


PR-10 SEGMENTS II, III, IV & V  
BENEFIT/COST ANALYSIS (BCA)

Prepared By  
Barrett Hale & Alamo LLC  
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## Summary and Findings

This Benefit Cost Analysis has been prepared for the design and construction of segments II, III, IV and V of Highway PR-10 along the municipalities of Utuado and Adjuntas. The proposed project will provide uninterrupted freeway travel to users traveling from north to south, and vice versa, connecting with PR-22 in the north and with PR-52 in the south, resulting in improved travel times and roadway safety for passenger cars and trucks. The period of analysis in the estimation of benefits and costs corresponds to 33 years, consisting of 3 years of construction and 30 years of operation after the completion plus a residual value after the final year. Total project costs are estimated at \$552 million, which include initial project costs such as engineering and property purchase costs, and maintenance and operation costs for the entire length of the analysis period.

The project is expected to generate \$729.3 million in discounted benefits and \$461.6 million in discounted costs using a 7 percent discount rate. Therefore, the project generates a Net Present Value (NPV) of \$267.7 million and a Benefit-Cost Ratio of 1.58, summarized in the table below.

<b>Life-Cycle Costs (mil. \$)</b>	\$461.6
<b>Life-Cycle Benefits (mil. \$)</b>	\$729.3
<b>Net Present Value (mil. \$)</b>	\$267.7
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<b>Benefit / Cost Ratio:</b>	1.58
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<b>Rate of Return on Investment:</b>	11.5%
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<b>Payback Period:</b>	8 years

This analysis was performed using Caltrans's most recent California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C version 8.1), which is consistent with the US Department of Transportation's Federal Highway Administration guidelines for performing Benefit Cost Analyses, [adjusted for Puerto Rico](#). Currently, dozens of individual analysis tools and methodologies designed for conducting B/C analysis have been developed by regional, state, and Federal agencies, as well as proprietary tools developed by many private-sector enterprises given that FHWA has not published a standard tool. Originally designed to conduct benefit/cost analysis of traditional highway improvements, Cal-B/C has been subsequently enhanced to be used to analyze many types of highway construction and operational improvement projects, as well as some Intelligent Transportation Systems and transit projects. Several agencies outside Caltrans have also adapted Cal-BC as the basis for their own tools.

## Project Overview

The proposed PR-10 highway (Utuado – Adjuntas) project is an approximate seven-point six (7.6)-kilometer segment designed to comply with the requirements of the latest construction codes of the

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American Association of State Highway and Transportation Officials (AASHTO) Design and Construction of Highway and Bridges to provide a resilient facility for future natural events (i.e., storms, hurricanes, and earthquakes). The project consists of the construction of a new roadway facility including twenty (20) bridges spanning over twenty to thirty (20-30) creeks and water bodies along one of the steepest terrains in Puerto Rico. The bridges will provide free flow to the storm runoff water which is the major cause of erosion and landslides of the highway embankments.

The construction of the proposed project will take place within the Central Mountain Range of Puerto Rico (Cordillera Central). This area includes some of the highest peaks in Puerto Rico and the least accessible terrain. These factors can drive up project costs due to the complexities of construction in such terrain with drastic shifts in elevation, not to mention the high cost of bridge construction standards.

Such cost considerations have proven prohibitive since the original conception of the project. The economic decline, which began with the Global Financial Crisis and continued for over a decade, pushed the possibility further out of sight. However, currently, an investment of this nature is imperative. As Irma and María showed us, this critical lifeline upon which others depend proved non-resilient to an incomplete segment along PR-123 in this region. The impact rendered this main thoroughfare essentially incapacitated limiting ingress/egress of surrounding communities. As evident in the risk assessment, a future hazardous event is imminent, and the probability of impact to this area is high.

The project design includes highway sections consisting of two (2) three-point sixty-five (3.65) meter lanes and one (1) one point eight zero (1.80) meter shoulder in the uphill segments. It also includes one (1) three-point sixty-five (3.65) meter lane and three (3) meter shoulder in the downhill segments. The steep cuts will be reinforced with a soil nails system which will protect the roadway against landslides and reduce the volume of cuts resulting in reduced environmental impacts.

In summary, the PR-10 (Utuado – Adjuntas) Project will provide:

- Continuity to the North-South ground commute. This connection reduces the time lost in the transport of lifeline service equipment and personnel during stable conditions as well as response in the event of partial or holistic instability.
- A safe and resilient transportation lifeline facility built to withstand impacts of future natural events in conformance with the latest construction codes of AASHTO Design and Construction of Highway and Bridges.
- Increased capacity within the transportation lifeline, upon which other lifelines depend, to provide the necessary mobility to emergency teams, rescuers, and utility crews to assist communities during a natural event and reduce the loss of lives and economic impacts.
- Reduction of carbon-monoxide emissions along existing PR-123 due to high fuel consumption of heavy and general vehicles.
- Reduction of contamination of the Rio Grande de Arecibo by the acquisition and demolition of existing structures in the upstream side of the river and providing a natural barrier to the remaining land from future development.
- Economic development potential for the surrounding communities.

The construction of PR-10 highway (Utuado – Adjuntas) will be performed in four sections utilizing the hybrid construction methods of Conventional Construction and Design-Build Construction. The project will have all permits and endorsements from regulatory agencies such as: Department of Natural

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Resources and Environment (DNRE), US Corp of Engineers, Fish and Wildlife, PREPA/LUMA, PRASA, JRTC, SHPO and OGPE. A protocol to protect the existing Flora and Fauna during construction was prepared and approved by DNRE. Biology specialists will be sub-contracted by the PRHTA to oversee implementing the protocol. Twenty (20) bridges will be built over more than 20 creeks and water bodies to provide free flow to the rainfall water and avoid the washing-out of the embankments of the new road during heavy rainfall events. Steep cut areas will be reinforced with soil nailing system.

#### Significance of PR-10 for the Economy and Resiliency of Puerto Rico

PR-10 is an important element of the Puerto Rico transportation network since it is an interface between the industrial centers of the PR-2 North Corridor (Arecibo – Aguadilla) and the PR-52 South Corridor (Ponce – Salinas) providing north-south connection to promote the industrial development of both centers and of the adjacent municipalities. Having the Port of Las Americas and Mercedita International airport in Ponce, and an emerging industrial region coupled with the international airport in Aguadilla, PR-10 will become the catalyst needed to boost the industrial development of Puerto Rico.

#### Consequences of the Missing PR-10 Segment (Utuado – Adjuntas)

The missing portion of PR-10 between Utuado and Adjuntas, became an obstacle for a faster recuperation of Puerto Rico after the Hurricanes Irma and Maria in September 2017. The lack of an effective ground communication system delayed the prompt assistance of the emergency and healthcare paramedics to avoid the loss of lives during the hurricanes and the months after. Tens of landslides along PR-123, lack of electricity and potable water in addition to a poor communication system provoked the loss of hundreds of millions in economic activity in the region.

#### USDOT Methodology for Transportation Projects

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of investment alternatives. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs).

The BCA framework involves defining a Base Case or “No Build” Case, which is compared to the “Build” Case, where the grant request is awarded, and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project life cycle. The importance of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT, which includes the following analytical assumptions:

1. Defining existing and future conditions under a No Build base case as well as under the Build Case
2. Estimating benefits and costs during project construction and operation, including 30 years of operations beyond the Project completion when benefits accrue;
3. Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;

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4. Presenting dollar values in real 2020 dollars. In instances where cost estimates and benefits valuations are expressed in historical dollar years, using an appropriate Consumer Price Index (CPI) to adjust the values;
  5. Discounting future benefits and costs with real discount rates of 7 percent consistent with U.S. DOT guidance. Including sensitivity analysis with a 3 percent discount rate.

## General Assumptions

1. The project construction period is 2022-2025 and begins operations in 2025. The BCA is evaluated for 30 years since the start of operations.
2. The discount rate is 7%.
3. All figures are expected in 2020 dollars.

## Factors considered in the BCA

### *I. No Build Scenario*

PR-10 is a principal arterial that connects Arecibo in the north and Ponce in the south, passing through the municipalities of Adjuntas and Utuado. The existing PR-10 north segment begins in the interchange with PR-2 and ends in the intersection of PR-123 over the Rio Grande de Arecibo at km 37.7. The PR-10 south segment begins in the PR-9 interchange and ends in the intersection with PR-123 at km 23.26. In its current state, it is a freeway only in the completed portions. The PR-123 is classified as a minor arterial with typical collector characteristics as it provides various direct access points for residential purposes. This 27.5-mile (44.26 km) segment of PR-123 currently offers one lane per direction plus a climbing lane in the uphill segments with mountainous terrain and capacity restrictions because of landslides from Hurricane María.

Our “no build” baseline scenario represents the expected outcomes if no changes are made to existing conditions. For the purposes of this analysis, this is represented by three (3) key underlying factors. The first is the added travel time and distance experienced by existing users of the PR-10 corridor that currently travel along PR-123 for sections where PR-10 is not complete. The second is the increased risk of traffic accidents on PR-123 due to its alignment and surface conditions compared to the expected risk for the PR-10 connector. The third crucial factor is directly related to hazard risks associated with the lack of connectivity on PR-10 and the reliance on PR-123 as a major thoroughfare in the region.

### *II. Build Scenario*

The proposed segment of highway PR-10 is seven-point six (7.6) kms long and consists of one (1)-3.65-meter lane plus three (3.0 m) shoulder in the downhill direction and two (2)-3.65 meter lanes, plus 1.80 m shoulder in the uphill direction. The speed limit is thirty-five (45) miles per hour (mph) conforming to the design criteria for the topography and terrain type. The new connector will not be tolled and is expected to open in 2027. Benefits generated from this project fall into the following categories:

1. Mitigation of negative impacts caused by natural disasters and resulting roadway closures including delay for response teams and loss of crucial access to goods and services.
2. Time and Distance Saved from the shorter, more efficient route.
3. Decreased risk of crashes from safer roadway alignment and modern design standards.

Key variables for this analysis include modeled traffic counts and travel times, which were sourced from traffic analysis and demand modeling performed in 2019.

## Demand Projections

Once the route is fully connected, it would become a preferred alternative for other north-south traffic in the region, pulling some amount of traffic from existing highways including PR-2 and PR-149. This scale of this shift is difficult to accurately project, so for the purpose of this analysis, baseline traffic counts were determined using 2025 projections for the north and south intersections of PR-10 and PR-123. These counts, shown below, are based on collected data in 2019 from km markers 29.6 -30.6 and 39.3-41.6. This provides a conservative estimate, as it does not fully account for the induced impacts of the completion of the route.

Variable	Project Opening Year (2025)		Final Year of Analysis (2054)	
	No Build	Build	No Build	Build
Daily Volume	10,038	10,038	12,249	12,249
VMT	90,746	47,079	110,727	57,446
VHT	5,019	1,205	6,124	1,470
Vehicle Occ.	1.5			

## Crash Data and Modification Factor

The following table shows the historical annual crash data for PR-123 as reported by Steer in their Traffic Analysis. The crash rates were calculated following the guidance from the Highway Safety Manual.

	Fatal	Injury	Damage
# of Events	0	112	720
Crash Rate	0.025	1.38	11.8

The Crash Modification Factor (CMF) of 0.64 used in the analysis represents the mean value of two probable CMF values of 0.50 and 0.80 with a standard error of 0.10 and reliability factor of 0.85. This approach is consistent with the criteria established by CLEARINGHOUSE in the estimate of the CMF.

The criteria established by CLEARINGHOUSE are summarized in the table below:

Reliability %	Confidence Factor (CF)	Significance Value
95%	1.96	.05
90%	1.64	0.10
85%	1.44	0.15
Formula: $CMF(\text{upper limit}) = CMF + CF \times \text{Std-error}$ $CMF(\text{lower limit}) = CMF - CF \times \text{Std-error}$		

For this analysis we used a conservative CMF base value of **0.64**, a standard error of 0.10 and a reliability factor of 85%. The results of this computation using the above criteria are:

- $CMF = CMF(\text{upper-limit}) - 1.44 \times 0.10 = 0.80 - .144 = 0.66$

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- $CMF = CMF \text{ (lower-limit)} + 1.44 \times 0.10 = 0.50 + .144 = 0.644$

A CMF of 0.64 is equivalent to a Crash Reduction Factor of 36% which was used in the analysis to calculate the expected number of crashes and the monetary value of its reductions.

