PUERTO RICO HIGHWAYS & TRANSPORTATION AUTHORITY

Puerto Rico Transportation Asset Management Plan 2032

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FINAL

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Business Innovations and Technology Advancements in Transportation

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Executive Summary

This is the Puerto Rico Highway and Transportation Authority's (PRHTA) four-year update to the Federally required transportation asset management plan (TAMP.)[1] This TAMP describes the condition of the National Highway System (NHS) pavements and bridges in Puerto Rico, identifies PRHTA's investment strategies to manage them for 10 years, and forecasts their condition based on those strategies.

For convenience, a glossary of terms and acronyms ais included in Appendix A.

This TAMP addresses only the NHS routes in Puerto Rico. It does not analyze the Non-NHS routes which are the majority of the Commonwealth's roadways. The NHS in Puerto Rico includes 799.6 miles out of a total of 4,851.8 total highway miles. While a minority of the overall miles, the NHS carries most of the people and freight across the three inhabited islands.

This TAMP covers Federal Fiscal Years (FFY) 2022 to 2032 and updates according to Federal regulation[2] to the preceding TAMP approved in 2019. This document also revises a November 18, 2022 submission to the Federal Highway Administration (FHWA.) This December submission includes the detail needed to address new Federal requirements that the TAMP's life-cycle analysis and risk analysis consider the impacts of extreme weather and resilience.[3] Those requirements came in the Bipartisan Infrastructure Law (BIL) passed in 2021. The November 2022 TAMP addressed resilience in its risk management section. This revised TAMP retains the risk management chapter and adds additional resilience strategies in the life-cycle planning chapter. Thus, this TAMP is what is known as "BIL compliant."[4]

PRHTA is a public corporation under the Department of Transportation and Public Works (DTPW.) This TAMP supports the DTPW's mission and vision which are:

> *"Our mission has always been to develop and promote an integrated transportation system that, together with the road infrastructure and the provision of services, facilitates the economic development of Puerto Rico in harmony with the environment.*
>
> *We have the vision of leading Puerto Rico towards economic development through an efficient and safe transportation system in harmony with the environment, seeking to provide innovative services and excellence."*

The TAMP includes three objectives which are:

[1] 23 CFR Part 515.
[2] 23 CFR 515.13(a)(2)
[3] 23 USC 119(e)(4)
[4] PRHTA informed FHWA in July 2022 that it was taking advantage of the option to submit a partially compliant TAMP in November and a fully compliant TAMP in December. This option was offered in a May 5, 2022 memorandum from Hari Kalla, FHWA's associate administrator for infrastructure.

> "PRHTA will implement data-driven life-cycle based pavement and bridge management processes to achieve the condition targets and the desired state of good repair (SOGR), enhance safety, increase resilience, and lower life-cycle costs for managing pavements and bridges.
>
> PRHTA will partner with the Metropolitan Planning Organization to communicate the targets and incorporate asset management-based projects into the Transportation Improvement Program, the Long-Range Statewide Transportation Plan, and the Metropolitan Transportation Plan.
>
> PRHTA will collaborate with stakeholders to communicate the importance of reliable and sufficient funding to achieve condition targets and desired SOGR to provide safe and reliable bridges and pavements for the movement of people and Goods."

The TAMP helps achieve the mission, vision, and objectives by developing life-cycle based investment strategies required to accomplish them.

Currently, PRHTA's NHS pavement and bridge conditions are below National averages. Additionally, the Interstate pavements are exceeding the Federal minimum allowable condition of having no more than 5 percent of them in Poor condition.

However, Puerto Rico's NHS pavements and bridges are improving. The percentage of Poor NHS bridge area and the lane miles of Poor Interstate pavements have declined substantially in the past few years. This plan helps continue that progress. It forecasts that PRHTA will achieve its Interstate pavement targets within 10 years while sustaining its NHS bridges that already are better than the targeted levels. A long-term goal for PRHTA is to improve NHS pavements and bridges until they equal the average conditions nationwide.

PRHTA faces unusual challenges to its intent to achieve its condition targets and reach National averages. It is contending with the Commonwealth's bankruptcy, Hurricanes Irma, Maria, and Fiona, as well as a series of earthquakes from 2019 to 2022. Natural disasters not only damage pavements and bridges, but they also consume the capacity of PRHTA staff and Puerto Rico contractors. Despite those challenges, PRHTA is moving ahead with aggressive strategies to not only repair past damage but to achieve an overall SOGR.

This TAMP includes a 10-year financial plan that is linked to the Statewide Transportation Improvement Program (STIP) as well as the 28-year Fiscal Plan approved in October 2022 by the Financial Oversight and Management Board (FOMB). This TAMP's financial plan shows the 10 - year investment levels for the NHS pavements and bridges. The TAMP shares the FOMB's Fiscal Plan's intent to bring Puerto Rico highways to a SOGR. In fact, the same analytical processes that PRHTA used for the TAMP were used to demonstrate to the FOMB how much investment was needed to achieve a SOGR.

The TAMP applies life-cycle planning to develop the detailed investment for preserving, maintaining , rehabilitating, and where needed, reconstructing or replacing critical assets. This TAMP embraces strategies to use preservation and rehabilitation as lower-cost means to extend the life of pavements and bridges. The life-cycle strategies support the agency's mission and vision. They provide the lowest-cost means for achieving the long-term condition targets needed for a safe, resilient highway system.

Many uncertainties and risks face PRHTA as it strives to achieve its ten-year objectives. At the time this TAMP was developed, inflation was unusually high. Rising prices threaten how many bridges and how many miles of roadway PRHTA can afford to improve. More hurricanes or seismic events could further damage the highway system and complicate PRHTA's objectives. Finding enough engineering firms to design the needed projects and enough contractors to build them is another risk facing PRHTA. Each year, the FOMB approves an updated fiscal plan. Any cut in expected funding could threaten the TAMP's investment strategies. This TAMP assesses those risks and identifies mitigation strategies to address them.

This TAMP provides the roadmap for PRHTA to continue improving its NHS pavements and bridges and to eventually reach a SOGR. The TAMP suggests annual investment levels and recommends the type of treatment the STIP should include. This TAMP also forecasts the condition levels expected to be achieved, while identifying the risks that could threaten that achievement. The TAMP supports both Puerto Rico's long-term objectives while also satisfying the National transportation goals.[5] In short, this roadmap identifies a path for PRHTA to achieve a long-term SOGR.

[5] 23 USC 150(b)

Background

The FHWA adopted the asset management regulation in 2016 that requires each State to develop an asset management plan that includes at least the NHS pavements and bridges. States could include additional assets if they chose. However, PRHTA is only including in this TAMP the NHS pavements and bridges.

FHWA regulation states, "A State shall develop a risk-based asset management plan that describes how the NHS will be managed to achieve system performance effectiveness and State DOT targets for asset condition, while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets. The State DOT shall develop and use, at a minimum the following processes to prepare its asset management plan:"[6]

1. A performance gap analysis process
2. A life-cycle planning process
3. A risk management process
4. A financial plan development process
5. A process for developing investment strategies

FHWA defines those terms in 23 CFR 515.5.

Performance gap means the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.

Life-cycle planning means a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition.

Risk management means the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance.

Financial plan means a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.

Investment strategy means a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks.

[6] 23 CFR 515.7

With those processes State DOTS produce for the TAMP eight sections. Those are shown in Diagram 1

Diagram 1: The Eight TAMP Elements

This document is organized around those eight elements. The TAMP was developed not only in the format to satisfy 23 CFR Part 515 but it includes other elements that satisfy the Federal requirements including:

1. It was developed with the best available data collected in 2021.
2. Its objectives align with the agency's mission and are consistent with the purpose of asset management.
3. It includes the State targets for NHS pavements and bridges.
4. It was developed with management system processes meeting the requirements of 23 CFR 515.17.

5. It is coordinated with planning by being shared with the long-range statewide transportation plan development process but also is closely linked to the STIP.
6. Necessary data was collected from other NHS owners such as concessionaires.
7. Its investment strategies support achievement of the National goals established in USC 23 Sec. 150.
8. It is coordinated with the Part 667 analysis of sites damaged during emergency events.

The many other TAMP requirements that are met will be evident in the individual chapters.

Asset Management History

The recent history of asset management in Puerto Rico began with a 2016 "gap analysis" report that suggested improvements in the State's asset management practices. In late 2017, PRHTA contracted with a consultant team that began work on the initial 2018 TAMP. As required, that initial TAMP was updated in 2019. Several other very important and relevant efforts also began after or during the development of those first two TAMPs including:

1. Bridge and pavement forecasting tools were developed to help forecast future pavement and bridge conditions under different investment scenarios.
2. Those tools were used to inform the Financial Oversight and Management Board of the investment needed to reach a SOGR. Since 2018, the FOMB has relied on the analyses produced by those tools to influence capital investment levels necessary to achieve the PRHTA condition targets.
3. PRHTA has developed a Pavement Data Quality Management Plan (PDQMP) to enhance the quality and completeness of the pavement-condition data.
4. PRHTA has set the pavement and bridge targets required by 23 CFR Part 490 and has focused the FOMB financial analysis and TAMP investment strategies on achieving those targets.
5. PRHTA has re-focused its STIP development processes to align the STIP projects with the investment strategies shwown in the TAMP. The STIP projects programed for FFY 2023 to 2026 include a mix of preservation, rehabilitation, and reconstruction projects aligned with the investment strategies.
6. PRHTA hired two consultant teams to oversee the delivery of the larger construction program needed to achieve the asset condition targets and to invest all of the FOMB funds.

Although the TAMP is based upon the best available data, that data does not reflect damages caused by earthquakes in 2022 nor hurricane Fiona. The full effect of those emergencies will not be assessed until another year of data is collected throughout calendar year 2022.

Coordination with Stakeholders

This TAMP was developed with input from the major concessionaire in Puerto Rico that manages two sections of the Interstate. Metropistas of Puerto Rico provided information on its capital planning, and it commented on the risk management analysis.

The developers of the statewide long-range transportation plan are also being provided the TAMP. Any data needed for the long-range plan related to asset conditions is also being provided. Also, the targets included in the TAMP were coordinated with the MPO earlier in 2022.

A very important stakeholder is the FOMB. Congress established it to oversee the Commonwealth's emergence from bankruptcy. As noted, the pavement and bridge analysis tools used to develop the TAMP were also used repeatedly to provide the FOMB with reports on how much investment was needed to achieve the condition targets. The tools were used to produce four investment scenarios in 2021 for the FOMB. The FOMB adopted what was known as Scenario 1 that was focused upon funding a SOGR as measured by the Federal pavement and bridge performance measures in 23 CFR Part 490. The Fiscal Plan for the Puerto Rico Highways & Transportation Authority (PRHTA) FY 2023-FY2051 expressly states it is closely based on Scenario 1, and that the intent is to achieve a SOGR.

Other Influences on the Asset Management Processes

The asset management plan is developed within a broader context that influences PRHTA's ability to deliver the TAMP investment strategies.

First, the hurricanes and earthquakes of recent years have required immediate emergency response that has prevented PRHTA from directing its full attention to the asset management plan investment strategies.

Second, PRHTA is still delivering a backlog of obligated but undelivered projects that it must construct under a memorandum of understanding developed with FHWA. Instead of focusing solely on delivering projects tied to the TAMP investment strategies, PRHTA is also clearing a backlog of old, obligated projects required under the Federal agreement.

Third, COVID-19 hit Puerto Rico particularly hard and led to months-long shutdowns. The pandemic delayed many of the projects anticipated in the 2019 TAMP.

Fourth, a long-planned revitalization of the Department of Public Works (DPW) is under way. DPW has received substantial new funding that will greatly increase the maintenance efforts on Puerto Rico highways. However, DPW is still gearing up for its role. The full contribution that the maintenance efforts will have on the NHS is not yet known.

Chapter 1. Asset Management Objectives

Photo 1-1: San Juan Highways at Night

This section describes the mission, vision, and objectives that guide the Highway and Transportation Authority's Transportation Asset Management Plan (TAMP) in fulfillment of 23 CFR § 515.9 (d)(1).

1.1 TAMP Objectives and their Alignment with the Instiutional Mission

The Federal TAMP regulation requires the establishment of objectives:

> "*Asset management objectives. The objectives should align with the State DOT's mission. The objectives must be consistent with the purpose of asset management, which is to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practicable cost*."

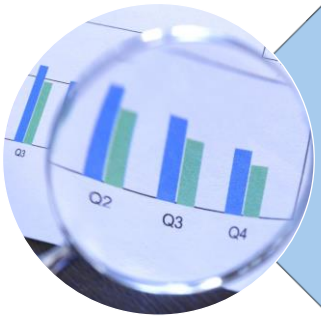
The PRHTA TAMP covers pavements and bridges within the National Highway System. In keeping with Federal regulations, the asset management plan adopts performance objectives that support the agency's mission and are consistent with the purpose of asset management. The PRHTA is a public corporation under the Department of Transportation and Public Works (DTPW)'s umbrella. The DTPW's published mission and vision are:

> *"Our mission has always been to develop and promote an integrated transportation system that, together with the road infrastructure and the provision of services, facilitates the economic development of Puerto Rico in harmony with the environment.*
>
> *We have the vision of leading Puerto Rico towards economic development through an efficient and safe transportation system in harmony with the environment, seeking to provide innovative services and excellence."*

The mission and vision recognize the need for PRHTA to help Puerto Rico improve its economy while investing in maintaining, preserving, and sustaining the transportation infrastructure essential to the movement of people and Goods. This mission and vision are also integral to revitalizing Puerto Rico's economy.

In addition to repairing damages from Hurricanes María, Fiona, and a series of earthquakes, PRHTA also is addressing a substantial backlog of unmet highway repair needs. The prolonged recession in Puerto Rico, combined with a lack of a sustained maintenance program, contributed to pavement and bridge conditions that are well below national averages. The objectives and targets included in this TAMP reflect another component of the PRHTA's comprehensive efforts to cost effectively achieve and sustain pavements and bridges in a state of good repair (SOGR). Achieving and then sustaining conditions that meet or surpass these targets requires consistent funding to support the investment strategies detailed in this plan.

Building from its mission, PRHTA adopted the objectives shown in Figure 1-1. to guide its asset management effort.



"PRHTA will implement data-driven life-cycle based pavement and bridge management processes to achieve the condition targets and the desired SOGR, enhance safety, increase resilience, and lower life-cycle costs for managing pavements and bridges."

"PRHTA will partner with the Metropolitan Planning Organization to communicate the targets and incorporate asset management based projects into the Transportation Improvement Program, the Long-Range Statewide Transportation Plan, and the Metropolitan Transportation Plan."

"PRHTA will work with stakeholders to communicate the importance of reliable and sufficient funding to achieve condition targets and desired SOGR to provide safe and reliable bridges and pavements for the movement of people and goods."

Figure 1-1: TAMP Objectives

1.2 Alignment with Other Plans

The three TAMP objectives also align with the PRHTA's most recently published 2045 Long-Range Multimodal Transportation Plan (LRTP) dated December 2018[7], and the 2019-2023 Strategic Highway Safety Plan (SHSP) dated July 24, 2019[8].

The 2045 LRTP emphasizes the close connection between the TAMP and the long-range statewide transportation plan. The long-range plan notes that it emphasizes asset management

[7] The next LRTP is planned to be published in 2023. Similar to the process followed in the previous version, the new LRTP will consider and will be aligned to the objectives and targets of the TAMP 2032.
[8] The SHSP is updated every 5 years by July 31st. The next update is due 2024.

to a greater extent than before the passage of the Moving Ahead for Progress in the 21st Century Act (MAP-21.) The TAMP was one of four plans considered in the development of the long-range plan[9]. Those are the Puerto Rico Complete Streets and Design Guidelines, Comprehensive Bicycle and Pedestrian Plans, the Strategic Highway Safety Plan, and the Asset Management Plan.

The linkages with the TAMP include the long-range plan's citing of asset management as a strategy to support the objective of, "Develop Strategies to deal with the cost of managing and operating Puerto Rico's transportation systems."[10] The long range plan incorporates the TAMP's objectives,[11] it cites the TAMP's bridge and pavement investment levels,[12] it incorporates the bridge and pavement targets, and its states that after disaster recovery the highest priority is to meet the bridge and pavement condition targets. The long-range plan also addresses the importance of a resilient and reliable infrastructure in the objective B.5 [13], to "Reduce transportation infrastructure's vulnerability to withstand extreme weather events through a resilient and reliable infrastructure." [14] The long-range plan also summarizes some of the investment scenarios generated for the TAMP to illustrate asset management investment needs for the plan's first 10 years.

The TAMP is also aligned with the Strategic Highway Safety Plan (SHSP). The SHSP is a requirement and major component of the FHWA's Highway Safety Improvement Program (HSIP), which objective is to improve conditions that can affect traffic safety. The SHSP's vision is for all users of the transportation system to move safely and effectively, while achieving the goal of reducing fatalities and serious injuries caused by traffic crashes. This is in alignment with the objectives of the TAMP that includes "to achieve condition targets and desired SOGR to provide safe and reliable bridges and pavements for the movement of people and Goods."

1.3 Alignment with State and National Goals

The TAMP objectives align with the purpose of asset management, which is to achieve and sustain the desired SOGR over the life cycle of the assets at a minimum practicable cost[15] while considering extreme weather and resilience[13]. These objectives led PRHTA to develop the processes that support the achievement of resilient assets and sustain them into the future.

These objectives also contribute significantly to other key Puerto Rican objectives such as improving safety and enhancing economic development. Well-maintained pavements have better surface friction and fewer ruts, both of which improve vehicle stopping distance and make

[9] 2045 Puerto Rico Long Range Multimodal Transportation, Puerto Rico Highways and Transportation Authority, December 2018, page 7.
[10] 2045 Puerto Rico Long Range Multimodal Transportation Plan (LRTP), Puerto Rico Highways and Transportation Authority, December 2018, page 154.
[11] Long range plan, page 162.
[12] Long range plan, page 212.
[13] Title 23, United States Code (U.S.C.), Section 119(e)(4), Section 11105, Bipartisan Infrastructure Law (BIL).
[14] Long range plan, page 155.
[15] 23 CFR 515.9(d)(1).

roads safer. Also, well-maintained roads reduce vehicle operating costs which increase when pavements are rough or have potholes that increase vehicle damage and the need for repairs. Good roads also support economic development by making Puerto Rico more attractive to tourists and to industries that depend upon shipping Goods into, across, or out of Puerto Rico. Bridges in Good condition can be more resilient in the face of seismic activity and increasing extreme weather events.

PRHTA's asset management objectives will also save money over the long term because Good roads cost less. It is much cheaper over the lifecycle of pavements and bridges to treat them with low-cost maintenance and preservation treatments when the assets are in Good and Fair condition as opposed to rebuilding them after they have deteriorated. A well-maintained bridge can last decades longer than one that receives no maintenance. Maintenance and preservation address small problems caused by rust and minor cracking that will worsen and lead to a failed bridge over time. Similarly with pavements, when small cracks and potholes are repaired quickly, the water stays out of the pavement base, the cracks do not expand, and the pavement lasts much longer. Almost universally, highway agencies have calculated that timely preservation and maintenance will cost a little each year but save the agency from large backlogs of deteriorated bridges and pavements that require expensive replacement.

The institutional mission/vision and TAMP objectives also support the seven national transportation goals which are to: Improve safety, maintain highway infrastructure in a SOGR, reduce congestion, improve system reliability, improve the freight network to support economic vitality, protect the environment, and reduce project delays.

Chapter 2. Measures and Targets for Asset Condition

Photo 2-1: La Plata Lake close to Jesús Izcoa Moure Cable-Stayed Bridge

This chapter discusses the measures and targets adopted by PRHTA to manage its NHS. Federal regulation established national performance measures for the condition of the NHS bridges and pavements.[16] In 2018, PRHTA and all State DOTs adopted these measures and established targets for the NHS pavements and bridges. As required, the targets were updated in December 2022.

The regulation also requires PRHTA to coordinate with the Metropolitan Planning Organization (MPO) in the selection of targets. PRHTA and the MPO agreed on the targets included in the TAMP and signed an agreement formalizing the target-selection process and sharing on April 29, 2022. Refer to Appendix B for evidence of the meeting and a copy of the agreement.

2.1 Pavement Condition Measures

Federal regulation also sets minimum allowable pavement conditions of no more than 5 percent Poor pavement on the Interstates. [17] Data for these measures. targets, and measurement of minimum allowable conditions must come from the Highway Performance Monitoring System (HPMS).

Federally required measures for assessing pavement conditions for the NHS are:[18]

[16] 23 CFR Part 490
[17] 490.315 Establishment of minimum level for condition of pavements.
[18] 490.307

1. Percentage of the Interstate pavement in Good condition
2. Percentage of the Interstate pavements in Poor condition
3. Percentage of NHS Non-Interstate pavements in Good condition
4. Percentage of NHS Non-Interstate pavements in Poor condition

The pavements are measured by lane miles. A lane mile is one lane wide and one mile long. Federal regulation specifies how pavements are measured, categorized, and rated as Good, Fair, or Poor. The Federal measure is based on four pavement condition metrics. For asphalt pavements the rating is based on the International Roughness Index (IRI), percent of cracking and rutting. For concrete pavements, the measure is based on IRI, cracking, and faulting.

Roughness is measured by the IRI that assigns ratings based upon the inches per mile of roughness. Rutting is the longitudinal depression in the wheel path in bituminous pavements and is measured in inches. Faulting is the vertical misalignment of pavement joints in concrete pavements and is measured in inches. Cracking is defined as a fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement. Cracking Percent is defined as the percentage of pavement surface exhibiting cracking.[19]

Table 2-1: FHWA Condition Metrics - Calculation of Performance Measures

FHWA's NHS Pavement Rating Scale						
Condition	**IRI Asphalt & Concrete (inches/mile)**		**Rutting Asphalt (inches)**	**Faulting Concrete (inches)**	**Cracking (%)**	
					Asphalt	**Concrete**
Good	<	95	0.2	0.1	5	5
Fair	<=	170	0.4	0.15	20	15
Poor	>	170	0.4	0.15	20	15

Table 2-1 shows the FHWA metrics used for the computation of pavement ratings.[20] The Federal regulation requires that two of the three performance metrics be rated Poor before a pavement section is rated Poor. Also, a pavement section is rated Good only if it is rated Good for all three conditions. Pavement sections not rated Good or Poor are rated Fair.

Depending on what metrics led to a Poor rating, two pavements may require very different treatments. Table 2.2 shows the more granular pavement condition rating metrics that PRHTA adopted that are aligned to the FHWA condition metrics to categorize pavements. Comparing the pavement rating scales in Table 2-1 and Table 2-2 shows that a pavement section under the Federal measures can be close to being Poor or close to being Good and still be rated as Fair. This more granular approach supports PRHTA with a more targeted selection of treatments for Fair pavements.

[19] Highway Performance Monitoring System Field Manual, December 2016.
[2020] 490.311 Calculation of pavement metrics

Table 2-2: PRHTA's More Granular Pavement Condition Rating Metrics

Condition	Code	Criteria Limit for Individual Distresses	Distress Criteria						Overall Criteria Considering the Three Distresses
			IRI		Rutting or Faulting		Cracking		
			Asphalt & Concrete		Asphalt	Concrete	Asphalt	Concrete	
			NHS	Non-NHS					
Good	G	<	95	135	0.2	0.1	5	5	3G
Fair to Good	F1	<	110	185	0.3	0.12	10	10	2G & F1 or F2 1G & 2 F1 or F2 or Combination 3 F1 or F2 or Combination
Fair	F2	<	130	235	-----	-----	15	-----	Other Combinations
Fair to Poor	F3	<=	170	285	0.4	0.15	20	15	> 1F3 and no P 1F3 and 1P
Poor	P	>	170	285	0.4	0.15	20	15	>1P

Non-NHS IRI criteria adopted by PRHTA is based on research by Arhin , Noel, and Ribbiso entitled Acceptable International Roughness Index Thresholds based on Present Serviceability Rating, published on the Journal of Civil Engineering Research (2015; 5(4): 90-96).

2.2 Pavement Condition Short Term Targets

PRHTA has established pavement targets based upon forecasted conditions in 2023 and 2025. Those targets are indicators of interim conditions and performance levels. They show how PRHTA is progressing toward its longer-term goals for the condition and performance of the NHS.[21]
Per CFR 490, transportation performance management (TPM) requirements, State DOTs must establish 2-year and 4-year targets for percent Good and percent Poor for the Interstate and NHS Non-Interstate pavements.[22] State DOTs must also report on the performance every 2 and 4 years to show progress. The last 2-year TPM mid-performance report was submitted by PRHTA in October 2020. The 4-year, full performance report that was scheduled for submission in October 2022, was delayed due to some technical issues with the FHWA TPM website. PRHTA's Full performance report as directed by FHWA was submitted Dec 16, 2022.[23]

PRHTA established new 2-year and 4-year pavement targets for 2023 and 2025 for the next reporting period.[24] Table 2-3 shows the new 2-year and 4-year pavement targets established by PRHTA.

[21] The preamble to the final asset management rule in 23 CFR Part 515 states that 2-year and 4-year targets should be interim indicators of conditions as States progress toward a long-term SOGR. Also, the TPM reporting format states that the 2-year and 4-year targets should reflect expected conditions in the targeted years.
[22] 490.107 Reporting on performance targets.
[23] FHWA Memorandum HISM-30, Adjustment to the 2022 TPM Biennial Reporting Timelines, Oct 4, 2022.
[24] Although 2-year and 4-year targets are set in 2022, the target years are 2023 and 2025. This is because the targets are based on condition data collected in 2021. The 2-year Mid-Performance and 4-year Full-Performance Reports will assess conditions based on the preceding year's data.

Table 2-3: Pavement Condition Targets

PRHTA Pavements Targets for 2 and 4 years		
Condition Measure	**2-year (2023)**	**4-year (2025)**
Interstate Pavements in Good Condition	20.0% or more	25.0% or more
Interstate Pavements in Poor Condition Poor	11.0% or less	11.0 % or less
Non- Interstate NHS Pavements in Good Condition	5.0% or more	10.0% or more
Non- Interstate NHS Pavements in Poor Condition	12.0% or less	14.0% or less

The chapter on Asset Inventory and Conditions discusses the progress made by PRHTA over a decade. The trends show that PRHTA is moving closer to the long-term goal of Interstate pavement being less than 5 percent Poor. However, conditions temporarily decline until pavement reconstruction projects are delivered by 2026. The Investment Strategy Chapter elaborates on how the 2-year and 4-year targets complement PRHTA's long-term strategy to reach no more than 5 percent Poor Interstate pavement.

2.3 Bridge Condition Measures

The Federal regulations state that the bridge measure [25] calculations will utilize data documented in the National Bridge Inventory (NBI). The bridges and culverts that are over 20 feet in length on the NHS are included in this TAMP. The Federally required bridge condition measures are: [26]

1. Percentage of NHS bridges classified as in Good condition
2. Percentage of NHS bridges classified as in Poor condition

Federal regulation specifies how bridges are measured, categorized, rated, and classified as Good, Fair, or Poor. The federal measure for assessing bridge condition is based on three NBI items and their condition ratings. For bridges the items are the substructure (item 60), superstructure (item 59), and deck (item 58). The method of assessment to determine the classification of a bridge will be the lowest condition rating of the three NBI items.[27] The bridges are measured by deck area, not the number of bridges.

Culverts' rating and classification of Good, Fair, or Poor is based on the overall condition rating of the culvert and is captured in the NBI item 62.[28] Table 2-4 shows the condition rating and classification for each of the four items. Each is rated on a scale of 0-9 and classified as Good, Fair, or Poor. Each bridge is assigned the lowest rating of the three NBI items. The culvert is classified as Good, Fair, or Poor based on the same rating scale for the NBI item 62.

[25] 490.407. National performance management measures for assessing bridge conditions.
[26] 490.407, National performance management for assessing bridge condition.
[27] 490.409 (b), Calculation of National performance management measures for assessing bridge condition
[28] 490.409, Calculation of National performance management measures for assessing bridge condition.

Table 2-4: FHWA Condition Metrics for Bridge Rating

FHWA Condition Definition	
Rate	**Condition Definition**
N	Not applicable.
9	Excellent
8	Very Good
7	Good
6	Satisfactory
5	Fair
4	Poor
3	Serious
2	Critical
1	Imminent Failure
0	Failed

TAMP Criteria		
Component		
Rate		**Condition**
=	N	Not Applicable
<=	4	Poor
=	5	Fair to Poor
=	6	Fair Satisfactory
>=	7	Good
Overall		
The overall bridge condition is determined by the lowest rating of deck, superstructure, substructure, or culvert.		

2.4 Bridge Condition Short Term Targets

As with pavements, PRHTA has established bridge targets based upon forecasted conditions in 2023 and 2025. Those targets are indicators of interim conditions and performance levels. Table 2-5 shows the 2-year and 4-year NHS bridge condition targets established by PRHTA to support the TPM bridge requirements.

Table 2-5: Bridge Condition Targets

PRHTA Bridge Condition Targets for 2 and 4 years (Deck Area)		
Condition Measure	**2-Year target (2023)**	**4-year target (2025)**
NHS Bridges in Good Condition	15% or more	15% or more
NHS Bridges in Poor Condition	10% or less	11% or less

PRHTA has made significant progress in maintaining the condition targets for the percentage of Poor NHS bridges. However, the percentage of NHS bridges in Poor condition could increase as explained in the Investment Strategy chapter. That chapter discusses how bridge conditions are forecasted to deteriorate for several years before improving again under the most likely investment strategy shown in Scenario 1. Also, the chapter on Summary Condition of Assets discusses the trend of bridge conditions over the past 20 years.

2.5 Long-Term SOGR

Although States must set short-term targets for two and four years, the intent of asset management is to achieve and sustain a SOGR indefinitely. PRHTA defines its long-term SOGR as achieving and maintaining its bridge and pavement targets, as shown in Table 2-6, through 2032, the final year of this TAMP period. Table 2-6 also shows the long term desired SOGR.

Table 2-6: Long Term Targets

Performance Measure	Target (10 years)	Desired Long Term SOGR (10 years or more)
Interstate Pavements in Good Condition	25.0% or more	25.0% or more
Interstate Pavements in Poor Condition Poor	5.0% or less	5.0% or less
Non Interstate NHS Pavements in Good Condition	10.0% or more	10.0% or more
Non- Interstate NHS Pavements in Poor Condition	18.0% or less	10.0% or less
NHS Bridges in Good Condition	15% or more	15% or more
NHS Bridges in Poor Condition	10% or less	10.0% or less

The 10-year target shown in Table 2-6 is based on forecasted conditions as per the expected budget. As the priority is to achieve the Interstate targets, available resources will be directed towards that. As a result, NHS Non-Interstate will reflect an increase in the percentage of Poor, hence the conservative target. Once the Interstate targets are achieved by the end of the 10-year period, it is expected that they can be maintained with less investment. Therefore, more resources can be directed towards Non-Intestate NHS so their Poor percentage can decrease towards the desired SOGR.

Chapter 3. Asset Inventory and Conditions

Photo 3-1: Dos Hermanos Bridge Connecting Condado Urban Center with Islet of San Juan

The asset management regulation requires the TAMP to include a summary description of the condition of NHS pavements and bridges, regardless of ownership.[29] This description must include the condition of the bridges and pavements based upon the Federal bridge and pavement performance measures. Furthermore, the description should be informed by the 23 CFR Part 667 evaluation. That is an evaluation of locations damaged more than once since 1997 during officially declared emergency events such as hurricanes.

3.1 Puerto Rico Highway Network

This TAMP only addresses the National Highway System bridges and pavements. However, the rest of the Puerto Rico highway system influences how much PRHTA can invest in the NHS. Although Puerto Rico's NHS network is one of the smaller in the country, the remaining Non-NHS Puerto Rico highway network is disproportionately large. This is because many of the other States have "home rule" laws. That means that many of the small, but very important, local roads are maintained not by the State but by cities, counties, and townships. That is not the case in Puerto Rico. The Commonwealth in Puerto Rico manages most of the small local roads that provide the only access to many communities. Maintaining the Non-NHS roads influences how much PRHTA, and the Directory of Public Works (DPW) can invest in the NHS.

[29] 23 CFR 515.9(d)(3)

Table 3-1 puts the Puerto Rico highway network into context. Table 3-1 includes the 13 states that comprise the smallest quarter of State highway systems nationally. As seen, Puerto Rico has more vehicle miles of travel (VMT) than any other of the other smaller states. It has more State-managed centerline miles than much larger and more populous States such as New Jersey or Massachusetts. Its NHS system is, however, among the smallest nationally. Some of Puerto Rico's NHS conditions are relatively low compared to other States. However, Puerto Rico manages a relatively large Non-NHS highway network and one that has been subject to more natural disasters over the past decade than the other small states. Those factors influence how much PRHTA can invest in the NHS.

Table 3-1 Comparison of Traffic, Miles, and NHS Among Small States

State	VMT (millions)	State	Managed Mileage	State	NHS Lane Miles
Puerto Rico	**13,762**	Delaware	5,466	Nevada	8,115
Maine	13,086	Nevada	5,354	Idaho	7,300
Montana	12,104	Maryland	5,207	West Virginia	6,298
New Hampshire	11,956	Idaho	4,968	Connecticut	5,172
Wyoming	9,800	**Puerto Rico**	**4,564**	Alaska	4,915
South Dakota	9,743	New Hampshire	3,897	Maine	3,633
Hawaii	8,785	Connecticut	3,715	**Puerto Rico**	**3,099**
North Dakota	8,768	Massachusetts	2,997	New Hampshire	2,815
Delaware	8,345	Vermont	2,628	Vermont	2,170
Rhode Island	6,864	New Jersey	2,329	Rhode Island	1,856
Vermont	6,007	District of Columbia	1,372	Delaware	1,743
Alaska	5,306	Rhode Island	1,105	Hawaii	1,496
District of Columbia	3,030	Hawaii	949	District of Columbia	572

Sources: FHWA Statistics Tables and PRHTA roadway inventory

This TAMP includes the NHS pavements and bridges regardless of ownership. Table 3-2 shows a summary of Puerto Rico roads as per the Highway Performance Monitoring System (HPMS) and bridges as per the National Bridge Inventory (NBI).[30] Note that the length and lane miles include both pavements and bridges.

Table 3-2 Total Miles and Structures as per HPMS and NBI

Totals				
	Centerline Miles	**Lane Miles**	**Structures**	**Area (Sq. Mts.)**
NHS	799.6	3,099.3	834	1,553,811
Non-NHS	4,052	8,295.1	1,501	666,468
Total	**4,851.8**	**11,394.4**	**2,335**	**2,220,279**

Table 3-3 provides more detail about the Puerto Rico highway mileage. Table 3-3 illustrates that although PRHTA manages most of the HPMS detail inventory's highway mileage[30], management is divided among multiple entities. Those entities include toll concessionaires, cities, and even the Federal government. The total length of the network measured by centerline is 4,851.82 miles. When multiplied by the number of lanes, there are 11,394.42 total lane miles. The Interstates comprise 11.29 percent of the total lane miles, or 1,286.69. PRHTA manages 1,032.14 Interstate lane miles and Metropistas manages 254.55 lane miles. The Interstates are part of the NHS. The remaining NHS is referred to as the NHS Non-Interstate. There are 1,812.60 NHS Non-Interstate lane miles, of which PRHTA manages the large majority, or 1,751.43 lane miles. Metropistas manages 9.07 NHS Non-Interstate lane miles.

[30] Notes:

- The HPMS contains administrative and extent of system information on all public roads, while information on other characteristics is represented in HPMS as a mix of universe and sample data for arterial and collector functional systems.
- The June 8, 2022 Certified Public Miles Letter (CPML) includes 19,968 miles while the TAMP includes 4,852. The main difference is because the TAMP is based on the HPMS' detailed inventory of other characteristics, which includes 226 miles of municipal roads, while the certification includes all municipal roads, which totalizes 15,149 miles. Note that most municipal roads are Non-NHS, and the NHS ones are included in the detailed HPMS inventory.
- The June 8, 2022 CPML includes 4,792 miles of state roads while the TAMP includes 4,564 miles. The TAMP used the HPMS inventory version dated December 20, 2021, which was extensively reviewed, and quality checked. The HPMS list was updated later, version dated December 31, 2021, which was the one used for the CPML.

Table 3-3 Road Mileage and Management.

System	Manager	Length (Km)	Lane Kms.	Length (Mi)	% Length	Lane Miles	% Lane Miles
INTERSTATE	PRHTA	374.25	1,661.08	232.55	4.79%	1,032.14	9.06%
	Metropistas	83.15	409.66	51.67	1.06%	254.55	2.23%
	Autopistas de PR	0.00	0.00	0.00	0.00%	0.00	0.00%
	Municipal	0.00	0.00	0.00	0.00%	0.00	0.00%
	Federal	0.00	0.00	0.00	0.00%	0.00	0.00%
	Subtotal	**457.40**	**2,070.74**	**284.21**	**5.86%**	**1,286.69**	**11.29%**
NHS NON-INTERSTATE	PRHTA	799.93	2,818.67	497.05	10.24%	1,751.43	15.37%
	Metropistas	3.65	14.60	2.27	0.05%	9.07	0.08%
	Autopistas de PR	2.40	9.60	1.49	0.03%	5.97	0.05%
	Municipal	13.40	46.84	8.33	0.17%	29.10	0.26%
	Federal	10.10	27.40	6.28	0.13%	17.03	0.15%
	Subtotal	**829.48**	**2,917.11**	**515.41**	**10.62%**	**1,812.60**	**15.91%**
NON-NHS	PRHTA	6,170.45	12,495.17	3,834.13	79.02%	7,764.11	68.14%
	Metropistas	0.00	0.00	0.00	0.00%	0.00	0.00%
	Autopistas de PR	0.00	0.00	0.00	0.00%	0.00	0.00%
	Municipal	350.95	854.59	218.07	4.49%	531.02	4.66%
	Federal	0.00	0.00	0.00	0.00%	0.00	0.00%
	Subtotal	**6,521.40**	**13,349.76**	**4,052.19**	**83.52%**	**8,295.13**	**72.80%**
TOTAL	PRHTA	7,344.63	16,974.92	4,563.73	94.06%	10,547.69	92.57%
	Metropistas	86.80	424.26	53.93	1.11%	263.62	2.31%
	Autopistas de PR	2.40	9.60	1.49	0.03%	5.97	0.05%
	Municipal	364.35	901.43	226.39	4.67%	560.12	4.92%
	Federal	10.10	27.40	6.28	0.13%	17.03	0.15%
	Total	**7,808.28**	**18,337.61**	**4,851.82**	**100.00%**	**11,394.42**	**100.00%**

Table 3-4 summarizes the number of Puerto Rico bridges and their area. The area is a bridge's deck length multiplied by its width. Management of the bridges is primarily by PRHTA, but the toll concessionaires have responsibility for managing the bridges on their tolled routes.

Table 3-4 Bridge Numbers, Ownership, and Area

System	Manager	Number	Deck Area (Sq. Mts.)	% Number	% Area
NHS	PRHTA	722	1,174,493	31%	53%
	Metropistas	111	325,204	5%	15%
	Autopistas de PR	1	54,114	0%	2%
	Federal	0	0	0%	0%
	Subtotal	**834**	**1,553,811**	**36%**	**70%**
NON-NHS	PRHTA	1,478	645,722	63%	29%
	Metropistas	15	19,963	1%	1%
	Autopistas de PR	0	0	0%	0%
	Federal	8	782	0%	0%
	Subtotal	**1,501**	**666,468**	**64%**	**30%**
TOTAL	PRHTA	2,200	1,820,215	94%	82%
	Metropistas	126	345,168	5%	16%
	Autopistas de PR	1	54,114	0%	2%
	Federal	8	782	0%	0%
	Total	**2,335**	**2,220,279**	**100%**	**100%**

Figure 3-1 illustrates the roadway lengths and lane miles by functional classification. As mentioned earlier, the lower functional classifications such as Local or Collector comprise a large portion of the Puerto Rico highway network. Those routes are critical for access to communities even though they carry a small percentage of the total Puerto Rico traffic.

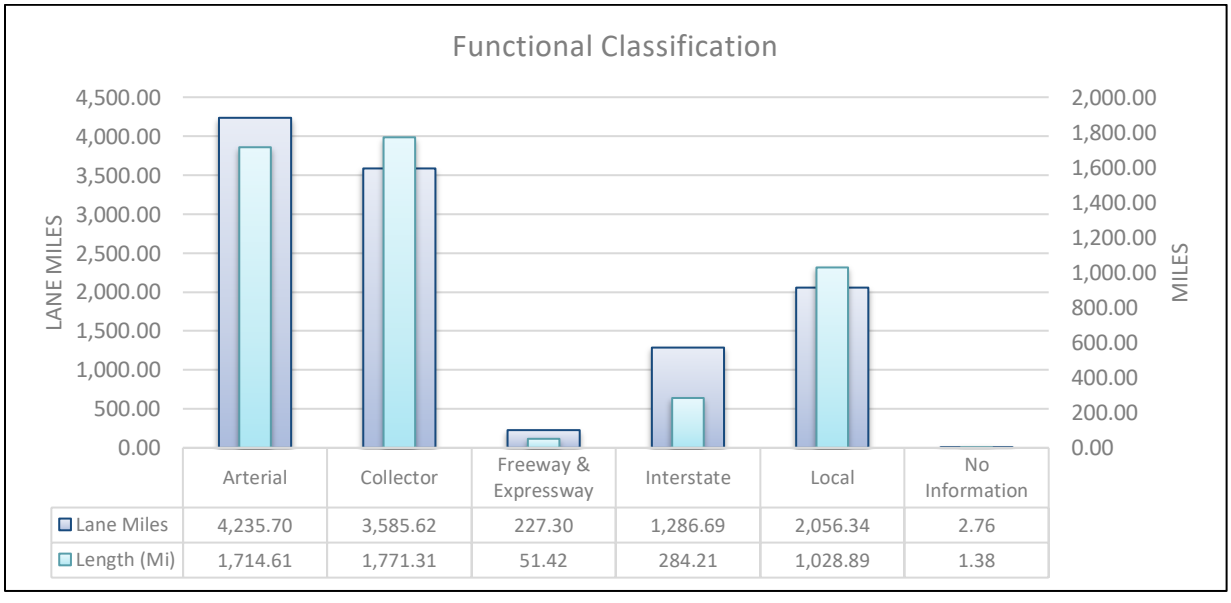


Figure 3-1 Length and Lane Miles by Functional Classification

The most heavily travelled[31] routes are the Interstates which are shown in Figure 3-2.

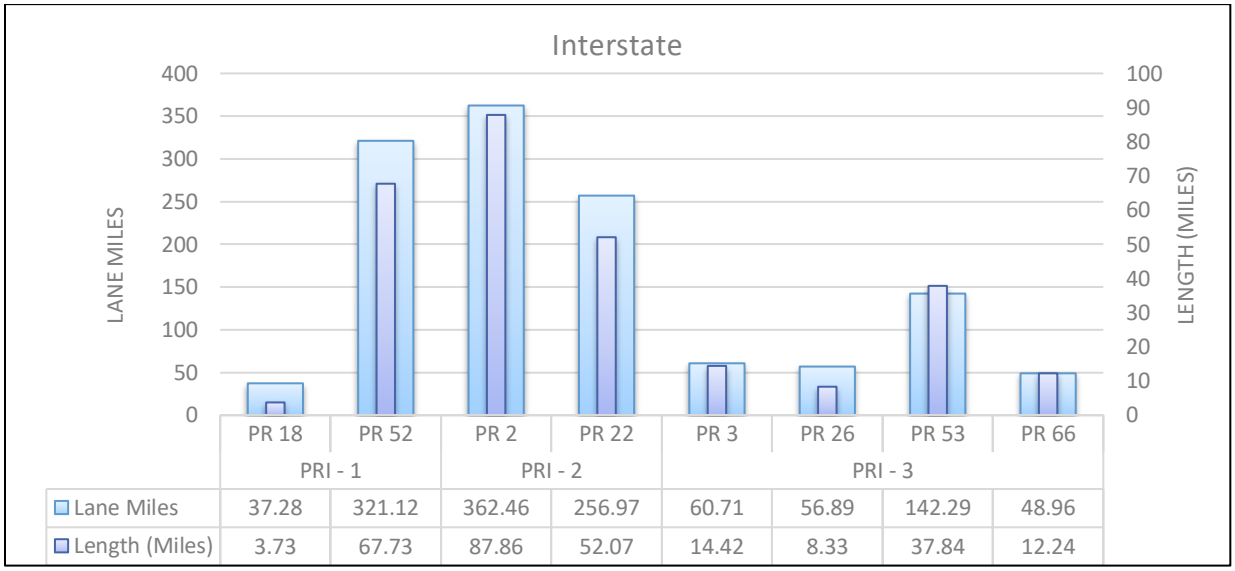


Figure 3-2 The Puerto Rico Interstates, Their Length and Lane Miles

Toll roads are an important part of the Puerto Rico highway system. They and the bridges on them are managed by PRHTA and two concessionaires. Autopistas Metropolitanas de Puerto Rico (Metropistas) manages parts of PR-22 and PR-5. Autopistas de Puerto Rico manages the Teodoro Moscoso Bridge that crosses the San Jose Lagoon on PR-17. Table 3-5 summarizes the toll road miles and management.

Table 3-5 Puerto Rico Toll Roads

Manager	Road	Length (Miles)	Lane Miles	Accounted	System
PRHTA	PR 5	2.21	12.15	Between PR-22 (PR-5 Km. 4.1) and PR-2 (PR-5 Km. 7.65)	NHS
	PR 20	5.97	28.46	Entire road	NHS
	PR 22	0.40	2.42	From start to Km. 0.65	Interstate
	PR 52	67.73	321.12	Entire road	Interstate
	PR 53	37.84	142.29	Entire road	Interstate
	PR 66	12.24	48.96	Entire road	Interstate
	Subtotal	**126.39**	**555.41**		
Metropistas	PR 5	2.27	9.07	Between PR-2 (PR-5 Km. 7.65) and PR-199 (PR-5 Km. 11.3)	NHS
	PR 22	51.67	254.55	From Km. 0.65 to end (Km. 83.8)	Interstate
	Subtotal	**53.93**	**263.62**		
Autopistas de PR	PR-17	1.49	5.97	Between Kms. 9.1 and 11.5	NHS
Total		**181.81**	**825.00**		

[31] As per the HPMS, about 236 of Interstate lane miles (18%) carry an Annual Average Daily Traffic between 100,000 and 261,400 vehicles per day.

