



MaineDOT Transportation Asset Management Plan

Results and Information Office

6/27/19

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Bruce A. Van Note, Commissioner

Date

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Introduction

The Moving Ahead for Progress in the 21st Century (MAP-21) Act became effective in June of 2012. MAP-21 under 23 U.S.C. 119 (e) required the State Departments of Transportation to develop a transportation asset management plan (TAMP). The TAMP documents the asset management processes with which the Maine Department of Transportation (MaineDOT) fulfills its mission:

The scope of this TAMP as required by MAP-21 is limited to National Highway System (NHS) Highways and Bridges. In Maine, this includes the Maine Turnpike. The purpose of the TAMP presented here is to summarize the extent of the NHS, report on current conditions, define an acceptable state of good repair (SOGR), to meet asset management requirements outlined in 23 CFR 515.9, and to document the required processes as outlined in 23 CFR 515.7:

1. Process to complete a performance gap analysis and to identify strategies to close identified gaps
 2. Process to complete life cycle planning
 3. Process to complete a risk analysis and develop a risk management plan
 4. Process to develop a financial plan covering at least a 10-year period
 5. Process to develop investment strategies
 6. Process for obtaining necessary data from NHS owners other than MaineDOT
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To responsibly provide our customers the safest and most reliable transportation system possible, given available resources.

7. Process for ensuring the TAMP is developed using the best available data and the MaineDOT uses bridge and pavement management systems meeting the requirements of 23 CFR 515.17

MaineDOT Strategic Goals and Asset Management

MaineDOT latest Strategic Plan update, completed in 2016, <http://www.maine.gov/mdot/publications/docs/plansreports/StrategicPlan2016Update.pdf> focused on developing a comprehensive asset management approach to our mission. To this end there are three primary goals that have been adopted:

1. **Manage the Existing System** – Effectively manage Maine's existing transportation system for safety and effectiveness with reliable funding levels.
 2. **Support Economic Opportunity** – Wisely invest available resources to support economic opportunity for our customers.
-

3. **Build Trust** – Demonstrate our core values of integrity, competence, and service both individually and organizationally

Well thought out and institutionalized asset management approach is critical in achieving these three goals. Perhaps most of all managing the existing system is best done through asset management. The following are the three objectives established under goal one:

1. Reduce the rate of fatalities, injuries and crashes on the transportation system.
2. Preserve and operate the existing system.
3. Optimize operational performance of the system using ongoing customer input.

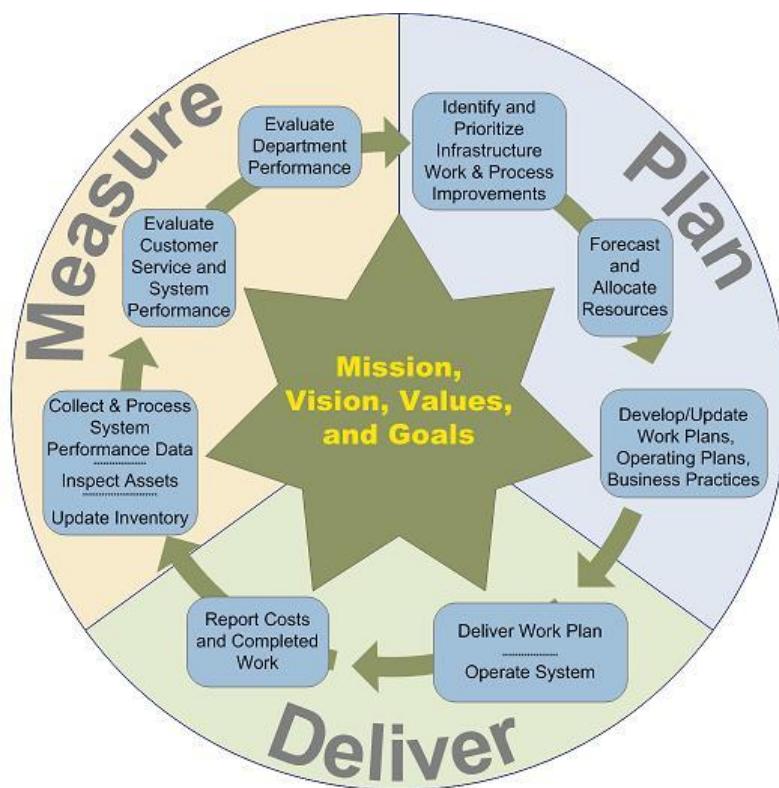
In essence, the three objectives encapsulate a well-run transportation system. One that is safe and efficient for users at an affordable cost and an acceptable level-of-service. MaineDOT's asset management efforts are largely focused on objective two. Ten key strategies have been developed to achieve this objective and serve as the core of MaineDOT's asset management:

1. Finalize and implement asset inventories, condition assessments, and corridor management strategies and develop short and long-range Asset Management Funding Strategies (AMFS) for each asset type to minimize life-cycle cost. Each AMFS will provide several investment levels and an associated characterization of benefit/risk. Considerations will include safety, program financing, economic impacts, system reliability, environment, sustainability and program delivery. Example: Keeping our Bridges Safe, The Roads Report, etc
2. Establish and maintain Customer Service Levels (CSL) targets in order to provide customers with acceptable levels of service. <http://www.maine.gov/mdot/about/assets/hwy/#undefined2>
3. Annually, develop Resource Allocation Goals (RAGS) on a network-wide basis balancing each AMFS by considering benefit and risk of each asset type in the context of available funding.
4. Annually, develop a prioritized Work Plan consistent with the RAGs. Develop a slate of additional projects within the various program areas to a stage where they can be delivered quickly, should additional resource become available.
5. Maximize efficiency by streamlining processes and then redirecting the savings to projects consistent with RAGs. Continuously measure consistency with the RAGs – Typically in June and January.
6. Deliver an annual Work Plan.
7. Annually, measure system performance in relation to AMFS and CSL targets.
8. Ensure the quality of delivered work.
9. Comply with state and federal laws, regulations, commitments, and policies.
10. Efficiently provide the support services needed to deliver the Work Plan and operate the system.

These objectives and key strategies are consistent with the purpose of asset management as defined in 23 CFR 515.9, which is to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practicable cost.

TAMP Integration with MaineDOT Processes/Management

MaineDOT operates under a single department wide business process, OneDOT. As depicted this process incorporates the three basic phases of any management process plan, deliver (implement), measure. These core pieces of management are replicated around the department through many different management efforts whether it be assets, risk, finance, etc. The department level business process is depicted below:



Furthermore, this process is institutionalized in departmental data through the phases of work that we undertake. There is a consistent hierarchy of data that is linked through each level as follows:

Management Cycle → Process Stage → Activity Groups → Activities

Each work effort and or expenditure can be tracked through this hierarchy. The OneDOT work model is laid out below:

Management Cycle	Process Stage	Activity Group - Select to See Activities
Plan	Strategic Goal and Policy Development	Policy Development and Amendment
		Community, Regional, Statewide Planning
		Trans. Planning Studies
	Planning	Complex Trans. Planning Projects
		Research and Pilot Projects
	Research	Resource Allocation
		Work Program Development
Deliver	Program Development	Contract Administration
		Program Resource Management
		Environmental Stewardship
		Quality Assurance
		Safety Assurance
		Civil Rights Administration and Compliance
	Work Program Management	Project Management
		Survey
		Design
		Project Environmental
		Geotechnical
		Right-of-Way
		Utility Coordination
		Traffic Design
		Construction Management
		Bridge and Structural Maintenance
	Infrastructure Projects	Custodial Maintenance
		Drainage Maintenance
		Operational and Safety Maintenance
		Surface and Base Maintenance
		Winter Maintenance
	Operations	Crew Operations
		System Operations
Measure	Asset Location and Inventory	Infrastructure Inspections and Inventory
		Asset Location Management
	Internal Operations Analysis	Data and Systems Governance
		Work Accomplishment and Cost Reporting
	System Performance Measurement	Data Collection and Processing
		System Performance Reporting
		Transportation Systems Data Analysis
Production Support	Production Support	Financial Administration
		Department, Bureau and Office Administration
		Department Building and Lot Maintenance
		Personnel Administration
		Employee Education and Training
		Information Technology Support
		Communication and Outreach

Through this extensive work model MaineDOT can effectively manage work to fulfill the mission and goals of the department.