### Qualitative Assessment of Landslide Hazard Mitigation Project Benefits

The extension of PR-10 in Utuado and Adjuntas provides a more stable north-south route that can reduce traffic delays from landslide damage along PR-123. Additionally, the PR-10 extension provides improved access to utility rights-of-way that can help facilitate post-disaster repairs to damaged electrical transmission lines. The Federal Emergency Management Agency (FEMA) BCA approach includes BCA Software that can be used to quantify landslide hazard mitigation benefits for the proposed project. This quantitative BCA approach requires extensive supporting documentation of anticipated landslide event recurrence intervals (RI) supported by geotechnical engineering studies, landslide damages and associated detour times based on FEMA Project Worksheets (PWs) or detailed repair estimates, and project effectiveness based on engineering analysis. Although research of available data and resources was not sufficient to prepare a FEMA landslide BCA; there was enough supporting documentation to support a qualitative assessment of landslide mitigation project benefits. The following approach was used to conduct a detailed qualitative assessment of landslide hazard mitigation project benefits.

### Assessment of Landslide Hazard Risk

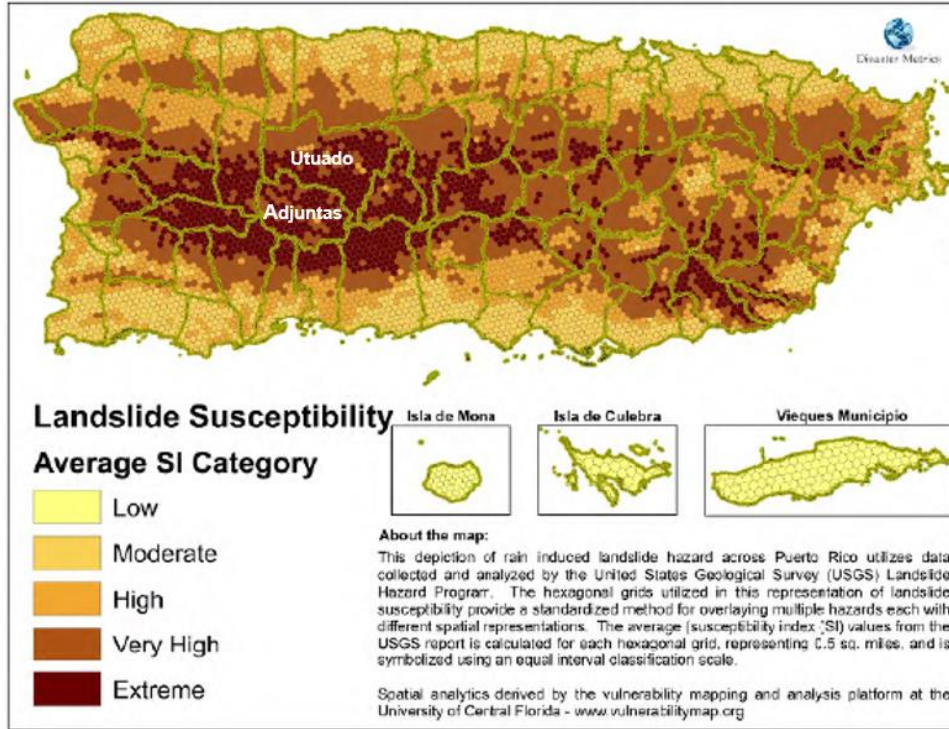
The geology and topography of Puerto Rico has always made Puerto Rico susceptible to landslides. A recent hazard risk assessment report for Puerto Rico<sup>1</sup> indicated the following:

- Landslides induced by heavy rain was one of the top three hazards impacting the island, second only to flooding and hurricane-force winds.
- For the two municipalities that make up the PR-10 extension, Utuado and Adjuntas, landslide is the second highest hazard risk behind hurricane wind.
- As shown in the figure at the top of Page 8, the municipalities of Utuado and Adjuntas have very high to extreme susceptibility to landslides.
- As shown in the figure at the bottom of Page 8, PR-123 has an extreme susceptibility to landslides along most of the PR-10 extension.

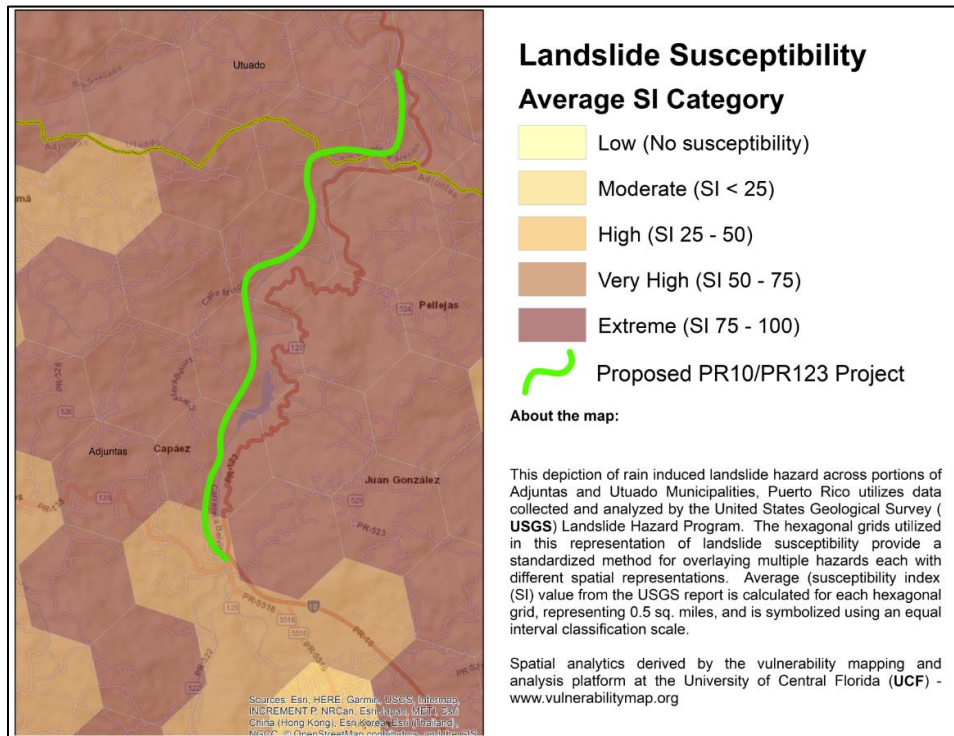
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<sup>1</sup> Puerto Rico's Hazard Risk Assessment. Prepared July 6, 2020 by University of Central Florida and Disaster Metrics LLC. Authored by Dr. Christopher T. Emrich and Dr. Yao Zhou. Available online([https://cdbg-dr.pr.gov/en/download/cdbg-mit-action-plan-effective-on-april-19th-2021/?ind=1619459686073&filename=1619459685wpdm\\_APPENDIX%20A\\_Puerto%20Rico%20Hazard\\_Risk\\_Assesment\\_Report\\_EN.pdf&wpdmdl=18594&refresh=62a9c2ae524191655292590](https://cdbg-dr.pr.gov/en/download/cdbg-mit-action-plan-effective-on-april-19th-2021/?ind=1619459686073&filename=1619459685wpdm_APPENDIX%20A_Puerto%20Rico%20Hazard_Risk_Assesment_Report_EN.pdf&wpdmdl=18594&refresh=62a9c2ae524191655292590))





Rain-Induced Landslide Susceptibility Areas in Puerto Rico, with labels added for Utuado and Adjuntas. (Source: Puerto Rico's Hazard Risk Assessment, June 2020, Figure 7.)



Rain-Induced Landslide Susceptibility Areas along PR-123 and the PR-10 extension. (Source: Prepared by Dr. Chris Emrich based on detailed analysis of Puerto Rico's Hazard Risk Assessment data, June 2020.)

In addition to statistical analysis, a detailed review of the PRHTA geotechnical engineering office (GEO) database geotechnical reports<sup>2</sup> revealed the following:

- Based on a review of more than 100 site locations along PR-10 and PR-123, there were at least 20 definite reports and 5 probable reports of documented landslide incidents, with 19 incidents along PR-10 and 6 incidents along PR-123. Most of these landslide reports are supported field observations and detailed subsurface exploration data including site photographs and measurements of slide areas, soil boring samples, rock cores, and inclinometer readings.
- Of these 25 geotechnical reports, there were four definite reports and two probable reports of documented landslide incidents within the 7.6-Km Utuado-Adjuntas extension of PR-10. Refer to the table below for a summary of these reports.

Geotechnical Reports of Documented Evidence of Landslide Damage Along the Proposed PR-10 Extension (Source: Prepared based on a review of the PRHTA GEO Geotechnical Reports Inventory Application)

Highway	Km	Municipio	Report Description	Landslide Indicated	Report Date(s)	Importance	Report Findings in Terms of Landslide Event(s)	Documented Landslide Damage
PR-123	48.80	Utuado	Geotech Evaluation Emergency Relief Program Landslide #ER-HWY-91	Yes	7/8/2019	High	Landslide damage to uphill slope, roadway embankment, and adjacent structure occurred post-Irma/Maria	Yes
PR-123	48.50	Utuado	Geotech Engineering and Subsurface Exploration Emergency Relief Program Landslide #ER-HWY-90	Yes	2/5/2019	High	Landslide damage to roadway embankment occurred post-Irma/Maria	Yes
PR-10	N. I.	Adjuntas	Geologic Study of PR-10 Relocation Between Arecibo and Ponce	Yes	12/1/1969	High	Old report, but provides evidence of landslide risk areas extending back to the 1960s	Maybe
PR-10	30.30	Adjuntas	Geotech Investigation for #ER-HWY-12 at PR-10 Km 30.3-30.4, Landslide Damage Repair	Yes	1/4/2019, 11/23/2021	High	Landslide damage to uphill slope, roadway shoulder occurred post-Irma/Maria	Yes
PR-10	30.30	Adjuntas	Geotech Investigation for #ER-HWY-12	Potential	1/4/2019	Medium	Evidence of damage to uphill slope from landslide post Irma/Maria	Yes
PR-10	30.00	Adjuntas	Evaluación de Terraplenes y Deslizamiento ocurrido entre las Station 116+00 y 117+20 PR-10 - Adjuntas	Potential	7/15/2010	Medium	Evidence of damage from landslide that occurred c 2008. Supported by inclinometer data (report in Spanish).	Maybe

Based on a review of this information, the landslide hazard risk was clearly established within the project area.

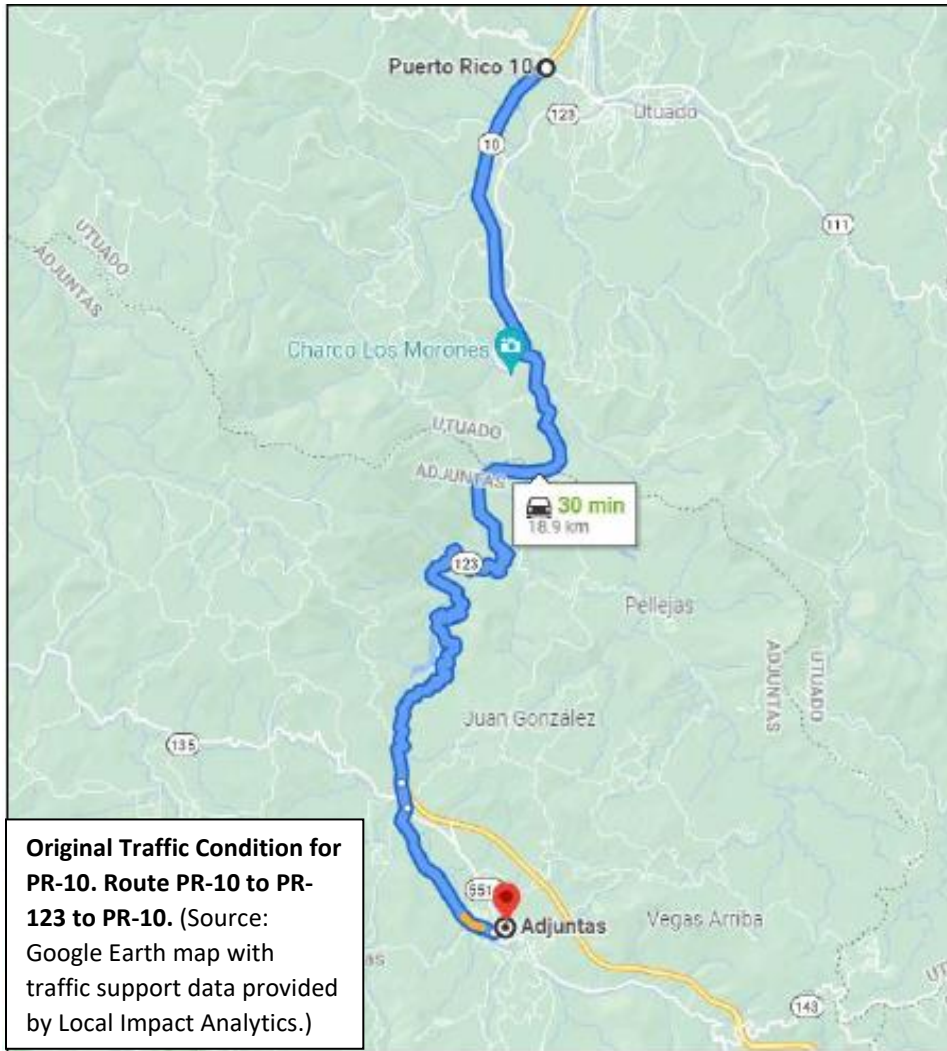
#### Estimated Landslide Damages and Roadway Detours in Project Area

Physical damages to roadways, embankments and uphill slopes and along PR-123 from Hurricanes Irma and Maria in the vicinity of the 7.6-Km Utuado-Adjuntas extension of PR-10 were estimated at approximately \$4.0 billion<sup>3</sup>. Although the extension of PR-10 cannot reduce the physical damages to PR-123, the project can reduce traffic delays from detours caused by landslide damage to PR-123. The following process was used to estimate the potential benefits of reduced traffic detours along PR-123.

