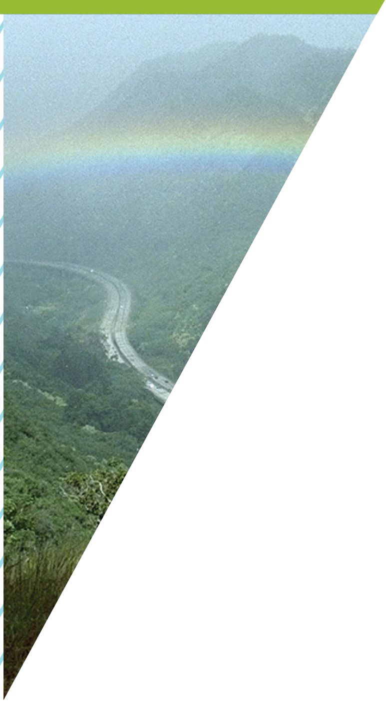
DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII



HAWAII

Statewide Transportation Asset Management Plan

February, 2024

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DEPARTMENT OF TRANSPORTATION
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The State of Hawaii Department of Transportation (HDOT) is pleased to present its July 2023 update to the Transportation Asset Management Plan. The HDOT remains committed to its mission and to preserving the investment it has made in its infrastructure. This Plan provides a solid foundation for making informed pavement and bridge infrastructure planning and programming decisions for the next 10 years. The benefits of this present-day Transportation Asset Management Plan are critical in developing a process for the State to achieve and sustain a state of good repair over the life cycle of its pavement and bridge assets.

Pavement and bridge infrastructure provide the central transportation network that allows for the efficient movement of people, goods, and services on each of our islands. If the transportation system cannot keep up with demand, we feel the effects in our schedules, our pocketbooks, and throughout our daily lives. This infrastructure needs regular maintenance and preservation activities to help it last longer and enable us to receive the most value from our transportation dollars.

The HDOT uses a data-driven, risk-based approach to asset management. Our Pavement Management System and Bridge Management System help to ensure that the right treatment is applied at the right time. The management systems optimize the asset condition and lowest practical life cycle to prioritize the right projects and best manage the transportation system. With this update, the Management Systems and the Plan incorporate resilience measures to increase the resiliency of the transportation system to existing and future risks.

This Transportation Asset Management Plan, as required by the Fixing America's Surface Transportation Act, describes those processes and formally defines HDOT's framework for asset management. Further, it projects needed levels of future investment to meet asset condition targets, contrasted with expected funding levels. This Plan evokes an important conversation regarding funding for a sustainable transportation system and allows a strong future for the State to provide it. We will also continue our collaborative efforts statewide to be resilient and meet our future needs.

In addition, this Transportation Asset Management Plan is available online at the HDOT's Highway webpage (http://hidot.hawaii.gov/highways/).

Sincerely,

EDWIN H. SNIFFEN
Director of Transportation

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CHAPTER 1

Introduction

Overview

> The HDOT's mission is to provide a safe, efficient, accessible, and sustainable inter-modal transportation system that ensures the mobility of people and goods and enhances or preserves economic prosperity and the quality of life. To this end, the TAMP establishes and documents policies and processes to guide the efficient use of Hawaii's resources for infrastructure investments in a data-driven, performance-based, and risk-based approach that is transparent and defensible.

The Hawaii Department of Transportation (HDOT) is responsible for planning, designing, constructing, operating, and maintaining transportation assets in the state of Hawaii that are under the HDOT's jurisdiction. Maintaining the National Highway System (NHS) is a top priority for the HDOT because of its vital contribution towards the economy, national security, and mobility and because the pavements and bridges of the NHS represent the HDOT's two largest land transportation assets.

Transportation asset management is a process to systematically manage transportation infrastructure through the asset's life cycle, in a cost-effective way. The Moving Ahead for Progress in the 21st Century Act (MAP-21), signed into law in July 2012 and codified in Title 23 United States Code (U.S.C.) 119, requires all states to develop and implement a risk-based Transportation Asset Management Plan (TAMP) that provides strategies to achieve national goals and state-established condition and performance thresholds for the NHS. The Fixing America's Surface Transportation Act (FAST Act), which was signed into law in December 2015, continued the TAMP requirements. The recent Bipartisan Infrastructure Law (BIL), signed on November 15, 2021, changes Title 23 U.S.C. 119 (e)(4) to require the consideration of extreme weather and resilience as part of the life cycle planning and risk management analyses within the state TAMP.

What is the TAMP?

A TAMP is a document that outlines a 10-year investment strategy for preserving existing assets. This plan facilitates the documentation of current system conditions, condition targets, risk evaluation, and guidance for transportation investment decision-making.

This TAMP focuses on pavement and bridges on the NHS to meet the requirements specified in 23 *Code of Federal Regulations* (CFR) Part 515. The HDOT will consider additional assets for future inclusion into the TAMP as additional data are collected, processes are enhanced or developed, TAMP operational funding is secured, and an adequate organizational structure is further established. Statewide, HDOT Highways is responsible for multiple assets, which include pavement, bridges, drainage (structures and culverts), tunnels, highway lighting, overhead signs, traffic signals, transportation management systems (including interconnect fiber), sidewalks, guard rails, pavement markings, office buildings, maintenance yards, and other transportation-related facilities.

The TAMP is organized as follows:

- **Chapter 2** outlines the proposed TAMP approach and process.
- **Chapter 3** documents current asset conditions.
- **Chapter 4** establishes asset performance measures and targets.
- **Chapter 5** evaluates risks that could impact the system condition and shows how resiliency is incorporated.
- **Chapter 6** identifies available funding.
- **Chapter 7** documents life cycle planning strategies.
- **Chapter 8** recommends investment strategies.
- **Chapter 9** identifies areas of potential improvement in asset management.

> Transportation asset management is defined by FHWA as 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 life cycle of the assets at minimum practicable cost."

Hawaii's Transportation System

The state of Hawaii includes eight major islands, six of which are permanently inhabited and have functionally classified roadways. The statewide transportation system is approximately 9,803 lane-miles. The federal-aid system, which consists of interstates, arterials, and collectors, is 40 percent of the entire system. Statewide, there are 1,124 bridges in total, with a total deck area of approximately 14,516,076 square feet.

Island State

Hawaii is the 50th and most recent state to join the United States, having joined on August 21, 1959, and is the only state composed entirely of islands. The state's eight major islands are Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and the island of Hawaii. The last, the largest island in the group, is often called the Big Island or Hawaii Island to avoid confusion with the state as a whole.

Ninole Bridge on Hawaii Island

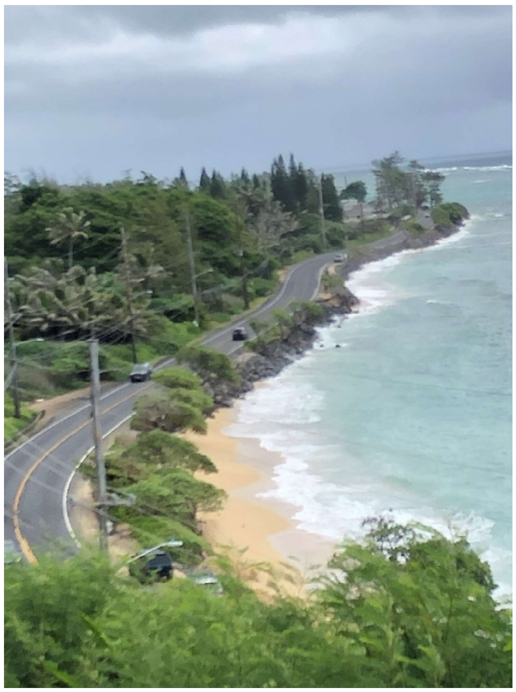
The Hawaiian Islands are home to more than 1.46 million people and draw over 9 million visitors each year. Hawaii's population is expected to grow to 1.65 million by 2045; this rise in population will bring greater pressure on natural resources and increasing demand on the transportation system.[1] The state's coastline is about 1,052 miles long, the 18th-longest in the U.S.[2]

[1] DBEDT. 2018. Population and Economic Projections for the State of Hawaii to 2045.

[2] WorldAtlas.com. 2020. US States With The Longest Coastlines. Geography. September 8. https://www.worldatlas.com/articles/us-states-by-length-of-coastline.html.

Uniqueness of Hawaii's Roadway System

All of Hawaii's islands are of volcanic origin, and as such, many of the islands feature one or more mountains or mountain ranges in the interior sections of the island, with flatter eroded topography along the coastline. Most of the major roadways that provide vehicular connectivity and mobility are constructed on these flatter coastline sections. On the islands of Hawaii and Maui, roadway systems completely encircle the island, forming a belt road or beltway. For other islands, roadways systems may encircle only a portion of the island, or roadways may continue along the coastline and end at some point, providing only one-way major access to communities.



Typical belt, shoreline road on the windward side of Oahu

Unlike other parts of the U.S., the useable land area in Hawaii is very limited. Many of the roadways are confined by developments abutting the facilities or by natural topographic features. Expansion of existing facilities or constructing alternative routes are cost-prohibitive and come with significant environmental impacts. In addition, the high cost of construction is exacerbated by the limited resources (including materials and labor) on the islands. Each island has its own unique roadway system, vital to that island.

Hawaii's existing functional classification system is like that of the rest of the U.S.; however, because of island geography and topography, Hawaii significantly relies on belt roads around the islands more so than the mainland. The functional classification of these belt roadways is either principal arterials on the NHS or minor arterials.

Because of the limited roadway options, the NHS serves many functions in many areas. The reliance on the NHS and the constrained geography increases traffic and congestion on roadways designated as arterials. Many of these belt roadways carry a large volume of traffic and serve as the primary means to transport freight and goods and are essential to the well-being of the communities they serve. Furthermore, there can be significant adverse effects to those communities in the event of an emergency road closure or utility construction closure, or other unplanned incidents on the roadway system.

As the primary road, the arterials also serve as both collectors and local roads, with small roads and driveways connecting directly to the principal arterial. Conversely, there are roadways on the smaller islands or in other areas that are isolated from the remaining parts of the state. These roads may not meet the specific criteria for a given classification, but still operate as an arterial or collector because they provide primary access.

Unique Challenges in Hawaii

Because of its location in a tropical zone, predominant coastal environment, and geologic and topographic factors, there are many challenges to Hawaii and its land transportation system. Hawaii's dependence on imported supplies, along with its geographic isolation, presents additional challenges when considering construction resources and emergency recovery and response factors. In addition to these local factors, global warming and sea level rise (SLR) also present significant challenges to Hawaii.

> Resilience is the ability to adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. *(HDOT Highways definition, December 20, 2019)*

These challenges are important considerations in the HDOT's life cycle planning and risk register. As the emphasis on transportation asset management continues to grow and the HDOT works on formalizing processes and policies, tough decisions will need to be made about preserving assets that are subject to climate change and natural disasters.

The Existing System

The NHS is a subset of the entire roadway system. It provides an interconnected system of freeway and principal arterial routes that serve population centers, ports, airports, military bases, public transportation facilities, and other intermodal transportation facilities and major travel destinations; meet strategic national defense requirements; and serve interregional travel. With Hawaii being an island state, although there are no interstate or international border crossings, the NHS remains vital infrastructure providing service to the state. The non-NHS assets are considered to be the remainder of the statewide roadway system.

Six of the eight major islands contain functionally classified roadways, and four of those islands include NHS routes: Hawaii, Maui, Oahu, and Kauai. These NHS roadways are under both State and County jurisdictions, as shown on Figure 1.1. The islands of Molokai and Lanai have both State and County roads (none of which are on the NHS). The islands of Niihau and Kahoolawe do not have any roads under the jurisdiction of the HDOT or individual county public works departments. The breakdown of NHS pavement and bridges compared to the statewide system is shown in Table 1.1 and on Figure 1.2.

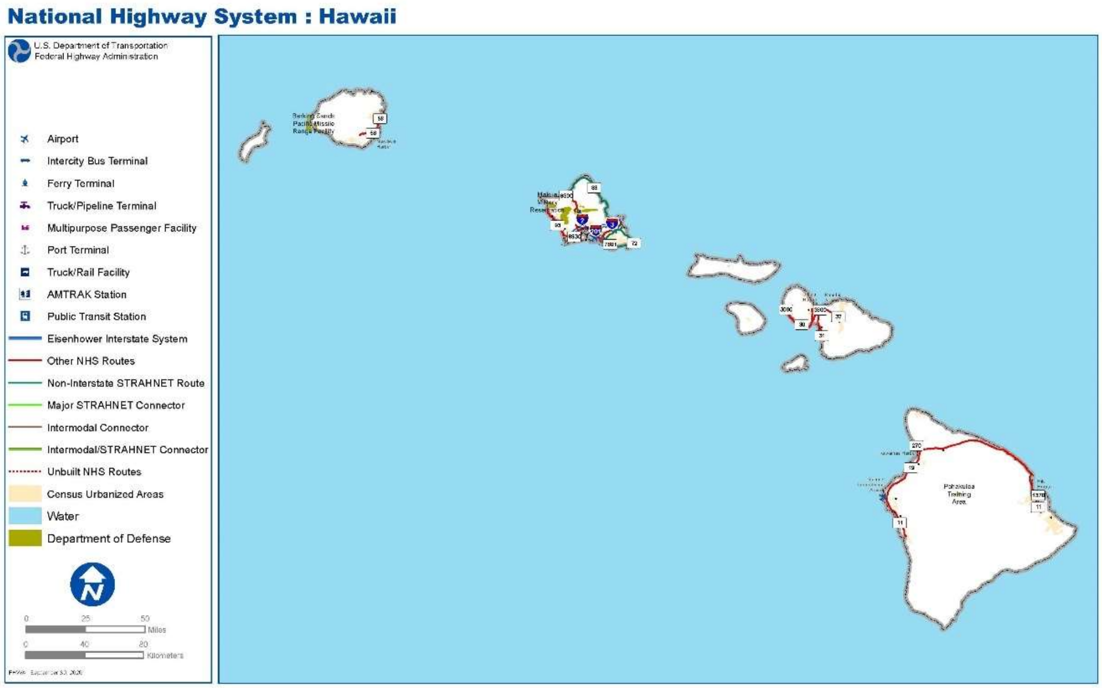


Figure 1.1. National Highway System

Source: http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/hawaii/hi_hawaii.pdf

Table 1.1. Statewide NHS vs. Non-NHS Pavement and Bridges

NHS Pavement	1,496 lane-miles
Non-NHS Pavement	8,307 lane-miles
NHS Bridges	511 bridges (12,078,704) square feet of deck area)
Non-NHS Bridges	613 bridges (2,437,373 square feet of deck area)

Source: HDOT, pers. comm. 2022

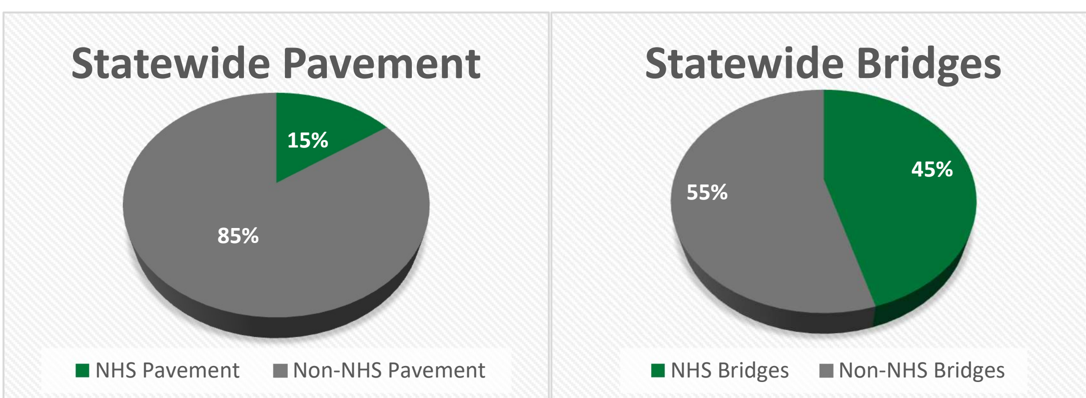


Figure 1.2. Percentage of NHS Pavement and Bridges on the State Land Transportation System

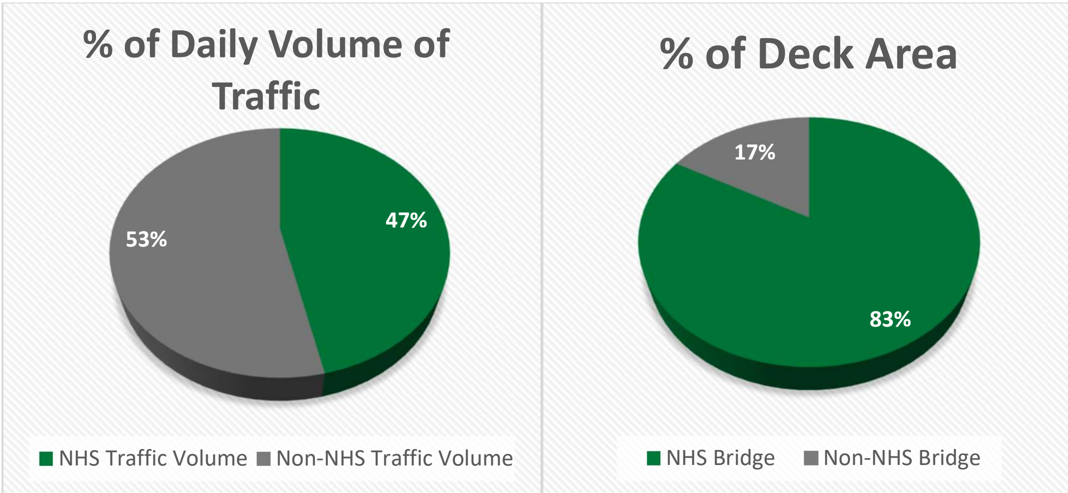


Figure 1.3. Daily Volume of NHS vs. non-NHS Traffic and Deck Area

Although only 15 percent of the state's entire land transportation system is part of the NHS, those roads carry close to 47 percent of the daily volume of traffic, as shown on Figure 1.3. Similarly, the number of bridges that are on the NHS is 45 percent of the total number of bridges; however, the deck area of the NHS bridges is 83 percent of the total, as shown on Figure 1.3.

Local Jurisdictions

There are five counties and two metropolitan planning organizations (MPOs) in the state of Hawaii, and four HDOT districts. Counties in Hawaii are the only legally constituted government bodies below state level. Honolulu is governed as the City and County of Honolulu, a county that covers the entire island of Oahu. Table 1.2 and Figure 1.4 show a breakdown of the jurisdictions in the state.

Table 1.2. Jurisdiction Breakdown

State	City/County	Island
HDOT Kauai District	County of Kauai	Kauai, Niihau [a]
HDOT Oahu District	City and County of Honolulu	Oahu
HDOT Maui District	County of Maui	Maui, Lanai, Molokai, [b] Kahoolawe [a]
	County of Kalawao [a]	Molokai
HDOT Hawaii District	County of Hawaii	Hawaii

[a] There are no state roads within this island or county.
[b] With the exception of the Kalaupapa peninsula on Molokai, which is the County of Kalawao
Note: There are also two MPOs within the state: OahuMPO comprises the entire island of Oahu and the Maui MPO comprises the entire island of Maui.

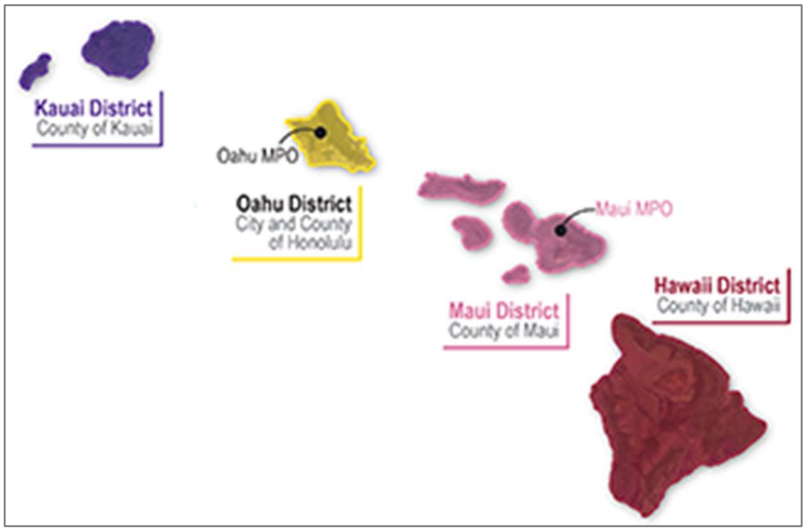
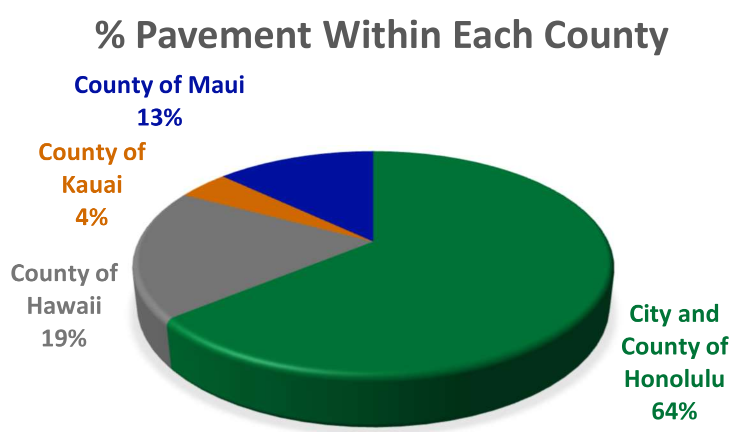


Figure 1.4. Jurisdiction Map in the State of Hawaii

Figure 1.5 shows the breakdown of all pavement and bridges (State and County jurisdictions) within each county.



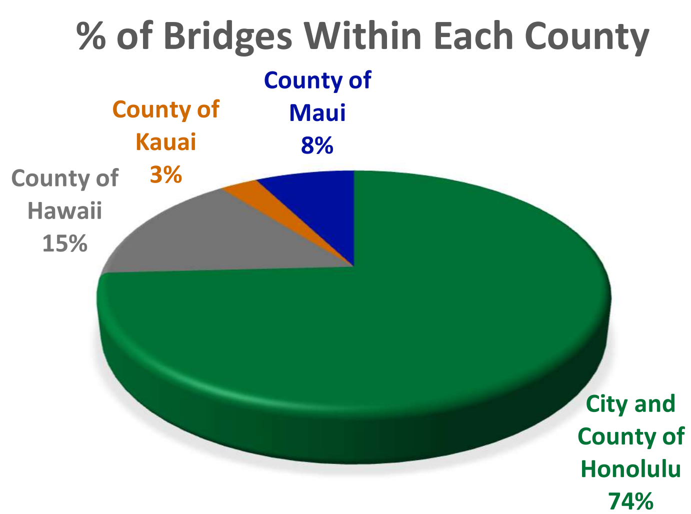


Figure 1.5. Percentage of Pavement and Bridges in each County

CHAPTER 2

Asset Management Approach and Process

Asset management is an integrated set of processes to minimize the life cycle costs of owning and cost-effectively operating and maintaining assets. Asset management provides data-driven answers to the question of how to operate and maintain assets while accepting some level of risk and meeting the level of service the traveling public expects. The HDOT's executive leadership is committed to implementing asset management initiatives for the state's roadways so that valuable resources can be effectively used to provide maximum benefits to the people of Hawaii.

