EVALUATION DESIGN REPORT | OCTOBER 2019

MCC - El Salvador I Connectivity Project and the El Salvador II Logistical Infrastructure Project

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Executive Summary

CH2M HILL Inc., now Jacobs Engineering Group Inc. (Jacobs),0F1 was procured by MCC to undertake an independent evaluation for transportation and border infrastructure improvements delivered as part of two compacts in El Salvador. CH2M HILL is supported in this evaluation by Social Impact and Transport Research Laboratory.

This Evaluation Design Report (EDR) describes the independent evaluation to be undertaken on behalf of MCC by the Evaluation Team. This EDR includes:

- A brief overview of the El Salvador compacts and their transportation and border crossing infrastructure activities
- A brief review of the relevant literature
- An overview of the evaluation design and individual research areas (RAs) and research questions (RQs)
- The methodologies that will be used to respond to each RQ
- The proposed primary and secondary data collection activities to gather evidence to support the evaluation
- The proposed analysis and presentation of final evaluation results
- The evaluation timeline for reporting and proposed headings for the two final evaluation reports.

El Salvador Compacts Overview

The two compacts are referred to as the first and second El Salvador Compacts (El Salvador Compact [ESI] and El Salvador Investment Compact [ESII], respectively). Table ES-1 provides the timelines for both compacts.

Table ES-1. El Salvador Compacts' Timeline

Compact	Start Date	End Date
ESI	Signed: November 29, 2006 Entry into force: September 20, 2007	Closed September 20, 2012
ESII	Signed: September 30, 2014 Entry into force: September 9, 2015	Expected to end September 9, 2020

Source: MCC

El Salvador Compact (2007 to 2012)

ESI was signed in 2006, enacted in 2007, and then closed in 2012. The compact is legally limited to 5 years from entry into force. Projects within the compact focused on delivering infrastructure development to the poorest communities in the Northern Zone of El Salvador. The ESI comprised the following three complimentary projects:

1) Productive Development Project
2) Human Development Project
3) Connectivity Project

[1] Since the award of this contract, CH2M HILL, Inc. was acquired by Jacobs Engineering Group Inc.

The total value of the ESI compact across all three was set at United States Dollar (USD) 460.9 million. The proposed Connectivity Project consisted of a substantial upgrade of the Northern Transnational Highway (NTH) and the Network of Connecting Roads (NCR). The total cost of both activities was initially estimated at USD 233.56 million. However, cost overruns during construction increased the total expenditure on the NTH to USD 270 million, almost twice the original budget, leading to cancellation of the NCR improvements on the ground of affordability.

El Salvador Investment Compact (2015 to 2020)

The second compact ESII was entered into force in September 2015. ESII comprises the following three separate projects:

1) Human Capital Project
2) Investment Climate Project
3) Logistical Infrastructure Project (LIP)

The LIP covers activities to improve transportation connectivity in the coastal region, close to the main international airport (El Salvador International Airport – "SAL"). This activity is called the Coastal Highway Expansion Activity. The LIP also includes the Border Crossing Infrastructure Activity at El Amatillo. El Amatillo is the main border crossing between El Salvador and Honduras.

The Investment Climate Project is composed of two activities:

1) The Regulatory Improvement Activity
2) The Partnership Development Activity

In a change to the original scope of work, the Anguiatú border crossing with Guatemala has been added to the independent evaluation. The Anguiatú border crossing forms part of the Partnership Development Activity within the Investment Climate Project. The two border crossing projects together (El Amatillo and Anguiatú) form the Trade Facilitation Investments.

ESII activities are currently being implemented and are expected to end in September 2020 when the compact closes. The ET understands that the border crossing activity at El Amatillo is currently running behind schedule and will be completed after the compact is expected to close in September 2020. Depending on the length of the delay, there may need to be amendments to the timeline set out in this EDR.

Evaluation Design and Research Questions

Evaluation Scope

The role of the Evaluation Team (ET) is to undertake an independent calculation of the post-project economic rate of return (ERR) achieved by delivered individual compact project activities. This economic evaluation is supplemented by a qualitative review across a series of standardized RQs. This EDR describes the RQs that will be answered, the methodologies that will be used to answer them, and the resulting necessary data collection efforts.

The specific RAs to be reviewed as part of this independent evaluation are as follows:

- Project Implementation
- Engineering Analysis and Economic Modeling
- Road Maintenance (split into three separate RQs)
- Road Usage and Changes in Road Usage (split into two separate RQs)
- Transportation Market Structure

- Border Crossing Infrastructure at El Amatillo (split into two separate RQs)
- Border Crossing Infrastructure at Anguiatú (split into two separate RQs)

Table ES-2 provides a summary of the RAs and evaluation questions.

Table ES-2. Research Areas and Questions by Compact

RA and RQ	ESI Questions	ESII Questions
RA0: Project Implementation	Was the Connectivity Project implemented according to plan?	Was the LIP Highway Expansion Activity implemented according to plan?
RA1: Engineering Analysis and Economic Model	What is the economic return of the Connectivity Project calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time? Optional: How could the project have been designed to result in a higher ERR?	What is the economic return of the LIP Highway Expansion Activity calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time? Optional: How could the project have been designed to result in a higher ERR?
RQ2a: Long-term Road Maintenance – Current Practices	What is the likelihood that the investments made under the Connectivity Project will be adequately maintained? Based on this assessment, what set of maintenance assumptions should be used in HDM-4 (World Bank, 2010) to yield the best road investment costs and benefits estimate?	What is the likelihood that the investments made under the LIP Highway Expansion Activity will be adequately maintained? Based on this assessment, what set of maintenance assumptions should be used in HDM-4 to yield the road investment costs and benefits estimate?
RQ2b: Long-term Road Maintenance – CP	Not required for ESI.	What was the effect of the Conditions Precedent on the LIP for road maintenance funding?
RQ2c: Long-term Road Maintenance – Factors Shaping Road Maintenance	Not required for ESI.	What political and economic incentives are shaping road maintenance decisions in the country? What other key factors are influencing actual maintenance practices?
RQ3a: Road Usage Patterns, Current Users	Who is traveling on the road, why, what are they transporting, what are they paying for transportation, and how long does it take to move along key routes?	Who is traveling on the road, why, what are they transporting, what are they paying for transportation, and how long does it take to move along key routes?
RQ3b: Changes in Road Usage Patterns	Have road usage patterns changed in terms of who is traveling on the road, why, what they are transporting, what they are paying for transportation, and how long it takes to move along key routes?	Have road usage patterns changed in terms of who is traveling on the road, why, what they are transporting, what they are paying for transportation, and how long it takes to move along key routes?
RA4: Transportation Market Structure	How are benefits from the Connectivity Project distributed among road users? Optional: What is the likelihood that VOC savings will be passed on to transportation services consumers?	How are benefits from the LIP Coastal Highway Expansion Activity distributed among road users? What is the likelihood that VOC savings will be passed on to transportation services consumers?
RQ5a: Border Crossing Implementation – El Amatillo	Not Applicable	Was the LIP Border Crossing Infrastructure Activity implemented according to plan?

RA and RQ	ESI Questions	ESII Questions
RQ5b: Border Crossing – El Amatillo Economic Model	Not Applicable	How have the average wait times at the border been effected by the intervention? How has the volume of traffic and goods changed? What is the economic return of the LIP Border Crossing Infrastructure Activity? What factors drove changes to the ERR over time?
RQ6a: Border Crossing Implementation – Anguiatú	Not Applicable	Were the improvements at the Investment Climate Project Anguiatú border crossing implemented according to plan?
RQ6b: Border Crossing – Anguiatú Economic Model	Not Applicable	How have the average wait times at the border been impacted by the intervention? How has the volume of traffic and goods changed? What is the economic return of the Investment Climate Project Anguiatú border crossing?

Notes:

HDM-4 = Highway Development and Management Model v4

TTS = travel time savings

VOC = vehicle operating cost

Evaluation Method

Detailed methodologies have been developed by the Evaluation Team for each of the RA and RQs to show how they can be addressed to achieve a successful evaluation of MCC's investments. Part of the analysis will make use of the analytical tool HDM-4 to re-estimate ERRs for the highway activities. Our proposed method includes a Level 1 and Level 2 calibration of HDM-4. New data will be collected and input into HDM-4 to re-estimate ERRs based on the actual performance of the highway investments. Similarly, economic models have been developed for the border crossing activities and the Evaluation Team will update these models with new data based on actual performance e.g. reduced transit times. Other research areas of the evaluation are qualitative, and the Evaluation Team will collect data to understand changes in travel patterns, journeys and so on resulting from the investments. The intention is to evaluate changes over time using a times-series approach. The Evaluation Team will use a mix a primary and secondary data sources including data made available by MOP. The evaluation will also look in some detail at road maintenance practices to understand the likelihood MCC's investments will be maintained.

Data Collection Approach and Time Frame of Exposure

The ET's approach to data collection is driven by engineering data required to update the HDM-4 models. Our approach was also informed by the Connectivity Project and the LIP's program logic and the expected timeframe of exposure. The NTH has now been in operation for almost 7 years, so changes in traffic patterns (see RA3) should have already happened and changes in travel behavior in evidence; hence, data collection for the NTH is planned to start in February to March 2020 with a proposed completion for the ESI evaluation in September 2020.

For the LIP, the ET recommends initial data collection to start before the compact closes in September 2020, with a further round planned for 2023. Road condition surveys will be undertaken in 2023 for ESII, 3 years after its expected opening to traffic. The ET considers 3 years is the appropriate elapsed time before the road shows visible signs of deterioration.

Some adjustment of the timeline will be required once the length of the delay to the border crossing activities is known by the ET although the Coastal Highway Expansion Activity is expected to be completed on time.

Evaluation Reporting Timeline

In accordance with the evaluator's scope of work, final evaluation reports will be produced as described in this section.

ESI Evaluation Report (Target Date: September 2020)

An evaluation report covering the Connectivity Project, will be delivered in September 2020. The report will cover the following RAs:

- RA0: Project Implementation
- RA1: Engineering Analysis and Economic Modeling
- RA2: Road Maintenance
- RA3: Road Usage and Changes in Road Usage

ESII Evaluation Report (Target Date: December 2023)

An evaluation report covering the Coastal Highway Expansion Activity and the upgrade of El Amatillo and Anguiatú border crossings will be delivered in December 2023, addressing the following RAs:

- RA0: Project Implementation (LIP only)
- RA1: Engineering Analysis and Economic Modeling (LIP only)
- RA2: Road Maintenance
- RA3: Road Usage and Changes in Road Usage
- RA4: Transportation Market Structure
- RA5: Border Crossing Activities at El Amatillo
- RA6: Border Crossing Activities at Anguiatú

The ET propose a series of technical memos for each of the research areas following completion of data collection activities and initial analysis given the long timeline for the evaluation i.e. 2020 to 2023. The technical memos will then be used to produce the final evaluation report.

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Acronyms and Abbreviations

AADT	average annual daily traffic (or TDPA in Spanish)
AASHTO	American Association of State Highway Transportation Officials
BCA	benefit to cost analysis
CAFTA-DR	Regional Program for the Dominican Republic-Central America Federal Trade Agreement
CP	conditions precedent
DOT	U.S. Department of Transportation
EDR	Evaluation Design Report
ERR	economic rate of return
ESI	El Salvador Compact
ESII	El Salvador Investment Compact
ET	Evaluation Team
GDP	gross domestic product
GIS	geographic information system
GoES	Government of El Salvador
GPS	global positioning system
HDM-4	Fourth Highway Development and Management Model
IDB	Inter-American Development Bank
ILO	International Labor Organization
IM	Investment Memo
IRB	Institutional Review Board
IRI	International Roughness Index
Jacobs	Jacobs Engineering Group Inc.
km	kilometer(s)
LIP	Logistical Infrastructure Project
LTPP	Distress Identification Manual for the Long-Term Pavement Performance
m	meter(s)
M&E	monitoring and evaluation
MCC	Millennium Challenge Corporation
MOP	Ministry of Public Works
MOU	memorandum of understanding
MSI	Management Systems International
NCR	network of connecting roads
No.	number
NRC	National Research Council
NTH	Northern Transnational Highway
O&M	operation and maintenance

O-D	origin and destination
PEA	Political Economy Analysis
PII	personal identifying information
Q2	second quarter
Q4	fourth quarter
RA	research area
RFP	Request for Proposal
RTFE	Regional Trade Facilitation Expansion
RTMA	Regional Trade and Market Alliances
RQ	research question
SAL	El Salvador International Airport
SDK	SDK Consulting
TIM	International Goods in Transit
TRL	Transport Research Laboratory
TTS	travel time savings
U.S.	United States
UK	United Kingdom
USAID	U.S. Agency for International Development
VOC	vehicle operating cost
VOT	value of time

1. El Salvador Compact Overview

1.1 Context

El Salvador is a small, densely populated country in Central America that borders the Pacific Ocean to the south, Honduras to the northeast, and Guatemala to the northwest. Unlike other countries in Central America, El Salvador does not have access to the Caribbean coast, and trade is dependent on its pacific ports or via road transit to ports in Guatemala. The geographic make-up of El Salvador is determined by the volcanic terrain that dominates the country's landscape, particularly the border with Honduras, and this hinders travel to remote areas.

Based on World Bank data, El Salvador has a population of 6.3 million and a gross domestic product (GDP) per head of United States dollars (USD) 8,000 in Purchasing Power Parity terms; this ranks El Salvador 117th out of 182 countries (World Bank, 2019c). Crime and violence remain significant throughout the country following a long civil war; in part, this is linked to the relative remoteness of some areas of the country.

1.2 El Salvador Compact Introduction

Table 1-1 provides the timelines for both compacts.

Table 1-1. El Salvador Compacts Timeline

Compact	Compact Start Date	Compact End Date
ESI	Signed: November 29, 2006 Entry into force: September 20, 2007	Closed September 20, 2012
ESII	Signed: September 30, 2014 Entry into force: September 9, 2015	Expected to end September 9, 2020 [a.]

[a] El Amatillo border crossing will be completed after compact closing.

1.2.1 El Salvador Compact

The first El Salvador Compact (ESI) was signed in 2006, enacted in 2007, and then closed in 2012. The ESI is legally limited to 5 years from entry into force. Projects within ESI focused on bringing infrastructure development to the poorest communities in Northern Zone of El Salvador (Figure 1-1). ESI comprised the following three complimentary projects:

1) Productive Development Project
2) Human Development Project
3) Connectivity Project

The focus of this ESI Evaluation Design Report (EDR) is the Connectivity Project and the activities within it. Section 1.4 provides more details. The compact was implemented by MCA-El Salvador or FOMILENIO I, an institution established by the Government of El Salvador as a requirement of the compact.

1.2.2 El Salvador Investment Compact

The second El Salvador Investment Compact (ESII) was entered into force in September 2015 and comprises three separate projects as follows:

- Human Capital Project

- Investment Climate Project
- Logistical Infrastructure Project (LIP)

The budget of the compact was USD 277 million, provided by MCC and a further USD 88.2m provided by the Government of El Salvador (see https://www.mcc.gov/where-we-work/program/el-salvador-investment-compact). The total budget of the LIP project is USD 104 million.

The LIP includes activities to improve transportation connectivity in the coastal region, close to the main international airport (El Salvador International Airport [SAL]). ESII activities are currently being implemented and are expected to be completed by September 2020, although border crossings will be completed after compact closing. The LIP is the second focus of this EDR.

The Investment Climate Project is composed of two activities:

- The Regulatory Improvement Activity
- The Partnership Development Activity

In a change to the original scope of work, the Anguiatú border crossing with Guatemala has been added to the evaluation. This project forms part of the Partnership Development Activity within the Investment Climate Project.

The compact was implemented by MCA-El Salvador or FOMILENIO II, an institution established by the Government of El Salvador as a requirement of the compact and program implementation agreement.

1.3 Evaluation Objectives

CH2M HILL, Inc., now Jacobs Engineering Group Inc. (Jacobs)[2], has been procured by the Millennium Challenge Corporation (MCC) to provide an independent evaluation of the ESI Connectivity Project and ESII LIP. Jacobs is supported in this evaluation by Social Impact and Transport Research Laboratory (TRL).

Other projects within the El Salvador compacts are currently being evaluated separately, and more information can be found in MCC's catalogue on their website: https://www.mcc.gov/our-impact/independent-evaluations.

The Evaluation Team (ET) will conduct an independent calculation of the post-project economic rate of return (ERR) achieved by the activities within the delivered individual compact projects. This economic evaluation will be supplemented by a qualitative review across a series of standardized research questions (RQs). This EDR describes the RQs to be answered, the methodologies that will be used to answer them, and the resulting necessary data collection efforts.

The specific research areas (RAs) to be reviewed as part of this independent evaluation are as follows:

- Project Implementation
- Engineering Analysis and Economic Modeling
- Road Maintenance (split into three separate RQs)
- Road Usage Patterns (split into two separate RQs)

[2] Since the award of this contract, CH2M HILL, Inc. was acquired by Jacobs Engineering Group Inc.

- Transportation Market Structure
- Border Crossing Infrastructure at El Amatillo (split into two separate RQs)
- Border Crossing Infrastructure at Anguiatú (split into two separate RQs)

Note that El Amatillo is the main border crossing between El Salvador and Honduras, while Anguiatú is the main border crossing with Guatemala.

As shown, some RAs are further subdivided into individual RQs. As indicated in the scope of work, there is a high degree of interdependence between each of the RAs. As such, this EDR seeks to provide an integrated approach, with each RA informing others where appropriate and making the best use of data sets given their costs.

Note that the border crossing infrastructure at Anguiatú is part of the Investment Climate Project rather than the LIP (see above).

The RQs to be addressed and the related RAs are discussed in Section 2.

1.4 El Salvador Compact (2007 to 2012)

1.4.1 Connectivity Project Overview

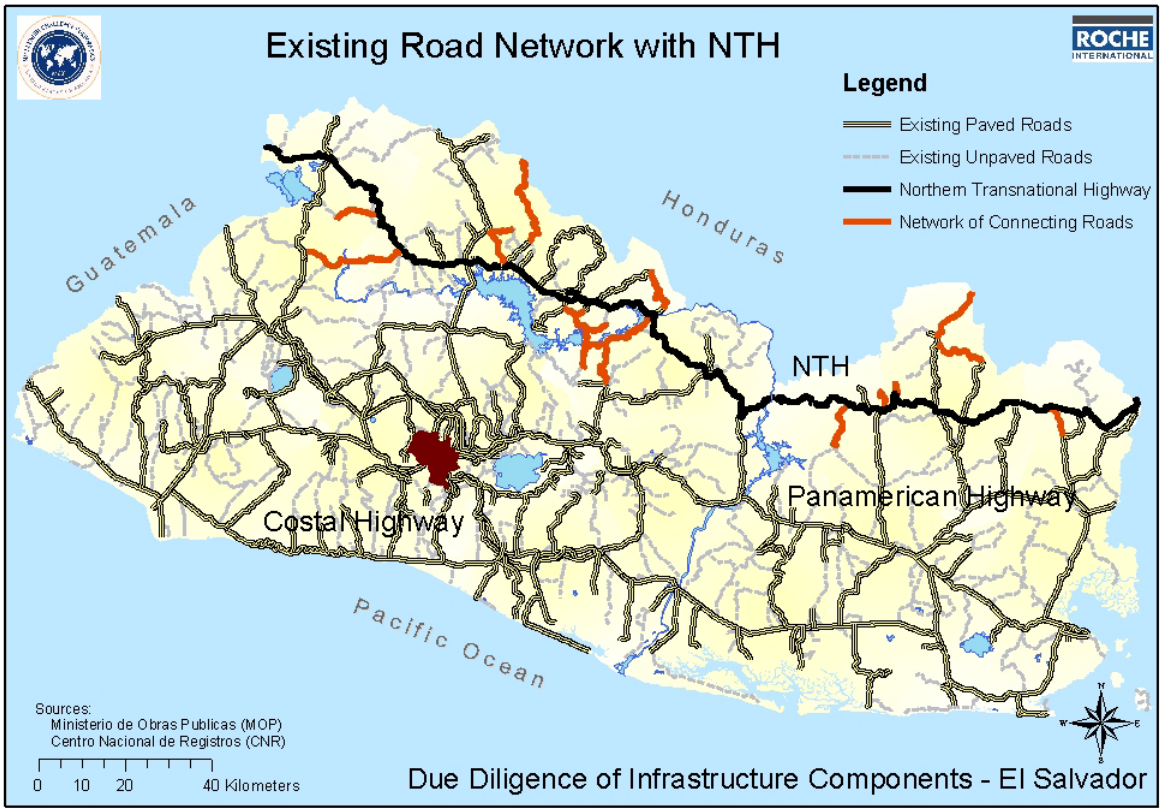
ESI closed in September 2012 and included two activities within the Connectivity Project as follows:

1) **The Northern Transnational Highway (NTH) Activity:** The first Connectivity Project activity was to provide an upgraded two-lane transnational highway across northern El Salvador to serve the Northern Zone, a remote mountainous region of the country, which was poorly integrated with the rest of the country due to its geography and relative isolation.
2) **The Network of Connecting Roads (NCR) Activity:** The second part of the Connectivity Project was to provide 240 kilometers (km) of upgraded feeder roads to improve connectivity to the NTH. The objective was to provide reliable paved roads connecting to the NTH for remote communities not directly served by the NTH. Due to financial constraints, the NCR Activity was cancelled, and funding was reallocated to the NTH.

The objective of the Connectivity Project was to “Reduce travel cost and time within the Northern Zone, with the rest of country, and within the region” (MCC, 2006b). The total cost of both the NTH and NCR activities was estimated at USD 233.56 million spread over the 5 years. The total value of the ESI compact was set at USD 460.9 million. However, cost overruns increased the total expenditure on the NTH to USD 270 million, almost twice the original budget, leading to cancellation of the all the NCR improvements.

1.4.2 Original Project Description

As noted, the focus of the Connectivity Project is the Northern Zone of El Salvador, which was selected due to its lower level of economic activity and its relative isolation within the country. Approximately half of El Salvador’s poorest municipalities are in the Northern Zone. Figure 1-1 shows the location of the NTH and NCR.



(Source: MCC, 2006)

Figure 1-1. El Salvador Road Network

Based on analysis of data provided by the Ministry of Public Works (MOP) and NTH workspaces, a total of 223.32 km of roads were delivered as part of ESI. The road sections that the ET will use for baseline data are provided in Appendix B and broadly correspond to these roads.

The NCR was not delivered as planned for multiple reasons, including cost overruns, as explained, and due to delays in detailed design. This represents a significant change to the scope of the original Connectivity Project, the impact of which will be explored in the evaluation, particularly as part of the Project Implementation (RA0).

1.4.3 Project Participants and Beneficiaries

According to the Closeout Monitoring and Evaluation (M&E) Plan (MCC, 2015b), the beneficiaries were identified as those living within a 5-km distance from the NTH, totaling 533,667 beneficiaries along the NTH. The direct beneficiaries from road improvements are the road users, including those who may not live in proximity to the road but use the improved roads. One of the conclusions from an evaluation undertaken in 2017 (see MCC, 2017) is that a deeper analysis is required to determine the composition of road users (Section 1.4.5 provides more details).

1.4.4 ESI Compact Close, 2012

ESI closed in September 2012. The Connectivity Project helped to unify El Salvador's Northern Zone with the rest of the country by improving the road systems, reducing travel times and vehicle operating costs (VOCs), thereby lowering transportation costs. Travel times, for example, between Guatemala and Honduras were reduced from 11.72 to 5.7 hours by reducing

the average International Roughness Index (IRI) from 11.5 to 2.8. (See https://www.mcc.gov/where-we-work/program/el-salvador-investment-compact)

The ET understands that some elements of the NCR were later built with international loans taken out by the Government of El Salvador totaling USD 143 million. However, for the NTH, a total of 223.32 km of upgrade were delivered against a plan of 195.6 km.

1.4.5 2017 Connectivity Project Evaluation

MCC commissioned an impact evaluation for the Connectivity Project in 2017 (MCC, 2017). The evaluation used an econometric approach and a computable general equilibrium model with primary household survey data. The evaluation concluded that:

- The NTH reduced travel times to a household's nearest market, as well the travel time to various services, and lowered the cost of accessing them.
- The evaluation only captured short-run effects; that longer-term benefits may take longer to quantify.
- Reducing transportation costs without an increase in productivity associated with it does not appear to have a very big payoff i.e. a reduction in transport costs alone is not sufficient.

