NEW YORK STATE OF OPPORTUNITY.

Department of Transportation

Transportation Asset Management Plan

June 2019

Marie Therese Dominguez, Commissioner

New York State Department of Transportation

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Acknowledgments

New York State Department of Transportation (NYSDOT) has created a multidisciplinary and cross functional team to develop its Transportation Asset Management Plan (TAMP). The team includes NYSDOT staff from: Policy and Planning, Maintenance, Budget and Finance, Structures, and Technical Services as well as members from the New York State Thruway Authority (NYSTA) and the Federal Highway Administration (FHWA). Oversight and governance of TAMP development was provided through NYSDOT's asset management business structure and through the FHWA with regular progress reports, conference calls, and feedback on key decisions and approaches.

Executive Summary

In May 2011, the New York State Department of Transportation (NYSDOT) established the Comprehensive Asset Management/Capital Investment (CAMCI) Team to develop and articulate an investment strategy, framework and process to preserve and manage the multimodal transportation assets of New York State in an economically, environmentally, and socially sustainable manner. Analysis, at that time, predicted that without a change in course, NYSDOT's investment approach would result in 40% poor pavements statewide - including 20% poor pavements on the interstate system and continued deterioration of bridge conditions - by 2018. NYSDOT's own analysis showed that it would be far more cost effective to keep assets in higher condition states than to postpone treatment until assets deteriorate.

Using this information, coupled with an understanding of current bridge and pavement conditions, the CAMCI Team led the Department to investigate different investment and treatment strategies for pavements and bridges. The result was a capital investment program that was made up of 60% preservation and 40% system renewal (rehabilitation and reconstruction) and improvement. System renewal and improvement places a high priority on projects that improve infrastructure conditions, while enhancing the economy and/or providing sustainability benefits such as environmental enhancements or resiliency to extreme weather events. Once NYSDOT adopted a preservation first approach, the percent poor pavements went from the predicted 40% to a current value of 10%.

Though the current investment strategy provides much better end conditions than the traditional decentralized approach, it does not result in a state of good repair for either pavements or bridges. State of good repair is the condition state of the system that can be maintained in perpetuity at the lowest annual cost. NYSDOT's assets are not currently in a state of good repair, and with current funding, even the most efficient investment plan results in a widening gap between desired and actual conditions. To achieve a state of good repair on the NHS in 10 years, NYSDOT would require approximately $2.5 billion per year for pavements and bridges from all levels of government, as compared to the current annual funding level for these assets of $875 million.

Based on recommendations from the CAM/CI Team, in 2011 NYSDOT established an asset management business structure to support consistent decision-making through a focus on system management. To support this effort, measures of accountability have been established to maximize return on investment and long term public benefits.

NYSDOT's asset management business structure enables consistent decision-making at all levels of the organization and sets consistent fiscal limits for performance across geographic boundaries. It helps to manage expectations and allows NYSDOT, as steward of the transportation system, to facilitate the best investment for the system and the State, regardless of ownership.

The asset management business structure calls for NYSDOT to:

1. **Improve the quality of investment decisions –** deliver projects that impact conditions; do not just report on them.
2. **Leverage existing data and tools** - minimize initial investment and time needed to implement new practices by utilizing current data and technology, more extensively and uniformly across the state.

3. **Establish collaborative relationships across the Department** - break through organizational cultures and data stovepipes.
4. **Employ transportation asset management guidance developed by the American Association of State Highway and Transportation Officials (AASHTO)** - start with what is available now and work to improve.
5. **Adopt a systems approach** - deliver the best possible results to the most system users.

The State will continue to improve its investment strategy through improvements in data collection, modeling software, organizational efficiency, management of risks and overall asset management capabilities to ensure that the State is making the best use of its available resources.

Moving forward, NYSDOT's current Capital Plan[1] provides an average of $4.4 billion in new capital program funding annually to improve the transportation system, enhance the system's resiliency and create jobs. Of that amount, approximately $3.5 billion in new funding is provided annually to support NYSDOT's highway and bridge program, including: more than $2.8 billion in new construction funding for the repair, rehabilitation and replacement of critical State and local infrastructure and approximately $775 million in engineering, right-of-way and other program delivery support. The capital program also provides $474 million in additional funding for local highway and bridge projects under the Consolidated local street and Highway Improvement Program (CHIPS) and $39.7 million for the local matching share of federal aid projects under the Marchiselli program.

The most significant risk to achieving the Transportation Asset Management Plan (TAMP) goals detailed below is the uncertainty of future federal funding for highways, bridges and transit. Federal aid comprises more than 40 percent of DOT's capital program and approximately 56 percent of on and off-system construction. The federal Highway Trust Fund has been insolvent since 2008 and has relied on more than $144 billion in revenue transfers to sustain authorized funding levels and prior commitments to the states. As a result, for more than a decade, federal support for the State's roads, bridges and transit systems has remained relatively flat.

GUIDING PRINCIPLES OF NEW YORK STATE'S ASSET MANAGEMENT PROGRAM

The primary focus of NYSDOT's and the New York State Thruway Authority's (NYSTA's) asset management efforts is the preservation and safety of the existing infrastructure. The State's objective is to manage the highway system as effectively as possible in an environment in which the infrastructure is nearing the end of its service life and the available funding is significantly lower than the system's needs. To ensure that good decisions are made in its efforts to preserve and enhance the safety and condition of the transportation system, the NYSDOT has adopted four guiding principles, known as the "Forward Four". Figure ES.1 illustrates these principles, along with public safety, which is inherent in all of NYSDOT's investment decisions. These principles have been in place at NYSDOT since before the last Comprehensive Update. NYSDOT has just codified our approach in our documentation. Implementation of this plan builds from and strengthens them.

[1] Current Five-Year Capital Program covers State Fiscal Years 2015-2016 through 2019-2020.

Figure ES-1.1 The Forward Four

NEW YORK STATE'S TRANSPORTATION ASSET MANAGEMENT PLAN

New York State's Transportation Asset Management Plan (TAMP), provides a window into NYSDOT's and the NYSTA's asset management practices. The TAMP also establishes a blueprint that includes considerations of: risk, life cycle management, performance management, service levels, strategic alignment, and user outreach. Though few, if any, states currently support such a holistic asset management process at present, the TAMP provides a forum to codify current practices in these areas where they exist, and identify gaps that the State will address in the future. The TAMP is an important step forward in furthering governmental thoughtfulness and accountability.

Specifically, the TAMP:

- Defines the NYSDOT's and the NYSTA's asset management objectives;
- Summarizes the inventory and condition of NHS highways and bridges, and travel trends on the system;
- Documents a realistic estimate of funding expected to be available for the system over the next 10 years;
- Documents NYSDOT's asset management business structure, policies and practices;
- Illustrates how risk is managed and presents a list of priority risks and mitigation strategies for addressing them;

- Describes how NYSDOT and the NYSTA manages their pavement and bridge assets throughout their lifetimes;
- Defines investment strategies used to guide the allocation of available funds;
- Lays out an agenda for future improvements to asset management and the TAMP.

The TAMP also addresses the requirements in the Moving Ahead for Progress in the 21st Century Act (MAP-21). MAP-21 and successor legislation requires all State DOTs to develop a risk-based TAMP that, at a minimum, addresses pavements and bridges on the National Highway System (NHS). To provide a full understanding of the asset management strategies practiced by NYSDOT, the New York State Thruway Authority (NYSTA), and other ancillary owners of the NHS, this TAMP addresses all bridges and pavements that are on the NHS, with special emphasis on the portions of the NHS that are eligible for funding from the NYSDOT comprehensive program. Much of this infrastructure is not owned by NYSDOT. Local agencies that maintain portions of the NHS do so by applying state and local investment strategies and available financial resources. Therefore, NYSDOT maintains close, collaborative relationships, as necessary with toll authorities, counties, cities and other municipalities who own and operate portions of the NHS as well as Metropolitan Planning Organizations (MPOs), which are essential partners in the asset management process.

Users of the transportation system should not be concerned with what entity owns the highway. They should perceive a consistent level of service as they travel along a corridor regardless of jurisdiction or political boundaries crossed. Similarly, all asset owners who are eligible to receive and invest New York State or federal transportation funds need a clear understanding and consistent set of performance standards, investment strategies and project selection criteria.

KEY ELEMENTS OF THE TAMP

This section summarizes key components of this plan.

Asset Registry

Table ES-1.1 summarizes the inventory and performance information of New York State's bridges and pavements.

Table ES-1.1 Asset Registry

INVENTORY												
Highway System#	**Pavements**				**Bridges**							
	Lane-miles				**Deck Area (1,000 sq. ft.)**				**Count**			
	NYSDOT	NYSTA	Others*	Sub-Total	NYSDOT	NYSTA	Others*	Sub-Total	NYSDOT	NYSTA	Others*	Sub-Total
Interstate	5,499	2,413	142	8,054	30,569	9,692	8,872	49,133	1,760	440	110	2,310
Non-Interstate NHS	14,270	37	4,395	18,702	30,620	1,206	15,773	47,599	2,553	65	557	3,175
Total NHS	19,769	2,450	4,537	26,756	61,188	10,898	24,645	96,732	4,313	505	667	5,485
NHS	19,769	2,450	4,537	26,756	61,188	10,898	24,645	96,732	4,313	505	667	5,485
Non-NHS FA Highways	17,675	1	23,685	41,361	16,432	1,410	10,184	28,026	2,671	144	1,908	4,723
Total Federal Aid Eligible	37,445	2,451	28,222	68,118	77,620	12,308	34,829	124,757	6,984	649	2,575	10,208
Federal Aid Eligible	37,445	2,451	28,222	68,118	77,620	12,308	34,829	124,757	6,984	649	2,575	10,208
Non-Federal Aid Eligible	1,123	0	167,377	168,500	3,244	967	13,790	18,001	538	117	6,626	7,281
Total Statewide	38,568	2,451	195,599	236,618	80,864	13,275	48,619	142,759	7,522	766	9,201	17,489

* Other owners of federal-aid eligible infrastructure include: Port Authority of NY and NJ, Bridge and Tunnel Authorities, cities, counties and other authorities and local governments

Refers to the highway. All highway bridges are potentially Federal Aid eligible.

CONDITIONS (NYSDOT Measures)												
Highway System#	**Pavements (Based on Lanemiles)**						**Bridges (based on Deck Area)**					
	NYSDOT		**NYSTA^**		**Others**		**NYSDOT**		**NYSTA**		**Others**	
	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	Average Condition Rating	% Deficient	Average Condition Rating	% Deficient	Average Condition Rating	% Deficient
Interstate	75.7%	2.6%	97.9%	0.0%	87.3%	12.7%	5.07	44.4%	4.76	62.6%	4.35	82.3%
Non-Interstate NHS	80.6%	3.6%	*100.0%*	*0.0%*	68.4%	4.6%	5.24	41.3%	4.77	65.6%	5	54.2%
Non-NHS FA Highways	56.8%	13.2%	*100.0%*	*0.0%*	NA	NA	5.47	28.6%	5.08	52.4%	5.47	33.8%
Total Federal Aid Eligible	75.7%	8.8%	97.9%	0.0%	*NA*	*NA*	5.22	39.8%	4.8	61.8%	4.97	55.4%
Non-Federal Aid Eligible	44.0%	33.8%	*NA*	*NA*	NA	NA	5.36	34.1%	5.11	57.5%	5.59	28.5%

Note: NYSDOT defines "Good" pavement as having a sufficiency rating of 7 or more, and defines "Poor" pavements as having a sufficiency rating of 5 or less. In order to avoid confusion with Federal definitions of "Good" and "Poor", these terms will be avoided where possible in the document.

^ The Total Lane Miles are an estimation since the total lanemiles is based on the NYSDOT's primary direction convention. The direction convention beween NYSDOT and NYSTA are not the same.

CONDITIONS (FHWA Measures)												
Highway System#	**Pavements (Based on Lane miles)**											
	NYSDOT			**NYSTA**			**Others**			**Total**		
	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor
Interstate	51.4%	45.2%	3.4%	*61.9%*	*36.1%*	*2.0%*	NA	NA	NA	42.4%	54.6%	3.0%
Non-Interstate NHS	20.7%	71.0%	8.3%	NA	NA	NA	3.7%	84.8%	11.5%	19.1%	72.3%	8.6%
Highway System#	**Bridges (based on Deck Area)**											
	NYSDOT			**NYSTA**			**Others**			**Total**		
	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor
NHS	24.98%	62.94%	12.08%	14.97%	75.80%	9.24%	10.14%	77.07%	12.80%	20.07%	67.99%	11.94%

Note: All inventory and condition information based on 2016 data.

Funding Available for Managing Highway Infrastructure

The State estimates that approximately $50 billion in funding will be available for highway infrastructure over the next ten years between the NYSDOT and the NYSTA. However, not all of these funds are available for asset management of pavements and bridges on the NHS. Figure ES-1.2 shows the average annual funding forecasted for NYSDOT and Figure ES-1.3 shows the anticipated funding for the NYSTA.

Figure ES-1.2 NYSDOT Funding Sources ($ Thousands)

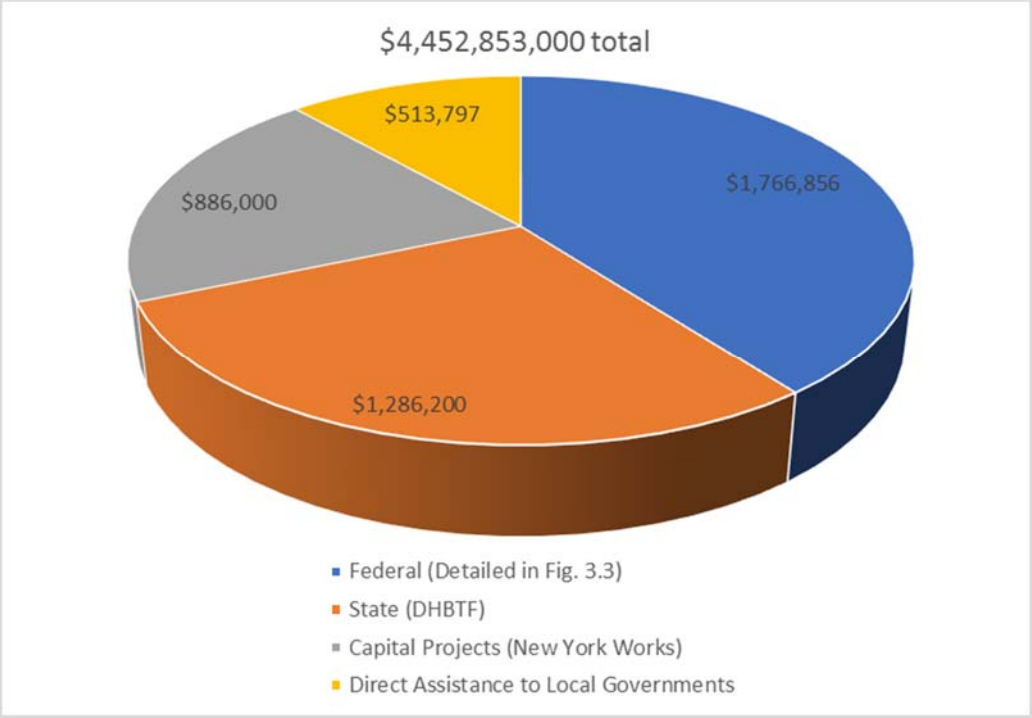
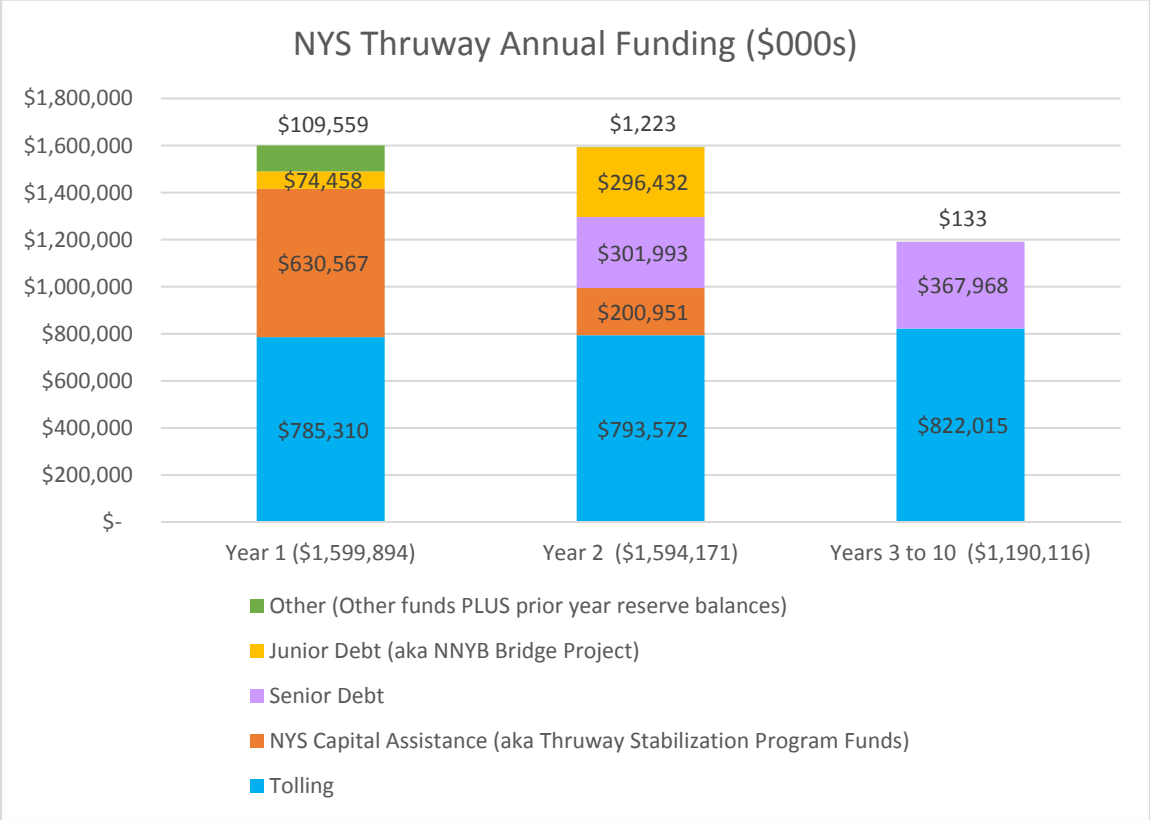


Figure ES-1.3 NYS Thruway Annual Funding ($ Thousands)



As shown above, NYSDOT's and the NYSTA's current fiscal plan includes approximately $5.6 billion[1] in available annual funding. However, not all funds are available for asset management of pavements and bridges on the NHS. NYSDOT has many responsibilities that must be funded, and some of the funds that are collected can only be used for certain functions. Table ES-1.2 shows NYSDOT's and NYSTA's current finance plan as it is distributed to these different missions. Only the Core Construction portion is available for asset management programming.

[1] Average Yearly Funding provided by 2015-2019 NYSDOT Capital Program

Table ES-1.2 Total Average Funds Available for NHS Work 2018-2028 ($ Millions)

NYSDOT Total Annual Funding (From Fig. 3.2)	$ 4,452,853,000
Minus (From Fig. 3.5):	
ROW Acquisition	$ 53,374,000
Engineering/Admin	$ 722,557,000
Operational Maintenance	$ 405,669,000
Transfers to MTA	$ 155,000,000
TMC's, Help Trucks, 511, HOV Ops, etc.	$ 62,195,000
Modal Funds	$ 240,658,000
Construction Safety	$ 152,487,000
Structures Inspection	$ 83,600,000
Safety Projects (HSIP)	$ 57,410,000
TAP/CMAQ Projects	$ 29,760,000
Direct Assistance to Local Governments	$ 514,000,000
Dedicated Local and Off-System Bridge	$ 150,000,000
NYSDOT Total for Core Construction	**$ 1,826,143,000**

NYSTA Total Annual Funding (From Fig. 3.4)	$ 1,594,172,000
Minus (From Fig. 3.6):	
Thruway Operating	$ 350,422,000
Debt Service	$ 314,611,000
State Police Operating	$ 66,477,000
Governor Mario M. Cuomo Bridge	$ 342,829,000
Arch, Facilities, Equipment	$ 233,261,000
Snow and Ice	$ 1,500,000
NYSTA Total for Core Construction	**$ 285,072,000**

Total Annual Average Core Construction Funds	**$ 2,111,215,000**

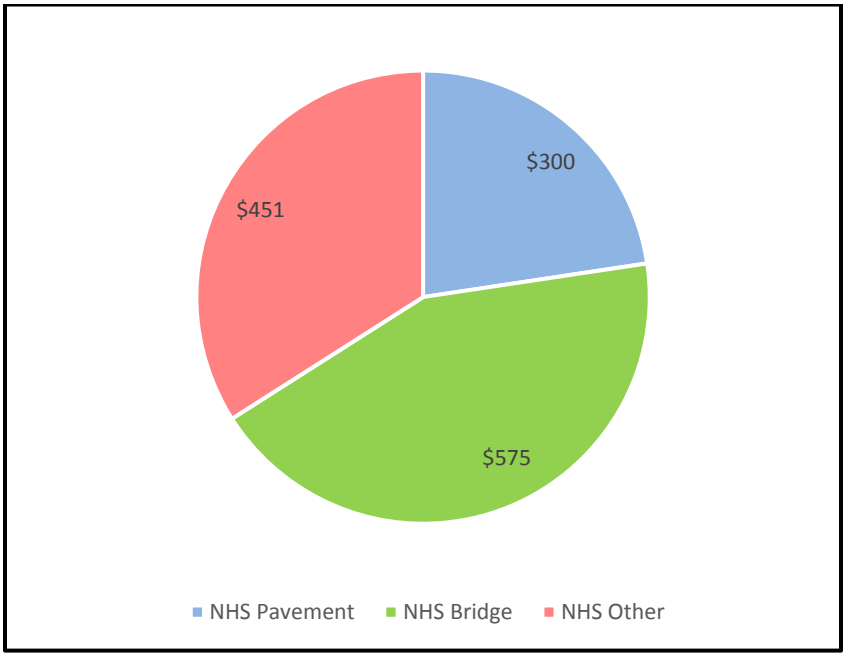
NYSDOT and NYSTA Core Construction funds are used for construction of projects throughout the state transportation system, not just on the NHS. For reference, the NHS represents about one third of the entire transportation system in the state. These funds are used to help local municipalities pay for construction projects as well. (For the TAMP it is assumed that all local funding of the NHS is reflected within the core construction category). In addition, not all of the core construction funds are used for pavement and bridge construction; a portion are used for "Other" needs, such as maintenance of ancillary assets and other improvements such as drainage repairs, pedestrian upgrades, or for large mobility projects or new construction. The "Other" category includes:

- mobility improvements,
- drainage improvements,
- secondary assets such as guiderail, signs, etc.,
- overhead sign structures,

- Information Technology Services (ITS),
- Signal improvements,
- Noise and retaining walls,
- Truck and freight facilities,
- Rest Area projects,
- Bike/Ped projects, (including ADA mandates on paving projects),
- Park and Ride work,
- and tree trimming, etc.

These funds can't be used in the context of the TAMP, because they don't contribute directly to the asset management of pavement and bridge assets on the NHS. This is demonstrated in Figure ES-1.4, below. The figure shows the average amount of combined annual NYSDOT and NYSTA funding available for pavement and bridge work on the NHS over the next ten year period. These funding amounts reflect our current four year STIP document, which outlines the current infrastructure commitments of the Department, and were developed as part of our Capital Program Update process, as discussed in Chapter 7.

Figure ES-1.4 Estimated Avg. Annual Funding Available for NHS Core Construction Activities ($ Millions)

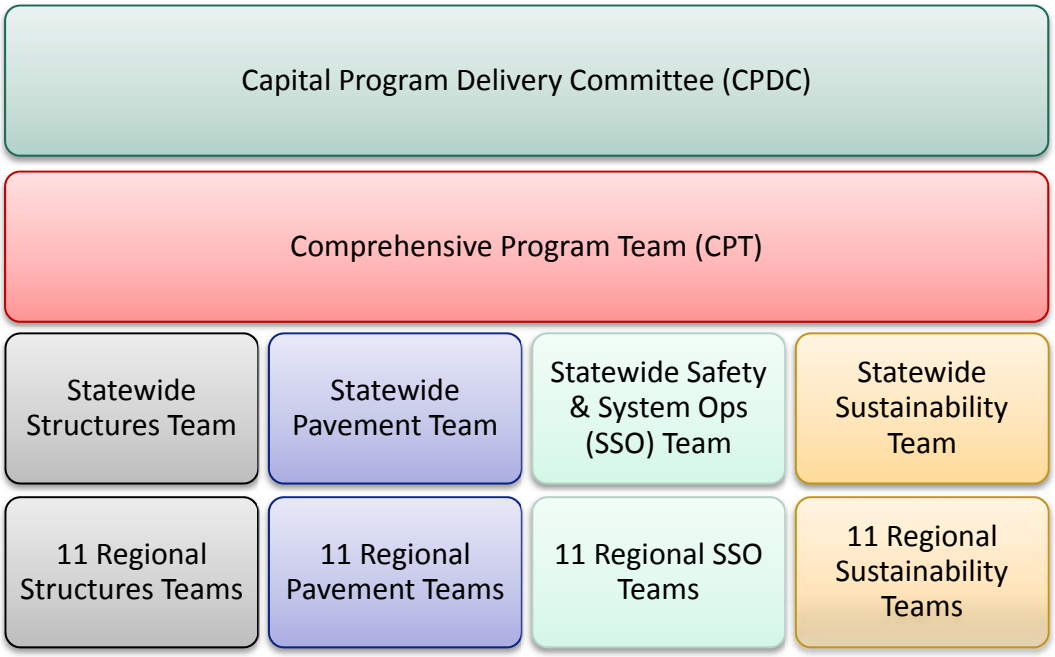


NYSDOT's Asset Management Business Structure

NYSDOT's internal asset management business structure is illustrated in Figure ES-1.5. The structure is functional rather than organizational. At this time these teams are not organizational units, but are comprised of dedicated groups of staff from across program areas throughout the

Department. The focus areas represented by the Statewide and Regional teams consist of the highest priority program areas for asset consideration.

Figure ES-1.5 NYSDOT's Internal Asset Management Business Structure



NYSDOT's Initial Risk Register

As part of NYDOT's Asset Management practices, CPT and the Statewide Teams identified agency-level risks that could impact NHS assets or the agency's ability to manage those assets. CPDC prioritized these needs and identified mitigation strategies for each. The following risks are included in the initial risk register:

- Federal funding is increasingly limited to use on the NHS and is insufficient to address all system needs. Only 27% of total federal aid may be used off the NHS;
- Climate change continues to impart a wetter weather pattern on New York State with more intense storms (e.g. Irene, Lee, Sandy, etc.) and sea level rise;
- Improved software tools and new performance measures must be developed by NYSDOT to quantifiably optimize investment levels across programs, (e.g. bridge, pavement, safety, mobility, access, etc.);
- Customer use (i.e. commuter/local, trade, intercity, emergency response and public evacuation, and tourism/recreation) is not yet applied to establish levels of service for managing highway corridors

Asset Management Investment Strategies

NYSDOT has developed the following investment strategy to guide the distribution of asset management funding:

- "Preservation First" prioritizes activities that maximize the service life of existing infrastructure assets over expansion or enhancement of the highway network. This work is performed on assets that are in relatively good condition to keep them from slipping to more costly reconstruction treatments in the future.
- "Beyond Preservation" addresses assets that have deteriorated beyond a state in which they can be preserved, or that require improvements to address operational, sustainability, economic development or other needs.

Asset Management Performance Targets

As part of its TAMP Update efforts, NYSDOT recently established condition targets for pavements and bridges on the NHS. These targets are provided in Table ES-1.3. These are not "aspirational" goals, but reflect an effort to minimize deterioration of the existing highway and bridge infrastructure in an environment where available resources are about one third of what is needed to maintain a state of good repair. The targets required by the FAST Act represent attainable conditions within the four year FHWA timeframe if the funding commitments and strategies presented in this TAMP are implemented.

As shown in the table, both NHS pavement and bridge conditions are projected to worsen over the next four years.

Table ES-1.3 NYS NHS Asset Management Performance Gap

Performance Measure	Baseline 2016	State of Good Repair	Target 2021	Performance Gap
NHS Interstate Pavements				
% Good	42.4%	60.2%	47.3%	-12.9%
% Fair	54.6%	38.4%	48.7%	NA
% Poor	3.0%	1.4%	4.0%	2.6%
Non-Interstate NHS Pavements				
% Good	19.1%	48.7%	14.7%	-34.0%
% Fair	72.3%	43.3%	71.0%	NA
% Poor	8.6%	8.0%	14.3%	6.3%
NHS Bridges(1)				
% Good	20.2%	34.3%	24.0%	-10.3%
% Fair	68.1%	55.7%	64.3%	NA
% Poor	11.7%	10.0%	11.7%	1.7%

(1) Based on Deck Area

(2) There are no performance targets for % Fair

Asset Management Improvements and Next Steps

There are profound and practical challenges ahead for New York State and for much of the country due to the aging of the nation's transportation infrastructure, changing climate, and inadequate funding relative to the growing needs of the State's infrastructure assets. The TAMP includes 10 year projections of system conditions based on expected funding. Left unabated, the amount of poor pavement on the NHS will more than double in the next ten years with the backlog of needed work increasing from $3.1 billion to $4.7 billion. Similarly, bridge conditions will become roughly 5 percent worse both in terms of deficiency and poor bridges.

Recognizing the difficult circumstances States are facing in managing an aging and underfunded highway infrastructure, there is still much that can and will be done to:

- Improve the State's ability to balance transportation investments,
- Provide meaningful information to user groups on the levels of service being provided on key corridors of the transportation system that most affect their interests;
- Develop more sophisticated pavement and bridge models that enables decision makers to assess multiple treatment and investment scenarios;
- Develop cross-asset trade-off optimization across scenarios;
- Improve coordination of capital construction program and state maintenance forces to ensure work is being delivered in the most efficient manner;
- Improve the way construction contracts are developed and managed; and
- Improve the efficiency of program delivery.

These initiatives are prioritized, resourced, and tracked to completion through NYSDOT's asset management business structure. They will advance asset management processes and enable NYSDOT to manage the highway system as effectively as possible.

1.0 Introduction

In 2011, Governor Cuomo directed the New York State Department of Transportation to establish the Comprehensive Asset Management/Capital Investment (CAMCI) Team. CAMCI was charged with developing and articulating an investment strategy, framework and process to preserve and manage the multimodal transportation assets of New York State in an economically, environmentally, and socially sustainable manner. At that time NYSDOT was using a traditional decentralized decision-making process and investing more than half of its pavement funds into very expensive reconstruction projects. Analysis predicted that without a change in course, this investment approach would result in 40% poor pavements statewide, including 20% on the interstate system, by 2018. At the same time, there was considerable discussion at the national level about the cost effectiveness of preservation strategies for both pavements and bridges. NYSDOT's own analysis showed that it would be far more cost effective to keep assets in higher condition states than it is to postpone treatment until assets deteriorate.

Using this information, coupled with an understanding of current bridge and pavement conditions, the CAMCI Team led the Department to investigate different investment and treatment strategies for pavements and bridges. The analysis was done using realistic funding predictions to develop a set of strategies that would generate the best end conditions 10 years into the future. The strategies needed to focus on preserving as much of the overall highway and bridge system as possible, to minimize future costs, while also treating assets in the worst conditions where those conditions impact the most travelers. The result was a capital investment program that was made up of 60% preservation and 40% system renewal (rehabilitation and reconstruction). One example of an expected benefit of this new programming direction in 2011 was a better than 50% reduction in the predicted amount of poor pavements, (based on the NYSDOT definition of poor), in 2018 from 40% to less than 19%. As of the writing of this TAMP, this prediction has been verified, with NYSDOT able to hold the % poor steady at 10%.

Though the current investment strategy provides much better end conditions, it does not result in a state of good repair for either pavements or bridges. State of good repair is the condition state of the system that can be maintained in perpetuity at the lowest annual cost. For example, if the pavement system were in a state of good repair, a vast majority of the system would be in good enough condition to only warrant a preventative maintenance treatment, with occasional heavier overlays. Only a small percentage of the system would be in bad enough shape to warrant major rehabilitation or reconstruction. As described in Chapter 5, the cost for these preventative maintenance treatments is much lower and more efficient than the heavier rehab and renewal treatments, allowing NYSDOT to maintain overall system conditions for the lowest annual cost. NYSDOT's assets are not currently in a state of good repair, and with current funding even the most efficient investment plan results in a widening gap between desired and actual conditions.

The ratio of actual funding to the funding level necessary to achieve state of good repair for an asset class is called the Asset Sustainability Index (ASI). To achieve a state of good repair on the NHS in 10 years, New York State would require approximately $2.5 billion per year for pavements and bridges as compared to its current annual funding level for these assets of $875 million. This results in a current ASI for state pavements and bridges of 35%, indicating that the State receives approximately one third of the funding from all levels of government needed to achieve a state of good repair.

Based on recommendations from the CAM/CI Team, in 2011 NYSDOT established an asset management business structure to support consistent decision-making through a focus on system management. To support this effort, measures of accountability have been established to maximize return on investment and long term public benefits.

NYSDOT's asset management business structure enables consistent decision-making at all levels of the organization and sets consistent fiscal limits for performance across geographic boundaries. It helps to manage expectations and allows NYSDOT, as steward of the transportation system, to facilitate the best investment for the system and the State, regardless of ownership.

The asset management business structure calls for NYSDOT to:

1. **Improve the quality of investment decisions –** deliver projects that impact conditions; do not just report on them.
2. **Leverage existing data and tools** - minimize initial investment and time needed to implement new practices by utilizing current data and technology.
3. **Establish collaborative relationships across the bureaucracy** - break through organizational cultures and data stovepipes.
4. **Employ transportation asset management guidance developed by the American Association of State Highway and Transportation Officials (AASHTO)** - start with what is available now and work to improve.
5. **Adopt a systems approach** - deliver the best possible results to the most users.

The State will continue to improve its investment strategy through improvements in data collection, modeling software, organizational efficiency, management of risks and overall asset management capabilities to ensure that the State is making the best use of its available resources.

Moving forward, NYSDOT's current Capital Plan[1] provides an average of $4.4 billion in new capital program funding annually to improve the transportation system, enhance the system's resiliency and create jobs. Of that amount, approximately $3.5 billion in new funding is provided annually to support NYSDOT's highway and bridge program, including: more than $2.8 billion in new construction funding for the repair, rehabilitation and replacement of critical State and local infrastructure and approximately $775 million in engineering, right-of-way and other program delivery support. The capital program also provides $474 million in additional funding for local highway and bridge projects under the Consolidated local street and Highway Improvement Program (CHIPS) and $39.7 million for the local matching share of federal aid projects under the Marchiselli program.

The most significant risk to achieving the Transportation Asset Management Plan (TAMP) goals detailed below is the uncertainty of future federal funding for highways, bridges and transit. Federal aid comprises more than 46 percent of DOT's capital program and approximately 56 percent of on and off-system construction. The federal Highway Trust Fund has been insolvent since 2008 and has relied on more than $144 billion in revenue transfers to sustain authorized funding levels and prior commitments to the states. As a result, for more than a decade, federal support for the State's roads, bridges and transit systems has remained relatively flat.

[1] Current Five-Year Capital Program covers State Fiscal Years 2015-2016 through 2019-2020.

1.1 BACKGROUND

From construction of the nation's first railroads to the Erie Canal to the Brooklyn Bridge to the New York City elevated subway lines to the Interstate Highway System, New York State has been a world leader in the construction of multi-modal transportation infrastructure – transportation infrastructure that has transformed our State's economy into the global centers for the financial, insurance, real-estate and technology sectors. New York's transportation infrastructure, much of it built before or during the Eisenhower Interstate Era, is among some of the oldest and most heavily utilized in the nation and is also subject to some of the harshest weather conditions. As a result, New York's infrastructure conditions rank among the lowest in the nation. The ability of people and goods to move through the State is dependent on a well functioning transportation system. The repair, rehabilitation, efficient operations and strategic replacement of existing transportation infrastructure are required for safety, mobility and for the State to remain economically competitive.

Recognizing the challenges ahead, NYSDOT reengineered its capital program – how it develops, programs and funds transportation infrastructure investments. Investments are focused on asset management and infrastructure preservation strategies. NYSDOT has implemented new strategies to select investments in projects that go beyond preservation, linking transportation with economic development and sustainability. NYSDOT is also successfully employing new procurement methods to deliver projects, such as Design-Build, authorized by the New York State Legislature in December 2011.

1.2 GUIDING PRINCIPLES OF NYSDOT'S ASSET MANAGEMENT PROGRAM

The primary focus of NYSDOT's asset management efforts is the preservation of the existing infrastructure and the safety of the travelling public. NYSDOT's objective is to manage the highway system as effectively as possible in an environment in which the available funding is significantly lower than the system's needs. To ensure that good decisions are made in its efforts to preserve and enhance the accessibility, safety and condition of the transportation system, the NYSDOT has adopted four guiding principles, known as the "Forward Four". Figure 1.1 illustrates these principles, along with public safety, which is inherent in all of NYSDOT's investment decisions. These principles have been in place at NYSDOT since before the last Comprehensive Update.