<sup>2</sup> The PRHTA GEO database of geotechnical reports for various roads throughout Puerto Rico can be accessed online using the following link: <https://experience.arcgis.com/experience/f10a52a1325d482bbc99daba3baefe98>.

<sup>3</sup> Based on a review of FEMA Damage Survey Reports and Project Worksheets for the FEMA disaster declarations for Hurricane Irma (FEMA-DR-4336-PR) and Hurricane Maria (FEMA-DR-4339-PR) data provided by PRHTA, there were an estimated \$4,061,391 in landslide damage and associated repairs to PR-123 in the area of the 7.6-Km Utuado-Adjuntas extension of PR-10. However, there was insufficient data available to estimate damages from previous landslide events that occurred more than 5 years ago.

- Step 1: Assess Original Traffic Conditions Along PR-10 and PR-123.** As shown in the figure below, the current north-south travel time along the 18.9 Km PR-10 via PR-123 in Utuado and Adjuntas is approximately 30 minutes, with an average travel speed of 37.8 Km/hour. As shown in the table at the bottom of Page 11, the current annual average daily traffic (AADT) traveling north-south along PR-123 in the area of the proposed PR-10 extension is approximately 5,738 vehicles/day<sup>4</sup>.

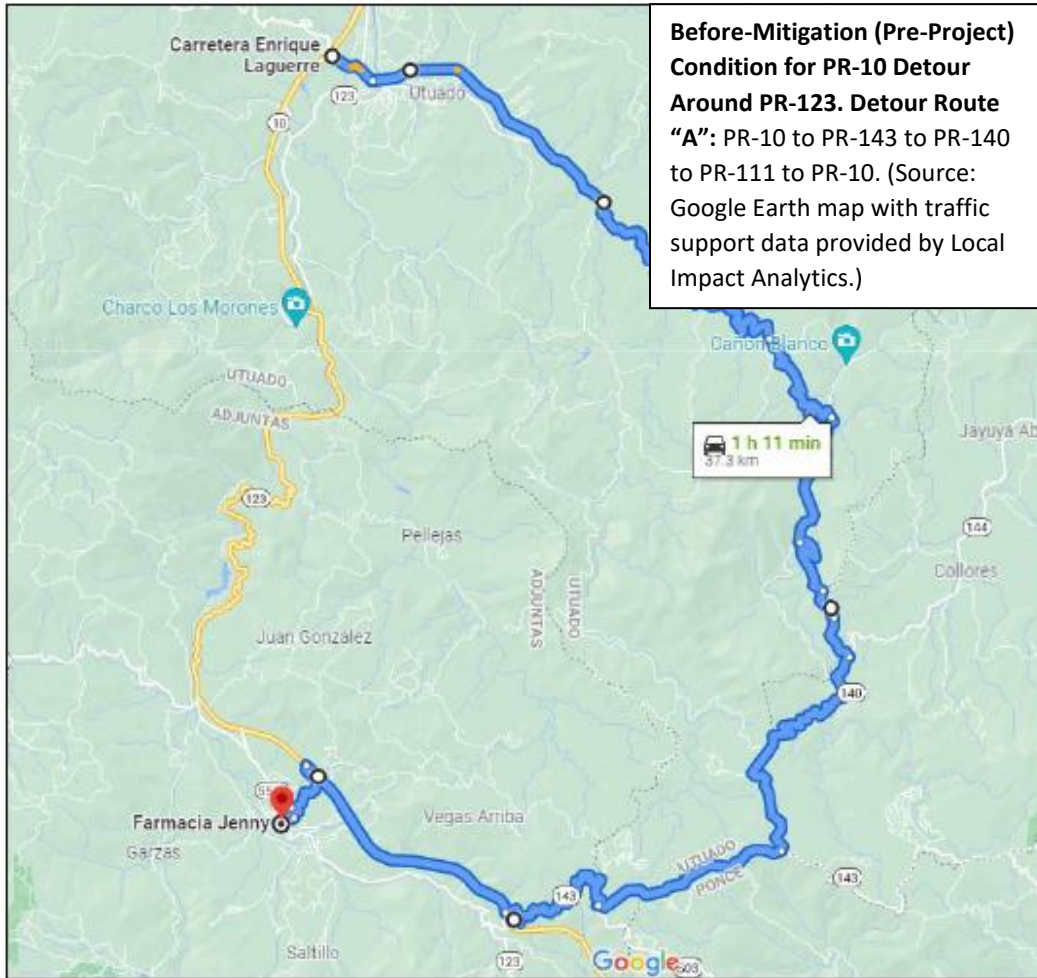


Average Annual Daily Traffic (AADT) for PR-123 along PR-10 Extension

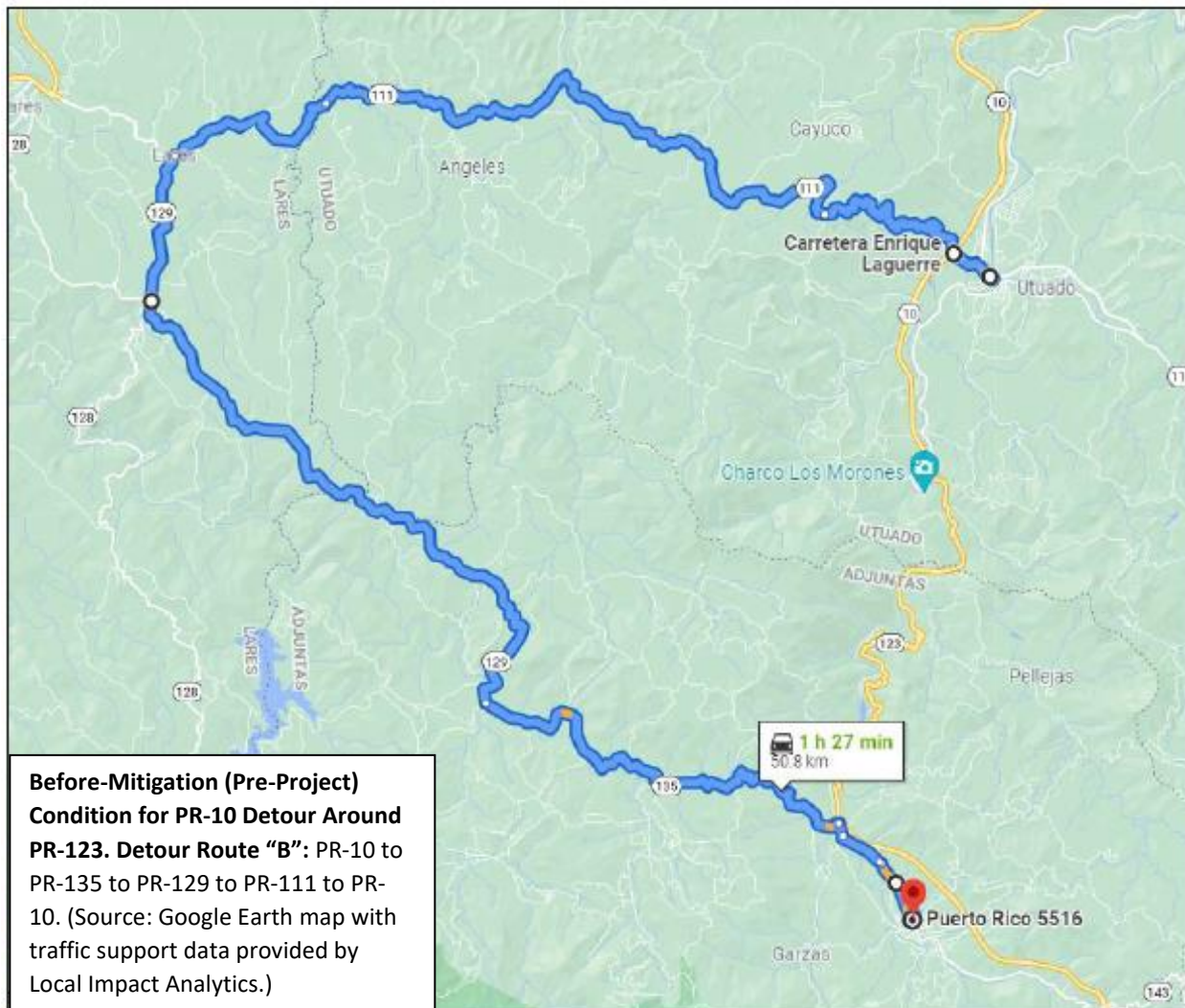
<sup>4</sup> Based on a review of PR-123 AADT counts along various sections in the area of the PR-10 extension taken between 2004 and 2019.



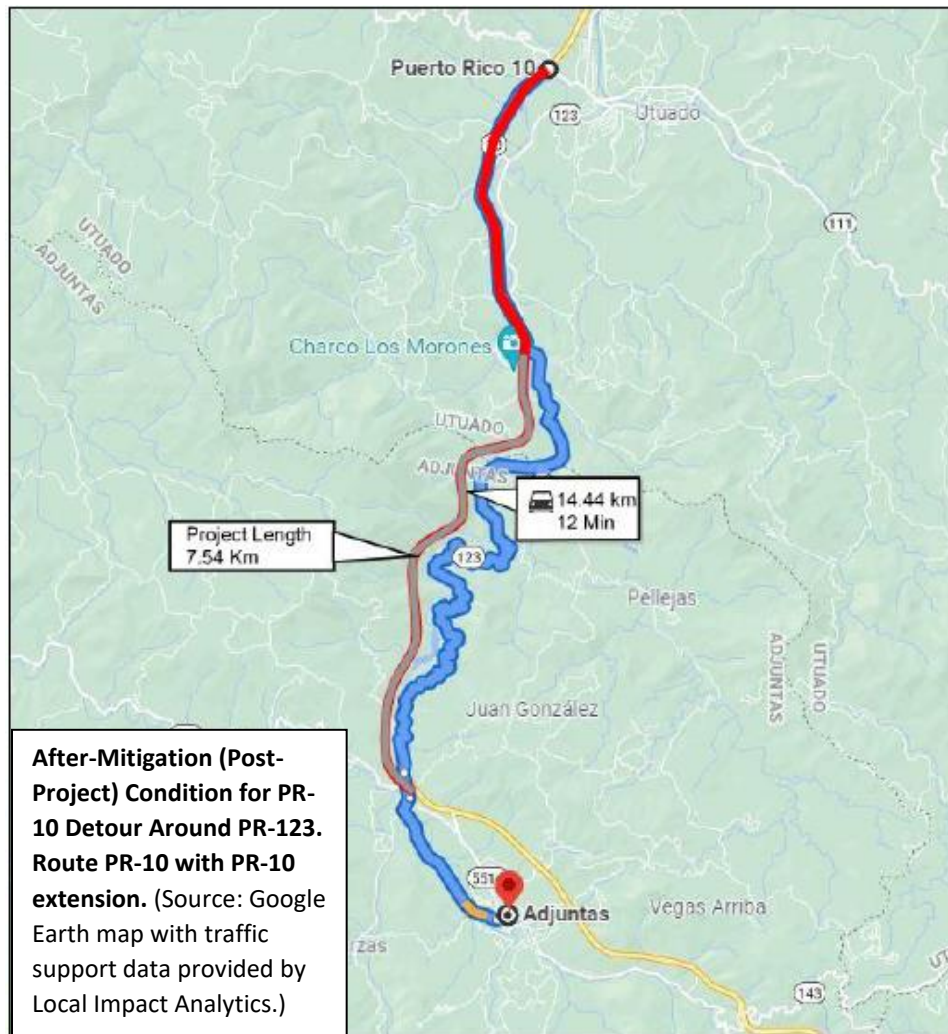
Highway	Municipio	Section Details		Length (Km)	Section ID	AADT Year	2020 AADT
		Km Start	Km End				
PR-123	Adjuntas	37.70	38.00	0.30	000123037700	2011	9,100
PR-123	Adjuntas	38.00	41.45	3.45	000123038000	2019	2,732
PR-123	Adjuntas	41.45	44.70	3.25	000123041450	2012	13,000
PR-123	Adjuntas	44.70	46.20	1.50	000123044700	2019	2,779
PR-123	Adjuntas	46.20	47.48	1.28	000123046200	2004	3,800
PR-123	Utuaado	47.48	49.50	2.02	000123047500	2019	3,019
<b>PR-123</b>	<b>-</b>	<b>37.70</b>	<b>49.50</b>	<b>11.80</b>	<b>-</b>	<b>-</b>	<b>5,738</b>