The following lessons were learned by MCC from the 2017 evaluation:

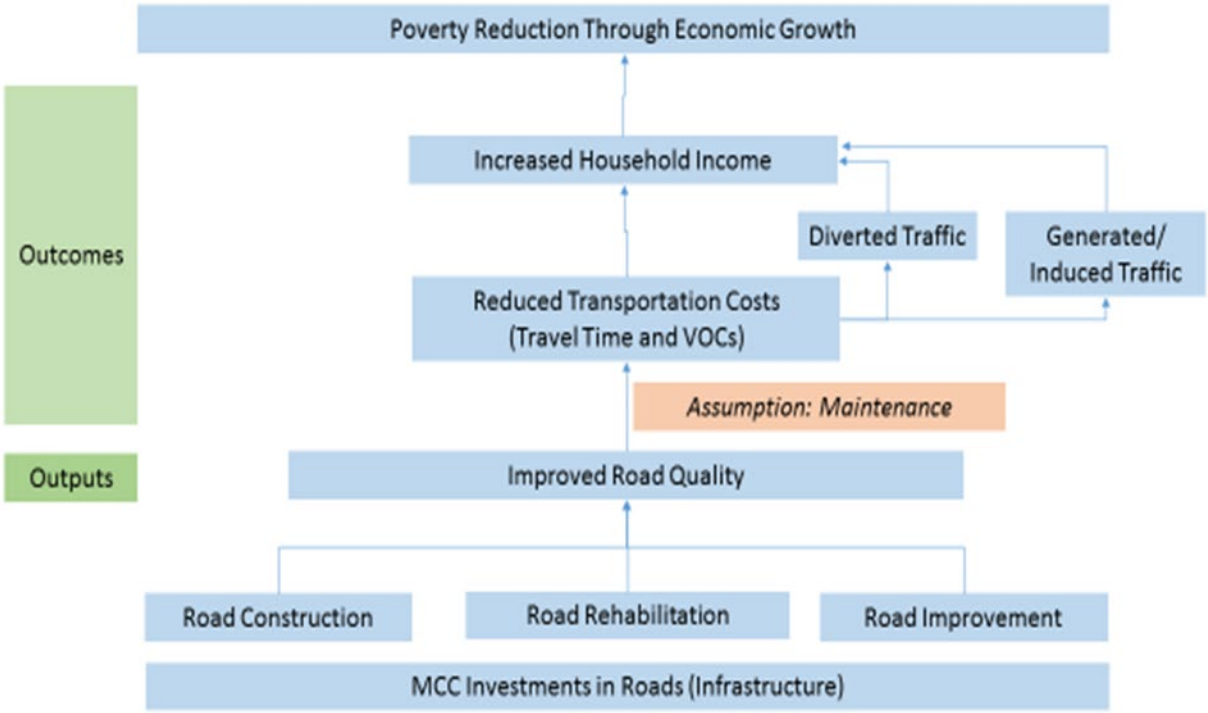
- Changes in travel times occur immediately after a road opens to traffic, yet behavioral change can take longer (that is, more than 1 to 2 years).
- MCC should consider low-cost methods of monitoring key intermediate outcomes to better inform the time pattern and composition of road impacts.
- Road evaluations should include an assessment of reduced VOCs because this is a key benefit in the economic analysis typically used to justify investment in road improvements.

The recommended next steps from the Connectivity Project 2017 evaluation inform the scope of work for this evaluation, namely:

- Determine the post compact ERR using the Fourth Highway Development and Management Model (HDM-4) (World Bank, 2010)
- Analyze the composition of road users.
- Assess the transportation market structure.

1.4.6 Theory of Change

The original ESI program logic was considered by the ET to be too high-level as a basis for the evaluation; therefore, a road investment-specific program logic was adopted instead, as shown on Figure 1-2. Key expected outputs were expected to be reduced travel time and VOCs. Time and VOC savings are transmitted as increased household income and, ultimately, reduced poverty. This process is mapped out in the program logic (Figure 1- 2).



(Source MCC, 2019)

Figure 1-2. El Salvador Compact Connectivity Project Program Logic

1.4.7 Cost Benefit Analysis and Economic Appraisal

MCC estimated a 23.9 percent ERR for the Connectivity Project at the feasibility stage, prior to signing of the compact. The estimated ERR is both for the NCR and NTH combined. Economic modeling was undertaken using the HDM-4 software package (World Bank, 2010) in line with internationally recognized best practice. HDM-4 estimates travel time savings (TTS) and VOC savings based on improved road designs, and the tool is widely used in developing countries for developing investment cases and optioneering.

Additional economic benefits can be included in the HDM-4 calculations such as changes in land value due to changes in accessibility. These benefits are included as exogenous benefits but must be calculated outside HDM-4. Similarly, HDM-4 requires traffic forecasts for individual sections or road which must be estimated externally.

At closeout due to the change in scope i.e. removal of the NCR activity, the ERR was estimated to have reduced marginally to 21.6 percent from 23.9 percent but importantly still above MCC's desired 10 percent hurdle rate, required for all projects. In the reworked calculations, key benefit streams were updated to only include VOC and TTS, and land value uplift benefits were removed.

As of the date of writing this evaluation report, and reviewing available baseline data, the ET does not have a version of the HDM-4 model that corresponds to the 21.6 percent return cited above. The agreed workspace (between MCC and the ET) is based on the sections listed in Appendix B and provides a return of 20.6 percent, this is the number the ET will use for the baseline analysis.

1.5 El Salvador Investment Compact (2015 to 2020)

1.5.1 Project and Implementation Plan Overview

As noted, ESII was implemented in September 2015 and is expected to continue until September 2020. The objective of the LIP is to "reduce logistical and transportation cost to increase investment and productivity in the trade of goods and services." The focus of this evaluation design is all activities in the LIP and the Anguiatú Border Crossing which is part of the Investment Climate Project.

1.5.2 Project Description

The LIP covers the following two activities:

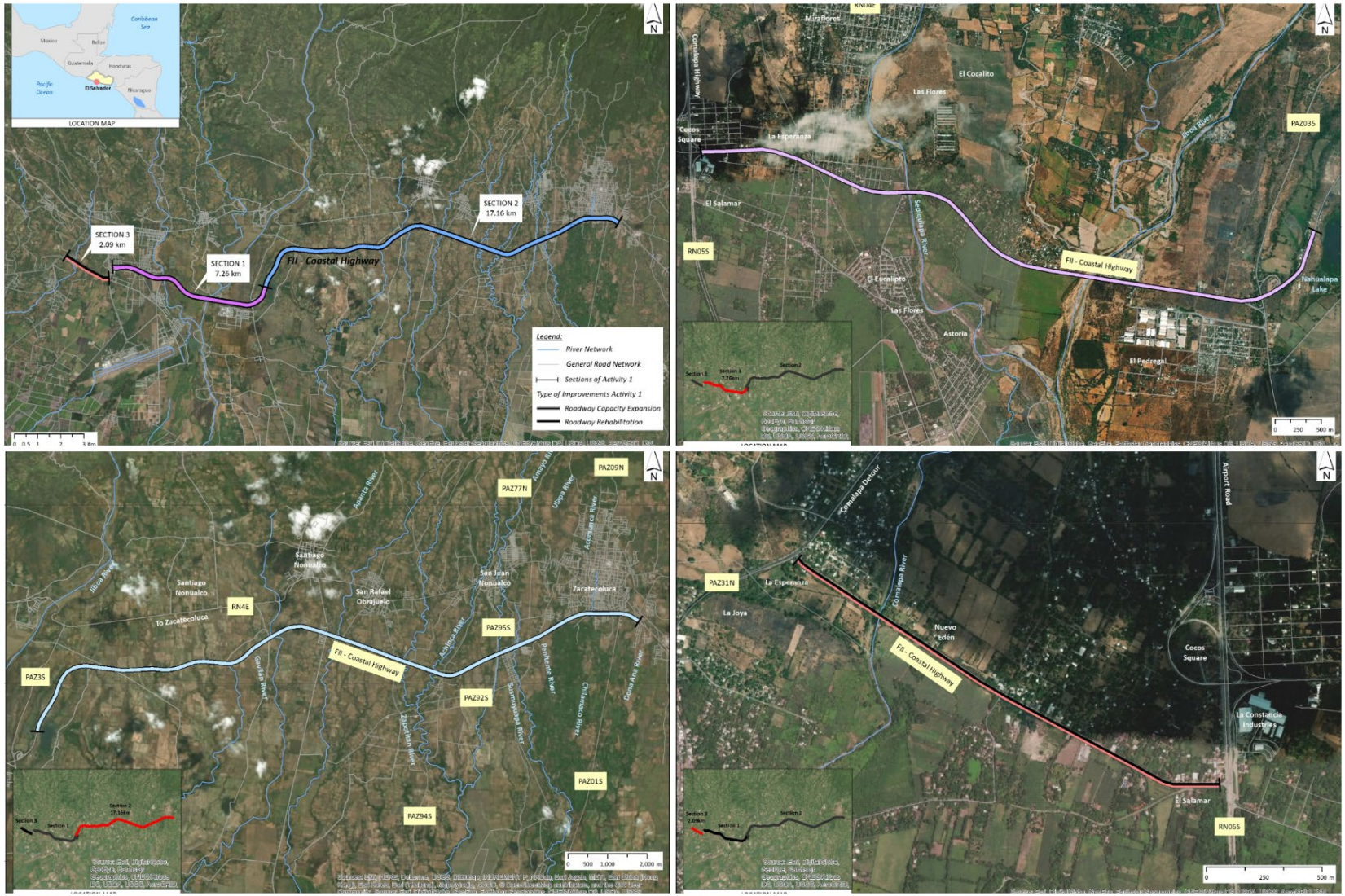
- **Activity 1 - Coastal Highway Expansion:** The first activity relates to the upgrade of CA-2, the El Salvador coastal highway. This is an upgrade and widening of a logistical route connecting two seaports (La Union and Acajutla) and the SAL. The focus of the investment is to both relieve existing congestion at the busiest sections and to prepare for future growth along the coastal zone of El Salvador. This activity is divided into three sections, as described below:
  - A 7.22-km segment from Comalapa to La Herradura (Section 1 [Figure 1-3])
  - A 16.98-km segment from La Herradura to Zacatecoluca (Section 2 [Figure 1-3])
  - A 2.97-km segment from the La Libertad intersection to the Comalapa Airport Road intersection (Section 3), as shown on Figure 1-3.
- **Activity 2 - Border Crossing Infrastructure:** The second activity seeks to:
  - Rehabilitate and improve 5.74 km of road that connects to the border crossing into El Amatillo
  - Improve and modernize border crossing facilities, including the construction of new customs station

The location of the LIP activities is show on Figures 1-3 and 1-4.

The Investment Climate Project is composed of two activities:

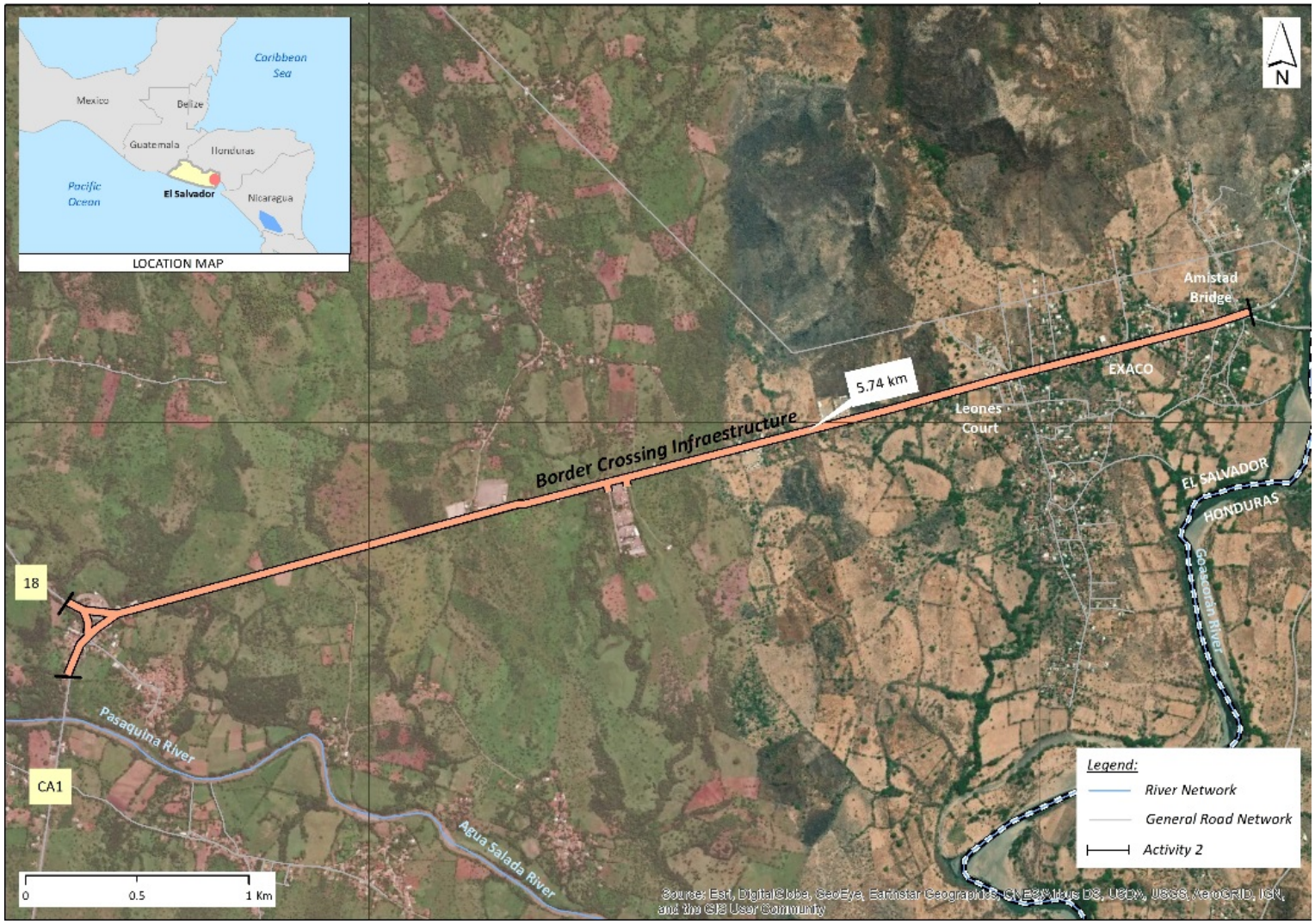
- The Regulatory Improvement Activity
- The Partnership Development Activity

In a change to the original scope of work, the Anguiatú border crossing with Guatemala has been added to the evaluation. This project forms part of the Partnership Development Activity within the Investment Climate Project. The two border crossing projects (El Amatillo and Anguiatú) together form the Trade Facilitation Investments.



Source: CH2M 2019

Figure 1-3. Activity 1 - Coastal Highway Expansion Extension by Segment



Source: MCC 2013

Figure 1-4. Activity 2 - Border Crossing Infrastructure

1.5.3 Project Participants and Beneficiaries

It is estimated that 171,159 people will benefit from this project, based on the number of individuals living within 5 km on either side of the project construction area. In addition, individuals and firms that use the supported roads will also benefit (even if they do not live within 5 km) (MCC, 2015b).

1.5.4 Implementation to Date

Currently, implementation is underway, with construction started on the Coastal Highway Expansion. During a site visit in February 2019, the ET were able to see work to expand the road well underway, with sections of the road in various stages of construction.

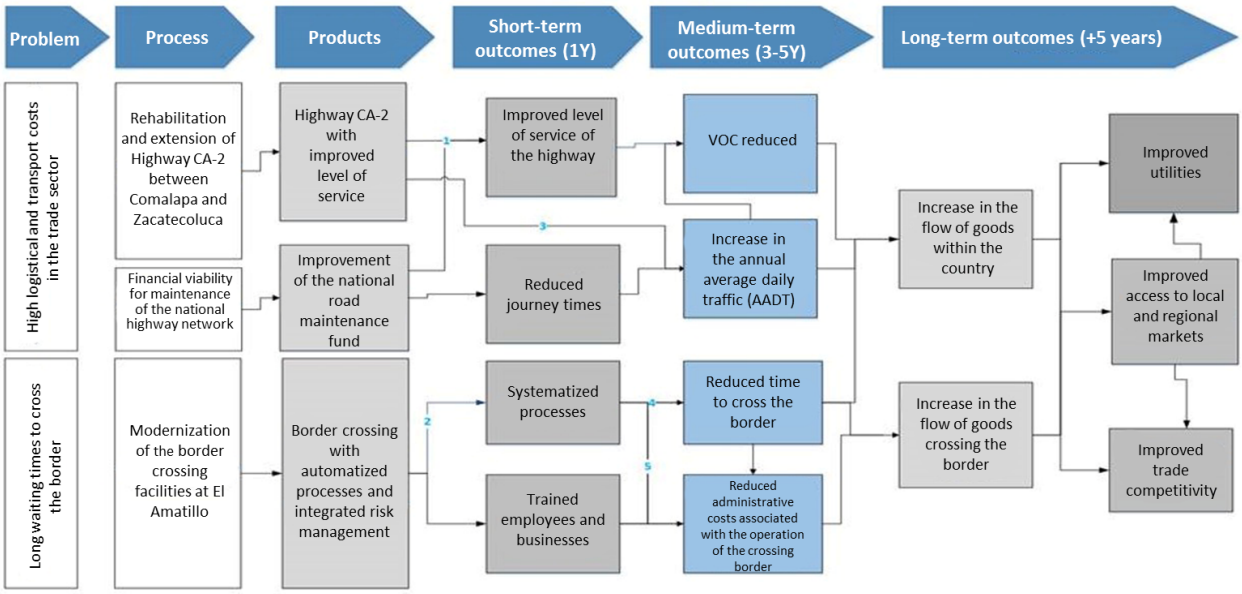
For the border crossing infrastructure, work has begun on the necessary process improvements, in addition to the purchase of land. However, the ET noted that construction of the improved facilities and rehabilitation of the road leading to the border crossing has not yet begun.

1.5.5 Theory of Change

The overall goal of ESII is to improve economic growth and reduce poverty. All three projects are expected to work together to increase employment and private sector investment and improve productivity. The LIP aims to reduce consistent congestion on important sections of the Coastal Highway and the road leading to the El Amatillo border crossing (referenced indirectly by reduced journey times). The LIP is also expected to increase the trade of goods and services throughout the region due to an expected reduction of logistical and transportation costs.

1.5.6 MCC Transportation Program Logic

Figure 1-5 shows the MCC LIP program logic.



Source: MCC 2018a

Figure 1-5. Logistical Infrastructure Project Program Logic

1.5.7 Economic Appraisal and Cost-Benefit Analysis

In the Investment Memo (IM), the ERR for the highway expansion was 16.3 percent, and the ERR for the improved border crossing was 35.4 percent (MCC, 2013). The overall ERR is 20.31 percent, using a weighted estimate of the calculated ERRs for each activity. The weighted average ERR is based on the proportional cost of the two investments. This, together with the other key reported parameters, is shown in Table 1-2.

Table 1-2. Estimated Economic Rate of Return for Logistical Infrastructure Project Activities 1 and 2 & Anguiatú Border Crossing

Activity	Cost (USD millions)	Length (km)	ERR (%)
Activity 1 – Costal Highway Expansion	111.25	27.17	16.3
Activity 2 – Border Crossing	26.74	5.74 (+2 Customs Stations)	33.4*
Anguiatú Border Crossing	26.3	Infrastructure Improvements	29.13

Source: MCC, 2013

Notes:

% = percent

* ERR for El Amatillo only.

The ET have reviewed the core economic benefits included in the HDM-4 workspaces that relate to VOC and TTS, and this is set out in the Baseline Report (CH2M, 2019).

1.6 Relevant Literature Review

The following subsections summarize the key literature reviewed, but with a focus on best practice practical applications where appropriate. We describe how our approaches differ from these best practices where appropriate and the reasons for those variations.

1.6.1 Economic Assessment of Road Projects in Developing Countries

MCC's focus on VOCs and TTS is a supported practice in literature for economic assessment of road projects in developing countries. VOCs are defined as the costs borne by owners of road vehicles to operate them. This includes fuel consumption, deterioration of tires and costs associated, repair and maintenance costs, and insurance. VOCs are correlated with type of vehicle; average travel speed; and characteristics of roads, such as design standards and surface conditions. The role of VOCs in performing a cost-benefit or ERR analysis is well-captured in the *Guide to Cost-Benefit Analysis of Investment Projects* (European Commission, 2014). VOC reduction and overall savings are a typical benefit of road rehabilitation projects, and the calculation of VOCs is explained in Ranawaka and Pasindu's May 2017 paper.

Economic assessment of road projects is a well-established field, with more than 50 years of study. Some of the key proponents of best practice guidance are the World Bank and MCC. A key distinction often made in undertaking economic analysis is whether the project analysis should be undertaken at a project level (in the form of a benefit to cost analysis [BCA]) or at an economic impact level, considering regional macro-economic effects, such as on land prices or employment. There is concern more generally about using both types of analysis in the ERR, as this is believed to result in double counting of benefits, which could cause the ERR to be upwardly biased.

The key differences between an economic impact analysis and a BCA are as follows:

- A BCA generally takes a wider view of benefits generated and costs to include. For example, it will seek to include the welfare utility gained by leisure travelers. This may not be considered in an economic impact analysis, as this would not generate productivity activities.
- A BCA also generally includes all economic costs in an analysis, including environmental costs and noise pollution, for example. These are often not assessed in an economic impact analysis.
- An economic impact analysis has a wider view of benefits, expecting a multiplier impact of the change in productivity from the intervention in a project. A BCA generally does not follow a multiplier-type approach to assess the economic viability of a project.

Table 1-3 compares some general principals in appraisal between the MCC, UK WebTAG, and World Bank approaches.

Table 1-3. Comparison of World Bank, UK WebTAG, and MCC Approach to Economic Appraisal

Parameter	World Bank	MCC Economic Analysis for Connectivity	UK WebTAG[a]
Appraisal Period	25 years	20 years	60 years
Residual Value	To be included for longer life assets	Not used, though no discussion on asset life exists	To be included if project span is less than 60 years
Discount Rate	Social time preference adjusted for cost of capital for capital costs	Not clear	Social time preference that equates to 3.5% for the first 30 years, with reduced rates for more distant time periods
Prices	Real	Unclear	Real
Unit of Account	Factor prices	Factor prices	Perceived costs, factor costs, and market prices
Wider Economic Benefits	Unclear	Unclear	When proportionate, but could relate to land value uplift, competition productivity and labor market changes, gross value added and employment changes, jobs created, and land for homes and commercial properties unlocked.

[a] Information based on UK Department for Transport, 2019.

A comparison of best practice benefit and cost categories from the World Bank Transport Notes Series (World Bank, 2016) compared to what has been included in this report is shown in Table 1-4.

Table 1-4. Mapping of Benefits between MCC and World Bank

Name	Used by MCC	Recommended by the World Bank
TTS	✓	✓
VOCs	✓	✓
Safety benefits	✓	✓
Economic development from generated traffic	×	✓
Environmental effects	×	✓
Distributional benefits	×	✓
Wider economic effects	×	✓
Land value uplift	✓	×

This comparison is helpful, as it helps show the difference between what might be considered best practice of a road maintenance economic appraisal and the approach used by MCC.

It should be noted, however, that there is less evidence of other international financing institutions performing ex-post analysis, but this should not change the overall method of economic appraisal.

1.6.2 Road Maintenance in Developing Countries

Road maintenance in developing countries is often neglected, for various reasons. In the context of these projects, paved roads will be the focus of maintenance because the project roads are surfaced. Paved road deterioration research essentially started with the American Association of State Highway Transportation Officials' (AASHTO's) road test in the early 1960s in the United States (U.S.) (NRC, 1961), which was probably the most significant pavement research carried out in the 20th century and has formed the basis of pavement design in many countries since (TRB, 2007). Overseas Road Note 31 (TRL, 1962) was also first published around this time and was designed to provide a guide to the structural design of bituminous surfaced roads in tropical and subtropical countries. This guide stressed the consideration of future maintenance when selecting materials and designing paved roads.

Research into pavement deterioration in developing countries has been ongoing for several decades, but the first significant work in this area dates to 1975, when a study was carried out in Kenya (Hodges et al., 1975). The aim of this project was:

> *"To relate the deterioration of several types of road common in developing countries to the original design and construction standard of the roads, the traffic loading carried by the roads and the characteristics of the natural environment".*

The roads studied included both asphaltic concrete and surface dressed. Asphaltic concrete road deterioration was found to be largely due to inadequate drainage; whereas, for surface dressed roads, the failure was shown in excessive roughness values and linked to traffic loading.

Research into road deterioration was also carried out for HDM in the 1970s and 1980s, with a report by Paterson (1987) being one of the most important to summarize road deterioration and maintenance effects. Paterson looks at how roughness can be used to provide a common standard for the comparison and validation of future deterioration studies worldwide, including its effects on vehicles. This study informed the development of HDM-3 and HDM-4. A further World Bank study (Harral and Faiz, 1988) provided quantification of the key relationships between road deterioration and maintenance needs. The authors demonstrate how investment decisions and maintenance actions are interdependent and affect the quality of information used for predictions of deterioration.

This research has set the foundation for effective maintenance strategies. However, it is recognized that there is a disconnect between the costs of road deterioration for road users and for the roads authority. In developing countries, there is usually relatively weak public pressure to maintain road quality (Suthanaya, 2017), which can be due to a lack of empowerment, reduced value of time (VOT), and an ignorance of the potential for road quality. There is a high demand for basic access, but little demand to maintain it to any level of quality. When linked with inadequate funding and low institutional capacity, a low public demand for road maintenance means that maintenance policies are seldom fully implemented.

The International Labour Organization (ILO) reports that the Employment Intensive Public Investments project, together with the MOP and FOVIAL, began a program of technical assistance in 2010 for the implementation of a Road Management System based on micro enterprise routine road maintenance. Moran (2014) discusses road maintenance under FOVIAL, including its legal framework, programs, administrative and operational organizations, project administration.

1.6.3 Changes in Traffic Patterns

Transportation forecasting models have been developed over the past 30 years as planning tools that aim to model changes in traffic patterns based on model predictions. The complexity of transportation models has, to a large part, reflected increases in available computing power, with models increasing in size. Models vary in sophistication but can provide a level playing field for decision making, given limited investment funds, and many models have been primarily built for this reason, such as the Regional Investment Strategy models for Highways England (Highways England, 2015). The Regional Investment Strategy models have been used to understand and model changes in travel patterns in response to planned infrastructure improvements and land use changes.