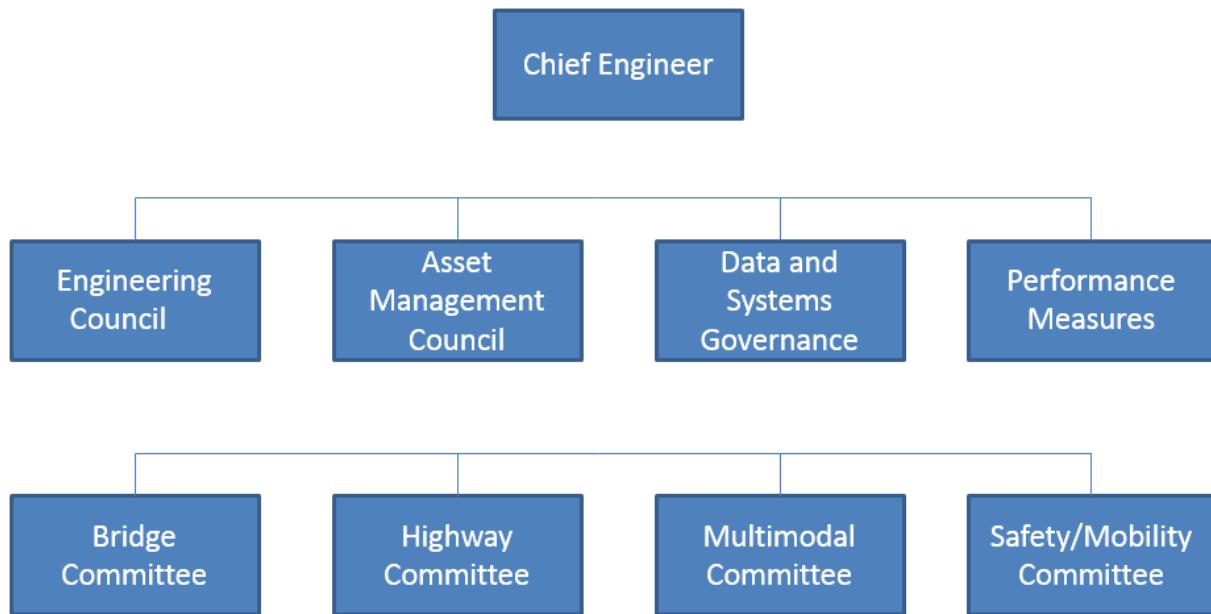
MaineDOT Asset Management Structure

MaineDOT and its OneDOT model are organized to support integrated and active asset management. MaineDOT assets are managed by many different resources making asset management a department

wide effort. Organizationally the responsibility for asset management falls within the Office of the Chief Engineer and specifically the Results and Information Office. Organizational charts can be found in Appendix A of this document.

Many of the activities surrounding asset management at MaineDOT are coordinated through a committee structure designed to bring department stakeholders together and provide an efficient management, communication, and decision-making structure for the asset management processes.

The following diagram lays out the general committee structure.



Bridge, Highway, Multimodal, and Safety/Mobility committees are responsible for development of design standards, AMFS, recommendations on RAG, specific projects for the Work Plan, data and process improvements, and performance targets, etc. with recommendation for final approval going to the appropriate council and ultimately through the Chief Engineer to the Core Management Team.

Much of this general committee structure has been in place many years at MaineDOT however, with recent focus being brought to asset management and the specific deliverables mentioned above the committee structure and membership has recently been modified. Specific charters, memberships as well as subcommittees can be seen in Appendix B.

MaineDOT uses the Best Available Data & Obtains Necessary Data from Other NHS Owners (23 CFR 515.7 (g)&(f))

Maine is somewhat unique in that MaineDOT owns the entire NHS system in Maine except for the Maine Turnpike. MaineDOT collects 100% of the Pavement data for the NHS System (including Turnpike) and inspects all non-turnpike bridges. The Maine Turnpike's bridges are inspected in accordance with standards and updates are shared annually with MaineDOT which includes these bridges in the bridge management system and with the annual National Bridge Inventory submittal. Maine NHS pavement data is collected by a single collection vehicle and a single MaineDOT crew, therefore, maximizing the potential for consistent data collection. MaineDOT and MTA bridge inspectors are trained and certified under consistent bridge inspection standards. As such 23 CFR 515.7(f), Process for Obtaining Data from Other NHS Owners, largely does not apply but will be discussed as part of MaineDOT's process for collecting pavement and bridge data.

The Maine Turnpike Authority (MTA) is responsible for the total management of the turnpike. This includes many of the analysis required in the TAMP. MaineDOT throughout the document address the turnpike as an entity that represents a significant portion of the interstate system. This plan will also recognize the autonomy of the turnpike in the management and planning of the asset. MaineDOT has coordinated with the MTA and leveraged their published plans to integrate into this plan. MaineDOT coordinates directly with MTA Chief Operating Officer Peter Merfeld, P.E. on issues related to performance measures and the TAMP.

Data Collection Schedule

Highways

MaineDOT collects pavement data on the NHS system, including the Maine Turnpike annually utilizing a Fugro-Roadware built ARAN 9000. This vehicle is operated by MaineDOT personnel. Data collection and processing is done in accordance with MaineDOT's Data Quality Management Plan, which was submitted to FHWA on May 17, 2018.

Bridges

MaineDOT inspects NHS bridges on a 24-month cycle in accordance with bridge inspection standards of 23 CFR 650 (c). MaineDOT employs full time certified bridge inspectors and maintains an underwater inspection team. Inspectors are trained on a regular basis in accordance with standards.

MTA inspects bridges on the Turnpike using certified trained consultant bridge inspectors on a 24-month cycle.

Management Systems

MaineDOT has a long history of utilizing asset management principles within many areas of the department. MaineDOT has had a pavement and bridge management system since the mid-1990s. These systems have been well integrated within the departments work flows. These management systems comply with the requirements of **23 CFR 515.17** as described below:

- (a) Collecting, processing, storing, and updating inventory and condition data for all NHS pavement and bridge assets.**

Highway

MaineDOT owns and operates a Fugro-Roadware built ARAN 9000 pavement data collection vehicle to collect pavement condition data on the entire NHS and processes this data in-house by employees of our Highway Management Unit in the Results and Information Office. Data is stored, managed, and processed in a Microsoft SQL Server database. Crack detection, classification, and rating is performed using Roadware's Vision software, then all condition data is imported to dTIMS CT, the Department's infrastructure management application developed by Deighton Associates.

Bridge

All NHS Bridge inventory and condition data is collected, processed, stored, and updated in InspectTech, the system of record, by qualified Bridge Inspection and Bridge Management personnel. MTA has consultant bridge inspectors who inspect all Turnpike bridges and MTA enters this data directly in to InspectTech. The Bridge data in InspectTech is imported to dTIMS CT, the Department's infrastructure management application developed by Deighton Associates.

- (b) Forecasting deterioration for all NHS pavement and bridge assets;**

Highway

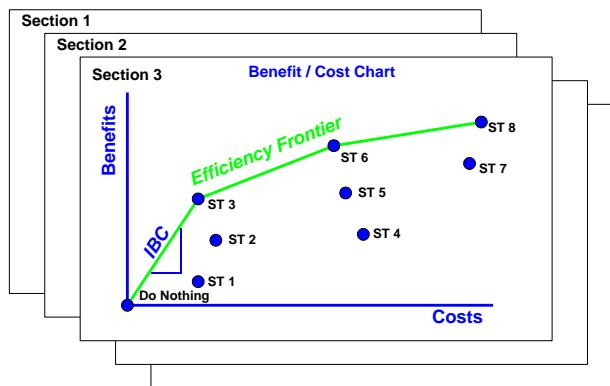
The Department has developed curves for International Roughness Index (IRI), Rutting, Functional Cracking, and Structural (Fatigue) Cracking based on historical data for developing deterioration models in dTIMS CT. These curves allow the forecast of future pavement condition indices for roadway segments as part of any analysis. Sample deterioration curves can be found in Appendix D. The Department also uses these indices to calculate an overall Pavement Condition Rating (PCR) used in calculating benefits during analysis.

Bridge

Forecasting deterioration is modeled by use of transition probability matrices at the bridge level for each material type of each Element Group for four possible Environments. (96 matrices) These transition probability matrices are based upon performance life estimates from local subject matter experts and observed history. Sample matrices can be found in Appendix D.

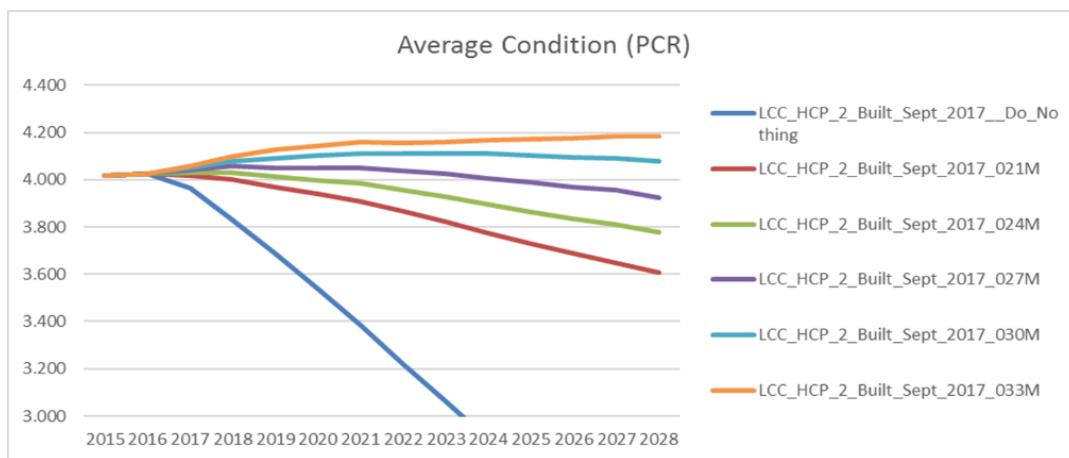
(c) Determining the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions), for managing the condition of NHS pavement and bridge assets;

dTIMS CT creates an analysis set by evaluating the benefit-cost of multiple strategies or sequences of applied treatments for each roadway section or bridge element group using the Incremental Benefit-Cost (IBC) method expressed in terms of present worth of each strategy for a given funding scenario. A Do-Nothing strategy is always included for each roadway section or bridge element group. Treatment strategies are developed based on current condition indices and triggers based on allowable index ranges for each treatment type within dTIMS.



