GEORGIA DEPARTMENT OF TRANSPORTATION

Transportation Asset Management Plan

FY 2022 – 2031

Table of Contents

EXECUTIVE SUMMARY

Georgia's Transportation Asset Management Plan (TAMP) defines the condition of the state's pavements and bridge structures, including culverts longer than 20 feet, on the National Highway System (NHS). This TAMP outlines the priorities and strategies used to cost effectively manage and preserve these assets over the next 10 years.

What are the requirements of this TAMP?

This TAMP meets the requirements of Title 23 Code of Federal Regulations (23 CFR) §515 (which defines compliance with 23 United States Code 119(e)). This regulation defines the processes and minimum requirements that a State Department of Transportation (DOT) must use to develop a TAMP.

How do we make decisions about when and how to invest?

The Georgia Department of Transportation (GDOT or Department) monitors assets over their lifespan and applies preservation and rehabilitation activities to extend asset life at a lower cost over the long term. For both pavement and bridge assets, GDOT uses lifecycle planning that includes analyzing asset deterioration rates and employing a wide range of treatment types to ensure the most appropriate maintenance activities are applied at the right time.

What are our assets?

GEORGIA State Route System		GEORGIA NHS *Covered in TAMP*	
17,923 Centerline miles	6,239 Bridge Structures	7,241 Centerline miles	4,089 Bridge Structures

What condition are our assets in?

Good Fair Poor

NHS Bridge Condition 2021

Interstate Pavement Condition 2021

Non-Interstate NHS Pavement Condition 2021

Pavement Management: Across Georgia's entire 17,923 centerline miles of the State Route System (SRS), GDOT uses computer models to predict pavement condition and identify the most cost-effective means of treating pavements with available funding. GDOT's Pavement Management System (PMS), Deighton Total Infrastructure Management System (dTIMS), establishes long-term lifecycle strategies for pavements and uses those strategies to inform capital and maintenance investments.

In 2018, GDOT set two- and four-year condition targets for the NHS as required by the National Highway Performance Program (NHPP) and these targets will be reassessed in 2022. Conservative targets were selected to account for the potential variability in pavement scores during a transition in collection and reporting methods.

GDOT uses two different condition ratings to measure pavement performance:

- **NHPP Measure.** As required by the NHPP, GDOT reports NHS pavement condition levels based on the National Highway Performance Measures for Pavement Condition (23 CFR 490).
- **OCI Measure.** This is a GDOT-specific performance measure, Overall Condition Index (OCI).

GDOT makes decisions and sets targets based on the OCI measure and uses the NHPP measure for federal reporting.

Bridge Management: GDOT owns, operates, and manages 96% (by deck area) of the bridges in Georgia that are on the NHS. Less than 1% of those bridges are in poor condition, surpassing federal minimum condition levels. The average age of an NHS bridge in Georgia is 44 years, which is close to the designed service life for most GDOT bridges (50 years). GDOT proactively preserves NHS bridge structures and has high condition standards for the NHS roadways, as demonstrated by the fact that only 0.9% of the bridges (by count) constructed before 1960 (more than 60 years old) are currently in poor condition.

GDOT uses a Bridge Management System (BMS) to analyze bridge and agency data to evaluate strategies for addressing network needs and achieving asset management goals while making cost-effective decisions. GDOT has implemented the AASHTOWare™ Bridge Management software (BrM) to plan bridge maintenance, preservation, rehabilitation, and reconstruction work. BrM recommends bridge projects using multi-objective analysis and incremental benefit-cost ratios to select cost-effective bridge treatments while considering the key performance goals for lifecycle planning. Within the BrM prioritization algorithm, multiple performance measures (e.g., condition, lifecycle cost, risk) can be combined into an overall utility function by applying different weights to the performance measures to align with the agency's lifecycle planning goals. GDOT performs the BrM program analysis for 10 to 20 years.

Georgia's NHS bridge condition is better than the national average. Seventy nine percent (79%) of NHS bridge deck area is in good condition, and less than 1% is in poor condition.

Alignment with Other GDOT Planning Initiatives: GDOT recently published its GDOT 2050 Statewide Transportation Plan (SWTP)/2021 Statewide Strategic Transportation Plan (SSTP). The investment strategies and decision-making processes presented in this TAMP are reflected in both plans. TAM is addressed through Foundational Investments in the SWTP/SSTP. In addition, the TAMP processes inform the State Freight and Logistics Plan and other planning documents. From a delivery perspective, the decision making described in the TAMP informs the Statewide Transportation Improvement Program (STIP) as described further in Section 2.2.2.

What are the top risks?

1 **Sufficient Funding Commensurate with Aging Infrastructure:** Legislative changes to fuel tax and funding categories in which these dollars can be spent (opportunity and risk) can increase/decrease available funding for aging infrastructure.

2 **Extreme Weather Events:** Extreme weather events (flooding, storm, fire) may divert funding from planned activities.

Risk management within this TAMP focuses on risks that could limit the GDOT's ability to deliver the investment strategies described in this document, and ultimately to deliver service to SRS and NHS users. GDOT established its risk management process and developed an enterprise-wide risk register covering three risk groups: enterprise/agency risks, program risks, and project/activity risks. Each risk was assigned a consequence level, resulting in two high-consequence risks – the first and third at the enterprise/agency level and the second at the program level.

Prevention and recovery actions, owners, and timeframes have been identified for top-priority risks, including the two above.

What are the projected 10-year funding levels for the NHS?

$2.96B **Pavement management**

$1.75B **Bridge management**

How are we considering resilience?

GDOT understands the importance of defining and integrating resiliency into every aspect of its strategic goals and planning because of the evolving natural and economic climate and associated uncertainties. Over the past years, Georgia has faced many weather-induced emergencies events such as hurricanes and storms with freezing rain and snow, as well as human-made emergency events, such as the Interstate 85 bridge collapse in March 2017.

GDOT focuses on anticipating, preparing for, and adapting to changing conditions, responding to emergencies in a timely manner, and ensuring that its transportation system recovers rapidly from disruptions. In addition, with PROTECT (Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation) funds, GDOT will be developing projects to further strengthen its infrastructure.

What will we achieve?

Currently, GDOT satisfies and will continue to satisfy in the future, the federal requirement of having less than 5% of interstate pavements and less than 10% of total NHS bridge deck area in poor condition. The goal to maintain 70% of the bridge inventory in good condition will continue to be met based on the investment strategy established in this TAMP. GDOT is not currently meeting its NHS goal to achieve an average OCI of 85. Further analysis is underway to assess closing this gap and investment decisions continue to prioritize preservation to ensure the most efficient and effective outcomes are achieved.

How have we improved?

GDOT has made significant strides toward advancing its TAM program. In 2020, the State Maintenance Office completed its deployment of the dTIMS software, including implementation to users across all Districts. Implementation of dTIMS has now moved into a continuous improvement phase. The deterioration curves of the state's pavement assets are updated using historical data in concert with geographical location, route prioritization, environmental conditions, traffic data, construction data, pavement design mixes, and types of pavement (e.g., asphalt vs. concrete). Targets have been established for all SRS (including NHS) pavements, and GDOT is actively managing investment levels to achieve these goals. In addition, GDOT has taken steps to customize BrM models to make them compatible with GDOT structures and policies and continues to update the BMS model inputs to ensure that the system is recommending a balanced and optimized project list.

GDOT's Commitment to Georgia

Georgia's SRS provides an integral foundation for the state's more than 10.7 million[1] citizens and $619.2 billion[2] economy to thrive and grow. For more than a decade, GDOT has been deploying transportation asset management (TAM) and risk principles to make better data-based investment decisions in its existing infrastructure. At a time when funding for transportation is constrained and programs are forced to compete with one another, TAM is an effective tool to determine how to best spend every transportation dollar in the most efficient way possible.

GDOT submits this TAMP in accordance with *23 CFR § 515*[3], focusing on pavement and bridge assets on the NHS. Like previous TAMPs, this 2022 TAMP update complies with federal requirements. As demonstrated through the collaborative development of this TAMP, and through the planned enhancements identified within, GDOT's executive leadership is committed to implementing the principles and practices defined in this TAMP for the benefit of Georgia's transportation system and its citizens.

Russell R. McMurry

Russell McMurry, P.E.

Georgia Department of Transportation Commissioner

1. https://www.flipsnack.com/gadot/strategic-plan-fy-2022-update.html
2. https://www.flipsnack.com/gadot/strategic-plan-fy-2022-update.html
3. https://www.federalregister.gov/documents/2015/02/20/2015-03167/asset-management-plan

Section 1
Introduction

The purpose of this Georgia Department of Transportation (GDOT or the Department) Transportation Asset Management Plan (TAMP) is to document GDOT asset management practices and outline the risk-based priorities and strategies used to cost-effectively manage and preserve Georgia's pavement and bridge assets on the National Highway System (NHS). The plan supports GDOT's approach to manage the transportation system through responsible stewardship, providing maximum efficiency and effectiveness.

1.1 Overview

Georgia's integrated roadway system consists of city streets, county roads, and state and national highways. Serving a statewide population of over 10.7 million,[4] this transportation system is critical to the State's $619.2 billion[5] economy because it provides an integral foundation for industries crucial to the State's economy to prosper and grow.

Figure 1 — *Composition of Georgia's Integrated Roadway System*

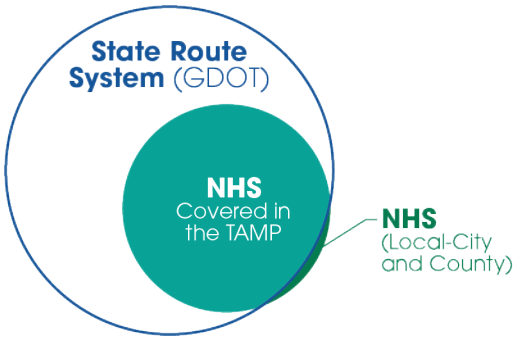


Figure 1 shows the entities responsible for ownership and management of the roadway system. The State Route System (SRS) is the part of network owned and maintained by GDOT. It includes 17,923 centerline miles of pavement and over 6,239 bridge structures, including culverts longer than 20 feet.

DEFINITION OF ROADWAY SYSTEMS

SRS – Georgia's State Highway System, owned and maintained by GDOT.

NHS – A network of selected principal arterial routes identified as essential for international, interstate, and regional commerce and travel; national defense; and the transfer of people and goods to and from major intermodal facilities.

Interstate System – Officially known as the Dwight D. Eisenhower National System of interstate and defense highways, it consists of routes of highest importance that are constructed to the standards of 23 United States Code (U.S.C.) 109(h) and connects principal metropolitan areas, cities, and industrial centers.

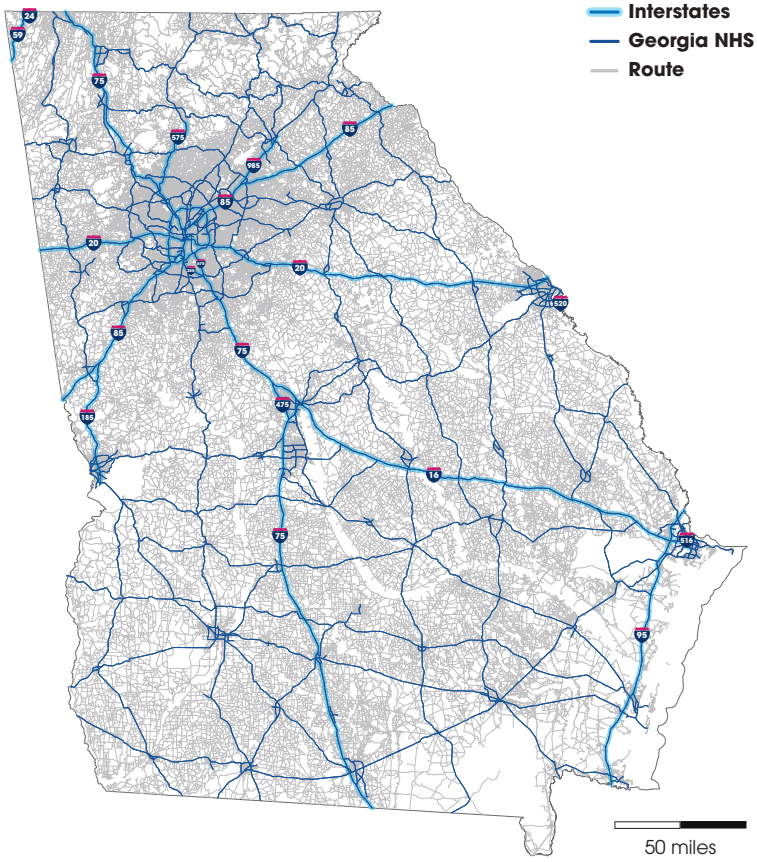
4. . https://www.flipsnack.com/gadot/strategic-plan-fy-2022-update.html
5. . https://www.flipsnack.com/gadot/strategic-plan-fy-2022-update.html

The NHS is largely owned and managed by GDOT. Five percent (5%) of the NHS is owned and maintained by local cities and counties in conjunction with their responsibility for the broader local road system.

The NHS in Georgia comprises more than 7,241 centerline miles of pavement and approximately 4,089 bridge structures (**Figure 2**).

In accordance with *Title 23 Code of Federal Regulations (23 CFR) § 515*[6] this TAMP focuses on these NHS assets.

Figure 2 — *NHS in Georgia*



GEORGIA SRS

17,923
Centerline miles

6,239
Bridge Structures

GEORGIA NHS *Covered in TAMP*

7,241
Centerline miles

4,089
Bridge Structures

6. . https://www.federalregister.gov/documents/2015/02/20/2015-03167/asset-management-plan

1.2 GDOT Transportation Asset Management Program

Transportation asset management (TAM) provides GDOT with an integrated, comprehensive, and strategic approach to meet Georgia's transportation needs. GDOT uses TAM (and the data that supports it) and sound engineering judgement to inform its decisions. At a time when funding for transportation is constrained and programs are forced to compete with one another, TAM is an effective approach to determine how to efficiently spend every transportation dollar.

GDOT formally embraced TAM in fall 2009 when the Office of Performance-based Management and Research was appointed to facilitate the development and implementation of the Department-wide TAM. Previously, the Department's investments were made independently within each asset category, often leading to a reactive "worst-first" approach in managing programs and allocating resources to address deteriorated assets. That approach resulted in limited resources for investing in lower cost preservation activities that slow the rate of deterioration.

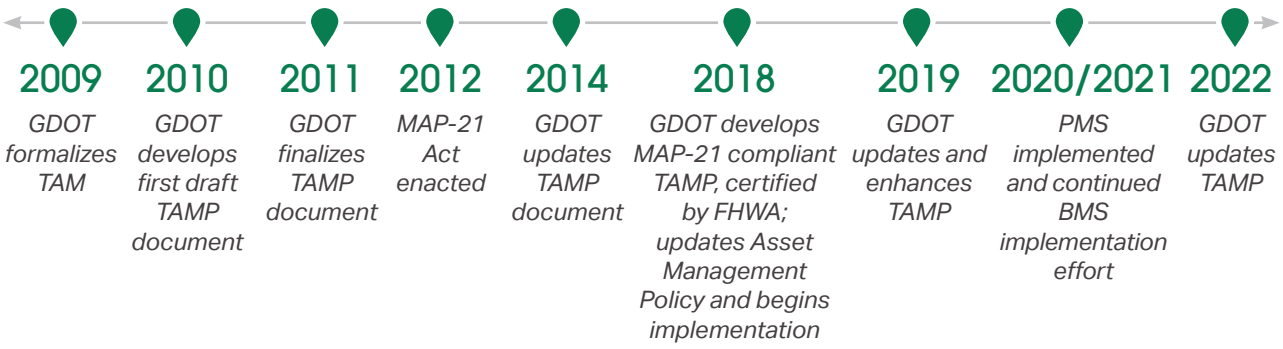
In 2010, GDOT developed its first TAMP draft – a document that outlined the Department's strategy for incorporating TAM philosophy into its business processes to support cost-effective decision-making. After the development of its first TAMP, GDOT management strategies and organizational culture began shifting toward an integrated, network-driven approach Department-wide. To encourage and support this shift, the TAM Task Force and the TAM Steering Committees were also formed this year, and the first TAMP policy was published.

In 2012, the Moving Ahead for Progress in the 21st Century (MAP-21) Act was enacted. MAP-21 (which continued with the Fixing America's Surface Transportation Act [FAST Act]) established requirements for states to develop risk and performance-based asset management plans for preserving and improving the condition of pavements and bridges on the NHS. The established requirements validated GDOT's forward thinking in transitioning, two years earlier, from a siloed investment strategy to an integrated, network-driven approach.

In 2018, GDOT developed an initial TAMP that met the requirements of MAP-21 and was certified by the Federal Highway Administration (FHWA). In the same year, GDOT updated its TAM policy to confirm TAM as the official, institutional approach to managing infrastructure assets and making capital investment decisions at GDOT. From this point onward, the Department has been implementing pavement and bridge management systems (i.e., Deighton Total Infrastructure Management System [dTIMS] and AASHTOWare Bridge Management [BrM], respectively) to enhance its TAM decision-making. The implementation of these systems has resulted in some significant progress, but work is ongoing due to the evolving and maturing nature of TAM practices.

The 2021 Bipartisan Infrastructure Law (BIL), signed into law in November 2021, requires State DOTs to take into consideration extreme weather and resilience within their lifecycle cost and risk management analysis. In response, this TAMP describes the policies and processes that GDOT utilizes to ensure the Department is prepared for when these events occur. Further information is provided in Sections 4.2, 4.2.2, 5.2.4 and within specific risks included in the risk register. These sections are highlighted with this climate/resilience icon: This 2022 TAMP provides an update on continuous development and the and advancement of GDOT's TAM processes.

Climate/Resilience



1.3 Federal TAMP Requirements

23 CFR § 515.9 defines the TAMP requirements, including:

A State DOT shall develop and implement an asset management plan to improve or preserve the condition of the assets and improve the performance of the NHS in accordance with the requirements of this part. Asset management plans must describe how the State DOT will carry out asset management as defined in *§ 515.5*.

An asset management plan shall include, at a minimum, the items identified in **Table 1** (which are cross-referenced against the sections in this TAMP).

ASSET MANAGEMENT PLANS (*§ 515.5*)

Asset management plan means a document that describes how a State DOT will carry out asset management, as defined in this section. This includes how the State DOT will make risk-based decisions from a long-term assessment of the 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 lifecycle of its assets. The term asset management plan under this part is the risk-based asset management plan that is required under *23 U.S.C. 119(e)* and is intended to carry out asset management as defined in *23 U.S.C. 101(a)(2)*.

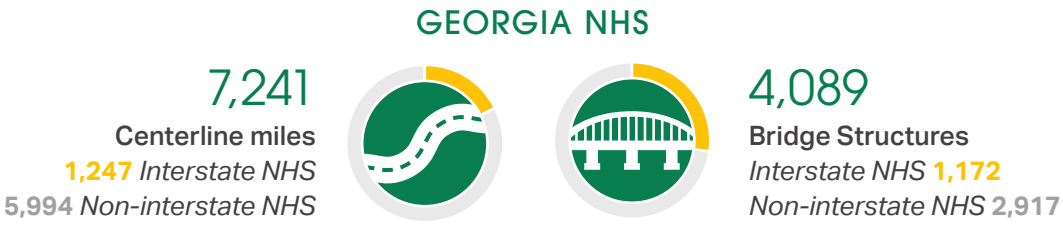
Table 1 — *Federal Elements of a TAMP*

Requirement 23 CFR § 515.9	**Description**	**GDOT TAMP Section**
Asset Management Objectives and Measures	• Alignment between asset management and the agency's mission	Section 2. Asset Management at GDOT
Inventory and Condition	• A summary listing of all NHS pavement and bridge assets • Measures and associated targets the State DOT can use in assessing the condition of the assets and the performance of the highway system as it relates to those assets	Section 3. Asset Inventory and Condition
Lifecycle Planning	• A process for conducting a lifecycle planning analysis • Employing cost-effective strategies to manage assets across their useful lives by minimizing lifecycle cost while achieving State DOT targets	Section 4. Lifecycle Planning
Risk Management Analysis	• Implementing a process to identify, assess, prioritize, mitigate, and monitor risks at the asset and organization level	Section 5. Risk and Resilience
Financial Plan and Investment Strategies	• Determining funding sources and expected funding levels (10-year) for NHS pavements and bridges • An investment strategy (dollars to be spent in defined work type categories)	Section 6. 10-Year Financial Plan and Investment Strategies
Performance Gap Analysis	• A comparison between current condition, short- and long-term targets, and the desired State of Good Repair	Section 7. Performance Gap Analysis

In addition, the TAMP should be updated at least every four years and be resubmitted to FHWA for recertification under *23 U.S.C.119(e)(6)(B)*. This recertification requirement is the purpose of this FY 2022 TAMP update.

1.4 TAMP Scope and Organization

This TAMP includes pavements and bridges on the NHS. Despite the focus of this TAMP, GDOT's decision-making considers the broader transportation system for which it is responsible.



GDOT's TAMP comprises seven sections.

- **Section 1. Introduction** — Summarizes GDOT's progress on advancing its TAM program, provides the purpose of developing a TAMP, and presents its scope and organization.
- **Section 2. Asset Management at GDOT** — Describes GDOT's approach to TAM, how it aligns with organizational goals, its relationship with other planning processes, and planned future enhancements.
- **Section 3. Asset Inventory and Condition** — Presents GDOT's condition assessment and inspection processes, inventories, and current condition levels for pavement and bridge assets.
- **Section 4. Lifecycle Planning** — Outlines GDOT's lifecycle planning practices for pavement and bridge assets.
- **Section 5. Risk and Resilience** — Defines GDOT's risk management methodology.
- **Section 6. 10-Year Financial Plan and Investment Strategy** — Discusses GDOT's revenue sources and estimated funding levels and proposes its investment strategies for effectively managing its pavement and bridge assets over the next 10 years.
- **Section 7. Performance Gap Analysis** — Compares current performance to state targets and federal requirements.

Section 2

Asset Management at GDOT

GDOT adopts FHWA's definition of asset management and continues advancing its holistic approach to incorporate risk and use data to preserve and improve transportation systems.

2.1 Goals and Objectives

GDOT's TAM policy mandates the adoption of TAM principles for managing its infrastructure and informing its investment decisions. This policy defines the intent of the TAM program and the roles and responsibilities of the TAM Committee. The TAM policy establishes that GDOT's TAM program consists of:

- **TAMP** — The plan will provide inventory, condition levels, and performance targets for all NHS bridge and pavement assets and a framework for how best to achieve the performance targets through a mix of investments.
- **TAM Implementation Plan** — The plan will look at GDOT's proficiency and maturity in TAM practices. The plan will identify strengths and weaknesses in the overall and individual TAM plans, TAM methodologies and practices, and it will set goals for their improvement.