Typically, transportation forecast uses a sequential four-stage model that considers:

1) Trip generation (located to a specific origin and destination [O-D])
2) Trip distribution (using synthetic gravity models to model the number of trips moving between O-D pairs using friction factors)
3) Transportation assignment (using Wardrop's equilibrium and assignment algorithms, such as Frank-Wolf, and consisting of a supply-side network with detail coding of road characteristics and demand-side trip matrices based on trip generation and distribution. These types of models seek to final the minimum travel time across all road users in a highway network and this minimum time is called a user equilibrium.
4) Mode choice (using multinomial or hierarchical logit models)

With the latter two stages interchangeable, traffic models can cycle between stages to achieve a user equilibrium and model convergence. These models are expensive and time-consuming to develop and can be very data intensive, particularly collecting data around trip generation and trip distribution. Road-side surveys are specifically designed to capture this type of data, but more recently, mobile phone data have been used to improve sample sizes and data coverage without the need for intrusive data collection. The use of mobile phone data is increasing, as the techniques to clean and process data sets are improving making this an alternative data collection method.

Another widely used technique is the use of an automatic number plate recognition camera, which can record the movement of vehicles in and out of a cordon. Both approaches have been used to build observed trip matrices.

In the United Kingdom (UK), transport modeling software is used, such as the Institute for Transport Studies' SATURN (Simulated Traffic in an Urban Network), and in the U.S., packages such as Caliper Corporation's TransCAD, INRO's Emme, and Citilabs' Cube are widely used. These transportation modeling packages are frequently used to test and model the effects of transportation investments through modeling predictions, including:

- Changes in land use that affect the total number of trips (for example, through a new housing or industrial development)
- Changes in distribution that are brought about by supply-side changes (such as a new railway or road)
- Estimation of travel time savings through modeling changes in travel patterns

Very large transportation models have been developed for London (See http://content.tfl.gov.uk/londons-strategic-transport-models.pdf) and are used to test new public transportation and road investment strategies. Planning-level models also exist for cities such as Washington, DC. HDM-4, used for developing the investment case for El Salvador, is static in the sense than it requires traffic forecasts as an input rather than being able to produce (predict) them.

1.6.4 Border Crossing Improvements

Facilitating trade across borders has been a focus of international development efforts for many years (McLinden et al., 2011; World Bank, 2019; MSI, 2010). Facilitating faster and simpler border crossing procedures has often been a focus under the premise that reducing logistical costs would increase overall trade flows, a premise supported by studies by Korinek and Sourdin (2011), the World Bank (2019a), and Management Systems International (MSI) (2010).

The literature review found several evaluations related to trade facilitation and border crossing improvements. However, none used impact evaluation methodologies that could reasonably compare observed outcomes with a counterfactual or do-nothing scenario. Most of the evaluations used primarily qualitative methods and focused more on measuring outputs and immediate-term outcomes than on longer-term outcomes, like border crossing times or trade flows.

Where efforts to streamline and simplify border crossing procedures were effectively implemented, and the evaluation looked at border crossing times, the findings were generally positive (Djanitey, 2018; Mendez England & Associates, 2017; MSI, 2010; Tosevska-Trpcevska, 2014). However, effective implementation was the critical step in the process, and several studies found that the intended systems were not fully implemented, the projects only achieved initial steps in the improvement process (such as passing laws or gaining agreement among stakeholders), or both, but did not yet embark on implementation (Checchi and Company Consulting, 2015; Development & Training Services, 2012a; MSI, 2003, 2014, 2018). Studies found that engagement, coordination of stakeholders, and political will were key challenges to effective implementation (Development & Training Services, 2012b; MSI, 2010; World Bank, 2019a).

1.6.5 Single Window Initiatives

Historically, efforts to improve border crossing procedures have focused on customs procedures and less on the other actors involved in trade across borders, such as immigration, agriculture, and police and security forces. Improvements have been achieved with this approach, and in many cases, customs are no longer the primary bottleneck or barrier in the border crossing process (McLinden, 2013; IDB, 2010). Rather, other entities are now posing the biggest barriers to cross-border trade, as discussed in the 2014 World Bank study that found that the largest share of informal payments were going not to customs agents, but to agriculture and immigration agents at the border in El Salvador (Osborne et al., 2014).

In more recent years, efforts to simplify border crossing procedures have often shifted towards implementation of “single window” initiatives. A single window approach puts all the necessary actors (including customs, immigration, agriculture) in the same place (either virtually or physically). In line with these findings, where they have been implemented, the single windows have resulted in substantial reductions in wait times and logistics costs (Djanitey, 2018; Tosevska-Trpcevska, 2014). However, the finding that stakeholder engagement, cooperation, and political will are key challenges applies even more strongly to single window initiatives than to those involving just one agency (Djanitey, 2018; McLinden, 2013; IDB, 2010, Vives, 2018).

1.6.6 Border Crossing Facilitation in Central America

Numerous efforts have been made to facilitate border crossings in Central America, and El Salvador specifically. Though not an exhaustive list, this section describes some of the key efforts in Central America and El Salvador.

In 2005, the U.S. Agency for International Development (USAID) completed the PROALCA II program, which, among other trade facilitation efforts, included activities to develop a regional customs union, harmonize laws between Central American nations, and create unified product registries in the region.

The PROALCA II final evaluation noted that El Salvador was helping lead the way in simplifying border crossing procedures (Wingerts Consulting, 2006).

From 2006 through 2010, USAID implemented the Regional Program for the Dominican Republic-Central America Federal Trade Agreement (CAFTA-DR), which focused on preparing the CAFTA-DR signatory countries for participation in the CAFTA-DR treaty and included a range of border facilitation activities, from harmonizing and implementing updated standards on Rules of Origin to implementation of customs and trade administration improvements. The project's final report states that they helped El Salvador implement a virtual single window for imports in El Salvador, Honduras, and Nicaragua (Chemonics, 2010).

In 2008, the Inter-American Development Bank (IDB) implemented an International Goods in Transit (TIM, in Spanish) system to improve the flow of goods transiting through partner countries (not for import or export). The project developed the TIM system and implemented it at one border crossing (El Amatillo) between El Salvador and Honduras. The International Finance Corporation reported that the system had "…dramatically improved the speed and efficiency of border clearance for goods in transit…," though no specific figures were provided (IFC, 2010).

Ending in 2018, Nathan Associates implemented the Regional Trade and Market Alliances (RTMA) and Regional Trade Facilitation Expansion (RTFE) activities for USAID, which consisted of a range of trade facilitation efforts, including streamlining border crossing processes and implementation of a radio frequency identification tracking and facilitation system at el Amatillo (Nathan Associates, 2018b, 2018c). The final report for RTMA reported that average import times at El Amatillo increased between 2013 and 2017. In 2013, it took 2 hours, 17 minutes (on average) to import goods and 3 hours, 22 minutes in 2017. An explanation is not provided for why this might have been the case, though they also state that the number of border operations at El Amatillo increased 49 percent, and the total weight of cargo processed increased 74 percent over the same period.

For exports, the average time necessary to cross the border was reduced from 1 hour, 11 minutes to 1 hour, 7 minutes, while the number of border operations increased 15 percent, and the weight of cargo processed increased 17 percent. The average time for transit trade through El Amatillo stayed roughly the same, at 17 to 18 minutes over the same period, while the number of border operations increased 2 percent, and the weight of goods processed increased 6 percent (Nathan Associates, 2018c). These numbers are different than MCC's monitoring indicators for the LIP, which show a baseline average border processing time of 6.1 hours at the start of ESII (FOMILENIO II, 2015).

2. Independent Evaluation Design

2.1 Introduction

In the past, MCC has often used quasi-experimental designs to evaluate road projects. However, through a peer review process, MCC has moved towards a standardized set of evaluation questions for evaluating road rehabilitation and improvement projects using HDM-4, with complementary questions to explore the how and the why of the observed economic benefits. This approach includes four standard RAs, plus a question on whether the project was implemented according to plan. The approach also provides independent evaluators the flexibility to propose specific methods to answer each question.

2.2 Evaluation Research Areas and Research Questions

Table 2-1 lists each of the RAs, summarizes the proposed methodology, and shows the data sources split by ESI and ESII activities. The rest of this EDR provide more detail on the Table 2-1 summary.

Table 2-1. Research Areas and Questions, and Proposed Methodology

RA and RQ	ESI	ESII	Evaluation Methodology	Primary Data	Secondary Data
RA0: Project Implementation	Was the Connectivity Project implemented according to plan?	Was the LIP Highway Expansion Activity implemented according to plan?	Compare planned versus actual implementation. Some key metrics will include: Kilometers upgraded, rehabilitated, or constructed Project timing and duration Investment costs (e.g., actual versus planned) Changes to engineering design and road construction Whether implementation was consistent with design in relation to build quality	Interviews with MCC, MOP, FOMILENIO II, and other local stakeholders involved in project implementation	Implementation documents from MCC, FOMILENIO II, MOP, and independent engineering reports including: Original design As-built drawings Progress reports Completion report Contract amendments Costing report
RA1: Engineering Analysis and Economic Model	What is the Connectivity Project's economic return – calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time? Optional: How could the project have been designed to result in a higher ERR?	What is the LIP Highway Expansion Activity's economic return – calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time? Optional: How could the project have been designed to result in a higher ERR?	Update HDM-4 for ESI and ESII used to estimate ERR. Conduct sensitivity tests to understand changes to the ERR over time and which factors led to changes in the ERR. Using HDM-4 analysis and outputs from RA0, examine whether a higher ERR could have been achieved.	Visual Condition Survey for calibration (to be done as part of RA2) RA1 will rely on the traffic count surveys conducted for RQ3a and RQ3b, which will be used in the HDM-4 analysis RQ1 will also rely on primary data collected from RQ2A to corroborate maintenance assumptions and inform future maintenance assumptions	As-built drawings (for ESII) Vehicle fleet data Road maintenance assumptions and costs (also using data from RA2) Climate zone data Economic parameters
RQ2a: Road Maintenance – Current Practices	What is the likelihood that the investments made under the Connectivity Project will remain adequately maintained? Based on this assessment, what set of maintenance assumptions should be used in HDM-4 to yield the best estimate of road investment	What is the likelihood that the investments made under the LIP Highway Expansion Activity will remain adequately maintained? Based on this assessment, what set of maintenance assumptions should be used in HDM-4 to yield the best estimate of road investment costs and benefits?	Describe how road maintenance decisions are currently made in El Salvador. For ESII, review a sample of similar roads FOVIAL is responsible for to assess the likelihood of actual maintenance and whether it is effective and timely.	Interviews with FOVIAL and MOP IRI Visual Condition Surveys (Data from the IRI and Visual Condition Surveys will be used during HDM-4 calibration – required for RA1)	FOVIAL maintenance records and other road maintenance providers as applicable Future maintenance plans Annual maintenance budget and expenditure data

RA and RQ	ESI	ESII	Evaluation Methodology	Primary Data	Secondary Data
	costs and benefits?				
RQ2b: Road Maintenance – CP	Not required for ESI	What was the effect of the CP on the LIP for road maintenance funding?	Describe how maintenance decisions are made by MOP and implemented by FOVIAL. Specifically, how the CP has changed behaviors and processes at FOVIAL.	Same as RQ2a	Same as RQ2a
RQ2c: Road Maintenance – Factors Shaping Road Maintenance	Not required for ESI	What political and economic incentives are shaping road maintenance decisions in the country? What other key factors are influencing actual maintenance practices?	Use USAID's Political Economy Tool to design and analyze qualitative interviews to explore key PEA facets, including identification of actors and their political and economic incentives regarding road maintenance activities	Use the same interviews as for RQs 2a and 2b, as a portion of those interviews will focus on the Political Economy question. Further questions will be added to interviews specific to RQ2c.	RQ2a data, plus any existing research on road maintenance and policy making in El Salvador and Central America more generally
RQ3a, Road Usage Patterns, Current Users	Who is traveling on the road, why, what are they transporting, what are they paying for transportation, and how long does it take to move along key routes?	Who is traveling on the road, why, what are they transporting, what are they paying for transportation, and how long does it take to move along key routes?	Describe current road users and their characteristics.	O-D/ intercept surveys Traffic counts Travel time surveys	MOP traffic count data Data and reports collected as part of feasibility studies Transportation studies for MOP and FOMILENIO
RQ3b Changes in Road Usage Patterns	Have road usage patterns changed, in terms of who is traveling on the road, why, what they are transporting, what they are paying for transportation, and how long it takes to move along key routes?	Have road usage patterns changed, in terms of who is traveling on the road, why, what they are transporting, what they are paying for transportation, and how long it takes to move along key routes?	Develop a before and after comparison to identify changes and differences	Retrospective and recall surveys for ESI. For ESII we intend to collect new data and compare with the baseline.	Same as RQ3a, with a focus on historical information
RA4: Transportation Market Structure	How are benefits from the Connectivity Project distributed among road users? Optional: What is the likelihood that VOC savings will be passed on to consumers of transportation services?	How are benefits from the LIP Highway Expansion Activity distributed among road users? What is the likelihood that VOC savings will be passed on to consumers of transportation services?	Use HDM-4 to select key transportation users (e.g., by journey purpose) to be analyzed for both ESI and ESII. Evaluate market structure, including formal (licensed) players and informal (nonlicensed) actors to provide evidence of how the transportation sector is structured and regulated, including changes for the	Semi-structured interviews with market stakeholders Trucking company surveys	El Salvador Competition Commission, MOP, including: List of all trucking, passenger transportation, and traders of goods Market concentration data Data on barriers to entry

RA and RQ	ESI	ESII	Evaluation Methodology	Primary Data	Secondary Data
			beneficiaries from the road investment: Evaluating market structure (including barriers to entry, noncompetitive behaviors, analyzing market intensity and density) Analyzing efficiency of market participants Reviewing the effectiveness of institutions in managing efficient market outcomes		Size of the transportation markets Number of participants Central regulatory authority data (number and scope)
RQ5a: Border Crossing Implementation – El Amatillo		Was the LIP Border Crossing Infrastructure Activity implemented according to plan?	Compare planned versus actual implementation	Interviews with MCC, MOP, FOMILENIO II, and other local stakeholders involved in project implementation	Implementation documents from MCC, FOMILENIO II, MOP, and independent engineering reports, including: Original design As-built drawings Progress reports Completion report Contract amendments Costing reports
RQ5b: Border Crossing – El Amatillo Economic Model		How have the average wait times at the border been changed by the intervention? How has the volume of traffic and goods changed? What is the economic return of the LIP Border Crossing Infrastructure Activity? What factors drove changes to the ERR over time?	Test observed wait times, traffic movement by type of goods against forecasts. Conduct sensitivity tests to understand the change on the ERR over time and which factors led to changes in the ERR.	No data collection proposed	USAID and Customs data
RQ6a: Border Crossing Implementation – Anguiatú		Were the improvements at the Investment Climate Project Anguiatú border crossing implemented according to plan?	Compare planned versus actual implementation	Interviews with MCC, MOP, FOMILENIO II, and other local stakeholders involved in project implementation	Implementation documents from MCC, FOMILENIO II, MOP, and independent engineering reports, including: Original design As-built drawings Progress reports Completion report

RA and RQ	ESI	ESII	Evaluation Methodology	Primary Data	Secondary Data
					Contract amendments Costing reports
RQ6b: Border Crossing – Anguiatú Economic Model	-	How have the average wait times at the border been changed by the intervention? How has the volume of traffic and goods changed? What is the economic return of the Crossing of the Investment Climate Project Anguiatú border crossing?	Test observed wait times, traffic movement by type of goods against forecasts. Conduct sensitivity tests to understand the change on the ERR over time and which factors led to changes in the ERR.	No data collection proposed	USAID and Customs data

Notes:

- = not applicable

CP = conditions precedent

PEA = Political Economy Analysis

2.3 Evaluation Reporting and Project Timeline

In accordance with the scope of work the final evaluation reports will be produced as follows:

Final ESI Evaluation Report (Target date: September 2020)

- An Evaluation Report covering the NTH, as an activity within the Connectivity Project, will be delivered in September 2020. The report will cover the following RAs:
  - RA0: Project Implementation
  - RA1: Engineering Analysis and Economic Modeling
  - RA2: Road Maintenance
  - RA3: Road Usage and Current Users

Final ESII Evaluation Report (Target date: December 2023)

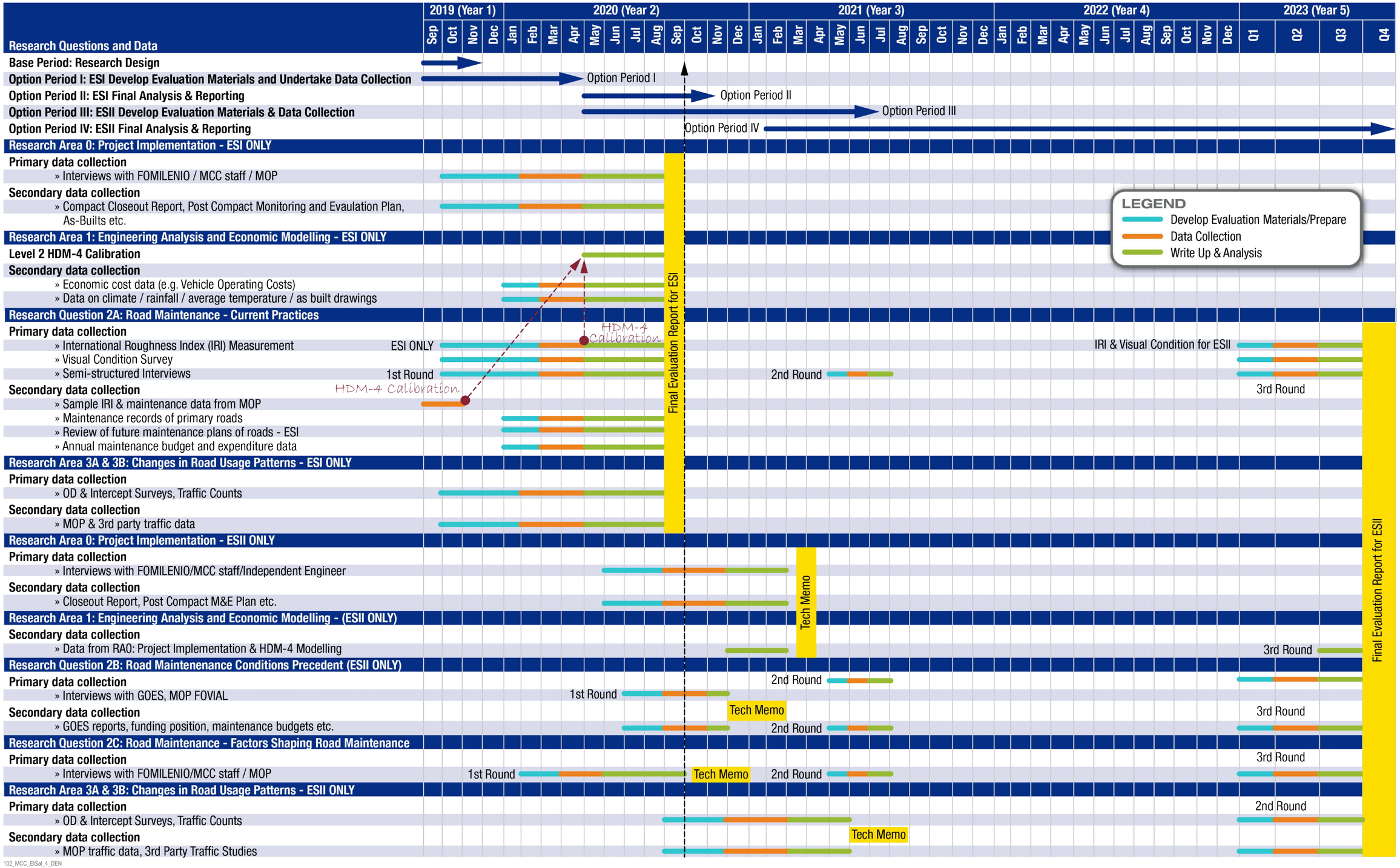
- An Evaluation Report covering the Coastal Highway Expansion Activity, and the upgrade of El Amatillo and Anguiatú border crossings will be delivered in December 2023, addressing the following RAs:
  - RA0: Project Implementation
  - RA1: Engineering Analysis and Economic Modeling
  - RA2: Road Maintenance
  - RA3: Road Usage and Current Users
  - RA4: Transportation Market Structure
  - RA5: Border Crossing Activities at El Amatillo
  - RA6: Border Crossing Activities at Anguiatú

Some activities will need to start before the ESII closes to make use of FOMILENIO II staff availability, and the timeline reflects this assumption.

The timeline (Figure 2-1) shows data collection activities for El Amatillo and Anguiatú to understand the potential long-term benefits of the border crossing activities in 2023. Road condition surveys will be

undertaken in 2023 for ESII, 3 years after opening to traffic, which is considered sufficient elapsed time for the road to show visible signs of deterioration. The ET is also aware of data collection activities that have been undertaken by MCC, MOP, and others. These data sets are reviewed in more detail in the Baseline Report (CH2M, 2019).

In a change from the original scope of work an Interim Report for the LIP will not be produced.


2019 (Year 1)
2020 (Year 2)
2021 (Year 3)
2022 (Year 4)
2023 (Year 5)
Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Q1 Q2 Q3 Q4
Research Questions and Data
Base Period: Research Design
Option Period I: ESI Develop Evaluation Materials and Undertake Data Collection
Option Period I
Option Period II: ESI Final Analysis & Reporting
Option Period II
Option Period III: ESII Develop Evaluation Materials & Data Collection
Option Period III
Option Period IV: ESII Final Analysis & Reporting
Option Period IV
Research Area 0: Project Implementation - ESI ONLY
Primary data collection
» Interviews with FOMILENIO / MCC staff / MOP
Secondary data collection
» Compact Closeout Report, Post Compact Monitoring and Evaulation Plan, As-Builts etc.
LEGEND
Develop Evaluation Materials/Prepare
Data Collection
Write Up & Analysis
Research Area 1: Engineering Analysis and Economic Modelling - ESI ONLY
Level 2 HDM-4 Calibration
Secondary data collection
» Economic cost data (e.g. Vehicle Operating Costs)
» Data on climate / rainfall / average temperature / as built drawings
Research Question 2A: Road Maintenance - Current Practices
Primary data collection
» International Roughness Index (IRI) Measurement
ESI ONLY
HDM-4 Calibration
IRI & Visual Condition for ESII
» Visual Condition Survey
» Semi-structured Interviews
1st Round
2nd Round
3rd Round
Secondary data collection
HDM-4 Calibration
» Sample IRI & maintenance data from MOP
» Maintenance records of primary roads
» Review of future maintenance plans of roads - ESI
» Annual maintenance budget and expenditure data
Final Evaluation Report for ESI
Research Area 3A & 3B: Changes in Road Usage Patterns - ESI ONLY
Primary data collection
» OD & Intercept Surveys, Traffic Counts
Secondary data collection
» MOP & 3rd party traffic data
Research Area 0: Project Implementation - ESII ONLY
Primary data collection
» Interviews with FOMILENIO/MCC staff/Independent Engineer
Secondary data collection
» Closeout Report, Post Compact M&E Plan etc.
Tech Memo
Research Area 1: Engineering Analysis and Economic Modelling - (ESII ONLY)
Secondary data collection
» Data from RA0: Project Implementation & HDM-4 Modelling
3rd Round
Research Question 2B: Road Maintenenance Conditions Precedent (ESII ONLY)
Primary data collection
2nd Round
» Interviews with GOES, MOP FOVIAL
1st Round
Tech Memo
3rd Round
Secondary data collection
» GOES reports, funding position, maintenance budgets etc.
2nd Round
Research Question 2C: Road Maintenance - Factors Shaping Road Maintenance
Primary data collection
3rd Round
» Interviews with FOMILENIO/MCC staff / MOP
1st Round
Tech Memo
2nd Round
Research Area 3A & 3B: Changes in Road Usage Patterns - ESII ONLY
Primary data collection
2nd Round
» OD & Intercept Surveys, Traffic Counts
Secondary data collection
Tech Memo
» MOP traffic data, 3rd Party Traffic Studies
Final Evaluation Report for ESII
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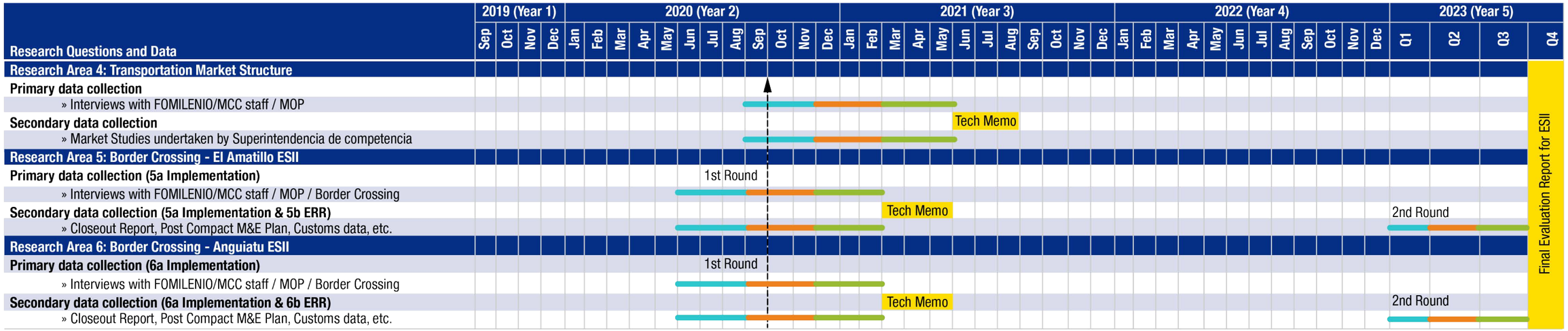

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3. Research Area 0: Project Implementation

3.1 Introduction

The purpose of this RA is to examine whether the projects were implemented in accordance with the plans set out in their respective compacts, specifically:

- Was the Connectivity Project implemented according to plan?
- Was the LIP Highway Expansion Activity implemented according to plan?