3.2 Pavements

Table 3-6 shows the final amount of measured NHS pavement lane miles without the bridges. The length without bridges is significant because that is the length upon which Federal pavement performance is measured. Each two years PRHTA and other States must provide to FHWA explanations about whether or not they are achieving their pavement and bridge condition targets. The percentage of Good, Fair, and Poor Interstate and NHS Non-Interstate pavement is based upon the mainline NHS routes with the bridge lengths excluded. Not included in the calculation are ramps or auxiliary lanes.

Table 3-6 Pavement Lane Miles Without Bridge Lengths

System	Lane Miles
Interstate	1,215.06
NHS Non-Interstate	1,673.58
Total	**2,888.65**

3.2.1 Pavement Data Collection and Submission Process

Pavement data is collected in accordance with PRHTA's Data Quality Management Program (DQMP) that complies with 23 CFR 490.319. Elements of the DQMP include:

1. Methods for data collection equipment calibration and certification
2. Certification process for persons performing manual data collection
3. Data quality control measures to be conducted before data collection begins and periodically during the data collection program
4. Data sampling, review, and checking processes
5. Error resolution procedures and data acceptance criteria

Pavement condition data was procured by the PRHTA through a service contract with Pathway. A PathRunner vehicle as the one shown in Photo 3-2 was used. The equipment includes sophisticated lasers, high-speed cameras, and motion detectors. The equipment measures the amount of cracking, the degree of roughness, and the depth of rutting or faulting.

Photo 3-2 Pavement Data Collection Equipment

In compliance with Federal regulation, Interstate pavement data is collected and reported to FHWA annually. Data is collected biennially on the Non-NHS highway network.

3.2.2 NHS Pavement Condition and Characterization

Table 3-7 shows the condition of the Puerto Rico pavements by system. Though FHWA requires pavement conditions to be reported only by the categories of Good, Fair, and Poor, PRHTA breaks them down into two additional categories. The Fair category is divided into Fair-to-Good, Fair-Fair, and Fair-to-Poor. This subdivision helps identify treatments and prioritization. Table 3-7 includes only the mainline pavements and not ramps or auxiliary lanes. Also, data collection is made on the rightmost mainline, generally in the direction where the kilometers increase, and then is extrapolated to all lanes in the mainline segment, including both directions.

Table 3-7 Pavement Conditions by Lane Miles and System

Condition	Lane Miles		
	Interstate (INT)	NHS Non-Interstate (NHS)	Total
Good (G)	234.20	67.19	301.39
Fair-to-Good (F1)	312.76	212.75	525.51
Fair-Fair (F2)	413.09	969.46	1,382.55
Fair-to-Poor (F3)	132.65	196.32	328.97
Poor (P)	109.09	129.74	238.83
Incomplete Data (I)	13.27	98.12	111.39
Total	**1,215.06**	**1,673.58**	**2,888.65**

Figure 3-3 shows the Interstate and NHS Non-Interstate conditions as measured by the Federal pavement performance measures. Figure 3-3 and all other pavement condition charts used in this section refer to conditions as measured by the Federal performance measures in 23 CFR Part 490.

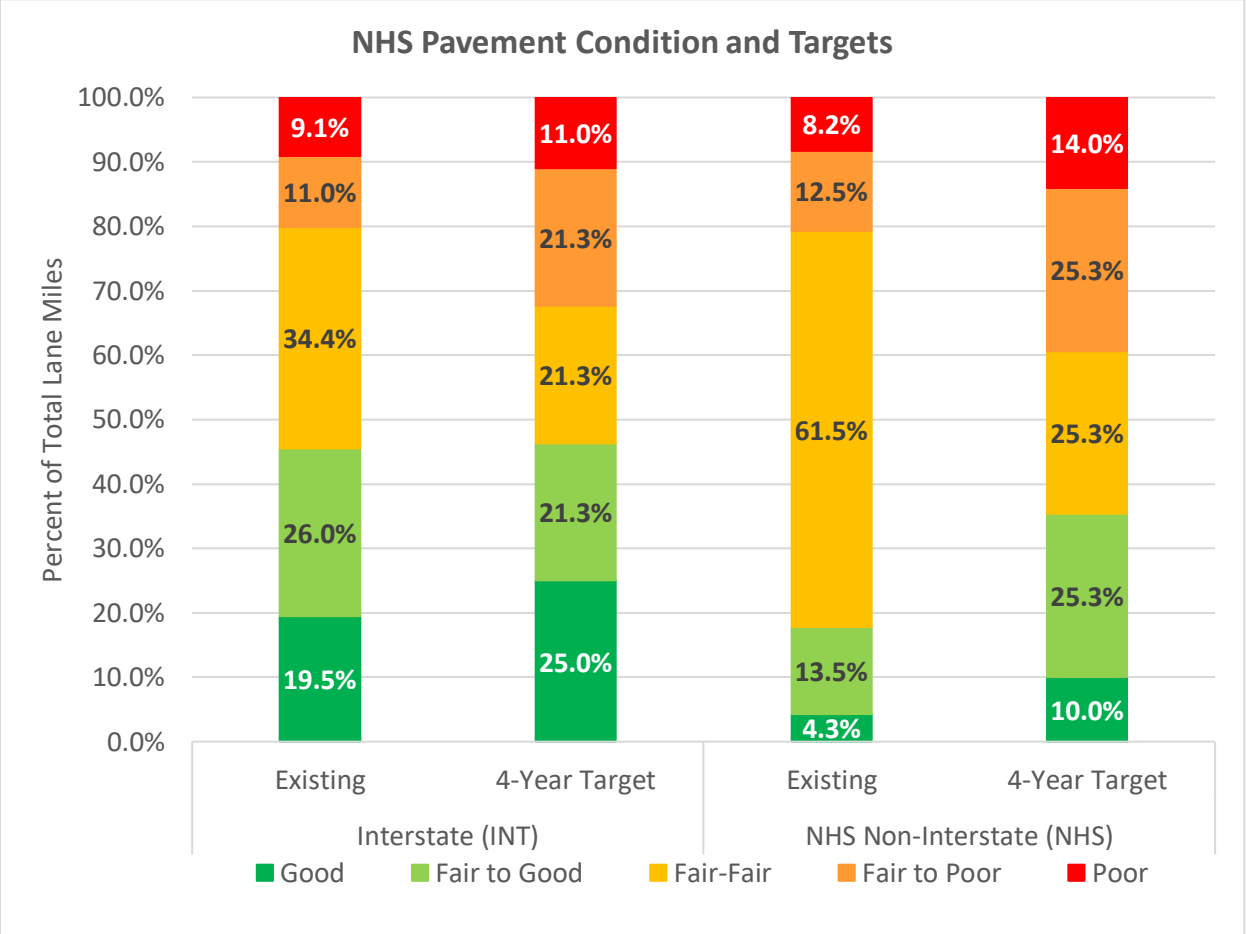


Figure 3-3 Pavement Conditions and Targets on the Interstates and NHS Non-Interstate

As seen in Figure 3-3, 9.1 percent of the Interstate pavement is Poor. Because the amount exceeds the Federal allowable minimum, PRHTA operates under a penalty. It must continue investing in Interstate pavement projects a certain percentage of its Federal funds until it achieves the no-more-than 5 percent Poor Interstate pavement condition level. A discussion of conditions compared to targets is in the Gap Analysis chapter.

Figure 3-4 illustrates the Interstate and NHS Non-Interstate pavement surface type or material. Most pavements are asphalt. The greatest proportion of concrete pavements are in the Interstate system.

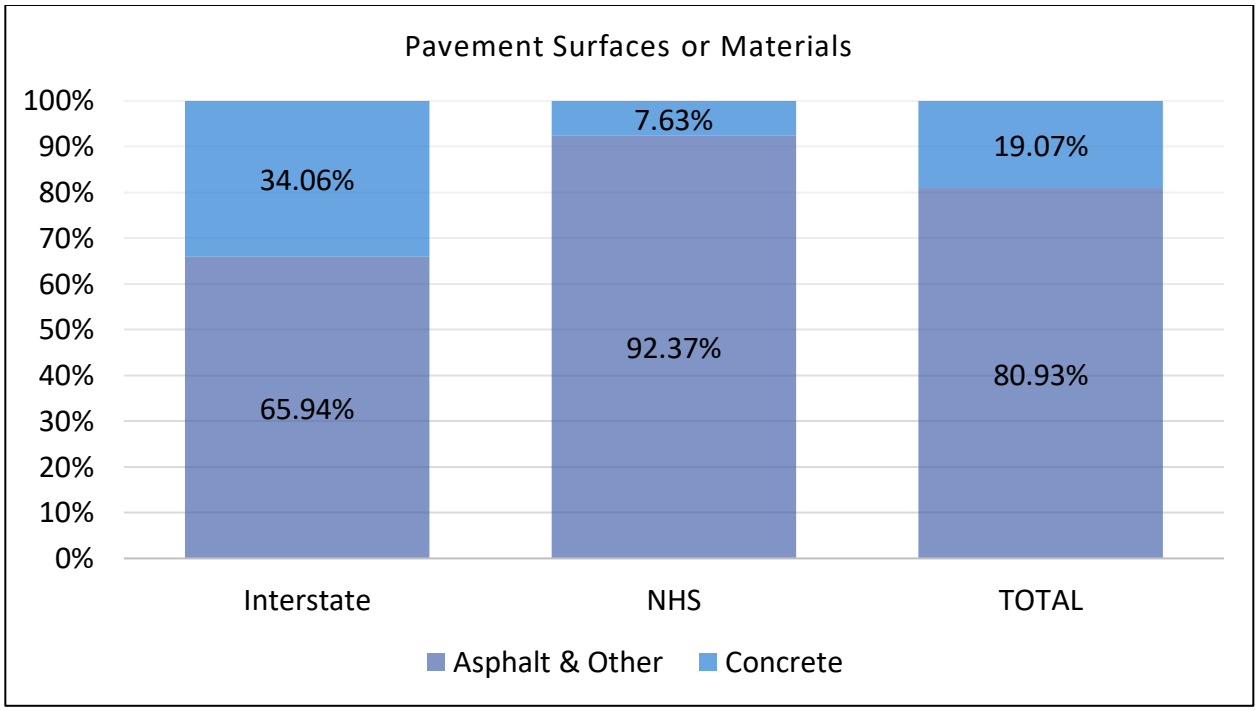


Figure 3-4 Interstate and NHS Non-Interstate Pavements by Material

Figure 3-5 shows the number of lane miles by condition state for the Interstate and NHS Non-Interstate asphalt pavements. Figure 3-6 shows similar data for the concrete Interstate and Non-Interstate pavements. Note that there were some data points that did not have the surface type, hence, not included here.

Seen in Figure 3-5, of the asphalt Interstate lane miles, 16.92 lane miles are Poor. For the concrete Interstate pavements, 92.17 lane miles are Poor as shown in Figure 3-6. Improving the Poor Interstate concrete pavements is an important part of PRHTA's strategy for achieving its Interstate pavement conditions.

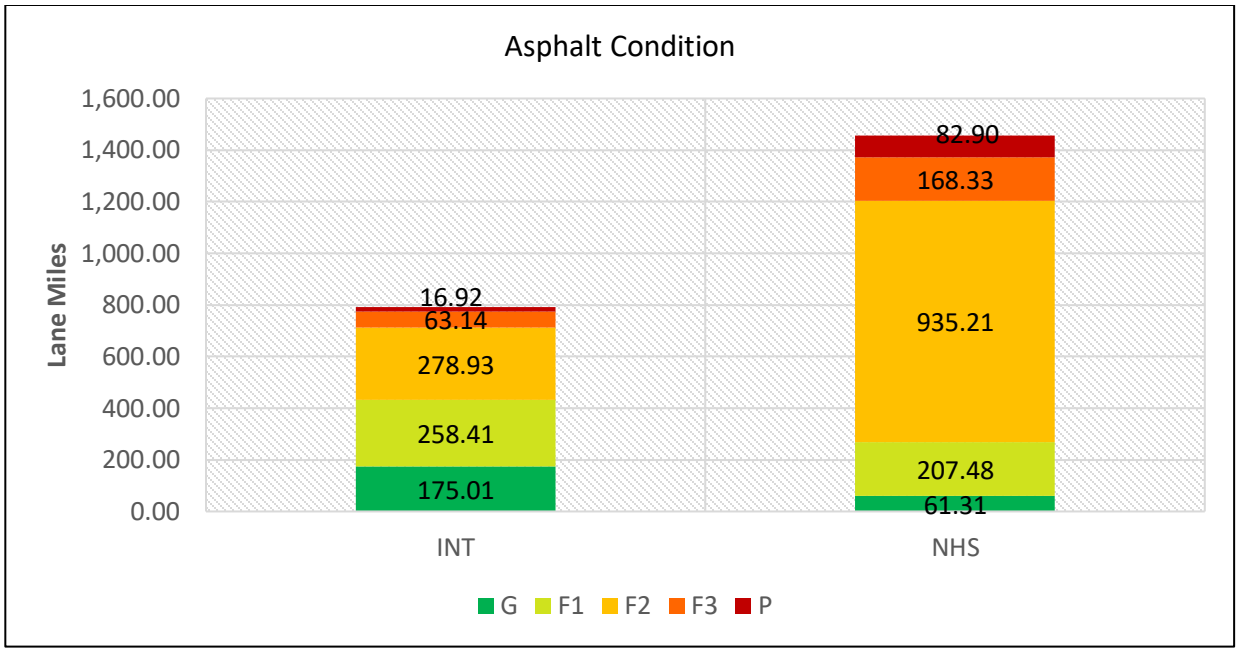


Figure 3-5 Lane Miles of Asphalt Pavement by Condition State, Interstate and NHS

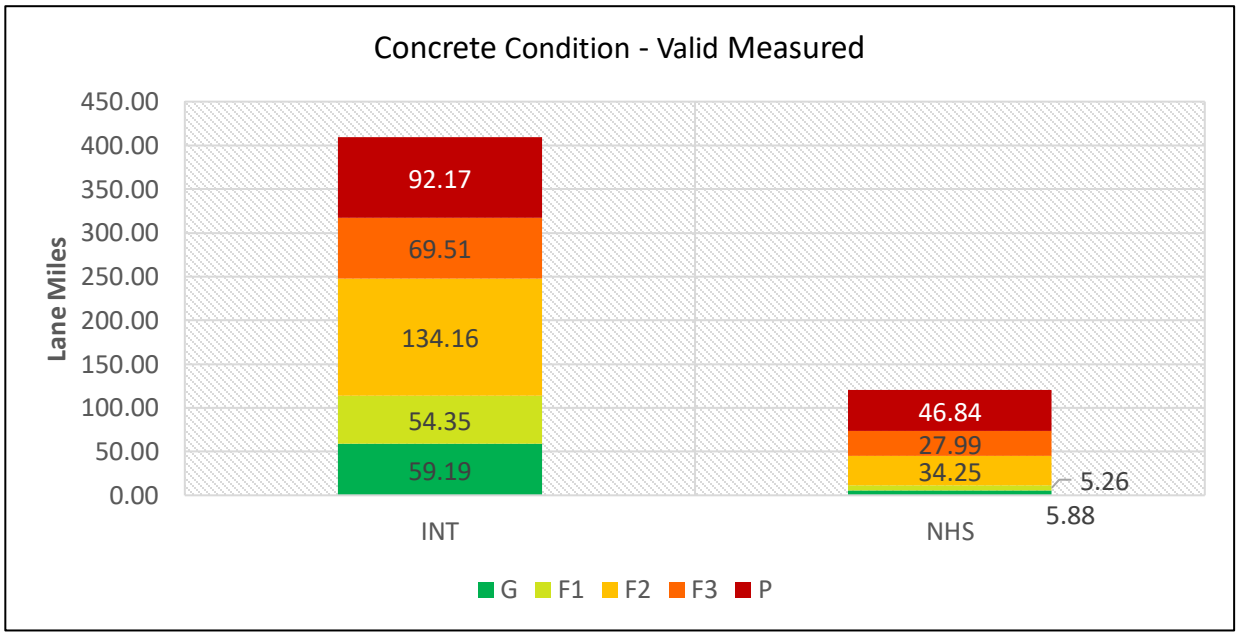


Figure 3-6 Lane Miles of Concrete Pavement by Condition State, Interstate and NHS

Figure 3-7 illustrates the lane miles by condition for each of the Puerto Rico Interstates. About 109 Interstate lane miles are rated Poor. The largest amount, 38.04, was on PR-52 according to the 2021 pavement condition data. However, the proposed 2023-2026 Statewide Transportation Improvement Program includes several projects that will improve almost 76 lane miles of PR-52 pavement. Almost 88 lane miles of pavement projects are programed for PR-2 and 42 lane miles on PR-52. When those projects are delivered, PRHTA will continue to make progress in reducing Poor Interstate lane miles.

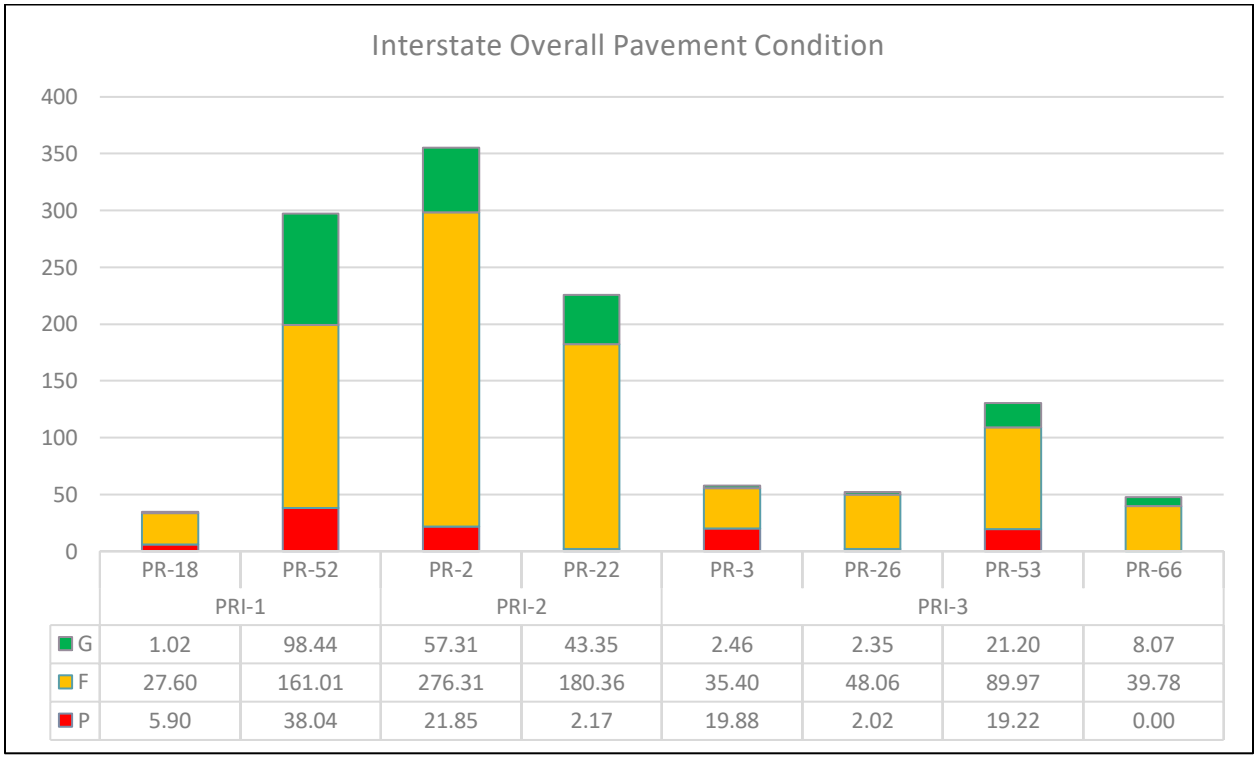


Figure 3-7 Lane Miles by Condition State for Puerto Rico Interstates

The need to focus on Interstate concrete pavement pavements is also highlighted by Figure 3-8. It shows the lane miles by condition for the concrete pavements on the Interstates. As seen, substantial numbers of Poor concrete lane miles are on PR-52, PR-53, PR-3, and PR-2. Those are in contrast to the fewer lane miles of Poor asphalt pavement seen in Figure 3-9.

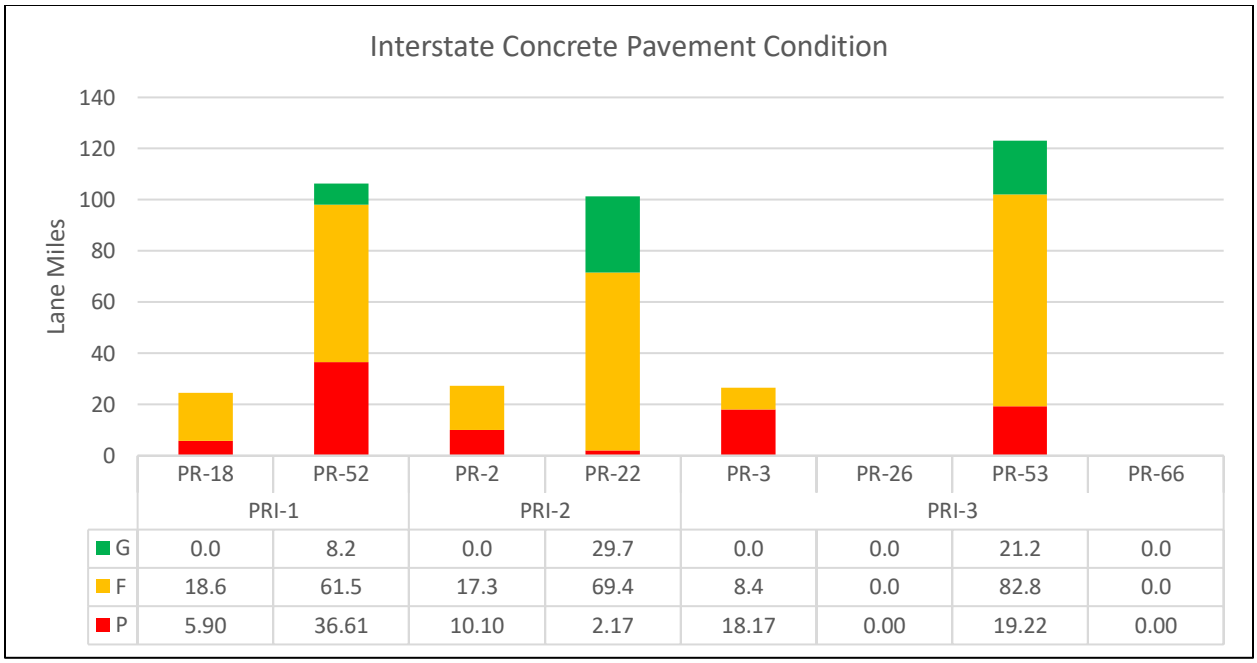


Figure 3-8 Lane Miles of Concrete Pavement by Condition State on the Interstates

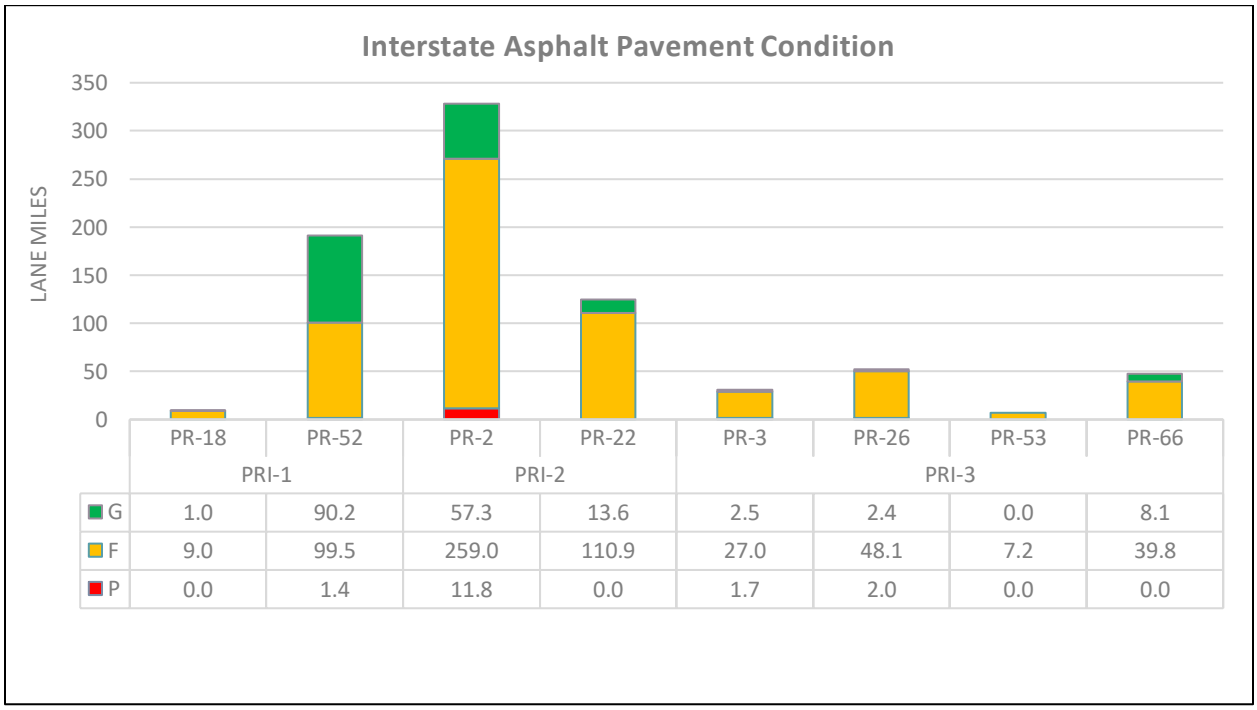


Figure 3-9 Lane Miles of Asphalt Pavement by Condition State on the Interstates

3.2.3 Pavement Condition Trends

Figure 3-10 and Figure 3-11 show the steady progress made in improving Puerto Rico's Interstate and NHS Non-Interstate conditions, respectively. Although PRHTA has not reached no more than 5 percent Poor Interstate, it is showing a declining Poor percentage and an increasing Good percentage. These improvements came despite three hurricanes and several earthquakes since 2017. Figure 3-11 also shows a trend of declining Poor and increasing Good pavement on the NHS Non-Interstate.

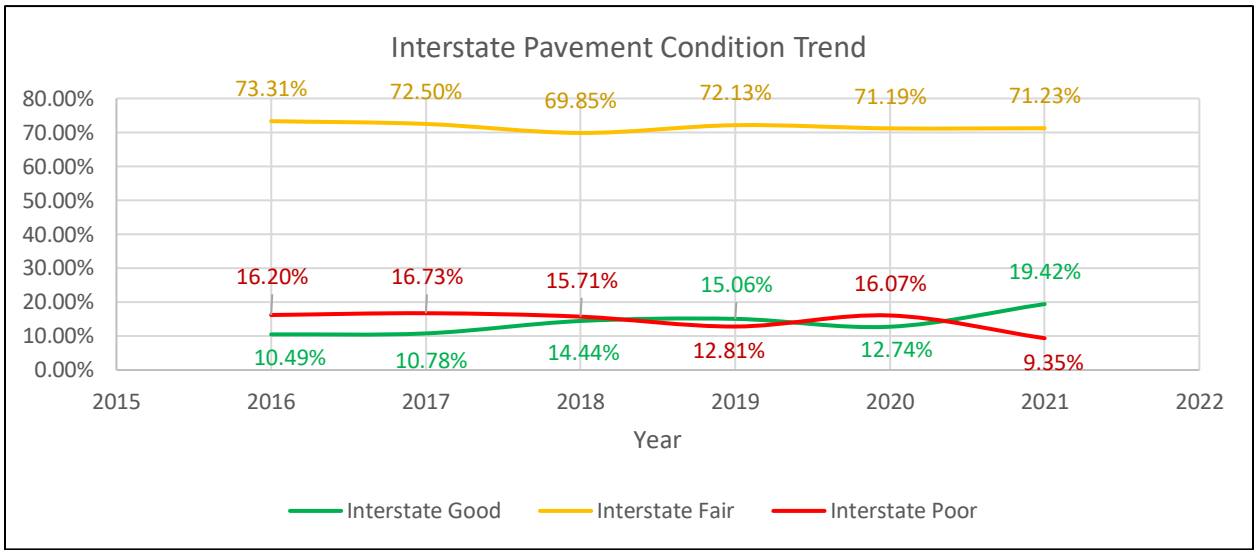


Figure 3-10: Interstate Pavement Condition Trend

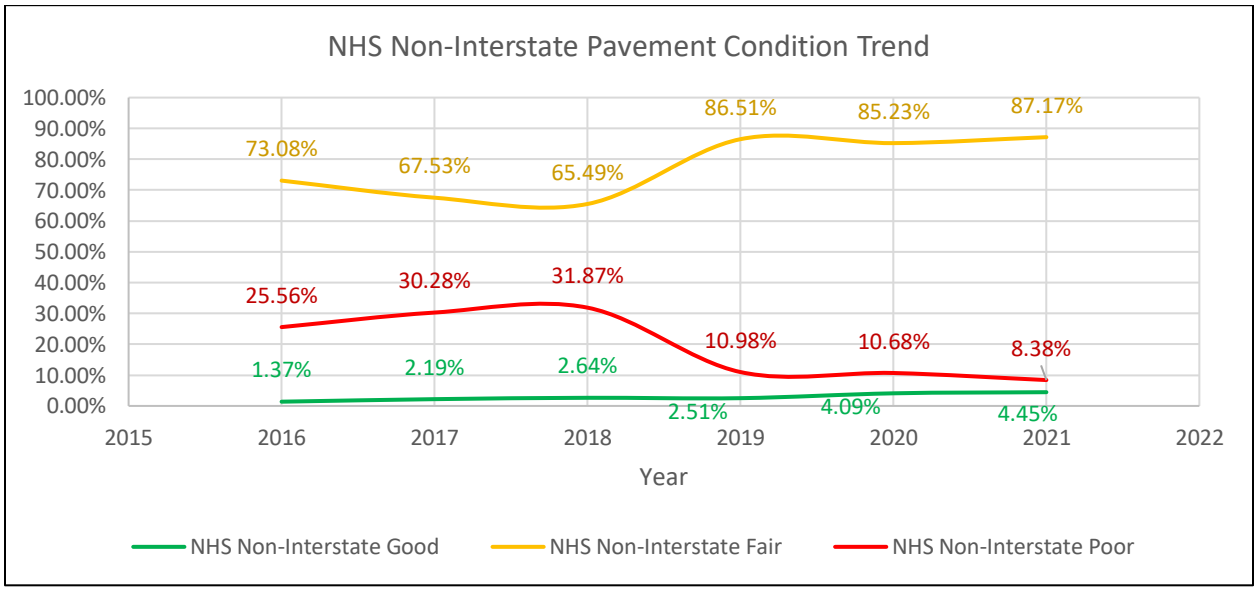


Figure 3-11: NHS Non-Interstate Pavement Condition Trend

3.3 Bridges

3.3.1 Bridge Data Collection and Submission Process

The data for this analysis comes from the National Bridge Inventory (NBI) published by FHWA. These data are the best available and result from PRHTA's compliance with the Federal National Bridge Inspection Standards. PRHTA uploaded the bridge data to FHWA in March of 2022 based upon inspections completed in 2021. PRHTA hires trained professional engineers and technicians to inspect each bridge at least once every two years to gather information for the NBIS. They collect about 200 pieces of information about each bridge according to the national inspection standards. Each inspector is formally trained, certified, and must undergo periodic refresher training. The inspectors collect data at the very detailed "element" level and at the more general "component" level. Photo 3-3 shows some pictures taken from the Bridge Inspection Reports.

Photo 3-3: Pictures from PRHTA Bridge Inspections

This TAMP reports conditions at the component level. The three bridge components are the deck, superstructure, and substructure (see Figure 3-12). The deck is the component that directly carries the traffic. The superstructure supports the deck and provides connection between substructure elements. The substructure supports the superstructure and distributes the bridge loads to the bridge footings. In addition, culverts, pipes, or small structures used for drainage, which are over 20 feet in length are also included in the NBI data. Smaller culverts are not. PRHTA inspects each bridge at least biennially.

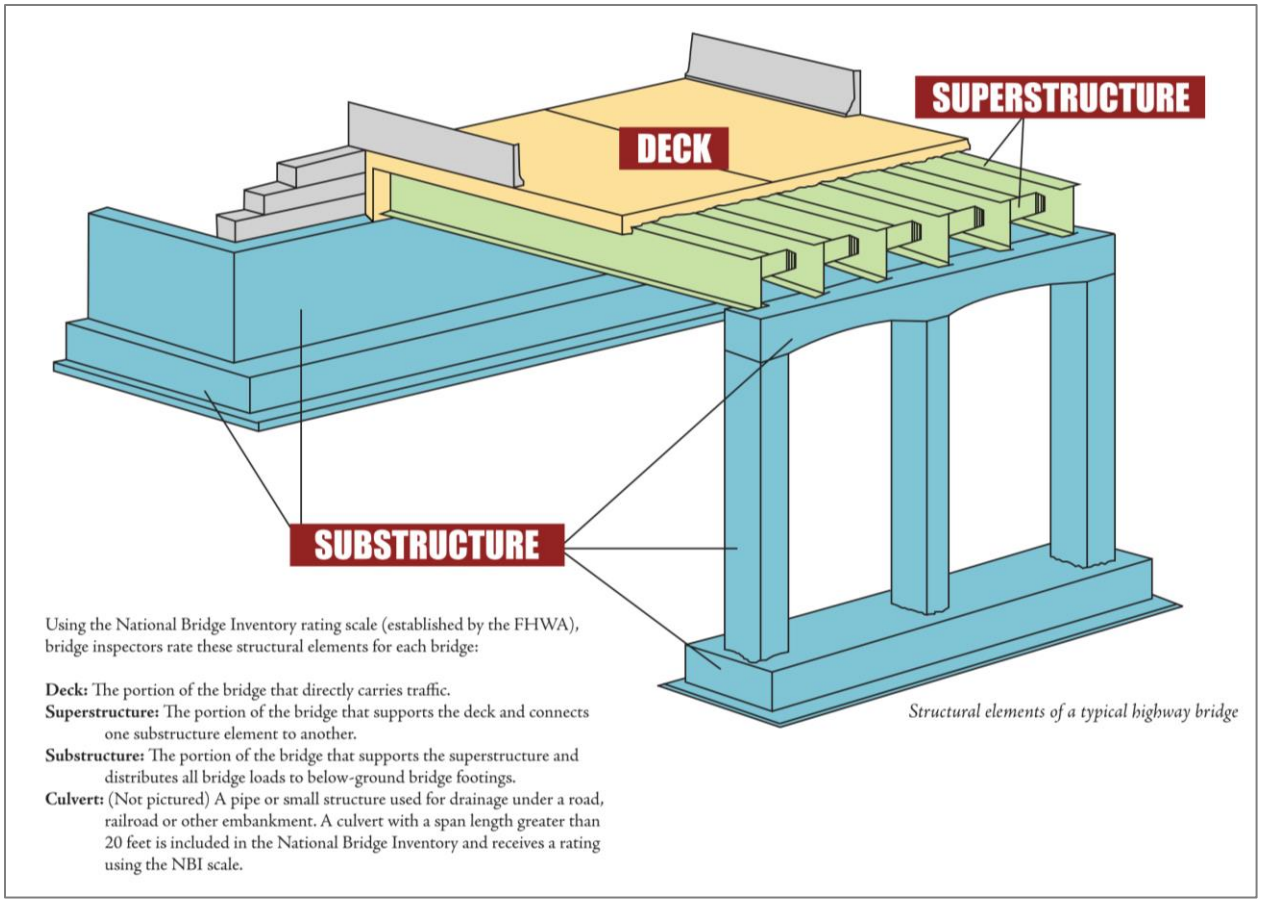


Figure from https://www.ncdot.gov/initiatives-policies/Transportation/bridges/Documents/elementsdiagram.pdf.

Figure 3-12: Bridge Components

3.3.2 NHS Bridge Condition and Characterization

Table 3-8 shows the number of bridges and deck area per condition. Most of the deck area is in Fair-to-Poor and Fair-to-Good condition.

Table 3-8: NHS Bridges and Deck Area per Condition

Condition	Number of Bridges	Deck Area (Sq. Mts.)
Good	151	251,364.5
Fair to Good	294	570,568.9
Fair to Poor	317	610,526.9
Poor	72	121,351.0
Total	**834**	**1,553,811.4**

Figure 3-13 shows the current NHS bridges condition compared to the targets. Currently, targets for Good and Poor condition are achieved and surpassed. However, the most realistic investment strategies forecast deteriorating bridge conditions. As a result, PRHTA adopted declining 2-year and 4-year targets as explained in the Gap Analysis and Investment Strategy chapters.

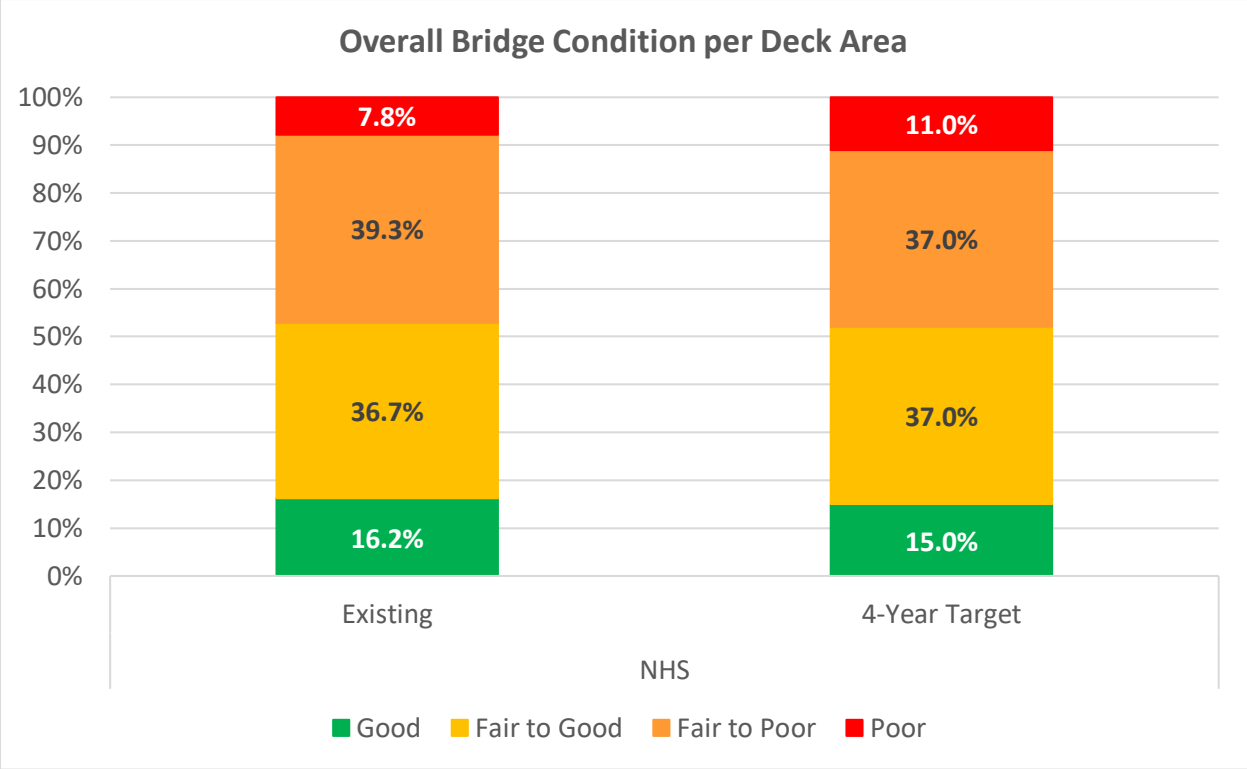


Figure 3-13: Bridge Condition and Targets on the NHS

Table 3-9 summarizes the number of NHS NBIS structures by type, average condition, and age. Puerto Rico has a total of 834 NHS NBIS structures, of which 81 are culverts over 20 feet long. Smaller culverts are not included in the NBIS inventory. Table 3-9 shows that the stringer/girder type of bridge is by far the most common.

As seen in Table 3-9, the average bridge has a built year of 1981 and has an average condition rating of 5.62. That is out of the 0-9 NBIS rating. Bridges rated as 9, 8, or 7 are Good. Those rated 6 and 5 are Fair. Ones rated 4 or less are Poor. A bridge's rating is based on the lowest rating of the three components' condition. For example, if only the deck is rated Poor, the entire structure is rated Poor. If one component is Fair and two are Good, the bridge is rated as Fair. For a bridge to be rated as Good, all three components must be rated as Good.

Table 3-9 Number, Area, Type, and Age of Puerto Rico Bridges

Row Labels	Number	Area	Lowest Rating Average	% of All Deck Area	Average Year Built
Stringer Girder	563	1,298,300	5.57	83.56%	1984
Culvert	81	35,517	6.36	2.29%	1980
Tee Beam	68	73,125	5.04	4.71%	1966
Slab	48	27,447	5.33	1.77%	1964
Multiple Box Beam	31	28,239	6.16	1.82%	1992
Frame	23	11,487	5.57	0.74%	1965
Girder Floor Beam	13	38,965	5.62	2.51%	1986
Single Box Beam	4	21,418	6.25	1.38%	1992
Seg. Box Girder	2	19,182	7.50	1.23%	2002
Arch Deck	1	131	5.00	0.01%	1924
Grand Total	**834**	**1,553,811**	**5.62**	**100.00%**	**1981**

Table 3-10 summarizes the NHS structures by number, area, and condition. For all NHS bridges and culverts measured by area, 7.81 percent are Poor, 76.01 percent Fair, and 16.18 percent Good. The Non-NHS has a higher percentage of both Good and Poor bridge area.

A total of 39.3 percent of the NHS bridge deck area is in condition state 5. That high percentage of Fair-to-Poor bridges will complicate PRHTA efforts to keep its NHS bridges meeting target and avoiding the 10 percent minimum allowable condition. As those structures age, they will require rehabilitation to avoid falling to Poor condition (rating 4). For the NHS, only 16.18 percent of the bridge area is rated as Good. The 16.2 percent Good, almost half of the National average for the NHS of 35.6 percent of NHS bridge area rated as Good.

Table 3-10: NHS Bridge and Culvert Conditions Detail

NHS Bridges and Culverts by Number, Area, Conditions											
Condition State	Bridge Count	Bridge Area	%	Culvert Count	Culvert Area	%	Total Area	Total %	Total Count	Condition Summary	
9	0	0	0.0%	0	0	0.0%	0	0.0%	0	Good	16.18%
8	13	34,765	2.3%	4	4,189	11.8%	38,953	2.5%	17		
7	96	193,546	12.7%	38	18,865	53.1%	212,411	13.7%	134		
6	268	563,155	37.1%	26	7,414	20.9%	570,569	36.7%	294	Fair	76.01%
5	306	605,933	39.9%	11	4,594	12.9%	610,527	39.3%	317		
4	58	102,721	6.8%	1	335	0.9%	103,056	6.6%	59	Poor	7.81%
3	9	16,381	1.1%	0	0	0.0%	16,381	1.1%	9		
2	0	0	0.0%	1	119	0.3%	119	0.0%	1		
1	0	0	0.0%	0	0	0.0%	0	0.0%	0		
0	3	1,794	0.1%	0	0	0.0%	1,794	0.1%	3		
Total	753	1,518,295	100.0%	81	35,517	100.0%	1,553,811	100.0%	834		100.0%

Figure 3-14 shows the condition by component. Most of the superstructures are in Good condition while most of the decks are in Fair-to-Poor condition. Since overall bridge condition is subject to the lowest condition among the three components, focusing on rehabilitating decks may significantly improve the overall bridge condition and avoid an increase in Poor condition.