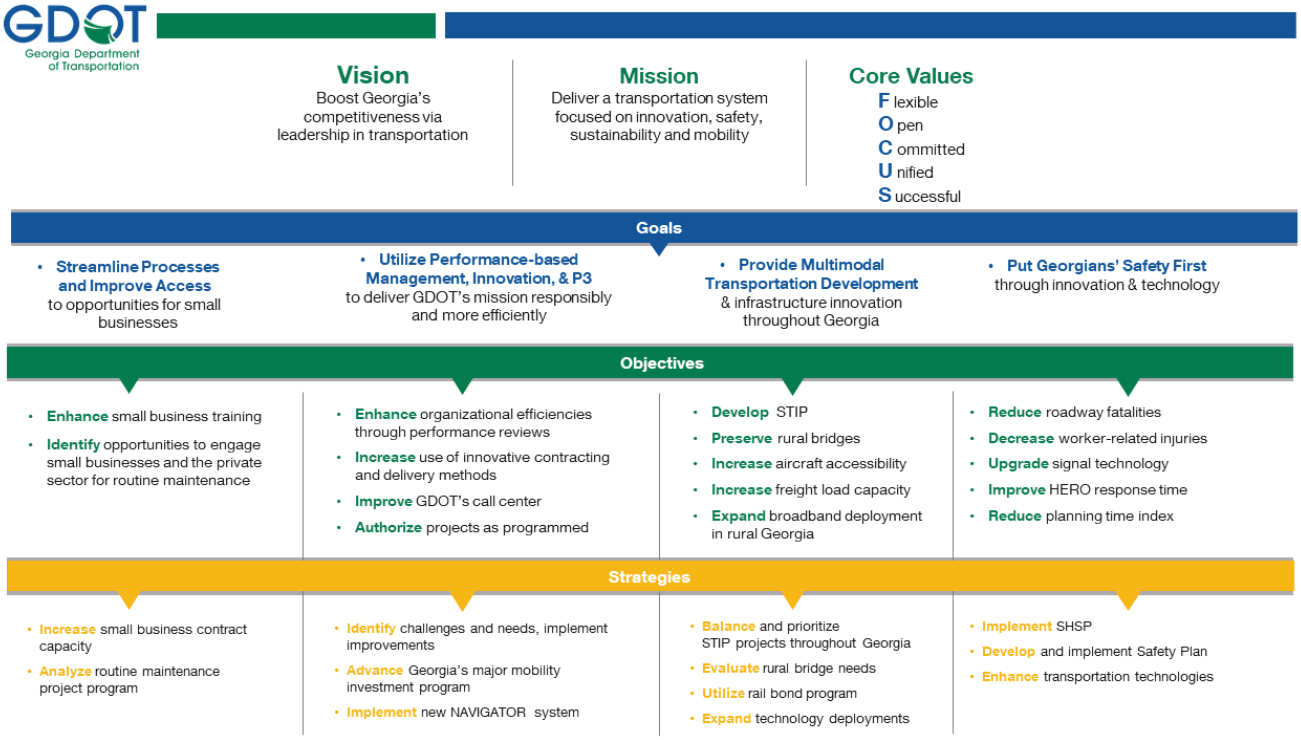
DEFINING ASSET MANAGEMENT

"Asset management is 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 state of good repair over the lifecycle of the assets at minimum practicable cost."

—Federal Regulation § 515.5, FHWA

The TAM policy and this TAMP are aligned with and support GDOT's strategic direction, which is established through mission, goals, objectives, and strategies outlined in the FY 2020 - FY 2023 Strategic Plan (FY 2022 Update). GDOT's mission is to deliver a transportation system focused on innovation, safety, sustainability, and mobility (see **Figure 3**).

Figure 3 — *GDOT Strategic Vision*



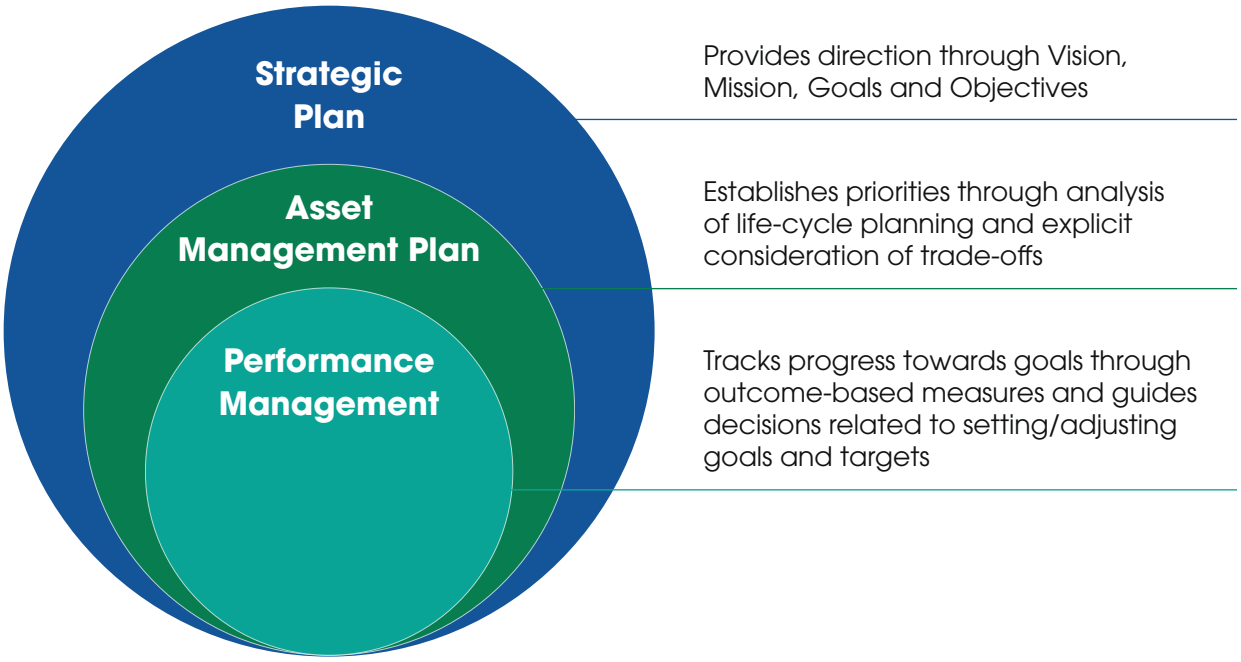
2.2 TAMP Relationship to GDOT Strategic Plans and Planning Processes

2.2.1. Relationship to GDOT Strategic Plans

GDOT's Strategic Plan sets the overall direction for GDOT, establishes goals and objectives, and identifies short-term actions and strategies. GDOT employs performance management and asset management principles documented in the TAMP to help deliver the Department's goals and objectives. Asset management enables GDOT to compare the inputs (labor and materials) and outputs (amount of work delivered) that drive performance outcomes, while minimizing lifecycle costs. GDOT's performance-based management process is described in more detail in **Section 2.2.2**.

Figure 4 (from the Strategic Plan) illustrates the relationship of the Strategic Plan and the TAMP, and more importantly, describes how this relationship links to Transportation Performance Management within GDOT.

Figure 4 — *Alignment of GDOT Strategic Plan, Asset Management, and Performance Management*



GDOT's 2021 Statewide Strategic Transportation Plan (SSTP)/2050 Statewide Transportation Plan (SWTP) are combined into a single policy document that provides a comprehensive look at transportation issues facing Georgia through 2050. The SSTP/SWTP establishes performance-driven and fiscally constrained long-range priorities and investment opportunities. In contrast to the TAMP, the SSTP/SWTP considers the entire GDOT budget, organized into statutory spending categories: Construction of New Highway Projects, Maintenance of Existing Infrastructure, Bridge Repairs & Replacements, Safety Enhancements, and Administrative Expenses.

The SSTP/SWTP acknowledges the importance of asset management as a key approach to cost-effectively maintain key freight corridors and pavement and bridge assets and to plan for future maintenance of new roadway capacity under development through the Major Mobility Investment Program (MMIP) and other projects. While GDOT's assets are in good condition, continued investment is required to maintain their condition levels and prevent operational disruptions as the assets continue to deteriorate and age. In addition, these needs will need to be balanced against increasing asset management demands as MMIP and other capacity projects, when completed, will be handed back to GDOT to manage.

As part of the SSTP/SWTP development, an investment tradeoff analysis tool was developed and used to compare the impacts of potential investment scenarios (at the network level) to performance outcomes. The tool compares five different programs: safety, pavement, bridge, operations, and capacity. The tradeoff analysis is an iterative process that looks at the effects on performance from incremental changes in investments, combining the analyses performed by the

PMS, BrM, and other GDOT decision-making tools. The outputs are used to inform the investment profile for the SSTP/SWTP and provide a long-range, performance-based justification to address Transportation Performance Management (TPM) requirements and set statewide performance targets. The constrained investment scenario and associated projected performance included in the TAMP are then based on the outcomes of the analysis performed by the Planning Office. These processes work hand-in-hand to inform long-range decisions.

2.2.2. Relationship to GDOT Planning Processes

Many of GDOT's existing planning processes and documents incorporate effective infrastructure management principles and indicate a commitment to preserve major transportation assets. In particular, performance-based management and TAM are seen as two interrelated activities because TAM uses performance management to set objectives, define measures, establish targets, and monitor results.

Performance-based management is a two-step process. In the first step, performance measures are developed to assess whether the Department is achieving the targets set forth in the strategic objectives. In the second step, the results of the performance measures are used to inform decision-making and take corrective actions where necessary, or to implement strategies and initiatives identified in the TAMP. Currently, GDOT facilitates quarterly performance-based discussions focused on the delivery of its internal goals, objectives, and performance measures. The Department will continue to regularly document, monitor, and update progress toward achieving its targets outlined in the TAMP.

Achieving the targets for asset condition and performance of the NHS will ultimately translate into progress toward national performance goals.[7] TAMP implementation will be aligned with proposed investments in the SSTP/SWTP and investment levels included in the Statewide Transportation Improvement Program (STIP).

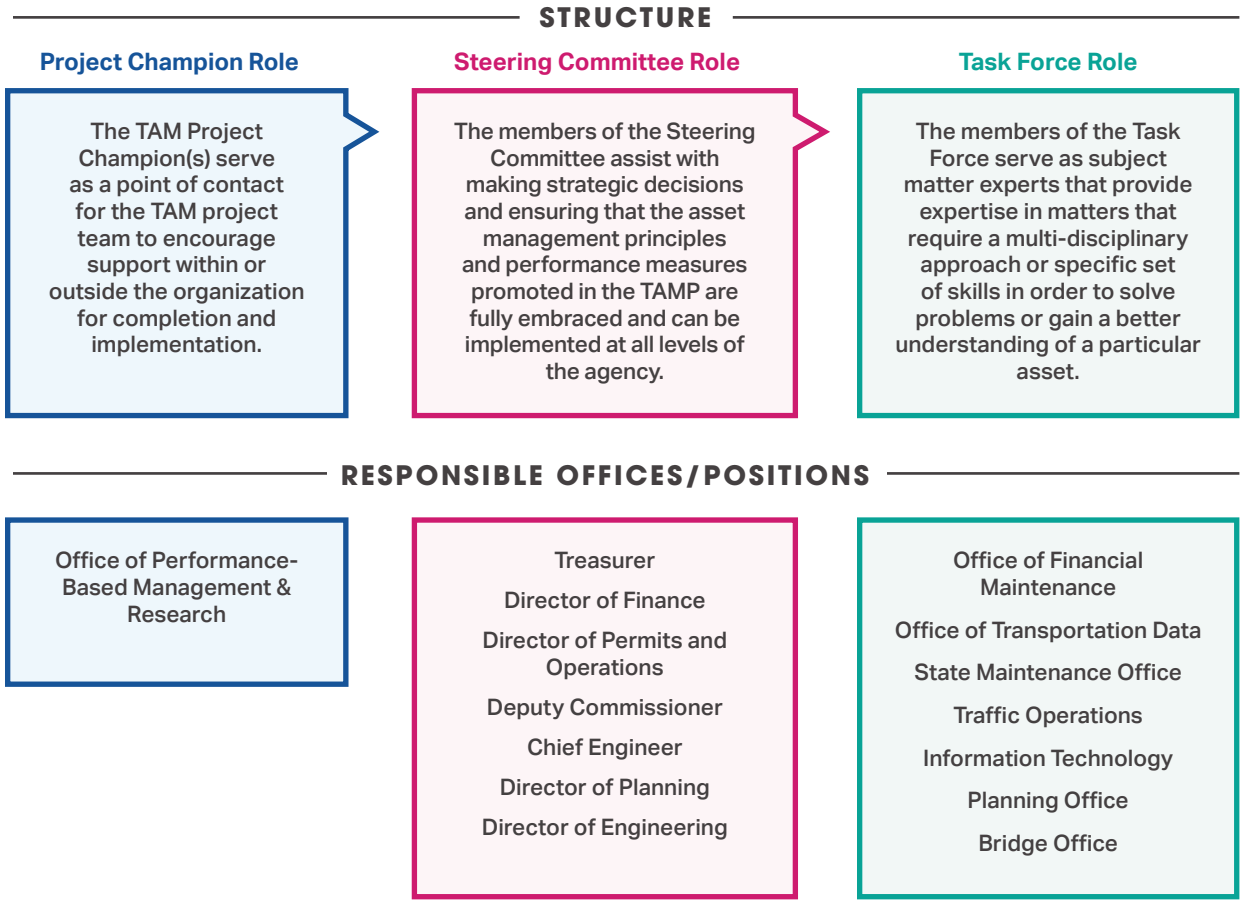
The connection between the TAMP and the STIP is critical to delivering performance outcomes. The analysis and decision making undertaken by the State Maintenance Office (pavements) and Office of Bridge Design and Maintenance that is used to develop this TAMP also informs the treatments/projects that are included in the STIP. The design and construction of these projects is measured quarterly through internal GDOT performance reporting and on an annual basis through the consistency determination process. This process tracks alignment between investment strategies in the TAMP and actual investments. Ultimately the TAMP aligned project delivery through the STIP enables GDOT to achieve the performance outcomes predicted in the TAMP.

7. . CFR Title 23 Part 515.11: https://www.ecfr.gov/cgi-bin/text-idx?SID=b2ae954ebca2fdd091546658a23dd871&mc=true&node=pt23.1.515&rgn=div5

2.3 TAM Organizational Structure

TAM entails working across multiple divisions within an organization and requires a variety of skill sets, expertise, and knowledge. Having representatives from various functional areas that play a role in TAM is crucial for plan development and the implementation process. TAM committees were formed to provide guidance for the TAM structure and to enhance communication between the subject matter experts (SMEs), asset managers, and executive leadership. The committees are directly responsible for the Department-wide TAM implementation. Improved communication and clear roles and responsibilities lead to better synergies and coordination of TAM practices and implementation. The responsibilities and structure of the TAM committees are shown in **Figure 5**. The Task Force and Steering Committees meet regularly to ensure Department-wide alignment and awareness.

Figure 5 — *TAM Committee Structure and Responsibilities*



Section 3

Asset Inventory and Condition

GDOT's knowledge of its assets provides the foundation for data-driven decision-making that includes asset condition, value, performance, and future performance targets.

3.1 Introduction

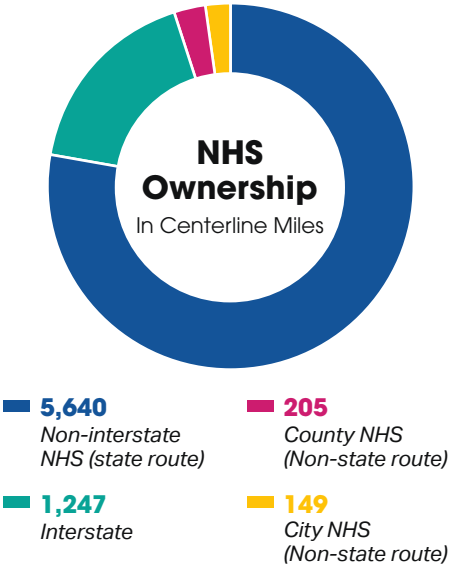
This section presents the inventory, evaluation methodology, and condition levels of pavements and bridges on the NHS in accordance with federal requirements. Requirements for collection, processing, storing, and updating inventory and condition data for pavement and bridge management systems are stated in *23 CFR 515.17.*

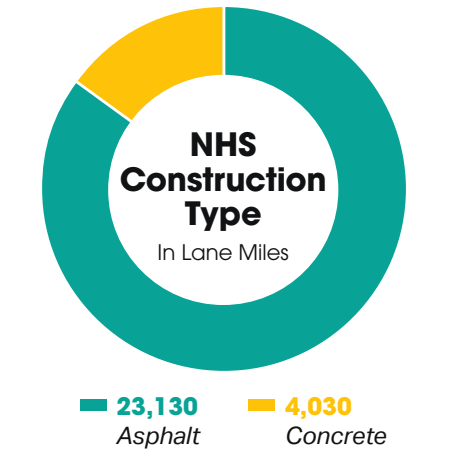
3.2 Pavements

GDOT is responsible for the majority (95%) of pavement centerline miles on the NHS in Georgia, with the remainder being the responsibility of other state agencies, local cities, and counties. The responsibility for maintaining pavements and bridges on the toll roads belongs to GDOT; therefore, these routes are included in the following discussion as part of this TAMP. Eighty-five percent (85%) of NHS pavements were constructed with asphalt; the remainder were constructed with concrete.

3.2.1. State Route Prioritization

In 2014, GDOT implemented the initial State Route Prioritization Network, which is periodically updated. As part of the 2022 update, GDOT undertook an assessment of the State's 17,923 centerline miles, using Geographic Information System (GIS) technology to graphically display and assist with the





evaluation of proposed prioritization criteria. Through a series of internal workshops and input from GDOT management, prioritization criteria were established, resulting in four categories of State Routes:

- **Critical:** Interstates, STRAHNET/STRAHNET Connectors, State Freight Corridors
- **High:** NHS/Intermodal Connectors, Governor's Road Improvement Program (GRIP) Corridors, Georgia Emergency Management Agency (GEMA) Routes,[8] Hurricane Evacuation Routes, Annual Average Daily Traffic – High[9]
- **Medium:** U.S. Highways, Four or More Lanes, Annual Average Daily Traffic – Medium[9]
- **Low:** All Unclassified Routes Including: Less than Four Lanes, Annual Average Daily Traffic – Low[9]

GDOT implemented the results of the prioritization effort to effectively allocate maintenance funding and ensure an acceptable level of service and quality across the network. GDOT will continue focusing its resources on the components of the transportation system that are most important to Georgia's economy — specifically, those that serve a significant role in freight movement, intrastate travel, tourism, and business travel. More than 95% of GDOT's NHS pavements fall mostly under the Critical and High Priority categories.

GDOT focuses its resources on components of the transportation system that are most important to Georgia's economy – those significant to freight movement, intrastate travel, tourism and business travel.

3.2.2. Pavement Data Collection

GDOT's Office of Transportation Data (OTD) collects and records asphalt and concrete pavement data annually for all NHS and SRS pavements. The data collection is performed by an automated data collection vehicle, equipped with an array of sensors that collect data on ride quality, cracking, and rutting, as well as video in both directions. Data are stored as part of the Highway Performance Monitoring System (HPMS) and used to calculate condition measures for federal HPMS reporting and GDOT's pavement management efforts, as described in the next section.

DATA QUALITY RISK MANAGEMENT

Data quality is critical to effective asset management and accurate reporting. OTD's data quality management plan includes processes to manage risk at the following stages:

1) Calibration and certification
2) Video and pavement condition data collection
3) Vendor internal quality assurance/quality control
4) GDOT internal quality control
5) Importing data
6) Publishing data

OTD trains staff to process all incoming data with established quality control rules and checklists.

8. Strategic state routes that will allow coastal and inland residents to evacuate during hurricane events.
9. Variable thresholds based upon geographic area.

Georgia collects condition data on the entire Georgia NHS in accordance with the 2010 Highway Performance Monitoring System (HPMS) field guide and subsequent updates (including PM2). The preparation, collection, quality control, assimilation, and reporting remain unchanged regardless of ownership.

3.2.3. Pavement Measures

This TAMP presents pavement performance based on two different approaches to defining pavement condition:

- **NHPP Measure**. As required by the National Highway Performance Program (NHPP), GDOT reports NHS pavement condition levels based on the National Highway Performance Measures for Pavement Condition (23 CFR 490).
- **OCI Measure.** The Overall Condition Index (OCI) is a GDOT-specific performance measure.

GDOT makes decisions and sets targets based on the OCI measure and uses the NHPP measure for federal reporting.

NATIONAL HIGHWAY PERFORMANCE PROGRAM (NHPP) MEASURE

GDOT reports NHS pavement condition based on the NHPP Measures for Pavement Condition. This measure considers data on international roughness index (IRI), cracking, rutting, and faulting for every 0.10-mile segment in accordance with federal regulations, 23 CFR 490.

- IRI is a measure of the ride quality or smoothness experienced by vehicles traveling on the pavement. In addition to being required for federal reporting, the GDOT State Maintenance Office uses IRI for its assessment of the pavement condition on the SRS.
- Cracking, for federal reporting, is a measure of cracking present in the wheel paths of the measured lane.
- Rutting measures the average depth of depression in the wheel path of the measured lane.
- Faulting is defined as the difference in elevation across a transverse joint or crack.

Table 2 summarizes how the metrics of IRI, cracking, and rutting/faulting are combined to calculate the NHPP performance measures.

Table 2 — *National Highway Performance Measures for Pavement Condition (23 CFR 490)*

		Measure		
Metric	**Units**	**Good**	**Fair**	**Poor**
International Roughness Index	Inches/mile	<95	95-170	>170
Cracking	Percent	<5	Jointed Concrete: 5-15 Asphalt: 5-20	>15 >20
and either				
Rutting (Asphalt)	Inches	<0.20	0.20-0.40	>0.40
or				
Faulting (Concrete)	Inches	<0.10	0.10-0.15	>0.15

OVERALL CONDITION INDEX (OCI) MEASURE

While GDOT collects and reports measures using IRI, cracking, and rutting or faulting in accordance with federal regulations, the Department has been using a more comprehensive pavement management measure, the OCI, to report the condition of its assets and inform decision-making. While IRI is included in the OCI calculation, it is not part of GDOT's primary decision tree. Other variables in GDOT's PMS decisions include, but are not limited to, the Annual Average Daily Traffic (AADT), Route Criticality, Total Lane Miles, and Length.

The OCI for asphalt surfaces incorporates IRI and six different distress indices (load cracking, edge cracking, block cracking, reflective cracking, rutting and raveling [**Table 3**]) collected and aggregated into a single numerical index score that ranges from 0-100. The OCI also includes an

adjustment index equal to the value of the distress index that triggers a recommended treatment in the PMS decision-making logic. Generally, the adjustment index is the lowest of the six other indices. The OCI for pavement concrete surfaces incorporates IRI in addition to faulting and cracking. Further information on how the PMS uses pavement data to recommend treatments and effective long-term strategies is provided in **Section 4.3**. **Figure 7** provides a comparison of metrics used in the OCI and those in the NHPP for pavement condition.