This first RA will provide a reference point for the other subsequent RQs by highlighting changes in project scope. The economic outcomes of scope changes will be analyzed in RA1.

3.2 Methodology

As noted, this RA seeks to examine differences in implementation, highlighting key variations from the original design concepts (that is, compare planned versus actual implementation). To limit the analysis, given the potentially large number of small changes, the ET expects to review, and document only changes that could materially affect the expected economic outcomes.

As part of this RA, the ET team also seeks to understand how changes to the project scope were managed and documented during the 5 years covering project delivery. Inevitably, all projects evolve from early feasibility designs through to final design and construction, as they move through the various stages of the project life cycle. The ET will highlight significant changes between the following stages:

- Design assumptions pre-compact up to the point of signing, supported by their respective IMs
- During project implementation, when most changes are expected to occur, potentially with multiple phases of work

One important consideration is whether changes in scope improved or reduced the expected economic outcomes (for example, an increased construction period or actual cost would reduce the ERR). Another example is changes in specifications (for example, the ET noted during the field trip that sections of the NTH were constructed with rigid pavements, and other sections with flexible asphalt pavements, with contractors adopting different design solutions for their respective road sections).

For ESII, there is an expectation that costs overruns will be managed "…through a reduction in scope and/or value engineering in a manner that seeks to fulfil the Activity Objective while maintaining an anticipated ERR of at least 10 percent…" (MCC, 2014a).

The ET will examine and comment on how change control was managed during the project life cycle. The ET will also comment about whether enough checks were done to assess the potential changes in benefits using HDM-4 (RA1). Finally, the ET will comment on potential lessons learned from project implementation for future compacts.

For both RQs, the ET will focus on the following indicators:

- Number of lane kilometers upgraded, rehabilitated, or constructed: The goal is to compare what was planned and what was built; if a discrepancy is found, the ET will investigate the reasons why. This is particularly relevant for ESI, where the number of kilometers of road changed during delivery. The ET notes that climbing lanes were added to some sections of ESI to improve road performance on steep gradients, but understands this additional cost is not reflected in the HDM-4 workspaces so far shared with the ET.
- Project timing and duration: The aim is to determine whether the investment was delivered in the expected time frame, and if not, to investigate the deviations. This is important in the economic

case, as a longer construction period will reduce the ERR due to construction cost inflation and delays to the realization of benefits that have a higher discount rate in later years of the economic appraisal.

- Investment actual costs: The ET will look at the overall actual cost of the projects to determine whether costs exceeded allocated budgets, or whether cost overruns were managed by reducing scope or use of risk allowances. The ET will document the reasons for the cost overruns from available data and reports produced by an independent engineer during construction.
- Changes to pavement design and road construction: The ET will comment on the differences in road and pavement design where they affect the economic outcomes (that is, trade-offs between higher investment costs and lower maintenance costs and vice versa).

The ET may propose additional metrics as the analysis proceeds.

3.3 Primary Data Requirements

A mix of primary and secondary data sources is proposed for both ESI and ESII. The methodology outlined in Section 3.2 relies heavily on documented differences between phases as captured by FOMILENIO I and FOMILENIO II. The ET intends to conduct interviews primarily to verify our interpretation of the documents listed in Tables 3-1 and 3-2. The interviews will allow the ET to understand from those involved some of the challenges with the implementation, reasons for design changes, and subsequent modeling of these changes.

The ET staff in charge of conducting the interviews will be the ET's key personnel who will be able to work in Spanish and English. The interviewers will use a pre-written interview guide or questionnaire. The interview questions and the category of people to be questioned will be based on a review of the documents outlined in this section.

The following interviews are proposed:

3.3.1 Primary ESI Interviews:

- MCC staff involved in developing the connectivity section of the 2006 IM, if available
- FOMILENIO I staff involving in drafting the Connectivity section of the Compact Agreement
- FOMILENIO I staff involved in the implementation of the Connectivity elements
- MOP staff as the key implementing organization working with FOMILENIO and responsible for tendering construction contracts
- Independent Supervising Engineer responsible for managing and agreeing to changes in scope
- FOVIAL as the entity responsible for maintaining the NTH

3.3.2 Primary ESII Interviews:

- MCC staff involved in LIP element development, including the relevant economist
- FOMILENIO II staff involved in drafting and preparing the LIP elements
- FOMILENIO II staff involved in delivery of the LIP elements
- MOP staff as the key implementing organization, responsible for tendering construction contracts
- Independent Supervising Engineer, currently providing oversight of LIP highway construction activities

Table 3-1 provides a summary of the proposed primary data collection.

Table 3-1. Summary of Primary Data Collection

Data Collection	Timing (includes multiple rounds)	Sample Unit or Respondent	Sample Size	Relevant Instruments	Time Required (weeks)
ESI Interviews	February to March 2020 (only a single trip envisaged)	MCC MOP FOMILENIO I FOVIAL Other stakeholders	At least one key informant per organization but likely up to four	Interview guide	1
ESII Interviews	September, October, November 2020 (only a single trip envisaged)	MCC MOP FOMILENIO II FOVIAL Other stakeholders	At least one key informant per organization but likely up to four	Interview guide	1

3.4 Secondary Data Requirements

For secondary data collection, the ET will seek to examine the following document types:

- Compact Closeout Report
- Post-Compact M&E Plan
- Independent engineering reports, including original design
- As-built drawings
- Progress and annual reports
- Completion reports
- Contract amendments
- Costing reports

Table 3-2 lists an initial list of documents to be reviewed.

Table 3-2. Secondary Data Required for ESI

Compact Stage	Documents to be Reviewed
Pre-Compact Before 2006	El Salvador Redacted IM Final (MCC El Salvador Transaction Team, 2006) The Compact Agreement (MCC, 2006a) Due Diligence of Infrastructure Components Final Report (Roche, 2006)
Project Implementation 2006 - 2012	Mejoramiento de la Red Vial de la Zone Norte de El Salvador (Consulta/Parsons Brinckerhoff, 2009b) Estudio de Impacto Ambiental. Factibilidad Tecnica y Diseno Final (Consulta/Parsons Brinckerhoff, 2009a) Post-Compact M&E Plan (FOMILENIO I, 2013a) Compact Completion Report (Revised) (FOMILENIO I, 2017) Final Costs per Section (FOMILENIO I, 2013b) Impact Evaluation of Millennium Challenge Corporation Connectivity Project in El Salvador (Torero et al, 2017) Compact Closeout Indicator Tracking Table. Post Compact ITT

The ET's understanding is that the memorandum of understanding (MOU) for access to MOP and FOVIAL ESI data is not currently signed (as of October 2019). The ET do not believe that the MOU is critical to the ET's effective delivery of the evaluation, based on the data and reports already received and discussions held with MOP during the February 2019 site visit.

For ESII, the analysis will cover the Coastal Highway Expansion and the Border Crossing Infrastructure Activities, including infrastructure improvements made at El Amatillo. Anguiatú will also reviewed. Table 3-3 lists the proposed documents to be reviewed. This list may be expanded after discussion with FOMILENIO II.

Table 3-3. Secondary Data Required for ESII

Compact Stage	Documents to be Reviewed
Pre-Compact Before 2014	El Salvador II Redacted IM (MCC, 2013) Estudio de Factibilidad y diseno Final del Proyecto (Acciona Ingeneria, 2016) Estudio de Factibilidad y diseno Final del Proyecto (Eurostudios, 2016) El Salvador II Millennium Challenge Compact (MCC, 2014a)
Project Implementation 2015 – 2020	El Salvador II Program Implementation Agreement (MCC, 2015a) Monitoring and Evaluation (M&E) Plan for ESII (FOMILENIO II, 2015) Compact Progress Reports submitted to MCC Annual Reports Independent Engineer Reports Trip reports prepared by the DCO staff
Post-Project 2020 onwards	Compact Closure Report (Expected to be published late 2020, FOMIELNIO II) Post-Compact M&E Report (MCC, date TBC) Compact Closeout Indicator Tracking Table. Post Compact ITT

3.5 Data Collection and Analysis Timeline

There is no restriction on data collection for ESI, as the compact closed in 2012 and a Compact Completion Report was published in 2017 (FOMILENIO I, 2017). All the documents in Table 3-2 are already to hand.

ESII data collection will take place after the compact ends between September and November 2020, and the Compact Closure Report is published.

3.6 Analysis Plan

The analysis will be summarized as shown in Table 3-4, with separate tables for each compact, supported by a technical report. This is not a comprehensive list of data or parameters but provides an indication of some of the key items that will be reviewed. The format shown in Table 3-5 will allow a roadmap to be created of how the project changed from pre- to post-project, together with a commentary on the key variances.

The analysis will be described in the respective compact evaluation reports.

Table 3-4. Proposed Analysis Plan

Data	Definition	Pre-Compact at Time of Signing	Post-Project	Discrepancies, with Source
Road Length	Number of kilometers upgraded, rehabilitated, or constructed	See baseline	To be completed as part of evaluation	To be completed as part of evaluation
Project Time and Duration	Delays against program schedule that affect timing of costs and benefits	See baseline		
Investment Costs	The fees paid and those programed to be paid for each activity of the road construction process	See baseline		
Road Design and Construction	Changes in design or specification that affect the expected ERR	See baseline		
Build Quality	Whether implementation was consistent with final design in relation to build quality	To be completed as part of evaluation		

4. Research Area 1: Engineering Analysis and Economic Modeling

4.1 Introduction

This RA involves re-running HDM-4 to understand the post-project ERR, and seeks to address the following research questions:

- What is the Connectivity Project's economic return – calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time?
- *Optional:* How could the project have been designed to result in a higher ERR?
- What is the LIP Coastal Highway Expansion Activity economic return – calculated in terms of VOC savings and TTS? What factors drove changes to the ERR over time?
- *Optional:* How could the project have been designed to result in a higher ERR?

The analysis in RA1 does not include the Border Crossing Infrastructure Activity's economic return which were developed in a Microsoft Excel workbook and a separate HDM-4 workspace (for the 5.7km border approach road only). Engineering analysis and economic modeling of Border Crossing Infrastructure Activity's activities are covered by RQ5b and RQ6b.

To address the RQs, the ET will refresh assumptions within HDM-4 to reflect the iterations of the project scope. The ET will track how the ERRs have changed and highlight key reasons for variances. This RA also links closely with RA0 Project Implementation, since variances in project scope will change ERRs.

The ET will seek to minimize primary data collection with the intent that all the primary data can be reused for other RQs. Primary data collected as part of RA2 Road Maintenance and RA3 Road Usage Patterns will be used to assess the post-project ERR and to improve the analytical assurance of the ERR calculations.

For the Connectivity Project and Coastal Highway Expansion Activity, the ET assumes that access to as-built drawings and construction records will be available to check and populate the HDM-4 workspaces, if needed. In the absence of these, primary data surveys may be needed, but potential alternative methods will be discussed with MCC in advance given the likely level of effort and cost.

Also, the ET does not propose to undertake any deflection surveys to determine the residual asset life of road sections. This is because in subtropical countries, the more common mode of road deterioration is aging of the bituminous surfacing, resulting in top-down cracking. Deflections are unlikely to indicate when these roads will fail because the top-down cracking happens before the fatigue deterioration in the lower layers. In addition, deflections do not change significantly on a road until the later stages of their design life when noticeable deterioration is occurring. Further details are provided in Appendix D.

4.2 HDM-4 Calibration

Before undertaking any new ERR calculations, the ET will calibrate the HDM-4 relationships to reflect pavement deterioration rates under El Salvadoran conditions. HDM-4 calibration is not completed separately for ESI or ESII. Moreover, calibration reflects pavement deterioration of bituminous roads in El Salvador. Once the relationships are calibrated, HDM-4 can be used for other road investment projects.

Two levels of calibration are envisaged as follows:

- Level 1 Calibration (Desk Study)

- Level 2 Calibration (Field Study)

4.2.1 Level 1 Calibration (Desk Study)

To derive more robust ERRs, it is necessary to calibrate the pavement deterioration relationships in HDM-4 so that predicted road conditions match observed road conditions. This has already been done using data from the various LIP and NTH workspaces provided by MCC. The calibration parameters are described in a separate report (Jacobs, 2019a)

Once HDM-4 has been calibrated, it will be used for LIP and NTH workspaces to calculate ERRs.

4.2.2 Level 2 Calibration (Field Study)

A Level 2 calibration of the road deterioration relationships involves the selection of short sections of road (typically, 100 to 500 meters [m]) that represent the types of road being analyzed in HDM-4 (in this case, bituminous roads), covering a range of values for parameters such as:

- Traffic levels (average annual daily traffic [AADT])
- Type of surfacing (for example, asphaltic concrete, surface dressing)
- Age of the pavement surface
- Pavement strength
- Condition of the surfacing (for example, cracking, rutting, potholing, roughness)

On the sections selected for calibration, the range of each parameter should cover the range of the roads being analyzed. For example, if high-trafficked sections of road are being analyzed, then calibration sections with these high traffic levels should be selected for calibration.

The condition of each of these sections is recorded and their observed condition compared with that predicted by the HDM-4 deterioration relationships for that type of road. The calibration factors for the deterioration relationships are then adjusted so that the predicted values for each distress match the observed values.

4.3 General Methodology

Assuming a satisfactory HDM-4 calibration is achieved (either Level 1 or Level 2), the ET intends to re-run HDM-4 several times to reflect the ‘as-delivered’ projects using either updated assumptions, actual costs and/or new traffic data. This analysis will address the key research question to estimate the post-project ERR achieved by both the Connectivity Project and the LIP.

As a large number of permutations are possible, the ET will adopt an incremental approach, so that the effect of individual changes can be understood and reported, holding other assumptions constant. The approach to all HDM-4 runs is listed in Table 4-1. Updated ERR calculations will be made as a series of sensitivity tests.

Table 4-1. General Approach to Update of ERR calculation using HDM-4

Activity	Economic Metric	HDM-4 Calibration	Pre-Compact at Time of Signing	Post-Project
Connectivity Project or Coastal Highway Expansion Activity	ERR	None	As reported in IM	As reported by MOP during any design changes during implementation
Connectivity Project or Coastal Highway Expansion Activity	ERR	Level 1	Estimated by ET	Estimated by ET
Connectivity Project or Coastal Highway Expansion Activity	ERR	Level 2	Estimated by ET	Estimated by ET

[a] Sensitivity tests will be run with revised traffic assumptions and revised economic values.

4.4 Detailed Methodology: Connectivity Project

Once the Level 1 calibration is completed, the ET will re-run HDM-4 separately as follows.

4.4.1 Pre-Compact

The ET will:

- Re-run the original workspace with the newly calibrated HDM-4 model to see if the ERR output matches the 23.9 percent reported in the IM (MCC, 2006). No other changes will be made to the workspace.
- Compare the IM ERR with the revised ERR and describe reasons for the variations.

4.4.2 Post-Project

To refresh the ERR calculation, the ET will:

1) Review the HDM-4 workspace used to generate the values reported in the IM (MCC, 2006b).
2) Adjust for obvious errors or anomalies in the workspace.
3) Conduct a revised run of HDM-4. Any remaining concerns with the veracity of the data in the ESI HDM-4 workspace will be documented.
4) Obtain a revised ERR for the Connectivity Project post-project. The ET understands that the workspace was updated in 2011 to reflect changes to project scope and this update generated a slightly decreased ERR of 21.6 percent.
5) Compare the reported ERR with the revised ERR; describe the reasons for the variations; and suggest ways the ERR could have been increased through changes in project scope, delivery, and timing.

4.4.3 Model Sensitivity Tests

In addition to these HDM-4 model runs (which will represent our central view of the actual ERR), the ET also proposes the following series of sensitivity tests:

- Sensitivity Test 1: Updated Economic Unit Costs and actual construction costs. The ET will re-run HDM-4 with revised economic unit costs, such as values of time and vehicle components. Consistent economic parameters will be used for all HDM-4 runs. The ET will collect new data where possible to update the economic unit costs, drawing on publicly available sources. The ET does not foresee the need for any primary research.

- Sensitivity Test 2: Updated Traffic Forecasts: As the NTH is open for traffic, it is possible to update AADT values by section in HDM-4 with actual rather than forecast flows. The main difficulty for the ET will be splitting traffic into reassigned and induced components. For this, the ET will use reasonable assumptions to infer splits using a plausible range from available data sets. As noted in section 6 this analysis will be considerably enhanced if the ET are provided with access to MOP's traffic count database.
- Sensitivity Test 3: Removal of Exogenous Benefits: The ET will re-run HDM-4 workspaces with exogenous benefits removed (that is, accident and land value uplift assumptions to understand the sensitivity of the final ERRs).
- Sensitivity Test 4: Actual Road Maintenance: The ET will re-run HDM-4 reflecting actual maintenance undertaken rather than that specified in the HDM-4 workspaces.

Sensitivity tests will be run for the Connectivity Project as summarized in Table 4-2.

Table 4-2. Analysis Summary with Estimated ERRs from HDM-4 Analysis

Project	Definition	Pre-Compact at Time of Signing	Post-Project	Explanation of the discrepancies and source
Connectivity Project	No calibration	IM value 23.9%	21.6%[a]	Set out in Evaluation Report or Technical Memorandum
	Level 1 Calibration	ERR to be estimated by ET	ERR to be estimated by ET	
	Level 2 Calibration	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 1	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 2	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 3	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 4	ERR to be estimated by ET	ERR to be estimated by ET	

[a] As reported by MCC (see https://www.mcc.gov/where-we-work/program/el-salvador-compact#project-sv-c-1-connectivity-project)

4.5 Detailed Methodology: Coastal Highway Expansion Activity

Once the Level 1 calibration is completed, the ET will re-run HDM-4 separately for the Coastal Highway Expansion Project, as follows.

4.5.1 Pre-Compact

- Re-run the workspaces with a calibrated model and report on revised ERR values
- Re-run the workspaces correcting for any obvious errors and documenting concerns

4.5.2 Post-Project

- Review the HDM-4 workspace used to generate the values reported in the IM
- Adjust for obvious errors or anomalies in the workspace
- Conduct a revised run of HDM-4; any remaining concerns with the veracity of the data in the Coastal Highway Expansion Project HDM-4 workspace will be described and documented
- Obtain a revised ERR for the post-project period, considering reported design changes and expected changes in cost
- Compare the reported ERR with the revised ERR, and describe the reasons for the variations

4.5.3 Model Sensitivity Tests

Sensitivity tests will also be run for the Coastal Highway Expansion Activity as summarized in Table 4-3 using the same tests as described 4.4.3.

Table 4-3. Analysis Summary with Estimated ERRs from HDM-4 Analysis

Project	Definition	Pre-Compact at Time of Signing	Post-Project	Explanation of the discrepancies and source
Coastal Highway Expansion Activity	No calibration	17% (Acciona) and 18% (Euroestudios)	ERR to be estimated by ET	Set out in Evaluation Report or Technical Memorandum
	Level 1 Calibration	ERR to be estimated by ET	ERR to be estimated by ET	
	Level 2 Calibration	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 1	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 2	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 3	ERR to be estimated by ET	ERR to be estimated by ET	
	Sensitivity Test 4	ERR to be estimated by ET	ERR to be estimated by ET	

4.6 Time Frame of Exposure

As the NTH was completed in 2012 an immediate start can be made on the analysis described.

The ET expects a traffic ramp-up period for all LIP activities, although it was noted during the field trip that the existing coastal highway road was well-used despite the restrictions imposed by construction work. Typically, the timeframe of exposure for a new road is 1 to 3 years, but interurban roads may experience longer periods of ramp-up. With this in mind the primary data will be collected in 2021 and 2023. The first round of data is planned to capture short-run effects while the second will capture long-run effects.

4.7 Primary and Secondary Data Collection

As noted, the ET does not anticipate the need for new primary data collection to re-run HDM-4, since the task is to update and re-run the existing model, and workspaces were created for both projects. However, primary data collected as part of RA2 will be used as inputs to improve the analytical assurance of the ERR calculations, as well as traffic data collected for other RAs (Table 4-4).

Table 4-4. Primary and Secondary Data Collection Proposed

Primary Data	Provided By	Use or Rationale
IRI	RQ2a	Not required for Level 1 but will be used for Level 2 calibration.
Classified traffic counts by vehicle type and road section	RQ3a	Use to populate HDM-4 model with actual traffic data by road section. Only required for post-project completion.
Secondary Data		
Economic Parameters, including VOC and VOT data, maintenance unit costs	Publicly available sources	Update key economic parameters (e.g., VOT, vehicle components) for El Salvador. Effort restricted to checking values in MOP workspaces; maintenance unit costs to be sourced from RQ2a.
Actual cost data	FOMILENIO	Used to calculate ERR.
Future road maintenance policies and practices	RQ2A	Used to validate assumptions in HDM-4.

4.8 Analysis Plan

HDM-4 will be run and estimated ERRs summarized, as shown in Tables 4-2 and 4-3, with a rationale and commentary provided for the changes.

5. Research Area 2: Road Maintenance

5.1 Introduction

For any road project, long-term road maintenance is necessary to realize the long-term benefits of MCC's investment. Without appropriate maintenance, roads may degrade much faster than expected, and the full economic benefits may not be realized in the long run.

This RA covers two road maintenance RQs and a single RQ covering political economy analysis related to road maintenance, as follows:

RQ2a: Road Maintenance Practices

- What is the likelihood that the investments made under the Connectivity Project will remain adequately maintained?
- What is the likelihood that the investments made under the LIP Coastal Highway Expansion Activity will remain adequately maintained?
- Based on this assessment, what set of maintenance assumptions should be used in HDM-4 to yield the best estimate of road investment costs and benefits?

RQ2b: Road Maintenance – Condition Precedent

- What was the effect of the Conditions Precedent on the LIP for road maintenance funding? This question applies to ESII only.

Note the CPs are different for each compact, with ESII relying on a gas tax to generate funding for road maintenance activities in El Salvador.

RQ2c: Road Maintenance – Factors Shaping Road Maintenance

- What political and economic incentives are shaping road maintenance decisions in the country?
- What other key factors are influencing actual maintenance practices?

Road maintenance activities apply to all roads within El Salvador rather than specifically the Connectivity Project or LIP. The ET's conclusions will be specific to safeguarding maintenance of MCC's investments.

5.2 Methodology

The application of appropriate road maintenance is a key requirement for achieving the expected economic benefits from MCC's road investments. A central assumption of assessing the long-term economic effects of a road investment is that MCC's road investments will be maintained and in this respect, maintenance assumptions are explicitly included in HDM-4. The ET proposed a mixed approach using both primary and secondary data sets taking a view across the whole El Salvador highway network since maintenance practices are applied to all roads not just MCC's.

By direct observation (visual condition surveys and IRI measurements) and through stakeholder interviews, the ET will be able to provide an independent view on the appropriateness of current maintenance practices (or lack of) and how these compare to international best practice techniques. The ET note that little or no maintenance appears to have taken place on the NTH evidenced by raveling on some sections despite the relatively recent rehabilitation and low traffic volumes, based on the field trip. In other words, the ET will seek to understand how bad does the condition of the NTH have to get before MOP will undertake any maintenance?

The first task for the ET will be to understand how road maintenance is currently meant to take place according to agreed practices between MOP and FOVIAL (and any other maintenance providers). Road maintenance clearly takes place in El Salvador, evidenced by sections of the Pan-American Highway receiving overlays close to the capital (San Salvador), and verbal comments made by MOP that road condition data are collected, presumably to identify and formulate an annual maintenance plan. The ET will build a picture of how maintenance is managed, and from this, conclude whether the Coastal Highway Expansion Activities road sections are likely to be maintained. If necessary, the ET will change the maintenance assumptions in HDM-4 to reflect actual maintenance practices and re-run various workspaces to re-estimate the ERRs.

MCC is aware of the need to provide adequate maintenance for infrastructure investments. During development of ESI and ESII, MCC found that the capacity for maintenance at FOVIAL and MOP was satisfactory, but that funding for maintenance could be improved (MCC, 2006, 2013). For this reason, ESI and ESII included the CPs so that adequate funding and planning for maintenance could be provided after compact closure. Thus, RQ2b assesses the effects of these efforts for ESII. Also, any effects resulting from MCC's maintenance improvement efforts will then be considered in answering RQs 2a and 2c.

Road maintenance practices are not just affected by funding levels and the technical capacity of maintenance staff, but also by political economy factors. Maintenance priorities do not always follow strict adherence to best practices and can be influenced by political pressure. Additionally, there can be political tradeoffs between spending scarce public resources on road maintenance (which tends to have lower visibility to the public) versus major road construction and rehabilitation. Thus, the political economy assessment will examine the many actors involved in the funding, prioritization, and implementation of road maintenance; the actors' primary incentives regarding maintenance; and their efforts (if any) to influence it. These political economy factors will then be considered when answering RQs 2a and 2b.

