



The Puerto Rico Highway and Transportation Authority is implementing a new risk management process to effectively plan for and mitigate issues that may affect the budget and on-time delivery of a bridge replacement project in Arecibo, Puerto Rico.

The Puerto Rico Highway and Transportation Authority (PRHTA) is paving the way for other transportation agencies to effectively anticipate, assess, and manage risk for rapid renewal projects. With the assistance of the FHWA Second Strategic Highway Research Program (SHRP2), PRHTA conducted a risk assessment and analysis workshop using the *Managing Risk in Rapid Renewal Projects* product developed through SHRP2.

The Challenge: Calculating and Managing the Impact of Risks on Any Size Project

In 2017, PRHTA will begin construction on a \$3.45 million (including engineering and design) bridge replacement, that while small, is quite complex (see Project Snapshot on page 2). The project has challenges that, if left unmanaged, could lead to cost overruns, schedule delays, and unmet stakeholder expectations. PRHTA needed to conduct a thorough risk assessment to understand and mitigate risks that could impact the project budget and schedule, but found that a full probabilistic risk assessment, such as those with a Monte Carlo simulation, would require unnecessary effort for this project's size. PRHTA went in search of a risk management process that was both comprehensive and easy to apply so that once the staff learned the process, they could use it on projects of various sizes and types.



The PRHTA project team discusses the Bridge 702 replacement project.

SHRP2 Solution: A Customizable Risk Management Process and Template

Managing Risk in Rapid Renewal Projects was the ninth research project in the SHRP2 Renewal Focus Area and is also known as Renewal 09 (R09). The product uses an Excel-based template to guide teams through a risk management process to identify, evaluate, and mitigate risks. The accompanying [R09 Guidebook](#) provides additional tools to assist with each step.

During a two-day workshop hosted by the Federal Highway Administration (FHWA), PRHTA's team of project managers, designers, and consultants applied the product's iterative process and R09 Excel-based template to the Bridge 702 project to:

- Holistically identify potential risks and opportunities
- Assess the severity of each unmitigated risk and its impact on cost and schedule
- Devise mitigation strategies for the most severe risks
- Assess the overall impact of each mitigated risk

“ The workshop showed us a new approach for assessing risk. By sitting down with the entire project team to complete the R09 exercises, we were able to develop risk mitigation strategies much earlier. This process helps us think ahead and come up with solutions before construction. ”

- Ray J. Morales, PRHTA

Project Snapshot: Bridge 702 Replacement

- 10.9 meters-wide bridge, built between 1953 and 1955, located on a narrow, two-lane road (PR-681) that leads to a beach, park, and residential area
- Crosses over the Caño Tiburones canal, the largest wetland in Puerto Rico, and abuts a marina and harbor leading to the Atlantic ocean
- Heavy weekend traffic, which is expected to increase after the unveiling of the Christopher Columbus statue in 2016
- Multiple utilities cross the bridge: aerial power lines, underground telephone fiber optic lines, portable sewer and water lines, and a diesel fuel line that supplies a nearby power plant
- Current condition is poor due to severely corroded beams and seats
- Key project features: replace bridge using existing alignment upstream; raise the profile to maximize drift clearance under the structure; minimize land acquisition; maintain local access and connections while minimizing environmental impacts
- \$3.45M project budget
- Design-Bid-Build project delivery method
- Estimated construction time is 1.5 years (18 months)

R09 Risk Management Process

1 Project Scope/Strategy/Conditions

PRHTA kicked off the risk management process by familiarizing the team with the project scope, strategy, and conditions. The project manager discussed the planned approach and alternatives, funding, technical conditions affecting the project, political and external conditions, performance (cost and schedule) estimates, and the team's strategy to replace the bridge upstream using the existing bridge alignment.

2 Structuring

Next, the team defined the "base" project scenario, or the best case scenario, for duration/schedule and cost, without accounting for risk, contingency, or inflation. The "base" performance data is entered into the R09 template and used as a comparison against the project unmitigated and mitigated performance, which includes the risks and opportunities that are identified, assessed, and managed.



Table 1: Base Project Summary

Base Construction Cost in Year of Expenditures (YOE)	\$3.30M (YOE)
Construction Notice to Proceed	8/21/2017
Construction Completion Date	2/20/2019

3 Risk Identification

The project team then identified 33 risks and 3 opportunities that could affect the project's "base" performance. Risks can degrade project performance, while opportunities can enhance project performance. PRHTA documented risks and opportunities in the risk register in the R09 template and categorized them by when they are most likely to occur (e.g., construction, preliminary design/environmental process, procurement, etc.). This step captures a comprehensive, non-overlapping list of risks and opportunities, rather than screening out issues prematurely.

Left: The unveiling of the Christopher Columbus Statue in 2016 is expected to increase traffic to Arecibo.



Right: Side view of the 702 bridge in Arecibo, Puerto Rico.



4 Risk Assessment

In this step, PRHTA assessed the probability of occurrence, mean cost impact and mean schedule impact of each risk and opportunity. They can be assessed qualitatively using pre-defined ratings that are linked to a range of values, or quantitatively, using mean values. Both assessment methods are applied for probability of occurrence (percentage of occurrence), mean cost change (in dollars), and mean duration change (in months). For example, PRHTA noted that the public may be opposed to the project due to its impact on nearby wetlands and assessed this risk as having a medium probability of occurrence (30% likelihood). Furthermore, this risk was assessed as having an impact of a medium mean cost change (\$0.20M) and a medium mean duration change (2.50 months). Once all of the risks and opportunities were assessed, the R09 template calculated and organized them by their mean severity to help the project team address the most severe risks and beneficial opportunities (see Table 2).

