conduct KIIs in Mongolian with the assistance from an interpreter and in English whenever possible. KIIs will be conducted by the Evaluation Expert and/or the Transport Economist, assisted by the In-Country Coordinator. While the Evaluation Expert and/or the Transport Economist leads the interviews and takes notes, the In-Country Coordinator will assist the interviews by taking notes that will be used to cross-reference with the notes taken by Evaluation Expert or the Transport Economist. The notes will also capture non-verbal information (body language etc.). Prior to data collection, the Evaluation Expert will provide the team members with guidelines for conducting KIIs including detailed instructions on taking notes, transcription, translation, and interpretation.

**Data Processing:** All KIIs will be audio recorded on digital voice recorders and transcribed by the In-Country Coordinator and reviewed by the Evaluation Expert and/or the Transport Economist as soon as possible after the interview. The In-Country Coordinator will transcribe the audio recording into Mongolian, which will be then translated into English, and corrected by the Evaluation Expert and/or the Transport Economist.

**Data Analysis:** The translated KII transcripts will be coded by the Junior Analyst with the guidance from Evaluation Expert and the Transport Economist. Responses will be coded using Microsoft Excel in a consistent manner to identify common themes and trends. Coding will allow the team to consistently categorize information and facilitate the team to reference the information. The team will cross-examine information when relevant to help build a body of evidence to support the analysis.

#### **Evaluation Area 3 and the Final Analysis**

Evaluation Areas 3A and 3B tests the assumption in a key linkage in the project logic between road improvement and economic benefits. In addition to providing detailed information on the project beneficiaries, the analysis under Evaluation Area 3 will test whether the estimated VOC savings and travel time savings are actually experienced by road users to translate into economic benefits.

## **7.3 CHALLENGES**

### **7.3.1 Limitations of Interpretation of the Results**

Road user study results are dependent upon the quality of the data. Therefore, the O-D surveys must be a representative sample and the collected data must be carefully processed and analyzed.

O-D surveys by their nature provide short-term snapshots of road usage and representativeness can be difficult to assess. However, the limitation can be mitigated through maximizing practical

duration and sample size, conducting surveys at complementary (and possibly overlapping) locations, a thorough set of interview questions including frequency of trip, and simultaneous traffic counts which are extended beyond O-D survey hours. With this in mind, the O-D survey is also being supplemented with an Expanded Road User survey and a Public Transport User survey which can serve as additional sources of data that will compare with and enrich the findings of the O-D survey.

Second, Evaluation Question 3B addresses travelers' perceptions on how the MCC-funded roads changed road usage patterns, including changes in travel times and costs; for many reasons, the answers to such questions are subject to uncertainty and possibly bias. Given that the projects were completed in 2013, the questions require respondents to recall what "average" conditions were like over 5 years ago. In addition to the uncertainty introduced by this recall period, it would probably be necessary to limit respondents to a minimum age: for example, someone who is 23 years old at the time of the survey would have been 18 years old or younger prior to the completion of the project, and thus it might be necessary to restrict respondents to those 23 or older if it is determined this is the appropriate threshold. It should also be noted that changes in road usage patterns can be attributed to different factors which together produce a cumulative effect; and while travelers may be able to perceive the cumulative effect it is unlikely that they are able to detect the contribution of the different factors. For example, in addition to the MCC road project, other factors that could have affected road usage patterns include personal income (which would lead to more frequent use of the road to travel to U-B for business, tourism or to visit relatives) or conditions associated with the railroad (the primary substitute for the road).

### ***7.3.2 Risks to the Study Design***

The single most significant risk of the collected data is that of either insufficient or unrepresentative samples. Inevitably, the data collected will form a sample of the usage of the project roads. Care will be taken to ensure that the samples obtained are both sufficient in size, dictated by duration of survey and sample rate, and representative of usage of the roads being surveyed as much as possible. Another possible risk with all surveys is that the road users may be foreigners (e.g. from China and Russia) and that we will not be able to capture data on their journeys due to language barriers. By offering written surveys in Russian, English, and Chinese languages for the public bus survey, the team may gain some information on travelers from China and Russia. When possible, the evaluation team will encourage data collection firms to work with surveyors who can speak Russian and/or Chinese.

## VIII. EVALUATION DESIGN – EVALUATION AREA 4: TRANSPORTATION MARKET STRUCTURE

### 8.1 LITERATURE REVIEW

The transportation market structure in Mongolia features intramodal competition (various transportation service providers on the road for different classes of vehicle types) as well as intermodal competition (road vs. rail). Some countries, such as India, have seen the transition from rail to road modes concomitant with the transition from an agricultural and heavy industry economy to one dominated by secondary goods and services<sup>75</sup>. Following this pattern, Mongolia is carrying more valuable goods and consumer products on the road based on preliminary interviews. As one researcher of intermodal and intramodal market behavior writes, in this environment – when operating under free market conditions – firms behave strategically when determining their prices, knowing that competitors do the same. As a result, if a firm raises its price this can lead to an increase in profit margin but a decrease in traffic which then can lead to a traffic increase for the competitors (in the same or another mode) who may want in turn to set slightly higher prices to increase their margins and this will continue until there is a Nash equilibrium in the marketplace.<sup>76</sup> In the case of Mongolia, there are barriers that prevent markets from freely operating in this manner, including the influence of cartels when it comes to the freight market and government regulated pricing in the passenger bus market.

The presence of cartels operating in Mongolia can prevent vehicle operating savings from being passed down to consumers. Studies from other parts of the world reflect this outcome. In a World Bank report by Teravaninthorn and Raballand (T&R), “Transport Prices and Costs in Africa: A Review of the Main International Corridors,”<sup>77</sup> the authors find that the transport of freight between Sahelian countries and their ports features prices that are significantly higher than the underlying costs. This finding suggests that large profits are funneled to rent-seeking road-transport cartels benefitting from oligopolies. T&R argue that unless governments take steps to remove the structural distortions of the trucking market, there is no point in investing to reduce road-transport costs. The authors claim that the cartels will capture the benefits from lowered costs while the prices will remain the same for the users. In India, truckers’ unions have also fixed freight restricting the ability to pass-through cost savings and choking out competition in the market.<sup>78</sup>

There are many reasons for regulation of the transport sector, including environmental impacts, accidents, and congestion.<sup>79</sup> In Mongolia, the rail sector is government-owned and its prices on cargo and passengers are regulated. In the road sector, bus prices are regulated (by the km), as well

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<sup>75</sup> Cook, P. D., Das, S., Aeppli, A., & Martland, C. (1999). Key factors in road-rail mode choice in India: applying the logistics cost approach. In Simulation Conference Proceedings, 1999 Winter (Vol. 2, pp. 1280-1286). IEEE.

<sup>76</sup> Ivaldi, Marc & Vibes, Catherine, 2005. "Intermodal and Intramodal Competition in Passenger Rail Transport," IDEI Working Papers 345, Institut d'Économie Industrielle (IDEI), Toulouse.

<sup>77</sup> Teravaninthorn, S., & Raballand, G. (2009). *Transport prices and costs in Africa: a review of the main international corridors*. World Bank Publications.

<sup>78</sup> Babu Chennupati, D., & Mouly Potluri, R. (2011). A viewpoint on cartels: an Indian perspective. *International Journal of Law and Management*, 53(4), 252-261.

<sup>79</sup> Maibach, M., Schreyer, C., Sutter, D., Van Essen, H. P., Boon, B. H., Smokers, R., ... & Bak, M. (2008). Handbook on estimation of external costs in the transport sector. *CE Delft*.

as routes, and cargo is regulated at ton-kilometer price – although buses and trucks are privately owned. In addition to the literature on state-owned public-sector enterprises and private enterprises, there is discussion of “hybrid” or public-private partnerships where some factor of operation is controlled by the state, such as setting routes or fares to “combine the benefits of a public monopoly with the benefits of private provision.”<sup>80</sup>

Intermodal competition between rail transportation and air transportation<sup>81</sup> has been extensively studied in the transport economic literature along with studies on competition between rail, air and road modes. As found in the work of authors including Antes et al, modes are competitive with one another, even when one is state-owned (as in the case of Germany where the price of air travel influenced the pricing strategy of the monopolistic rail operator)<sup>82</sup> and in the case of France.<sup>83</sup> Thus, when examining the sector to understand the pricing mechanisms at work, many authors have evaluated a marketplace of intermodal competition and not just intramodal competition.

## **8.2 EVALUATION QUESTIONS**

### **4) How is the transportation market structured and what is the likelihood that VOC savings will be passed on to consumers of transportation services? [Supplemental]**

#### **Structure of the Transportation Market**

The two-part evaluation question first asks about the structure of the transportation market. For the purposes of this question, the markets for 1) passengers and 2) cargo will be discussed. Following these modes of transport on the N-S road, the Mongolian train (MTZ) will be discussed because it is the primary substitute mode of transportation for both passengers and cargo.