Figure 6 — *Examples of Pavement Distress – Rutting, Load Cracking, and Raveling (left to right)*

Table 3 — *Metrics used in NHPP and OCI Pavement Performance Measures*

NHPP Metrics	GDOT OCI Metric (Implemented in 2020)
IRI	IRI (International Roughness Index)
Rutting (asphalt)	Rutting
Wheel path Cracking	Load Cracking
	Edge Cracking
	Block Cracking
	Reflective Cracking
	Raveling
	Adjustment Index
Faulting (concrete)	Faulting (concrete)

Using the OCI measure, GDOT can assess pavement conditions in terms of the percentage of pavement in good, fair, or poor condition. As already stated, the OCI is reported as a score of 0 to 100 for each pavement segment, with 100 representing a pavement in good condition. Pavement segments are assigned a rating of good, fair, or poor based on the following criteria:

- Good - OCI of 85 or higher
- Fair - OCI between 70 and 84
- Poor - OCI less than 70

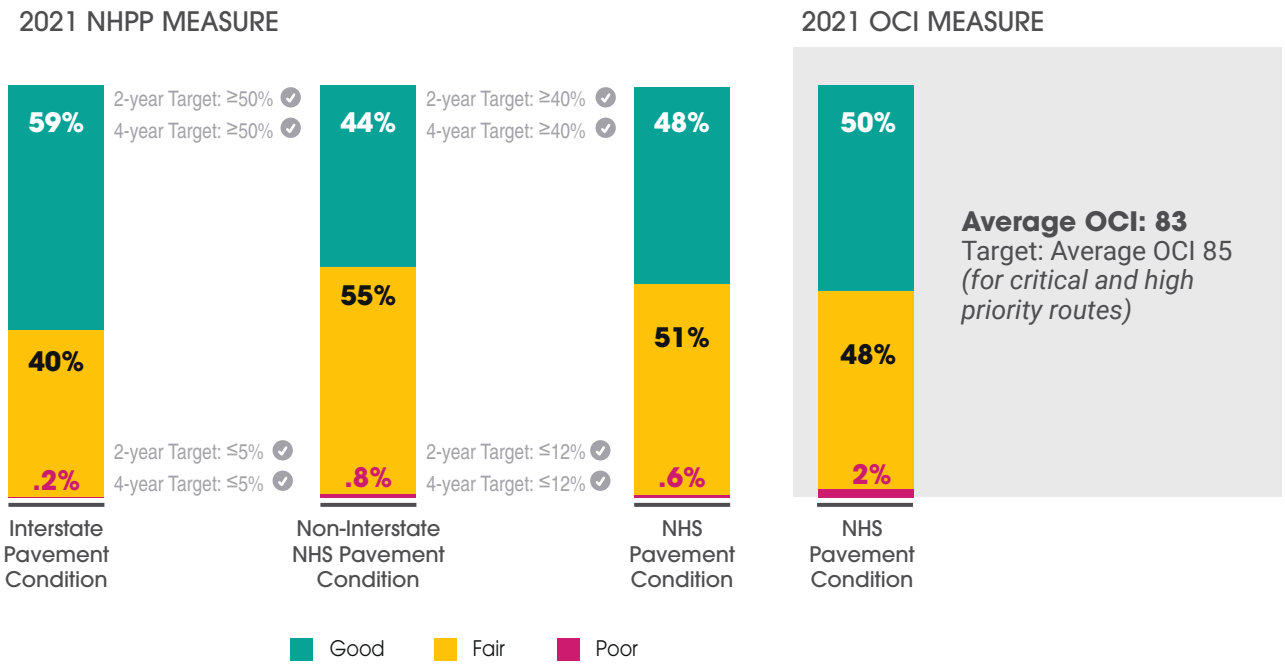
3.2.4. Pavement Condition and Targets

In 2018, GDOT set two- and four-year condition targets for the NHS as required by the NHPP. These targets are scheduled to be updated in 2022. In 2018, conservative targets were selected to account for the potential variability in pavement scores during a transition in collection and reporting methods.

Since implementation of the PMS and subsequent data collected for the OCI measure, GDOT has set targets for the SRS (Critical, High, Medium, and Low priority routes). Most of the NHS (>95%) is classified as Critical or High priority routes for which the OCI target is 85% or higher.

Current pavement condition data for both Interstate and Non-Interstate NHS in Georgia (NHPP and OCI measures), are presented in **Figure 7**.

Figure 7 — *NHS Pavement Condition (by Lane Miles)*

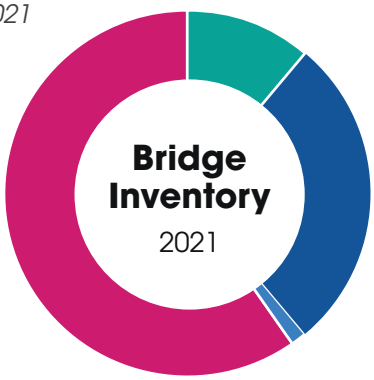


3.3 Bridge Structures

As of March 2021, the NHS in Georgia contains approximately 4,089 bridge structures, with a total deck area of 67,248,850 square feet.

Figure 8 illustrates the average age of NHS bridges (expressed in terms of bridge deck area) by each decade. The average age of an NHS bridge in Georgia is 44 years, which is close to the designed service life for most GDOT bridges (50 years). More than 56 percent of NHS bridges in Georgia are more than 40 years old. Effective preservation can extend this service life. GDOT proactively preserves NHS bridge structures and has high condition standards for the NHS bridges, as demonstrated by the fact that only 0.9 percent of the bridges (by count) constructed before 1960 (being more than 60 years old) are currently in poor condition. Bridge structures constructed before 1960 make up 19.4 percent of the current NHS inventory (**Figure 9**). Recently designed bridges have a 75-year service life expectancy.

Figure 9 — *NHS Bridge Ownership as of 2021*



State Route System
Count: 6239
Deck Area: 75,768,009

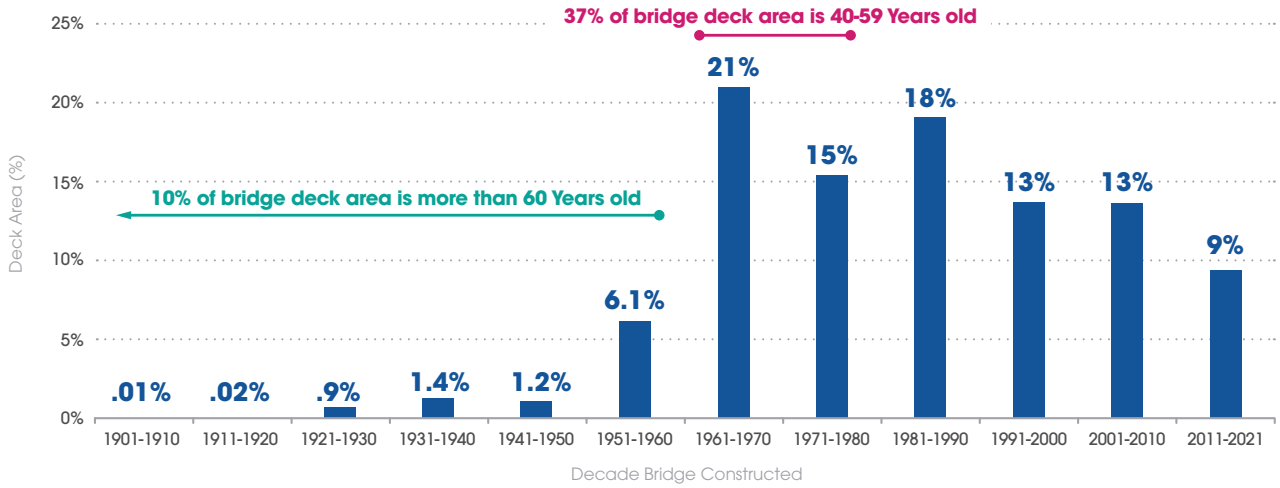
Interstate NHS
Count: 1172
Deck Area: 25,267,875

Non-Interstate NHS
Count: 2917
Deck Area: 41,980,974

Includes:

Local NHS (City and County)
Count: 167
Deck Area: 3,231,237

Figure 8 — *Average Age of Georgia NHS Bridges by Deck Area*



GDOT owns, operates, and manages 96 percent (by deck area) of the bridges on the NHS. Less than 1 percent of those bridges are in poor condition, surpassing federal minimum condition levels. Counts and deck areas of Georgia NHS bridges that are not owned by GDOT have been included in **Appendix B**.

3.3.1. Bridge Data Collection

GDOT's Bridge Maintenance Unit in the Office of Bridge Design and Maintenance is responsible for inspecting bridge structures in compliance with federal regulations, including the National Bridge Inspection Standards (NBIS). The NBIS defines a "bridge structure" and sets minimum requirements for inspection. Most of Georgia's bridge structures are inspected every two years. Some are inspected more frequently, depending on condition or structure type (e.g., some fracture-critical bridges).

In-house GDOT inspection teams inspect NHS bridge structures, and GDOT has established quality control (QC) and quality assurance (QA) programs. Bridge and bridge culvert data are collected by 12 topside inspection teams, 2 specialized inspection teams, and 2 underwater inspection teams. The inspection follows the QA process: first, the Bridge Inspection Supervisor reviews the bridge inspection report, then the Regional Bridge Inspection Specialist conducts field checks to confirm inspection data. The Department also uses consultant inspectors to conduct a QA program and some specialized inspections. Further review of the data occurs periodically throughout the year using FHWA's error-check program and automatic data quality checks within the bridge inspection data collection software (e.g., avoiding input data type, typographical or alphabetical errors).

3.3.2. Bridge Measures

For federal reporting purposes, structure condition is assessed by bridge inspectors based on the National Bridge Inventory (NBI) condition rating scale from 0 to 9. The condition-based performance measure classification is based on the NBI condition ratings for item 58 - Deck, item 59 - Superstructure, item 60 - Substructure, and item 62 - Culvert. Condition is determined by the lowest rating of deck, superstructure, substructure, or culvert. If the lowest rating is greater than or equal to 7, the bridge is classified as good; if the lowest rating is less than or equal to 4, the classification is poor. Bridges rated below 7 but above 4 are classified as fair, as illustrated in **Table 4.**

Table 4 — *National Bridge Inventory Condition Metrics*

Condition rating scale									
Good			**Fair**		**Poor**				
9	8	7	6	5	4	3	2	1	0

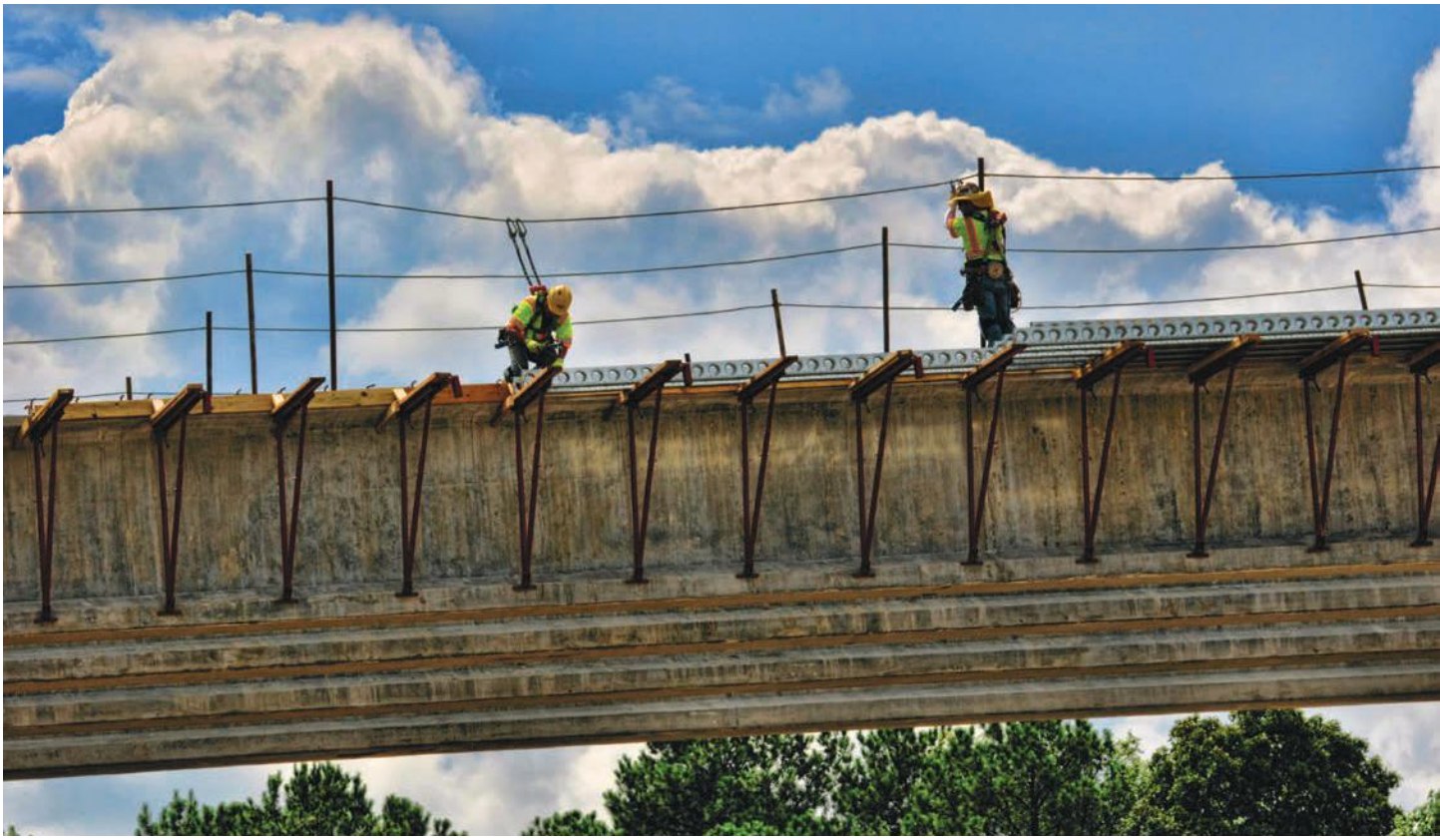
Bridge condition is summarized as the percent of the inventory in good or poor condition. For example, percent good is calculated from the total size of all bridges in good condition, divided by the total size of all bridges in the inventory. Size is expressed as deck area, which is approximately the length of the structure times its width, in square feet. In this TAMP, bridge condition is always expressed in this manner.

Aside from bridge condition, for maintenance planning purposes, GDOT also uses the American Association of State Highway and Transportation Officials' (AASHTO) elements. Each bridge is divided into spans delineated by its supporting piers or abutments. Each span is divided into distinct structural elements such as railings, deck wearing surface, deck slab, expansion joints, girders, coating system, bearings, and columns. The inspector examines each element and assesses its condition by the percent of the element in each of four levels ranging from good to severe, based on the Specification for the National Bridge Inventory Bridge Elements. These elements and condition levels relate directly to feasible agency actions for maintenance, preservation, or rehabilitation.

An important function of GDOT's bridge management system (BMS) is to keep track of all this detailed information and use it to support decision-making. Data on spans, elements, and condition levels are used to propose treatment actions, estimate their cost, forecast their effect on future condition, and calculate lifecycle cost. The results are used to set priorities while considering the most effective use of limited funding.

3.3.3. Bridge Condition and Targets

Georgia's NHS bridge condition is better than the national average—79 percent of NHS bridge condition deck area is in good condition and less than 1 percent is in poor condition. With federal minimum condition levels set at 10 percent for poor condition bridges, there is a very small possibility that Georgia's bridges will deteriorate severely in 10 years under anticipated funding levels (**Figure 10**).

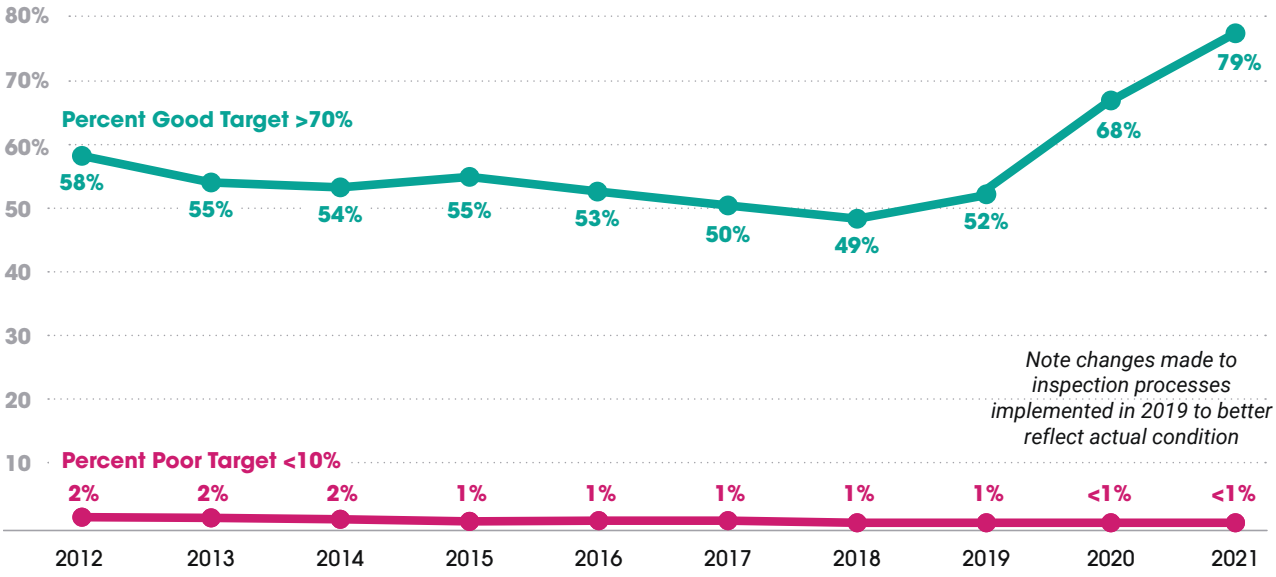


In comparison to 2019 data, a large increase in bridge deck area in good condition is a result of refined inspection practices that were implemented in early 2019. Prior to this change, the element condition data and general condition ratings for some bridges that underwent preservation or repair were not increased to account for the work undertaken. To correct this, the Bridge Maintenance Unit conducted refresher training in early 2019 for all the Bridge Inspection Supervisors to ensure that the inspectors were coding all the elements first and then using that data to derive the NBI general condition ratings. The inspectors then upgraded the ratings with each new inspection, taking a full inspection cycle to complete previous records. This new practice helped increase the bridge condition ratings. Additionally, during this time, bridge improvements, replacements, and new bridge construction projects were completed, further increasing the bridge deck area to good condition.

From 2012 to 2018, the percentage of bridges in good condition declined while the percent in poor condition improved, as shown in **Figure 10**. GDOT reversed the decline of bridges in good condition with an enhanced program of bridge work and refinement of the bridge inspection program.

Preliminary condition levels for bridge conditions are shown in **Figure 10**.

Figure 10 — *Condition Trends, NHS bridges in Georgia 2012-2021*



Section 4

Lifecycle Planning

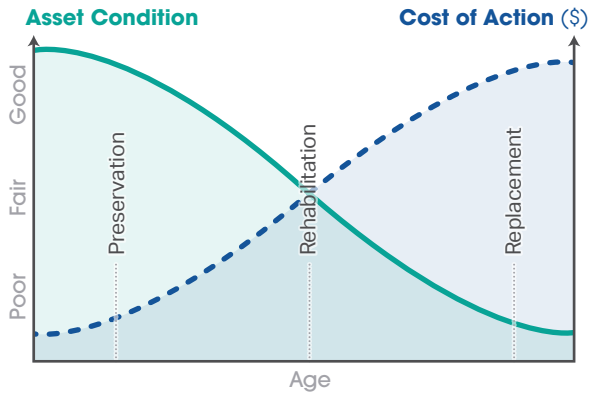
GDOT's asset lifecycle planning delivers cost-effective preservation treatments to prolong asset life while supporting progress toward transportation system performance goals.

4.1 Introduction

Lifecycle planning is the cost-effective management of transportation assets over their whole lives, from the initial construction until the time the assets are replaced, retired, or disposed. Lifecycle planning emphasizes long-term performance through cost-effective preservation, seeking sustainable asset conditions while providing needed system performance or public safety.

Figure 11 illustrates the connection between asset condition, age, treatment options, and cost. Early in the life of an asset, deterioration is limited, so preventive maintenance treatments can be used to delay the onset or stop the progression of distress. As deterioration progresses, rehabilitation is needed to fix the deteriorated areas. Eventually, the asset needs to be completely replaced. As the cost-of-action curve shows, the cost of each level of repair increases exponentially as the amount of distress increases and the overall asset condition decreases.

Figure 11 — *Illustration of the Relationship between Asset Condition and Cost of Action*



GDOT applies lifecycle planning strategies to its pavement and bridge assets — identifying preservation and rehabilitation activities that will extend the life of the assets at the lowest cost over the long-term. This may mean that maintenance and preservation treatments are applied to facilities that are in relatively good condition because the strategic timing of this work is often the least expensive way to maintain service in the long-term.

4.2 Factors that Influence Lifecycle Planning at GDOT

The condition of pavement and bridge assets declines due to age, exposure to traffic and weather, and several other, key factors can influence the rate of deterioration of these assets. In addition to understanding these factors, it is important to understand the role pavement and bridge assets have in addressing the goals of the transportation network.

Bridge and pavement assets help GDOT achieve the federal transportation system goals listed in 23 USC 150(b), which align with the goals GDOT established in its FY 2020-FY 2023 Strategic Plan (FY 2022 Update). GDOT considers several key factors that influence its lifecycle planning.

- **Safety** — The condition of pavements and bridges may influence crash rates. In addition, standards for bridge roadway width and railings influence the frequency and severity of crashes. The ability of pavement and bridge assets to avoid and resist certain natural or human-made hazards, such as flooding, have an impact on the resiliency of the highway network.
- **System Resilience** — Over the past few years, Georgia has faced many weather-induced and catastrophic emergency events that have strained and tested the performance of its infrastructure system, including the 2009 catastrophic flood of Atlanta, the 2014 Atlanta 'Snowmageddon,' the Interstate 85 fire and bridge collapse in March 2017, hurricanes (including 2016 Matthew, 2017 Irma, and 2018 Michael), numerous bridge overpass hits, the 2017 airport blackout, and the COVID-19 pandemic. In anticipation of further emergencies, GDOT is undertaking steps, such as partnering with academia, to conduct research on resilience to better inform its strategic goals and planning around resiliency preparedness. In addition, with PROTECT funds, GDOT will be developing projects to further strengthen its infrastructure.
- **Condition** — Changes in asset condition because of normal deterioration influence the feasibility and cost of maintenance and preservation. Bridges and pavements that are allowed to deteriorate too far may require much more expensive rehabilitation or replacement.

NATIONAL PERFORMANCE GOALS

(1) **Safety.** To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.

(2) **Infrastructure condition.** To maintain the highway infrastructure asset system in a state of good repair.

(3) **Congestion reduction.** To achieve a significant reduction in congestion on the National Highway System.

(4) **System reliability.** To improve the efficiency of the surface transportation system.

(5) **Freight movement and economic vitality.** To improve the National Highway Freight Network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.

(6) **Environmental sustainability.** To enhance the performance of the transportation system while protecting and enhancing the natural environment.

(7) **Reduced project delivery delays.** To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

- **Mobility, including congestion and reliability** — The number of lanes and geometry of bridges affect their ability to carry sufficient traffic at free-flowing legal speeds.
- **Freight movement** — The demands of commerce rely on an increasing volume of trucks. System performance and asset condition is affected by increased rates of deterioration while accommodating heavy truck traffic.
- **Environmental sustainability** — Certain maintenance and preservation actions can have positive or negative impacts on the environment, depending on the methods used. Similarly, environmental changes can have significant impacts on asset performance. GDOT routinely reviews lifecycle strategies and treatment to manage environmental impacts while increasing infrastructure resilience to extreme weather and other environmental conditions.
- **Project delivery** — Work zone traffic control is increasingly important in deciding the timing of preservation work. GDOT strives to coordinate this work with other needs on a corridor and with the work of other agencies, all with the goal of delivering work quickly and with minimal disruption to the public.

These factors are closely associated with lifecycle cost and risk. Preservation work is selected in a manner that attempts to offset deterioration and reduce long-term costs while also minimizing near-term inconvenience to the public. The risks associated with natural and human-made hazards are regularly assessed to consider the economic effect on road users when service is disrupted by road/bridge closures or restrictions. Effective planning of agency actions to protect and improve performance depends on several tools and concepts discussed in the following sections and the remainder of this chapter.

4.2.1. Freight Movement

Expected freight loading is the primary criteria considered during the structural design of pavements and bridges. These assets are designed to carry legal loads for their full lifecycle. Significant increases in the weight or frequency of freight loads, beyond design expectations, can lead to early deterioration. GDOT's design standards are established to maximize the likelihood that pavements and bridges are built to handle the loads they will be subjected to.

Georgia's leading industry is agribusiness. It produces 1.3 billion chickens annually and leads the nation in timber production. In addition, the ports in Georgia, including two ports in Savannah and one port in Brunswick, open commerce to nearly 44 percent of the United States and include a large volume of containerized freight with trucks weighing 100,000 pounds and moving by annual permit across roads and bridges. In any given week, a combined 5.9 million tons of freight is moved across Georgia (Georgia Department of Economic Development).