- Step 2: Assess Before-Mitigation (Pre-Project) Conditions Along PR-10.** There are two potential detour routes for PR-10 traffic in the event of a landslide along PR-123 in Utuaado or Adjuntas. Detour Route "A", shown in the figure below, involves taking PR-10 to PR-143 to PR-140 to PR-111 to PR-10 for a total distance of 37.3 Km. The travel time for Detour Route "A" is approximately 1 hour 11 minutes, with an average travel speed of 31.5 Km/hour. Detour Route "B", shown in the figure on Page 12, involves taking PR-10 to PR-135 to PR-129 to PR-111 to PR-10 for a total distance of 50.8 Km. The travel time for Detour Route "B" is approximately 1 hour 27 minutes, with an average travel speed of 35.0 Km/hour.



- Step 3: Assess After-Mitigation (Post-Project) PR-10 Condition.** As shown in the figure on Page 13, the north-south route along PR-10 in the event of a landslide along PR-123 is reduced to 14.44 using the new PR-10 extension, with an average travel time of only 12 minutes and an average travel speed of 72.2 Km/hour.



- Step 4: Estimate Cost Savings of Landslide-Related Detours Along PR-123 for PR-10 Extension.**  
 Once the data in Steps 1 through 3 assembled, the cost savings for landslide-related traffic detours along PR-123 in the vicinity of the PR-10 extension can be estimated FEMA standard values of \$32.18/vehicle/hour of delay<sup>5</sup> and \$0.585/mile<sup>6</sup>. These calculations are summarized in the table at the top of Page 14, and result in an estimated traffic cost savings of \$267,967/day in the event of a landslide that impacts PR-123 in the vicinity of the PR-10 extension.

<sup>5</sup> The FEMA Standard Value of \$32.18/vehicle/hour of delay is documented in FEMA’s Standard Economic Values Methodology Report dated June 30, 2020. This value is programmed into the current version of the FEMA BCA Tool Version 6.0 software that is available for download from the FEMA website (<https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis/full-bca#download>).

<sup>6</sup> The FEMA Standard Value of \$0.585/mile follows current General Services Administration (GSA) mileage rate for personal vehicles that can be found on the GSA website (<https://www.gsa.gov/travel/plan-book/transportation-airfare-pov-etc/privately-owned-vehicle-pov-mileage-reimbursement-rates>).



Summary of PR-10 Extension Detour Cost Savings from Landslides along PR-123.

Landslide Event Along PR-123 in Vicinity of PR-10 Extension			
Before-Mitigation (Pre-Project) Condition		After-Mitigation (Post-Project) Condition	
<b>AADT</b> (vehicles/day):	5,738	<b>AADT</b> (vehicles/day):	5,738
<b>Route Description:</b>	50% AADT on Detour Route "A" 50% AADT on Detour Route "B"	<b>Route Description:</b>	100% AADT on PR-10 with PR-10 Extension Route
<b>Route Distances</b> (Km):	37.3 Detour Route "A" 50.8 Detour Route "B"	<b>Route Distance</b> (Km):	14.44
<b>Travel Times</b> (hours):	1.18 Detour Route "A" 1.45 Detour Route "B"	<b>Travel Time</b> (hours):	0.20
<b>Unit Value for Vehicle Detour</b> (\$/vehicle/hour):	Current FEMA \$32.18 Standard Value	<b>Unit Value for Vehicle Detour</b> (\$/vehicle/hour):	Current FEMA \$32.18 Standard Value
<b>Subtotal Delays</b> (\$/day):	\$243,135	<b>Subtotal Delay</b> (\$/day):	\$36,932
<b>Unit Value for Vehicle Mileage</b> (\$/mile):	2022 GSA Rate for \$0.585 Personal Vehicle	<b>Unit Value for Vehicle Mileage</b> (\$/mile):	2022 GSA Rate for \$0.585 Personal Vehicles
<b>Subtotal Mileage</b> (\$/day):	\$91,884	<b>Subtotal Mileage</b> (\$/day):	\$30,120
<b>Total Travel Cost</b> (\$/day):	\$335,019	<b>Total Travel Cost</b> (\$/day):	\$67,052
Reduced Roadway Detour Costs for Landslide Event Along PR-123 in Vicinity of PR-10 Extension			
Reduced Travel Delays = (Subtotal Delays Before Mitigation) - (Subtotal Delays After Mitigation)			
<b>Reduced Delays</b> (\$/day):	\$206,203		
Reduced Travel Mileage = (Subtotal Mileage Before Mitigation) - (Subtotal Mileage After Mitigation)			
<b>Reduced Mileage</b> (\$/day):	\$61,763		
Reduced Travel Cost = (Total Travel Cost Before Mitigation) - (Total Travel Cost After Mitigation)			
<b>Reduced Travel</b> (\$/day):	\$267,967		

**Note:** While it is useful to quantify the estimated landslide-related traffic cost savings of \$267,967/day, it is important to remember that this value cannot be quantified as a project benefit of the overall PR-10 project BCA for the following reasons.

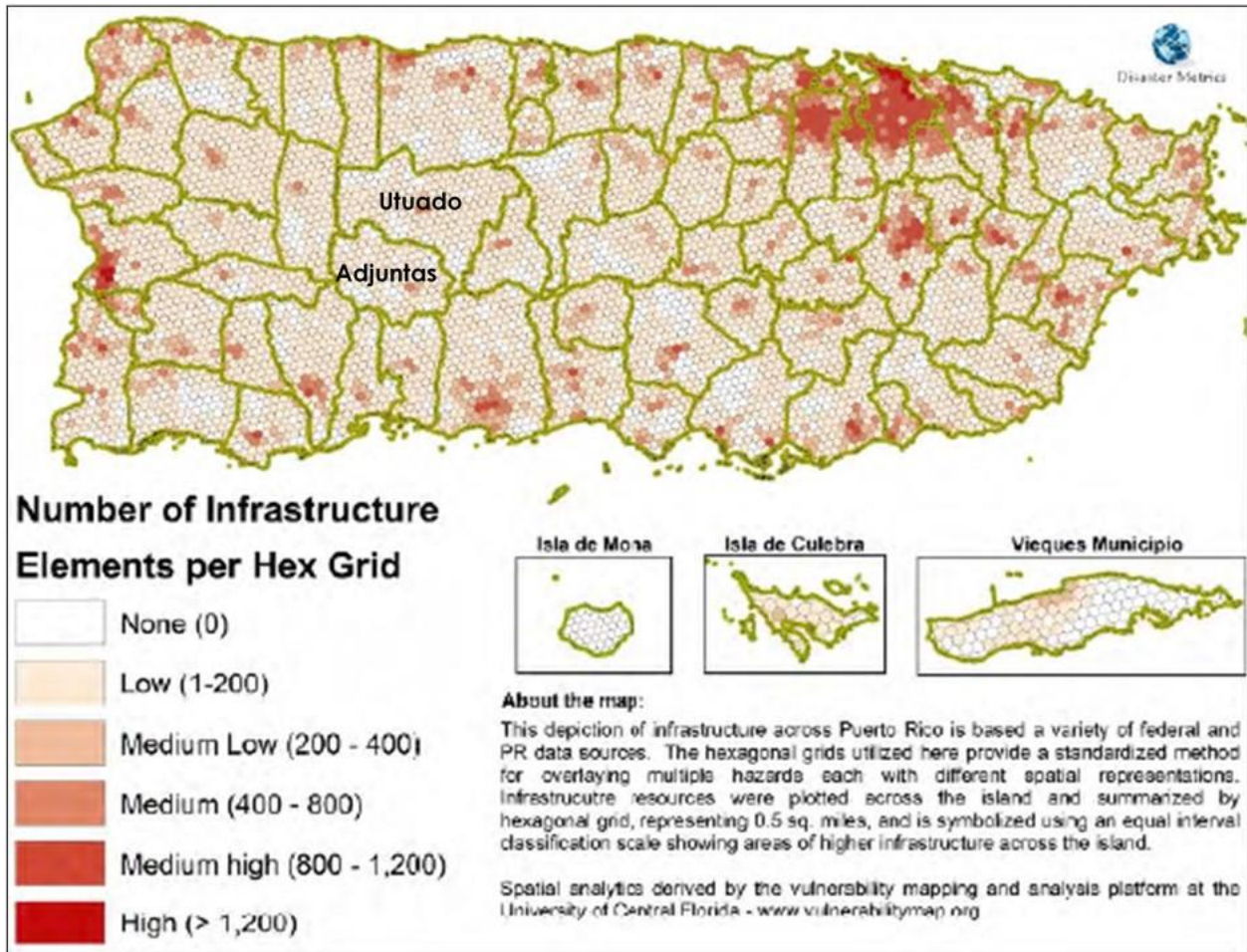
1. The landslide-related traffic cost savings is not tied to a landslide event with a specific duration of roadway service loss or a recurrence interval (RI). Without this information, the landslide-related traffic cost savings cannot for a specific event cannot be estimated and the annualized losses cannot be quantified and applied to the project BCA.
2. The landslide-related traffic cost savings is not tied to design level of effectiveness for the proposed PR-10 extension. While it is anticipated that the design of the PR-10 extension will be highly effective at reducing the risk of landslide damages and service losses along the new roadway, the actual project effectiveness must be established for a specific design hazard event recurrence interval in order to estimate the annualized avoided losses and apply them to the project BCA.

#### Other Qualitative Landslide Mitigation Project Benefits

In addition to the landslide-related traffic cost savings for PR-10 extension, there are some additional categories of landslide benefits that need to be considered as part of a qualitative assessment of project benefits.

- **Reduced Utility Service Losses and Critical Infrastructure Vulnerability.** Puerto Rico suffered widespread, extended losses of electrical power following Hurricanes Irma and Maria in 2008, in part due to difficulties in accessing power transmission lines in the interior of the island that were damaged by landslides and high winds. The 2020 hazard risk assessment report for Puerto Rico conducted an assessment of critical infrastructure including major power transmission lines and water and wastewater lines. Although this report did not indicate a high density of critical

infrastructure in the vicinity of the PR-10 extension based on FEMA’s lifeline guidance as shown in the figure below, there are some key utility transmission lines in the area that are adjacent to PR-10 and PR-123. As stated previously in this section, the construction of the PR-10 extension will improve access to rights-of-way for these lines. During a landslide or other major disaster event, the PR-10 extension will provide a wider, more reliable roadway that can access the utility rights-of-way and deliver the necessary labor and equipment to facilitate repairs to damaged utility transmission lines, thereby reducing the duration and impact of utility service losses.