The first part of the question asks about the transportation market. In the transportation market for passenger, in order of expected volume of passengers, the market for passengers consists of 1) private vehicles, 2) passenger buses, and 3) some other vehicles, including taxis and or transport vehicles in the informal market (“unofficial” taxis). It should be noted that the market for buses is a relatively new market. Now, there are two travelling in each direction as well as an additional bus that travels twice a month. The O-D survey, passenger bus survey, expanded road user survey and key informant interviews will help us evaluate the structure of the passenger transportation market and the pricing of transporting passengers.

In the transportation market for cargo, the trucks can be divided into categories which may include the following: freight forwarders in an association that are hired to carry freight, independent (owner-operated) truckers that are hired to carry freight and independent (owner-operated) truckers that carry their own freight. Companies may use freight forwarders to transport their freight or

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<sup>80</sup> Estache, A., & Lobo, G. (2004). The Limits to Competition in Urban Bus Services. *Developing Countries, World Bank Policy Research Working Paper*, 3207, p. 35.

<sup>81</sup> Antes, J., Friebe, G., Niffka, M., and D. Rompf (2004): “Entry of Low-Cost Airlines in Germany. Some Lessons for the Economics of Railroads and Inter-Modal Competition”, Paper presented on the 2<sup>nd</sup> Conference on Rail Industry Structure, Competition and Investment, Evanston, USA; Behrens C. and E Pels. (2011) “Intermodal competition in the London-Paris passenger market: High-Speed rail and air transport”, *Journal of Urban Economics* 71(3) pp278-288; Capon, P., Longo, G. and Santori, F. (2003) “Rail vs. Air Transport for Medium Range Trips”. ICTS, Nova Gorica, pp1-11

<sup>82</sup> Antes, J., Friebe, G., Niffka, M., and D. Rompf (2004)

<sup>83</sup> Perennes, Patricia. "Intermodal competition: studying the pricing strategy of the French rail monopoly." *Transport Research Arena* 2014. 2014.

may have their own truck or fleet of trucks. The transportation market for cargo has significantly changed since before the road was paved in 2009. The volume of trucks carrying freights has increased. The O-D survey and key informant interviews from freight forwarding associations and with independent truckers will help us evaluate the structure of the cargo market, including the pricing of transporting cargo, which currently is subject to “exemplary prices” set by the government, although transportation associations indicate there is room to deviate from those prices which will be evaluated in this evaluation area.

One key area of analysis in the transportation market is the degree to which the rail competes with the N-S road as a transporter of goods and passengers. Key informants have indicated that the substitution effect has been significant for passengers, due in part to time savings. There are varying accounts of the degree to which there has been a substitution effect for cargo although there seems to be a consensus that there has been some effect. Charges for cargo travelling on the road are by weight (ton-km) whereas cargo travelling on the rail are measured by container, resulting in heavier goods usually being transported on the rail, when possible.<sup>84</sup> The O-D survey, bus passenger survey, expanded O-D survey, and key informant interviews will help us evaluate the volume of passengers and cargo and the types of cargo that are going across the border. The MTZ and Customs offices will provide us with data on passengers and cargo that will help us evaluate the role of the rail in the transportation market.

### **Likelihood that VOC savings will be passed on**

The second part of this evaluation questions asks about the likelihood that VOC savings will be passed on to consumers of transportation services. The project logic assumed that any reductions in VOC were project benefits. Yet, the program did not identify to whom these benefits will accrue. For road users that use their own vehicle, it is clear that they will benefit from the VOC savings. However, for users relying on transport operators, the savings in VOC can be either transmitted completely to the user in a highly competitive transport market or retained by cartels of transport operators or companies if transportation costs are set below market prices by the government.

Since the Compact’s overall goal is economic growth, it would be most useful if the reductions in VOC accrued completely to the road users. This would provide a maximum incitement for them to increase production leading to economic growth (assuming they use the savings in travel costs for productive purposes). This evaluation question will examine to what degree transport costs were reduced for passenger traffic and transporters of cargo after the improvement of the roads.

Through interviews with key informants, the O-D survey and the expanded O-D survey, the team will be able to learn if riders switched from use of the train to use of a private vehicle, passenger bus, or official/unofficial taxi to the road based on a calculated reduction in price and/or travel time. Documents from the MTZ on volume of ridership and price from before and after the road will help support this analysis of substitution from rail to car traffic. If indeed there is a substitution effect, assuming the price of the train remains relatively stable (and this will also be analyzed), this group of passengers benefited from the VOC savings. For road users that use their own vehicle, it is clear that they will benefit from the VOC savings. Additionally, the team will examine the

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<sup>84</sup> Trucks do travel on the road carrying heavy goods such as coal and copper when the mines such as the case of Tolgoi coal mine where there is a 240 km road to the Chinese border. In these cases, the roads have been constructed to handle the additional axles and weight of the truck. This information was obtained at an interview with Mr. Purevchuluun, the General Director with Tushin Freight Forwarder.



effects of “exemplary prices” issued by government from preventing a pass-through with the consideration that transport associations told us they have some room to deviate from that price.

Through the O-D survey and interviews with key informants, the team also will evaluate the market of taxis and unofficial taxis (owner-operators who are not officially licensed by the government giving rides to passenger). Since the passenger buses offer an alternative that was not officially there, and the rate of private car ownership has gone up, the team expects that there will be lower numbers of passengers in this segment of the market.

## **8.3 EVALUATION APPROACH**

### **8.3.1 Summary of Existing Data**

To corroborate the information gathered during the site visit, and fill in missing details, the evaluation will identify and attempt to obtain any existing data that can be used to provide a comprehensive review of the road transport market structure.

The team will collect historical data on fares, where available. For example, the team will collect passenger rail fares, but the team cannot collect bus fares prior to the Compact because the bus lines did not exist until after the MCC road was completed. The team will collect information on reported fares for passenger service, such as fares set in the informal market from providers of transport in the informal market and from the expanded road survey and the public bus survey. The team will collect freight prices from existing associations of drivers (e.g. the Mongol Transport Union) and from independent owner-operated drivers who the team have been told by the Chamber of Commerce offer lower prices and have a downward effect on the market price. The team will collect data in the unit available, e.g. container, ton-kilogram, ton-kilogram-meter. It will also be harder to obtain historical pricing data on cargo because few trucks were on the road. (Based on the preliminary interviews, there was very little truck traffic and most cargo came by rail.)

The team will collect passenger and freight prices from rail as part of the evaluation. The Mongolian Transport Corporation told us that since cargo prices on the road have gone down, the price of rail has lowered 10 percent. The team will attempt to find corroborating information about this and other factors affecting price. While users consider the price when choosing between rail and road, they also consider factors of competition include travel time, reliability and convenience and point-to-point service.

Data which may exist and could be valuable includes association membership rosters and licensee information, both of which could potentially help (1) estimate the number of operators servicing the MCC roads or (2) identify subjects for key informant interviews.

### **8.3.2 Evaluation Question 4 Methodology**

**Description of Methodology:** The evaluation team will analyze the transportation market structure and the formal and informal institutions that regulate and govern the transportation market. The evaluation team will explore the structure and competitiveness of the transportation sector to understand how likely it is that VOC savings have been passed on to transport consumers, such as public transport users or herdsman transporting their livestock to market or truck operators transporting their food, perishable goods, chemical fertilizers to U-B or consumer goods for Ali-



Baba<sup>85</sup> (According to the ADB Feasibility Report, domestic rail freight in the following categories was projected to divert 100 percent to the road after the construction of the road: food, perishable goods, live animals, chemical fertilizers). KIIs and O-D survey will help the team understand how regulated tariff are determined and enforced would be part of the study. the question. The team will also gain information about the transportation logistics market has structured and been affected by the road improvements, producing economic efficiencies in the transport market (for example, the team learned of logistics centers under development at Zamyn-Uud).

The evaluation team will employ qualitative methods to answer the two evaluation questions, which will include collecting and reviewing reports and documents, and conducting interviews with informants in the government and the private sector. In preparation of the EDR, the team collected documents from various sources and will continue to collect additional documents to address evaluation questions under Evaluation Area 4.

The team will also examine the impacts of the transportation market structure on women, which in turn impacts the degree to which women are beneficiaries of the road. For example, the team will ask transport service drivers about industry norms/practices and setting of fares as a means of asking whether women receive any prejudicial or preferential treatment. This will complement the information gathered from the O-D survey. If there are any transport service drivers or transport service non-driver owners that are women, the team will also seek to interview them.

**Instrument/Equipment:** The main data gathering instrument to be used for Evaluation Area 4 will be KIIs in the transport sector. The team will conduct semi-structured interviews, based on a fairly open framework which will allow for focused, conversational, two-way communication. The evaluation team will ask questions and lead the discussion based on the evaluation questions listed above. Relevant follow-up questions will be asked by the team to obtain more specific information. A stand-alone survey-based data collection is not expected as part of this Evaluation Area according to the evaluation's scope of work.