GDOT and the Georgia Department of Public Safety (DPS) coordinate and oversee the issuance of permits for oversized and overweight vehicles in the state of Georgia (Official Code of Georgia, volume 23, Title 32-6-28). Oversized and overweight vehicles are used mostly for the movement of goods and the movement of heavy equipment for the construction industry. These vehicles may weigh anywhere from 150,000 pounds to 1,000,000 pounds. GDOT and DPS evaluate and issue permits for these vehicles while prioritizing the safety of the traveling public and safeguarding the state's roadway pavement and bridge assets.

The costs borne by road users are a significant GDOT concern, particularly in the context of freight movement. Over the last 50 years, the population of Georgia and the traffic volumes have increased. Georgia's population continues to grow at 1.1 percent annually, which is among the top 10 percent of the country. At the same time, the state's gross domestic product has grown at about 4.4 percent per year. Traffic growth is a causative factor for adverse changes in asset performance.

Freight corridors are considered when making asset management decisions on maintaining and enhancing the physical condition of pavements, bridges, and other State-owned infrastructure. The State Route Prioritization Process (see Section 3.2.1) helps to establish priorities for asset management with consideration of these freight corridors. GDOT asset management decision making helps deliver the outcomes of the State Freight and Logistics Plan and ultimately the U.S. Department of Transportation's National Freight Strategic Plan.

4.2.2. Extreme Weather and Resilience (Addressing BIL Requirements)

Climate/Resilience

GDOT's pavements and bridges are subjected to numerous environmental stressors that contribute to deterioration. In response, GDOT has established strategies to improve resilience at all stages of the asset lifecycle and in all aspects of pavement and bridge management.

Georgia regularly experiences extreme rain events that can significantly affect highway travel. During rain events, water drains from a typical roadway surface in sheet flow. As the intensity of rain increases, the depth of water on the pavement surfaces also increases, contributing to reduced visibility through splash and spray and increasing the likelihood of hydroplaning. To maintain highway safety during rain events, GDOT uses open graded friction course (OGFC) on most interstate asphalt pavements. OGFC is a porous layer that works by allowing water to drain from the highway below the level of the pavement surface. The porous nature of the layer means that it ages differently than dense-graded pavements and requires different treatments to renew the pavement surface

when distress becomes unacceptable. GDOT has incorporated specific deterioration rates and treatment options in its PMS to develop optimized lifecycle strategies for pavements with OGFC.

In addition, GDOT is currently working with Georgia Tech to understand how the Department can include a resiliency lens in transportation planning, design, and operation across the organization – through agency policies, business processes (i.e., work methods), plans, and procedures, and supporting decision-making tools and data. Resilience is the ability to anticipate, prepare for, adapt to changing conditions and withstand, respond and recover rapidly from disruptions.[10] Where a system cannot resist degradation, resilience is the ability of a system to degrade safely, even under unanticipated conditions.[11] And where it is difficult to anticipate future disruptions, resilience involves flexibility (i.e., capabilities needed to meet changing demands in the face of predictable and unpredictable events) and agility (i.e., capabilities needed to change physical structures and governing processes to adapt and transform infrastructure services in time as environments change).[12] Furthermore, mitigation – i.e., the reduction of greenhouse gas emissions – is essential for long-term climate resilience.

For transportation systems to be more effective and efficient in delivering performance, transportation organizations must become more resilient and develop their physical systems to be more resilient. Disruptions, if not well planned for, can lead to additional workload and changes in routine planning and implementation efforts – affecting the efficiency and effectiveness of general performance management efforts. A more resilient organization and system will perform more effectively and efficiently. To this end, GDOT has formed an inter-agency resilience committee that is working collaboratively with the Georgia Tech team. This effort includes **workforce training** on principles and applications of resilience and collaboration with GDOT staff to develop **resilience-enhancing policies, business processes, plans and procedures**, as well as assessing and enhancing adaptive resilience capabilities. It also involves the **development, application and implementation of tools and technologies** to enhance the resilience of the physical transportation system (including its cyber components) and the agency.

Figure 12 shows the climate vulnerability assessment and adaptation framework under development. GDOT will use this approach to identify assets and corridors that have higher exposure to climate hazards, higher sensitivity to damage, and lower resilience. These assets and corridors will be prioritized for adaptation to strengthen the resilience of the transportation system.

In addition to this ongoing resiliency research, GDOT has also initiated a research project "Design Controls and Interventions to Manage Ecological and Cultural Resources on Bird-Long Island," to protect ecological, historical, and cultural resources and infrastructure in Georgia's coastal communities. In 2016, as part of another research project, GDOT developed the Interstate System Preservation Plan, which focuses on identifying and defining the risks that the state's interstate

10. Federal Highway Administration. FHWA Order 5520: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events, December 15, 2014. National Research Council. Disaster Resilience. A National Imperative. The National Academies. The National Academies Press, 2012: Washington, D.C.

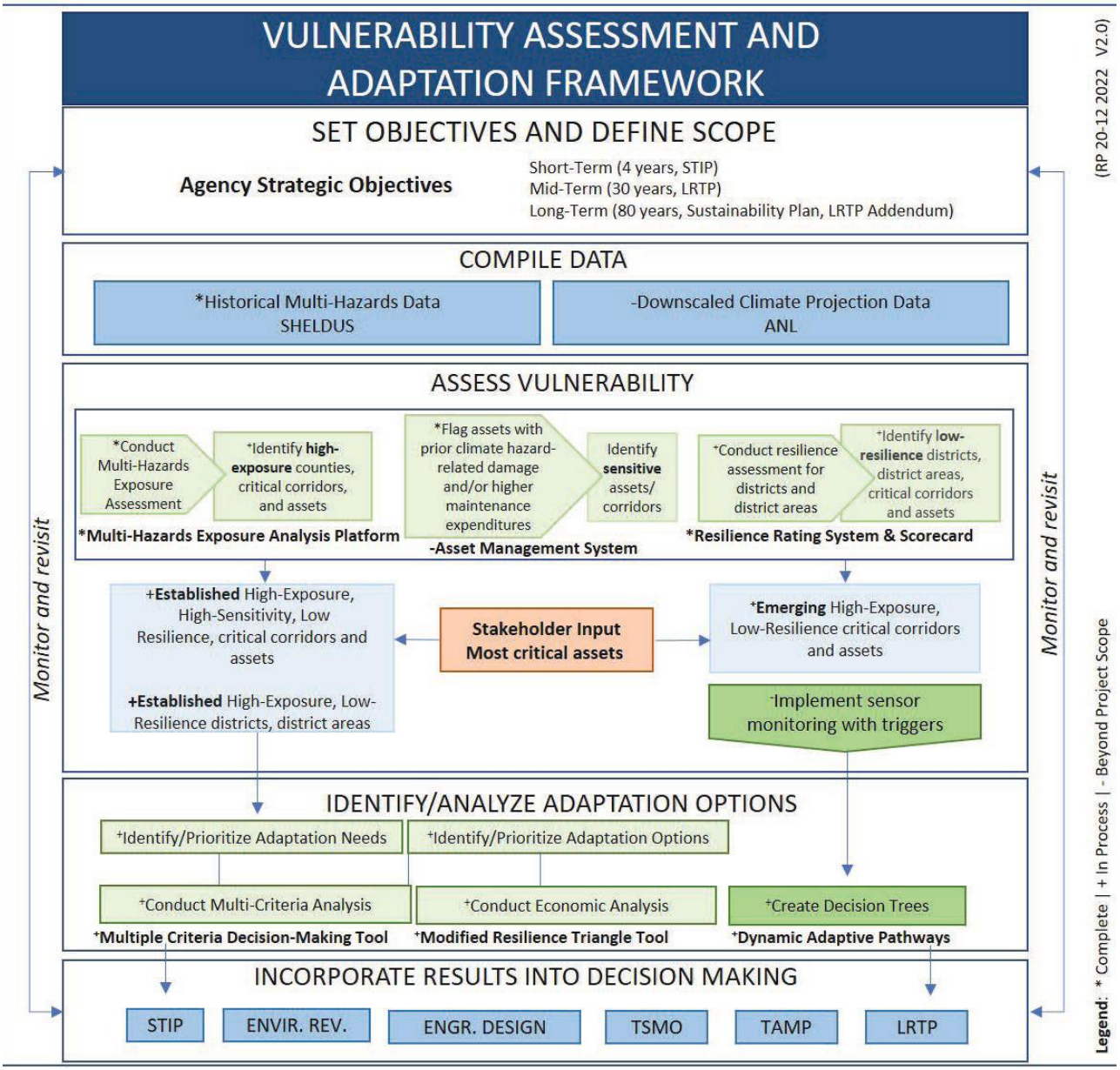
11. Allenby, B. R., and J. Fink. Toward Inherently Secure and Resilient Societies, Science 309 (2005): 1034 – 1036.

12. Allenby, B, and M. V. Chester. What COVID-19 Has Taught Us About Our Infrastructure. ASCE News, April 14, 2020.

system faces and enhancing the leadership decision-making preservation process for the system. Although the primary goal of this plan is not resiliency, reducing risks of a system decreases vulnerability and increases reliability, and subsequently, increases resiliency.

GDOT also leverages technology and lessons learned to better integrate resilience into its core principles and increase organization resilience. For instance, during weather events, GDOT uses the U.S. Engineering Solutions' Infrastructure Management Module Bridge-Watch to monitor its bridges and plan strategic inspection activities that assist in determining whether bridges should remain open to traffic or be closed. The data are incorporated back into GDOT's bridge planning efforts.

Figure 12 — *GDOT Vulnerability Assessment and Adaptation Framework | Version 2.0*



Moreover, with the new PROTECT (Promoting, Resilient Operations for Transformative, Efficient, and Cost-saving Transportation) formula program made available under the BIL, GDOT will be developing projects specifically designed to increase the resiliency of its infrastructure. The projects will be strategically designed to strengthen against and mitigate damage to the transportation network, including coastal evacuation routes, associated with emergency and extreme weather events.

4.3 Pavement Management

Pavement management involves the use of computer models to predict pavement condition and identify the most cost-effective means of treating pavements with available funding. GDOT uses its PMS, dTIMS, to establish long-term lifecycle strategies for pavements and uses those strategies to inform capital and maintenance project selection.

A PMS enables GDOT to predict pavement conditions and identify the most cost-effective means of treating pavements while also addressing deterioration and factoring risks into the models. Current practices are based on asset condition levels, dTIMS analysis, constrained funding, engineering judgement, and years of experience from GDOT's experts.

GDOT uses dTIMS to validate and improve the established pavement management practices.

In 2020, the State Maintenance Office completed its deployment of the dTIMS software across all Districts. Implementation of dTIMS has now moved into a continuous improvement phase that includes regular updates to roadway prioritization, completed projects, and unit costs.

The State Maintenance Office uses the PMS to develop statewide lifecycle strategies for pavements and allocate pavement funding. District offices use the PMS to identify candidates for paving to implement the lifecycle strategies and achieve condition targets. The PMS considers different options for treatment types and timing to establish multiple long-term strategies for each pavement section. When a budget is established, the PMS recommends the projects that provide the best long-term benefit with the available funding. Through this process, the PMS optimizes short-term investment decisions based on long-term benefits, optimizing lifecycle strategies for each pavement segment within available funding. Budgets can be varied to determine the short- and long-term impacts of various funding levels.

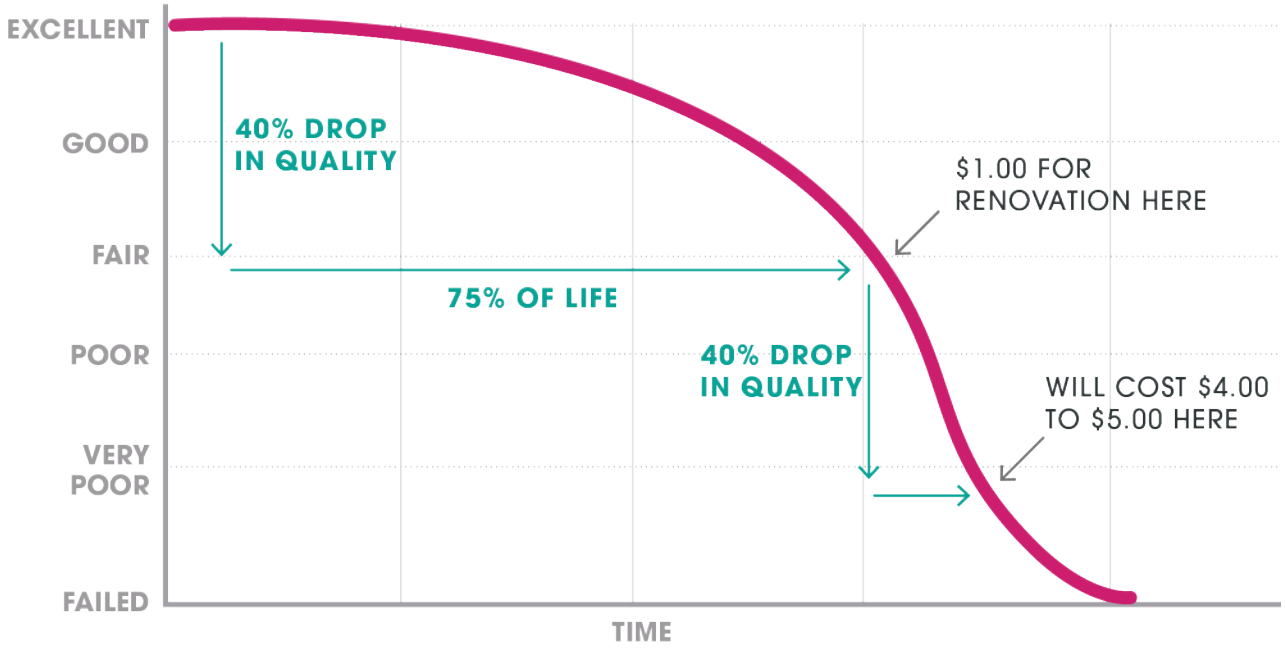
District staff use the PMS project recommendations for their allocated budget levels and field observations to optimize their pavement program. This includes coordinating candidate projects with projects that address other highway projects and routine maintenance needs. Once the Districts select the projects, the State Maintenance Office uses the PMS to forecast expected conditions and works with the Districts to further refine the paving program, as needed.

4.3.1. Pavement Performance Model

GDOT uses dTIMS to establish long-term lifecycle strategies for pavements and applies those strategies to inform capital and maintenance lifecycle planning. Since dTIMS' implementation in 2020, GDOT has updated its PMS deterioration curves to better reflect the state's pavement inventory, historical performance, and environmental conditions. The deterioration curves of the state's pavement assets are derived using the pavements' historical data in concert with geographical location, route prioritization, environmental conditions, traffic data, construction data, pavement design mixes, and types of pavement (e.g., asphalt vs. concrete).

Figure 13 depicts the relationship between pavement condition and appropriate treatment costs that is the cornerstone of GDOT's approach to optimize the life of its pavement and manage long-term costs. Delivering preservation treatments at the right time avoids more costly rehabilitation and reconstruction. Pavement condition drops slowly in the early stages of a pavement's service life but then deteriorates quickly in later stages as it reaches the end of its service life. As illustrated in **Figure 13**, the pavement condition drops 40 percent during the first 75 percent of its service life; then it drops another 40 percent in the next 12 percent of its service life. Thus, applying the right pavement preservation treatment at the right time is critical to prolonging the pavement's life; it will cost up to 80 percent less at the end of the first 75 percent of a pavement's life than anytime thereafter (GDOT Pavement Preservation Guide).

Figure 13 — *Examples of Pavement Performance Curves*



In addition, a well-maintained roadway can benefit end users by reducing overall vehicle operating costs. The biggest benefit to GDOT is the strategic allocation of funding based on data-driven decisions that result in performing the right activities at the right time (GDOT Pavement Preservation Guide). While the factors mentioned in the previous section as well as additional factors (including quality of drainage, type of underlying material, material properties and maintenance frequency) play a role in pavement performance, it is impractical to incorporate each of these factors in performance models. GDOT incorporates information on pavement type, design, environment, and traffic loading to establish performance models that are used to forecast pavement condition. These deterioration models are used within the PMS in conjunction with treatment selection rules and cost data to determine the appropriate treatment at the current or any future time for each pavement.

As noted above, recent years have seen greater use of deicing chemicals. Traffic volumes continue to increase, and heavy trucks are expected to increase as a percentage of total vehicles, particularly on interstate pavements. These changes in factors that affect pavement condition require GDOT to monitor pavement condition and update its models on a regular basis.

4.3.2. Treatments to Maintain and Improve Performance

GDOT employs a wide variety of treatments to manage its pavements, all of which are considered in the lifecycle planning process. GDOT's State Maintenance Office collaborated with the Georgia Institute of Technology to document GDOT's pavement preservation practices and develop a comprehensive pavement preservation guide. The manual defines pavement preservation methods, their application criteria, and their performance to ensure that cost-effective pavement maintenance strategies are applied statewide. The districts and GDOT's local partners use the manual to better train their employees in evaluating pavement needs and selecting the correct treatment techniques to preserve the pavements. **Table 5** provides a summary of the pavement treatments and their typical costs used for analysis in the PMS. The costs presented are based on 2019 estimates. They are used to show the cost difference between treatment types, but do not represent a 2022 actual cost per work type.

GDOT PAVEMENT PRESERVATION INTERACTIVE TOOL (PITT)

This web-based tool allows any pavement owner/manager to select the different pavement distresses, the AADT for the route, and the percent of trucks on the route, and the interactive tool will suggest a treatment type for the roadway segment.

Table 5 — *Summary of GDOT Pavement Treatments by Work Type*

Work Type	Treatment Category	Typical Treatments	2019 Weighted Unit-Cost / Lane-Mile
Maintenance	**Light Treatment**	• Crack Seal; Strip Seal; Fog Seal	**$7,300**
	Rutting Treatment	• Micro Seal, Mill-Spot Overlay, Thin Lift Asphaltic, Concrete Overlay, Level-Resurface (< 2" Depth)	**$53,000**
	Ravel Treatment - Fog	• Fog Seal	**$8,000**
	Ravel Treatment	• Mill-Resurface (< 2"), Micro Mill Resurfacing	**$86,000**
Preservation	**Preservation (Minor)**	• Mill, Chip Seal, Slurry Seal, Micro Seal, Mill-Micro Seal • Mill-Spot Overlay, Scrub Seal. Double Chip Seal • Chip Seal with Light Weight Aggregate, Double Chip Seal with Sand, Double Strip Seal, Double Strip Seal with Sand • Thin Lift Asphaltic Concrete Overlay, Cape Seal	**$36,000**
	Preservation (Major)	• Patch, Mill-Resurface (< 2"), Level-Resurface (< 2") • Mill-Level-Resurface (< 2"), Shoulder Paving/Widening (< 2") • Overlay (< 2"), Chip Seal-Resurface (< 2") • Single Chip Seal-Level-Resurface, Double Chip Seal-Resurface • Chip Seal-Resurface/Shoulder Build (< 2") • Level Chip Seal-Resurface/Shoulder Build (< 2") • Overlay/Shoulder Build (< 2"), Mill-Resurface/Shoulder Build (< 2"), Level-Resurface/Shoulder Build (< 2") • Mill-Level-Resurface/Shoulder Build (< 2"), Micro Mill Resurfacing • Ultra-Thin Bonded Wearing Course (Asphalt) • Hot in Place Recycle (≤ 2") • Open-graded Crack Relief Interlayer with Resurface	**$76,000**

Work Type	Treatment Category	Typical Treatments	2019 Weighted Unit-Cost / Lane-Mile
Rehabilitation	**Rehabilitation (Minor)**	• Mill-Resurface (2"- 4"), Level-Resurface (2"- 4") • Mill-Level-Resurface (2"- 4"), Shoulder Paving/Widening (2"- 4") • Overlay (2"- 4"), Chip Seal-Resurface (2"- 4" Depth) • Level Chip Seal-Resurface (2"- 4" Depth) • Level Chip Seal-Resurface/Shoulder Build (2"- 4" Depth) Overlay/Shoulder Build (2"- 4"), Mill-Resurface/Shoulder Build (2"- 4"), Level-Resurface/Shoulder Build (2"- 4") • Mill-Level-Resurface/Shoulder Build (2"- 4") • Chip Seal-Resurface/Shoulder Build (2"- 4") • Ultra-Thin White Topping, Cold in Place Recycle (2"- 4") • Shoulder Paving and Resurface (2"- 4")	**$204,000**
	Rehabilitation (Major)	• Mill-Resurface (> 4"), Level-Resurface (> 4") • Mill-Level-Resurface (> 4"), Shoulder Paving/Widening (> 4") • Overlay (> 4"), Overlay/Shoulder Build (> 4") • Mill-Resurface/Shoulder Build (> 4") • Level-Resurface/Shoulder Build (> 4"), White Topping/Concrete Overlay • Shoulder Paving and Resurface (> 4")	**$437,000**
Reconstruction	**Reconstruction**	• Full Depth Reconstruction, Reconstruction as AC • Reconstruction as PCC, Reconstruction as CRC	**$590,700**

Each treatment is appropriate for use under certain conditions and not appropriate for use under others. Maintenance and preservation treatments are generally used on pavements in good and fair condition to prevent further deterioration or restore surface condition. Rehabilitation and reconstruction are used for pavements that have deteriorated to the point of losing structural capacity and need more substantial work.

4.3.3. PMS Decision Trees

The PMS uses treatment rules, organized in decision trees, to select the appropriate treatment for each pavement in each year of an analysis. Since dTIMS implementation, GDOT has been refining its decision trees to ensure that the model is evaluating and determining the optimal cost-effective preservation methods and timing for the state's pavements. The updated decision trees (**Figure 14** and **Figure 15**) provide examples of how dTIMS considers the route classification,

AADT, and the OCI score when recommending treatment types. In **Figure 15**, the Treatment Type boxes indicate the likely treatment type for different OCI scores (0-100); an OCI score of 90-100 means that no treatment (do nothing) will be recommended.