Figure 1.1 Guiding Principles of the Asset Management Program

Preservation First

Expected resources are not sufficient to support a "build new" or "worst first" approach. Therefore NYSDOT has chosen to adopt a "preserve what we have" approach. The Preservation First strategy starts with Asset Management principles and data driven decision making. The highest priority is to preserve the functionality and safety of the existing highway system. It is very important to recognize that a Preservation First strategy is a long term strategy. The Agency must have patience to hold the course.

System not Projects

To meet the needs of the entire system, NYSDOT requires a system wide, program-driven approach, instead of individual project solutions. That means, when the Agency considers an individual project, it must be examined in the context of the larger transportation system: Who does this asset serve? Is it on a corridor that is essential to move people or goods? Where does it fit within Regional and State priorities? Inherent in these decisions is the need to identify better ways to manage and operate the transportation system as a whole, to most effectively use the capacity of the current system. System improvement projects that promote economic development, livability, and system connectivity must also be strategically advanced to provide the greatest benefit to the system.

Maximize Return on Investments

Funding for transportation has been, and will continue to be, significantly less than the amount required to address all of the State's recognized needs. Insufficient investments have resulted in declining system conditions and a growing backlog of needs required to bring the system to a

state of good repair. Given the significant needs of the transportation system, it is essential that a strategy be established to invest in a way that produces the greatest possible return on investment.

The objective is to develop an approach that encourages good decision making and allocation of funds in a manner that not only preserves the most important assets but also meets the needs of those who rely on the transportation system.

This approach has lead NYSDOT to implement whole life management principles (explained in Chapter 5) which emphasizes investments in appropriate treatments, at appropriate times, and at appropriate locations. Safety standards will be maintained. Focused rehabilitation work will be performed, fixing only those elements in need of repair, when it is determined that significant life can be bought with limited investment. All work will be timed appropriately within the "window of opportunity" for the selected treatment The scope of work will be constrained to include what is required to achieve the full remaining life of the asset while providing for a safe and accessible highway system. Bridges and highways will be replaced when replacement provides the best return on investment. Mobility enhancement and modernization projects will be included when it makes strategic and economic sense.

Make It Sustainable

A sustainable approach to programming considers the relative and cumulative value of the assets as they benefit the public, economy, and environment. In this way the decision-making process can be enhanced in terms of looking broadly at the wider benefits of the work done with each Comprehensive Program. The focus will be on ways to preserve the existing transportation system by incorporating sustainability considerations into decisions and actions; and support opportunities for innovation, economic growth and development. This must be done in a fiscally responsible manner by considering life cycle cost as well as fiscal cycles.

A strategy that allows development of a sustainable program has been adopted, one that maximizes the return on investment, extends the life of the assets, and provides users of the system with a safe, reliable, balanced and environmentally sound transportation system. A sustainable program also incorporates strategies to minimize transportation system disruptions resulting from routine incidents, planned events, and non-routine events such as natural disasters or security related events. NYSDOT will seek out and implement creative and low-cost ways to leverage funding to minimize costs over the life of the investments while fostering:

- **Economic competitiveness:** Improve efficiencies in work/business travel and freight movement; improve tourism access and inter-modal connectivity; develop investments which complement or enhance the strategic investments proposed by Regional Economic Development Councils.
- **Social equity/community:** Improve accessibility for transit; recreation; education; health care; support smart growth, complete streets and livability; increase safety; weigh climate associated risk to transportation infrastructure.
- **Environmental stewardship:** Increase energy efficiency and reduce greenhouse gas emissions; reduce resource consumption; limit impacts that encroach on the environmental footprint; not deplete, and where practicable, enhance resources for future generations; improve air quality.

1.3 COMPREHENSIVE PROGRAM UPDATE

NYSDOT's comprehensive program is the primary mechanism for delivering on its mission to provide safe and reliable transportation to its customers. NYSDOT typically develops a Comprehensive Program Update every two years. The update establishes a program of projects for all infrastructure and delivery mechanisms for the subsequent five years. The program is developed under the direction of the asset management organization structure and follows the asset management practices described in Chapter 4. Projects are prioritized and selected according to the asset management investment strategies described in Chapter 7. The program is fully funded, fiscally constrained and includes expected budgets, accomplishments, and key milestone dates for every project. The resulting program represents the mix of projects which provide the best progress towards the Department's goals.

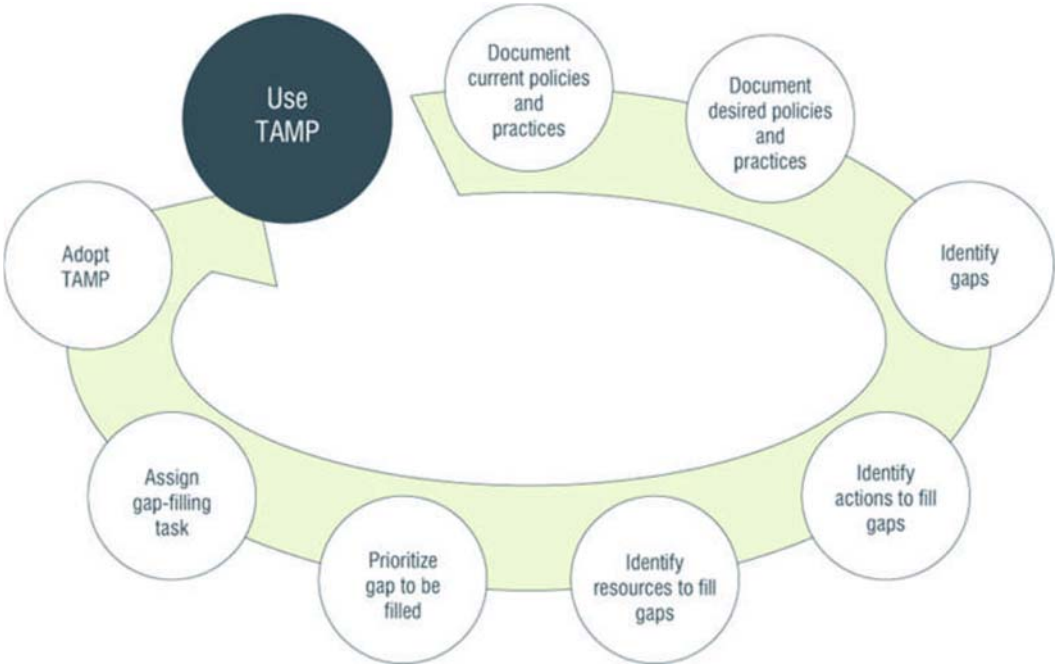
1.4 OBJECTIVES OF THIS DOCUMENT

This Transportation Asset Management Plan (TAMP) is a window into NYSDOT and NYSTA policy. It explains the roles, responsibilities and processes related to establishing and executing transportation asset management activities at NYSDOT and the NYSTA. The plan covers the breadth of asset management practices at NYSDOT and the NYSTA and was developed to achieve the following objectives:

1. **Institutionalize the implementation of asset management practices**. New York State has made great strides in modernizing its programming processes. The Federal Highway Administration (FHWA) certification of NYSDOT's process for developing this plan ensures that these strategies, processes and tools will continue to shape future programming efforts.
2. **Communicate Asset Management Policy and Strategy.** To date, NYSDOT's asset management policy has been scattered in numerous documents, such as its STIP update instructions and statewide team charters. The TAMP pulls together all of the relevant information from these sources to present internal and external stakeholders with a clear understanding of NYSDOT's vision and implementation of asset management.
3. **Document and prioritize opportunities for improvement of business practices.** Transportation asset management is a continual improvement process. As described in the *AASHTO Transportation Asset Management Guide: A Focus on Implementation*, the development of a TAMP "is an ongoing process of communication with partners, self evaluation, gap identification, prioritization, improvement, and adoption." [2] This plan lays out the process for continual improvement of TAM business practices and contains NYSDOT's current asset management improvement plan. Figure 1.2 illustrates this concept.

[2] *AASHTO Transportation Asset Management Guide: A Focus on Implementation*, Washington DC, January 2011.

Figure 1.2 Iterative TAMP Development Process



Source: AASHTO Transportation Asset Management Guide, A Focus on Implementation

1.5 SCOPE OF THE TAMP

To provide a full understanding of the asset management strategies practiced by NYSDOT, the New York State Thruway Authority (NYSTA), and other ancillary owners of the NHS, this TAMP addresses all bridges and pavements that are on the NHS, with special emphasis on the portions of the NHS that are eligible for funding from the NYSDOT comprehensive program.

About 74% of the NHS is owned and maintained by NYSDOT. The remainder of the NHS is split between the NYSTA and local agencies. NYSDOT maintains close, collaborative relationships with Metropolitan Planning Organization (MPO) members, toll authorities, counties, and municipalities who own and operate portions of the NHS. It should be noted that because of this collaboration, the term "the State" will be used when the goals and strategies of the state as a whole, as encompassed by the actions of the NYSDOT, it's local partners, and the NYSTA, are highlighted. In cases where the strategies differ, the particular agency will be called out in the document.

Transportation system users should not be concerned with what entity owns the highway. They should perceive a consistent level of service as they travel along a corridor, regardless of jurisdictions or political boundaries. Similarly all asset owners who are eligible to receive and invest New York State or federal transportation funds need a clear understanding and consistent set of performance standards, investment strategies, and selection criteria. Towards this end, this document addresses asset management practices of the NYSDOT and the New York State Thruway Authority. NYSDOT can not and does not dictate investment strategy to partner agencies; however, "compatibility with the TAMP approach is encouraged for federal aid projects

and federal aid eligible assets". More detail on how NYSDOT works with its partner infrastructure owners is provided in Chapter 4.

There are several significant federal fund sources that are not within the scope of pavement and bridge asset management, including the federal Congestion Mitigation and Air Quality (CMAQ), Transportation Alternatives Program (TAP) (formerly Transportation Enhancement Program - TEP), Transportation Investment Generating Economic Recovery (TIGER) and Highway Safety Improvement Program (HSIP). These programs have organizational and procedural requirements that are different from the more mainstream highway funds. The integration of projects funded by these programs will evolve over time as the TAMP's scope expands to address priority assets other than bridges and pavements.

1.6 TAMP STRUCTURE

The "Moving Ahead for Progress in the 21st Century" Act (MAP-21) and the "Fixing America's Surface Transportation" (FAST) Act, contain specific provisions for the content to be included in a TAMP. The requirements for TAMP contents include:

1. A summary listing of the pavement and bridge assets on the National Highway System in the State, including a description of the condition of those assets;
2. Asset management objectives and measures;
3. Performance gap identification;
4. Lifecycle cost and risk management analysis;
5. A financial plan; and
6. Investment strategies.

In order to meet these requirements, this TAMP is presented as follows:

- **Chapter 2 - State of the System** examines the overall demand on the New York State NHS system by the traveling public, and summarizes the inventory and condition of the state's pavements and bridges.
- **Chapter 3 - Financial Summary** documents the expected funding for the system over a ten-year period.
- **Chapter 4 - Transportation Asset Management Practices** describes NYSDOT's and NYSTA's asset management business structure, policies and practices.
- **Chapter 5 - Life Cycle Planning** presents the principles of life cycle management used by the State and explains the process used to prioritize projects under this philosophy.
- **Chapter 6 - Risk Management** outlines the process used to assess risk, and presents a risk register that lists priority risks and associated mitigation activities.
- **Chapter 7 - Investment Plan** illustrates how the available funds are provided for planning purposes and describes the State's investment strategies related to asset management.
- **Chapter 8 - Asset Management Improvements and Next Steps** defines specific improvement areas the State will be pursuing in the near term and lays out an agenda for future improvements to asset management policy and practices as well as the TAMP.

2.0 State of the System

This chapter describes the state of New York's highway system in terms of demand, inventory and condition.

2.1 SYSTEM DEMAND

Figure 2.1 shows the number of vehicles miles traveled (VMT) on NYSDOT's highway system since 1920. The chart can be broken down into several key phases or epochs based on world events and sustained rates of VMT growth. Those epochs are:

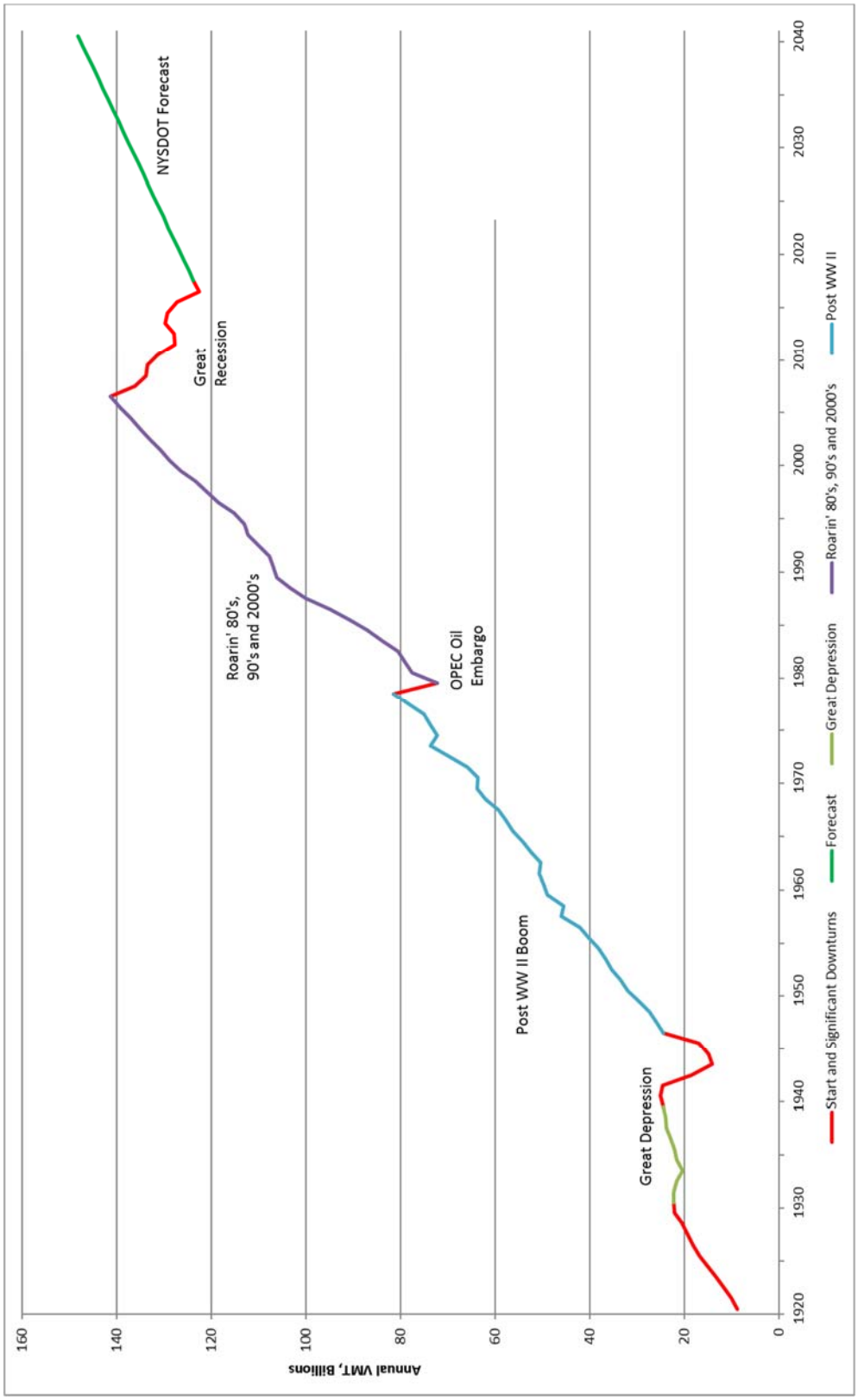
- The Great Depression (1931-1939);
- World War II (1941-1945);
- Post War Boom (1946-1978);
- "Roarin' 80's, 90's, and 2000's" (1979-2006); and
- Great Recession (2007-2011).

The chart shows that VMT growth was the lowest during the Great Depression. VMT growth was the highest during the Roarin' 80's, 90's and 2000's period. This epoch captures the transportation related "coming of age" (marriage, family development, career start) during the late 70's, early 80's of the Baby Boom generation (i.e. those born between 1946 and 1964) as well as the beginnings of its "sunset" (grown children now independent, family unit downsized, career retirement).

The graph also shows the dramatic impact that the "Great Recession" had on VMT in New York. The severe economic downturn of the 2007-2009 period dramatically shrank the economy and hence dramatically lessened travel. The impact of the Great Recession appears to be larger than either of the two previous VMT downturn events, which occurred during the Organization of the Petroleum Exporting Countries (OPEC) Oil Embargo of the late 1970's, and World War II.

Figure 2.1 also shows that NYSDOT expects a steady, 2% annual increase in VMT going forward, although at a lower growth rate than that experienced in the past. To meet the expected increase in demand for the next 25 years, it is vitally important that NYSDOT effectively manage its existing highway system. This is at the heart of NYSDOT's asset management approach.

Figure 2.1 Vehicle Miles Traveled on NYSDOT Highways (1920-2040)



2.2 ASSET REGISTRY

Table 2.1 presents New York's current highway asset registry. It summarizes inventory and condition information for bridges and pavements. The condition measures used in the registry are described in the following chapters.

Table 2.1 includes all bridges and pavements that are eligible for funding from the NYSDOT comprehensive program. The comprehensive program includes all available State and federal highway funds and covers all NYSDOT owned assets as well as all Federal-Aid eligible assets. Federal-Aid assets are stratified in two tiers - NHS and non-NHS. The NHS is further stratified by interstate and non-interstate. This creates a four tier hierarchy of:

- Interstates,
- Non-interstate NHS,
- Non-NHS Federal-Aid system, and
- Non-Federal-Aid eligible NYSDOT-owned assets.

NYSDOT owns and manages 74 percent of the NHS. The remaining portion is managed by NYSTA and other entities. Sections 2.3 and 2.4 present a more detailed breakdown of asset inventory and conditions.

Table 2.1 Asset Registry

INVENTORY												
Highway System#	Pavements				Bridges							
	Lane-miles				Deck Area (1,000 sq. ft.)				Count			
	NYSDOT	NYSTA	Others*	Sub-Total	NYSDOT	NYSTA	Others*	Sub-Total	NYSDOT	NYSTA	Others*	Sub-Total
Interstate	5,499	2,413	142	8,054	30,569	9,692	8,872	49,133	1,760	440	110	2,310
Non-Interstate NHS	14,270	37	4,395	18,702	30,620	1,206	15,773	47,599	2,553	65	557	3,175
Total NHS	19,769	2,450	4,537	26,756	61,188	10,898	24,645	96,732	4,313	505	667	5,485
NHS	19,769	2,450	4,537	26,756	61,188	10,898	24,645	96,732	4,313	505	667	5,485
Non-NHS FA Highways	17,675	1	23,685	41,361	16,432	1,410	10,184	28,026	2,671	144	1,908	4,723
Total Federal Aid Eligible	37,445	2,451	28,222	68,118	77,620	12,308	34,829	124,757	6,984	649	2,575	10,208
Federal Aid Eligible	37,445	2,451	28,222	68,118	77,620	12,308	34,829	124,757	6,984	649	2,575	10,208
Non-Federal Aid Eligible	1,123	0	167,377	168,500	3,244	967	13,790	18,001	538	117	6,626	7,281
Total Statewide	38,568	2,451	195,599	236,618	80,864	13,275	48,619	142,759	7,522	766	9,201	17,489

* Other owners of federal-aid eligible infrastructure include: Port Authority of NY and NJ, Bridge and Tunnel Authorities, cities, counties and other authorities and local governments

Refers to the highway. All highway bridges are potentially Federal Aid eligible.

CONDITIONS (NYSDOT Measures)												
Highway System#	Pavements (Based on Lanemiles)						Bridges (based on Deck Area)					
	NYSDOT		NYSTA^		Others		NYSDOT		NYSTA		Others	
	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	% VMT on Pavements rated 7+	% LMs Pavement rated 5-	Average Condition Rating	% Deficient	Average Condition Rating	% Deficient	Average Condition Rating	% Deficient
Interstate	75.7%	2.6%	97.9%	0.0%	87.3%	12.7%	5.07	44.4%	4.76	62.6%	4.35	82.3%
Non-Interstate NHS	80.6%	3.6%	*100.0%*	*0.0%*	68.4%	4.6%	5.24	41.3%	4.77	65.6%	5	54.2%
Non-NHS FA Highways	56.8%	13.2%	*100.0%*	*0.0%*	NA	NA	5.47	28.6%	5.08	52.4%	5.47	33.8%
Total Federal Aid Eligible	75.7%	8.8%	97.9%	0.0%	*NA*	*NA*	5.22	39.8%	4.8	61.8%	4.97	55.4%
Non-Federal Aid Eligible	44.0%	33.8%	*NA*	*NA*	NA	NA	5.36	34.1%	5.11	57.5%	5.59	28.5%

Note: NYSDOT defines "Good" pavement as having a sufficiency rating of 7 or more, and defines "Poor" pavements as having a sufficiency rating of 5 or less. In order to avoid confusion with Federal definitions of "Good" and "Poor", these terms will be avoided where possible in the document.

^ The Total Lane Miles are an estimation since the total lanemiles is based on the NYSDOT's primary direction convention. The direction convention beween NYSDOT and NYSTA are not the same.

CONDITIONS (FHWA Measures)												
Highway System#	Pavements (Based on Lane miles)											
	NYSDOT			NYSTA			Others			Total		
	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor
Interstate	51.4%	45.2%	3.4%	*61.9%*	*36.1%*	*2.0%*	NA	NA	NA	42.4%	54.6%	3.0%
Non-Interstate NHS	20.7%	71.0%	8.3%	NA	NA	NA	3.7%	84.8%	11.5%	19.1%	72.3%	8.6%
Highway System#	Bridges (based on Deck Area)											
	NYSDOT			NYSTA			Others			Total		
	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor	% Good	% Fair	% Poor
NHS	24.98%	62.94%	12.08%	14.97%	75.80%	9.24%	10.14%	77.07%	12.80%	20.07%	67.99%	11.94%

Note: All inventory and condition information based on 2016 data.

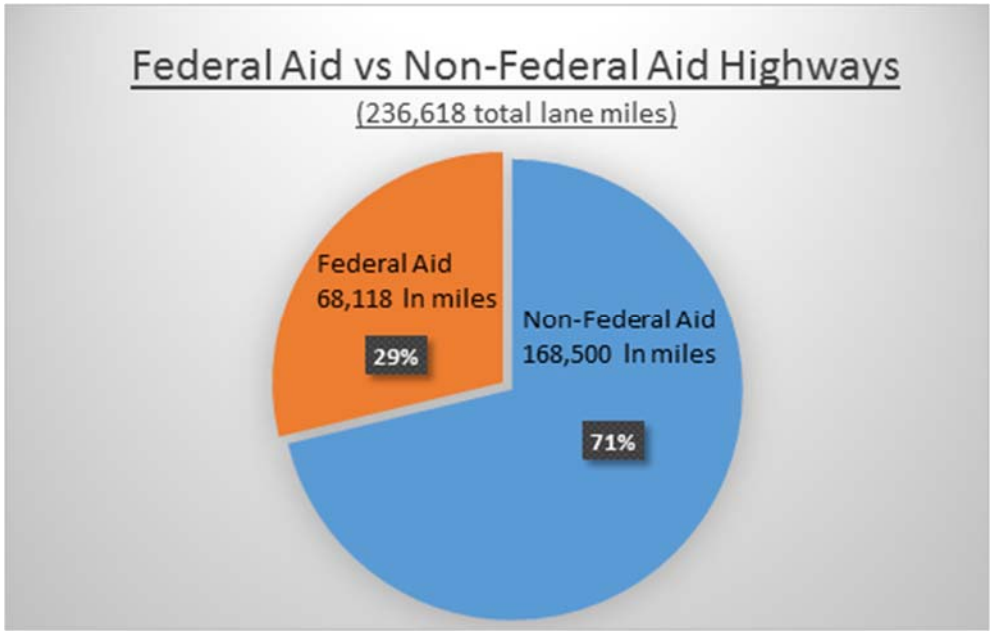
2.3 PAVEMENT INVENTORY AND CONDITION

The TAMP is primarily focused on the National Highway System (NHS) of roadways. However, the NHS is a small subset of the entire roadway network in New York State.

There are approximately 236,620 lane miles of public roadways in the state. A public road is any road or street owned and maintained by a public authority and open to public travel. The term "maintenance" means the preservation of the entire highway, including surfaces, shoulders, roadsides, structures, and such traffic-control devices as are necessary for safe and efficient utilization of the highway. To be open to public travel, a road section must be available, except during scheduled periods, extreme weather, or emergency conditions, passable by four-wheel standard passenger cars, and open to the general public for use without restrictive gates, prohibitive signs, or regulation other than restrictions based on size, weight, or class of registration. Toll plazas of public toll roads are not considered restrictive gates. A public authority is defined as a Federal, State, county, town or township, Indian tribe, municipal or other local government, or instrumentality with authority to finance, build, operate, or maintain toll or toll-free facilities.

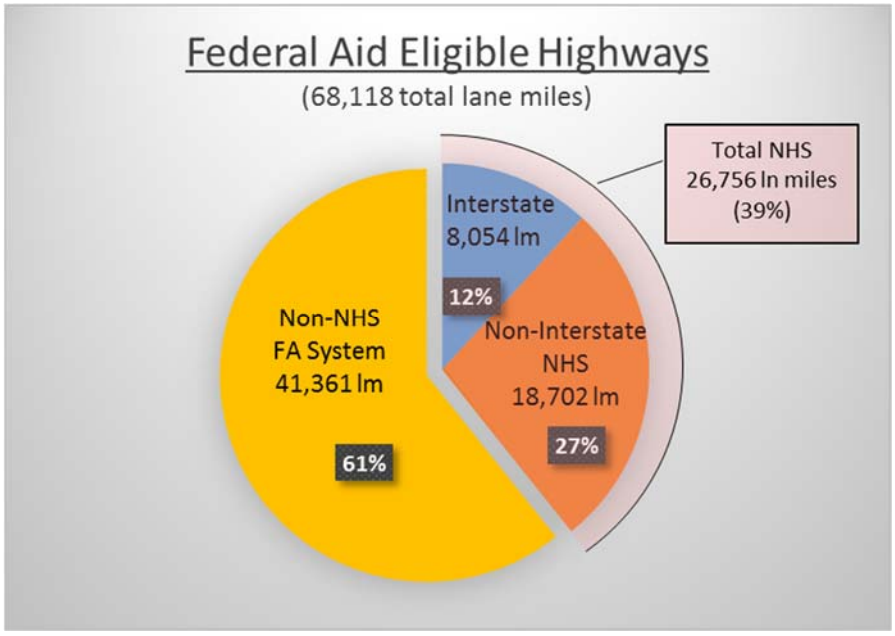
All of these public roadways are assigned an FHWA functional class, which is a broad descriptor of the uses and configuration of the road. The roadway network can also be divided into roadways that are eligible for federal aid and roadways that aren't. For a roadway to be eligible for federal aid it has to either be on the NHS or it has to have a "higher" functional class, including Interstates, Other Freeways and Expressways, Principal Arterials, Major Collectors and Urban Minor Collectors. The distribution of the state roadway network between federal aid eligible and non-eligible roads is presented in Figure 2.2

Figure 2.2 Lane Miles of Public Roadways in New York State



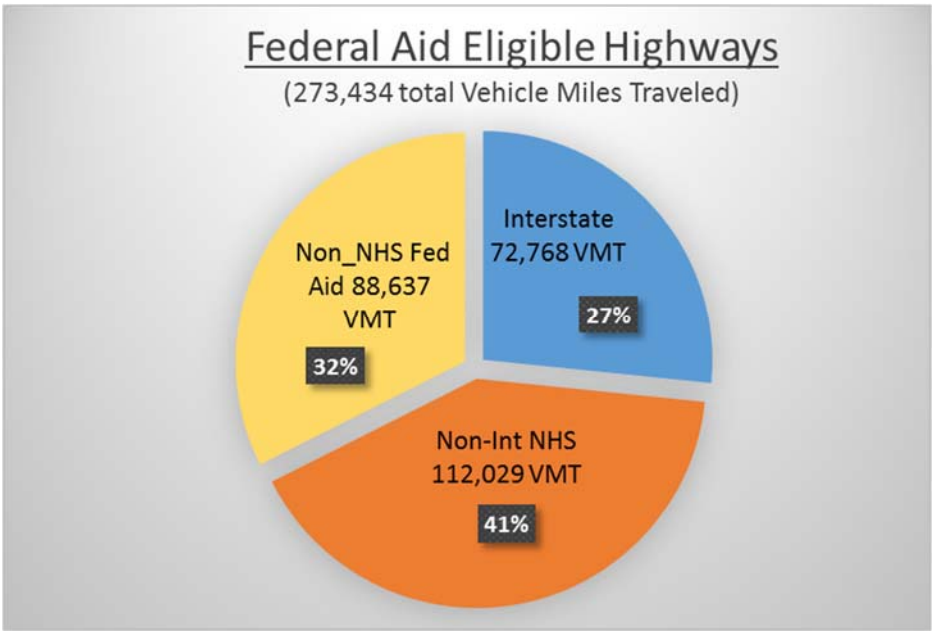
As mentioned above, the most important roadways in the Federal Aid eligible roadway network are included on the National Highway System (NHS). The National Highway System is a network of nationally significant highways which consist of interconnected urban and rural principal arterials and highways (including toll facilities) which serve major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities and other major travel destinations; meet national defense requirements; and serve interstate and interregional travel. All routes on the Interstate System are a part of the National Highway System. The TAMP is primarily focused on the NHS.

Figure 2.3 Federal Aid Eligible Highways in New York State by Lane Miles



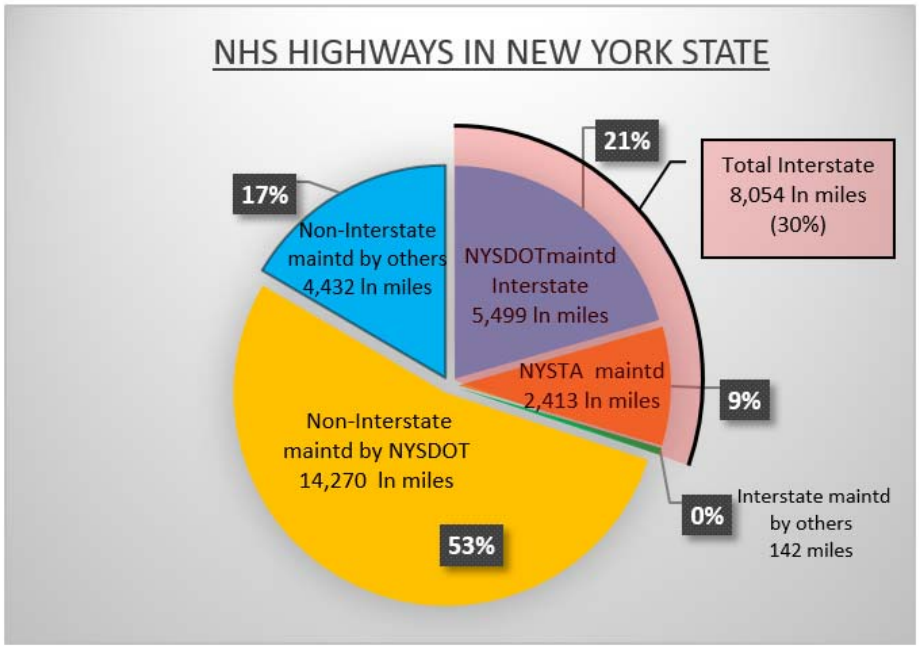
As shown in the figure above, about 39% of the Federal Aid Eligible lane miles of pavement in the state are on the NHS. However, the NHS carries almost 70% of the total traffic on the federal aid eligible portions of the state highway system, as expressed by vehicle miles of travel. This is illustrated in the chart below.

Figure 2.4 Federal Aid Eligible Highways in New York State by VMT



The NHS in New York State consists of 26,756 lane miles. Like most states, the NYSDOT doesn't bear sole responsibility for administration and maintenance of the NHS. Significant portions of the NHS are maintained by other agencies. Other owners of NHS facilities in New York State include the New York State Thruway Authority, Mid-Hudson Bridge Authority, Triborough Bridge and Tunnel Authority, Port Authority of New York and New Jersey, counties, cities and towns. In total, NYSDOT maintains 19,769 lane miles of the NHS. Figure 2.5 shows a breakdown of the NHS, by maintenance jurisdiction.

Figure 2.5 NHS Pavement Lane Miles



Pavement Performance Measures

NYSDOT collects a wide variety of data relating to pavement condition and uses a number of performance measures as part of its pavement program. NYSDOT uses these measures for three purposes – reporting to State and Federal authorities, selecting projects, and managing the network. This section explores pavement data collected, the associated performance measures, and the applications for those measures.

NYSDOT has both State and Federal reporting requirements. The Department creates an annual Highway Mileage Report for pavement inventory which is distributed to the public on our website. NYSDOT also submits an annual Pavement Condition Report to the State legislature, which includes a summary of the condition of the highway system, using the New York State pavement condition metrics outlined below. For the Federal government, detailed pavement information, including inventory, traffic and condition, primarily consisting of Federal cracking and roughness data, is submitted annually through FHWA's Highway Performance Monitoring System (HPMS).

As detailed below, NYSDOT collects cracking data, rutting, faulting, etc. for the entire NHS, and we share the data with the Thruway and our other NHS partners, regardless of jurisdiction. Even though other NHS owners, such as the New York State Thruway, may collect additional pavement data for their own purposes, NYSDOT doesn't ask for this additional data because it isn't used for federal reporting, and it isn't used by NYSDOT to program projects.

NYSDOT collects, processes, stores and updates inventory and condition data for NHS pavement assets in our pavement management system, in compliance with 23 CFR 515.17.

Measures Used for Treatment Selection

Surface Rating: NYSDOT has traditionally collected their pavement surface rating, which is an overall measure of pavement quality, based on the severity, extent and location of pavement cracking.

The Surface Rating is based on a 10 point scale and is reported as follows:

10-9	Excellent (no work needed)
8	Very Good (crack seal candidate)
7	Good (preventative maintenance candidate)
6	Fair (corrective maintenance candidate)
<=5	Poor (rehabilitation or reconstruction candidate)

For reporting purposes surface rating may be provided for an individual segment, or reported as an average for a corridor, geographic area, any subset of pavements, or the entire network.

NYSDOT's surface scores have traditionally been generated through visual-based "windshield surveys". In 2015 NYSDOT began phasing out windshield surveys and replaced them with an automated crack/distress detection system. This system uses 3D technology to more accurately identify and quantify the degree of distress exhibited by highway pavement. The new crack data is consistent with the latest federal HPMS requirements, and records the amount of cracking over five distinct zones within the pavement surface. In an effort to maintain consistency in monitoring the rate of deterioration over the life of the pavement, NYSDOT has developed an

algorithm by which to convert the automated distress data back into the traditional 10 point "Surface Rating" scale. NYSDOT's long term approach to working with this new data stream will be further explored in Chapter 8.

IRI: International Roughness Index is a national-standard measure of ride quality reported as in./mi.. NYSDOT categorizes pavements as follows:

≤ 60	Very Smooth
60-119	Smooth
120-170	Fair
171-220	Rough
>220	Very Rough

For reporting purposes, IRI may be provided for an individual segment, or reported as an average for a corridor, geographic area, any subset of pavements, or the entire network.

Dominant Distress: There is another component of the surface rating that identifies the presence of a dominant distress on the pavement section. A pavement section with a dominant distress requires a more significant treatment to be applied than when a dominant distress is not present. These include:

- Faulting: The measure of elevation difference between sequential slabs in rigid pavements. Faulting indicates failure of the load transfer devices between slabs;
- Spalling: The loss of material from the surface of concrete pavement due to corrosion of reinforcing steel;
- Alligator cracking: Areas of interconnected cracks in flexible pavements, occurring in the wheel path, identifying failure of the pavement material; and
- Widening drop-off: the measure of elevation difference between one longitudinal area of a paving lane and an adjacent area that was constructed at a different time.

Depending on the type of dominant distress, it will have a classification with it that tells whether its presence is < 20 %– "Isolated" (i) of the pavement section, ≥20% - "General" (g) of the pavement section, or if it is "Low Severity" (l) or "High Severity" (h).

Both condition rating and IRI are used along with the dominant distress to select appropriate treatments and identify, prioritize, and select pavement projects. These measures are calculated for every pavement segment, so treatments can be optimized to the specific conditions at each location.

Additional Measures Collected by the New York State Thruway for Treatment Selection

The basis of the NYSTA's Pavement Management System (PAMS) is the annual Pavement Distress Survey, data from which is used to generate a Pavement Distress Index (PDI) for each segment of the NYSTA pavement network. The Pavement Distress Survey is conducted each spring by two trained NYSTA employees driving on the shoulder at 10 to 15 mph, visually observing and recording pavement distresses. Conducting the survey in the spring takes advantage of longer days, allows the pavement to be evaluated after winter, provides time to program emergency repairs as needed before the construction season, and limits the number of

miles not rated due to construction. Most importantly, it provides current condition data in time to be used in the development of the annual capital program.
Five different distresses are rated for both asphalt-overlaid and concrete pavements:

Asphalt-Overlaid Pavement

- Centerline Cracking
- Transverse Cracking
- Edge of Pavement/Shoulder Cracking
- Other Lane Cracking/Defects
- Shoulder Cracking/Defects

PCC Pavement

- Centerline Joint Cracking/Spalling
- Transverse Joint Cracking/Spalling
- Edge of Pavement/Shoulder Joint Cracking/Spalling
- Slab Surface Cracking/Defects
- Shoulder Cracking/Defects

The survey collects data in one-mile increments in each direction of travel, along the entire length of the Thruway. Visible rutting is also identified for asphalt pavements, however it is not included in the PDI calculation since it is not a predominate issue on Thruway pavements.