Asset Management uses data analyses to compare processes and results against desired results and performance goals and targets.

Federal Requirements

MAP-21 contains requirements for the development of TAMPs that include strategies leading to a program of projects that would make progress toward achieving the state targets for asset condition and performance of the NHS. MAP-21 requires a TAMP to include, at a minimum, the following seven components:

- A summary listing of the pavement and bridge assets on the NHS and a description of their condition
- Asset management objectives and measures
- Performance gap identification and analysis
- Risk management analysis
- Life cycle planning analysis
- A financial plan
- Investment strategies

The FAST Act was signed into law in December 2015 and includes provisions to (1) make the federal surface transportation system more streamlined, performance-based, and multimodal and (2) address challenges facing the U.S. transportation system. This includes improving safety, maintaining infrastructure condition, reducing traffic congestion, improving the efficiency of the system and freight movement, protecting the environment, and reducing delays in project delivery. The FAST Act builds on the changes and requirements of MAP-21 as they relate to asset management.

The BIL, signed on November 15, 2021, focuses on a significant investment in our nation's roads and bridges, promoting safety for all road users, helping to combat climate change, and advancing equitable access to transportation. The BIL encourages projects that build a better America and changes Title 23 U.S.C. 119 (e)(4) to require the consideration of extreme weather and resilience as part of the life cycle planning and risk management analyses within the state TAMP.

Governance

Asset management is viewed as a way of doing business, and organizational culture may be one of the most significant obstacles to advancing asset management in an agency. Implementation of the TAMP requires coordinated business processes between the HDOT's districts and branches to successfully achieve the performance goals and objectives.

Development of this TAMP has provided the opportunity to improve coordination between the HDOT's maintenance, preservation, and capital programs, as well as the Planning and Design offices, Materials and Testing Laboratory (Lab), and individual district offices. To emphasize the HDOT's commitment to asset management, an Asset Management Leadership Team to guide the implementation of asset management throughout the HDOT and to monitor the progress at every step was created.

The enhanced organization structure brings greater clarity to the process, better identifies the roles and responsibilities at each level, and brings new parties to the process. The Asset Management Leadership Team works to achieve the TAMP goal and objectives as follows.

HDOT TAMP Goal

Provide a process to achieve and sustain a state of good repair over the life cycle of the assets and to improve and preserve the condition of the state's transportation assets.

The **HDOT's objectives** are as follows:

- Implement plans and projects to support the transportation asset management process
- Establish data governance and data collection standards
- Facilitate coordination, collaboration, and knowledge transfer within the team
- Communicate the transportation asset management activities to the executive levels of the HDOT
- Pursue the solicitation and promotion of asset management best practices
- Promote transportation asset management benefits and uses throughout the HDOT, counties, and other external stakeholders

The Asset Management Leadership Team is supported by the activities of various subgroups, as highlighted on Figure 2.1.

Figure 2.1. Asset Management Leadership Team Subgroup Organization

The Approach

Consistent with best management practices, this TAMP uses a data-driven, performance-based, and risk-based approach that does the following:

- Guides decisions that are consistent with overarching national and state policies and goals
- Uses a technical and data-driven process based on quality information
- Evaluates assets using performance-based targets
- Considers the life cycle of assets to develop preservation and investment strategies
- Considers resiliency in the life cycle of assets and as part of the HDOT's risk register
- Tracks progress in a long-term, ongoing, and collaborative process
- Is transparent and defensible

The Leadership Team is led by the Highways Administrator, who serves as TAMP leader, and includes representatives of the HDOT's major branches. Comprehensive asset management requires a full team effort and important input and participation from all of the technical branches. Figure 2.2 further breaks down the roles and responsibilities of asset management at the HDOT, as well as the inclusion of the City and County of Honolulu and the MPOs (OahuMPO and the Maui MPO). As reflected in Chapter 3, the City and County of Honolulu is the only jurisdiction that owns and maintains a portion of the NHS, other than the HDOT.

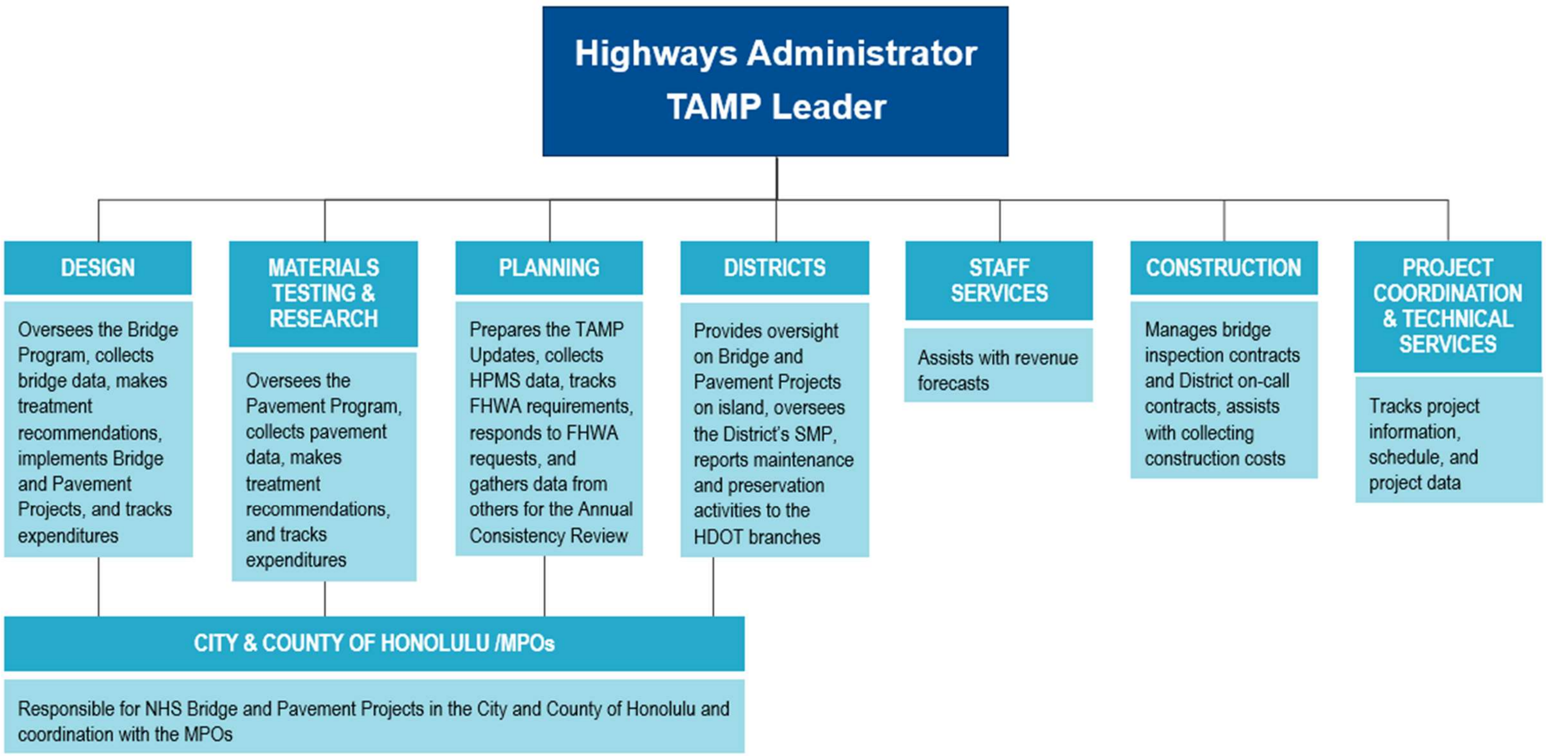


Figure 2.2. Asset Management Roles and Responsibilities by Branch/Agency

The Process

The TAMP will use a data-driven and technical process that will objectively guide investment decisions to operate, maintain, and improve transportation assets, and will justify the HDOT's funding needs. The data collection and technical evaluation will be conducted in an ongoing and iterative process of activities, as shown on Figure 2.3 and described in this section.

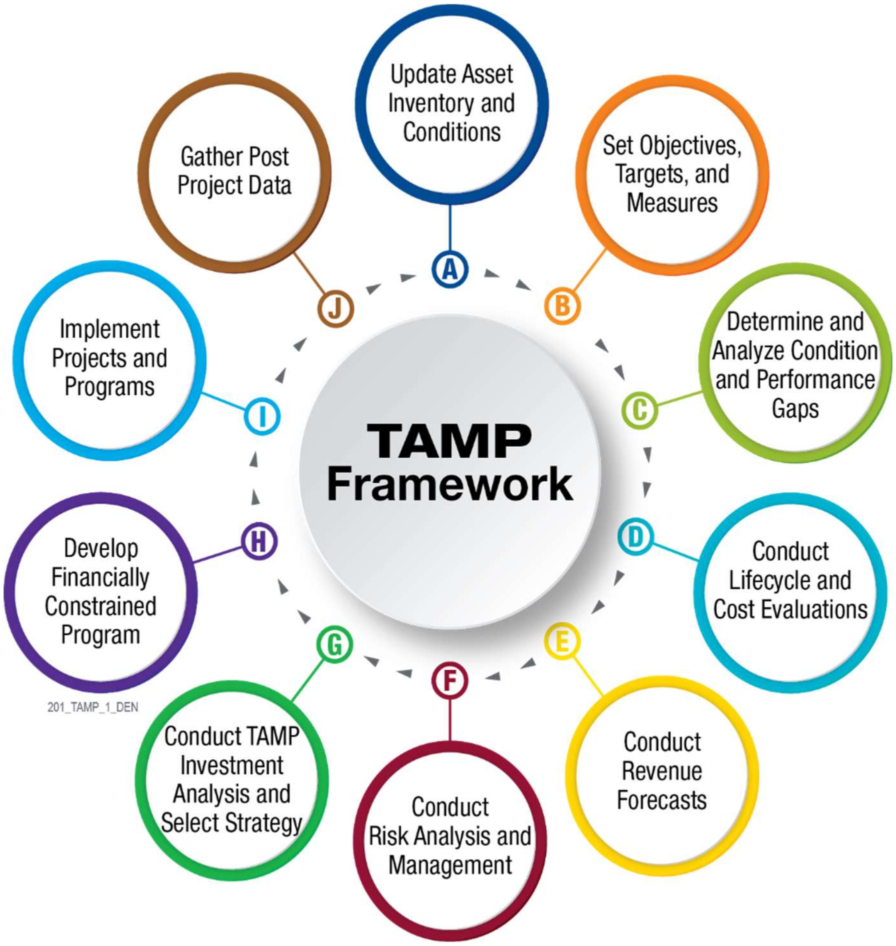


Figure 2.3. HDOT TAMP Framework and Activities

A. **Update Asset Inventory and Conditions**

- What assets do we have?
- What are the current conditions of the assets?
- How well are they performing?

B. **Set Objectives, Targets, and Measures**

- What are the objectives of the TAMP?
- What is the desired state of repair?
- How will it be measured?

C. **Determine and Analyze Condition and Performance Gaps**

- What and where are the differences between actual and desired conditions?
- What are the differences between asset types?

D. **Conduct Life Cycle and Cost Evaluations**

- What is the expected life of the assets?
- How will the assets depreciate and decline in value and state of good repair?
- Are the assets located within the HDOT's hazard zone?
- When will repairs or treatment be necessary to prevent assets from slipping from one level of maintenance to the next?
- What is the cost of the appropriate level of maintenance?

E. **Conduct Revenue Forecasts**

- What is the current revenue and sources?
- What factors might affect revenues in the future?
- How much money can we reasonably expect?
- What are the present inflation rate assumptions and future purchasing power?

F. **Conduct Risk Analysis and Management**

- What are the threats and risks that may prevent achieving desired goals?
- What are the strategies to avoid, minimize, mitigate, and manage risks?

G. **Conduct Investment Analysis and Select Strategy**

- What are the best investment strategies?
- What is the minimum life cycle cost of the assets?
- What life cycle treatment types can be considered?
- What is the cost of treatment type?
- What risks should be considered?
- Identify investment scenarios and select an investment strategy
- Perform gap analysis

H. **Develop Financially Constrained Program**

- Which projects from the pavement and bridge management systems should be carried forward to the Mid-Range Transportation Plan (MRTP)?
- Make cross-asset comparisons and decisions between the range of HDOT's programs

I. **Implement Programs and Projects**

- Programming in the MRTP and Statewide Transportation Improvement Program (STIP)
- Monitoring costs and schedules
- Performing improvements

J. **Gather Post-Project Data**

- How are we doing?
- Gather data related to estimated vs. actual costs
- Update management systems and long-range plans with data

Figure 2.4. Plan-Do-Check-Act Process

Much like every Plan-Do-Check-Act process, as shown on Figure 2.4, the TAMP process starts all over again to ensure the best investments are being made. As operational budgets are planned for and secured, reorganizations are implemented, additional data are collected and made available, and data systems are enhanced or established, the HDOT will incorporate other relevant asset data into the TAMP as the program matures. Time is needed to further research and evaluate the availability of existing data and challenges in the extraction and conversion of such data into a new or enhanced data system, and then to determine additional data needs and develop budgetary and implementation timeline estimates. These will be presented in future updates to the TAMP.

Integration of the TAMP into HDOT Highways Planning and Programming Components

System preservation has been a priority for the HDOT for many decades, and starts at the top. Figure 2.5 depicts the HDOT's family of plans and the relationship with the Hawaii Statewide Transportation Plan (HSTP), which provides overarching policy to implementation of transportation plans and programming components. The HSTP focuses on broad policy, goals, and objectives for the three primary modes of transportation—air, water, and land systems—as well as nonmotorized modes and intermodal connections. The HSTP has an infrastructure goal emphasizing maintenance of its assets.

The highway statewide system plan provides overarching goals and ensures equity and consistency among the regional or county plans. Each of these plans identifies needs and potential solutions to address those needs. The Statewide Land Transportation Plan also has an infrastructure goal emphasizing the maintenance of highway assets, further prioritizing the need for system preservation.

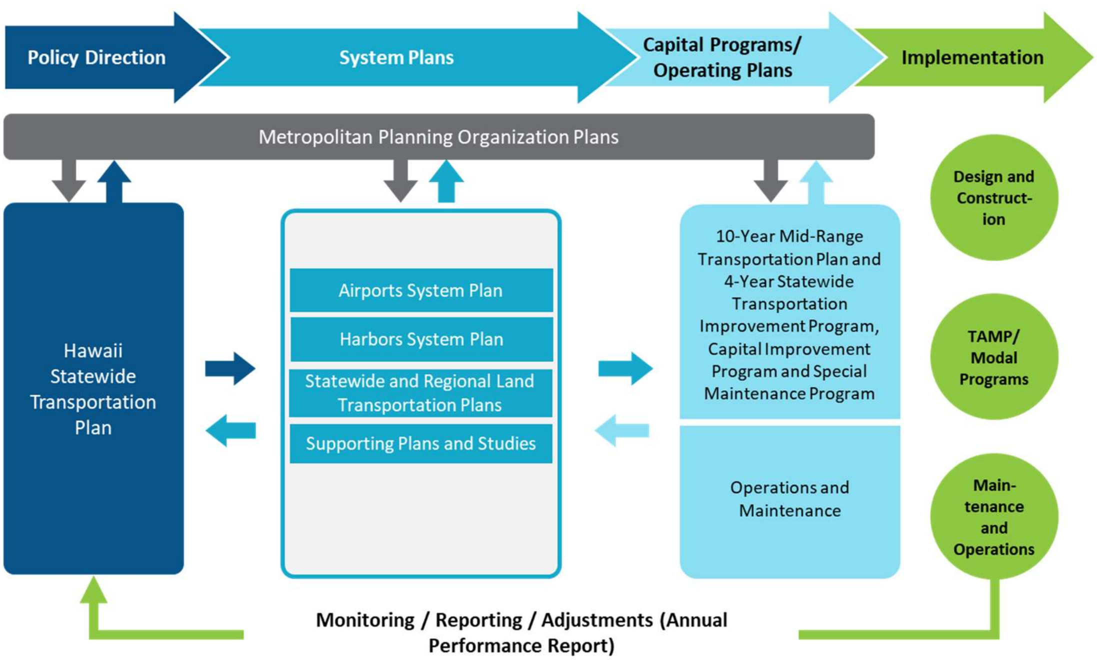
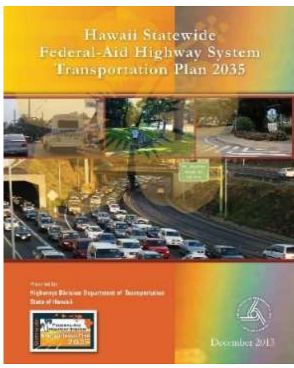


Figure 2.5. HDOT's Family of Plans

In the Statewide Federal-Aid Highway System Transportation Plan 2035, the HDOT committed 65 percent of its program needs to safety and preservation. The Statewide and Regional plans and the HDOT primary programs (that is, pavement, bridge, rockfall, shoreline, traffic safety, and congestion) identify priorities and program that feed into the HDOT's MRTP. The MRTP provides the bridge between the 20-year long-range transportation plans (LRTP) and the HDOT's 4-year STIP and 2-year Capital Improvement Program (CIP). The MRTP has a 10-year planning horizon and evaluates the projects against the State's goals and objectives, priorities, and project readiness. A cross-asset/program evaluation and prioritization is conducted.

> ***Infrastructure***
>
> **HSTP Infrastructure Goal:**
> Provide a high-quality, well-maintained multimodal system



> **Hawaii Statewide Federal-Aid Highway System Transportation Plan 2035 Goal 3.1:**
> Manage transportation assets and optimize investments.

To show the importance of asset management and how it is further integrated into the HDOT's planning and programming process, the MRTP evaluates whether a project is improving pavement and bridge conditions. The project receives additional evaluation points if the project is on the NHS and the roadway is used by many (that is, if it has a higher amount of annual average daily traffic). The MRTP allows the HDOT to:

- Better guide HDOT's project development;
- Assist in investment decision making and trade off analysis;
- Assess and rank projects based on the extent to which projects meets HDOT's multiple goals;
- Build credibility, by providing objective, transparent documentation of a data-driven, consistent approach;
- Facilitate coordination with Districts/Partners;
- Be transparent and accountable; and
- Maximize return on investment, by right-sizing projects.

The prioritized projects on the MRTP are programmed in the STIP, Transportation Improvement Plans (TIP), CIP, and Special Maintenance Program (SMP), and are then implemented. This process ensures that all of the investments made in programming are consistent with the HDOT's long-term vision and goals. Figure 2.6 shows the evaluation of the long-range transportation goal to project delivery and how asset management is fully integrated.

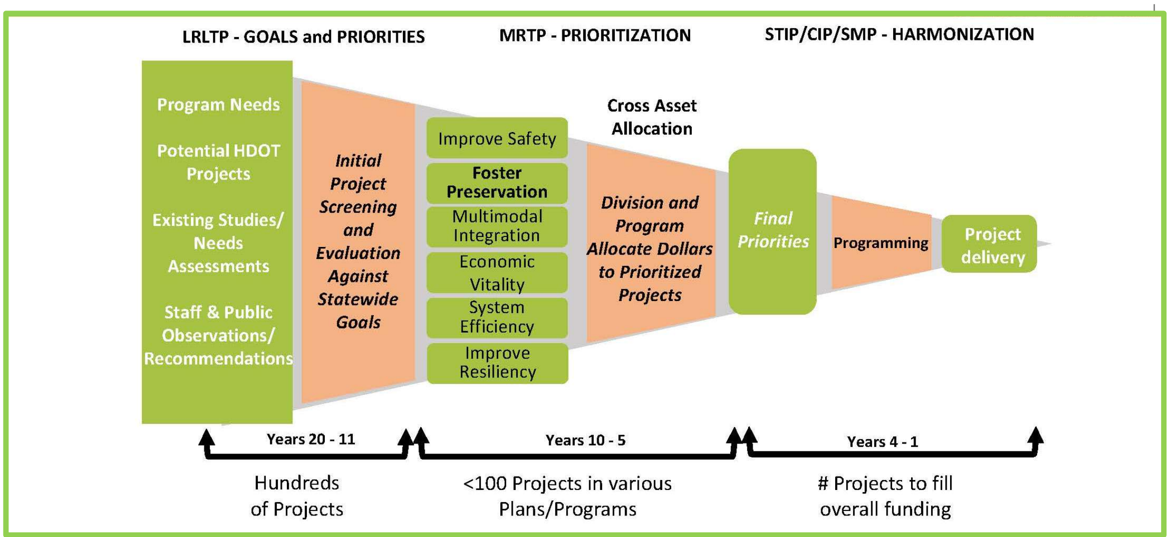


Figure 2.6. HDOT Programming Process

Figure 2.7 reflects an overview of this process – the HDOT Highway Division's Planning and Programming Process. It starts with the LRTP, where a 20-year forecast is conducted and needs are assessed. With the LRTP, programs and projects are prioritized, funding is forecasted, and the funding gap is identified. The next step is to further develop those programs (for example, the bridge and pavement programs), update modal plans (such as the bicycle, pedestrian, and freight plans) and the TAMP. Out of these plans and programs, the HDOT program managers submit their 10-year plan and prioritized projects to the MRTP. As mentioned previously, projects placed on the MRTP feed into the STIP, TIP, CIP, and SMP, and are then implemented. Monitoring and feedback from implementation, maintenance, and operations go back to the plans, creating a continuous feedback loop of data and process improvements.

Figure 2.7. Implementation from Long-Range Plan to Mid-Range Plan to STIP

CHAPTER 3

Inventory and Condition

Overview

Information is necessary to develop a robust TAMP. To have a data-driven, performance-based, and risk-based TAMP, asset inventory and condition data are needed. These data provide the foundation for supporting asset management process, such as life cycle planning, prioritizing projects, and determining future needs.

As mentioned earlier, the HDOT has a lot of assets to maintain and manage. This TAMP is focused on NHS pavement and bridges, critical transportation infrastructure that is vital for Hawaii’s economy and survival. Pavement and bridge conditions for the entire state system are considered in the development of this TAMP but are not included. Future TAMPs may include all of the State’s pavement and bridges and other important infrastructure.

Hawaii’s NHS System

As mentioned in Chapter 1, the NHS provides an interconnected system of freeway and principal arterial routes that connects communities, ports, airports, military bases, and major travel destinations. The majority of the NHS in Hawaii is under State jurisdiction, with a small percentage under county jurisdiction. The jurisdictional breakdown in Hawaii of pavement and bridges on the NHS is summarized in Table 3.1 and shown on Figures 3.1 and 3.2.