Figure 14 — *Decision Tree for Concrete Pavement Preservation*

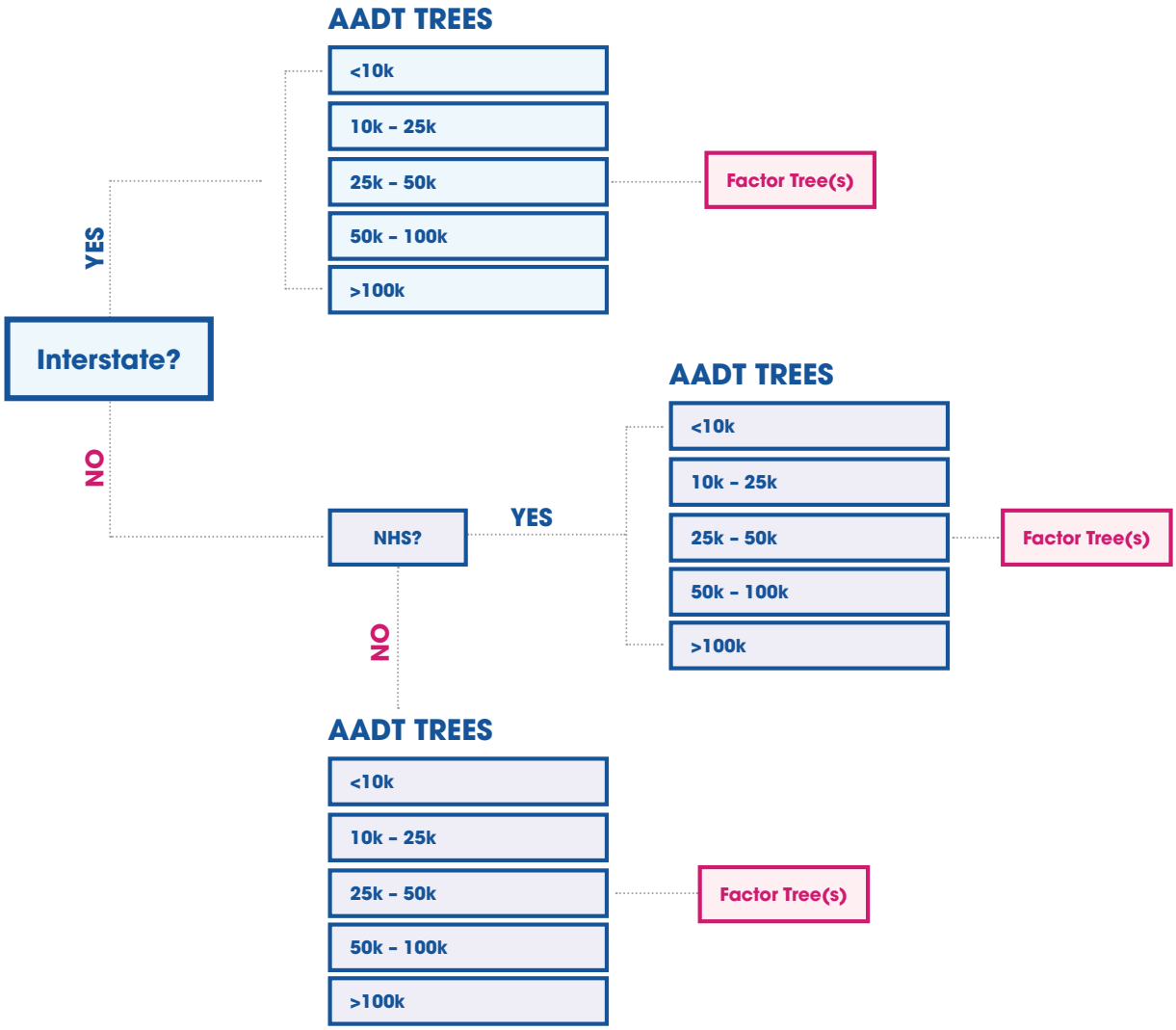
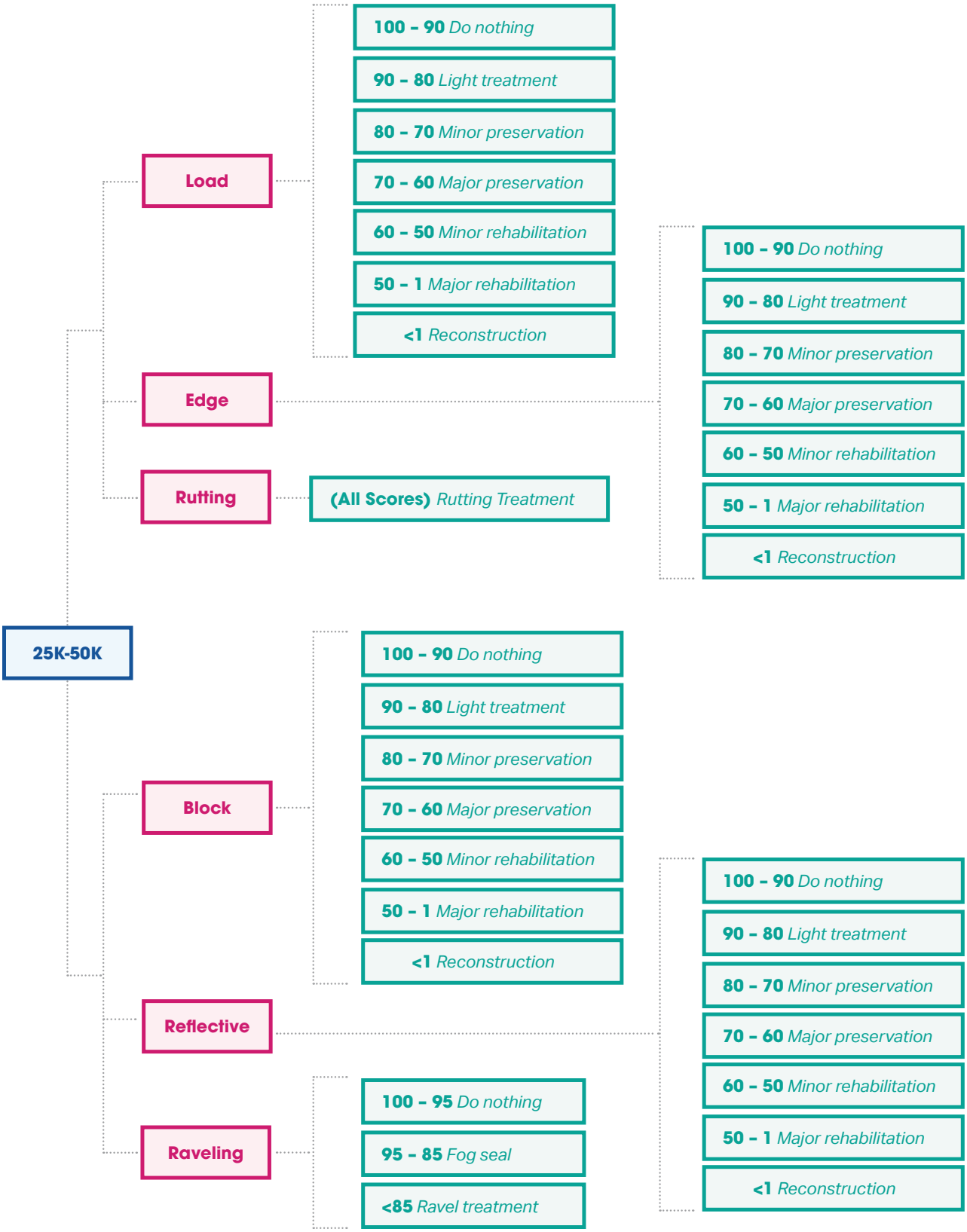


Figure 15 — *Factor Tree for NHS Asphalt Pavement Preservation*



4.3.4. Pavement Project Selection Process

The dTIMS software application has been designed for multi-year programming of road work activities. It enables a user to find the optimal set of maintenance strategies to apply to a network under a given set of constraints, usually cost. The tool uses data on existing conditions, feasible treatments, business rules concerning what treatments are feasible under what conditions, and models for predicting pavement deterioration. dTIMS provides GDOT with a mechanism for analyzing a variety of maintenance and rehabilitation treatments over a 30-year period and optimizes the benefits to the networks for various budget scenarios. It also supports GDOT in understanding and establishing the funding needed to achieve desired performance targets, either federally required performance targets for the NHS or state performance targets for the broader state-owned system.

The State Maintenance Office generates project lists in dTIMS based on projected pavement conditions and funding levels. The list is provided to the districts to aid in their project selection process. The districts can also run their own scenarios at any time to help decide which projects to work on. Limitations of the collected pavement data and subsequent dTIMS outputs prevent GDOT SMEs from relying entirely on the project list provided by dTIMS. For example, occasionally, the pavement condition data will show positive changes in a pavement section's condition compared to the previous year's condition when no improvements were made to that section of the road. SMEs within the districts provide additional insight into the needed projects, and in combination with the model output, develop a list of planned work activities that will produce the most cost-effective outcome for the overall system.

4.3.5. Lifecycle Strategies for Minimizing Long-Term Cost

GDOT uses its PMS to analyze various treatment strategies on each roadway segment across the entire network. The lifecycle analysis is based on the benefit-cost ratio developed from the cumulative costs and benefits for the analysis period. For developing lifecycle strategies, GDOT performs analyses of at least 10 years.

The PMS models the deterioration of each individual pavement segment and identifies potential treatment options for that segment. The cost for each potential treatment (or combination of treatments) over time is calculated, along with the benefit.

The State Maintenance Office uses the analysis outputs and the funding levels in dTIMS to determine the optimal treatment on each road segment. GDOT's dTIMS model has been configured to consider the cost and benefit for each potential treatment (or combination of treatments) over time. The benefit is calculated as the cumulative increase in the OCI pavement condition score

over the analysis period, as compared to a do-nothing scenario. The benefit calculation also incorporates a traffic-weighting factor that increases the benefit proportional to the AADT on the highway segment. This ensures that treatments on highway segments with high traffic volumes take precedence over segments with low volumes. The benefit of a treatment or strategy on a given highway segment is divided by the cost to determine the benefit-cost ratio. The higher the benefit-cost ratio for a treatment or strategy, the more cost-effective the strategy is. This analysis allows for the determination of both the best long-term strategy for each pavement section and the best set of treatments to maximize the benefit to the entire network.

Based on lifecycle analysis, GDOT has developed a strategy that prioritizes the most cost-effective preservation treatments to extend the service life of its network. By employing an array of preservation treatments applied at the proper times, GDOT extends the time before more costly rehabilitation or replacement activities are needed. When it is no longer cost effective to apply a preservation treatment, a more substantial project may be programmed that could include rehabilitation or reconstruction. A well-maintained roadway can benefit end users by reducing overall vehicle operating costs. The biggest benefit to GDOT is the strategic allocation of funding based on data-driven decisions that result in performing the right activities at the right time.

4.4 Bridge Management

Most existing bridges in Georgia were designed for a 50 year lifespan, with some of the newest bridges designed for 75 years. However, bridges can last much longer if appropriate steps are taken to preserve them. GDOT's management strategies to minimize lifecycle costs while achieving and maintaining desired asset conditions are designed to slow bridge deterioration. Bridge deterioration is a natural phenomenon that occurs over time that can be delayed with designed treatments or accelerated if no preventive measures are taken due to environmental factors and increasing live loads on the bridges (in the form of AADT). By studying bridge deterioration, GDOT bridge asset owners understand how to strategically design cost-effective maintenance strategies to postpone the eventual deterioration and associated high costs. Cost-effective treatments, such as maintenance and preservation, are applied at the optimal time during a bridge's lifecycle to slow deterioration and therefore delay costly treatments, such as rehabilitation and reconstruction.

BMS are decision support tools that analyze bridge and agency data to evaluate alternative strategies for addressing network needs and reaching asset management goals while making cost-effective decisions. GDOT has implemented BrM to plan bridge maintenance, preservation, rehabilitation, and reconstruction work. BrM selects bridge projects using multi-objective analysis and incremental benefit-cost ratios to select cost-effective bridge treatments while considering the key performance goals for lifecycle planning. Within the BrM prioritization algorithm, multiple

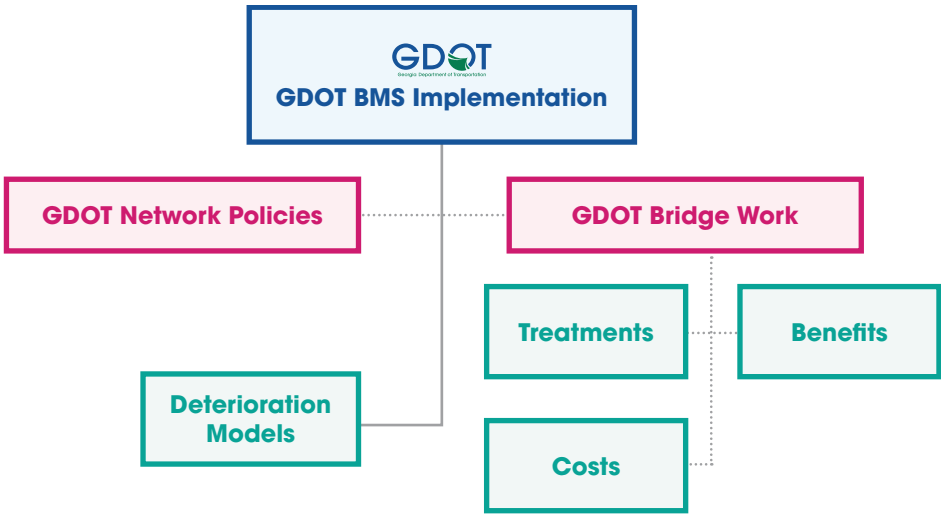
performance measures (e.g., condition, lifecycle cost, risk) can be combined into an overall utility function by applying different weights to the performance measures as they align with the agency's lifecycle planning goals. GDOT performs program analysis for 10-20 years. BrM can analyze bridge conditions at two levels of detail:

- **NBI components:** This is the traditional deck, superstructure, substructure, and culvert 0-9 general condition rating (GCR) system that GDOT has used since 1992.
- **AASHTO elements:** This is a more detailed system that describes each span of each bridge as a collection of elements selected from a catalog of more than 100 types of bridge members of varying functions and materials. Each element is rated on a scale of 1-4. GDOT has been gathering condition data in this format since 2014.

4.4.1. Strategy for Minimizing Lifecycle Cost

GDOT has taken steps to customize BrM models to make them compatible with GDOT structures and policies and continues to update the BMS model inputs to ensure that the system is recommending a balanced and optimized project list. **Figure 16** shows major implementation steps that GDOT has worked on to customize the BrM modeling framework. These implementation steps are discussed in more detail below.

Figure 16 — *Major BMS Implementation Steps*



GDOT NETWORK POLICIES

To evaluate alternative strategies that represent GDOT policies and bridge work, 17 network policies were developed and defined under the BMS models. The network policies resemble decision trees that identify condition thresholds that make bridge treatment alternatives eligible for subsets of the network. For example, the Slab Preservation Policy is eligible only for bridges with a slab design and with superstructure and substructure conditions above poor. Element condition data are also used for defining network policies (e.g., Paint Structure Policy is eligible only for bridges that have painted steel elements and includes thresholds on paint element condition). Network policies encompass bridge maintenance, preservation, rehabilitation, and replacement treatments performed by GDOT.

GDOT BRIDGE WORK

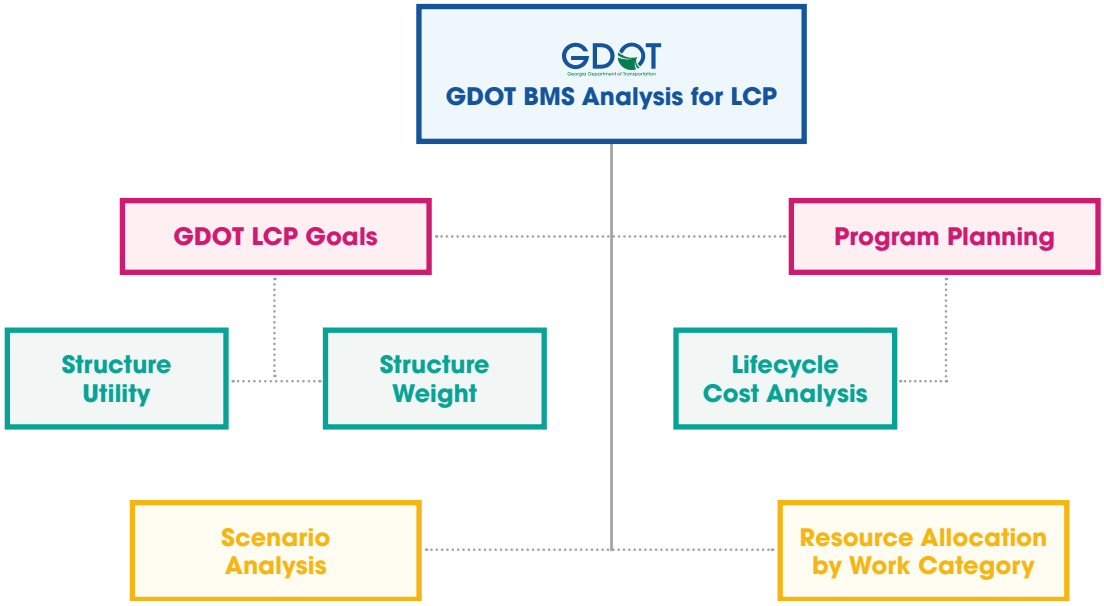
GDOT bridge work is defined in the BMS by specifying **treatments** (e.g., deck preservation, joint repair, thin epoxy overlay), associated **costs** (e.g., treatment cost per element unit for joint repair or thin epoxy overlay), and **benefits** (e.g., the improvement that specified treatment achieves, such as improving joint element condition to condition state 1 (good) from condition states 2 (fair) or 3 (poor)). Costs for most bridge treatments are assigned at the element-level to properly capture the cost of element condition improvements and associated lifecycle cost impacts in the analysis.

DETERIORATION MODELS

To develop deterioration models that best represent GDOT's bridge inventory, GDOT developed NBI GCR median transition time estimates using historical bridge condition ratings. The historical data consist of 25 years of bridge inspection data for all state bridges. Median transition times for each NBI GCR were estimated for decks, superstructures, substructures, and culverts. Separate models were estimated for concrete and steel bridge structures and are utilized in the BMS analysis. Currently, element-level data history is limited to seven years. As more data are collected, GDOT plans on developing deterioration models for the bridge elements.

After customizing the BMS models, GDOT performed program analyses to further refine the models and develop financial plans and investment strategies. Program analysis is a simulation on the bridge network that assesses bridge treatment alternatives (maintenance, preservation, rehabilitation, and reconstruction) over a planning horizon (20+ years) and provides a list of bridge projects that maximize the bridge utility (lifecycle planning (LCP) goals) in the most cost-effective way. **Figure 17** shows model refinements and major analysis steps that were used for representing GDOT bridge management strategies in the BMS.

Figure 17 — *BMS Analysis Approach*

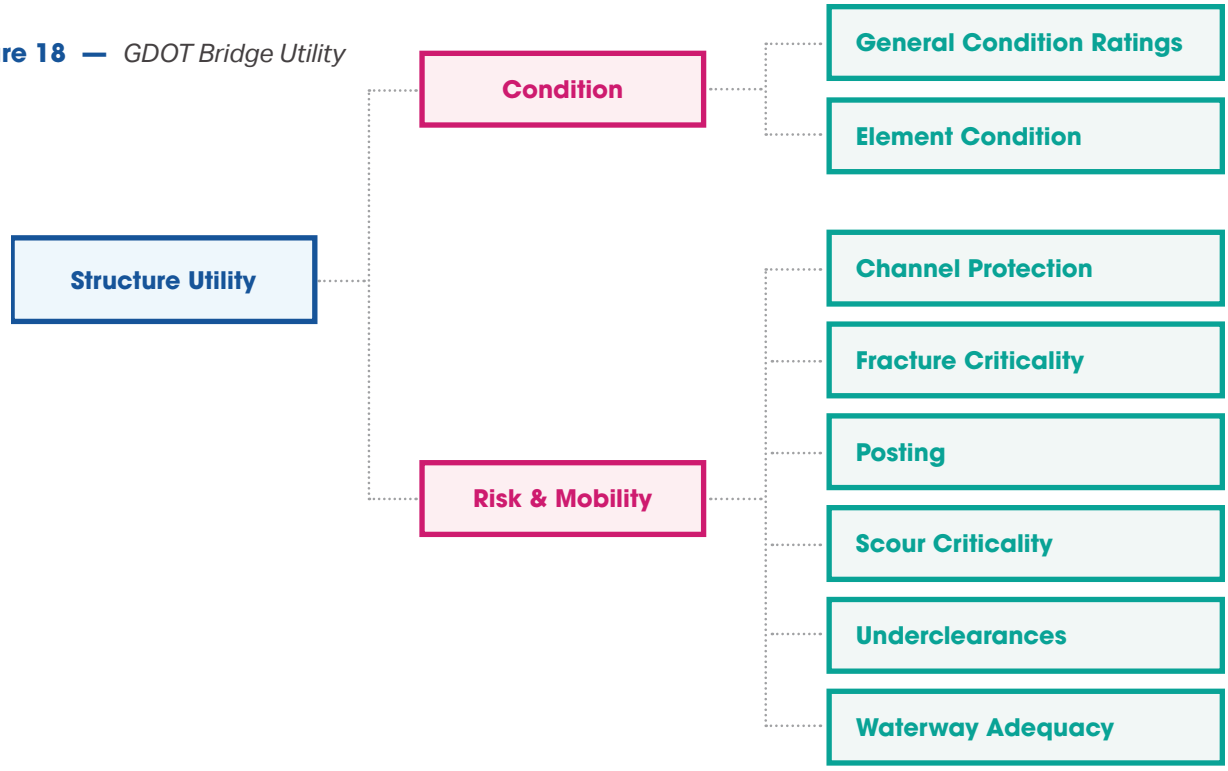


GDOT LIFECYCLE PLANNING GOALS

Life Cycle Planning goals are presented under the structure utility and structure weight criteria in the BMS analysis. Performance measures captured under GDOT's bridge utility are presented in **Figure 18** and address the safety, condition, mobility, and reliability goals for LCP. For structure utility, each performance measure is converted into a unitless 0-100 index by scaling or by a formula. Every treatment alternative has predefined benefits (in terms of performance measures) and associated costs. The BMS optimizer calculates potential utility improvements for alternative treatments based on treatment benefits and the relative weight of performance measures in the utility function (e.g., 70 percent condition and 30 percent risk). The utility-cost ratios are calculated to compare treatment options for each structure. Treatment options with the highest utility-cost ratios, the ones that provide the maximum benefit at the minimum cost, are included in the bridge program list. Structure weight is another component of BMS modeling that incorporates LCP goals into the analysis. GDOT structure weight includes parameters such as forecasted traffic volume (mobility), detour lengths (user costs), and bridge posting (safety and mobility) to prioritize bridge work aligned with LCP goals.

Minimizing asset-level risks over the bridge lifecycle is one of the LCP goals. GDOT's strategy is to continuously monitor vulnerabilities, assess and prioritize asset-level mitigation within planning, and improve resiliency when rehabilitation or reconstruction projects allow (e.g., installing ripraps, reducing scour vulnerability). Asset-level risks account for 30 percent of the BMS utility and include channel and channel protection (NBI 61), fracture criticality (NBI 92a), posting (NBI 70), scour criticality (NBI 113), and waterway adequacy (NBI 71). Scour criticality is also captured in the structure weight. Monitoring, evaluating, and mitigating these risks for the bridge network are high priorities and suitably captured within LCP modeling.

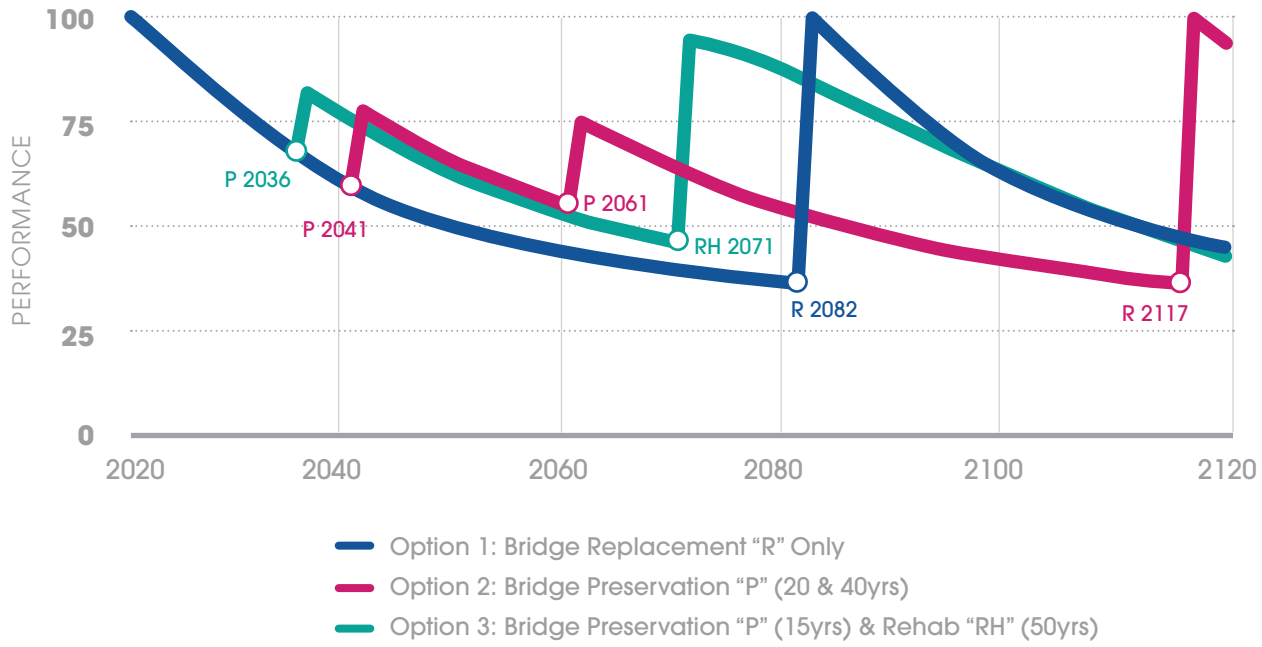
Figure 18 — *GDOT Bridge Utility*



PROGRAM PLANNING - LIFECYCLE COST ANALYSIS

While BMS models discussed so far collectively guide program planning, this section is focused on Lifecycle Cost Analysis (LCCA) policy rules and their effect on LCP. LCCA policy rules provide the BMS optimizer with GDOT's typical bridge preservation, rehabilitation, and replacement plans. These rules are then used to model future benefits and costs of performing work by the optimizer and are essential in capturing the lifecycle cost impact of bridge work. GDOT established LCCA policy rules based on agency policies and information from iterative BMS LCCA analysis. **Figure 19** shows an example LCCA analysis that was used for developing GDOT LCCA policy rules.