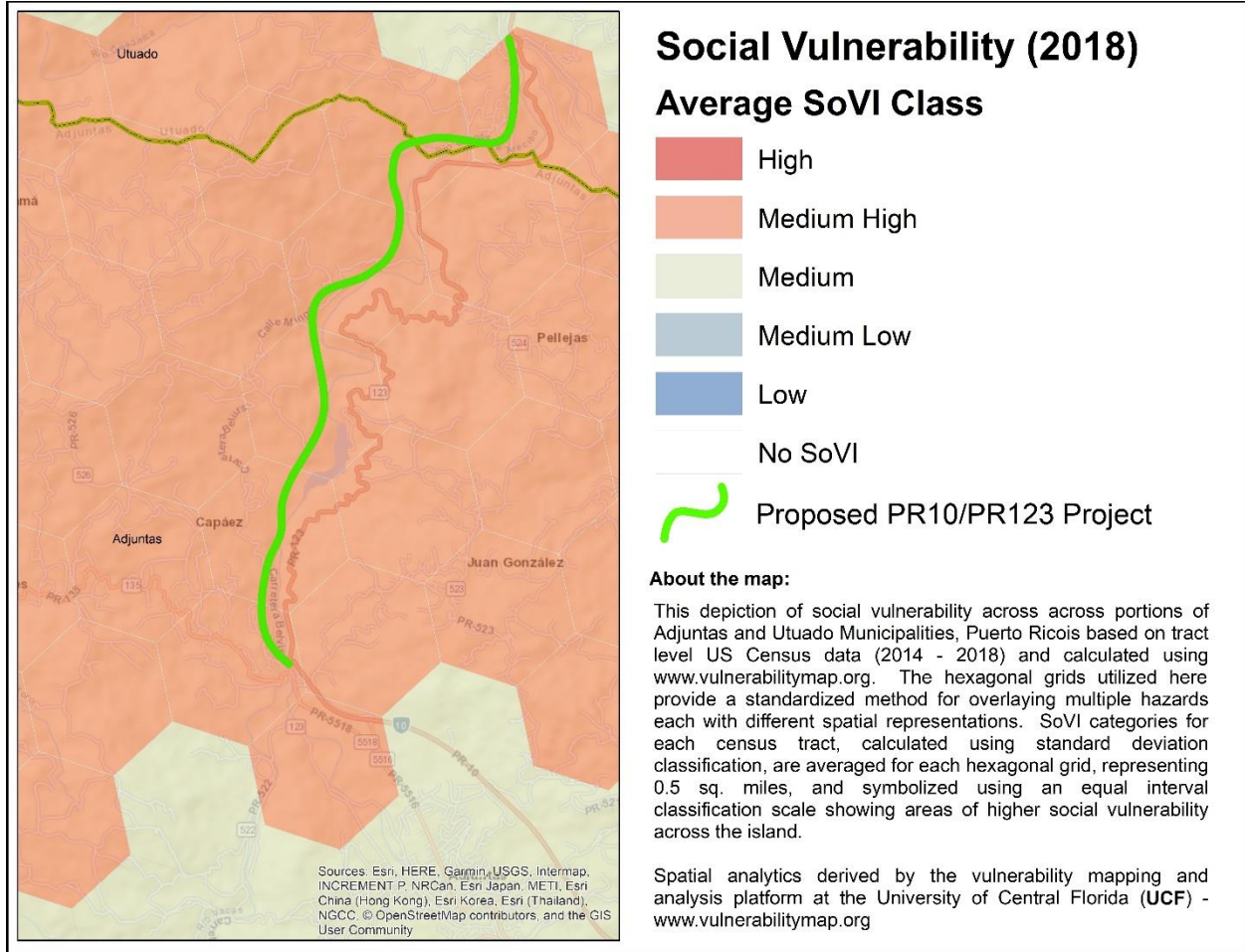
Puerto Rico’s Critical Infrastructure Elements gathered using FEMA’s lifeline guidance, with labels added for Utuado and Adjuntas (Source: Puerto Rico’s Hazard Risk Assessment, June 2020, Figure 32.)

- Social Vulnerability.** As part of the project BCA, a qualitative examination of project impacts on low-to-moderate income (LMI) persons or other socially vulnerable persons that are less able to mitigate risks or respond to and recover from disasters. A social vulnerability assessment was conducted as part of the 2020 hazard risk assessment report for Puerto Rico<sup>7</sup>. A review of social vulnerability assessment results in the figure on Page 16 indicate a medium-high social vulnerability index in the vicinity of the PR-10 extension project. Part of the social vulnerability in

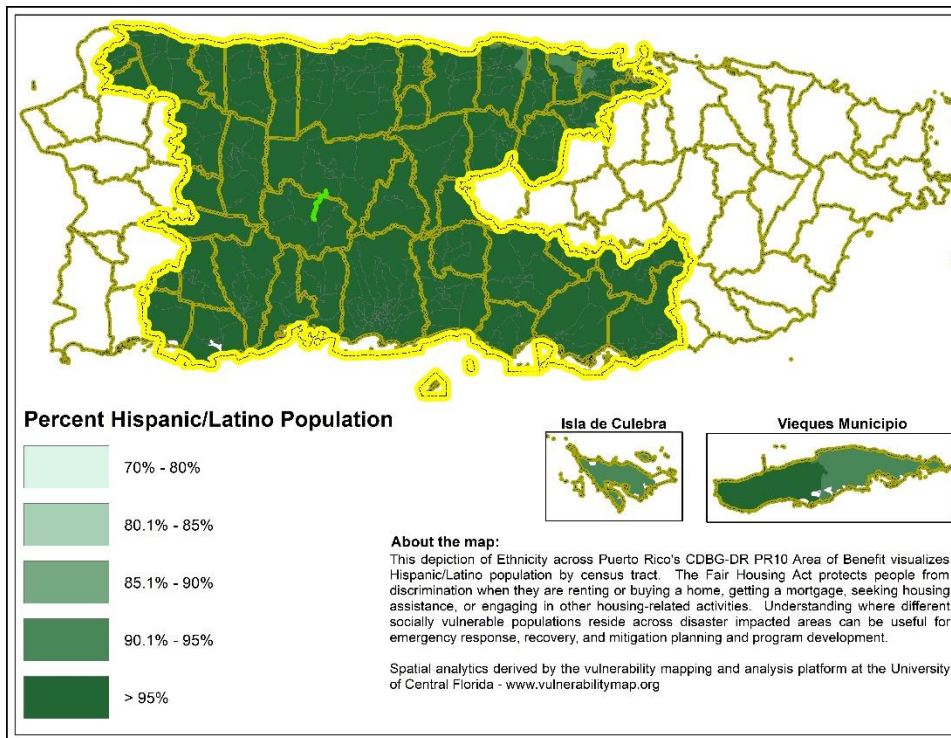
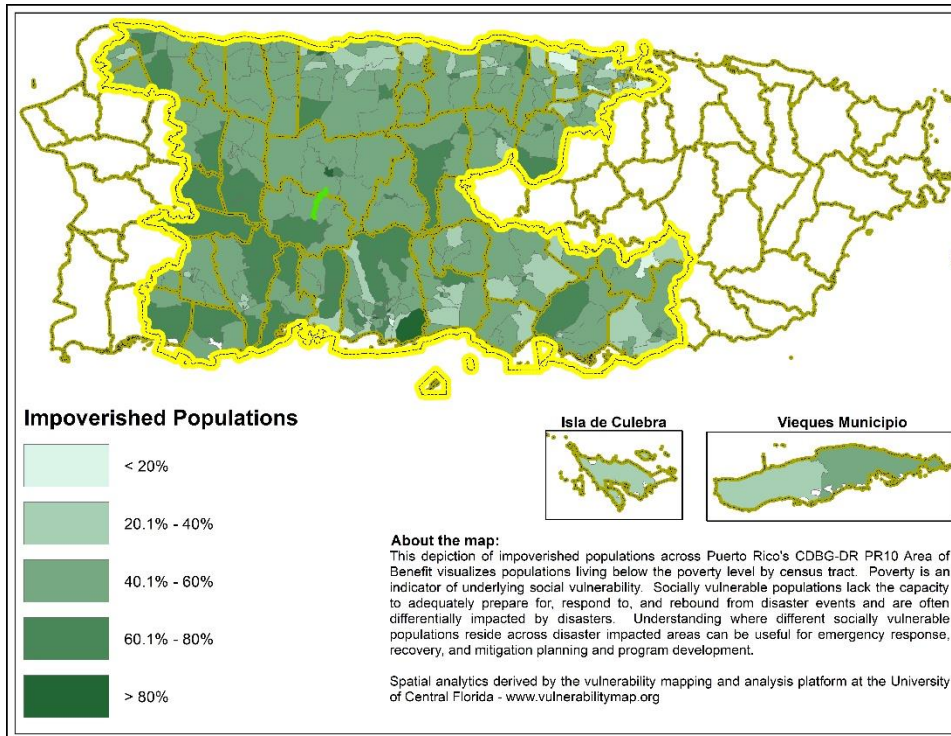
<sup>7</sup> The social vulnerability assessment was prepared based on 29 indicators of social vulnerability collected from an online resource ([www.vulnerabilitymap.org](http://www.vulnerabilitymap.org)).



the immediate project area can most likely attributed to low population density and limited access to resources. However, the social vulnerability impacts of this project extend far beyond the location of the PR-10 extension, as shown in the figures on Pages 17-18 on poverty, ethnicity, and the combined effects of poverty and ethnicity.

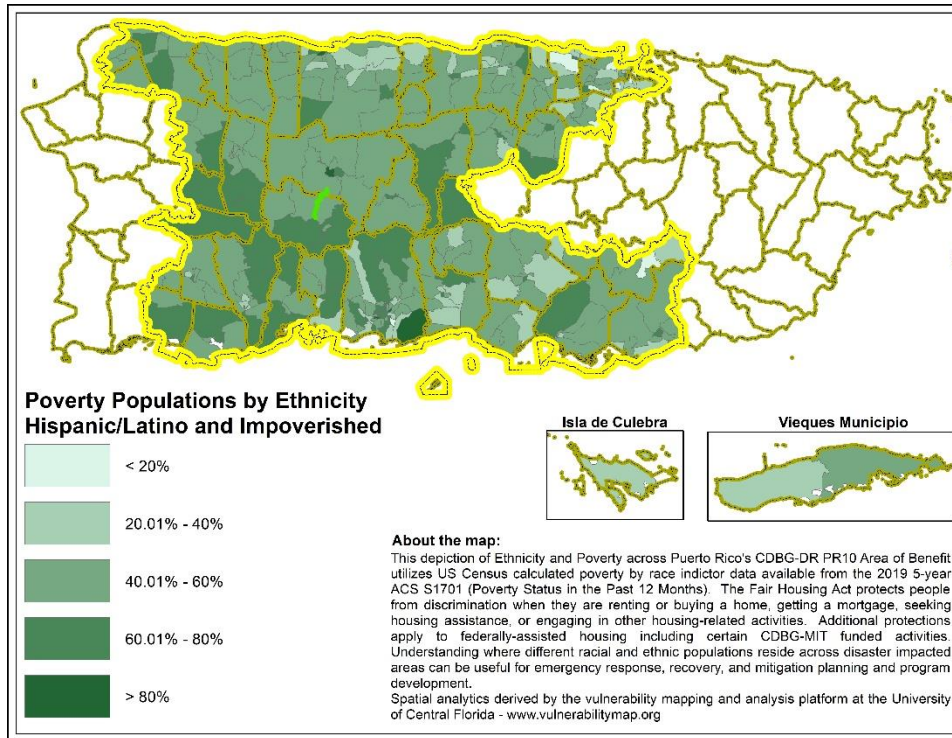


Puerto Rico’s Social Vulnerability Index in the vicinity of the PR-10 extension project. (Source: Prepared by Dr. Chris Emrich based on detailed analysis of Puerto Rico’s Hazard Risk Assessment data, June 2020, Figure 34.)



Puerto Rico's poverty levels throughout the impact area of the PR-10 extension project. (Source: Prepared by Dr. Chris Emrich based on detailed analysis of Puerto Rico's Hazard Risk Assessment data, June 2020.)

Puerto Rico's ethnicity throughout the impact area of the PR-10 extension project. (Source: Prepared by Dr. Chris Emrich based on detailed analysis of Puerto Rico's Hazard Risk Assessment data, June 2020.)



The combined effects of Puerto Rico’s poverty and ethnicity throughout the impact area of the PR-10 extension project. (Source: Prepared by Dr. Chris Emrich based on detailed analysis of Puerto Rico’s Hazard Risk Assessment data, June 2020.)

### Project Benefits

The primary monetized benefits of the project are reductions in travel time, vehicle operating costs, accident costs, and emissions costs. The benefits of increased freight movement and the overall impact on the regional economy have not been quantified or monetized.