Table 3.1. NHS Pavement and Bridges (2020)

Jurisdiction	NHS Pavement (lane-miles)	NHS Bridges (each)
State	1,391	492
Oahu District	874	361
Hawaii District	273	78
Maui District	189	39
Kauai District	55	15
City and County of Honolulu	79	18
County of Maui	0	0
County of Kauai	0	0
Total	**1,470**	**511**

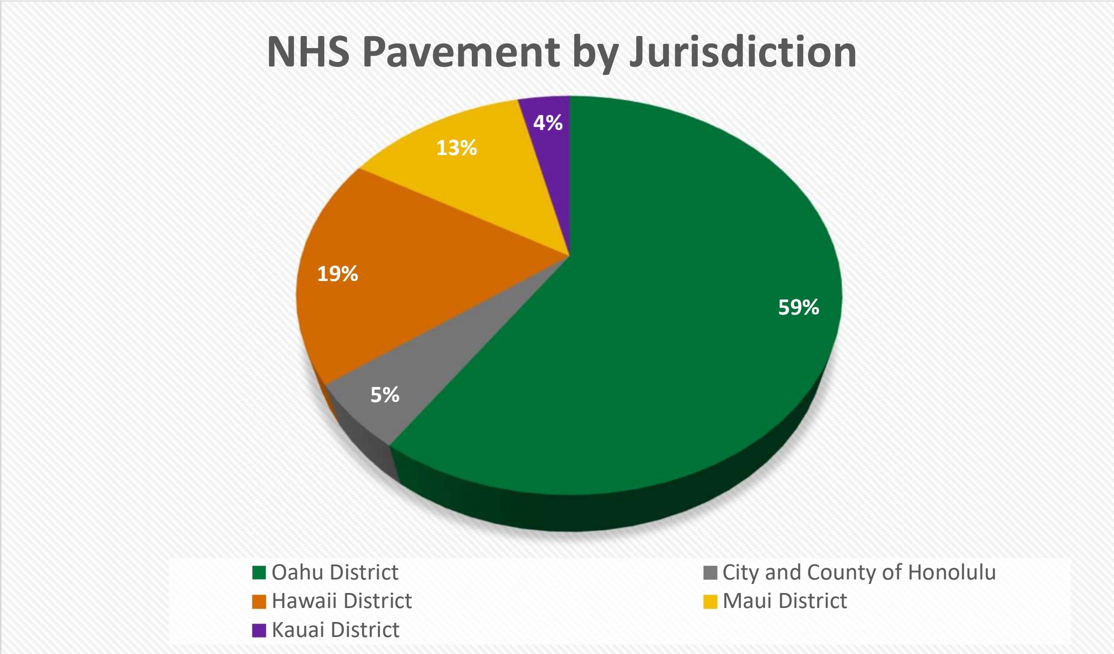


Figure 3.1. NHS Asset Jurisdiction – Pavement

Note: Numbers have been rounded to the nearest whole percent.

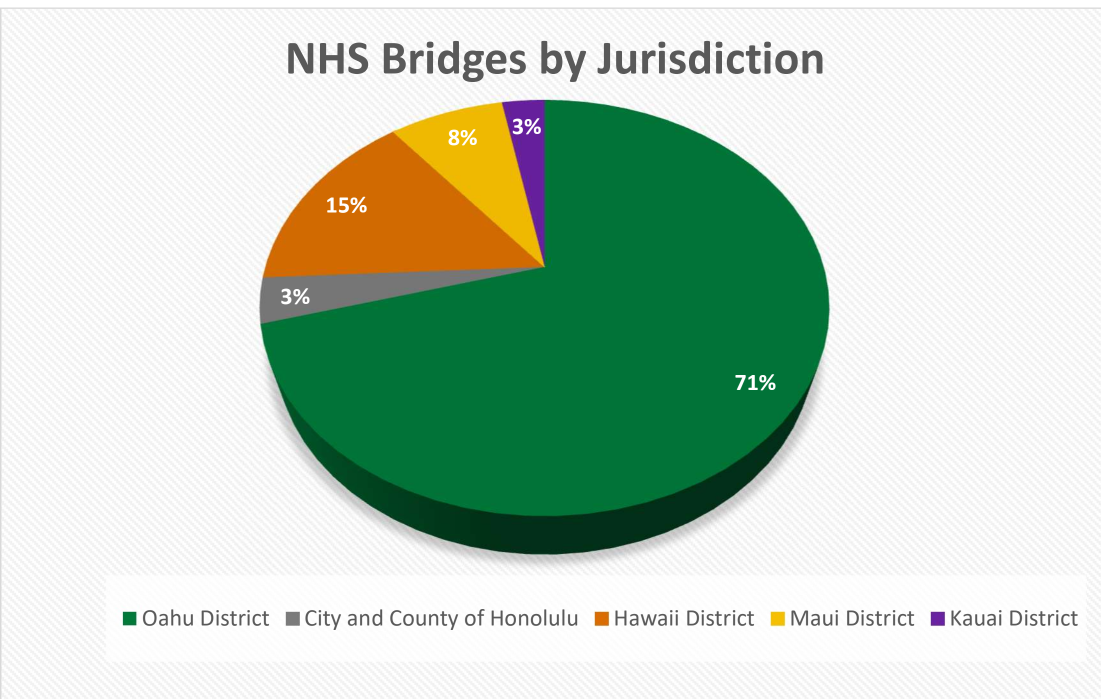


Figure 3.2. NHS Asset Jurisdiction – Bridges

Note: Numbers have been rounded to the nearest whole percent.

Coordination with Counties and MPOs

The State Transportation Planning (STP) office implements the HDOT's transportation planning process. STP convenes quarterly (or as needed) meetings that bring together governmental agencies imperative to transportation planning in Hawaii, to coordinate and collaborate on the State's transportation planning process. Involved agencies include the HDOT Highways, Airports, and Harbors Divisions, City and County of Honolulu, County of Hawaii, County of Maui, County of Kauai, Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Federal Aviation Administration (FAA), Oahu MPO, Maui MPO, and other applicable governmental agencies. During the development of this and the previous TAMP, the process and methodology was shared with these important stakeholders.

The City and County of Honolulu (CCH) is the only jurisdiction that has roads on the NHS that are not owned by the HDOT. The HDOT met separately with the CCH to discuss their pavement management and bridge management programs. Data collection, data sharing, risks, maintenance strategies, and how the pavement and bridge projects are prioritized were all discussed. The HDOT collects all of the NHS pavement data for the state. The CCH also collect their own pavement condition data.

The HDOT continued collaboration and coordination with the Oahu MPO and Maui MPO to discuss the TAMP objectives, TAMP program needs, and program priorities, and share draft pavement and bridge performance targets. Important discussions about performance measures, impacts to other program needs, vision, and goals for their LRTPs, as well as effects to the STIP and TIP, are covered. In addition, the MPOs had multiple opportunities to provide comments on the proposed targets and draft TAMP document throughout the update process. The HDOT has data-sharing agreements with both MPOs.

Data Management

Through the Highway Performance Monitoring System (HPMS) program, the HDOT collects a variety of data on the federal-aid highway system, regardless of jurisdiction. These data are shared with the City and Counties. Each jurisdiction manages their own pavement management system (PMS) but collaborates on lessons learned and successful preservation strategies. Bridge condition data are collected through bridge inspections done by the individual jurisdictions, then reported to the HDOT and ultimately to the FHWA, to support the National Bridge Inventory (NBI). The jurisdictions also share strategies and resources; for example, bridge inspectors from one jurisdiction may assist with bridge inspections in another (because of the limited number of bridge inspectors a jurisdiction may have). Communication and coordination of the inspections is helping to ensure consistency and quality of the inspection reports.

The HDOT has numerous data management systems for storing and managing inventory and condition data. The HDOT also understands the significance of the management and quality control of its data resources. Data provide the foundation of the PMS and Bridge Management System (BMS). As part of the TAMP process and HDOT's commitment, the HDOT has established a data governance group to oversee the collection of all asset data collection and to establish data standards and guidelines.

Data management is at the foundation of a TAMP, as follows:

- Data access (How easy is it to retrieve the data?)
- Data quality (How accurate and useful are the data?)
- Data integration (Can different data sets be combined and from different sources?)
- Data governance (Who oversees the data and what are the policies for managing the data?)

HDOT Pavement Program

Hawaii Pavement Inventory

Pavements are a critical part of the HDOT transportation network, providing mobility and access to a wide variety of users and being used to move goods for the economic vitality of the state. Overall, the State and individual counties maintain over 9,803 lane-miles of pavement. The federal-aid highway system consists of approximately 3,916 lane-miles (Table 3.2). As the population and economy continues to grow, the state's pavement inventory is also expected to grow. As required by the FHWA, this TAMP only includes the pavement conditions for the 1,496 lane-miles of Interstate and Non-Interstate NHS. The remainder of the state's pavement system is considered in the life cycle planning and investment strategies for the NHS system but is not included in this TAMP document. The HDOT may include the entire state system in future iterations of the TAMP.

Table 3.2. Federal-Aid Highway System Pavement Breakdown (excluding bridges)

Federal-Aid Highway System	Lane-Miles
Interstate	317
Non-Interstate NHS	1,179
State Highways/Roads	1,071
County Highways/Roads	1,349

Pavement Conditions

The HDOT has adopted FHWA's definitions of pavement condition performance measures, as follows:

- Good condition: Suggests no major investment is needed.
- Fair condition: Suggests that minor investment and preventative maintenance is needed.
- Poor condition: Suggests major reconstruction investment is needed.

The pavement conditions are calculated based on data that the HDOT collects through the HPMS. The pavement conditions are determined by using quantitative data on the following metrics (and shown on Figure 3.3):

- **International Roughness Index (IRI)** is often referred to as pavement roughness. It is an indicator of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and therefore the road user).
- **Cracking** is measured by the percentage of cracks in the pavement surface. Cracks are often caused (or accelerated) by excessive loading, poor drainage, poor subbase, and construction flaws.
- **Rutting** is a typically caused by heavy traffic and heavy vehicles. It is measured in asphalt by the depth of the rut along the wheel path.
- **Faulting** is a difference in elevation across a concrete joint or crack (usually along concrete slab edges). It can be caused by misaligned concrete slabs, settlement, warping, or a combination thereof. There are two types of concrete pavement: jointed

concrete pavement (JCP) and continuously reinforced concrete pavement (CRCP). Currently, only the JCP type is used in the state.

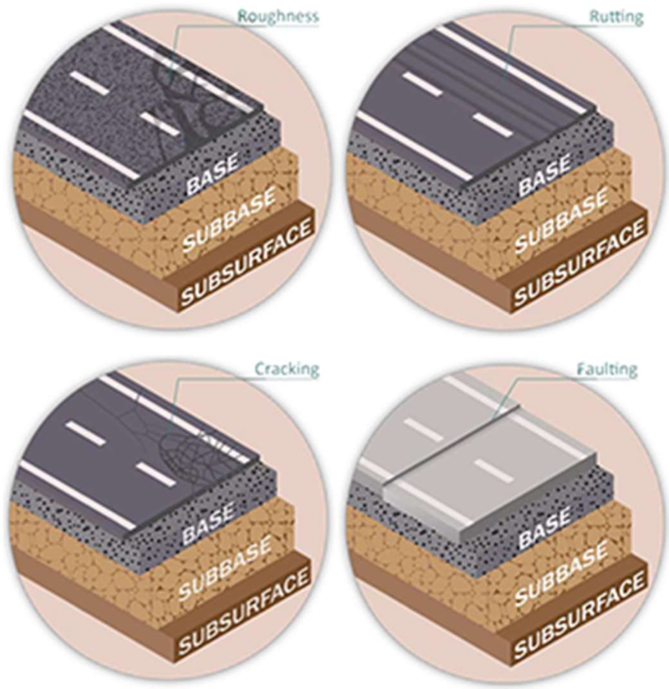


Figure 3.3. Four Pavement Condition Metrics

Source: Caltrans Draft Transportation Asset Management Plan, October 2017

Pavement Raveling

Rippling or Shoving

Wheel Track Rutting

Alligator Cracking

Potholes/Raveling

Examples of Bad Pavements

Examples of Good Pavements

It should also be noted the FHWA does allow the Present Serviceability Rating (PSR) to be used for roads where the speed limit is less than 40 miles per hour.

The FHWA provides guidance for pavement condition thresholds for each section of roadway, as shown in Table 3.3.

Table 3.3. Pavement Condition Thresholds

	Good	Fair	Poor
IRI (inches/mile)	<95	95 to 170	>170
Rutting (inches)	<0.20	0.20 to 0.40	>0.40
Faulting (inches)	<0.10	0.10 to 0.15	>0.15
Cracking (%)	<5	5-20 (asphalt) 5-15 (JCP) 5-10 (CRCP)	>20 (asphalt) >15 (JCP) >10 (CRCP)

Notes:

> = greater than

< = less than

Each pavement section is then determined to be in good, fair, or poor condition by the FHWA guidance for the calculation of pavement measures shown in Table 3.4.

Table 3.4. Calculation of Pavement Measures

	Pavement Type		
	Asphalt and Jointed Concrete	**Continuously Reinforced Concrete**	
Overall Section Condition Rating	**3 metric ratings (IRI, cracking, rutting/faulting)**	**2 metric ratings (IRI and cracking)**	**Measures**
Good	All three metrics rated "Good"	Both metrics rated "Good"	**Percentage of lane-miles in "Good" condition**
Poor	Two out of three metrics rated "Poor"	Both metrics rated "Poor"	**Percentage of lane-miles in "Poor" condition**
Fair	All other combinations	All other combinations	

HDOT Pavement Management System (PMS)

The HDOT is responsible for managing and maintaining all State-managed roadways classified as Interstate, Non-Interstate NHS, and non-NHS Routes. HDOT pavements consist of two types: flexible and rigid. Flexible pavements are typically asphalt pavement, while rigid pavement is jointed concrete (that is, JCP). Figure 3.4 shows the percentage of NHS pavement type in the state.

HDOT collects automatic pavement condition data annually for both NHS and non-NHS routes since 2017. The collected data are then entered into the HDOT's PMS for data analytics and scheduling of maintenance activities.

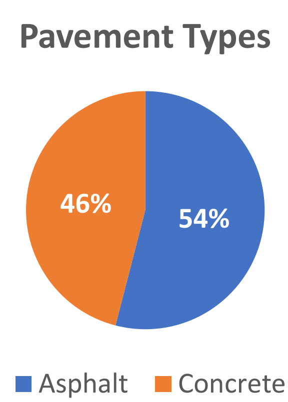


Figure 3.4. Percentage of NHS Pavement Type

PMS Process

A further breakdown of the PMS process is reflected on Figure 3.5, Pavement Wheel, which represents a continuous cycle of collecting data, analyzing data, implementing recommendations, and verifying the performance of the recommendations.

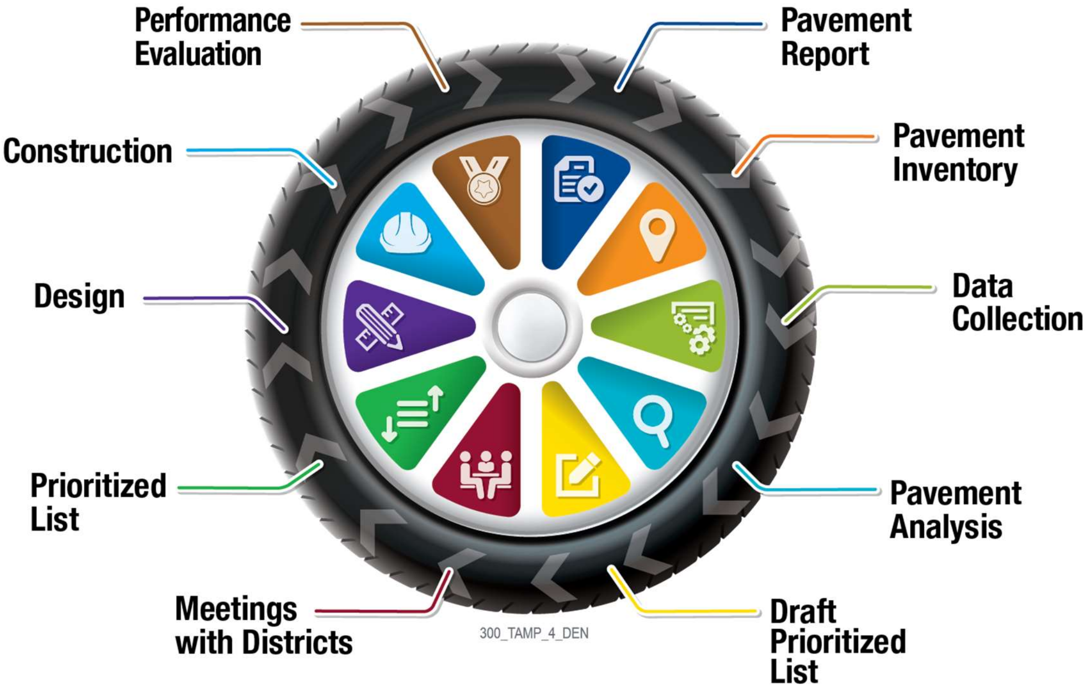


Figure 3.5. Pavement Wheel

The continuous cycle includes the following activities:

- Reviewing pavement inventory statewide.
- Collecting pavement data annually and sharing with other NHS owners.
- Conducting the pavement analysis, where the result is a multi-year pavement program with prioritized projects and yearly predicted pavement condition under various budget scenarios.
- Sharing the draft pavement program list, which includes both preservation and reconstruction projects, with pavement engineers and district engineers. At this stage, additional pavement segments that are exhibiting structural or performance-based issues that were not apparent in the initial data collection phase (that is, not included in the pavement program) are investigated and scheduled for treatment as a means of providing users with a safe and operable highway transportation system. In collaboration with the districts, other resiliency and risk factors are considered, such as proximity to exposure hazards, SLR, and coordination with Shoreline and Rockfall programs.
- Establishing the prioritized list. Once the pavement program is vetted, finalized, and approved by the HDOT administration, HDOT staff will coordinate with other branches to address other needs such as safety, maintenance needs (such as filling of potholes), and other upcoming projects in the corridor. The prioritized list is then incorporated into the HDOT's MRTP and programmed for funding. The MRTP also has evaluation criteria that further prioritizes system preservation and resiliency.

- Designing and constructing the projects.
- After design and construction, further evaluating performance the roadway segment and updating the pavement report and incorporating into the PMS.
- Continuing the cycle as needed.

dTIMS Program

The HDOT continues to explore new and innovative ways to improve the pavement network and expedite project delivery. The HDOT transitioned to using a new asset management software for their PMS, dTIMS, in 2022.

The dTIMS software performs three core functions to produce an actionable multi-year treatment program: condition forecasting, treatment selection, and optimization. The following briefly describes these core functions:

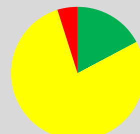
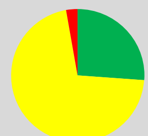
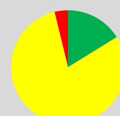
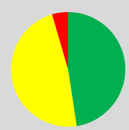
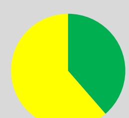
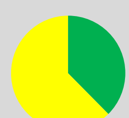
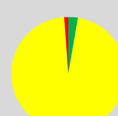
1) Condition Forecasting: Predicting future pavement conditions is essential to scheduling multi-year maintenance activities and establishing budget requirements. Historical and current condition data are imported into dTIMS and used to create deterioration models that predict future condition states over the life of the pavement. Understanding past, present, and future condition states, dTIMS determines (1) when typical maintenance treatments should be considered, (2) what life expectancy can be achieved, and (3) what impact particular treatments will have over the subsequent performance of the pavement.
2) Treatment Selection: dTIMS uses a treatment decision tree that determines when a pavement segment should be considered for a particular treatment. A list of potential life cycle maintenance strategies and alternative strategies is created for every pavement segment that is included in its inventory. Each strategy consists of maintenance activities such as preventative maintenance, rehabilitation, and reconstruction treatments. Table 7.1 in Chapter 7 lists the activity types that the HDOT uses as pavement treatment activities.
3) Optimization: A life cycle cost analysis is completed for each project section (that is, at a project level). Optimization is about optimizing the benefit of the network, which is commonly used to compare different strategies for maintaining and/or improving the pavement network (that is, at a network level). dTIMS considers all the HDOT pavement segments, each with various treatment strategies and benefits with varying annual budget constraints, to select the ‘best’ investment strategy for the HDOT pavement network.
4) Risk and Resiliency: With the dTIMS software, the HDOT will be able to assign up to 25 percent benefit/cost to risk. The 25 percent risk provides the opportunity to influence the project, which would allow the project to move higher up in the prioritized list, if the proposed treatment will address the risk. Examples of this risk or importance include whether the pavement is on a high volume or low volume road, is in front of a hospital, or is prone to flooding due to extreme weather. The proposed pavement treatment does not always address the risk or importance (that is, pavement in front of the hospital is not dependent on the pavement treatment). However, considerations such as saturated soil conditions can be addressed through programming and design where extreme weather and resiliency factors can be further implemented.

The HDOT Highways Division Material Testing and Research Branch (HWY-L) is also preparing a pavement manual and establishing new standards, with the use of new pavement types to help increase the life cycle benefit and costs. As more pavement condition data become available, newer, more accurate deterioration models will be developed to better predict pavement deterioration.

Summary of NHS Pavement Conditions

Table 3.5 summarizes NHS pavement inventory and conditions by NHS and by jurisdiction.

Table 3.5. 2020 NHS Pavement Inventory and Condition (HPMS)

	Lane- Miles	Good	Fair	Poor	
All NHS					
Interstate	317	17.2%	77.9%	4.9%	
Non-Interstate NHS	1,179	26.1%	71.1%	2.8%	
By Jurisdiction					
Oahu District	874	16.2%	80.1%	3.8%	
Hawaii District	273	47.3%	47.8%	4.9%	
Maui District	189	38.7%	61.3%	0%	
Kauai District	55	37.6%	62.4%	0%	
City and County of Honolulu	79	2.7%	96.1%	1.2%	

HDOT Bridge Program

Hawaii Bridge Inventory

There are 1,124 total bridges on State and County roadways in Hawaii, of which 511 structures are on the NHS. A structure is considered to be a bridge (23 CFR 650 Subpart C –National Bridge Inspection Standards) if the following conditions are met:

- Is a structure including supports erected over a depression or an obstruction?
- Has a track or passageway for carrying traffic or other moving loads.
- Has an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes.

The majority of bridges in Hawaii are predominately concrete girder structures, although a small number of the bridges were originally constructed for the sugar plantation railroads and are of steel trestle construction, which were later retrofitted to carry vehicular traffic. The HDOT also has a small number of wood bridges that are in the process of being replaced by concrete structures. The majority of bridges in Hawaii are over 50 years old. In comparison, the average bridge-structure age of bridges nationwide is 40 years.[3] With the large number of older bridges in Hawaii, the HDOT implements repairs and rehabilitation to extend the service life of bridges as much as possible. Bridge replacement projects are expensive and usually challenging, with environmental issues and limited redundancy or alternative routes.

In accordance with 23 CFR 650, Subpart D, the HDOT maintains a BMS that contains data for all state- and county-owned bridges in the state. The HDOT BMS is AASHTOWare BrM, which includes a programming module that meets FHWA requirements.

Data are collected from bridge inspection reports biannually using in-house forces or vendors. As recorded in the NBI, the HDOT determines and tracks structural condition and sufficiency ratings.

Bridge Conditions

The HDOT has adopted FHWA's bridge condition performance measures, as follows:

- Good condition (weighted by deck area)
- Fair condition (weighted by deck area)
- Poor condition (weighted by deck area)

The FHWA NBI standards for inspections are based on a minimum value rating for a bridge's three components: deck, superstructure, and substructure, as shown on Figure 3.6. The scale goes from 0 (worst) to 9 (best).

NBI Component Condition Rating Values:

9 – Excellent
8 – Very Good
7 – Good
6 – Satisfactory
5 – Fair
4 – Poor
3 – Serious
2 – Critical
1 – "Imminent" Failure
0 – Failed

[3] Transportation Research Board. 2009. Demographic Changes Drive Change. TR News 264.-September-October 2009. https://onlinepubs.trb.org/onlinepubs/trnews/trnews264.pdf.