Figure 19 — *Example Comparison of LCCA Policy Rules*



The analysis compares three alternatives for concrete structures:

- Option 1. Bridge replacement only
- Option 2. Bridge preservation in years 20 and 40
- Option 3. Bridge preservation in year 15 and rehabilitation in year 50

The results show that Option 3 (preservation followed by rehabilitation) had the lowest total lifecycle cost, followed by Option 2. Option 3 is the best LCCA policy rule among the three alternatives. Similar analyses informed GDOT LCCA policy rules and provided a reference for LCCA calculations in the BMS.

- **Scenario analysis:** Scenario analysis entails program analyses with alternative budgets to inform LCP. Forecasted network condition for alternative budgets informs financial planning.

- **Resource allocation by work category:** GDOT has used a recent feature of the BMS that allocates select portions of the budget to bridge work categories (preservation, rehabilitation, and replacement) in program analysis. The purpose of the feature is to align BMS analysis with program delivery needs. GDOT conducted program analysis with current and alternative allocations for preservation, rehabilitation, and reconstruction to inform LCP and financial planning. With this feature, preservation work gets priority over rehabilitation, and replacement and rehabilitation get priority over replacement, if the options are cost-effective.

4.4.2. Treatments to Maintain and Improve Performance

Table 6 provides a summary of the bridge treatments and their typical costs used for analysis in BrM. The approximate unit costs vary by the elements treated. Element units vary by element type and can be each, square foot, or lineal foot.

Table 6 — *Summary of GDOT Bridge Treatments by Work Type*

Work Type	Treatment Description	Typical Treatments	2022 Approximate Unit-Cost
Maintenance	**Condition-based or interval-based activities that do not require engineering or multi-year programming, usually determined by local crews.**	• Drift removal • Cleaning of scuppers and expansion joints	**$4 to $25 per square foot**
Preservation	**Actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements.**	• Seal bridge decks (polymer overlay) • Minor deck spall repairs or deck crack sealing • Paint steel super and substructure components • Joint replacements or resealing of joints • Spot painting of girder ends or bearings • Minor spall repairs to the super and substructure components • Epoxy injection of cracks • Header repair	**$5 to $42 per square foot $70 to 15,000 per lineal feet $1,000 to $5,000 each**

Work Type	Treatment Description	Typical Treatments	2022 Approximate Unit-Cost
Rehabilitation	**Major work required to restore or increase the structural integrity of a bridge, as well as improvements to function, capacity, resilience, or safety.**	• Deck Rehab • Latex overlay • Polyester Polymer Concrete Overlay • Hydro-blasting of the bridge deck overlay • Replacement of the deck • Pile encasements/jacketing • Bridge jacking to reset bearings or increase vertical clearance • Steel or concrete beam repair or replacement • Major spall repairs to the super and substructures components • Scour counter measures • Carbon-reinforced polymer repairs and strengthening • Wingwall repair on culverts • Heat straightening of damage steel beams • Edge beam reconstruction • Major deck spall repairs • Slope paving repair • Installation of sway bracing	**$9 to $70 per square foot $70 to 27,000 per lineal feet $1,000 to $15,000 each**
Reconstruction	**Bridge Replacement — Removal of an existing bridge and construction of a replacement bridge to serve the same alignment as the removed bridge.**		**Based on a formula using bridge deck area, length, and number of spans**

In GDOT's bridge management, the distinction between rehabilitation and preservation is mainly determined by the severity of defects. Both categories are programmed on a multi-year basis within BrM, both are managed within the same office, and both types of activities can occur within the same project on the same bridge. All actions are selected and prioritized based on treatment feasibility, traffic impacts, environmental concerns, lifecycle cost, and BMS analysis.

Activities in the Maintenance category (see **Table 6** above) slow the rate of deterioration. Because these activities are frequent, low-cost, and minimally disruptive, they are not programmed as individual projects in BrM. GDOT plans these as operational activities that crews perform on a scheduled basis or in response to work orders. Real-time monitoring is also beginning to play a role. GDOT's BridgeWatch system, for example, monitors the clearance between a body of water and the underside of a bridge to warn of potential flood damage due to rainfall or storm surge.

The allocation of funding is determined in the budgeting process. A goal for GDOT's BrM implementation is to incorporate lifecycle cost in the budgeting process.

4.4.3. Other Factors Influencing Bridge Lifecycle Planning Decision Making

Georgia has been replacing all state-owned bridges that require truck weight restrictions, also known as "posted bridges." As of March 2021, only 11 structures on the NHS require load limit posting, all of which are either under construction or are in the program for replacement. GDOT has also scheduled replacement of bridges that require temporary shoring to keep the structures open and carrying trucks meeting state legal limits.

Bridges on the interstate were built to the HS20 design standard. However, nearly 1,930 bridges off the interstate were designed at a standard below the HS20 standard. Georgia has prioritized these structures to ensure mobility for permitted heavy loads.

As of March 2021, local jurisdictions or counties across Georgia own 1,423 structures that are weight restricted or even closed. With limited funding available, GDOT has been focused on reducing the number of these posted/closed bridges. The Department has been replacing bridges using a streamlined approach for low-impact bridges that can be temporarily closed during construction, can be constructed within existing right-of-way, and have minimal environmental and utility impacts. GDOT has also partnered with many local agencies to replace posted/closed bridges that require a conventional approach.

Because of the emphasis on heavy freight movement, many large bridges on Georgia's NHS have already been replaced. Given more modern design standards and the state's benign climate, these structures remain in excellent condition. The Department's focus for LCP is to determine the ideal preservation strategies to keep the state's bridges in optimal condition while minimizing costs in the long term. GDOT's analysis thus far indicates that the percentage of NHS deck area in good condition may be increased to at least 70 percent with a strategic preservation and rehabilitation program.

Section 5

Risk and Resilience

GDOT's risk management process focuses on risks that may limit the Department's ability to deliver the investment strategies presented in this TAMP, and ultimately to deliver service to NHS users.

5.1 Introduction

Risk management is critical when making asset-related decisions at GDOT. It entails considering and managing uncertainties that might adversely affect business objectives and stakeholder safety. When considering the risk inherent to an asset, GDOT considers five key questions:

- How likely will **a catastrophic event or hazard occur** that could impact the asset?
- What are the **consequences to the asset i**f a catastrophic event or hazard occurs?
- What are the **impacts to the agency or public** if the asset can no longer perform its function?
- What various **risk categories** should GDOT consider?
- What **agency and programmatic risk** does the Department face?

Overall, the goal is to enhance GDOT's decision-making capabilities regarding the preservation of its assets.

5.2 Risk Management Process

GDOT has adopted a risk management process to support TAM activities. It addresses both internal risks at the enterprise, program, and project levels and external risks affecting different categories of consequences.

Risks include current and future environmental conditions relevant to GDOT such as extreme weather events and the risks of recurring damage and costs from repeated emergency events specified in 23 CFR 667 that relate to pavements and bridges. Financial risks, operational risks, and other strategic risks are also addressed by the risk management plan. The risk management

process undertaken by GDOT, illustrated in **Figure 20,** meets federal TAMP requirements for managing risk, follows the FHWA risk management guidance, and is aligned with the International Organization for Standardization (ISO) 31000 Risk Management System framework.

Figure 20 — *GDOT Risk Management Process*[13]

As depicted above, the risk management process includes the following elements:

- **Establishing the context** involves developing an understanding of the internal and external drivers of the risk management process. This includes establishing an approach and a team to develop, implement, and maintain the risk management framework and document and administer action items for managing risk.
- **Risk identification** is the process of compiling effects generated from uncertainties impacting organizational objectives. Risks can come from various sources and span different time frames with varying scopes or resolution, whether enterprise wide or project specific.
- **Risk analysis** involves understanding the cause of risks, the likelihood of their occurrence, and the possible outcomes and their potential impacts. Likelihood is defined with a qualitative description of the chance of an event occurring defined by combining information about probability and the agency's historical records and experience, while consequence is defined with a qualitative description of the impact or outcome of a risk event. In this analysis step, both factors are assigned a grade to aid in risk evaluation.
- **Risk evaluation** compares the likelihood of a risk event occurring against the consequence of the event and uses the resulting risk rating to prioritize the risks.
- **Risk management** refers to the selection of a(n) action(s) to respond to the risks identified. There are several response options to manage risk, and the determined risk rating can inform the selected response option.

13. . Incorporating Risk Management into Transportation Asset Management Plans. FHWA (November 2017)

- **Communicate, consult, monitor, and review** are overarching, continual improvements demonstrating the iterative nature of risk management. Communicating and consulting allows for the exchange of information and dialogue with stakeholders to ensure varied views are considered, that all participants are aware of their roles and responsibilities, and to ensure transparency and understanding around specific actions in response to risks raised. Continuous reviews will include opportunities to refine the risk management framework, policy and process for the changing organization's context.

5.2.1. Establish the Context

As part of the initial TAMP submitted in April 2018, GDOT developed an enterprise-wide risk register covering three risk groups and six consequence categories. This process was further developed in 2019 and updated in 2022.

The development of the risk management process was led by the Office of Performance-Based Management & Research and included the TAM committees with significant involvement by the Steering Committee and Task Force.

RISK MANAGEMENT PROCESS

GDOT's risk management process focuses on risks that limit the Department's ability to deliver the investment strategies presented in this TAMP, and ultimately to deliver service to SRS and NHS users.

5.2.2. Assess Risk – Identification, Analysis, and Evaluation

The risk identification process (involving the TAM Steering Committee, Task Force, and members of the Focus Group) identified 23 risks (see **Table 8** for full list) organized into three groups:

- **Enterprise/Agency** — Risks that affect more than one major program or objective of the organization.
- **Program** — A collection of related projects or ongoing efforts to ensure achievement of specific organizational objectives.
- **Project/Activity** — In this context, these risks refer to a single or group of assets.

The risk analysis step identified six consequence categories (**Table 7**) and five consequence levels upon risk occurrence.

Risks may include both threats that should be avoided or mitigated and opportunities that should be exploited or enhanced.

Table 7 — *Consequence Scale*

	Consequence Category	System Performance	Reputation	Safety	Legal & Compliance	Workforce	Financial
Consequence Levels	**Catastrophic**	Loss of asset functionality causing significant travel disruption on multiple highway systems.	Public Investigation, international media, potential management change.	Several deaths, severe injuries.	Significant legal consequences with major interruption to operations.	Disrupts operations and hinders agency objectives.	Lack of financial resources to maintain acceptable level of service. Potential risk of penalties, loss of federal funds. Critical cost impact.
	Major	Extended travel disruption on highway systems.	Loss of confidence, sustained national publicity, public protest for action.	Low number of deaths or injuries.	Legal consequences with interruption to operations.	Significant organizational changes required for operations, meet agency objectives.	Inadequate financial resources to maintain acceptable level of service with considerable difficulty justifying requests for funds. High impact on costs.
	Moderate	Some travel disruption.	Public community discussion, broad negative regional media coverage.	Minor injuries, possible serious injury.	Requiring investigation, non-compliance with major fine, legal action.	Some organizational change for operations and agency objectives.	Potential gap between resources and acceptable level of service. May be able to meet compliance with funding. Moderate impact on costs.
	Minor	Short delays, operational slowdowns.	Minor community interest, and local media coverage.	Possible minor injury.	Non-compliance with minor fine, managed internally.	Agency can meet objectives with slight difficulty, operational interruption.	Adequate financial resources with little to no difficulty justifying funds. Minor impact on costs.
	Insignificant	Un-noticed operational delays.	Individual interest.	No injury.	No consequences, manageable actions.	Manageable work-arounds for agency objectives.	Largely adequate financial resources with no difficulties justifying funds. Little to no cost impact.

A risk rating is then assigned from the risk matrix (**Table 8**), based upon the consequence level and likelihood of occurrence. GDOT developed the descriptions and indicators (timeframes for likelihood) to help prioritize the risks identified.

Table 8 — *Risk Matrix*

Consequence		Likelihood Rare <1x/20year	Unlikely <1x/10year	Possible 1x/5year	Likely 1x/year	Very likely >1x/year
Catastrophic	Potential for multiple deaths, injuries, substantial public, private costs				**Extreme**	
Major	Potential for multiple injuries, substantial public, private costs, and/or foils agency objectives				**High**	
Moderate	Potential for injury, property damage, increased agency cost, and/or impedes agency objectives				**Medium**	
Minor	Potential for minor agency cost and impact to agency objectives				**Low**	
Insignificant	Potential impact low and manageable with normal agency practices				**Very Low**	

The risk rating (based upon the consequence and likelihood) is used to prioritize each item in the risk register to identify the top risks. **Table 9** presents the risk register with risks identified and assessed.

Table 9 — *GDOT Risk Register*

Risk ID	Risk Description	Consequence Category	Rating (Consequence x Likelihood)
Enterprise/Agency Risks			
1	**Staffing/Knowledge Retention:** If the agency does not implement workforce planning for required skillsets, then there may not be enough qualified employees for project delivery. In addition, if the agency does not implement succession planning, valuable institutional knowledge may be lost as employees leave the agency or retire.	Workforce	**Low**
2	**Economic Downturn:** If there is an economic downturn that results in an impact on key revenue sources (e.g., fuel tax revenue, toll revenue) then it can increase/decrease available funding. The COVID-19 pandemic, for example, resulted in significant impacts to the economy that affected GDOT's operating revenues.	Financial	**Medium**
3	**Sufficient Funding Commensurate with Aging Infrastructure:** If there are legislative changes to fuel tax and funding categories in which it can be spent (opportunity and risk) it can increase/decrease available funding, which can impact funding of priority projects and aging infrastructure.	Financial	**High**
4	**Delay in Federal Funding:** If there is federal budget uncertainty (timing) caused by a delay in Congress passing a full year funding bill, this can result in a delay in projects and reduce the capacity to deliver within the financial year.	Financial	**Low**
5	**Opportunity to Leverage IIJA/BIL Funding:** The Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Bill/IIJA) will provide additional funding for critical highway and bridge programs. The ability to align projects with the priorities in IIJA/BIL will be especially important to maintain eligibility and competitiveness. In addition, GDOT will need to be conscious of project readiness and ensure there are no missed discretionary funding opportunities due to the lack of developed projects.	Financial	**Medium**
6	**Lack of Organizational Alignment:** If the agency is not aligned on priorities and the delivery of investment strategies, the agency may not deliver planned activities.	Workforce	**Low**

Risk ID	Risk Description	Consequence Category	Rating (Consequence x Likelihood)
7	**Operational Resiliency:** The COVID-19 pandemic resulted in unprecedented challenges to GDOT's ability to deliver its mission and maintain business operations. Future potential pandemics could risk disruption to GDOT's operations, result in challenges to creating a safe work environment for staff (e.g., social distancing, addressing exposures) and affect GDOT's ability to recruit and retain staff.	Workforce	**Medium**
8	**Equity**: Consider how project selection through the TAMP is linked to delivering more equitable outcomes and analyze how investments can advance social equity across the state of Georgia. Inequitable investments have the potential to disproportionately affect historically marginalized or underinvested neighborhoods.	Financial, System Performance	**Medium**
Program Risks			
9	**Project Delivery:** If projects are not delivered on time, it can affect the ability to delivery in the following year and future ability to secure support from public, political, and regulatory stakeholders.	Reputation	**Low**
10	**Data Reliability:** If asset data collected are inaccurate or incomplete, then the ability to meet performance targets may be reduced, which may impact reporting and decision-making.	System Performance	**Low**
11	**Shift in Modal Choice:** If there is a shift to alternative transport modes resulting in a reduction in fuel usage, then available funding can decrease.	Financial	**Low**
12	**Construction Pricing Variations:** If there is an increase in construction prices or changes to the cost/ availability of labor, then the ability to deliver planned activities can be compromised.	Financial	**Medium**
13	**Extreme Weather Events:** If extreme weather events (flooding, storm, fire) occur, then funding may need to be diverted from planned activities.	Financial	**High**
14	**Access to Assets Due to Natural Emergencies:** If flooding, storm, fires occur with assets becoming difficult to service, it can pose a safety concern for the public and staff.	Safety, System Performance, Legal & Compliance	**Medium**

Risk ID	Risk Description	Consequence Category	Rating (Consequence x Likelihood)
15	**Major Capacity Projects:** If there is a higher than anticipated delivery costs for new assets, then existing funding levels may be inadequate to deliver asset outcomes (likely longer term).	Financial, System Performance	**Low**
16	**Emerging Technology:** If the cost of implementing new technology (e.g., CAV, BrM) is significant, then available funding may need to be diverted from planned activities.	Financial, System Performance	**Low**
17	Safety: If assets are not in a state of good repair due to funding or resource constraints to maintain assets, there may be safety risks to the traveling public and GDOT.	Financial, System Performance	**Low**
Project / Activity Risk			
18	**Increased Asset Deterioration:** If environmental impacts (marine environment, sea level rises, snow (increasing deicing use) occur at levels greater than currently expected, then asset deterioration rates could increase without appropriate mitigation measures in place.	System Performance	**Low**
19	**Quality of New Assets:** If workmanship on new projects (e.g., poor construction quality) does not meet expectations, then earlier/increased interventions may be required.	System Performance	**Low**
20	**Vehicle Loading:** If there are increases in legal/illegal vehicle loads, then asset deterioration rates will increase.	System Performance	**Medium**
21	**Emergency Situation:** If there is a localized emergency event (e.g., bridge hit, flooding, fire), then service can be disrupted.	System Performance	**Low**
22	**Effective Intervention:** If preservation activities are not effective (do not achieve expected life extension outcome), then performance targets may not be met.	System Performance, Legal & Compliance	**Low**
23	**Timely Intervention:** If preservation activities are not performed at the right time, then the treatment required may increase in cost.	System Performance, Financial	**Medium**

5.2.3. Manage Risk – Prevention and Mitigation

For each item on the risk register, three actions were identified:

- **Risk Prevention** — An action to be taken before the event to reduce the likelihood or prepare for the event occurrence.
- **Risk Exploitation** – An action to be taken to ensure the opportunity is realized.
- **Risk Recovery** — A recovery action taken after the event occurs to minimize the consequence.

Figure 21 presents two of the three types of actions. **Table 10** presents a management plan for top priority risks including the trigger, actions, owners, and timeframe.

Figure 21 — *Risk Prevention/Recovery Actions*

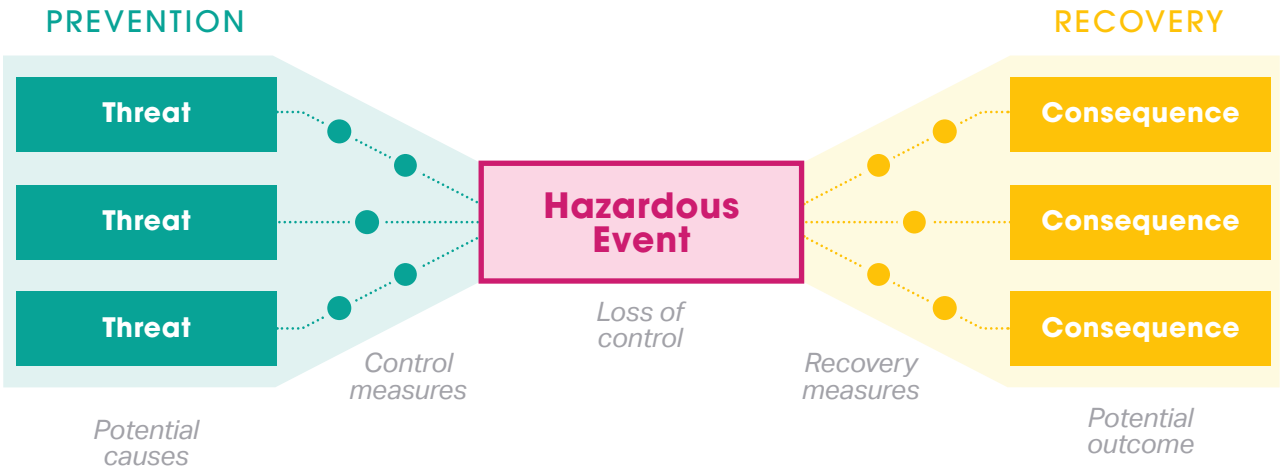


Table 10 — *Top Priority Risk Management Plan*

Risk ID	Rating	Trigger	Prevention and Recovery with Owners	Mitigation Start Date, End Date
3	High	Legislative changes to fuel tax such as spending criteria, tax amounts	**Prevention Action:** Develop or find other revenue mechanisms. Build in excess funding to lessen impact of legislative changes, develop strategies for operating with less funding. Owner: Executive Leadership/Planning/Finance and Budget **Recovery Action:** Apply asset management prioritization processes to determine highest priority work with reduced funding, raise funding from other sources or operate with less funding. Owner: Executive Leadership/Planning/Finance and Budget	**Start:** (January each year) Regular discussions during the legislative session (January through mid-April) with the Office of Planning and Budget (OPB), House and Senate Budget offices to ensure a full understanding of the Department's budget. **End:** (April each year) Before Conference Committee changes are agreed to.
13	High	Extreme weather events and natural disasters (Risk – Extreme weather events)	**Prevention Action:** Define extreme weather events and build in excess funding in the planning process. Owner: Executive Leadership/Planning/Asset SMEs **Recovery Action:** Use contingency fund or divert spare resources from other programs in the event of extreme weather events. Seek Federal Emergency Management Agency (FEMA)/ FHWA support where appropriate. Owner: Executive Leadership/ Planning/Asset SMEs	**Start:** (Already in place) Areas of extreme weather risk have been identified. Dedicated GDOT funding reserve exists for extreme events.
5	Medium	IIJA/BIL funding becomes available	**Exploit Action:** Identify critical projects that will leverage IIJA funding to increase safety, relieve congestion, and address other needs across the state. Determine which projects will optimize funding allocation. Owner: Executive Leadership/ Planning/Finance and Budget/Asset SMEs. Develop project pipeline comprising of projects that are eligible and ready to receive funding. Owner: Planning/Finance and Budget/Asset SMEs	**Start:** Underway **End:** Will continue until further guidance becomes available.
2	Medium	Economic downturn with fewer people driving on fuel decreasing tax revenue	**Prevention Action:** Develop or find other revenue mechanisms. Build in excess funding to lessen the impact of economic downturn, develop strategies for operating with less funding. Owner: Executive Leadership/Planning/Finance and Budget **Recovery Action:** Apply asset management prioritization processes to determine highest priority work during downturns, raise funding from other sources or operate with less funding. Owner: Executive Leadership/Planning/Finance and Budget	**Start:** (Ongoing) Monitor news and media outlets daily. **End:** Two to three months after projections indicate a high probability of declining revenues for a sustained period of time.