(d) Identifying short- and long-term budget needs for managing the condition of all NHS pavement and bridge assets;

Short and long term budget needs for managing NHS pavement and bridge conditions can be determined in dTIMS CT by performing analyses with multiple budget scenarios for a user-defined length of time or analysis period. Graphical representations of the resulting average network condition of these scenarios are used to select the optimum funding level to maintain or improve network pavement (shown below) or bridge condition.

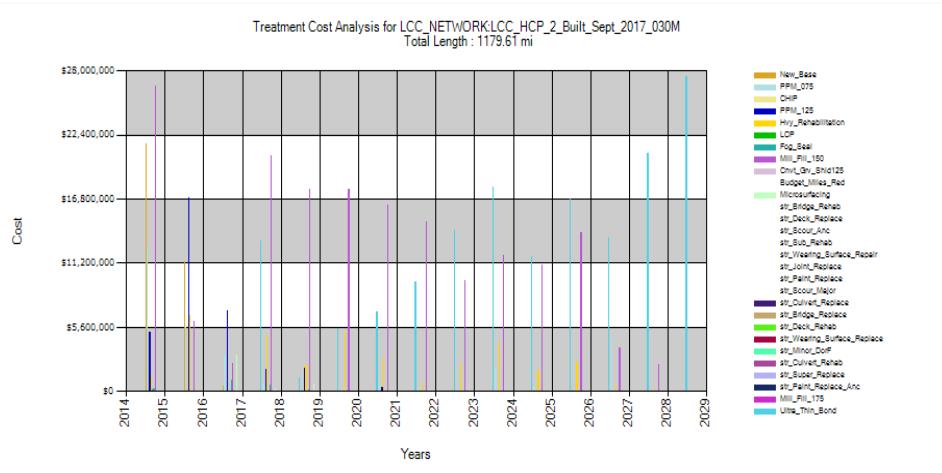


(e) Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints.; and

dTIMS generates strategies of treatments for each bridge or highway segment over a set analysis period for a given set of treatments that are triggered by set criteria for condition deterioration levels. For each asset, multiple alternative strategies are generated with treatments in different years. Incremental benefit cost optimization uses a search strategies method within the network to maximize benefits while meeting a cost constraint/budget. dTIMS optimizes the selection of strategies by analyzing the various treatment strategies for all bridges and highway segments within the network and selecting the mix of treatments and strategies that maximize the benefit/cost for a program of a specific funding level. The result of each analysis run is a recommended work program (see f) that is then verified by MaineDOT engineers. This analysis and budget setting is done separately for highway and bridge but is iterative to maximize the benefit to both through resource allocation and the Departments annual work plan.

(f) Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints.

dTIMS will generate a recommended construction program of location-specific highway and bridge treatments for each year of an analysis period based on optimization for a given funding scenario. The selected strategy for each asset, determined by the optimization within policy and budget constraints given in the analysis, is compiled into a Construction Program report that may be exported out of dTIMS. The report contains the recommended treatments for the asset for each year. Projects already in the work plan are included in dTIMS as committed work and are considered first in the optimization and are assigned funds before any other projects. The pavement work program shown below by treatment type and schedule is tied directly to highway segments. As stated above all recommended work is verified by MaineDOT engineers prior to inclusion in the work plan.



STIP Consistency

MaineDOT's asset management processes are independent of STIP development. As described in early sections AMFS funding strategies and annual RAG developed through analysis using the management systems are utilized to develop the Department's 3-Year Work Plan. As a result of an annual Work Plan update the department completes a new 4-Year STIP on an annual basis. Therefore, the STIP is not a substitute for any TAMP process it is a final document that allows the latest results of the TAMP process to be implemented.

The current approved MaineDOT STIP process can be found in Appendix C.

Maine's National Highway System

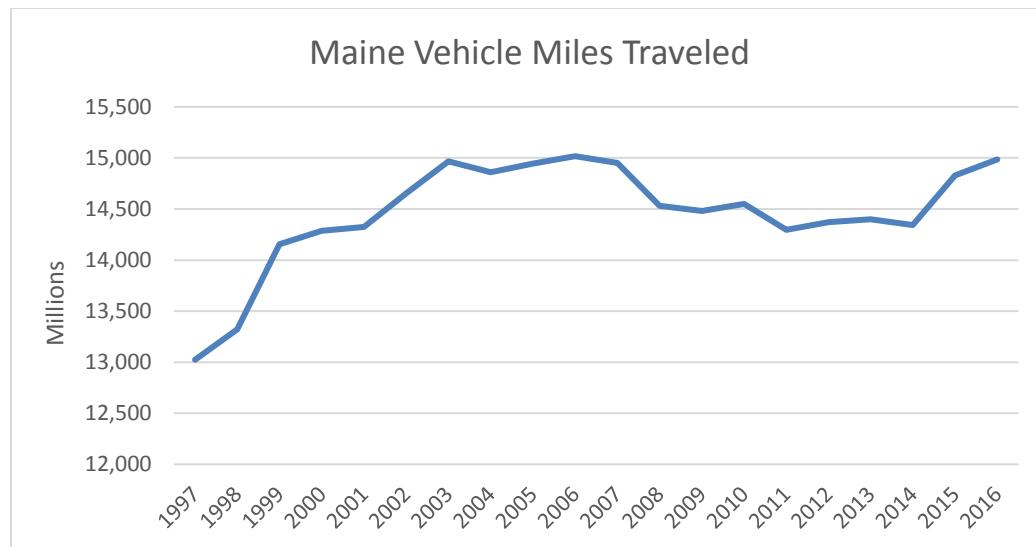
The NHS in Maine is the core of the highway network. The NHS includes the entire interstate system, including the Maine Turnpike, and in whole or in part many of the US Routes such as 1, 1A, 2, 201, 202, 302 as well as key geographic and economic state route connectors such as State Route 3, 4, 9, 25, 26, 109, 111, 196, etc and NHS Inter-Modal Connectors.

1. A more detailed description of the Maine NHS:

www.maine.gov/mdot/traffic/docs/obds/descriptionofMaineNHS.docx

A complete explanation of the NHS, its history, purpose and extents can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/



Maine's vehicle miles traveled (VMT) has seen a leveling off after a period of significant growth through the late 90's and early 2000's. Over the last twenty years VMT has grown at an average rate of 0.75% per year, with an overall increase of 2 billion VMT from 13 to 15 billion, 15%. The VMT on the NHS is 6.2

billion and represents 41% of all traffic and slightly less than 6% of the overall public road mileage. These numbers reinforce the importance of this crucial network of highways to Maine people and the economy.

NHS Performance

The PM3 metrics are utilized to evaluate the performance of the NHS in Maine. The metrics are currently consuming 2017 data and being updated ongoing with 2018 data. In general, the NHS is performing reliably based on the measures.

NHS PM3 Measures	
<i>Performance Measure</i>	<i>2018 Data</i>
Truck Travel Time Reliability Index (TTTR)	
Statewide	1.24
ATRC	1.20
BACTS	1.29
KACTS	1.30
PACTS	1.28
% Person Miles Travel Reliable Interstate	
Statewide	100.0%
ATRC	100.0%
BACTS	100.0%
KACTS	100.0%
PACTS	100.0%
% Person Miles Travel Reliable Non-Interstate	
Statewide	91.5%
ATRC	93.5%
BACTS	85.5%
KACTS	87.6%
PACTS	76.4%

At a high level, each of the measures evaluates travel time based on the ratio of congested travel time divided by average travel time. If this ratio is less than 1.5 than the section of highway is deemed to be reliable.

Asset Registers

The tables below quantify the miles of NHS highway and number and square feet of deck area of bridges in Maine by owner and jurisdiction.

Maine NHS System				
	Interstate		Non-Interstate	
Owner	Centerline Miles	Lane Miles	Centerline Miles	Lane Miles
MaineDOT	507	1,017	976	2,092
Maine Turnpike Authority	226	538	0	0
Total	733	1,555	976	2,092

Maine NHS System				
	Interstate		Non-Interstate	
Owner	Bridges	SF Deck Area	Bridges	SF Deck Area
MaineDOT	212	2,617,442	209	2,363,629
Maine Turnpike Authority	99	1,003,380	0	0
Total	311	3,620,822	209	2,363,629

The Maine NHS is 1,709 centerline miles in length comprised of 43% interstate, each bound of interstate counted separately. MaineDOT is the owner of 87% of the system. There are 520 total bridges which carry the NHS with MTA owning 19%.