Table 2: Top 5 Risks from PRHTA's Unmitigated Risk Register
(ranked by mean severity)

- 1 – Environmental assessment turns into EIS requirement
- 2 – USACOE permit takes longer than anticipated
- 3 – Access to additional funding in case of overruns
- 4 – Public opposition to disturbance of wetlands
- 5 – Moving of high voltage powerlines takes longer than expected

5 Risk Analysis

Using the outputs from steps 2 to 4, PRHTA combined the “base” performance data and risk assessments to calculate the impact of each risk and opportunity on project performance measures (i.e., schedule, uninflated and inflated cost) if they remained unmitigated (see Table 3). Understanding the impact of unmitigated risks will help PRHTA make informed decisions throughout the planning and construction phases.

Table 3: Comparison of Base Project Performance vs. Unmitigated Project Performance

	Base	Unmitigated	Difference
Cost	\$3.30M (YOE)	\$4.67M (YOE)	+\$1.37M (YOE)
Construction Notice to Proceed	8/21/2017	5/17/2018	+ 9 months
Construction Completion Date	2/20/2019	2/27/2020	+ 1 year

6 Risk Management Planning

PRHTA then planned potential actions to mitigate the top 9 risks and the highest severity opportunity in the unmitigated risk register (see Table 4). For example, the team recommended launching an early community involvement plan to mitigate their fourth most severe risk: public opposition to disturbance of wetlands.

Table 4: Mitigation Actions from PRHTA's Strategy Register

Risk Description	Mitigation Action
Environmental assessment turns into EIS requirement	Minimize affected area of project footprint during construction
USACOE permit takes longer than anticipated	Early involvement of US Army Corps of Engineers
Access to additional funding in case of overruns	Pass along issues as early as possible
Public opposition to disturbance of wetlands	Early community involvement
Moving of high voltage powerlines takes longer than expected	Negotiate Memorandum of Understanding with power authority

Using the R09 template, the project team assessed the impact of the mitigation actions (using mean values or pre-defined ratings) on project cost and schedule. This results in a mitigated risk register, which calculates the severity of the risks if selected mitigation actions were applied (see Table 5).

Table 5: Top 5 Risks from PRHTA's Mitigated Risk Register
(ranked by mean severity)

1 – Access to additional funding in case of overruns
2 – Public opposition to disturbance of wetlands
3 – Litigious culture of contractors
4 – Extreme weather events/hurricanes
5 – Rock slope instability

Next, PRHTA used their mitigated risk register to conduct a final performance analysis. Table 6 compares the project cost and construction duration between the base, unmitigated and mitigated project performance. The mitigated performance includes any residual risk (the portion of the risk that remains after mitigation).

Table 6: Comparison of Base Performance, Unmitigated Performance, and Mitigated Performance

	Base	Unmitigated	Mitigated	Mitigation Savings
Cost	\$3.30M (YOE)	\$4.67M (YOE)	\$3.82M (YOE)	\$0.85M
Construction Notice to Proceed	8/21/2017	5/17/2018	10/4/2017	7 months
Construction Completion Date	2/20/2019	2/27/2020	5/28/2019	9 months

7 Risk Management Implementation

To finalize the risk management plan, PRHTA identified who within the agency would be responsible for implementing each risk mitigation action to ensure risks continued to be monitored throughout the project lifecycle.

“ The R09 template methodically steps teams through the risk management process and calculates the impact of both risks and associated mitigation strategies. This process could be applied to a variety of projects—both big and small—to reduce unexpected delays and costs. ”

– Evelyn Colon, FHWA Puerto Rico Division Office

Implementation Benefits

Applying the R09 risk management process has already helped PRHTA to:

- Effectively identify and evaluate the project’s most severe unmitigated risks and their impact on project cost and schedule
- Create a risk management plan to mitigate risks
- Develop a greater understanding of the project’s scope, conditions, and strategies earlier in the planning stages and prior to construction

PRHTA will continue to use R09 leading up to the Bridge 702 construction phase, scheduled to begin in 2017.



FHWA and PRHTA review project plans for the Bridge 702 replacement in Arecibo, Puerto Rico.



Save Lives



Save Money



Save Time

Resources to Help You Use Managing Risk in Rapid Renewal Products

The product’s **guidebook and other materials** are available on the Transportation Research Board website: <http://www.trb.org/Main/Blurbs/168369.aspx>

To learn more, visit <http://www.fhwa.dot.gov/GoSHRP2/Solutions/Renewal/R09> or contact:

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Implementing SHRP2

The second Strategic Highway Research Program (SHRP2) is a national partnership of the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the Transportation Research Board. Together, these partners conducted research and are deploying resulting products to help the transportation community enhance productivity, boost efficiency, increase safety, and improve the reliability of the Nation’s highway system.

The Puerto Rico Highway and Transportation Authority (PRHTA) applied *Managing Risk in Rapid Renewal Projects* on the Bridge 702 replacement project as part of the **SHRP2 Implementation Assistance Program**.