Risk ID	Rating	Trigger	Prevention and Recovery with Owners	Mitigation Start Date, End Date
13	Medium	Extreme weather events and natural disasters (Risk – Access to assets due to natural emergencies)	**Prevention Action:** Highlight areas of vulnerability for flooding, storm, fires, and natural hazards to implement monitoring systems, warning programs. Exercise emergency scenarios for safety preparation among staff, including potential evacuation. Owner: District/State Maintenance Office/Maintenance SMEs **Recovery Action:** Enact appropriate emergency action protocols, including escalation, evacuation. Owner: District/State Maintenance Office/Maintenance SMEs	**Start:** Areas of risk/ vulnerability have been identified.
20	Medium	Increased traffic, economic activity for higher vehicle loads	**Prevention Action:** Highways susceptible to increased loading will be highlighted for more monitoring, additional maintenance, treatment, divert traffic and load to prevent, slow down deterioration. Owner: Asset SMEs/Department of Public Safety **Recovery Action:** Implement repairs, treatment to slow deterioration. Owner: Asset SMEs/Department of Public Safety	**Start:** Key freight corridors and those used by heavier loads have been identified. Need to consider additional monitoring requirements. and effectiveness of this approach.
22	Medium	Preservation activities not conducted at right time	**Prevention Action:** Have preservation timing based on performance, condition, and risk. Keep track of preservation timing activities and enforce with the right resources to support it. Owner: Asset SMEs **Recovery Action:** Review performance targets for the next period to see if targets can be improved. Inform stakeholders of implications of targets not being met. Owner: Asset SMEs	**Start:** GDOT to continuously review and enhance practices for tracking and reporting completion of preservation (and other work type) activities.
9	Medium	Untimely project delivery	**Prevention Action:** Determine factors affecting project delivery timing and prevent them. Keep clear communication on all project phases with stakeholders to inform status and potential scenarios. Owner: Planning/Program Delivery **Recovery Action:** Explain to stakeholders the reasons for untimely deliveries to manage expectations affecting future funding. Owner: Planning/Program Delivery	**Start:** Assess year-to-year project delivery to identify appropriate investment levels that can be effectively managed.
12	Medium	Construction prices increase	**Prevention Action:** Identify potential additional funding sources that can help supplement existing sources to account for increases to construction costs. Owner: District/State Maintenance Office/Maintenance SMEs **Recovery Action:** Evaluate how existing and future funding sources and be leveraged to mitigate price increases. Owner: District/State Maintenance Office/ Maintenance SMEs	**Start:** Ongoing challenge but increased focus under current supply and labor challenges

Risk ID	Rating	Trigger	Prevention and Recovery with Owners	Mitigation Start Date, End Date
7	Medium	Pandemic disrupts operations and creates workforce challenges	**Prevention Action:** Assess areas of the business that the current pandemic or a future pandemic may affect and develop mitigation plans for potential impacts. Continue workforce planning initiatives to identify workforce needs and retain and recruit staff. Owner: Executive Leadership/ Planning/Finance and Budget/Asset SMEs **Recovery Action:** Implement Continuity of Operations Plans (COOP)/Business Impact Analysis (BIA) plans. Owner: Executive Leadership/Planning/Finance and Budget/Asset SMEs	**Start:** (Ongoing) Continue to monitor potential impacts of pandemic.
8	Medium	Investments are not distributed equitably across the state of Georgia	**Prevention Action:** Determine how equity can be incorporated into the capital planning and prioritization process so that equity considerations are considered upfront in the process. Ensure equity considerations are also built into the project planning process. Owner: Executive Leadership/ Planning/Finance and Budget **Recovery Action:** Conduct analysis to determine where investments are most needed to advance and improve social equity. Owner: Executive Leadership/ Planning/Finance and Budget	**Start:** (Ongoing) Is continual focus for GDOT.

5.2.4. Understanding Resilience (Addressing BIL Requirements)

Climate/Resilience

FHWA defines resiliency as the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions (FHWA Order 5520).

Normally, resiliency is thought of as preparing and responding to environmental challenges (as discussed in greater detail in the following section), but this approach of resiliency can also be applied to the risk items within this TAMP and the focus on delivery of the investment strategies presented in this TAMP, and ultimately to deliver service to NHS users.

GDOT understands the importance to defining and integrating resiliency into every aspect of the Department's strategic goals and planning because of the evolving natural and economic climate and associated uncertainties. Over the past years, Georgia has faced many weather-induced emergencies events such as hurricanes, weather storms with freezing rain and snow and manmade emergencies events, such as the Interstate 85 bridge collapse in March of 2017, and numerous bridge overpass hits.

With these known and unknown uncertainties, GDOT focuses on anticipating, preparing for, and adapting to changing conditions; responding to emergencies in a timely manner; and ensuring that its transportation system recovers rapidly from disruptions.

During weather events, for instance, GDOT uses the U.S. Engineering Solutions' Infrastructure Management Module Bridge-Watch to monitor its bridges and to plan strategic inspection activities which assist in determining whether bridges are to remain open to traffic or should be closed. When faced with unknown uncertainties, as was the case with the I-85 bridge collapse, GDOT ensures that its transportation system recovers rapidly from disruptions and that lessons learned are incorporated into its planning and operation strategies.

GDOT is also in the process of conducting a resiliency study to develop and apply approaches for implementing resiliency efficiently across Georgia's transportation system. The project involves training its workforce on the principles and application of resiliency; developing resilience-enhancing policies, business processes, plans, and procedures; and developing, applying, and implementing tools and technologies that will enhance the resiliency of the physical transportation system. The outputs of this study will enable GDOT to develop the capabilities and tools to enable the agency to make more efficient resilience investments and coordinate in-house resiliency initiatives with its key metro Atlanta partners.[14]

5.2.5. Communicate, Consult, Monitor and Review – The Risk Register

Risk management is an iterative process to reduce risk, re-prioritize and continually improve and refine with new risks that may emerge. As identified in the risk register, those risks determined to have the largest potential impact have associated risk prevention and recovery actions to actively work to reduce risk.

5.3 Assessment of Assets Repeatedly Damaged by Emergency Events

23 CFR Part 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, requires GDOT to conduct an evaluation of facilities (on the NHS at a minimum) that have required repairs to emergency events on two or more occasions.

GDOT undertook this analysis for all State Routes, and there were no roads with two or more repairs or reconstruction due to emergency events since 1997.

The process to undertake this assessment included a review of the following data sources:

- **Bi-Annual Pipe Inspection** — Identifies damaged or non-functioning drainage assets.
- **Maintenance Management System** — Manages day-to-day activities and tracking of work orders for damaged assets.
- **PMS** — Identifies the condition and prioritization of GDOT's largest asset. It is used to plan pavement preservation to prolong the life of these assets.
- **GEARS** — Identifies damages that are recovered by insurance claims to roadside assets.
- **Collector app/GIS based mapping** — Inventories roadside assets and MS4 structures to gather current data and build a historical database.

The systems enable GDOT to look at historical damage and work orders to identify any instance of the same work occurring in the same location.

The State Maintenance Office is responsible for this process. After each future emergency event, the event is logged, and the system is checked to see if this is a repeat event. This will inform decision-making on repairs and whether an alternative approach is required.

14. These key partners include: Atlanta Regional Commission, Georgia Regional Transportation Authority-State Road and Tollway Authority, Atlanta-region Transit Link Authority, Metropolitan Atlanta Regional Transit Authority (MARTA), the City of Atlanta Department of Transportation, and others.

Section 6

10-Year Financial Plan and Investment Strategies

GDOT's TAMP Financial Plan provides projected available annual revenues and anticipated expenditures over a 10-year period. These projections are used to support asset management objectives to achieve the Department's performance targets.

6.1 Introduction

GDOT's 10-year Financial Plan is comprised of anticipated federal and state revenue sources. The Financial Plan sets the baseline funding for bridge maintenance, bridge replacements and pavement maintenance and resurfacing activities. Investment strategies then define the mix of work types that will be used to deliver the outcomes discussed in this TAMP.

6.2 Projected Funding Levels

Projected Federal Aid funding levels are derived by using GDOT's actual FY 2022 apportionments for the core Federal Aid programs authorized in the current Transportation Act (IIJA/BIL) as a baseline. A 2% growth factor compounded annually is then applied to fiscal years 2023 – 2026. FY 2027 is held flat with the assumption that the current Transportation Act (IIJA/BIL) has expired, and funding is maintained at FY 2026 levels. A conservative growth factor of 1% compounded annually is applied to core Federal Aid apportioned programs for fiscal years 2028 – 2031 with the assumption that a new transportation bill has been enacted to re-authorize funding for the Federal Aid program. In addition, due to obligation limitations, these projections assume 96% of the apportioned funding provided for the core Federal Aid programs will be received. Also, programs exempt from obligation limitation are included in these projections as well; however, no growth factor is applied due to the nominal funding increases anticipated for these programs.

Risks associated with Federal Aid revenues are political in nature. Although Federal Aid funding levels are currently authorized for a period of 5 years (FY22 - FY26), Congressional action is required through the Appropriations process to transfer funds into the Highway Trust fund to support payments to States. Congress has historically been slow to enact Appropriations bills leading to funding uncertainties during the first and second quarters of the federal fiscal year. During this time period, the department's budget is closely monitored to ensure fiscal capacity

is maintained until funding becomes available from the enactment of a Continuing Resolution or an Appropriations bill.

Table 11 shows 10 years of projected GDOT revenues (from 2022 to 2031).

Table 11 — *Predicted GDOT Revenues 2022 to 2031 (in millions)*

Year	State Motor Fuel Tax	License, Vehicle Fees	Toll Revenue Bonds	Federal Aid	Federal Loans TIFIA	Total
2022	1,960	93		1,621		**3,674**
2023	1,960	162		1,743		**3,866**
2024	2,059	177		1,775		**4,011**
2025	2,111	178	24	1,807	24	**4,144**
2026	2,132	180	24	1,840	54	**4,230**
2027	2,153	182	41	1,840	71	**4,287**
2028	2,175	184	23	1,926	71	**4,379**
2029	2,196	186	138	1,944	71	**4,536**
2030	2,218	188		1,963	71	**4,440**
2031	2,240	189		1,982	24	**4,436**

Projected State Motor Fuel Tax revenue is derived by using the current estimate for FY 2022 and FY 2023 developed by the Office of Planning and Budget. FY 2024 and FY 2025 estimated revenue growth of 2.5% is due to the impacts of indexing for fuel efficiency, adjustments due to the consumer price index (CPI), and consumption growth. A lower 1% growth estimate is used for the remaining years due to the sunset of the CPI adjustment in FY 2026.

Transportation fee revenue consists mainly of a $5 fee on hotel stays, fees on electric and plug in vehicles, and heavy vehicles. Projected State Transportation License and Vehicle fee revenue is derived by using the current amount for FY 2022, as well as the current estimate for amended 2022 and FY 2023 received from the Office of Planning and Budget and is net funding for transit and other transportation modes. FY 2024 revenue growth is estimated at 30% due to the expected rebound in hotel fee revenue while FY 2025 – FY 2031 includes growth of 1% per year.

Revenue risks for State Motor Fuel Tax revenue stem from the sunsetting of the CPI adjustments, increases in fuel efficiency in vehicles, adoption of electric vehicles, as well as economic downturns during the estimate period. Increases in fuel efficiency are mitigated from an annual adjustment

to the motor fuel tax rate based on the efficiency of new vehicles registered in the state each year. However, there is a risk that gains in efficiency are greater than the tax adjustment. The risks due to the adoption of electric vehicles are mitigated by the alternative fuel vehicle fee. Revenue risks for transportation fees mainly stem from an economic downturn during the estimate period which would result in a lower number of hotel stays.

Bond issuances and other financing revenues are recognized in their anticipated year based on investment assumptions.

All funding within this section is presented in 2022 dollars and is broken down by the different types of expenditure within GDOT.

6.2.1. Funds Available for Pavement Investment Strategies

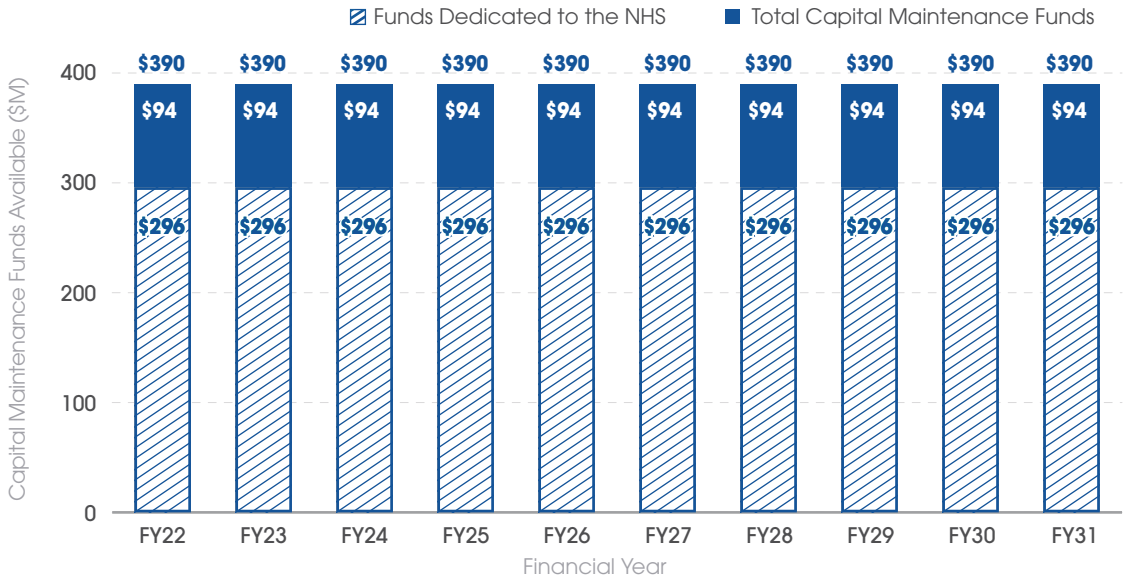
The capital maintenance budget funds resurfacing and striping for the full SRS. A portion of the total capital maintenance budget is available specifically to meet pavement targets on the NHS. As a result of increased funding through the Transportation Funding Act (2015), GDOT has increased its focus on deferred maintenance activities, enabling it to work towards a 15-year pavement resurfacing cycle compared to a previous 50-year cycle.

TRANSPORTATION FUNDING ACT

In 2015, the Georgia's General Assembly passed –and the Governor signed—the Transportation Funding Act, to provide much-needed funding to repair, improve, and expand the state's transportation network through routine and capital improvement projects.

The 10-year funding available for the NHS represents a total of about $2.96 billion (see **Figure 22**). The remainder of the capital maintenance budget ($1.7 billion) is utilized for the broader SRS for which GDOT is responsible. GDOT maintains some flexibility to utilize the non-NHS capital maintenance funds to ensure that NHS performance targets will be achieved.

Figure 22 — *Capital Maintenance Funds Available for the SRS and Specifically for NHS Pavements, FY 2022 - FY 2031*



In addition to the dedicated NHS funding, in some instance, Invitation-To-Bid contracts (ITB) funding can also be used on NHS assets. GDOT's District Offices may elect to perform routine maintenance activities, based on needs, on NHS bridges and pavements. Although the routine maintenance activities do not structurally improve the assets, they do assist in delaying more costly preservation work. At GDOT's discretion, the ITB funding has not been added to the total funds allocated to NHS because of the variability in the District's needs.

6.2.2. Funds Available for Bridge Investment Strategies

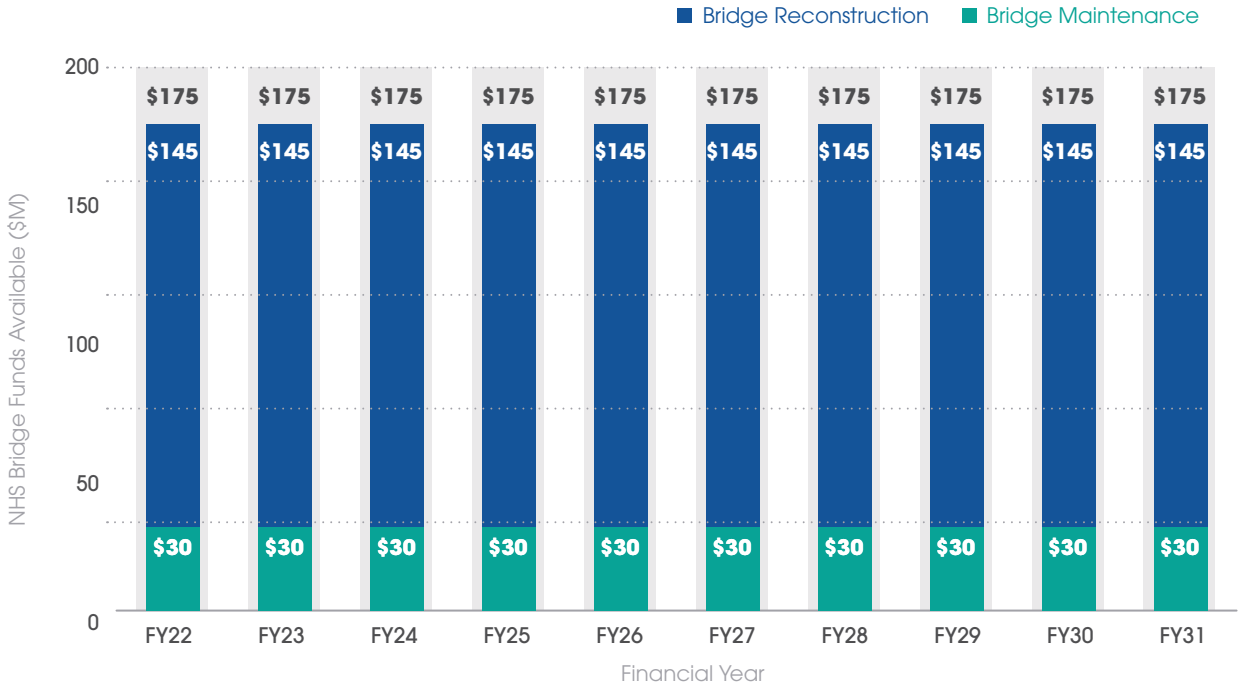
The bridge program receives funding from several sources. Bridge maintenance, including preservation and rehabilitation, primarily receives funding from two federal lump-sum pools: 1) Bridge Paint and Rehabilitation Interstate and 2) Bridge Paint and Rehabilitation Any Area. As illustrated in **Figure 23**, $30 million is available for bridge maintenance (including preservation and rehabilitation) on the NHS, an additional $15 million is available for non-NHS.

Bridge reconstruction also obtains funding primarily from two sources: 1) federal bridge set asides and 2) state-funded lump sum. **Figure 23** illustrates that $145 million is available to meet bridge performance targets on the NHS.

A federal or state "lump sum" is programmatic funding to address the highest priority needs (including bridge maintenance, operations, Intelligent Transportation System, and resurfacing) on an annualized basis not programmed in the four-year STIP/TIP. Funding levels are established based on need through a coordinated effort involving the Planning Division and Chief Engineer. The lump sum program is comprised of set aside funds for 12 groups of projects that do not alter the capacity of the roadway.

In total, GDOT anticipates approximately $1.75 billion in bridge funding over the 10-year period 2022-2031.

Figure 23 — *Funds Available for NHS Bridges FY 2019 – FY 2028.*



6.2.3. Managing Risk to Funding Levels

The TAMP risk assessment identified one High risk, one Medium risk, and one Low risk related to uncertainty in future funding as follows:

- **Sufficient Funding Commensurate with Aging Infrastructure:** If there are legislative changes to fuel tax and funding categories in which it can be spent (opportunity and risk) it can increase/decrease available funding for aging infrastructure. (High risk)
- **Economic Downturn:** If there is an economic downturn and impact on fuel tax revenue, then it can increase/decrease available funding. (Medium risk)
- **Delay in Federal Funding:** If there is federal budget uncertainty (timing) caused by a delay in Congress passing a full year funding bill, this can result in a delay in projects and reduce the capacity to deliver within the financial year. (Low risk)

These areas of risk are a significant priority to GDOT, and mitigation actions have been identified that can be applied to the NHS. These actions include the following, already in place:

- The ability to supplement the funding for the NHS (from the wider SRS) through flexibility in the capital maintenance and bridge reconstruction budgets.
- Prioritization processes where limited funds are available as defined by the State Route Prioritization.

6.3 Asset Valuation

Asset valuation informs public officials and citizens of the value of transportation assets owned and their required maintenance. It also enhances the importance of, and provides an indicator in, the level of investment needed to preserve and maintain assets. An asset valuation assigns a monetary amount to the asset based on criteria such as size, age, condition, performance, and replacement cost. There are a range of different approaches to asset valuation with associated advantages and disadvantages. Many state DOTs use more than one approach for different purposes.

GDOT has used two sources of existing information as a basis for asset valuation. Both methods have limitations, as described in the following section. Recognizing these limitations, GDOT has determined NHS asset valuations as an upper and lower bound.

6.3.1. Depreciated GASB 34 Approach — Lower Bound

For federal reporting, GDOT produces an asset valuation that is consistent with the Governmental Accounting Standards Board (GASB 34) accounting rules and regulations. This approach starts with the original cost at the year of construction, and then the annual depreciation and accumulated depreciation are determined and subtracted from the original cost to yield the asset value at any year. This approach is expected to form a lower bound as it is based on the original rather than current-day cost of the asset. This approach is not linked to asset condition, however, so any improvements made to the asset are not recognized.

6.3.2. Replacement Value Approach — Upper Bound

This approach estimates the cost of replacing the asset now with an asset of the same function and performance. This approach is expected to form an upper bound because it does not take in to account that assets in almost all instances are not in a new condition; meaning, there has been some depreciation in their value. However, this 'new' value may represent value to the traveling public better as it reflects current costs and technology.

Based on these two approaches, the estimated valuation for NHS pavements is a range of $7.6 to $45.3 billion. For NHS bridges, the range is $616 million to $23 billion.

6.3.3. Asset Valuation — Comparison to Funding Levels

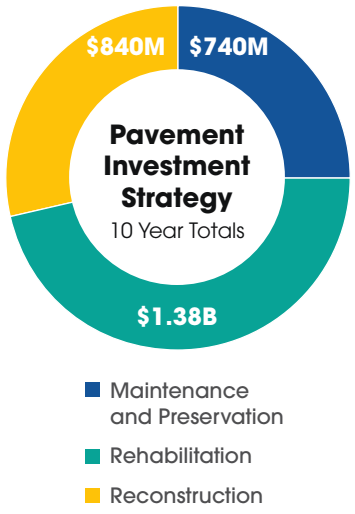
An ongoing comparison of the funding levels to asset value can be used as an indicator of whether the level of investment, relative to the value of the asset, is increasing or decreasing. When comparing these valuation numbers to the funding levels identified in the Financial Plan:

- Yearly funding for pavements on the NHS is in the range of 0.5 percent—4.5 percent.
- Yearly funding for bridges is likely greater than 1 percent of the asset valuation (based on the upper bound valuation).

6.4 Investment Strategies

For this TAMP, GDOT analyzed investment strategy options that will enable the Department to preserve and improve the condition of the NHS. This process leverages GDOT lifecycle planning tools (including deterioration modelling and treatment selection) and considers funding and delivery risk to provide investment strategies that can be achieved.

The outcomes of the recommended strategy are discussed in more detail in **Section 7**, Performance Gap Analysis.



6.4.1. Investment Strategy – NHS Pavements

The proposed investment strategy for NHS pavements was developed based on optimized analysis within the PMS.

As expected for pavements that currently exceed NHPP targets, the investment strategy includes a strong focus on maintenance and preservation activities to continue on-target performance (see **Table 12**). This proactive approach to pavement management will enable GDOT to continue to achieve high pavement condition standards.