**Rounds and Timing:** For Evaluation Area 4, data collection will occur in tandem with one of the O-D surveys and Expanded Road User surveys, to potentially leverage contacts with drivers, who may be willing to participate in the more in-depth interviews later.

**Sample/Data Collection Location:** The interviews/meetings will be divided into the following groups based on the different types of information the interviewees can provide. The list below is preliminary, and a limited number of additional stakeholders may be added during the data collection phase. The list is available above under Section 6.2.3.

**Staffing:** The evaluation team anticipates the data collection and analysis to be completed by the Evaluation Expert and/or the Transport Economist. No additional staffing is anticipated for the KIIs.

**Safety Procedures:** No additional safety precautions are required for this survey.

**Data Quality:** To ensure high quality data collection, the interviews will be conducted in Mongolian, with the assistance of an interpreter if needed.

**Data Processing/Analysis:** Qualitative data analysis will be used to analyze the data collected from the interviews. The evaluation team will classify, sort, and arrange information gathered to

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<sup>85</sup> According to the Mongolian Transport Corporation, the road is used by drivers carrying consumer products from Alibaba.

identify trends and examine the relationships in the data. The team will cross-examine information when relevant to help build a body of evidence to support the analysis and decide on the extent to which the VOC savings have accrued to relatively low-income groups.

#### **Evaluation Area 4 and the Final Analysis**

Evaluation Area 4 allows the team to assess the actual distribution of benefits of the MCC road investment for the road users. Especially, the analysis will illustrate the different level of benefits experienced by vehicle owners vs. transportation service consumers, if any.

## **8.4 CHALLENGES**

### **8.4.1 Limitations of Interpretation of the Results**

The proposed methodology for Evaluation Area 4 comes with the following limitations. First, there is a risk that the interviewees will not provide accurate information; for example:

- The interviewee may provide information they believe the interviewer wants to hear, rather than more accurate information they believe is not desired;
- The interviewer may withhold, or even provide misleading information, to protect sensitive or proprietary information; and
- The interviewee may not trust the intentions of the Evaluation Team.

Second, understanding an issue does not imply that MCC (or any other development partner) can influence it. External development partners may face severe limits in being able to ameliorate problems in transport market.

### **8.4.2 Risks to the Study Design**

Similar to the risks associated with Evaluation Area 3, the single most significant risk of the collected data is that of either insufficient or unrepresentative samples. Inevitably, the data collected will form a sample of the usage of the project roads. Care will be taken to ensure that the samples obtained are both sufficient in size, dictated by duration of survey and sample rate, and representative of usage of the roads being surveyed as much as possible. Another possible risk with all surveys is that the road users may be foreigners (e.g. from China and Russia) and that the evaluation will not be able to capture data on their journeys due to language barriers.

## **IX. ADMINISTRATIVE**

### **9.1 SUMMARY OF IRB REQUIREMENTS AND CLEARANCES**

The evaluation team will prepare and submit an Institutional Review Board (IRB) application to an IRB registered with the Office for Human Research Protections with the US Department of Health and Human Services for approval of the research and data collection plan involving human subjects. The team expects the following data collection to involve human subjects:

- Origin-Destination survey
- Public Transport User survey
- Expanded Road User Survey
- Key Informant Interviews

The application materials for IRB will include four sets of documents: 1) a copy of the Design Report, 2) a copy of survey protocols, 3) a copy of all data collection instruments that will be used for the survey, and 4) a completed IRB application form summarizing protection of participant's rights and data safety. All materials will be translated into Mongolian by the evaluation team before submission. The team anticipates only minimal psychosocial stress and related risks for the research participants.

The selection of the participants of the surveys will respect the principle of equity since participants will be randomly selected among the road users on MCC-funded road segments. The O-D survey, Public Transport User survey, and the Expanded Road User survey procedures will be based on the principles of voluntary participation and informed consent. Prior to participating in the survey, the road users interviewed will be given sufficient information on the objective of the survey and the use of the data collected to decide whether they wish to participate in the survey. The informed consent statement will closely follow the guidelines provided by MCC.

### **9.2 APPROVAL FROM LOCAL AUTHORITIES**

For the collection of field data, the evaluation team will contact the necessary authorities early and work closely to ensure their timely cooperation. For data collection that requires traffic control or traffic diversion, the team will work with the MRTD and the local authorities including the police to acquire official approval and cooperation well in advance. For all collection of field data, the evaluation team will contact the necessary authorities early and work closely to ensure their timely cooperation. The team will work closely with other local authorities, such as the local transport centers, bus stations, police, and toll stations as needed for approval prior to starting data collection.

### **9.3 DATA PROTECTION, ACCESS, AND DOCUMENTATION**

The study will ensure that the confidentiality of information obtained from or about human participants is maintained. The evaluation team will ensure that the raw datasets are cleaned and de-identified closely following MCC's guidelines for public use of data. The obtained data will be stored in a secured server with limited access to key project personnel who signed the non-disclosure agreement.

The evaluation team will provide a clean, de-identified dataset to MCC for public and internal use. The public-use dataset will be free of personal or geographic identifiers that would permit identification of individual respondents. Any additional variables with risk of divulging identity of individual subjects will be removed. In order to facilitate access to and usability of data, all datasets delivered to MCC will be accompanied with completed documentation in the form of standardized metadata.

## 9.4 DISSEMINATION PLAN

A draft Evaluation Report will be submitted to MCC in February 2020. The evaluation team will also submit the final datasets (a raw dataset and a de-identified dataset) and the analysis files. Feedback from MCC and local stakeholders will be incorporated to produce the final reports in April 2020 with Public Statement(s) of Difference/Support. Upon review by the Evaluation Management Committee (EMC), the evaluation team will present the results of the evaluation in Mongolia and Washington DC. The evaluation team will deliver the entire contents of the project library in good order properly indexed and marked in both digital and paper copy to MCC.

## 9.5 EVALUATION TEAM ROLES AND RESPONSIBILITIES

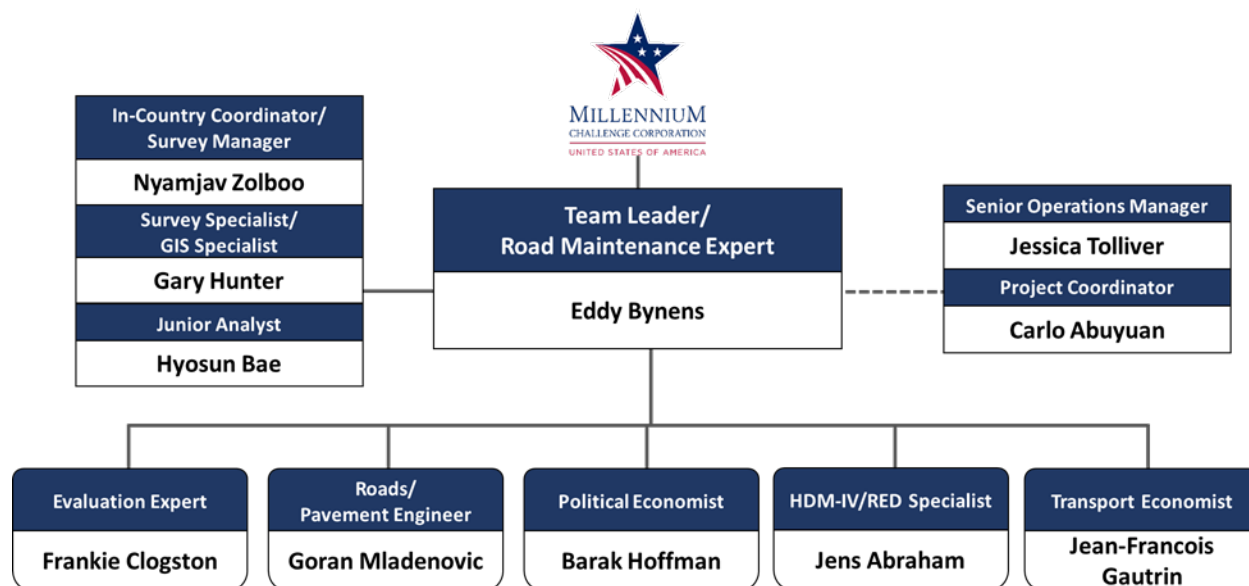
The evaluation team has seven key personnel that work closely together for evaluation. The table below presents each of the key personnel on the evaluation team and their responsibilities. The support team will provide technical and administrative capacity to carry out the project activities and achieve MCC's goal and objectives. The diagram (Figure 10) below shows the organogram of the complete evaluation team.