The PDI is a composite measure and is calculated from the five individual distress ratings collected for each pavement type. The PDI uses a weighted formulation and a deduct approach. Indices and sub-indices are calculated for each mile of road, in each direction. The distress indices are a non-dimensional measure that expresses the relative amount of surface damage. The distress survey has been conducted since 2012.

The PDI ranges from 100 to 0, with 100 representing a new pavement with no visible surface distresses, and 0 representing a pavement that is severely distressed. Pavement with a PDI between 90 and 100 is classified as Excellent. Pavement with a PDI less than 60 is classified as Poor.

For asphalt treatment pavements, the PDI, rater comments, contract work history, associated treatments and lives achieved for a particular segment are analyzed together to realistically infer the condition of the underlying concrete slabs without cores, FWD or other testing. Accident history, traffic and truck volumes, drainage problems, and other relevant factors are also taken into account when determining the appropriate treatment and timing for each pavement section, subject to financial constraints and minimum performance criteria. NYSTA is exploring the use of automated or semi-automated survey methods, including Laser Crack Measuring Software (LCMS), to replace the manual survey.

Federal (FHWA) Reporting Measures

The Final Rule enacting 23 CFR Part 490 – National Performance Management Measure, pursuant to MAP 21, establishes the following **performance measures** for State DOTs to use in managing pavement on the NHS:

% of interstate pavements in Good condition

% of interstate pavements in Poor condition

% of non-interstate NHS pavements in Good condition

% of non-interstate NHS pavements in Poor condition

FHWA has identified three **pavement metrics** for each type of pavement in order to assess these performance measures:

- IRI (Asphalt, Jointed Concrete Pavement)
- Cracking Percent (Asphalt, Jointed Concrete Pavement)
- Rutting (Asphalt Pavement)
- Faulting (Jointed Concrete Pavement)

The pavement metrics and rating thresholds used to determine the performance measures are identified in Figure 2.6

Figure 2.6 Pavement condition metrics and thresholds

§ 490.311 Metric Thresholds in Final Rule

Rating	Good	Fair	Poor
IRI *(inches/mile)*	<95	***95-170***	***>170***
PSR* *(0.0-5.0 value)*	≥4.0	2.0-4.0	≤2.0
Cracking Percent *(%)*	<5	***CRCP: 5-10 Joined: 5-15 Asphalt: 5-20***	***>10 >15 >20***
Rutting *(inches)*	<0.20	0.20-0.40	>0.40
Faulting *(inches)*	***<0.10***	0.10-0.15	>0.15

*PSR may be used only on routes with posted speed limit < 40mph.

The appropriate metrics are applied to each 0.1 mile section to determine the overall section rating:

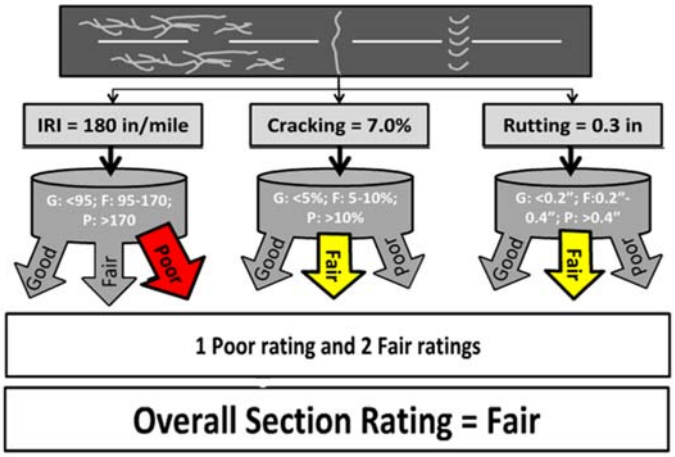
Good = all three metrics rated "Good"

Poor = two or more metrics rated "Poor"

Fair = less than 3 metrics rated "Good" and less than 2 measures rated "Poor"

Figure 2.7 provides an example for rating a 0.1 mile section of asphalt pavement.

Figure 2.7 Pavement Section Rating for 0.1 Mile Asphalt Pavement



The individual segments are then combined into the Interstate or Non-Interstate NHS categories to determine the system-wide performance measures as shown in Figure 2.8.

Figure 2.8 Calculation of Statewide Performance Measures

Overall Section Condition Rating	3 metric ratings (IRI, cracking and rutting/faulting)		Measures
Good	All three metrics rated "Good"	→	percentage of lane-miles in "Good" condition
Poor	≥ 2 metrics rated "Poor"	→	percentage of lane-miles in "Poor" condition

Present Serviceability Rating (PSR) is a performance measure for pavement condition on the NHS. This rating is calculated on NHS roadway sections where the posted speed limit is less than 40 MPH and where actual IRI values are unable to be collected. When an IRI value is unavailable, the surface rating and dominant distress can be used to calculate PSR. The PSR can be determined by dividing the New York State surface rating by 2 and subtracting 0.5 if a dominant distress of General Alligator Cracking (Ag), General Spalling (Sg), or High Severity Widening Dropoff (Wh) is present.

The calculation: (PSR = (Surface Score/2) – (0.5 if there is Ag, Sg or Wh present).

Ex. Surface Rating = 5 Ag, so PSR = 2.0

PSR= 5/2 = 2.5, Ag = -5

PSR = 2.5 – .5 = ***2.0 (Poor)***

The metric thresholds of the new rule making set forth in MAP-21, Section 490.11:

PSR > 4.0 Good

PSR > 2.0 and < 4.0 Fair

PSR < 2.0 Poor

PSR	Description
4.0 – 5.0	Only new (or nearly new) superior pavements are likely to be smooth enough and distress free (sufficiently free of cracks and patches) to qualify for this category. Most pavements constructed or resurfaced during the data year would normally be rated in this category.
3.0 – 4.0	Pavements in this category, although not quite smooth as described above, give a first class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid Pavement may be beginning to show signs of slight surface deterioration, such as minor cracks and spalling.
2.0 – 3.0	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching Rigid pavements in this category may have a few joint failures, faulting and/or cracking, and some pumping.
1.0 – 2.0	Pavements in this category have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes raveling, cracking, rutting that occurs over 50% of the surface. Rigid pavement distress includes joint spalling, patching, cracking, scaling, and may include pumping and faulting.
0.1 – 1.0	Pavements in this category are in extremely deteriorated condition. The facility is passable only at reduced speeds, and with considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs over 75% or more of the surface.

FHWA has established minimum conditions for **Interstate Highways** such that the percentage of lane-miles in poor condition shall not exceed 5%. The regulation further states that if the minimum interstate pavement condition standard is not met for two consecutive years, the following penalties shall be applied:

- The State shall obligate a portion of National Highway Performance Program (NHPP) funding for interstate maintenance
- The State shall transfer funding from the State component of the STP program to the NHPP program.
- NHPP obligation will be equal to the 2009 interstate Maintenance program and increase by 2% for each subsequent year the state fails to meet the minimum condition standard.
- The amount transferred from the State component of the STP program will be 10% of the 2009 statewide Interstate Maintenance apportionment.

These penalties could result in less flexibility in funding projects. It should be noted that the penalties apply to State funding on a statewide basis. Penalties are not applied regionally, to local apportionments or to sub-allocations.

Measures Used for Network Management

NYSDOT uses the following performance measures to manage its pavement network:

- **Percent Vehicle Miles Travelled (VMT) on Good or Excellent Pavements** is a measure of how much of the customers' travel is on a good road. It also reflects the program's emphasis on prioritizing the high volume roads for preservation work.
- **Percent Poor Pavement** is a measure of the extent of the system that has deteriorated to the point of requiring major rehabilitation or reconstruction.
- **Backlog** represents the funding needed to bring every pavement to a state of good repair today. A better system condition will have fewer needs and therefore a lower backlog. Since backlog is computed by the pavement models using condition trend data, it knows what the appropriate treatment is for each segment and will not recommend "band-aid" treatments that tend to cause a short term bump in ratings.

NYSDOT tracks and evaluates these measures at the network level and uses them to support the setting of planning targets between Regions and programs. It also establishes target values for % VMT on Good or Excellent and % Poor Pavement. These target values are provided in Chapter 7. In addition, NYSDOT uses the federal requirement of no more than 5% poor interstate pavement as a further constraint in its modeling when developing its capital program.

2.4 BRIDGE INVENTORY AND CONDITION

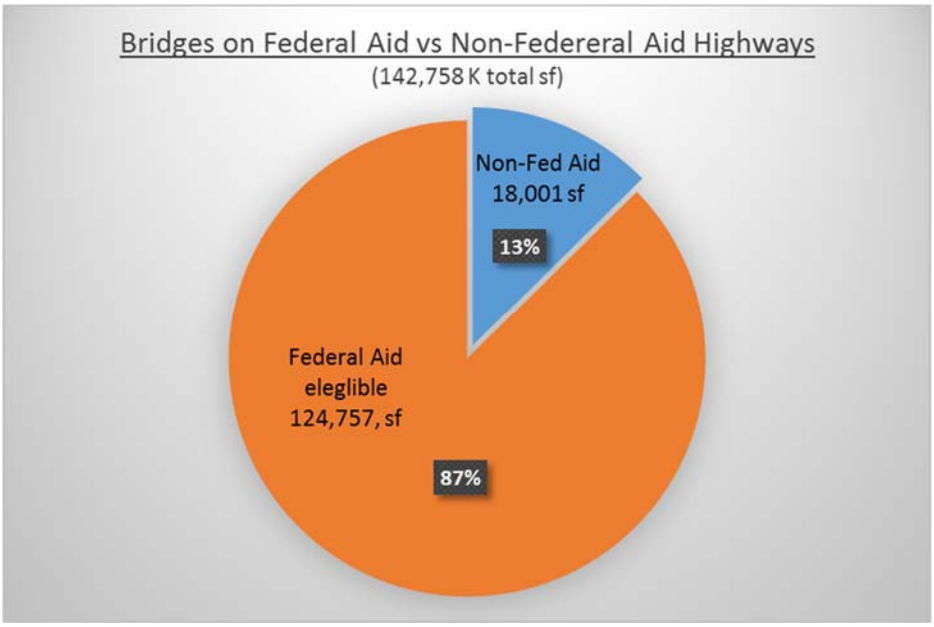
Similar to pavements, NYSDOT has both State and Federal reporting requirements pertaining to the structures on the highway network. NYSDOT submits the "Graber Report", containing inventory and condition information using the State condition metrics, to the state legislature. This report is available to the general public on our website. For the Federal government, NYSDOT annually reports bridge inventory and condition information, using the federal metrics, through FHWA's National Bridge Inventory System.

NYSDOT collects, processes, stores and analyzes data in their bridge management system meeting the minimum requirements of 23 CFR 515.17.

Inventory

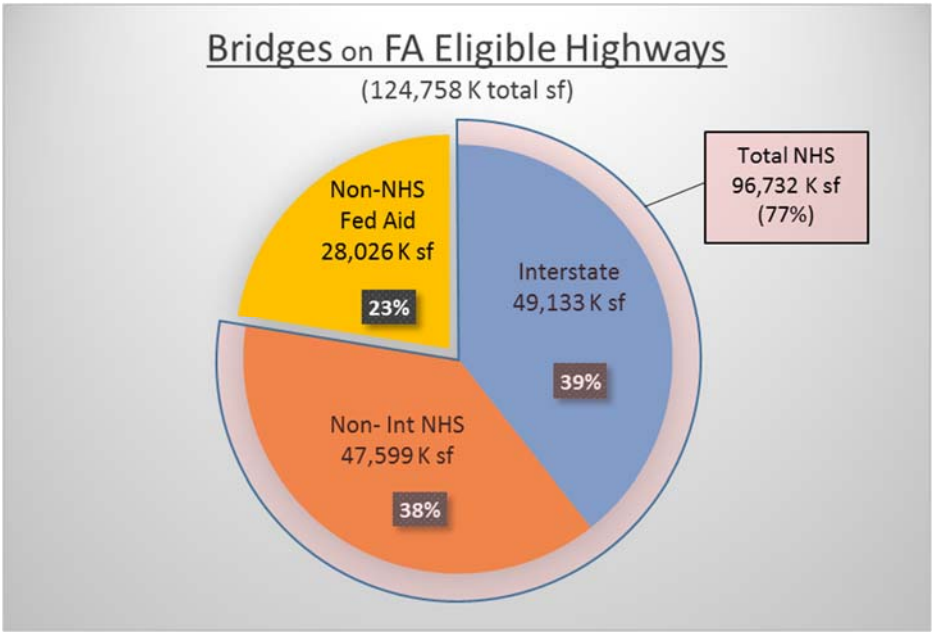
New York State has 17,489 highway bridges totaling 142,759,000 square feet of deck area. Unlike pavements, a majority of these structures, (10,208 of them), are eligible for Federal Aid. And, as you would expect, these federal aid eligible structures make up a vast percentage of the total deck area in the state. The breakdown, by deck area, is shown below.

Figure 2.9 Total NYSDOT Bridges by Deck Area (1000 sf. ft)



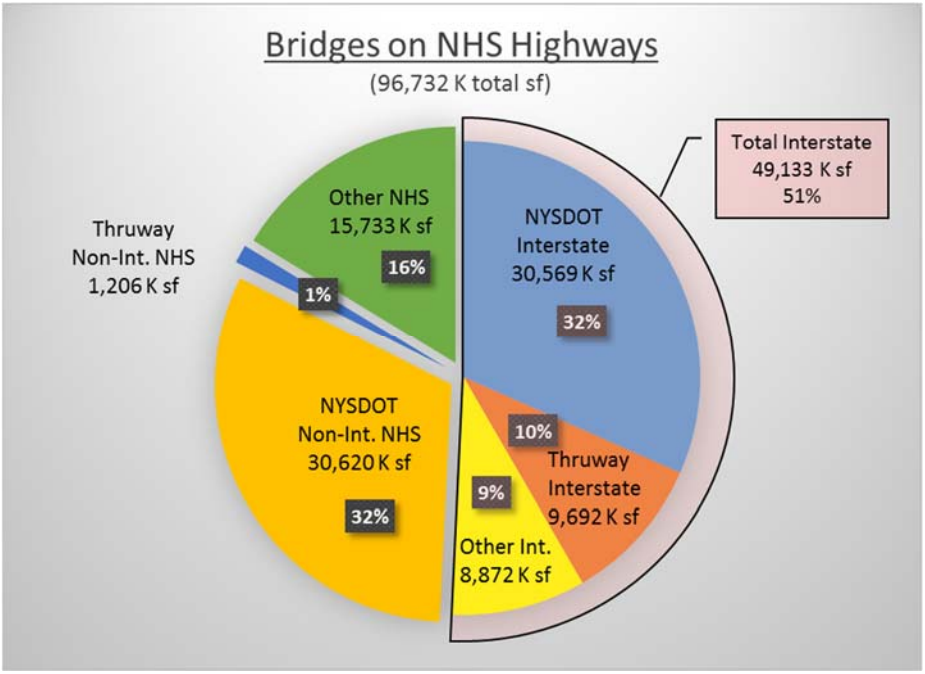
Over 10,200 structures in the state are eligible for federal aid, with a small majority of these structures, (5,485), on the NHS. Once again, as you'd expect, the larger structures in the population are on the NHS, so even though the number of NHS structures make up a slim majority (54%), the breakdown of these structures by total deck area skews heavily toward the NHS (77%), as shown in the figure below.

Figure 2.10 Deck Area of Federal Aid eligible Bridges, by System Tier (1,000 sq. ft.)



Finally, both the structures located on the interstate system and the non-interstate portions of the NHS, are administered by NYSDOT, the New York State Thruway Authority, other bridge and tunnel authorities, counties and other local governments. This breakdown is shown in Figure 2.11.

Figure 2.11 Deck Area of NHS Bridges, by System and Jurisdiction (1,000 sq. ft.)



Bridge Performance Measures

As part of its bridge program, NYSDOT uses performance measures for three purposes – state reporting, federal reporting, and managing the network. Following is a summary of the performance measures in each of these categories.

NYSDOT either collects the bridge condition data ourselves, through our inspection program, or administers and oversees inspection contracts for the bridges under our or our partner's jurisdiction. The New York State Thruway Authority performs their own bridge inspections, but they adhere to all of our rules and all Federal requirements. Regardless of who performs the inspection, all of the bridge condition data is submitted to NYSDOT. NYSDOT is responsible for all QA on the data for all bridges, regardless of ownership, and is responsible for all State and Federal reporting.

Measures Used for New York State Reporting

New York State previously used a numerical inspection condition rating scale ranging from 1 (minimum) to 7 (maximum). During each general inspection, various components or elements of each bridge span are rated by the inspector as to the extent of deterioration, as well as the component's ability to function structurally relative to when it was newly designed and constructed. A Condition Rating (CR) is calculated for each bridge from inspection ratings for 13 bridge components weighted in proportion to their respective and relative structural importance.

The CR, based on a 7-point scale, is reported as follows:

CR = 7	Excellent (no work needed)
CR 5.8 to 7	Good (preventive maintenance candidate)
CR < 5.0	Structurally Deficient
CR 4.9 to 5.8	Fair – Protective (preservation candidate).
CR 4.4 to 4.9	Fair – Corrective (repair candidate)
CR < 4.4	Poor (rehabilitation or replacement candidate).

For reporting purposes, CR may be provided for an individual bridge, or reported as an average for a corridor, geographic area, any subset of bridges or the entire inventory. Unless otherwise noted average condition rating is reported as a weighted average by deck area.

Condition Rating and its components are key indicators used to identify and prioritize projects for maintenance, preservation, and capital program (rehabilitation and replacement) activities at the system level. Once projects are identified at the system level, each of the projects is reviewed at the regional level to account for local knowledge and engineering experience of regional staff before the bridge program is finalized.

Effective in 2016, NYS began the transition to collecting bridge inspection data using the AASHTO-Element based inspection system. This new system uses a scale of 4 (Good) to 1 (Severe), while NYSDOT's system used a scale of 1 (New) to 7 (Failed) for more than four decades. The highway bridges in New York State were inspected using the new system since the 2016

inspection cycle. This transition poses two challenging issues. First, all previous condition evaluations and bridge management efforts of NY bridges were based on the NYS rating scale and the Condition Rating (CR) performance measure, both of which will cease to exist. Second, the new AASHTO element system has no historical data to easily predict future conditions or develop work strategies. To address the difference in scales for the short term, a translator algorithm was developed to estimate the Condition Rating [CR] of the bridges that are inspected with the new system to bridge the gap between the two systems. Since the ratings are not directly correlated, the resulting translated data will not be totally consistent with the actual NYS element data. The transition from actual NYS Element data to translated NYS Element data will occur over two years because of the bridge inspection cycle. Therefore, evaluating bridge conditions in 2016 through 2017 will be difficult. While the safety aspects of the Bridge Inspection Program remain intact, the continuum of bridge condition data will be impacted. A project is underway to develop performance measures based on the new AASHTO Element system and is expected to complete by December 2020.

Measures Used for Federal Reporting Requirements

Federal reporting measures are based on National Bridge Inventory (NBI) data. The 1-7 NYSDOT old bridge inspection scale as well as the 4-1 AASHTO element based rating scales are separate and different from the NBI rating scale (see below).

9 EXCELLENT CONDITION

8 VERY GOOD CONDITION - no problems noted

7 GOOD CONDITION - some minor problems.

6 SATISFACTORY CONDITION - structural elements show minor deterioration

5 FAIR CONDITION - all primary structural elements are sound but may have minor corrosion, cracking or chipping. May include minor erosion on bridge piers.

4 POOR CONDITION - advanced corrosion, deterioration, cracking or chipping. Also significant erosion of concrete bridge piers.

3 SERIOUS CONDITION - corrosion, deterioration, cracking and chipping, or erosion of concrete bridge piers have seriously affected deck, superstructure, or substructure. Local failures are possible.

2 CRITICAL CONDITION - advanced deterioration of deck, superstructure, or substructure. May have cracks in steel or concrete, or erosion may have removed substructure support. It may be necessary to close the bridge until corrective action is taken.

1 "IMMINENT" FAILURE CONDITION - major deterioration or corrosion in deck, superstructure, or substructure, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.

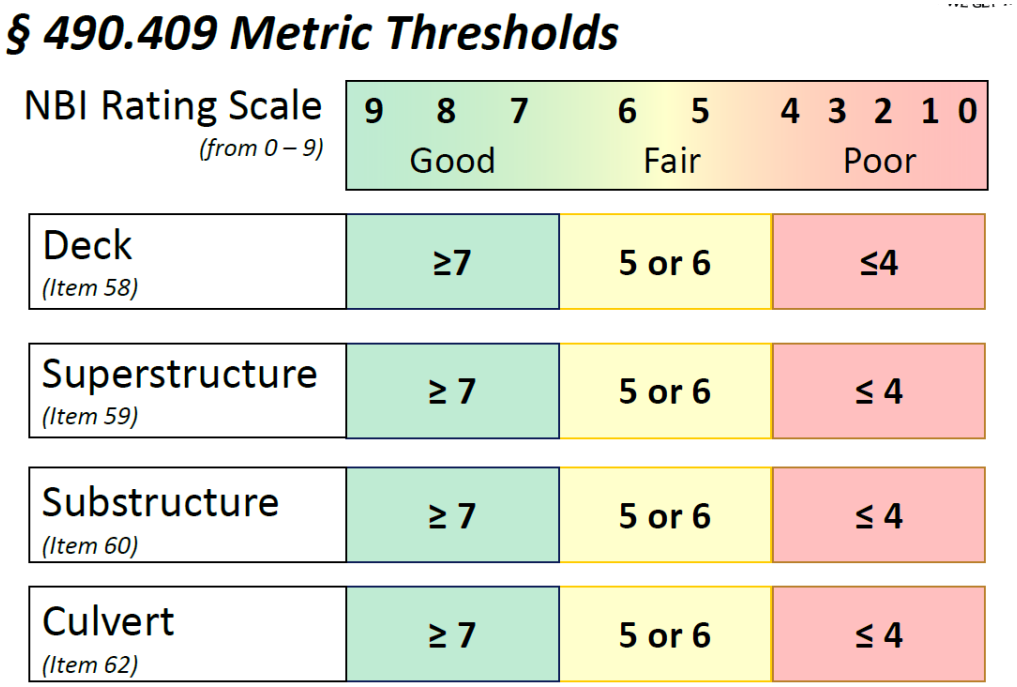
0 FAILED CONDITION - out of service - beyond corrective action

N Not applicable

In New York State, bridge inspectors assess and record NBI ratings (0-9 scale as shown above) for all bridges, in addition to the AASHTO Element rating data in 4 to 1 scale, during field inspections. This data is used to determine the FHWA bridge classification as outlined below.

National performance management measures for assessing bridge condition, based on NBI data, has three condition classifications. They are: (1) Percentage of NHS bridges classified as in Good condition; (2) Percentage of NHS bridges classified as in Fair condition; and (3) Percentage of NHS bridges classified as in Poor condition. These are in relation to the NBI ratings for the Bridge Deck, Substructure and Superstructure, as shown in Figure below.

Figure 2.12 Federal Reporting Metrics



Pursuant to the requirements of MAP-21, NYSDOT is required to report on NHS bridge conditions. The Federally mandated reporting measure for NHS bridges is "Structurally Deficient" deck area – represented in terms of percent. Effective January 1, 2018, a Structurally Deficient (Poor) bridge is defined by FHWA as when the lowest rating of the 3 NBI items for a bridge is 4, 3, 2, 1, or 0. When the rating of NBI item for a culvert is 4, 3, 2, 1, or 0, the culvert will be classified as Poor. MAP- 21 requires that the NHS bridge Structurally Deficient deck area not exceed 10 percent.

Measures Used for Network Management

NYSDOT uses the condition rating to manage its bridge network (definition of CR ranges is provided below):

- Good: Bridges in good condition that generally require preventive and corrective maintenance actions such as bridge washing, deck sealing, and bearing lubrication; [CR greater than 5.8]

- Fair–Protective: Bridges in fair condition that generally require relatively minor preventive and corrective maintenance actions such as, bearing repairs, joint repairs, zone and spot painting and girder end repairs; [CR between 4.9 (inclusive) and 5.8 (inclusive)]

- Fair–Corrective: Bridges in fair condition that generally require moderate preventive and corrective maintenance actions, such as, bearing replacement, deck replacement, and major substructure repairs; [CR between 4.4 (inclusive) and 4.9]

- Poor: Bridges in poor condition that generally require major rehabilitation or replacement [CR less than 4.4].

- Deficient: NYSDOT defines a "deficient bridge" as one with a Condition Rating (CR) of less than 5. A deficient CR indicates the presence of sufficient deterioration and/or loss of original function that requires corrective maintenance or rehabilitation to restore the bridge to its fully functional, non-deficient condition. It does not mean that the bridge is unsafe.

3.0 Financial Resources

This chapter discusses the value of New York State (NYS) NHS assets and describes the funding expected to be available over the next 10 years. NYSDOT and the NYSTA receive funding from multiple sources and are tasked with multiple missions. Only a portion of overall funding is available for asset management of pavements and bridges. This chapter describes NYSDOT's various revenue streams and explains how the Department arrives at an average annual core construction investment level for highway assets.

3.1 Valuation of NYSDOT Assets

NYSDOT uses the Government Accounting Standards Board Statement No. 34 (GASB-34) modified method to determine the value of its assets on an annual basis. In this method, the collective original construction cost of all road and bridge assets is determined, then each year NYSDOT adds the value of all new construction and subtracts the depreciation. The valuation for roads includes the cost of pavement construction and all other assets necessary for the operation of the highway such as signs, striping and drainage. The current value of assets on the NHS is:

- Pavements - $38.02 billion or $38.02B/26,756 Ln-Miles = $1.42M/lane-mile
- Bridges - $19.03 billion or $19.03B/5,485 bridges = $3.47M/Bridge

Figure 3.1 Value of NHS Infrastructure According to GASB-34 Modified Method

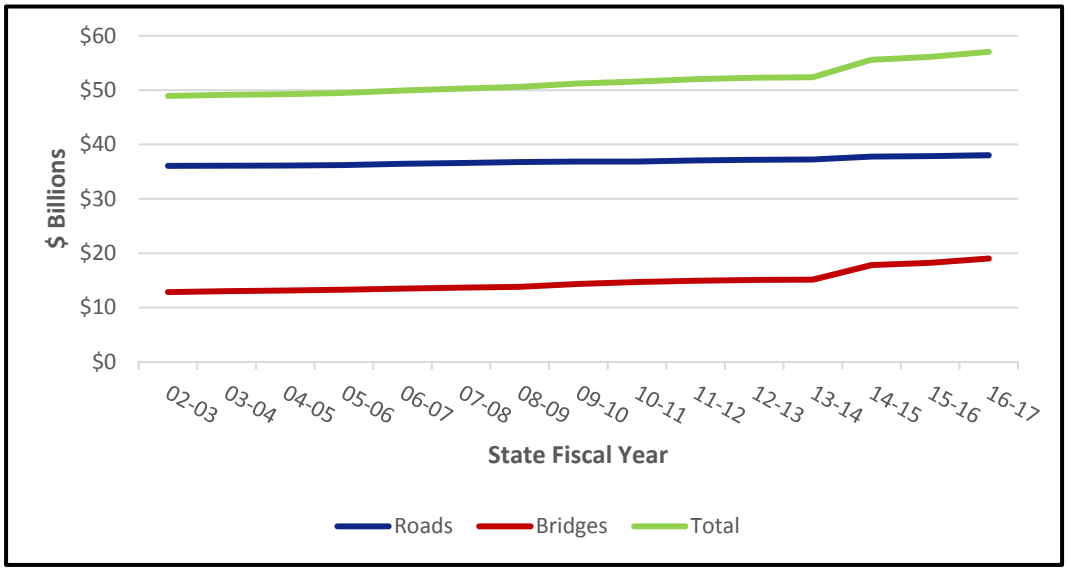


Figure 3.1 shows how the value of NYS NHS assets has changed over time. The increase in asset value is primarily due to the increased cost of construction over time. Labor and materials costs are higher on any new construction, and the carrying value on the inventory is historical cost, not current replacement cost. When a bridge is replaced, the cost of the new bridge is added and

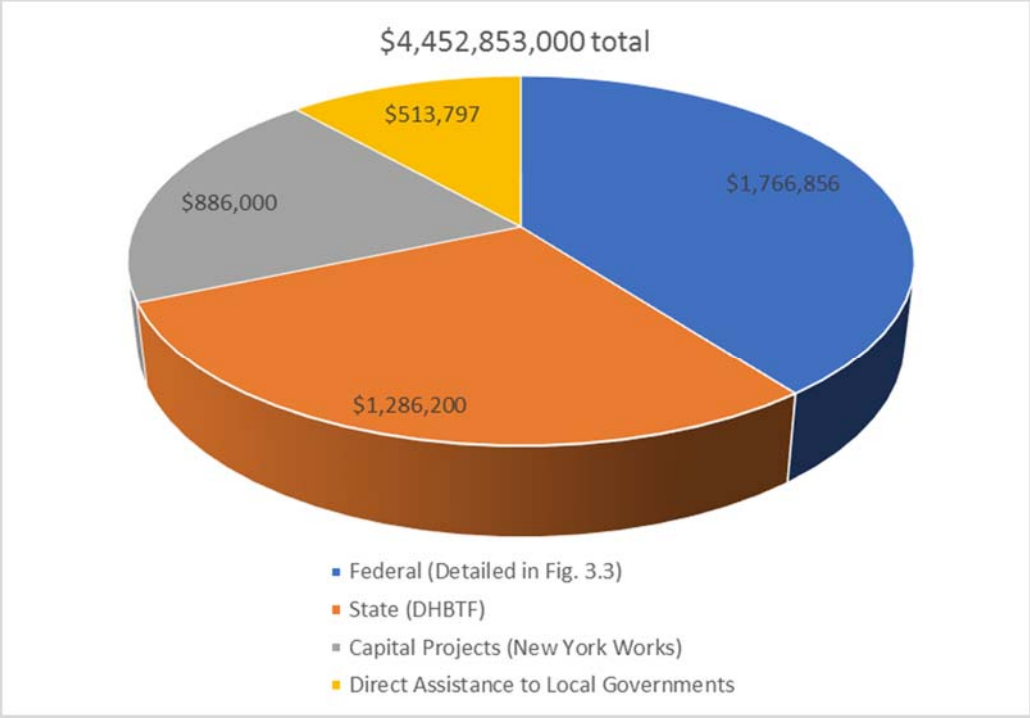
the historical cost to construct the original bridge is subtracted. The replaced bridge could have been constructed 50 or more years ago. For example, bridge 1043220 was built in 1941 with a historical cost of $33,606. Replacement of this bridge was completed in 2012 for $1,024,213 for a net increase of $990,607 or 2,947%.

NYSDOT does not consider asset valuation when setting asset management strategies. Instead NYSDOT uses condition-based measures to determine annual financial need, as described in Chapter 7. However, asset valuation is an important measure that indicates the soundness of NYSDOT's investment decisions.

3.2 CORE FUND SOURCES OVERVIEW

NYSDOT receives funding for use on the NHS, as well as the wider state and local transportation system. In contrast, the NYSTA receives funding and collects revenues, but they are only to be used on the New York State Thruway, which is completely on the NHS. Based on the best available information from state and federal sources, NYSDOT is forecasting flat funding for the next ten years. This section describes the sources of funding that are eligible for use on the transportation system in New York State, as shown in Figure 3.2 for NYSDOT and 3.4 for the NYSTA. Each of these fund sources is further defined below.

Figure 3.2 NYSDOT Funding Sources ($ Thousands)[2]



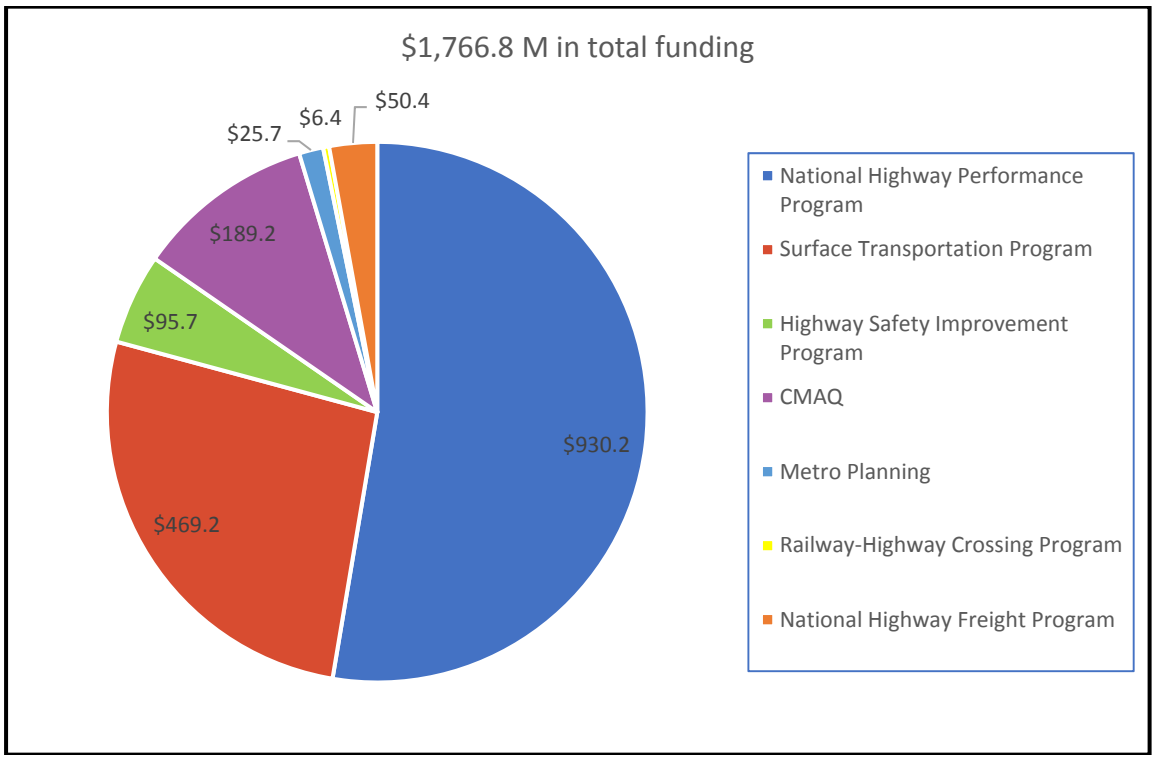
- **State Funds** are **c**omprised of funds from the New York State Dedicated Highway and Bridge Trust Fund (DHBTF) . The fund sources are subsidized by the Petroleum Business Tax, Motor Vehicle Fees, Motor Fuel taxes, and other taxes and fees. On average, budgets for the next ten years are anticipated to include about $1.3 billion per year in State funds

for support of NYSDOT's comprehensive program. The two specific fund sources are described below:

> **DHBTF (Dedicated Highway and Bridge Trust Fund).** These funds are appropriated by the State Legislature to be utilized for reconstruction, replacement, reconditioning and preservation of highways and bridges, to restore such facilities to their intended functions, and construction, reconstruction and improvement of highways and bridges thereon, to address current and projected severe capacity problems. Additional permissible uses include: State matching payments for federal highway grants; Acquisition of real property for highway projects; Payments to private engineers, architects, and surveyors; Preventative maintenance of highways and bridges; Engineering services at the Department of Transportation; debt service payments on State aid for local highway and bridge bonds; and any other highway or bridge purpose that in the past had been supported by other State funds.

- **Federal-Aid** is comprised of federal transportation funding and authorization programs such as the FAST Act and its predecessors. Total Federal funding is anticipated to be approximately $1.766 billion per year. Federal transportation funding is typically split into broad categories of eligible work. The FAST Act consolidated the number of these historical categories. Figure 3.3 illustrates the mix of these funds received by New York State by program within the FAST Act. In general terms, programs such as the Highway Safety Improvement Program (HSIP), Congestion Mitigation and Air Quality (CMAQ), Railway-Highway Crossing Program, National Highway Freight Program, and Metropolitan Planning (MP) have very specific goals, while the National Highway Performance Program (NHPP) and Surface Transportation Program (STP) can be used to satisfy a range of core system bridge and highway needs.