	Total Over 30 Years	Average Annual
<b>ITEMIZED BENEFITS (mil. \$)</b>		
Travel Time Savings	\$451.9	\$15.1
Travel Time Reliability Benefits	\$0.0	\$0.0
Veh. Op. Cost Savings	\$111.2	\$3.7
Accident Cost Savings	\$157.6	\$5.3
Emission Cost Savings	\$8.6	\$0.3
<b>TOTAL BENEFITS</b>	<b>\$729.3</b>	<b>\$24.3</b>
<b>Person-Hours of Time Saved</b>	<b>72,655,510</b>	<b>2,421,850</b>
<b>Fatalities Avoided</b>	<b>21</b>	<b>1</b>
<b>Injuries Avoided</b>	<b>1,521</b>	<b>51</b>
<b>PDO Avoided</b>	<b>28,828</b>	<b>961</b>

### Travel Time Savings

Travel time savings includes in-vehicle travel time savings for passenger-car drivers and passengers as well as truck drivers. Travel time is considered a cost to users, and its value depends on the disutility that travelers attribute to time spent traveling. A reduction in travel time translates into more time available for work, leisure, or other activities. As shown in the table above, the proposed project achieves a reduction in both the vehicle miles traveled and vehicle hours traveled. This is reflected in travel time savings of \$451.9 million over 30 years, equivalent to 72.7 million person-hours saved in total.

### Vehicle Operating Costs

Vehicle operating costs savings include the cost of fuel, as well as maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. Consumption rated per vehicle miles traveled are used to calculate the vehicle operating cost savings. Estimates of VMT and unit costs for each component of vehicle operating costs are applied to the consumption rates to calculate the total operating cost. Since the proposed project leads to a decrease in in VMT, the quantified operating costs result in a benefit of \$111.2 million over 30 years.

### Accident Cost Savings

The accident cost savings benefits assessed in this analysis include a reduction in fatalities, injuries, and property damage crash costs as a result of the safety improvements provided by the new route. To quantify the number of reduced incidents, both the Crash Modification and Crash Reduction Factors were based on the USDOT guidance. The total value of reduced accidents (all types) is \$157.6 million over 30 years, or \$5.3 million per year, or a reduction of 1 fatality, 51 injuries, and 961 property damage events per year.

### Emissions Cost Savings

The difference in vehicle miles traveled between the build and no-build scenarios is associated with a change in emissions. Grams of emissions for carbon dioxide, NOX, SOX, PM10, and VOCs were calculated based on the Environmental Protection Agency's (EPA) emission factors per VMT. The proposed project achieves a reduction in VMT which translates into a reduction in emissions for a total benefit of \$8.6 million over 30 years. The table below shows the breakdown for each factor.

EMISSIONS REDUCTION	Tons		Value (mil. \$)	
	Total Over 30 Years	Average Annual	Total Over 30 Years	Average Annual
CO Emissions Saved	449	15	\$0.0	\$0.0
CO <sub>2</sub> Emissions Saved	263,006	8,767	\$7.0	\$0.2
NO <sub>x</sub> Emissions Saved	166	6	\$0.9	\$0.0
PM <sub>2.5</sub> Emissions Saved	2	0	\$0.7	\$0.0
SO <sub>x</sub> Emissions Saved	3	0	\$0.0	\$0.0
VOC Emissions Saved	21	1	\$0.0	\$0.0



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## Project Cost

The PR-10 engineering cost estimate is based on quantity take-off based on the level of completion of each section. Cost estimation was based on the PRHTA unit prices database which is informed by historical prices from different highway projects pre-Maria. Since this project represents the first transportation infrastructure project of this magnitude in more than ten (10) years (PR-66) and the escalation of prices as a consequence of the latest events (COVID-19, Russian-Ukraine war, energy, and labor turnover), those unit prices are no longer valid.

To work a reasonable cost estimate that considers the present economic global and local condition we factorized in the unit prices based on research of the latest RS Means prices and price indexes. Current project costs are shown by activity in the chart that follows.

As mentioned in the Project Scope, site factors that affect the construction costs of the project include:

- Project completion requires the construction of twenty (20) bridges in the span of seven point six (7.6) kilometers.
- Project implementation requires the construction of segments II & V before segment IV can be constructed. This is due to site accessibility considerations in construction.
- Site construction activities requires extensive cut and fill of mountains and valleys.

## Overview of Project Costs

Category No.	Project Category Description	Cost
1	Mobilization	\$ 13,973,136.00
2	Studies	\$ 8,217,200.00
3	Design	\$ 17,048,418.00
4	Permits and Endorsements	\$ 3,119,900.00
5	Construction Management & Inspection	\$ 12,000,000
6	Pavement Structure (Include Sub-Base)	\$ 25,922,650.00
7	Earthwork	\$ 126,273,186.00
8	Utilities	\$ 707,020.00
9	Drainage and Erosion Control	\$ 19,943,882.00
10	Bridges	\$ 283,169,026.00
11	Retaining Walls	\$ 35,110,590.00
12	Safety Elements	\$ 4,894,672.00
13	Signage & Pavement Marking	\$ 1,690,296.00
<b>Total</b>		<b>\$ 552,069,976.00</b>

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## Operations and Maintenance

The PRHTA will develop a plan for the Operations and Maintenance (O&M) of the proposed segments of the PR-10 project throughout its useful life. The PRHTA and DTPW are the two Puerto Rico Central Government Agencies that have the primary responsibility to design and implement the operation and maintenance of freeways and primary roads in Puerto Rico. These entities have processes in place for managing the short- and long-term operation and maintenance of the roadway network in Puerto Rico. The Puerto Rico Highways and Transportation Authority (PRHTA) Transportation Asset Management Plan (TAMP) for the National Highway System (NHS) for pavements and bridges for the years 2019 to 2028 details current asset management.

During the design phase of the project a detailed O&M Plan will be developed as follows:

- a. Require a draft O&M plan as part of the sixty percent (60%) design submittal and review process.
- b. Require final O&M plan as part of the ninety percent (90%) Final Design submittal and review process.

The O&M Plan to be developed shall include:

- 1) Schedules and projections of O&M tasks, staffing, and estimated costs for the useful life of the project.
- 2) How O&M for CDBG-MIT project is anticipated to be funded and resourced including borrowing authority, retargeting of existing financial resources, proposed changes to tax policy or practices that would be required, or any State or local resources identified to pay for or provide O&M costs.
- 3) Signed Commitment of Responsible Entity/Entities towards funding and carrying out required O&M, including any MOUs, Service, or other agreements, as necessary, when multiple parties are involved.
- 4) Infrastructure Maintenance
  - a. Short Term Maintenance
  - b. Long Term Maintenance
- 5) Site Management
  - a. Roles and Responsibilities
  - b. Hours of Operation
  - c. Staffing
  - d. Security
  - e. Visitation
  - f. Communication Plan

At the current stage of development of the project PRHTA has established:

- 1) That the long-term funding for O&M of the PR-10 project will be included into the operating and capital budgets of the PRHTA and DTPW as a standard asset. Funding will be provided by annual budget assignments from the Central Government.
- 2) PRHTA will expand the maintenance program of the DTPW to include the new segments of the PR-10 as had been done with the previous sections completed.

- 3) Legal agreements with the Municipalities of Utuado and Adjuntas will be negotiated to maintain the vegetation and erosion control and cleaning of the water courses and drainage outlets. This strategy has already been implemented in the sections of the PR-10 that are currently in use.

During the planning and design phases of the project, O&M has been estimated on an annual basis based on current conditions<sup>8</sup>. This estimate is incorporated in the BCA analysis provided in the next section. Development and maintenance of the O&M plan will be monitored by PRDOH in accordance with HUD requirements and industry standards.

Year	Maintenance Personnel	Equipment	Materials	Total O&M Cost	7% Discount O&M Cost
Y1	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$305,638.25
Y2	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$285,643.23
Y3	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$266,956.29
Y4	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$249,491.86
Y5	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$233,169.96
Y6	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$217,915.85
Y7	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$203,659.67
Y8	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$190,336.14
Y9	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$177,884.24
Y10	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$166,246.96
Y11	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$155,370.99
Y12	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$145,206.53
Y13	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$135,707.04
Y14	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$126,829.01
Y15	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$118,531.78
Y16	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$110,777.37
Y17	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$103,530.25
Y18	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$96,757.24
Y19	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$90,427.33
Y20	\$286,000.00	\$28,420.00	\$60,000.00	\$374,420.00	\$84,511.52
<b>Total</b>	<b>\$5,720,000.00</b>	<b>\$568,400.00</b>	<b>\$1,200,000.00</b>	<b>\$7,488,400.00</b>	<b>\$3,464,591.50</b>

Changing environmental conditions such as climate sensitive events, more frequent and severe weather events, and localized hazardous events, will be addressed by incorporating risk assessment activities into the O&M plan for the project. Risk assessment for changing climatical conditions will allow:

- 1) Identification of the Risks related to changing environment. For example, change in frequency of occurrence of natural hazards.

<sup>8</sup> The USDOT methodology requires that all dollars be adjusted to a single base year. Maintenance costs are estimated to begin in 2025; costs for the second and third periods have been inflation adjust to the first period annual values.

- 
- 2) Assessment of Consequences. Assess the consequences of the natural hazard events resulting in disaster.
  - 3) Assess the probability. Establish the probability of a specific event occurring.
  - 4) Risk Characterization. Ranking of risk according to severity and potential consequences.

The O&M Plan will be amended and updated according to the results of the risk assessment.



## EXHIBITS



## Travel Time Savings

Year	TOTAL VHT (veh-hours/yr)		AVERAGE VEH OCC (persons/vehicle)		TOTAL VEHICLE TRIPS (trips/yr)		PERCENT TRUCKS (%)		AVERAGE TRAVEL TIME (hours/trip)		TOTAL VEHICLE TRIPS (trips/yr)	TIME BENEFIT (\$/yr)	Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	Adjusted (no induced) Build	Existing Users		
2025	1,831,977	439,675	1.50	1.50	3,663,955	3,663,955	20.0%	20.0%	0.75	0.18	3,663,955	\$43,105,694	\$43,105,694	\$30,733,764
2045	2,235,360	536,487	1.50	1.50	4,470,721	4,470,721	20.0%	20.0%	0.75	0.18	4,470,721	\$52,597,138	\$52,597,138	\$9,690,979
2025	1,831,977	439,675	1.50	1.50	3,663,955	3,663,955	20.0%	20.0%	0.75	0.18	3,663,955	\$43,105,694	\$43,105,694	\$30,733,764
2026	1,852,146	444,515	1.50	1.50	3,704,293	3,704,293	20.0%	20.0%	0.75	0.18	3,704,293	\$43,580,266	\$43,580,266	\$29,039,371
2027	1,872,316	449,356	1.50	1.50	3,744,631	3,744,631	20.0%	20.0%	0.75	0.18	3,744,631	\$44,054,838	\$44,054,838	\$27,435,139
2028	1,892,485	454,196	1.50	1.50	3,784,970	3,784,970	20.0%	20.0%	0.75	0.18	3,784,970	\$44,529,410	\$44,529,410	\$25,916,522
2029	1,912,654	459,037	1.50	1.50	3,825,308	3,825,308	20.0%	20.0%	0.75	0.18	3,825,308	\$45,003,983	\$45,003,983	\$24,479,185
2030	1,932,823	463,878	1.50	1.50	3,865,646	3,865,646	20.0%	20.0%	0.75	0.18	3,865,646	\$45,478,555	\$45,478,555	\$23,118,991
2031	1,952,992	468,718	1.50	1.50	3,905,985	3,905,985	20.0%	20.0%	0.75	0.18	3,905,985	\$45,953,127	\$45,953,127	\$21,832,000
2032	1,973,161	473,559	1.50	1.50	3,946,323	3,946,323	20.0%	20.0%	0.75	0.18	3,946,323	\$46,427,699	\$46,427,699	\$20,614,454
2033	1,993,331	478,399	1.50	1.50	3,986,661	3,986,661	20.0%	20.0%	0.75	0.18	3,986,661	\$46,902,272	\$46,902,272	\$19,462,775
2034	2,013,500	483,240	1.50	1.50	4,027,000	4,027,000	20.0%	20.0%	0.75	0.18	4,027,000	\$47,376,844	\$47,376,844	\$18,373,557
2035	2,033,669	488,081	1.50	1.50	4,067,338	4,067,338	20.0%	20.0%	0.75	0.18	4,067,338	\$47,851,416	\$47,851,416	\$17,343,555
2036	2,053,838	492,921	1.50	1.50	4,107,676	4,107,676	20.0%	20.0%	0.75	0.18	4,107,676	\$48,325,988	\$48,325,988	\$16,369,684
2037	2,074,007	497,762	1.50	1.50	4,148,014	4,148,014	20.0%	20.0%	0.75	0.18	4,148,014	\$48,800,560	\$48,800,560	\$15,449,008
2038	2,094,176	502,602	1.50	1.50	4,188,353	4,188,353	20.0%	20.0%	0.75	0.18	4,188,353	\$49,275,133	\$49,275,133	\$14,578,734
2039	2,114,346	507,443	1.50	1.50	4,228,691	4,228,691	20.0%	20.0%	0.75	0.18	4,228,691	\$49,749,705	\$49,749,705	\$13,756,208
2040	2,134,515	512,284	1.50	1.50	4,269,029	4,269,029	20.0%	20.0%	0.75	0.18	4,269,029	\$50,224,277	\$50,224,277	\$12,978,908
2041	2,154,684	517,124	1.50	1.50	4,309,368	4,309,368	20.0%	20.0%	0.75	0.18	4,309,368	\$50,698,849	\$50,698,849	\$12,244,436
2042	2,174,853	521,965	1.50	1.50	4,349,706	4,349,706	20.0%	20.0%	0.75	0.18	4,349,706	\$51,173,422	\$51,173,422	\$11,550,515
2043	2,195,022	526,805	1.50	1.50	4,390,044	4,390,044	20.0%	20.0%	0.75	0.18	4,390,044	\$51,647,994	\$51,647,994	\$10,894,983
2044	2,215,191	531,646	1.50	1.50	4,430,383	4,430,383	20.0%	20.0%	0.75	0.18	4,430,383	\$52,122,566	\$52,122,566	\$10,275,788
2045	2,235,360	536,487	1.50	1.50	4,470,721	4,470,721	20.0%	20.0%	0.75	0.18	4,470,721	\$52,597,138	\$52,597,138	\$9,690,979
2046	2,255,530	541,327	1.50	1.50	4,511,059	4,511,059	20.0%	20.0%	0.75	0.18	4,511,059	\$53,071,710	\$53,071,710	\$9,138,709
2047	2,275,699	546,168	1.50	1.50	4,551,398	4,551,398	20.0%	20.0%	0.75	0.18	4,551,398	\$53,546,283	\$53,546,283	\$8,617,223
2048	2,295,868	551,008	1.50	1.50	4,591,736	4,591,736	20.0%	20.0%	0.75	0.18	4,591,736	\$54,020,855	\$54,020,855	\$8,124,856
2049	2,316,037	555,849	1.50	1.50	4,632,074	4,632,074	20.0%	20.0%	0.75	0.18	4,632,074	\$54,495,427	\$54,495,427	\$7,660,031
2050	2,336,206	560,690	1.50	1.50	4,672,413	4,672,413	20.0%	20.0%	0.75	0.18	4,672,413	\$54,969,999	\$54,969,999	\$7,221,250
2051	2,356,375	565,530	1.50	1.50	4,712,751	4,712,751	20.0%	20.0%	0.75	0.18	4,712,751	\$55,444,572	\$55,444,572	\$6,807,097
2052	2,376,545	570,371	1.50	1.50	4,753,089	4,753,089	20.0%	20.0%	0.75	0.18	4,753,089	\$55,919,144	\$55,919,144	\$6,416,226
2053	2,396,714	575,211	1.50	1.50	4,793,428	4,793,428	20.0%	20.0%	0.75	0.18	4,793,428	\$56,393,716	\$56,393,716	\$6,047,363
2054	2,416,883	580,052	1.50	1.50	4,833,766	4,833,766	20.0%	20.0%	0.75	0.18	4,833,766	\$56,868,288	\$56,868,288	\$5,699,303
<b>Total</b>														<b>\$451,870,613</b>