**Table 6: Evaluation Team and Responsibilities**

Name	Position	Responsibility
Eddy Bynens	Team Leader/Senior Analyst II, Road Maintenance Expert	<ul style="list-style-type: none"> <li>Evaluation Coordination and Quality Control</li> <li>Technical lead for the evaluation of Evaluation Area 2 on road maintenance</li> </ul>
Jens Abraham	Senior Analyst II, HDM-IV/RED Specialist	<ul style="list-style-type: none"> <li>Technical lead for Evaluation of Evaluation Area 1: Engineering Analysis and Economic Model</li> <li>Technical support for the evaluation of Evaluation Area 3: Road Usage Patterns</li> </ul>
Frankie Clogston	Senior Analyst II, Evaluation Expert	<ul style="list-style-type: none"> <li>Technical lead for the evaluation of Evaluation Area 3: Road Usage Patterns</li> <li>Technical support for Evaluation of Evaluation Area 4: Transportation Market Structure</li> </ul>
Goran Mladenovic	Senior Analyst II, Roads/Pavement Engineer	<ul style="list-style-type: none"> <li>Technical support for the evaluation of Evaluation Area 1: Engineering Analysis and Economic Model, especially for the roughness study</li> <li>Technical support for the evaluation of Evaluation Area 2: Maintenance, especially for assisting the analysis of road maintenance quality</li> </ul>
Barak Hoffman	Senior Analyst II, Political Economist	<ul style="list-style-type: none"> <li>Technical support for the valuation of Evaluation Area 2: Maintenance</li> </ul>
Jean-Francois Gautrin	Senior Analyst II, Transport Economist	<ul style="list-style-type: none"> <li>Technical lead for the evaluation of Evaluation Area 4: Transportation Market Structure</li> </ul>

Name	Position	Responsibility
		<ul style="list-style-type: none"> <li>Technical support for the evaluation of Evaluation Area 2: Maintenance</li> </ul>
Zolboo Nyamjav	In-Country Coordinator	<ul style="list-style-type: none"> <li>Assist the team to arrange meetings with different stakeholders and facilitate the data collection procedures</li> </ul>
Gary Hunter	Survey Specialist/GIS Specialist	<ul style="list-style-type: none"> <li>Responsible for development of itinerary diagrams</li> </ul>

**Figure 10: Evaluation Team Organogram**



## 9.6 EVALUATION TIMELINE & REPORTING SCHEDULE

The work plan for the evaluation is outlined in Annex II which accounts for each of the major deliverables along with the expected timeline of the evaluation. The detailed data collection work plan is outline in Annex III.

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(updated March 29, 2019)

\***Key Personnel** - TL: Team Leader/Road Maintenance Expert; EE: Evaluation Expert; HS: HDM-4/RED Specialist; RE: Road/Pavement Engineer; PE: Political Economist; TE: Transport Economist; IC: In-country Coordinator /  
**Non Key Personnel** - JA: Junior Analyst, SS: Survey Specialist  
 \*\* Weeks/quarters marked in blue indicate a team member traveling to Mongolia

[illegible]

## ANNEX III: DATA COLLECTION WORK PLAN

(updated March 29, 2019)

[illegible]

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

## ANNEX IV: ILLUSTRATIVE SURVEY INSTRUMENT FOR TRAFFIC COUNT

<b>Name of Enumerator:</b>		<b>Name of Road:</b>			
<b>Date (dd/mm/yy):</b>		<b>Count Location/ Station:</b>			
<b>Day of Week:</b>		<b>Weather (circle 1):</b>	Clear	Overcast	Rain
<b>Counting Period:</b>		<b>Direction of Travel:</b>			
<b>Start Time:</b>		<b>From:</b>			
<b>End Time:</b>		<b>To:</b>			

Time Period (15 mins)	Passenger Vehicles						Goods Vehicles				Tractor	Others (incl slow moving)
	Motor- cycles	Car (Small/ Medium)	Jeep/ 4WD	Bus			Truck					
				Micro	Medium	Heavy	Small	Medium	3-axle	4+ axle		
06h00-06h15												
Sub-total												
06h15-06h30												
Sub-total												
06h30-06h45												
Sub-total												
06h45-07h00												
Sub-total												
Hour Total												

Single tire on rear axle	Double tires on rear axle		
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## ANNEX V: RATIONALE FOR SELECTING THE TRAFFIC COUNT LOCATIONS

### MCC's comment:

- The traffic counts should serve two purposes: 1) to estimate the overall volume and composition of traffic; and 2) determine the rate of increase in traffic volumes since the original due-diligence studies. For the first purpose, locations unaffected by local traffic is preferred. But this will generate unreliable estimates of traffic growth. To adjust for this, conduct the OD survey where ADB conducted the traffic counts. Each OD survey interview starts with a screener question: Did you pass location X (the location of the out-of-town traffic counters) on this trip, or will you pass it on this trip? If no, record only the time and type of vehicle. If yes, conduct the full OD survey. The ratio of OD vehicles screened out to those fully surveyed provides a crude estimate of the local traffic to through traffic ratio. (Note that this can also be calculated with the ADB's raw OD survey data.) The unscreened OD survey respondents should be close to a representative sample of the traffic observed by the outside-of-town traffic counters.

### IDG's response:

#### ADB's 2003 traffic count/O-D locations and results

- ADB conducted traffic count and O-D at two locations in 2003 as part of their Feasibility Study for the entire length of the road from Choir to Zamyn Uud (Chinese border). The survey locations are 1) near the railway crossing in choir, and 2) 2 km from Sainshand. The traffic count and O-D survey conducted ADB are simple and not much information is provided in the report. The team was unable to obtain the raw O-D data files from ADB. Also, no other information is provided in the report on the details of these two locations. The first survey location (railway crossing in Choir) is estimated to be 6 km north of where MCC road section begins. The second survey location (2km from Sainshand) is estimated to be 37km south of where MCC road section ends. Therefore, both ADB survey locations fall outside the road section rehabilitated by MCC.
- ADB's 2003 traffic volume is presented below in the table.

Table SRV1.2-3: DAILY VARIATION OF TRAFFIC VOLUMES AT TRAFFIC SURVEY LOCATIONS

No	Road No.	Name of survey location	Direction of Road	Car Equivalent Units			Average for 3 Days	Coefficient for Earth Roads	Average Daily Traffic ADT	Minimum Daily Traffic	Maximum Daily Traffic	Traffic Variability Ratio
				August 04-05	August 05-06	August 06-07						
1	A0102	Near the railway crossing in Choir	Choir-Sainshand	97	53	26	59	1.32	77	26	97	3.73
2	A0102	2 km from Sainshand, near the railway crossing	Sainshand-Choir	52	56	47	52	1.32	68	47	56	1.19
3	A0103	Khanginuur pass	Sainshand-Zamiin Uud	52	47	41	47	1.32	61	41	52	1.27
4	A0103	5 km from Zamiin Uud	Zamiin Uud-Sainshand	42	39	31	37	1.32	49	31	42	1.35

Source: Traffic Survey data collected by TA Consultant.

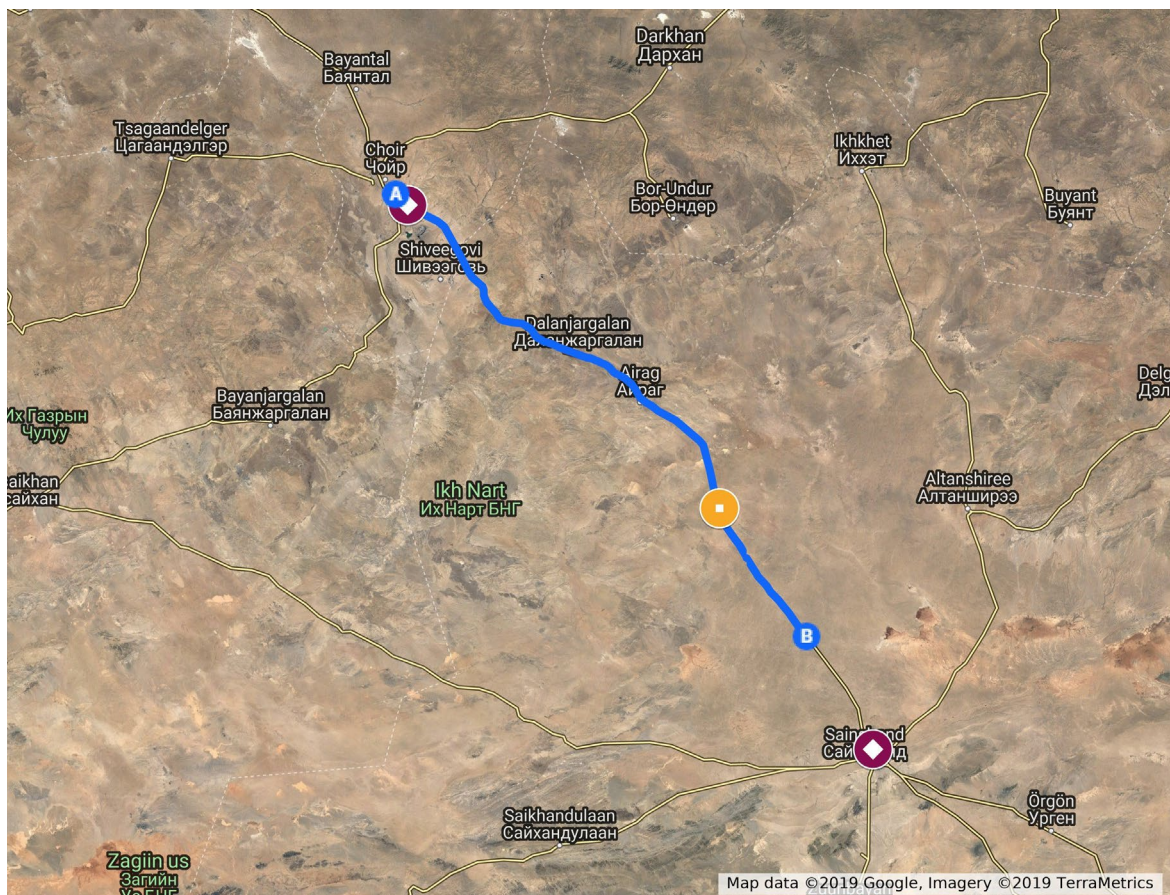
Proposed survey locations for IDG's evaluation