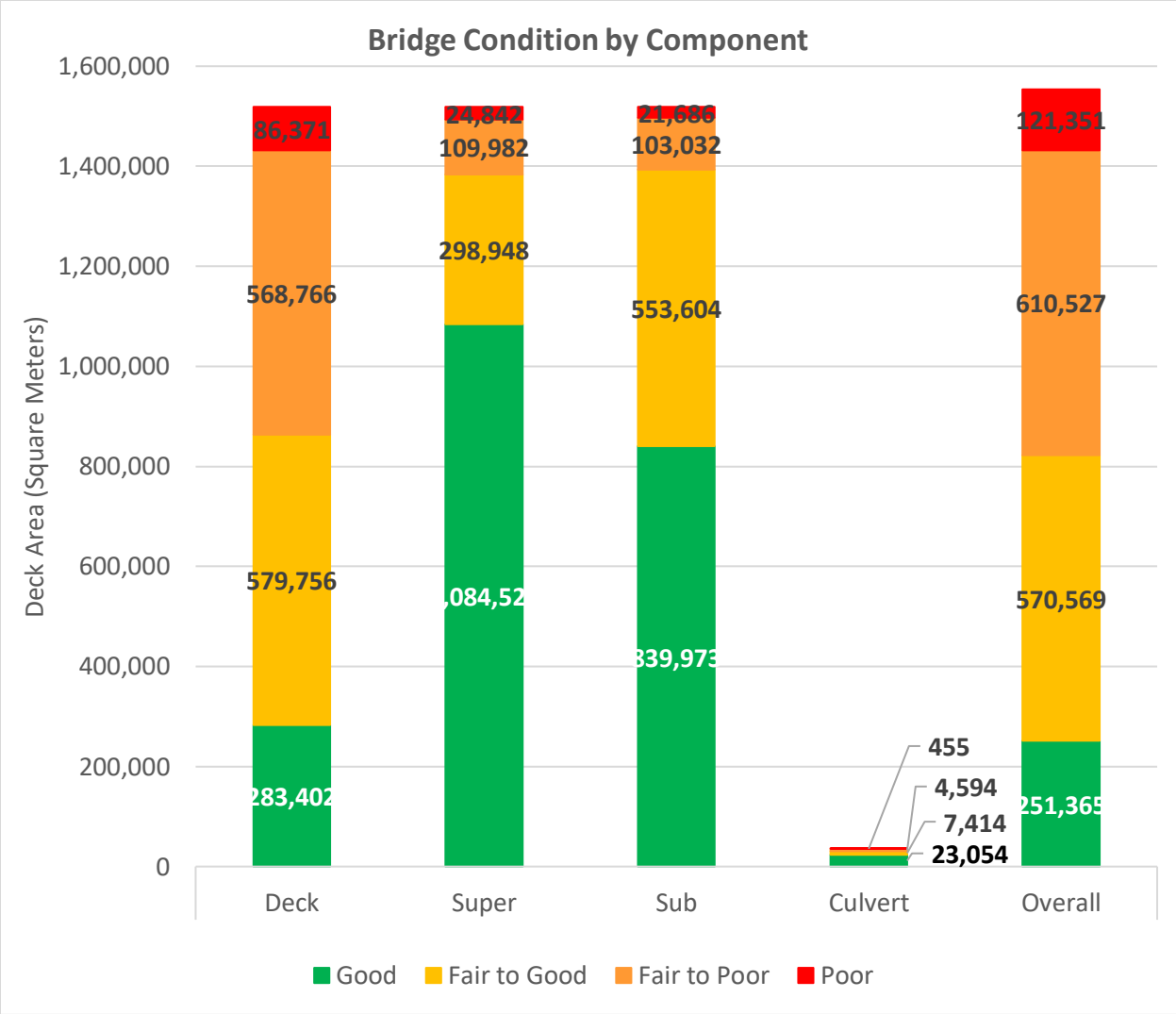
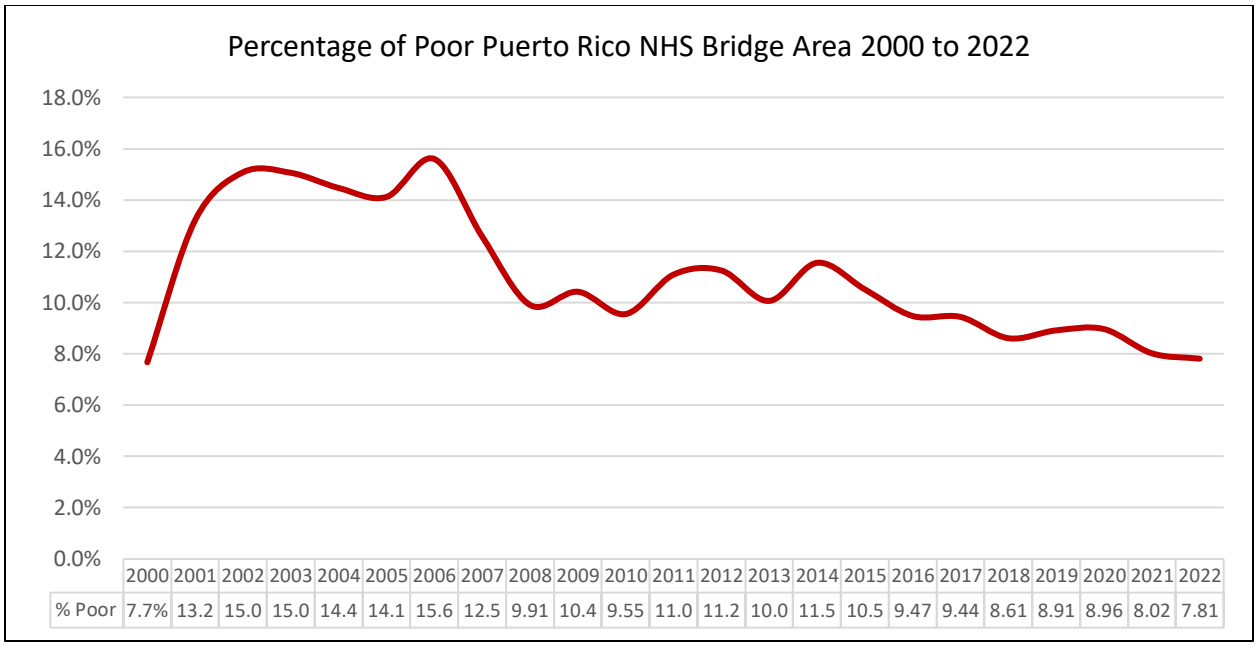


Figure 3-14: NHS Bridge Condition by Component

3.3.3 Bridge Condition Trends

The long-term picture of PRHTA bridges is mixed. One the one hand, PRHTA has steadily reduced the number of Poor NHS bridges by focusing on the critical bridges as seen in Figure 3-15. Note that the years in Figure 3-15 identify the year where the data was published on the FHWA website, but they correspond to the previous year data; hence, labeled 2022 means 2021 data and so on. The percentage of Poor NHS bridge area peaked at 15 percent in 2003. Since then, it has fallen more or less regularly. By 2022, the percentage of Poor NHS bridge area declined to 7.81 percent.

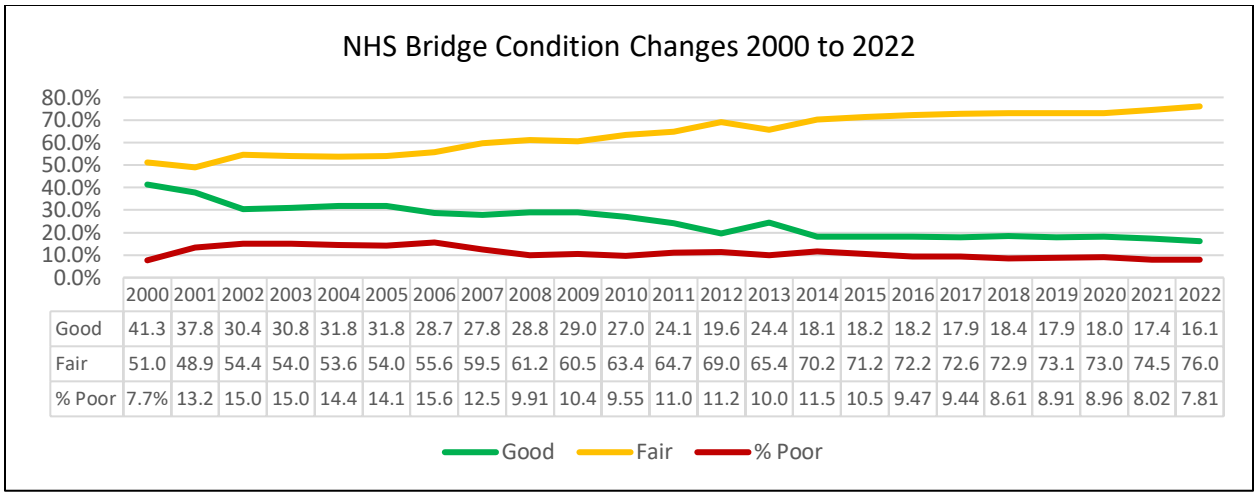


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
% Poor	7.7%	13.2	15.0	15.0	14.4	14.1	15.6	12.5	9.91	10.4	9.55	11.0	11.2	10.0	11.5	10.5	9.47	9.44	8.61	8.91	8.96	8.02	7.81

The years in the chart mean the year where the data was published on the FHWA website, but they correspond to the previous year's data; hence, 2022 means 2021 data and so on.

Figure 3-15: Change over Time in Percentage NHS Poor Bridge Area

However, as Figure 3-16 indicates, while the percentage of Poor deck area declined so did the percentage in Good condition. Since 2000, the percentage of bridge deck area in condition states 6 and 5 steadily increased. The implication for that change is that the condition of the overall bridge inventory declined. More bridges declined into the Fair and Fair-to-Poor condition. This increase in Fair and Fair-to-Poor conditions probably reflects a lack of investment in the preservation of Good bridges and rehabilitation of Fair ones. PRHTA since 2019 has reversed that long-term trend and is now focusing on preservation and rehabilitation. The STIP adopted in 2019 and amended in 2022 includes dozens of bridge projects focusing on preservation and rehabilitation to reduce the trends seen in Figure 3-16.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Good	41.3	37.8	30.4	30.8	31.8	31.8	28.7	27.8	28.8	29.0	27.0	24.1	19.6	24.4	18.1	18.2	18.2	17.9	18.4	17.9	18.0	17.4	16.1
Fair	51.0	48.9	54.4	54.0	53.6	54.0	55.6	59.5	61.2	60.5	63.4	64.7	69.0	65.4	70.2	71.2	72.2	72.6	72.9	73.1	73.0	74.5	76.0
% Poor	7.7%	13.2	15.0	15.0	14.4	14.1	15.6	12.5	9.91	10.4	9.55	11.0	11.2	10.0	11.5	10.5	9.47	9.44	8.61	8.91	8.96	8.02	7.81

The years in the chart mean the year where the data was published on the FHWA website, but they correspond to the previous year's data; hence, 2022 means 2021 data and so on.

Figure 3-16: Change in NHS Bridge Conditions

Further analysis of the long-term change in PRHTA bridge conditions indicates that the increase in bridges in condition states 6 and 5 are primarily because of declining deck conditions. When decks are not preserved, the stresses they are exposed to can deteriorate more quickly than substructures or superstructures. Decks are directly subject to the impacts of vehicles which can deteriorate their condition. The impacts of vehicles on the decks can be increased if the bridge expansion joints and bearings are not regularly maintained. They help absorb the impact of vehicles driving on the decks. Also, if the deck and the adjacent roadway are not horizontally aligned, the "bump" from a truck is increased as the truck moves from the pavement to the bridge. Also, if the concrete is not regularly sealed, water can infiltrate the concrete and create rust in the deck's reinforcing steel. These stresses can lead to increased deck deterioration. They also are the reason Good bridge management includes regular preservation and maintenance of decks, joints, bearings, and bridge drainage elements.

3.4 Linkage of Conditions to Strategies

When pavements and bridges are well maintained, they can remain in service for many years. However, their long-term condition depends upon the maintenance, preservation, and rehabilitation they receive. Managing assets for the lowest life-cycle cost requires a long-term perspective and long-term strategy for providing maintenance, preservation, and rehabilitation at the appropriate points in a bridge's life-cycle.

The trends seen in the tables and charts presented in this Chapter strongly influence PRHTA's life-cycle strategies, its risk analysis, its financial allocations, and its investment strategies. Each of those TAMP sections will discuss the strategies PRHTA has adopted to improve the overall condition of its bridges, achieve its targets, and sustain its assets in a SOGR.

Chapter 4. Performance Gap Identification and Analysis

Photo 4-1: PR-52 in Cayey

This chapter summarizes the performance gaps related to NHS bridges and pavements in Puerto Rico.

FHWA defines performance gap as the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.[32]

Additionally, State transportation departments are to have a process to identify deficiencies that hinder progress to achieving a SOGR. That process must address at least the following:

1. Gaps between bridge and pavement conditions and targets.
2. Gaps that affect performance, such as safety, travel speed or freight movement.
3. Alternative strategies to close the gaps.

[32] 23 CFR 515.5

4.1 Gap Analysis Process

PRHTA adopted a simple but effective annual process for conducting the performance gap analysis. This process includes the following steps.

1. The pavement and bridge conditions are reviewed based upon the most recent and best available data.
2. The current condition of NHS pavements and bridges are compared against the targets and the current gaps, if any, are noted.
3. The 10-year TAMP Investment Strategies are used to identify the needs to reach the targets, in terms of investment, lane miles, and bridge deck area per work type and year.
4. The most recent available condition data is used to identify additional investment by work type needed to close the gaps.
5. The cycle will continue annually to allow the continual review of the bridge and pavement condition and performance gaps and to influence the selection of projects included in the STIP.

4.2 TAMP Support to STIP

Since 2020, the TAMP team has been collaborating with the PRHTA's Project Management Information System (PMIS) effort. The first stage of the PMIS involved a process to create and manage project initiatives. A simple process was developed to identify potential initiatives that will fulfill TAMP strategies. The process is based on the current TAMP, the TAMP Excel tools, and the current STIP and other PRHTA project programs. Since then, the TAMP team has been identifying sites for potential projects, with emphasis on NHS pavements and bridges. In addition to addressing critical bridges, PRHTA has expanded programming of projects to preserve and rehabilitate bridges, achieve condition targets, and achieve PRHTA's desired SOGR. These project initiatives serve as a pool from which the STIP and other PRHTA programs can select projects that will help towards achieving the TAMP goals.

The general procedure to identify project initiatives that close or prevent condition gaps can be summarized as follows:

1. Use the TAMP investment strategies to identify the recommended treatment lane miles and bridge deck area per year and treatment type.
2. Identify the treatment gaps.
3. Identify road segments and bridges with unfulfilled treatment needs compatible with the identified gaps. This is performed using the Condition, Inventory, and Base Treatment Excel TAMP tools.
4. Compare those road segments and bridges with the projects recently finished, in progress, or programmed. Select those that are not already in contract, construction, or programmed. These become the potential project initiatives to be further evaluated.

5. Use engineering judgement to group pavement segments needing similar treatments and with a total length adequate for construction. These will constitute the project initiatives.
6. Lists of potential projects are produced.
    a. Each potential pavement project includes an identification code, road number, kilometer segment, pavement surface type, lane miles, road system, preliminary treatment type, and a preliminary cost estimate based on TAMP unit costs and measured segments requiring treatment.
    b. Each potential bridge project includes an identification code, bridge number, deck area, road system, preliminary treatment type per bridge component (deck, superstructure, substructure), and a preliminary cost estimate based on TAMP unit costs and bridge deck area.

4.2.1 STIP Programming Approach for Pavement

The following explains how pavement projects to close or prevent gaps are selected.

1. The pavement initiatives discussed in subsection 4.2 are gathered. Even though the initiatives identify a potential treatment type, they are not classified as such on the STIP to allow for refinements once further studies are performed during the design process.
2. In general, the PRHTA tends to include several improvement types in its projects. Therefore, pavement projects may also include other features such as highway safety devices, signage, acceleration or deceleration lane improvements, shoulder improvements, and minor bridge preservation. To account for such potential additional features and current inflation, a buffer is applied to the initiatives' preliminary cost estimate. This is the construction cost that is included in the STIP.
3. Priority was given to segments on the NHS. First priority was given to the NHS-Interstate system to advance achieving the TAMP target of no more than 5 percent lane miles in Poor condition and to get out of the current penalty as soon as possible. Second priority was given to the NHS Non-Interstate system.
4. Another element considered in programming projects in the STIP is how ready is the project for obligation of FHWA funds.
    a. Projects in the final stage of design/permits are generally assigned to the closest year.
    b. Projects starting or in the early stages of design are generally assigned to the near to mid years.
    c. Projects in the procurement process for design are generally assigned to the mid-to-later years.
    d. Projects in the early planning process are generally assigned to the latest year.
5. As the STIP needs to be fiscally constrained, projects are programmed based on funding availability and the previously mentioned priorities.

4.2.2 STIP Programming Approach for Bridges

The following explains how bridge projects to close or prevent gaps are selected.

1. Gather information from the TAMP, including targets, yearly bridge investment strategy, and unit costs.
2. Develop Bridge Program yearly budgets based on guidance from PRHTA Programming Office, available funds information from PRHTA Federal Liaison Office, and FHWA Bridge Program Notice for Apportionment.
3. Adjust the construction unit cost estimates from the TAMP to reflect observed increases in construction costs due to market fluctuations and the impacts of the pandemic and Hurricane Maria in the past years.
4. Bridge project selection is aimed to reach TAMP targets for improvement in condition rating of bridges by incorporating bridge rehabilitation and preservation projects in addition to Bridge Replacement projects. Project selection also considered site conditions, complexity of the National Environmental Policy Act (NEPA) process compliance and right of way (ROW) considerations.
5. Priority was given to bridge projects with advanced design progress that was already included in previous STIP revisions.
6. Priority was also given to Critical Finding Bridges and all types of projects for bridges with Off-System classification to comply with Bridge Program Notice and Guidance for additional funding and allocation for Bridges beginning within the STIP period.
7. Project readiness for FHWA funds obligation was also considered. Projects in the design phase were advanced as follows:
8. First, projects in final stage of design/permits
9. Second, projects starting or in early stages of Design
10. Third, projects in procurement process for Design
11. Fourth, all other projects

4.3 Pavement and Bridge Conditions, Targets, and Gaps

Table 4-1 includes the pavement and bridge targets for 2021, 2023, 2025, and long-term 10-year targets. This is based on Scenario 1 of the investment strategies shown in section 8.3.1. Although 10-year targets are not required, PRHTA adopts them to indicate its long-term objectives for pavement and bridge conditions.

Table 4-1: Condition Targets and Gaps

Condition, Targets, and Gaps							
		Target	Actual	Gap	Target	Target	Target
Performance Measure		2021	2021	2022	2023	2025	2032
Interstate Pavement							
% Lane Miles in Good Condition	>=	5.0%	19.40%	None	20.0%	25.0%	25.0%
% Lane Miles in Poor Condition	<=	14.0%	9.10%	None	11.0%	11.0%	5.0%
NHS Non-Interstate Pavement							
% Lane Miles in Good Condition	>=	1.0%	4.50%	None	5.0%	10.0%	10.0%
% Lane Miles in Poor Condition	<=	20.0%	8.40%	None	12.0%	14.0%	14.0%
NHS Bridges							
% Area in Good Condition	>=	10.0%	16.20%	None	15.0%	15.0%	15.0%
% Area in Poor Condition	<=	10.0%	7.80%	None	10.0%	11.0%	10.0%

As will be explained in the Investment Strategy chapter, both NHS pavement and bridge conditions are forecast to deteriorate for a few years through 2026 before improving if investment shown in Scenarios 2 or 3 are implemented. Therefore, PRHTA set declining 2-year and 4-year condition targets, which is permitted by Federal regulation. As indicated by the 10-year targets in Table 4-1, after about 2026 PRHTA forecasts that Interstate and NHS Non-Interstate pavement conditions will improve under certain investment scenarios. That expected improvement influenced the setting of 10-year targets that generally reflect better conditions in 2032 than in 2025.

As seen in Table 4-1, the percentage of Good Interstate and NHS Non-Interstate pavement also exceeded the target, therefore no gaps existed in 2021 for those measures. The percentage Poor for NHS Non-Interstate pavement also was better than the 2021 target for that measure.

NHS bridges also faced no 2021 gaps with both the percentage Good and percentage Poor better than those targets.

4.4 Future Condition and Performance Gaps

As will be explained in the Investment Strategy chapter, both NHS pavement and bridge conditions are forecast to deteriorate for a few years through 2026 before improving if investment shown in Scenarios 2 or 3 are implemented. Therefore, PRHTA set declining 2-year and 4-year condition targets, which is permitted by Federal regulation. As indicated by the 10-year targets in Table 4-1, after about 2026 PRHTA forecasts that Interstate and NHS Non-Interstate pavement conditions will improve under certain investment scenarios. That expected improvement influenced the setting of 10-year targets that generally reflect better conditions in 2032 than in 2025.

The issues surrounding PRHTA's future performance gaps are mixed. PRHTA exceeds its targets in 2021 and is forecast to meet its 2023 and 2025 targets. Therefore, no gap between conditions and targets existed in 2022 or are forecast for 2023 and 2025, the years for which targets are required. However, PRHTA will face a gap between the minimum amount of allowable Poor pavement of no more than 5 percent.[33] Such a gap existed in 2021 and is forecast to continue through much of the TAMP's 10 years. Details are in section 8.3.1.1. Likewise for bridges, one Investment Strategy Scenario forecast the percentage of Poor NHS bridges being above 10 percent for 2025 and beyond. If that occurs, a bridge investment penalty also would apply, similar to the one for Interstate pavements. The situation is complex, however. Under one Investment Scenario, gaps would exist in some years but not in others. Full details are in section 8.3.

4.5 Gaps to System Performance Effectiveness

PRHTA has determined that Poor pavement and bridge conditions can contribute to highway crashes and thereby limit the performance effectiveness of the NHS. The PRHTA links its asset management program and its safety program to improve the system performance effectiveness. PRHTA includes pavement preservation on sections that have been identified for improvement by the Highway Safety Improvement Program (HSIP). These preservation treatments allow for visible highway pavement markings to be restored on the sections as part of a larger project to also improve signage, guardrail, and other safety barriers. The combination of safety treatments and pavement preservation also reduces the costs for project development, mobilization, and inspection. The improved pavement is likely to increase skid resistance and reduce rutting, both of which contribute to highway safety.

PRHTA prioritizes repairing critical bridges that could be vulnerable to flooding. By reducing the number of critical bridges, PRHTA is closing what could be a resilience gap. The frequency of hurricanes and intense rainfall create threats to the resilience of the highway system. The "resilience gap" is reduced when the number of critical bridges is reduced.

4.6 Strategies to Close the Gaps

The risk management analysis and investment strategies described in later Chapters are designed to help close the forecasted future condition gaps.

[33] The FHWA performance regulation 23 CFR Part 490 differentiates between bridge and pavement targets set by each State and the minimum allowable Interstate pavement condition and NHS bridge conditions. Generally, FHWA expects targets to reflect conditions expected to be better than the minimum allowable levels. However, in the case of Puerto Rico and a few other States, departments have set targets that exceed the minimum allowable levels. FHWA expects targets to reflect forecasted conditions, even if those conditions are worse than the allowable minimum levels.

Chapter 5. Life-Cycle Planning

Photo 5-1: Jesús Izcoa Moure Cable-Stayed Bridge connecting Naranjito and Toa Alta

The asset management regulation in 23 CFR 515.7(b) states that State DOTs shall develop a process for life-cycle planning. As per the FHWA definition:

> *"Life-cycle planning is a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition."*

Life-cycle planning capitalizes on the well-documented fact that timely preservation, maintenance, and rehabilitation can extend the life of pavements and bridges. Those timely treatments also save money over the long term. Generally, it is less expensive over the life of a pavement and bridge to maintain it than to let it deteriorate to the point that it requires reconstruction or replacement.

An important note is that this version of the PRHTA TAMP is the Bipartisan Infrastructure Law (BIL) Compliant." BIL is the law that Congress enacted on Oct. 21, 2021. That law added that State DOTs are required to consider extreme weather and resilience as part of their TAMP's life-cycle

planning and risk management analyses. This TAMP includes resilience considerations in this life-cycle planning chapter as well as in the risk management chapter.

The asset management regulation[34] requires the steps shown in Figure 5-1 and which are explained in more detail next.

Figure 5-1: Required Steps in the Life-Cycle Planning Process.

5.1 PRHTA's Life-Cycle Planning Process

PRHTA has a process for life-cycle planning that involves specific targets, considers deterioration, recommends work types, optimizes cost allocations, anticipates high inflation, and considers other potential impacts such as extreme weather that address the BIL requirements.

PRHTA's life-cycle planning process includes the following steps that respond to 23 CFR 515.7(b), the life-cycle planning requirement.

1. **Target Setting:** The process must include the State targets for asset conditions for each asset class or asset sub-group. For PRHTA, those are the NHS pavement and bridge targets described in the Measures and Targets chapter.

2. **Deterioration Models:** The life cycle planning process must include identification of deterioration models for each NHS asset class or asset subgroup. In PRHTA's case, those

[34] 23 CFR 515.7(b)

asset classes are the NHS pavements and bridges. As described next, the models were developed by analyzing how PRHTA's NHS pavements and bridges deteriorated over time. Deterioration was analyzed taking into consideration when assets were treated, as well as when they were left untreated. The analysis allowed PRHTA to predict the future state of assets based on their treatment.

3. **Work Types:** The life-cycle planning process must include potential work types. The regulation says those work types extend, "across the whole life of each asset class or subgroup with their relative unit cost." PRHTA has developed processes to identify the appropriate work types to apply to NHS pavements and bridges depending on those assets' condition state.

4. **Life-Cycle Strategies:** The regulation requires strategies for managing each asset class by minimizing life-cycle costs while achieving the State DOT targets for NHS pavements and bridges. PRHTA has adopted treatment plans based on life-cycle strategies to apply preservation, minor and major rehabilitation, and reconstruction or replacement to pavements and bridges based upon their condition and the cost of treatment.

The regulation also requires PRHTA and other States to consider factors that could influence how assets are affected including future changes in traffic demand, environmental conditions and extreme weather, seismic events, or other factors that could affect the "whole life cost" of the bridges and pavements.

5.2 Life-Cycle Planning Helps Cost-Effectively Manage PRHTA Assets

The following is an overview of how the PRHTA life-cycle planning process helps the authority to cost-effectively manage its assets over their whole life.

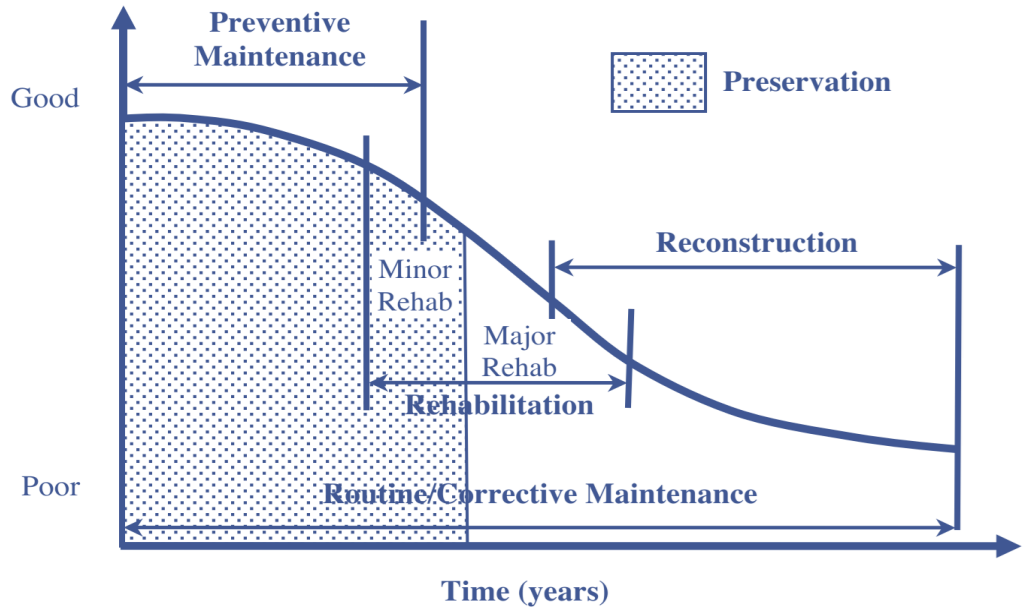
1. **Assess Current Condition:** Central to the life-cycle planning process is assessing in detail current conditions compared to targets to identify trends that could help improve the life-cycle performance of bridges and pavements. Detailed analysis looks at the specific metrics for bridge and pavement conditions. Pavement metrics include the ones discussed in the Measures and Targets chapter such as IRI, rutting or faulting, and cracking. For bridges, analyzing the metrics includes examining whether decks, superstructures, or substructures contribute more to current condition trends. Also examined is how asphalt and concrete pavements perform and whether certain bridge types, bridges of certain age, or other factors contribute disproportionately to bridge conditions. The advantage of the detailed assessment of current conditions is to identify the asset types or asset conditions that could most benefit from life-cycle treatments. For example, earlier sections of this TAMP discussed how concrete Interstate pavements and NHS bridge decks are asset sub-groups that are very important to long-term life-cycle strategies for sustaining targeted condition levels.

2. **Evaluate Historical Deterioration:** The PRHTA life-cycle planning process involves examining historical deterioration rates. Those rates inform the forecasting process. Assets that are not treated are assumed to deteriorate at an average rate. Also, the analysis helps to identify more specific information about how and why the assets deteriorate which supports targeting the most effective treatment strategies. More details on deterioration are provided in Pavements Life-cycle Planning and Bridges Life-cycle Planningsections, 5.5 and Bridges Life-cycle Planning5.6, respectively.

3. **Evaluate Historical Improvements after Treatments:** The PRHTA also assesses how assets perform over time based upon different treatments. From this information, the expected conditions can be forecast. Data for the expected life of treatments comes from historical observation and from data generated by national research or FHWA resources.

4. **Identify Work Types:** FHWA regulations state that TAMPs must report on investments in five work types: initial construction, preservation, maintenance, rehabilitation, and reconstruction. PRHTA categorizes its typical treatments into one of these five categories for the TAMP life-cycle analysis. For example, thin pavement overlays are categorized as preservation and full depth repairs are categorized as reconstruction. The categorization of treatments into work types helps to identify what work types are needed based upon the condition of each bridge or pavement section. The PRHTA has treatment criteria based on the condition of the several pavement and bridge condition indicators.

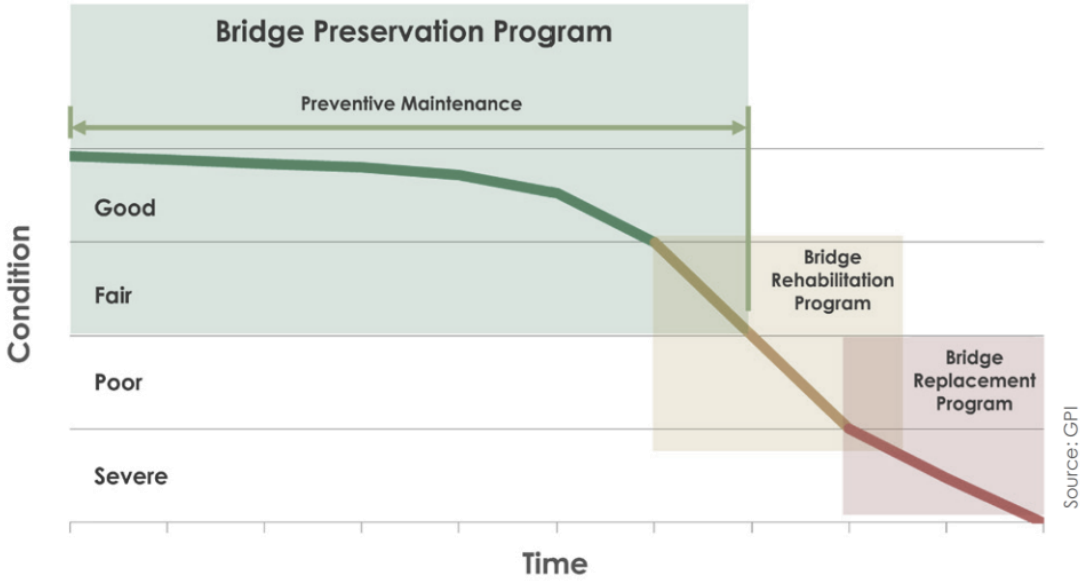
   In general, work types are based on the concept shown in Figure 5-2 for pavements and Figure 5-3 for bridges. When the assets are in Good and Fair condition, they deteriorate at a lower rate than when in worse condition. Therefore, maintenance and preservation activities are warranted to extend its life in this satisfactory condition. When they are in worse condition, they deteriorate at a higher rate, so more aggressive treatments are required to extend their life.



Source: Adapted from Peshkin et al. 2007.

From Guidelines for the Preservation of High-Traffic-Volume Roadways (2011) <https://nap.nationalacademies.org/catalog/14487/guidelines-for-the-preservation-of-high-traffic-volume-roadways>.

Figure 5-2 General Illustrations of Pavement Deterioration Models Similar to PRHTA's



From FHWA Bridge Preservation Guide (2018) <https://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf>.

Figure 5-3: General Illustrations of Bridge Deterioration Models Similar to PRHTA's

5. **Identify Committed Projects:** PRHTA's life-cycle planning process incorporates the already committed pavement and bridge projects in the STIP, and other programs if and when applicable. Because many projects recently added to the STIP come from the investment strategies from the 2019-2028 TAMP, those projects incorporate life-cycle-based treatments. Table 5-1 illustrates the life-cycle-based logic reflected in recently programmed projects for the PRHTA STIP. It shows the total dollar amount by year programmed for Interstate pavements between FFY 2023 and 2026. Most of the investment is for minor rehabilitation, with a total of $47.6 million. The second major investmen is for the most expensive, reconstruction, with $22.7 milion. The greatest proportion of lane miles impacted are in Fair -Fair condition with half of the total lane miles impacted, followed by Fair to Good and Fair to Poor. 9.4percent of the pavementsare expected to be impacted are in Poor condition. These projects are captured in the life-cycle planning process. Additional needs beyond these projects are then identified.

Table 5-1 Project Amounts Programmed for Interstate Pavements

Interstate STIP Investment (Adjusted)						
Treatment	**2023**	**2024**	**2025**	**2026**	**Total**	**Percentage**
Preservation	$1,720,603	$0	$8,029,489	$0	$9,750,093	10.6%
Minor Rehabilitation	$15,970,331	$0	$16,836,140	$14,773,860	$47,580,331	**51.5%**
Major Rehabilitation	$0	$12,305,635	$0	$0	$12,305,635	13.3%
Reconstruction	$0	$10,453,100	$0	$12,262,500	$22,715,600	**24.6%**
Total	**$17,690,934**	**$22,758,735**	**$24,865,629**	**$27,036,360**	**$92,351,658**	**100.0%**

Interstate STIP Lane Miles (Adjusted)						
Condition	**2023**	**2024**	**2025**	**2026**	**Total**	**Percentage**
Good	3.5	0.6	8.1	3.3	15.5	6.3%
Fair to Good	17.4	4.8	10.3	10.2	42.6	17.5%
Fair - Fair	36.1	6.1	44.7	35.8	122.7	**50.2%**
Fair to Poor	12.2	9.3	8.0	11.0	40.5	16.6%
Poor	1.8	13.6	4.6	2.8	22.8	**9.4%**
Total	**71.0**	**34.4**	**75.7**	**63.1**	**244.2**	100.0%

Note: These amounts include the deduction explained in Chapter 7 Financial Plan to exclude potential works included in the project that are not directly related to pavements such as lighting, signage, utilities' relocation, etc. A similar reduction was applied to the lane miles to account for the possibility that not all the lane miles within the project limits will be impacted. The reduction factors were based on past consistency analyses, and they are as follows:0.545 for the total project investment and 0.908 for the total lane miles within the project limits. Refer to Appendix J for more details.

6. **Identify Available Budget:** The total budget available to PRHTA is set by the FOMB as discussed in the Financial Plan chapter. For the TAMP, three budget scenarios are shown with the preferred one indicated. Details are in the Financial Plan and Investment Strategy chapters. Additional budgets from other sources such as local funding or the investment programs from the concessionaires are also considered if and when available.

7. **Forecasted Conditions Based on Different Budget Scenarios**: The TAMP life-cycle planning process is constrained by the total available funds. However, forecasted conditions based on different budget scenarios were performed for the PRHTA's Capital Improvement Program. The PRHTA proposed four different budget scenarios that aim to achieve and sustain the PRHTA performance targets and/or the national average values. The FOMB selected the scenario with the lowest budget. This scenario aimed to achieve the 2028 TAMP targets or better for pavements and bridges within the 30-year analysis period of the PRHTA's CIP. In addition, multiple scenarios were developed with the pavement and bridge analysis tools for the TAMP to develop investment scenarios to optimize the use of the pavement and bridge funds. A preferred mix of treatments to optimize the future bridge and pavement conditions is a product of the life-cycle analysis process.

8. **Evaluate Scenarios:** Different scenarios are compared and evaluated for both how practical they are and how much they will maximize pavement and bridge conditions. A practical consideration is how quickly PRHTA could increase the size of its construction program with a limited contractor pool. Another practical consideration is the need for PRHTA to use its staff resources to deliver already programmed projects. The scenarios examine not only the best use of the budget among the assets in their varied conditions, but also how the needed increase in investment can be phased into place over the 10 years of the TAMP.

9. **Recommended Investment Strategies:** The forecasted future conditions produced by the scenarios are compared and preferred scenarios that most improve pavement and bridge conditions with the available budget approved by FOMB and contracting resources are adopted by PRHTA.

5.3 Quality Control Process

Several quality control steps are taken to ensure that the life-cycle planning process is based on the best available data so that PRHTA can cost-effectively manage its assets.

Extensive quality control checks were performed on the 2021 pavement data to ensure that it was accurate and complete. PRHTA worked continuously with the pavement-data-collection vendor, the HPMS data input vendor, and with FHWA to develop a final 2021 pavement dataset. A final pavement dataset was provided by FHWA after it was processed and further revised by PRHTA's TAMP team. The selection of that dataset allowed PRHTA to use the best available pavement data for the TAMP, and specifically for the life-cycle analysis.[35]

As mentioned in the Summary Condition of Assets section, the 2022 NBI dataset was used for bridges. That data was collected in 2021 by PRHTA and submitted to FHWA. This data was further

[35] 23 CFR 515.7(g)

checked by the PRHTA's TAMP team. Using the published 2022 NBI data set also assured PRHTA that it was using for the TAMP the best available data.

Not only was the data regarding current conditions updated, but the TAMP development process also was coordinated with the setting of new pavement and bridge condition targets. Coincidental to the TAMP-development deadline, PRHTA also had in December 2022 to set new or updated Interstate pavement and NHS bridge and pavement targets. Those targets are mentioned in the Measures and Targets chapter and were used as benchmarks for the TAMP's life-cycle planning analysis. Scenarios were evaluated based upon how much they contributed to achieving the updated targets.

The updated pavement and bridge data inventories were input into the pavement and bridge analysis tools. Those tools and the analysis they provide are discussed below individually for the pavement and bridge life-cycle planning process.

5.4 Incorporating Extreme Weather and Other Factors

The asset management regulation states that agencies' life-cycle planning process should include consideration of several elements. These are future changes in demand, current and future environmental conditions, extreme weather, resilience, climate change, seismic events, and other factors that could affect the whole life of assets.

Inherent in the PRHTA's life-cycle planning process is consideration of the effects of extreme weather and the need to enhance the resilience of the highway network. The need to address resilience is important to PRHTA because of Puerto Rico's vulnerability to hurricanes and earthquakes, such as the recent Hurricanes Irma, Maria, Fiona, and the earthquakes of 2019-2022.

Some of the strongest resilience influences on PRHTA's life-cycle planning process are summarized next.

1. **The Part 667 Process:** Part 667 of the asset management rule directs States to, "conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events." PRHTA has embraced the 667 process and uses it as an opportunity to analyze the sites of repeated damage so that their root cause can be identified. Then, as projects are planned at those locations, PRHTA can evaluate those locations to determine if any alternative is possible to, "mitigate, or partially or fully resolve, the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution." A more detailed discussion of the Part 667 analysis and sites it identified is included in the Risk Management chapter.

2. **The Climate Challenge Initiative:** PRHTA is one of the 27 agencies participating in FHWA's Climate Challenge initiative. PRHTA will be working on two projects that will start in 2023.

   The first project consists of a series of workshops, tailored to Puerto Rico, to provide participants with the knowledge about sustainable pavements, including Life Cycle Assessment (LCA), Environmental Product Declaration (EPD), and Product Category Rules (PCR). This first project will be developed with technical assistance from FHWA.

   The second project will start after the first project is fulfilled. The second is about creating a Sustainable Pavement Initiative development plan. This plan will include research and documentation of implementation efforts and lessons learned from other state DOTs, will capture potential alternatives for local implementation, will recommend a feasible roadmap for future implementation, and will create educational material in Spanish to assist the local industry in developing EPDs for their products.

3. **Improving Critical Bridges:** A bridge is classified as a scour critical bridge if its foundations are determined to be unstable either by a documented evaluation or by assessed conditions in the field. For many years, PRHTA has focused on bridges with critical findings, including scour critical bridges, given the importance of addressing critical findings in a timely manner. To improve resilience, bridges that were previously determined to be scour critical by evaluation and are addressed in an active or future bridge preservation or rehabilitation project receive scour countermeasures to protect the structure from extreme weather events. They are re-coded to indicate the foundations are stable, and eventually removed from the scour critical list.

   When scour-critical bridges are identified, PRHTA's typical approach is to:

   a. Evaluate the general bridge condition, geometric functionality, estimated remaining service life (assuming the scour problem is successfully mitigated), bridge replacement cost, and bridge scour mitigation cost.
   b. Evaluate the importance of the bridge to the community, for example, the access it provides, average annual daily traffic (AADT), or important nearby services such as security facilities, schools, or hospitals.
   c. Performed a benefit cost analysis (BCA).
   d. If BCA determines that bridge scour mitigation is feasible, establish scour countermeasures with added resiliency. If not, implement immediate temporary scour mitigation and design a new bridge to provide resiliency to the asset.

   In addition to scour-critical bridges, PRHTA responds quickly to any bridge with a critical bridge finding. Any element found to require immediate attention is documented under the inspection Metric 21 from the NBIS Oversight Program's Metrics for the Oversight of the National Bridge Inspection Program. These could include scour but also findings such as damage, corrosion, section loss, settlement, or any condition that could pose an imminent public threat. When found, bridges with critical findings are prioritized for repair or replacement.

4. **BridgeWatch:** PRHTA uses the BridgeWatch system to monitor all the structures that are part of the National Bridge Inventory, approximately 2,334 structures, for extreme and emergency events that could threaten bridges. Upon the occurrence of events that meet or exceed the monitoring thresholds established, the BridgeWatch system sends alerts and notifications to PRHTA in-charge personnel to execute bridge safety inspections. To improve resilience, the BridgeWatch system has been renewed and expanded annually to enhance the monitoring program of bridge structures, including adding seismic and stream gauge monitoring. Since PRHTA acquired the BridgeWatch system, it has been used to mitigate risks in bridges when coordinating inspection efforts during recent events such as Storm Isaiah, the January 2020 Earthquake, and Hurricane Fiona, among other events.

5. **Seismic Designs:** PRHTA incorporates seismic resistence design elements into structures across Puerto Rico. PRHTA is already conducting seismic spectra analysis on three projects sites: one in Mayagüez (AC-200200), and two in Arecibo (AC-065404 and AC-068112). These studies are being conducted on liquifiable soils which usually amplify seismic waves.

6. **Geotechnical Engineering Asset Management**: Although this TAMP only addresses NHS pavements and bridges, the management of geotechnical assets supports pavement and bridge performance by reducing the threat of geotechnical failures that could damage pavements and bridges.

   The PRHTA Office of Soil Engineering (OSE) has been at the forefront of developing a Geotechnical Asset Management (GAM) program which can reduce the threat from slope failures and other climate-or-seismic related emergencies. In fact, "The 1st Geotechnical Asset Management Peer Exchange" was held in Puerto Rico in September 2019. Three years later, in May 2022, "The 2nd Geotechnical Asset Management Peer Exchange" was held in North Carolina in which the OSE actively participated. Subsequently, in October 2022, the OSE actively participated with its GAM program in the "51st Southeastern Geotechnical Engineering Conference (STGEC)" and as a result was included in the steering committee of that organization.

   Geotechnical assets are those built of terrestrial materials. In the design of these, principles of soil mechanics and rock mechanics are used. Geotechnical assets are part of the highway and highway corridors around Puerto Rico. Examples of geotechnical assets are: embankment slopes, slopes of cuts in soil and rock, earth retention walls, culverts, tunnels and small bridges, among others. The failure of a geotechnical asset results in the failure of the corridor, this despite the fact that the pavement or bridges are in Good condition. Some examples of cases where the corridor has been affected by the failure of geotechnical assets are: PR-52 Km 49.2, Monumento al Jibaro, Salinas; PR-6 Km 1.2, Villa España, Bayamón; and PR-53 Km 14.7, Naguabo. Therefore, the management of transportation assets is not limited to pavements and bridges.

   Geotechnical assets can be classified into tangible assets and intangible assets. Tangible assets would be walls, ditches and slopes. On the other hand, examples of intangible

geotechnical assets would be geotechnical reports, experience, field tests and hole logs. Since fiscal year 2015, more than seven years ago, the OS began developing a GAM program with the inclusion of three (3) tasks in the "State Planning and Research Program (SPR)". The tasks are as follows:

Task 621 – Inventory and evaluation of retaining walls;
Task 649 – Geotechnical Reports Database; and
Task 674 – Development of an Unstable Slope Management Program (USMP).

For each of the geotechnical assets mentioned, geo-referenced databases were created and mobile applications were created that allow inventorying and evaluating the risk hazard of each asset in real time, obtaining a hazard rating. In the case of culverts, the recommendations established in the "Culvert Assessment and Decision Making Procedures Manual For Federal Lands Highways" (publication number FHWA-CFL/TD 10-005) were used. Currently, the OIS has inventoried 3,500 NHS culverts. The recommendations of the "Retaining Wall Inventory and Assessment System" manual (publication number FHWA/NC/2014-10) were used to inventory and evaluate the condition of the walls. Following the process adopted, 250 walls have been inventoried. In the case of slopes, the recommendations of the "Unstable Slope Management Program (USMP) for Federal Land Management Agencies" (publication number FHWA-FLH-19-002) were adopted. The OIS has inventoried 750 slopes in rock and soil. Finally, for intangible assets, 3,000 geotechnical reports and 26,000 hole logs were georeferenced. In addition, applications were created to allow consultants and other agencies to access logbooks and reports through the cloud.

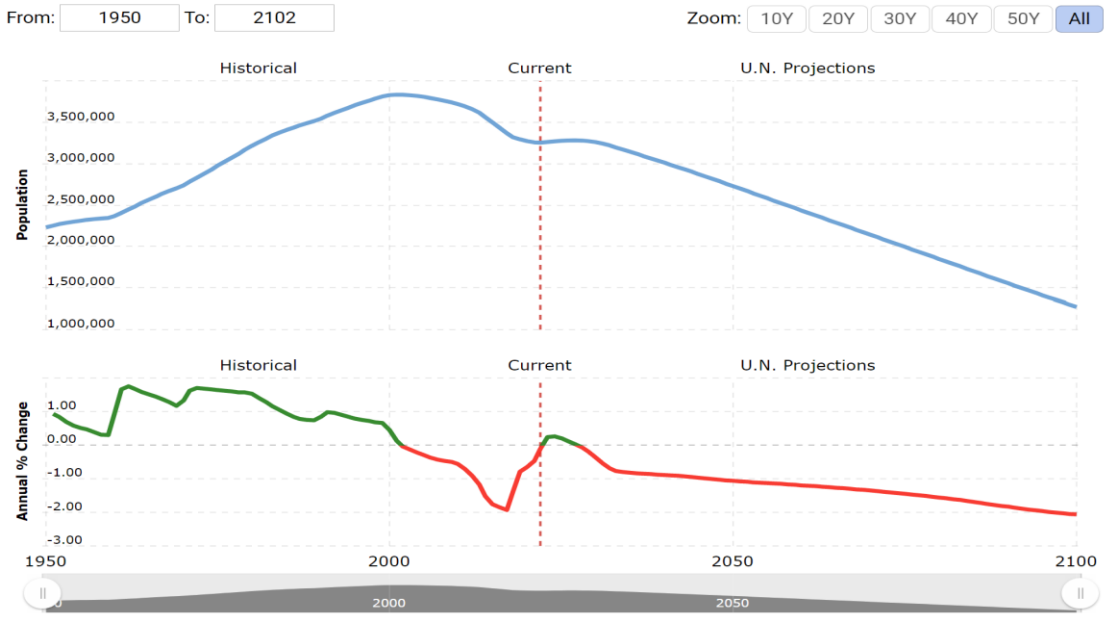
7. **Heat-Responsive Pavement Binders:** Because of the increase in temperatures and the duration of peak temperatures, PRHTA is examining the use of additional asphalt binders. PRHTA is considering using these improved binders at the right time in the pavement treatment cycle following lifecycle planning.

8. **New Pavement Treatments to Enhance Life-Cycle Performance:** PRHTA is incorporating new pavement preservation treatments to provide more options for extending pavement life. These include micro-surfacing, unbonded concrete overlays, and rubblization. Appendix C includes more details on these new treatments. A pilot project for micro-surfacing was successfully completed in 2021 and another microsurfacing project is undergoing. An unbonded concrete overlay project is under way, and a rubblization specification has been developed.