## Vehicle Operating Savings

Year	TOTAL VMT (veh-miles/yr)		TOTAL VHT (veh-hrs/yr)		AVERAGE SPEED (mph)		TOTAL VEHICLE TRIPS (trips/yr)		PERCENT TRUCKS (%)		BENEFITS (\$/yr)		Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	Fuel Costs	Non-Fuel Costs		
2025	33,122,150	17,183,947	1,831,977	439,675	18.1	39.1	3,663,955	3,663,955	20.0%	20.0%	\$3,344,963	\$7,264,633	\$10,609,595	\$7,564,495
2045	40,415,318	20,967,681	2,235,360	536,487	18.1	39.1	4,470,721	4,470,721	20.0%	20.0%	\$4,081,490	\$8,864,233	\$12,945,723	\$2,385,239
2025	33,122,150	17,183,947	1,831,977	439,675	18.1	39.1	3,663,955	3,663,955	20.0%	20.0%	\$3,344,963	\$7,264,633	\$10,609,595	\$7,564,495
2026	33,486,808	17,373,134	1,852,146	444,515	18.1	39.1	3,704,293	3,704,293	20.0%	20.0%	\$3,381,789	\$7,344,613	\$10,726,402	\$7,147,454
2027	33,851,467	17,562,321	1,872,316	449,356	18.1	39.1	3,744,631	3,744,631	20.0%	20.0%	\$3,418,615	\$7,424,593	\$10,843,208	\$6,752,605
2028	34,216,125	17,751,507	1,892,485	454,196	18.1	39.1	3,784,970	3,784,970	20.0%	20.0%	\$3,455,442	\$7,504,573	\$10,960,014	\$6,378,828
2029	34,580,784	17,940,694	1,912,654	459,037	18.1	39.1	3,825,308	3,825,308	20.0%	20.0%	\$3,492,268	\$7,584,553	\$11,076,821	\$6,025,057
2030	34,945,442	18,129,881	1,932,823	463,878	18.1	39.1	3,865,646	3,865,646	20.0%	20.0%	\$3,529,094	\$7,664,533	\$11,193,627	\$5,690,272
2031	35,310,100	18,319,068	1,952,992	468,718	18.1	39.1	3,905,985	3,905,985	20.0%	20.0%	\$3,565,921	\$7,744,513	\$11,310,434	\$5,373,506
2032	35,674,759	18,508,254	1,973,161	473,559	18.1	39.1	3,946,323	3,946,323	20.0%	20.0%	\$3,602,747	\$7,824,493	\$11,427,240	\$5,073,831
2033	36,039,417	18,697,441	1,993,331	478,399	18.1	39.1	3,986,661	3,986,661	20.0%	20.0%	\$3,639,574	\$7,904,473	\$11,544,046	\$4,790,369
2034	36,404,076	18,886,628	2,013,500	483,240	18.1	39.1	4,027,000	4,027,000	20.0%	20.0%	\$3,676,400	\$7,984,453	\$11,660,853	\$4,522,280
2035	36,768,734	19,075,814	2,033,669	488,081	18.1	39.1	4,067,338	4,067,338	20.0%	20.0%	\$3,713,226	\$8,064,433	\$11,777,659	\$4,268,766
2036	37,133,392	19,265,001	2,053,838	492,921	18.1	39.1	4,107,676	4,107,676	20.0%	20.0%	\$3,750,053	\$8,144,413	\$11,894,465	\$4,029,067
2037	37,498,051	19,454,188	2,074,007	497,762	18.1	39.1	4,148,014	4,148,014	20.0%	20.0%	\$3,786,879	\$8,224,393	\$12,011,272	\$3,802,461
2038	37,862,709	19,643,374	2,094,176	502,602	18.1	39.1	4,188,353	4,188,353	20.0%	20.0%	\$3,823,705	\$8,304,373	\$12,128,078	\$3,588,261
2039	38,227,367	19,832,561	2,114,346	507,443	18.1	39.1	4,228,691	4,228,691	20.0%	20.0%	\$3,860,532	\$8,384,353	\$12,244,884	\$3,385,813
2040	38,592,026	20,021,748	2,134,515	512,284	18.1	39.1	4,269,029	4,269,029	20.0%	20.0%	\$3,897,358	\$8,464,333	\$12,361,691	\$3,194,496
2041	38,956,684	20,210,935	2,154,684	517,124	18.1	39.1	4,309,368	4,309,368	20.0%	20.0%	\$3,934,185	\$8,544,313	\$12,478,497	\$3,013,720
2042	39,321,343	20,400,121	2,174,853	521,965	18.1	39.1	4,349,706	4,349,706	20.0%	20.0%	\$3,971,011	\$8,624,293	\$12,595,304	\$2,842,926
2043	39,686,001	20,589,308	2,195,022	526,805	18.1	39.1	4,390,044	4,390,044	20.0%	20.0%	\$4,007,837	\$8,704,273	\$12,712,110	\$2,681,580
2044	40,050,659	20,778,495	2,215,191	531,646	18.1	39.1	4,430,383	4,430,383	20.0%	20.0%	\$4,044,664	\$8,784,253	\$12,828,916	\$2,529,177
2045	40,415,318	20,967,681	2,235,360	536,487	18.1	39.1	4,470,721	4,470,721	20.0%	20.0%	\$4,081,490	\$8,864,233	\$12,945,723	\$2,385,239
2046	40,779,976	21,156,868	2,255,530	541,327	18.1	39.1	4,511,059	4,511,059	20.0%	20.0%	\$4,118,316	\$8,944,213	\$13,062,529	\$2,249,309
2047	41,144,634	21,346,055	2,275,699	546,168	18.1	39.1	4,551,398	4,551,398	20.0%	20.0%	\$4,155,143	\$9,024,193	\$13,179,335	\$2,120,955
2048	41,509,293	21,535,242	2,295,868	551,008	18.1	39.1	4,591,736	4,591,736	20.0%	20.0%	\$4,191,969	\$9,104,173	\$13,296,142	\$1,999,769
2049	41,873,951	21,724,428	2,316,037	555,849	18.1	39.1	4,632,074	4,632,074	20.0%	20.0%	\$4,228,795	\$9,184,153	\$13,412,948	\$1,885,362
2050	42,238,610	21,913,615	2,336,206	560,690	18.1	39.1	4,672,413	4,672,413	20.0%	20.0%	\$4,265,622	\$9,264,133	\$13,529,754	\$1,777,365
2051	42,603,268	22,102,802	2,356,375	565,530	18.1	39.1	4,712,751	4,712,751	20.0%	20.0%	\$4,302,448	\$9,344,113	\$13,646,561	\$1,675,429
2052	42,967,926	22,291,988	2,376,545	570,371	18.1	39.1	4,753,089	4,753,089	20.0%	20.0%	\$4,339,275	\$9,424,093	\$13,763,367	\$1,579,224
2053	43,332,585	22,481,175	2,396,714	575,211	18.1	39.1	4,793,428	4,793,428	20.0%	20.0%	\$4,376,101	\$9,504,073	\$13,880,174	\$1,488,436
2054	43,697,243	22,670,362	2,416,883	580,052	18.1	39.1	4,833,766	4,833,766	20.0%	20.0%	\$4,412,927	\$9,584,053	\$13,996,980	\$1,402,768
<b>Total</b>														<b>\$111,218,819</b>