Figure 3.3 FAST Act Federal Funding Mix for NYS ($ Millions)[3]



- **Direct Assistance to Local Governments.** State aid to municipalities for highway infrastructure purposes primarily includes the Consolidated Local Street and Highway Improvement Program (CHIPS), Extreme Winter Recovery Program, and the Marchiselli Program.
- **Local Municipal Investments.** Local municipal investment levels vary widely across the state. Local funding is subsidized through local tax collections, primarily sales and property taxes. These funds are not collected, managed or distributed by New York State or NYSDOT, they are collected and remain in the municipalities in which they originate. Therefore these revenues aren't listed for the purposes of the TAMP.
- **Capital Projects/New York Works.** Periodically the State supplements transportation funding provided by dedicated sources, such as the Dedicated Highway and Bridge Trust Fund. Examples include the Rebuild and Renew New York Transportation Bond Act of 2005. The total remaining available funds from the 2005 Bond Act is $31 million. Additional supplemental funding sources include the New York Works programs, which provide funding for specific projects or project types. Whereas the core construction funds are funds gathered from dedicated state and federal transportation funding streams, the NY Works program is primarily funded by personal income tax receipts and is used to provide funding for infrastructure investment as a means of job creation.
- **Tolling.** NYSDOT can not raise revenue through tolling; however, several transportation authorities who are responsible for segments of the National Highway System in New York State can and do. These authorities include the NYSTA, Mid-Hudson Bridge

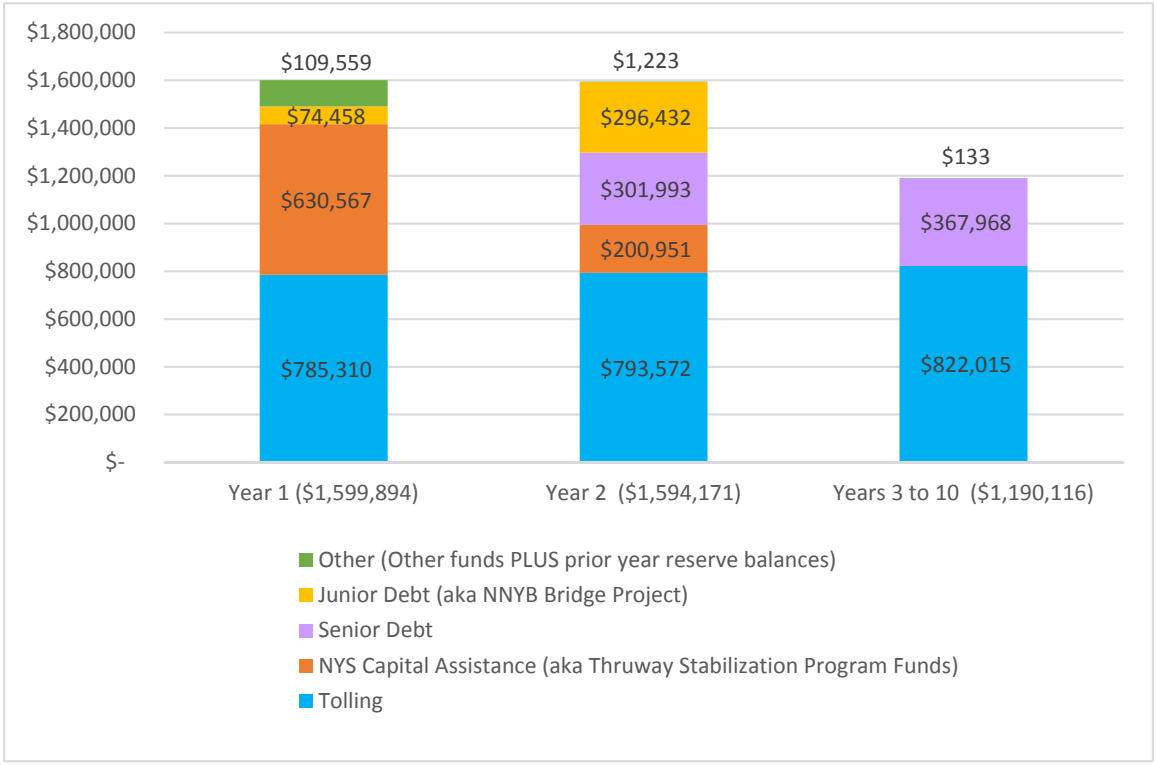
[3] State Fiscal Year 2017-2018 New York State Enacted Budget Financial Plan Commitments for NYSDOT.

Authority, Triborough Bridge and Tunnel Authority and the Port Authority of New York and New Jersey. The toll authority which owns the largest portion of NHS in New York State is the NYSTA, which raises a majority of its revenue through the collection of tolls. NYSTA funding is shown in Figure 3.4 below.

- **Thruway Stabilization Program Funds.** In April of 2015, the State of NY established a grant known as the Thruway Stabilization Program of $1.985 Billion over two years to fund the Governor Mario M. Cuomo Bridge, and other NYSTA capital projects.
- The **NYSTA Senior and Junior Debt** amounts shown in figure 3.4 represent proceeds (monies) of a prior or current year debt issuance (bonds) that would be planned to be available to be used for capital projects. Senior debt (bond) proceeds are available for use for any Thruway capital project expenditures that are not Mario M. Cuomo Bridge Project related. Junior debt (bond) proceeds are available for use only for Mario M. Cuomo Bridge Project expenditures. The Senior and Junior Debt amounts shown in Figure 3.4 represent the annual total of the semi-annual principal and interest payments due on the related outstanding debt, with those payments being made from our revenue sources.

Figure 3.4 shows the projected Thruway revenues for the next ten years. The drop in projected revenues reflects the removal of the Thruway Stabilization Program after next year, and a reduction in projected revenues from debt service.

Figure 3.4 NYS Thruway Annual Funding ($ Thousands)

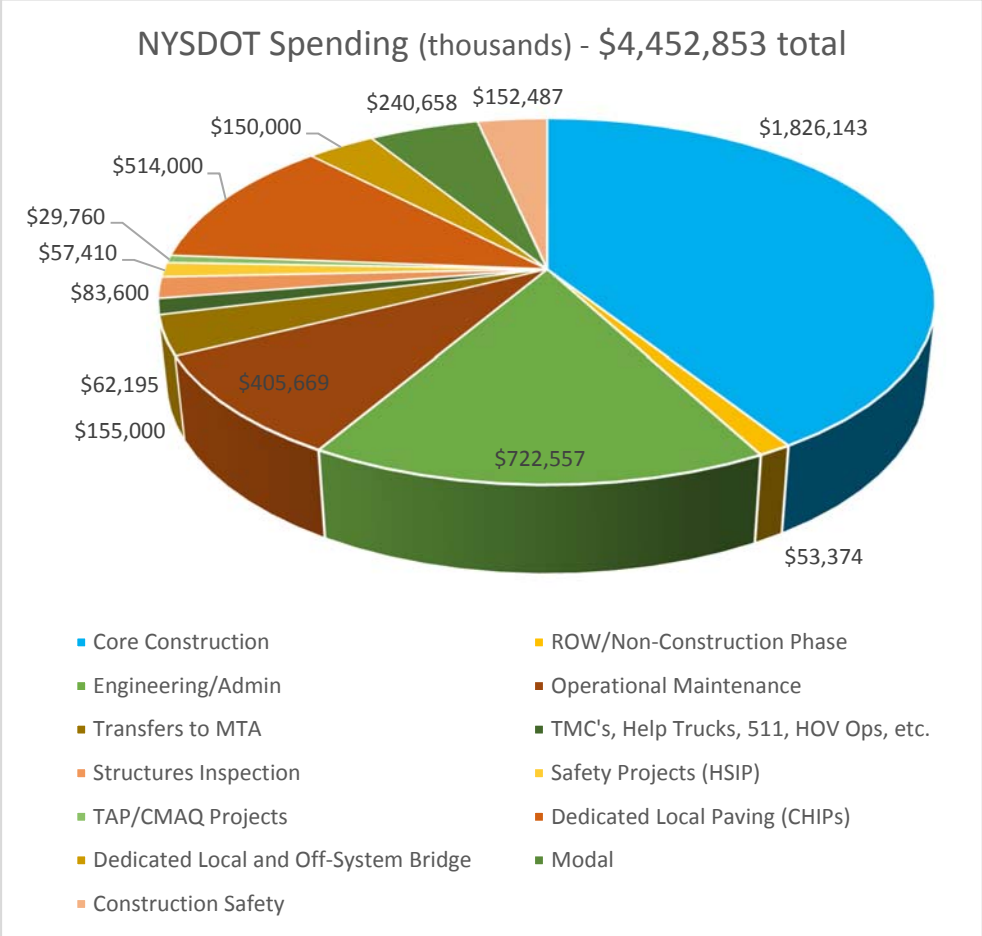


3.3 FUNDS TO SUPPORT HIGHWAY INFRASTRUCTURE

As shown above in Figure 3.2, NYSDOT's current fiscal plan includes approximately $4.4 billion[4] in available funding annually from the fund sources described in the previous section. However, not all funds are available for asset management of pavements and bridges on the NHS. NYSDOT has many responsibilities that must be funded, and some of the funds that are collected can only be used for certain functions. These include, for example, safety initiatives which are managed through the Highway Safety Improvement Program, the Congestion Mitigation and Air Quality Improvement Program (CMAQ), and spending on multimodal facilities.

Figure 3.5 shows NYSDOT's current finance plan as it is distributed to these different missions. The segments of Figure 3.5 are governed by distinct, legislated appropriations that direct how the funding can be used. Only the portion shown in blue for Core Construction is available for asset management programming.

Figure 3.5 NYSDOT Financial Plan ($ Thousands)

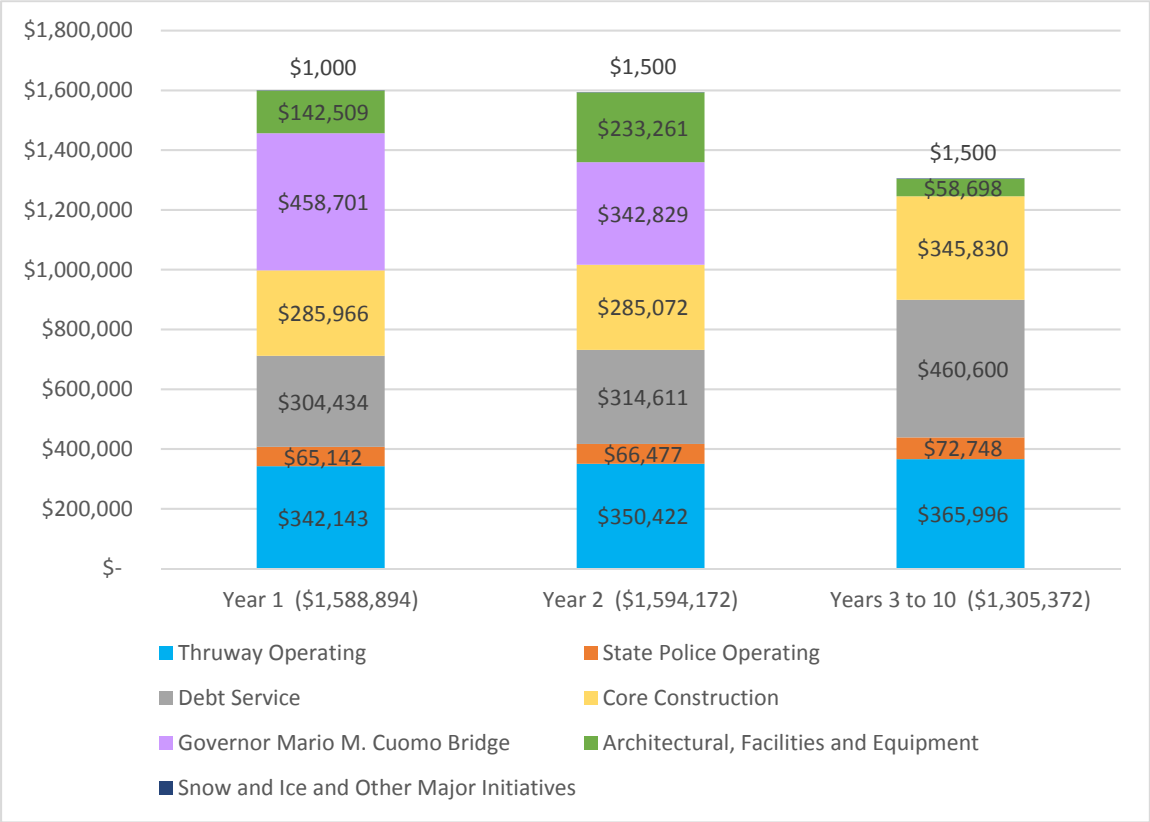


[4] Average Yearly Funding provided by 2015-2019 NYSDOT Capital Program

- **ROW/Non-Construction Phase Funds** ($53,374,000) are used for the right of way acquisition of property to support the construction of projects throughout the state transportation system, not just on the NHS.
- **Engineering/Admin Funds** ($722,557,000) are used to support NYSDOT's engineering and administration expenses.
- **Operational Maintenance Funds** ($405,669,000) are used to support NYSDOT's non-winter maintenance operations, as well as the Department's maintenance facilities.
- **Transfers to MTA** ($155,000,000) are funds that NYSDOT transfers to the Metropolitan Transit Authority to help maintain the transit infrastructure around NYC.
- **TMC's, Help Trucks, 511, etc.** ($62,195,000) are funds used to support the state's Transportation Management Centers and other operational endeavors, such as the state's roadside Help trucks, our 511 traveler information system, and operation of HOV lanes in NYC.
- **Modal Funds** ($240,658,000) are used to support NYDOT's modal programs, transit, rail, and aviation. This does not include NYS transit operating aid (approximately $5 billion annually), FTA funds that are provided directly to NY's transit systems, or NYS capital funds provided to the Metropolitan Transportation Authority (MTA).
- **Construction Safety Funds** ($152,487,000) are used to support NYSDOT's efforts to provide a safe work area for workers within the roadway, while facilitating the safe and orderly flow of all road users.
- **Structures Inspection:** ($83,600,000) These funds are used for the inspection of our bridges, large culverts, and other structures to ensure the safety of the travelling public.
- **Safety Projects (HSIP):** ($57,410,000) These dedicated funds are used to pay for projects delivered under the Highway Safety Improvement Program.
- **TAP/CMAQ:** ($29,760,000) These dedicated funds are used to deliver projects under the Transportation Alternatives Program, which promotes non-vehicle transportation such as bike and ped facilities, etc. and the Congestion Mitigation and Air Quality Improvement Program, which include projects that reduce emissions and improve air quality. These projects are primarily mobility projects.
- **Direct Assistance to Local Governments :** ($514,000,000) This category is paid for with CHIPs, Extreme Winter Recovery, and Marchiselli Funds, which are solely dedicated for that purpose. These funds, by law, cannot be used for anything except local infrastructure.
- **Dedicated Local and Off-System Bridge Funds** ($150,000,000) are allocated for the sole purpose of local bridge construction, off of the state highway system and the NHS.
- **Core Construction Funds** ($1,826,143,000) are used for construction of projects to meet the needs of the entire state maintained portion of the transportation system, not just on the NHS. Our methods of allocating these funds to meet those needs are detailed in Chapter 7.

Figure 3.6 shows the ten-year financial plan for the NYSTA. Thruway Expenses include operating and maintenance expenses, debt service, snow/ice, policing, the core construction funds, architectural and engineering services, equipment purchases and upgrades, and other major initiatives such as the Mario M. Cuomo Bridge capital project. Pursuant to the requirements of the Authority's bond resolution, operating expenses and debt service requirements are funded prior to the capital program and reimbursement of NY State Police. (Note: Only salt is included in the snow and ice expenses. Labor, fuel and related items are included in Thruway operating, while equipment expenses are included in Architectural, Facilities and Equipment.)

Figure 3.6 NYS Thruway Financial Plan: 2018 through 2028 ($ Thousands)



When all of the various budget sources from NYSDOT and the NYSTA are combined, we see a total picture of the core construction funding available on the state system, as shown in Table 3.1. For purposes of this analysis, we used the Thruway's Year 2 funding to model future outcomes. These combined funding amounts were used in our performance modeling and forecasting of the state system and the NHS, and in setting the 2 and 4 year condition targets shown in Chapter 7.

Table 3.1 Total Average Funds Available for NHS Work 2018-2028 ($ Millions)

NYSDOT Total Annual Funding (From Fig. 3.2)	$ 4,452,853,000
Minus (From Fig. 3.5):	
ROW Acquisition	$ 53,374,000
Engineering/Admin	$ 722,557,000
Operational Maintenance	$ 405,669,000
Transfers to MTA	$ 155,000,000
TMC's, Help Trucks, 511, HOV Ops, etc.	$ 62,195,000
Modal Funds	$ 240,658,000
Construction Safety	$ 152,487,000
Structures Inspection	$ 83,600,000
Safety Projects (HSIP)	$ 57,410,000
TAP/CMAQ Projects	$ 29,760,000
Direct Assistance to Local Governments	$ 514,000,000
Dedicated Local and Off-System Bridge	$ 150,000,000
NYSDOT Total for Core Construction	**$ 1,826,143,000**

NYSTA Total Annual Funding (From Fig. 3.4)	$ 1,594,172,000
Minus (From Fig. 3.6):	
Thruway Operating	$ 350,422,000
Debt Service	$ 314,611,000
State Police Operating	$ 66,477,000
Governor Mario M. Cuomo Bridge	$ 342,829,000
Arch, Facilities, Equipment	$ 233,261,000
Snow and Ice	$ 1,500,000
NYSTA Total for Core Construction	**$ 285,072,000**

Total Annual Average Core Construction Funds	**$ 2,111,215,000**

4.0 Transportation Asset Management Practices

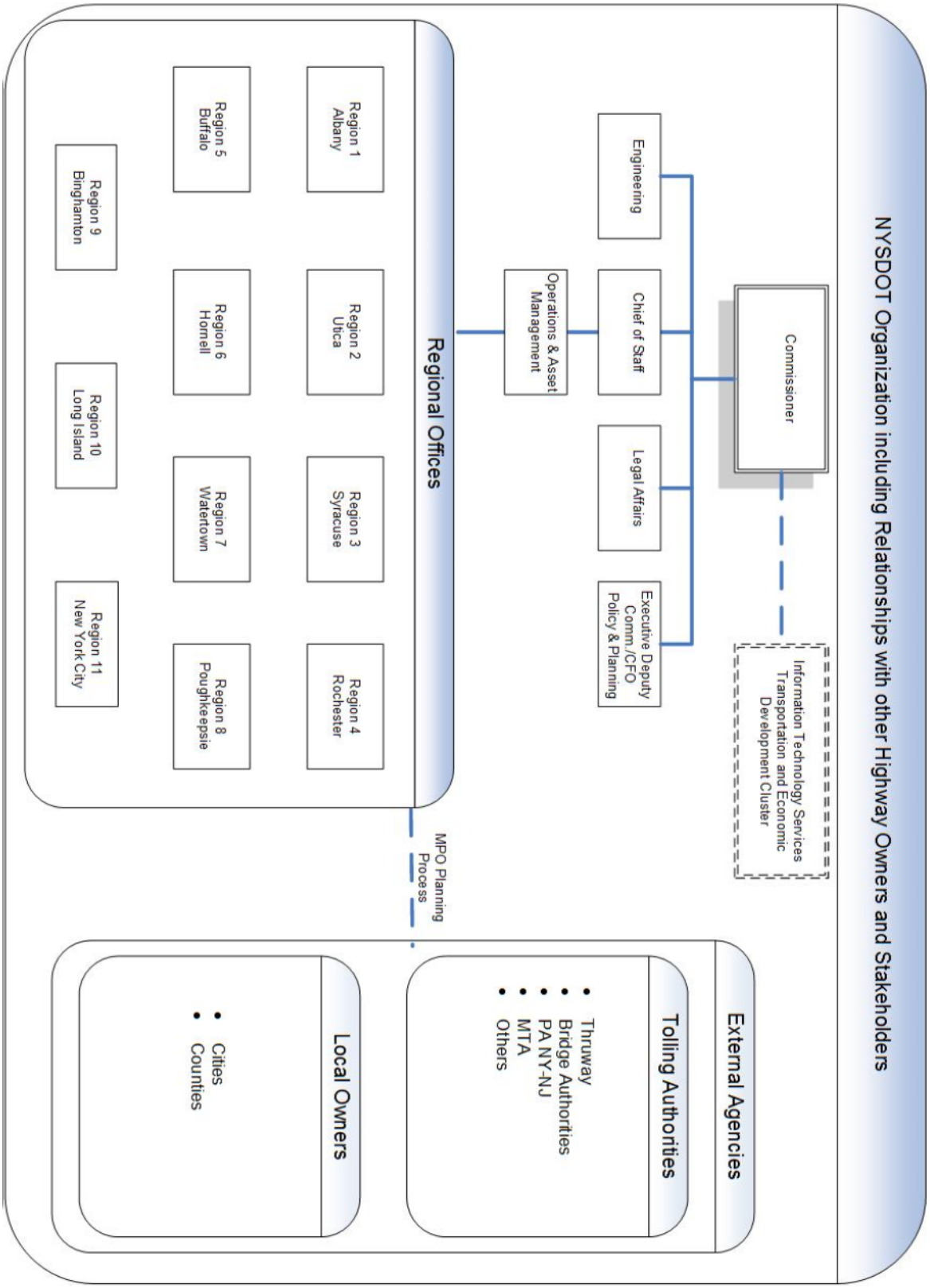
This chapter describes NYSDOT's asset management business structure, policies and practices. It addresses the following topics:

- NYSDOT's organizational structure;
- NYSDOT's asset management business structure;
- The role of the TAMP in asset management practices;
- Asset management policy development process;
- TAMP management;
- Asset management improvement process;
- New York State Thruway practices; and
- Partnering with other owners of NHS assets

4.1 NYSDOT'S ORGANIZATIONAL STRUCTURE

NYSDOT is led by the Commissioner of Transportation. NYSDOT has four main office divisions responsible for statewide policy and oversight of the program in the areas of: Engineering, Legal Affairs, Operations and Asset Management (under the auspices of the Chief of Staff), and Policy and Planning (under the auspices of the Executive Deputy Commissioner/CFO). The heads of each of these divisions report directly to the Commissioner. NYSDOT's 11 Regional offices are responsible for program delivery and operating NYSDOT's highway network. The overall structure of NYSDOT is shown in Figure 4.1.

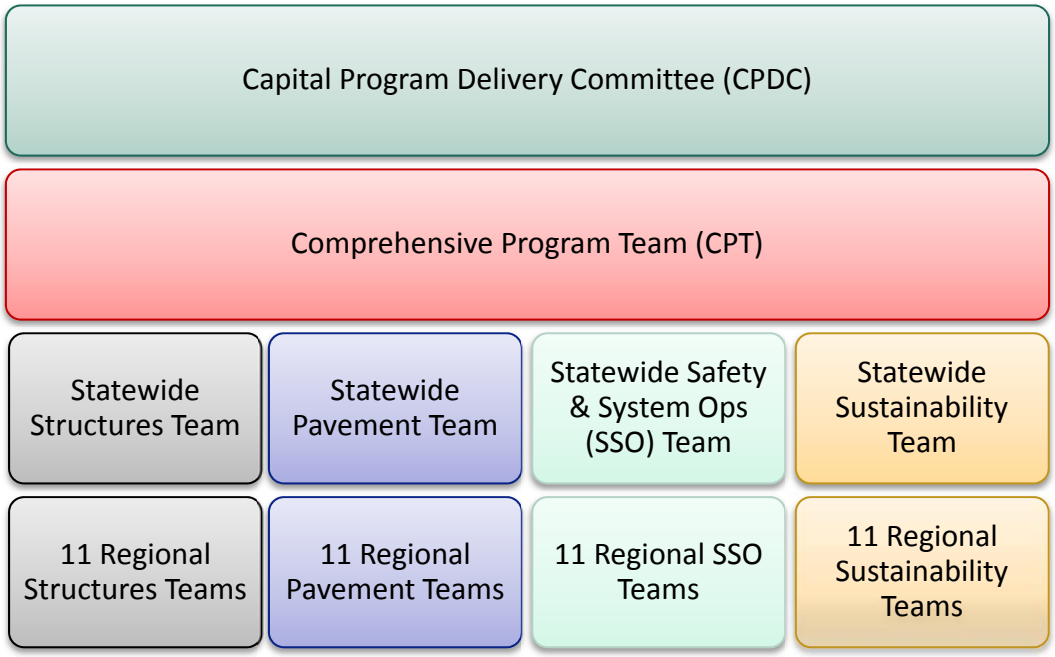
Figure 4.1 NYSDOT Organizational Chart



4.2 NYSDOT's Asset Management Business Structure

NYSDOT's internal asset management business structure is illustrated in Figure 4.2. The structure is functional rather than organizational. At this time these teams are not organizational units, but are dedicated groups of staff from across program areas in the Main Office and Regions. The focus areas represented by the Statewide and Regional teams consist of the highest priority program areas for asset consideration.

Figure 4.2 NYSDOT's Internal Asset Management Business Structure.



This structure has been established to:

- Generate consistent decision-making;
- Set consistent performance measures and establish appropriate targets;
- Ensure accountability;
- Guide local and regional decisions for preservation of the system;
- Make centralized decisions for the most important system renewal and strategic improvement projects;
- Manage expectations; and
- Ensure the best investment practices regardless of ownership.

The following is a synopsis of each Team's role in asset management governance and practice. Additional details for each of the groups included in NYSDOT's asset management business structure are provided in Appendix B.

Capital Program Delivery Committee (CPDC)

The Capital Program Delivery Committee (CPDC), headed by the Commissioner of Transportation and consisting of executive-level and other key staff, provides strategic vision and executive leadership for asset management.

Comprehensive Program Team (CPT)

The Comprehensive Program Team (CPT) provides Statewide leadership on asset management policies, practices, tools and investments. Since its inception, CPT has been co-chaired by the Asset Management Champion and the Program and Project Management Champion. This linkage has been established to foster connection between program development and program delivery.

Statewide Asset Management Teams (SAMT)

Statewide Asset Management Teams (SAMTs) have been established for specific asset classes and functions: pavement, safety and operations, structures, and sustainability. Each team has an established charter that clearly articulates the assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities.

Regional Asset Management Teams (RAMTs)

Regional Asset Management Teams (RAMTs) are responsible for programming decisions related to their specific areas of responsibility: pavement, safety and operations, structures, and sustainability. The teams work under the direction of the Regional Program Committee (RPC). RAMTs are shown in Figure 4.2 as subordinate to Statewide teams in that they receive some goals and functional guidance from Statewide teams.

4.3 THE ROLE OF THE TAMP IN ASSET MANAGEMENT PRACTICES

Consistent with AASHTO guidelines, "the TAMP plays a key role in connecting the Agency's corporate strategic direction with implementation tools, ensuring that the Agency can achieve its mission in the most cost effective manner while achieving the required levels of service."[5] This plan provides a link between NYSDOT's strategic investment decisions, and program development practices. NYSDOT's comprehensive program is its primary mechanism for delivering on its mission to provide safe and reliable transportation to its customers. The TAMP provides strategic direction to ensure consistent programming processes and expectations. It informs NYSDOT's stakeholders, such as the Governor, State legislature, MPOs, Cities, county highway departments and commercial and private travelers, of NYSDOT's objectives and the path to achieving them. Finally, it helps maximize return on investment by ensuring asset investments are delivered at the optimal time to minimize whole life costs.

[5] AASHTO, 2010; "AASHTO Transportation Asset Management Guide: A Focus on Implementation," p. 4-23.

4.4 ASSET MANAGEMENT POLICY DEVELOPMENT PROCESS

This section describes the process for development, review, and acceptance of all NYSDOT asset management policies and standards. Asset management policy includes documents such as the TAMP, comprehensive program and STIP update guidance, and similar strategic and tactical directives related to investments in highway infrastructure.

Policy may be drafted by a Statewide Asset Team, an organizational unit, or a temporary task force. In the case of a temporary task force, a member of CPT will be identified to champion the effort, and will be responsible to inform the CPT on the status of the assignment.

Once the policy is drafted, it is reviewed internally by the CPT and any internal stakeholders identified by the CPT. For policy impacting the STIP or comprehensive program update (CPU) this will, at a minimum, include the statewide teams. The internal review process utilizes the resources of NYSDOT's Asset Management Framework described in section 4.2. This framework provides thorough reviews at multiple layers of management within the organization, and makes it easier to obtain full support for the policy document and its implementation. Although NYSDOT's asset management structure contains representatives from several of the Regions in order to assure their full buy-in, it is recommended that Regional Directors and Regional Planning and Program Managers be briefed on the content and purpose of policy changes impacting their programs through normal organizational channels of communication. After addressing the comments of the internal reviewers to the CPT's satisfaction, the policy is approved with the signature of the Assistant Commissioner of Operations and Asset Management.

For policy impacting external stakeholders, a minimum of 30 days is provided for external review and comment. The CPT will oversee the collection of comments and develop any necessary revisions. Following revisions from external review the draft is resubmitted to CPT and then to CPDC for approval. Statewide policy will be approved by the Commissioner of Transportation's signature.

4.5 TAMP MANAGEMENT

NYSDOT's TAMP is designed to be a living document, in that the processes, strategies, and funding levels described in it are all subject to continuous improvement. The TAMP is also very closely related to NYSDOT's Comprehensive Program Update and STIP processes, and hence changes to the TAMP should be reflective of revisions to these processes. Accordingly, the TAMP will be updated on a biennial cycle, permitting the introduction of major programmatic changes in advance of the Program Update and/or the STIP update. This will enable new criteria and methods to be thoroughly vetted and refined prior to the initiation of the Program Update or STIP updates.

The TAMP will be subject to a series of continuous improvements. Examples include the need to address additional assets, and the clarification or creation of new performance measures or definitions. Accordingly, the TAMP update process will include the creation of a list of improvements to asset management business practices that should be addressed over time.

The TAMP biennial review process will be initiated by the CPT. At that time, the CPT will agree on a scope for the review, and identify a TAMP project manager and working group. The TAMP Working Group will develop a draft scope of changes for CPT review. The scope will identify changes in practices, tools, policies, fiscal projections, condition projections, risks, mandates, etc. that will impact asset management outcomes. The draft scope may expand the TAMP to include additional assets as well.

Following review, the TAMP Working group will draft a revised TAMP for approval through the Asset Management Policy Development process as described above.

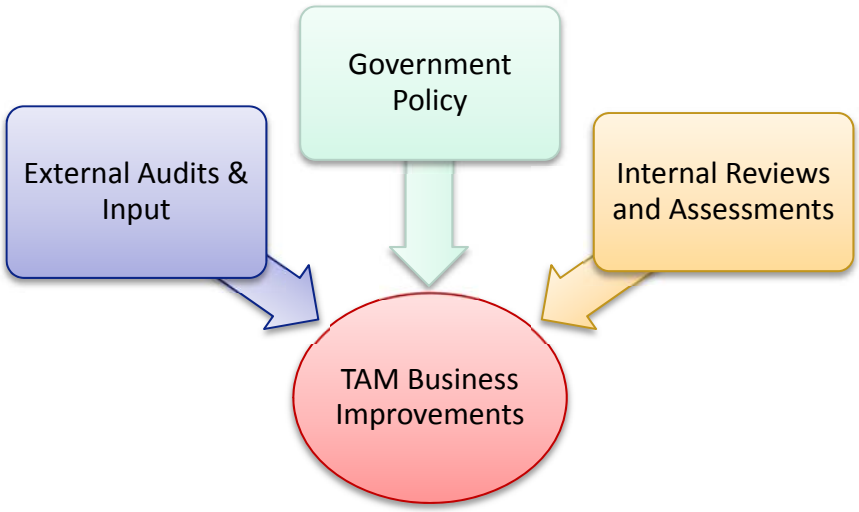
4.6 ASSET MANAGEMENT IMPROVEMENT PROCESS

NYSDOT is continually improving the efficiency and effectiveness of its asset management business practices and tools. Until all highway assets are incorporated into the asset management business structure, and the business structure is fully integrated with other strategic plans, NYSDOT will continue to expand the scope of its asset management practices.

Targeted business improvements are generated from many sources, as shown in Figure 4.3. The three primary sources are:

- External policies including legislative actions, federal agency rules, judicial findings, etc.
- External reviews and audits by regulatory agencies such as FHWA and New York State Office of the State Comptroller.
- Input and best practices from external partners.
- Internal assessments, reviews, and audits, which are performed by program areas as part of the normal business practice of continual improvement, as well as on a larger scale in preparation for major efforts such as a program update or reorganization.

Figure 4.3 Asset Management Improvement Sources



The result of this process is NYSDOT's Asset Management Improvement Plan, which is the focus of Chapter 8. Development and updating of the Improvement Plan is managed according to the Asset Management Policy Development Process as described in Section 4.4.

4.7 NEW YORK STATE THRUWAY AUTHORITY PRACTICES

The New York State Thruway Authority (NYSTA) operates as an independent authority and manages a significant portion of the State's NHS assets. Their program areas are highways, bridges, architecture, and ITS, with the majority of the funding going to highways and bridges.

With both the pavement and bridge programs, NYSTA is moving to a preservation-based strategy with the goal of keeping infrastructure that is rated good, in good condition. Specific treatments for bridges and highway segments are selected based on: current condition, actual and projected rate of deterioration, expected service life of the last treatment, traffic/truck volumes, vulnerabilities, and coordination requirements. Currently, life cycle costs are considered during scoping. In the future, whole life management of assets is expected to be more highly integrated into decision making and operations.

The Board-approved capital program is updated each spring/summer by adding a new year to the program and reviewing the projects in the existing program. Other changes are made to the program over the course of the year due to a variety of factors including changing financial conditions or the need to modify the scope of work, cost, and schedule of existing projects. The update process involves evaluating all of the 70 highway planning segments on the Thruway, using the most current condition data and other information. The purpose of reviewing all segments is to review performance predictions, and to compare predicted versus actual performance in order to improve modeling efforts.

The bridge evaluation and long range plan for bridges included in the existing program is reviewed to confirm the appropriateness of the project scope, budget, and timing. New bridge projects are added based on the same analysis, taking into account the recommendations of Maintenance and the Divisions. The result is a prioritized list of candidate projects subject to both network level goals, objectives, and constraints as well as project level conditions and needs, for inclusion in the capital program. This list is reviewed by both headquarters Maintenance and the Divisions. Design reviews the list for deliverability. A letting and cash flow analysis is performed by the Office of Capital and Contracts Management and the Department of Finance to verify consistency with available funds.

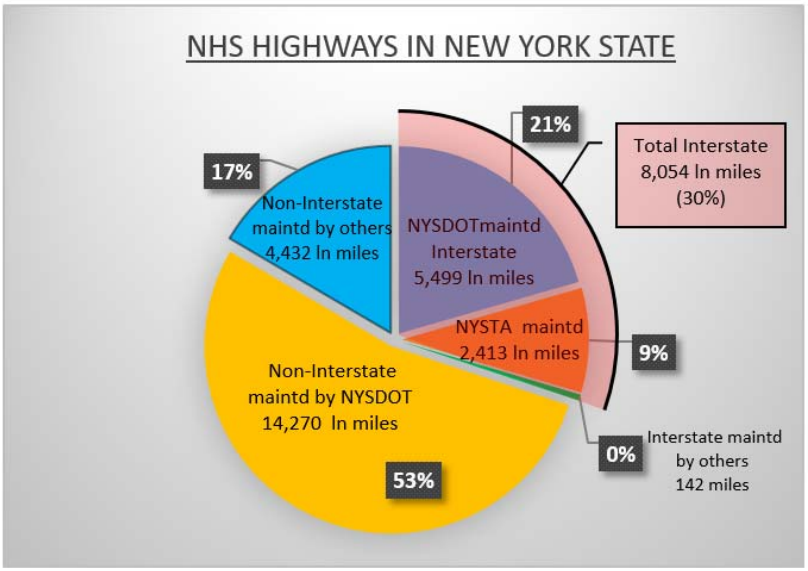
4.8 PARTNERING WITH OTHER OWNERS OF NHS ASSETS

Federal law requires that the TAMP cover all of the NHS. However, NYSDOT does not have jurisdiction over the entire NHS in New York. Portions of the NHS are owned and maintained by local governments and independent public authorities such as the New York State Thruway Authority (NYSTA), the New York State Bridge Authority (NYSBA), and the Tri-borough Bridge and Tunnel Authority (aka Metropolitan Transportation Authority (MTA) Bridges and Tunnels). NYSDOT coordinates with other asset owners, as necessary, in investing on non-NYSDOT

portions of the NHS through the MPO process and consultation with local governments in areas outside of an MPO.

Specifically, 74 percent of the NHS is owned by NYSDOT, which has the responsibility of developing the TAMP; 17 percent is owned by other governmental entities (county, town, village or city), and 9 percent is owned by the NYS Thruway Authority. Figure 4.4 shows a break down of this system by jurisdiction.

Figure 4.4 NHS Pavement Lane Miles by Jurisdiction



MPO review facilitates local input to the TAMP. NYSDOT has shared TAM principles with its partners and is working cooperatively with MPO staff and membership and local governments outside of MPO areas to adopt asset management practices. To assist other NHS owners in adopting asset management, NYSDOT is working to provide data, analysis tools and support through the MPO and rural consultative process.

NYSDOT provides guidance and financial resource estimates for the federal-aid program through the State Transportation Improvement Program (STIP) update process. The STIP is developed by including the State's 14 Metropolitan Planning Organizations' (MPOs') Transportation Improvement Programs (TIPs) in their entirety. The STIP also includes the nonmetropolitan projects, developed in consultation with affected nonmetropolitan transportation officials and in cooperation with local governments. The STIP is a compilation of regional TIPs that are adopted by MPOs and, combined with transportation projects in non-metropolitan areas, becomes a comprehensive list of all highway and transit projects that propose to use federal funds.