5.3 Detailed Methodology

The maintenance RQs will be addressed through a mixed-methods approach combining the following strategies:

- Visual condition surveys
- IRI measurement of roads
- Qualitative interviews
- Review of maintenance records
- Quantitative assessment of maintenance budgets and expenditures

5.3.1 Research Question 2a: Road Maintenance Practices

5.3.1.1 ESI Approach

The ESI road sections are currently more than 7 years old, having been fully completed in 2012. For the re-analysis of the ESI project, the pre-investment roughness at year 0 in the previous HDM-4 analysis will be used, as it can no longer be derived. Furthermore, roughness progressions will be modelled in HDM-4 using the calibrated road deterioration relationships, as described in RA1.

To provide independent data, the ET proposes to undertake roughness surveys on the NTH to examine the effectiveness of maintenance practices, including a potential need for a realignment of the maintenance intervention criteria to reflect actual maintenance carried out since construction of the road sections.

Note that in order to complete the evaluation of ESI by September 2020 the analysis will be necessarily more limited but the issue of why no road maintenance appears to have taken place will be documented, and this analysis will inform work on ESII later in the evaluation. The Evaluation Team will review current maintenance practices as this is required in any case for the HDM-4 model.

5.3.1.2 ESII Approach

The ESII road sections are currently being rehabilitated or constructed. On completion of road section construction in 2020, the roughness of these sections will be low (IRI between 1.5 and 2.5) for the next few years, unless the construction is poor quality. Hence, it is proposed that roughness surveys on the ESII roads not be undertaken before 2023, which would be 3 years after the end of construction and consistent with expected traffic ramp-up. This length of time is appropriate because it will allow enough time for some road operation and maintenance (O&M) to have taken place, while being within the overall project timeline.

5.3.1.3 Detailed Approach (ESI and ESII)

The ET propose to proceed as follows:

1) Review actual maintenance practices and records undertaken by FOVIAL and MOP. Maintenance records will serve two purposes: they will provide an overview of FOVIAL's maintenance practices and their relative costs, which can be compared with regional averages and best practices; and they will provide a sampling frame for the visual condition surveys.
2) Assess whether road maintenance intervention criteria need to be adjusted in HDM-4 based on observed maintenance practices (this could have the effect of reducing project ERRs as the road's roughness deteriorates more rapidly due to lack of maintenance).
3) Undertake visual condition and IRI surveys for ESI, given the final section was opened for traffic in 2012. These measurements will provide the ET with independent data that can be cross-referenced with data collected by MOP across the wider network and possibly already collected for ESI by MOP and FOVIAL.
4) Start surveys for ESII on the newly constructed road in 2023, 3-years after opening.

The ET will review documentation and undertake direct interviews with road maintenance authorities to determine whether:

- The documentation of maintenance processes provides enough detail on maintenance requirements to support roads being maintained at an adequate standard.
- The processes described in written road maintenance documentation are being applied daily, by corroborating processes versus maintenance records, as well as corroborating processes by discussions with maintenance staff.

In addition to maintenance records and upcoming plans, the ET will also seek detailed budget and expenditure data from FOVIAL. These data would ideally include annual anticipated budgets, funds made available to FOVIAL, and total expended (including disaggregation by types of maintenance and class of road, where possible). Financial data will be sought for every year from 2005 to present day.

The ET would also like to see additional information (and sample contracts, if possible) for the contracted maintenance firms that are implementing road maintenance on the network. Maintenance procedures and planning protocols would also be useful to the ET in better understanding how FOVIAL approaches maintenance.

Should there be any significant gaps in data or doubts over the completeness of the data, the ET will propose additional checks and interventions so that the standard of maintenance can be adequately assessed.

5.3.2 Research Question 2b: Road Maintenance – Conditions Precedent (applies to ESII Only)

Due to the elapsed time and in agreement with MCC, the ET does not propose to undertake any work on the ESI CP. This RQ therefore applies to ESII only. The primary objective of the CP is to generate funding for road maintenance activities which is not dependent on general taxation. The CP for ESII is a gas tax whereby a small tax is added to gas prices and collected for road maintenance activities. ESII established a maintenance CP that commits GoES, via the gas tax, to increase its annual road maintenance budget exclusively for FOVIAL by at least 20 percent, or the amount set forth in the Road Maintenance Study, whichever is less.

In cases where MCC has invested in improving maintenance practices or included a maintenance CP, the focus is primarily on the roads constructed with MCC assistance. Where no maintenance is undertaken the standard of the road can quickly deteriorate and the expected benefits eroded. This issue will be explored further in the HDM-4 analysis where a range of maintenance intervention strategies can be specified.

The ET recognizes that MCC is interested in general maintenance standards because this will have a bearing on the likelihood that MCC's investment will be protected beyond the timeline of the compact, and that a functioning highway network is as important as any single improved section to achieve the wider compact objectives. The objective of this RQ is to understand what has happened to road maintenance activities as a result of a CP compared to a counter-factual or do-minimum where no additional funding was provided.

In respect to RQ2b, by ESII close, the initial effects of the ESII maintenance CP on maintenance funding should be observable, as the gas tax increases have already started to come into effect. However, the sustainability of those effects would not yet be apparent on the wider highway network.

Maintenance funding is closely linked to GoES budget funding cycles. Thus, data collection in 2021 will allow for a new budget cycle to begin and for any post-compact changes in funding to be felt. The data will be revisited and updated in 2023 with a third round to provide a revised position for the final report.

For ESII, the ET will examine how these policies have worked in practice, and whether there has been any change in behaviors and process by FOVIAL and MOP.

The ET's approach will seek to determine:

- MCC's expectation about changes from the CP and whether the expectation has been realized
- A counter-factual position (that is, without the CP)
- Whether the CP has had a marginal effect on road maintenance in the country
- Whether the CP has had enough effect on maintenance in El Salvador to maintain MCC assets, and why it has or has not been effective
- Whether CP funding has been adequately secured and 'ring-fenced' for maintenance i.e. not used by GoES for other areas of government spending.
- Whether CP funding is enough to adequately provide for maintenance

5.3.3 Research Question 2c: Road Maintenance – Factors Shaping Road Maintenance

For RQ2c, the findings will be analyzed using USAID's 2018 political economy framework assessing the 'foundational factors', 'rules of the game', the "here and now," as well as the dynamics of how the first three factors interact (Menocal et al., 2018). The question aims to understand the political and economic incentives shaping road maintenance decisions in the country, and what other key factors are influencing actual maintenance practices. These analysis approaches are discussed below in section 5.7.2.

Semi-structured interviews will be used to provide insights about how and why road maintenance and its funding happen - both officially, as well as in practice. Though all data will be used as inputs to the political economy assessment, the interviews are important in helping to understand the roles of different actors, as well as their incentives around maintenance. The interviews will help provide a nuanced understanding of road maintenance practices in El Salvador.

5.4 Time Frame of Exposure

For the ESI investments, data collection in 2020 will provide observable change on the MCC-supported roads after 7 years. Thus, though predictions will still have to be made regarding future maintenance (up to the expected remaining service life of the road), the ET will be able to observe what has been done (or not) for the first 7 years. The ET expects that some routine and recurrent maintenance would be needed within 7 years of construction, though the need for periodic maintenance is not likely unless there were serious design or construction issues.

Within 7 years of construction, the ET expect that routine maintenance, such as clearing drainage structures, repair or repainting signage and road markings, and clearing vegetation, would have occurred regularly. Recurrent maintenance, such as repairing cracks, potholes, and other minor defects, may also have occurred in this time as needs dictate. Thus, through visual condition surveys and reviews of maintenance records, the ET will be able to directly assess the extent to which this maintenance has occurred, which will provide a strong predictor of whether additional maintenance will be conducted in the future.

A similar process for ESII will be followed albeit 3 years after the compact ends.

5.5 Primary Data Collection

5.5.1 International Roughness Index

Road roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (thus, the road user's experience). Roughness changes VOCs and maintenance costs, as well as travel times; therefore, it is an important pavement characteristic. IRI is used to define a characteristic of the longitudinal profile of a traveled wheel track and constitutes a standardized roughness measurement in meters per kilometer. IRI measurements will be collected for all roads sections in both compacts using a laser profilometer.

5.5.2 International Roughness Index Sampling

IRI surveys can be conducted on the NTH in 2020, as these road sections have showed signs of deterioration some 7 to 10 years after construction. All sections of the NTH will be sampled.

The LIP sections are currently under construction; therefore, they do not need to be surveyed until deterioration of parts of the sections begin to be visible, but the earliest time will be 2023. All sections of the LIP will be sampled. The ET assumes that IRI surveys will be undertaken as part of the hand-over and acceptance of the road once construction is finished. The working assumption is that the highway will meet the IRI standard set out in the design specification, if not this will be noted in the project implementation research area RA0.

5.5.3 Visual Condition Survey

Visual condition surveys will be undertaken at the same time as the IRI surveys for both the LIP and NTH. A visual road condition survey in accordance with the *Distress Identification Manual for the Long-Term Pavement Performance* (LTPP) (DOT, 2003) will be conducted on project roads to record their condition. These surveys can be conducted on ESI in 2020, as these road sections have showed signs

of deterioration 7 to 10 years after construction. ESII sections are currently under construction; therefore, they should not be surveyed until deterioration of parts of the sections begin to be visible.

The ET proposes to conduct visual surveys using a dashcam along on the entire lengths of the road sections. As this is a continuous survey along the road, no sampling intervals will be applied. A dashcam will be used to record defects on the road and could be incorporated into the vehicle used to measure IRI. In this case, the dashcam will record footage for each lane of road. This footage will then be reviewed in an office environment, and a second pass will be made to allow closer visual inspection of defects and any structures not visible on the dashcam, by walking and physical measurement.

5.5.4 Semi-structured Interviews

Semi-structured interviews will aim to collect a broad spectrum of stakeholder perspectives on road maintenance in El Salvador. Thus, interviews will be conducted with:

- MCC and FOMILENIO staff
- GoES officials (including the MOP)
- FOVIAL staff
- Maintenance contractor staff
- Other donors, transport operators, and transport associations

Sampling among each type of respondent during semi-structured interviews will be intended to maximize potential learning. The specific selection criteria for each type of respondent are discussed in this section, and the total number of anticipated respondents is summarized in Table 5-1. Interviews will be conducted either with individuals or with small groups of two to three individuals. ET will target those respondents who are or were most closely involved in the road projects and in maintenance, specifically. This would include:

- Former Connectivity staff (ESI, if available)
- LIP staff (ESII)
- M&E staff

The ET will consult with current staff to determine who the best respondents are and to encourage their participation in the evaluation. It is recognized that a more limited round of interviews may only be possible for ESI given the elapsed time.

Among GoES officials, the ET will target:

- MOP staff
- Staff within the broader Ministries of Public Works, including Transport, Housing, and Urban Development, and the Ministry of Finance

Staff with specific roles relevant to the implementation, management, and funding of road maintenance will be targeted. The ET will target individuals in both managerial and technical roles. To the extent possible, both men and women will be interviewed to avoid gender bias in the results.

At FOVIAL, the ET will target technical, financial, and managerial staff to glean a variety of perspectives on road maintenance planning, funding, and implementation. The ET will consult with FOMILENIO and local consultants regarding the best individuals to interview.

FOVIAL currently contracts with private firms to conduct maintenance of the primary network. Thus, the ET would like to interview members of these maintenance firms to get their perspectives on how maintenance is planned for and implemented. The ET will target those who have the most relevant

knowledge and involvement in maintaining the El Salvador road network, to include both technical and managerial staff.

Other donors who are active in the roads sector (and road maintenance, specifically) will add an outside perspective to the discussions. Targeted donors include:

- USAID
- IDB
- World Bank
- Development Bank of Latin America
- Central American Bank for Economic Integration

At each donor agency, the ET will target respondents who are most heavily involved in the donor's road sector work; in particular, those involved in any road maintenance improvement projects.

To gain a view of road user perspectives on road maintenance across the country, the ET will also interview transportation operators, including trucking companies and passenger transportation companies. The ET will target those operating on different routes and different types of operators to gain a broad view of perceptions of the road network quality. If lists of transportation operators can be obtained from the GoES or business associations, the operators will be selected from these lists. If such lists cannot be obtained, the ET will solicit advice from the business associations and FOMILENIO II regarding potential operators to interview.

Similar to the inclusion of specific operators, representatives of transportation associations will also be interviewed. Representatives of these organizations with the most knowledge of the road infrastructure, status, and maintenance will be targeted. Table 5-1 shows the anticipated sample size by respondent.

Table 5-1. Anticipated Sample Size by Respondent Type

Respondent Group	Approximate Sample Size (No. of Respondents)
MCC and FOMILENIO Staff	4-6
GoES Officials	6-10
FOVIAL Staff	6-8
Maintenance Contractor Staff	4-5
Other Donors	5-10
Transportation Operators	5-10
Transportation Associations	1-3
Total	**32-52**

Notes:

No. = number

During the second round of data collection in 2021, interviews will be conducted with a smaller subset of the listed respondents, focusing primarily on GoES staff, maintenance contractor staff, and other donors. The goal will be to get a brief update on how the funding situation for maintenance changed since the end of ESII. A third and final round of data collection is planned in 2023. The second and third rounds of data collection are anticipated to be smaller to avoid excessive costs.

5.5.5 Survey Instruments

For each of the types of respondents mentioned, a separate interview protocol will be created. Though some questions will overlap between groups, each will be designed to capture respondents' unique perspectives and insights. Common questions will focus on the relevant actors involved in road maintenance and perspectives on the key challenges and barriers to road maintenance.

Protocols for MCC and FOMILENIO staff will focus on their efforts to engage with and observe FOVIAL and GoES regarding maintenance. In particular, they will focus on experiences trying to implement and provide follow-through on the maintenance-related CPs.

Protocols with GoES officials will focus on detailing different perspectives on the key issues in road maintenance funding and implementation and unraveling the varied roles and responsibilities for maintenance planning and funding within GoES. In addition, interviews with FOVIAL staff will include questions on the day to day issues of maintenance planning and implementation. Similarly, interviews with staff from the contracted maintenance firms will provide insights into their perspectives on maintenance planning and implementation.

Interviews with donors, transportation operators, and transportation associations will provide a perspective external to GoES on the key issues, challenges, and efficacy of road maintenance in El Salvador.

5.5.6 Rounds, Locations, and Timing

Two rounds of interviews will be conducted. The first will occur in early 2020. The second round, intended to capture key changes in road maintenance funding after the end of ESII, will be conducted in 2020. 2021 and 2023. Most interviews will be conducted in San Salvador, though some interviews with key stakeholders may have to occur outside the capital, depending on the location and availability of intended respondents. Each interview will be expected to take no more than 60 to 90 minutes.

Table 5-2 summarizes the primary road maintenance data collection activities.

Table 5-2. Primary Road Maintenance Data Collection

Data Collection Approach	Timing MM/YYYY	Sample Unit or Respondent	Sample Size	Relevant Instruments and Interviews
Visual Condition Surveys and IRI Measurement	NTH March – April 2020 LIP - 2023	Road Segment	All segments of both highways	Visual Condition Surveys Protocol
Semi-structured Interviews	2020 2021 2023	Individual or Small Group	32-52 initially, reducing in subsequent rounds to provide time series data	Interview Protocols for: • MCC and FOMILENIO Staff • Ministry Officials • FOVIAL Staff • Other Donors • Transportation Operators • Transportation Associations

Notes:

Q2 = second quarter

5.6 Secondary Data

5.6.1 Access to FOVIAL Maintenance Records

The ET assumes that access will be provided to FOVIAL's detailed maintenance records for the NTH, as well as future maintenance plans. Ideally, these maintenance records would include:

- A list of all road segments maintained in the last 2 years (or longer)
- The age of each segment
- As detailed information as possible regarding what maintenance was conducted on each section
- The cost of maintenance for each section
- Information on the nature and extent of any major defects, if available

Similar data would also be requested for planned maintenance activities. If asset management models are employed, they are likely to contain the necessary data, so information will be obtained from that source if available.

The ET is currently in discussion (as of August 2019) with FOMILENIO II to obtain samples of road maintenance data for the Coastal Highway and Pan-American Highway. The ET will seek to obtain completion reports provided by the Supervisor Engineer with IRI measurements at completion.

As the ET recognizes that responses to political economy questions can be subjective, the ET will triangulate findings with existing secondary research and data. These secondary resources include existing studies of road maintenance and transportation policy decision making, such as Osborne et al. (2014), Zietlow (2004), and Streatfield (2019).

Evaluation of the maintenance questions will require substantial cooperation from the GoES and FOVIAL, specifically. The ET seeks their participation both in terms of being an active participant in interviews and the evaluation more broadly, but also in terms of sharing data, maintenance records, and budget and expenditure data. If this cooperation cannot be secured and the necessary documents and data are not provided, these sources will have to be removed from the methodology, which would then rely more heavily on the other methods, such as the interviews.

5.7 Analysis Plan

5.7.1 International Roughness Index and Visual Condition Data

The observation data will be entered directly into distress map forms and data sheets specifically designed for road condition assessment and in line with the LTPP (DOT, 2003), typically recording severity and extent of the defect. It will then be transcribed into an Excel spreadsheet where it can be analyzed. The IRI data from the laser profilometer is automatically generated for each wheel path and can be exported into Excel format. The combination of these data will aid in determining key trends across road segments. Summary statistics will be calculated for key outcomes and condition data.

The completed interview notes will be coded using VERBI GmbH's MaxQDA software or Dedoose's software, which will assist the team in identifying key trends and perspectives among the respondents.

The findings from each of these methods will be triangulated and compared to the predicted maintenance expected, given the committed investments into maintenance as agreed with MCC through the compact. These results will then be used to answer each of the three maintenance-related evaluation questions.

In 2020, the findings from this analysis will be integrated into the ESI Final Evaluation Report and will feed into the determination of the maintenance needs and the realistic maintenance case for the NTH HDM-4 run. This will be done by recalibrating the key parameters in HDM-4 so that maintenance assumptions reflect the actual maintenance undertaken and the key indicators, such as the existing IRI.

5.7.2 Political Economy Analysis

For the political economy analysis, the ET will rely on USAID's updated political economy assessment guidelines (Menocal et al., 2018) to structure the analysis. While other frameworks exist for structuring political economy analyses, such as the Overseas Development Institute's (Harris, 2013) or the World Bank's (2014). However, these frameworks are problem-driven, with a focus on identifying potential solutions (thereby, development projects) that are viable given the political economy environment. While useful for this purpose, our evaluation does not call for the identification of potential future maintenance projects. Thus, USAID's framework, which focuses more generally on the foundational factors, rules of the game, the here and now, and the dynamics between these, provides a more useful paradigm.

The foundational factors focus on key contextual factors, like long-term institutions, socioeconomic factors, and geography. The rules of the game focus on the formal and informal rules and norms, as well as the political and economic incentives that different actors face. The here and now refers to current events and circumstances affecting decision making and stakeholder behavior. The dynamics component focuses on how the first three components affect each other and interact to influence the potential for change (Menocal et al., 2018).

The timeline for the PEA is consistent with the wider road maintenance data collection efforts and can be done at the same time. After final maintenance-related data are collected in 2023, a similar process of determining the maintenance needed and the realistic maintenance case will be completed for the LIP.

6. Research Area 3: Changes in Road Usage Patterns

6.1 Introduction

The methodology described in this section was designed to identify changes in road use patterns because of improvements resulting from the Connectivity and Coastal Highway Expansion Activities. The evaluation seeks to address the following RQs:

RQ3a: Who is using the road?

1) Who is traveling on the road?
2) Why?
3) What are they transporting?
4) What are they paying for transportation?
5) How long does it take to move along key routes?

RQ3b: How has road usage changed?

1) Have road usage patterns changed in terms of who is traveling?
2) Why?
3) What they are transporting?
4) What they are paying for transportation?
5) How long it takes to move along key routes?

Through updating the HDM-4 and answering RQ1, the ET will have a good understanding of how total traffic patterns have changed. However, without a more detailed analysis of how and why the traffic patterns have changed, understanding the mechanisms of change would be limited. For this reason, RQs 3a and 3b will consider the issues around road usage patterns in more detail.

6.2 Methodology

To answer RQs 3a and 3b, the ET will use a mixed-methods approach, combining quantitative traffic counts, O-D surveys, and secondary traffic count data with qualitative interviews. These methods will provide a nuanced understanding of responses to the five RQ3a questions. Comparing road usage patterns before (pre-compact) and after (post-project) will provide an insight into the changes in road usage as a result of the respective activities, addressing RQ3b directly.

Two types of primary data collection needed as follows:

1) Traffic counts: Information required to understand the aggregate traffic flow by vehicle type, road section, and activity. This is expected to be done via automatic traffic counts or manual classified counts (the former preferred). A detailed discussion is provided below.
2) O-D (or intercept) surveys: Information that explains the qualitative reasons for the journey, including what is being transported, the cost of transportation, and reasons for travel. These data will require a manual intercept survey approach.

6.2.1 General Principles of Traffic Count Data

Analysis of all highway projects is greatly enhanced if traffic count data is collected across the highway network under study. In the UK, a sophisticated network of traffic counters provides traffic data by

vehicle type, time of day, and depending on the detector type, vehicle speeds. Most of the UK's traffic counters are permanently installed in that they collect count data continuously 24-hours a day 365-days a year. Once collected, the data is uploaded to an open source database (see https://webtris.highwaysengland.co.uk) and can then be freely downloaded for transport studies. Similar databases exist in the US by individual states.

6.2.2 Data Collection Instruments

Traffic count surveys are normally done via permanent embedded detection loops, and increasingly in the UK, via roadside radar cameras. Other survey techniques include the use of close circuit TV high definition (CCTV HD) cameras (see figure 6-1) which can capture vehicle plates images, and if used together, can generate multiple observations of a single vehicle plate across the network under study. Matched multiple observations of a single vehicle plate can be used to form an origin and destination data to build a deeper picture of vehicle travel patterns.

Figure 6-1. CCTV HD camera survey equipment located with battery pack (Source: Jacobs)

Where permanent counters are not available so-called 'short' counts are undertaken; typically, ‘short’ traffic counts are for a period of one to two weeks using surface mounted detection loops and roadside data boxes. Short counts traffic loops are physically pinned or nailed to the highway pavement to prevent them from being detached, as shown in Figure 6-2.

Short surveys are always done in ‘neutral’ months to avoid potential distortion due to seasonality factors e.g. summer holidays or local religious festivals. Finally, if loop detection equipment is not available traffic counts can be done using traditional road-side survey teams with manual counters and vehicle check sheets/tablets, but this method is labor intensive which limits the number of potential surveys which can take place. For El Salvador, the ET note that both short and manual counts have been undertaken for previous traffic studies (see Jacobs, 2019b).

Figure 6-2. Typical traffic counter with loop detection (Source: Jacobs)

6.2.3 Use of Traffic Count data for Road Usage Patterns

Traffic count data sets can be used as follows:

- Traffic counts can be assembled into time-series data sets for analysis of a specific location or section of highway either by time of day or day of week or month of year. The analysis can be used to understand changes in traffic volumes over time. Typically, data sets are smoothed to remove any one-off effects and used as inputs into traffic forecasting models (the ET note this is the forecasting methodology followed in the two Coastal Highway Expansion project traffic studies); and/or
- Traffic counts can be also assembled into cross-sectional data sets i.e. assembled across the wider highway network by either by time of day, day of week, and month of year but aggregated across a series or sections of road. Traffic data assembled in this way is particularly useful for understanding changes across a network and usage patterns, and hence access to MOPs traffic database will considerably enhance the analysis undertaken by the ET.

6.2.4 Estimation of Seasonality/Annualization Factors

As short counts are for 1 to 2 weeks they must be converted to annual estimates or annual average daily traffic (AADTs). This is done using seasonality or annualization factors which are estimated from a representative permanent count station close to the location of the short count site. In the case of El Salvador, the ET were told by MOP that there are permanent counters and the assumption is that this data will be made available for the analysis.

6.2.5 Establishing a Road Usage Baseline

For RQ3b, the change in traffic patterns requires a baseline position, ideally before any construction work started on any of the activities. However, this is no longer possible for either compact. Detailed baseline data are likely to be available via previous traffic studies carried out during their respective feasibility stages. The ET also has access to two traffic studies undertaken for ESII by separate consultants. An assessment of both these studies is provided in the Baseline Report (Jacobs, 2019b).

6.2.6 Northern Transnational Highway Activity Baseline

For the NTH, existing surveys may still be available from MOP but are expected to be dated and may be difficult to interpret given the elapsed time; if a baseline cannot be established, this will limit analysis of the change in user patterns. The proposed workaround is to use a retrospective recall question during the O-D surveys to understand how users' travel patterns have changed since the road was upgraded. The practicality of this will be explored during pilot surveys prior to commencing full surveys.

MCC requested MOP to conduct a traffic analysis on the NTH between Guatemala and Honduras. This was a post-project count, undertaken in 2013 and will be use as part of the time-series for the NTH analysis.

6.2.7 Coastal Highway Expansion Activity Baseline

For LIP, the ET is aware of existing traffic surveys that were undertaken and commissioned by MCC in 2012. Based on an initial review, in 2012, MCC procured SDK Consulting (SDK, 2012) to undertake traffic surveys across the LIP activities related to the following projects, now part of the Coastal Highway Expansion Project.