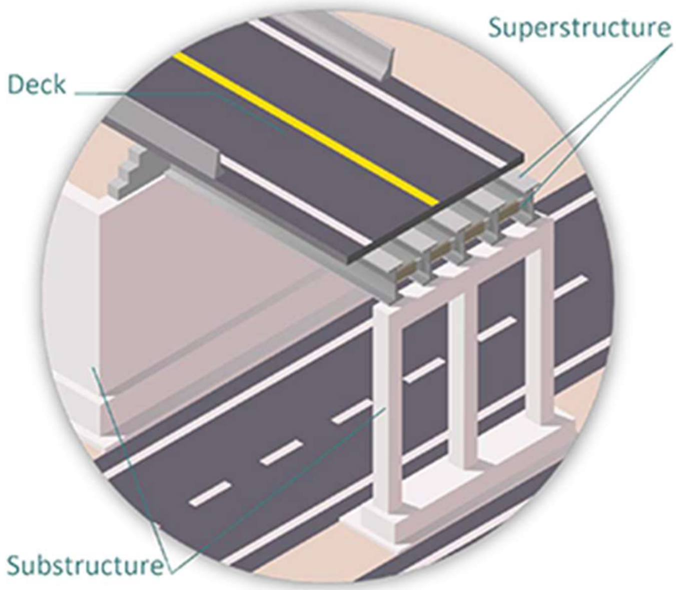


Figure 3.6. Bridge Components

Source: Caltrans Draft Transportation Asset Management Plan, October 2017

The FHWA has provided the following guidance for determining bridge condition:

- The lowest of the three ratings for deck, superstructure, and substructure determines the overall rating of the bridge as shown on Figure 3.7.
- A bridge is determined to be in poor condition when the minimum value of NBI deck, superstructure, and substructure is calculated and is considered to be in poor condition.

Condition Rating Thresholds for Classification Type				
	NBI Rating Scale *(from 0 -9)*	9 8 7 Good	6 5 Fair	4 3 2 1 0 Poor
BRIDGE	Deck *(Item 58)*	≥ 7	5 or 6	≤ 4
	Superstructure *(Item 59)*	≥ 7	5 or 6	≤ 4
	Substructure *(Item 60)*	≥ 7	5 or 6	≤ 4

Figure 3.7. Bridge Condition Rating Thresholds

Source: FHWA 2017[4]

HDOT Bridge Management System (BMS)

To achieve and sustain a bridge inventory that is in alignment with the HDOT mission, the HDOT continues to employ and enhance its BMS. The HDOT's BMS is a strategic and systematic data-driven process that uses life cycle planning to move and keep its bridge assets in a state of good repair and other HDOT policy requirements. This process allows the HDOT to improve system preservation, safety, and resiliency, at minimum practicable cost.

[4] Federal Highway Administration (FHWA). National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program. Final Rule. *Federal Register.* 82(11):5886-5970. https://www.govinfo.gov/content/pkg/FR-2017-01-18/pdf/2017-00550.pdf.

Foundational to the HDOT's BMS being a data-driven process are its Bridge Inspection Program (BIP) and the AASHTOWare BrM BMS. Through the BIP, inspectors collect bridge inventory appraisal and condition data on a 24-month (or less) cycle. Subsequently, these data, along with inspection reports and other related bridge information, are processed and stored in BrM.

Using the condition and appraisal data available, each bridge in the HDOT's inventory is analyzed and assigned to a State of Good Repair subprogram and an action, if applicable, to restore or keep the bridge in a state of good repair. The subprograms and actions (that is, potential projects) assigned are the result of a benefit/cost analysis, which considers a bridge's life cycle phase and forecasted deterioration, as well as risk and resiliency, such as bridge element condition severity. Figure 3.8 illustrates the breakdown of the bridge subprograms.

As applicable, each bridge may also be assigned to the bridge Safety Restoration subprogram, which addresses safety-driven deficiencies, or to one or more of the Resiliency subprograms of Strengthening, Scour, and Seismic Retrofit. Bridges within these subprograms will also be assigned an action to address a safety or resiliency need.

Acknowledging similarities between the scope of potential projects and simplifying project prioritization, potential projects are grouped into Primary Actions. Primary Actions are prioritized considering bridge state of good repair, safety, and resiliency objectives. Within each Primary Action, potential projects are further prioritized considering community impacts such as average daily traffic and detour length and risks such as seismic vulnerability. The list of Primary Actions is shown on Figure 3.9.

Using the two levels of prioritization in the HDOT's BMS, projects are selected through an iterative process of running funding scenarios until all bridge state of good repair objectives and other HDOT policy requirements are met in the short- and long term. More information on the HDOT's BMS can be found in the *HDOT Bridge Asset Management Manual (BAMM)*.

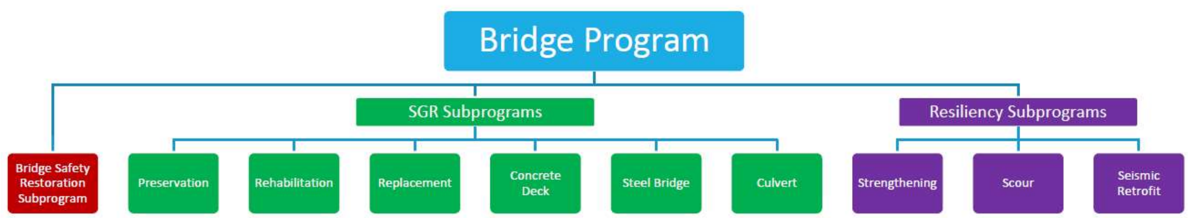


Figure 3.8. Bridge Subprograms

Primary Actions

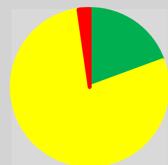
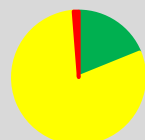
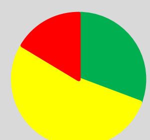
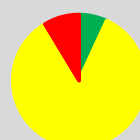
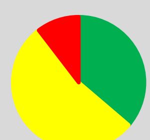
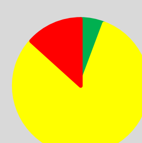
1. Bridge Safety
2. Replacement
3. Rehabilitation – Structural Rehabilitation – Bridge
4. Rehabilitation – Structural Rehabilitation - Culvert
5. Preservation – Scour Repairs
6. Preservation – Steel Bridge – Rehabilitation & Painting
7. Preservation – Rehabilitation - Bridge
8. Preservation – Rehabilitation - Culvert
9. Preservation – Steel Bridge – Repairs & Painting
10. Preservation – Repairs – Bridge
11. Preservation – Repairs – Culvert
12. PM – Steel Bridge – Painting Restoration
13. PM – Concrete Deck – Overlay Restoration
14. Preservation – Scour Countermeasures
15. Preservation – Strengthening (Capacity-Driven)
16. Preservation – Seismic Retrofit (Capacity-Driven)

Figure 3.9. Primary Actions

Summary of NHS Bridge Conditions

Table 3.6 summarizes 2020 NHS bridge inventory and condition data by jurisdiction.

Table 3.6. 2020 NHS Bridge Inventory and Conditions

	Amount	Good	Fair	Poor	
All NHS					
NHS Bridges	511	19.4%	78.3%	2.3%	
By Jurisdiction					
Oahu District	361	18.9%	79.9%	1.2%	
Hawaii District	78	30.7%	52.9%	16.4%	
Maui District	39	6.9%	84.5%	8.6%	
Kauai District	15	36.2%	53.4%	10.4%	
City and County of Honolulu	18	5.7%	81.0%	13.3%	

Bridges in poor condition require additional monitoring, maintenance, or repair to ensure safe and continued service. If a bridge is in poor condition, it does not mean that it is unsafe or will immediately collapse. With updated federal legislation, the FHWA requires that state departments of transportation (DOTs) maintain NHS bridges at less than 10 percent of the bridge deck area in poor condition. Table 3.7 provides a summary of the percentage of bridge deck area in poor condition for the last 5 years. Table 3.8 shows the number of bridges in poor condition for the last 5 years.

Table 3.7. Bridge Deck Area in Poor Condition

Network System	Year								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
NHS - ALL	1.2%	1.2%	1.2%	1.2%	1.8%	2.0%	2.3%	2.3%	1.2%
Interstate	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Non-Interstate NHS	4.8%	4.9%	5.1%	5.2%	7.8%	8.4%	9.4%	9.2%	4.8%
Non-NHS	3.2%	3.7%	3.3%	3.4%	4.2%	4.5%	4.1%	3.7%	3.2%

Note: The values provided are based on the condition history of the HDOT's inventory from the 2021 NBI data submittal.

Table 3.8. Number of Bridges in Poor Condition

Network System	Year								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
NHS - ALL	22	21	22	23	30	31	31	35	22
Interstate	1	1	0	0	0	0	0	0	1
Non-Interstate NHS	21	20	22	23	30	31	31	35	21
Non-NHS	35	36	38	40	46	47	49	48	35

Note: The values provided are based on the condition history of the HDOT's inventory from the 2021 NBI data submittal.

The data show that bridge conditions on the NHS in Hawaii are well below the FHWA threshold of 10 percent of total deck area of bridges on the NHS classified as poor condition.

CHAPTER 4

Asset Management Performance Measures and Targets

A key component of asset management is using performance-based measures and targets to identify needed transportation improvements and monitor their effectiveness over time. To evaluate how well a project is performing, the transportation system is monitored and the results measured against the predetermined performance targets. Meeting these targets could mean that the implemented project was the appropriate one, and that there is value being gained from the dollars invested. If targets are not met, changes to the projects or priorities could be made to more effectively achieve the milestone. Using these measures to assess roadway system performance after projects are implemented is an important part of the overall long-range planning process and achieving an overall goal.

The performance management process, as illustrated on Figure 4.1, begins with shared goals and objectives, performance measures and targets for gauging progress, strategies for achieving the goals, and reporting to periodically assess and revise goals and objectives as needed.

Figure 4.1. Performance Management Process

Long-range Planning Goals

Collectively, the long-range state, regional, and local plans guide the planning of Hawaii's transportation system and ultimately provide the basis for investment decisions in the system. As described in Chapter 2, these plans are developed within a consistent planning framework to ensure that the long-range planning process at the state and regional levels reflect the State's overall vision guiding future transportation investment decisions consistent with the HDOT mission and implementation of TAMP priorities.

HDOT Goal and Objectives

The overarching goal of the HDOT TAMP is to provide a process to achieve and sustain a state of good repair over the life cycle of the assets and to improve and preserve the condition of the state's transportation assets. As noted in Chapter 2, the HDOT's objectives are as follows:

- Implement plans and projects to support the transportation asset management process.
- Establish data governance and data collection standards.
- Facilitate coordination, collaboration, and knowledge transfer within the team.
- Communicate the transportation asset management activities to the executive levels of the HDOT.
- Pursue the solicitation and promotion of best practices.
- Promote transportation asset management benefits and uses throughout the HDOT, counties, and other external stakeholders.

Performance Measures and Targets

The FHWA requires TAMPs to include performance measures and targets for asset condition for pavements and bridges on the NHS. The performance measures are intended to fulfill the HDOT's goal and objectives, carry out the National Highway Performance Program, and assess the condition, performance, effectiveness, and progress of the Federal-Aid Highway Program at a regional, state, and national level. Using the performance measures, states must define their desired state of good repair for the 10-year analysis period of the TAMP.

Table 4.1 presents the HDOT's performance measures and 10-year performance goals (desired state of good repair) for bridges and pavements on the NHS. The HDOT considered multiple risks and factors in its goal-setting, including the following:

- Existing inventory and conditions for all of the state's pavement and bridges
- Large number of older non-NHS bridges in the state's highway system that provide the only access to communities
- Other assets, such as drainage facilities, tunnels, highway lighting, signage, and traffic management facilities
- The needs of other programs (for example, capacity, congestion, bike and pedestrians, environment, and similar)
- Limited resources and funding
- Shifting administrative and legislative priorities
- Diverting funds for emergency events

As part of the performance management rule, MAP-21 and the FAST Act set minimum condition levels for NHS pavements and bridges. States are required to have no more than 5 percent of their interstate pavements in poor condition and no more than 10 percent of NHS bridges, by total deck area, in poor condition. The HDOT meets both of these minimum condition requirements.

Table 4.1. HDOT's Performance Measures and Performance Goals for NHS Pavements and Bridges

Asset	Performance Measure	Current Condition 2020	2-year Target 2023	4-year Target 2025	Performance Goal (Desired Condition) 10-year Goal
NHS Pavements	Percentage of pavements on the Interstate in good condition	17.2%	25%	30%	40%
	Percentage of pavements on the Interstate in poor condition	4.9%	4%	4%	3%
	Percentage of Non-Interstate NHS pavements in good condition	26.1%	25%	30%	40%
	Percentage of Non-Interstate NHS pavements in poor condition	2.8%	4%	4%	3%
NHS Bridges	Percentage of NHS bridges classified in good condition	19.4%	25%	30%	40%
	Percentage of NHS bridges classified in poor condition	2.3%	4%	4%	2%

State DOTs are also required to establish 2- and 4-year targets that serve as interim indicators of changes in condition levels. The targets can help states determine how well they are progressing towards its long-term state of good repair goals. Table 4.1 also reflects the 2- and 4-year targets. Chapters 7 and 8 further discuss how the HDOT selected these targets for this TAMP.

CHAPTER 5

Risk and Resiliency

Overview and Requirements

Overview

With the increased emphasis on performance-based planning and programming, it is even more important to manage risk. By managing risk and pursuing resiliency, agencies can achieve their goals, objectives, and targets. The purpose of risk management is to identify threats, followed by an assessment of likelihood and consequences, then develop response strategies to preemptively manage the risks and increase the possibility of the agency in being successful in meeting its goals and objectives.

> Risk management enables agencies to thrive amidst uncertainty by being more understanding of and better poised to respond to the full range of possible outcomes—both threats and opportunities—that may impact the success of their organization.

The FHWA considers risk the positive or negative effects of uncertainty or variability upon agency objectives. Risk management generally consists of the cultures, processes, and structures that are directed towards the effective management of potential opportunities and threats. However, the FHWA recognizes that different agencies can use different definitions. The FHWA requires transportation agencies to consider risk as part of the strategic and systematic process of operating, maintaining, and improving physical assets and managing their highway network with a focus on the program and agency level. A risk-based plan can make tradeoffs based on risk. In addition, risk should be considered at a programmatic level and the project level to control cost, scope, and schedule.

State DOTs are required to establish a management plan that identifies risks to assets and the highway system, including those associated with current and future conditions, such as extreme weather events and climate change. The risk analysis also needs to account for roads and bridges that require repeated repair or reconstruction as a result of emergencies.

With the recently passed BIL, the TAMP is required to do the following:

- Clearly explain the processes used to consider the extreme weather and resilience within the risk management and life cycle planning sections of the TAMP
- Discuss how the investment strategies are influenced by the results of the risk management and life cycle planning analyses

The HDOT has recognized the importance of resiliency early on. As previously discussed in the HDOT 2019 TAMP, there are many challenges to Hawaii and its land transportation system because of its location in a tropical zone, predominant coastal environment, geologic and topographic factors, and geographic isolation.

Resiliency

The HDOT adopted a Resiliency Policy on June 18, 2021, that was developed to ensure that resilience measures are implemented into all HDOT Highway programs and projects to increase the resiliency of the highway system to existing and future risks. The focus of the policy is to adjust internal practices within HDOT Highways to ensure that all decisions made include future-oriented designs and cost-effective investments that lead to a more resilient highway system. The directive applies to all operations and branches of HDOT Highways, such as maintenance, construction, right-of-way, design, and planning, which will include actions that help achieve highway network resilience.

> *Resilience is a cross functional discipline that should be engrained in the project delivery process as a part of everyone's job, like safety, as it enhances asset management, sustainability, and the public's quality of life.*
>
> -HDOT Highways Resilience Policy

Statewide Coastal Highway Program Report

In 2017, the HDOT, in partnership with the University of Hawaii, worked to develop a scientifically rigorous method to assess and rank the susceptibility of the HDOT's coastal roads to erosion and structural degradation. The project team developed an evaluation methodology that considers all ocean hazards, such as waves, currents, tides, storm surges, and SLR. The purpose of the report was to identify and rank stretches of roadway, in a quantifiable way, that are in need of short- to mid-term remediation measures to prevent traffic interruptions and road closures during storm and hurricane events.

Through site visits, previous studies, and input from field staff, the final report offered a new, single index that considered the principal factors that cause coastal erosion and road degradation. The Coastal Road Erosion Susceptibility Index (CRESI) approach involves the characterization of coastal road locations using an index that reflects how likely the roadway will erode and structurally collapse. A similar index was developed by the HDOT to evaluate and rank roads susceptible to rock falls and soil slides. The CRESI is based on the concept that the width of the land between the road and the ocean acts as a buffer to erosion and controls how vulnerable a particular location is to structural road damage and collapse. A road further inland has a more significant buffer from damage than a road that is low and adjacent to the ocean. The following variables are used in the calculation of CRESI and are reflected on Figure 5.1:

- Beach geomorphology
- Coast geomorphology
- Erodible volume
- Slope
- Coastal ground cover and existing structures above ground
- Road base and subgrade conditions
- Armoring
- Rate of sea level change
- Shoreline accretion or erosion rate
- Mean tidal change
- Significant wave height

The 20 most critical road locations are reflected in the final report, and available on the HDOT's website, [Statewide Coastal Highway Program Report (hawaii.gov)](). The report was prepared to address the FHWA requirement to provide a process in the TAMP to include extreme weather events and resiliency. As the Pavement and Bridge Program develops their prioritized list, they collaborate and coordinate improvements with the Shoreline Program to ensure that resiliency efforts are considered.

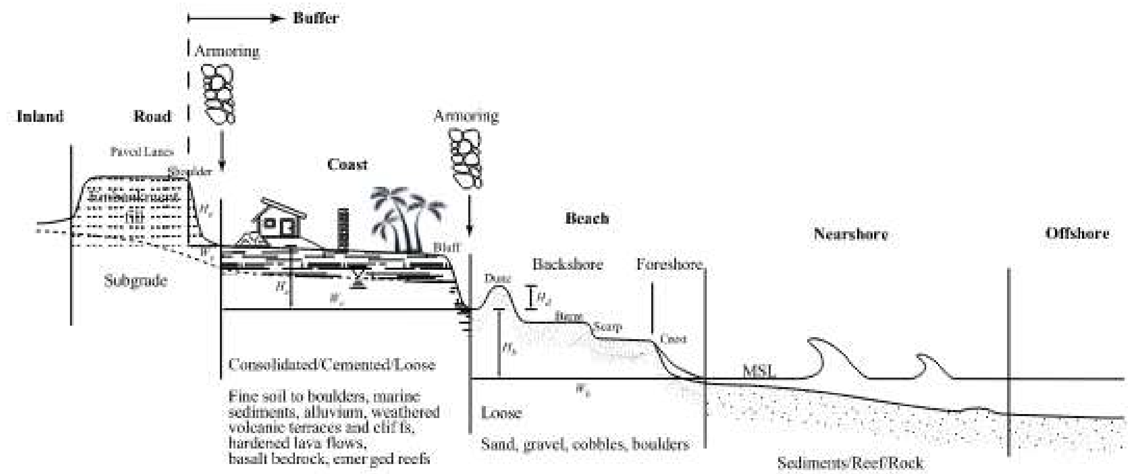
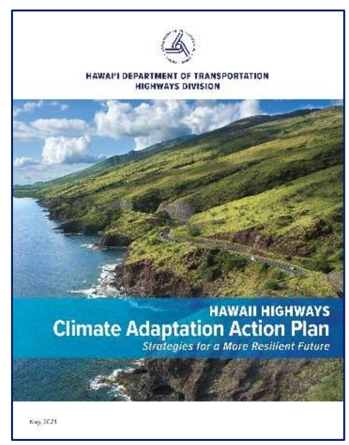


Figure 5.1. Generic Road to Ocean Cross Section
Source: State of Hawaii 2019[5]

Hawaii Highways Climate Adaptation Action Plan



Going further, the HDOT developed a Climate Adaptation Action Plan (CAP)[6] in 2021 to explore and ensure that they have the information required to minimize impacts and increase asset and system resiliency. The purpose of the CAP is to provide a roadmap for the HDOT to make the highway system more resilient to climate-related effects. The CAP identifies locations through an exposure assessment of climate hazards to the State's highways based on both historical and future climate condition research and data. The CAP then outlines strategies to be implemented and actions to be taken to incorporate resilience into its programs and policies. The multi-year implementation plan encompasses all aspects of HDOT's core functions – funding, planning, designing, constructing, operating, and maintaining.

Figure 5.2 shows the basic framework from the CAP that the HDOT is taking to achieve system resilience to continue to serve communities and businesses in the Hawaiian Islands. The process starts by looking forward at potential future risks to developing cost-effective investments and solutions.

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[5] State of Hawaii. 2019. *Statewide Coastal Highway Program Report*. Prepared by Oceana Francis, Ph.D, P.E., Horst Brandes, Ph.D, P.E, Guohui Zhang, Ph.D, David Ma, Ph.D. August 21. https://hidot.hawaii.gov/highways/files/2019/09/State-of-Hawaii-Statewide-Coastal-Highway-Program-Report_Final_2019.pdf

[6] State of Hawaii Department of Transportation Highways Division. 2021. *Hawaii Highways Climate Adaptation Action Plan*. May. HDOT-Climate-Resilience-Action-Plan-and-Appendices-May-2021.pdf

Figure 5.2. Basic Framework for Achieving System Resilience
Source: HDOT 2021

Figure 5.3. Makaha Bridge No. 3

An example of how this framework is implemented within the TAMP and the HDOT's pavement and bridge programs is the Makaha Bridge Replacement Project No. 3 and No. 3A. Along Farrington Highway (Route 93) on the west side of the Island of Oahu, the Makaha bridges (Figure 5.3) were in need of replacement. Considering the location of the bridge within the identified exposure hazard, a standard bridge replacement in the same location would not be a wise investment. However, Farrington Highway provides the sole method of access to the communities on the west side, which must be maintained. Doing nothing is also not acceptable. The HDOT decided on the mid-term cost-effective solution of a replacement bridge with a 25- to 30-year design life versus the 75-year design standard. In the meantime, the HDOT can complete the necessary environmental studies and community outreach to pursue a permanent solution.

HDOT's Risk Management Process

Management of Risk

The HDOT uses a continuous cycle of risk management. Figure 5.4 shows the steps of the risk management cycle. The following pages describe each step in more detail.

A. Risk Identification – The identification and documentation of the material threats to the organization's achievement of its objectives and goals is accessed in Step 1. A risk matrix is developed for each identified risk, as shown in Table 5.1.

B. Analyzing, Quantifying & Assessing Risks – Identifying the probability and consequences of each risk occurs at Step 2.

C. Developing & Implementing Response Strategies – The formulation of methods and implementation measures to avoid, minimize, transfer (share), or mitigate risks at the organizational, programming, and project levels is completed at Step 3. This may include project prioritization or project-specific implementation considerations.

D. Risk Monitoring – Step 4 includes the continual measurement and monitoring of the risk strategies using a risk register.