- **10km from Choir:** IDG proposes to keep its original location of 10km from Choir. While screener questions may help identify local traffic, the team is uncertain that the O-D survey can capture sufficient number of respondents travelling the Choir-Sainshand section. Given the local development in Choir that the team observed during the trip, conducting the survey at the railway crossing may result in interviewing more respondents, which may cause logistical difficulties and increase cost of data collection. In addition, the ADB Feasibility Study (TERA report Table 1.2-8) shows that no local traffic (Choir - Choir) was observed in 2003. Therefore, the team believes its critical to conduct the surveys well away of the local development. 10km from Choir is sufficiently further away from Choir to avoid local traffic but at the same time will allow a reasonable comparison with the ADB count conducted in 2003. This location will also allow the survey location to be within the MCC road section.
- **2km from Sainshand:** IDG will conduct the survey at the ADB location near Sainshand. IDG evaluation team assumes that the ADB survey was located near the entrance of Sainshand, where the road leading to Sainshand meets the N-S road. Therefore, we believe that this location is sufficiently far away from the local development and will allow to compare the results with the ADB results from 2003. It should be noted that this falls OUTSIDE of MCC's improved road section and that the evaluation team does not expect much difference in the traffic pattern from this location to the original position proposed, which is mid-way of Lot 2 (20km south of Airag).
- **Rationale for choosing two stations:** While the average traffic volumes for ADB stations 1 and 2 were similar in 2003, the traffic variability ratio was highest at Choir (3.73) and lowest at Sainshand (1.19). The ADB report suggests that “the wide difference in ADT variability could be due to a number of reasons, which cannot be surmised from the limited number of days used in traffic counts.”<sup>86</sup> Based on the visit to the N-S road in 2018, the team also expects the traffic pattern between to the two stations to be different. For instance, the team observed no truck trailer units near Choir whereas a significant number were observed at Sainshand. The evaluation team also expects the traffic pattern to have changed for both Choir and Sainshand since the ADB traffic count/O-D. Therefore, the team believes that there may be variations in traffic and transport patterns between the two locations. By conducting the traffic count and O-D at two stations, the evaluation team will be able to understand any differential traffic patterns between the two locations and accurately answer Evaluation Question 3A (who is travelling, why, and what are they transporting).

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<sup>86</sup> ADB, TERA Supplementary Report Volume 1: Page 27.

## ANNEX VI: MAP OF TRAFFIC COUNT LOCATIONS



Legend	
	Starting and ending point of the MCC-funded road section
	Manual Traffic Counts (MTC) and Origin Destination (O-D) Survey
	Axle Load Survey

## **ANNEX VII: SPECIFICATIONS FOR VIDEO RECORDING OF ROAD CONDITION**

### **Google Street View Policy**

Google allows the public to contribute content to Google Maps, including the street view. According to Google's Maps User Contributed Content Policy ([Google's Maps User Contributed Content Policy](#)), if the content is accepted for external publication, it will be publicly visible to anyone who accesses any of the Google products and services. For privacy, it is advisable to blur identifiable images (license plate, pedestrians etc.).

According to the Google Maps ([Google Maps Help](#)), only Street View trusted photographers can upload videos which can be converted into Street View or connect multiple 360 photos. It requires the publisher to have uploaded a certain number (50) of 360 photos that are approved by Google prior to allowing the publisher to use these functions.

### **Format Specific Criteria for Street View Content**

1. 360 photos must wrap 360° without any gaps in the horizon imagery. These images do not have to extend to the zenith and nadir (top to bottom), but between the top and bottom edges of your 360 photo only minor gaps/holes are acceptable.
2. Minor stitching errors are acceptable but those with significant stitching artifacts may be rejected.
3. 360 photos must be at least 4K (3,840 pixel by 2,160 pixel resolution or greater).
4. When multiple 360 photos are published to one area, connections between them may be automatically generated. Whether your connections were created manually or automatically, we may adjust, remove, or create new connections — and adjust the position and orientation of your 360 photos — to ensure a realistic, connected viewing experience.
5. When connecting 360 photos, ensure that any links you create are between nearby vantage points. Do not attempt to create connections that will disorient those exploring your connected 360 photos for the first time.
6. When publishing multiple 360 photos in an area, never use their close pin/dot proximity or the resulting blue line map visualization to write messages, draw symbols, pictures, or otherwise deface the map.
7. If you're appending any form of attribution (watermark, authorship information, etc.) to the zenith or nadir of your 360 photo, please note the relevant requirements under the Superimposed text or graphics section above (For 360 photos, superimposed content must be limited to either the zenith or nadir (top or bottom 25% of the equirectangular image) but cannot be present in both).

### **Guidance on Capturing 360 Videos for Street View**

#### Setting up Camera

1. Remember to disable any gyroscopic stabilization.
2. Keep your camera upright and as high above your camera support system as possible.
3. Try to position your camera support system so that it takes up less than 25% of the bottom of the resulting 360 image. You can check this if your camera supports a real-time preview.



4. Consider the lighting of your environment (e.g. avoid sunrise/sunset, adjust exposure for bright conditions). If your camera supports a real-time preview, you can use signs and storefronts to verify proper exposure.
5. Consider using available tools from the manufacturer, like a mobile app, to control the camera.

#### Additional tips

1. If supported by your camera, consider setting the frame rate to 5 frames per second at driving or biking speeds and 1 frame per second for walking speeds.
2. To ensure that GPS data is properly collected, start and stop your collection path in areas with open sky (e.g. avoid trees, buildings, etc.)
3. To help us automatically position 360 images in relation to one another, when capturing imagery, try to overlap with some areas you already captured in the collection. This include turns (e.g. a city block) in your collection path.
4. Try to limit your speed to:
5. Under 5 mph or 8 kmh when capturing at 1 fps
6. Under 30 mph or 45 kmh when capturing at 5fps
7. Under 45 mph or 70 kmh when capturing at 7fps
8. Try to record your 360 videos for at least 2 minutes but for no longer than 60 minutes at a time (unless otherwise advised by the camera manufacturer).

#### **Equipment for Street View**

##### Minimum Video Criteria for Street View (Street Ready)

1.  $\geq 4K$  at  $\geq 5FPS$
2.  $360^\circ$  horizontal FOV
3.  $\geq 120^\circ$ , contiguous vertical FOV
4. On-device stitching
5. Google will review image and geometry quality

##### Price of Street Ready Cameras

1. Lower price camera option 1: Ricoh Theta VS (\$429)
  - [Example of video on road](#) (change resolution setting to 4K)
  - 4K at 30 FPS
  - Compact but may not be suitable for mounting on vehicle
  - Recording time: 80 minutes
  - Storage: 19 GB
2. Lower price camera option 2: 360 FLY 4K (\$500)
  - [Example of video on road](#) (change resolution setting to 4K)
  - 4K at 30 FPS
  - Shockproof, waterproof
  - Recording time: 90 minutes
  - Storage: 64 GB
3. Higher price camera: INSTA360 Pro (\$3,548)
  - [Example of video on road](#) (change resolution setting to 8K)
  - 8K at 5 FPS

- Recording time: 75 minutes
- Storage: SD card

## **Methodology for the Evaluation**

### Data Collection

Use one of the above Street Ready cameras to capture 360 Street View photos of the MCC-funded road section between Choir and Sainshand. The camera will be mounted on top of the vehicle with protective gear. The video may be recorded in sections due to battery life or storage issue. The image quality will be 4K at 5 FPS at the minimum. The video will be recorded one direction. Considering the local condition (weather, traffic), the team will conduct a test-drive to ensure that the basic functions are working accordingly (battery, speed, data management etc.)