As one can see when looking at ownership distribution the MTA owns and maintains a significant portion of the NHS. As the asset management analysis are outlined going forward they will largely be separate for MTA but an overall picture will be included.

Asset Conditions

NHS Highways

PM2 Pavement Measures

The TAMP will quantify pavement conditions in terms of the PM2 performance measures for pavements. The measure will classify all pavements in terms of a good, fair, or poor rating. This rating is based on the evaluation of three distinct pavement condition metrics identified in 23 CFR 490.309(a) and 490.311(a):

- International Roughness Index – Measure of pavement roughness (inches/mile)
 - PSR – Pavement serviceability rating may be substituted for IRI in areas that it is not practicable to collect the IRI data
- Rutting – measure of depth of wheel path rutting (inches)
- Cracking – percentage of roadway which exhibits wheel path cracking

The following standard thresholds are used for applying the good, fair, poor ratings in each category:

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	<i>CRCP: 5-10 Jointed: 5-15 Asphalt: 5-20</i>	>10 >15 >20
Rutting (inches)	<0.20	0.20-0.40	>0.40

Note: taken from FHWA TPM website

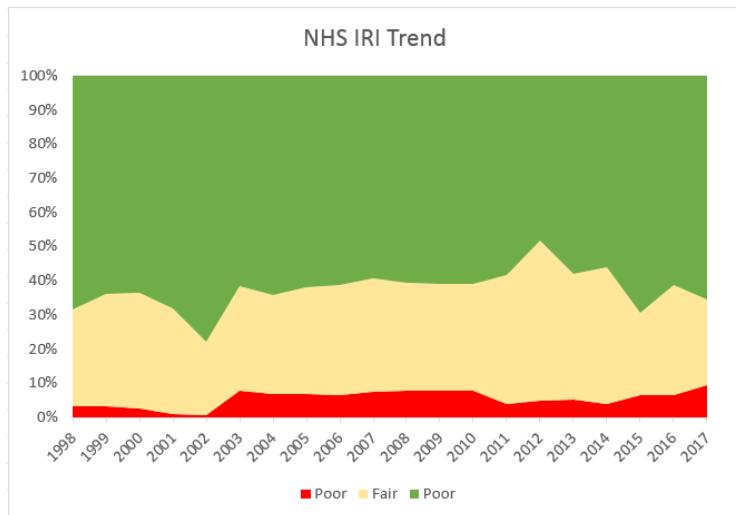
The procedure for determining an overall rating for a section of roadway is outlined in 23 CFR 490.313 and states:

- Good – all three metrics must be good
- Poor – two of three metrics must be poor
- Fair – all other combinations.

MaineDOT collects data and performs the calculations for these three metrics through its pavement data collection procedures and the management system. The metrics are used to develop the four performance measures for assessing pavement condition in 23 CFR 490.307 1. Percentage of Interstate Pavement classified Good, 2. Percentage of Interstate Pavement classified Poor, 3. Percentage non-NHS pavement classified as Good, 4. Percentage non-NHS pavement classified as Poor.

Historic Trends

Historically through the Highway Performance Monitoring System the pavement condition was summarized good, fair, poor in Table HM-47. While this is not meant to replicate the current measure, it does give MaineDOT a feel for at least one of the three measures and its historical trend. The following chart is a percentage distribution for the IRI metric over the last 20 years:



Current State

The 2017 pavement data has been collected and processed for the three metrics and the appropriate measure is shown below:

Maine NHS Pavement Condition				
NHS System		Lane Miles	Centerline	Percent
Interstate				
	Good	564.5	252.8	36.3%
	Fair	972.7	471.5	62.5%
	Poor	18.0	8.9	1.2%
Interstate Total		1,555.3	733.2	100.0%
Non-Interstate				
	Good	652.7	308.9	31.2%
	Fair	1,324.6	615.9	63.3%
	Poor	114.7	51.5	5.5%
Non-Interstate Total		2,092.1	976.4	100.0%
Maine Turnpike	Good	286.5	114.5	53.3%
	Fair	250.0	111.1	46.5%
	Poor	1.3	0.7	0.2%
Main Turnpike Total		537.9	226.2	100.0%
NHS All	Good	1,217.3	561.7	33.4%
	Fair	2,297.3	1,087.5	63.0%
	Poor	132.7	60.4	3.6%
NHS All Total		3,647.4	1,709.6	100.0%

As expected we can see in the table that the non-interstate NHS has a higher rate of poor pavements at 5.5% compared to the overall interstate pavements at 1.2%. The clear majority of pavements fall in the fair category, nearly 2/3rd across the board, indicating that one of the metrics was measured as poor. While roughly 1/3rd of the pavements had all three-metrics reported good.

Minimum Conditions

Minimum acceptable conditions were established for interstate pavements in 23 CFR 490.315 at level not greater than 5%. FHWA will make a yearly determination for the minimum pavement condition and if that minimum is not met the MaineDOT will be required to obligate 100% of NHPP funds and transfer a portion of STP funds to adequately address pavement conditions.

NHS Bridges

PM2 Bridge Measures

The TAMP will quantify bridge conditions in terms of the PM2 performance measures for bridges. The measures will classify all bridges in terms of a good, fair, or poor rating. This rating is based on the evaluation of four distinct National Bridge Inventory (NBI) metrics:

- Item 58 – Deck Condition
- Item 59 – Superstructure Condition
- Item 60 – Substructure Condition
- Item 61 – Culvert Condition (where applicable)

NBI items are rated on a 0-9 scale, the following standard thresholds are used for applying the good, fair, poor ratings in each category:

NBI Rating Scale (from 0 - 9)		9	8	7	6	5	4	3	2	1	0
		Good			Fair			Poor			
Deck (Item 58)		≥7		5 or 6		≤4					
Superstructure (Item 59)		≥7		5 or 6		≤4					
Substructure (Item 60)		≥7		5 or 6		≤4					
Culvert (Item 62)		≥7		5 or 6		≤4					

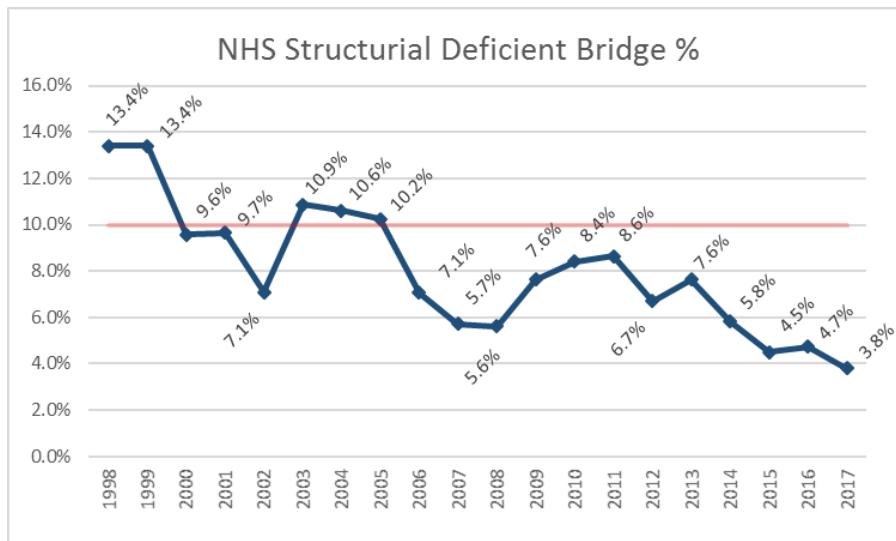
Note: Taken from FHWA TPM Website

When any of the NBI items listed are less than or equal to four the bridge is considered both structurally deficient and poor. To be considered good all items must be good and all other combinations would be considered fair.

MaineDOT collects these items through biennial bridge inspections, the ratings are loaded to the InspectTech inventory system and the dTIMS asset management system for reporting and analysis. The metrics are used to develop the three performance measures for assessing bridge condition as defined in 23 CFR 490.407 - 1. Percentage of NHS bridges classified as Good, 2. Percentage of NHS bridges classified as Fair condition, and 3. Percentage of NHS bridges classified as Poor condition.

Historic Trends

Historic data for structurally deficient bridges is available through the National Bridge Inventory Database. This measure shows a marked trend for bridges on the NHS. The graphic below shows the last 20 years of percent structurally deficient.



The overall trend for bridges on the NHS is quite promising. There are some fluctuations in the overall trend with periods illustrating significant jumps. One of the issues with this percentage method is that there are several large bridges on the NHS in Maine. This illustrates a sensitivity risk as a large bridge can swing the percentage considerably. As an example, the Piscataqua River Bridge and associated Maine approach accounts for nearly 10% of the entire NHS bridge deck area, there are 13 other bridges that are > 1% and 7 of these are greater than 2%. While the trend is good, as bridges age and are identified for replacement it is likely the last few years of bridge life will be in a structurally deficient state. This could significantly influence the percentage structurally deficient measure.