Risk Identification and Levels of Risks

The HDOT knows that the identification of risk is the important first step. Management and consideration of the risks occurs at the following, multiple levels to be effective:

- A higher, organizational level
- The programming level
- The project implementation level

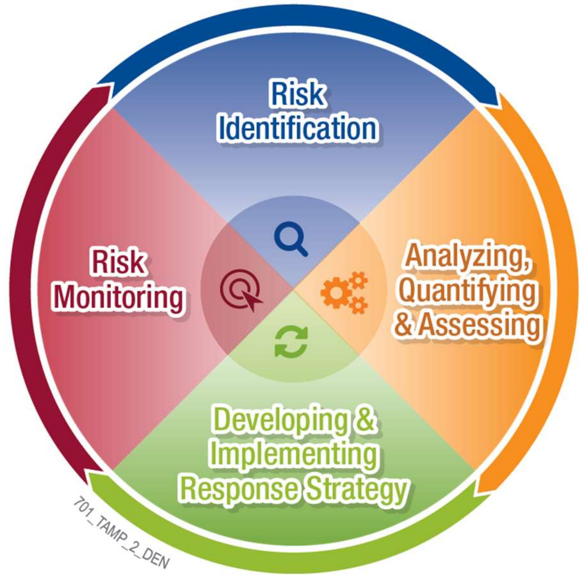

Figure 5.4. Risk Management Cycle

For example, for anticipated severe weather caused by climate change, at the global level, the HDOT implements updated design policies for certain facilities by using a larger design storm event (such as a 500-year event instead of 100-year). At the project selection and prioritization process (programming) stage, if it is recognized that a bridge structure is located in an area with repeated flooding history, that particular bridge may be given additional priority considerations within the BMS. Finally, when the project is designed, the HDOT may determine that using a larger design storm event or selecting a certain type of foundation (for example, using drilled shafts because of scour history) is appropriate given the identified risks for the structure. In addition, dependent on the bridge location, different design adaptation may also be implemented. Figure 5.5 illustrates this principle.

Figure 5.5. Levels of Risks, Management, and Response

This approach allows the HDOT to develop and address response measures to risks and foster resiliency at the appropriate levels. Risks related to asset management often faced by the HDOT include those noted in Table 5.1.

Table 5.1. HDOT Risks related to Asset Management

Risk Category	Risk Description	Organization	Program	Project
Hazard	Severe weather events (tropical storms, hurricanes, and tsunamis)	X	X	X
	Climate change and SLR	X	X	X
	Shoreline erosion	X	X	X
	Rockfall/slope stability	X	X	X
	Lava flows	X	X	X
	Earthquakes	X	X	X
Financial	Dependence on fuel tax revenues	X	X	
	Understanding of financial data to make appropriate TAMP planning decisions	X	X	
	Continuous short-term federal transportation bills or extensions	X	X	
	Renewable energy policies	X	X	
Organizational	Changes in administration or priorities	X	X	
	HDOT and its partnering agencies staff shortage	X	X	
	Loss of organizational or departmental information as a result of HDOT and its partnering agencies' staff turnover and retirements	X	X	X
	Program prioritization	X	X	
Strategic	Maintenance policies	X	X	X
	Complexity and amount of environmental regulations	X	X	X
	Length of procurement	X	X	X
	Data management	X	X	X
	Lack of a variety of effective preventative practices and maintenance measures	X	X	
	Resistance to culture change and TAMP sustainment	X	X	X

After a risk has been identified (Step 1), the probability or likelihood of the risk occurring is considered and the impact of each risk accessed (Step 2). This information is inputted into a risk matrix, as shown in Table 5.2. Table 5.2 also includes the probability inputs and impact inputs. A risk matrix is developed for each identified risk. Following this approach, the highest priority risk would be almost certain to occur and have extreme consequences. The lowest priority risk would be rare and would have negligible consequences. This practice builds resiliency into HDOT programs and incorporates the appropriate response strategies.

Table 5.2. Risk Matrix

Probability	VH					
	H					
	M					
	L				X	
	VL					
		VL	L	M	H	VH
		Impact				

Risk Matrix - Probability Input		
VL	-	Some certainty it will occur within the next 20 years
L	-	Somewhat certain it may occur within the next 8 years
M	-	Likely to occur within the next 4 years
H	-	Currently occurring to some extent
VH	-	Occurring daily or almost certain to occur

Risk Matrix - Impact Input		
VL	-	Little noticeable impact to the system; system minimally affected; little or no public awareness and pressure; most HDOT operational processes unaffected
L	-	Some noticeable impact to the system performance; some localized but noticeable difference in performance; general public complaints, but mostly accepts; HDOT operational processes slightly affected
M	-	Noticeable impact to the system performance; portions of system poorly performing; localized public complaints; some public awareness; some effect to operational processes
H	-	Large Impacts to the overall system performance; large portions of system poorly performing; public aware and concerned; widespread effect on operational processes
VH	-	Catastrophic to overall system performance; public safety and health severely compromised; widespread impact, loss of public trust and confidence; large segments of society and operational processes not functioning

Risk Response Strategies and Risk Monitoring

Strategies and mitigation for each risk are developed and placed in a risk register, similar to the sample shown on Figure 5.6. The risk register is used to do the following:

- Identify the risk (risk item, cause, and effect).
- Conduct a qualitative risk assessment (probability, impact, and risk matrix).
- Develop the risk response plan (response strategy and actions).
- Monitor and control (responsible office/lead, monitoring frequency, and status updates).

The risks are continually measured and monitored. The HDOT reviews the risk register annually or more frequently, as needed. The risk register inputs are shown in Table 5.3. The HDOT risk register for the TAMP is included in Appendix A.

Risk Management Register for HDOT

#	Status	Risk Category	Risk Item	Cause	Effect	Threat or Opportunity	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsible Entity/Lead Office	Monitoring Frequency	Status Update
1	Active	Hazard	Climate Change: Severe Weather Events, Tropical Storms, and Hurricanes	Flooding and storm drainage capacity	Loss of access	Threat	Moderate	Very High		Mitigate	HDOT to review design storm to determine impacts (construction cost, etc.) and then make a decision to adopt change or not	HWY-D	TBD	
2	Active	Hazard	Climate Change: Sea Level Rise	Shoreline erosion, inundation, and flooding	Loss of access	Threat	Very Low	High		Accept	HDOT to monitor ongoing data and studies. HDOT to continue to update asset inventory data and to consider SLR for new roadway alignments in long-range plans.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing
3	Active	Hazard	Earthquakes	Bridge, rockfall, or roadway fill failures	Loss of access	Threat	Very Low	Very High		Accept	HDOT to continue to update asset inventory data. HDOT to develop/update emergency response procedures and interagency MOUs. HDOT to continue to bridge seismic retrofit and rockfall programs.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing

Figure 5.6. Sample Risk Register

Table 5.3. Risk Register Inputs

Status	Active – risk strategy implemented or to be implemented Closed – risk item avoided or eliminated due to implementing strategy
Risk Category	Hazards – item related to climate, weather, and/or emergencies Financial – item related to budgeting and/or revenues involving federal, state, or other funds Organizational – item related to HDOT policy, processes, personnel, or culture Strategic – item related to data, program processes, operations, or similar
Matrix Reference	Reference number assigned to Risk Matrix developed for a particular risk Item
Response Strategy	Avoid – strategies to reduce or eliminate a risk Minimize – strategies to reduce or minimize the effects Transfer – strategies to transfer (or share) risk to other parties Mitigate – strategies to take acceptable actions to address risk, but may require additional resources Accept – accept that the risk will occur and develop strategies and/or opportunities to address the effects; typically associated with initiatives (such as Everyday Counts), where this may result in possible opportunities, but may affect schedules or cost
Lead Office	Office in HDOT that would be responsible to assess, develop response strategies lead, or participate in the implementation, and monitor effectiveness of implemented strategy

How Resiliency and Risk are Considered in Programming and Projects

Both the PMS and BMS actively consider a variety of risks and resiliency in their programming and prioritization of projects. Pavement projects have a shorter design life than bridges, so the approach to resiliency is different from the approach to bridges, where the design life is typically 75 to 100 years. As mentioned in Chapter 3, the PMS considers the proximity of the pavement to the exposure hazards during programming and design.

Resiliency solutions are addressed in collaboration with the Shoreline and Rockfall programs.

For the Bridge Program, the following resiliency policy was adopted:

HWY-DB Resiliency Policy:
1. Key assumptions: a. The *HDOT Climate Adaptation Action Plan*, dated May 2021, identifies "the 3.2 feet sea level rise (SLR) exposure area projected to occur in the State by the end of the century as one of the primary planning criteria for existing and future development". This policy regards "3.2 feet SLR by the end of the century" as implicit. b. Based on the 3.2 ft. SLR by the end of the century, the *Hawaii Sea Level Rise Vulnerability and Adaptation Report* determined that a 1.1 ft. sea level rise is expected by 2050. c. This policy considers the sea level rise effects on State of Hawaii bridges in the next 30 years and will assume 1.1 ft. SLR as its projection in the next 30 years. d. This policy does not apply to culverts. **2. Determining which State of Hawaii bridges are subject to 1.1 ft. SLR.** a. The *HDOT Climate Adaptation Action Plan*, dated May 2021, Appendix B identifies the online Pacific Islands Ocean Observing System, 2020, Hawaii Sea Level Rise Viewer at: https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/ b. When using the 1.1 ft. SLR on the PACIOOS website, please note that the 1.1 ft. SLR overlay on State of Hawaii bridges also includes: i. Passive flooding which is for all islands. ii. Annual High Wave Flooding which is for only Oahu, Kauai and Maui iii. Coastal Erosion which is only for Oahu, Kauai and Maui c. Using PACIOOS, 1.1 ft. SLR shape files are overlaid over the State of Hawaii bridges in Google Earth. If the 1.1 ft. SLR covers the bridge area (highway approaches), the user should assume the 1.1 ft. SLR will inundate that bridge area *and you will have identified if a State of Hawaii bridge is subject to the 1.1 ft. SLR*. If the sea level rise appears to be limited to the stream area under the bridge, the user should assume the 1.1 ft. SLR will not inundate that bridge. d. Also, as mentioned below, the bridge's highway should be checked for "choke points" along the highway *which will also identify if a State of Hawaii bridge is subject to the 1.1 ft. SLR.*

Source: HWY-DB Bridge Program

The Bridge Program has an identified list of routes, locations, and bridges where portions of the highway are susceptible to the 1.1-foot SLR anticipated in 2050. The first alternative considered for any bridge that needs rehabilitation or replacement that is subject to 1.1-foot SLR is one that does not require the use of a temporary detour road or temporary detour bridge. Other considerations include replacing the existing bridge with a prefabricated steel bridge system that can be easily removed and replaced in the future until a longer-term solution for the highway route is determined (such as harden and remain in place or relocate).

After a project is selected for implementation, additional risks may be considered and either eliminated, minimized, or mitigated at the project level in design. Examples of such other risk-related concerns include maintenance history related to overtopping, scouring, over-height and over-weight vehicle movements, economic importance (for example, Sand Island Bridge, which is a significant freight route), and limited right-of-way.

Therefore, in addition to project identification and prioritization using asset condition and other technical factors within each management system, specific risks are recognized, and additional prioritization considerations are given in addition to the normal prioritization factors within the management system processes.

In addressing these organizational and program-level risks, and further considering project-specific risks, the HDOT is fulfilling the FHWA requirement to consider resiliency and risk in asset management.

Continued Risk Monitoring and Data Collection

After projects are constructed, the HDOT collects post-project data to confirm if unit cost estimates, and other assumptions were accurate. The data are also used to determine the effectiveness of resiliency and risk response measures incorporated in the projects. These data and inspection data provide the foundation for the Bridge and Pavement Management Systems to update asset inventories, forecasting models, and input into the applicable risk registers.

Dependent on the type of data, collection frequencies can be matched with normal cycles prescribed by federal requirements or existing or newly developed HDOT procedures, or as applicable upon completion of projects.

In special circumstances, the HDOT considers incorporating research studies as part of projects that may provide opportunities for alternative construction materials or methods that may be used for risk management responses. Collection of such data would be determined by procedures established in the research project.

Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events

As part of the federal requirements, state DOTs are required to identify roads and bridges that require repeated repair or reconstruction as a result of emergencies. The proposed rule is designed to ensure that state transportation asset management plans are truly risk-based, as required by MAP-21, by ensuring that states have the information required to minimize impacts and increase asset and system resiliency.

> As defined by 23 CFR 667.3, *emergency event* means a natural disaster or catastrophic failure resulting in an emergency declared by the governor of the state or an emergency or disaster declared by the President of the United States.

In 2019, the HDOT conducted a statewide evaluation of all emergency events dating back to January 1997. Using an iterative process, the HDOT cross-referenced the 33 Federal Emergency Management Agency (FEMA) events between January 1997 and May 2019 and 60 State Proclamations between January 1997 and May 2019 with emergency projects that identified work on a road, highway, or bridge with reconstruction elements (permanent repair). Not every emergency event caused permanent damage to the transportation assets. Emergency repairs that minimized the extent of the damage, protected the remaining facilities, or helped to restore essential traffic were not included (23 CFR 668.103). In the 2019 TAMP, 19 locations were identified; there was no transportation asset that had been replaced or reconstructed on two or more occasions as a result of an emergency event.

As required by 23 CFR 667, as of November 23, 2020, the HDOT has included all roads, highways, and bridges in the evaluation, and additional locations were added to the updated summary of emergency events and transportation assets affected. The statewide evaluation must be updated every 4 years and its results must be considered in the TAMP updates and preparation of the STIP. The updated summary of the emergency events and transportation assets affected is provided in Appendix B.

For this TAMP update, the following two locations have received emergency funding on at least two occasions for similar events:

- Route 56, Kuhio Highway, Wailua Bridge, Milepost 5.8: Scour repairs near the piers and footings
- Route 560, Kuhio Highway, Milepost 4.43: Landslide repairs.

A summary of each event is provided in Appendix B.

The Construction Branch maintains a log of all emergency repairs and events. All project managers are required to check the log before their project is submitted to the MRTP and the STIP.

CHAPTER 6

Financial Plan

The purpose of the TAMP financial plan is to create a link between performance targets and project prioritization and funding. The financial plan summarizes current revenue sources, trends, and projections, estimates funding needs, and identifies potential funding needs, and potential funding gaps.

Financial Plan Process

The HDOT uses the following steps to develop its financial plan:

A. **Identify Available Revenue.** The first step in TAMP financial planning is to identify what sources of revenue are available for asset management. In addition, the amount of annual funding available for asset management for the duration of the TAMP needs to be estimated.

B. **Estimate Funding Needs.** In the TAMP financial plan, funding needs are generally described as the amount of money needed in each year of the TAMP period to implement the asset strategies recommended by the life cycle planning, to manage risks, and to address other performance gaps detailed in the TAMP. Estimating the funding needs is not as straightforward as projecting revenue because the funding needs is also dependent on condition targets that the HDOT has selected.

C. **Quantify Funding Gaps.** In Step 3, the results of the revenue projections of Step 1 and the funding needs analysis of Step 2 will be compared. The results of this analysis will indicate if the project annual funding levels are sufficient to achieve the condition targets and mitigate risks and identify whether there is a funding gap or funding surplus.

D. **Selecting an Investment Strategy.** Selecting an investment strategy is an iterative process. If a funding gap is identified, the HDOT will need to conduct a cross-asset (trade-off) analysis. This gap can be addressed in several ways, such as increasing the level of funding, redistributing funding from other programs to asset management, lowering the condition targets, changing life cycle planning strategies, or modifying the HDOT's resiliency and risk mitigation approach and level of tolerance.

Financial Analysis

The following sections are a summary of the recent financial forecast of the Highways that was conducted by the HDOT Statewide Transportation Planning Office for the 2045 HSTP.

State Revenue Sources

The HDOT collects revenues from multiple sources in the form of taxes, fees, and surcharges to fund the operating and capital costs. These sources include charges for services, taxes, grants, and proceeds from highway revenue bonds issued by HDOT Highways. For the 5-year period from fiscal year (FY) 2016 to FY 2020, the average operating revenues (including operating grants) was $367 million, and the average amount for capital grants was $115 million. Revenues are deposited into the State Highway Fund and are used for the design, construction, repair, and maintenance of the public highways. Figure 6.1 summarizes the HDOT Highway's revenue and funding sources.

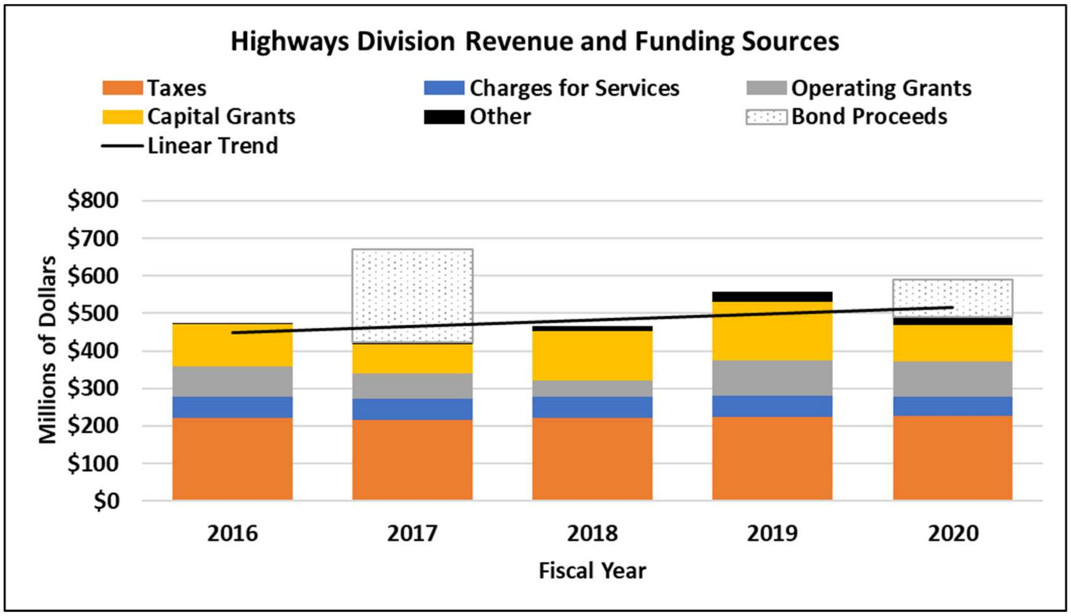

Figure 6.1. State Revenue Resources (millions of dollars)

Charges for Services

Table 6.1 summarizes the revenue items for charges for services. The largest portion includes registration fees and includes revenues generated from annual vehicle registrations. As of June 30, 2020, the vehicle registration fee was $45 per vehicle and the motor carrier safety inspection was $1.50 per vehicle.

Table 6.1. HDOT Highways: Charges for Services, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Vehicle registration fees	$45.0	$45.0	$46.7	$45.9	$42.8
Other fees and permits	$3.2	$3.1	$3.4	$3.2	$3.3
Penalties and fines	$5.6	$5.2	$5.7	$4.7	$3.6
Rentals	$1.4	$1.3	$1.2	$1.1	$1.0
Charges for services	**$55.2**	**$54.6**	**$57.0**	**$54.9**	**$50.7**
Annual percent change	N/A	-1%	4%	-4%	-8%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Note: N/A = not applicable

Taxes

Table 6.2 summarizes the revenue items for taxes related to highways, including the state liquid fuel tax, vehicle weight tax, and surcharge tax for rental motor and tour vehicles.

Annually, these taxes generate approximately $227 million. As of June 30, 2020, the state liquid fuel tax includes the following items:

- Gasoline: $0.16 per gallon
- Diesel Fuel: Non-highway use, $0.01 per gallon
- Diesel Fuel: Highway use, $0.16 per gallon
- Liquified petroleum gas: $0.52 per gallon

The vehicle weight tax ranged from $0.0175 to $0.0225 per pound of the net vehicle weight and is capped at $300 per vehicle. During FY 2018, the rental motor surcharge tax was $3 per day. In FY 2020, the rental motor surcharge tax increased to $5 per day for the rental. Effective January 1, 2022, the rate increased to $5.50 per day for rentals. During FY 2018, the tour vehicles surcharge was $65 per month for vehicles categorized as 25 or more passengers and $15 per month for vehicles categorized 8 to 25 passengers. In FY 2019, the tour vehicles surcharge was increased to $66 per month for vehicles categorized as 25 or more passengers and $16 per month for vehicles categorized 8 to 25 passengers. There is also a car-sharing vehicle surcharge tax of $0.25 per half-hour for rentals by car-sharing organizations.

Table 6.2. HDOT Highways: Taxes, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
State liquid fuel tax	$87.8	$83.0	$83.2	$83.5	$77.3
Vehicle weights taxes and penalties	$79.5	$80.6	$83.9	$83.1	$77.4
Rental motor and tour vehicle surcharge tax	$54.9	$53.2	$54.8	$58.0	$72.5
Taxes	$222.2	$216.8	$222.0	$224.6	$227.2
Annual percent change	N/A	-2%	2%	1%	1%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Operating and Capital Grants

The FHWA provides operating and capital grants for the maintenance and construction of public highways. These grants require a matching share and funds are provided on a reimbursement basis. The annual grant funding changes year over year due to maintenance and construction activity. Capital grant funds, mostly related to FHWA programs, are deposited into the Capital Project Fund. Operating grant funds are deposited into the State Highway Fund. Table 6.3 summarizes the disbursement of grants funds based on the single audit documents for HDOT Highways.

Table 6.3. Highways Operating and Capital Grants, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Operating Grants	$82.2	$68.5	$42.5	$95.6	$93.3
Capital Grants	$112.9	$79.1	$130.9	$155.8	$96.7
Grants	$195.1	$147.6	$173.4	$251.4	$190.0
Annual Percent Change	N/A	-24%	18%	45%	-24%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

The operating and capital grants for highways are derived from FHWA programs. Table 6.4 summarizes the FHWA grant funding provided to Hawaii from 2016 to 2021. During this period, the average apportionment was $180.2 million per year. In 2021, FHWA updated apportionments to states resulting from the Infrastructure Investment and Jobs Act (IIJA). Table 6.5 summarizes the estimated apportionments for FY 2022 to FY 2026.

The apportionments presented in Table 6.4 and Table 6.5 reflect what is available to the State of Hawaii. It is possible that actual spending on projects and reimbursements from FHWA do not track the annual amounts shown. For purposes of the 2045 HSTP financial analysis, it is assumed 25 percent is allocated to cities and counties and 75 percent is allocated to the State. It is also assumed that the State allocation is split between operations (40 percent) and capital (60 percent) based on historical data provided in highway fund annual reports.