- Adaptation and Enlargement of Highway CA02E, Section: Comalapa Diversion (PAZ31N) - Deviation Airport El Salvador (RN05S) - Zacatecoluca (Roundabout). Length = 26.44 km. Department of La Paz.
- Rehabilitation of Highway CA01E, Section: Sirama - Bridge of La Amistad (El Amatillo). Length = 32.5 km. Department of La Union.
- Reconstruction of Rural Road USU08S, Section CA02E (Deviation San Marcos Lempa) – La Canoa. Length = 17.65 km. Department of Usulután.

The ET intends to approach SDK, Euroestudios (2016) and Acciona Ingeneria (2016) for access to their original data sets via FOMILENIO II. These SDK surveys should provide an initial view of ESII road users and traffic patterns to help establish a baseline, triangulated with the traffic studies undertaken by Euroestudios and Accionia Ingeneria.

6.3 Detailed Methodology

In accordance with best practice, the ET will conduct O-D surveys at the same time as the short traffic counts for efficient data collection. This will keep the traffic counts and O-D data consistent with each other so they can be factored. As noted above, annualization of the 'short' traffic counts will require access to MOP's national traffic database so that factors can be estimated for individual sites. Traffic count data from the sites will be assembled into individual cross sectional and times-series data panels following the method described above.

During O-D surveys, vehicles will be selected randomly at strategic locations chosen to maximize capture rates and provide a representative sample of vehicles traveling the road.

The types of vehicles expected to be surveyed include:

- **Public transportation (operators and users):**
  - Operators are likely to benefit from road improvements that result in reduced road maintenance bills because of fewer potholes.
  - Operators may also benefit from higher fares because of improved journey quality and reliability. If there is enough additional demand, operators might be able to increase user fares. It is possible, depending on the level of vehicle cost-reduction passed through, that increased fares could increase operator profits.

  - Users are likely to benefit from road improvements because service will be more reliable, journey times shorter, and (depending on the level of competition) fares could also be lower.
- **Trucks (operators and users):**
  - Operators, like haulers, may benefit from road improvements that result in shorter journey times, the ability to carry heavier loads (therefore, making more efficient use of the cargo space available in their vehicles), and a higher demand for their services because of improved agricultural output.
  - Users of hauler services (for example, farmers or aggregates) may benefit from lower haulage costs, as well as a more frequent and reliable service timetable.
- **Private car owners and users:**
  - Car owners and users are likely to see a reduced costs and improved journey times for their travel. (This is measured by a change in consumer surplus).

For each stopped vehicle, a surveyor (the person conducting the interview) will conduct the survey in person with vehicle occupants and drivers by soliciting responses verbally. To encourage respondents to provide accurate responses, the surveyor will explain the purpose and use of the data and provide an assurance that the data will be treated anonymously.

The ET will conduct an extended O-D survey to collect the necessary data to obtain information for RA3, such as:

- Journey purpose
- Travel time
- Vehicle classification
- Passengers per vehicle
- Number of traveling passengers in current employment
- Number of crew
- Type and approximate weight of transported goods
- Cost of the journey
- How the journey has changed compared to pre-project

Though the RQ3a and RQ3b analyses and data collection specifics will be different for ESI and ESII, the overall methodology is the same for consistency. The proposed data to be collected for ESI is show in Table 6-1 and ESII in Table 6-2. Data collection activities are compared to the previous studies (see section 6.2.7).

Table 6-1. Proposed ESI Traffic Data Collection

Data to be Collected	Previous Studies	Proposal	Comment
Journey time surveys and observed road speeds	Values stated in MOP 2013 study	Very unlikely to have changed from 2013. Almost all delays are in settlements on NTH.	Can be done by GPS during surveys.
Traffic counts, including by vehicle type	Values stated in MOP 2013 study	Repeat 2012 surveys at same location as 2013 MOP to provide comparison.	Use a similar time of year (i.e., November, a neutral month) to avoid seasonality bias. 7 days as a minimum including a weekend. 14 days is better, to allow for any one-off events e.g. road accidents Potential estimation errors due to calculation of annualization factors if short counts are used.
O-D / Intercept surveys	Not undertaken or believed not reliable.	Use recall method to ask road users how their travel patterns	Lack of re-project data will make comparisons difficult.

Data to be Collected	Previous Studies	Proposal	Comment
		have changed since opening of road.	
Notes: GPS = global positioning system			

Table 6-2. Proposed ESII Traffic Data Collection

Data to be Collected	Previous Studies	Proposal	Comment
Journey time surveys and observed road speeds	Method not stated	Repeat surveys when count data is collected as road is relatively short. Not expected to change over time.	Can be done by GPS surveys typically using up to 10 runs to understand journey time reliability.
Traffic counts, including by vehicle type	Automatic traffic counters using loop detectors for 7 days 24 hours per day	Repeat 2012 surveys after opening in 2021 and again in 2023 for the final report. 2021 surveys are required to understand short term impact of road investment.	Use a similar time of year (i.e., November, a neutral month) to avoid seasonality bias. 7 days as a minimum including a weekend. 14 days is better, to allow for any one-off events e.g. road accidents Potential estimation errors due to calculation of annualization factors if short counts are used. Video cameras may support traffic counts to provide visual checking if available locally.
O-D surveys	Undertaken at three locations	Repeat 2014 surveys once improvements are completed in 2021 and again in 2023 for the final report.	The ET expect to use a similar survey design to allow a comparison between surveys to provide panel data sets.
Notes: GPS = global positioning system			

6.4 Time Frame of Exposure

6.4.1 Northern Transnational Highway Activity

The NTH opened for traffic in 2012. The NTH M&E Plan anticipates project benefits within 5 years. It is not yet clear if any detailed data exists for the highway prior to 2009. In this case, the ET would seek to use retrospective questions in the survey program. The surveys will ask about road users' behaviors both before and after the road investment to help understand changes in road use patterns. The ET appreciates that this approach might introduce biases to the data set and will design an approach to minimize these as much as possible.

6.4.2 Coastal Highway Expansion Activity

The ESII road is currently being constructed and should open for traffic in September 2020. The ET expect that much of the change in road user habits will have occurred after 3 years of operation based on experience with other highway projects. This can be checked by references to the traffic count dataset and comparison to average national rates of traffic growth.

6.5 Primary Data Collection O-D Surveys and Traffic Counts

An O-D survey is a powerful tool used to collect information about a population's movement patterns in a study area, helping to identify the following:

- Main trip generators and attractors (the purpose of those trips)

- The means of transportation used to meet the traveling need
- The socio-economic levels of the population at issue

Table 6-3 summarizes the information that will be collected.

Table 6-3: Summary of O-D Survey Data to be Collected

Theme	RQ3a	RQ3b
Who is traveling on the road?	• Journey start point • Journey end point • Frequency of journey (per day, week, month, and year) • Whether the journey surveyed is a return journey, and if so, when the return leg will be made • Whether the journey represents an intermediate step in a longer journey, and if so, what the other stages of the journey are • Gender • Passenger age • Passenger income • Type of vehicle (e.g., car, truck) • Vehicle age • Type of operator (i.e., hauler, PT, or private owner)	• Change in journey start point • Change in journey end point • Change in how much more frequently they travel as a result of the new road • Changes in passenger demographics as a result of intervention (view from passengers and operators) • Change in average vehicle age • Change in typical vehicle mix
How long does it take to move along key routes?	• Time journey began • Expected time of journey end • Estimated journey time	• Change in journey time as a result of intervention (estimate from both users and transportation service providers)
What are they transporting?	• Number of passengers in vehicle • Total permitted axel weight • Whether goods are carried, and if so, type of goods • Total loading as a proportion of total permitted • Goods origin and destination • Purpose of transit (e.g., sale at market)	• Change in vehicle passenger numbers • Change in loadings (for haulers) • Change in composition of goods carried (for haulers) • Change in passenger demographic composition
What are they paying for transportation?	• Passenger fare • Freight charge (and weight and size of cargo) • Vehicle owner's estimate of operating costs (including maintenance) • Operators estimate of operating costs (including maintenance) • Levies paid for road use (e.g., unofficial tolls)	• Operator's assessment of whether operating costs have fallen or risen • Owner's assessment of whether operating costs have fallen or risen • Passengers' assessment of whether price paid has risen or fallen
Why they are traveling along the route?	• Purpose of journey (leisure, commuting, business, deliveries, other)	• Traveler or operator's view on whether typical journey purpose was different before road investment

Notes:

PT = Public Transport

For the Coastal Highway Expansion, appropriate baseline data on road user patterns is likely to be available from existing sources. A short program of primary data collection will complement this so that the ET has enough baseline data to effectively answer RQ3b in 2021.

6.5.1 Sampling

The ET expects that the sample size should be equivalent to 20 percent of the total AADT traffic flow in accordance with MCC requirements but would seek to verify the appropriateness following a pilot O-D survey.

6.5.2 Seasonality - Business Hours, Weather, and National Holidays

The ET proposes to hold full-day surveys in conjunction with a local survey firm and determine how best to assure the data is reflective of normal operations on roads in El Salvador. We expect to conduct the surveys considering seasonal issues due to national holidays or changes in travel patterns due to seasonal changes.

6.5.3 Scope

For each vehicle stopped, the surveyors will:

1) Survey the driver.
2) Randomly select three adult passengers over 18 years old for additional survey questions (all passengers will be surveyed if there are three or fewer passengers). Particularly for large buses, it will not be possible to survey all passengers without causing substantial delays. Thus, three passengers will be selected to provide a broad sample while limiting inconvenience to travelers. Passenger will be selected randomly so that the same types of passengers (age, gender) are not always selected for interview.

6.5.4 Sampling Strategy

A sampling strategy is needed to prevent biases from entering the data set which could later affect the validity of evaluation analysis results. The ET proposes that a detailed sampling framework i.e. location and number of vehicles to be surveyed to be developed after the pilot O-D stage, which will allow the ET to inform the sampling frame and strategy.

The ET proposes to perform randomized sampling so that survey results are not biased. There are several barriers to receiving truly randomized data. These include participant bias (for example, there will be differences in participation rates across different groups), seasonality (as discussed), and forms of response bias. Mitigations to potential bias will be considered as part of the detailed design.

6.5.5 Survey Instruments

Traffic counts can be done either using loop counters (see figure 6-2) or manual counter. A more recent method is to use high-definition cameras (see figure 6-1). The final traffic count surveys will depend on the availability of local equipment but as a minimum will be expected to use loop counters. A final decision will be made during the procurement and in agreement with MCC.

An O-D survey protocol will be developed, which will include questions for the driver as well as for a selected number of passengers, as described. Drivers will be asked questions about the starting and ending location for the vehicle, as well as the consumer costs for the vehicle (the price passengers pay, or the price paid for the vehicle to transport freight). Passengers will be surveyed about:

- The start and end of their specific trip (which may be different for bus start and end locations)
- The purpose of their trip
- How much they paid
- How much the price they pay for transportation has changed over time

- Whether and to what extent the number of trips they take has changed (Table 6-3)

Separate protocols will be developed for the NTH and the Coastal Highway Expansion Activity to reflect the differences in likely answers (such as O-D), as well as for differences in the period that has elapsed since completion of the projects. To minimize travel delays, multiple surveyors will be located at each site so that driver and passenger surveys can happen simultaneously. All surveys should be completed within a maximum of 30 minutes. Data will be collected electronically on tablets. The surveyors mobilized by the data collection firm will use a short questionnaire for drivers and passengers and record responses in the device.

6.5.6 Rounds, Locations, and Timing

For the NTH, the data will be collected from February to April 2020. A short pilot survey will be undertaken to test the survey prior to the main surveys starting in accordance with best practice.

The first round of data collection for the Coastal Highway Expansion Activity is planned to occur in 2021 to evaluate the short-term impact. A second round is planned for Q2 2023 to allow evaluation of the long-term impact.

6.5.7 Survey Staff

Survey staff will be provided by the data collection firm. The staff must be local, native language speakers, and experienced in these types of surveys. Likewise, the data collection firm will take charge of the logistics of the study (mobilization of personnel, provision of materials, and data collection).

The number of interviewers and supervisors will be commensurate with the amount of work at each road section.

The ET will be responsible for completing the data analysis.

6.5.8 Data Processing

Data processing will be completed by a local firm selected by the ET that specializes in data collection and processing. The survey firm will be expected, as part of the Request for Proposal (RFP) process, to provide a plan for both data entry and processing. As part of the RFP process, proposed methods will be checked against best practice guidelines already developed by the ET for traffic data collection.

Traffic counts used in conjunction with survey data will be processed digitally automatically with no need for staff data entry. Data is automatically captured.

The ET will provide oversight to the data collection firm in preparing the data entry forms and will conduct bench and pilot-scale testing to confirm the data entry tools. Surveyor protocols will be written, and surveyors will be trained on them to provide consistent and high-quality data collection. After data collection is complete, data will be cleaned and analyzed using StataCorp's Stata software.

6.5.9 Data Quality

As noted, the ET will provide oversight from the beginning to the end of the data collection process. Strict protocols will be established for conducting the traffic stops, surveying respondents, and uploading the data. Data uploads (internet connection permitting) will be done on daily, with consistency checks to make sure no data has been lost during transfer. Both the ET and the data collection firm will conduct frequent data quality checks to verify that data are being properly collected and that there are no major issues with the surveyors implementing the surveys. At the end of data collection, the data will be cleaned and prepared for analysis.

6.5.10 Safety Procedures and Precautions

As survey activities will be undertaken in areas with moving traffic, typically using pull outs or laybys, the ET proposes that team members wear appropriate personal protective equipment when onsite (for example, high-visibility jackets) and are provided with torches for working in periods of low light. The ET will verify they wear vests correctly during field visits. Other safety equipment to be mobilized by the firm includes umbrellas or tent-like structures for protection against sun and rain. Reports from previous traffic surveys (e.g. SDK 2012) show similar survey setups. Normal practice is to engage with the local police and to ask for assistance with flagging down of drivers for the survey.

Project staff will be expected to complete a risk assessment (prior to commencing survey work) and a risk audit (after completing survey work). The latter will be used to inform other team members of potential risks.

All safety procedures implemented as part of this project will be consistent with the ET's industry-leading BeyondZero safety program (Security Magazine, 2018), which seeks to eliminate all accidents and fatalities by fostering a culture of caring both through their parent organization as well as in their partner organizations and subcontractors.

The data collection team will be trained on safety-related matters, including the necessity to stand out off of the roadway to avoid risks, and to be alert when it is necessary to cross the road.

To ensure the safety of the operation and avoid risk of accidents, survey stations will be placed on straight alignments and flat sections with better visibility. Agreement will be sought with the appointed local survey company and security risks jointly addressed (for example, feasibility of undertaking surveys at dawn and dusk due to security risks).

6.6 Primary Data Collection Summary

Table 6-4 summarizes the rounds of data collection, timing, respondents, sample size, sample units, and relevant instruments to be used to collect primary data.

Table 6-4. Primary Data Collection Summary

Data Collection	Timing (includes multiple rounds)	Sample Unit or Respondent	Sample Size	Relevant Instruments and Modules	Time Required
Pilot Surveys (NTH only)	Feb to April 2020	Public transportation operators Public transportation passengers Vehicle owners Truckers	20% of the traffic per type of vehicle	Information to be collected electronically	1 day
NTH Survey, Full Traffic Count Survey	Feb to April 2020	Vehicle, by type	Number of vehicles during 7 days for each round	Manual count form Pneumatic detector	0.25 month (7 days) per station for each survey type and each round
NTH O-D Survey (concurrent with above)	Feb to April 2020	Public transportation operators Public transportation passengers Vehicle owners Truckers	20% of the traffic per type of vehicle	Information to be collected electronically	2 consecutive days

Data Collection	Timing (includes multiple rounds)	Sample Unit or Respondent	Sample Size	Relevant Instruments and Modules	Time Required
Coastal Highway Expansion Activity Survey, Traffic Count Survey. Journey time survey	December 2020 – February 2021 (first round) Q2 2023 (second round)	Vehicle, by type	Number of vehicles during 7 days for each round	Manual count form Pneumatic detector	0.25 month (7 days) per station for each survey type and each round
Coastal Highway Expansion Activity Survey, O-D Survey	December 2020 – February 2021 (first round) Q2 2023 (second round)	PT operators PT passengers Vehicle owners Haulers	20% of the traffic per type of vehicle	Information to be collected electronically	2 consecutive days

6.7 Secondary Data Collection

The ET understands the MOP maintains a national database of traffic count data available for the network. Access to this data set will provide a richer picture for the evaluation analysis. The ET expect to use:

- Data and reports collected as part of previous feasibility studies
- Transportation studies undertaken for MOP and FOMILENIO (See Jacobs, 2019b)
- MOP national traffic count data sets
- Spreadsheets and models used during feasibility studies.

6.8 Analysis Plan

The information (both primary and secondary) outlined will be used to answer both RQ3a and RQ3b. The primary information collected will be processed and used to inform spreadsheet analysis, which will be performed to answer the questions about changes in road use patterns and behavior as a result of the compacts.

Data will be processed by the appointed El Salvador surveying firm and will be quality checked by the ET to verify the data's compatibility with the modeling spreadsheet (for example, that outputs are in a consistent format and that data have been cleaned to remove erroneous entries). The data will also be checked for consistency when they are used for other purposes (for example, in updating the ERR calculations) to confirm they are fit-for-purpose for use in HDM-4.

The analysis will be completed by a senior economist, using modeling best practice as developed by the contractor leading the ET. Following a detailed quality assurance process for the inputs, modeling assumptions, methodology, and quality check of outputs, the findings of this analysis will be documented in the evaluation report.

7. Research Area 4: Transportation Market Structure

7.1 Introduction

This RA covers the following:

- RQ4: How is the transportation market structured and what is the likelihood that VOC savings will be passed on to consumers of transportation services?

Savings in the cost of production are not necessarily passed to consumers. Whether or not these savings are likely to be passed to consumers depends on the structure of the market and regulatory controls. With regard to transportation, in a perfectly competitive environment, any VOC and VOT savings would be passed on to those who hire the transporters (for example, farmers transporting goods, passengers on buses). However, in practice, most transportation markets are not likely to be competitive.

In developing countries, the lack of competitiveness is exacerbated by a lack of regulatory controls that can result in significantly distorted markets. In a market that is distorted, the transportation operators are the price makers (that is, they set the price), rather than price takers (that is, the market sets the price). Such scenarios are often characterized by disproportionate returns earned by transportation providers, an inefficient transportation sector (costs are higher than they should be), and a lesser quality of service than would be expected under more competitive conditions or if an appropriate market structure is enforced.

RA4 aims to determine the transportation market structure in El Salvador, and subsequently seeks to determine whether the benefits from VOC and VOT are likely to be passed on to consumers of transportation services. This understanding will then have implications on understanding how traffic patterns have (or have not) changed as a result of the road projects (feeding into RQs 3a and 3b). Given that the transportation market structure is unlikely to change substantially over several years, the evaluation will only answer RA4 once, and the findings regarding the market structure will be applied to both ESI and ESII.

7.2 Methodology

7.2.1 Overview

The ET will employ a mixed-methods design combining semi-structured interviews, a survey of trucking and passenger transportation companies and O-D surveys with extensive consultation of secondary data. The key primary data that we will collect is set out below.

- Semi-structured interviews: To build an evidence base around the type of transportation markets and the competitiveness of the relevant transportation markets

- Survey of public transport providers and trucking companies: To get a better understanding of the drivers for providers of commercial transport, including pricing drivers and cost drivers, and collect quantitative data on costs and pricing

- O-D surveys to understand the geographical scope of the markets, the types of goods being moved and the key markets using transportation services.

This broad approach reflects the fact that there is unlikely to be one set of evidence that can be used to provide a definitive answer on whether cost savings are passed on to consumers. This approach will seek to determine a basket of evidence to determine the competitiveness of the various transportation market segments. A key part of our analysis will be to determine specific segments prior to assessing how competitive they are.

There is no time frame of exposure for this activity, as none of the activities are expected to directly influence the market structure. However, this RA helps with the direct interpretation of the results and is central to the overall evaluation.

The approach to providing an answer to this question will rely on the following four separate components:

1) An overall review of the market structure for each transportation market
2) An overall review of efficiency within each market
3) A review of the barriers to entry
4) A review of the effectiveness of government institutions in managing efficient market outcomes.

We will define the markets that we will review during the next phase. We will use HDM-4 to inform this.

7.2.2 Review of Market Structure by Market Segment

One type of market segment might be the market for long distance freight. Another might be the market for public transportation. We will split the overall transportation market into individual segments to complete our analysis.

Semi-structured interviews will be conducted to gain nuanced insights into how the transportation market structure operates both officially and unofficially within El Salvador. The survey of trucking and passenger transportation companies will provide representative data regarding transportation costs and prices, as well as other market data. Official data about transportation firms, competitiveness, pricing, and profits will provide a framework around which the qualitative findings can support a better depth of understanding. O-D surveys will allow us to understand the geographic scope of the problem and the extent that producers rely on external transportation companies or are vertically integrated to accommodate getting their goods to market. This will also provide us with a view on the role of the state in the provision of transport services.

These data will provide the ET enough information to define the various markets being assessed. Market definition is critically important prior to assessing the structure of the market. An example of the types of markets that might be defined are:

- Road-based freight transportation
- Local and regional public transportation
- Private commercial transportation (such as taxis)

For each of the markets identified, the specific structure will be addressed, including:

- Is the market within the public transportation realm (is it available for use by the general public and operates a broadly fixed route while charging individuals for use per trip)?
- Is the market for freight services, which might be defined as transporting goods from Location A to Location B for a fee?
- Is the market for private commercial transportation, such as taxis, hire cars, and minibuses? In these instances, the transportation is not constrained to a fixed route and charges a fee in return for services.

The above are potential definitions which will be refined as the study progresses. The geographical scope of the analysis will be defined once we have completed the secondary data review. To aid the analysis, the ET will complete the following activities:

- Conduct a quantitative analysis of the operators within each of the markets to determine the concentration of firms using the Herfindahl-Hirschman Index[3].
- Assess a transportation operator's profitability and whether they are price takers or makers. This will rely on primary data collection (Transportation company surveys)
- Assess the geographical scope of the market using O-D surveys
- Assess the types of commodity being transported and if this has any bearing on the cost of transportation services.

As well as secondary data the ET intends to use primary data related to semi-structured, O-D surveys and surveys of transport providers, both trucking and public transport firms to respond to assess the market structure by market segment.

7.2.3 Review of the Efficiency of Each Market Segment

It is possible that low levels of cost-savings pass-through could be the result of low levels of efficiency. A firm or sector may be inefficient because of:

- Disproportionate returns that reduce the incentive for efficient operation
- Lack of incentive to adopt new technologies due to market failures
- Disproportionate regulatory burdens or lack of regulatory controls that affect a transportation operator's operations

The ET is familiar with the World Bank study on the High Price of Road Freight Transport in Central America (World Bank, 2014). This study concludes that El Salvador is one of the least efficient markets regionally for the provision of road freight transportation. These data will be reviewed and investigated to determine what the inefficiencies are in El Salvador. Further data collection with the firms interviewed will be sought to investigate some of the key reasons for the inefficiency.

This will be informed by the semi-structured interviews, but the data will primarily come from the surveys of private transportation companies.

7.2.4 Evaluation of Noncompetitive Behavior and Barriers to Entry

If noncompetitive behavior is prevalent in the marketplace, then it is likely to lead to lower levels of cost-savings pass-through. Non-competitive behavior can take a number of forms, including:

- Price fixing arrangements between market participants
- Denial of access to a service that is vital to compete in the marketplace (for example, along ESI and ESII, this could be denial of access to garages that are commonly used as stops by public transportation providers to pick up and drop off passengers)
- Dividing territories (for example, informal arrangements that might prevent haulers from operating along the whole of each route)
- Other barriers to entry and competition such as large capital costs or regulatory behaviors.

The ET proposes to ascertain whether noncompetitive behavior is prevalent along the roads in ESI and ESII using both the semi-structured interviews and surveys of private transportation companies.

[3] The **Herfindahl**-Hirschman **Index** (**HHI**) is a commonly accepted measure of market concentration.

7.2.5 Assess the regulatory controls to determine if this is sufficient to allow an efficient operation of the market segments

Market failure require external intervention. Often the state will take stock about whether or not the market is sufficiently failing. Using the primary, particularly the semi-structured interviews and secondary data collected we will:

- Assess the economies of scale and scope to determine whether an efficient market structure might require a central regulator.
- Determine whether there is enough regulatory control, including effective standards for service provision, and also that prices reflect costs, where natural monopolies are present.

7.3 Primary Data Collection: Semi-Structured Interviews

Semi-structured interviews will be conducted with the following entities:

- Trucking companies
- Passenger transportation companies
- Traders of goods
- Business groups
- The MOP and Ministry of Transportation
- The Competition Commission
- Economic regulators
- Other donors

Individual respondents will be selected purposively, as described in this section, for each type of respondent. Interviews will be conducted either with individuals or in small groups (two to three people) of respondents of the same type. All interviews are anticipated to take between 60 and 90 minutes. Table 7-1 provides a summary of the anticipated sample sizes for each respondent group.

Trucking company interviews will focus on companies that hire out their vehicles to transport goods (as opposed to companies that haul their own goods). The interviews will focus on the following:

- Their experiences while transporting goods
- The costs they incur
- Their profitability
- Barriers to entry into the market

These interviews will target a variety of trucking companies, including larger and smaller companies, as well as both formal and informal companies. To the extent possible, female-led companies will also be targeted. All interviews will target managerial staff who would have the most information regarding overall operations. If possible, a list of eligible firms will be obtained either from the Chamber of Commerce or the Competition Commission. If a list is not available, the ET will seek the input of these entities and FOMILENIO to identify a pool of potential respondents we will choose from.