## Accident Savings

Year	TOTAL VMT (veh-miles/yr)		TOTAL FATALITIES (events/yr)		TOTAL INJURIES (events/yr)		TOTAL VEHICLES DAMAGED (events/yr)		ACCIDENT BENEFITS (\$/yr)			Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	Fatality Cost Savings	Injury Cost Savings	Property Damage Cost Savings		
2025	33,122,150	25,628,519	0.9	0.5	69.5	34.4	1,316.9	652.1	\$5,527,598	\$4,221,402	\$3,057,826	\$12,806,826	\$9,131,090
2045	40,415,318	20,967,681	1.2	0.4	84.8	28.2	1,606.8	533.5	\$8,924,878	\$6,815,889	\$4,937,175	\$20,677,942	\$3,809,894
2025	33,122,150	25,628,519	0.9	0.5	69.5	34.4	1,316.9	652.1	\$5,527,598	\$4,221,402	\$3,057,826	\$12,806,826	\$9,131,090
2026	33,486,808	25,395,477	1.0	0.5	70.3	34.1	1,331.4	646.2	\$5,697,462	\$4,351,126	\$3,151,793	\$13,200,381	\$8,795,971
2027	33,851,467	25,162,435	1.0	0.5	71.0	33.8	1,345.9	640.3	\$5,867,326	\$4,480,851	\$3,245,760	\$13,593,937	\$8,465,621
2028	34,216,125	24,929,394	1.0	0.5	71.8	33.5	1,360.4	634.3	\$6,037,190	\$4,610,575	\$3,339,728	\$13,987,493	\$8,140,848
2029	34,580,784	24,696,352	1.0	0.5	72.6	33.2	1,374.9	628.4	\$6,207,054	\$4,740,299	\$3,433,695	\$14,381,049	\$7,822,338
2030	34,945,442	24,463,310	1.0	0.4	73.3	32.8	1,389.4	622.5	\$6,376,918	\$4,870,024	\$3,527,663	\$14,774,605	\$7,510,660
2031	35,310,100	24,230,268	1.0	0.4	74.1	32.5	1,403.8	616.5	\$6,546,782	\$4,999,748	\$3,621,630	\$15,168,161	\$7,206,284
2032	35,674,759	23,997,226	1.0	0.4	74.8	32.2	1,418.3	610.6	\$6,716,646	\$5,129,472	\$3,715,598	\$15,561,716	\$6,909,588
2033	36,039,417	23,764,184	1.0	0.4	75.6	31.9	1,432.8	604.7	\$6,886,510	\$5,259,197	\$3,809,565	\$15,955,272	\$6,620,871
2034	36,404,076	23,531,142	1.0	0.4	76.4	31.6	1,447.3	598.7	\$7,056,374	\$5,388,921	\$3,903,533	\$16,348,828	\$6,340,357
2035	36,768,734	23,298,100	1.0	0.4	77.1	31.3	1,461.8	592.8	\$7,226,238	\$5,518,645	\$3,997,500	\$16,742,384	\$6,068,210
2036	37,133,392	23,065,058	1.1	0.4	77.9	31.0	1,476.3	586.9	\$7,396,102	\$5,648,370	\$4,091,468	\$17,135,940	\$5,804,536
2037	37,498,051	22,832,017	1.1	0.4	78.7	30.7	1,490.8	581.0	\$7,565,966	\$5,778,094	\$4,185,435	\$17,529,496	\$5,549,389
2038	37,862,709	22,598,975	1.1	0.4	79.4	30.3	1,505.3	575.0	\$7,735,830	\$5,907,819	\$4,279,403	\$17,923,051	\$5,302,784
2039	38,227,367	22,365,933	1.1	0.4	80.2	30.0	1,519.8	569.1	\$7,905,694	\$6,037,543	\$4,373,370	\$18,316,607	\$5,064,695
2040	38,592,026	22,132,891	1.1	0.4	81.0	29.7	1,534.3	563.2	\$8,075,558	\$6,167,267	\$4,467,338	\$18,710,163	\$4,835,062
2041	38,956,684	21,899,849	1.1	0.4	81.7	29.4	1,548.8	557.2	\$8,245,422	\$6,296,992	\$4,561,305	\$19,103,719	\$4,613,798
2042	39,321,343	21,666,807	1.1	0.4	82.5	29.1	1,563.3	551.3	\$8,415,286	\$6,426,716	\$4,655,273	\$19,497,275	\$4,400,792
2043	39,686,001	21,433,765	1.1	0.4	83.3	28.8	1,577.8	545.4	\$8,585,150	\$6,556,440	\$4,749,240	\$19,890,831	\$4,195,909
2044	40,050,659	21,200,723	1.1	0.4	84.0	28.5	1,592.3	539.5	\$8,755,014	\$6,686,165	\$4,843,208	\$20,284,386	\$3,998,998
2045	40,415,318	20,967,681	1.2	0.4	84.8	28.2	1,606.8	533.5	\$8,924,878	\$6,815,889	\$4,937,175	\$20,677,942	\$3,809,894
2046	40,779,976	20,734,640	1.2	0.4	85.6	27.8	1,621.3	527.6	\$9,094,742	\$6,945,613	\$5,031,143	\$21,071,498	\$3,628,417
2047	41,144,634	20,501,598	1.2	0.4	86.3	27.5	1,635.8	521.7	\$9,264,606	\$7,075,338	\$5,125,110	\$21,465,054	\$3,454,379
2048	41,509,293	20,268,556	1.2	0.4	87.1	27.2	1,650.3	515.7	\$9,434,470	\$7,205,062	\$5,219,078	\$21,858,610	\$3,287,583
2049	41,873,951	20,035,514	1.2	0.4	87.9	26.9	1,664.8	509.8	\$9,604,334	\$7,334,787	\$5,313,045	\$22,252,166	\$3,127,827
2050	42,238,610	19,802,472	1.2	0.4	88.6	26.6	1,679.3	503.9	\$9,774,198	\$7,464,511	\$5,407,012	\$22,645,721	\$2,974,903
2051	42,603,268	19,569,430	1.2	0.4	89.4	26.3	1,693.8	497.9	\$9,944,062	\$7,594,235	\$5,500,980	\$23,039,277	\$2,828,601
2052	42,967,926	19,336,388	1.2	0.4	90.1	26.0	1,708.3	492.0	\$10,113,926	\$7,723,960	\$5,594,947	\$23,432,833	\$2,688,710
2053	43,332,585	19,103,346	1.2	0.3	90.9	25.7	1,722.8	486.1	\$10,283,790	\$7,853,684	\$5,688,915	\$23,826,389	\$2,555,016
2054	43,697,243	18,870,304	1.2	0.3	91.7	25.3	1,737.3	480.2	\$10,453,654	\$7,983,408	\$5,782,882	\$24,219,945	\$2,427,307
<b>Total</b>													<b>\$157,560,438</b>

## Emissions Savings

Year	TOTAL VMT (veh-miles/yr)		TOTAL VHT (veh-hrs/yr)		AVERAGE SPEED (mph)		PERCENT TRUCKS (%)		AVERAGE VOLUME (vehicles/yr)		RUNNING EMISSIONS STARTING EMISSIONS (\$/yr) (\$/yr)				Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build		
2025	33,122,150	17,183,947	1,831,977	439,675	18.1	39.1	20.0%	20.0%	2,442,636	2,442,636	\$1,645,961	\$642,555	\$33,784	\$33,784	\$1,003,406	\$715,415
2045	40,415,318	20,967,681	2,235,360	536,487	18.1	39.1	20.0%	20.0%	2,980,481	2,980,481	\$1,599,761	\$720,308	\$31,778	\$31,778	\$879,453	\$162,038
2025	33,122,150	17,183,947	1,831,977	439,675	18.1	39.1	20.0%	20.0%	2,442,636	2,442,636	\$1,645,961	\$642,555	\$33,784	\$33,784	\$1,003,406	\$715,415
2026	33,486,808	17,373,134	1,852,146	444,515	18.1	39.1	20.0%	20.0%	2,469,529	2,469,529	\$1,689,708	\$660,198	\$34,388	\$34,388	\$1,029,510	\$686,006
2027	33,851,467	17,562,321	1,872,316	449,356	18.1	39.1	20.0%	20.0%	2,496,421	2,496,421	\$1,734,531	\$678,285	\$35,001	\$35,001	\$1,056,246	\$657,777
2028	34,216,125	17,751,507	1,892,485	454,196	18.1	39.1	20.0%	20.0%	2,523,313	2,523,313	\$1,780,458	\$696,827	\$35,625	\$35,625	\$1,083,631	\$630,683
2029	34,580,784	17,940,694	1,912,654	459,037	18.1	39.1	20.0%	20.0%	2,550,205	2,550,205	\$1,827,515	\$715,835	\$36,258	\$36,258	\$1,111,680	\$604,680
2030	34,945,442	18,129,881	1,932,823	463,878	18.1	39.1	20.0%	20.0%	2,577,097	2,577,097	\$1,875,733	\$735,322	\$36,902	\$36,902	\$1,140,411	\$579,727
2031	35,310,100	18,319,068	1,952,992	468,718	18.1	39.1	20.0%	20.0%	2,603,990	2,603,990	\$1,925,139	\$755,299	\$37,557	\$37,557	\$1,169,840	\$555,783
2032	35,674,759	18,508,254	1,973,161	473,559	18.1	39.1	20.0%	20.0%	2,630,882	2,630,882	\$1,123,141	\$501,697	\$24,916	\$24,916	\$621,444	\$275,929
2033	36,039,417	18,697,441	1,993,331	478,399	18.1	39.1	20.0%	20.0%	2,657,774	2,657,774	\$1,154,508	\$516,055	\$25,386	\$25,386	\$638,453	\$264,935
2034	36,404,076	18,886,628	2,013,500	483,240	18.1	39.1	20.0%	20.0%	2,684,666	2,684,666	\$1,186,678	\$530,786	\$25,865	\$25,865	\$655,892	\$254,366
2035	36,768,734	19,075,814	2,033,669	488,081	18.1	39.1	20.0%	20.0%	2,711,559	2,711,559	\$1,219,672	\$545,900	\$26,353	\$26,353	\$673,773	\$244,206
2036	37,133,392	19,265,001	2,053,838	492,921	18.1	39.1	20.0%	20.0%	2,738,451	2,738,451	\$1,253,512	\$561,405	\$26,851	\$26,851	\$692,107	\$234,440
2037	37,498,051	19,454,188	2,074,007	497,762	18.1	39.1	20.0%	20.0%	2,765,343	2,765,343	\$1,288,218	\$577,313	\$27,357	\$27,357	\$710,905	\$225,054
2038	37,862,709	19,643,374	2,094,176	502,602	18.1	39.1	20.0%	20.0%	2,792,235	2,792,235	\$1,323,811	\$593,633	\$27,874	\$27,874	\$730,178	\$216,033
2039	38,227,367	19,832,561	2,114,346	507,443	18.1	39.1	20.0%	20.0%	2,819,127	2,819,127	\$1,360,315	\$610,375	\$28,400	\$28,400	\$749,940	\$207,365
2040	38,592,026	20,021,748	2,134,515	512,284	18.1	39.1	20.0%	20.0%	2,846,020	2,846,020	\$1,397,752	\$627,551	\$28,936	\$28,936	\$770,201	\$199,035
2041	38,956,684	20,210,935	2,154,684	517,124	18.1	39.1	20.0%	20.0%	2,872,912	2,872,912	\$1,436,144	\$645,170	\$29,483	\$29,483	\$790,975	\$191,031
2042	39,321,343	20,400,121	2,174,853	521,965	18.1	39.1	20.0%	20.0%	2,899,804	2,899,804	\$1,475,517	\$663,243	\$30,040	\$30,040	\$812,274	\$183,341
2043	39,686,001	20,589,308	2,195,022	526,805	18.1	39.1	20.0%	20.0%	2,926,696	2,926,696	\$1,515,894	\$681,783	\$30,608	\$30,608	\$834,110	\$175,953
2044	40,050,659	20,778,495	2,215,191	531,646	18.1	39.1	20.0%	20.0%	2,953,588	2,953,588	\$1,557,300	\$700,801	\$31,187	\$31,187	\$856,499	\$168,856
2045	40,415,318	20,967,681	2,235,360	536,487	18.1	39.1	20.0%	20.0%	2,980,481	2,980,481	\$1,599,761	\$720,308	\$31,778	\$31,778	\$879,453	\$162,038
2046	40,779,976	21,156,868	2,255,530	541,327	18.1	39.1	20.0%	20.0%	3,007,373	3,007,373	\$1,643,303	\$740,317	\$32,381	\$32,381	\$902,986	\$155,490
2047	41,144,634	21,346,055	2,275,699	546,168	18.1	39.1	20.0%	20.0%	3,034,265	3,034,265	\$1,687,953	\$760,840	\$32,995	\$32,995	\$927,113	\$149,201
2048	41,509,293	21,535,242	2,295,868	551,008	18.1	39.1	20.0%	20.0%	3,061,157	3,061,157	\$1,733,739	\$781,891	\$33,622	\$33,622	\$951,848	\$143,160
2049	41,873,951	21,724,428	2,316,037	555,849	18.1	39.1	20.0%	20.0%	3,088,049	3,088,049	\$1,780,688	\$803,481	\$34,261	\$34,261	\$977,207	\$137,359
2050	42,238,610	21,913,615	2,336,206	560,690	18.1	39.1	20.0%	20.0%	3,114,942	3,114,942	\$1,828,829	\$825,625	\$34,914	\$34,914	\$1,003,205	\$131,788
2051	42,603,268	22,102,802	2,356,375	565,530	18.1	39.1	20.0%	20.0%	3,141,834	3,141,834	\$1,878,192	\$848,335	\$35,579	\$35,579	\$1,029,857	\$126,439
2052	42,967,926	22,291,988	2,376,545	570,371	18.1	39.1	20.0%	20.0%	3,168,726	3,168,726	\$1,928,807	\$871,627	\$36,259	\$36,259	\$1,057,180	\$121,302
2053	43,332,585	22,481,175	2,396,714	575,211	18.1	39.1	20.0%	20.0%	3,195,618	3,195,618	\$1,980,706	\$895,514	\$36,952	\$36,952	\$1,085,191	\$116,370
2054	43,697,243	22,670,362	2,416,883	580,052	18.1	39.1	20.0%	20.0%	3,222,511	3,222,511	\$2,033,918	\$920,012	\$37,659	\$37,659	\$1,113,906	\$111,635
<b>Total</b>																<b>\$8,625,398</b>