Table 6.4. State of Hawaii Allocation of FHWA Apportionments, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020	2021
National Highway Performance Program	$96.0	$98.2	$100.0	$102.1	$104.2	$103.0
Surface Transportation Block Grant Program	48.0	49.1	50.2	51.1	52.2	51.6
Highway Safety Improvement Program	9.4	9.6	9.8	10.0	10.2	10.0
Railway - Highway Crossings Program	1.1	1.2	1.2	1.2	1.2	1.2
Congestion Mitigation and Air Quality Improvement (CMAQ) Program	10.3	10.5	10.7	10.9	11.2	11.0
Metropolitan Planning	1.7	1.8	1.8	1.9	1.9	1.9
National Freight Program	4.9	4.7	5.1	5.8	6.4	6.3
Apportioned Total	$171.6	$175.1	$178.9	$182.9	$187.3	$185.2

Source: HDOT Highways and FHWA

Table 6.5. State of Hawaii Allocation of FHWA Apportionments, FY 2022 to FY 2026 (millions of dollars)

Fiscal Year	2022	2023	2024	2025	2026
National Highway Performance Program	$ 120.9	$ 123.3	$ 125.8	$ 128.3	$ 130.9
Surface Transportation Block Grant Program	58.8	60.0	61.2	62.4	63.7
Highway Safety Improvement Program	12.5	12.8	13.0	13.3	13.6
Railway - Highway Crossings Program	1.2	1.2	1.2	1.2	1.2
CMAQ Program	11.3	11.5	11.7	12.0	12.2
Metropolitan Planning	2.3	2.4	2.4	2.4	2.5
National Freight Program	5.9	6.0	6.1	6.2	6.3
Carbon Reduction Program	5.2	5.3	5.5	5.6	5.7
PROTECT formula Program	6.0	6.1	6.2	6.3	6.5
Total	$ 224.1	$ 228.6	$ 233.1	$ 237.8	$ 242.5

Source: HDOT Highways

Highway Revenue Bonds

On occasion, HDOT Highways will issue highway revenue bonds to fund construction projects, with the bond proceeds deposited into the Capital Projects Fund (Table 6.6). During FY 2016, HDOH Highways issued Series 2016A for $103,395,000 at a premium of $17,107,039 amortized over the life of the bonds. HDOT Highways also refunded outstanding amounts for Series 2008 and Series 2011A by issuing Series 2016B for $101,090,000. During FY 2019, HDOT Highways issued Series 2019A for $81,835,000. In 2021, HDOT Highways issued Series 2021 for $137,205,000 at a premium of $43,908,935 amortized over the life of the bonds. The proceeds from the Series 2016A, Series 2019A, and Series 2021A bonds were used for construction of capital projects. The net proceeds for Series 2016B were used to purchase U.S. Treasury Securities to fund the debt service on the unrefunded portions of Series 2008 and Series 2011A bonds. The annual debt service on outstanding highway revenue bonds is discussed further under Operating Expenses.

Table 6.6. Highway Revenue Bonds, FY 2016 to FY 2021 (millions of dollars)

Fiscal Year	2017	2020	2021
New Money	N/A	N/A	N/A
Series 2016A	$103.4	N/A	N/A
Series 2019	N/A	$81.8	N/A
Series 2021	N/A	N/A	$137.2
Refunding	N/A	N/A	N/A
Series 2016B	$101.1	N/A	N/A
Highway Revenue Bonds	$231.5	$81.8	$137.2

Sources:
FY 2020 Financial Statement for HDOT Highways
Official Statement for State of Hawaii Highway Revenue Bonds, Series 2021

Operating Expenses

Over the past 5 years (FY 2016 to FY 2020), on average the annual operating expenses have been approximately $307 million. Figure 6.2 and Table 6.7 summarize the annual operating expenses. While the annual amount has fluctuated during this period, there has been a slight increase, a compound annual growth rate of 2.5 percent. HDOT Highways's audit report attributes the decrease in FY 2018 compared to FY 2017 to a lower payroll as a result of staff vacancies. The operating costs for HDOT Highways are categorized in the annual audit reports as follows:

- Operations and maintenance
- Motor Vehicle Safety Office
- Surcharges on gross receipts
- Administration of HDOT Highways

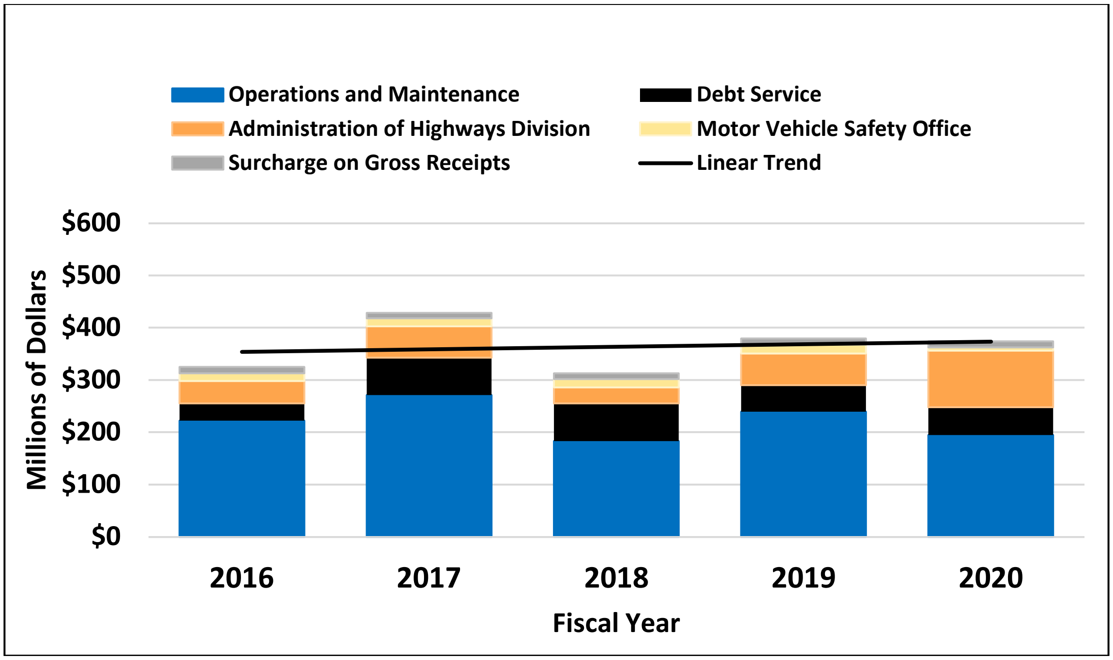

Figure 6.2. HDOT Highways Operating Expenditures

Operations and Maintenance

HDOT Highways' operations and maintenance expense is the largest component of operating expenses. Table 6.7 summarizes the annual operations and maintenance for the past 5 years, organized by island. Operations and maintenance accounts for approximately 72 percent of annual operating expenses.

Motor Vehicle Safety Office

The Motor Vehicle Safety Office oversees highway vehicle safety and was established as part of the Hawaii Highway Safety Act in 1967 and reorganized in 1977 to include heavy motor vehicles. The Motor Vehicle Safety Office accounts for approximately 5 percent of the annual operating expenses.

Surcharge on Gross Receipts

To recover expenses for shared central services among government agencies, the State of Hawaii assesses a 5 percent surcharge on all receipts of the State Highway Fund. The surcharge on gross receipts accounts for approximately 4 percent of the annual operating expenses.

Administration of HDOT Highways

Similar to the surcharge on gross receipts, HDOT Highways is assessed a percentage of the costs for general administration. Assessments account for approximately 19 percent of the annual operating expenses.

Table 6.7. Highway Operating Expenses, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Oahu highways and services	$99.5	$154.2	$109.8	$93.2	$92.1
Kauai highways and services	18.1	22.5	16.0	53.6	20.0
Maui highways and services	25.9	23.5	22.2	45.5	17.8
Hawaii highways and services	22.9	28.0	16.0	12.8	28.1
Molokai highways and services	7.1	5.6	2.1	5.6	2.4
Lanai highways and services	0.5	3.3	0.6	0.3	0.6
Pass through for County highways and services	48.0	33.7	16.3	28.4	33.9
Operations and maintenance	222.0	270.9	183.0	239.3	194.8
Administration of HDOT Highways	42.7	59.7	30.7	60.4	108.4
Motor Vehicle Safety Office	14.5	15.6	15.4	16.9	6.2
Surcharge on gross receipts	12.1	10.0	11.1	11.7	11.6
Total operating	291.3	356.2	240.2	328.4	321.0
Annual percent change	N/A	22%	-33%	37%	-2%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Debt Service

As of June 30, 2020, there were approximately $431 million in highway revenue bonds outstanding, net of unamortized premium and principal payment for FY 2020. Table 6.8 summarizes the amount of highway revenue bonds outstanding. Figure 6.3 summarizes the annual debt service for the past 5 years for the outstanding obligations identified in Table 6.8. Assuming no other highway revenue bonds are issued during the 25-year period from FY 2021 to FY 2045, the outstanding bonds will mature in 2041.

Table 6.8. Highway Revenue Bonds Outstanding, FY 2016 to FY 2020 (millions of dollars)

Highway Revenue Bond Series	Maturity (July 1)	Outstanding Amount
2005B	2021	$12.6
2011	2032	$42.7
2014	2034	$103.5
2016	2036	$190.9
2019A	2040	$81.8
2021A	2027 to 2041	$137.2
	Total	$568.7

Sources:
FY 2020 Financial Statement for HDOT Highways
Official Statement for State of Hawaii Highway Revenue Bonds, Series 2021

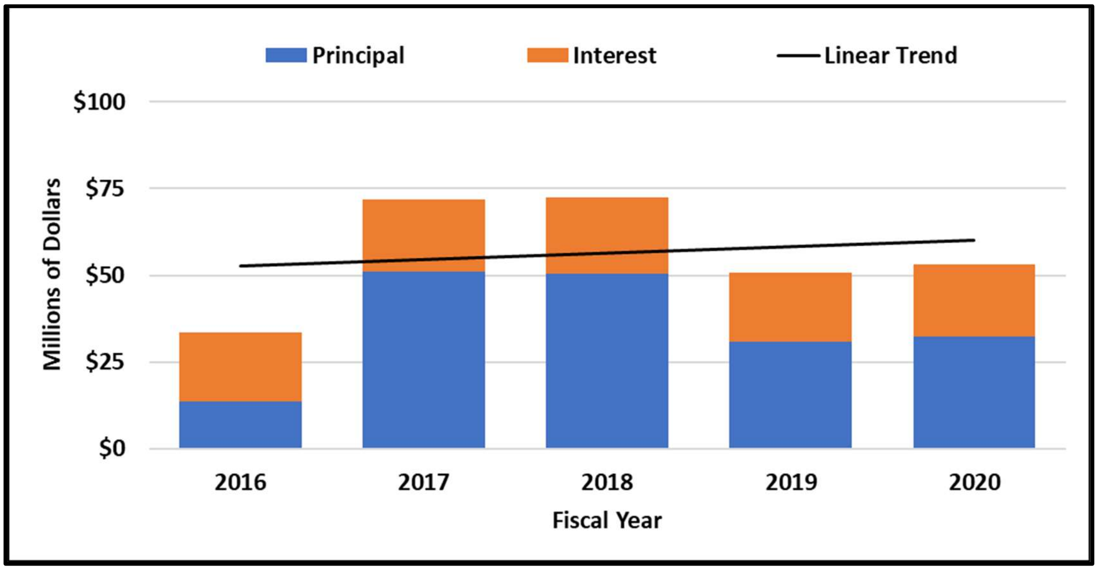

Figure 6.3. HDOT Highways Debt Service

Capital Project Costs

Based on HDOT budgets for HDOT Highways, Figure 6.4 summarizes the historical annual capital budgets amounts by category. The actual capital expenditure may differ from the budgeted amounts, but this summary provides approximate annual capital needs. The budget documents identify funding sources to include capital grants, highway revenue bonds, and the State Highway Fund. Table 6.9 summarize the CIP budget for FY 2016 to FY 2020. It is important to note that this is for planning purposes and may not reflect actual activity, including use of bonds. This table is provided for reference and helps identify a starting point for projections.

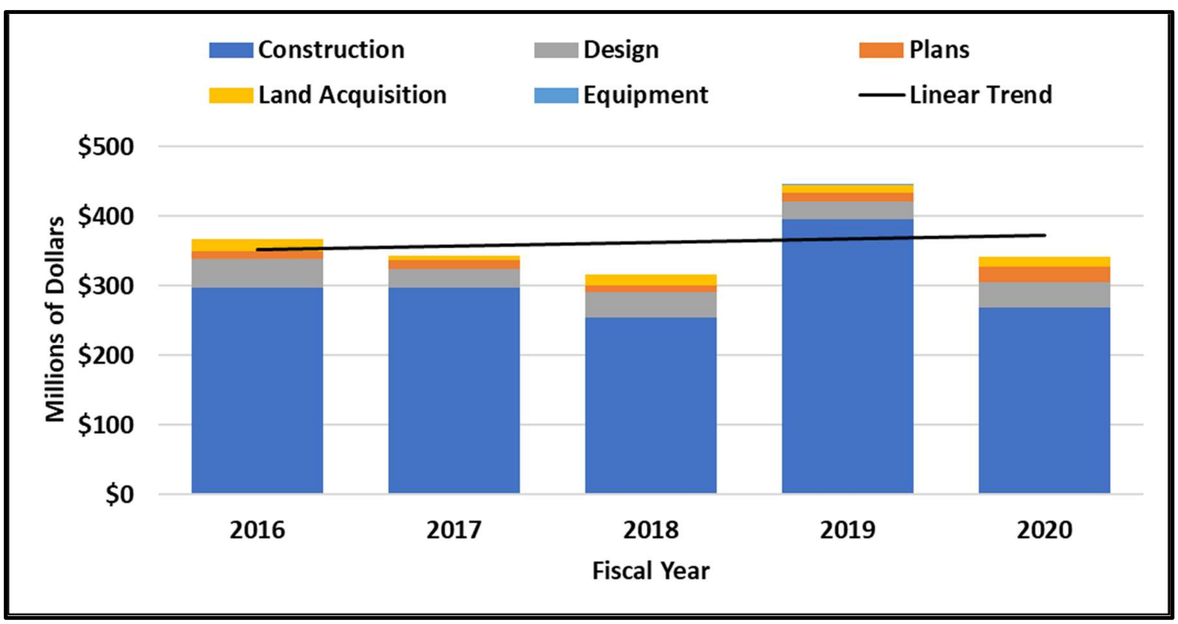

Figure 6.4. HDOT Highways Capital Budget, FY 2016 to FY 2020

Table 6.9. HDOT Highways CIP Budgets, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Use of Funds [a]					
Plans	$12.1	$12.9	$9.7	$12.7	$23.3
Land Acquisition	$17.3	$5.9	$15.4	$10.6	$13.2
Design	$41.3	$26.9	$35.8	$25.3	$35.8
Construction	$296.5	$297.5	$255.0	$395.9	$268.9
Equipment	N/A	N/A	N/A	$1.0	N/A
Total Uses	$367.2	$343.2	$316.0	$445.5	$341.3
Sources of Funds					
Capital Grants [b]	$112.9	$79.1	$130.9	$155.8	$96.7
Special Fund, Bonds and Other [c]	$254.4	$264.1	$185.1	$289.7	$244.6
Total Sources	$367.2	$343.2	$316.0	$445.5	$341.3

[a] Based on HDOT Budgets FB17-19, FB19-21, FB21-23

[b] Based on HDOT Highways Financial Statements FY 2016 to FY 2020

[c] Difference Between Total Uses And Capital Grants

Financial Forecast

10-Year Forecast

A financial forecast of HDOT Highways was prepared as part of the 2045 HSTP, which includes projections for the 25-year study period FY 2021 to FY 2045. As a starting point, the audited financial reports for FY 2016 to FY 2020 were used to analyze historical revenues and expenditures from HDOT Highways. For FY 2021 to FY 2023, the biennial budget (FB21-23) was used. Figure 6.5 summaries the revenues and expenditures for the 10-year financial forecast that is required for this TAMP. The revenues include charges for services, taxes, grants, other income, and is net of transfers. The expenditures include operations and maintenance, administration, Motor Vehicle Safety Office, and surcharge on gross receipts. Debt service includes existing schedules for outstanding obligation, as well as projected debt service for assumed future bond issuances. Based on feedback provided by HDOT Highways, bonds are issued every other year. Projected CIP costs (gross) were calculated based on the 3-year trailing average. As shown on Figure 6.5 and tabulated in Table 6.10, the area between the green line and top of the bars is the amount of revenue over the projected expenditures.

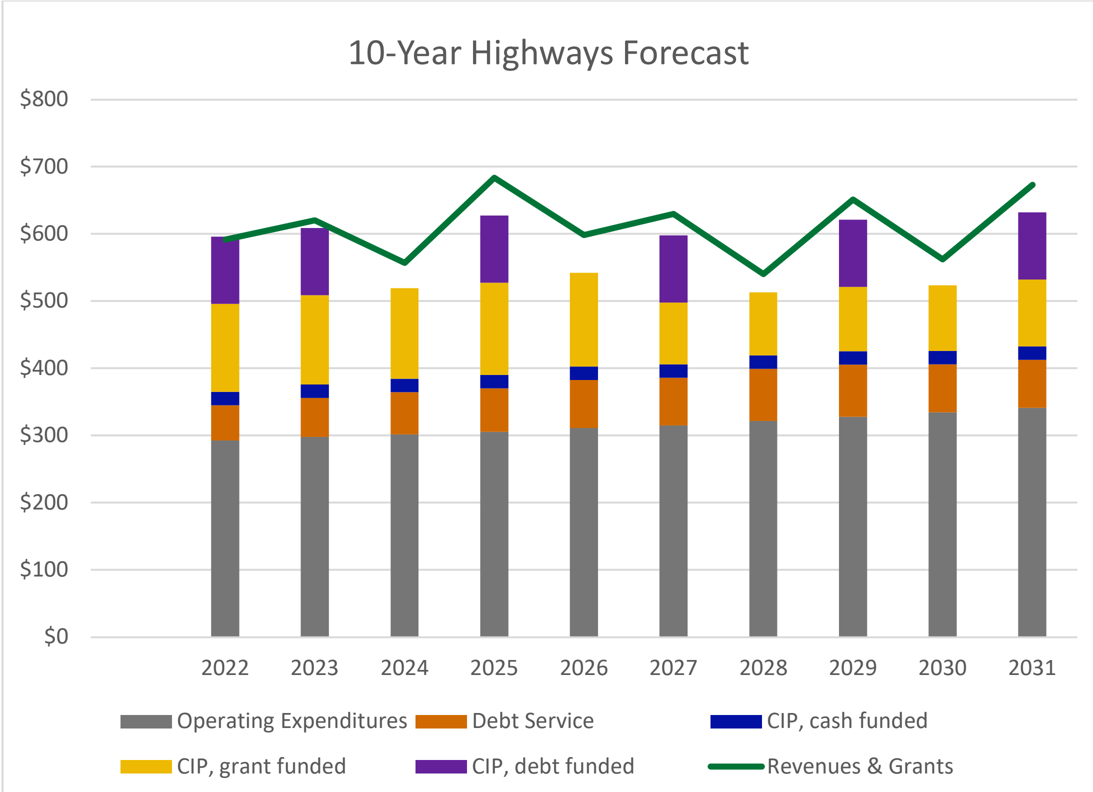

Figure 6.5. 10-Year Financial Forecast

Table 6.10. 25-Year Financial Forecast (Millions of Dollars)

Fiscal Year	Revenues, Grants, and Bond Proceeds ($)	O&M, Debt Service, and CIP ($)	Funding Gap ($)
2022	591	596	4
2023	620	609	0
2024	557	519	0
2025	684	627	0
2026	598	542	0
2027	630	598	0
2028	540	513	0
2029	651	621	0
2030	562	523	0
2031	673	632	0

Funding Needs and Gaps

Although a small funding gap was identified in 2022, not all of the projects that were planned to be obligated in 2022 were obligated. As reflected on Figure 6.6, the current breakdown of funding per program in the current STIP reflects the HDOT Highways commitment to system preservation. HDOT Highways will continue to prioritize the projects necessary to meet the NHS pavement and bridge 2-year and 4-year targets. In the meantime, the HDOT continues to explore sustainable funding solutions that allow Hawaii's economy and communities to achieve their goals. The HDOT will be starting the update of their 20-year Statewide Long-Range Land Transportation Plan, which will include a comprehensive review of the State's transportation needs and CIP to help explore other priorities and how best to efficiently meet the State's mission and goals.

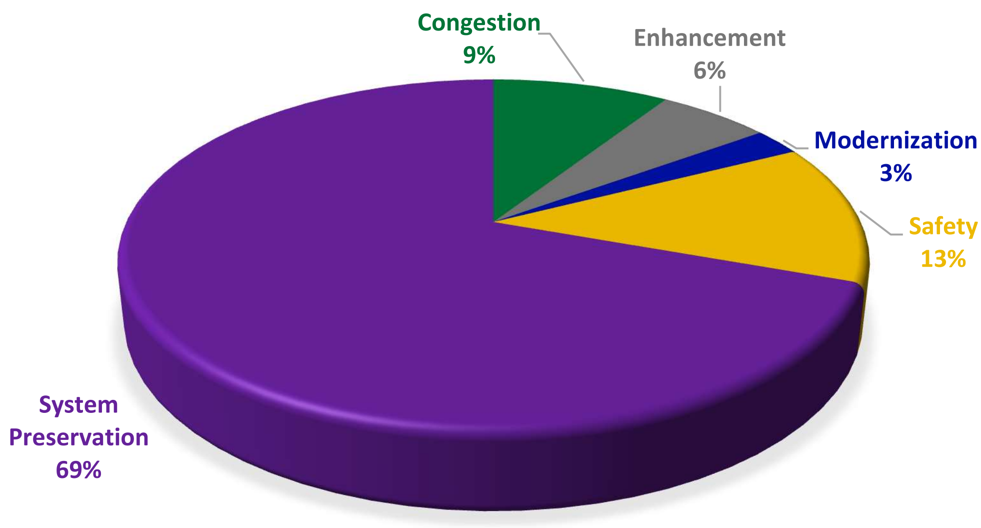

Figure 6.6. HDOT Expenditures by Program in FY 2019-22 STIP

Summary Valuation of NHS Assets

FHWA requires an estimate of the asset value for bridges and pavements on the NHS be included in the TAMP. This asset valuation is summarized in Table 6.11.

Table 6.11. Summary of Inventory and Asset Value of NHS Pavement and Bridge Assets

National Highway System Asset	Count	2021 Asset Value
Bridges	12.1 million square feet (deck area)	$2.6 billion
Interstate Pavements	317 lane-miles	$2.4 billion
Non-Interstate Pavements	1,179 lane-miles	$4.9 billion
Total	**-**	**$9.9 billion**

Source: HDOT Highways Fiscal Office

Asset value is recorded at estimated historical cost and does not take into account maintenance or rehabilitation. Therefore, replacement value is often more meaningful when analyzing future costs. The replacement values of NHS pavement and bridge assets are summarized in Table 6.12.

Table 6.12. Replacement Value of NHS Pavement and Bridge Assets

National Highway System Asset	Count	Unit Replacement Cost	Current Replacement Value
Interstate Bridges	9.1 million square feet (deck area)	$8,000/ square foot	$72.8 billion
Non-Interstate Bridges	3.0 million square feet (deck area)	$6,000/ square foot	$18.0 billion
Pavements	739 centerline miles	$5 million/centerline mile	$3.7 billion
Total			**$94.5 billion**

CHAPTER 7

Life Cycle Planning

Life cycle planning is an integral part of the TAMP approach and can be applied to any highway asset that relies on maintenance and perseveration activities to cost-effectively extend its service life. Life cycle planning is performed at the network level, where the needs of all assets in a system are considered over a specified period. The general stages of an asset life cycle are shown on Figure 7.1.

Life cycle planning saves money. It helps to achieve the lowest practical cost for improving and preserving the HDOT's transportation assets.