### Video Display for the Evaluation

GPS coordinates will be overlaid on the video and the audio will be removed.

### Video Display for Public Release

To ensure privacy, personally identifiable information will be protected by blurring people's faces and license plate numbers, if published online.

## **Remaining Issues**

1. Capturing a Street View compatible video does not necessarily indicate the video will be published online. Currently, uploading video as Street View photos are only available to Google approved users. Other programs such as Mapillary (<https://www.mapillary.com/>) can be considered for public sharing to photos.
2. Google Street View currently displays the Choir-Sainshand road section photographed in April 2015. When addition Street Views are published where some already exists, Google automatically determines the default collection for a street based on quality, resolution, and recency. Therefore, the 360 photos published by the team may not be the default image on Google Street View. They may be accessible with a link by clicking the Time Machine feature on Google Maps.
3. Uploading of photos and videos is currently managed through an app on a phone or a tablet and uploading of videos is only available on an Android device.



## **ANNEX VIII: EVALUATION QUESTION I CHANGES IN DATA COLLECTION**

The initial data collection for Evaluation Area 1 included conducting 1) a road condition study, 2) a deflection study, and 3) a geotechnical study. As discussed further under Section 3.2.1, the evaluation team removed the following primary data collection to use secondary data or limited data collection. Below presents the initial data collection methodology considered for the evaluation for each data collection effort.

### **Road Condition Study**

**Description of Methodology:** A road condition study in accordance with the Distress Identification Manual for the Long-Term Pavement Performance (LTPP, Fourth Revised Edition) (June 2003) will be conducted on the Project road to examine pavement distress on MCC-funded road section. The purpose of visual road condition survey is to measure, and record defects shown by each of the road elements in a standard and objective manner by walking over the selected inspection length. The distresses to be recorded will include:

- **Cracking:** fatigue, block, edge, longitudinal, reflection (at joints), and transverse
- **Patching and Potholes:** patch deterioration, potholes
- **Surface Deformation:** rutting, shoving
- **Surface Defects:** bleeding, polished aggregate, raveling
- **Miscellaneous Distresses:** lane-to-shoulder, water bleeding, pumping

The evaluation team will closely follow the Appendix A of the LTPP Manual which provides a detailed guidance as to how the data collection should be carried out. The data obtained from the study will be used in the HDM-4 calibration.

During the site visit, the evaluation team noticed transverse cracks at a regular interval of between 6m to 10m along the MCC-funded road section. Transverse cracking refers to cracks that are perpendicular to the pavement's centerline.<sup>87</sup> According to the Director of the Dornogobi maintenance company, who also worked on the MCC road project as one of the Highway Engineers and Mr. Ravjir Baljir of RCSC LCC, who in 2010 was the Vice Director in the Project Implementation Unit of MCA-M, the transverse cracks were observed in the stabilized base layer even before the laying of the asphalt concrete on top. In the course of discussion with stakeholders, the evaluation team was also informed that these transverse cracks do also occur in unbound base layers. The stakeholders noted that this is due to the peculiar climatic condition in Mongolia where the temperature varies to the extreme daily and seasonally. The Ulaanbaatar Road and Transport Center engineers noted that the use of geotextiles on top of the base course prevented cracks from propagating through the asphalt layer to the top of the pavement on some roads in Ulaanbaatar.

There are a number of probable causes of these cracks on the surface. There is literature on types of distress, symptoms, and probable cause.<sup>88</sup> One of the possible cause is cracks in pavement layer

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<sup>87</sup> Pavement Interactive, Pavement Distress, <http://www.pavementinteractive.org/general-guidance/pavement-distress/>, accessed: June 6, 2018.

<sup>88</sup> Asphalt Institute, Pavement Distress Summary, <http://www.asphaltinstitute.org/engineering/maintenance-and-rehabilitation/pavement-distress-summary/>, accessed: June 6, 2018;

underneath, mostly due to low temperature thermal cracking. These are called “bottom-up cracks”, which refer to cracks propagating from the bottom of the pavement to the top.<sup>89</sup> Another potential cause of the transverse cracks is due to shrinkage of the asphalt concrete layer from Mongolia’s cold winter climate. According to the materials report of Lot 1 (2014), the contractor used bitumen with 90/130 penetration grade bitumen (page 39, paragraph 6.1.1).<sup>90</sup> This is the hardest penetration grade bitumen used for roads (other grades are 40/50, 60/70, 80/100), which may lead to cracking in low winter temperatures.

In order to verify the cause of distress for the MCC-road, and the mostly commonly observed transverse cracks specifically, the team will use various sources as illustrated in the table below:

**Table 7: Detailed Methodology for Determining the Cause of Transverse Cracks**

Potential cause of distress	Methodology for confirming the cause
Cracking of bound and unbound base layers	Coring of Asphalt Concrete and CTB layer at transverse cracks to determine the direction and depth of cracks
	Consulting a cement stabilization expert on to determine the cause of cracking of the CTB layer <sup>91</sup>
	Review of MRTD’s research on surface base layer types best fit for Mongolia <sup>92</sup>
	Review of existing data on Mongolia’s use of CTB and cracking <sup>93</sup>
	Interview of engineers with experience of using CTB in Mongolia (including the Ulaanbaatar Road and Transport Development Center)
	Literature review on the cause of transverse cracks
Shrinkage of asphalt concrete due to low temperature	Coring of Asphalt Concrete and CTB layer at transverse cracks to determine the direction and depth of cracks
	Detailed review of the material testing reports from MCC contractors <sup>94</sup>

Gregory E. Halsted, P.E., Portland Cement Association, Minimizing Reflective Cracking in Cement-Stabilized Pavement Bases, 2010.;

Willway, T, L Baldachin, S Reeves, M McHale and M Nunn. ‘The effects of climate change on highway pavements and how to minimise them: Technical Report’. TRL Published Project Report, PPR 184, Crowthorne, England, 2008.;

Kachroo P N, N G R Raju and L Gambo. ‘Freeze-thaw effects on roadways: approach to pavement design with special reference to roads in Mongolia’;

Otto F, P Liu, Z Zhang, D Wang and M. Oeser. ‘Influence of temperature on the cracking behaviour of asphalt base courses with structural weaknesses’. International Journal of Transportation Sciences and Technology. 2018.

<sup>89</sup> Asphalt Institute, Pavement Distress Summary, <http://www.asphaltinstitute.org/engineering/maintenance-and-rehabilitation/pavement-distress-summary/>, accessed: June 6, 2018.

<sup>90</sup> Ministry of Roads, Transportation Construction, and Urban Development, Halla Engineering and Construction Corporation, Material Report, 2014.

<sup>91</sup> While a cement content may be helpful to a certain extent, precision of the test is not fully determined (refer to ASTM D806-11). Therefore, IDG will determine whether additional tests on cement content of the CTB layer is necessary upon consulting a cement stabilization expert.

<sup>92</sup> During the trip to Mongolia, MRTD mentioned that they were in the process of conducting a research with a private firm to test different base types to determine surface base layer best fit for Mongolia. While this project is still ongoing, and the team is uncertain about the timeline of the research project, the team will obtain this information as soon as available to cross-reference with the findings from the evaluation.

<sup>93</sup> During the trip to Mongolia, the Team Leader was notified that a PhD student in Mongolia is conducting a research on the use of CTB in Mongolia and its relationship to cracking. IDG will be in contact with the researcher to obtain more information about the research conducted.

<sup>94</sup> The team located four files on material testing of Lot 1 (3 files) and Lot 2 (1 file) from the boxes of documents identified during the visit to Mongolia in June 2018. As they are more than 200 pages each, it will take some time for the team to thoroughly review the documents.

	Review of MRTD's research on surface base layer types best fit for Mongolia
	Review of existing data on the effect of Mongolia's extreme climate on road condition
	Review of asphalt concrete used in Mongolia or in other similar climate zones
	Literature review on the cause of transverse cracks

**Instrument/Equipment:** The list of equipment for the road condition study will follow the example found in Appendix A of the Distress Identification Manual. The road condition study will be a visual inspection. The surveyors will record the surface distresses. any major maintenance performed, and potential cause of deterioration on a hand-held devise or an A4 or letter size sheet of paper.

**Rounds and Timing:** The road condition study will be carried out in June 2019, prior to the geotechnical study.

**Sample/Data Collection Location:** Project level evaluation is conducted on foot to map the type and extend of the distress in detail and the condition statistics summarized over the length of the project road. Inspection length is the portion of the road which is physically inspected. The evaluation team has set the inspection lengths of five percent sampling per 1 km.<sup>95</sup> Therefore, 50 meters per each kilometer of the project road (KM 0 – 176.4) will be physically inspected. The inspection length will begin 500 meters after the start of the road section.