NYSDOT provides two sets of guidance to MPOs and Regions for developing the STIP. The first is STIP Policy Guidance which reflects NYSDOT's capital program direction for asset management practices. These asset management practices focus investments in current infrastructure on preventive, corrective and demand maintenance to preserve the functionality of the existing transportation system. Planning targets, or estimates of future federal and state funding, are established for each NYSDOT Region and used for planning in conjunction with the

MPOs and nonmetropolitan transportation officials. Planning targets reflect estimates of anticipated federal funding and may not reflect actual federal funds received. Planning targets for both FHWA funds are distributed in conjunction with the STIP Policy Guidance.

The MPOs work with NYSDOT and other members to develop the TIP; both for the NHS and for the rest of the federal-aid system. NYSDOT and other NHS owners share their investment strategies for these assets and work within the MPO process to program projects to address needs on the NHS. Many MPOs have their own project evaluation criteria by which they rate and rank potential projects for the TIP. The project evaluation criteria is developed cooperatively with all of the MPO members and reflects the programming approach agreed upon by the members to the extent practicable.

The second set of guidance NYSDOT provides to the MPOs and Regions is STIP Technical Guidance for Process and Procedures. This guidance covers the federally required components for TIPs and the STIP and the schedule for submission to the NYSDOT Main Office. The guidance addresses items such as fiscal constraint, STIP project data and required certifications and resolutions.

For the purposes of the TAMP, NYSDOT will review all projects on the STIP that are on the non-State owned NHS. This level of investment will be used as an estimate for future investment levels for the remaining years of the TAMP. Programmed projects and funding estimates will be factored into the overall NHS pavement condition estimates and targets, as shown in Chapter 7.

5.0 Life Cycle Planning

This chapter introduces the principles of life cycle management and the resulting whole life management process adopted by NYSDOT and the NYSTA. Whole life management considers the most economical approach to manage inventories of assets by applying cost effective investment strategies. Whole life management applies the principles of life cycle cost analysis to program management practices. Just as traditional life cycle costing leads to the selection of the most cost effective alternative for a project, whole life management leads to the selection of the most cost effective strategies for managing multiyear, multi-asset investment programs.

Before we begin discussing investment strategies, we need to lay out the work types used by NYSDOT, the Thruway, and other owners of the NHS. FHWA lists five broad work types in their regulations, including Initial Construction, Maintenance, Preservation, Rehabilitation, and Reconstruction. However, we use a more detailed list of work types to manage the bridge and pavement assets on the NHS, both in our modelling systems and our program planning systems.

The Initial Construction work type refers to the construction of brand new assets, either bridges or highways, on new alignments. Given the current funding shortfalls that the department is contending with, construction of brand new facilities is extremely rare, and aren't included in our short or long term modeling.

A crosswalk table showing the relationship of the detailed treatments to the FHWA work types is provided below. The remainder of the TAMP will reference the FHWA work types.

Table 5.1 Crosswalk of FHWA to Treatment Types

FHWA Work Type	Pavement Treatment Category	Bridge Treatment Category
Preventive Maintenance	Maintenance Activities, including: • Crack Seal • Crack Fill • Filling Pot Holes • Pavement Patching, etc.	Preventive Maintenance, including: • Painting • Cleaning • Joint Resealing • Deck Sealing & Overlays
Preservation	Preventive Maintenance, including: • Chip Seal • Quick Set Slurry • Microsurface • Paver Placed Surface Treatment • 6.3mm HMA Overlay • Single Course HMA Overlay • PCC Repair	Preservation encompasses all Preventive and Corrective Maintenance activities. (Therefore, bridge preservation will not be shown as a separate category in any of the following tables and charts).
Rehabilitation	Corrective Maintenance, including: • HMA Mill and Fill • Hot-in-Place recycling • Cold-in-Place Recycling • HMA Mill and Fill on Composite Pavement with underlying joint repair.	Corrective Maintenance, including: • 5 to 7 Repairs which is element level repair work performed on structures which are in generally good condition • Deck Replacement • General Rehab • General Repairs

Highway Reconstruction/ Bridge Replacement	Renewal, including: • Multi-Course HMA • Multi-Course Mill & Fill • Multi-Course Cold-in-Place Recycling • Crack & Seat • Rubblization of PCC • Reconstruction, Remove and Replace.	Renewal, including: • Structure Replacement • Superstructure Replacement

All physical assets deteriorate with age and use. As assets deteriorate there are appropriate treatments which can be applied to slow or repair that deterioration. In general, treatments can be categorized by their impact and cost:

- **Preventive maintenance treatments** typically arrest deterioration without significantly improving condition or provide a modest improvement in condition. These treatments are only applicable to assets that are still in relatively good condition. Examples of preventive maintenance treatments include crack sealing, pavement patching, painting bridges, and waterproofing concrete.
- **Preservation treatments** generally involve repairs to specific elements or aspects of an asset. These treatments are used for assets which are in fair to good condition, but in need of specific repairs. Examples of corrective repairs include thin pavement overlays and concrete repairs.
- **Rehabilitation** is required for assets which still have a potential for significant remaining service but have a substantial number of components in need of repair, or major components in need of substantial repair. Examples of rehabilitation treatments include bridge deck replacement and thicker pavement mill and overlays.
- **Replacement/reconstruction** is required when an asset has reached the end of its service life and can no longer be extended though repair or rehabilitation.

5.1 WINDOWS OF OPPORTUNITY

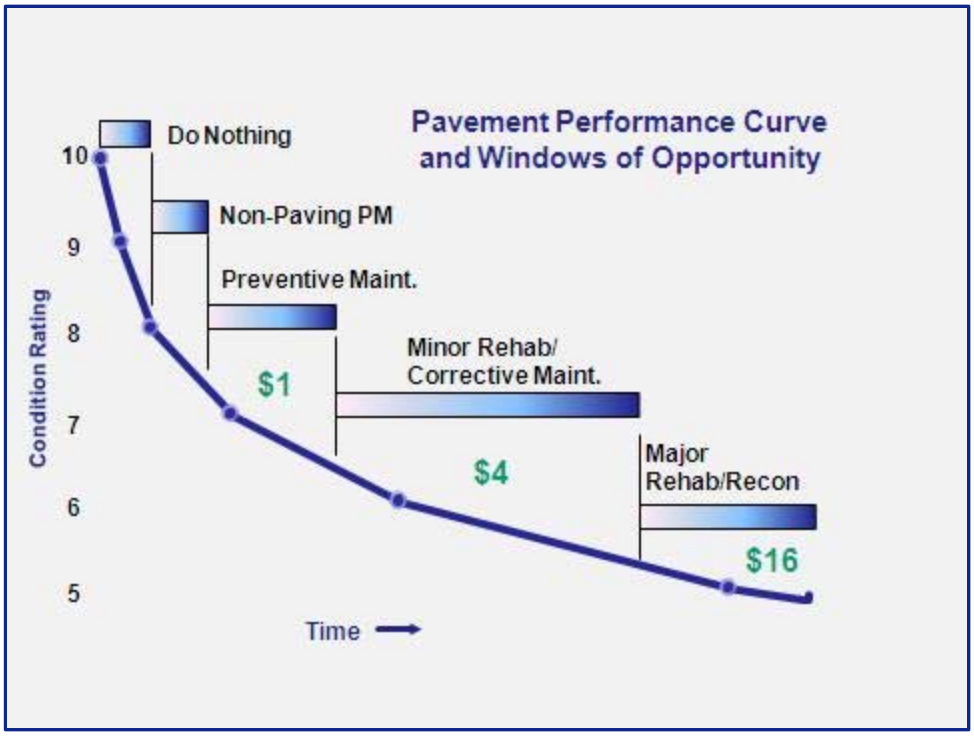
Over time, assets deteriorate through different stages of condition. As the asset condition gets worse, it will require more extensive treatments to bring it back to a state of good repair. The period of time where a particular work type is the proper treatment for the distress in the asset is called the "window of opportunity."

Figure 5.1 illustrates the window of opportunity concept for pavements. As a pavement deteriorates there is a period of time, a window of opportunity, to perform a lower cost treatment before the distress becomes too severe and a more expensive treatment is required to properly repair the pavement. This concept is true for each treatment window the pavement passes through, as untreated distress continues to advance.

Windows of opportunity are treatment specific. For example, the window of opportunity for a preventive maintenance overlay on pavement is approximately 3 years, while the window of opportunity for a more extensive treatment like mill and inlay is between 5 and 10 years. This does not mean the preventive maintenance overlay will only last for three years. It is simply the time period in which a preventive maintenance overlay is the appropriate treatment for the

pavement. If applied within the window of opportunity the preventive maintenance overlay should last 8 years or more. These precepts are reflected in our modeling rules used in both the PMS and BMS analyses.

Figure 5.1 Pavement Performance Windows of Opportunity[6]



The dollar amounts shown in Figure 5.1 represent the ratio of typical costs between treatments which are appropriate in each window of opportunity. In general, the cost of treatment increases exponentially between categories. For example, the typical cost of a thin overlay on a good pavement is approximately $75,000 per lane-mile. The cost to mill and place two layers of asphalt on the same pavement when it reaches fair condition is typically $250,000 to $400,00 per lane-mile. The typical cost to rehabilitate that pavement if it reaches poor condition is $1 to $5 million per lane-mile. Because major work is necessary to recover the condition of poor assets, the cumulative cost of multiple preservation treatments, applied multiple times over the life of the asset, is several times less expensive than postponing that work and replacing the asset prematurely.

This same concept applies to bridges, but is more complex as each component of the bridge deteriorates along its own curve and each has independent windows of opportunity. NYSDOT's whole life approach to managing bridges recognizes the causality of robust cyclical and preventive maintenance programs and prolonging the service life as well as slowing the rate of

[6] The shape of this curve is a function of the unique rating scale used by the NYSDOT's pavement surface rating system. It may appear to be inverted to those in the pavement management industry.

deterioration of structures. Conceptually, the effects of a systematic maintenance program can be represented as shown in Table 5.2.

Table 5.2 Bridge Preservation Cost Effectiveness

NHS Bridge Treatment Costs by Condition	
Condition	**Cost per Structure for Applicable Treatment**
Good	$10K per year - Cyclical
Fair	Corrective Treatment - Range $100K - $2.0M
Poor	Renewal Treatment - Median cost $8M

5.2 PAVEMENT AND BRIDGE MODELING SYSTEMS/ TRACKING ASSET NEEDS AND DETERMINING BACKLOG

At NYSDOT, asset needs are defined on both a micro level (the needs of each individual asset based on its current or projected conditions) and the macro level (the annual program funding required to achieve a target set of conditions for the entire population of a given asset). As outlined in Chapter 2, NYSDOT collects comprehensive and varied sets of data on all of its pavements and bridges to meet the state's programming and reporting needs, and to meet all federal mandates. These data sets are updated annually, and the data resides in the Agile Assets Enterprise Asset Management (EAM) System, which includes the Pavement and Bridge Management Systems (PMS and BMS).

These pavement and bridge management systems meet all the requirements of **23 CFR 515.17**, including the ability to:

- Collect, process, store, and update inventory and condition data for all NHS pavement and bridge assets, (as described in Chapter 2 and further outlined in the department's Data Quality Management Plan).
- Forecast deterioration for all NHS pavement and bridge assets, (as described in section 5.2.1 below).
- Determine the benefit-cost over the life cycle of assets to evaluate alternative actions, (including no action decisions), to manage the condition of NHS pavement and bridge assets, (as described in section 5.2.2).
- Identify short and long-term budget needs to manage the condition of all NHS pavement and bridge assets, (as described in section 5.2.3).
- Determine the strategies to identify potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints, (as described in section 5.2.2).

- Recommend programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints, (as described in section 5.2.2).

Asset Deterioration and Predicting Asset Conditions

The Agile system encompasses sophisticated computer models to forecast asset conditions and determine the appropriate treatment for each individual asset based on its condition. NYSDOT uses the Pavement and Bridge modules of the Agile Assets Enterprise Asset Management System, which use asset inventory and condition data along with NYSDOT custom developed deterioration curves to determine the appropriate treatment for each asset in a given year.

For pavement, these deterioration curves, 45 in all, account for the significant factors which impact asset deterioration including:

- asset type and material (flexible, rigid or composite pavements, for example),
- the last work type performed on the asset (more extensive work types last longer),
- the condition the asset was in the last time work was performed (work types performed on assets in good condition last longer), and
- the location within the state to address climactic differences between geographic regions (for example, pavements in the Adirondacks deteriorate rapidly due to severe freeze thaw, but they stay in fair condition much longer than other parts of the state because of the strong soils).

For bridge structures, a detailed study of deterioration rates of various bridge elements has been carried out using the historical bridge inspection data. In order to investigate effects of numerous factors, e.g., ADT, climate, DOT regions, ownership, design types, etc., on the deterioration rates, a versatile cascading approach was developed to classify bridge elements on the basis of selected factors. The cascading approach generates classes of bridges based on the classification factors selected. These classes can be analyzed to calculate deterioration rates.

A detailed case study was carried out to compare Markov chain and Weibull-based approaches for deterioration rates. Since the Weibull-based method utilizes actual scatter in duration data for a particular rating and considers this duration as a random variable, it has been found to be more reliable for calculating deterioration rates for bridge elements. Hence, deterioration curves and equations using the Weibull-based method were used.

Thus, deterioration plots for various bridge elements inspected by the New York State (on 1-7 scale) were developed using this historical data. These components include abutment backwall, various abutment bearings, various joints, abutment pedestal, abutment stem, abutment wingwall, deck curb, pier bearing, pier cap, pier column, pier footing, pier joints, pier pedestal, pier stem, primary members, secondary members, sidewalk fascia, structural deck, and wearing surface. Polynomial equations of condition ratings of bridge elements were developed as a polynomial function of the element age in years considering the effects of key factors, such as the bridge material type, on the deterioration rates. These deterioration rate equations are then incorporated into the bridge model on a regional basis to account for climatic differences between geographic regions.

Model Work Recommendations

Our pavement and bridge models make work recommendations for each stretch of road or individual bridge on the NHS. The recommended treatments are always appropriate for the amount of distress present in the asset. For example, the pavement model will only recommend a lighter maintenance treatment on a stretch of road that's relatively smooth with little cracking. It won't recommend a lighter treatment for a road in very bad shape, because that treatment won't be giving the required service life and isn't adequate to address the damage on the road. In this way, the recommended treatments maximize the overall project and program benefits within the fiscally constrained environment.

The models also determine the optimal time to treat each asset in order to minimize the life-cycle cost. The software uses the windows-of-opportunity approach described above to optimize the timing of each treatment on each asset. In general, the models aim to maximize investment in maintenance treatments to keep assets in good condition as long as possible and delay the need for substantially more expensive treatments. This is analogous to performing routine maintenance on your car to maximize the life of its engine. Some assets may be within a window of opportunity for a specific treatment for many years. The pavement model optimizes treatment timing by predicting which year the asset is likely to slip out of its current window and recommending an appropriate treatment take place a year or two before that time. This allows NYSDOT to plan its treatments in advance to maximize return on investment and provide sufficient lead time for project delivery. Bridge Analyst allows the user to perform multiple runs to determine optimal treatment timing.

These work recommendations are then prioritized using cost/benefit optimization, with the preventive and corrective maintenance usually getting precedence over more expensive reconstruction projects. The model then recommends a program of pavement or bridge projects that provides the highest overall benefits to the system for the cost incurred, within the policy and budget constraints. In addition, the PMS and BMS can handle projects that were previously programmed on the STIP, taking these projects "off the top" for purposes of the overall budget, but also showing the benefits to the system of accomplishing these projects.

This approach is further refined for pavements and bridges by using NYSDOT's pavement management and bridge management software to compare actual investment decisions to optimized investment scenarios. Differences between "actual" and "ideal" represent opportunities to improve future decisions or improve the data used for modeling the ideal.

Determining Budget Needs for Managing Assets

One of the key metrics that NYSDOT uses is the infrastructure debt, or the Backlog, of the system. The Backlog is the total cost to do all of the work recommendations for all of the assets in a given year, minus the spending in that year. The difference, or the gap, represents the remaining Backlog of the system. If the Backlog increases over time, it means that the system conditions have necessitated more expensive repairs, and that additional funding will be required in the future to bring the system back to a state of good repair. For example, the average pavement conditions in New York have stayed relatively stable, but the Backlog has grown $800M in the past 5 years. This is due to the increase in the lane miles of poor pavements as well as the increased cost to do construction work in the state due to inflation. Backlog is one of the main

metrics we use, along with average condition rating and % poor, to determine if a given paving or bridge program is acceptable.

At the macro level NYSDOT uses their pavement and bridge models to predict system wide conditions for various funding levels and preservation/renewal splits. This helps inform our funding decisions for how to allocate funds between assets and between work levels. The PMS and BMS can develop an efficient work plan given a set budget and spending strategy, and conversely, it can also show the overall cost required to meet certain system-wide metrics. For example, NYSDOT uses the PMS and BMS to determine the overall funding required to achieve State of Good Repair on the NHS, or meet federal targets on parts of the system, such as the interstates. The PMS and BMS identify short and long-term budget needs for managing the condition of all NHS pavement and bridge assets. The analysis that NYSDOT conducts with these tools is a vital component of the target setting and resource allocation processes described in subsequent chapters. The Agile EAM is used by NYSDOT to set Federal targets for the pavements and bridges on the entirety of the NHS, including the portions that are owned and operated by local government agencies and the New York State Thruway Authority.

New York State Thruway Authority (NYSTA) Pavement and Bridge Models

As stated earlier, NYSDOT collects pavement and bridge condition information for all of the assets on the NHS, and stores that data in their Agile EAM. The Agile system is then used to set federal targets and to forecast conditions. This condition information is shared with the Thruway for their information. The New York State Thruway has their own pavement and bridge models that they use to perform their pavement and bridge management activities and to help them manage their portions of the NHS. These models are described below.

NYSTA has developed a Pavement Asset Management System (PAMS) with the capability to define the needs and forecast conditions for its network of roadways (network level analysis), and define a list of individual projects for inclusion in the capital program (project level analysis). The PAMS was developed by those experienced in the field, and has been tailored to the unique aspects of the NYSTA pavement network. NYSTA's PAMS has been peer reviewed by Applied Research Associates, Inc. (ARA), an internationally recognized consulting firm in the field of asset management. The data collected and collection procedures are relatively objective, inexpensive, repeatable, and capture the data critical to management of the pavement network. Extensive pavement construction and rehabilitation history has been well documented and is readily retrievable.

As mentioned in Chapter 2, the basis of PAMS is the annual Pavement Distress Survey, data from which is used to generate a Pavement Distress Index (PDI) for each segment of the NYSTA pavement network. At the network level, PAMS helps to evaluate capital investment scenarios using performance-based management approaches, goals, and constraints. The results of the network level analysis facilitate a more thorough understanding of current and future infrastructure needs, better communicate NYSTA's long-term and major project needs, prepare for economic changes, address unfunded mandates, and strategize viable business solutions.

The project level analysis develops feasible pavement treatment alternatives, estimates costs, and combines these needs with other infrastructure needs into capital projects. The project level analysis helps to prioritize projects using a repeatable, clearly defined structure. The result of the

project level analysis is a set of well-defined project needs in terms of scope of work, timing, cost estimate and coordination requirements subject to network level goals and constraints.

NYSTA is in the process of enhancing its Bridge Asset Management System (BAMS). The updated system will incorporate the lessons learned during the development of PAMS. Each of the 809 NYSTA bridges is in the process of being evaluated in order to develop a unique long-range plan. The bridge evaluation process is integrated and multi-tiered. Each bridge is evaluated as a whole, taking onto account current and past conditions, load rating, vulnerabilities, work history, and maintenance and operational concerns. In addition, the bridge's location (i.e., congested corridor, paving section prioritized for reconstruction) is considered in the development of its long range plan. A field review may be conducted, and Division input sought as well.

It should be reiterated here that the NYSTA uses their asset management systems to help program planning on the Thruway. However, New York State uses the Agile Assets EAMP to forecast conditions on the entire NHS, predict future needs, and set performance targets.

6.0 Risk Management

Risk Management is a key component of asset management as it allows NYSDOT to prepare for the occurrence of events that could impact the Agency's ability to deliver its planned infrastructure investments or manage the network effectively. Risks can be beneficial to a program such as increased funding, or negative such as damage from a major weather event. In either case, it is important that NYSDOT be prepared for major risks that could impact the delivery of the Comprehensive Program, ultimately affecting the condition and performance of the transportation system.

NYSDOT's approach to risk management is consistent with its overall approach to asset management with the objective of managing risks at the system level, to maximize opportunities and minimize threats to the comprehensive program. This approach requires balancing risk across geographic areas and programs with a focus on minimizing overall risk to the comprehensive program. The focus is not on making the most conservative decision on any specific project or policy. Instead the intent is to make informed decisions based on reasonable consideration of future events and a reasoned estimate of the impacts of those events.

6.1 DEFINITIONS

The following definitions are provided within the context of asset management at NYSDOT:

- **Risk** - The chance of something happening that will impact highway infrastructure or the NYSDOT's ability to manage the highway infrastructure, measured as a combination of the likelihood an event will occur and the event's impact.
- **Risk Management** - The identification, assessment, and prioritization of risks followed by coordinated and efficient application of resources to monitor risks, mitigate threats and maximize the realization of opportunities.
- **Gap –** An existing condition that limits NYSDOT's ability to manage its highway infrastructure. Gaps can be in policy, tools, available information, resources or performance.
- **Risk Context –** The risk categories to which the comprehensive program is sensitive. The context allows risk management to be tailored to the Agency's needs and circumstances. Context is represented by categories established in NYSDOT's risk management policy. The risk categories used by NYSDOT are shown later in this chapter.
- **Risk Assessment** - The combination of likelihood and impact that defines the significance of a risk to the highway infrastructure or NYSDOT's ability to manage that infrastructure. Risk assessment is established in the risk analysis process which culminates in the development of a risk register.
- **Risk Level** - Risks can have impacts on an agency at various levels. Some risks may impact the entire Department; others may impact a single asset type or a single Region. For the TAMP, risks are categorized into the levels of: Agency, Program or Project, as defined in Figure 6.1. To help illustrate, inflation would be an example of agency risk, while asphalt

price volatility would be a program risk, and the ability to get hot-mix asphalt to a job site would be a project risk.

Figure 6.1 Levels of Risks

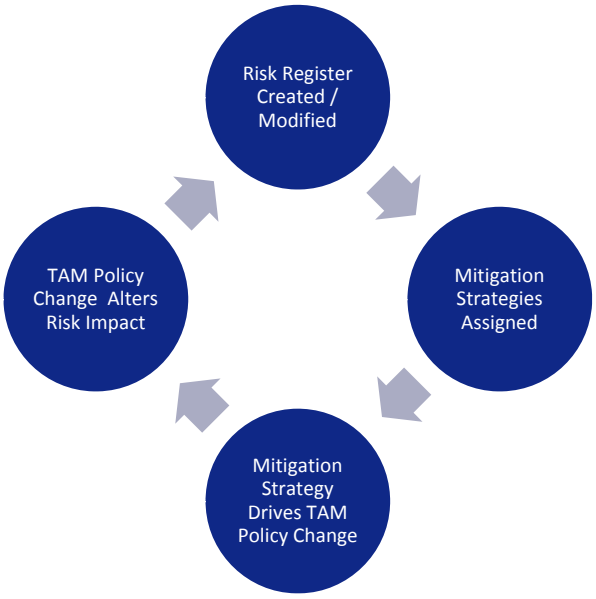
Source: Risk-Based Asset Management: Examining Risk-based Approaches to Transportation Asset Management; Report 2: Managing Asset Risks at Multiple Levels in a Transportation Agency, FHWA, 2013

- **Asset Management Business Unit –** The groups, teams and committees identified in the TAMP as being active in the development and execution of asset management policy. Examples include the CPDC, CPT, Statewide asset management teams and Regional asset management teams.

6.2 ROLE OF RISK MANAGEMENT IN THE ASSET MANAGEMENT PROCESS

The CPT and Statewide Teams refer to the risk register when developing or revising asset management policies or guidance. Figure 6.2 demonstrates the feedback loop between the risk register and policy development process. As risks are identified and mitigated, the risk register will need to be updated. Updating the risk register will alter mitigation strategies and drive new policy improvements.

Figure 6.2 Risk Management and Asset Management



To facilitate this process, NYSDOT assigns each mitigation strategy to a specific resource which can be a business unit or an asset management team. The assigned resource will be responsible for delivery of the mitigation strategy and keeping the CPT informed on their status.

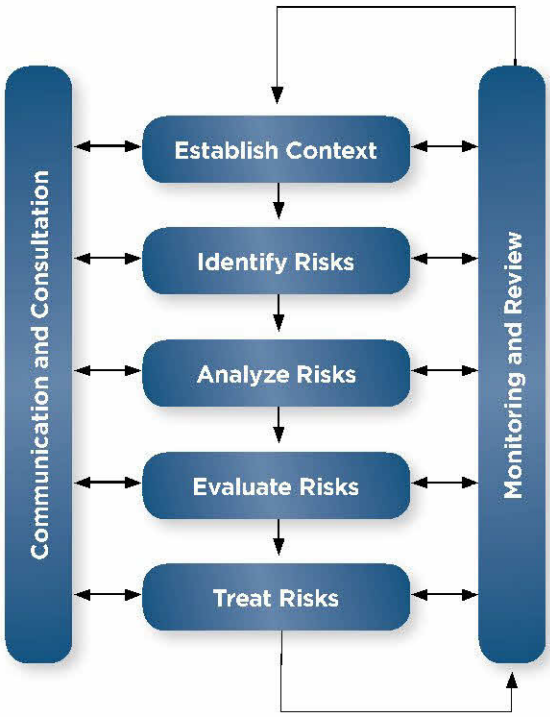
6.3 NYSDOT'S RISK MANAGEMENT PROCESS

NYSDOT's risk management process consists of the following five primary steps:

- **Step 1 - Establish Context.** This step involves understanding and documenting the social, cultural, legal, regulatory, economic and natural environment to which the Agency is sensitive.
- **Step 2 – Identify Risks.** NYSDOT formally identifies the risks that could affect its programs.
- **Step 3 – Analyze Risks.** NYSDOT evaluates the probability of the risk with its impact.
- **Step 4 – Evaluate Risks.** NYSDOT supports decision making by comparing the magnitude of the risks identified in the preceding two steps with its risk tolerance.
- **Step 5 – Treat Risks**. This decision-making step applies the "five Ts." These are to treat, tolerate, terminate, transfer or take advantage of the risk.

This process, which NYSDOT has adopted from International Organization for Standardization (ISO), is illustrated in Figure 6.3.

Figure 6.3 ISO Risk Management Framework



Source: International Standards for Risk Management (Principles and Guidelines) ISO 31000:2009

More details on these steps are provided below.

Step 1. Establish Context and Step 2. Identify Risks

NYSDOT combines step 1 and step 2 into a group exercise that includes brainstorming of risks by individuals, combining of risks by the group, developing risk descriptions, and reaching a working consensus on which risks will be included in further analysis and prioritization. This process is done by Statewide asset teams through facilitated discussion. Before analysis and prioritization can begin, the risks must be clearly defined so each member of the asset team has the same understanding of the risk and the risk can be communicated to other stakeholders. Table 6.1 identifies the risk categories that were considered by NYSDOT during its initial risk identification process.

Table 6.1 NYSDOT's Risk Categories

Risk Categories	Examples
Economic	Inflation, commodity spikes, uncertain funding
Effectiveness of TAMP and TAM policies	Incorrect assumptions, unforeseen consequences
Environmental	Weather events
External stakeholders	Investments made by other owners of NHS Infrastructure
Fiscal	Budget fluctuation
Leadership change	Retirements, Administration changes
Legal/liability	New legal precedents
Organizational capacity	Staffing, structure, training, availability of data, improved IT systems
Political	Federal, State, Local
Regulatory	ADA, sign retro-reflectivity
Reputation, public perception	Findings of Waste, Fraud, or Mismanagement of Public Resources
Safety	Considered in TAM, but managed separately by Strategic Highway Safety Plan
Security	Terrorist attack

Step 3. Analyze Risks

The analysis and prioritization of risks is an iterative process, in which risks are initially prioritized by each asset team, then a combined risk register is reprioritized by the CPT, and finally the CPDC may recommend adjustments to this prioritized order.

Initial prioritization by the asset team is done objectively. Each risk is assigned an overall risk score equal to the product of its impact and likelihood scores. The business unit records the risk score in their risk register and sorts the list in order of descending score.

Risk score = impact score x likelihood score

The likelihood and impacts scales that NYSDOT used for its analysis are listed in the table below.

Table 6.2 NYSDOT's Risk Likelihood and Impact Scales

Risk Likelihood		
Scale	**Definition**	
Certain	Already occurring or is certain to occur in the short term	4
Probable	Very likely to occur, has happened before in the recent past	3
Possible	May occur, has happened before	2
Unlikely	Not likely to occur	1
Risk Impact		
Scale	**Definition**	
Major	Program operations in the immediate term are significantly reduced or impacted; long term operations are potentially impaired	100
Moderate	Program operations avoid suspension or long-term impairment, but modifications to operations must be implemented	70
Minor	Program impairments are limited to short-term consequences with few or no long-term effect. Minimal changes to current operations needed	30
Insignificant	Program remains mostly unchanged in the immediate or long terms, but risk awareness and monitoring remains worthwhile	10

Step 4. Evaluate Risks and Step 5. Treat Risks

During risk evaluation, each asset management asset team compares each risk to the NYSDOT's risk tolerance and develops a recommended treatment. In this context, treatments are referred to as risk mitigation strategies. The strategy is recorded in the risk register.

6.4 COMPILING THE RISK REGISTER

Compiling the risk register and subsequent review process are the final key elements to the risk management process. When the CPT receives the risk registers from the other asset teams, the risks are added to the CPT's register. CPT then reviews the combined risk register looking for opportunities to combine risks, find synergies between mitigation strategies, and adjust priorities.

- **Combining Risks**. It is likely that a given risk can impact several of NYSDOT's programs and possibly impact the Department at both the program and Agency level. In such cases, the same risk may be identified by multiple business groups. The CPT identifies such redundant risks and determines how best to include the risk in the comprehensive risk register. The CPT has the ability to eliminate duplicate risks, edit the description of risks, and revise the prioritization of the remaining risks. The CPT may also delegate this role to representatives of the other asset teams.
- **Synergies in Mitigation Strategies.** In some cases, a single strategy such as a policy change may act to mitigate multiple risks. When reviewing the asset team's risk registers, the CPT looks for opportunities to mitigate multiple risks with a single strategy. This is

done by looking for similar mitigation strategies proposed by multiple business units or by deciding to handle some program level risks with Agency level mitigation strategies.

- **Adjusting Overall Priorities.** Initially, the combined register is sorted according to the scores assigned by the original asset teams. CPT then reviews the list, comparing each risk to the risks immediately above and below, determining if adjustments need to be made in the overall priority. If the CPT determines an adjustment is needed, they may change the score of any specific risk as necessary to achieve the appropriate overall priority. This process is done only to adjust the relative priority of risks identified by different asset teams.

6.5 INITIAL RISK REGISTER

Table 6.3 presents NYSDOT's initial risk register. It defines priority risks, summarizes the impact, defines mitigation strategies, identifies who is responsible for tracking and mitigating the risk, and provides a status of the mitigation strategy. It should be noted that the initial risk register only includes agency and program level risks. This register will continually evolve as described in the following section. NYSDOT will update this register on a biennial basis in accordance with updating the TAMP.

6.6 UPDATING THE RISK REGISTER

Keeping the risk register up to date is the responsibility of the CPT. The risk register will be managed following the asset management policy development process as described in section 4.4. Under the CPT's direction, Statewide Teams discuss risks and the status of mitigation strategies as part of normal meetings. As changes to risks or mitigations strategies that impact the risk register emerge the statewide team will notify the CPT.

The CPT is responsible for making necessary changes to the risk register and recommending new or modified mitigation strategies to CPDC. At least annually, the CPT will review the risk register and make changes as necessary. The CPT may assign a working group or sub-team to track the register as well.

Any changes requiring CPDC approval will be presented at regularly scheduled CPDC meetings. These occur at least quarterly.

Table 6.3 NYSDOT's Initial Risk Register

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
If overall long term funding for transportation continues to be insufficient to efficiently operate and maintain system asset conditions	Then, - Asset conditions will deteriorate to a level requiring progressively more expensive treatments, ultimately deteriorating to a level that is financially unrecoverable, - There will be increasing need to post and close structures to maintain public safety, - Demand maintenance costs will increase, - The list of safety deficiencies will continue to increase, increasing the likelihood of serious crashes, and increasing the Department's exposure to tort liability. These impacts will begin with portions of the secondary system; however, kept unchecked asset conditions on all portions of the system will be at risk.	100	4	400	High	Engage our political representatives and explain the consequences of current funding and urgency of providing adequate finding to sustain the existing transportation system.	Executive Deputy Commissioner	Ongoing
						Develop a capital plan that most cost effectively gets the State's infrastructure to a sustainable condition at the lowest cost, including levels of service achievable for various funding levels.	Office of Finance / CPT	Ongoing
						- Engage the FHWA and our political representatives and explain the consequences of various mandates on overall infrastructure conditions - Seek new rules and processes that meet other social and political objectives - Provide NYSDOT the flexibility necessary to have separate programs and funding to address mandates and not tie them to infrastructure preservations or renewal projects	CPDC	Short Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
						- Ensure that sufficient funds are set aside to account for the increasing cost of Demand Repairs.	CPDC	Short Term
						Consider divestment of portions of the transportation system if funding does not improve.	CPDC	Short Term
If risks associated with climate change, such as increased frequency and intensity of storms as well sea-level rise are not adequately addressed in the planning, programming, design, construction, maintenance and operation of transportation infrastructure assets.	Then, - we will not be able to minimize, to the extent possible, the effects of increased flooding on our transportation facilities, which will impact public safety, mobility and the economy, - we will be required to repair and replace assets damaged or compromised during storm events before the end of their life cycle, - resources will be strained by repeated emergency response and recovery efforts, further impeding efforts to deliver the core pavement and bridge program, and - there will be accelerated deterioration of the bridge and pavement assets.	100	3	300	High	Update Statewide Flood Vulnerability Assessment GIS Layer	Policy and Planning Division	Ongoing
						Improve and maintain emergency response plans. Coordinate those plans with OEM and Local Emergency Operations Centers.	Operations and Asset Management Division	Ongoing
						Develop an infrastructure hardening plan with prioritized locations.	Office of Policy and Planning / Statewide Sustainability Team	Long Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
If the Department does not address existing limited staff resources and the potential for mass staff turnover due to the age of the work force, and if we continue to lose staff expertise in key areas due to lack of skill redundancy, and if we cannot recruit qualified staff within the specialized skills required,	Then we will lack the skills, expertise, and ability to appropriately plan, design, build, operate, maintain and manage the State's transportation infrastructure amidst a rapidly changing environment and emerging transportation technologies. This will lead to increased project delays, possible safety issues for the public, issues with meeting federal mandates, an increase in tort liability, and an erosion of public trust. In addition, increasing reliance on consultants as replacements could result in higher program costs and a lack of continuity of knowledge, which will lead us	70	4	280	High	Modify the CPU process to: - Use automation to reduce the amount of staff time needed for development and review, - Reduce the reliance on specific individuals for mission-critical tasks - Shift programming and user support to IT services	CPT	Ongoing
						Establish a formal Asset Management organization at Main Office and dedicated positions in the Regions to: - Carry out the business tasks necessary for NYSDOT to continue implementation of Transportation Asset Management; - Eliminate critical resource "pinch points;"	Executive	Short Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
	further down an unsustainable path.					- Develop a plan to partner with Academia and other external institutions to develop new technologies and practices and bring them into our practice to improve program effectiveness. - Commit to building internal planning capacity and partnering with others. - Reassess priority of business tasks needed for program development. - Reassess use of resources for program development versus program delivery activities. (production vs. decision making) - Allocate adequate resources to core asset management tasks such as data collection and analysis. - Establish access to areas of expertise not traditionally found in DOTs or in the transportation industry (e.g. economists).	CPDC	Long Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
If the Department does not prepare for short term funding uncertainty (both sudden losses of funding or sudden increases in funding),	Then, For sudden losses of funding: - regions will be forced to phase larger projects into multiple years, causing many construction inefficiencies and disrupting traffic over a longer period, - projects will be postponed and stop-gap repairs will be needed to keep the assets safe in the interim. This leads to additional costs with little benefit. - the transportation construction industry will become destabilized due to unreliable work opportunities resulting in worker layoffs, contractor bankruptcies, plant closures, less competition/higher prices, and negative impacts on state and local economies. For sudden infusions of funding: - we will not be prepared to take advantage of funding opportunities to bring improvements and enhancements to the	70	3	210	Medium	For sudden losses of funding: - Train regions to progress only critical infrastructure projects in times of austerity. - Reserve funds for demand response and inspection to either keep the system safe or close affected facilities.	Program Management Bureau	Short Term
						For sudden increases in funding: - Instruct regions to be prepared with a list of projects that can be delivered quickly. - Have regional and statewide asset teams review projects annually to insure that projects are appropriate for the distresses present. - Identify projects that have design approval that can be accelerated as Design Build projects. - Maintain a 'shelf' of projects from each region that are shovel ready and are progressed through final design.	Program Management Bureau	Short Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
	traveling public. When funding becomes available, it usually is restricted to be used in a certain time frame that requires quick delivery and decision making that may not be optimum. New Funding is directed to projects that can be delivered quickly within the accelerated time frame rather than to address more critical asset needs.							