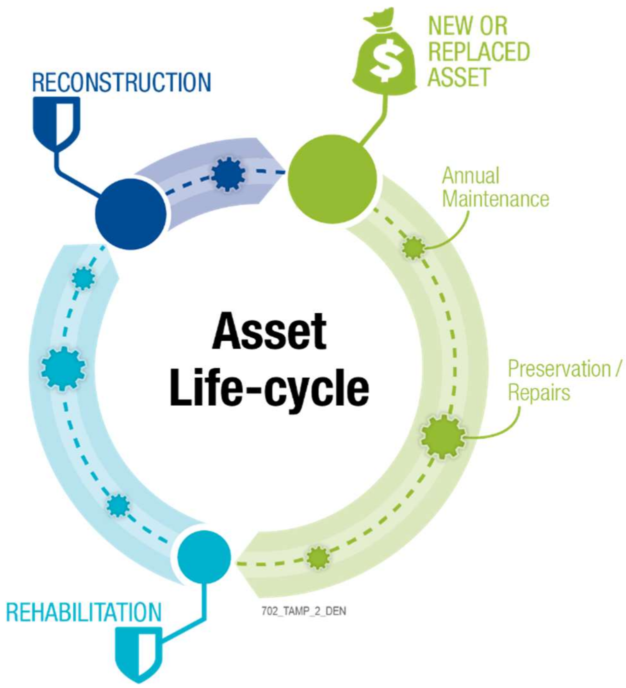

Figure 7.1. Stages of an Asset Life Cycle

Life cycle planning considers the cost and benefits of an asset from the time its need is identified until the need no longer exists and the asset is replaced or retired. It requires consideration of future outcomes and not just current performance. By considering the current condition of system assets relative to their life cycle, actions can be developed that reduce long-term costs, which in turn allows a wider range of investment choices. To this end, the HDOT's TAMP is based on a maintenance and preservation philosophy to prolong the service life of HDOT assets and get the best return on the HDOT's investment.

Federal Requirements

FHWA requires that state DOTs establish a process for conducting life cycle planning at the network level for NHS pavements and bridges. FHWA defines life cycle planning as "a process to estimate the cost of managing an asset class, or asset subgroup over its whole life with consideration for minimizing cost while preserving or improving the condition." Life cycle planning should include potential work types, including treatment options and unit costs, identification of deterioration models, and a strategy for minimizing life cycle costs and achieving asset performance targets.

Life Cycle Planning Process

The HDOT is using the AASHTOWare BrM system for bridges and dTIMS software for pavements to support life cycle and investment planning. Both BrM and dTIMS meet the requirements outlined in 23 CFR 515.17 and is part of a multi-step process used for conducting the following steps to conduct its life cycle planning analysis:

A. **Select and identify the asset classes and networks that will be analyzed.** The HDOT will decide how best to develop a life cycle planning scenario for its transportation network. For example, a different life cycle planning scenario may be developed for the NHS system vs. the rest of the state's transportation system.

B. **Define life cycle planning strategies.** Each life cycle planning strategy includes a variety of treatment costs and options that considers the condition and asset performance needs (deterioration rates) over the life of the asset. The following section shares some of the preservation treatments that the HDOT uses and the importance of implementing preventative maintenance. Various treatment options are used to address the pavement and bridge network, including routine maintenance, preservation, rehabilitation, and reconstruction.

C. **Set life cycle planning scenario inputs.** Establish the analysis period to be used, desired state of good repair, identify risks, anticipated funding levels (which comes from financial planning), and any constraints or requirements, such as minimum pavement and/or bridge conditions, that must be taken into consideration in evaluating life cycle planning scenarios. The variety of life cycle planning scenarios include a preservation scenario, a worst-first scenario, and a hybrid of the two.

D. **Run various life cycle planning scenarios.** Using the asset strategies developed in Step B and the inputs from Step C, various life cycle planning scenarios are run. Because of the iterative nature of the analysis, the development of these scenarios may lead back to Step B and the development of new asset strategies.

E. **Select an investment strategy.** Using the information from Step D, professional judgement, and an agreed-upon funding scenario, the best strategy to carry forward is selected and implemented.

Minimizing the Whole Life Cost

While the HDOT strives to make facilities, equipment, and other assets function for a long, useful life at the lowest reasonable cost, they are challenged by the dual problems of deferred maintenance and balancing current needs with future needs. The HDOT's life cycle planning process is guided by our BMS and PMS that uses deterioration models for elements, specific work actions, and costs to generate system-wide recommendations. The HDOT is committed in investing in life cycle planning strategies, which prioritizes preventative maintenance.

Figure 7.2 shows the importance of how timely investments in an asset can result in improved condition and lower long-term cost. Figure 7.2 reflects the HDOT's previous practice of rehabilitating asphalt pavement (mill and fill) every 12 years until a full reconstruction is needed after 60 years. With the consideration of a 2 percent inflation rate per year, the full pavement life cycle cost is $29.0 million. Figure 7.2 also reflects the implementation of preventative maintenance activities over the full pavement life cycle.

With the consideration of a 2 percent inflation rate per year, the full pavement life cycle cost is $21.4 million.

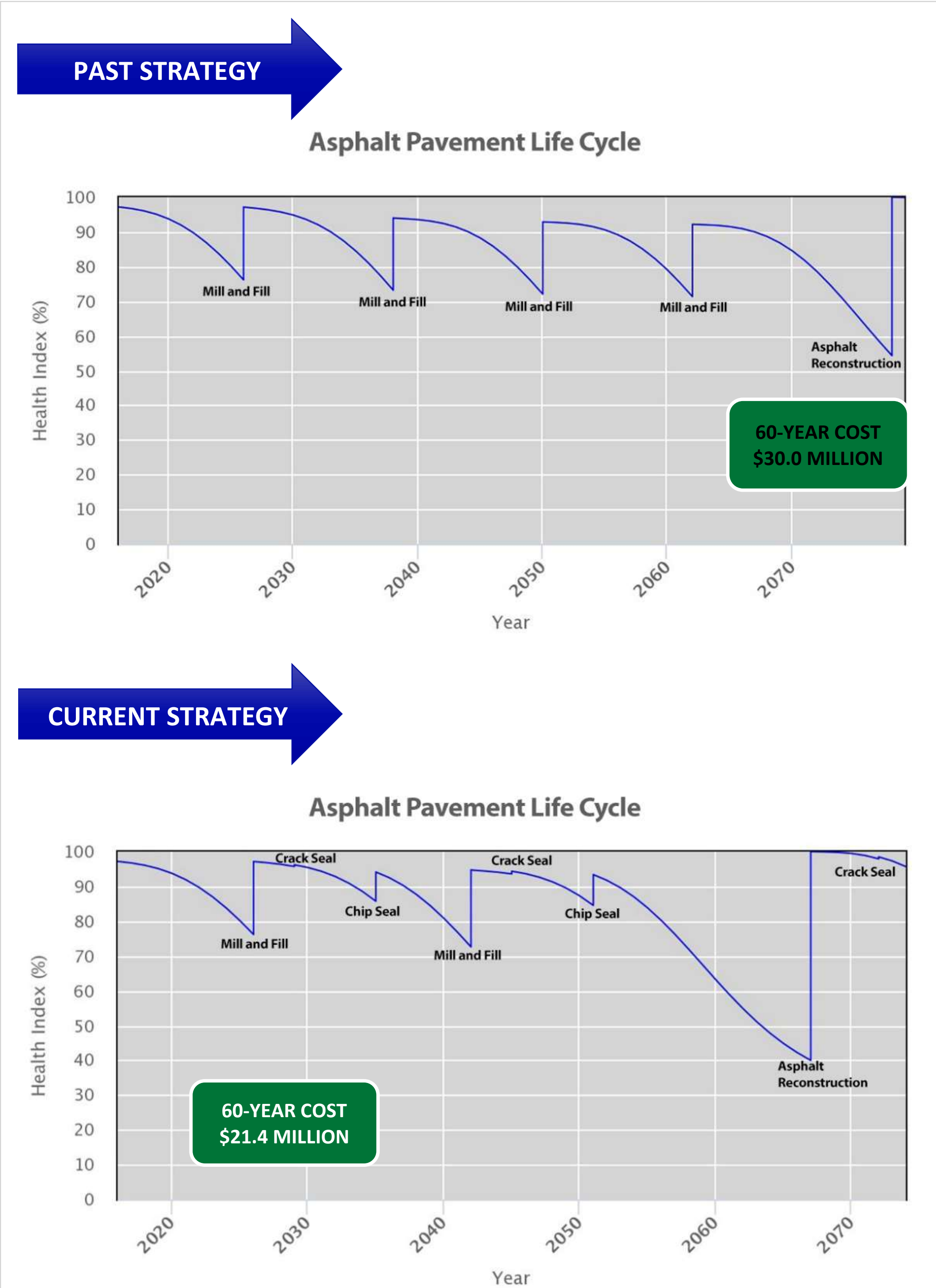

Figure 7.2. Pavement Preservation Strategies

Life Cycle Planning Strategies

A preservation strategy is designed to include low-cost treatments for assets already in good condition and to keep these assets in good condition longer. It optimizes the timing of rehabilitation and replacement options, as effective preventative maintenance activities involve a small, near-term expenditure calculated to avoid or delay a later, much larger expenditure. Agencies have found that asset strategies employing low-cost treatments that extend service life, preserve desired asset conditions longer, and postpone the need for rehabilitation can be effective at reducing performance gaps. This approach also enables agencies to reallocate more funding towards other preservation needs by deferring the need for more costly rehabilitation activities.

The HDOT is committed to achieving the lowest practical cost for improving and preserving HDOT's transportation assets over the service life of its assets. As the next section shares, the HDOT is committed to activities or strategies that prevent, delay, or reduce deterioration of its elements, keeps it assets in good or fair condition, and extends their service life. These maintenance and preventative activities may be cyclic or condition driven.

The challenge for the HDOT has been to strive to keep the percent poor condition low, while conducting enough preventative maintenance to keep the good condition from dropping to fair and the fair condition from dropping to poor. The HDOT continues to work towards a preventative maintenance approach for both pavement and bridge, while balancing needs, maintenance, staff resources, and funding.

Preservation Treatments

Pavement

The HDOT maintains State-managed roadways by programming and executing maintenance strategies that address the needs of the roadway. Each maintenance strategy uses a combination of treatment activities that optimize the pavement life cycle and reducing overall life cycle costs. Treatment activities can be separated into the following four categories:

1) Routine Maintenance: Routine maintenance generally consists of day-to-day activities that are scheduled for maintenance personnel to preserve a desired level of service to the users. Typical work may include clearing of roadside shoulders, cleaning of drainage structures, or filling of potholes.

2) Preventative Maintenance: Preventative maintenance activities are cost-effective, proactive, surface treatments that prevent the deterioration of pavements that are in good structural and operational condition.

3) Rehabilitation: Rehabilitation activities address pavements in overall poor condition due to surficial deterioration with limited or no indications of structural failure.

4) Reconstruction: Reconstruction activities are the most expensive and invasive treatment activity that can be employed. Reconstruction is typically used where the surficial pavement structure is in a poor condition and there are indications that the underlying layers are structurally deficient or need to be rebuilt to accommodate current or future traffic conditions.

Table 7.1 shows the pavement preservation and rehabilitation treatments that the HDOT is pursuing. These work activities are incorporated into the asset management process and the HDOT PMS's life cycle planning. The PMS software breaks up the road network into chunks using what is called a segmentation analysis. The segmentation analysis looks for road sections (that is, Begin Mile Post and End Mile Post), such that the road condition is similar enough to be treated as a singular unit. The PMS software applies the assigned deterioration rates to the project section to forecast future IRI, cracking, rutting, and faulting conditions for the next 25 years. The software calculates condition improvement for these metrics for every single treatment HDOT performs, for every single year in the analysis period, and returns a benefit/cost ratio for every single possible treatment that HDOT could consider performing. Annual budgets are provided to the system as an iterative process to project the targeted percent poor. As the result, dTIMS creates a construction program that represents the best investment strategy that can be performed for that budget and recommends a program of work activities based on various funding scenarios and the goal of more cost-effectively extending the life of pavements in good condition statewide at the lowest practical cost.

Table 7.1. Pavement Management System Work Activities

Work Activity	Activity Type	Unit Cost
Preservation/ Preventative	Asphalt Crack Fill/Seal	$30,000 to $500,000 per lane-mile
	Asphalt Slurry Seal	
	Asphalt Microsurfacing (pilot)	
	Asphalt Thin Overlay	
	Concrete Joint Resealing	
	Concrete Spall Repair	
	Concrete Diamond Grinding	
Rehabilitation	Asphalt Localized Repair	$400,000 to $900,00 per lane-mile
	Asphalt Mill and Fill	
	Concrete Dowel Bar Retrofit	
	Concrete Slab Replacement	
Reconstruction	Asphalt Reconstruction	$1,100,000 to $2,300,000 per lane-mile
	Concrete Reconstruction	

As part of investment planning for pavement on the Interstate NHS, three levels of performance scenarios were considered:

1) Upper limit of 5.0 percent poor
2) Upper limit of 4.0 percent poor
3) Upper limit of 3.0 percent poor

These analyzed levels of performance resulted in an average annual expenditure of approximately $27 million, $30 million, and $40 million, respectively. The resulting construction program for each level of performance includes a hybrid of preservation and rehabilitation treatments that were selected by the PMS based on overall network improvement. With the need to reduce the percentage of poor Interstate pavements, a hybrid scenario approach to effective preservation and worst-first best achieved the desired targets; therefore, an upper limit of 4 percent poor, or $30 million average annual expenditure, was selected to be implemented by the HDOT.

Figure 7.3 presents the anticipated percent of Interstate NHS pavements in good condition. The solid line represents the investment strategy that was selected by HDOT, and the dotted lines represent the considered strategies, for reference.

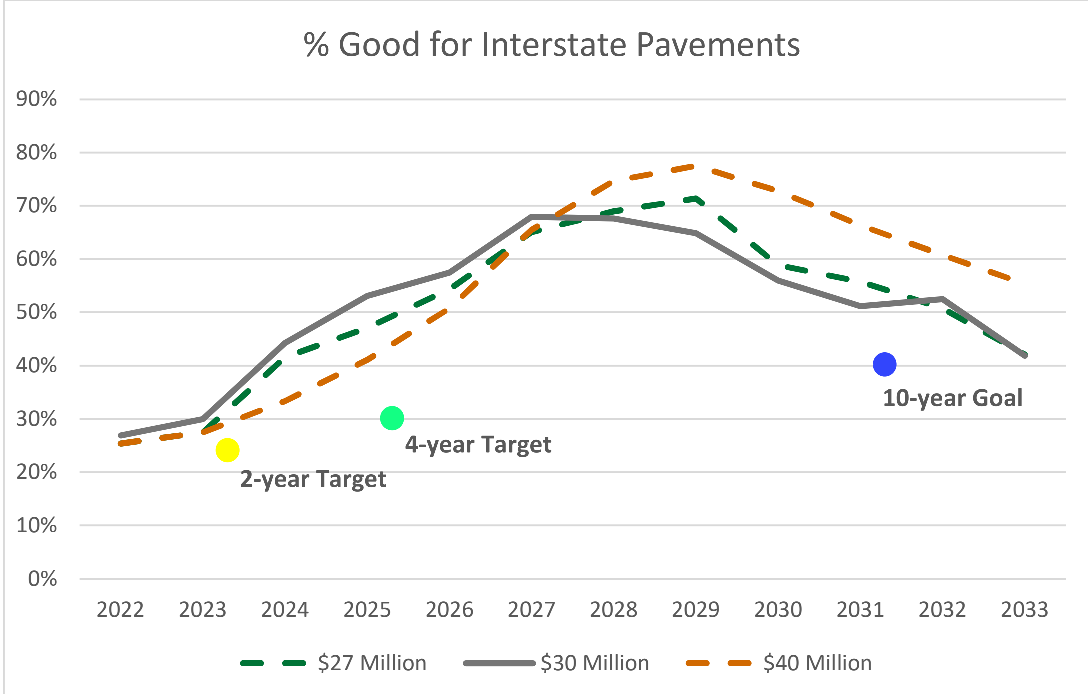

Figure 7.3. Projected State of Good Repair for Interstate Pavements

Figure 7.4 presents the anticipated percent of Interstate NHS pavements in poor condition. Again, the solid line represents the investment strategy that was selected by the HDOT, and the dotted lines represent the considered strategies.

The steep decline in percent of Interstate NHS poor pavement between FY 2026 and FY 2028 can be attributed to several large treatments being planned. Preservation work activities will not be enough to prevent the good and fair pavement from reaching a poor condition. More than 7 centerline miles of pavement of the total 55 centerline miles of Interstate NHS pavement are scheduled to be treated within FY 2026 and FY 2028, which is more than 10 percent of the total Interstate roads in Hawaii. In addition, the higher project costs for work on the Interstate NHS may be attributed to the fact that approximately 45 percent of the Interstate NHS is concrete pavement, which can delay the prioritization of the project.

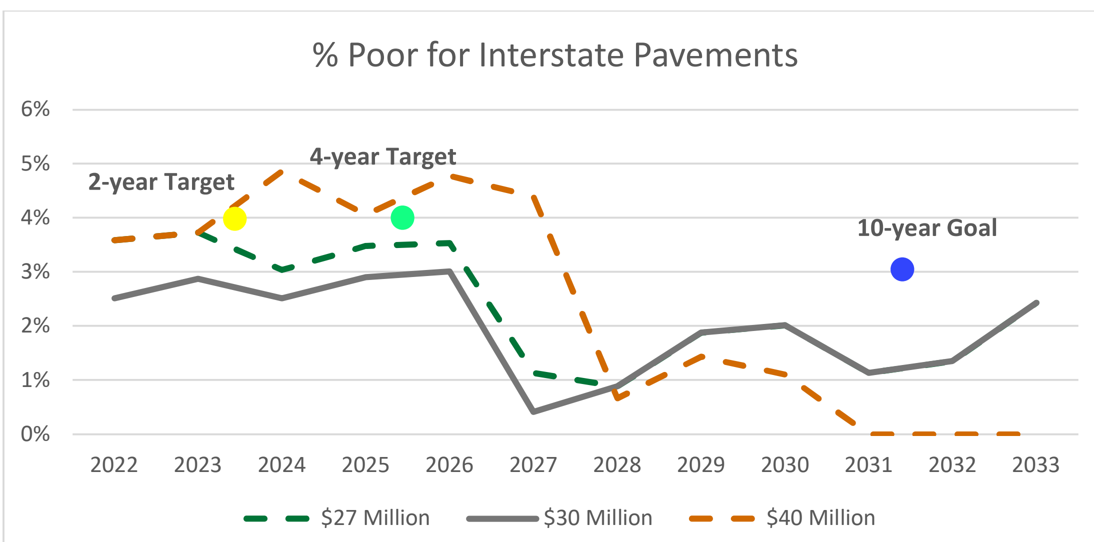

Figure 7.4. Projected State of Poor Repair for Interstate Pavements

As with the Interstate NHS, as part of investment planning for pavement on the Non-Interstate NHS, three levels of performance scenarios were considered:

1) Upper limit of 5.0 percent poor
2) Upper limit of 4.0 percent poor
3) Upper limit of 3.0 percent poor

The analyzed levels of performance resulted in an average annual expenditure of approximately $55 million, $60 million, and $70 million, respectively. The resulting construction program for each level of performance includes a hybrid of preservation and rehabilitation treatments that were selected by the PMS based on overall network improvement. Based on the results of the PMS, the most effective strategy is one that has an equal emphasis on life cycle planning strategies and condition-based strategies. An upper limit of 4 percent poor, or $60 million average annual expenditure, was selected to be implemented by the HDOT.

Figure 7.5 presents the anticipated percent of Non-Interstate NHS pavements in the state of good repair. Here also, the solid line represents the investment strategy that was selected by the HDOT, and the dotted lines represents the considered strategies.

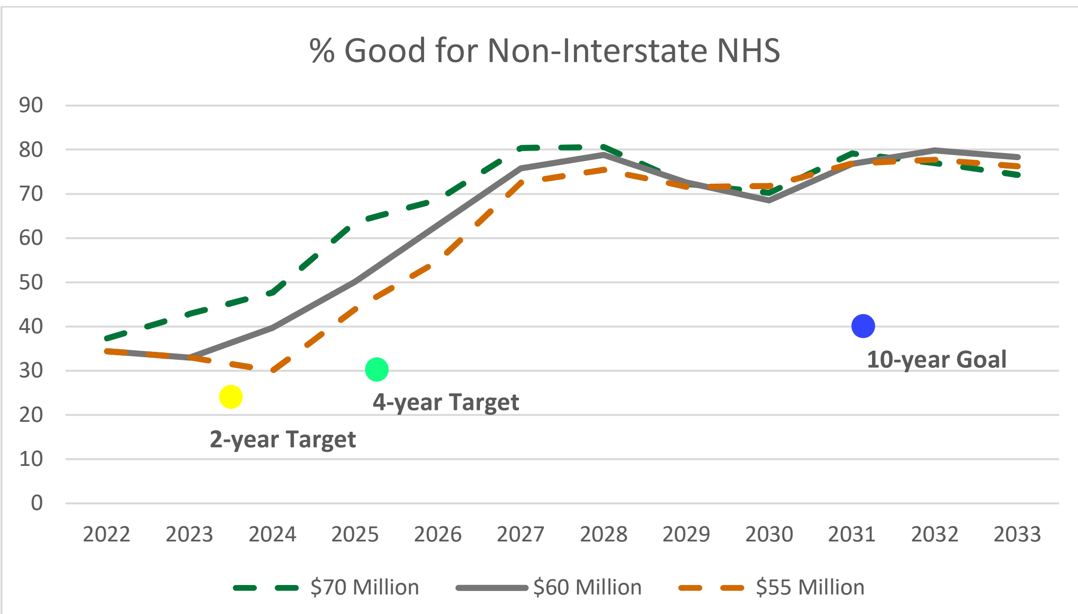

Figure 7.5. Projected State of Good Repair for Non-Interstate NHS

Figure 7.6 presents the anticipated percent of Non-Interstate NHS pavements in a state of poor repair. The solid line represents the investment strategy that was selected by HDOT, and the dotted lines represents the considered strategies.

In contrast to the Interstate NHS, the condition distribution is less influenced by individual treatments due to the Non-Interstate NHS having more than 450 centerline miles of pavement on the system. In addition, approximately 95 percent of the system is asphalt concrete pavement, which results in more uniform project unit costs and uniform network influence. The emphasis on life cycle planning strategies is an effective preservation approach. Preservation work activities will help to prevent the pavement from reaching a poor condition. For the Non-Interstate NHS, a greater emphasis was placed on the life cycle analysis to prevent good and fair pavement from transitioning to poor pavement. Due to the condition of the poor pavements, costly reconstructions project will be necessary to raise the % poor number. With limited budgets and a desire to maintain what is in place, less reconstruction projects are planned over the next 10 years.