For passenger transportation companies, the interviews will target inter-city bus, taxi, and other passenger service companies. The interviews will focus on the following:

- Their experiences transporting passengers
- Costs to the transporters

- Prices paid by passengers (including any change over time)
- Barriers to entry into the market

These interviews will target a variety of passenger transporters, including both bus and taxi services, larger and smaller companies, as well as owner operators, and those that are formal and informal. To the extent possible, female-led companies will also be targeted. All interviews will be conducted with managerial staff with a broad understanding of company operations. The sampling frame and selection will be the same as for the transportation companies.

In addition to the companies that transport goods, the ET will also interview companies that rely on transporters to move their goods around the country and internationally. These interviews would focus on companies that have to hire other firms to transport their goods (as opposed to those who transport their own goods). The interviews will focus on the following:

- Their experiences hiring transportation firms
- Costs (and how they've changed over time)
- Challenges

Talking with these firms will provide an external perspective on whether transportation companies are competitive (or not). The ET will target a variety of firms, including larger and smaller companies, as well as both formal and informal companies. To the extent possible, female-led companies will also be targeted. All interviews will be conducted with managerial-level staff who have a broad understanding of company operations. The sampling frame and selection will be the same as for the transportation companies.

The ET will also interview representatives of business groups, such as the Chamber of Commerce, who will be able to provide insight into both the experiences of transportation companies, as well as those companies that work with or hire transportation companies. These interviews will target organizational representatives who have the strongest knowledge of transportation companies and issues.

Official policy perspectives will be gleaned through discussions with representatives at the Ministry of Transport and MOP. Ministry representatives will be asked questions on both official policy and how policy is implemented, their perspectives on competitiveness of the market, and on the barriers that exist in the sector. For these entities, the ET will target representatives who are most closely involved in policy and competitive issues. The ET will work with FOMILENIO and MOP contacts to identify the best individuals to interview.

Representatives from the Competition Commission and transportation regulator bodies will be interviewed for their perspectives on official policy and regulations, as well as their perceptions of how the transportation market works unofficially. The ET will target those representatives with the most direct knowledge of transportation regulation and competitiveness.

Other donors will be interviewed to provide an external perspective on the transportation market in El Salvador. Targeted donors will include the World Bank, the IDB, and USAID. The ET will target those representatives with the most knowledge of the transportation sector and of the transportation market structure, specifically.

Table 7-1 lists the anticipated sample size by type of respondent.

Table 7-1. Anticipated Sample Sizes by Type of Respondent for Semi-Structured Interviews

Respondent Type	Approximate No. of Respondents
Trucking Companies	10-15
Passenger Transportation Companies	10-15
Traders of Goods	10-15
Business Groups	2-3
MOP and Ministry of Transport	3-5
Competition Commission and Regulators (Superintendiencia de Competencia)	2-3
Other Donors	3-8
Total	39-63

7.3.1 Survey Instruments

Separate interview protocols will be established for each type of respondent. This will allow the protocols to focus on the key issues that are most pertinent to each respondent group. Notes will be taken during the interviews and finalized in English, using Microsoft Word.

7.3.2 Rounds, Locations, and Timing

As the transportation market structure is not anticipated to change significantly over time, only a single round of interviews is anticipated. The ET expects to undertake these interviews between December 2020 and February 2021, which puts them near the end of ESII, but does not overlap with the planned maintenance-related interviews. Avoiding overlap with other interview and data collection efforts will relieve some of the burden on respondents, MCC, and FOMILENIO, who will likely be very busy as ESII closes out. It also allows the necessary staff to be available to support the data collection and subsequent analysis.

The ET expects that most, if not all, interviews will be conducted in San Salvador, as that is where most companies and organizations are based. However, it may be necessary in some cases to travel outside of the capital to interview some desired respondents.

7.3.3 Respondents within the Sample Unit

As described, the specific respondents to the interviews will be individuals meeting the required criteria.

7.3.4 Staff

Two teams of two people will conduct interviews. One person will lead the interview while the other takes notes. The interview team will match a transportation economist with a specialist in qualitative methods so that both sectoral and regulatory expertise is represented. If any member of the interview team does not speak Spanish fluently, an interpreter will be added to the team.

7.3.5 Data Processing

Interviews will be conducted in Spanish, and notes will be translated into English. Though recording interviews for later elaboration of notes or transcription is a potential option, this option can lead respondents to be hesitant to answer sensitive questions and be “on the record.” Thus, given the potentially sensitive nature of the interviews, particularly in regard to firm behavior, profits, and potential illicit payments or costs, the ET will not record interviews. For this reason, thorough notetaking during

the interview will be of utmost importance. A maximum of four interviews will be conducted per day to allow the team enough time to review and fully elaborate their notes each day.

7.3.6 Data Quality

The lack of interview recordings will be a key challenge to data quality and making sure that key information is captured in the interview notes. Thus, so that high-quality notes are obtained, strong notetakers will be required for each team, and limiting the number of interviews per day to allow enough time to complete all notes before the end of the day will be crucial to supporting data quality.

During the coding process, intercoder reliability will be verified through double coding and frequent quality checks. If errors or discrepancies are noted, they will be corrected, and clear channels of communication with the coders and the ET will be maintained to provide high-quality coding.

7.3.7 Safety Procedures and Precautions

Basic security precautions will be taken while traveling in El Salvador. As most interviews will be conducted in respondent offices in San Salvador, additional security precautions beyond basic precautions are unlikely to be necessary.

7.4 Primary Data Collection: Transportation Company Surveys

7.4.1 Sampling

Ideally, the ET will obtain a list of transportation companies (both those that transport freight, as well as passenger transportation companies) from the Competition Commission or the Chamber of Commerce. If such a list cannot be obtained, the ET will acquire these data from the intercept surveys to be conducted during the response to RQ2a, and RQ3a and RQ3b.

If a list of transportation firms can be obtained, the ET will randomly select at least 15 firms to be surveyed, stratified on tonnage of goods transported that are based in the Northern Zone for road freight companies, but on a random sample basis for public transportation companies. This sample size is deemed appropriate because the ET expects it will cover a large proportion of freight and passenger transportation operators.

At each selected firm, the ET will purposively select the individuals to speak with. The ET will target company representatives who are familiar with the company's costs and pricing, as well as the transportation sector more broadly. Most likely, these respondents will serve in a managerial role within the company (for example, owner, manager).

7.4.2 Instruments

A single transportation company survey questionnaire will be developed for each market identified. The survey time will be limited to 90 minutes or less. Data will be collected electronically using tablets. Key questions covered by the survey will include:

- Transportation costs experienced by the firm (and change over time)
- Costs charged to consumers (and change over time)
- Behavior of other firms in the market
- Barriers to entry into the market
- Number of years of operation
- Pricing strategy

7.4.3 Rounds, Locations, and Timing

As with the semi-structured interviews, only one round of surveys with transportation companies is anticipated. The survey will occur between December 2020 and February 2021, alongside the interviews, which will allow for ET members to participate in surveys. It is expected that most, if not all, surveys will be conducted in or around San Salvador. Table 7-2 shows the proposed rounds and survey dates.

7.4.4 Respondents within the Sample Unit

The specific transportation company respondents will be company representatives who have a managerial-type role and who would have insights into company costs and revenues, as well as the sector more broadly.

7.4.5 Staff

The data collection firm to be hired for the transportation company survey will need to have the following key staff qualifications:

- Team Leader: Must have at least a master's degree and 5 to 10 years implementing large-scale surveys, including transportation surveys
- Survey Coordinator: Must have at least a bachelor's degree and 5 years of experience coordinating fieldwork for quantitative surveys, ideally in the transportation sector
- Surveyors: Must have at least a high school diploma and experience implementing surveys or qualitative interviews, ideally in the transportation sector

The ET transportation economist will oversee the data collection firm.

7.4.6 Data Processing

Data will be collected electronically using tablets running Dobility, Inc.'s SurveyCTO software. Electronic data collection, with proper skip patterns and allowable values preprogramed, will help the ET provide oversight to the data collection firm in preparing the data entry forms. The ET will conduct bench- and pilot-scale testing to confirm the data entry tools. Survey protocols will be written, and surveyors will be trained on them to support consistent and high-quality data collection. After data collection is complete, data will be cleaned and analyzed using Stata.

7.4.7 Data Quality

As noted, the ET will provide oversight to the data collection firm from the beginning to the end of the data collection process. Data uploads (internet connection permitting) will be done daily, with consistency checks to make sure no data has been lost during transfer. Both the ET and the data collection firm will conduct frequent data quality checks to verify that data are being properly collected and that there are no major issues in surveyor implementation of the surveys or their understanding or interpretation of the questions. At the end of data collection, the data will be cleaned and prepared for analysis.

7.4.8 Safety Procedures and Precautions

The general safety and security precautions necessary for all travel in El Salvador will be applied.

7.5 O-D Surveys

The O-D surveys are discussed in section 6.3 and hence are not repeated here. The O-D surveys will allow us to:

- Determine the movement of the geographical scope of the different transportation markets
- Assess to what extent commercial goods are being transported using self-owned vehicles by business
- Assess the involvement of the state in the provision of transportation services and the drivers behind this.

7.6 Primary Data Collection Summary

A summary of the primary data collection is set out below:

Table 7-2. Data Collection Summary

Data Collection	Timing (includes multiple rounds)	Sample Unit or Respondent	Sample Size	Relevant Instruments and Modules
Semi-Structured Interviews	December 2020 to February 2021	Individual or small group	39-63	• Interview Protocols • Trucking Companies • Regulators • International Financing Institutions • Chamber of Commerce
Transportation Company Survey	December 2020 to February 2021	Company manager	To be confirmed depending on the number of transportation companies	Transportation Company Survey Questionnaire
O-D Surveys	Consistent with data for RQ3	Consistent with data for RQ3	Consistent with data for RQ3	Consistent with data for RQ3

7.7 Secondary Data

Analysis of secondary data will be important and will require the cooperation of the GoES. The desired secondary data includes:

- A list of all trucking operators
- A list of all passenger transportation operators
- A list of all traders of goods
- Market concentration data
- Data on barriers to entry
- Size of the transportation markets
- Number of participants in the market
- Central regulatory authority data (number and scope)

This secondary data list will be refined in discussion with GoES, who are responsible for economic regulation within El Salvador. A preliminary discussion with the Competition Authority was held during the February 2019 site visit.

7.8 Analysis Plan

The completed interview notes will be coded using VERBI GmbH's MaxQDA software or Dedoose's software, which will assist the team in identifying key trends and perspectives among the respondents. The findings from each of the data sources will be triangulated to define the nature of the transportation market and determine whether consumers of transportation services will experience cost savings as a result of the road improvements. Below we set out the approach to analysis of the data in more detail.

7.8.1 Analysis of qualitative data

Qualitative data will be coded into themes. All interviewees will be requested to code data in an appropriate template. Data will either be coded electronically or transposed into appropriate templates prior to coding. The coding scheme will be based on categories relevant to the research question. In this regard the focus of the parent categories will be on the competitive structures of the market, barriers to entry, efficiency and regulatory controls. Using this approach and the software we intend to employ will allow us to categorize our qualitative data. From the initial coding we will develop more general themes and patterns. This includes reviewing word and phrase repetitions, reviewing the findings with existing literature and economic theory on market structures and assessing missing information i.e. the key areas that we would have expected to be present from the discussions that are omitted or poorly represented.

Our staff will code the analysis into the selected software. This will be used to allow us to create illustrations of the data so that data can be visualized and summarized by respondents and by themes. We will use the data illustrations to allow us to determine emerging views on the key elements of Transportation Market Structure research question.

Data will also be triangulated between sources to test if themes are present across data sets and identify any consistencies or discrepancies between different respondents. This data will allow us to gauge from the various respondents and stakeholders their views on the market structure, regulatory protections, barriers to entry and efficiency.

The ET will consolidate the findings from the qualitative analysis and set out how they inform the topics of interest being explored in this question. The results will be written up in a report format.

7.8.2 Quantitative Data Analysis

All quantitative data will be imported into a MS Excel or other similar analytical software. The data analysis will be led by a Senior Transport Economist. The HH index will be examined based on the data that is collected to form a view of the structure of the transportation markets being explored. The outcome from this analysis will be checked against data from the qualitative analysis.

Data on pricing and O-D and costs will be reviewed and analyzed using MS Excel to determine the geographical scope of the market and reach of firms in the Northern Zone, the extent that manufacturers rely on external transportation companies for transportation of goods to market and the overall scope of the public transportation market for the relevant road users. If sufficient granularity is obtained from the surveys, we will take a view about whether prices are being set at an efficient level or whether they reflect market power that would prevent savings being passed to end users of transportation.

Where sufficient granularity is obtained, we will seek to determine the unit cost of transportation services for freight and compare this with other benchmarking data, such as the data collected from the World Bank study on freight costs in Central America (World Bank, 2014).

Our findings will enable the ET to comment using qualitative and quantitative data and analysis on the likely distribution of benefits from MCC investments among different segments of consumers.

8. Research Areas 5 and 6: Border Crossing Infrastructure at El Amatillo and Anguiatú

8.1 Introduction

This section describes the RQs for the LIP Border Crossing Infrastructure Activity at El Amatillo (RA5) and the Anguiatú border crossing, (RA6) which is part of the Investment Climate Project. El Amatillo is the main border crossing between El Salvador and Honduras, while Anguiatú is the main border crossing with Guatemala and El Salvador. The border crossing investments at El Amatillo and Anguiatú together make up the Trade Facilitation Investments.

The main benefit of both MCC's border crossing investments is the reduction in transit times through providing additional border capacity to process transiting vehicles achieved through the construction of two stations for customs controls. The border initiatives aim to take advantage of the recently created Central America customs union, also known as the 'Northern Triangle Customs Union' between El Salvador, Guatemala and Honduras which El Salvador joined on August 20th 2018[4].

Border crossing capacity improvements will also be helped through other third party funded initiatives including the "single window initiative" which aims to simplify paperwork when crossing the international borders in the Northern Triangle. Part of the challenge for the evaluation will be to avoid double counting of benefits as there are multiple initiatives with funding from different investors.

Physically, the El Amatillo the Border Crossing Infrastructure Activity also includes upgrade of 5.74 km of approach road (CA01-E). On the site visit the ET observed this approach road (CA01-E) to be narrow and in a poor condition but that it was primarily being used as waiting area for trucks while they stand waiting to clear customs and border procedures (see figure 8.1)

Figure 8-1. Trucks waiting to cross international border at El Amatillo (Source: Jacobs, 2019)

[4] (see https://econamericas.com/2018/08/el-salvador-bolsters-central-american-customs-union/).

Delays were observed by the ET to impede the flow of traffic from Honduras creating safety issues. Economic benefits from the upgraded road i.e. travel time and vehicle operating cost savings are therefore dependent on removal of stationary traffic at the border crossing, or at the very least a substantial reduction in queuing traffic.

As for the other roads, economic appraisal of the 5.74 km approach road has been undertaken using HDM-4 albeit with an uncalibrated model (Jacobs, 2019a). For the feasibility study, carried out in 2015, a separate traffic study and forecasts were produced (Technology and Management Ltd, 2015) as an input into the HDM-4 model. The estimate ERRs range from 19.0% for a 'concrete' alternative to 9.9% and 10.2% for two asphalt alternatives.

Note the upgrade of Anguiatú does not include any improvement to the border approach road and therefore there is no corresponding HDM-4 model.

The ET's approach is identical for both border crossings to allow a direct comparison between them highlighting an differences in the evaluation. The detailed RQs for RA5 (El Amatillo) and RA6 (Anguiatú) are as follows:

Project Implementation (RQ5a & RQ6a)

- RQ5a: Was the LIP Border Crossing Infrastructure Activity at El Amatillo implemented according to plan?
- RQ6a: Was the Investment Climate Project at Anguiatú implemented according to plan?

Economic Model (RQ5b & RQ6b)

- RQ5b: Economic Model for El Amatillo border crossing
  - How have the average wait times at the border been changed by the intervention?
  - How has the volume of traffic and goods changed?
  - What is the economic return of the LIP Border Crossing Infrastructure Activity?
  - What factors drove changes to the ERR over time?
- RQ6b: Economic Model for Anguiatú border crossing
  - How have the average wait times at the border been changed by the intervention?
  - How has the volume of traffic and goods changed?
  - What is the economic return of the Investment Climate Project Border Crossing Infrastructure Activity?
  - What factors drove changes to the ERR over time?

As an additional piece of analytical work, the ET will undertake a comparison between the two border crossings to understand why there are differences, if any, in their respective economic performances. Differences will be highlighted and, where possible, lessons learned documented.

8.2 Methodology for Project Implementation for RQ5a & RQ6a

RQ5a and RQ6a will be answered following a similar methodology to RA0 for the Coastal Highway Expansion Activity. For brevity, the full methodology from RA0 is not repeated here, but the metrics for RQ5a and RQ6a will include:

- Was the Border Crossing Infrastructure Activity implemented according to plan? The goal is to see the coherence of what was planned and what was built; if any misalignment is found, the ET will investigate the reasons.
- Project timing and duration: - the aim is to determine whether the investment was delivered in the expected time frame, and if not, to investigate deviations. This is important in the economic case,

as a longer construction period will reduce the ERR due to construction cost inflation and delays to the realization of benefits that have a higher discount rate in later years of the economic appraisal.

- Investment costs (actual versus planned): The ET will look at the overall actual cost of the projects to determine whether costs exceeded allocated budgets, or whether cost overruns were managed by reducing scope or using risk allowances. The ET will document the reasons for the cost overruns from available data and reports produced by the independent engineer during construction.

8.3 Primary Data Collection for RQ5a and RQ6a

A mix of primary and secondary data sources is proposed for both border crossing activities. The methodology outlined in Section 8.2 relies heavily on documented differences between phases as captured by FOMILENIO II. The ET intends to conduct interviews primarily to verify our interpretation of the documents listed in section 8.4. The interviews will allow the ET to understand from those involved some of the challenges with the implementation, reasons for design changes, and subsequent modeling of these changes.

The ET staff in charge of conducting the interviews will be the ET's key personnel who will be able to work in Spanish and English. The interviewers will use a pre-written interview guide or questionnaire with the questions to be asked and the category of people to be questioned based on the review of the documents outlined below.

The following interviews are proposed:

8.3.1 Primary ESII Interviews:

- MCC staff involved in LIP and Investment Climate Project, including the relevant economist
- FOMILENIO II staff involved in drafting, preparing and delivering the LIP and Investment Climate Project elements
- MOP staff as the key implementing organization, responsible for tendering construction contracts
- Customs and Border agents involved in the implementing the changes
- Independent Supervising Engineer, currently providing oversight of the construction activities for both the border approach road and border crossing infrastructure.

Table 8-1 provides a summary of the proposed primary data collection.

Table 8-1. Summary of Primary Data Collection

Data Collection	Timing (includes multiple rounds)	Sample Unit or Respondent	Sample Size	Relevant Instruments	Time Required
El Amatillo and Anguiatú	September, October, November 2020	MCC MOP Customers and Border agents FOMILENIO II Other stakeholders	At least one key informant per organization but likely up to four	Interview guide	1 week

8.4 Secondary Data Collection for RQ5a and RQ6a

The ET will seek to examine the following types of document(s):

- Independent engineering reports, including original designs
- As-built drawings
- Progress reports
- Completion reports
- Contract amendments
- Costing reports
- HDM-4 model (Jacobs 2019a, Jacobs 2019b)

8.5 Analysis Plan Project Implementation for RQ5a and RQ6a

The ET will document the changes between pre and post project positions. The analysis will be summarized as shown in Table 8-2. This is not a comprehensive list of data of parameters but provides an indication of some of the key items. The list maybe expanded as the evaluation proceeds.

Table 8-2. Proposed Analysis Summary at each border crossing

Data	Definition	Pre-Compact or at Time of Signing	Post-Project	Explanation of the Discrepancies and Source
Border Crossing Capacity	Capacity delivered compared to design and specification	See Baseline Report	To be populated during evaluation	To be populated during evaluation
Project Time and Duration	Delays against program schedule that affect timing of costs and benefits	See Baseline Report	To be populated during evaluation	To be populated during evaluation
Investment Costs	Actual versus planned costs, including variation orders	See Baseline Report	To be populated during evaluation	To be populated during evaluation
Road Elements (El Amatillo only)	Lane Km upgraded	See Baseline Report	To be populated during evaluation	To be populated during evaluation

8.6 Methodology for Border Crossing Economic Model (RQ5b and RQ6b)

The second part will seek to understand how the Border Crossing Infrastructure Activity has changed the operation of the international border crossings:

- Have average wait and transit times reduced?
- How do they vary?
- Based on observed wait times, what is the economic return?
- How has the volume of traffic and goods changed?

Both border crossings will be evaluated using an identical methodology to allow comparison and lessons to be drawn highlighting differences. Revised economic parameters e.g. vehicle operating costs and values of time will be taken from RA1 and run as a sensitivity test.

The ET have conducted a review of the economic analysis and assumptions of the IDB study and the spreadsheet model to support the initial investment decision, as well as the HDM-4 model for the border approach road. The findings of the baseline review are set out in the Baseline Report (Jacobs, 2019b).

Each investment appraisal model will be updated with actual data (e.g. traffic flow and average weight times) to re-estimate the ERR reflecting changes in cost, scope, and specification, as derived from Table 8-2. The ET will ensure there is consistency in assumptions between the two models including economic parameters.

8.7 Primary and Secondary Data Collection for Economic Models

No primary data collection is envisaged due to the availability of USAID's data and to avoid duplication of data collection efforts. USAID are collecting data to understand the performance of individual steps in the customs border processes for a separate study, but the dataset can be used to establish a baseline position. Therefore, for the purpose of economic evaluation, the ET assume they will have timely access to USAID data sets for the baseline and up to 2023, the final year of the evaluation. The ET also intend to supplement USAID's dataset with customs data collected by the Border Authorities to provide an analysis of the types of goods being carried, and possibly data on the origin/destination of trucks, if collected electronically. From the USAID data, the ET anticipate being able to evaluate how average wait and transit times have reduced over time, how they vary over time and then use these observations to estimate revised ERRs.

8.8 Time Frame of Exposure

Changes at the border crossing activities are expected to have both short- and long-term impacts on transit times. It is reasonable to assume that there will be a period of gradual improvements in the operation of the border crossing as new equipment and the 'single window' initiative take time to bed down. Therefore, the ET propose to undertake RA5b and RA6b an initial evaluation in the period following the opening of the activities, allowing time for any teething problems to be resolved, and then to wait until 2023 before undertaking a long-term evaluation.

8.9 Analysis Plan RQ5b and RQ6b

The analysis will be presented as shown in Table 8-3 with revised ERRs. The HDM-4 model for CA01-E will also be re-run with revised costs/traffic data using a Level 1 or 2 calibration.

Table 8-2. Suggested Analysis Plan for ERRs for El Amatillo and Anguiatú Economic Model

Scenario	Pre-Compact at Time of Signing	Post-Project	Explanation of the Discrepancies and Source
El Amatillo	**see baseline**	**ET to estimate ERR**	
El Amatillo – Sensitivity Test 1	ET to estimate ERR	ET to estimate ERR	Updated wait times and revised project costs
El Amatillo – Sensitivity Test 2	ET to estimate ERR	ET to estimate ERR	Revised economic parameters and actual wait times
El Amatillo – Sensitivity Test 3	ET to estimate ERR	ET to estimate ERR	Revised forecast of average wait times and truck volumes
Anguiatú	**see baseline**	**ET to estimate ERR**	
Anguiatú – Sensitivity Test 1	ET to estimate ERR	ET to estimate ERR	Updated wait times and revised project costs
Anguiatú – Sensitivity Test 2	ET to estimate ERR	ET to estimate ERR	Revised economic parameters and actual wait times
Anguiatú – Sensitivity Test 3	ET to estimate ERR	ET to estimate ERR	Revised forecast of average wait times and truck volumes

9. Administrative and Staffing

9.1 Summary of Institutional Review Board Requirements and Clearances

Only some of the proposed data collection methods for this evaluation involve human subjects. For those that do not (such as IRIs and classified traffic counts), no Institutional Review Board (IRB) approval is required. However, the ET will work with local authorities to obtain the proper permissions and approvals for data collection.

For all data collection efforts involving human subjects (including interviews and O-D surveys), clearance will be sought from Social Impact's internal IRB. During this process, the IRB will review all data collection protocols, informed consent statements, and an IRB application. During the review process, the IRB reviewers will examine:

- Potential risks, if any, to research subjects
- The procedure to obtain consent
- The content covered in the consent statement to verify it adequately covers the purpose of the surveys, risks, and privacy
- The overall study design and protocols
- Methods to be used to protect safety, privacy, and confidentiality, as applicable
- Processes to be used to minimize risk to the fullest extent possible

The IRB will notify the ET of any necessary modifications, which the ET will incorporate into the study.

Once approved, documentation of this IRB approval will be provided to MCC prior to the commencement of data collection activities.

9.2 Creation of Geographic Information System Database

The ET will create a geographic information system (GIS) database that will allow the visualization of all collected data, imagery, and photos. All collected quantitative data will be linked to GPS coordinates. The ET will collect GPS coordinates for:

- Surveys stations for traffic counts, O-D, and weighbridges/stations
- Spatial data about roads sections and cities, which will be obtained from existing open sources, such as open street maps

The ET will geo-reference and match the aerial imagery with roads data. In addition, all collected data will be properly indexed, referenced, and managed in the GIS database. The creation of the GIS database will rely on PostGIS, a powerful open source spatial database management system. All data collected will be organized into a relational database, which can then be migrated to a server accessible remotely through the web.