9. **Updating Hydraulic Standards to Account for Increased Rain Events**: The Department of Natural and Environmental Resources (DNER) through their established "Guidelines for the Preparation of Hydrologic-Hydraulic Studies", requires that H-H studies be analyzed for several recurrence events, including the event with a 1 percent probability of occurrence, or a 100-year flood. However, Hydraulic Engineering Circular publications recommend that a higher recurrence event is used for scour design (e.g., 200-year flood) over the hydraulic design (100-year flood). An even higher recurrence event is used for

scour check (e.g., 500-year flood) this with the purpose of designing a bridge structure that will resist scour conditions during extreme events that exceed the 100-year flood. To improve resilience, PRHTA is currently enforcing the use of the 200-year flood for the scour evaluation and design of scour countermeasures.

10. **Anticipating Future Changes in Demand:** With Puerto Rico's population forecast to slowly decline (see Figure 5-4), traffic volumes are unlikely to increase enough to influence the pavement and bridge tools' deterioration curves and to not create significant future changes in demand. An exception could be the surroundings of Aguadilla Airport which is planning an extensive expansion.[36] However, this expansion is expected for a long range (more than 10 years) and include enhancements to the surrounding transportation facilities.



From Puerto Rico Population 1950-2022 | MacroTrends https://www.macrotrends.net/countries/PRI/puerto-rico/population; data source: World Population Prospects - Population Division - United Nations <https://population.un.org/wpp>).

Figure 5-4: Puerto Rico Population 1950-2022

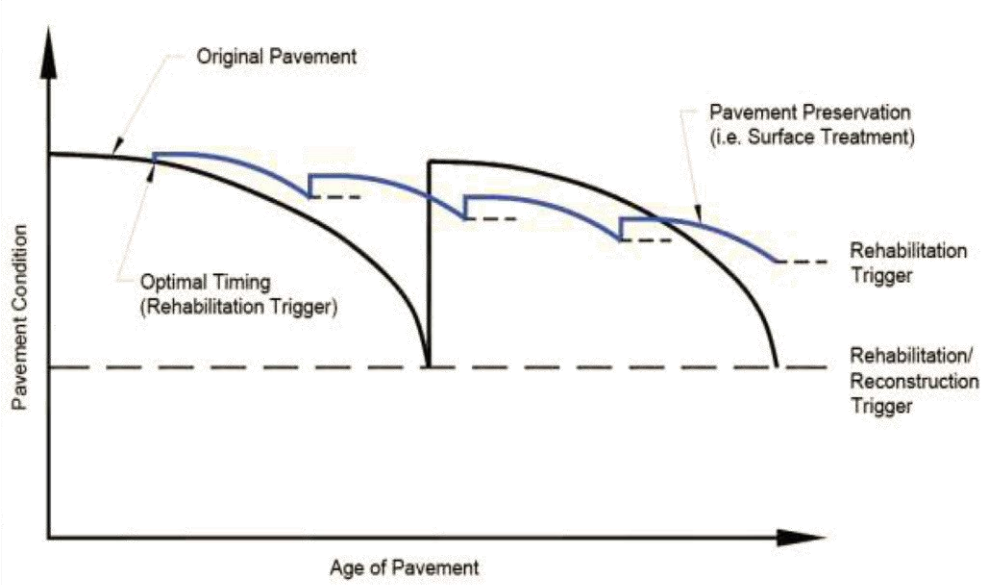
5.5 Pavements Life-cycle Planning

Pavement life-cycle planning in Puerto Rico includes the following elements:

[36] Team ERA, Enrique Ruiz and Associates Campbell and Paris P.C., Rafael Hernández Airport Aguadilla, PR Master Plan Update Final. Puerto Rico Ports Authority, November 2005.

1. Systematic processes for collecting, processing, storing, and updating pavement inventory and condition data. The data collection process complies with the PRHTA's Data Quality Management Plan.
2. PRHTA consultants developed tools that use past years PRHTA data to forecast the condition of PRHTA pavements, including both the NHS and Non-NHS systems.
3. The tools help determine what mix of investment levels and treatment types will provide the greatest condition benefits with the available budget.
4. The tools identify the funding levels needed to achieve a given condition level in either the short-or-long-term.
5. The tools assist with identifying strategies to maximize the overall program benefits.
6. They also lead to recommended investment levels in certain years to achieve the short-term and long-term targets.

Figure 5-5 illustrates the concept inherent in the PRHTA life-cycle planning process. The logic seen in Figure 5-5 is inherent in the pavement analysis tools, and inherent in the overall decision-making process for pavements.



From: AC 150/5380-7B, Airport Pavement Management, 10/10/2014 (faa.gov) <https://www.faa.gov/documentlibrary/media/advisory_circular/150-5380-7b.pdf>.

Figure 5-5: Pavement Deterioration and Preservation Concept

Analysis of PRHTA pavement trends indicate that Puerto Rico pavements perform over time in a typical fashion, as shown in Figure 5-6. After treatment, or when new, they decline slowly in their first several years. However, their decline begins to increase exponentially after a few years if left untreated. Left untreated, they will after a decade or longer demonstrate many distresses such as roughness, cracking, rutting, or faulting.

As shown in Figure 5-5, a pavement management process such as inherent in the PRHTA life-cycle processes will trigger preservation or rehabilitation treatments at the appropriate points on the deterioration curves. Then, as shown in Figure 5-5 and Figure 5-6, the pavement conditions improve. When repeated over the life of the pavement, such timely interventions generally produce a lower life-cycle cost compared to letting pavements deteriorate until they need reconstruction.

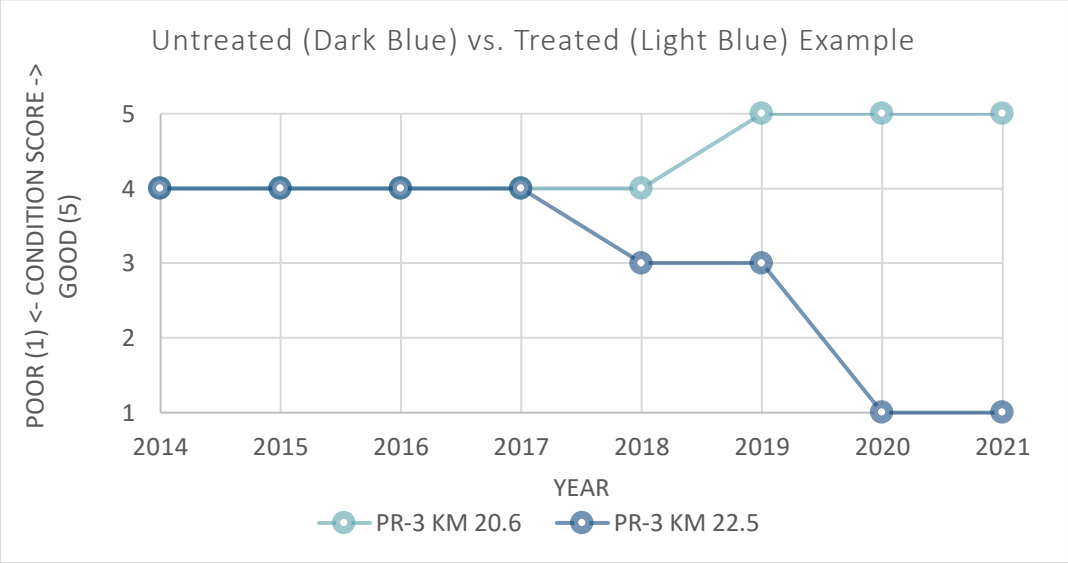


Figure 5-6: Example of Condition Change of Untreated and Treated Segments

The pavement deterioration analysis cannot rely on pavement data earlier than 2014 because earlier years lacked the distress detail that FHWA now requires. Data on specific FHWA-required pavement distresses such as the percentage of cracking, rutting, faulting, and roughness are now used to generate deterioration curves. The use of this FHWA-required data facilitates PRHTA's forecasting of future conditions based upon the FHWA metrics. The pavement deterioration tool developed for the 2028 TAMP is based upon the performance data of four years, which was the number of years for which data in the current format was available at the time. This TAMP used a newly developed tool that takes advantage of the eight years of data that are currently available from year 2014 to 2021. Table 5-2 shows how the deterioration analysis works. The annual rate of deterioration for pavements based upon their change in condition is estimated; the calculation of this rate does not include positive changes (improvements). Then, that deterioration rate is applied to a percentage of the pavements. Both parameters are based upon the observed values in historic pavement datasets.

Table 5-2: Pavement Deterioration Model

Average Overall Deterioration Rate	
Interstate	-0.4158
NHS Non-Interstate	-0.3428
Proportion Deteriorating	
Interstate	24.15%
NHS Non-Interstate	23.15%

The PRHTA pavement analysis tools use the distress indicators (IRI, Rutting, Faulting, Cracking Percent) to support life-cycle planning (see Table 5-3).

Table 5-3: Pavement Condition Criteria

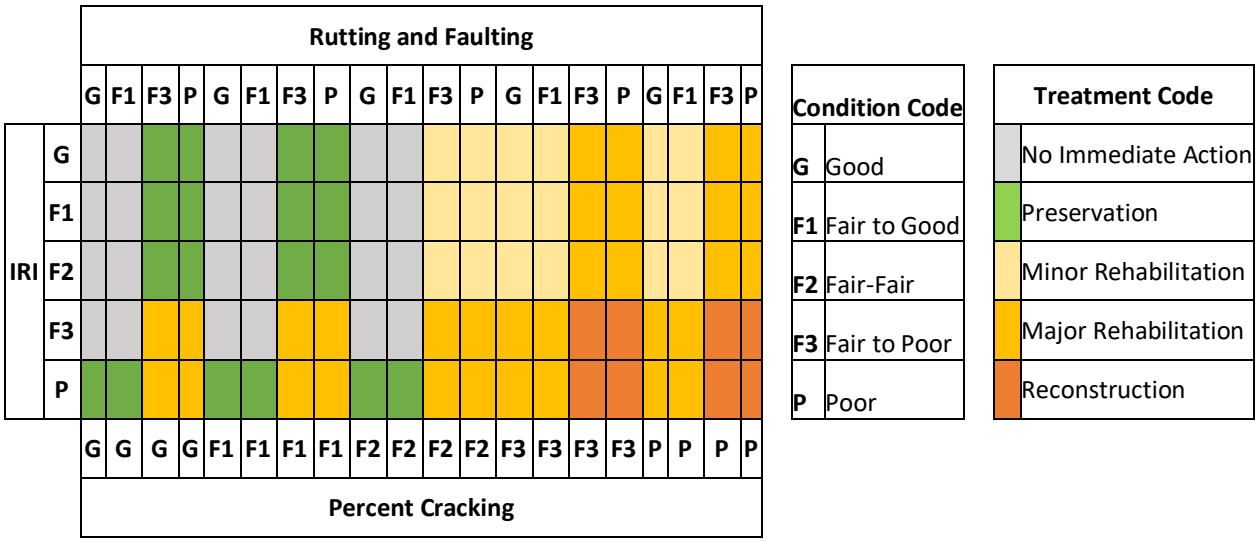
Condition	Code	Criteria Limit for Individual Distresses	Distress Criteria						Overall Criteria Considering the Three Distresses
			IRI		Rutting or Faulting		Cracking		
			Asphalt & Concrete		Asphalt	Concrete	Asphalt	Concrete	
			NHS	Non-NHS					
Good	G	<	95	135	0.2	0.1	5	5	3G
Fair to Good	F1	<	110	185	0.3	0.12	10	10	2G & F1 or F2 1G & 2 F1 or F2 or Combination 3 F1 or F2 or Combination
Fair	F2	<	130	235	-----	-----	15	-----	Other Combinations
Fair to Poor	F3	<=	170	285	0.4	0.15	20	15	> 1F3 and no P 1F3 and 1P
Poor	P	>	170	285	0.4	0.15	20	15	>1P

IRI is measured in inches of roughness per mile. Rutting and faulting are measured in fractions of inches. Cracking is measured as the percentage of cracks in the pavement section.

As mentioned earlier, PRHTA divides the category of pavements that FHWA considers to be Fair into three more granular categories. That division allows PRHTA to identify more precisely the type of pavement treatment needed to implement a life-cycle planning strategy. A pavement that is Good-Fair may benefit from a preservation treatment. One assessed as Fair-Poor requires more substantial rehabilitation treatment. The subdividing of the Fair pavements supports PRHTA's efforts to apply life-cycle based treatment strategies to economically extend pavement life.

The PRHTA pavement analysis tools use the logic inherent in the Table 5-4 matrix. Table 5-4 illustrates that the distresses a pavement faces can be quite varied. A pavement may have Poor IRI values but not be severely rutted or cracked. Conversely, a pavement could be cracked but still be relatively smooth. Or a pavement rated Fair could have serious rutting that could increase crash risks. The pavement analysis tools use detailed pavement distress data to categorize each pavement section by its distresses. Such categorization allows for more refined assignment of potential treatments, as seen in the color coding of the matrix in Table 5-4.

Table 5-4: Condition & Work Types Matrix



The detailed analysis included in the Table 5-4 matrix allows PRHTA to make planning-level pavement treatment suggestions based upon life-cycle logic that minimizes the long-term costs. When the pavement is designed, additional detail gathered from coring or deflection data could lead to a more refined pavement treatment. However, the detail seen in Table 5-4 supports the planning-level recommendations needed for PRHTA's long-term, life-cycle planning to sustain pavement conditions while minimizing life-cycle costs.

The pavement work types and their costs which are assigned in the pavement analysis tools are shown in Table 5-5. The work types reflect Good life-cycle planning by assigning the lowest-cost treatment at the appropriate point in the pavement's life-cycle to extend its performance.

The unit costs in Table 5-5 are based on the ones used for the 2028 TAMP, with an inflation rate of 4.2 percent compounded annually (as per the U.S. Labor Statistics Consumer Price Index Inflation Calculator). These values were compared to the unit costs estimated based on the past three years' consistency evaluations. Consistency values were comparable. However, we conservatively kept the inflated 2028 TAMP values because they were slightly higher, and the consistency projects did not include several projects for all work types as to be considered representative. The definitions of the treatments are aligned with the ones from the Design Directive 115 which was developed to aid in the consistency assessment. These definitions are shown in Appendix D.

Table 5-5: TAMP 2028 Pavement Unit Costs

Asphalt	Unit Cost		
	Interstate	NHS (Non-Interstate)	Non-NHS
Preservation	$230,936.97	$190,126.56	$157,036.80
Minor Rehabilitation	$482,641.48	$447,299.77	$368,350.19
Major Rehabilitation	$746,563.05	$524,150.75	$431,514.47
Reconstruction	$763,094.02	$548,360.17	$451,396.69

Concrete	Unit Cost		
	Interstate	NHS (Non-Interstate)	Non-NHS
Preservation	$505,364.44	$469,987.45	$394,110.80
Minor Rehabilitation	$683,069.02	$647,692.03	$536,807.49
Major Rehabilitation	$732,106.93	$691,282.94	$568,853.73
Reconstruction	$1,219,620.03	$1,184,243.04	$973,902.62

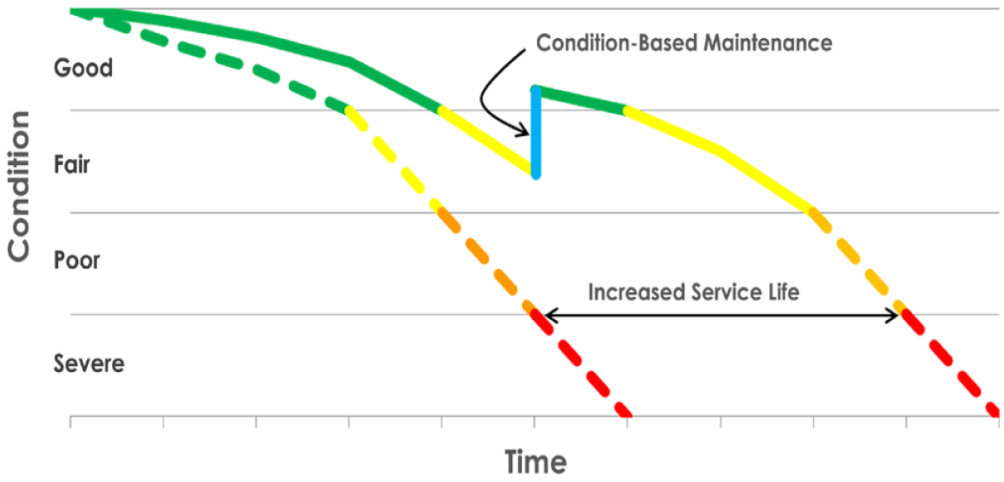
PRHTA uses three main Excel-based tools its consultants developed to conduct the pavement life-cycle planning. The pavement tools are developed to be applied stepwise. The first tool is used to identify the highway inventory and to calculate the pavement condition, including the PRHTA's more granular Fair condition sub-categories. This tool also determines the recommended treatment for each entry based on the condition and treatment matrix. This information can be used for planning projects. The second tool is used to develop the deterioration model. Historical condition data is used to estimate average deterioration per system.

The final tool is used to input some of the results from the previous tools (condition, deterioration, improvements after projects) and information from projects that are already programmed to develop the investment strategies. PRHTA has used these tools successfully in the last TAMP and in the long-term FOMB-approved fiscal plan to compute investment needs based on various funding scenarios.

The use of the life-cycle based pavement treatment strategies has produced positive results for PRHTA. The decline in the percentage of Poor NHS and Interstate pavements and increase in the percentage Good shown in the Summary of Asset Conditions chapter reflect the benefits of PRHTA's use of pavement life-cycle strategies.

5.6 Bridges Life-cycle Planning

As it does for NHS pavements, PRHTA also conducts life-cycle planning for its bridge inventory. Figure 5-7 illustrates the general concept PRHTA is increasingly applying to manage its bridges to maximize conditions at the most practicable cost applying life-cycle strategies.



From FHWA Bridge Preservation Guide (2018) <https://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf>.

Figure 5-7: Bridge Deterioration and Preservation Concept

The timely application of preservation or rehabilitation treatments prevents the rapid deterioration seen in Figure 5-8.

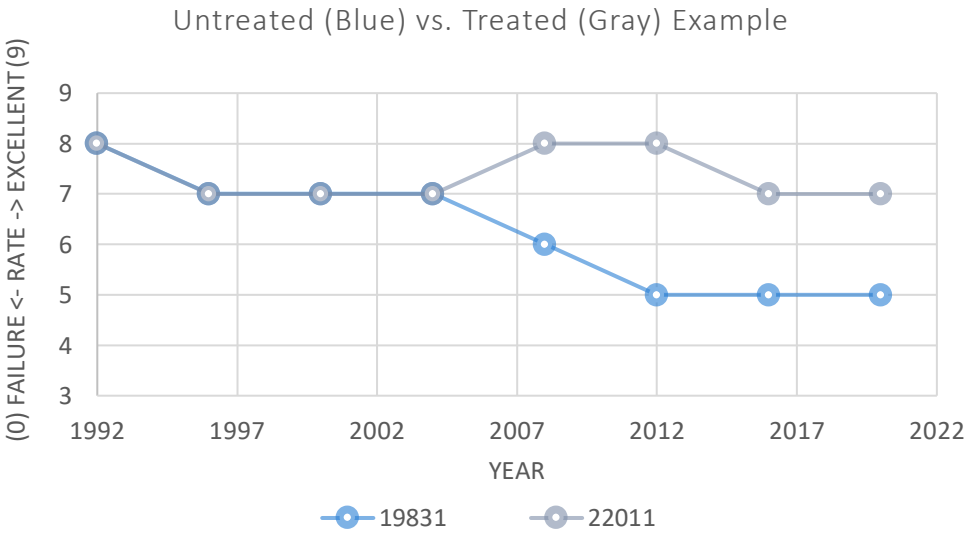


Figure 5-8: Example of Condition Change of Untreated and Treated Bridges

The rate of deterioration that PRHTA estimates is based upon analysis of multiple years of bridge data. Unlike pavements that had new distress requirements in 2014, NBI bridge data has been collected consistently for at least 40 years. That inventory history provides PRHTA with a robust data set from which to calculate the deterioration rates.

Based on the analysis of historical bridge-condition data, PRHTA developed the bridge deterioration model seen in Table 5-6. The deterioration tool uses 8 years of data. The model used in this TAMP is shown in Table 5-6; it was based on data from the years 1992, 1996, 2000, 2004, 2008, and 2012, 2016, and 2020. As with the pavement deterioration model, the analysis of data provided an average of the annual rate of deterioration that is experienced by a percentage of the bridges each year. Those data points are used to forecast at the network level an annual rate of deterioration. The bridge deterioration tool also allows the calculation of deterioration rates for each individual component (deck, superstructure, substructure, culvert).

Table 5-6: Bridge Deterioration Model

Average Deterioration Rate						
Average "Not Improving" Rate Change per Year (Weighted by Deck Area)	**Deck**	**Superstructure**	**Substructure**	**Culvert**	**Overall (Lowest Component)**	**Average of Three Components (Used for Calculations)**
NHS	-0.0652	-0.0327	-0.0332	-0.0243	-0.0661	-0.0436

Percent of Area Deteriorating						
Percent Deck Area with Decreasing Rate	**Deck**	**Superstructure**	**Substructure**	**Culvert**	**Overall (Lowest Component)**	**Average of Three Components (Used for Calculations)**
NHS	70.18%	43.23%	39.69%	36.04%	67.86%	50.93%

Note: Bridge deterioration tool allows for up to eight years of data; hence, analysis was performed data from every four years from 1992 to 2020 (same used for PRHTA's latest CIP).

PRHTA bases its assessment of bridge conditions upon the FHWA bridge condition metrics. Table 5-7 shows the condition assessments used by FHWA and applied by PRHTA. Bridges are rated on a 9-0 scale with bridges rated 9 to 7 as Good. Those rated 5 or 6 are Fair. Those rated 4 and below are Poor. The rating applies to each of the three bridge components – the deck, superstructure, and substructure. Each is rated on the 9-0 scale. The lowest rating of any of the three components is the overall rating for the bridge. Culverts are also rated on the 9-0 scale, but they are inspected differently as they do not have the components that a bridge has.

The detail of which component contributes most to a bridge's lowest condition supports PRHTA's life-cycle treatment strategies. As noted in the Summary Condition of Assets, PRHTA's Poor and Fair bridge deck conditions contribute the most to PRHTA's overall bridge conditions. The decks are disproportionately Poor or in condition state 5, which is considered Fair-to-Poor. The PRHTA bridge tool and the PRHTA project-selection process both emphasize focusing on the bridge component treatments that will use life-cycle strategies to provide the best treatment using lowest practicable cost treatments over the life of the asset.

Table 5-7: Bridge Condition Criteria

NBI Component Rate	NBI Condition Definition	PRHTA TAMP Condition Definition
9	Excellent	Good
8	Very Good	
7	Good	
6	Satisfactory	Fair Satisfactory
5	Fair	Fair to Poor
4	Poor	Poor
3	Serious	
2	Critical	
1	Imminent Failure	
0	Failed	
The overall bridge condition is determined by the lowest rating of deck, superstructure, substructure, or culvert.		

Table 5-8 illustrates the life-cycle-based treatment logic inherent in PRHTA's bridge analysis tool. An individual work type is assigned per individual component, as shown in the upper part of Table 5-8. This is the part that is used for planning works and performing estimates. For TAMP purposes, an overall work type is assigned based on the work types per individual component, as shown in the lower part of Table 5-8.

Table 5-8: Bridge Condition Rate & Work Type Criteria

Individual Treatment Criteria				
Treatment	**Rate**			
	Deck	**Superstructure**	**Substructure**	**Culvert**
Replacement	<=4 or Sup<=4 or Sub<=4	<=4 or Sub<=4	<=4	<=4
Major Rehabilitation	5	5	5	5
Minor Rehabilitation	6	6	6	6
Preservation	7	7	7	7
No Immediate Action	>7	>7	>7	>7

Overall Treatment Definition			
Individual Component Work Type	**Bridge Work Type Score for Calculations**		**Overall Treatment Definition as per Sum of Scores**
	Score Assigned to Each Component as per Individual Work Type	**Sum of Scores of All Bridge Components**	
Replacement	4	If Total Score = 12	**Replacement**
Major Rehabilitation	3	If Sub Scores <=3 and Super Scores <=4	**Major Rehabilitation**
Minor Rehabilitation	2	If Sub and Super Scores <=2	**Minor Rehabilitation**
Preservation	1	If Sub and Super Scores <=1 and Deck Score <=2	**Preservation**
No Immediate Action	0	If Total Score = 0	**No Immediate Action**
Culvert treatment remains equal to individual criteria.			

The treatment logic in Table 5-8 drives the bridge analysis tool to select recommended treatments per work type (preservation, maintenance, minor and major rehabilitation, reconstruction / replacement) with the objective of minimizing bridge life-cycle cost.

Table 5-9 shows the bridge work types and their unit costs. The tool recommends the appropriate treatment based on the life-cycle logic and then summarizes how much the treatments will cost. PRHTA uses the tool's recommendation and applies engineering judgement to make the final treatment selection decision.

The unit costs in Table 5-9 are based on the ones used for the 2028 TAMP, with an inflation of 4.2 percent compounded annually (as per the U.S. Labor Statistics Consumer Price Index Inflation Calculator). These values were compared to the unit costs estimated based on the past three years' consistency evaluations. Consistency values were comparable. However, we conservatively kept the inflated 2028 TAMP values because they were slightly higher, and the consistency projects did not include several projects for all work types as to be considered representative. The definitions of the treatments are aligned with the ones from the Design Directive 115 which was developed to aid in the consistency assessment. These definitions are shown in Appendix E.

Table 5-9: Bridge Work Types and Unit Costs

Work Type	Base Average Cost per Square Meter			
	Deck	Superstructure	Substructure	Culvert
Replacement	$1,416.00	$1,239.00	$1,062.00	$944.00
Major Rehabilitation	$1,416.00	$708.00	$708.00	$708.00
Minor Rehabilitation	$708.00	$472.00	$472.00	$472.00
Preservation	$177.00	$147.50	$147.50	$147.50
No Immediate Action	$0.00	$0.00	$0.00	$0.00
NOTE: Unit costs are additive. For example, if deck needs replacement, superstructure needs minor rehabilitation, and substructure has no immediate need, the total cost per square meter would be $1,200+400 = $1,600/sq. mt. Inputted average unit cost per treatment needs to account for this.				

As with the pavement life-cycle analysis, PRHTA uses three Excel-based tools to generate investment scenarios. The three bridge tools are developed to be applied stepwise. The first tool is used to identify the bridge inventory and to calculate the bridge condition, including the Fair condition sub-categories. This tool also determines recommended treatments for each bridge component based on the condition and work type matrix. This information can be used for planning projects. The second tool is used to develop the deterioration model. Historical condition data is used to estimate average deterioration per system.

The final tool is used to input some of the results from the previous tools (condition, deterioration, improvements after projects) and information from projects that are already programmed to develop the investment strategies.

PRHTA's use of these life-cycle treatment strategies has resulted in substantially improved percentages of Poor condition bridges. As shown in the Summary Condition of Assets chapter, the percentage Poor has fallen from a peak of 15.6 percent in 2006 to only 7.81 percent based on the 2022 published NBI data (2021 collection). An analysis of the programmed STIP projects also reveals that PRHTA is programming an increasing number of bridge projects. Those projects continue the emphasis upon the critical bridges but also accelerate investments into preservation and rehabilitation to implement the life-cycle planning strategies. It is notable that PRHTA has comfortably exceeding its target of no more than 10 percent of the NHS bridge area being Poor.

Chapter 6. Risk Management and Resilience

Photo 6-1: PRHTA Faces Repeated Threats from Extreme Weather

This chapter discusses the processes PRHTA has implemented to manage risks to its NHS pavements and bridges and to provide a transportation system that is safe and reliable for the movement of people and Goods in Puerto Rico. It also explains how PRHTA meets the various Federal regulations relating to risk management.

6.1 Regulatory Background

There are several Federal regulations relating to managing risk and resilience of NHS assets. These include the 23 CFR Part 515 [37] TAMP Federal requirements, the 23 CFR Part 667 requirements [38] relating to assets impacted by emergency events, and the new Bipartisan Infrastructure Law [39] that was enacted by Congress in 2021.

The Part 667 Federal regulations require State DOTs to consider when developing their TAMP at a minimum the results of periodic evaluations of the State's NHS pavements and bridges impacted by repeated damages from emergency events. [40] As part of the BIL, the Federal

[37] 23 CFR 515.7(c),515.9(d)(6) Asset management plan requirements
[38] 23 CFR 515 Part 667 Periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events
[39] U.S.C .23 Sec. 119(e)(4)
[40] 515.7(c)(1), Process for establishing the asset management plan

requirements for the TAMP were amended to include consideration of extreme weather and resilience in life-cycle planning and risk management.

The sections that follow explain how PRHTA satisfies the Part 667 requirements and also included consideration of the extreme weather and resilience BIL requirement that needs to be addressed in the Risk Chapter of the TAMP.

6.2 Risk and Resilience Management Process

PRHTA has adopted the FHWA approved risk management process that meets all FHWA TAMP regulations. Figure 6.1 shows the steps in this process. PRHTA's process addresses all its internal risk management requirements, while also meeting all the Federal requirements.

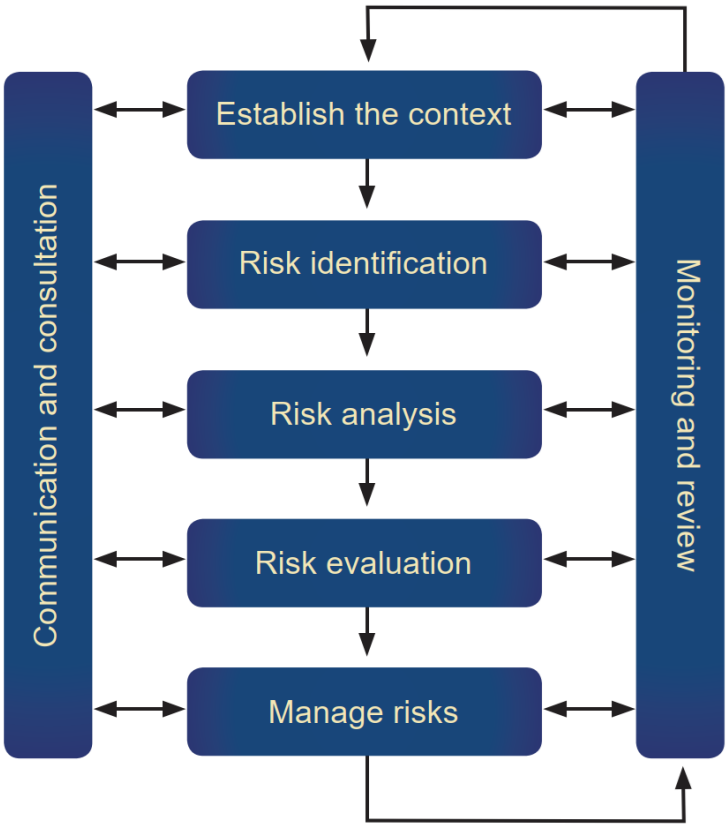


Figure 6.1 FHWA approved AASHTO Risk Management process

6.2.1 PRHTA 's Risk and Resilience Management Process

The PRHTA risk management process engages subject matter experts (SMEs) to focus on risks to the numerous transportation assets managed by the agency. This section focuses on the PRHTA

process to manage risk to NHS pavements and bridges. At a summary level, the steps include the following:

1. **Establish Context -** The PRHTA mission, vision, goals, and the TAMP objectives provide the primary context for the risk management process. While establishing the context, PRHTA also considers Puerto Rico's changing transportation needs and the territory's social, economic, climate, and financial environment.

2. **Identify Risks** - The PRHTA's risk identification process includes the next steps:
    a. Identify risks to pavements and bridges including those due to extreme weather, climate change, data quality, knowledge loss, planning and programming, seismic events, and financial risks.
    b. Review the 667 PRHTA database and reports of all emergency events and identify assets at-risk per the 667 Federal requirements.
    c. Identify assets that are not resilient to extreme weather impacts to address the new BIL TAMP requirements on risk management.
    d. Identify risks due to accelerated deterioration, and condition of bridges and pavements.
    e. Group the risks to pavements and bridges based on:
        i. Current conditions and projected trends
        ii. Current and future environmental risks such as extreme weather events
        iii. Lack of resilience
        iv. Climate change
        v. Seismic activity
        vi. Planning and programming delays
        vii. Recurring damaged identified through the Part 667 process

3. **Analyze, Evaluate, and Prioritize Risks -** The following actions are performed by the PRHTA during this step:
    a. Assess and score all the risks for likelihood and impact on a scale of 1-5.
    b. Prioritize the risks using Risk Values (Likelihood times Impact) on scale of 1-25 and PRHTA's risk tolerance.

4. **Develop Mitigation Strategies -** In collaboration with SMEs, PRHTA develops mitigation strategies for all high priority risks. Each high priority risk will typically include one or more mitigation strategies.

5. **Update the Risk Register -** The results of all the previous steps are captured in a detailed risk register to guide mitigation actions. This register addresses the risks to pavements and bridges. The register provides a list of risks by priority ranking addressing the categories identified earlier.

6. **Monitoring and Managing Risks -** PRHTA has implemented a process to monitor and manage risks. Risk priorities can change over time and the process implemented enables PRHTA to ensure that risk priorities are updated, high priority risks are continuously monitored, and progress of mitigation actions tracked, revised, and escalated as appropriate.

6.2.2 PRHTA 's Process for developing the 2022 TAMP Risk Register

For the 2023-2032 TAMP, PRHTA engaged 24 SMEs to collaborate in an exercise to develop an updated risk register. This register captured the current and future risks to achieving and sustaining the performance and condition targets for NHS pavements and bridges. It also addressed the resiliency risks to bridges and pavements and the risks resulting from the 667 emergency events. SMEs from PRHTA, DTPW, FHWA, and Metropistas participated in the exercise. As a result, 62 Risks to NHS pavements and bridges were identified, in eight different categories. They also identified 68 mitigation strategies to address these risks. After review and feedback, the updated risk register formed the basis for developing the final 2022 TAMP Risk Register (also referred to as "Risk Register").

The process to prepare this updated risk register and the final Risk Register included the following steps:

1. **Risk Management Overview Session -** Conducted a webinar providing an overview of risk management and the process to identify, evaluate, analyze, score, and prioritize risks. The session also explained how to develop mitigation strategies to address a risk.

2. **Develop and Circulate Initial Draft Risk Register along with Detailed Guidance -** The PRHTA TAMP team developed an initial draft Risk Register incorporating past, present, and potential future risks. This register was circulated in October 2022 to 24 SMEs for their input. Accompanying the risk register was a guidance document that included:
    a. Detailed guidance to assist SMEs in editing, adding, or deleting risks.
    b. Detailed guidance on analyzing and evaluating each risk based on Likelihood and Impact and assigning scores for those parameters.
    c. Guidance on prioritizing risks.
    d. Guidance on incorporating mitigation strategies for each risk.

    SMEs were asked to recommend one or more mitigation strategies for risks in their area of expertise. The topics in the risk register covered financial, planning, drainage, design, extreme weather, technology, knowledge management, and other risks to bridges and pavements on the NHS. Because the SMEs represented PRHTA leadership and experts from several offices, including the concessionaires, the feedback received was holistic.

3. **Consolidate and Recirculate -** Feedback received from the experts was consolidated into an intermediate Risk Register and circulated for final feedback from SMEs. The intent of circulating the consolidated register was to provide all SMEs an opportunity to review the

risks, risk ratings, priorities, and mitigation strategies provided by others, and as appropriate, revise, edit and provide feedback on all the risks in the register.

4. **Consolidate Mitigation Strategies and Prioritize Risk -** The feedback received on the mitigation strategies for all the risks was also incorporated into the consolidated risk register. The risks were prioritized using the Risk Values as computed. The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk. The updated consolidated risk register was circulated for final feedback. The information received was input into a final 2022 TAMP Risk Register.

6.2.3 The Top 10 Risks

The top 10 risks are listed below.

1. If PRHTA does not methodically plan and program rehabilitation and reconstruction of the aging interstate pavements, then the condition of the Interstate will deteriorate resulting in the percentage of Poor Interstate exceeding the Federal minimum 5 percent acceptable level leading to funding penalties.
2. If PRHTA does not methodically fix the concrete pavement on the interstate and NHS Non-Interstate, then, it will not be able to reduce the percentage of Poor pavements and achieve its condition and desired SOGR targets.
3. If PRHTA continues to lose knowledge staff, then there will be a vacuum in knowledge about important aspects of pavement and bridge inventory, condition, performance, deterioration, and history, delaying decisions or resulting in incorrect decisions that may be more expensive and negatively impact the condition, and performance of bridges and pavements, posing safety risks.
4. If PRHTA does not use asset management processes to create and deliver a realistic list of required STIP projects, then our NHS pavements and bridges could deteriorate, and we will not achieve our pavement condition targets and our desired SOGR, and negatively impact safety and resiliency.
5. If PRHTA does not invest in making critical assets resilient, then we will continue to have asset failures and will have to invest resources to work on emergency projects after each major natural event (hurricanes, earthquakes).
6. If PRHTA does not have sufficient trained contract management personnel, then we will be delaying the authorization and re-authorization of many important service contracts, that will cause delays in planning, programming, design, and delivery of important bridge and pavement projects.
7. If PRHTA is not able to measure pavement friction and address low-friction sites, then we may experience increased crashes posing safety risks.
8. If PRHTA does not ensure succession planning in important areas of asset management and decision making, then all the Good work done to date will be lost and new personnel will waste significant time in recreating or learning about Good practices that support data-driven asset management decisions negatively impacting the progress made.

9. If PRHTA does not train and retain sufficient knowledge staff, then, we will not have sufficient knowledge staff with the ability to manage, direct, and guide consultants, contractors, and other external service providers to provide Good services and products to support our transportation asset management needs.
10. If PRHTA does not develop and implement a robust preservation and maintenance program for pavements and bridges, then we will have Good and Fair pavements and bridges that will deteriorate necessitating more expensive rehabilitation and reconstruction treatments.

The top two risks in each of the eight categories are shown in the next table excerpts from the risk registers. The complete risk register is in Appendix F.

Table 6-1 The Top Two Pavement Risks

Top Two Pavement-Related Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA does not methodically plan and program rehabilitation and reconstruction of the aging interstate pavements,	then the condition of the Interstate will deteriorate resulting in the percentage of Poor Interstate exceeding the Federal minimum 5 percent acceptable level leading to funding penalties.	22.50	PRHTA will develop a STIP that will prioritize Interstate pavements in Poor condition and ensure that the projects are delivered on time.
If PRHTA does not methodically fix the concrete pavement on the interstate and NHS Non-Interstate	then it will not be able to reduce the percentage of Poor pavements and achieve its condition and desired SOGR targets.	21.25	PRHTA will prioritize the rehabilitation and reconstruction of its aging concrete Interstate pavements.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-2 The Top Two Bridge Risks

Top Two Bridge-Related Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA does not implement a plan to address the bridge decks in Poor and close to Poor condition	then, the percentage of bridges in Poor condition will increase to exceeding the federal minimum of 10 percent Poor by deck area.	15.94	PRHTA will emphasize when programming bridges the need to address the large number of bridge decks in Poor or "near-Poor" condition.
If PRHTA does not focus on preservation and treat the Fair and Poor bridges	then, bridges that are in Fair condition will continue to deteriorate, necessitating more expensive treatments.	13.13	PRHTA will actively manage the STIP's bridge projects, analyze the bridge conditions and ensure that appropriate funding is allocated to preservation and maintenance of Good and Fair bridges.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-3 The Top Two Planning Risks

Top Two Project-Planning Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA does not use asset management processes to create and deliver a realistic list of required STIP projects	then our NHS pavements and bridges could deteriorate, and we will not achieve our pavement condition targets and our desired SOGR, and negatively impact safety and resiliency.	20.00	1) PRHTA will increase the number of STIP projects to fully use the funds provided by the FOMB. 2) PRHTA will complete and implement PMIS. 3) PRHTA will devote adequate resources to effectively manage the larger planning, design, and construction efforts needed to deliver the larger program.
If PRHTA does not develop and implement a robust preservation and maintenance program for pavements and bridges	then, we will have Good and Fair pavements and bridges that will deteriorate necessitating more expensive rehabilitation and reconstruction treatments.	17.00	1) PRHTA will adopt programming policies to emphasize the selection of preservation projects in the STIP. 2) PRHTA will coordinate with the DPW to implement low-cost maintenance treatments and preservation projects to extend the life of pavements and bridges.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-4 The Top Two Information Risks

Top Two Information and Data-Related Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA does not invest in timely pavement data collection and data quality improvements	then, we will not have the accurate data to understand the pavement deterioration trends to plan for investments in timely preservation and the delay may require resorting to more expensive treatments.	14.88	PRHTA will consider investing additional resources to manage (including integrity and security) the quality and timely collection of pavement data.
If there is no single reliable source of master bridge and pavement inventory with tracking of changes used by all offices	then, information will keep changing year by year, resulting in confusion and errors and lack of credibility to use the data for decisions.	14.00	PRHTA will develop and implement a plan that prioritizes the different data, and implement a plan to clean and update, and upload the data to a Data Warehouse that will serve as the single source of all data.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-5 The Top Two Funding Risks

Top Two Funding-Related Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If inflation continues at a high rate	then we will be unable to deliver the projects needed to achieve our condition and performance targets and ensure safe movement of people and freight.	16.88	Continue to monitor bid prices and be prepared, if necessary, to ask the FOMB for additional monies.
If PRHTA does not get sufficient, timely, and consistent funding for pavements and bridges	then the pavements and bridges will continue to deteriorate necessitating more expensive treatments.	16.25	PRHTA will communicate to its stakeholders the importance of delivering the projects aligned to the TAMP to improve and sustain the condition and performance of assets. PRHTA will also advocate to the MPO to continue supporting the use of Federal and State funds primarily to improve and sustain asset conditions.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-6 The Top Two Extreme Weather Risks

Top Two Extreme Weather-Related Risk			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA does not invest in making critical assets resilient	then we will continue to have asset failures and will have to invest resources to work on emergency projects after each major natural event (hurricanes, earthquakes).	20.00	PRHTA should incorporate resiliency in all new design and rehabilitation/reconstruction projects.
If PRHTA does not give the Notice to Proceed to the pavement data collection contract on the first months of the year	then we will continue to have limited time to properly review the quality of the data before HPMS data submission	15.00	PRHTA will prioritize to give the Notice to Proceed for the data collection in January of every year.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-7 Top Two Knowledge Risks

Top Two Knowledge and Information Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA continues to lose knowledge staff	then there will be a vacuum in knowledge about important aspects of pavements and bridges inventory, condition, performance, deterioration, and history, delaying decisions or resulting in incorrect decisions that may be more expensive and negatively impact the condition, and performance of bridges and pavements, posing safety risks.	21.25	PRHTA should develop succession strategies as staff retire or leave PRHTA.
If PRHTA does not have sufficient trained contract management personnel	then we will be delaying the authorization and re-authorization of many important service contracts, that will cause delays in planning, programming, design, and delivery of important bridge and pavement projects.	20.00	PRHTA will recognize that increasing the size of its program requires increased contracting support and will commit the necessary resources to quickly authorize contracts.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

Table 6-8 The Top Two Stakeholder Risks

Top Two Stakeholder Risks			
Risk Event	**Primary Impact & Consequence**	**Risk Value**	**Mitigation Strategies**
If PRHTA is unable to educate political leaders and other stakeholders to accept and buy-in to analytical data-driven decisions that are aligned to Good asset management practices	then, project selection will be based on political factors and not support the overall SOGR for Puerto Ricans that will help the economy grow and ensure safety of travelers.	13.8	PRHTA will publicize and educate the need for a TAMP, the benefits of asset management, and document the higher conditions and costs savings that have resulted from using asset management principles.
If PRHTA is unable to educate political leaders and other stakeholders to understand and collaborate on asset management decisions	then there will be a lot of push back on support for the delivery of much needed projects that will improve and sustain asset condition and SOGR targets.	13.8	PRHTA will brief legislators and new members of the governor's staff about the benefits and cost savings produced by asset management.

The Risk Value ranges from 1 to 25 and is computed by multiplying the Likelihood score and the Impact score of each risk.

6.2.4 Monitoring and Managing Risks

PRHTA has implemented a process to monitor risks and manage the progress of the mitigation strategies for all the high priority risks. In October 2022, PRHTA implemented a new "Quality Control and Quality Assurance" process for the management and coordination of contracted design projects. This quality management process includes the participation of PRHTA Construction Area personnel. Schedule, scope, cost, and quality risks to projects in design phases are being cataloged and managed by PRHTA. These risks will be reviewed quarterly with the PRHTA leadership and mitigation strategies will be implemented to manage the risks.

The final Risk Register that was developed will be periodically updated to reflect changes as they are identified.

6.3 Part 667 Requirements

The 23 CFR Part 667 regulation states that each state shall conduct statewide evaluations to determine if there are alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events that occurred since January 1, 1997.[41]

Federal regulations define an emergency event as a natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States.[42] These regulations also state that State DOTs shall consider the results of the evaluation prepared under this part (23 CFR Part 667) when developing projects.[43] Prior to approving new STIP projects, FHWA reviews the list of included project sites to validate that 667 considerations are addressed in the design of the new project.

6.3.1 PRHTA Part 667 Analysis

PRHTA meets all the Federal regulations relating to the 23 CFR 667 requirements. In 2018-19, adhering to the requirements for timing of statewide Part 667 related evaluations,[44] PRHTA conducted a detailed review and evaluation of all the NHS roads, highways, and bridges. As a result, a detailed assessment was included in the 2028 TAMP, sections *2.7 Assessment for Recurring Damages* and *5.3 Risks Associated with Environmental Conditions*. In 2020, PRHTA addressed the Federal requirements to evaluate affected portions of roads, highways and bridges of all roads, highways, and bridges. PRHTA conformed to the requirement that portions of these facilities that were subject to repeated damages should be evaluated prior to developing any new projects on those portions. A copy of the main columns of the database, showing only the sites with repeated impact, is included in Appendix G. A copy of the cover and table of contents of the 2020 Part 667 report is included in Appendix H.

6.3.2 Summary of PRHTA's Part 667 Process

PRHTA has developed a database of all sites that are known to have been damaged since Jan. 1, 1997. It has implemented a process to update the Part 667 database. Figure 6-1 shows the detailed process that PRHTA has developed to address the Part 667 requirements.