Current State

2017 NBI submittal was completed and submitted on March 15, 2018. The resulting analysis of this data gives us the following conditions:

Maine NHS Bridge Condition			
NHS System		SF Deck Area	Percent
MaineDOT			
	Good	1,545,108	31.0%
	Fair	3,247,382	65.2%
	Poor	188,580	3.8%
MaineDOT		4,981,070	100.0%
Maine Turnpike	Good	248,034	24.7%
	Fair	719,385	71.7%
	Poor	35,961	3.6%
Main Turnpike Total		1,003,380	100.0%
NHS All	Good	1,793,142	30.0%
	Fair	3,966,767	66.3%
	Poor	224,541	3.8%
NHS All Total		5,984,450	100.0%

Minimum Conditions

Minimum acceptable conditions were established for NHS bridges in 23 CFR 490.411 at a level not greater than 10%. FHWA will make a yearly determination for the minimum bridge condition and if that minimum is not met for 3 consecutive years the MaineDOT will be required to obligate NHPP funds and reserve funds for eligible bridge projects.

Life Cycle Planning (23 CFR 515.7(b))

Life cycle planning for both pavement and bridges are done at the asset level (example – individual bridge), the asset class level (example – asphalt pavement) and at the network level (example – NHS or Interstate). The primary tool for accomplishing this planning is the Department's management systems which have been built using the dTIMS CT tool. These management systems and their capabilities are described previously in this plan.

The management systems contain the deterioration models, available treatments & costs, triggers for acceptable treatments, rules for treatment strategies at all three levels of analysis, and the ability to analyze multiple budget scenarios. Treatment and trigger matrixes can be found in Appendix D.

State of Good Repair

A key component of the asset management process is defining a “state of good repair” (SOGR). The SOGR definition acts as the control for the overall asset management process that allows MaineDOT to answer the key questions throughout the sub processes such as:

- Financial Planning – What is the investment level needed to achieve the desired SOGR
- Life Cycle Planning – What collection of treatments produce the minimum life cycle cost of an asset while achieving a SOGR

- Risk Management – What level of risk is necessary to implement strategies that achieve a SOGR within constraints such as financial, environmental, and processes.
- Performance Gaps – What is the gap in condition and performance between current conditions and a SOGR

In the SOGR determination the PM2 measures must be used. Under PM2 targets are set for both good and poor pavements and bridges. This results in a network distribution of conditions that is sustainable and fits within the Life Cycle, Investment, and Risk models that have been developed as part of asset management. For the purposes of this TAMP MaineDOT has established two and four year targets in the following sections in order to fully complete the performance gap analysis. Additionally, the SOGR defined below is an attempt by MaineDOT to establish a sustainable distribution of conditions for both pavement and bridges.

Maine NHS State of Good Repair		
Asset		Percent
Interstate Pavement		
	Good	40.0%
	Fair	57.0%
	Poor	3.0%
Non-Interstate Pavement		
	Good	35.0%
	Fair	55.0%
	Poor	10.0%
NHS Bridges	Good	40.0%
	Fair	53.0%
	Poor	7.0%

PM2 Targets

In setting targets for use in the TAMP the management systems were utilized to determine the feasible gains available based on potential funding. Through iterative budget scenarios for both bridge and pavement realistic targets were set for both good and poor conditions that maintain current conditions or move assets towards the SOGR goals. The following table summarizes these findings:

Maine PM2 Targets					
Asset		Existing Conditions	2-Year Target	4-Year Target	SOGR
Interstate Pavement					
	Good	36.3%	38.0%	40.0%	40.0%
	Fair	62.5%			57.0%
	Poor	1.2%	1.5%	1.5%	3.0%
Non-Interstate Pavement					
	Good	31.2%	32.0%	34.0%	35.0%
	Fair	63.3%			55.0%
	Poor	5.5%	5.0%	5.0%	10.0%
NHS Bridges	Good	30.0%	32.0%	34.0%	40.0%
	Fair	66.3%			53.0%
	Poor	3.8%	4.0%	4.0%	7.0%

Pavement Target Setting

When looking at pavements and the individual components that go into ratings, IRI, Rut, Cracking, it becomes evident that the rutting threshold becomes the limiting factor for Maine pavements. The table below clearly illustrates this for interstate pavements:

Maine Interstate Pavement Condition				
Interstate		MaineDOT	MTA	Overall
All Components				
	Good	27.3%	53.3%	36.3%
	Fair	71.0%	46.5%	62.5%
	Poor	1.6%	0.2%	1.2%
IRI				
	Good	83.2%	86.9%	84.5%
	Fair	14.6%	12.5%	13.9%
	Poor	2.2%	0.6%	1.6%
Rutting	Good	29.2%	58.9%	39.5%
	Fair	46.9%	34.0%	42.4%
	Poor	24.0%	7.1%	18.1%
Cracking	Good	98.1%	95.3%	97.2%
	Fair	1.0%	0.7%	0.9%
	Poor	0.8%	4.0%	1.9%

The table shows that if it were not for rutting Maine would have a significantly larger percentage of good pavement. This is not surprising as in the last 10 years Maine has experienced a problem with aggregate loss over time in the wheel path that creates rutting. The rutting problem has been identified and significant sections are being treated with alternative methods to address this issue. It is anticipated through this practice that the overall rutting scores will improve.

Bridge Target Setting

When setting bridge targets there were no such unusual conditions. With a focus on preservation it is expected that bridges will be kept in the good and upper fair states longer than in the past. Therefore, as we move to more of a preservation model the expectation is that the % good will improve. This is reinforced through our management systems and our long-term investment models that have been run. Therefore, the gradual increase in % good is the forecast and corresponding targets.

Maine Turnpike Authority

The MTA is an independent entity from MaineDOT. Currently MaineDOT does not include MTA bridges or pavements in our analysis. The Maine Turnpike has independent strategies that are utilized in managing their assets. MaineDOT does not influence any of the investments on these assets. While targets will consider the MTA strategies and current conditions, life cycle analysis will be left to the MTA. However; while developing gap analysis MaineDOT did run alternative analysis on MTA bridges and pavements to verify investment levels and project future conditions. These analysis and results were shared and discussed with the MTA engineering group to ensure consistency with the plans below:

MTA 10 Year Plan can be found at:

<http://www.maineturnpike.com/getattachment/Projects-Planning/Planning-Projects/FINAL10-Year-Plan-2014-012214.pdf.aspx?lang=en-US>

MTA 4 Year Capital Investment Plan can be found at:

<http://www.maineturnpike.com/getattachment/Projects-Planning/Planning-Projects/4-Year-Capital-Investment-Plan-Revised-Board-approved-Dec212017.pdf.aspx?lang=en-US>

Investment Strategies (23 CFR 515.7 (e)&(f))

Investment Priorities

MaineDOT prioritizing investments in accordance with strategic goals and objectives as discussed on page 4 of this plan. When prioritizing investments in infrastructure MaineDOT depends heavily on the Highway Corridor Priority (HCP) system. HCP have been established for the entire public road network. The priorities range from 1(interstate & most of NHS) to 6 (local roads). The entire NHS is in either priority one or two corridors. A further explanation of HCP can be found at:

<http://www.maine.gov/mdot/about/assets/hwy/>

The higher the corridor priority (1 being the highest) the more funding and LOS is expected. With the Interstate and NHS as the highest priority system it also receives funding levels to provide the “right

treatment at the right time" maximizing the life of the asset through preventative maintenance and preservation.

Investment strategies are developed by applying the MaineDOT standard tool kit of treatments for each analysis. The treatments included in the management systems analysis can be found in Appendix D for both highways and bridges. These treatments and triggers are developed as part of AMFS for bridge and highway asset classes. The latest AMFS for Highway, Roads Report – 2016, Interstate Operating Plan - 2018 and Bridge, Keeping our Bridges Safe – 2014 can be found at

<http://www.maine.gov/mdot/publications/>

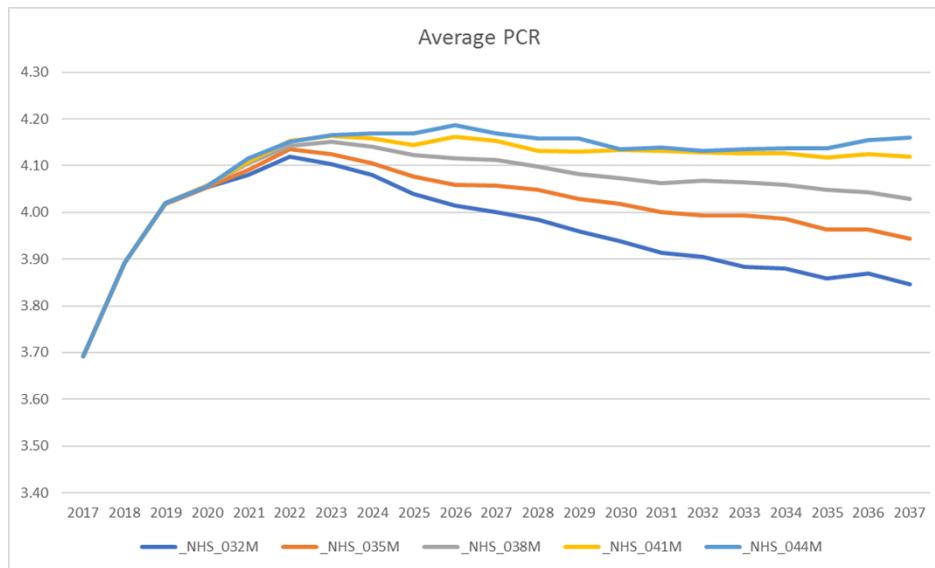
These reports are based on a series of analysis and resulting network conditions along with varying investment strategies, treatment types and fine tuning of triggers that initiate a treatment.