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
If the Department fails to optimally balance resource investments across asset classes (bridges, pavements, safety, sustainability), and fails to properly balance system investment between preservation of the existing system and enhancements,	Then, - the most critical assets will not receive the most cost effective treatments at the time they are needed, leading to needs that cost significantly more to treat and in some cases leading to classes of assets that can no longer be economically sustained, - the overall system conditions may decrease over time as large parts of the system become unrecoverable from an economic standpoint, - the infrastructure backlog (the cost to bring the system to a state of good repair), will continue to increase to an unrecoverable level.	70	3	210	Medium	Complete implementation of Enterprise Asset Management Program Software that optimizes treatment strategies within asset classes and then allows for cross asset trade-off optimization.	CPT	Short Term
						Continue to implement Preservation First strategies that focus on delivering the most benefit to the most transportation users at the least cost.	CPDC, CPT, SAMTs, RAMTS, Regions	Ongoing

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
If the Department does not develop strategies to manage innovation, research, and knowledge transfer,	Then we will, - continue to experience knowledge and skill gaps across the organization; - miss opportunities to learn best practices from academia and other stakeholders/researchers; - fall behind the curve in adopting innovative technology that might drive down costs and improve safety; - continue to fall further behind in developing research methodologies and practices;	70	3	210	Medium	Develop strategies that enable key Department staff to attend conferences, workshops and participate in research or pilot projects at the regional or national level that enable those staff in positions to make critical advances within their programs and areas of expertise. Re-establish an operational research program within the Department to make practical improvements in how the Department operates and maintains the State highway and bridge infrastructure.	MO Program Areas	Ongoing
If we do not fully utilize the capability of our existing data and analysis systems to optimize their use, and if we are	Then, - NYSDOT will be unable to set meaningful performance targets, make informed project selection decisions across assets, accurately estimate needs, and track	70	3	210	Medium	Complete implementation of Enterprise Linear Referencing Software (ELRS), Roads and Highways.	IT Services / Office of Technical Services	Short Term

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
unable to maintain and enhance these systems, and further develop and integrate them with one another,	progress toward Department-wide goals; - our ability to adequately plan and scope projects across assets, (including secondary assets), will be impaired; - project quality will be impacted from erroneous or inadequate data; - we will be unable to continue to meet all the data driven requirements of MAP-21/FAST-ACT; - our ability to identify and target high risk locations, perform analysis and measure performance of transportation improvements will be impaired; - we will be unable to provide quality data to our partners; - we will not have the data available to efficiently manage system performance.					Develop Pavement and Traffic Data Strategic Plan, including scope, available technology, cost, and effort to collect and maintain necessary data on the full Federal-aid highway system.	Highway Data Services Bureau / SPMT / Policy and Planning Division	Short Term
						Implement OPPM including the What-If Analysis tool so that RPPMs can efficiently explore the impact of various funding levels and program mixes	Program Management Bureau	Short Term
						Complete implementation of Enterprise Asset Management Program software modules for maintenance management, roadway inventory and asset trade-off.	CPT	Short Term
If the Department doesn't develop strategies for engaging customers to determine their	Then, - we will not understand public expectations, and won't be able to factor them into program goals;	30	3	90	Low	Partner with other transportation agencies, industry and other States to increase funding for transportation, and continue to develop alternatives for funding transportation.	CPDC	Ongoing

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
needs and demands, and to educate the public on Department strategies and functions to help set realistic expectations,	- we may develop solutions that do not meet current/future user needs; - public pressure will force the Department to redirect investment of infrastructure funding away from high priority core bridge and pavement infrastructure to projects with lower benefits for higher costs; - the department will be forced to do more nighttime construction work, with higher costs, possible impacts to construction quality and increased safety risks; - public trust may be decreased.					Factor customer use into programming decisions.	CPT	Long Term
						Initiate a customer outreach program to: - Identify our customer groups; - Develop systematic means of assessing customer expectations; Tie highway infrastructure investment strategies to economic development strategies.	Asset Management, External Relations, Planning	Long Term
						Incorporate customer input into prioritization and trade-off analysis policies and practices.	CPT	Long Term
						Develop customer outreach for each category.	Asset Management, External Relations, Planning	Long Term
If the Department does not develop strategies for consistently collaborating, cost sharing, and setting and delivering priorities with multiple system owners, operators and service	Then, - services will not be coordinated across system owners and modes (e.g., signal coordination; modal transfers; parking) which could lead to inconsistent delivery of transportation services and lack of mobility during emergency events;	30	2	60	Low	Develop formal partnerships and operating coalitions as well as routine operations collaboration protocols between NYSDOT and other transportation asset owners and service providers. Examples include: - Coalitions such as TRANSCOM, NITTEC, I-95 Corridor Coalition, etc.	Policy and Planning Operations	Ongoing

Risk Event	Primary Impact	Impact Value	Likelihood Value	Risk Rating	Rank	Mitigation Strategy	Responsible	Status
providers, both public and private,	- we will fail to provide seamless, efficient, resilient, redundant, connected and multi-modal transportation for all; - we will fail to be prepared for new and emerging models of transportation service delivery such as transportation networking companies (Uber/Lyft) or connected/autonomous vehicles; - we may overbuild or under build the infrastructure and will not maximize the resilience of our investments; - we will not deliver the services needed for people and freight, will fail to take advantage of the capabilities of emerging technologies, and will not provide the support needed for the economy to grow and thrive; - we may fail to support the development of livable and quality communities.					- Joint projects including Integrated Corridor Management, Active Transportation and Demand Management, TSMO, TIM, etc. Continue to pursue technology and best practice sharing and collaboration projects, including HOOCS, traffic signal integration, BRT and complete streets/pedestrian safety measure.		

6.7 NEW YORK STATE'S APPROACH TO INCREASING RESILIENCY TO EXTREME WEATHER AND CLIMATE CHANGE

Under Governor Cuomo's leadership, NY State has launched multi-pronged efforts to protect NY State from the crippling impacts of extreme weather events such as those brought by Hurricanes Sandy and Irene. The State's focus includes proactively addressing transportation infrastructure risk to increase public safety and reduce future transportation disruptions and the high costs of emergency reconstruction. Initiatives include:

- **NYS's Community Risk and Resiliency Act (CRRA)**[7] was signed into law by Governor Cuomo in 2014. The law requires that certain state permit and funding programs consider future climate risk including sea level rise, storm surge, and inland future conditions in project design and planning. NYSDOT and other agencies worked with the NYS Department of Environmental Conservation and the Department of State to identify ways to implement the provisions of the Act and provide State guidance.

- **NYS Flood Risk Management Guidance** (SFRMG) - was drafted to meet the obligation to develop guidance for the implementation of CRRA. The SFRMG is intended to inform state agencies as they develop program-specific guidance to require that applicants demonstrate consideration of sea-level rise, storm surge and flooding, as permitted by program-authorizing statutes and operating regulations. The SFRMG incorporates possible future conditions, including the greater risks of coastal flooding presented by sea-level rise and increased storm surge, and of inland flooding expected to result from increasingly frequent extreme-precipitation events.

- **Smart Growth Public Infrastructure Assessment Guidance** requires that state agencies consider sea-level rise, storm surge and flooding in design of public-infrastructure projects, as required by CRRA. New and replacement transportation projects exposed to flooding hazards will require such assessment.

- **Mitigate NY**[8] **–** NYS's Hazard Mitigation Plan, required by the Federal Emergency Management Agency (FEMA), is the first in the nation to present an all-hazards approach in an interactive online format. Analyses of natural hazard potentials in NYS include flooding, hurricanes, wind, snow, and ice storms, among others. The Plan supports communities and agencies as they consider risk in decision-making. It is expected to be expanded to include a specific transportation component for state and local transportation agencies.

[7] NYS Community Risk and Resiliency Act website: https://www.dec.ny.gov/energy/102559.html

[8] https://mitigateny.availabs.org/

Footnote continued

- **New York State 2100 Commission** - Following Superstorm Sandy in late 2012, Governor Cuomo convened three (3) commissions[9], i.e. NYS 2100, NYS Ready and NY Respond, to improve the State's emergency preparedness and response capabilities, and strengthen infrastructure to withstand natural disasters. Under the NYS 2100 Commission, NYSDOT completed a statewide transportation infrastructure vulnerability assessment, especially for areas hit by Hurricane Sandy. The Commission's interim report[10] outlines transportation priority actions such as strengthening existing networks; achieving a State of Good Repair; addressing scour critical bridges; and enhancing guidelines, standards, policies and procedures to address resiliency.

- **NY Rising Community Reconstruction Program[11] –** is led by Governor Cuomo's Office of Storm Recovery. The program focuses on revitalization of 124 flood-impacted communities through resiliency planning that includes funding for projects. NYSDOT provides support for the development of transportation projects, which may include drainage improvements, road elevation, and other projects that directly repair or enhance structures which are integral to the integrity of transportation routes and devices that are critical to a community during a severe storm event.

6.8 NYSDOT'S APPROACH TO INCREASING RESILIENCY TO EXTREME WEATHER AND CLIMATE CHANGE

NYSDOT is continually assessing risk and has identified climate change and extreme weather as a significant factor to be addressed in asset management planning. NYSDOT has undertaken and identified mitigating strategies to increase resiliency. Some of these actions and approaches include:

Life Cycle Management

23 CFR Part 515 requires that the lifecycle planning process should include information on current and future environmental conditions including extreme weather events, climate change and other factors that could impact whole of life cost of assets. NYSDOT addresses resiliency to extreme weather and climate change in all aspects of its transportation infrastructure, from planning to design, construction, maintenance and operations.

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[9] https://www.governor.ny.gov/news/governor-cuomo-announces-commissions-improve-new-york-states-emergency-preparedness-and

[10] https://www.governor.ny.gov/news/nys2100-commission-releases-preliminary-report-improving-strength-and-resilience-new-york

[11] https://stormrecovery.ny.gov/community-reconstruction-program

Preventing Catastrophic Losses

Life cycle planning relies on known trends and averages. However, catastrophic events can disrupt expected life spans especially for those assets that have known vulnerabilities such as scouring, or are debris prone or near the end of their useful life. To prevent catastrophic losses of bridges and highways due to extreme events, NYSDOT has instituted protocols that are carried out throughout the year, including before and after flooding events:

- ***Flood Watch Bridge Program***[1] requires inspection protocols for all scour-critical bridges in the State.

- NYSDOT instituted a ***Debris Prone Bridges and Culverts Instruction*** in 2017 that requires inspection protocols for known debris-prone bridges and culverts.

- NYSDOT identifies **maintenance needs of *roadway and roadside drainage*** (culverts, ditches, closed drainage systems, etc.) on a continual basis through a variety of sources including windshield inspections, patrols, observations from field staff, conditions reported by the public, in-depth drainage investigations and regular inspections.

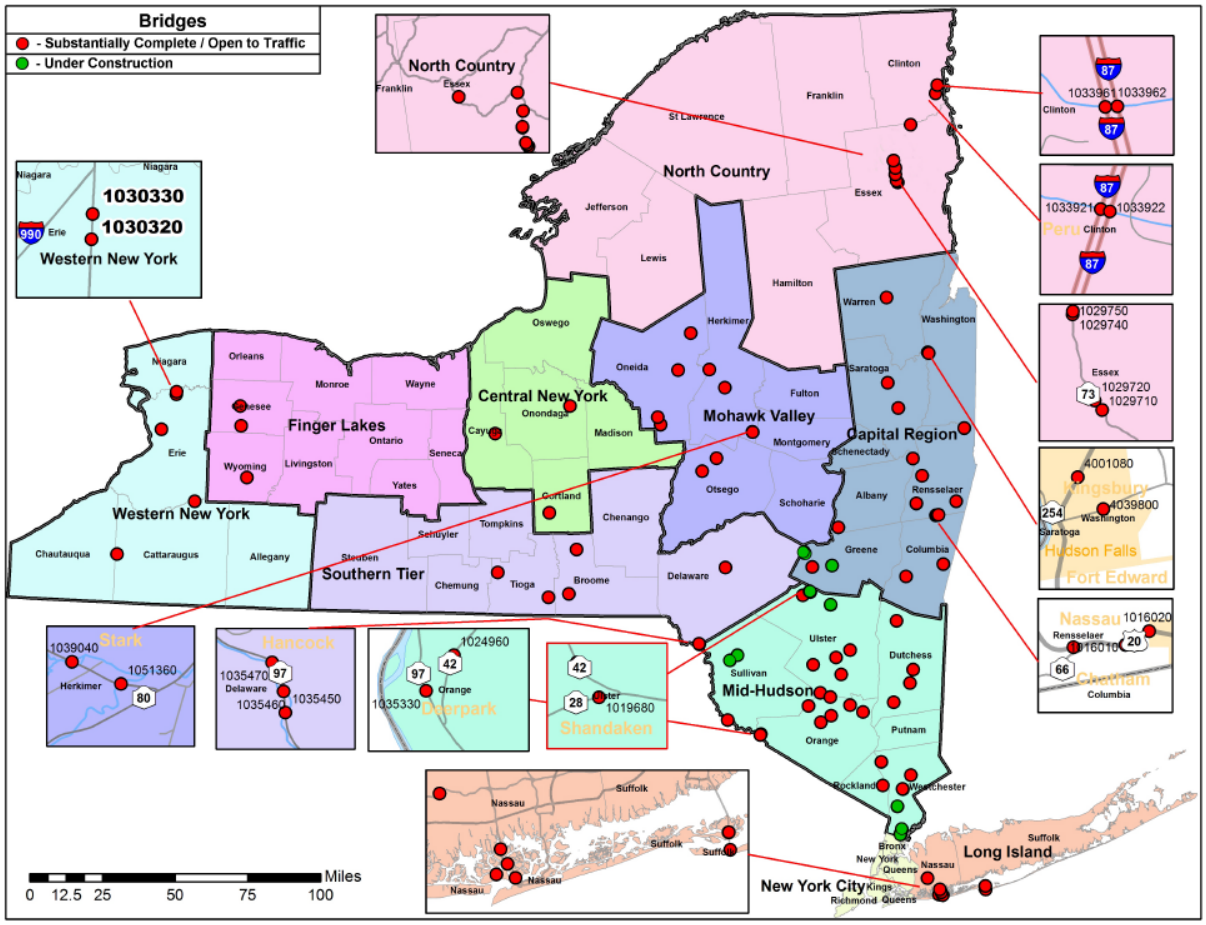
Needs are prioritized and highest priorities are given to the greatest **public safety risks**. Urgent maintenance needs, including culvert or bridge red flags are addressed in a timely manner by NYSDOT crews or emergency stand-by contractors. Determining priorities requires that risk management considerations and engineering judgement be employed on a case by case basis.

Projects and Programs

NYSDOT considers cost-effective solutions for reducing extreme weather and future climate change risk through project and program level decision-making. Some examples are:

- The **Statewide Scour Critical Flood Prone Bridges** program is an initiative to harden 106 at-risk bridges against extreme weather, including scour and flooding. By December 2016, NYSDOT had received funding approvals from FEMA for all of the bridges in the program totaling $518 million dollars. One hundred and one projects have been completed and five projects are still under construction. Construction of the remaining bridges will be completed in 2019.

Figure 6.4 Locations and Status of Projects under the Critical Bridges over Water Program January 2018



- NYSDOT has built resiliency-related criteria into its **bridge management system**, which is used to help prioritize bridge investments. A portion of a structure's prioritization score is determined by hydraulic vulnerability. Another factor accounts for the required detour length should a facility need to be closed.

- **Weather Hardening**: To mitigate destructive impacts of extreme weather to the state's infrastructure, the state provided $500 million in 2016 to make roadways across the state that are susceptible to flooding and other extreme weather-related events, including ice jams, safe and passable. Projects under the program include sections on the Nassau Expressway and the Saw Mill River Parkway.

- The **NYSDOT Statewide Flooding Vulnerability Assessment**: In 2014, NYSDOT completed an evaluation of locations vulnerable to flooding. The evaluation began with an analysis of historical flooding events as well as an assessment of future increases of extreme precipitation and associated flooding. This was supplemented by discussions

with each regional office, and a comprehensive survey of knowledgeable "on the ground" operations staff within each of NYSDOT's 11 regional offices. The assessment resulted in a GIS-based tool that identifies known flooding vulnerable locations on State-owned roads. The assessment identifies low, medium and high impact vulnerabilities based on criticality factors as assessed by regional staff and is available for informing program and project decisions. The 2014 Statewide Flooding Vulnerability Assessment was updated and expanded in 2018. NYSDOT has shared its approach with MPOs and localities, some of whom have undertaken similar analyses.

- **Bridge and Culvert Design:** After NYS's Community Risk and Resiliency Act (CRRA)[12] was signed into law in 2014, NYSDOT worked with the lead agencies to identify ways to implement the provisions of the Act and the NYS Flood Risk Management Guidance. After careful analysis on considering future conditions in project design and planning, coordination with state agencies and analysis of climate data and projections, NYSDOT revised its Bridge and Highway Design Manuals[13,14] to accommodate future design flows for bridges and culverts. Future design flows were carefully derived through research and analysis by working with state and federal agencies. These standards thus factor into every project. In addition, NYSDOT added a consideration for sea level rise for bridges (via the Bridge Manual) in current and future tidal areas. Sea-level rise elevations are based on NYS's officially adopted projections.

- NYSDOT is developing resiliency planning criteria under its **Smart Growth Public Infrastructure Act** guidance. The guidance will take into account future design flow considerations as well as certain sea level rise projections over the design life of new and replacement road, bridge and culvert projects.

6.9 SUMMARY OF PERIODIC EVALUATION OF FACILITIES REPEATEDLY REQUIRING REPAIR AND RECONSTRUCTION DUE TO EMERGENCY EVENTS

Federal Highway Administration (FHWA) 23 CFR Part 667 requires that State DOT's evaluate federal-aid eligible assets that have been repetitively damaged due to events that are declared Presidential or Governor disasters. The rule requires DOT's to conduct statewide evaluations[15] to determine root cause and consider reasonable alternatives to roads, highways and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events.

[15] Federal Register https://www.govinfo.gov/content/pkg/CFR-2018-title23-vol1/xml/CFR-2018-title23-vol1-part667.xml

NYSDOT's Process

For these purposes, NYSDOT evaluated historic records submitted to FHWA under the Federal Emergency Relief (ER) program. These records consist of reimbursement requests for repair and reconstruction of damaged federal-aid eligible highways and bridges in the State, regardless of ownership; i.e. state and locally owned and maintained.

NYSDOT's analysis starts with the most current declared emergency events and adds historical events until the required starting year of 1997. Damaged and repaired assets are digitally mapped in GIS and linked to available ER information. After mapping, identification of repetitively damaged assets is accomplished using GIS and spreadsheet tools.

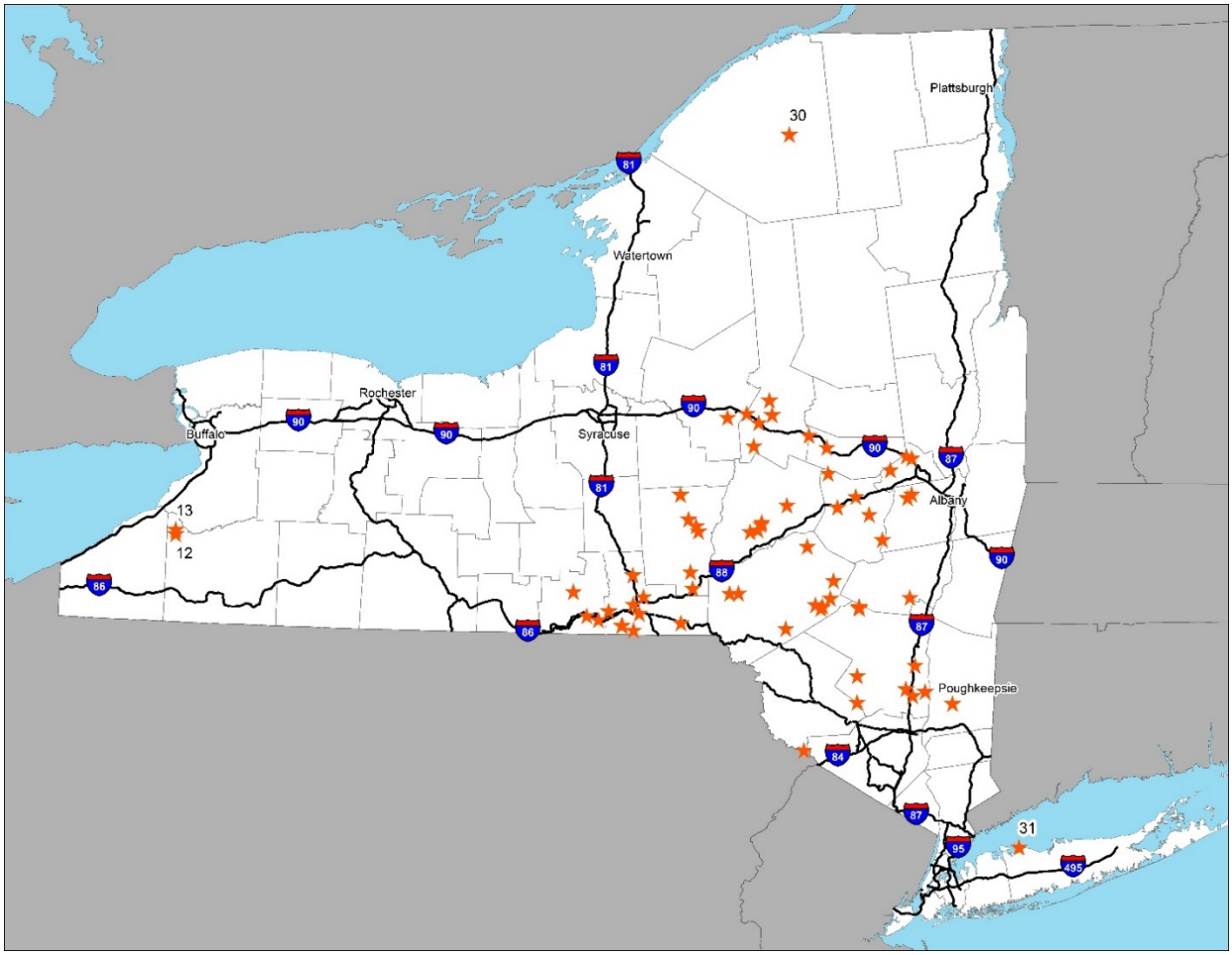
Mapping is based on the descriptions associated with the submissions to FHWA for Emergency Relief reimbursements. Mapping historic repair sites can be difficult. While linking repeated damage events to easily identifiable assets such as bridges or culverts is fairly straightforward, some past damage assessments are described vaguely. For example, a summary may simply state: "*road damage for five miles due to multiple shoulder washouts, ditch damage and culvert damage*". In these situations, information on specific assets is extracted where identified; otherwise, such damages may be displayed as linear sections of roadways. These linearly displayed damage sites could trigger more frequent evaluations required under this Part as the probability of repeated events are more likely along longer stretches of roadway.

Results

As of December 31, 2018, GIS mapping has been accomplished for 1,732 ER repair sites for events from 2005 to 2017. Mapped assets include roads, bridges, culverts, ditches, shoulders, slopes, walls and others. For these events, sixty-six (66) repetitive damage areas have been identified. General locations of these areas are shown on the statewide map below.

The effort to map repair sites and fine-tune previous efforts will continue. GIS mapping is underway to also include events dating back to 1997 as well as more recent events.

Figure 6.5 Statewide Map of Repeatedly Damaged Areas Identified in Analysis (12/31/2018)



The locations of repetitive damages areas identified to date are generally in areas of the state that have experienced the highest number flooding events and damages (excluding hurricanes) since 1996. See Figure 6.5 "*Statewide Map of Flooding Events in NYS 1996-2017*".

Evaluations

Once an asset has been repeatedly damaged, the rule requires that an evaluation be completed to find the root causes and consider what reasonable alternatives could partially or fully reduce the need for repeated repairs, better protect public health and safety, the human and natural environment and meet transportation needs described in transportation plans including the Statewide Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP). Repairs to the 66 sites identified to date have been completed. NYSDOT will implement evaluations per FHWA guidance for future events.

More importantly, NYSDOT is exploring a process that would trigger required evaluations when assets are repeatedly damaged so that evaluations are integrated into design alternatives of permanent repairs. Key to such evaluations is the identification of damaged assets by location

during emergency events. NYSDOT is looking to implement real-time, digitally mapped damage assessments during emergency events. In the interim, desk-top mapping of ER projects during and after emergency events and before permanent repairs will provide the necessary information for the Part 667 evaluations.

The information developed under this process will also be used to inform the STIP and future project development in repetitive damage areas.

6.10 IMPACTS OF EXTREME WEATHER AND CLIMATE CHANGE IN NEW YORK STATE

Declared Events

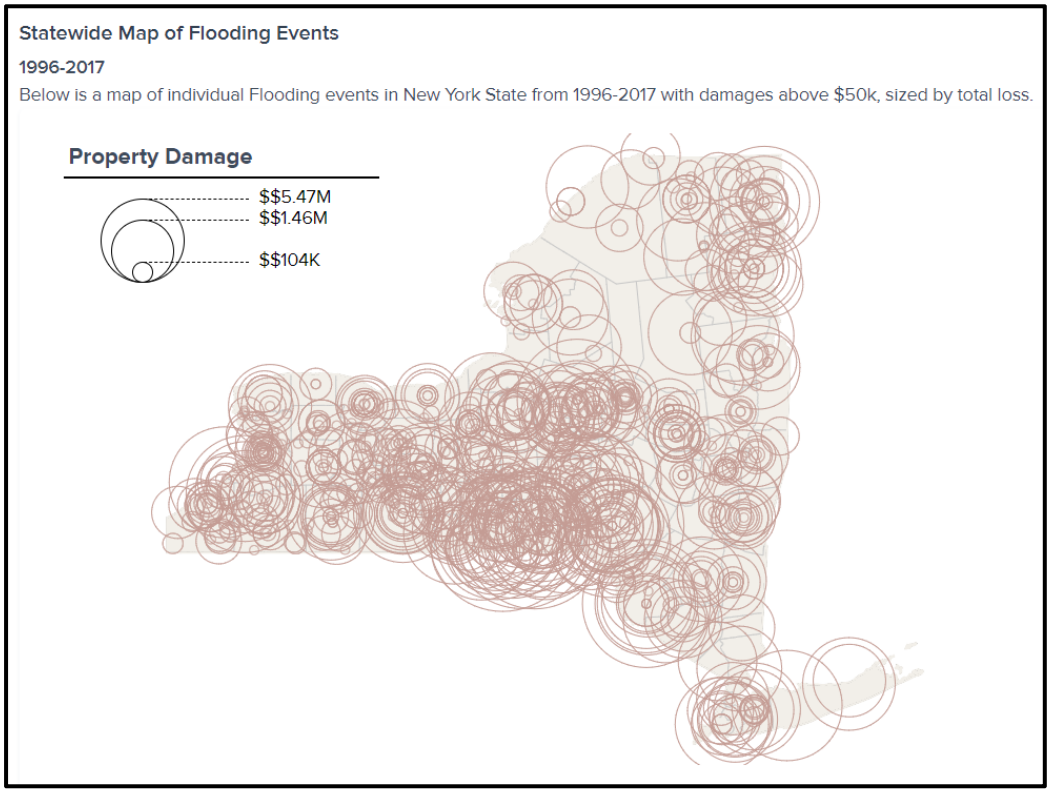
Since 1997, the recommended year to start evaluations under Part 667, NY State has experienced numerous officially declared emergency events. Of these, 39 resulted in submissions under FHWA's Emergency Relief reimbursement program (Table 6.4); of which 29, more than 70%, were related to flooding. Others included wind damage, snow and ice storms, a power outage and the 9/11 World Trade Center terrorist event. Clearly, flooding events frequently qualify for official disaster declarations and impact the transportation system most frequently.

Table 6.4 NYS Declared Events that Required FHWA ER Submissions since 1997

	EVENT	FHWA ER NUMBER	Event Type
1	1/98 Ice Storm and Flooding	98-1	Ice and Flooding
2	6/98 -7/98 Flooding	98-2	Flooding
3	9/98 Windstorms	98-3	Wind
4	7/99 Flooding and Windstorms	99-1	Flooding & Wind
5	9/99 Hurricane Floyd	99-2	Flooding
6	Summer 2000 Floods and Windstorms	00-1	Flooding & Wind
7	12/00 Storms	01-1	Snow
8	World Trade Center Incident	01-2	Terror
9	4/02 Earthquake	02-01	Seismic
10	4/03 Ice Storm	03-01	Ice
11	7/20-8/18/03 Storms	03-02	Flooding & Wind
12	8/14/03 Power Outage	03-03	Power Outage
13	Spring 2004 Flooding and Windstorms	04-01	Flooding & Wind
14	Flooding (8/29-9/24/04)	04-02	Flooding
15	April 2-4, 2005 Flooding	05-01	Flooding
16	Henry Hudson Parkway Wall Collapse (6/12/05)	05-02	Collapse of privately owned retaining wall
17	June 13, 2005 Flooding	05-03	Flooding

18	Hadlock Pond Dam Failure (7/2/05)	05-04	Dam Failure
19	Route 56 Washouts/Damages (9/17/05)	05-05	Beaver Dam Failure
20	June 2006 Flooding	06-01	Flooding
21	October 2006 Snowstorm (10/12-13/2006)	06-02	Snow
22	November 16, 2006 Flooding	06-03	Flooding
23	April 2007 Nor'easter	07-01	Flooding & Wind
24	June 19, 2007 Flash Flood	07-02	Flooding
25	August 8, 2007 Severe Storms, Flooding & Tornado	N/A	Flooding & Wind
26	July 23-27, 2008 Severe Storms	08-01	Flooding
27	December 11, 2008 Ice Storm	09-01	Ice
28	August 2009 Severe Rainstorms and Flooding	09-02	Flooding
29	January 24-25 2010 floods	10-01	Flooding
30	February 24-26 2010 heavy snow (tree debris event)	10-02	Snow
31	March 13-15 2010 Nor'easter	10-03	Flooding
32	Sept 29-Oct 1, 2010 Severe Storms	10-04	Flooding
33	April-May 2011 flooding	11-01	Flooding
34	Hurricane Irene	11-02	Flooding
35	Tropical Storm Lee	11-03	Flooding
36	Hurricane Sandy	13-01	Flooding & Wind
37	June-July 2013 Severe Storms and Flooding	13-02	Flooding
38	May 2014 Severe Storms and Flooding	14-01	Flooding
39	August 2018 Flooding	18-02	Flooding

Figure 6.6 Statewide Map of Flooding Events in NYS 1996-2017. Source: NOAA and Mitigate NY[16]

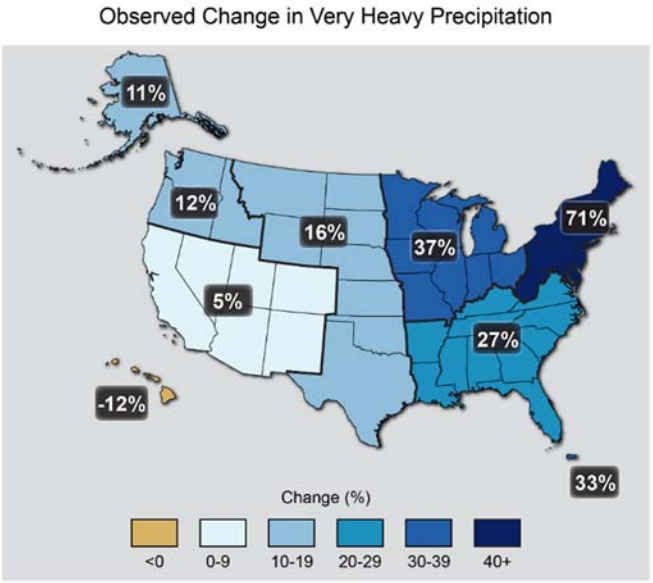


6.11 EXTREME WEATHER AND CLIMATE CHANGE

Observed impacts from flooding reinforces that New York is experiencing an increase in extreme precipitation events. Between 1958 and 2012, the northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events).[17]

[16] Mitigate NY: https://mitigateny.availabs.org/hazards/riverine

[17] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.



Looking forward, climate science for NYS forecasts that without a dramatic decrease in the global generation of greenhouse gases, critical changes can be expected in New York's climate over the next century that would impact NY's transportation infrastructure including:

- **Intense downpours** will likely become more frequent.
- **Extreme weather events** are predicted to occur with increasing frequency and intensity.
- The number and duration of **extreme heat events** are likely to increase.

In 2017, New York State adopted sea-level rise projections[18] applicable to the tidal coasts of Long Island, New York City and the Hudson River. Due to continued GHG emission trends, NYS can expect impacts, including:[19]

- **Continuation of sea-level rise** along NY's tidal coast, up to 71-75 inches by 2100;
- Magnification of dangerous **storm surges**;
- Increased areas of coastal inundation during regular tidal cycles (**nuisance flooding**).

While sea level rise and storm surge risks are a considerable risk along NYS's tidal coast (Atlantic Ocean, Long Island Sound, Hudson River to Troy Dam), flood risk from precipitation events, ice jams and other causes exist across the state. Although some areas are more prone to flooding than others, the risk exists broadly. NYSDOT continually assesses its system for flooding vulnerability (see "Projects and Programs").

[18] http://www.dec.ny.gov/regulations/103877.html

[19] NYS 2100 Commission, 2013.

Figure 6.7 NYS's Tidal Coast is indicated by heavy outline.

Research

To better inform program and project development decisions related to climate change and extreme weather, NYSDOT monitors research on observed climate trends, and continues to support and participate in research relevant to transportation infrastructure decision-making. Recent research participation includes, but is not limited to, the following:

- Federal Highways Administration (FHWA) Research Project: Post-Sandy Transportation Vulnerability Assessment and Adaptation Analysis with NY-NJ-CT https://www.fhwa.dot.gov/environment/sustainability/resilience/publications/hurricane_sandy/fhwahep17097.pdf
- **FHWA Study Pilot: Climate Vulnerability and Economic Assessment for At-Risk Transportation Infrastructure in the Lake Champlain Basin, New York** https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/2013-2015_pilots/new_york/index.cfm
- Downscaling of Extreme Precipitation Events in New York State http://ny-idf-projections.nrcc.cornell.edu/
- USGS Future Peakflow Explorer Tool (Expanded StreamStats Tool) http://ny.water.usgs.gov/maps/floodfreq-climate/

7.0 Investment Plan

This section describes the investment strategies that guide NYSDOT, the NYSTA, and the local agencies with maintenance jurisdiction over parts of the NHS, in maintaining NHS bridge and pavement assets. Unless otherwise stated, the rest of this chapter will refer to the combined efforts of the NYSDOT, the NYSTA, and the myriad local agencies that maintain the NHS, as "the State" or "New York State".

7.1 FHWA REQUIREMENTS

Pursuant to MAP-21 and the FAST Act, the Federal Highway Administration published a final rule, "National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program". The rule defined new methods to rate the conditions of pavements and bridges. These methods are detailed in Chapter 2. FHWA also requires that the TAMP include a section on how a state plans on setting performance targets for NHS conditions, based on those new metrics. This rule requires states to establish condition targets by May 20, 2018 for the full extent of the Interstate and non-Interstate NHS, regardless of ownership. Required targets include: statewide 2-and 4-year targets for the non-Interstate NHS and 4-year targets for the Interstate.

Further, pursuant to § 490.315 and § 490.407, this rule establishes minimum condition levels for pavement and bridges as follows:

- No more than 5% of the pavement lane miles on the interstate system can be in Poor condition.
- No more than 10% of the total bridge deck area on the entire NHS in the state can be classified as Structurally Deficient.

FHWA established penalties for not maintaining these minimum condition levels. Specifically, a state failing to meet the minimum pavement condition level must obligate a portion of its National Highway Performance Program (NHPP) funds and transfer a portion of its Surface Transportation Program (STP) funds to improve Interstate pavement condition. Similarly, if for 3 consecutive years the minimum bridge condition level is not met, the State must obligate and set aside NHPP funds for eligible bridge projects on the NHS.

New York State currently meets the federal pavement requirement, but fails the federal bridge requirement. However, the state is already allocating more money to address bridge conditions than are required by the penalty. That being said, the federal metrics are key components of our asset management strategy for the NHS.

The State's method for asset management, and for setting these condition targets, is detailed in the following sections.

7.2 NYSDOT'S ASSET MANAGEMENT INVESTMENT STRATEGY

NYSDOT and the NYSTA are operating in an environment in which the needs of the transportation system far outweigh the funding available to address them. NYSDOT is responsible for the conditions of the wider, statewide transportation system, not just the NHS. Within this context, NYSDOT currently only has 35% of the funding required to address NHS pavement and bridge needs. To keep the NHS, and New York State's wider transportation system functioning in a safe and reliable manner, while at the same time recognizing the current fiscal constraints, it is essential to follow a deliberate and strategic approach to setting planning targets. By necessity, this includes setting priorities - priorities that will allow the state to meet long-term goals and short-term objectives.