[41] 23 CFR Part 667.1 -Statewide evaluations
[42] 23 CFR Part 667.3 Definitions
[43] 23 CFR 667.9 Considerations of evaluation
[44] 23 CFR 667.7 Timing of evaluation

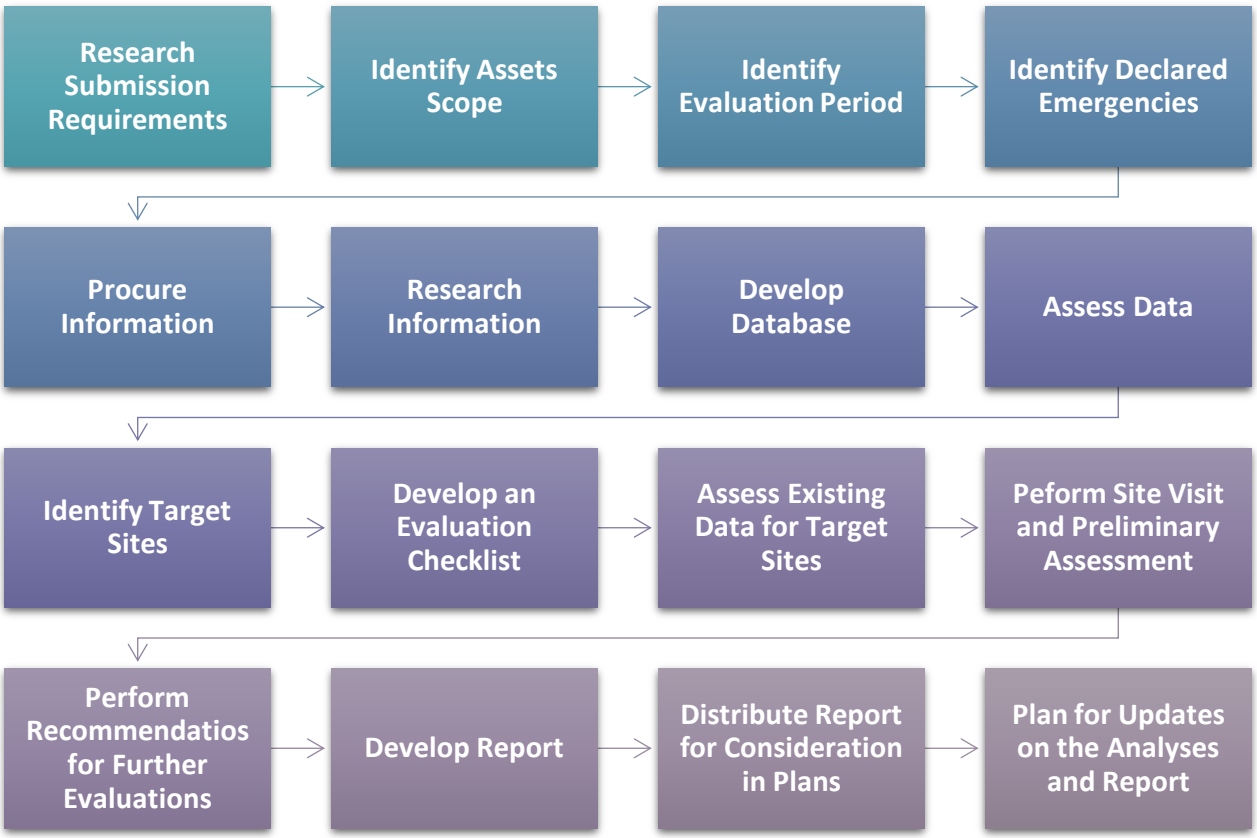


Figure 6-1: Part 667 Process

As part of this process, PRHTA completed the following activities in 2022:

Reviewed all FHWA and PRHTA reports to identify sites damaged during emergency events since January 1, 1997.

1. Created a Part 667 database that serves as the main data source of all sites damaged during emergency events since January 1, 1997. The database includes the location, whether NHS or non-NHS and where on the NHS or non-NHS, details of the portions of roads, highways or pavements impacted, the nature of damage, dates of the events, and computations to identify the number of times the site was damaged by emergency events.
2. Conducted a statewide evaluation after the 2020 earthquakes, February 2022 heavy rains, and 2022 hurricane Fiona to determine if any new sites were impacted by any new emergency events. The sites identified as being impacted were added to the Part 667 database.

3. Evaluated data to identify if any such sites required repair and reconstruction on two or more occasions due to emergency events.
4. Reviewed each site to identify if there were reasonable alternatives to roads, highways, and bridges that were impacted and required repair.

6.3.3 2022 Summary

Following the process on Figure 6-1, the Part 667 database was updated to include Information about new damaged sites, making possible the identification of additional locations with repeated damages.

Based on the evaluation of the updated database on damaged sites due to declared emergency events, PRHTA identified three (3) additional NHS sites that were impacted more than once due to declared emergency events. They were on the Interstate system. One of the Interstate sites is a bridge. The other two sites are located on PR-26. The PR-26 sites were impacted by flooding. More details on these sites are provided next.

1. The bridge has a PRHTA structure number 1668 and is a culvert type one. It was built in 1979 and, as of 2021, it had a Fair-to-Poor condition. The type of damage reported were large debris accumulation and erosion after hurricane María in 2017, and spalling and exposed reinforcement after the 2020 earthquakes. This bridge was repaired with minor rehabilitation works in 2022, as part of the project AC 200029.

2. The PR-26 segments are located around kilometers 2.3 and 3.1. The type of damage reported was flooding, at both sites and at both heavy rain events in 2014 and 2022. The road at those sites is currently in Fair-Fair condition. The current STIP includes, as part of its Pavement Rehabilitation and Reconstruction program, a minor rehabilitation project at this road that includes both of the identified segments. The project is currently under design and is expected to go into a bid process by 2023.

These Interstate sites are added to other three (3) sites on the NHS Non-Interstate that were previously identified and included in the 2028 TAMP, the 2020 Part 667 Report, and the database sample on Appendix G.

The updated database will be extremely useful if any future emergency event occurs, as it will be possible to easily identify sites that have already been impacted due declared emergencies in the past. This will also expedite the identification and evaluation of project sites prior to programming a project at those locations.

6.3.4 Next Steps

PRHTA has instituted additional steps to address the programming of projects that address the Part 667 sites. These include:

1. The TAM program manager will send the list of all Part 667 impacted sites to the Areas of Design and Construction, so they can consider that those are vulnerable sites.
2. The TAM program manager will request the Construction Area director to direct the appropriate regional offices to visit the impacted sites and provide their assessment and recommendations to the Design and Construction Area directors on the condition and state of the asset. This information will influence the design and construction of the project. The TAM program manager will also be updated throughout the process.
3. The TAM program manager will procure from Construction and Design Area, the projects in the pipeline to check if any project is located on a Part 667 impacted site. The TAM project manager will also ask for their recommendations on the best approach to make them resilient.
4. The Appendix G includes a copy of the memo that was sent to Construction Area personnel regarding the above points concerning Part 667 process.

Chapter 7. Financial Plan

Photo 7-1: Highway through Puerto Rico's Central Mountain Range

This chapter includes a ten-year financial plan to fund the NHS bridges and pavements in Puerto Rico. The chapter is organized to satisfy the FHWA asset management regulation. It also explains how PRHTA funds are planned to be invested to maintain NHS pavements and bridges in a SOGR.

7.1 Regulation Background

The Federal asset management regulation in 23 CFR Part 515 requires state DOTs to implement a process to develop 10-year asset management financial plans. FHWA defines asset management financial plans as:

> *"Financial plan means a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies*." (23 CFR 515.5)

The financial planning process must produce, at a minimum:[45]

1. The estimated cost of expected future work to implement investment strategies contained in the asset management plan, by State fiscal year and work type.
2. By work types, FHWA means initial construction, maintenance, preservation, rehabilitation, and reconstruction. In other words, the financial plan must indicate how much will be invested in NHS pavements and bridges each year for 10 years in the 5 work types.
3. The estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of future work types. State DOTs may estimate the amount of available future funding using historical values where the future funding amount is uncertain.
4. Identification of anticipated funding sources.
5. An estimate of the value of the agency's NHS pavement and bridge assets and the needed investment on an annual basis to maintain the value of these assets.

7.2 What the Plan Covers and What it Does Not Cover

Because this TAMP only addresses NHS pavements and bridges, the financial plan only includes the amounts for NHS pavements and bridges. The plan does not address the PRHTA expenditures, for non-NHS pavements and bridges, salaries, bond repayment, safety, emergency repairs, or traffic-related investments such as for signs or traffic signals.

7.3 The Financial Planning Process

As noted in the above regulation, PRHTA must have both a process for developing the TAMP financial plan, and the 10-year plan itself. The process for developing the financial plan was stated in the 2028 TAMP. The process has been updated and is included in this chapter.

7.4 Steps in the Financial Planning Process

The Congressionally enacted Puerto Rico Oversight, Management, and Economic Stability Act of 2016 (PROMESA) controls PRHTA annual budgeting and long-term financial planning. Unlike in other States, the Legislative Assembly of Puerto Rico and the Puerto Rico Governor do not solely decide on the PRHTA budget. The Governor negotiates with the Financial Oversight and Management Board for Puerto Rico (FOMB) to develop annual budgets as well as a long-term Fiscal Plan. The process generally reflects the following steps.

[45] 23 CFR 515.7 (d)(1-4)

1. Both PRHTA and the FOMB expressed the intent to invest adequately in Puerto Rico highways to achieve a SOGR. However, the FOMB stated in the Fiscal Plan that revenues were inadequate to fund optimum investment scenarios.
2. For the NHS, PRHTA has adopted the FHWA bridge and pavement performance measures and the minimum allowable condition levels to set targets and to define the SOGR. (23 CFR 490.315(a) and 23 CFR 490.411(a)).
3. PRHTA and its consultants estimated the investment level scenarios needed to achieve the 2-year and 4-year bridge and pavement targets as well as a 10-year SOGR target. These scenarios are developed with analytical tools that mimic the requirements of 23 CFR 515.17 and are explained in the Life-Cycle Planning chapter.
4. PRHTA:
    a. Reviews the funding available for how to allocate funds to achieve the highest conditions with limited resources.
    b. Considers alternative strategies to economize or achieve the targets through different treatment strategies.
    c. Reviews risks that could accompany the investment levels.
5. The PRHTA submitted its SOGR funding request to the central government that submitted it to the FOMB. However, the FOMB states in the PRHTA Fiscal Plan that revenues were inadequate to fund PRHTA's desired investment levels. Of four investment scenarios PRHTA presented to the FOMB, the FOMB adopted – with some reductions – the lowest cost scenario.
6. The FOMB in October 2022 issued a 28-year financial plan and an FY 2023 budget that influenced the fiscal plan below.
7. The FOMB long term plan influenced but did not finalize the TAMP financial plan. The FOMB financial plan included funds for multiple purposes such as operational costs and all construction funds, not only funds for NHS pavements and bridges. The TAMP Financial Plan is derived from the "capital hard cost" portion of the funds included in the FOMB fiscal plan.
8. The TAMP financial plan also incorporates the STIP. The TAMP Financial Plan estimates how much of the STIP funds for FY 2023 – FY 2026 will be allocated for bridge and pavement expenditures. For STIP projects identified as pavement and bridge projects, the TAMP financial plan estimates that only 54.5 percent of pavement projects and 83.0 percent of bridge projects' cost will go to running lanes' pavement and bridge work items. The remaining funds usually go to related work such as slope stabilization, signage, shoulders, acceleration or deceleration lanes, or traffic safety devices. Therefore, the TAMP financial plan is based upon those fractions of the STIP amounts. Then, the amounts from FY 2023 – FY 2026 are used as the basis for forecasting funding amounts for the remaining years of the 10-year financial plan. Funding amounts from FY 2023 to FY 2026 are based on the discounted amount of STIP projects for those years. Average expected funding amounts from FY 2027 to FY 2032 are based on the average discounted amounts from the STIP.

The process of discounting the TAMP investment strategy amounts from the larger amounts in the STIP is intended to more appropriately represent the actual pavement and bridge

investments from the total project investments and therefore assist with the "consistency process."[46] Each July, PRHTA must submit documentation to FHWA that the projects it authorized in the past 12 months are "consistent" with the TAMP investment strategies. Based on past history, only a portion of the expenditures for projects given a "notice to proceed" were for pavement and bridge items. Therefore, the TAMP investment strategies are based upon estimates of what percentage of STIP projects will go to bridge and pavement work items.

7.5 Revenue Sources

Although Puerto Rico generates several highway-related revenue sources such as fuel taxes, those funds are not dedicated to highway purposes as is common in most States. The FY 2023-FY 2051 Fiscal Plan for the PRHTA notes that before 2015, PRHTA received appropriations from cigarette taxes, gasoline and diesel taxes, a petroleum tax, and vehicle license fees.[47] The Puerto Rican central government began retaining those funds in October 2015. The central government began two transfers to PRHTA. One is for capital expenditures, known as CapEx, and the other is a general transfer for operational expenses and capital needs of non-toll assets. Of relevance to the TAMP is the CapEx because it relates to capital investments such as bridges and pavements. Included in the total funding the FOMB allocates to PRHTA are the FHWA funds in addition to the State-generated CapEx funds.

7.6 Federal Funds Forecast

Other States receive Federal funds from several programs such as the National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STPBG), or the Highway Safety Improvement Program (HSIP). However, Puerto Rico receives just two Federal Highway funding sources that are relevant to the TAMP (Table 7-1). Those are the Puerto Rico Highway Program and the Bridge Formula Program. PRHTA also receives extensive Emergency Repair funds as well as funds for transit and miscellaneous programs such as for electric vehicle charging stations. However, those funds are not eligible for implementing the TAMP's NHS pavement and bridge investment strategies.

[46] 23 CFR 515.13(b)(2)

[47] Fiscal Plan for the Puerto Rico Highways & Transportation Authority (PRHTA) FY2022-FY2051, certified on Oct. 14, 2022, page 111.

Table 7-1 FHWA Funds Allocated to PRHTA in the Bipartisan Infrastructure Law

FHWA Program Allocations to PRHTA FY 2022-26 (Million USD)						
Program	**2022**	**2023**	**2024**	**2025**	**2026**	**2022-2026**
Puerto Rico Highway Program	$173	$177	$180	$184	$187	$901
Bridge Formula Program	$45	$45	$45	$45	$45	$225
Total	**$218**	**$222**	**$225**	**$229**	**$232**	**$1,126**

The forecasted FHWA revenues for the 11 years of the TAMP are shown in Table 7-2. The amounts in FY 2022 to FY 2026 are from the recent Congressional appropriation tables. The Puerto Rico Highway Program projections for FY 2027 to 2032 are based upon 1.7 percent annual growth rate estimates.[48] The TAMP's FHWA fund forecast does not assume that the BIL bridge funding program will continue beyond FFY 2026.

Table 7-2 Actual and Estimated FHWA Funds Relevant to the TAMP Financial Plan

FHWA Program Allocations: Actuals to FY 2026 and Estimates From FY 2027 to FY 2032 (Million USD)											
Program	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
P.R. Highway Program	$173	$177	$180	$184	$187	$190	$193	$197	$200	$203	$207
Bridge Formula	$45	$45	$45	$45	$45						
Total	**$218**	**$222**	**$225**	**$229**	**$232**	**$236**	**$240**	**$243**	**$247**	**$251**	**$256**

PRHTA also receives Federal Emergency Repair (ER) funds, it may apply for funds from the Community Development Block Grant Program (CDBG), and other sources. However, those funds are not allocated to the regular repair and maintenance of NHS pavements and bridges. Therefore, they are not included in the financial plan nor do the investment strategies rely on those funding sources.

7.7 Projected Funding Allocations for NHS Pavements and Bridges

The FOMB produced a long-term forecast of capital investment amounts for PRHTA as part of the Fiscal Plan for the Puerto Rico Highways & Transportation Authority (PRHTA) FY2023-FY2051, certified on October 14, 2022. For the 11 years of this TAMP, the "capital hard costs," or amounts allocated to highway construction programs, are shown in Table 7-3: . These funds include a combination of State CapEx funds, FHWA funds, and toll revenues. The fiscal plan provides additional revenues for right of way and soft costs such as planning, design, material testing, and inspection.

[48] The 1.7% estimate is consistent with the FOMB-approved Fiscal Plan.

Table 7-3: Table 7-3 includes funds for both the tolled and non-tolled Puerto Rico highways. In 2022, PRHTA was in the process of selecting a concessionaire to operate the tolled highways not already under a concession. The FOMB Fiscal Plan separates PHRTA's funding into tolled and non-tolled amounts in anticipation of the concession agreement. This TAMP, however, does not analyze the tolled and non-tolled roads separately, nor does it include a financial plan discerning tolled and non-tolled roads. When the concession agreement is completed and implemented, the TAMP will be updated to reflect changes in funding streams, if any. It was not certain at the time this TAMP was completed when the concession agreements would be finalized or their exact scope.

Table 7-3: Total FOMB-Allocated Highway 'Hard Costs'

FOMB-Approved Capital Investment Forecast											
Year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Hard Cost Forecast (Million USD)	$172.17	$281.37	$272.94	$298.69	$291.61	$294.07	$295.90	$280.96	$228.53	$232.41	$235.23

The funding in Table 7-3 is for all highway purposes, not only for NHS pavements and bridges. To develop the TAMP financial plan, PRHTA needed to estimate how much of the total funds from Table 7-3 would be allocated to NHS pavements and bridges. The FOMB-Fiscal Plan does not specify how much of the total Hard Costs should be allocated to what assets. However, the FOMB-Fiscal plan was partially based on a December 2021 analysis submitted by PRHTA. That December 2021 analysis assumed the following splits for key programs: Interstate pavements 12.5 percent, NHS Non-Interstate pavements 11.8 percent, and NHS bridges 22 percent. All other funds went to Non-NHS assets, safety, traffic control devices, or other uses.

The percent splits cited in the preceding paragraph influence Scenarios 2 and 3 in the Investment Strategy chapters. However, the TAMP financial plan does not assume the full amounts from the FOMB-Fiscal Plan will be invested in FYs 2023-2032. The TAMP Financial Plan and Investment Strategies are based on smaller investment levels taken from the STIP NHS bridge and pavement projects. Because of the annual need to demonstrate consistency, the TAMP relies on the amounts in the 2023-2026 STIP to form the Financial Plan. This STIP was developed in alignment with the strategies included in the 2028 TAMP, as explained in section 4.2 TAMP Support to STIP, constrained by the available budget.

The TAMP Financial Plan for NHS pavements and bridges uses as estimates for NHS pavement and bridge investments for FY 2023-2026, the amounts in the STIP. Table 7-4 shows the NHS pavement and bridge amounts in the STIP from FY 2023 to FY 2026. The 2022 amount is included to assist with the 2023 condition forecast and with the consistency review due in 2023; it is not part of the 10-year financial plan. The 2022 amounts in Table 7-4 include only the funds in projects that were given a notice to proceed (NTP) in FY 2022 and which were devoted to NHS pavement or bridge work types. Funds for non-pavement and non-bridge items were excluded, as well as those outside the main lanes such as works in shoulders and acceleration or

deceleration lanes. While the amounts for FY 2023 to FY 2026 are actual amounts from the STIP, the amounts for FY 2027 to FY 2032 are estimates based on the average of the amounts included on the STIP. Note that the amounts on Table 7-4 are in current (2022) dollars and do not reflect inflation. To perform the currently expected works based on these amounts in the future, the amounts would need to be adjusted to reflect the current inflation at the time.

Table 7-4 Actual and Estimated STIP Amounts, as Well as NTP Amounts for 2022 Only

Asset	System	Actual TAMP Related NTP	Expected General Funding in Million USD									
			STIP				Estimated Average Funding based on STIP					
	Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pavements	Interstate	$35.8	$34.2	$41.8	$45.6	$49.6	$42.8	$42.8	$42.8	$42.8	$42.8	$42.8
	NINHS	$17.9	$16.5	$26.7	$24.9	$26.8	$23.7	$23.7	$23.7	$23.7	$23.7	$23.7
	Subtotal	**$53.7**	**$50.7**	**$68.5**	**$70.5**	**$76.4**	**$66.5**	**$66.5**	**$66.5**	**$66.5**	**$66.5**	**$66.5**
Bridges	NHS	$2.7	$12.7	$27.2	$32.8	$13.4	$21.5	$21.5	$21.5	$21.5	$21.5	$21.5
Total		**$56.4**	**$63.4**	**$95.7**	**$103.3**	**$89.8**	**$88.0**	**$88.0**	**$88.0**	**$88.0**	**$88.0**	**$88.0**

To produce financial plan investment levels based on the STIP forecasts, the STIP amount used in forecasting funding allocations for the Financial Plan needed to be adjusted. The adjustments reflect the fact that projects that are labeled as "pavement projects" or "bridge projects" contain non-pavement and non-bridge work items such as lighting, relocation of utilities, signage, among others. It would overstate the actual pavement and bridge investment levels if the entire project cost were assumed to be for pavement or bridge work items.

Analysis[49] of recent bridge and pavement projects indicated that, on average, 54.5 percent of the work items in "pavement projects" went to pavement items on the main running lanes (excluding shoulders and acceleration or deceleration lanes). For "bridge projects", 83.0 percent of the projects' cost when to bridge items.

The STIP amounts from Table 7-4 were multiplied by the 54.5 percent for pavement projects and 83.0 percent for bridge projects to produce the amounts in Table 7-5. Those amounts reflect how much of the STIP projects are expected to improve pavements and bridges. The remaining costs will go for the additional items such as traffic control devices, slope improvement, or other items besides pavement and bridge improvement.

[49] Refer to Appendix J for information regarding the assessment of the pavements and bridges portion of the total project investment.

Table 7-5 TAMP Financial Plan Investment Levels Based on Discounted STIP Amounts

Asset	System	Actual TAMP Related NTP	Expected TAMP Related Funding in Million USD									
			Discounted STIP				Estimated Average Funding based on Discounted STIP					
	Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pavements	Interstate	$35.8	$17.7	$22.8	$24.9	$27.0	$23.1	$23.1	$23.1	$23.1	$23.1	$23.1
	NINHS	$17.9	$10.0	$14.6	$13.6	$14.6	$13.2	$13.2	$13.2	$13.2	$13.2	$13.2
	Subtotal	**$53.7**	**$27.6**	**$37.3**	**$38.4**	**$41.6**	**$36.3**	**$36.3**	**$36.3**	**$36.3**	**$36.3**	**$36.3**
Bridges	NHS	$2.7	$8.7	$22.5	$27.2	$11.2	$17.4	$17.4	$17.4	$17.4	$17.4	$17.4
Total		**$56.4**	**$36.4**	**$59.9**	**$65.7**	**$52.8**	**$54.7**	**$53.7**	**$53.7**	**$53.7**	**$53.7**	**$53.7**

Metropistas also performs planned improvements. A similar exercise to the above was applied to its 2021-2030 Capital Investment Plan. It is shown in Table 7-6. An additional annual average of $6.4 million is expected for the facilities they manage.

Table 7-6: Expected Metropistas Investment

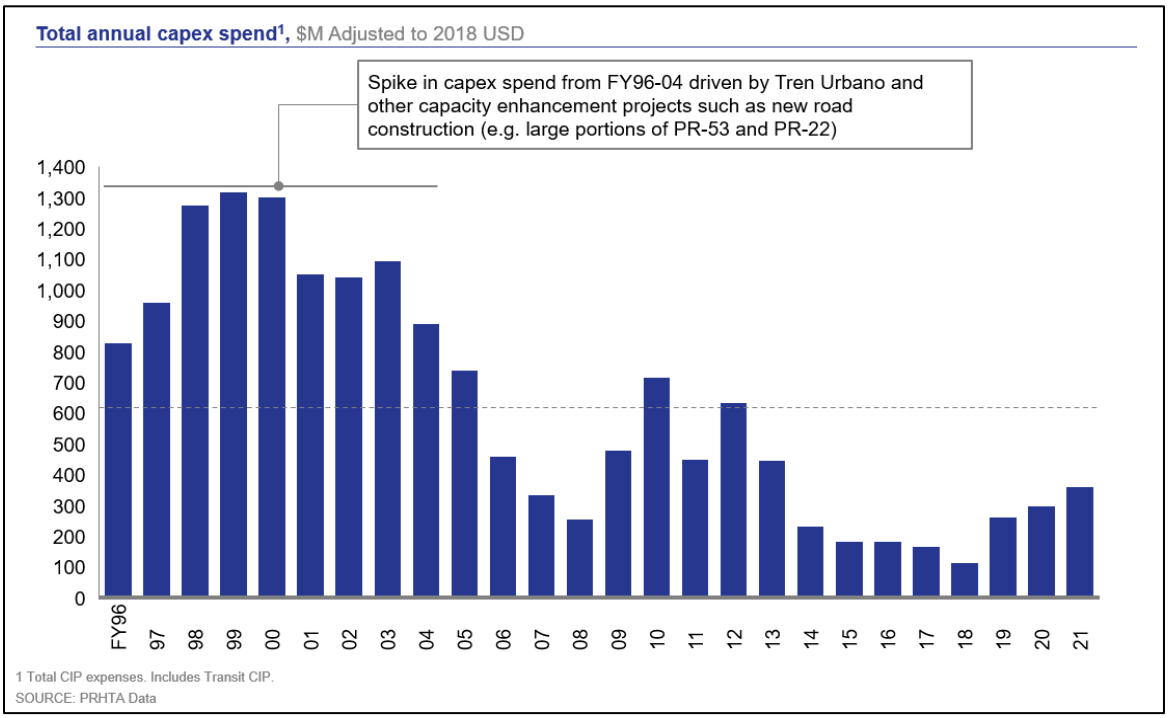
From Metropistas 2021-2030 CIP											
Asset	NTP	2021-2030 CIP								2023-2030 CIP Average	
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pavements	$5.8	$5.6	$8.5	$8.6	$5.5	$6.5	$7.6	$1.4	$6.9	$6.3	$6.3
Bridges	$4.6	$4.3	$3.8	$3.7	$3.9	$4.0	$2.9	$2.9	$3.1	$3.6	$3.56
Total	**$10.4**	$9.9	$12.3	$12.3	$9.4	$10.4	$10.5	$4.3	$10.0	**$9.9**	**$9.9**
TAMP Adjusted											
Asset	NTP									2023-2030 CIP Average	
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pavements	$5.8	$3.0	$4.6	$4.7	$3.0	$3.5	$4.1	$0.8	$3.8	$3.50	$3.54
Bridges	$4.6	$3.6	$3.2	$3.1	$3.2	$3.3	$2.4	$2.4	$2.5	$2.97	$3.0
Total	**$10.4**	$6.6	$7.8	$7.8	$6.3	$6.8	$6.6	$3.1	$6.3	**$6.4**	**$6.4**

Additional bridge and pavement funds are allocated to the Department of Public Works. FY 2022 was the first year in which a sizeable allocation has been made to DPW for several years. It is possible that some DPW funds may be used on NHS pavements or bridges. However, at the time the TAMP was developed, details regarding investment and scope of NHS projects funded by DPW were unclear. Therefore, the TAMP includes no assumptions about additional NHS investments from DPW.

7.8 Disbursement Trends

This TAMP financial plan represents PRHTA's intent to develop a stable, steady, predictable amount of investment to achieve a SOGR. A comparison of historical trends to planned trends shows the marked change represented by PRHTA's TAMP financial plan.

Figure 7-1 is from the October 2022 FOMB-approved fiscal plan. It shows capital expenditures by PRHTA from FY 1996 through FY 2021.[50] Amounts include both highway and transit capital expenditures with the large increase in the 1990s driven by the Tren Urbano rail system and large highway expansions.



Source 2023-2051 Fiscal Plan

Figure 7-1 Historical Disbursements for Capital Projects

The Fiscal plan indicates that from FY 1996 to FY 2004, PRHTA averaged $661 million in total capital disbursements, excluding Tren Urbano. By FY 2007, capital spending fell to below $400 million and fell further to $257 million in FY 2008. In 2018, capital spending reached a low point of $168 million.

The 2022-2032TAMP financial plan, showed in Figure 7-2, represents a substantial change. Although still constrained, it attempts to provide a steady, predictable funding stream to support the TAMP's 10-year investment strategies, unlike the unsteady and unpredictable spending levels seen in Figure 7-1.

[50] 2023-2051 Fiscal Plan p45

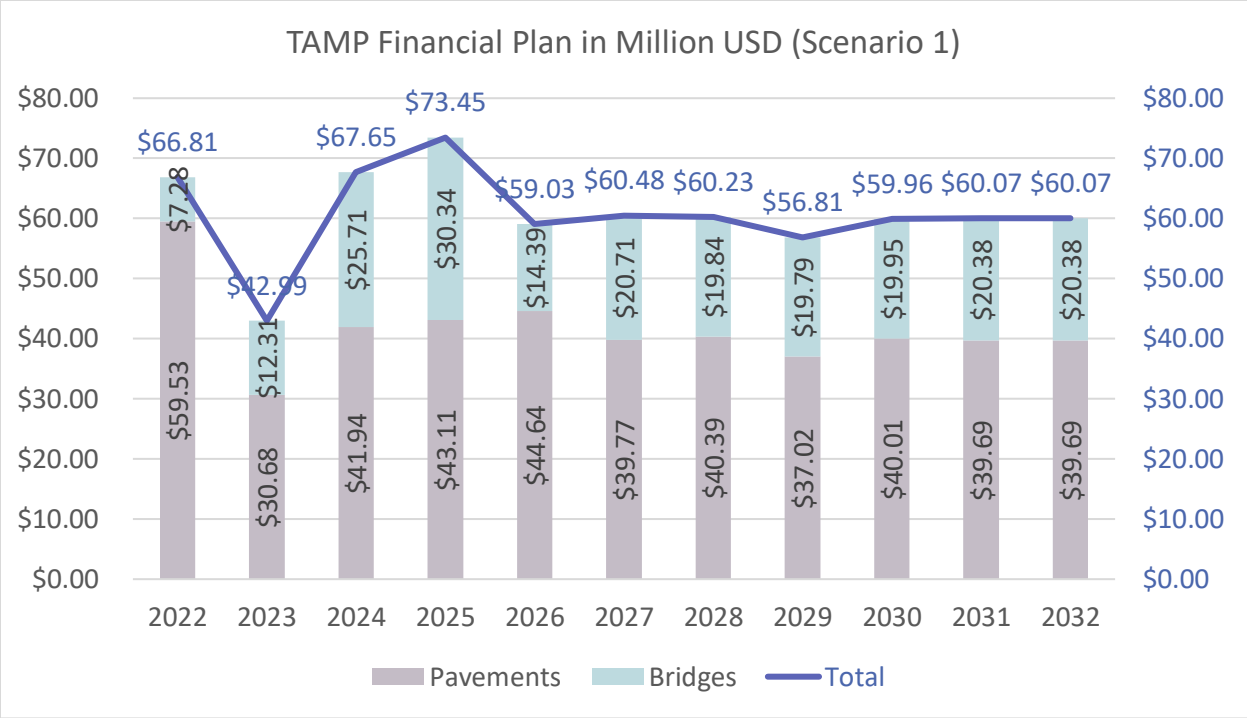


Figure 7-2: TAMP Financial Plan (Scenario 1)

7.9 TAMP Related Expenditure Trends by Federal Work Types

Recent expenditures for NHS pavements and bridges are shown by work type in Table 7-7 and Table 7-8. They show PRHTA delivering a combination of preservation, rehabilitation, and reconstruction/replacement projects. These expenditures are in terms of TAMP-related costs of the projects that have received notice to proceed during each fiscal year, as per the annual consistency evaluations.

Table 7-7 Expenditures from FY 2019 to FY 2022 by Work Type

NHS Pavements					
System	**Treatment**	**2019**	**2020***	**2021**	**2022**
Interstate	Preservation	$25,698,968	$2,880,860	$0	$6,001,632
	Rehabilitation	$33,396,842	$2,063,371	$4,545,606	$8,406,608
	Reconstruct \ Replacement	$0	$8,061,902	$0	$21,408,379
	Subtotal	**$59,095,810**	**$13,006,132**	**$4,545,606**	**$35,816,620**
NHS Non-Interstate	Preservation	$35,206,984	$41,596,433	$4,186,067	$886,686
	Rehabilitation	$6,361,136	$6,943,431	$9,918,343	$15,133,305
	Reconstruct \ Replace	$7,203,376	$7,286,704	$468,827	$1,891,978
	Subtotal	**$48,771,497**	**$55,826,567**	**$14,573,237**	**$17,911,969**
NHS	**Total**	**$107,867,307**	**$68,832,700**	**$19,118,843**	**$53,728,589**

**Includes obligations as accepted by FHWA due to extenuating circumstances.*

Table 7-8 includes the amount of TAMP related costs of NHS bridge projects by treatment type that have received notice to proceed between FY 2019 and FY 2022. These expenditures are in terms of TAMP related costs of the projects that have received notice to proceed during each fiscal year, as per the consistency evaluations.

Table 7-8 NHS Bridge Treatment Amounts from 2019 to 2022

NHS Bridges					
System	**Treatment**	**2019**	**2020***	**2021**	**2022**
NHS	Preservation	$10,937,319	$605,985	$3,348,106	$2,412,401
	Rehabilitation	$22,605,828	$5,332,868	$5,253,751	$263,949
	Reconstruct \ Replace	$0	$2,171,545	$3,556,673	$0
NHS	**Total**	**$33,543,147**	**$8,110,398**	**$12,158,530**	**$2,676,350**

**Includes obligations as accepted by FHWA due to extenuating circumstances.*

7.10 Estimated Allocations by Federal Work Types

Table 7-9 shows the Interstate and NHS Non-Interstate pavement treatment amounts programmed in the FY 2023 to FY 2026 STIP. They show that PRHTA continues to program a mix of treatments to implement life-cycle strategies. Pavement treatments are programmed to assign the appropriate treatment to each pavement segment based upon the segment's condition. In general, pavements in Poor condition are treated with reconstruction projects while preservation is assigned to pavement in the Fair-Good category. Minor or major rehabilitation is assigned for projects in different states of Fair condition. Note that the amounts in Table 7-9 include only the TAMP related portions; that is, works directly related to pavements in the main running lanes.

Table 7-9 Interstate and Non-Interstate STIP Pavement Treatment Amounts

System	Treatment	2023	2024	2025	2026	Total
Interstate	Preservation	$1,720,603	$0	$8,029,489	$0	$9,750,093
	Minor Rehabilitation	$15,970,331	$0	$16,836,140	$14,773,860	$47,580,331
	Major Rehabilitation	$0	$12,305,635	$0	$0	$12,305,635
	Reconstruction	$0	$10,453,100	$0	$12,262,500	$22,715,600
	Total	**$17,690,934**	**$22,758,735**	**$24,865,629**	**$27,036,360**	**$92,351,658**
NHS	Preservation	$1,366,610	$5,014,000	$0	$3,795,925	$10,176,535
	Minor Rehabilitation	$8,579,041	$2,180,000	$2,180,000	$4,360,000	$17,299,041
	Major Rehabilitation	$0	$7,364,040	$0	$0	$7,364,040
	Reconstruction	$0	$0	$11,391,045	$6,431,000	$17,822,045
	Total	**$9,945,651**	**$14,558,040**	**$13,571,045**	**$14,586,925**	**$52,661,661**
Total		**$27,636,585**	**$37,316,775**	**$38,436,674**	**$41,623,285**	**$145,013,319**

Table 7-10 includes the amount of NHS bridge treatment by work type included in the FY 2023 to FY 2026 STIP. Note that the amounts in Table 7-10 include only the TAMP related portions, that is, works directly related to bridges.

Table 7-10 NHS Bridge Treatment Amounts Programmed in the STIP

Work Type	2023	2024	2025	2026	Total
Preservation	$1,660,000	$6,932,921	$3,950,800	$1,947,180	$14,490,901
Minor Rehabilitation	$0	$0	$0	$0	$0
Major Rehabilitation	$290,500	$3,916,139	$0	$0	$4,206,639
Replacement	$6,764,500	$11,700,806	$23,281,500	$9,208,496	$50,955,303
TOTAL	**$8,715,000**	**$22,549,867**	**$27,232,300**	**$11,155,676**	**$69,652,843**

The detailed allocations by work type for the remaining years of the TAMP are shown in the Investment Strategy chapter.

7.11 Asset Valuation

The FHWA asset management regulation[51] requires TAMPs to include, "An estimate of the value of the agency's NHS pavement and bridge assets and the needed investment on an annual basis to maintain the value of these assets." The estimation of the monetary value of physical assets is known as asset valuation. Valuation is based upon assets' condition, construction cost, age, obsolescence, and other factors.

Estimating the value of highway assets and the needed investment to maintain that value is another way to assess if agencies are investing enough to sustain asset conditions. Highway networks generally represent a state's largest capital investment. Investing adequately in them can ensure that future generations inherit a well-maintained asset, and not a major liability that is in a state of disrepair.

[51] 23 CFR 515.7(d)(4)

PRHTA estimated the value of its assets for this asset management plan using the concept of Depreciated Replacement Cost. This is an accounting concept adopted in Australia and Great Britain. It seeks to estimate the value of highway assets "as is." That is, what would it cost to replace them "in kind" to their current conditions.

This depreciation method differs from the historical cost method often used to estimate asset values. The historic cost usually applies a fixed amount of deterioration to an asset based entirely on its age. For example, if a bridge is built for $1 million and is expected to provide a useful life of 50 years, its value is depreciated by 2 percent annually. At the end of 50 years, the bridge will have a "book value" of $0. Even if the bridge has been rehabilitated and is in Good condition, it still will be carried on the books at a value of $0. By this logic, the Golden Gate Bridge and Brooklyn Bridge have no monetary value simply because of their age.

The historic cost method provides little value for asset management. If an asset is valued at $0 there is little incentive to invest further in its maintenance. However, as a practical matter, an aged bridge or pavement could have significant utility and warrant substantial maintenance and investment to prolong its useful life.

7.11.1 Pavement Asset Valuation

To calculate the depreciated replacement cost of PRHTA's pavements, the analysis first estimates what it would cost to replace the authority's pavements. This provides a "like new" or "replacement cost" estimate of the pavement assets. Then, depreciated cost is calculated by deducting value based on the assets' deterioration.

The logic of the analysis follows:

1. PRHTA manages 2,957 NHS lane miles of pavement. Those are separated by asphalt, concrete, Interstate and NHS Non-Interstate.
2. Based on PRHTA's previous projects, the average cost per lane mile to replace pavements at each system and surface type were calculated. They are shown in Table 7-11.
3. The corresponding average unit costs were multiplied by the lane miles under each category to obtain the replacement cost if all pavements were "like new." As seen in Table 7-11, the "like new" or "replacement value" of NHS pavements is estimated at $2.157 billion dollars. That excludes rights of way, engineering costs, or other costs besides pavement related components.
4. A depreciated replacement proportion was obtained based on the current condition of the NHS pavements.
    a. First, a numerical rate was assigned to the previously defined conditions of Good, Fair-to-Good, Fair-Fair, Fair-to-Poor, and Poor. A value of 5 was assigned to Good. One point less was assigned to each subsequent condition down to a value of 1 for Poor. Good condition and its assigned value of 5 was also used to represent the "like new" condition.
    b. A weighted rate was calculated for each system and surface type combination, based on the assigned rates and their corresponding lane miles. This resulted in

four weights, one each for asphalt and concrete on the Interstates and NHS Non-Interstate pavements. The rates represent overall condition on a 5-1 scale.

c. Dividing the resulting average rate for each of the four categories produced four rates, or conditions. As seen, the rate for asphalt Interstate pavement was 3.65. If all the lane miles were "like new" the rate would have been 5. Then, how much the rate is below "like new" is converted to a percentage. The percentage represents how much of the "like new" value has been "consumed" or "used up". The remainder (1 – the rate) produces the percentage by which the pavement value is multiplied. The $605.8 million dollars replacement cost for asphalt Interstate pavement is multiplied by the remainder, or 62.8 percent, to produce the depreciated replacement value of the Interstate asphalt pavement.

5. Similar calculations were performed for the other three categories and the totals were summed. That produced a final depreciated replacement value for NHS pavements of $1.2160 billion. The difference between the replacement value of $2.157 billion and the depreciated replacement cost represents how much of the NHS pavement asset has been "consumed," "used up", or "depreciated."

Table 7-11: Depreciated Replacement Calculation for NHS Pavements

System	Surface	Lane Miles		Replacement Cost Per Lane Mile (Million USD)	Pavement Replacement Cost (Million USD)		Rate	Rate for As New	Ave. Rate Difference from New	Discounted by Condition	Remaining	Depreciated Replacement Cost (Million USD)	
Int.	Asphalt	794	1,208	$0.76	$605.81	$1,110.55	3.65	5	1.35	37.20%	62.80%	$380.64	$661.83
	Concrete	414		$1.22	$504.75		2.79	5	2.21	44.30%	55.70%	$281.19	
NHS	Asphalt	1,612	1,749	$0.55	$883.93	$1,046.68	3	5	2	40.10%	59.90%	$529.77	$599.12
	Concrete	137		$1.18	$162.75		2.13	5	2.9	57.40%	42.60%	$69.35	
Total			**2,957**			**$2,157.23**	**2.89**	**5**	**2.11**	**44.73%**	**55.27%**		**$1,260.95**

7.11.2 Bridge Asset Valuation

The bridge asset valuation exercise used a similar logic as the one used for pavements. The analysis first estimated what it would cost to replace all of PRHTA's NHS bridges and culverts. That provided the "like new" or replacement value of the bridge inventory. Then, the deterioration was subtracted from the "like new" value to produce the depreciated replacement cost. The logic of the analysis that produced Table 7-12 is as follows:

1. PRHTA has a total of 1,553,811 square meters of NHS bridges and culverts.
2. The replacement cost for a bridge averaged $3,660 per square meter. For culverts, the square meter replacement cost averaged $944.
3. Those costs were multiplied by the square meters of bridges and culverts to produce the replacement value of $5.590 billion.
4. Bridges and culverts are rated on a 9-0 scale with 9 representing a new bridge. The condition of each bridge was obtained and multiplied by the bridge area. That produced a weighted average value of 5.60 for NHS bridges and 6.61 for culverts. That compares to a value of 9 if they were "like new."

5. As with the pavement exercise, the difference between the "like new" 9 and the value of 5.60 and 6.61 was generated. That difference generated the number of bridges and culverts that were "consumed" or "used up." The value was 37.8 percent for NHS bridges and 26.6 percent for NHS culverts.
6. Those percentages are subtracted from 1 to generate the remaining value of 62.2 percent for NHS bridges and 73.4 percent for culverts. The replacement value is multiplied by 62.2 percent and 73.4 percent to generate the final depreciated replacement value of $3.481 billion.

Table 7-12 Depreciated Replacement Calculation for NHS Bridges

Calculation for Depreciated Replacement Cost of PRHTA Bridges	NHS Bridges	NHS Culverts	Total
Total Square Meters	1,518,295	35,517	1,553,811
Average Cost Sq./M.	$3,660	$944	
Replacement Cost	$5,556,958,675	$33,527,755	$5,590,486,431
Average Condition Rate	5.60	6.61	
As New Condition Rate	9	9	
Ave./ Rate Difference from New	3.40	2.39	
Discounted by Condition	37.8%	26.6%	
Remaining	62.2%	73.4%	
Depreciated Replacement Cost	**$3,457,301,095**	**$24,606,956**	**$3,481,908,052**

Assuming a 20-year life for NHS pavements and a 50-year life for NHS bridges and culverts, the investment levels cited in the Financial Plan and Investment Strategies appear to be adequate to sustain PRHTA's NHS asset values at current levels.

Chapter 8. Investment Strategies

Photo 8-1: Construction to Repair Damage Near Utuado

This chapter summarizes the PRHTA's asset management investment strategies for FFY 2022 to 2032. These strategies are the result of all the analysis described in the earlier chapters of this asset management plan. The investment strategies allocate the available funding using life-cycle strategies to advance toward the SOGR while managing risks.

8.1 Regulation Background

The asset management regulation defines investment strategies as: A set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks.[52]

State DOT's must develop a process for developing investment strategies. Asset investment strategies must result in a description of how the investment strategies are influenced, at a minimum by:[53]

1. The performance gap analysis
2. Life-cycle planning for asset classes or asset sub-groups

[52] 23 CFR 515.15
[53] 23 CFR 515.7(e)

3. The risk management analysis
4. Anticipated available funding and estimated cost of expected future work types associated with candidate strategies based on the financial plan

8.2 The PRHTA Investment Strategy Development Process

PRHTA described in the 2019 TAMP an investment strategy development process based on the asset management regulation requirements. FHWA certified that the 2019 TAMP met the requirements of the asset management regulation in 23 CFR Part 515. For this TAMP, the investment strategy development process is based on the 2019 process with some modification to reflect recent events. The most influential event was the adoption in October 2022 of a 28-year PRHTA Fiscal Plan by the Financial Oversight and Management Board. As noted in the Financial Plan Chapter, FOMB based the investment levels in the Fiscal Plan on analysis produced by the same tools that produced these TAMP investment strategies. Therefore, much of the TAMP Financial Plan and Investment Strategy analysis is based on similar unit costs, deterioration rates, and life-cycle logic used to produce the 28-year Fiscal Plan.

1. PRHTA subject matter experts approved the update of pavement and bridge condition data and treatment unit costs included in the pavement and bridge tools, and within the three-dimensional matrixes in the tools.
2. The current condition gaps were updated by comparing the best available pavement and bridge condition data with the condition and performance targets. Gaps compared to the 2-year and 4-year targets were assessed. The change in the size, or lack, of gaps compared to the 2019 TAMP was noted.
3. Based on detailed assessment of pavement and bridge conditions, the analysis identified which asset sub-groups contributed most to condition gaps. For example, Interstate concrete pavements and NHS bridge decks were identified as contributing disproportionately to condition and performance gaps.
4. The pavement and bridge analysis tools were used to assess scenarios of what mix of preservation, rehabilitation, or reconstruction would most economically achieve the short-term condition targets and the long-term SOGR. The mix of treatments is influenced by the analysis in the life-cycle planning process.
5. The financial plan influenced the investment strategies by setting the upper limit of investment levels. Within the funding limits, the life-cycle-based analyses conducted with the tools identified an efficient allocation of funds across work types to achieve the targets and SOGR. Although the Non-NHS pavements and bridges are not included in the TAMP, funds for them were identified and deducted from the funds available for NHS investments. With the remaining NHS funds, the tools were used to develop iterations of funding levels by work type to achieve the highest forecasted condition levels.
6. Once recommended investment levels were determined, project development schedules were considered. Large, short-term increases in the construction program is not likely given the complexity of the project-development process and the size of the current Puerto Rico construction industry. Gradual increases in NHS pavement and bridge increases were adopted to reflect the project-delivery realities.