**Staffing:** The evaluation team intends to subcontract the road condition data collection and the team sizes will be determined by the successful bidder based on a competitive procurement process. Usually three people will be involved in data collection, one technician, one assistant, and a driver.

**Safety Procedures:** Personnel conducting the survey will wear safety caps and high-visibility safety vests and the assistant will act as a flagman to control the traffic. Adequate signs will be placed in the test area as the test progresses. The vehicle used by the staff will follow the investigators to provide some protection from the traffic on the lane in which the test is being conducted.

**Data Quality:** The survey will be conducted strictly as per the procedures laid out in the Distress Identification Manual and will be under the supervision of the Road/Pavement Engineer to ensure that high quality is maintained.

**Data Processing/Analysis:** Data collection will follow the guidelines in Appendix A of the manual. When LTPP classifications are not compatible with HDM-4 input requirements, the team will use the information gathered to derive HDM-4 inputs as needed. The results of the analyzed data will be used in the calibration of the HDM-4 model by comparing the model predictions of pavement deterioration at this point in time and modifying the model parameters as needed. The Roads/Pavement Engineer will determine the cause(s) of any pavement distress. The road segment will then be sub-sectioned into homogeneous sections which will also be illustrated in graphical format. The road distresses observed will be presented with LTPP distress identification with colors to indicate the severity.

### **Deflection Study**

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<sup>95</sup> Road Assessment and Maintenance Management System (RAMM) Road Condition Rating & Roughness Manual, July 1997.

**Description of Methodology:** Pavement surface deflection measurements are main means of evaluating the integrity of a pavement structure. Deflection measurements can be used to determine the thickness of overlay required to increase the life of the road or can be used in back-calculation methods to determine the pavement layer stiffnesses and the subgrade modulus. Deflection measurements are affected by a number of factors including the temperature of the asphalt and the moisture condition of the subgrade. Measurements will be made at temperatures as close as possible to a reference temperature, and all readings will be corrected to the reference temperature. Tests are also conducted when the subgrade is unfrozen, and the pavement is at its weakest condition. Therefore, the deflection study will be conducted in the spring. The evaluation team will use collect deflection data to obtain the modulus of pavement layer and subgrade and determine the remaining structural life of the N-S road. As noted in Annex J, deflection will be measured on the outer wheel path according to the ASTM standard (D 4695).

**Instrument/Equipment:** There are broadly three methods for deflection measurements, and hence equipment for deflection measurement:

- **Static deflections:** equipment measures deflection in response to static load (e.g. Benkelman Beam (BB))
- **Steady state deflections:** equipment measures dynamic deflection in response to oscillating load (e.g. Dynaflect, Road Rater)
- **Impact load deflections:** equipment delivers a transient impulse load to the pavement (e.g. Falling Weight Deflectometer (FWD))

The BB apparatus is a convenient, cost effective, and accurate device used for measuring deflection of flexible pavements. This equipment, unlike the others, is available in Mongolia and the locals are familiar with its use. Therefore, the evaluation team proposes to use the BB for the deflection study.

**Round and Timing:** While deflection as an input for HDM-4 can be adjusted based on its data collection timing, deflection tests are normally conducted when the pavement is in its weakest condition, which would be the spring for Mongolia.<sup>96</sup> Following this general guideline, deflection measurements will be taken in the March - May of 2019, after the thawing of snow, when the pavement is in its weakest state and deflections are at their highest values.

**Sample/Data Collection Location:** ASTM (D 4695) recommends that for Network Level Testing, tests are performed at 100m - 500m intervals, for General Project Level Testing, the intervals are 50m – 200m, and for Detailed Project Level Testing, test are performed at 10m to 100m intervals. Annex J states that deflection be performed at 1-kilometer increments. The general project-level testing is the most appropriate for the evaluation and the suggested interval is between 50 and 200 m. The evaluation team will conduct deflection tests at 500-meter intervals in the outer wheel paths of the MCC-funded N-S road section (KM 0-176.4) in both directions of traffic to be cost-effective and consider increasing the interval where the IRI is high.

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<sup>96</sup> When deflection tests are conducted outside this ideal period, corrections are applied to account for the difference in temperature and moisture level. For example, in India, deflection tests are done all year round, but the asphalt temperature and moisture content of the subgrade are recorded, and pavement rebound deflection is corrected to standard temperature and moisture content. In New Zealand, tests are not permitted outside the temperature range of 5 degrees Celsius.

**Staffing:** The evaluation team intends to subcontract the work to a private company with expertise in this type of road condition study. A data collection team usually consists of at least four people: the flagman to control traffic, the driver of the vehicle, a technician, and an assistant.

**Safety Procedures:** Traffic will have to be diverted from the section of the lane where the test is being conducted by the use of traffic control devices. These will include the installation of warning signs prior to the start of the survey. These warnings will need to be moved as the survey progresses. Traffic cones shall be used by channelizing traffic away from locations where testing is taking place. The volume of traffic on the Project road is not heavy, therefore traffic cones and the flagman will be able to control the traffic. The local traffic police could be brought in to ensure appropriate measures are taken to protect the team while conducting the test.

**Data Quality:** To ensure a high-quality data collection, it is essential that the instrument is properly calibrated and regularly checked and that proper testing procedures are followed. The Road/Pavement Engineer will oversee the deflection testing. The evaluation team will also compare the deflection results with the Dynamic Cone Penetrometer (DCP) testing results to identify any discrepancy in data, if present.

**Data Processing/Analysis:** Deflection measurements will be plotted for the entire road (deflection on y-axis and kilometer on x-axis). From this graphical presentation, homogeneous sections will then be obtained. From the layer thicknesses and deflection data, the Structural Number (SN) can be calculated.

For determining the remaining structural life of the road investment, the empirical based procedure includes methods developed by Transport and Road Research Laboratory<sup>97</sup> and the India Road Congress<sup>98</sup>. The TRRL provides graphs for relation between structural deflection and life for different pavement types. The IRC method presents a graph where for each characteristic deflection of the pavement, and the future traffic, the overlay thickness can be estimated. The mechanistic procedure is based on the analysis of the stress and strain in the existing pavement. The mechanistic approach is based on sound analyses of stresses and strength of material used. In the AASHTO method<sup>99</sup>, the input required includes the subgrade modulus, the structural number for the various layers and the layer thicknesses.

### **Geotechnical Study**

**Description of Methodology:** Ground Penetrating Radar (GPR) is a non-destructive device which can be used for pavement evaluation to provide information on changes in pavement construction, layer thicknesses and defects/features in the pavement. Annex J (Data Collection Quality Protocols) of the terms of reference requires that Ground Penetrating Radar with GPS capability to be used for a thorough verification of the thickness of the built road vis-à-vis the design. Inquiries made by the evaluation team during their first mission to Mongolia indicate that the GPR machine is not available in the country. Importing the equipment into the country is deemed to be expensive and therefore not cost-effective.

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<sup>97</sup> Kennedy, C. K. and Lister, N. W. Prediction of pavement performance and the design of overlays. TRRL Laboratory Report 833. Crowthorne, 1978.

<sup>98</sup> India Road Congress. Guidelines for strengthening of flexible road pavements using Benkelman beam deflection techniques, IRC:81-1997. New Delhi, 1997.

<sup>99</sup> Molenaar, A. A. A. Structural evaluation and strengthening of flexible pavements using deflection measurements and visual condition survey. Lecture Note Part V1. Structural Design of Pavements. 2009.



During the second trip to Mongolia (June 2018), the Team Leader located a number of document which includes the as-built drawing of Lot 2 (provided by Jiangxi Water and Hydropower Construction), which confirms the pavement structure of 50mm of asphalt concrete, 200mm of cement treated base, and 200mm of granular sub-base. The team was not able to locate the as-built drawing for Lot 1.

Based on this document, the evaluation team, therefore intends to core the bound layers (asphalt concrete 50mm and CTB 200mm). A Dynamic Cone Penetrometer (DCP) will be used for the unbound layers in the core holes. The sample from the cores and the DCP will be used to identify pavement layer boundaries, record layer thicknesses, and calculate the California Bearing Ratio (CBR) values of the layers. All tests will follow ASTM standards as applicable. Soil samples will also be collected from an earth track where they can be located to test gradation, Atterberg's limits required for "without project" road definition.

Upon completing the tests, the road will be preserved to its original condition by backfilling of core holes after the operation.

**Instrument/Equipment:** The evaluation team will use a core drill for the bound layers and a DCP for the unbound layers. Measuring tapes will be used to record the layer thicknesses from the cores.