Given the significant needs of our transportation system, the State has established a strategy to invest in a way that produces the greatest possible return on investment. As stated in Chapter 5, a large part of this approach emphasizes proper management of assets with appropriate treatments, at appropriate times, and at the appropriate locations. At State DOT, it means making strategic and deliberate decisions that support our transportation system today, while optimizing transportation for future generations. This starts with taking care of what we have first. By preserving our existing system, NYSDOT will help build the foundation for future economic growth of New York State. How we make funding decisions is consistent with this strategy.

Where allowed under the program area guidelines and where appropriate for the underlying infrastructure, NYSDOT uses the Highway and Bridge Core Construction Program funding to address two broad purposes: system preservation and beyond preservation.

Preservation First

As stated in Chapter 5, the State has embraced a "Preservation First" approach in our program planning activities. Preservation activities are those undertaken to extend or maximize the service life on an existing asset or highway facility. This work includes preventive maintenance, and preservation activities on pavements and additionally includes rehabilitation treatments on bridges.

The "Preservation First" strategy prioritizes activities that maximize the service life of existing infrastructure assets over expansion or enhancement of the highway network. The strategy prioritizes managing conditions across the entire system, not just the NHS, by keeping preservable assets in the lower-cost preservation treatment cycle.

For any funding and project prioritization scenario, system conditions will stabilize given enough time. In most instances of under funding, sub sections of the system may never rise to the importance of being programmed for work on a regular cycle. For example, if a state has only a portion of the funding required to keep the entire system in good condition, they may opt to prioritize scarce resources on higher volume facilities, letting the lower volume "secondary" system deteriorate to poor. In this manner, the size of the "abandoned" portion of the system will increase as available funding decreases. Please note that system conditions could stabilize with a majority of the system in poor condition if funding was chronically inadequate to meet the annual construction needs.

Once network conditions are stabilized, the amount of preservation funding required from year to year will stabilize as well. If the State funds their Core Construction Program at a higher amount then the required Preservation funding, then the additional funds are applied to "Beyond Preservation" or Reconstruction/Replacement projects on pavements and bridges. These projects are performed on more deteriorated assets to bring them into a state of good repair. It is very important to recognize that a Preservation First strategy is a long-term commitment and will take years before the State fully achieves the desired results. This is a message that must be recognized by NYSDOT and NYSTA staff, external stakeholders, and decision makers.

The following Preservation First precepts are considered as part of NYSDOT's Program Update efforts:

1. The overall program strategy is preservation focused and safety sensitive.
2. Preservation projects will address all applicable safety and accessibility requirements and will go through a SAFETAP screening to make sure that any deficiencies are addressed during construction.
3. Preservation performance targets for structures and pavements are set and agreed to. Each asset team determines the needs required to achieve a State of Good Repair in a ten year period for each of their assets. The relative preservation and renewal needs, by asset type and by region, are reviewed and agreed to by the CPT. The planning targets are set based on the relative needs of each region, heavily weighted toward preservation needs. Regions are expected to spend most of their planning targets on preservation activities.
4. The details of which treatments and combinations of treatments are considered preservation are set by the asset management teams and are defined in program update instruction documents. The detailed breakdown can be found in Chapter 5.
5. The expectation is that a Preservation First strategy is a long term commitment, and requires adequate funding. It may take years before the desired results are fully achieved and the system obtains a state-of-good-repair.

In general, preservation project selection decisions are prioritized on a regional basis. Resources are managed and prioritized by Regional offices and MPOs for purposes of infrastructure preservation.

As detailed in Chapter 5, these needs are determined by the State's pavement and bridge management systems and include not just the recommended lowest cost effective treatment, but also whether that treatment is due within the "window of opportunity" for that treatment. These systems analyze each highway segment and bridge and recommend treatments based on a combination of historic cost information, models that estimate how an asset will deteriorate over time, and a set of work treatment selection algorithms that reflect conditions, life cycle costs, and statewide policies. The regional planning target development process enables NYSDOT to balance system preservation across the network.

Beyond Preservation

Beyond Preservation projects address assets that have deteriorated beyond a state in which they can be preserved and or meet statewide goals of economic development, resiliency or

sustainability. These projects include highway reconstruction/bridge replacement projects. Beyond Preservation projects are divided into two categories.

- **System Renewal** investments are existing system restorations and are defined as all bridge replacements and major rehabilitations, road reconstructions in villages, hamlets, and cities, and major rehabilitation and reconstruction pavement projects. Projects are designed and constructed to address Complete Street enhancement needs, such as new sidewalks, bicycle access or any other elements necessary to meet accessibility needs.
- **System Improvement** is a term for investments that provide capacity or operational improvements like new roadways, capacity projects, and any fundamental change in function or functional class. In addition to asset management resources, system improvement projects can be funded with discretionary sources such as BUILD, INFRA, TEP and TAP. These resources are *outside* of the scope of the TAMP and can be used, when awarded, for system improvement type projects by NYSDOT and local recipients as appropriate.

Beyond preservation projects are usually not affordable within a region's planning targets, Regions provide information on these projects as part of the capital program update process. The objective of the statewide planning process is to identify projects at the locations of greatest need from an overall Statewide perspective. The process considers asset condition, facility importance and potential risk to infrastructure condition. This is necessary because of the very limited amount of funding available and the need to channel that funding where it is most desperately needed. Projects that are selected are then proposed to be added to the STIP.

7.3 NEW YORK STATE CAPITAL PROGRAM DEVELOPMENT

Approximately every two years NYSDOT goes through a process of updating the capital program. Regions receive Program Update Instructions from the Main Office which provide guidance on the Department's Strategies and emphasis areas for the upcoming update. All statewide asset teams participate in the writing of the Program Update instructions.

In advance of the Program Update, the Department performs a Needs Analysis that determines the funding required to achieve a State of Good Repair for each asset class in each region of the state, within a 10 year period. Not only does this involve analyzing Bridge and Pavement conditions, but also includes secondary assets like guiderail, signs, drainage, signals and others. The needs study also includes Safety and System Operations which includes things like TMC operations, Help trucks, signal timing, ADA and ITS. Most needs are broken down into a preservation component (what funds are necessary to preserve an asset) and a renewal component (what funds are necessary to enhance, reconstruct or replace an asset).

Regions are provided with "planning targets" for preservation and renewal work. Those "planning targets" are based on the proportional needs of the transportation system. Over the last several updates the Regions have been instructed to use their planning targets almost exclusively on projects that will preserve the existing transportation system.

In addition, Regions typically have a large list of renewal projects that they would like to deliver but they do not have sufficient planning targets to fund. The regional asset teams review these projects and submit them to the statewide asset management teams for review and evaluation. The asset teams and CPT review all the submitted projects and determine which of these projects are the most important to the state. These projects typically consist of System Renewal projects on critical facilities across the state as well as Strategic investments that will benefit the state's economic well being.

The Department also conducts competitive solicitations for TAP and CMAQ projects as well as Local Bridge NY projects which are scored by Regional Review Teams and selected by and approved for Funding by the Commissioner of NYSDOT. Lastly Freight Projects that have been identified in our Statewide Freight plan are added to the capital program with NHFP funds. These projects are paid for with funds that are dedicated for these specific purposes, and are separate from the analysis of the main portions of the capital program.

These four components (Preservation projects selected by the regions, major capital projects selected based on Statewide needs, projects selected through statewide competitive solicitations, and projects selected through the statewide freight plan) make up our capital program. It should be restated that this process involves an analysis of the entire New York State Highway System, not just the NHS.

The Program Management Bureau manages our Capital Program. Regions are monitored to insure they stay within their "planning targets" and statewide selected projects are monitored for cost, scope and schedule.

7.4 SCENARIO ANALYSIS

Funds Available for Pavement and Bridge Assets on the NHS

As stated in Chapter 3, NYSDOT and the NYSTA have a combined $2,111,215,000 in Core Construction funds available to meet the needs of the entire state transportation system, not just on pavement and bridge assets on the NHS. Not all of the core construction funds are used for pavement and bridge construction; a portion are used for "Other" needs, such as maintenance of ancillary assets and other improvements such as drainage repairs, pedestrian upgrades, or for large mobility projects or new construction. The "Other" category includes:

- mobility improvements,
- drainage improvements,
- secondary assets such as guiderail, signs, etc.,
- overhead sign structures,
- Information Technology Services (ITS),
- Signal improvements,
- Noise and retaining walls,
- Truck and freight facilities,

- Rest Area projects,
- Bike/Ped projects, (including ADA mandates on paving projects),
- Park and Ride work,
- and tree trimming, etc.

These funds can't be used in the context of the TAMP, because they don't contribute directly to the asset management of pavement and bridge assets on the NHS. As stated earlier, NYSDOT assesses the needs of these assets as part of the Needs Study that is performed during the Capital Program Update Process. These needs are then weighted against the pavement and bridge needs, and a portion of the overall funding is supplied to the regions to meet these needs. In the context of the capital program, these "Other" projects are handled in two ways. First, NYSDOT and the NYSTA design and bid projects specifically to meet these system needs. For example, NYSDOT spent approximately $250M last year on projects dedicated to meeting drainage, mobility, bike/ped, transit, and "Other" needs. Second, a given pavement or bridge project may have an "Other" component, based on the particular scope elements included in the project. So, for example, if a bridge replacement project includes the addition of a dedicated bike/ped lane, then some of the cost for that project would be attributed to the "bridge" category and some would be attributed to the "Other" category. On average about 15% of the total pavement spending and 30% of the total bridge spending goes toward the "Other" category. These portions have been removed from the pavement and bridge budgets presented in the sections below, and are represented in the "Other" category in the associated figures and tables.

It should be noted that the TAMP is primarily concerned with the conditions of pavement and bridge assets on the NHS, and further analysis of ancillary asset conditions is outside of the scope of the TAMP.

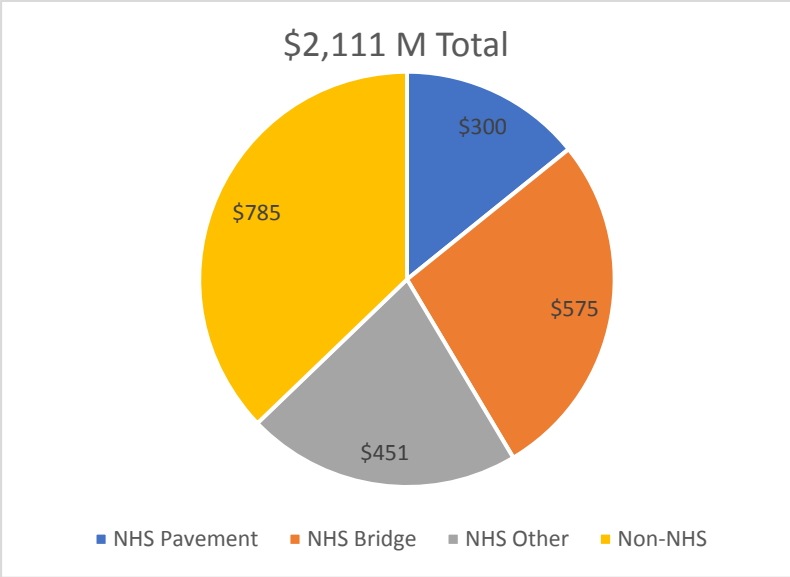
As presented in Chapter 2, the NHS comprises only a portion (roughly 40%) of the total lane-miles of federal aid eligible highway system in New York State. However, the NHS carries almost 70% of the traffic, (as expressed in Vehicle Miles Travelled, or VMT) in the State. Virtually all of the New York State Thruway is on the NHS. Therefore, it's assumed that all of the $285M in NYSTA Core Construction funding is used on the NHS. However, unlike the NYSTA, NYSDOT is responsible for the conditions of the entire Federal Aid system. Therefore, when developing the system needs, and when running our pavement and bridge management systems, we consider the entire state system, not just the NHS. However, we do prioritize our pavement and bridge projects using traffic volume, functional class, and other factors that keep the NHS in better condition than the non-NHS portions of the system. For example, in our latest Capital Program, we anticipate that the non-NHS portions of the system will be in considerably worse condition than the NHS over a ten year period.

It should be noted that when we do trade-off analysis to balance the future conditions of pavement and bridge assets in the state, that we include funding for the entire system, not just the NHS. Once the statewide outcomes are calculated we then separate the money that is spent on the NHS from the money spent on the non-NHS portions of the state system. All of the funding amounts presented in the later sections of this document are for the NHS only, unless clearly stated.

It should also be noted that the TAMP is primarily concerned with the conditions of pavement and bridge assets on the NHS, and the conditions of the non-NHS system are outside of the scope of this document.

This breakdown of core construction funds is demonstrated in Figure 7.1, below. The figure shows the average amount of NYSDOT and NYSTA funding available for pavement and bridge work on the NHS over the next ten-year period.

Figure 7.1 NYSDOT and NYSTA Average Annual Funds Available for NHS Work ($ Millions)



These funding amounts were derived from the Department's Capital Program Update exercise, (and are reflected in the current four-year STIP document), which outlines the current infrastructure commitments of the Department. It should be noted that the amount of money spent on the non-NHS part of the system is only 37% of the available total core construction funding, despite the fact that it comprises over 60% of the total lane-miles. Our methodology for how we determine the NHS pavement and bridge spending, in the context of the overall capital program update, is presented in the sections below.

Scenario Analysis

An important aspect of the State's Capital Program Update (CPU) process is understanding the relationship between funding levels and future asset management performance. This section describes how NYSDOT forecasts future performance levels on the NHS and conducts scenario analysis as part of the CPU. This is done for two primary reasons.

- To provide a basis for cross asset trade-off analysis to see what critical performance levels can be achieved by moving funds from one asset class to another.
- To demonstrate critical thresholds that could be achieved by additional funding. For example, at a certain funding level bridge conditions could be stabilized at current levels

or pavement conditions could achieve a perpetual state of good repair, or what combination of pavement and bridge funds would be needed to keep the backlog of funding needs from further increasing.

As outlined in Chapter 5, the various funding levels for each asset and for each subset of the entire highway network are developed in relation to the overall needs for those assets. Through the comprehensive needs study that is completed as part of the Capital Program Update, we can determine the relative needs for Pavements, Bridges, other structures, secondary assets, Safety, Mobility, etc. We then run funding scenarios for each asset, on a statewide level, to compare condition outcomes. The last step in the exercise involves analyzing the statewide conditions of the overall highway system using different combinations of asset funding scenarios that total the overall core construction budget. Because the TAMP is primarily concerned with NHS conditions, a representative selection of various funding levels for pavement and bridge assets on the NHS are presented below. Please note that these are just a few of the dozens of funding scenarios that are considered between the various assets during the capital program development process.

The Agile Assets Bridge and Pavement Management Systems were used to develop the forecasts that follow. The forecasts reflect the Core Construction funding levels described in Chapter 3 and the investment strategies described earlier. All model runs were performed to include all state maintained and NHS pavement and bridges. It should be noted that for the State's Capital Program Update exercise, we analyze scenarios on a ten year time frame. This is separate from the FHWA target setting exercise, which spans a 2 and 4 year time frame. The FHWA target setting is discussed in detail in later sections.

Future Pavement Scenarios

When developing potential pavement scenarios, NYSDOT evaluated many annual funding levels for all pavements on the state highway network. For the TAMP, we'd like to highlight four representative funding levels for the NHS pavements in the State, (assumed to be constant $ for the next 10 years):

$300 million – current funding level;

$375 million – amount required to stabilize the percent of vehicle miles traveled on the NHS on good and excellent pavement at the existing value of 82%. This is a customer focused metric that New York State uses to reflect driver satisfaction and to help prioritize pavement work on the higher volume roadways.

$575 million – amount needed to:

- achieve the federal target of no more than 5% poor pavement on the Interstates,
- Hold the poor pavements on the entire NHS at 10%
- Provide that 90% of the VMT on the NHS is driving on good roads.

$725 million – amount needed to achieve a State of Good Repair on the entire NHS, including:

- achieve a maximum of no more than 5% "Poor" pavement on the entire NHS, according to the FHWA definition of "Poor" from the NPRM,

- provide that over 90% of the VMT on the NHS is driving on roads with a NYSDOT condition rating of 7 or better,
- hold the backlog of infrastructure needs steady over the ten year period.
- At this funding level, pavements will reach a condition state in year ten which will take the least funding after that to maintain pavement conditions. This is considered the State of Good Repair for pavements.

These funding levels were selected to illustrate the gap between current funding and the funding needed to stabilize critical state and federal pavement performance measures. The large jumps in cost between scenarios are due to the need to address the poor interstate and NHS pavements, to stay compliant with new Federal performance measures and priorities. The existing NHS pavement system is in relatively good condition, especially when compared to the rest of the state highway network. But in order to hold these conditions constant, the percentage of renewal work required is much higher than a standard preservation first approach.

The results of the pavement analysis are shown in Figures 7.1 and 7.2. Each figure shows projected performance for the four funding scenarios described above. The projections were developed using the Agile Assets Pavement Management System and by applying the preservation-first logic and priorities described above.

Figure 7.2 2027 Interstate Pavement Conditions by Avg. Annual Funding

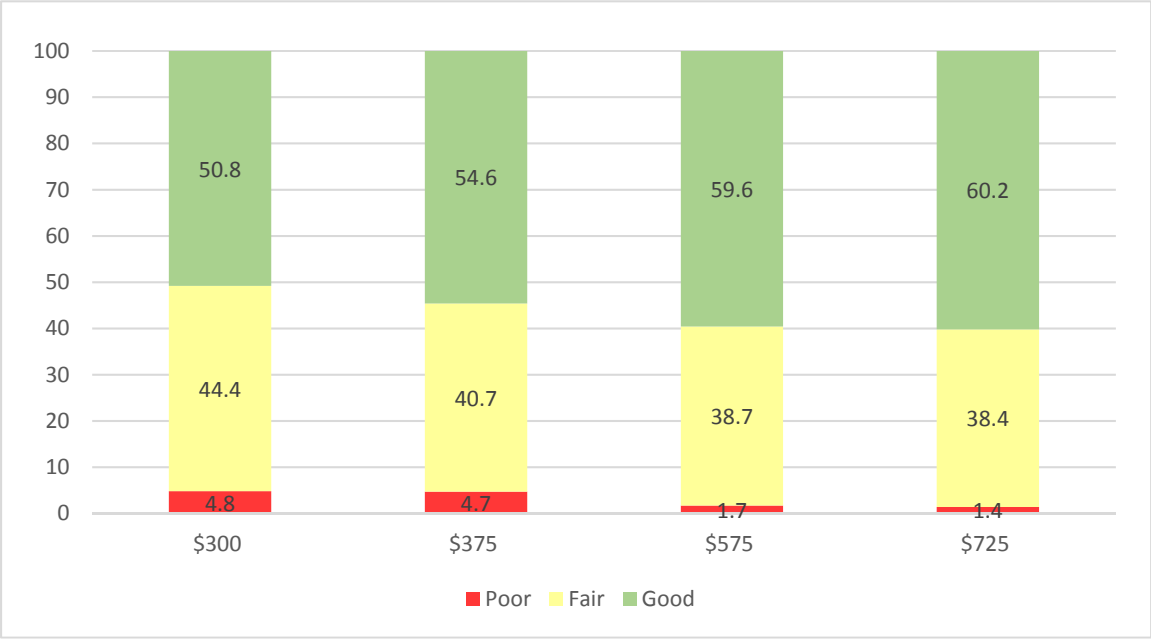
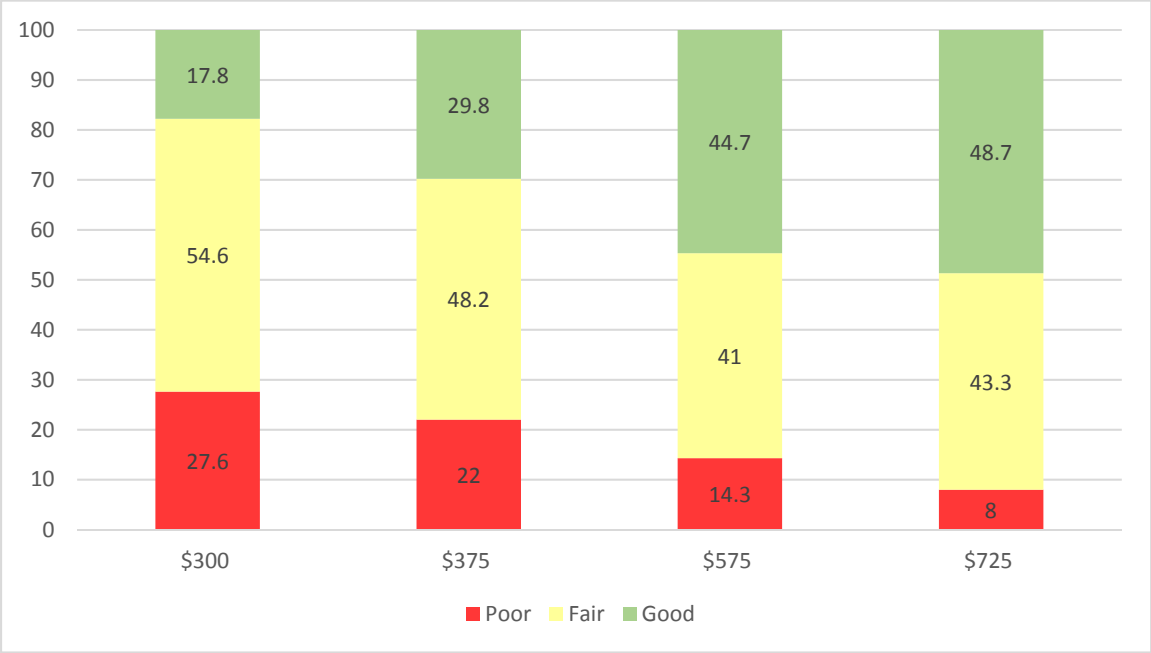


Figure 7.3 2027 Non-Interstate NHS Pavement Conditions by Avg. Annual Funding



Future Bridge Scenarios

Similar to pavements, NYSDOT reviews many funding scenarios for our bridge assets on the state highway network. For the TAMP, we'd like to highlight four funding scenarios for structures on the NHS.

$575 million – current funding level.

$1.15 billion – funding range needed to stabilize the combination of fair-corrective and lower (using the state condition metrics) at the existing value of 42 percent.

$1.4 billion – Amount needed to stabilize the percent poor at the current value of 10.88%

$1.7 billion - amount needed to achieve a State of Good Repair by 2028, where the population of poor bridges is reduced to and stabilized at 10% by deck area. This will also allow the state to be compliant with the new federal bridge condition targets.

The results of the bridge analysis are shown in Figure 7.3. Figure 7.3 shows a summary of bridge conditions for NHS bridges in the year 2027 that would result from each funding level. The projections were developed using the Bridge Analyst and by applying the preservation-first logic where possible and the priorities described above.

Figure 7.4 2027 NHS Bridge Conditions by Avg. Annual Funding

7.5 FHWA PAVEMENT AND BRIDGE TARGETS

In order to be compliant with federal guidance, as part of its Comprehensive Program Update efforts NYSDOT recently established condition targets for pavements and bridges on the NHS. These are not "aspirational" goals, but reflect an effort to minimize deterioration of the existing highway and bridge infrastructure in an environment where available resources are about one third of what is needed to maintain a state of good repair. The targets represent conditions that are attainable in four years for the entirety of the NHS if the funding commitments and strategies presented in this TAMP are implemented.

At the time of this writing, New York has a large number of projects programmed on its STIP. The state has made commitments to deliver the existing projects on the STIP, and these commitments are a significant constraint in our various pavement and bridge modeling scenarios for asset conditions on the NHS. The projects on the current STIP were determined as part of the last Comprehensive Program Update, and were informed by our modeling, local knowledge and statewide priorities at the time. These projects were programmed using the state's "Preservation First" approach, and are meant to maximize system condition based on the state's condition metrics, outlined in Chapter 2. These projects were programmed before the latest rules were laid forth in MAP-21 and the FAST Act. With the advent of the new FHWA performance metrics, and the associated condition targets that are part of MAP-21 and the FAST Act, New York State will need to take these new targets into account when developing our next Comprehensive Program Update. These new targets will be additional constraints in our program modelling and allocation strategy.

When doing follow-up modeling for the next 4 year window, we use the projects from the current STIP in the short term to model expected outcomes for setting NPRM targets. That being said, after accounting for these projects, any remaining funds in years 1-3 and all of the funds in year 4 of the analysis will be programmed in an efficient manner using asset management principals and taking the new federal metrics into account.

Federal NHS Bridge Target Setting Process

As mentioned in Chapter 2, FHWA has mandated new data collection methods for the assessment of bridge conditions, which differ substantially from the traditional condition data that the state has used. This has brought some issues in bridge modeling that aren't unique to just New York State. Our existing bridge modeling software uses the New York State component ratings (1-7 scale) to model bridge element deterioration and to recommend bridge treatments. Due to the recent requirement for collection of AASHTO element inspection data, NYSDOT stopped collection of NYS component condition information. We don't currently have enough data using the new AASHTO element approach to model element deterioration or to make work recommendations. Therefore, to provide continuity in analysis and deterioration modeling, NYSDOT has performed statistical analysis on structures with AASHTO element inspection ratings and created a conversion method to NYSDOT component ratings. This allows us to model the system and predict performance using our traditional data.

The statewide bridge team used the latest condition data for each structure to perform the analysis. All NHS structures in the state were part of the analysis. The model calculates work

strategies for all analyzed structures which depend on Component Condition Indices. Work strategy types include Preventive Maintenance (bridge painting, cleaning, joint resealing, deck sealing and overlays), Rehabilitation (element level repair work, deck replacement, general rehab and repairs), and Renewal (structure and superstructure replacement). The program prioritizes work based on Bridge Priority Index, which is a weighted index that takes the structure condition, the operational function and the vulnerability aspects of the structure into account. The analysis also includes deterioration of the bridge components as described elsewhere in this document. Similar to pavements, projects from the STIP were used in the PM-2 target setting analysis.

Once modeling was completed, structures were sorted into NYSDOT condition categories (Good, Fair Protective, Fair Corrective, and Poor). TAMP/NPRM requires reporting in NBI rating (0-9 scale) based condition categories (Good, Fair, and Poor). After discussions with FHWA, a translation was performed using base year data for correlating NYS categories to NBI categories. To verify the consistency of this approach, NYSDOT performed an analysis of variability over the NPRM recording requirement timeframe (4-years) and the overall TAMP timeframe (10-years). Conveniently, the correlation was excellent at the 4-year timeframe, however consistency decreased at the 10-year mark.

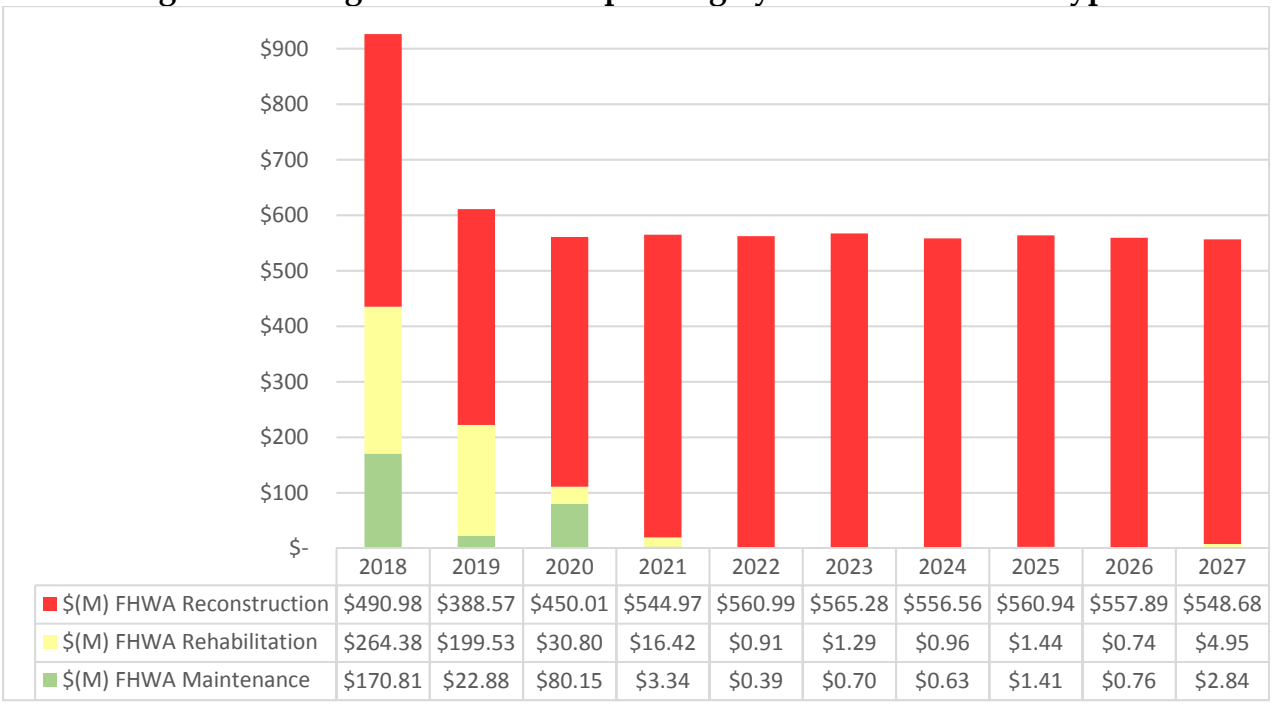
Having to convert from AASHTO element data to NYSDOT component data for modeling then again converting NYSDOT condition categories to NBI categories will cause variability in results and therefore must be explicitly noted here. In addition, it is worth noting that there are several modeling issues which particularly affect short-term modeling consistency. Since most bridges are inspected on a biennial basis, modeling does not use the most current structural conditions for all structures. However our modeling does use the most recent data available for each structure. This inconsistency could either show that conditions are better than they actually are, as recent deterioration is not noted on all structures, or worse than they actually are, as recent construction improvements would not be noted. In addition, the modeling system does not take account for the delay in completion of a construction project from its programmed date, and assumes the project is completed "instantaneously". The overall effect of this issue will cause modeled conditions to be better than expected in the short term. These limitations, at the system level, are addressed in the risk matrix and in setting the targets at the end of the four years.

Figure 7.5 Bridge Condition by Deck Area - $575M Average Annual Spending

NHS Structures – Final Performance Measure, by sf of Deck Area				
Federal Rating	**Baseline (%)**	**2 Year Interim Target (%)**	**4 Year Target (%)**	**10 Year Projection (%)**
GOOD	20.2	23.0	**24.0**	19.4
FAIR	68.1	65.4	**64.3**	66.7
POOR	11.7	11.6	**11.7**	13.9

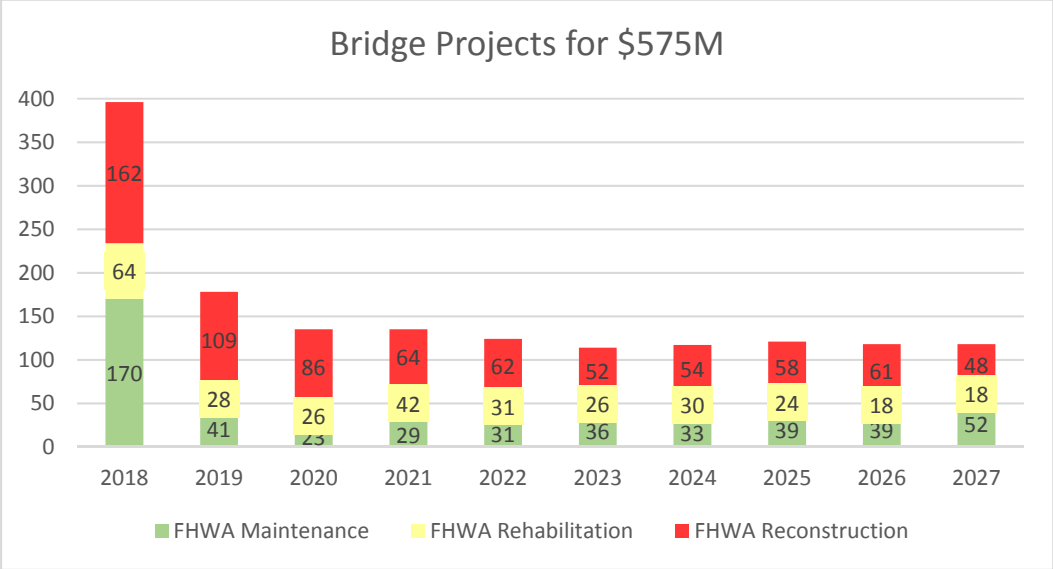
The charts below show the construction spending and the number of projects by year for an annual average funding value of $575M. It should be noted that the spending amounts and the projects listed in the first three years of the analysis are heavily influenced by our existing STIP. As stated earlier in the document, we cannot rely on a similar level of funding in the future. In the outer years, the model prioritizes more reconstruction projects, and spends almost all of the projected available budgets on reconstruction, to try to chase the federal target of 10% poor deck area. This explains the bias toward the heavier treatments in the outer years of the analysis.

Figure 7.6 Bridge Construction Spending by FHWA Treatment Type



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
$(M) FHWA Reconstruction	$490.98	$388.57	$450.01	$544.97	$560.99	$565.28	$556.56	$560.94	$557.89	$548.68
$(M) FHWA Rehabilitation	$264.38	$199.53	$30.80	$16.42	$0.91	$1.29	$0.96	$1.44	$0.74	$4.95
$(M) FHWA Maintenance	$170.81	$22.88	$80.15	$3.34	$0.39	$0.70	$0.63	$1.41	$0.76	$2.84

Figure 7.7 Bridge Projects by Year by FHWA Treatment Type at $575M Avg. Annual Funding



Federal NHS Pavement Target Setting Process

Pursuant to new federal requirements, NYSDOT forecast Interstate NHS and non-Interstate NHS pavement conditions to establish two-year and four-year pavement targets. Not all data needed to support these metrics has matured, so actual pavement condition and funding data was used where available, but calculated data was required to supplement this actual and historic data. This analysis considered all NHS pavement segments, regardless of ownership.

As mentioned in Chapter 2, FHWA has recently instituted new data collection requirements, using automated crack detection methods. We currently do not have enough automated distress data to develop new deterioration curves or provide treatment recommendations in our models using these new measures. Our existing pavement management system, like most systems in use, relies on our legacy condition indices to do modeling. New York currently uses the New York State Condition Rating to assess the amount of cracking in the pavement. This means that we can't use our existing models to forecast conditions using the new federal metrics, which are required to set adequate condition targets on the NHS to meet PM-2.

After consultation with FHWA, it was decided that we would use NYSDOT's % Poor and % Very Good and Excellent as surrogates for the Federal % Poor and % Good Measures. Pavement management sections rated Poor by NYSDOT's standard will typically have fatigue type cracking in the wheel path throughout most of the section, as well as poor ride quality or rutting. In contrast, pavement management sections rated Very Good and Excellent by NYSDOT's standard will typically have minimal to no cracking in the wheel path, good ride quality, and minimal rutting.

In addition, this new pavement condition data is currently collected and stored on 0.1 mile long sections. Because our pavement management system, like most PMS's in the country, uses pavement management sections larger than 0.1 miles, there is no direct correlation to the federal condition metrics that are reported on the 0.1 mile and the forecast conditions from a given PMS analysis. For example, if a given mile of roadway has two 0.1 mile long segments that are rated "poor", but the remaining eight segments are rated "fair", then when the average condition of the combined one mile project level segment is calculated, the entire mile would be rated "fair". The two tenths of "poor" pavement would disappear from the data, reducing the overall amount of "poor" pavement in the system.

To account for differences between the federal measures on 0.1 mi segments and the averaging that occurs for pavement management sections, including portions of those sections that may not follow the typical trends stated above, we calculated the differences in percent poor and percent good between the 2016 federal report card and NYSDOT's data. The differences were calculated independently for Interstate NHS and non-Interstate NHS separately to account for the differences in how those pavements deteriorate. The differences are assumed to remain relatively constant over the span of a given modeling scenario.

NHS Type	Fed Report		NYSDOT Score		Delta (Fed Rep - NYSDOT)	
	% G	% P	% VG/E	% P	% G	% P
Interstate	52.24	2.74	45.2	1.5	7.0	1.2
non-Interstate	20.4	8.3	26.2	4	-5.8	4.3

This essentially means that once the 0.1 mile sections on the Interstates are rolled up to project length sections, there is a drop of 1.2% in the percent poor. To account for this drop, an additional 1.2% poor is added to the forecast poor conditions from any model run in regards to the NPRM target setting.

All NHS pavement segments, regardless of ownership, were loaded into the Agile PMS. The state hasn't traditionally collected cracking information on some of the locally maintained portions of the NHS. We only recently began collecting profiler information on this subset of the system, and we have one year of data available. To populate the required historic surface score information that we do not currently collect for the local maintained NHS pavement sections, we used the 2016 profiler crack data to calculate a surface score for each of those sections using the algorithm NYSDOT created to implement automated surface scoring. Prior to rounding the score to a whole number, the value of the decimal place was used to estimate the number of years at that score.

As mentioned earlier, the projects on the existing STIP were loaded into the Agile PMS, and were taken into account in our target setting analysis. An Agile PMS scenario was run using the committed projects and projected funding. Constraints related to IRI, rutting, faulting and

cracking (Surface Score) were included for the Interstates to allow us to set the constraint of a maximum 5% poor lane miles. The results of this analysis are shown below.