7. Risks also influenced the investment strategies. Funding levels reflect the need to continue delivering "critical bridge" projects to reduce the risk those bridges would be damaged during intense storm events. The risk of not achieving condition targets was considered and therefore critical assets such as Interstate concrete replacement projects and bridge deck replacements are recommended.

8.2.1 Incorporating Committed Projects

The investment strategies are also linked to the statewide planning process that leads to a program of projects in the STIP. The linkage occurs two ways. First, the investment strategies incorporate the funding levels and pavement and bridge work types included in projects from the FFY 2023 to FFY 2026 STIP. Second, many of the STIP projects come from recommendations produced by the pavement and bridge tools used for the investment strategies. The STIP projects reflect pavement and bridge analysis from 2020 and 2021. It is planned that the 2022 pavement and bridge analysis will be the basis for updating the STIP for FFY 2027 and beyond.

Considerable effort was put into determining the contribution of each STIP project. Each was examined for its lane miles or square meters of investment by work type. The analysis of the projects allowed the pavement and bridge tools to incorporate the type and volume of committed work types.

The budget available for NHS investments was based on several factors. The Fiscal Plan provided a total amount of construction funds for all programs, not just NHS pavements and bridges. From the total amount, the budgets for safety, traffic control devices, Non-NHS routes and other costs were deducted. Then, the already committed STIP projects were analyzed in detail to assess their contributions to the NHS pavements and bridges and to document investment levels.

8.2.2 Forecasting Conditions Based on Different Scenarios

Although total funding amounts were fixed, the investment analysis considered options for allocating pavement and bridge funds by work type and between asset types and highway networks. The analytical logic in the pavement and bridge tools favor life-cycle based strategies but tempered by PRHTA's need to achieve Interstate pavement condition targets. The tools apply a life-cycle based treatment to pavement and bridge sections based upon their condition. Preservation is applied to Good or Fair-Good assets, rehabilitation to Fair or Fair-Poor assets, and reconstruction to Poor ones. However, the Interstate pavements are in worst condition than allowed by the FHWA minimum allowable limits. Therefore, the investment strategies include a substantial amount of Interstate pavement reconstruction. Those treatments focus on the primarily concrete Interstate pavements that are not suitable for preservation or rehabilitation. A similar logic applies with bridge deck replacement. Many of the NHS bridge decks are Poor and rehabilitation or preservation are probably not appropriate treatments. These reconstruction treatments represent Good life-cycle practices because of the lack of preservation or maintenance options for those deteriorated assets.

The inputs to the investment strategies generated by the tools include current conditions, programmed projects, deterioration rates, and projected budgets. The details compiled from the programmed projects include the projects' work type, timing, and quantities of lane miles or bridge area.

Three scenarios are provided:

1. **Scenario 1** is based on the STIP investment levels for FY 2023 to FY 2026. Amounts for FYs 2027 to 2032 are based on the average STIP amounts from 2023 to 2026. The investment levels are adjusted to account only for the pavement and bridge related works, as explained in section 7.7 Projected Funding Allocations for NHS Pavements and Bridges. Similarly, the lane miles and deck area were adjusted to account for the expected intervention, which does not necessarily include all the lanes and bridge area within the project limits. The adjustments were based on the analysis of past projects to account for only pavement and bridge related work. Refer to Appendix J for more details on the calculations of these adjustments.

2. **Scenario 2** is based on a December 2021 analysis PRHTA submitted to the FOMB. That analysis encompassed various alternatives but the one included in this scenario is the most conservative one, which recommended minimum investment levels over 10 years to bring Puerto Rico pavements and bridges to a minimally acceptable SOGR. The December 2021 analysis recommended specific allocations per year and per asset type and roadway system such as Interstate pavements, NHS Non-Interstate Pavements and NHS bridges. Since the December 2021 analysis accounted separately for the costs of the different assets such as lighting and signage, the costs associated with pavement and bridges did not include other works, so no adjustments were needed.

3. **Scenario 3** is based on the "Hard Cost" amounts provided in the Oct. 14, 2022 Fiscal Plan approved by the FOMB. The FOMB-approved fiscal plan does not allocate the Hard Costs by specific asset type and roadway system. Therefore, for the TAMP Scenario 3, the percentage splits between asset type and roadway system from Scenario 2 were applied to the Hard Cost amounts from the Oct. 14, 2022 FOMB-approved Fiscal Plan. No additional adjustments were needed as the applied splits already accounted for the pavement and bridge specific allocation.

The three scenarios illustrate the conditions that are forecast to result from the different investment levels. As shown below, the STIP investment amounts from Scenario 1 lead to declining conditions. In Scenario 1, additional investment could be applied to NHS pavements and bridges if additional funds could be used from the FOMB-approved Fiscal Plan to increase the amounts shown in the STIP years and to the remaining six years of the TAMP, from 2027 to 2032. However, funds from the FOMB-approved Fiscal plan must pay for all highway investments, not only for NHS pavements and bridges. As noted in section 3.1, PRHTA has a large non-NHS highway network that also needs additional investment.

8.3 Pavement and Bridge Investment Scenarios

8.3.1 Scenario 1

Scenario 1 for pavements and bridges is based on the investment levels described in the Financial Plan chapter in Table 7-4, Table 7-5, and Table 7-6. Scenario 1 is the most financially constrained scenario. It assumes that only the investment levels comparable to those in the current STIP will continue through 2032. Scenario 1 includes the following assumptions:

1. The amounts shown in this scenario are based on the NHS pavement and bridge projects in the 2023-2026 STIP using only the amounts estimated to be for pavement and bridge work items.
2. Amounts for 2027 to 2032 are based on the average amounts from 2023 to 2026.
3. The amounts shown for 2022 reflect the amounts of projects in FY 2022 that received a Notice to Proceed (NTP). This information is included to estimate the 2022 conditions[54] and to support the July 2023 consistency review.

8.3.1.1 Pavement Scenario 1

Table 8-1 shows the estimated Scenario 1 investments for pavements. Highlighted in green is what differentiates this scenario from the two scenarios presented next.

Table 8-1 Budget Amounts for Pavement Scenario 1

Scenario 1 Pavement Budget (Million USD)													
System	**Funding ID**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
Interstate	PRHTA NTP	$35.82	---	---	---	---	---	---	---	---	---	---	**$35.82**
	STIP	---	$17.69	$22.76	$24.87	$27.04	---	---	---	---	---	---	**$92.35**
	STIP Average	---	---	---	---	---	$23.09	$23.09	$23.09	$23.09	$23.09	$23.09	**$138.53**
	Metropistas NTP	$5.80	---	---	---	---	---	---	---	---	---	---	**$5.80**
	Metropistas CIP	---	$3.04	$4.62	$4.67	$3.02	$3.52	$4.13	$0.77	$3.76	---	---	**$27.53**
	Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$3.44	$3.44	**$6.88**
NHS Non-Interstate	PRHTA NTP	$17.91	---	---	---	---	---	---	---	---	---	---	**$17.91**
	STIP	---	$9.95	$14.56	$13.57	$14.59	---	---	---	---	---	---	**$52.66**
	STIP Average	---	---	---	---	---	$13.17	$13.17	$13.17	$13.17	$13.17	$13.17	**$78.99**
Total		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$39.77**	**$40.39**	**$37.02**	**$40.01**	**$39.69**	**$39.69**	**$456.48**

As seen in Table 8-2 the percentage of Poor Interstate pavement increases under Scenario 1 until it peaks in 2026. Eventually, by 2032, the long-term target of no more than 5 percent Poor Interstate pavement is achieved with the funding in Scenario 1.

[54] Base condition data is the most recent available, corresponding to 2021. Therefore, to estimate the conditions within the TAMP period, which starts in 2023, it is necessary to estimate the 2022 condition. To do so, the projects executed in 2022 and the expected deterioration rate were used.

Also as seen in Table 8-2, the NHS Non-Interstate pavements deteriorate throughout the 11-year period. The percentage of Poor NHS Non-Interstate pavement increases from 8.2 percent in 2021 to 17.9 percent in 2032.

Table 8-2: Forecasted Pavement Conditions under Pavement

NHS Pavements-Resulting Projected Conditions														
System	Condition	10-Year Target	Base	Forecast										
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Good	25.0%	19.5%	24.7%	27.6%	27.5%	30.2%	31.8%	30.9%	30.0%	29.0%	28.3%	27.7%	27.1%
	Fair to Good	23.3%	26.0%	26.3%	25.2%	25.4%	25.3%	25.4%	26.4%	27.3%	27.9%	28.4%	28.8%	29.1%
	Fair - Fair	23.3%	34.4%	29.5%	26.0%	25.3%	21.3%	18.6%	19.2%	19.8%	20.5%	21.1%	21.8%	22.4%
	Fair to Poor	23.3%	11.0%	12.1%	12.8%	13.3%	13.8%	13.6%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%
	Poor	5.0%	9.1%	7.4%	8.5%	8.5%	9.4%	10.6%	9.5%	8.4%	7.7%	6.7%	5.8%	4.9%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
NHS Non-Interstate	Good	10.0%	4.3%	6.5%	8.4%	11.1%	11.8%	13.4%	13.5%	13.6%	13.7%	13.8%	13.8%	13.9%
	Fair to Good	23.3%	13.5%	13.0%	12.5%	12.4%	12.3%	12.6%	12.8%	13.1%	13.3%	13.5%	13.7%	13.9%
	Fair - Fair	23.3%	61.5%	56.2%	50.8%	45.4%	41.7%	37.1%	35.1%	33.3%	31.6%	30.1%	28.7%	27.5%
	Fair to Poor	23.3%	12.5%	15.5%	18.3%	20.5%	22.2%	23.4%	24.5%	25.3%	25.9%	26.3%	26.6%	26.7%
	Poor	18.0%	8.2%	8.8%	9.9%	10.5%	12.0%	13.6%	14.2%	14.8%	15.5%	16.3%	17.1%	17.9%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

With the constrained funding of Scenario 1, most pavement funds are allocated to the Interstate. The logic was to improve the Interstate pavement conditions, meet the National minimum condition standard, and avoid the financial penalty of exceeding 5 percent Poor Interstate pavement. As seen in Table 8-3 more lane miles are treated on the Interstate than on the NHS Non-Interstate. Also, the Interstates receive under Scenario 1 more reconstruction than does the Non-NHS. Similarly, more dollars are invested by work type on the Interstate as shown in Table 8-4:.

Table 8-3 Number of Lane Miles Treated under Pavement Scenario 1

System	Work Types	Expected Lane Miles to Treat										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Preservation	62.23	9.09	1.84	37.27	2.45	3.43	2.76	2.42	2.74	2.72	2.72
	Minor Rehabilitation	11.81	65.65	0.46	44.25	44.39	0.45	0.46	0.40	0.46	0.45	0.45
	Major Rehabilitation	0.00	0.53	24.58	0.71	0.56	20.36	20.89	18.29	20.70	20.54	20.54
	Reconstruction	31.32	0.09	12.34	0.15	19.77	9.97	10.23	8.96	10.14	10.06	10.06
	Total	**105.36**	**75.36**	**39.21**	**82.38**	**67.17**	**34.21**	**34.35**	**30.08**	**34.04**	**33.76**	**33.76**
NHS Non Interstate	Preservation	3.36	22.18	19.43	2.40	23.42	3.43	2.87	2.87	2.84	2.82	2.82
	Minor Rehabilitation	35.23	32.12	24.17	7.10	14.94	0.32	0.33	0.33	0.32	0.32	0.32
	Major Rehabilitation	7.85	0.34	22.44	0.57	0.39	14.52	14.90	14.90	14.77	14.65	14.65
	Reconstruction	2.64	0.06	0.26	19.33	9.56	7.12	7.30	7.30	7.24	7.18	7.18
	Total	**49.08**	**54.71**	**66.30**	**29.40**	**48.30**	**25.38**	**25.40**	**25.40**	**25.17**	**24.97**	**24.97**
Total		**154.44**	**130.07**	**105.52**	**111.78**	**115.47**	**59.59**	**59.76**	**55.48**	**59.20**	**58.73**	**58.73**

Table 8-3 also shows that, as per the lifecycle planning concept, there is a distribution of lane miles among all different work types. The STIP period prioritizes minor rehabilitation and preservation. Although this result in an increase in Poor pavements, the treated areas will last

more time without requiring reconstruction. After the STIP period, emphasis is given to major rehabilitation and reconstruction, which results in the lowering of the percentage Poor.

Table 8-4: shows the corresponding investment per work type to address the lane miles indicated in Table 8-3, which would result in the forecasted condition presented in Table 8-2.

Table 8-4: Dollars of Investment by Work Type under Pavement Scenario 1

System	Work Types	Estimated Investment in Million USD										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Preservation	$11.80	$1.10	$0.69	$1.60	$0.92	$1.94	$2.00	$1.75	$1.98	$1.94	$1.94
	Minor Rehabilitation	$8.41	$19.19	$23.03	$25.82	$27.61	$0.40	$0.41	$0.36	$0.41	$0.40	$0.40
	Major Rehabilitation	$0.00	$0.41	$1.40	$0.52	$0.42	$14.64	$15.09	$13.22	$14.95	$14.61	$14.61
	Reconstruction	$21.41	$0.10	$0.64	$0.15	$0.11	$9.66	$9.96	$8.73	$9.87	$9.64	$9.64
	Total	**$41.62**	**$20.80**	**$25.76**	**$28.09**	**$29.06**	**$26.65**	**$27.46**	**$24.06**	**$27.21**	**$26.60**	**$26.60**
NHS Non Interstate	Preservation	$0.89	$1.75	$0.47	$0.53	$0.29	$0.75	$0.61	$0.61	$0.60	$0.62	$0.62
	Minor Rehabilitation	$10.68	$7.93	$15.10	$14.11	$15.03	$0.15	$0.15	$0.15	$0.15	$0.15	$0.15
	Major Rehabilitation	$4.45	$0.17	$0.44	$0.31	$0.21	$7.86	$7.82	$7.84	$7.75	$7.93	$7.93
	Reconstruction	$1.89	$0.04	$0.16	$0.07	$0.05	$4.36	$4.34	$4.36	$4.30	$4.40	$4.40
	Total	**$17.91**	**$9.88**	**$16.18**	**$15.02**	**$15.58**	**$13.12**	**$12.92**	**$12.96**	**$12.80**	**$13.10**	**$13.10**
Total		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$39.77**	**$40.39**	**$37.02**	**$40.01**	**$39.69**	**$39.69**

8.3.1.2 Bridge Scenario 1

Table 8-5 shows the estimated Scenario 1 investments for bridges. Highlighted in green is what differentiates this scenario from the next two that will be presented.

Table 8-5: Budget Amounts for Bridge Scenario 1

Budget Bridge Scenario 1 (Million USD)												
Funding ID	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
PRHTA NTP	$2.68	---	---	---	---	---	---	---	---	---	---	$2.68
STIP	---	$8.72	$22.55	$27.23	$11.16	---	---	---	---	---	---	$69.66
STIP Average	---	---	---	---	---	$17.41	$17.41	$17.41	$17.41	$17.41	$17.41	$104.46
Metropistas NTP	$4.60	---	---	---	---	---	---	---	---	---	---	$4.60
Metropistas CIP	---	$3.60	$3.16	$3.11	$3.24	$3.30	$2.43	$2.37	$2.53	---	---	$23.74
Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$2.97	$2.97	$5.94
Total	**$7.28**	**$12.31**	**$25.71**	**$30.34**	**$14.39**	**$20.71**	**$19.84**	**$19.79**	**$19.95**	**$20.38**	**$20.38**	**$211.08**

Table 8-6 shows the forecasted conditions resulting from the Scenario 1 bridge investments. As seen, the percentage Poor NHS bridge area increases from 7.8 percent in 2021 to 13.1 percent in 2032. If the percentage of Poor NHS bridge area exceeds 10 percent for three consecutive years, PHRTA would face a penalty as it does now for Interstate pavement. The penalty would require PRHTA to invest more FHWA funds in NHS bridges until the percent Poor is less than 10 percent.

Table 8-6 Forecasted Bridge Conditions under Scenario 1

NHS Bridges -Resulting Projected Conditions													
Conditions	**10-Year Target**	**Base 2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Good	15.0%	16.2%	16.4%	16.3%	16.5%	16.7%	16.7%	16.8%	16.8%	16.9%	16.9%	17.0%	17.0%
Fair to Good	37.5%	36.7%	36.2%	35.8%	35.5%	34.9%	34.5%	34.2%	33.9%	33.6%	33.3%	33.0%	32.8%
Fair to Poor	37.5%	39.3%	38.7%	38.4%	38.1%	38.0%	37.6%	37.6%	37.5%	37.4%	37.3%	37.2%	37.1%
Poor	10.0%	7.8%	8.7%	9.5%	9.8%	10.4%	11.2%	11.5%	11.8%	12.2%	12.5%	12.8%	13.1%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8-7: contains the square meters of bridge area to be treated under bridge Scenario 1. It also shows that, as per the lifecycle planning concept, there is a distribution of treated area among all different work types. The STIP period prioritizes preservation, to extend the life of bridges that are still in a satisfactory condition. However, this result in an increase in percent Poor. After the STIP period, emphasis is given to major rehabilitation and reconstruction, which results in the lowering of the rate of increase in percentage Poor, taking about four years to increase a percentage as opposed to about two years.

Table 8-7: Annual Deck Area to be Treated under Scenario 1

NHS Bridge Deck Area by Work Types (Sq. Mts.)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	7,201	2,948	6,989	11,610	3,410	750	718	716	722	738	738
Minor Rehabilitation	6,589	474	195	315	550	1,342	1,286	1,283	1,293	1,321	1,321
Major Rehabilitation	3,791	807	6,911	503	663	3,352	3,211	3,202	3,228	3,299	3,299
Replacement	0	1,997	5,050	3,927	4,917	3,596	3,445	3,436	3,464	3,539	3,539
TOTAL	**17,580**	**6,225**	**19,145**	**16,355**	**9,540**	**9,040**	**8,661**	**8,637**	**8,708**	**8,897**	**8,897**

Table 8-8: shows the amount of annual investment by work to address the area indicated in Table 8-7:, which would result in the forecasted condition presented in Table 8-6.

Table 8-8: Annual Investments by Work Type under Bridge Scenario 1

Projected Annual NHS Bridge Investments by Work Type (Million USD)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	$2.41	$2.52	$7.94	$4.37	$2.57	$0.31	$0.30	$0.30	$0.30	$0.31	$0.31
Minor Rehabilitation	$0.26	$0.98	$0.44	$0.63	$1.04	$3.17	$3.04	$3.03	$3.06	$3.12	$3.12
Major Rehabilitation	$4.60	$1.78	$4.87	$1.17	$1.38	$8.30	$7.95	$7.93	$7.99	$8.16	$8.16
Replacement	$0.00	$7.03	$12.46	$24.17	$9.41	$8.93	$8.55	$8.53	$8.60	$8.79	$8.79
TOTAL	$7.3	$12.3	$25.7	$30.3	$14.4	$20.7	$19.8	$19.8	$19.9	$20.4	$20.4

8.3.2 Scenario 2

8.3.2.1 Pavement Scenario 2

Scenario 2 retains the same investment levels for FY 2023 to 2026 as in Scenario 1 and increases investments after 2026. Funding increases only after 2026 to maintain alignment with the existing STIP. The increase after 2026 presumes that: more funds from the FOMB-approved Fiscal Plan would be available, and that they would be distributed exactly as per the annual distribution between years 2027 and 2032 of the most conservative alternative presented on the December 2021 analysis that PRHTA submitted to the FOMB. The funding distribution of this scenario is shown in Table 8-9. Highlighted in green is what differentiates this scenario from the other two that are presented.

Table 8-9 Scenario 2 Pavement Budget

Budget Bridge Scenario 1 (Million USD)													
System	**Funding ID**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
Interstate	PRHTA NTP	$35.82	---	---	---	---	---	---	---	---	---	---	**$35.82**
	STIP	---	$17.69	$22.76	$24.87	$27.04	---	---	---	---	---	---	**$92.35**
	PRHTA 2021 Analysis	---	---	---	---	---	$39.30	$39.30	$39.30	$26.30	$24.50	$24.50	**$193.20**
	Metropistas NTP	$5.80	---	---	---	---	---	---	---	---	---	---	**$5.80**
	Metropistas CIP	---	$3.04	$4.62	$4.67	$3.02	$3.52	$4.13	$0.77	$3.76	---	---	**$27.53**
	Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$3.44	$3.44	**$6.88**
NHS Non-Interstate	PRHTA NTP	$17.91	---	---	---	---	---	---	---	---	---	---	**$17.91**
	STIP	---	$9.95	$14.56	$13.57	$14.59	---	---	---	---	---	---	**$52.66**
	PRHTA 2021 Analysis	---	---	---	---	---	$32.70	$32.70	$32.70	$32.70	$34.50	$34.50	**$199.80**
Subtotal		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$75.52**	**$76.13**	**$72.77**	**$62.76**	**$62.44**	**$62.44**	**$631.96**

Table 8-10 shows the pavement conditions forecasted for Scenario 2. The long-term 5 percent Poor target is reached in 2029 under Scenario 2, as compared to 2032 in Scenario 1. Substantially better NHS Non-Interstate conditions result from Scenario 2 than Scenario 1. In Scenario 1, by 2032, 17.9 percent of the NHS Non-Interstate would be Poor. Under scenario 2, by 2032, only 8.6 percent of the NHS Non-Interstate would be in Poor condition.

Table 8-10 Forecasted Pavement Conditions under Scenario 2

System	Condition	10-Year Target	Base	Forecast										
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Good	25.0%	19.5%	24.7%	27.6%	27.5%	30.2%	31.8%	32.4%	32.9%	33.3%	33.5%	33.5%	33.5%
	Fair to Good	23.3%	26.0%	26.3%	25.2%	25.4%	25.3%	25.4%	26.4%	27.3%	27.6%	27.0%	26.5%	25.7%
	Fair - Fair	23.3%	34.4%	29.5%	26.0%	25.3%	21.3%	18.6%	18.9%	19.3%	19.7%	20.0%	20.2%	20.6%
	Fair to Poor	23.3%	11.0%	12.1%	12.8%	13.3%	13.8%	13.6%	13.9%	14.1%	14.4%	14.7%	14.9%	15.3%
	Poor	5.0%	9.1%	7.4%	8.5%	8.5%	9.4%	10.6%	8.5%	6.5%	4.9%	4.9%	4.9%	4.9%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
NHS Non-Interstate	Good	10.0%	4.3%	6.5%	8.4%	11.1%	11.8%	13.4%	15.4%	17.2%	18.9%	20.5%	22.1%	23.5%
	Fair to Good	23.3%	13.5%	13.0%	12.5%	12.4%	12.3%	12.6%	12.8%	13.2%	13.7%	14.3%	14.9%	15.7%
	Fair - Fair	23.3%	61.5%	56.2%	50.8%	45.4%	41.7%	37.1%	34.8%	32.8%	30.9%	29.3%	27.8%	26.5%
	Fair to Poor	23.3%	12.5%	15.5%	18.3%	20.5%	22.2%	23.4%	24.3%	25.0%	25.4%	25.7%	25.8%	25.8%
	Poor	18.0%	8.2%	8.8%	9.9%	10.5%	12.0%	13.6%	12.7%	11.8%	11.1%	10.3%	9.4%	8.6%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 8-11 shows the number of lane miles to be treated per work type that will result in the forecasted conditions presented in Table 8-10. It also shows that, as per the lifecycle planning concept, there is a distribution of lane miles among all different work types. As indicated in Scenario 1, the STIP period prioritizes minor rehabilitation and preservation. After the STIP period, emphasis continues in Preservation but also in major rehabilitation and reconstruction, which allows to lower the percentage in Poor condition and increase the percentage in Good condition.

Table 8-11: Number of Lane Miles Treated under Pavement Scenario 2

System	Work Types	Expected Lane Miles to Treat										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Preservation	62.23	9.09	1.84	37.27	2.45	13.84	13.95	18.17	27.35	25.51	27.64
	Minor Rehabilitation	11.81	65.65	0.46	44.25	44.39	1.83	1.85	1.70	2.56	2.39	1.20
	Major Rehabilitation	0.00	0.53	24.58	0.71	0.56	30.25	30.50	26.52	15.68	14.62	14.10
	Reconstruction	31.32	0.09	12.34	0.15	19.77	14.28	14.40	12.47	6.66	6.21	6.50
	Total	**105.36**	**75.36**	**39.21**	**82.38**	**67.17**	**60.21**	**60.70**	**58.87**	**52.25**	**48.73**	**49.42**
NHS Non Interstate	Preservation	3.36	22.18	19.43	2.40	23.42	17.48	17.63	17.63	17.57	18.49	18.49
	Minor Rehabilitation	35.23	32.12	24.17	7.10	14.94	1.98	2.00	2.00	1.99	2.09	2.09
	Major Rehabilitation	7.85	0.34	22.44	0.57	0.39	33.34	33.61	33.62	33.51	35.26	35.26
	Reconstruction	2.64	0.06	0.26	19.33	9.56	15.77	15.90	15.90	15.85	16.68	16.68
	Total	**49.08**	**54.71**	**66.30**	**29.40**	**48.30**	**68.58**	**69.14**	**69.15**	**68.92**	**72.53**	**72.53**
Total		**154.44**	**130.07**	**105.52**	**111.78**	**115.47**	**128.79**	**129.84**	**128.02**	**121.17**	**121.26**	**121.95**

Table 8-12 shows the corresponding investment per work type to address the lane miles indicated in Table 8-11, which would result in the forecasted condition presented in Table 8-10.

Table 8-12: Dollars of Investment by Work Type under Pavement Scenario 2

System	Work Types	Estimated Investment (Million USD)										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Preservation	$11.80	$2.78	$0.69	$9.63	$0.92	$5.23	$5.27	$6.86	$10.33	$9.63	$10.44
	Minor Rehabilitation	$8.41	$16.50	$0.27	$17.79	$15.35	$1.08	$1.09	$1.00	$1.51	$1.41	$0.70
	Major Rehabilitation	$0.00	$0.39	$13.70	$0.52	$0.42	$22.35	$22.54	$19.59	$11.58	$10.80	$10.41
	Reconstruction	$21.41	$0.09	$11.10	$0.15	$12.37	$14.38	$14.50	$12.56	$6.70	$6.25	$6.54
	Total	**$41.62**	**$19.76**	**$25.76**	**$28.09**	**$29.06**	**$43.04**	**$43.40**	**$40.02**	**$30.13**	**$28.10**	**$28.10**
NHS Non Interstate	Preservation	$0.89	$1.79	$5.49	$0.53	$4.08	$3.83	$3.86	$3.86	$3.84	$4.05	$4.05
	Minor Rehabilitation	$10.68	$8.91	$2.72	$2.72	$4.81	$0.93	$0.93	$0.93	$0.93	$0.98	$0.98
	Major Rehabilitation	$4.45	$0.19	$7.81	$0.31	$0.21	$18.05	$18.19	$18.20	$18.14	$19.09	$19.09
	Reconstruction	$1.89	$0.04	$0.16	$11.46	$6.48	$9.67	$9.75	$9.76	$9.72	$10.23	$10.23
	Total	**$17.91**	**$10.92**	**$16.18**	**$15.02**	**$15.58**	**$32.47**	**$32.74**	**$32.75**	**$32.64**	**$34.34**	**$34.34**
Non NHS	Preservation	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Minor Rehabilitation	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Major Rehabilitation	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Reconstruction	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Total		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$75.52**	**$76.13**	**$72.77**	**$62.76**	**$62.44**	**$62.44**

8.3.2.2 Bridge Scenario 2

Like Pavement Scenario 2, Bridge Scenario 2 retains the same investment levels for FY 2023 to 2026 as in Scenario 1 and increases investments after 2026. Funding increases only after 2026 to maintain alignment with the existing STIP. The increase after 2026 presumes that more funds from the FOMB-approved Fiscal Plan would be available, following the distribution of the most conservative alternative presented on the December 2021 analysis that PRHTA submitted to the FOMB. The funding distribution of this scenario is shown in Table 8-13. Highlighted in green is what differentiates this scenario from the other two that are presented.

Table 8-13 Scenario 2 Bridge Budget

Scenario 2 -NHS Bridge Funding Based ($Million USD)												
Funding ID	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
PRHTA NTP	$2.68	---	---	---	---	---	---	---	---	---	---	$2.68
STIP	---	$8.72	$22.55	$27.23	$11.16	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$69.66
PRHTA 2021 Analysis	---	---	---	---	---	$59.04	$57.57	$61.56	$61.30	$65.54	$62.35	$367.36
Metropistas NTP	$4.60	---	---	---	---	---	---	---	---	---	---	$4.60
Metropistas CIP	---	$3.60	$3.16	$3.11	$3.24	$3.30	$2.43	$2.37	$2.53	---	---	$23.74
Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$2.97	$2.97	$5.94
Total	**$7.28**	**$12.31**	**$25.71**	**$30.34**	**$14.39**	**$62.33**	**$60.00**	**$63.93**	**$63.84**	**$68.50**	**$65.32**	**$473.95**

The resulting conditions are in Table 8-14. In Scenario 2, the percent of Poor NHS deck area declines to 6.5 percent in 2032 compared to rising to 13.1 percent in Scenario 1. In Scenario 2, conditions still decline until 2026 because no increased investment is planned before then. However, as the increased investment phases in after 2026, NHS bridge conditions steadily improve.

Table 8-14 Forecasted NHS Bridge Conditions under Scenario 2

Scenario 2-NHS Bridges Condition Projections (Percentages)													
Conditions	**10-Year Target**	**Base 2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Good	15.0%	16.2%	16.4%	16.3%	16.5%	16.7%	16.7%	17.7%	18.5%	19.5%	20.4%	21.4%	22.3%
Fair to Good	37.5%	36.7%	36.2%	35.8%	35.5%	34.9%	34.5%	34.4%	34.3%	34.2%	34.2%	34.2%	34.2%
Fair to Poor	37.5%	39.3%	38.7%	38.4%	38.1%	38.0%	37.6%	37.5%	37.4%	37.4%	37.3%	37.2%	37.1%
Poor	10.0%	7.8%	8.7%	9.5%	9.8%	10.4%	11.2%	10.4%	9.8%	9.0%	8.2%	7.3%	6.5%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8-15 shows the deck area to be treated per work type and year that will result in the forecast shown in Table 8-14.

Table 8-15: Annual Deck Area to be Treated under Scenario 2

Annual Projected NHS Bridge Deck Area Treated by Work Type (Sq. Mts.)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	7,201	2,948	6,989	11,610	3,410	2,257	2,172	2,314	2,311	2,480	2,365
Minor Rehabilitation	6,589	474	195	315	550	4,040	3,889	4,144	4,138	4,440	4,234
Major Rehabilitation	3,791	807	6,911	503	663	10,088	9,711	10,347	10,332	11,087	10,572
Replacement	0	1,997	5,050	3,927	4,917	10,825	10,420	11,103	11,086	11,896	11,343
TOTAL	**17,580**	**6,225**	**19,145**	**16,355**	**9,540**	**27,210**	**26,192**	**27,909**	**27,867**	**29,904**	**28,513**

Table 8-16 shows the investment needed to impact the area indicated in Table 8-15 that will result in the forecast shown in Table 8-14.

Table 8-16: Annual Investments by Work Type under Bridge Scenario 2

Projected Annual NHS Bridge Investments by Work Type (Million USD)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	$2.41	$2.52	$7.94	$4.37	$2.57	$0.94	$0.90	$0.96	$0.96	$1.03	$0.98
Minor Rehabilitation	$0.26	$0.98	$0.44	$0.63	$1.04	$9.55	$9.20	$9.80	$9.78	$10.50	$10.01
Major Rehabilitation	$4.60	$1.78	$4.87	$1.17	$1.38	$24.97	$24.03	$25.61	$25.57	$27.44	$26.16
Replacement	$0.00	$7.03	$12.46	$24.18	$9.41	$26.87	$25.87	$27.56	$27.52	$29.53	$28.16
TOTAL	**$7.28**	**$12.31**	**$25.71**	**$30.34**	**$14.39**	**$62.33**	**$60.00**	**$63.93**	**$63.84**	**$68.50**	**$65.32**

8.3.3 Scenario 3

8.3.3.1 Pavement Scenario 3

Pavement Scenario 3 is a variation on Scenario 2. It also assumes the same investment between FY 2023 and 2026 based on the STIP. Between FY 2027 to 2032, it assumes that the "Hard Costs" approved by the FOMB in the October 14, 2022 Fiscal Plan is available to PRHTA. Then, it applies the average annual percentage allocations from the most conservative alternative shown in the Dec. 21, 2021 PRHTA analysis to divide the "Hard Costs" between the assets and road system types. The Dec. 21, 2021 report recommended that 12.5 percent of the total available capital budget be allocated to Interstate pavements. Another 11.8 percent was recommended for NHS Non-Interstate pavements. The funding distribution of this scenario is shown in Table 8-9. Highlighted in green is what differentiates this scenario from the other two that are presented. Note that Scenario 2 uses the exact dollar allocations per year as per the 2021 analysis while Scenario 3 uses the 50-year annual average proportion applied to each year's total on the Fiscal Plan.

Table 8-17 Scenario 3 Pavement Budget

Scenario 3 Pavement Budget (2022 Million USD)													
System	**Funding ID**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
Interstate	PRHTA NTP	$35.82	---	---	---	---	---	---	---	---	---	---	**$35.82**
	STIP	---	$17.69	$22.76	$24.87	$27.04	---	---	---	---	---	---	**$92.35**
	Fiscal Plan	---	---	---	---	---	$37.88	$38.12	$36.26	$29.59	$30.09	$30.45	**$202.39**
	Metropistas NTP	$5.80	---	---	---	---	---	---	---	---	---	---	**$5.80**
	Metropistas CIP	---	$3.04	$4.62	$4.67	$3.02	$3.52	$4.13	$0.77	$3.76	---	---	**$27.53**
	Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$3.44	$3.44	**$6.88**
NHS Non-Interstate	PRHTA NTP	$17.91	---	---	---	---	---	---	---	---	---	---	**$17.91**
	STIP	---	$9.95	$14.56	$13.57	$14.59	---	---	---	---	---	---	**$52.66**
	Fiscal Plan	---	---	---	---	---	$34.42	$34.63	$32.86	$26.69	$27.15	$27.48	**$183.24**
Total		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$75.81**	**$76.89**	**$69.89**	**$60.05**	**$60.68**	**$61.37**	**$624.59**

The pavement conditions resulting from Pavement Scenario 3 are shown in Table 8-18. Scenario 3 spends slightly less than Scenario 2 and it takes longer to achieve the less than 5 percent Poor target. In Scenario 2, the 5 percent target is reached in 2029 and in Scenario 3 it is reached 2032.

Table 8-18 Forecasted Pavement Conditions under Scenario 3

System	Condition	10-Year Target	Base 2021	Forecast 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Good	25.0%	19.5%	24.7%	27.6%	27.5%	30.2%	31.8%	32.7%	33.5%	33.8%	33.8%	33.6%	33.7%
	Fair to Good	23.3%	26.0%	26.3%	25.2%	25.4%	25.3%	25.4%	25.9%	26.3%	26.9%	27.4%	27.9%	28.3%
	Fair - Fair	23.3%	34.4%	29.5%	26.0%	25.3%	21.3%	18.6%	18.6%	18.6%	18.7%	18.7%	19.0%	19.0%
	Fair to Poor	23.3%	11.0%	12.1%	12.8%	13.3%	13.8%	13.6%	13.6%	13.7%	13.8%	13.9%	14.1%	14.2%
	Poor	5.0%	9.1%	7.4%	8.5%	8.5%	9.4%	10.6%	9.2%	7.9%	6.9%	6.2%	5.5%	4.9%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
NHS Non-Interstate	Good	10.0%	4.3%	6.5%	8.4%	11.1%	11.8%	13.4%	15.3%	17.2%	18.7%	19.5%	20.4%	21.4%
	Fair to Good	23.3%	13.5%	13.0%	12.5%	12.4%	12.3%	12.6%	13.2%	13.8%	14.6%	15.3%	16.0%	16.5%
	Fair - Fair	23.3%	61.5%	56.2%	50.8%	45.4%	41.7%	37.1%	35.0%	33.1%	31.5%	30.1%	28.8%	27.5%
	Fair to Poor	23.3%	12.5%	15.5%	18.3%	20.5%	22.2%	23.4%	24.4%	25.2%	25.7%	26.1%	26.4%	26.4%
	Poor	18.0%	8.2%	8.8%	9.9%	10.5%	12.0%	13.6%	12.1%	10.7%	9.5%	9.0%	8.4%	8.0%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 8-19 shows the number of lane miles to be treated per work type that will result in the forecasted conditions presented in Table 8-18. It also shows that, as per the lifecycle planning concept, there is a distribution of lane miles among all different work types. As indicated in Scenarios 1 and 2, the STIP period prioritizes minor rehabilitation and preservation. After the STIP period, emphasis continues in Preservation but also in major rehabilitation and reconstruction, which allows lowering the percentage in Poor condition and increasing the percentage in Good condition.

Table 8-19: Number of Lane Miles Treated under Pavement Scenario 3

System	Treatment	Expected Lane Miles to Treat 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	**Preservation**	62.23	9.09	1.84	37.27	2.45	21.29	21.60	18.92	19.08	17.04	19.15
	Minor Rehabilitation	11.81	65.65	0.46	44.25	44.39	3.55	3.60	3.15	4.29	2.84	4.31
	Major Rehabilitation	0.00	0.53	24.58	0.71	0.56	26.73	27.11	23.75	20.36	21.40	20.44
	Reconstruction	31.32	0.09	12.34	0.15	19.77	11.73	11.90	10.42	8.78	9.39	8.82
	Total	**105.36**	**75.36**	**39.21**	**82.38**	**67.17**	**63.30**	**64.20**	**56.23**	**52.52**	**50.67**	**52.72**
NHS Non Interstate	**Preservation**	3.36	22.18	19.43	2.40	23.42	7.35	7.45	7.07	5.69	5.88	11.08
	Minor Rehabilitation	35.23	32.12	24.17	7.10	14.94	0.83	0.84	0.80	0.64	0.67	1.68
	Major Rehabilitation	7.85	0.34	22.44	0.57	0.39	38.15	38.69	36.73	29.55	30.54	29.34
	Reconstruction	2.64	0.06	0.26	19.33	9.56	18.70	18.96	18.00	14.48	14.96	13.90
	Total	**49.08**	**54.71**	**66.30**	**29.40**	**48.30**	**65.03**	**65.95**	**62.61**	**50.36**	**52.05**	**56.00**
Total		**154.44**	**130.07**	**105.52**	**111.78**	**115.47**	**128.33**	**130.15**	**118.84**	**102.88**	**102.72**	**108.72**

Table 8-20 shows the amount of annual investment by work to address the lane miles indicated in Table 8-19, which would result in the forecasted condition presented in Table 8-18.

Table 8-20: Dollars of Investment by Work Type under Pavement Scenario 3

System	Treatment	Estimated Investment in Million USD										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Interstate	Preservation	$11.80	$2.78	$0.69	$9.63	$0.92	$8.04	$8.16	$7.14	$7.20	$6.44	$7.23
	Minor Rehabilitation	$8.41	$16.50	$0.27	$17.79	$15.35	$2.09	$2.12	$1.86	$2.53	$1.67	$2.54
	Major Rehabilitation	$0.00	$0.39	$13.70	$0.52	$0.42	$19.75	$20.03	$17.55	$15.05	$15.81	$15.10
	Reconstruction	$21.41	$0.09	$11.10	$0.15	$12.37	$11.81	$11.98	$10.49	$8.85	$9.46	$8.88
	Total	**$41.62**	**$19.76**	**$25.76**	**$28.09**	**$29.06**	**$41.70**	**$42.29**	**$37.04**	**$33.63**	**$33.37**	**$33.76**
NHS Non Interstate	Preservation	$0.89	$1.79	$5.49	$0.53	$4.08	$1.61	$1.63	$1.55	$1.24	$1.29	$2.42
	Minor Rehabilitation	$10.68	$8.91	$2.72	$2.72	$4.81	$0.39	$0.39	$0.37	$0.30	$0.31	$0.79
	Major Rehabilitation	$4.45	$0.19	$7.81	$0.31	$0.21	$20.65	$20.94	$19.88	$15.99	$16.53	$15.88
	Reconstruction	$1.89	$0.04	$0.16	$11.46	$6.48	$11.47	$11.63	$11.04	$8.88	$9.18	$8.53
	Total	**$17.91**	**$10.92**	**$16.18**	**$15.02**	**$15.58**	**$34.12**	**$34.60**	**$32.85**	**$26.42**	**$27.31**	**$27.62**
Total		**$59.53**	**$30.68**	**$41.94**	**$43.11**	**$44.64**	**$75.81**	**$76.89**	**$69.89**	**$60.05**	**$60.68**	**$61.38**

8.3.3.2 Bridge Scenario 3

Bridge Scenario 3 follows the same logic as Pavement Scenario 3. It assumes only the current STIP funding levels for FY 2022 through 2026. After 2026, it invests slightly less than Scenario 2. Its allocation is based on the annual average percentage allocation from the most conservative alternative shown in the December 2021 PRHTA report applied to the October 2022 FOMB-approved Fiscal Plan. The Dec. 21, 2021 report recommended that 22.0 percent of the total available capital budget be allocated to NHS bridges. The funding distribution of this scenario is based on the recommended 22 percent and shown in Table 8-21. Highlighted in green is what differentiates this scenario from the other two that are presented.

Table 8-21 Scenario 3 Bridge Budget

Scenario 3 -NHS Bridge Funding Based ($Million USD)												
Funding ID	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Total**
PRHTA NTP	$2.68	---	---	---	---	---	---	---	---	---	---	$2.68
STIP	---	$8.72	$22.55	$27.23	$11.16	---	---	---	---	---	---	$69.66
PRHTA Fiscal Plan	---	---	---	---	---	$66.00	$66.42	$63.14	$51.47	$52.34	$52.97	$352.34
Metropistas NTP	$4.60	---	---	---	---	---	---	---	---	---	---	$4.60
Metropistas CIP	---	$3.60	$3.16	$3.11	$3.24	$3.30	$2.43	$2.37	$2.53	---	---	$23.74
Metropistas CIP Average	---	---	---	---	---	---	---	---	---	$2.97	$2.97	$5.94
Total	**$7.28**	**$12.31**	**$25.71**	**$30.34**	**$14.39**	**$69.29**	**$68.85**	**$65.51**	**$54.00**	**$55.30**	**$55.94**	**$458.92**

Table 8-22 shows the NHS bridge conditions forecast to result from Scenario 3.Under Scenario 3, the percentage of Good deck area is less, and the percentage of Poor is slightly higher than in Scenario 2.

Table 8-22 Forecasted NHS Bridge Conditions Under Scenario 3

Scenario 3-NHS Bridges Condition Projections (Percentages)													
Conditions	**10-Year Target**	**Base 2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Good	15.0%	16.2%	16.4%	16.3%	16.5%	16.7%	16.7%	17.8%	18.9%	19.8%	20.5%	21.2%	21.9%
Fair to Good	37.5%	36.7%	36.2%	35.8%	35.5%	34.9%	34.5%	34.4%	34.3%	34.3%	34.2%	34.1%	34.1%
Fair to Poor	37.5%	39.3%	38.7%	38.4%	38.1%	38.0%	37.6%	37.5%	37.4%	37.4%	37.3%	37.2%	37.1%
Poor	10.0%	7.8%	8.7%	9.5%	9.8%	10.4%	11.2%	10.3%	9.4%	8.5%	8.0%	7.5%	6.9%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8-23 shows the deck area to be treated per work type and year that will result in the forecast shown in Table 8-22.

Table 8-23: Annual Deck Area to be Treated under Scenario 3

Annual Projected NHS Bridge Deck Area Treated by Work Type (Sq. Mts.)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	7,201	2,948	6,989	11,610	3,410	2,509	2,492	2,372	1,955	2,002	2,025
Minor Rehabilitation	6,589	474	195	315	550	4,492	4,463	4,246	3,500	3,585	3,626
Major Rehabilitation	3,791	807	6,911	503	663	11,215	11,143	10,602	8,740	8,951	9,053
Replacement	0	1,997	5,050	3,927	4,917	12,034	11,957	11,376	9,378	9,604	9,714
TOTAL	**17,580**	**6,225**	**19,145**	**16,355**	**9,540**	**30,249**	**30,055**	**28,597**	**23,574**	**24,141**	**24,417**

Table 8-24 shows the investment needed to impact the area indicated in Table 8-23 that will result in the forecast shown in Table 8-22.

Table 8-24: Annual Investments by Work Type under Bridge Scenario 3

NHS Bridge Investments by FHWA Work Type (Million USD)											
Work Types	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Preservation	$2.41	$2.52	$7.94	$4.37	$2.57	$1.04	$1.04	$0.99	$0.81	$0.83	$0.84
Minor Rehabilitation	$0.26	$0.98	$0.44	$0.63	$1.04	$10.62	$10.55	$10.04	$8.28	$8.48	$8.57
Major Rehabilitation	$4.60	$1.78	$4.87	$1.17	$1.38	$27.76	$27.58	$26.24	$21.63	$22.15	$22.41
Replacement	$0.00	$7.03	$12.46	$24.18	$9.41	$29.87	$29.68	$28.24	$23.28	$23.84	$24.11
TOTAL	**$7.28**	**$12.31**	**$25.71**	**$30.34**	**$14.39**	**$69.29**	**$68.85**	**$65.51**	**$54.00**	**$55.30**	**$55.94**

8.4 Recommended Pavement and Bridge Investment Strategies

Very late in the TAMP development process, the FOMB updated the long-term PRHTA Fiscal Plan. The Fiscal Plan includes the potential for higher funding levels than seen in the STIP. The STIP cannot be quickly or simply updated to reflect the higher FOMB Fiscal Plan amounts. To be added to the STIP, projects need to be added to the MPO long-range transportation plan, must be subject to public review, and meet other Federal requirements. Also important, is the "consistency" process. If PRHTA adds projects to the STIP, each year FHWA will require documentation that the investment levels in the projects are actually delivered. Over committing in the STIP could lead to findings that PRHTA is not implementing its TAMP. Such a finding could result in serious Federal penalties.

Therefore, the recommended investment scenarios are Scenario 2 for both pavements and bridges. They balance the need to not overcommit to projects before 2026 which could lead to annual consistency problems. They allow for a phasing in of the increased investment levels available from the FOMB Fiscal plan. The larger Scenario 2 investment strategies result in a more robust pavement and bridge inventory and a balanced life-cycle based mix of treatments.

8.5 Supporting National Goals and Achieving State Targets

The asset management rule says[55] that the TAMP shall discuss how the investment strategies collectively would make or support progress toward:

1. Achieving and sustaining a desired SOGR over the life cycle of the assets.
2. Improving or preserving the condition of the assets and the performance of the NHS relating to physical assets.
3. Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d).
4. Achieving the national goals identified in 23 U.S.C. 150(b).