Table 12 — *Planned Investment for NHS Pavements by Work Type FY 2022 – FY 2031 ($M)*

	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	10 Year Totals
Maintenance and Preservation	$74	$74	$74	$74	$74	$74	$74	$74	$74	$74	**$740**
Rehabilitation	$138	$138	$138	$138	$138	$138	$138	$138	$138	$138	**$1.38B**
Reconstruction	$84	$84	$84	$84	$84	$84	$84	$84	$84	$84	**$840**
Total:	**$296**	**$296**	**$296**	**$296**	**$296**	**$296**	**$296**	**$296**	**$296**	**$296**	**$2.96B**

INVESTMENT STRATEGY – NHS BRIDGES

The investment strategy for NHS bridges is influenced by existing funding processes and by a range of analyses. Although the BMS is still at an early stage of development, the results of the NBI component-level analysis align with the results from a spreadsheet analysis developed by GDOT. With the investment levels available, both anticipate achieving similar outcomes given the proposed split between maintenance/preservation and rehabilitation work types.

With some aggressive NHPP targets set for increasing the number of good bridges over the next three fiscal years, the amount of reconstruction proposed—89 percent of total planned investment for bridges on the NHS—will be necessary (see **Table 13**). Once these goals are met and the BMS is better refined to suit Georgia, the split between reconstruction and other work types will be further considered.

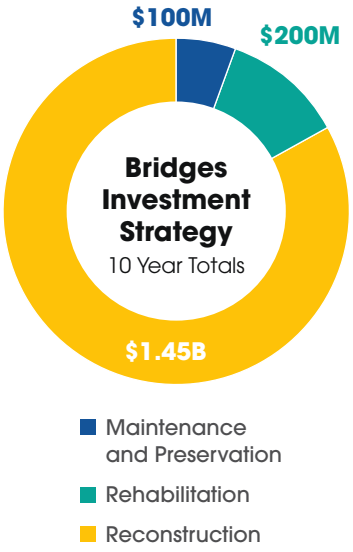


Table 13 — *Planned Investment for NHS Bridges by work type FY 2022 – FY 2031 ($M)*

	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	10 Year Totals
Maintenance and Preservation	$10	$10	$10	$10	$10	$10	$10	$10	$10	$10	**$100M**
Rehabilitation	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20	**$200M**
Reconstruction (Replacement)	$145	$145	$145	$145	$145	$145	$145	$145	$145	$145	**$1.45B**
Total:	**$175**	**$175**	**$175**	**$175**	**$175**	**$175**	**$175**	**$175**	**$175**	**$175**	**$1.75B**

6.4.2. Initial Construction

Through development of the 2022 TAMP, GDOT worked to quantify the impact of initial construction on the outcomes and investments made. For this TAMP, GDOT defines initial construction as work undertaken to improve mobility and safety. GDOT is looking to quantify the investment made to improve existing pavements and bridges as well as the addition of new pavements and bridges that will be the future responsibility of the bridge and pavement programs.

ALTERNATIVE DELIVERY

GDOT is making major investments in the state's transportation network to deliver projects that will meet a community need and deliver positive benefits to drivers. Major Mobility Investment Program (MMIP) projects (**Figure 24**) that will create additional capacity, improve freight movement, provide transportation improvements and efficiencies, enhance safety, and decrease travel times were pinpointed.

Figure 24 — *MMIP Program Elements (for more information: https://majormobilityga.com/)*

In addition, there are other alternative delivery projects which are not part of the MMIP program. Analysis of the alternative delivery program demonstrates the following:

- Overall investment in pavements and bridges over the 2022 TAMP timeframe is expected to total approximately $3.350 million.
- Of this, approximately 80 percent will be maintained by developers through a 35-50 year maintenance period.
- Approximately 75 percent of the investment in pavement is expected to be for new structures, with the remainder (25 percent) allocated for rehabilitation of existing pavements.
- Approximately 90 percent of the investment in bridges is expected to be for new structures with the remainder (10 percent) allocated for rehabilitation of existing bridges.

PROGRAM DELIVERY

GDOT is continuing to quantify additional programs delivering investment on NHS pavements and bridges. This analysis requires linking projects through multiple financial systems to track investments from planning, through design, construction, and into maintenance.

Section 7

Performance Gap Analysis

With the implementation of the PMS and BMS for pavements and bridges, GDOT is well positioned to understand the outcomes achieved through future investment scenarios. This positions GDOT to consider these asset outcomes in relation to other goals of the Department such as safety and mobility.

7.1 Introduction

GDOT has identified condition targets to meet or exceed minimum federal requirements. GDOT is also, in most cases, already achieving the two- and four-year NHPP condition targets for the NHS that were set in 2018.

As introduced in **Section 2.2.**, meeting the targets for asset condition on the NHS will assist GDOT in achieving national performance goals.

GDOT SOGR

A capital asset is in a state of good repair when that asset is able to perform its designed function & does not pose a known safety risk.

7.2 State of Good Repair (SOGR)

GDOT has developed a definition for SOGR: *A capital asset is in a state of good repair when that asset is able to perform its designed function and does not pose a known safety risk.*

Since 2019, GDOT has implemented and worked to refine the PMS and BMS long-term targets for pavements and bridges are being considered.

Targets have been established for all SRS (including NHS) pavements and GDOT is actively managing investment levels to achieve these goals. The pavement management system is implemented and being used to direct investments and forecast conditions. Bridge management system refinement is ongoing and is currently informing the understanding of future bridge condition outcomes.

GDOT works to ensure the state's transportation infrastructure is well-maintained, allowing residents and travelers across Georgia to enjoy a safe and sustainable transportation system that improves mobility and connectivity, and supports the state's growing population and economy. GDOT is confident in its robust lifecycle planning and effective financial decision-making. This is reflected in the current SOGR of the NHS system.

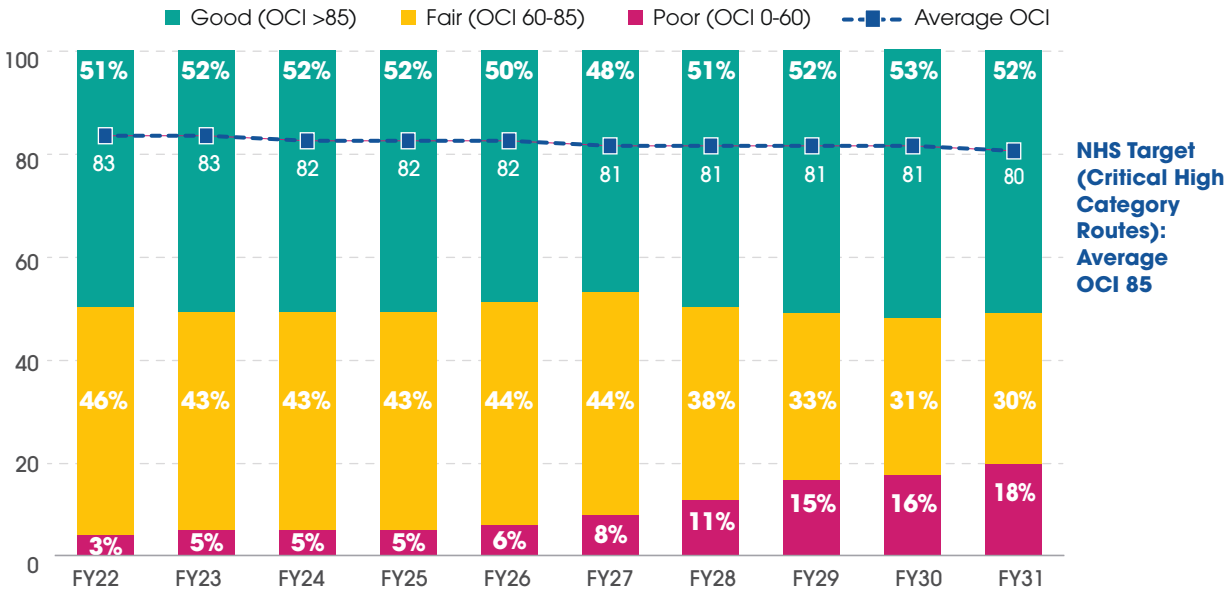
7.3 Performance Gap Analysis

Comparing the current condition of GDOT's NHS assets to performance targets identifies limited gaps.

Figure 25 compares NHS pavement conditions with OCI measures and targets over the 10-year period given the estimated funding levels and investment strategies presented in this TAMP. During this analysis period, percent of pavements in Poor condition increases from 3% to 18%, percent of pavements in Fair condition decreases from 46% to 30%, and percent of pavements in *Good* condition increases from 51% to 52%.

The target condition for these Critical and High Category routes is a system average OCI of 85. The current condition is 83 and that is expected to decline slightly over the 10-year analysis period to 81.

Figure 25 — *Predicted NHS Pavement Condition, OCI Measure (2022-2031)*



GDOT's PMS is configured to optimize future pavement conditions, under a given budget scenario, based on OCI measures. OCI is also the primary measure used by GDOT for reporting future pavement conditions. To forecast conditions in terms of the federal performance measures, GDOT applies the annual rate of change in forecasted OCI to the 2020 federal baseline conditions. **Figure 26** and **Figure 27** show the results of this forecast in terms of the federal measures for pavement condition for interstate and non-interstate NHS pavement.

In the 10-year analysis period Interstate pavement, conditions are expected to remain relatively stable. The percent of interstate pavement s in *Poor* condition is expected to increase from 0.3%

to 1.5%, the percent *Fair* is expected to decrease from 39.6% to 36.7%, and the percent *Good* is expected to increase from 60.1% to 61.8%. During the same analysis period, non-Interstate NHS pavement conditions are expected to decline slightly. The percent of non-Interstate NHS pavement in *Poor* condition is expected to increase from 1.2% to 5.94%, while the percent *Fair* decreases from 54.09% to 48.1%, and percent *Good* increases slightly from 44.71% to 45.97%.

Figure 26 — *Predicted Interstate Pavement Condition, NHPP Measure (2022-2031)*

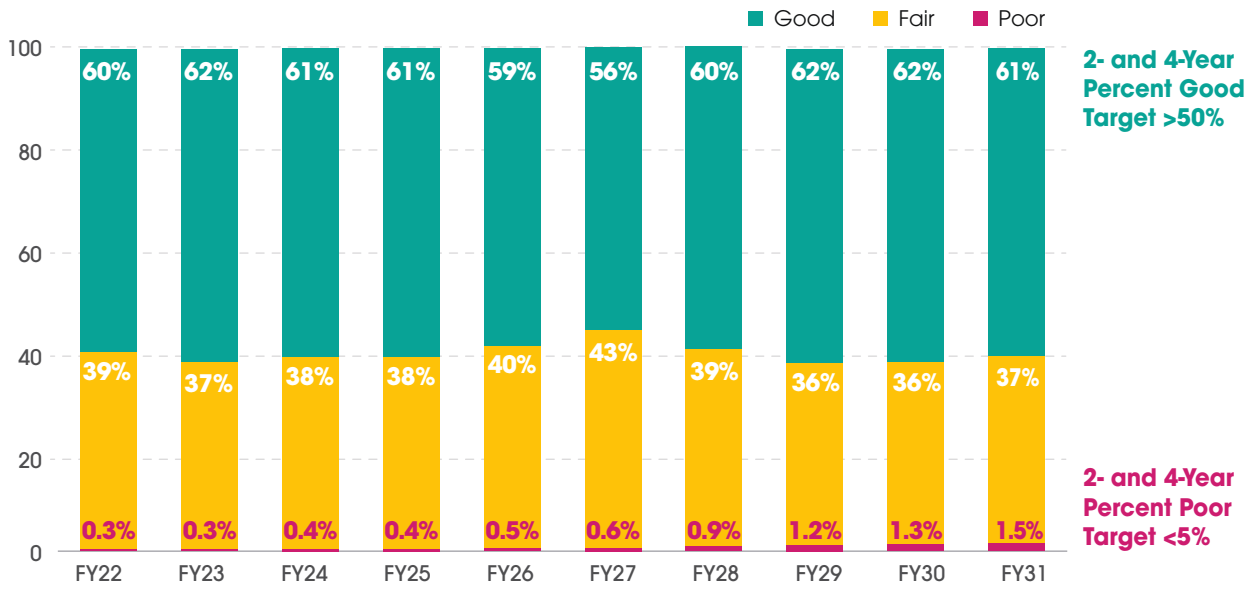


Figure 27 — *Predicted Non-Interstate NHS Pavement Condition, NHPP Measure (2022-2031)*

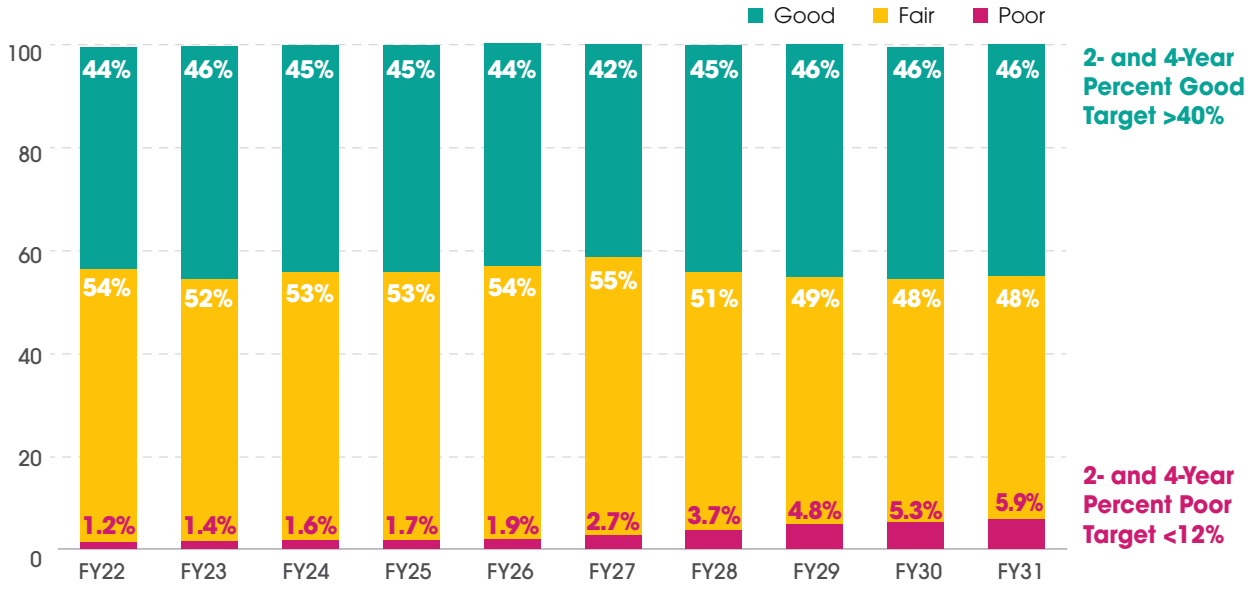
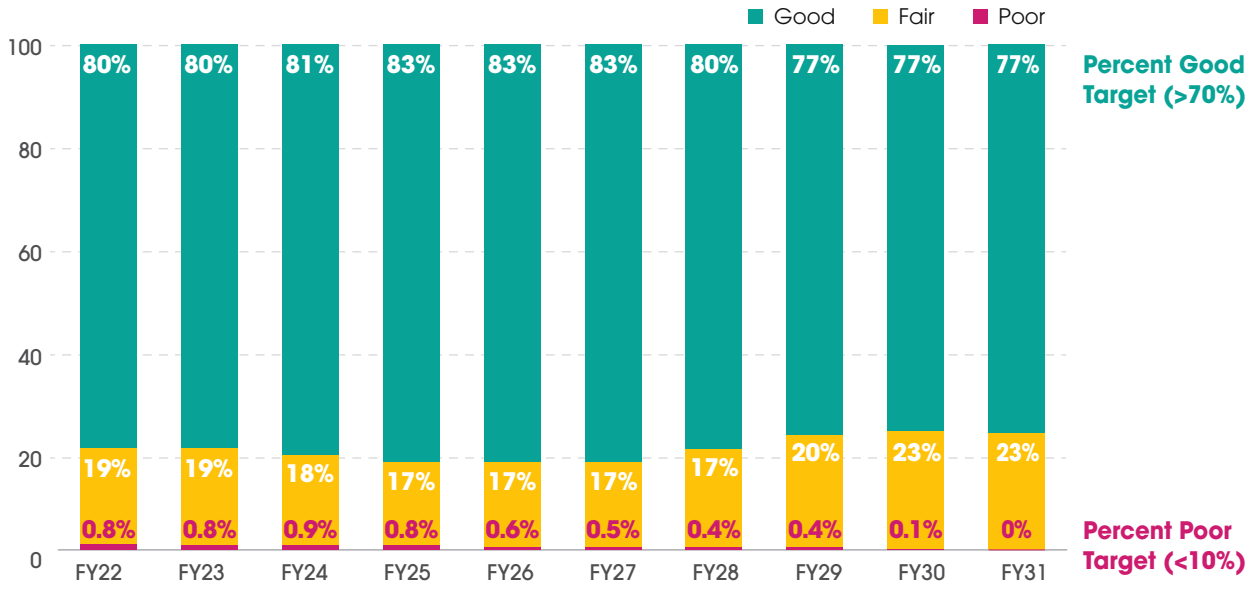


Figure 28 illustrates the predicted bridge condition over the 10-year period given the estimated funding levels and investment strategy presented in this TAMP (see **Table 13**).

In the 10-year analysis period bridge conditions are expected to remain relatively stable. The percent *Poor* decreases from 0.8% to 0%, the percent *Fair* is expected to increase from 19% to 23%, and the percent *Good* is expected to decrease from 80% to 77%.

Figure 28 — *Predicted NHS Bridge Condition (2022-2031) based on 2022 TAMP Investment Strategy*



GDOT recognizes the role that the condition of pavement and bridge assets have in the overall performance of the NHS. There are currently 13 structures on the NHS requiring load limit posting; of these, 10 are either currently under construction or in preliminary engineering and three are to be programmed in the upcoming year.

7.4 Performance Summary

GDOT is currently satisfying the federal requirement of having less than 5% of interstate pavements in poor condition and having less than 10% of total NHS bridge deck area in poor condition. GDOT is also meeting 2-year and 4-year targets for good and poor condition pavements and this performance can be maintained. The goal to maintain 70% of the bridge inventory in good condition can be met based on the investment strategy established in this TAMP.

The one gap that exists is the GDOT goal of achieving an average OCI of 85 for NHS pavements. The forecast of pavement performance indicates that GDOT's strategy of prioritizing preservation treatments to manage long-term conditions and costs, in combination with its route prioritization structure, will be successful in maintaining the percentage of GDOT's interstate and non-interstate NHS pavements rated in Good condition. However, funding is not adequate to deliver the needed level of rehabilitations and reconstructions to keep the percentage of pavements in Poor condition

from increasing. Shifting to a worst-first strategy that prioritized major work on poor pavements could provide a short-term solution. However, due to the significantly fewer lane-miles of pavement that can be rehabilitated versus preserved, within the same budget, the long-term implications would be even greater deterioration than the current strategy.

If funding remains as defined within this TAMP, then GDOT will continue to meet federal condition performance requirements.

Appendix A
Pavement Inventory by Ownership

NHS Pavement Inventory by Ownership

Appendix A-1 — *County-owned NHS Pavements*

County	Centerline Miles	Lane Miles
021 - Macon-Bibb County	7.07	21.0
051 - Chatham	20.08	73.2
059 - Athens-Clarke County	1.77	7.3
063 - Clayton	0.64	4.0
067 - Cobb	18.79	83.3
073 - Columbia	3.82	7.6
089 - DeKalb	17.71	68.0
095 - Dougherty	3.12	7.9
097 - Douglas	3.20	6.4
107 - Emanuel	0.59	1.4
115 - Floyd	1.46	2.9
127 - Glynn	0.86	1.8

County	Centerline Miles	Lane Miles
135 - Gwinnett	50.11	218.1
143 - Haralson	0.07	0.1
153 - Houston	8.19	32.8
215 - Columbus-Muscogee County	21.14	71.3
217 - Newton	3.51	7.0
219 - Oconee	0.98	3.9
225 - Peach	0.07	0.3
245 - Augusta-Richmond County	25.83	95.7
247 - Rockdale	3.27	11.1
255 - Spalding	1.61	3.2
277 - Tift	0.22	0.4
299 - Ware	6.65	13.3
313 - Whitfield	4.38	8.8
City NHS	149	500

Appendix A-2 — *Municipality-owned NHS Pavements*

Municipality	Centerline Miles	Lane Miles
0410 - Albany	14.52	55.8
0460 - Alpharetta	1.13	4.0
0650 - Atlanta	14.93	46.1
1230 - Brunswick	4.78	18.0
1330 - Calhoun	0.29	1.1
1510 - Cedartown	3.88	8.2
1580 - Chamblee	1.34	5.4
1820 - College Park	1.62	5.3
1920 - Conyers	3.29	6.9
2040 - Cumming	1.79	3.7
2110 - Dalton	3.38	11.9
2220 - Decatur	0.81	1.6
2350 - Doraville	0.98	2.0
2370 - Douglasville	0.64	2.1
2410 - Duluth	4.22	18.8
2480 - East Point	2.07	7.2
2700 - Fairburn	0.61	1.2
2820 - Forest Park	0.52	1.0
2860 - Fort Valley	0.08	0.3
2930 - Garden City	0.42	1.1
3140 - Griffin	0.72	2.3
3170 - Grovetown	0.29	0.6

Municipality	Centerline Miles	Lane Miles
3710 - Kennesaw	0.17	0.7
4170 - Marietta	0.96	3.9
4250 - Mcdonough	0.97	2.1
5330 - Port Wentworth	1.55	3.1
5350 - Porterdale	0.10	0.2
5780 - Saint Marys	6.25	23.0
5850 - Savannah	35.53	118.7
6010 - Smyrna	2.36	9.4
6300 - Swainsboro	2.97	5.9
6480 - Thomasville	5.41	17.5
6710 - Valdosta	3.88	12.8
6860 - Warner Robins	9.38	37.7
6920 - Waycross	3.15	6.1
7420 - Sandy Springs	3.49	14.6
7430 - Johns Creek	4.42	19.1
7450 - Chattahoochee Hills	1.80	3.6
7460 - Dunwoody	0.62	4.5
7480 - Tucker	3.39	13.6
7490 - Stonecrest	0.29	1.0
SRS	17,923	49,490

Appendix B

Bridge Inventory by Ownership

NHS Bridge Inventory by Ownership

Appendix B-1 — *County- and City-Owned NHS Bridges*

	County-Owned		City-Owned	
County	Deck Area (sq.ft.)	Number of Structures	Deck Area (sq.ft.)	Number of Structures
015 - Bartow	11,516	1	-	-
021 - Bibb	83,433	4	-	-
039 - Camden	1,729	1	14,069	2
051 - Chatham	788,175	32	762,013	18
059 - Clarke	11,117	1	12,152	1
063 - Clayton	3,535	2	-	-
067 - Cobb	520,535	18	-	-
089 - DeKalb	54,952	5	-	-
095 - Dougherty	12,607	2	4,605	4
107 - Emanuel	-	-	544	1
121 - Fulton	-	-	126,091	12

	County-Owned		City-Owned	
County	Deck Area (sq.ft.)	Number of Structures	Deck Area (sq.ft.)	Number of Structures
135 - Gwinnett	320,528	26	-	-
151 - Henry	61,898	2	-	-
153 - Houston	39,330	3	37,148	3
215 - Muscogee	33,419	3	120,696	3
217 - Newton	24,799	4	-	-
219 - Oconee	17,433	1	-	-
233 - Polk	2,892	3	32,138	3
245 - Richmond	47,678	3	-	-
247 - Rockdale	41,500	1	-	-
255 - Spalding	7,430	1	-	-
269 - Taylor	9,370	1	-	-
299 - Ware	5,999	2	-	-
313 - Whitfield	6,608	3	15,299	1