MaineDOT's strategies support progress towards achieving the national goals as stated in 23 USC 150 (b). Maintaining infrastructure condition in a state of good repair through a comprehensive asset management strategy is one primary way. Additionally, MaineDOT's Strategic Plan which guides the management and decision making of the department is in line with these goals and supports each.

NHS Pavement Investment Strategy

The NHS pavement strategy was broken into two parts; MaineDOT NHS and MTA analysis. While MaineDOT does not influence MTA investments the analysis was needed to complete the target setting and SOGR determination as well as a check with investment levels outlined in MTA's 10 year Plan.

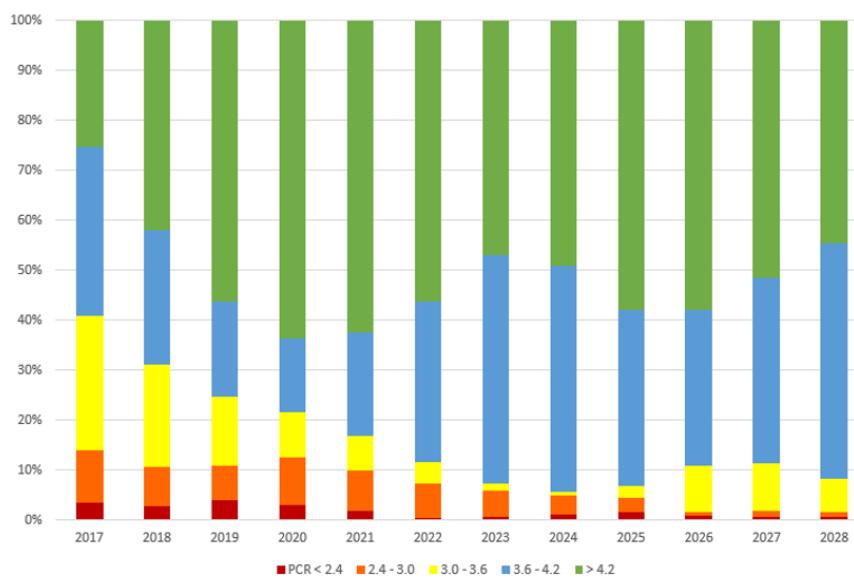
The MaineDOT NHS analysis was run with the standard pavement tool kit as outlined in Appendix D. There were five funding levels modeled; \$32M, \$35M, \$38M, \$41M, \$44M. All the analysis included projects that are in the current 2018-2020 Work Plan and were run for a 20-year timeframe. The following graph shows the resulting overall network level pavement condition.



As can be seen in the graphic the return on investment measured as improved network level PCR significantly decreases as we invest more than the \$41M per year average. As such this is typically what we would consider to be the appropriate funding level to maintain network condition in sustainable condition and an overall SOGR. This is illustrated by the flattening of the average PCR curve over time.

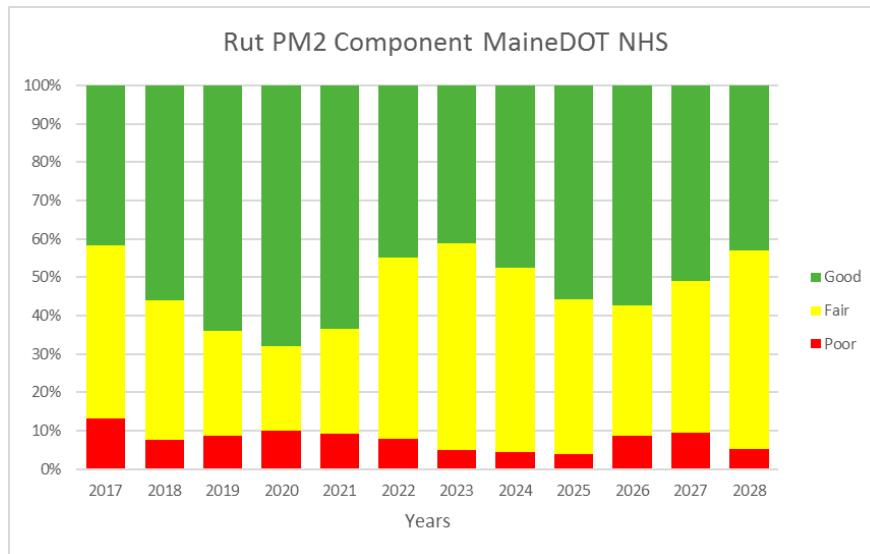
Additionally, the distribution of pavement conditions is evaluated to compare to the targets and the MaineDOT definition of the SOGR. The 10-year condition distribution at the \$41M annual investment can be seen in the chart below:

PCR Distribution MaineDOT NHS



This is not a direct representation of PM2 pavement measure, however, it is the basis for network condition optimization in dTIMS and contains the three metrics as a composite.

As discussed in the Pavement Target Setting section the rut metric is the controlling element of the PM2 measure for pavements in Maine. The chart below is the isolated rut metric for the MaineDOT NHS:



When the rut metric is isolated, the results show the percentage of good will increase significantly in the near term settling at slightly more than 40% good. The percentage of poor conditions are steady in the first four years but then are driven down in the remainder of the analysis period. This is consistent with both the targets and the SOGR as discussed in Life Cycle Planning section of this plan. This investment level is also consistent with analysis completed and reported in the Interstate Operating Plan and the Roads Report.

Pavement 10-Year Work Summary

As a result of the \$41M investment strategy for pavement treatments, there are investment levels provided for each of the first 10 years of the analysis period. These are categorized in the five work types as defined by the rules. The following scopes are included in each as depicted in the table below:

MaineDOT Treatment Classification	
<i>Classification</i>	<i>Scopes</i>
Initial Construction	
	New Construction
Reconstruction	
	Highway Reconstruction
Rehabilitation	
	Pavement Rehabilitation/Stabilization
	Cold-In-Place Recycling
	Hot-In-Place Recycling
	Mill and Fill - 1.5" or more
Preservation	
	3/4" Overlay
	Ultra-Thin Bonded Overlay
	1 1/4" Overlay
Preventative Maintenance	
	Chip Seal
	Fog Seal
	Crack Seal

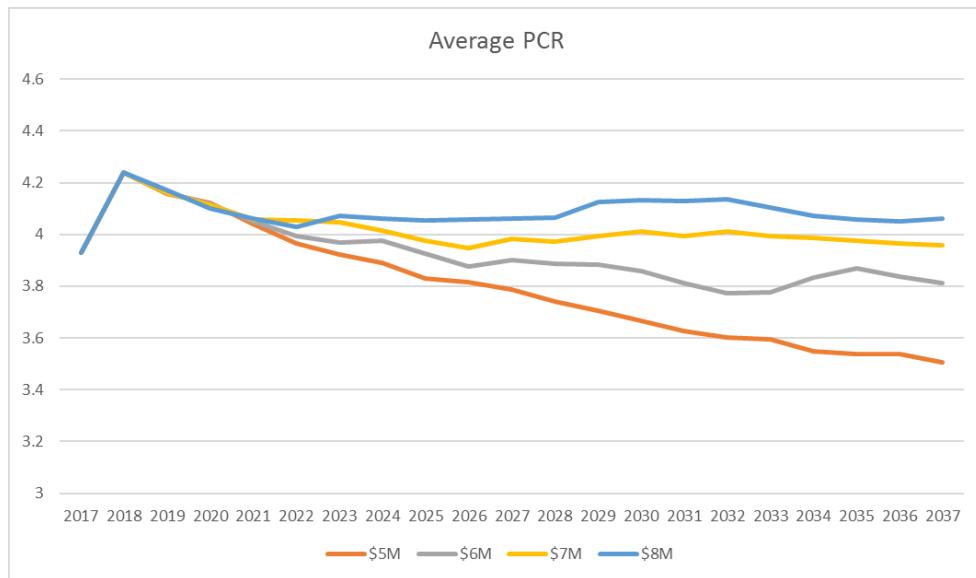
The following table shows the investment levels with the corresponding miles of accomplishment anticipated from the investment strategies for pavements:

MaineDOT 10 Year Investment Strategy						
Year	Prev Maint	Preservation	Rehabilitation	Reconstruction	Initial Const	
2018	\$1.5	\$24.4	\$32.0	\$13.4	\$0.0	
2019	\$1.5	\$30.0	\$31.9	\$15.0	\$0.0	
2020	\$1.5	\$28.5	\$10.5	\$35.0	\$0.0	
2021	\$1.5	\$10.0	\$30.9	\$5.3	\$35.0	
2022	\$1.5	\$10.7	\$29.7	\$0.0	\$0.0	
2023	\$1.5	\$19.6	\$21.3	\$0.0	\$0.0	
2024	\$1.5	\$29.2	\$11.5	\$0.0	\$0.0	
2025	\$1.5	\$35.0	\$4.3	\$0.0	\$0.0	
2026	\$1.5	\$26.4	\$14.2	\$0.0	\$0.0	
2027	\$1.5	\$35.4	\$2.3	\$0.0	\$0.0	
2028	\$1.5	\$36.6	\$0.6	\$0.0	\$0.0	
Totals	\$15.0	\$261.3	\$157.2	\$55.3	\$35.0	

MTA Pavement Investment Strategy

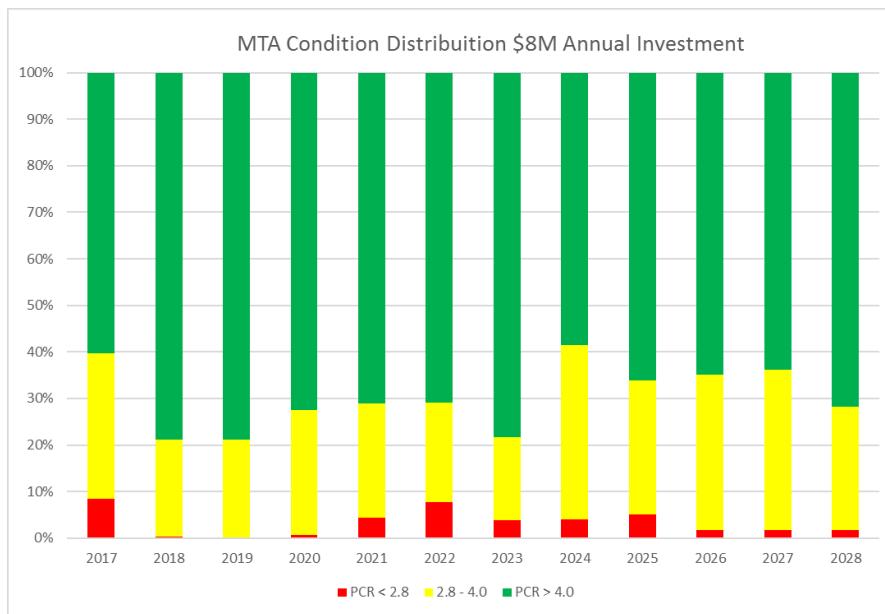
MTA outlines the highway preservation investment strategy in the latest 30 year asset modeling of May 2019. As a result of this modeling, MTA indicates that it will spend \$102M in the 10-year time frame on pavement preservation. This investment level results in a \$10.2M annual average investment. As with MaineDOT analysis, an MTA specific pavement analysis was completed. The MTA analysis was run with

the standard MaineDOT pavement tool kit as outlined in Appendix D. There were four funding levels modeled; \$5M, \$6M, \$7M and \$8M for a 20-year timeframe. The following graph shows the resulting overall network pavement condition.



It is apparent that the \$8M annual investment levels out the network condition at a very sustainable condition. The closing of the gap between investment levels as funding is increased is similar to the MaineDOT NHS analysis and indicates a lessening on the return on investment.

The following graphic shows the network condition distribution as a result of the \$8M annual investment level:

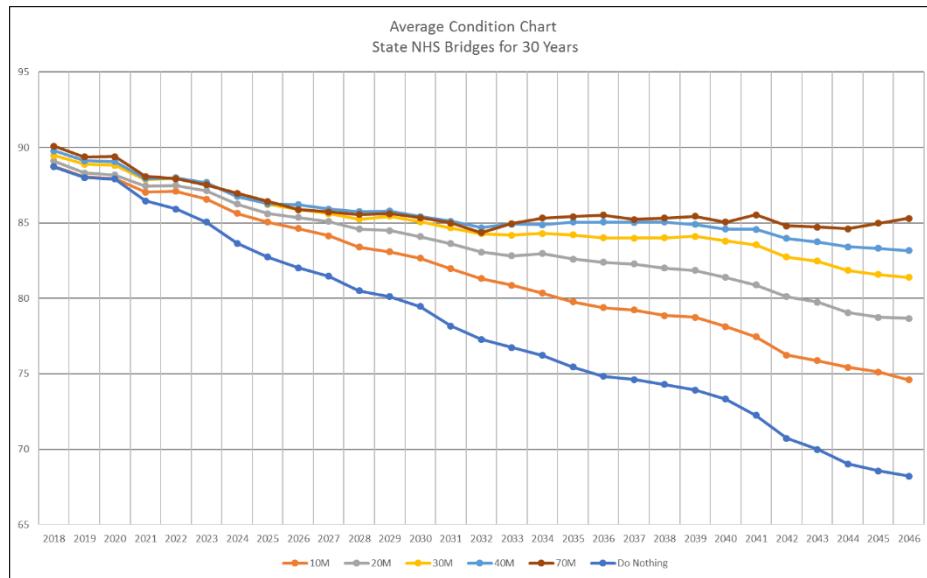


Therefore, as shown through the pavement PM2 measure as well as this analysis by MaineDOT the current investment level of \$10.2M per year is adequate to maintain a SOGR within the TAMP timeframe.

MTA 10 Year Pavement Investment Strategy	
Year	Paving Maineline Mill & Fill
2019	\$1,900,000
2020	\$7,688,113
2021	\$5,673,139
2022	\$14,695,486
2023	\$12,538,819
2024	\$12,269,234
2025	\$3,015,218
2026	\$18,953,749
2027	\$14,159,593
2028	\$10,805,039
Total	\$101,698,389

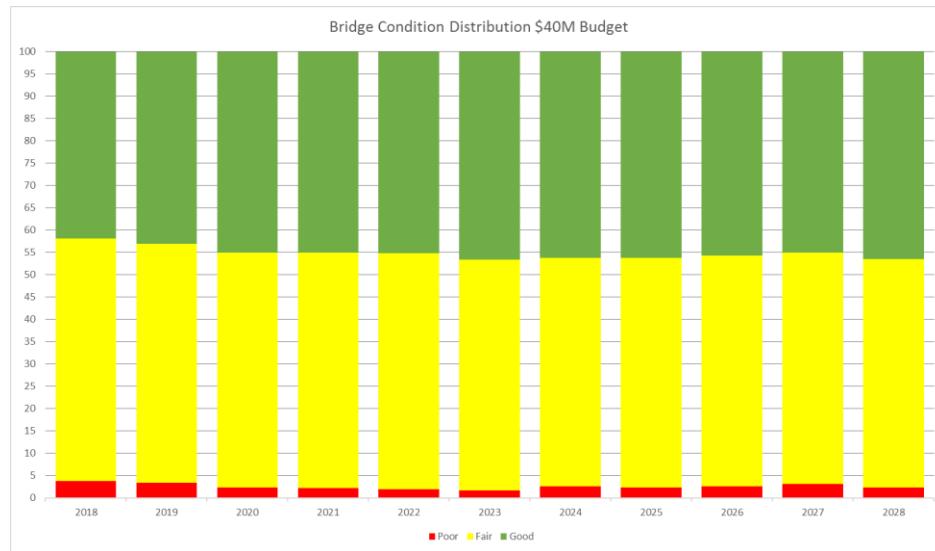
Bridge Investment Priorities

As with pavement the bridge analysis was completed for the MaineDOT NHS and the MTA separately. The MaineDOT NHS analysis was run with the standard bridge tool kit as outlined in Appendix D. There were five funding levels modeled; \$10M, \$20M, \$30M, \$40M, \$70M. All the analysis included projects that are in the current 2018-2020 Work Plan and were run for a 30-year timeframe. The following graph shows the resulting overall network bridge condition.



The return on investment, measured as improved network level bridge condition, significantly decreases as investment increases more than the \$40M per year average. In fact, in the first 10 years of the analysis no investment scenario could spend greater than \$40M given the MaineDOT decision matrix. In fact, the \$40M and \$70M investments and resulting condition levels are very similar for the first 20 years. Only after the 20-year time frame do we see the added available funds being utilized regularly. As such the \$40M funding level is what we would consider to be the appropriate funding level to maintain network condition in a sustainable condition and an overall SOGR. This is illustrated by the flattening of the average bridge condition curve over time and explicitly in the 10-year time frame of the TAMP.

Additionally, the distribution of bridge conditions is evaluated to compare to the targets and the MaineDOT definition of the SOGR. The 10-year condition distribution as required by the TAMP process can be seen in the chart below in terms of the PM2 Bridge measure:



As can be seen by the condition distribution it is projected that MaineDOT will meet its SOGR and Targets with the \$40M investment level.