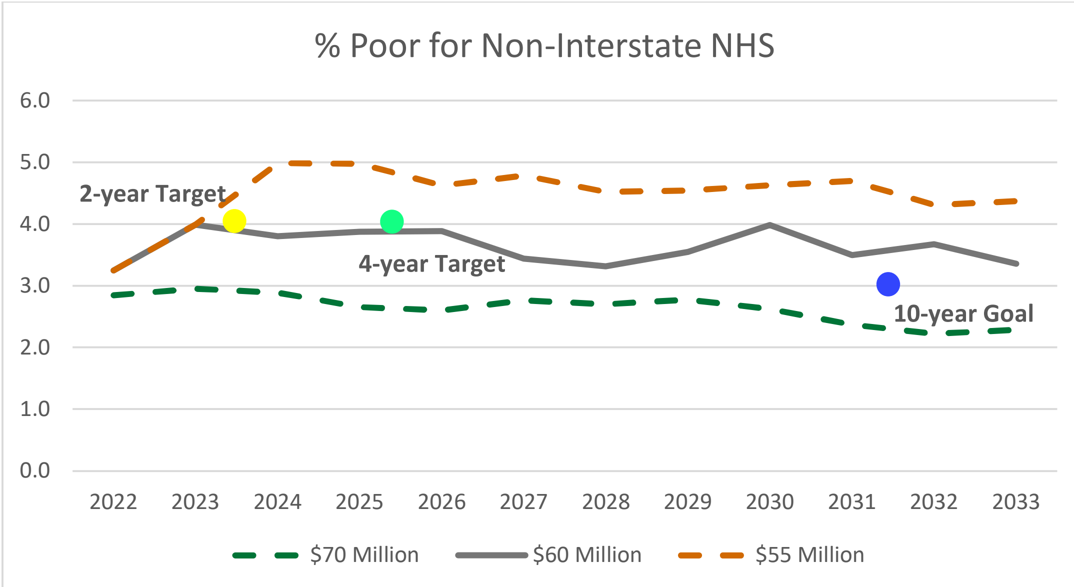

Figure 7.6. Projected State of Poor Repair for Non-Interstate NHS

Bridge

The BrM program also conducts a life cycle cost analysis for bridges for given treatments or work to ensure the lowest practical cost over the life span of a structure. The BrM considers the deterioration of 70 bridge elements and 43 different defects. Similar to the PMS, the BMS produces a recommendation of work activities based on various funding scenarios and the goal of more cost-effectively extending the life of bridges in good condition statewide. The HDOT also implements best practices in its maintenance work activities for bridges. Crack sealing, spall repairs, inlet cleaning, and bridge inspections are done annually, in addition to the preservation, rehabilitation, and reconstruction work activities. Table 7.2 has the bridge work activities and preventative measures that have been incorporated into BrM.

Using the condition and appraisal data available, the HDOT BMS assigns each bridge in its inventory to a subprogram and an action, if applicable, to restore or keep the bridge in a state of good repair. The assigned actions (that is, potential projects) are in accordance with the following work types:

1) Routine and Preventative Maintenance: Routine and preventative maintenance includes work or strategies that arrest or slow the deterioration of a bridge to keep it in good or fair condition. They can also consist of day-to-day activities to preserve a desired level of service to the users. Work or strategies that restore the condition of a bridge are categorized as preservation.

2) Preservation: Preservation involves work that restore the condition of a bridge while it is in good or fair condition. Restoration work includes minor non-structural repairs of elements and major non-structural repairs of components (that is, rehabilitation).

3) Rehabilitation: Rehabilitation involves work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects. Work includes localized structural repairs of components, major structural repairs of bridges (that is, structural rehabilitation), partial or complete component replacement (that is, reconstruction), major safety improvements, strengthening, and seismic retrofits.

4) Replacement/Initial Construction: Replacement involves the total replacement of an existing bridge with a new facility constructed in the same general traffic corridor. This is new or initial construction.

Table 7.2. Bridge Life Cycle Work Activities

Work Activity	Activity Type	Frequency (years)	Baseline Unit Cost
Preventative Maintenance	Paint Structure	*Additional information can be found in the HDOT Bridge Asset Management Manual (BAMM)*	$315/square foot
	Scour Countermeasures		$140/square foot
Preservation	Repair of Steel Bridge		$325/square foot
	Repair of Concrete Bridge		$500,000/bridge
	Repair of Culvert		$300,000/bridge
	Rehabilitation of Steel Bridge		$885/square foot
	Rehabilitation of Concrete Superstructure or Substructure		$375/square foot
	Rehabilitation of Deck		$75/square foot
	Rehabilitation of Culvert		$125/square foot
Rehabilitation	Replacement of Deck		$1,100/square foot
	Structural Rehabilitation of Concrete Bridge		$800/square foot
	Structural Rehabilitation of Steel Bridge		$2,600/square foot
	Structural Rehabilitation of Culvert		$175/square foot
	Seismic Retrofit		$140/square foot
Replacement	Replacement of Concrete Bridge		$6,030/square foot
	Replacement with Modular Steel Bridge		$3,250/square foot

Figures 7.7 and 7.8 show the projected state of good and poor repair for the next 10 years. For the Bridge Program, ambitious targets of 2 percent poor and 20 percent good were selected. To meet those targets, an aggressive preservation, rehabilitation, and replacement strategy scenario was run, and an annual amount of $78 million is needed as a comfortable baseline. As reflected in the scenarios presented here, if preventative actions are not implemented, a large number of NHS bridges will slip from fair to poor condition.

Both Figures 7.7 and 7.8 reflect a range of spending scenarios, with the following outcomes:

- $67.4 million average is the baseline scenario
  - Reduces the percent poor bridges
  - Advances preservation rehabilitation to prevent percent poor from increasing
  - Maintains the percent good bridges
- $75.2 million average scenario
  - Performs the outcomes for the baseline
  - Advances preservation rehabilitation projects on fair bridges

- $52.9 million average scenario
  - Performs the outcomes for the baseline
  - Reduces funding (projects) for bridges in the fair condition
- $50.4 million average scenario
  - Performs the same outcomes for the $52.9 million scenario
  - Reduces funding (projects) for bridges in the good condition
- $43.7 million average scenario
  - Performs the same outcomes for the $50.4 million scenario
  - Reduces funding (projects) for bridges in the poor condition

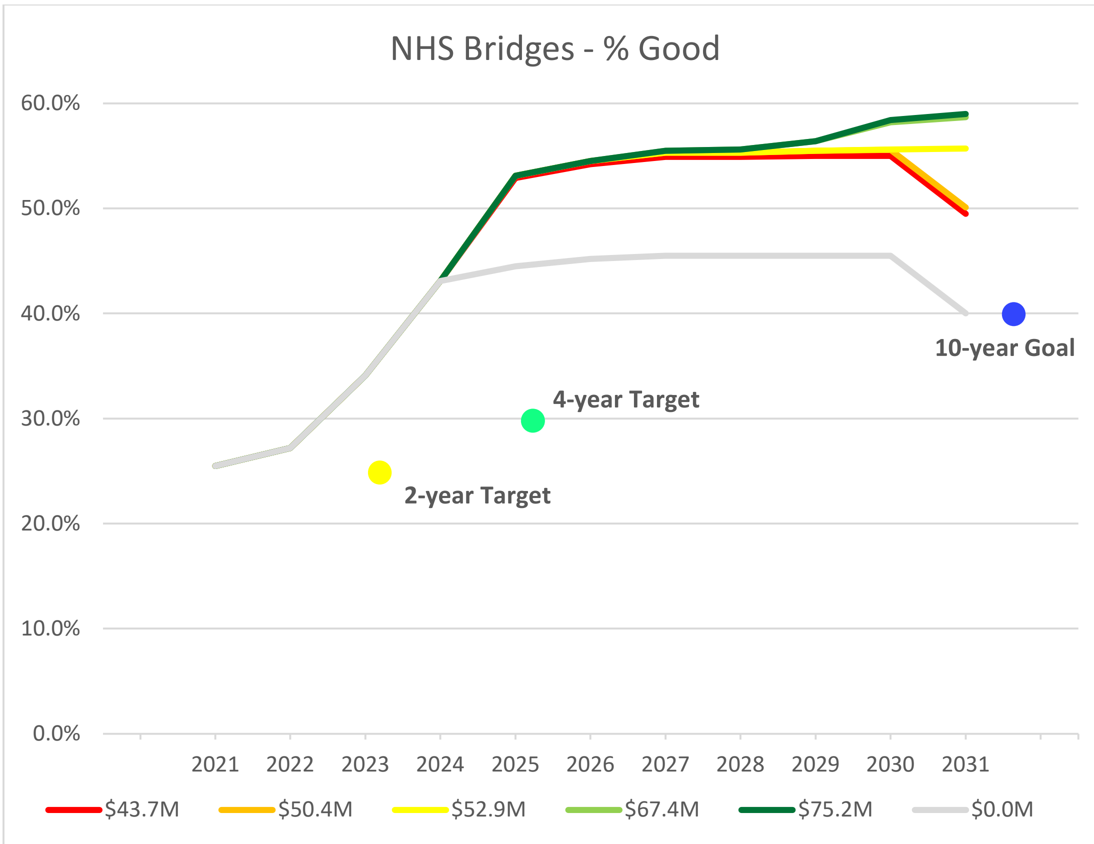

Figure 7.7. Projected State of Good Repair for NHS Bridges

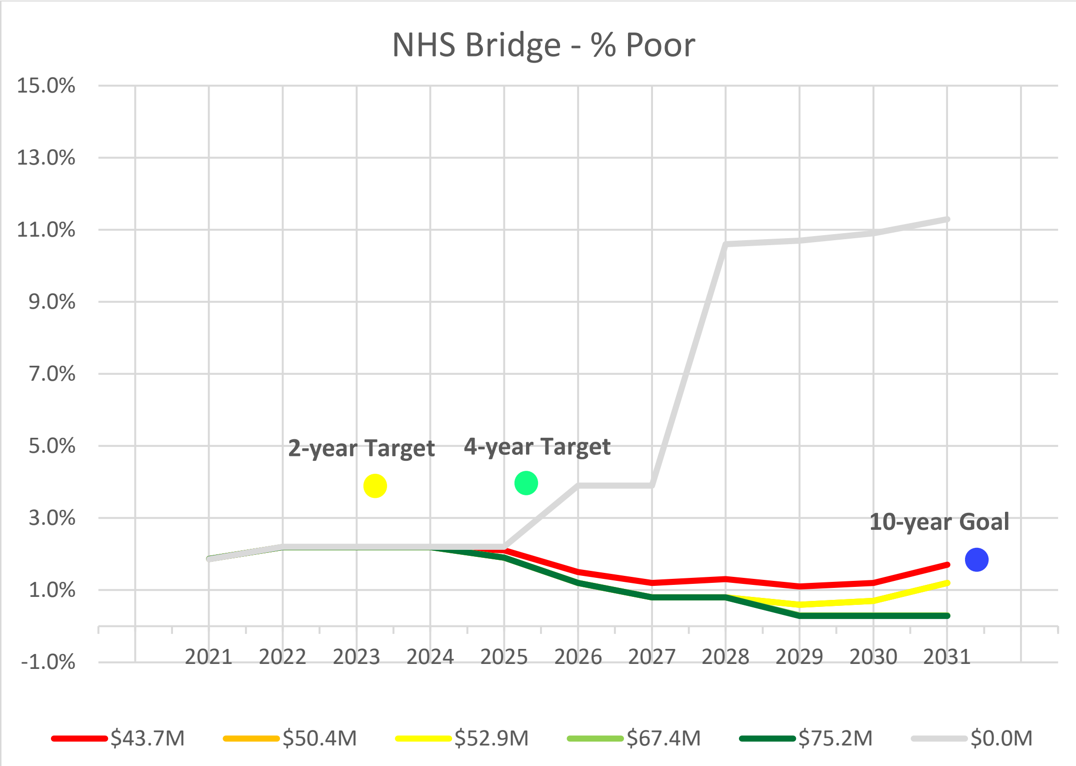

Figure 7.8. Projected State of Poor Repair for NHS Bridges

Implementation

Using the Life Cycle Planning Process steps, the HDOT implements the pavement and bridge work activities through its PMS and BMS and programming. The preservation strategies are implemented at the network level so that the HDOT can devise an optimal long-term strategy. Realistically, the number of projects that can be delivered and implemented will vary by year based on the project status, environmental impacts, priorities, and staff resources. As the various strategies and work activities are implemented, the HDOT continues to collect data on the cost and effectiveness. The HDOT will use the data to reinforce or revise the predictive models of how the assets will deteriorate following different types of treatments. The HDOT does not have decades of data that can be used to create custom, localized deterioration models that reflect our corrosive, salinity-rich environment. Some of the deterioration models within the BrM and dTIMS softwares are based on industry standard. As more data are collected and validated, the HDOT will have more reliable bridge and pavement condition models to implement. The modeling of future asset conditions based on funding assumptions and application of life cycle strategies will continued to be improved and inputted to the BrM and dTIMS softwares.

CHAPTER 8

Performance Gap and Investment Strategies

As noted in Chapter 4, this TAMP provides an opportunity for the HDOT to develop performance measures and targets that unify federal, state, and regional goals and link observed performance to subsequent planning and programming decisions. These performance targets can be used to compare the current condition against the desired performance condition. Any gap between the current condition and desired condition will inform the HDOT about the improvements and cost that may be necessary to meet asset management objectives.

Performance Gap Analysis Process

The HDOT is using the following steps to conduct its performance gap analysis:

A. Performance measures were proposed and established in Chapter 4 of this TAMP.

B. The current condition of the assets is presented in Chapter 3 of this TAMP.

C. BrM is used to conduct multiple performance-based scenarios based on condition and life cycle policies and consideration of the full life cycle. In addition, funding assumptions and risks are considered.

D. Based on the results of the different life cycle planning scenarios, the HDOT is able to identify a performance strategy and the gap between the desired condition or target and the current condition.

E. If a gap occurs between the desired condition/target and current condition, investment strategies will be identified to close or reduce the gaps.

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

What are the Gaps between Existing and Desired Performance?

The current asset conditions for NHS pavement and bridges were shared in Chapter 3. With the application of life cycle planning strategies shared in Chapter 7, the HDOT is planning on investing in more preventative maintenance strategies to cost-effectively minimize the life cycle cost and extend the overall pavement and bridge life.

The HDOT conducted a forecast of revenue over the next 10 years; this forecast is reflected in Chapter 6, where there is an anticipated $6,106 million in revenue over the next 10 years. The HDOT administration has committed to provide the funding necessary to achieve the program's desired targets.

Table 8.1 presents the performance gap analysis for the NHS Interstate pavements, showing the HDOT-planned investments and life cycle strategies appear to be effective in the HDOT meeting its 2- and 4-year targets and 10-year goal for the Interstate. There is a positive performance gap for the Interstate. As mentioned in Chapter 7, the HDOT does not have decades of data that can be used to create custom, localized deterioration models that reflect our corrosive, salinity-rich environment. Some of the deterioration models within the BrM and dTIMS softwares are based on industry standard and are not accurate for Hawaii's conditions. As more data are collected and validated, the HDOT will have more reliable bridge and pavement condition models to implement. In addition, there has been a transition in the models between BrM and dTIMS. The HDOT has chosen to be conservative in establishing their 10-year goal with the acknowledgement that the goal will likely change as more local data is collected and built in the pavement and bridge management systems. In the meantime, the current performance scenario results of the BrM and dTIMS software are reflected in Tables 8.1, 8.2, and 8.3.

Table 8.1. NHS Interstate Asset Performance and Gap

NHS INTERSTATE	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$21.4 million	17.2%	4.9%
2-year Target (2023)	N/A	25%	4%
2-year Projection	$23 million	42%	3%
4-year Target (2025)	N/A	30%	4%
4-year Projection	$31 million	54%	4%
10-year Desired State of Repair (2031)	N/A	40%	3%
10-year Goal Projection	$31 million	51%	1%
10-year Goal Projected Gap	N/A	+11%	+2%

Table 8.2 presents the performance gap analysis for the Non-Interstate NHS pavement, showing the HDOT-planned investments and life cycle planning strategies are effective in the HDOT meeting and exceeding its 2- and 4-year targets and its 10-year goal for the non-Interstate NHS pavement. There is a positive performance gap for the Non-Interstate NHS pavement.

Table 8.2. Non-Interstate NHS Pavement Asset Performance and Gap

Non-Interstate NHS Pavement	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$55 million	26.1%	2.8%
2-year Target (2023)	N/A	25%	4%
2-year Projection	$30 million	40%	3.8%
4-year Target (2025)	N/A	30%	4%
4-year Projection	$50 million	63%	3.9%
10-year Desired State of Repair (2031)	N/A	40%	4%
10-year Goal Projection	$60 million	75%	3.7%
10-year Goal Projected Gap	N/A	+35%	+0.3%

Table 8.3 presents the performance gap analysis for the NHS bridges, showing the HDOT-planned investments and life cycle strategies appear to be effective in the HDOT meeting its 2- and 4-year targets and 10-year goal for the NHS bridges. There is a positive performance gap for the bridges.

Table 8.3. NHS Bridge Asset Performance and Gap

NHS BRIDGES	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$34 million	19.4%	2.3%
2-year Target (2023)	N/A	25%	4%
2-year Projection	$33 million	43.1%	2.2%
4-year Target (2025)	N/A	30%	4%
4-year Projection	$50 million	54.5%	1.2%
10-year Desired State of Repair (2031)	N/A	40%	2%
10-year Goal Projection	$65 million	58.7%	0.3%
10-year Goal Projected Gap	N/A	+18.7%	+1.7%

Investment Strategies

Investment strategies are the culmination of the risk management, life cycle planning, and performance gap analyses and results, and take into consideration the anticipated available funding and estimated cost of future work. It is through this TAMP process that the HDOT will determine how best to invest in and prioritize projects that will achieve the performance targets and national and statewide goals.

Performance-based Investment

The HDOT is committed in its financial plan and investment in life cycle planning strategies to keep the existing transportation system in a state of good repair over the next 10 years and reach the HDOT's performance goal for NHS bridges and pavements.

In accordance with FHWA requirements, the TAMP must identify investment strategies that make progress towards:

- Achieving a desired state of good repair over the life of the assets
- Improving or preserving the asset condition and performance
- Achieving the targets for asset condition and performance of the NHS
- Achieving national performance goals

Strategies

The TAMP recognizes the need to make hard investment decisions and provides a data- and technical-driven prioritization process that will objectively guide investment decisions. Overall, the funding allocation emphasizes statewide needs by program and asset, rather than by district. The HDOT's commitment to its PMS and BMS also reflects the network prioritization approach vs. a district approach.

The HDOT's investment strategies are consistent with national and statewide goals of improving or enhancing current assets and preserving and maintaining the existing system through low-cost treatments. The combined results from life cycle planning (Chapter 7), performance gap analysis (Chapter 8), risk analysis (Chapter 5), the financial plan (Chapter 6), and pavement and bridge management systems (Chapter 3) form the foundation for establishing these investment strategies. The HDOT runs a variety of performance scenarios with different combinations of funding and different combinations of work activities (that is, maintenance, preservation, rehabilitation, and reconstruction) to determine the preferred investment strategy moving forward. The end result is the Pavement and Bridge's 10-year Program, which is submitted to the MRTP and ultimately implemented through the STIP, the HDOT's CIP, or its SMP.

TAMP NHS Funding

The HDOT's performance goal is to maintain and improve the overall condition of its NHS assets over the next 10 years. The HDOT will prioritize its NHS assets and strive to maintain its current funding of the System Preservation Program, understanding that there may be consequences to its other programs and non-NHS assets. Tables 8.4, 8.5, and 8.6 reflect the anticipated annual expenditures for the next 10 years by work activity for both the State and City-owned NHS pavement and bridge assets. The HDOT is working to improve their procurement, design, and construction processes to close the gap between programming and expenditures and improve coordination with the City and County of Honolulu.

Table 8.4. Anticipated Annual Expenditures for NHS Interstate Pavement Assets (millions of dollars)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Maintenance	1	1	1	1	1	1	1	1	1	1
Preservation	1	0	4	12	11	11	11	11	11	11
Rehabilitation	10	22	18	0	19	19	19	19	19	19
Reconstruction	0	0	0	0	0	0	0	0	0	0
Initial Construction	12	0	0	0	0	0	0	0	0	0
Annual Total	**$24**	**$23**	**$23**	**$13**	**$31**	**$31**	**$31**	**$31**	**$31**	**$31**

Table 8.5. Anticipated Annual Expenditures for NHS Non-Interstate Pavement Assets (millions of dollars)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Maintenance	4	4	4	4	4	4	4	4	4	4
Preservation	0	0	3	18	6	6	6	6	6	6
Rehabilitation	4	39	39	24	39	39	39	39	39	39
Reconstruction	24	0	0	0	6	11	11	11	11	11
Initial Construction	0	0	0	0	0	0	0	0	0	0
Annual Total	**$32**	**$43**	**$46**	**$46**	**$55**	**$60**	**$60**	**$60**	**$60**	**$60**

Table 8.6. Anticipated Annual Expenditures for NHS Bridge Assets (millions of dollars)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Maintenance	4	4	4	4	5	6	7	7	8	10
Preservation	8	10	15	20	35	38	40	40	50	50
Rehabilitation	12	15	25	25	20	20	25	20	15	15
Reconstruction	0	0	0	0	0	0	0	0	0	0
Initial Construction	5	7	18	25	15	10	5	4	1	0
Annual Total	**$29**	**$36**	**$62**	**$74**	**$75**	**$74**	**$77**	**$71**	**$74**	**$75**

The PMS and BMS reinforce the investment strategies and process improvements that will be implemented to achieve the HDOT's long-term performance goals. However, the HDOT understands that funding needs may change over time due to the amount of funding available, the backlog of work types, accelerated deterioration or slower deterioration on different parts of the system, unanticipated emergencies, and agency capacity to get work done. The HDOT expects to review and amend the 10-year goals and funding commitments when the TAMP is reviewed in 4 years.

CHAPTER 9

Process Improvements

TAMP Governance and Sustainment

> Failure to establish an accepted TAMP and failure to obtain a positive annual Consistency Determination by FHWA will result in a lowered federal participation rate of 65 percent for projects on the NHS.

The goal of the federal performance measures is to establish transparent, formalized policies and processes that aid the various DOTs to make consistent and defensible decisions in asset investments, regardless of whether they are on or off the NHS. The TAMP performance measures will satisfy this need and can also be used to justify HDOT investment decisions and legislative funding requests. The HDOT's top officials are committed to providing resources, including funding, training, and personnel for the long-term sustainment of the asset management program.

Continuous Review (Living Document)

It is recognized that the TAMP program is not static and it is good business practice to continuously re-evaluate practices and procedures. The HDOT administration is working on its organizational structure to build a stronger connection between its mission and the transportation asset management goals and objectives. This requires a strategy and successful implementation that needs to address culture change, identification of new requirements and functions, HDOT reorganization, process review and changes, operational budgeting, and contracting actions.

The Asset Management Leadership Team is focusing on the following key process improvements:

- **Planning and Programming**
  - Strengthen the programming process – providing detailed information on the data, tools, and measures that are used to support transportation asset management decisions and actions
  - Merge capital and maintenance activities into a district's work plan
  - Continue to improve coordination with the OahuMPO
  - Continue to develop and strengthen the 10-year MRTP, which will help prioritize between the various HDOT programs

- **Data Governance**
  - Strengthen information systems and data – investing, as necessary, in the data and information systems needed to be confident in transportation asset management decisions and actions
  - Establish data collection standards and implement a data governance plan
  - Integrate the maintenance management processes of the districts into the asset management program
  - Continue to work with the City and County of Honolulu on sharing data on the NHS
- **Infrastructure**
  - Continue with the process improvements on the AASHTOWare BrM software for the bridge management systems
  - Continue with process improvements on the dTIMS software
  - Continue to use the data collected to develop localized deterioration models to improve the predictability of the infrastructure's performance
  - Identify and implement opportunities to incorporate new means, methods, treatments, specifications, and technology into the construction of preservation treatments for both pavement and bridges
  - Continue to collaborate on effective pavement and bridge work activities and strategies with the City and Counties