The investment strategies illustrate how PRHTA could achieve and sustain a SOGR by fully investing the funds from the FOMB Fiscal plan. To date, the STIP has not been programmed to fully use all the Fiscal Plan funds in part because the most recent Fiscal Plan was not approved until Oct. 14, 2022. The pavement and bridge scenarios that illustrate use of more of the FOMB-Fiscal Plan funds would result in improved conditions.

By improving the pavement and bridge conditions, the investment strategies support achieving the national goals. Those goals address safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, and reduced project delivery delays. The strategies support safety by improving pavement conditions which should improve skid resistance which is an important safety element. Infrastructure condition will be improved. The

[55] 23 CFR 515.9(f)

highways will be more reliable and freight movement enhanced if bridges are not load-limited or in critical condition so that they could fail during extreme weather events. The improved bridge conditions support freight movement which is important for economic vitality. Reduced project delivery delay is outside the TAMP's scope. However, PRHTA is investing in a project management system and hired two teams of project management consultants to reduce project delivery delays.

8.6 Risks and Uncertainties Around the Investment Strategies

The long-term horizon and volatile environment surrounding these investment strategies create several risks to their implementation. Some of the greatest risks are summarized.

The volatile and changing climate has demonstrated the risks it creates. Hurricanes Irma, Maria, and Fiona are obvious reminders that the steady, predictable improvement of pavements and bridges can be interrupted by extreme weather events. The earthquakes from 2019 to 2022 represent another risk to PRHTA's forecasted asset conditions. Extreme weather and seismic events not only create more damage, they also delay planned preservation and rehabilitation projects. Once delayed, the pavements and bridges could deteriorate necessitating more expensive treatments, so the planned work types are no longer appropriate. Another risk is that when emergencies damage utilities, construction projects cannot proceed because of a lack of power or potable water.

The COVID-19 pandemic proved to be an unexpected threat to the PRHTA asset management program. Any repeat of COVID-19 or a similar pandemic could again harm the schedules of planned investment strategies.

At the time this TAMP was developed, Puerto Rico and the rest of the developed world faced the worst inflation in 40 years. If inflation remains high, it could restrict the number of lane miles of pavement and square meters of bridge investments Puerto Rico can afford.

Puerto Rico's continuing financial struggles pose another risk. Each year, the FOMB updates the Fiscal Plan. Economic downturns or bankruptcy proceedings could change the investment strategies' financial assumptions.

Delivering a larger construction program called for in these strategies represents another risk. PRHTA is attempting to increase the capacity of its project design and construction industry. The Puerto Rico design and construction industry adapted to the smaller PRHTA program of the 2000s. Now, as the program grows the industry needs to expand its capacity. Economic and private-sector considerations outside the control of the PRHTA will influence how quickly the design and construction industry grow to meet PRHTA's investment needs.

Delays in project development or delivery could cause pavement and bridge deterioration to be greater than anticipated in these investment strategies. If a preservation project is delayed, the pavement or bridge may have deteriorated to the point that a rehabilitation project may be needed. Delays in delivering projects could result in more deterioration than anticipated in these strategies.

These many risks illustrate the need for PRHTA to continue its risk management efforts. Among the efforts are monitoring these risks and scanning for additional ones. The threats, variability, or uncertainty caused by these risks need to be monitored and mitigation steps taken if they threaten the success of PRHTA's investment strategies.

Chapter 9. Conclusions

Photo 9-1: PR-2 Expressway Mayagüez - Hormigueros

This fully compliant TAMP documents that PRHTA has a data-driven performance process and a framework to implement the TAMP according to 23 CFR Part 515. PRHTA has implemented policies and project-selection processes to align the TAMP investment strategies with the projects delivered by the STIP and supported by the statewide and metropolitan planning processes. This TAMP fully complies with the new requirements in Title 23 Section 119(e)(4). This TAMP addresses resilience in the risk management chapter and in the life-cycle planning chapter.

As noted in the preceding chapters, PRHTA uses life-cycle planning and optimized investment strategies to select investment strategies for NHS pavements and bridges. PRHTA works within the constraints of the FOMB Fiscal Plan to cost-effectively manage the short-and-long-term condition of its bridges and pavements. The cost-effective management is reflected in the improved condition of recent years and by the life-cycle based funding allocations seen in the investment strategies.

PRHTA also has identified the risks to its investment strategies and to the improved conditions that those strategies seek to obtain. PRHTA will monitor those risks and implement mitigation strategies to minimize the negative effects or to capitalize on any positive opportunities.

The 10-year targets, as shown in section 2.5 Long-Term SOGR, are reached for pavements with all three scenarios. However, the percentage Poor target for bridges is not met under Scenario 1.

Table 9-1 shows a summary of the three scenarios. Scenario 2 is the one that provides the best overall condition results among all three scenarios. Although this scenario is $175.5 million higher than Scenario 1 and $7.4 million higher than Scenario 3, it reaches the national Interstate pavement Poor target three years earlier than the other scenarios. Scenario 2 will get PRHTA out of the penalty sooner.

Table 9-1: Summary of the Three Scenarios

Scenario	2022-2032 Total Investment (Million USD)			Target Attainment					
	Pavements	Bridges	Total	Interstate Pavements		NHS Non-Interstate Pavements		NHS Bridges	
Scenario 1	$456.48	$211.08	$667.56	<= 5% Poor reached in 2032	>=25% Good reached by 2023	<= 18% Poor sustained through 2032	>=10% Good reached by 2024	<=10% Poor sustained until 2024, then **increases to 13.1% by 2032**	>=15% Good sustained through the TAMP period
Scenario 2	$631.96	$473.95	$1,105.91	**<= 5% Poor reached in 2029**	>=25% Good reached by 2023	<= 18% Poor sustained throughout the TAMP period	>=10% Good reached by 2024	<=10% Poor reached by 2028	>=15% Good sustained through the TAMP period
Scenario 3	$624.59	$458.92	$1,083.51	<= 5% Poor reached in 2032	>=25% Good reached by 2023	<= 18% Poor sustained throughout the TAMP period	>=10% Good reached by 2024	<=10% Poor reached by 2028	>=15% Good sustained through the TAMP period

Scenario 2 also:

1. Reaches the Interstate pavement Good target by 2023.
2. Sustains the NHS Non-Interstate pavement Poor target throug the TAMP period.
3. Reaches the NHS Non-Interstate pavement Good target by 2024.
4. Reach the NHS bridge Poor target by 2028.
5. Sustains the NHS bridge Good target through the TAMP period.

This TAMP reflects another step forward in the continuing improvement of Puerto Rico's highways, and its asset management processes. These improvements will make Puerto Rico's highways safer and more efficient for its residents. They will lower Puerto Rican's long-term costs for sustaining assets and make the highway system more convenient and attractive. These improvements will support economic development, facilitate freight movement, be more in harmony with the environment, and make travel more pleasant for Puerto Ricans and visitors.

This TAMP was developed, in part, to comply with Federal asset management regulations in 23 CFR Part 515. But more importantly it was developed to provide Puerto Ricans with a safer, more resilient, more efficient, and more attractive transportation system.

PRHTA received some preliminary comments from FHWA on the November version of the TAMP. The PRHTA's answer to those comments is included in Appendix K.

Appendices

Appendix A: Glossary of Terms and Acronyms

Term	Definition
Asset Management	Asset management means a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired SOGR over the life cycle of the assets at minimum practicable cost.
Asset Management Plan	Asset management plan means a document that describes how ...the state will make risk-based decisions from a long-term assessment of the National Highway System (NHS), and other public roads included in the plan at the option of the State DOT, as it relates to managing its physical assets and laying out a set of investment strategies to address the condition and system performance gaps. This document describes how the highway network system will be managed to achieve State DOT targets for asset condition and system performance effectiveness while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets.
Autopistas de Puerto Rico	The privately owned toll authority that manages the Teodoro Moscoso bridge in San Juan on PR-17.
Bridge Deck	The horizontal component of the bridge that provides the driving service and connects to the roadway surface.
Bridge Substructure	The piers, pilings, foundations, and abutments that support the superstructure.
Bridge Superstructure	The beam, girders, and related elements such as bearings that support the deck.
Center Line Mile	The length of one mile of roadway without regard to the number of lanes.
Consistency Determination	Annual Consistency Determination Documents mean documents a State Department of Transportation (State DOT) uses to demonstrate development and implementation of a Transportation Asset Management Plan (TAMP) as described in 23 CFR 515.13(b).

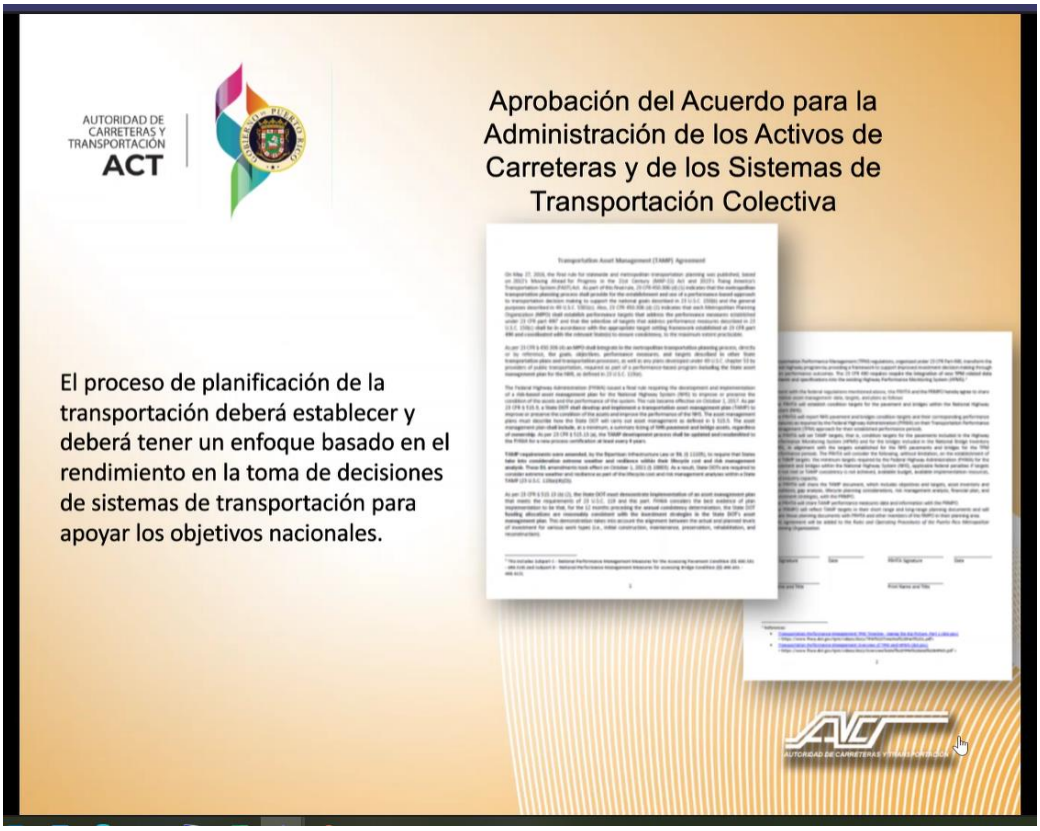
Term	Definition
Cracking	An unintentional break in the continuous surface of a pavement.
Faulting	A vertical misalignment of pavement joints in Portland Cement Concrete Pavements.
Financial Plan	Financial plan means a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.
Full Performance Period Progress Report	Full Performance Period Progress Report means the TPM report referenced in 23 CFR 490.107(b)(3) in which State DOTs report by October 1st of the first year following the reference performance period, including a State DOT's discussion of its progress toward achieving the 4-year targets and the effectiveness of investment strategies in the State DOTs' TAMP.
Good, Fair, and Poor	When capitalized in this document, mean the conditions defined in 23 CFR 490.313 and 490.409 relating to assessing conditions for bridges and pavements on the National Highway System (NHS) in connection with TPM.
Highway Performance Monitoring System (HPMS)	A national level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways. The HPMS contains administrative and extent of system information on all public roads, while information on other characteristics is represented in HPMS as a mix of universe and sample data for arterial and collector functional systems.
Highway Safety Improvement Program (HSIP)	This is a is a core Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land.
International Roughness Index	Statistics are used to estimate the amount of roughness in a measured longitudinal profile.

Term	Definition
Interstate System	A network of 46,876 miles of designated by Congress as the Interstate System that connect principle metropolitan areas, cities, industrial centers, border points, and supports the national defense.
Investment Strategy	Investment strategy means a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks.
Jointed Concrete Pavement	Pavements where the top-most surface is constructed of Portland cement concrete with joints.
Lane Mile	A lane mile is the centerline length in miles multiplied by the number of lanes.
Life Cycle Planning	Life-cycle planning means a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition.
Long-Range Statewide Transportation Plan (LRSTP)	means the official, statewide, multimodal, transportation plan covering a period of no less than 20 years developed through the federally required statewide transportation planning process. (23 U.S.C. 135 and 23 CFR 450.104)
Management System	Means a systematic process, designed to assist decision makers in selecting cost effective strategies/actions to improve the efficiency or safety of, and protect the investment in the nation's infrastructure. A management system may include procedures for functions such as identification of performance measures; data collection and analysis; determination of needs; evaluation and selection of appropriate strategies/actions to address the needs; and evaluation of the effectiveness of the implemented strategies/actions. (*see, e.g.*, 23 CFR 450.104 and 23 CFR 515.17)
Metric	means a quantifiable indicator of performance or condition.
Metropistas	A privately own toll road operator that manages the parts of PR-22 and PR-5.
Mid-Performance Period Report	The biennial report required under 23 CFR Part 490 that reports on the condition of NHS bridges, pavements, and performance related to congestion, travel time reliability, freight movement on the

Term	Definition
	Interstate System, and on-road mobile source emissions.
MPO	Metropolitan Planning Organization means the policy board of an organization created and designated to carry out the metropolitan transportation planning process
National Bridge Inspection Standards (NBIS)	The standards that govern the inspection and reporting of the nation's bridges.
National Bridge Inventory (NBI)	The National Bridge Inventory (NBI) is the database of the nation's bridges, inspected according to Federal Highway Administration standards, and updated annually by State DOTs and FHWA.
National Highway System (NHS)	Consists of 161,000 miles of highway routes that serve major population centers, international border crossings, airports, public transportation facilities and other intermodal and major travel destinations.
Performance Gap	Performance gap means the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.
Performance Measure	An expression based on a metric that is used to establish targets and to assess progress toward achieving the established targets (e.g., a measure for flight on-time performance is percent of flights that arrive on time, and a corresponding metric is an arithmetic difference between scheduled and actual arrival time for each flight).
Risk	Risk means the positive or negative effects of uncertainty or variability upon agency objectives. Risk means the positive or negative effects of uncertainty or variability upon agency objectives.
Rutting	The longitudinal surface depressions in the pavement derived from measurements of a profile transverse to the path of travel on a highway lane. It may have associated transverse displacement.
SOGR (SOGR)	A capital asset is in a SOGR if it is able to perform its designed function in a condition sufficient for the asset to operate at a full level of performance and does not pose a known unacceptable safety risk.

Term	Definition
Statewide Transportation Improvement Program (STIP)	Statewide Transportation Improvement Program (STIP) means a statewide prioritized listing/program of transportation projects covering a period of 4 years that is consistent with the long-range statewide transportation plan, metropolitan transportation plans, and TIPs, and required for projects to be eligible for funding under title 23 U.S.C. and title 49 U.S.C. Chapter 53.
Strategic Highway Safety Plan (SHSP)	This is a requirement and major component of the FHWA's HSIP; its purpose is to significantly reduce fatalities and serious injuries from traffic crashes on public roads in the United States and its territories.
Target	A quantifiable level of performance or condition, expressed as a value for the measure, to be achieved within a time period required by the Federal Highway Administration (FHWA)
VMT	Vehicle miles travelled.

Appendix B: MPO Agreement



Transportation Asset Management (TAMP) Agreement

On May 27, 2016, the final rule for statewide and metropolitan transportation planning was published, based on 2012's Moving Ahead for Progress in the 21st Century (MAP-21) Act and 2015's Fixing America's Transportation System (FAST) Act. As part of this final rule, 23 CFR 450.306 (d) (1) indicates that the **metropolitan transportation planning process shall provide for the establishment and use of a performance-based approach** to transportation decision making to support the national goals described in 23 U.S.C. 150(b) and the general purposes described in 49 U.S.C. 5301(c). Also, 23 CFR 450.306 (d) (2) indicates that each Metropolitan Planning Organization **(MPO) shall establish performance targets that address the performance measures** established under 23 CFR part 490[1] and that **the selection of targets** that address performance measures described in 23 U.S.C. 150(c) **shall be in accordance with the appropriate target setting framework established at 23 CFR part 490 and coordinated with the relevant State(s) to ensure consistency**, to the maximum extent practicable.

As per 23 CFR § 450.306 (4) **an MPO shall integrate in the metropolitan transportation planning process**, directly or by reference, **the goals, objectives, performance measures, and targets described in other State transportation plans and transportation processes**, as well as any plans developed under 49 U.S.C. chapter 53 by providers of public transportation, required as part of a performance-based program **including the State asset management plan for the NHS**, as defined in 23 U.S.C. 119(e).

The Federal Highway Administration (FHWA) issued a final rule requiring the development and implementation of a **risk-based asset management plan** for the National Highway System (NHS) to improve or preserve the condition of the assets and the performance of the system. The rule became effective on October 2, 2017. As per 23 CFR § 515.9, a **State DOT shall develop and implement a transportation asset management plan** (TAMP) to improve or preserve the condition of the assets and improve the performance of the NHS. The asset management plans must describe how the State DOT will carry out asset management as defined in § 515.5. The asset management plan **shall include**, at a minimum, a summary listing of **NHS pavement and bridge assets, regardless of ownership**. As per 23 CFR § 515.13 (a), the **TAMP development process shall be updated and resubmitted** to the FHWA for a new process certification **at least every 4 years**.

TAMP requirements were amended, by the Bipartisan Infrastructure Law or BIL (§ 11105), to require that States **take into consideration extreme weather and resilience within their lifecycle cost and risk management analysis**. These BIL amendments took effect on October 1, 2021 (§ 10003). As a result, State DOTs are required to consider extreme weather and resilience as part of the lifecycle cost and risk management analyses within a State TAMP (23 U.S.C. 119(e)(4)(D)).

As per 23 CFR § 515.13 (b) (2), **the State DOT must demonstrate implementation of an asset management plan** that meets the requirements of 23 U.S.C. 119 and this part. FHWA considers the best evidence of plan implementation to be that, for the 12 months preceding the **annual consistency** determination, the State DOT **funding allocations are reasonably consistent with the investment strategies in the State DOT's asset management plan**. This demonstration takes into account the alignment between the actual and planned levels of investment for various work types (i.e., initial construction, maintenance, preservation, rehabilitation, and reconstruction).

[1] This includes Subpart C - National Performance Management Measures for the Assessing Pavement Condition (§§ 490.301 - 490.319) and Subpart D - National Performance Management Measures for Assessing Bridge Condition (§§ 490.401 - 490.413).

The Transportation Performance Management (TPM) regulations, organized under 23 CFR Part 490, transform the Federal-aid highway program by providing a framework to support improved investment decision making through a focus on performance outcomes. The 23 CFR 490 **requires require the integration of new TPM related data requirements** and specifications into the existing Highway Performance Monitoring System (HPMS).[2]

In fulfilment with the federal regulations mentioned above, the PRHTA and the PRMPO hereby agree to share transportation asset management data, targets, and plans as follows:

- The PRHTA will establish condition targets for the pavement and bridges within the National Highway System (NHS).
- The PRHTA will report NHS pavement and bridges condition targets and their corresponding performance measures as required by the Federal Highway Administration (FHWA) on their Transportation Performance Management (TPM) approach for their established performance periods.
- The PRHTA will set TAMP targets; that is, condition targets for the pavements included in the Highway Performance Monitoring System (HPMS) and for the bridges included in the National Bridge Inventory (NBI), in alignment with the targets established for the NHS pavements and bridges for the TPM performance periods. The PRHTA will consider the following, without limitation, on the establishment of the TAMP targets: the minimum targets required by the Federal Highway Administration (FHWA) for the pavement and bridges within the National Highway System (NHS), applicable federal penalties if targets are not met or TAMP consistency is not achieved, available budget, available implementation resources, and industry capacity.
- The PRHTA will share the TAMP document, which includes objectives and targets, asset inventory and conditions, gap analysis, lifecycle planning considerations, risk management analysis, financial plan, and investment strategies, with the PRMPO.
- The PRHTA will share TAMP performance measures data and information with the PRMPO.
- The PRMPO will reflect TAMP targets in their short range and long-range planning documents and will share those planning documents with PRHTA and other members of the RMPO in their planning area.
- This agreement will be added to the *Rules and Operating Procedures of the Puerto Rico Metropolitan Planning Organization.*

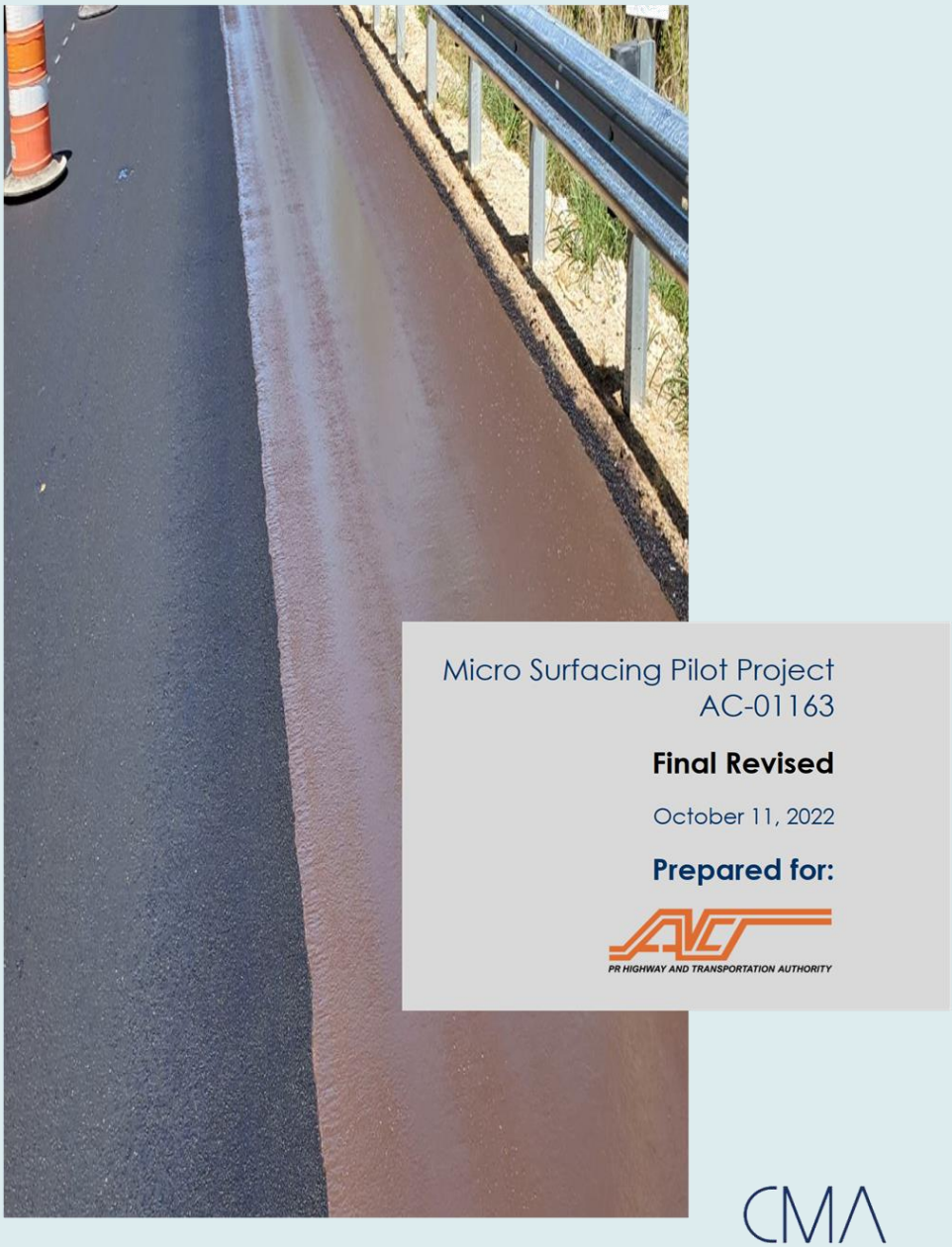
PRMPO Signature	Date	PRHTA Signature	Date
Print Name and Title		Print Name and Title	

[2] References:

- Transportation Performance Management TPM Timeline - Seeing the Big Picture, Part 1 (dot.gov)
  < https://www.fhwa.dot.gov/tpm/videos/docs/TPM%20Timeline%20Part%201.pdf>
- Transportation Performance Management Overview of TPM and HPMS (dot.gov)
  < https://www.fhwa.dot.gov/tpm/videos/docs/Overview%20of%20TPM%20and%20HPMS.pdf >

Appendix C: Pavement Preservation Innovations

Microsurfacing



Unbonded Concrete Overlay

Targeted Overlay Pavement Solutions (TOPS)
EDC-6 State of the Practice/ Implementation Plan Form

Progress Report #3 (January – June 2022)

Progress Report Questions: **Progress Report #3 (January – June 2022) - Due July 15, 2022**	
1) If there has been NO CHANGE on this innovation during this reporting period and the previous Report is still accurate, select "No Change from last Progress Report" and you do not need to complete Questions 2-5.	(Choice) ☐ No Change from last Progress Report ☒ Changes indicated in Progress Report Below
2) What is the State's current stage of innovation implementation? Review your past progress report responses and the Implementation Stage Definitions on page 1.	(Choice) ☐ Not Implemented ☒ Development Stage ☐ Demonstration Stage ☐ Assessment Stage ☐ Institutionalized
3) Describe the State's accomplishments for this reporting period (State DOT, local agency, and transportation partners accomplishments). -- If advanced to the next implementation stage, consider the prompt questions in the chart and explain the advancements made to support your selection. -- Please include benefits as part of your explanation (i.e. time/cost savings, delay/crash reductions, etc.)	The major activities performed during this reporting period and its related accomplishments are described below in the following three categories; Construction, Guidance, and Monitoring. • **Construction** - The project ***AC-200286 Pavment Rehabilitation and Improvements to Safety of PR-2 Kilometers 185.8 to 195.0 at the Muicipalities of Sábana Grande and Guánica*** will include a segment of 800 meters length in Unbonded Concrete Over Concrete Overlay, from kilometer 193.10 to kilometer 193.98. The construction proposals were due February 16 and were Publicly read on February 17, 2022. The bid was adjudicated, the 30-day waiting period passed, and the PRHTA is in the process of signing the construction contract. • **Guidance** - The PRHTA will create a committee composed of representatives from the Design Area, Construction Area, and Material Testing Office to evaluate newly proposed specifications. The previously developed documents, the ***Unbonded Concrete Overlays Candidate Project Design Guidance*** and the **Supplemental Specification for Unbonded Concrete Overlays of Concrete Pavements** are pending to be reviewed by this future committee before adoption. • **Monitoring** - The subject matter experts from the PMO consultant team have made some observations on the design that may warrant special attention. For example, the use of higher strength concrete for the concrete overlay; they recommend using typical paving concrete strength instead, to avoid excessive shrinkage, and to add macrofibers with short slabs (6ftx6ft).

Rubblization

Department of Transportation and Public Works
Highway and Transportation Authority
Design Area

DESIGN DIRECTIVE XXX

HMA Overlay of Rubblized PCC Pavement[1]

1 Application of Design Method

The following procedures are to be used to determine the appropriate HMA overlay thickness to be placed over rubblized PCC pavement. Rubblization is a reconstruction alternative in which the existing PCC pavement is broken (in-place) into small pieces and compacted to create a uniform base for the new HMA overlay.

These guidelines encompass the evaluation of an existing pavement structure to determine if the section can support the rubblizing construction process, and design and construction steps needed to successfully use this option. The use of rubblizing requires close attention to subgrade support. This technique requires sufficient thickness of the rubblized pavement and subbase structure to protect the subgrade during construction operations.

2 Review of the Existing Pavement Structure

The selection of rubblization with an HMA overlay as a viable reconstruction alternative should be the result of a thorough review of the existing pavement structure and other design issues. A thorough investigation of the existing pavement and subsurface should be conducted. The purpose of the investigation is to determine if the pavement section can be successfully rubblized. It is essential that only constructible sections be selected for this reconstruction alternative. This requires adequate support from the subgrade, subbase, and rubblized pavement section for each of the various construction activities. If conditions exist that would result in extensive removal and replacement of the existing pavement, or the subgrade is weak and would result in severe construction problems, the designer should consider other options.

2.1 Preliminary Soils Review

From the typical pavement sections, soil maps, and typical CBRs of soils in the area, the designer and geotechnical engineer should determine if the rubblized section will protect the subgrade, by having sufficient "cover" ("Remedial Thickness") of the Subgrade as outlined in Figure 1.

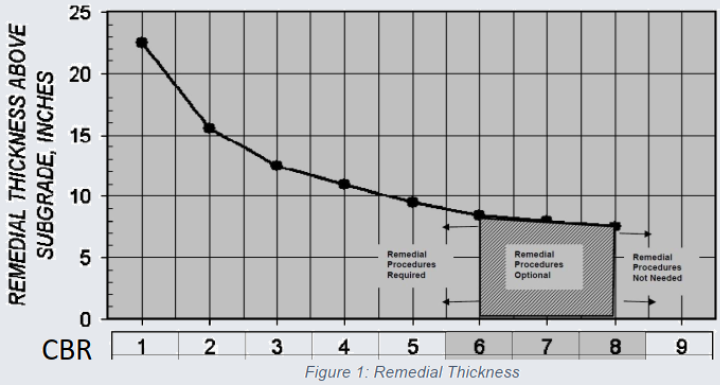


Figure 1: Remedial Thickness

[1] Based on the ILDOT 2017 Design Method

DD-XXX [1 / 6]

Appendix D: Design Directive 115 Pavement Work Types Definitions

Flexible Pavement (Asphalt) Project Type	Description (Type of treatment or works included)
Preservation	Less than 2” of Micro Milling & Overlay, Crack Filling, Crack Sealing, Fog Seal, Sand Seal, Flush Seal, Slurry Seal, Micro-Surfacing, Cape Seal
Minor Rehabilitation	From 2” to less than 6” of Cold Milling & Overlay, HIR (Hot in place recycling), Pothole Patching
Major Rehabilitation	6” or more of Cold Milling & Overlay, CIR (Cold in place recycling), Drainage Repairs
Reconstruction	Full Depth Repairs (Base replacement if needed), FDR (Full Depth Reclamation)
Rigid Pavement (Concrete) Project Type	**Description (Type of treatment or works included)**
Preservation	Joint Sealing, Crack Sealing, Diamond Grinding, Diamond Grooving
Minor Rehabilitation	Partial Depth Repairs, Undersealing or Slab Jacking, LTR (Load Transfer Restoration)
Major Rehabilitation	Full Depth Repairs, Drainage Repairs
Reconstruction	Slab Replacement (Base replacement if needed), CRR (Cracking Reseating & Resurfacing)

Appendix E: Design Directive 115 Bridge Work Types Definitions

Bridges Approach of the Project	Component	Description (Type of treatment or works included)
Preservation Cyclic Maintenance	Deck, Approach Slab, and Barrier	Sweeping/washing
		Corrosion inhibitor
		Sealing
		Polymer overlay
		Joints clean/repair/replace/elimination
		Drain clean
	Superstructure	Bearing clean/lubricate
		Clean
		Corrosion inhibitor
		Crack sealing
	Substructure	Clean
		Corrosion inhibitor
		Crack sealing
		Scour countermeasures
Minor Rehabilitation Condition Based	Deck, Approach Slab, and Barrier	Partial depth patching
		Cyclic works
Major Rehabilitation Condition Based	Deck, Approach Slab, and Barrier	Partial/full depth patching
		Concrete overlay
		Cyclic works
	Superstructure	Bearing rehabilitate/replace
		Repair/rehabilitate/retrofit
		Cyclic works
	Substructure	Repair/rehabilitate/retrofit
		Cyclic works
Reconstruction Rehabilitation/ Replacement		Replace Deck
		Replace superstructure
		Replace substructure

Culverts with Single 20 ft Span or More Approach of the Project	Component	Description (Type of treatment or works included)
Preservation Cyclic Maintenance	Slab, Approach slab, and barrier & walls	Sweeping/washing
		Corrosion inhibitor
		Crack sealing
		Polymer overlay
		Partial depth patching
		Clean debris
		Scour countermeasures
		Channel improvements
Minor Rehabilitation Condition Based	Slab, Approach slab, and barrier & walls	Partial depth patching
		Repair/rehabilitate/retrofit
		Cyclic works
Major Rehabilitation Condition Based	Slab, Approach slab, and barrier & walls	Partial/full depth patching
		Repair/rehabilitate/retrofit
		Concrete overlay
		Cyclic works
Reconstruction Rehabilitation/Replacement	Slab, Approach slab, and barrier & walls	Replace slab
		Replace walls/headwalls

Appendix F: Risk Register

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
1	If PRHTA does not methodically plan and program rehabilitation and reconstruction of the aging interstate pavements,	then the condition of the Interstate will deteriorate resulting in the percentage of Poor Interstate exceeding the Federal minimum 5% acceptable level leading to funding penalties.	4.50	5.00	22.50	PRHTA will develop a STIP that will prioritize Interstate pavements in Poor condition and ensure that the projects are delivered on time.
2	If PRHTA does not methodically fix the concrete pavement on the interstate and NHS Non-Interstate	then it will not be able to reduce the percentage of Poor pavements and achieve its condition and desired SOGR targets.	4.25	5.00	21.25	PRHTA will prioritize the rehabilitation and reconstruction of its aging concrete Interstate pavements.
3	If PRHTA continues to lose knowledge staff	then there will be a vacuum in knowledge about important aspects of pavements and bridges inventory, condition, performance, deterioration, and history, delaying decisions or resulting in incorrect decisions that may be more expensive and negatively impact the condition, and performance of bridges and pavements, posing safety risks.	4.25	5.00	21.25	PRHTA should develop succession strategies as staff retire or leave PRHTA.
4	If PRHTA does not use asset management processes to create and deliver a realistic list of required STIP projects	then our NHS pavements and bridges could deteriorate, and we will not achieve our pavement condition targets and our desired SOGR, and negatively impact safety and resiliency.	4.00	5.00	20.00	1) PRHTA will increase the number of STIP projects to fully use the funds provided by the FOMB. 2) PRHTA will complete and implement PMIS. 3) PRHTA will devote adequate resources to effectively manage the larger planning, design, and construction efforts needed to deliver the larger program.
5	If PRHTA does not invest in making critical assets resilient	then we will continue to have asset failures and will have to invest resources to work on emergency projects after each major natural events (Hurricanes, earthquakes).	4.00	5.00	20.00	PRHTA should incorporate resiliency in all new design and rehabilitation/reconstruction projects.
6	If PRHTA does not have sufficient trained contract management personnel	then we will be delaying the authorization and re-authorization of many important service contracts, that will cause delays in	4.00	5.00	20.00	PRHTA will recognize that increasing the size of its program requires increased contracting support and will commit

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
		planning, programming, design, and delivery of important bridge and pavement projects.				the necessary resources to quickly authorize contracts.
7	If PRHTA is not able to measure pavement friction and address low-friction sites	then we may experience increased crashes posing safety risks.	3.75	5.00	18.75	PRHTA will invest in the personnel, equipment, and contractors to staff a continuous skid-measurement program.
8	If PRHTA does not ensure succession planning in important areas of asset management and decision making	then all the Good work done to date will be lost and new personnel will waste significant time in recreating or learning about Good practices that support data driven asset management decisions negatively impacting the progress made.	4.25	4.25	18.06	PRHTA will identify the skill sets needed to sustain its asset management efforts and appropriately staff the efforts.
9	If PRHTA does not train and retain sufficient knowledge staff	then we will not have sufficient knowledge staff with the ability to manage, direct, and guide consultants, contractors, and other external service providers to provide Good services and products to support our transportation asset management needs.	4.00	4.50	18.00	PRHTA will recognize specialty knowledge staff such as pavement and bridge management experts as important resources to be trained, retained, and recruited.
10	If PRHTA does not develop and implement a robust preservation and maintenance program for pavements and bridges	then we will have Good and Fair pavements and bridges that will deteriorate necessitating more expensive rehabilitation and reconstruction treatments.	4.00	4.25	17.00	1) PRHTA will adopt programming policies to emphasize the selection of preservation projects in the STIP. 2) PRHTA will coordinate with the DPW to implement low-cost maintenance treatments and preservation projects to extend the life of pavements and bridges.
11	If inflation continues at a high rate	then we will be unable to deliver the projects needed to achieve our condition and performance targets and ensure safe movement of people and freight.	3.75	4.50	16.88	Continue to monitor bid prices and be prepared, if necessary, to ask the FOMB for additional monies.
12	If PRHTA does not get sufficient, timely, and consistent funding for pavements and bridges	then the pavements and bridges will continue to deteriorate necessitating more expensive treatments.	3.25	5.00	16.25	PRHTA will communicate to its stakeholders the importance of delivering the projects aligned to TAMP to improve and sustain the condition and performance of assets.

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
						PRHTA will also advocate to the MPO to continue supporting the use of Federal and State funds primarily to improve and sustain asset conditions.
13	If PRHTA does not implement a plan to address the bridge decks in Poor and close to Poor condition	then the percentage of bridges in Poor condition will increase to exceeding the federal minimum of 10% Poor by deck area	3.75	4.25	15.94	PRHTA will emphasize when programming bridges the need to address the large number of bridge decks in Poor or "near-Poor" condition.
14	If PRHTA does not implement timely construction quality checks	then the pavements and may not achieve the expected pavement life necessitating more expensive treatments.	3.00	5.00	15.00	PRHTA will increase the size of its inspection and testing capacity to keep pace with the growing size of its construction program.
15	If PRHTA does not improve the roughness on the interstate pavement	then we will have difficulty in meeting the Federal minimum condition levels of no more than 5% Poor for the Interstates.	3.00	5.00	15.00	1) PRHTA will assess the reasons for the large amount of lane miles with high International Roughness Index (IRI) levels and develop specifications and implement other tactics to improve pavement smoothness. 2) PRHTA will assess its pavement measurement equipment and processes to ensure it is accurately measuring IRI and take necessary corrective action.
16	If PRHTA continues to add more routes to the NHS	then PRHTA may not be able to maintain or achieve the targets established	3.00	5.00	15.00	PRHTA will try to improve the condition of the existing NHS routes and after achieving that they can consider adding new routes.
17	If PRHTA does not give the Notice to proceed to the pavement data collection contract on the first months of the year	then we will continue to have limited time to properly review the quality of the data before HPMS data submission	3.00	5.00	15.00	PRHTA will prioritize to give the Notice to proceed for the data collection in January of every year.
18	If PRHTA does not give the Notice to proceed to the pavement data collection contract on the first months of the year	then the data collection can be interrupted or delayed because of the hurricane season	3.00	5.00	15.00	PRHTA will prioritize to give the Notice to proceed for the data collection in January of every year.

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
19	If PRHTA does not assess and address drainage needs	then pavements may get flooded, roads will be blocked during storm events, and fail prematurely.	3.50	4.25	14.88	PRHTA will develop an inventory of at-risk culverts and flood-prone areas for long-term improvement.
20	If PRHTA does not invest in timely pavement data collection and data quality improvements	then we will not have the accurate data to understand the pavement deterioration trends to plan for investments in timely preservation and the delay may require resorting to more expensive treatments.	3.50	4.25	14.88	PRHTA will consider investing additional resources to manage (including integrity and security) the quality and timely collection of pavement data.
21	If PRHTA does not invest in data collection and data maintenance activities	then data quality and data-driven decisions will suffer, leading to incorrect project decisions.	3.50	4.25	14.88	1) PRHTA will use funds allocated by the FOMB to support an adequate data collection and management process. 2) PRHTA will implement more stringent data quality checks to support project selection decisions.
22	If PRHTA does not invest in in-house resources and process optimization	then the resources needed with the necessary agility to review and process project documentation, invoices, and service contracts can be negatively impacted.	3.50	4.25	14.88	PRHTA will "scale up" and appropriately train its internal resources to manage the contracting needed for its larger design and construction program.
23	If sufficient funding is not allocated for maintenance activities and preservation treatments	then we will experience accelerated asset deteriorated necessitating investment in expensive treatments.	3.25	4.50	14.63	PRHTA will work closely with DPW to maximize the investment of maintenance and preservation funds.
24	If PRHTA does not invest in in industry partnership	then the existing cadre of industries may not be sufficient to support the development of the needed projects and the timely investment of funds.	3.25	4.50	14.63	PRHTA will regularly communicate to the consulting and contracting industry of its need for an industry large enough to support the growing construction program.
25	If PRHTA does not streamline and align the STIP process with the TAMP and the Long-range statewide transportation plan	then we may select incorrect treatments and projects to include in the STIP that will not achieve the desired improvements, necessitating changes to the STIP or result in waste of resources and negatively impact PRHTA's credibility (Example delivering rehabilitation when	3.50	4.00	14.00	PRHTA will ensure that the TAMP strategies and life-cycle processes influence the STIP project selection.