**Round and Timing:** The geotechnical study will take place in September 2019, after the deflection and the road condition survey to ensure that the DCP tests or the coring do not affect the other test results.

**Sample/Data Collection Location:** The team will sample a total of 28 cores, 14 cores per lot. DCP will be conducted at the same locations after the top two layers are cored. Six cores will be excavated at staggered locations, each 15 km apart, within Lot 1 (KM 0-90). Additional eight cores will be excavated where major distresses are observed, based on the Road Condition study, including the transverse and centerline cracks. Following the same procedure within Lot 2 (KM 90 – 176.4), six cores will be excavated at staggered locations, each at least 10 km apart and eight cores at major distress locations. Depending upon the test results from the deflection and the road condition survey, some locations may be changed to capture locations where the pavement shows significant structural problem.

**Staffing:** The work will be undertaken by a private company.

**Safety Procedures:** Traffic will have to be diverted from the section of the lane where the test is being conducted by the use of traffic control devices. These will include the installation of warning signs prior to the start of the survey. These warning will need to be moved as the survey progresses. Traffic cones shall be used by channeling traffic away from locations where testing is taking place. The volume of traffic on the Project road is not heavy, therefore traffic cones and the flagman will be able to control the traffic.

**Data Quality:** To ensure a high-quality data collection, it is essential that the instrument is properly calibrated and regularly checked and that proper testing procedures are followed. The Road/Pavement Engineer will oversee the DCP testing and the core excavations. The evaluation team will also compare the results with deflection testing results to identify any discrepancy in data, if present.

**Data Processing/Analysis:** For the estimation of the CBR value and the layer thickness of the unbound layers, the penetration per blow will be plotted against the depth of penetration. A well-



defined change of slope on the graph of blows against penetration will indicate a change of layer. The layer thickness will be calculated and the penetration rate for that layer will be converted to nominal CBR value by using the appropriate DCP-CBR relationship. The modulus of each layer will then be calculated from the CBR values. The thicknesses of pavement layers will be graphically presented (kilometers on x-axis, thickness on y-axis). Based on the DCP results, the road segment will then be sub-sectioned into homogeneous sections which will also be illustrated in graphical format.

## ANNEX IX: EVALUATION QUESTION 2C AND CHANGES TO THE SOW

### Evaluation Question 2C

The initial scope of work from MCC include an additional question, Evaluation Question 2C. Evaluation Question 2C was later removed from the evaluation based on discussions with MCC.

Evaluation Question 2C was as follows:

**2C) What political, and economic incentives are shaping road maintenance decisions in the country? And what other key factors are influencing actual maintenance practices? [Supplemental]**

The objective of Evaluation Question 2C was to conduct a political economy analysis to examine the effect of the road maintenance activities under the Roads Project. The analysis was intended to improve MCCs assumption on post-Compact maintenance and project-life assumptions about its infrastructure investments.

Political economy analysis, in part, seeks to identify the key stakeholders around issues, determine their power and incentives, and comprehend the formal rules and informal norms that determine decision making processes. Evaluation Question 2C would allow the team to assess relative power among stakeholders in road maintenance, and link decisions in this area to variation in the interests and influence of sector stakeholders.

### Evaluation Approach

The evaluation design developed by IDG for Evaluation Question 2C can be summarized below:

Key Outcome	Data Source (Data Type)	Annex J Require ment	Methodology*
Road maintenance sector key actors and relationship defined	KIIs with maintenance stakeholders (Primary Source Qualitative)	No requireme nt specified	KIIs will be conducted with the road maintenance stakeholders to conduct a political economy analysis of Mongolia's road maintenance sector. The team will conduct semi-structured interviews to obtain qualitative information on Mongolia's maintenance practices. The KIIs will be used to obtain information on the formal and informal road maintenance system, and identify economic, political and social factors influencing the government capacity. The team will use KIIs and other relevant documents relevant for Evaluation Questions 2A and 2B to identify opportunities and constraints to improving the road maintenance practices in Mongolia.
Road maintenance sector implementation capacity assessment			
Constraints/opportunities of reform identified for the road maintenance sector			

**Description of Methodology:** Building on the secondary document review conducted to answer Evaluation Question 2A and 2B, the evaluation team will conduct KIIs to identify political and economic incentives shaping road maintenance decisions in Mongolia. Interviews will aim to examine the extent to which actual processes for road maintenance diverged from the formal ones outlined in Mongolia's laws and regulations.

**Timeframe of Exposure:** MCC's N-S Road Project did not attempt to directly influence the political economy of Mongolia's road maintenance sector other than the TA Activity which is discussed in further detail under Evaluation Question 2B. Numerous factors can influence the

political economy of road maintenance such as government and parliament priorities, the structure of government agencies involved in road construction and maintenance, private sector influence and interests, proximity of elections, and broader economic conditions. Therefore, the most relevant timeframe for data collection would be concurrent with gathering information need to answer questions 2A and 2B, and track how political economy factors influenced road maintenance trends since the completion of the Mongolia Compact in 2013.

**Sample:** Key stakeholders we will interview include relevant officials from the MTRD (e.g., Policy and Planning Department, Road Policy Implementation and Coordination Department, Road Transport Policy Implementation and Coordination Department, Road and Transport Inspection and Registration Division, National Road Transport Service Center, and the RTD Center); maintenance firms (SOE and private), and donors active in the road sector (e.g., ADB, World Bank).

**Instrument/Equipment:** The team will conduct semi-structured interviews with a fairly open framework which allow for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data are collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries questions to obtain more specific information to fully understand the political and economic incentives influencing Mongolia's actual maintenance practices.

**Rounds and Timing:** The KIIs will be conducted in October – November of 2019 to obtain the latest information available on Mongolia's road maintenance sector before the analysis period (Option Period II). The data collection will coincide with those of 2A and 2B to maximize the information gathered during interviews.

**Staffing:** The KIIs will be conducted by the evaluation team and no additional staffing is anticipated for this evaluation area. The Team Leader/Road Maintenance Expert and the Political Economist will lead the data collection procedure to conduct KIIs with key stakeholders in Mongolia, supported by the In-Country Coordinator.

**Data Quality/Processing/Analysis:** The team will follow the same procedure described under Section 5.3.2 to ensure high quality data collection, processing, and analysis. For the analysis, the team will mainly employ the USAID Applied Political Economy Analysis Field Guide for the analysis.<sup>100</sup> This occurs through three levels:

- 1. Defining the Sector:** This requires identifying key actors in a sector and the nature of the relationship between them. Above, we identified our preliminary lists of key actors in road maintenance in Mongolia. This list will likely evolve and become more specific as we conduct the interviews.
- 2. Assessing Sectoral Implementation Capacity:** This level of analysis examines how economic, political, and/or and social factors influence the capacity of government officials to implement policies. It focuses on issues such as budgetary allocations, staff levels and salaries, as well as accountability of government officials.

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<sup>100</sup> USAID's Applied Political Economy Analysis Field Guide provides a clear framework of problem-driven political economy analysis. For an example please see: USAID. 2016. *USAID Applied Political Economy Analysis (PEA) Field Guide*. Washington, DC: USAID

**3. Identify Constraints and Opportunities for Reform:** After understanding the sector and assessing policy implementation capacity, the analysis determines constraints and opportunities for reform. It seeks to answer questions such as: Who would block reforms and why? Is it possible to build a coalition for reform among concerned stakeholders? Are capacity constraints in some government agencies due to lack of funds or rather, government disinterest in the sector? Are there areas in need of support that the government and other cooperating partners have ignored?

### **Challenges**

**Limitations of Interpretation of the Results:** Particularly for the political economy analysis, understanding an issue does not imply that MCC (or any other external partner) can influence it. For example, if tolerance for corruption at high levels of government is part of a country's elite settlement or social polarization has deep historical roots, it will likely prove challenging for external development partners to fully ameliorate these problems. A political economy analysis cannot necessarily provide solutions to weaknesses in governance or resolve political/social tensions in a country.

While political economy analysis can provide insight into decision making processes around key issues in a country, it cannot promise a single, objective account of all problems. In many cases, especially in countries that have deep political or social cleavages, there may not be a single, objective truth to uncover. Rather, there may be multiple versions of the truth by various stakeholders. Political economy analysis can document these competing claims but may not be able to adjudicate them. Even when it can do the latter, that does not mean it is possible to change perceptions among parties to a conflict.

**Risks to the Study Design:** A major risk to the PEA is gathering accurate information from KIIs that we cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to us. To minimize against these risks, we will interview all relevant institutional stakeholders for road maintenance in order to validate the information from multiple perspectives.

## **ANNEX X: STAKEHOLDER COMMENTS AND EVALUATOR RESPONSES**

\*Comments from stakeholders and evaluator's responses were removed from the report for the external version.

## **ANNEX XI: EVALUATION BUDGET**

\* The evaluation budget is removed from the report for the external version.