In addition, the ET proposes to use QGIS, an open source GIS software, for further data visualization and manipulation. Figure 9-1 summarizes the process of GIS database creation.

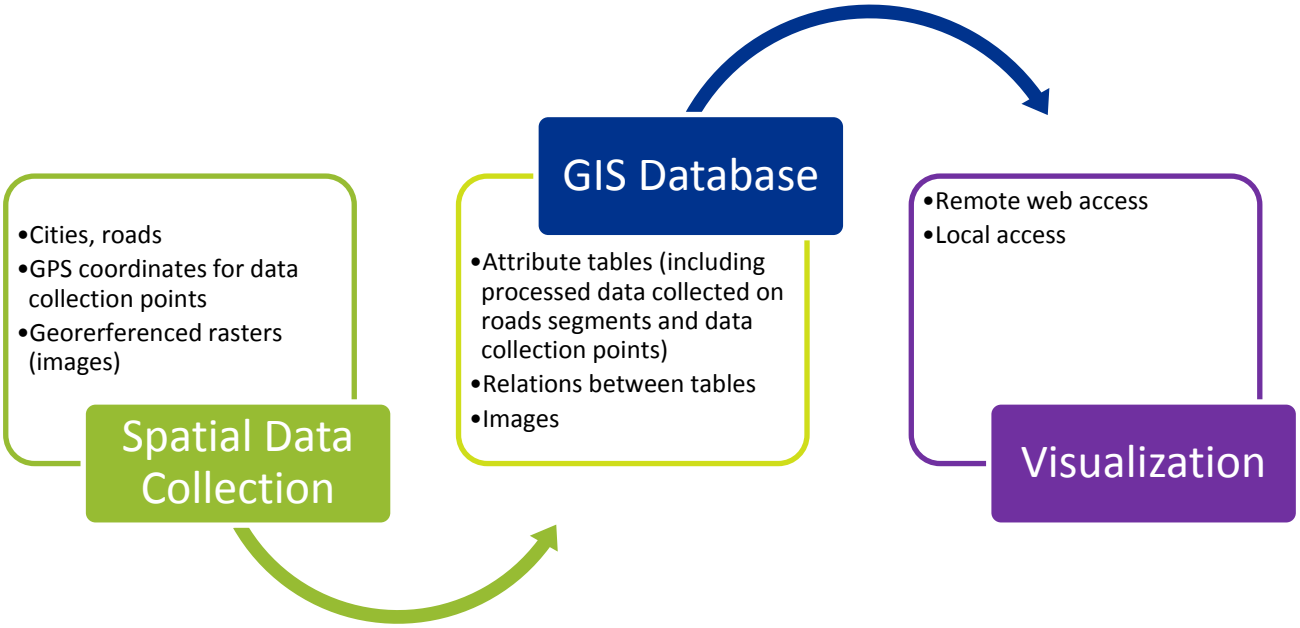

Figure 9-1. Geographic Information System Database Creation Process

9.3 Data Protection

Protecting the privacy of respondents throughout the evaluation process is of utmost importance. For all data collection efforts with human subjects, each respondent will be read an informed consent statement outlining the objectives of the study, the risks they might face as a result of participation, as well as details on how their information will be used. As little personal identifying information (PII) as possible will be collected from respondents. Only those pieces of information necessary to achieve the evaluation's goals will be requested.

For quantitative data, all survey data will be kept on password-protected computers. Only those team members requiring access to the data will be provided access. PII will be kept separate from the fuller data sets with survey answers. While the data sets will only be available to a small subset of the ET, the PII data will only be available to two to three team members as a means of controlling and limiting that access. At the completion of analysis, the data will be saved to a protected and encrypted server.

For qualitative data, the interview notes will not contain PII. Rather, PII will be collected in a separate spreadsheet, using a unique identifier. Only two to three people will have access to the PII spreadsheet. Once data collection is complete and all notes are transferred to a central repository, all other copies of interview notes (such as those on notetaker computers) will be deleted. At the completion of coding, the notes will be saved to a protected and encrypted server.

9.4 Preparing Data Files for Access, Privacy, and Documentation

The ET will follow MCC's guidance regarding the anonymization and publication of data. All data that will be shared publicly in MCC's Evaluation Catalogue will first be reviewed by Social Impact's IRB and then MCC's Data Review Board prior to publication to verify that potential risks or privacy concerns are mitigated prior to publication.

9.5 Dissemination Plan

All key evaluation reports (EDR, data collection protocols, and interim and final evaluation reports) will be published in MCC's Evaluation Data Catalog for public dissemination. The associated anonymized data described will also be published in the catalog.

The ET will present the evaluation findings to both MCC in Washington, DC, and to local stakeholders in San Salvador. Dissemination events will be planned after the completion of the ESI final and ESII interim reports and then after finalization of the ESII final report. In addition, the ET will work with MCC and the Evaluation Management Committee to create an Evaluation Briefs to assist in disseminating the evaluation findings to a broader audience through MCC's website.

9.6 Evaluation Team Roles and Responsibilities

Figure 9-2 shows the ET's roles and responsibilities.

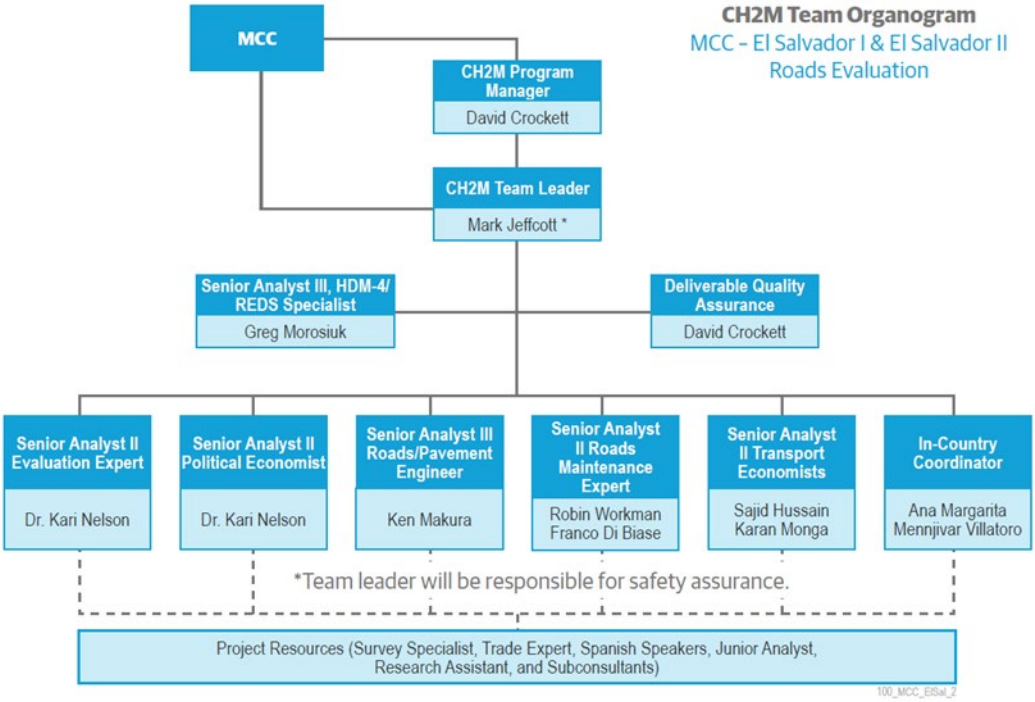

Figure 9-2. Team Members and Associated Roles and Responsibilities

9.7 Roads Safety Protocol

Safety serves a central role in this evaluation of ESI and ESII design and implementation. Precautions will be taken during travel and data collection activities to be consistent with the ET's industry-leading BeyondZero safety program. This helps to eliminate accidents and fatalities by fostering a culture of caring both through the ET parent organization as well as in partner organizations and subcontractors. Thus, for any data collection activities, the ET will treat safety matters as a priority. In particular, the ET will take the following precautions:

- Training and pilot testing: Data collection staff proposed by the data collection firms will follow training sessions and pilot tests in the presence of the ET. The training sessions will cover safety-related matters, and how to use protection equipment and where to stand along the road for better

visibility to minimize risks and hazards. The ET will confirm that this training is applied during pilot testing.

- Safety equipment: The ET will confirm key safety equipment is provided for data collection staff, including:
  - High-visibility vests
  - Battery-enabled lamps
  - Umbrellas
  - Warning signs
  - Flashing lights
  - Other necessary safety equipment required to complete the surveys
  - Private Security: When necessary, Jacobs internal security will determine what in-country security and security for subconsultants is required so that staff can conduct surveys safely. This cost will be advised to MCC in advance of an audit program.
  - Communication: The ET encourages a communication process during the data collection period. Continuous communication will be required from the data collection firm:
    - At the beginning of the day to verify staff carry out the surveys safely
    - At midday to confirm data collection is progressing safely
    - At the end of the data collection day to confirm the staff completed the day safely
- An emergency number will also be made available to the staff.

9.8 Quality Protocols

From training to data processing, the ET will take the necessary actions to provide good-quality primary quantitative and qualitative data, including:

- Pre-test: Before using the evaluation instruments (especially questionnaires and interview guides), the ET will test them to confirm that their contents are consistent with the requirements of the evaluation and that the flow of the questions is optimal. The relevant experts will conduct the pre-testing to provide confidence in the data collection instruments and the data collected.
- Training: The ET will verify that mobilized data collection staff are properly trained by actively supervising the training sessions. The surveyors will also receive training on the most efficient way to ask questions of respondents to achieve a successful survey.
- Pilot testing: The ET will prepare and supervise pilot surveys to confirm that data collection staff understand the data collection process. This will help in making required adjustments before generalizing the data collection.
- Survey manager and supervisor's role: During data collection, at each data collection milestone, the survey manager will verify that agents are conducting the surveys correctly and that relevant questions asked of the respondents are recorded correctly. Shortcomings will be addressed.
- Supervision by the ET: The ET will conduct field visits to supervise the whole process and perform random checks to verify the quality of the data collected and entered. Detected anomalies will be immediately corrected.
- Data entry: For any data collection recorded on paper, the data collection firm will confirm the data are appropriately transferred to electronic media. Data will be checked against hard copy notes to confirm that it is being correctly entered.

10. References

CH2M HILL, Inc. (CH2M). 2019. *Analysis*.

Checchi and Company Consulting. 2015. Mid-Term Evaluation: The Afghanistan Trade and Revenue Project.

Chemonics. 2010. USAID Regional Trade Program for CAFTA-DR: Final Report.

Consulta/Parsons Brinckerhoff. 2009a. Estudio de Impacto Ambiental. Factibilidad Tecnica y Diseno. Final.

Consulta/Parsons Brinckerhoff. 2009b. Mejoramiento de la Red Vial de la Zone Norte de El Salvador.

Development & Training Services. 2012a. Evaluation of West Africa Trade-Related Projects.

Development & Training Services. 2012b. The USAID Regional Trade Liberalization and Customs Project Evaluation Final Report.

Djanitey, R. 2018. Assessing the Impact of National Single Window on the Competitiveness of Ghana's Maritme Sector. World Maritime University Dissertations.

European Commission. 2014. Guide to Cost-Benefit Analysis of Investment Projects. .

FOMILENIO I. 2013a. *Post-Compact M&E Plan*.

FOMILENIO I. 2013b. Final Costs per Section.

FOMILENIO I. 2017. Compact Completion Report.

FOMILENIO II. 2015. Monitoring and Evaluation Plan.

Harral, C.G., and A. Faiz, World Bank. 1988. Road deterioration in developing countries: Causes and remedies.

Harris, D. 2013. Overseas Development Institute. Applied Political Economy Analysis: A Problem-Driven Framework.

Hodges, J.W., J. Rolt, and T.E. Jones. 1975. *The Kenya Road Transport Cost Study: Research on Road Deterioration.* TRRL Laboratory Report 673.

Inter-American Development Bank (IDB). 2010. Electronic Single Window: Coordinated Border Management - Best Practices Studies.

Inter-American Development Bank (IDB). 2013a. *Assessment of Port Performance and Port Connectivity Study in Belize Central America and the Dominican Republic.* https://publications.iadb.org/en/publication/16684/assessment-port-performance-and-port-connectivity-studybelize-central-america

Inter-American Development Bank (IDB). 2013b. *Trucking Services in Belize Central America and the Dominican Republic.* https://publications.iadb.org/en/publication/11843/trucking-services-belize-central-america-anddominican-republic-performance

International Finance Corporation (IFC). 2010. Automating the Control of Goods in International Transit: Implementing the TIM in Central America.

International Labour Organisation (ILO). 2010. *Employment-Intensive Investment in El Salvador, Activities of the Employment Intensive Investment Programme in El Salvador.*. https://www.ilo.org/global/topics/employment-intensive-investment/countries/WCMS_329105/lang--en/index.htm.

Jacobs, 2019a, *El Salvador HDM-4 Level 1 Calibration Report*

Jacobs, 2019b, *El Salvador Baseline Report*

Korinek, J., and P. Sourdin, OECD, 2011. To What Extent are High-Quality Logistics Services Trade Facilitating?

Management Systems International (MSI). 2003. Evaluation of Trade Facilitation and Investment Activity.

Management Systems International (MSI). 2010. From Aid To Trade: Delivering Results: A Cross-Country Evaluation of USAID Trade Capacity Building.

Management Systems International (MSI). 2014. Pakistan Trade Project: Midterm Performance Evaluation Report.

Maximo Torero. 2014. Evaluation Design MCC Connectivity Project in El Salvador, The Northern Transnational Highway. February.

McLinden, G. World Bank, 2013. *Single Window Systems: What We Have Learned*. April 30. https://blogs.worldbank.org/trade/single-window-systems-what-we-have-learned

McLinden, G, E. Fanta, D. Widdowson, T. Doyle. World Bank, 2011. *Border Management Modernization*.

Mendez England & Associates. 2017. Final Performance Evaluation: Regional Integrated Trade and Food Security Strategy 2011-2017.

Menocal, R.M., M. Cassidy, S. Swift, D. Jacobstein, C. Rothblum, and I. Tservil. USAID, 2018. *Thinking and Working Politically through Applied Political Economy Analysis: A Guide for Practitioners.* https://www.usaid.gov/sites/default/files/documents/1866/PEA2018.pdf.

Millennium Challenge Corporation (MCC). 2006a. *The Compact Agreement.*

Millennium Challenge Corporation (MCC). 2006b. *El Salvador I Investment Memorandum* - FINAL (redacted).

Millennium Challenge Corporation (MCC). 2013. *El Salvador II Investment Memorandum* (redacted).

Millennium Challenge Corporation (MCC). 2014a. *El Salvador II Millennium Challenge Compact.*

Millennium Challenge Corporation (MCC). 2014b. *Project Evaluability Assessment*.

Millennium Challenge Corporation (MCC). 2015a. *Program Implementation Agreement.*

Millennium Challenge Corporation (MCC). 2015b. *Closeout Monitoring and Evaluation Plan*. Version 1.

Millennium Challenge Corporation (MCC). 2017. *Measuring Results of the El Salvador Connectivity Project*. May 2. https://www.mcc.gov/resources/doc/summary-measuring-results-el-salvador-connectivity-project

Millennium Challenge Corporation (MCC). 2017. *Policy for Monitoring and Evaluation.* March 15. https://www.mcc.gov/resources/doc/policy-for-monitoring-and-evaluation

Millennium Challenge Corporation (MCC). 2018a. *Beneficiary Analysis.* https://www.mcc.gov/ourimpact/beneficiary-analysis

Millennium Challenge Corporation (MCC). 2018b. *Principles into Practice: Lessons from MCC's Investments in Roads.* October 9. https://assets.mcc.gov/content/uploads/paper-2017001200401a-principles-roads.pdf

Millennium Challenge Corporation (MCC). 2018c. 9533241XQ0047/Approved Solicitations and attachments

Millennium Challenge Corporation (MCC). 2019. Updated Programme Logic. Email from Rebecca Goldsmith, Company, Title to First Name Last Name, Company. Month day. .

Millennium Challenge Corporation (MCC) and Partnership for Growth (PfG). 2011. *El Salvador. Constraints Analysis.*

Millennium Challenge Corporation El Salvador Transaction Team. 2006. *El Salvador Redacted IM Final*. August 24.

Moran, C. 2014. *Salvador: The Experience of Road Maintenance Fund*. https://trid.trb.org/view/876394. Accessed on 1 May, 2019.

Nathan Associates. 2018b. Final Report of the Central America Regional Trade Facilitation Expansion Activity: An LPFM II Activity.

Nathan Associates. 2018c. *RTMA Final Report.*

National Research Council (NRC). 1961. *AASHTO Road Test: History and Description of Project.* Publication 816, National Academy of Sciences.

Osborne, T., M.C. Pachon, and G.E. Araya. 2014. *What Drives the High Price of Road Freight Transport in Central America?* World Bank, Policy Research Working Paper.

Paterson, W.D.O. 1987. Road deterioration and maintenance effects; Models for Planning and Management. The World Bank.

Ranawaka S., and H.R. Pasindu. 2017. Estimating the Vehicle Operating Cost used for Economic Feasibility Analysis of Highway Construction Projects. Moratuwa Engineering Research Conference.

Roche. 2006. Due Diligence of Infrastructure Components Final Report. September 27.

SDK Consulting (SDK). 2012. Estudio de prefactibilidad de actividades de infraestructura Del Compacto II, MCA El Salvador.

Security Magazine. 2018. "BeyondZero: How Jacobs is Fostering a Culture of Caring." *Security Magazine*. December 7. https://www.securitymagazine.com/articles/89637-beyondzero-how-jacobs-is-fostering-a-culture-of-caring

Smith, J. (n.d.). Road Condition Assessment: North Ayrshire Council.

Suthanaya, P.A. 2017. "Road Maintenance Priority Based On Multi-Criteria Approach (Case Study of Bali Province, Indonesia)." *International Journal of Engineering and Technology*. Vol. 9, No. 4. pp. 3191-3196.

Tosevska-Trpcevska, K. 2014. "Effects of the implementation of single window and simplified customs procedures in the Republic of Macedonia". *World Customs Journal*. 8 (1).

Transport Research Laboratory (TRL). 1962. ORN 31: A guide to the structural design of bituminous surfaced roads in tropical and sub-tropical countries.

Transportation Research Board (TRB). 2007. Pavement Lessons Learned from the AASHO Road Test and Performance of the Interstate Highway System.

U.S. Department of Transportation (DOT). 2013. *Distress Identification Manual for the Long-Term Pavement Performance.* Fourth Revised Edition. June. https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/reports/03031/03031.pdf

UK Department for Transport. 2019. Transport Appraisal Guidance (WebTAG).

UNDP. 2017. Projects Evaluation Under Regional Programme for Arab States: AfTIAS Evaluation Report.

Vives, L. 2018. Study on Single Window Systems' International Interoperability: Key Issues for Its Implementation. Asia-Pacific Economic Cooperation, Committee on Trade and Investment.

Wingerts Consulting. 2006. Evaluation of the PROALCA II Program.

World Bank. 2010. *Fourth Highway Development and Management Model (HDM-4) road use costs model documentation* (English). Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/793271468171847482/Fourth-Highway-Development-and-Management-Model-HDM-4-road-use-costs-model-documentation

World Bank, 2014, *What Drives the High Price of Road Freight Transport in Central America? Policy Research Paper 6844, Th World Bank, Latin America and the Caribbean Region, Sustainable Development Department.*

World Bank. 2014. *Problem-Driven Political Economy Analysis: The World Bank's Experience.* Verena Fritz, Brian Levy, and Rachel Ort, authors. January 1. https://esmap.org/node/71294.

World Bank. 2016. *World Bank Transport Connections Notes Series.* http://www.worldbank.org/en/topic/transport/brief/connections-notes-series-2016.

World Bank. 2017. Approach Paper: Grow with the Flow: IEG Evaluation of World Bank Group Support to Facilitating Trade 2006-17.

World Bank. 2019a. *The World Bank In El Salvador.* https://www.worldbank.org/en/country/elsalvador/overview

World Bank. 2019b. Grow With the Flow: An Independent Evaluation of the World Bank Group's Support to Facilitating Trade 2006–17. Independent Evaluation Group. World Bank.

World Bank. 2019c. "GDP per capita, PPP (current international $)." *World Bank, International Comparison Program Indicators Database*. July 1. http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?view=chart. Accessed on 2 July 2017.

Zietlow, G. 2004. *Road Funds in Latin America*. University of Birmingham (UK) Senior Road Executives Programme: Road Financing & Road Fund Management, Birmingham. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.555.1527&rep=rep1&type=pdf

Appendix A Stakeholder Comments and Evaluator Responses

(See Separate Document)

Appendix B Northern Transnational Highway HDM-4 Road Sections

ID	Name	Length (km)
3B (16 17)	3B (16) Guarjila - Sn I. Labrador 16-17	2.78
3B (19-20)	3B (19) SalSn I.Labrador-Sn Ant.Cruz (19-20)	12.65
24	24 Sensuntepeque-Dolores	14.47
31	31 Dv. Carolina - Dv. Ciudad Barrios	4.53
35-36	35 Osicala-Dv.D Concepción (35-36)	5.25
38	38 Cacaopera - Corinto	17.89
AC02	AC02 Entrada Acceso Sensentepeque - NTH?	0.92
AC05	AC05 Chalatenango Guarjila	3.56
AC06	AC06 Acceso Guarjila	0.49
AC07	AC07 Guarjila - San Isidro Labrador	0.49
AC08	AC08 Acceso San Isidro Labrador	0.86
AC09	AC09 San Isidro Labrador - Alterna San Antonio de la Cruz	0.08
Bp Osi	By pass Osicala	1.15
PNJ	Puente Nombre de Jesus	0.84
PMESJ	Puente Nuevo Eden de San Juan	0.93
07B	2B1 (07B)	6.07
2A (06)	2A (06) Salida Metapán - Tahuilapa	6.18
2A (07A)	2A (07A) Tahuilapa - Santa Rosa Guachipilin	13.66
2A (ACC1a)	2A (ACC1a) Acceso a Metapan - NTH?	0.66
2A (ACC1bc)	2A (ACC1bc) Salida de Metapán	2.64
2B1 (VT19)	2B1 (VT19) Tahuailipa	1.62
2B2 (08)	2B2 (08) El Matazano - Nva. Concep	13.63
21A	21A Potrerillos La Trinidad	9.49
26A	26A Actual Carretera a Nuevo Eden de San Juan	3.77
39	39 Corinto-Lislique	8.42
4a (21)	4A (21) Potrerillos - La Trinidad	9.18
4A (22)	4A (22) La Trinidad - Cantón Agua Zarca	13.22
4C (25)	4C (25) Dolores - Río Lempa	9.19
4C (26)	4C (26) Nvo Eden S Juan (actual en comparacion nueva)	3.77
AC03	AC03 Nuevo Eden de San Juan - Alterna San Gerardo - NTH?	1.78
AC04	AC04 Acceso Concepcion de Oriente - NTH?	2.30
T5 (27-30)	T5 (27) Nvo.Edén S. Juan - S. Gerardo-S. Luis La Reina-Dv.Caro	36.14
T6 (32-34)	T6 (32) Desv.Ciudad Barrios-El Carrizal (32-34)	22.59
T6 (37)	T6 (37) Delicias de Concepción - Cacaopera	7.36
VT03	VT03 Anamorós - Lislique	8.55
Total		**247.11**

Appendix C Evaluation Budget Redacted in Public Document

Appendix D Response to Section J Attachment 8 Data Collection Quality Protocols

Proposed Survey	Required (yes/no)	Comments/Rationale
International Roughness Surveys (IRI)	Yes	Required for evaluation of maintenance practices. Survey method will comply with minimum quality protocol set out in Section J Attachment 8. IRI surveys were discussed during field trip and suitable equipment is available locally to undertake measurements. MOP have supplied sample IRI to the Evaluation Team giving confidence in local capacity/capability to undertake and organize surveys. IRI will be use for the Level 2 HDM-4 calibration.
Deflection	Not required	Not required as all roads in the evaluation have been constructed to known design standards. Requires use of 'as built' drawings. Note road deterioration in tropical countries is a result of top-down cracking due to aging rather than fatigue deterioration in lower layers. Deflections are only relevant in the later stage of a road design life where noticeable deterioration is occurring, none of MCC's are approaching their design life.
Geotechnical	Not required	Sample coring and ground penetrating radar are not required. All roads in the evaluation have been constructed to known design standards. Requires use of 'as built' drawings. There may be issues with the NTH due to poor record keeping.
Road Condition Surveys	Yes	Visual conditions surveys will be undertaken using HD cameras as the same time as the IRI surveys. The Evaluation Team noted evidence of pavement distress on the NTH during the field trip and intend to follow this up during the evaluation. Visual Condition Surveys will also be used for the Level 2 HDM-4 calibration.
Traffic Surveys	Yes – Counts, OD/Intercept Survey, Travel Time Surveys and Vehicle Operating Costs Axle load surveys not required	Traffic counts, OD/Intercept surveys, travel time surveys and vehicle operating cost surveys are proposed. For vehicle operating costs surveys, we propose to review and check existing data sets within the HDM-4 models supplied and develop a survey program to address any outstanding gaps. We do not propose axle load surveys and note that there is a MOP weighbridge/weigh station in operation on the Coastal Highway CA01. We will discuss with MOP the extent to which truck overloading is an issue in El Salvador. Detailed survey protocols will be developed and shared prior to any commissioning surveys.

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