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
		preservation is the appropriate treatments).				
26	If there is no single reliable source of master bridge and pavement inventory with tracking of changes used by all offices	then information will keep changing year by year, resulting in confusion and errors and lack of credibility to use the data for decisions.	4.00	3.50	14.00	PRHTA will develop and implement a plan that prioritizes the different data, and implement a plan to clean and update, and upload the data to a Data Warehouse that will serve as the single source of all data.
27	If PRHTA does not plan the timely delivery of its pavement and bridge projects	then we may have a large backlog of projects that will negatively impacts our consistency review and increases the overall percentage of Poor Interstate and NHS Non-Interstate pavements, and Poor NHS bridges.	3.25	4.25	13.81	PRHTA will devote adequate resources to effectively manage the planning, design, and construction efforts needed to deliver the larger program.
28	If PRHTA does not develop and publish a detailed realistic STIP list with all the necessary pavement and bridge projects to achieve the condition and desired SOGR targets	then we will not be able to attract the industry to proactively plan to hire and train the required number of personnel to support PRHTA in the development and delivery of all the necessary projects.	3.25	4.25	13.81	PRHTA will develop a multi-year project schedule and meet regularly with the construction industry to keep it informed of the increasing size of the construction program.
29	If PRHTA does not invest in timely data collection and data quality improvements to support decisions	then we will not be able to make data-driven project planning, programming, or project selection decisions for our STIP or TAMP, negatively impacting the project delivery necessary to achieve our target conditions and desired SOGR, that could also result in penalties.	3.25	4.25	13.81	PRHTA will develop data-management processes to specify what data it needs, to what quality, and within what timeframes.
30	If PRHTA is unable to systematically coordinate projects with utilities' agencies	then it is likely that work done on roadways will get damaged by a later intervention (work) of utilities' agencies, necessitating additional avoidable investment in bridges and pavements.	3.3	4.3	13.81	PRHTA should proactively coordinate with utility companies to ensure that all utility work relevant to PRHTA projects are aligned with PRHTA work. This must include that if the effort does not have positive results, notify the utilities agencies that must be responsible for the costs of the new investment in the project.
31	If PRHTA is unable to educate political leaders	then there will be a lot of push back on support for the	2.8	5.0	13.75	PRHTA will brief legislators and new

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
	and other stakeholders to understand and collaborate on asset management decisions	delivery of much needed projects that will improve and sustain asset condition and SOGR targets.				members of the governor's staff about the benefits and cost savings produced by asset management.
32	If PRHTA is unable to educate political leaders and other stakeholders to accept and buy-in to analytical data driven decisions that are aligned to Good asset management practices	then project selection will be based on political factors and not support the overall SOGR for Puerto Ricans that will help the economy grow and ensure safety of travelers.	2.8	5.0	13.75	PRHTA will publicize and educate the need for a TAMP, the benefits of asset management, and document the higher conditions and costs savings that have resulted from using asset management principles.
33	If PRHTA does not focus on preservation and treat the Fair and Poor bridges	then bridges that are in Fair condition will continue to deteriorate, necessitating more expensive treatments.	3.50	3.75	13.13	PRHTA will actively manage the STIP's bridge projects, analyze the bridge conditions and ensure that appropriate funding is allocated to preservation and maintenance of Good and Fair bridges.
34	If PRHTA's concessionaires of NHS Pavements and Bridges do not use asset management practices	then we may not be able to achieve the condition and SOGR targets.	3.50	3.75	13.13	PRHTA will consider and implement options to encourage concessionaires to use asset management practices and were appropriate use preservation and maintenance practices.
35	If the PRHTA does not plan now to systematically address the aging bridges	then the number of bridges requiring major rehabilitation in the next 15 to 20 years will be unmanageable .	3.25	4.00	13.00	1) PRHTA will increase the number of STIP bridge projects. 2) PRHTA will provide project-management resources to manage the delivery of bridge projects.
36	If PRHTA does not increase the number of bridge projects, it delivers annually	then it may negatively impact safety and resiliency.	3.25	4.00	13.00	PRHTA will increase the resources needed to deliver NHS bridge projects and ensure that resiliency and safety are considered in the projects.
37	If PRHTA does not get sufficient, timely, and consistent funding for pavements and bridges	then we will not be able to plan or program for the timely delivery of projects.	3.25	4.00	13.00	PRHTA will have ongoing communications with the FOMB to continue informing them about the program of projects for delivery, the impacts of inflation, and the impact

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
						of any redirection of resources and funds to support emergencies, and any negative impacts of changes in investment levels on project delivery.
38	If there is no clear understanding about the data needs among the offices that are collecting, managing, or using the data	then some essential data will not be collected, identified, and tracked as needed, requiring the use of resources for extensive manipulation the data, also requiring additional data collection.	3.50	3.50	12.25	PRHTA will develop data-management processes to capture the data needed by the different office and specify which offices are responsible for collecting which data sets, what the datasets are used for and protected, and the quality to which data should be collected.
39	If there is no uniformity in the data nomenclature for the data stored in different databases(naming convention, data format etc.,) and no single source of data	then data may become unusable for decision making and we will have inconsistent data that requires many hours of scrubbing before it can be used, making it difficult to use the data for federal submissions and as input for decisions.	3.50	3.50	12.25	PRHTA will develop data dictionaries and data standards, "clean up" existing data sets, collect new data in accordance with the data standards and provide the necessary training to the data collectors, managers and users on these standards.
40	If PRHTA does not implement data driven asset management processes to improve and sustain asset conditions	then we will not be able to accurately ascertain the asset conditions or forecast the right level of investment needed to achieve the SOGR.	3.50	3.50	12.25	PRHTA will implement a single database for decision support that will be used to support all pavement and bridge related decision.
41	If PRHTA does not maintain a uniform database of its damaged sites	then we will be unable to properly identify the critical assets that need to be proactively addressed to sustain or manage impact of extreme weather.	3.50	3.50	12.25	PRHTA will keep a list of its damaged sites in one database, update it after every emergency event, and ensure that users can easily access it to identify, analyze, and prioritize the sites to address the impacts of extreme weather.
42	If PRHTA does not increase the number of bridge projects, it delivers annually	then we will not be able to meet the NHS bridge or the desired SOGR targets.	3.00	4.00	12.00	1) PRHTA will increase the planning and programming of bridge projects and have a sufficient number of projects on the shelf ready to bid to address any gaps. 2) PRHTA will provide project-management

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
						resources to manage the timely delivery of bridge projects.
43	If PRHTA does not properly address bridges with Critical Findings (CF), which require immediate action per NBIS federal regulation	then PRHTA will continue to be under a Plan of Corrective Action (PCA) for CF metric	4.00	3.00	12.00	PRHTA will expedite the process of contracting a Consultant to manage CF projects in a timely manner
44	If PRHTA does not coordinate with the qualified design consultants and expands the qualified consultant list before continuing the increase in bridge projects that are programmed	then PRHTA will not have the design consultant capacity to execute the large numbers of bridge projects expected to meet objectives (e.g. same consultant firms are being contracted for several simultaneous projects without having sufficient resources)	4.00	3.00	12.00	PRHTA will communicate the intention and ensure multi-year bridge projects to emphasize the importance of acquiring sufficient resources for the simultaneous projects
45	If PRHTA does not plan, train, and allocate resources, and communicates its focus on preservation and maintenance	then there will be a lack of well-trained resources and insufficient resources (materials and technologies) and guidelines for implementing proper and cost-effective pavement and bridge preservation and maintenance.	3.00	4.00	12.00	PRHTA will use NHI, FHWA, Universities, and consultants to develop training plans, specifications, and manuals to support a robust preservation and maintenance program.
46	If PRHTA does not increase the number of bridge projects, it delivers annually	then over the longer-term we may lose the funding needed to meet the bridge needs.	2.75	4.25	11.69	1) PRHTA will prioritize and, as appropriate, increase the number of bridges it delivers, and provide additional necessary resources to ensure the timely delivery of bridge projects. 2) PRHTA will demonstrate that it can fully utilize all the funding available to the bridge program.
47	If the MPOs and other transportation planning organizations in Puerto Rico do not understand and support asset management practices and the TAMP	then we will not be able to implement Good asset management practices and apply life-cycle planning to cost-effectively ,and systematically manage, and improve the condition and performance of bridges and pavements.	2.8	4.3	11.69	PRHTA will brief new MPO board members on the benefits of asset management and continue to promote Good bridge and pavement management practices at the lowest possible cost.
48	If PRHTA does not use asset management and life-cycle planning, including a plan for systematic maintenance	then we may not be selecting the right treatments at the right time based on the lowest life cycle costs resulting in some pavements and bridges	3.25	3.50	11.38	PRHTA will coordinate with the DPW to use low-cost maintenance treatments and preservation projects to

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
	and preservation of assets, to make timely investment decisions	deteriorating prematurely to levels that require more expensive rehabilitation or reconstruction.				extend the life of pavements and bridges.
49	If PRHTA does not coordinate with the construction industry and inform it of the increasing bridge projects that are programmed.	then we will have not had the contractor capacity to deliver the large numbers of bridges needed to meet our bridge objectives.	2.75	4.00	11.00	PRHTA will develop a multi-year bridge project schedule and meet regularly with the construction industry to keep it informed of the increasing size of the bridge program.
50	If Poor assets are prioritized and worst-first strategy is implemented, and no funding is allocated to preservation and maintenance of bridges and pavements	then we will have more bridges and pavements that deteriorate to Poor conditions requiring more expensive treatments and we will always be treating to fix Poor assets.	2.50	4.25	10.63	PRHTA will communicate to decision makers, and train agency personnel as needed, so they understand the importance and cost-effectiveness of preservation and maintenance, and the need to allocate appropriate amounts of funds to preserve and maintain bridges and pavements.
51	If PRHTA does not focus on preservation and treat the Fair and Poor bridges	then it may cause the percentage Poor to exceed the 10% federal minimum.	3.25	3.25	10.56	PRHTA will continue programming bridge preservation projects and ensure they are delivered on time.
52	If PRHTA does not invest in data collection and data maintenance activities	then federal submissions will be negatively impacted.	3.25	3.25	10.56	PRHTA will create a check list of federal submissions and allocate funds and adequate resources to data collection, maintenance, and quality checks specifically to support all federal submissions.
53	If PRHTA does not properly address bridges with Critical Findings (CF), which require immediate action per NBIS federal regulation	then the PCA could turn into a Non-Compliance for not being met accordingly	2.00	5.00	10.00	PRHTA will ensure PCA is met accordingly to avoid a Non-Compliance
54	If PRHTA does not prepare a proper inventory of temporary structure elements and parts, as well as a designated storage facility for these	then the PRHTA will not have sufficient elements, materials, and resources to respond under emergency situations (e.g. a bridge failure requires the purchase of a temporary structure and shipping from	5.00	2.00	10.00	PRHTA will complete the inventory of temporary structure elements and parts and designate a storage facility to be prepared for emergency

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
	elements and repair materials	the mainland, which adds months to the project)				situations and accelerated projects.
55	If PRHTA is unable to maximize the use of the funds available by planning, designing, and delivering projects to align with the TAMP each year	then bridges will continue to deteriorate creating a major backlog of bridges that need treatments.	3.25	3.00	9.75	PRHTA will add resources to align projects with the TAMP, maximize the planning, design, and delivery of bridge projects, and closely monitor the process through project delivery.
56	If PRHTA is unable to maximize the use of the funds available by planning, designing, and delivering projects to align with the TAMP each year	then there will be an increase in the bridges that need more expensive treatment.	3.25	3.00	9.75	PRHTA will add the necessary resources to maximize the timely planning, design, and delivery of projects.
57	If the PRHTA continues to be impacted by hurricanes and is unable to make timely investments to make bridges more resilient	then bridges may fail making some essential services unreachable to communities posing safety risks.	3.00	3.25	9.75	PRHTA will continue emphasizing the repair and replacement of critical bridges assessed to be scour critical.
58	If PRHTA does not implement a pavement preservation program	then the Good condition pavements will deteriorate in an accelerated manner and will make it more difficult to improve their condition.	3.00	3.00	9.00	PRHTA will develop a systematic pavement preservation program, especially in the NHS.
59	If PRHTA does not invest in making critical assets resilient	then, assets may fail prematurely and not be available for use during critical weather events (Hurricanes, flooding, etc.).	2.25	4.00	9.00	PRHTA should regularly update its 667 list of repeated damage sites and conduct assessments and develop plans on how to prevent future damage when projects at those sites are considered.
60	If PRHTA does not implement timely construction quality checks	then expected life of bridges may be reduced and some may fail prematurely posing safety risks.	2.50	3.50	8.75	PRHTA will increase its construction testing and inspection resources to keep pace with the increasing size of the bridge program.
61	If PRHTA does not proactively focus on improved design and delivery standards to make bridges and pavements more resilient	then bridges may fail prematurely, and pavements may get flooded, accelerating deterioration necessitating expensive reconstruction and rehabilitation.	2.50	3.50	8.75	PRHTA will make increased resilience a component of any updated or new design standards.
62	If PRHTA is unable to maximize the use of the funds available by planning, designing, and delivering projects to	then the fiscal board may reduce the bridge funding.	2.00	3.50	7.00	PRHTA will add necessary resources and increase the number of STIP bridge

ID	Risk Event	Primary Impact & Consequence	Ave. Likelihood	Ave. Impact	Ave. Risk Value	Mitigation Strategies
	align with the TAMP each year					projects and ensure its timely delivery.
63	If PRHTA does not develop and train bridge inspectors on Good inspection practices	then there will be no consistency in how bridges are inspected and rated.	2.50	2.75	6.88	PRHTA will use the NHI courses and other available resources to keep bridge inspectors well trained.
64	If the PRHTA does not plan and make roadways and drainage assets more resilient for extreme weather events (hurricane, flooding, etc.,)	then the roadways could experience accelerated deterioration, be unavailable due to flooding, detachments, or landslides (cut off communication links to communities) and pose safety risks.	2.25	3.00	6.75	PRHTA will prioritize developing a list of high-hazard sites for increased investment to make them more resilient.
65	If PRHTA does not maintain a uniform emergency management process	then rapid identification, hazard management, and restoration will be delayed and likely be more expensive.	2.25	2.75	6.19	PRHTA will ensure that with staff turnover it maintains its ability and experience to respond quickly to emergency events.
66	If PRHTA does not coordinate including scour evaluation and countermeasure design as part of bridge preservation and rehabilitation projects	then the amount of scour critical bridges in Puerto Rico will remain the same or increase, presenting a higher risk of structure failures during heavy storm events	2.00	3.00	6.00	PRHTA will ensure scour evaluation and countermeasure design are included within RFP documents for the bridge preservation and rehabilitation projects
67	If PRHTA does not coordinate and achieve a long-term agreement with the Department of Natural and Environmental Resources (DNER) to exempt the PRHTA from having to furnish H-H Studies for bridge projects requiring minor works	then PRHTA will need to prepare and obtain endorsements from DNER to H-H Studies for bridge projects requiring minor works and thus not expected to have adverse impacts in existing conditions, adding significant months and costs to each project.	2.00	3.00	6.00	PRHTA will coordinate, renew and follow-up on a long-term agreement with DNER to exempt the PRHTA from this requirement
68	If PRHTA does not invest in research	then existing materials and technology may not be sufficient to support the durability/resilience needed.	2.50	2.00	5.00	PRHTA will focus Federal research dollars on research to extend the life of Puerto Rico pavements and bridges and will implement pilot projects to capitalize on the research findings.

Appendix G: Part 667 Database

ID	Event Year	Event Start Date	Main Event Type	Road Name Class	Road Name or Number	Road System	From KM Calc	To KM Calc	Asset Type	Asset Number (NBIS)	Damage Type	Other Damage Description	Repair Nature	Repair Type
47	2017	9/19/2017	Hurricane	PR-	2	Interstate	192.2	192.2	Bridge	1668	Debris	Large debris accumulation & erosion		
48	2020	1/7/2020	Earthquake	PR-	2	Interstate	192.2	192.2	Bridge	1668	Other	medium spellings and exposed reinforcement between the west cell and the downstream wingwall	Other	Repair
192	2014	8/22/2014	Storm	PR-	26	Interstate	2.3	2.3	Road Segment	N/A	Flood	Road flooded near Minillas Tunnel		Repair Type
193	2022	2/2/2022	Heavy Rains	PR-	26	Interstate	2.3	---	Road Segment	N/A	Flood	Lane flooded due to obstruction in the sewer systema. They were cleaned		
194	2014	8/22/2014	Heavy Rains	PR-	26	Interstate	3.1	---	Road Segment	N/A	Flood	One Lane Flooded		Repair Type
195	2022	2/2/2022	Heavy Rains	PR-	26	Interstate	3.1	3.2	Road Segment	N/A	Flood	Flood		
297	2014	11/5/2014	Heavy Rains	PR-	111	NHS Non-Interstate	13.1	13.1	Road Segment	N/A				Repair Type
298	2017	9/19/2017	Hurricane	PR-	111	NHS Non-Interstate	13.1	13.1	Road Segment	N/A	Scour	Scouring at temporary acrow bridge		
818	2011	8/22/2011	Hurricane	PR-	185	NHS Non-Interstate	17.6	17.6	Road Segment	N/A	Collapse of Asset	Reconstruction of PR-185 KM 17.6	Permanent	Reconstruct
819	2017	9/19/2017	Hurricane	PR-	185	NHS Non-Interstate	17.6	18	Road Segment	N/A	Landslide	Landslide	Permanent	Repair Type
820	2010	10/4/2010	Storm	PR-	185	NHS Non-Interstate	18.3	18.3	Road Segment	N/A		Roadway Section reconstruction and construction of gravity wall	Permanent	Repair Type
821	2011	8/22/2011	Hurricane	PR-	185	NHS Non-Interstate	18.3	18.3	Road Segment	N/A	Collapse of Asset	Reconstruction of PR-185 KM 18.3	Permanent	Reconstruct

Appendix H: 2020 Report on Part 667

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Appendix I: Memo from TAM Program Manager Regarding Part 667

AUTORIDAD DE CARRETERAS Y TRANSPORTACIÓN

Fecha: 11 de febrero de 2022

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Asunto: **CUMPLIMIENTO CON LA REGULACIÓN RELACIONADA A DAÑOS REPETIDOS POR EMERGENCIA COMO PARTE DEL PLAN DE GERENCIA DE ACTIVOS DE TRANSPORTACIÓN**

La regulación federal 23 CFR Parte 515.7 indica que, como parte del Plan de Gerencia de Activos de Transportación (TAMP por sus siglas en inglés), se debe establecer un proceso para desarrollar un plan de gerencia de riesgos. Este plan debe contemplar la identificación de riesgos que afecten la condición y el rendimiento de los pavimentos y puentes del Sistema Nacional de Carreteras, incluyendo los riesgos asociados con las condiciones ambientales actuales y futuras, tales como eventos de condición climática extrema, cambio climático, actividad sísmica, y riesgos relacionados a daños y costos recurrentes según identificados por la evaluación de daños repetitivos a facilidades debido a eventos de emergencia, según la regulación federal 23 CFR Parte 667. La Parte 667 indica que cada estado, incluyendo Puerto Rico, debe conducir una evaluación para determinar si hay alternativas razonables a las carreteras y puentes que han requerido reparación y reconstrucción en dos o más ocasiones debido a eventos de emergencia. La Parte 667.3 define la evaluación requerida como un análisis que incluye la identificación y consideración de alternativas que mitiguen o resuelvan completa o parcialmente la causa del daño recurrente, los costos de la solución y la duración posible de la solución. La Parte 667.9 indica que los resultados de la evaluación deben ser considerados al desarrollar proyectos.

Centro Gubernamental Roberto Sánchez Vilella, Torre Sur
PO Box 42007, San Juan, PR 00940-2007 | Tel. 787-721-8787 | www.dtop.pr.gov

Como parte de los esfuerzos para el desarrollo del TAMP 2028, y en cumplimiento con la regulación, la ACT procuró una evaluación inicial que se describe en el reporte titulado "*PRTAMP 23 CFR PART 667 REPORT - Final |November 20, 2020*". El Anejo 1 incluye información de acceso a este reporte y a la base de datos que se desarrolló para realizar el análisis.

El contenido de este reporte debe implementarse y actualizarse como parte de los esfuerzos de la actualización al TAMP 2032 que se está desarrollando.

Para viabilizar el mantener actualizada la base de datos de los daños por eventos y el seguimiento a la implementación de alternativas, le he nombrado persona de contacto y responsable por esta ejecución.

Agradezco le provea la información al Gerente del Programa de Gerencia de Activos, Ing. Cándido Camacho Ayala, según el itinerario mostrado en la Tabla 1.

Tabla 1: Itinerario de Entrega

ID	Tarea	Fecha de Entrega
1.	Base de datos actualizada e identificación de sitios adicionales con daños repetidos	9 de marzo de 2022
2.	Reporte de visita a los sitios previamente identificados y los nuevos, indicando status y recomendación. El capítulo 15 del reporte recomienda un comité de revisión, considere la implementación del mismo.	6 de abril de 2022

El Ing. Camacho procurará la actualización del reporte y la distribución de las recomendaciones según indicado en los capítulos 16 y 17 del reporte.

De tener preguntas puede comunicarse con la doctora Zaida Rico, P.E., consultora de la ACT para el TAMP, a través de zrico@cmapr.com.

Anejo:

Anejo 1: Reporte sobre Evaluación en Cumplimiento con Parte 667 y Base de Datos

Anejo 1: Reporte sobre Evaluación en Cumplimiento con Parte 667 y Base de Datos

El archivo del reporte tiene el siguiente nombre:
17130 PRTAMP Part 667 Report 2020-11-20.pdf

El archivo de la base de datos tiene el siguiente nombre:
2022-02-10 Part 667 Workbook 2019-04-15 Database.xlsx

Para acceder la herramienta, haga doble "click" al ícono correspondiente:

- Desde PDF, refiérase a los anejos incluídos, según se muestra en la siguiente figura.

- Desde DOCX, refiérase a los siguientes íconos.

Reporte	*Base de Datos*
17130 PRTAMP Part 667 Report 2020-11-	2022-02-10 Part 667 Workbook 2019-04-1

Appendix J: Notes on the Assessment of Pavements and Bridges Portion in Projects

The assessment of the portion of projects actually invested in existing mainline pavements and bridges was based on the Consistency Evaluations.

Consistency project assessments of investments are available since FY 2019. For that year, about 87% of bridge project costs, 93% of Abriendo Caminos projects costs, 51% of pavement preservation project costs, and 49% of pavement rehabilitation projects costs were attributable to TAMP related costs. Note that the investment during this year was an atypical amount of $108 million, much higher than in previous and posterior years.

Since FY 2020 we have been using the process and tools related to the Design Directive 115 (DD115) to perform project analyses; hence, data from years 2020 to present are organized differently from the 2019 data. To include all the years in a single analysis, extensive data manipulation would be required. Refer to DD115 for details on the specific costs considered for the analyses

FY 2020 did not have bridge projects; there was only one mixed assets project in which investment in bridges was minimal.

The analysis of FY 2020 and 2021 lead to the percentages used in Appendix Table 1. At the time of the drafting of Chapter 7, a comparable analysis of FY 2022 was not available yet; hence, not included.

Appendix Table 1: Project Proportion for Pavements and Bridges

FY 2020 & 2021	Total Project Cost	Consistency Related Cost	Percentage of Consistency Related
Pavement Only Projects	$70,607,179.69	$38,470,048.33	54.5%
Bridge Only Projects	$7,427,686.50	$6,164,100.50	83.0%

The results shown are for those projects that include only one of the assets within the same project. Although there are projects with works in both types of assets, it cannot be known from the project descriptions provided on the STIP. This type of information has been able to be determined with construction documents, which are not available during the planning phase.

Similar calculations were made for the worked lane miles and deck area. Results are shown in Appendix Table 2. These proportions were applied to STIP totals to develop the investment strategies.

Appendix Table 2: Project Impact Proportion for Pavement and Bridges

Indicator		FY 2020 & 2021	Percent Worked
Pavement	Lane Miles within Project Limits	334.46	90.8%
	Lane Miles Worked	303.52	
Bridges	Deck Square Meters. within Project Limits	54,399.97	82.1%
	Deck Square Meters Worked	44,659.64	

Appendix K: Answer to FHWA's Preliminary Comments

This appendix enumerates FHWA preliminary comments to the Non-BIL compliant TAMP delivered in November and shows PRHTA's answers below each comment.

1. Clarify / further elaborate as to what PRHTA considers "maintenance" (per work types in 23 CFR 515) as well as how the work types are directly associated with what is considered maintenance (i.e., unclear if "preservation" includes or excludes maintenance).

- The TAMP uses the word "maintenance" generically to describe many types of treatments such as preservation or rehabilitation. Generally, the TAMP uses the word simply to explain why timely treatments extend asset life.
- The TAMP does not include investment amounts for the maintenance work type as it does for other work types.
- Puerto Rico turned the maintenance program over to the DTPW's Directory of Public Works (DPW). That Directory was unable to provide an estimate of NHS maintenance expenditure per year so the TAMP could not include estimated maintenance work type amounts.

2. Regarding the use of management systems and investment decision tools, PRHTA needs to clarify/elaborate:

2.1. How the procedures in the TAMP are formalized within PRTHA (for example, through standards procedures, internal guidelines, memoranda, or other adopted procedures). This is because there are limited details presented.

- The management systems and investment decision tools were formalized in PRHTA in two major ways.
- First, the same management systems and investment decisions tools used to develop the 2018, 2019, and 2022 TAMPs were used by PRHTA to request Fiscal Plan investment levels from the Financial Oversight and Management Board (FOMB). PRHTA consultants developed in 2021 four investment scenarios using the management systems and investment decisions. PRHTA presented those scenarios to the FOMB which based its eventual 28-year Fiscal Plan, in large part, on that analysis. Therefore, the TAMP and the Fiscal Plan developed by the Congressionally appointed FOMB used the same management systems, investment decision tools, condition data, deterioration rates, and same condition targets.
- Second, the 2023-2026 Statewide Transportation Improvement Program (STIP) pavement and bridge program was developed based upon the TAMP investment strategies. Data about the condition of the NHS bridges and pavements used for the TAMP was also used to identify the needed pavement and bridge projects included in the STIP. PRHTA directed its program-management consultants and its TAMP

consultants to share information and to develop for the STIP pavement and bridge projects consistent with the TAMP investment strategies.

- This consultation process was based on the collaboration that the TAMP team has been providing since 2020 with the PRHTA's Project Management Information System (PMIS) efforts. The first stage of the PMIS involved a process to manage project initiatives. CMA developed a simple process that uses the current TAMP, the TAMP Excel tools, and the current STIP and PRHTA project programs to identify potential initiatives. Since then, CMA has been identifying sites for potential projects for PRHTA's pavements. The process can also be applied to bridges. Also, PRHTA consultants to the Bridge Office have indicated that they relied on the TAMP to identify the bridge projects they developed. This process has also been documented in the 2021 Consistency Supporting Documentation provided to FHWA in July 2022.

2.2. How the analysis (such as deterioration models / deterioration rates) will be refined in the future.

- As explained in the TAMP Tools Guide and Appendix M of the 2028 TAMP, the deterioration models rely on actual condition data, where the variations in condition are analyzed.
- Deterioration rates are determined based on the sites that have data in more than one year and have not shown an improvement, presumably due to treatment.
- The proportion of all data that actually shows deterioration is also calculated and included in the model.
- Since the original deterioration tool for bridges was based on data from several years, we have maintained this tool. However, we updated the data years for the development of the 2021 CIP and 2022 TAMP.
- For pavements, the original tool was based on the 4 years of data that were available at the time. Now, we have 8 years of data. For the 2022 TAMP, we created a separate tool that performs the overall deterioration analysis with all the available years. The same logic as in the previous tool is used, where the deterioration rate is based on the sites that actually show deterioration and the proportion of all data that those sites represent.
- The current model is based on data and is simple to explain and apply. It has provided us with a conservative Good base for forecasting conditions at a high level.
- More refined models are expected to be developed and used but mostly for more detailed analysis such as lifecycle planning of specific roads sections as described on the Segmentation Initiative. This will allow for optimization of treatment selection based on the specific site conditions.
- To be able to produce refined models, we first need to gather data. PRHTA has started several initiatives to start collecting the necessary data that will allow for those refined models.
- Through the Design Directive 115 that recently started implementation, the PRHTA will start collecting data related to work types and sites. In the future, this data can

be useful to determine the impact of the work types on the condition and life of the assets that can further be taken into consideration for future improvements on the model.

- HTA is collecting and analyzing sample truck weight data from its mobile stations to determine if there are patterns related to geographical area, traffic volume, and direction. In addition to providing a base for updating the Design Directive 200 (design loads), the information will eventually allow correlation analysis for more sophisticated deterioration models.
- HTA is also collecting data on the sites that have been impacted by natural disasters in fulfillment with Part 667. This data is allowing PRHTA to identify sites that will require special attention to make them resilient. This data can also be used to improve the models.
- HTA has been collecting traffic volume data for some time, which can be included in the refinements of the models.
- The goal is to eventually be able to geolocate the available condition, traffic, weight, weather sensitive sites, and treatment data that will allow for the development of sophisticated models.
- HTA has also evaluated software alternatives to allow more sophisticated analysis. Extensive research and personal interviews with other states have been part of such analysis. However, we first need to have the data collected to avoid spending on a service from which we cannot get the desired benefit yet. Moreover, some of that software relies on customization that can become obsolete before the data needed to implement them is available.

2.3. How these proposed deterioration rates may change in the future based on system-wide factors such as traffic volumes, climate, or changing design standards.

- Please refer to the comments in the previous point.
- HTA is also participating in FHWA's Climate Challenge that will eventually allow the agency to develop an implementation plan for Life Cycle Assessments (LCAs) and Environmental Product Declarations (EPDs). This will also allow the collection of additional data that can be used to refine or customize different models.
- HTA is also working on the update of asphalt mix specification to better address PR climate (specification 702). Also, PRHTA is researching alternatives to facilitate its fulfilment by the industry (researching pellet-type additives provider).
- HTA is also working on trying different treatment initiatives (microsurfacing, unbonded overlay, bonded overlay, rubblization) and is starting monitoring those that have been implemented (microsurfacing). The main focus is to gather data to assess its duration in different conditions. This information can eventually be used to refine the models.

3. Regarding risk management, clarify the specific process for continuous monitoring or accountability procedures, such key milestones, champions, or reporting.

- The PRHTA will appoint a committee that will review and update the risk register on an annual basis.
- The committee will be composed of a representative of each PRHTA office that is in charge of Pavements, Bridges, Finances, Planning, Design, and Construction. The committee will be presided by the TAM program manager. They will choose a secretary that will record the proceedings.
- The committee will meet quarterly to assess if there is a situation that could result in any changes to the risks. They will set a schedule indicating the due date for their individual assessment and the date for the group discussions regarding the potential risk changes.
- The president will be responsible for gathering the collective assessments' results and for the update of the risk register.
- The updated risk register will then be reviewed and approved by all the members of the committee and the president will distribute the updated register to the executive officials including the Executive Board.

4. The TAMP shows a gap for meeting long-term SOGR for bridge conditions but does not detail the critical factors that would hinder progress towards filling this gap, and how PRHTA will address this gap. Thus PRHTA needs to:

4.1. Detail the critical factors that would hinder progress towards filling the gap.

- Critical factors include some that result from a lack of necessary resources to manage and complete the needed tasks.
- Inability to timely get the needed funding
- Inability to timely complete design, bidding, and construction of projects.
- Further extreme weather or seismic events could also hinder progress toward filling the gap.

4.2. Explain/further elaborate on how PRHTA will address this gap.

- Publish a realistic STIP that considers the actual expected work to be fulfilled in terms of investment, work types, pavement lane miles to be treated, and bridge area projection to be treated, for the next five years (or as many years as possible). This goes together with the implementation of strategies to follow up on getting the necessary resources to fulfill the planning and execution stages.
- Provide training to contract and consulting resources to get them ready to join the workforce to do these critical activities. Customized training may be provided to address the gaps and build expertise.

4.3. Discuss potential funding impacts due to not meeting minimum bridge conditions per 23 CFR 490.413.

- PRHTA is aware of the funding impacts as per regulation: § 490.413 Penalties for not maintaining bridge condition. The regulation is cited below.
    - If FHWA determines for the 3-year period preceding the date of the determination, that more than 10.0 percent of the total deck area of bridges in the State on the NHS is located on bridges that have been classified as Structurally Deficient, the following requirements will apply.
        - During the fiscal year following the determination, the State DOT shall obligate and set aside in an amount equal to 50 percent of funds apportioned to such State for fiscal year 2009 to carry out 23 U.S.C. 144 (as in effect the day before enactment of MAP-21) from amounts apportioned to a State for a fiscal year under 23 U.S.C. 104(b)(1) only for eligible projects on bridges on the NHS.
        - The set-aside and obligation requirement for bridges on the NHS in a State in paragraph (a) of this section for a fiscal year shall remain in effect for each subsequent fiscal year until such time as less than 10 percent of the total deck area of bridges in the State on the NHS is located on bridges that have been classified as Structurally Deficient as determined by FHWA.
- The worst case of the TAMP scenarios show NHS bridges more than 10% Poor for three consecutive years. Hence, the penalty would apply for a year.
- We will try to procure a better budget scenario to avoid the expected impact from Scenario 1.

5. Specifically state who collects the data for pavements and bridges across the NHS regardless of ownership (i.e. Does PRHTA collect all the pavement and bridge data for the NHS).

- Pavement NHS data is collected by PRHTA through a contract with Pathway Services. Interstate data is collected annually. NHS Non-Interstate data is collected over a period of two years, reported annually.
- Bridges NHS data is collected by PRHTA through in-house and contracted inspectors. Data is collected in different recurrences, depending on the condition of the bridge. Recurrence varies between 3, 6, 12, and 24 months. Data is reported every year.

6. Further elaborate as to how system performance and safety performance are linked to TAMP investment decisions.

- The TAMP indicates that improved pavement conditions are likely to reduce rutting and improve skid resistance, both of which improve safety.
- It also says reducing the number of critical bridges increases safety by reducing the possibility of failure during storm events.
- The safety program includes pavement treatments to both improve pavement conditions and presumably enhance friction and reduce rutting.

- The priority the TAMP gives to funding the Interstate maximizes the pavement and safety linkage by focusing limited investments where traffic and risk is greatest.
- PRHTA includes in pavement projects treatments for signage, barrier, pavement markings, and traffic safety devices which can improve safety.

7. Revise condition measure in tables 2-3 and 2-6 to indicate: Interstate Pavement Poor Condition instead of Interstate Pavement Poor condition Poor.

6. This editing error was fixed.

8. Clarify the magnitude in the units of VMT used in table 3-1.

7. They are millions; it was clarified.

9. How does the information contained in the Certified Public Miles Letter for Puerto Rico for this year compared to the information contained on the TAMP.

- The June 8, 2022 certification includes 19,968 miles while the TAMP includes 4,852. The main difference is because the TAMP is based on the HPMS' inventory, which includes 226 miles of municipal roads, while the certification includes all municipal roads, which totalizes 15,149 miles. Note that most municipal roads are Non-NHS, and the NHS ones are included in the HPMS.
- The June 8, 2022, certification includes 4,792 miles of state roads while the TAMP includes 4,564 miles. The TAMP used the HPMS inventory version dated December 20, 2021; this version was extensively reviewed, and quality checked, which took considerable time. This HPMS list was updated later, with a version dated December 31, 2022, which was the one used for the certification.

10. Revise data labels included in the graphs through the document to be consistent (i.e. in some graphs data labels are INT and NHS were as in others the data labels are Interstate and NHS (Non-Interstate).

- This editing error was be fixed.

11. Clarify if and when PRHTA is able to achieve the interstate pavement condition target (5% or less), how would it impact the investment strategies.

- The TAMP indicates that once the 9.35 percent of the Interstate that already is Poor is improved, PRHTA would increase the amount of preservation to sustain a SOGR with a more balanced mix of treatments.

12. Further elaborate as to the Quality Assurance process performed by PRHTA as part of the DQMP.

- The PRHTA got approval of its current DQMP (SOP) in May 2019. Since then, several data quality control and assurances are being enhanced. This includes the performance of daily field checks and office data validations.
- HTA has also implemented bi-weekly meetings with its data collection contractor to closely monitor and document the collection activities.
- The contractor provides an internet-based platform where several documents are shared, including vehicle testing, operator's certifications, and samples of daily field checks.
- HTA is updating its DQMP to better represent the FHWA's published successful practices, update the testing standards, clarify the sampling and acceptance criteria per stage (pre, during, and post collection), improve the checklists to simplify implementation, among others.
    - The checklists are being programmed into an internet-based app that facilitates its fulfillment on the field and the transition of the information into a database.
    - The new version is expected to be available for FHWA review by the end of 2022.
    - HTA plans to start with its implementation with the 2023 collection.

13. If the targets are substantially different than those used earlier, the TAMP should include a discussion about how these changes would affect investment decisions.

- The targets were central to the TAMP development process. The intent of all the investment strategies was to achieve the targets using the most economical mix of treatments. The TAMP's LCP section indicates that the LCP process relies on identifying treatments to sustain the targets.
- The process used can be summarized as follows:
    - Identify the budget.
    - Optimize the investments' distribution to decrease the percent Poor, emphasizing the Interstate, and increasing the percent Good.
    - Estimate future conditions based on the current condition, programmed works, investments made with available budget, and expected deterioration.
    - Select conservative 2 and 4 year targets that are aligned with the expected condition from the analysis.
- The 1st and 2nd cycle targets and an explanation for their modification are shown in the next table.

Asset	System	Condition	Period Target	Target 1st Cycle	Target 2nd Cycle	Notes
Pavements	Interstate	Good	2-Year	5%	20%	Target increased to reflect improvement through the first cycle and expected values.
			4-Year	5%	25%	
		Poor	2-Year	14%	11%	Target decreased to reflect improvement through the first cycle and expected values.
			4-Year	14%	11%	
	NHS Non-Int.	Good	2-Year	1%	5%	Target increased to reflect improvement through the first cycle and expected values.
			4-Year	1%	10%	
		Poor	2-Year	20%	12%	Target decreased to reflect improvement through the first cycle and expected values.
			4-Year	20%	14%	
Bridges	NHS	Good	2-Year	10%	15%	Target increased to reflect improvement through the first cycle and expected values.
			4-Year	10%	15%	
		Poor	2-Year	10%	10%	The 2-year target remained similar. The 4-year target was slightly adjusted to reflect expected value with the conservative investment of Scenario 1.
			4-Year	10%	11%	

- We used the TAMP tools to forecast the conditions every year, based on:
  - The current condition (2021 data)
  - The projects executed in 2022
  - The projects programmed from 2023 to 2026
  - The expected budget from 2027 to 2032
  - The expected deterioration.

14. There are several references to external Excel-based tools that are used to analyze recent deterioration to forecast future performance. Thus, please include and provide the exact calculations or models used.

- The TAMP includes the average deterioration rates and proportion deteriorating that were used for the condition forecast. These values were calculated with a simple process, based on the actual data.
- The general process to determine the overall average rates and percent deteriorating is as follows:
  - Organize uniformly the condition score data so it can be compared between different years.
  - Identify the entries that have data for more than one year.
  - Identify the changes on condition score between the years.
  - Identify the entries that show deterioration; that is, those that do not show stability (no change) or improvement.
  - Determine an average score downgrade per year. This is the average deterioration rate, based on condition score downgrade history.
  - Determine the proportion of the entries that showed deterioration. This is the proportion to which the deterioration rate is applied. The rest of the data is presumed to maintain its condition from one year to the next or is presumed to improve due to application of treatment.

15. Revise typo in first sentence in page 3-3 (i.e. total length of network measured by centerline should be 4,851.82).

- The typo was fixed.

16. Clarify how does the TAMP and the HSIP align with other safety plans in PR.

- Please see item 6.
- The total lane miles in STIP safety projects are about 858. The TAMP and HSIP align in that both seek to improve pavement conditions that can affect safety.
- The SHSP's vision is for all users of the transportation system to move safely and effectively, while achieving the goal of reducing fatalities and serious injuries caused by traffic crashes. This is in alignment with the objectives of the TAMP that includes "to achieve condition targets and desired SOGR to provide safe and reliable bridges and pavements for the movement of people and Goods."

17. Include the current list of critical finding bridges on the NHS and what strategies PRHTA is implementing to address them.

- The list of critical findings and recommended actions are included in the next table.

	Bridge #	Facility Carried	Km	Feature Intersected	Critical Finding Description	Item 41	Item 58 Deck Cond.	Item 59 Super. Cond.	Item 60 Sub. Cond.	Item 62 Culvert Cond.	Minimum Condition Rating	Date of Finding (Group X or Date)	PRHTA Leadership Notified? (Y/N)	Maintenance Responsibility (Item 21)	*Immediate Action Recommended by NBI Office	Immediate Action Recommendation Implemented at Time of Report? (Y/N)	Long Term Action Recommended by NBI Office (Repair/Replace)
1	116	PR 3	53.4	CEIBA CREEK	T Beams Crack-Spall (longitudinal, not structural).	P	5	3	6	10	3	Group 5	Y	state highway agency	Lane Closure. Load Tested. Posted 15 TON.	Yes	Replace Bridge
2	162	PR 123	67.0	EL JOBO CREEK	Pier Scour	P	6	6	3	10	3	Jul-21	Y	state highway agency	Load Test - Posting for 5 Tons	Yes	Repair Scour
3	382	PR 7731	0.8	LA PLATA RIVER	Structure Deterioration	P	4	4	3	10	3	Group 5	Y	state highway agency	Posted 35 TON. Load Rated. SI @ 6 months - Structure Deterioration	Yes	Replace Bridge
4	385	PR 172	9.0	LA JOYUELA CREEK	Deck Deterioration	P	3	3	6	10	3	Jan-00	Y	state highway agency	SI @ 6 Months	Yes	Repair Deck
5	790	PR 2	167.1	ROSARIO RIVER	Scour at Abutment Piles Exposed (1 meter).	P	5	6	3	10	3	Sep-20	Y	state highway agency	Load Rated. Posted 35 TON. SI @ 6 months - Scour - Repair WTBP CSA	Yes	Repair Scour
6	809	PR 348	0.3	NUEVE PASOS RIVER	Scour	P	6	6	3	10	3	Jun-19	Y	state highway agency	Posted 30 TON. SI @ 6 months - Scour - Rock Foundation - Repair WTBP by CSA	Yes	Repair Scour
7	850	PR 912	0.9	ARENAS CREEK	Scour at Abutment	P	5	6	4	10	4	Nov-20	Y	state highway agency	Load Tested. Posting for 5 TON in progress.SI @ 6 Months. Scour	Yes	Repair Scour
8	851	PR 765	1.1	BEATRIZ CREEK	Exterior Beam Deterioration	P	5	3	6	10	3	Sep-19	Y	state highway agency	Load Tested. Posted 5 Ton. Monitoring - Exterior Beam Deterioration - Repair WTBP CSA	Yes	Repair Beams

	Bridge #	Facility Carried	Km	Feature Intersected	Critical Finding Description	Item 41	Item 58 Deck Cond.	Item 59 Super. Cond.	Item 60 Sub. Cond.	Item 62 Culvert Cond.	Minimum Condition Rating	Date of Finding (Group X or Date)	PRHTA Leadership Notified? (Y/N)	Maintenance Responsibility (Item 21)	*Immediate Action Recommended by NBI Office	Immediate Action Recommendation Implemented at Time of Report? (Y/N)	Long Term Action Recommended by NBI Office (Repair/Replace)
9	1016	PR 18	3.3	PR 23 (ROOSEVELT AV.)	Deck	P	3	7	6	10	3	Group 5	Y	state highway agency	Asphalt Patching. SI @ 12 months	Yes	Replace Super
10	1086	PR 163 EASTBOUND	1.1	PORTUGUES RIVER	Deck	P	3	5	6	10	3	Group 5	Y	state highway agency	Asphalt Patching. SI @ 12 Months. Monitoring - Deck	Yes	Replace Deck
11	1133	OFF PR 200	0.0	CREEK	Deck & T beam deterioration	P	4	3	5	10	3	Group 5	Y	municipal highway agency	Load Tested. Posted 5 TON. SI @ 6 months - Exterior Beams	Yes	Replace Bridge
12	1157	PR 558	0.2	USABON RIVER	Exterior Beam Damage	P	6	3	4	10	3	Oct-19	Y	state highway agency	Load Tested. Posted 5 TON. SI @ 6 months - Exterior Beam Damage (María) - Repair WTBP by CSA	Yes	Repair Beams
13	1201	PR 920	0.4	WATERWAY	Scour	A	4	4	2	10	2	Jan-20	Y	state highway agency	SI @ 6 months - Scour - Repair WTBP by CSA. Posting for 5 TON in progress.	Yes	Repair Scour
14	1325	PR 757	4.0	DEL APEADERO RIVER	Culvert deterioration.	P	10	10	10	3	3	Group 5	Y	state highway agency	Posted 5 TON. SI @ 6 months - Box Deterioration	Yes	Replace Bridge
15	1390	PR 303	0.1	PLANTINA CREEK	Scour at Abutment Piles Exposed (1 meter).	A	6	6	2	10	2	May-20	Y	state highway agency	Load Rated. No posting Required. SI @ 6 months - Scour - Repair WTBP CSA	Yes	Repair Scour
16	1465	PR 150	0.2	JACAGUAS RIVER	Scour	P	7	7	3	10	3	Aug-18	Y	state highway agency	SI @ 6 months - Scour - Rock Foundations (María) - Repair WTBP CSA	Yes	Repair Scour
17	1486	PR 115	1.3	UNKNOWN CREEK	Steel Pipe Failure	P	10	10	10	3	3	Jul-21	Y	state highway agency	Lane Closure. SI @ 6 months to monitor Scour.	Yes	Replace Bridge
18	1638	VICTOR ROJAS AVE.	0.1	GRANDE DE ARECIBO RIVER	Approach Roadway unsupported due to Scour. Scour @ abutment.	P	5	4	6	10	4	Group 5	Y	state highway agency	Posted 5 TON. Load Tested. Piles exposed. SI @ 6 months.	Yes	Repair Approach and Abutment
19	1711	QUEBRADA CEIBA ST.	0.2	GUAYANES RIVER	Sub - Columns Deterioration, steel exposed.	A	5	5	3	10	3	Group 5	Y	municipal highway agency	SI @ 6 months - Columns. Load Rated. No posting Required	Yes	Repair Columns (jacket)
20	1730	LOCAL ROAD	0.3	DESCALABRADO RIVER	Sub/Super Deterioration	P	4	4	3	10	3	Group 5	Y	municipal highway agency	Posted 5 TON. SI @ 6 months - Substructure	Yes	Repair Pier/Install Scour Protection
21	1772	PR 167	9.1	LA PLATA RIVER	Scour, Super Deterioration.	A	4	4	5	10	4	Aug-19	Y	state highway agency	Asphalt Patching. SI @ 12 months - Deck Deterioration - Repair WTBP CSA	Yes	Replace deck
22	2012	PR 18	0.7	CHARDON STREET	Deck	P	3	6	6	10	3	Group 5	Y	state highway agency	Asphalt Patching. SI @ 12 months - Deck Deterioration - Repair WTBP CSA	Yes	Replace Super
23	2069	LOCAL ROAD	0.2	YAGUEZ RIVER	Superstructure deterioration	P	2	3	6	10	2	Aug-19	Y	municipal highway agency	Posted 5 TON. SI @ 6 months - Steel Modular Bridge - Replace - Repair WTBP CSA	Yes	Replace Steel Modular Bridge
24	2294	PR 5556	0.5	CUYON RIVER	Deck	P	3	6	6	10	3	Group 5	Y	state highway agency	Asphalt Patching. SI @ 12 months - Deck Deterioration - Repair WTBP CSA	Yes	Replace Deck
25	2348	PR 52	104.9	PR 12	Deck Deterioration	A	3	7	7	10	3	Group 5	Y	state toll authority	Asphalt Patching. SI @ 12 months - Deck Deterioration	Yes	Replace Deck
26	2369	PR 52	102.3	DIRT ROAD	Deck	A	3	7	6	10	3	Group 5	Y	state toll authority	Partial Closure. Asphalt Patching. SI @ 12 months - Deck Deterioration	Yes	Replace Deck

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27	2588	OFF PR 184	0.1	GRANDE DE PATILLAS RIVER	Super Deterioration	P	4	4	5	10	4	Aug-19	Y	municipal highway agency	Posted 5 TON. SI @ 6 months - Super Deterioration - Replace Recommendation - WTBP CSA	Yes	Replace Bridge
28	2593	PR 28	6.0	PR 2	Deck Deterioration	A	3	7	7	10	3	Aug-19	Y	state highway agency	Deck Patches. SI @ 12 months - Deck Deterioration - Repair WTBP CSA	Yes	Repair Deck
29	623	PR 378	7.4	GUAYANILLA RIVER	Scour, Column Deterioration	A	6	6	2	10	2	Aug-22	Y	state highway agency	SI @ 6 months R12-1 35 TON Posting in Progress	Yes	Repair Scour - Repair Column Base
30	1287	PR 52 SOUTHBOUND	25.0	PR 765 & BEATRIZ CRE	Deck Spalling	A	3	6	7	10	3	Jun-22	Y	state toll authority	SI @ 6 Months - Steel Plates	Yes	Repair Deck
31	2200	PR 250	0.1	ENSENADA CHANNEL	Trough Girder Deterioration	P	7	3	7	10	3	Aug-22	Y	state highway agency	SI @ 6 Months - Load Test Scheduled - Posted for 5 TON	Yes	Replace Bridge
32	3049	2ND STREET	0.1	STREAM	Culvert Scour	A	10	10	10	3	3	Aug-22	Y	state highway agency	SI @ 6 Months, Partial lane Closure in Progress (6 feet of roadway)	Yes	Repair Scour
33	2574	OFF PR 428	0.1	PRIETO RIVER	Damage to Temporary Bridge	E	0	0	0	10	4 Temp	May-22	Y	municipal highway agency	Temporary Bridge - Damage - Load Tested - Posted for 5 TON	Yes	Replace Damage Section
34	1357	PR 190	0.1	SUAREZ CHANNEL	CRFP Repair Deterioration and beam deterioration	P	5	5	4	10	4	Dec-22	Y	state highway agency	SI @ 6 Months, Load Test, Posting (in progress)	No	Replace Bridge
35	1621	PR 187	29.9	LA VEGA CREEK	Temporary Bridge Deterioration	E	4	1	3	10	3 Temp	Dec-22	Y	state highway agency	SI @ 6 Months, Load Test, Posting (in progress)	No	Replace Bridge

18. PRHTA elaborates on the quality control process used to ensure the best data available for the life cycle planning process. As PRHTA was not able to meet the MIU threshold of 5% for NHS Non-Interstate, elaborate how this would be improved for the future.

- The team has discussed this issue and identified the cause. PMO provided the segment list for the 2021 collection to Pathway based on the list provided by Highway Systems Office and the established cycles (yearly for the NHS Interstate, bi-annually for the NHS Non-Interstate and 3 years for the HPMS samples). Then, Pathway proceeded with the data collection. After data collection was completed, the Works team provided an updated list. That list identified the missing segments, but they could not put that list in the format that Pathway needed to collect them. The geographical codification used by the two service providers used to be slightly differ and need to be reconciled (start kilometer vs coordinates, for example) and we found some differences in the classification that made some segments nonexistent on the list. We understand the differences and decided that the Works team will be providing the segment list in the format that Pathway need it for the data collection to avoid missing segments.

- This issue has been resolved as now both services will use geolocation to identify the segments. Shapefiles were produced and shared among the providers.

19. Include / elaborate what would the effect of the Transportation Sector Reform Toll Office (Ring fence approach) on the investment strategies.

- This will happen but the effective date is uncertain. When the concession agreement is concluded and concessionaires begin managing the routes, the TAMP financial plan and investment strategies can be updated.