Interstate NHS – Final Performance Measure				
Federal Rating	**Baseline (%)**	**2 Year Interim Target (%)**	**4 Year Target (%)**	**10 Year Projection (%)**
GOOD	52.24	46.4	**47.3**	50.8
FAIR	45.02	50.5	**48.7**	44.4
POOR	2.74	3.1	**4.0**	4.8

Non-Interstate NHS – Final Performance Measure				
Federal Rating	**Baseline (%)**	**2 Year Interim Target (%)**	**4 Year Target (%)**	**10 Year Projection (%)**
GOOD	20.4	14.6	**14.7**	17.8
FAIR	71.3	73.4	**71**	54.6
POOR	8.3	12.0	**14.3**	27.6

When running our models to set targets and predict future conditions, we use a single amount of funding for the entire NHS, and we use the Department's endorsed preservation strategy to direct investments toward lower cost maintenance type treatments on good pavements, thereby optimizing system conditions with the available funds. However, it should be noted that to ensure compliance with the federal Interstate pavement condition threshold, the Department was forced to use a tiered or bifurcated approach, treating Interstate NHS and non-Interstate NHS pavements differently. For Interstate NHS pavements, the analysis was constrained by IRI, rutting, faulting and cracking (i.e., surface score) in a manner that directed investments toward poor pavements – essentially a worst-first approach.

Because of this tiered investment approach and the federal worse-first strategy toward Interstates, overall NHS conditions deteriorate more quickly than if we used a Preservation First strategy for all pavements. In the outer years of the analysis, the model directs more and more of the available funding to the Interstate system, regardless of the actual VMT on the roadway, in order to meet the federal % Poor threshold. This is at the expense of doing preservation work on the non-interstate NHS, which sees a drastic increase in % Poor pavement between years 5-10 of the analysis. At current funding levels, conditions on Interstate NHS pavements decline marginally, but conditions on non-Interstate NHS pavements decline precipitously with % Poor pavement jumping from 8% to 14% in just four years. Further, this worst first approach on the interstates directs, on average, almost 50% of the available funding toward only 30% of the NHS pavement system.

Figure 7.8 Interstate Pavement Conditions by Lane Mile - $300M Avg. Annual Spending

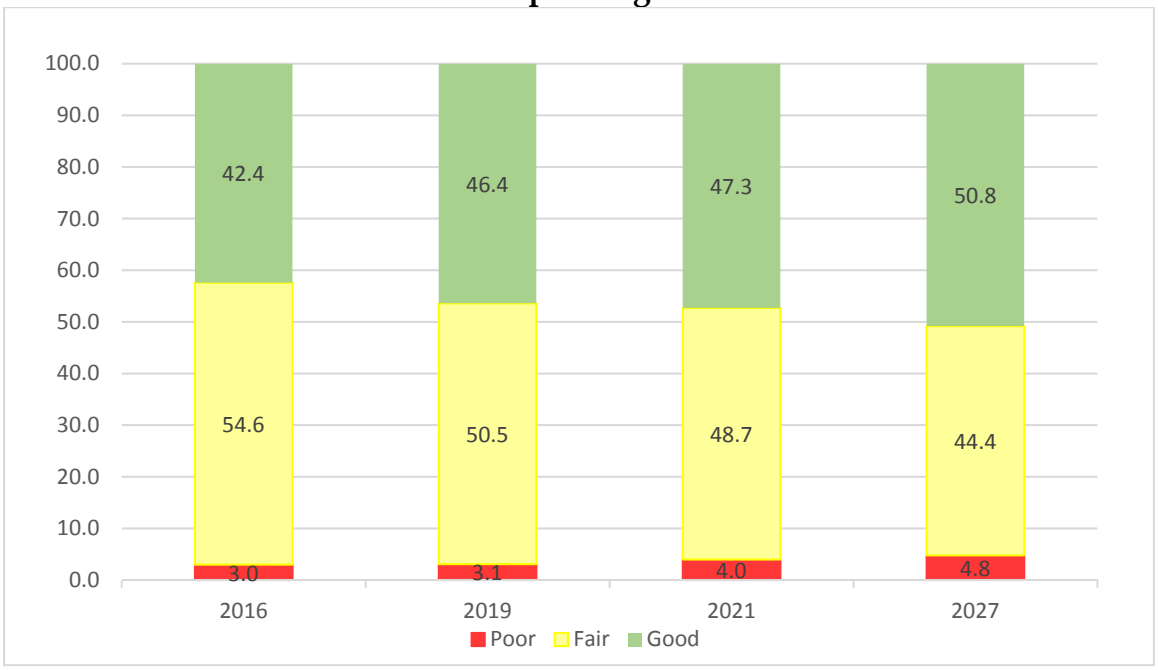
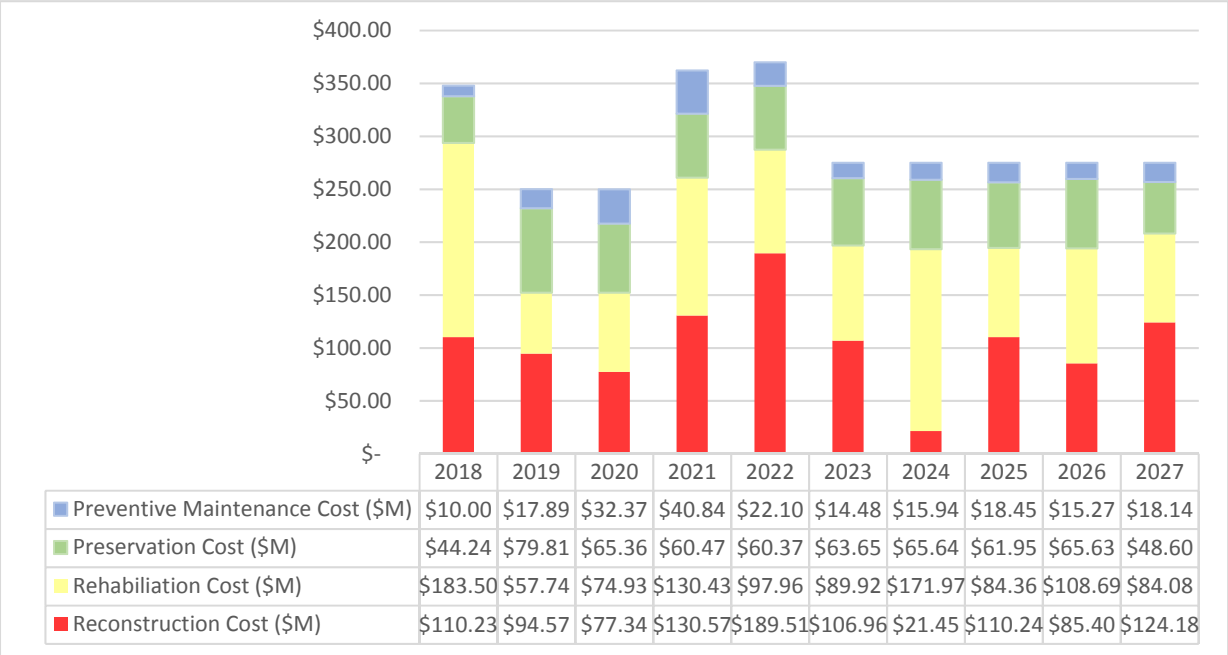


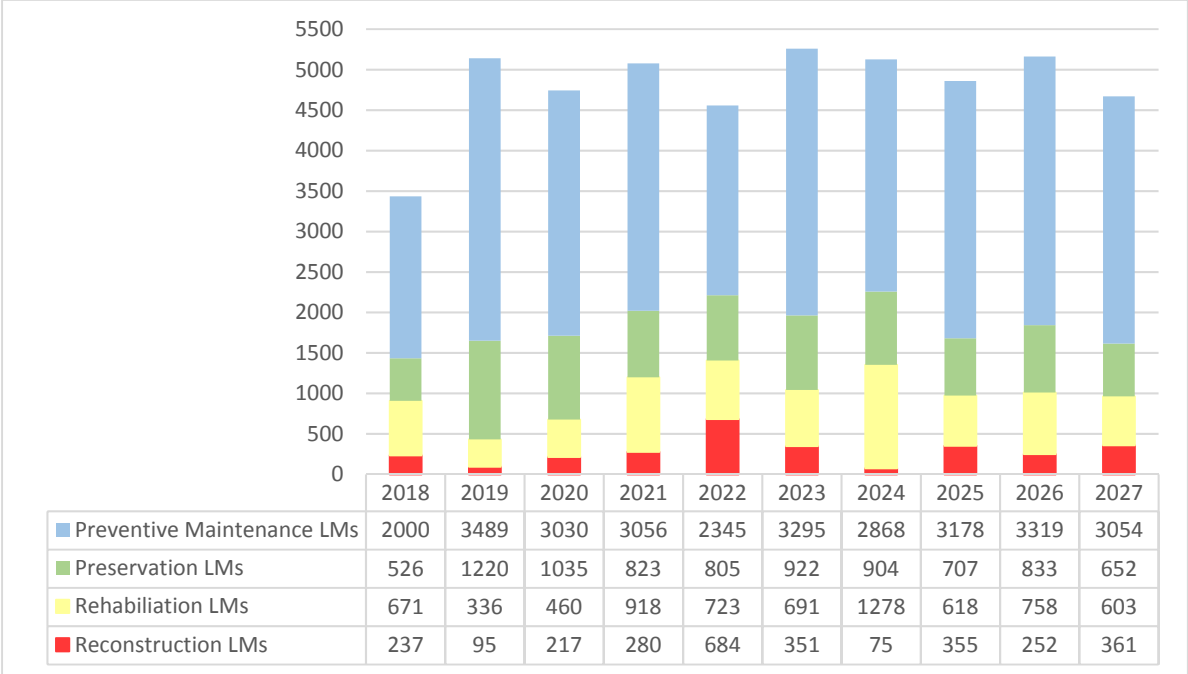
Figure 7.9 Non-Int NHS Pavement Conditions by Lane Mile - $300M Avg. Annual Spending

Figure 7.10 Annual NHS Pavement Construction Spending by FHWA Treatment Type at $300M Avg. Annual Spending



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Preventive Maintenance Cost ($M)	$10.00	$17.89	$32.37	$40.84	$22.10	$14.48	$15.94	$18.45	$15.27	$18.14
Preservation Cost ($M)	$44.24	$79.81	$65.36	$60.47	$60.37	$63.65	$65.64	$61.95	$65.63	$48.60
Rehabiliation Cost ($M)	$183.50	$57.74	$74.93	$130.43	$97.96	$89.92	$171.97	$84.36	$108.69	$84.08
Reconstruction Cost ($M)	$110.23	$94.57	$77.34	$130.57	$189.51	$106.96	$21.45	$110.24	$85.40	$124.18

Figure 7.11 Annual NHS Pavement Lane Miles of Construction by FHWA Treatment Type at $300M Avg. Annual Spending



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Preventive Maintenance LMs	2000	3489	3030	3056	2345	3295	2868	3178	3319	3054
Preservation LMs	526	1220	1035	823	805	922	904	707	833	652
Rehabiliation LMs	671	336	460	918	723	691	1278	618	758	603
Reconstruction LMs	237	95	217	280	684	351	75	355	252	361

Performance Target MPO Coordination

NYSDOT has coordinated target setting with the MPOs in a number of ways. The New York State Association of Metropolitan Planning Organizations (NYSAMPO) established a MAP-21/FAST Act Working Group which held periodic discussions to coordinate comments on performance management rulemakings, and discuss target setting processes and timelines.

Any issues related to performance management are discussed at the NYSAMPO bi-weekly Directors meetings (includes all 14 MPOs, NYSDOT, FHWA and FTA) and questions are addressed in coordination with federal partners. This includes not only target setting, but the development of templates for State/MPO performance management agreements and templates for TIP anticipated effects narratives and Long Range Plan System Performance Reports.

NYSDOT developed fact sheets describing how all statewide targets were established. These were discussed and shared in person with the MPOs for their use in coordinating with their members and considering next steps (support the statewide targets or develop separate targets.) NYSDOT also provided data and technical assistance to the MPOs as they were considering whether to develop their own targets. Each of the State's 14 MPOs have adopted resolutions supporting the statewide targets for all measures as applicable.

Performance Gap Analysis

The scenario analysis described above shows the amounts needed to stabilize each of the measures used by the State to manage its pavements and bridges. However, the fiscally constrained targets defined in Table 7.1 indicate that stabilization is not feasible within the current funding environment. Therefore, the performance of NHS pavements and bridges is expected to worsen over the next 10 years, based on the current resources available. This difference between state of good repair levels and future target levels can be considered to be a performance gap. Table 7.1 illustrates this performance gap. It should be noted here that the TAMP is concerned with the conditions and funding of the NHS. However, as has been stated in other parts of this document, NYSDOT is tasked with sustaining the conditions of the entire highway network in the state. At the current funding levels, conditions on the NHS are projected to deteriorate.

Table 7.1 NYS NHS Asset Management Performance Gap

Performance Measure	Baseline 2016	State of Good Repair	Target 2021	Performance Gap
NHS Interstate Pavements				
% Good	42.4%	60.2%	47.3%	-12.9%
% Fair	54.6%	38.4%	48.7%	NA
% Poor	3.0%	1.4%	4.0%	2.6%
Non-Interstate NHS Pavements				
% Good	19.1%	48.7%	14.7%	-34.0%
% Fair	72.3%	43.3%	71.0%	NA
% Poor	8.6%	8.0%	14.3%	6.3%
NHS Bridges(1)				
% Good	20.2%	34.3%	24.0%	-10.3%
% Fair	68.1%	55.7%	64.3%	NA
% Poor	11.7%	10.0%	11.7%	1.7%

(1) Based on Deck Area

(2) There are no performance targets for % Fair

8.0 Asset Management Improvements and Next Steps

This chapter identifies NYSDOT's priorities for future improvements to its asset management program and the TAMP.

NYSDOT has made significant inroads in managing the State's bridge and pavement assets over the past five years. These improvements include:

- The implementation of a robust asset management business structure
- Estimating planning targets based on needs,
- Using empirically-based bridge and pavement condition modeling, and forecasting to efficiently and effectively drive treatment strategies,
- Development of programming instructions that preserves far more of the system than previous Department approaches,
- Holding Regions tightly accountable for their project selection and program delivery, and
- Developing nationally recognized expertise and vision in shaping the future direction of asset management.

NYSTA has also continued to develop its asset management program by establishing a formal organization with an asset management mission, by developing very detailed pavement and bridge condition models, and by becoming very deeply customer-focused.

There are profound and practical challenges ahead for New York State and for much of the country due to the aging of the nation's transportation infrastructure, changing climate, and inadequate funding relative to the growing needs of the State's infrastructure assets. Left unabated, the amount of poor pavement on the NHS will more than double in the next ten years with the backlog of needed work increasing from $3.1 billion to $4.7 billion. Similarly, bridge conditions will become roughly 5 percent worse both in terms of deficiency and poor bridges.

Assets in "poor" condition are extremely expensive to restore when compared to keeping good assets in good shape. Poor pavements need to be rebuilt from the ground up and poor bridges need to be replaced. Pavements and bridges in better condition can be kept that way through preservation efforts for very long periods of time, but need a level of funding at least adequate to treat those assets that can still be preserved. Because NYSDOT has roughly a third of the resources it needs to preserve the system, in spite of the Agency's best efforts to program efficiently, conditions are expected to be significantly worse in the future.

Recognizing the difficult circumstances States are facing in managing an aging and underfunded highway infrastructure, there is still much that can and will be done to:

- Improve the State's ability to balance transportation investments,
- Provide meaningful information to customer groups on the levels of service being provided on key corridors of the transportation system that most affect their interests;

- Develop more sophisticated pavement and bridge models that enables decision makers to assess multiple treatment and investment scenarios;
- Develop cross-asset trade-off optimization across scenarios;
- Improve coordination of capital construction program and state maintenance forces to ensure work is being delivered in the most efficient manner;
- Improve the way construction contracts are developed and managed; and
- Improve the efficiency of program delivery.

8.1 NEXT STEPS

The section defines next steps that NYSDOT will take in order to improve its asset management program. In the next five years NYSDOT plans to make some improvements, including:

Refine the Balance of Investments

Continue to refine the distribution of available resources between Preventive & Corrective Maintenance vs. System Renewal and Improvements. This will always be a fluid process.

Continue to Develop a True Enterprise Asset Management System

NYSDOT has developed a new Bridge Data Information System (BDIS) as part of an evolving Enterprise Asset Management System. The new system combines bridge inventory and inspection, large culvert inventory and inspection, inspection scheduling, load rating, vulnerability analysis, and flag tracking into one Structures Data Management System. NYSDOT recently expanded the system to include: overhead sign structures, retaining and noise walls and small culverts as part of the Bridge Management implementation phase of EAMP. This year NYSDOT also implemented the Bridge Management and Pavement Management modules in Agile EAMP.

The next phase of EAMP development will include Roadway Inventory, Portfolio Analysis (Asset Trade-Off) and Maintenance Management

The new Roadway Inventory module will include a Smart Entry Engine (SEE) that enables the user to perform inventory edits to both tabular and geospatial data in one place, solving the current need to perform such edits in two separate systems. It will include a Straight Line Diagramming tool tied to the linear referencing system to enable the user to easily locate all assets in a user friendly visual manner. The project also includes the replacement and enhancement of the current data warehouse to also include secondary assets. The project is also being architected to enable the agency to solve the problem of dual carriageways.

The Portfolio Analysis tool is a program level asset trade off tool to determine the funding levels across asset classes (starting with pavements and bridges) that results in the best overall combined asset conditions for the funding available. This tool compares pavement and bridge scenarios previously optimized in the pavement and bridge analyst tools and determines the optimal balance of investment across those classes of assets. The Department is also beginning to look at project level asset trade off tools that perform similar analysis comparing individual

projects to come up with an optimized portfolio. These tools are driven by utility curves and utility functions that look at the deterioration of these assets relative to critical trigger points where treatment costs grow geometrically and manages those asset portfolios to try to keep as much of the asset valuations in the higher and less costly condition levels while also minimizing the growth of economic backlog of work that limited funding will not allow to progress.

The Maintenance Management System (MMS) will replace both the Department's current maintenance management system (MAMIS) and signals management system (Cartegraph) with one overall work order based management system for all State Forces maintenance. The new module will include both mobile and AVL tool integration and will enable the agency to collect and manage secondary asset inventories and conditions. The Department has contracted with Fugro to perform an initial inventory of approximately a dozen secondary assets that can be seen from the roadway.

Improve Condition Modeling and Forecasting

With the recent implementation of the federal NPRM Performance Measures, the EAMP for pavements and bridges will need to develop new deterioration models, decisions trees, and benefit calculations to accommodate the new metrics and targets. NYSDOT is also working toward being able to consider multiple decision trees that vary based on fiscal environment, treatment strategies and program objectives. NYSDOT will be able to use these decision trees to create different scenarios that can be used to support the resource allocation and programming processes.

The Department has begun to investigate how the use of National Bridge Element (NBE) based inspections will change how bridge needs modeling will have to be done in the future. The NBE based inspections reverse the current 1 (poor) to 7 (excellent) scale to a 1 (new) to 4 (failed) scale that includes quantity or percentage of defect for a bridge element.

The Department has also needed to modify the existing pavement models to meet the new NPRM performance reporting requirements. This is a fairly significant effort, especially on the pavement side.

Assess Non-Condition Related Trade-Off Impacts

Additional factors beyond condition outcomes need to be systematically considered in establishing an ideal program balance. Factors such as: bridge closures and postings, maintenance costs, roads deteriorating to a point where they can no longer be plowed or traveled at the posted speed ("very poor" roads), impacts to associated assets such as safety appurtenances, bike routes or sidewalks, economic impacts to businesses, mobility and congestion, and any other quantifiable impacts should be considered in making trade-off decisions. NYSDOT will evaluate these options to determine which can become systematically measured and used in decision making.

Improve Program Balance for Optimal Sustainability

The primary goal of the current pavement and bridge program is to preserve the condition of as much of the system as possible. NYSDOT will continue to investigate options for assessing additional impacts of programming decisions such as social, economic, and environmental

consequences of programming decisions to create a highway system that is sustainable from not just the perspective of the physical asset, but also the activities that the assets support.

Determine Best Mechanism to Complete Work

There is currently very little connection from a cost effectiveness perspective of what types of work activities should be done by in-house State Maintenance Forces, by simple service contracts, or by full Department let heavy construction contract. NYSDOT is aware that certain bridge maintenance activities like element-level corrective bridge repairs, repairs to short runs of damaged guide rail, and painted pavement markings are done at much lower cost by State Forces than by contractors, while production type work like highway paving, major bridge rehabilitation or replacements, and production guide rail installation are done more effectively and efficiently by contractors. By having State Forces do work that is not cost effectively done by contract leaves more contract dollars available to do the types of work contractors do best, making more optimal use of available funding.

Implement Countermeasures to Identified Risks

Chapter 6 of this document summarizes the key risks to the State's highway and bridge assets or the Agency's ability to manage those assets effectively. The key identified risks include: climate change, making data-driven decisions, organizational issues, program balance, funding, demographic changes and understanding what key corridors are for critical transportation purposes like commerce, tourism, commuting, emergency response and evacuation, pedestrian and bike use, and mass transit. NYSDOT will dedicate resources to either evaluate or act on the countermeasures identified in the Risk Register.

Improve Reliability of Program Delivery

With the implementation of OPPM the Department will be able to calculate and report on the benefits from specific projects or phases of projects that contribute toward specific program and programmatic goals, by aligning performance reporting capabilities in the Portfolio Management module with the agency's asset management strategies. In addition, projects can be entered on the department's Roads and Highways system, meaning that all projects can be reconciled with the latest condition, safety and maintenance data.

9.0 Appendices

A. List of Acronyms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ASI	Asset Sustainability Index
BDIS	Bridge Data Information System
BP	Beyond Preservation
CAM-CI	Capital Asset Management-Capital Investment
CHIPS	Consolidated Local Street and Highway Improvement Program
CIPR	Cold-In-Place Recycling
CMAQ	Congestion Management Air Quality
CPDC	Program Delivery Committee
CPR	Concrete Pavement Restoration
CPS	Comprehensive Program Summary
CPT	Comprehensive Program Team
CPU	Comprehensive Program Update
CR	Condition Rating
dSGEIS	draft Supplemental Generic Environmental Impact Statement
FA	Federal-Aid
FHWA	Federal Highway Administration
GIS	Geographic Information System
HBP	Highway Bridge Program
HBRR	Highway Bridge Replacement and Rehabilitation
HELP	Highway Emergency Local Patrol
HMA	Hot Mix Asphalt
HOV	High Occupancy Vehicle
HSIP	Highway Safety Improvement Plan

HTF	Highway Trust Fund
IPPs	Initial Project Proposals
IRI	International Roughness Index
ISO	International Organization for Standardization
ITS-TED	Information Technology Services, Transportation and Economic Development Cluster
LM	Lane-miles
LOS	Level of Service
LRP	Long Range Plan
MAP-21	Moving Ahead for Progress in the 21st Century Act
MOVES	Mobility, Operations, Vehicular systems, Environment, Safety
MP	Metropolitan Planning
MPO	Metropolitan Planning Organization
MTA	Metropolitan Transit Authority
NASTO	Northeast Association of State Transportation Officials
NBI	National Bridge Inventory
NHPP	National Highway Performance Program
NHS	National Highway System
NYMTC	New York Metropolitan Transportation Council
NYS	New York State
NYSBA	New York State Bridge Authority
NYSDEC	New York Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSTA	New York State Thruway Authority
OCTC	Orange County Transportation Council
OPEC	Organization of the Petroleum Exporting Countries
RAMT	Regional Asset Management Team
REDC	Regional Economic Development Council
RPC	Regional Program Committee
SAFETAP	Safety Appurtenance Program
SAGE	Spending and Government Efficiency Commission
SAMT	Statewide Asset Management Team

SDF	State Dedicated Funds
SFY	State Financial Year
SHSP	Strategic Highway Safety Plan
SOGR	State of Good Repair
SPMT	State Pavement Management Team
SSMT	Statewide Structures Management Team
SSO	Safety and Systems Optimization
STIP	Statewide Transportation Improvement Program
STP	Surface Transportation Block Grant Program
TA	Transportation Alternatives
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TDM	Travel Demand Management
TEP	Transportation Enhancements Program
TIP	Transportation Improvement Program
TMC	Traffic Management Center
VMT	Vehicle Miles Travelled

B. NYSDOT Asset Management Business Units

This appendix documents the description, mission, responsibilities, and membership listing of each of the groups/components of NYSDOT's asset management business structure. An overview of the business structure is provided in Chapter 2.

Program Delivery Committee (CPDC)

The Capital Program Delivery Committee (CPDC), headed by the Commissioner of Transportation and consisting of executive-level and other key staff, provides strategic vision and executive leadership for asset management.

Mission

- Develop and communicate a vision for a sustainable transportation system to support a vibrant New York State economy;
- Ensure asset management strategy and policy is in harmony with long term strategic plans and Statewide economic development policy; and
- Create an environment in which the most effective program of projects is selected and delivered on time and on budget.

Responsibilities

- Approve of all asset management policies and standards that impact external stakeholders;
- Manage communications with external stakeholders;
- Set expectations for Comprehensive Program Updates (CPU) and Statewide Transportation Improvement Program (STIP) updates; and
- Approve final program.

Membership

- Commissioner;
- Executive Deputy Commissioner/CFO;
- Assistant Commissioner for Operations and Asset Management;
- Chief Engineer; and
- Director of Regional Planning and Program Management.

Comprehensive Program Team (CPT)

The Comprehensive Program Team (CPT) provides Statewide leadership on asset management policies, practices, tools and investments. Since its inception, CPT has been co-chaired by the Asset Management Champion and the Program and Project Management Champion. This linkage has been established to foster connection between program development and program delivery.

Mission

- Bring leaders from across the Agency together to direct asset management policies and effort;
- Establish policy to achieve CPDC's vision;
- Recommend deliverables for CPDC approval;
- Develop and articulate an investment strategy, framework, and process to preserve and manage the multimodal transportation assets of the State in a manner that is economically, environmentally, and socially sustainable. Elements include:
  - Asset management business structure and process: definitions, descriptions, roles and responsibilities;
  - Investment strategy definition;
  - Accountability definition;
  - Immediate focus: augmenting program update instructions; and
  - Create a standard asset management business structure and process using existing titles to staff permanent asset/goal teams.
- Serve as an advocate and provide guidance for the Statewide Asset Management Teams (SAMT);
- Issue Asset Management Manual(s) as appropriate;
- Define objectives and strategies for preservation - preventive and corrective maintenance;
- Recommend performance measures and review performance of Regional Asset Management Teams (RAMT's);
- Align NYSDOT's asset specific management efforts across Engineering, Operations, and Policy and Planning;
- Develop/share best practices across SAMTs;
- Recommend policy and procedure modifications to improve project development and delivery; and
- Provide an advocacy role with FHWA on policy and procedural matters relating to asset management.

Responsibilities

- Prepare draft Program Update Instructions;
- Prepare draft STIP Update Instructions;
- Develop and oversee the continual improvement of the TAMP;
- Prepare and manage asset management Risk Register; and
- Recommend actions to be taken on submitted programs and projects as detailed in the Comprehensive Program and/or STIP Update Instructions.

Membership

Membership Guidelines - In general, members should be Main Office Bureau Directors, Regional Group Directors or higher in rank. The following is a list of organizational units that should be represented on the CPT:

- Assistant Commissioner for Operations and Asset Management;
- Director of Regional Planning and Program Management;
- Chief Financial Officer;
- Chief Engineer;
- Director Policy and Planning Division;
- SAMT Co-Chairs; and
- At least 1 Regional Director.

Statewide Asset Management Teams (SAMT)

Statewide Asset Management Teams (SAMTs) have been established for specific asset classes and functions: pavement, safety and operations, structures, and sustainability. Each team will establish a charter that clearly articulates the assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities.

Mission

Each Statewide team shall be responsible for the management of their specific asset class from a Statewide perspective. The focus includes maintenance and operations, preservation and capital program actions necessary to efficiently manage the State's assets. The teams are established in support of the overall strategy and asset management priorities provided by the CPT. The specific mission of the group is to:

- Bring technical experts from across the Agency together to direct asset management policies and effort;
- Establish practices and tools to achieve CPDC's vision;
- Provide CPT with input to program update guidelines;

- Prepare a uniform approach to estimating accomplishments associated with block funded projects;
- Propose operational impairment (e.g. bridge posting) tradeoffs for less important assets if necessary to fund higher priority investments;
- Analyze deliverables for CPT recommendations;
- Serve as an advocate and provide guidance for the RAMTs;
- Coordinate cross-organizational actions necessary to advance asset management practices;
- Recommend objectives and strategies for preservation - preventive and corrective maintenance;
- Review performance of Regional Asset Management Teams (RAMTs);
- Develop measures and indices to advance objective, systems-based decision making;
- Provide a forum for sharing of best practices and addressing issues and concerns related to each team's area of focus;
- Identify and promote best practices to improve project development and delivery; and
- Support CPT in their advocacy role with FHWA.

Responsibilities

- Draft technical guidance for CPU and STIP updates;
- Propose quantifiable prioritization criteria to be used by Regional asset management teams in capital program development. Where possible, criteria should incorporate both asset condition and operational performance characteristics. Priorities should be ranked from most important to least important (short term and long term task).
- Develop necessary measures, forms, and submission tools for CPU and STIP updates;
- Provide leadership and guidance to Regions in complying with asset management policies and directives;
- Analyze CPU and STIP deliverables to advance consistency with overall goals, objectives, and strategies as established by the CPT;
- Recommend the approval of individual Regional comprehensive programs and Capital Investment projects to the CPT;
- Gather Regional feedback on asset management policies, directives, requirements and tools, and recommend improvement actions to CPT;
- Establish a charter that clearly articulates the assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities; and
- Set requirements for RAMT charters.

Membership

SAMTs are assembled of managers and technical experts in the areas of: pavement, safety and operations, structures, and sustainability. Teams are diverse in areas of expertise and geography (main office and regional employees). The chair or at least one co-chair of each team will be a member of the CPT. SAMTs will typically have approximately 12 members.

In general, SAMTs are comprised of:

- Main Office - Policy/Planning
- Main Office - Operations
- Main Office - Engineering
- Main Office - Asset technical specialist representative(s) (one as Co-Chair)
- Regions - 2+ Regional asset team representative(s)
- ITS-TED - Database/GIS support as/if needed.

Regional Asset Management Teams (RAMTs)

Regional Asset Management Teams (RAMTs) are responsible for programming decisions related to their specific areas of responsibility: pavement, safety and operations, structures, and sustainability. The teams work under the direction of the Regional Program Committee (RPC). RAMTs are shown in Figure 9.1 as subordinate to Statewide teams in that they receive some goals and functional guidance from Statewide teams.

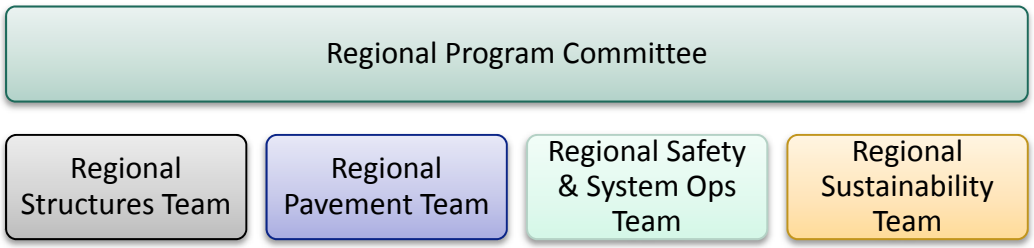
Mission

Take ownership of the Region's achievement of targets within their respective program area. Lead project selection process and manage delivery of projects to ensure the achievement of program targets. Support SAMT mission to develop and disseminate best practices.

Responsibilities

- Prioritize capital investment and preservation project candidates for recommendation to RPC;
- Lead Regional efforts to develop CPU and STIP updates;
- Select projects for Capital Investment and develop any necessary submittal documentation;
- Oversee delivery of Region's program to optimize return on investment for the program, not individual projects;
- Establish a team charter according to SAMT directions; and
- Additional program-specific responsibilities as identified in team charters.

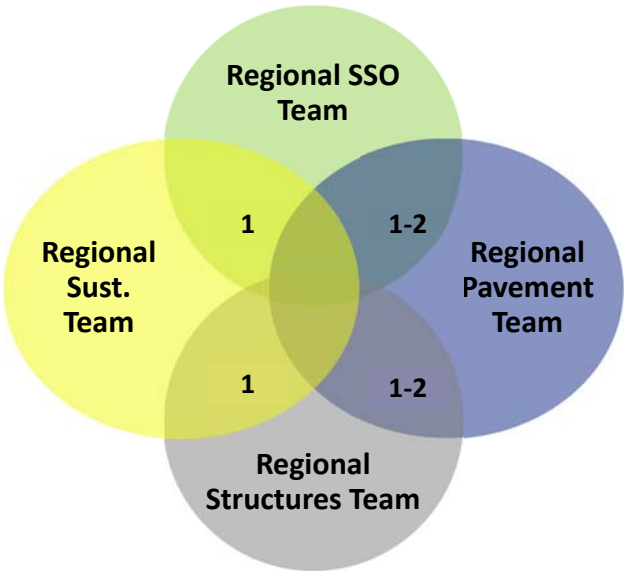
Figure 9.1 Regional Program Committee components.



Membership

Membership varies by program area and Region. Figure 9.2 presents guidelines for membership on each team showing program areas that should be represented. Typically RAMTs will have four to nine members.

Figure 9.2 Regional Asset Management Team Cross-Participation



- Regional Structures Team
  - Regional Structures Engineer;
  - Regional Structures Management Engineer;
  - Regional Bridge Maintenance Engineer;
  - Planning and Program Management;
  - Representative from Sustainability Team; and
  - Representative from Safety and Operations Team.

- Regional Pavement Team
  - Maintenance;
  - Pavement Manager/Modeler;
  - Materials;
  - Highway Design;
  - Representative from Sustainability Team; and
  - Representative from Safety and Operations Team.
- Regional Safety and Systems Operations Team
  - Traffic Safety;
  - Traffic Operations;
  - Maintenance;
  - Highway Design;
  - Representative from Sustainability Team;
  - Representative from Pavement Team; and
  - Representative from Structures Team.
- Regional Sustainability Team
  - Sustainability Team Leader;
  - Cross-discipline representation; and
  - At least one member shared with each of the other Regional teams.

C. Sustainability Index

The word 'sustainability' is used in many different contexts, and NYSDOT has a formal definition for the concept that includes considerations such as generational equity, environmental impacts, and balanced transportation options. The discussion below is more narrowly focused on the Asset Sustainability Index (ASI) defined as an index comparing a given level of resource investment with the underlying asset need.

A basic economic notion behind asset management is the idea that assets deteriorate from use, weather and age. That loss can be quantified as a "need" or amount of asset value lost that needs to be restored so that the asset can continue to function as necessary. That loss is counterbalanced through investment in restoring that asset. An index has been created to demonstrate the sustainability of an asset, class of assets or maintenance of assets through the creation of an index. The index, as follows, is simply the amount of money budgeted that directly impacts asset conditions divided by the amount needed to restore the asset. That is called the Asset Sustainability Index. An index value of 1.0 indicates that the asset is economically sustainable.

ASI= (Amount Budgeted ($/yr))/(Amount Needed ($/yr))

Currently the ASI for NYS highways and bridges combined is 0.30. That indicates that no matter how sophisticated the treatment strategy that an agency uses, the funding alone is inadequate to sustain the current portfolio of assets NYS owns.

Before the accounting exercise associated with tabulating investment levels or asset needs, any computation of an ASI must first set the boundaries being considered with a clear definition of:

1. System Extent: Whether the whole system is being considered, or just some subset of it such as bridges. System extent may also be used to reflect variations in system ownership such as between a State and array of local municipalities, or geographic variations in extent.
2. Performance Metric: Reference performance metric used to characterize the system being evaluated. For the example of bridges, this might be the fraction of the system that is characterized by some condition metric such as percent Structurally Deficient under the federal definition.
3. Level of Service: Performance goal or target associated for the system under consideration. The two basic infrastructure cases which might be considered include:
    a. Status Quo or Steady State: Maintaining current level of service.
    b. State of Good Repair: Improving level of service to some ideal.
4. Time Horizon: Time period of analysis over which the performance target must be reached or maintained.

NYSDOT has traditionally characterized the performance of major assets like pavement and bridges in terms of an operational component and a condition component.

The most recent detailed assessment of major asset needs was conducted as part of the upcoming 2018 Comprehensive Program Update. This effort relied on the detailed bridge and pavement modeling tools, all project costs, and all work types for each asset. This effort showed needs assessments yielding an approximate ASI value of 0.36, as shown in Table 9.1 below.

Table 9.1 Asset Sustainability Index – NYSDOT Bridges and Pavements

	Asset Sustainability Index		
Asset	State of Good Repair ($ millions)	Anticipated Investment Level ($ millions)	Asset Sustainability Index
Bridge	$1,700	$575	0.34
Pavement	$725	$300	0.41
Combined	$2,425	$875	0.36