Bridge 10-Year Work Summary

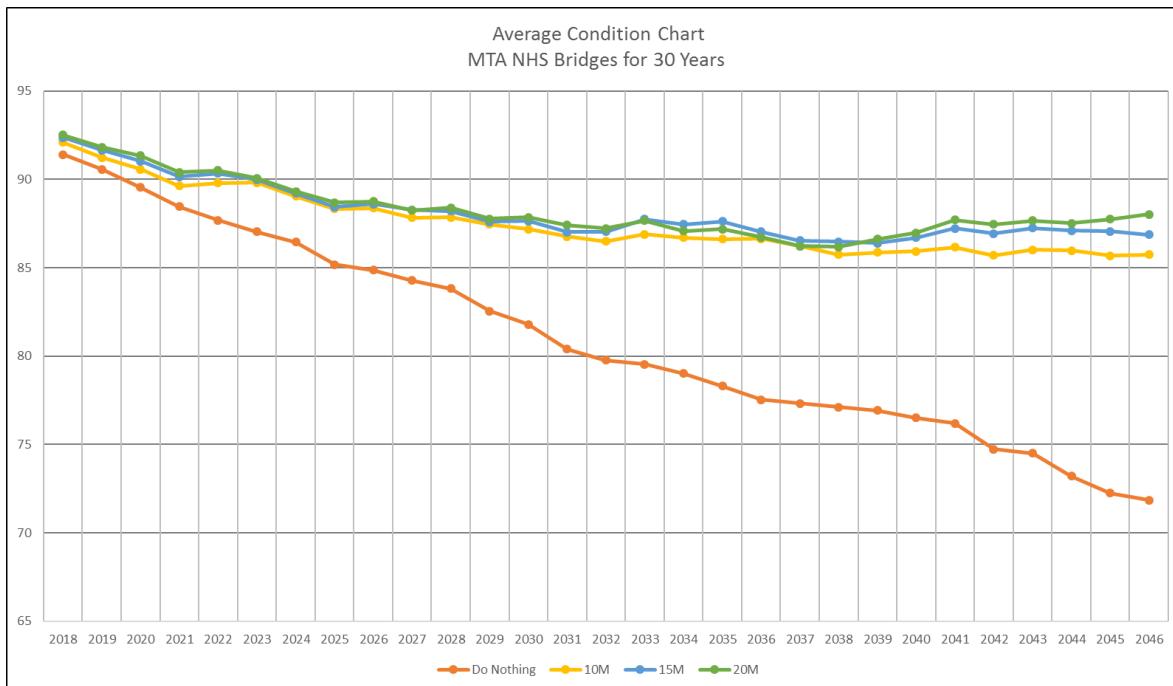
As a result of the \$40M investment strategy, there are investment levels provided for each of the first 10 years of the analysis period. These are categorized as preservation, rehabilitation, or replacement.

MaineDOT 10 Year Investment Strategy					
Year	Bridge Treatment Classification				
	Maintenance	Preservation	Rehabilitation	Recon/Replace	Initial Constr
2018	\$2.0	\$34.8	\$1.6	\$3.2	
2019	\$2.0	\$5.9	\$3.8	\$25.8	
2020	\$2.0	\$3.4	\$11.9	\$33.1	\$15.0
2021	\$2.0	\$4.1	\$5.7	\$30.0	\$20.0
2022	\$2.0	\$8.2	\$13.1	\$16.9	
2023	\$2.0	\$7.1	\$26.7	\$4.8	
2024	\$2.0	\$3.8	\$0.0	\$36.2	
2025	\$2.0	\$11.0	\$29.0	\$0.0	
2026	\$2.0	\$15.3	\$15.9	\$5.1	
2027	\$2.0	\$34.3	\$5.7	\$0.0	
2028	\$2.0	\$23.3	\$8.0	\$8.0	
Totals	\$20.0	\$116.5	\$119.6	\$159.9	\$35.0

MTA Bridge Investment Strategy

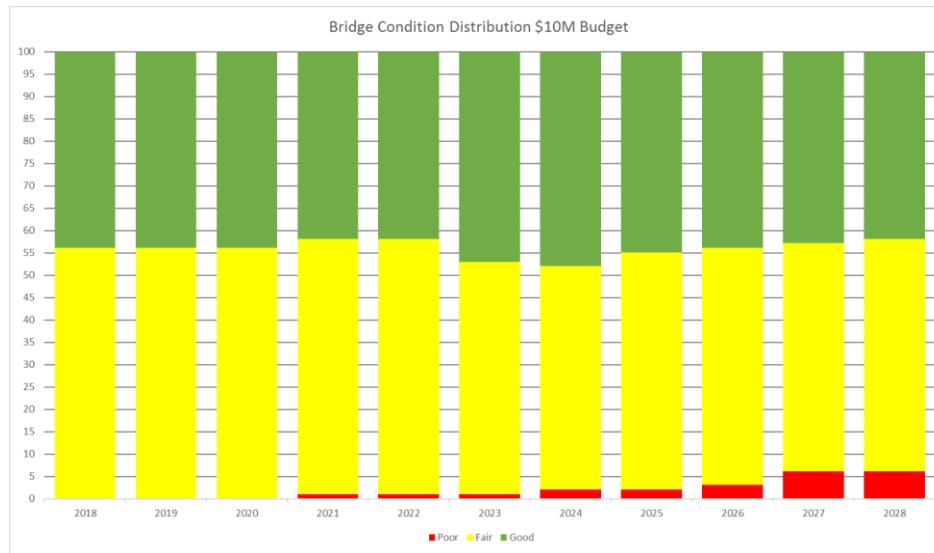
MTA outlines the bridge investment strategy in the 30 year asset model runs of May, 2019. As a result of these runs, MTA indicates that it will spend \$124M in the 10-year time frame. This investment level results in a \$12.4M annual average investment. As with MaineDOT analysis, an MTA specific bridge

analysis was completed. The MTA analysis was run with the standard MaineDOT bridge tool kit as outlined in Appendix D. There were three funding levels modeled; \$10M, \$15M, \$20M for a 30-year timeframe. The following graph shows the resulting overall network Bridge condition.



As with the MaineDOT analysis there is very little difference in the \$10M to \$20M investment options in the TAMP 10-year timeframe. It is not until the 20-year timeframe that you see a real difference in investment levels.

The following graphic shows the condition distribution resulting in a \$10M investment level.



As shown through the bridge PM2 measure as well as this analysis by MaineDOT the current investment level of \$12.6M per year is adequate to maintain a SOGR within the TAMP timeframe. The following table summarizes MTA Bridge Investment Strategy:

MTA 10 Year Bridge Investment Strategy				
	Bridge Rehab	Bridge Repair	Bridge Painting	Total
2019	\$28,277,259	\$62,779	\$0	\$28,342,056
2020	\$22,072,459	\$0	\$0	\$22,074,479
2021	\$2,319,138	\$1,553,327	\$0	\$3,874,486
2022	\$0	\$2,336,204	\$807,019	\$3,145,245
2023	\$0	\$1,181,968	\$2,027,872	\$3,211,863
2024	\$8,609,242	\$0	\$2,850,773	\$11,462,039
2025	\$12,901,604	\$1,569,824	\$1,878,542	\$16,351,995
2026	\$14,761,013	\$2,586,133	\$954,028	\$18,303,200
2027	\$2,972,600	\$5,039,313	\$4,640,438	\$12,654,377
2028	\$0	\$1,556,810	\$5,754,067	\$7,312,905
	\$91,913,315	\$15,886,357	\$18,912,738	\$126,712,410

Investment Strategy Consistency

These strategies are consistent with the life cycle analysis process of the MaineDOT management systems as described previously. As outlined in financial plan section of the document the National Highway Performance Program (NHPP) has the funding available to maintain the existing assets on the NHS. In addition, there is limited funding available to address isolated congestion areas and safety concerns through the NHPP and the HSIP programs.

The investment strategies presented in this document are consistent with the National Goals found in 23 USC 150 (b) and are in alignment with 23 USC 150 (d) and the performance measures guidance found

in 23 USC 150 (c). Particularly the performance measures the department has established for PM1, PM2 & PM3 as well as MaineDOT's Integrated Freight Plan.

Investment strategies are subject to risk impact as outlined in the Risk Process. Risks that directly affect availability of funding and the ability of the department to deliver these strategies have the potential to impact the viability of these investments and will be monitored accordingly.

MaineDOT is continuously monitoring the accuracy and reliability of our management systems in calculating life cycle planning and investment strategies. While MaineDOT is confident in the resulting projections these systems are constantly evolving as we add new treatment alternatives or adjust deterioration curves/assumptions based on continuous data feedback. These changes could affect the investment strategies going forward.

Additionally, investment level, resultant conditions and performance are monitored on a regular basis with both targets and SOGR in mind. As these components are updated investment strategies may need to be altered to attain the desired outcomes.

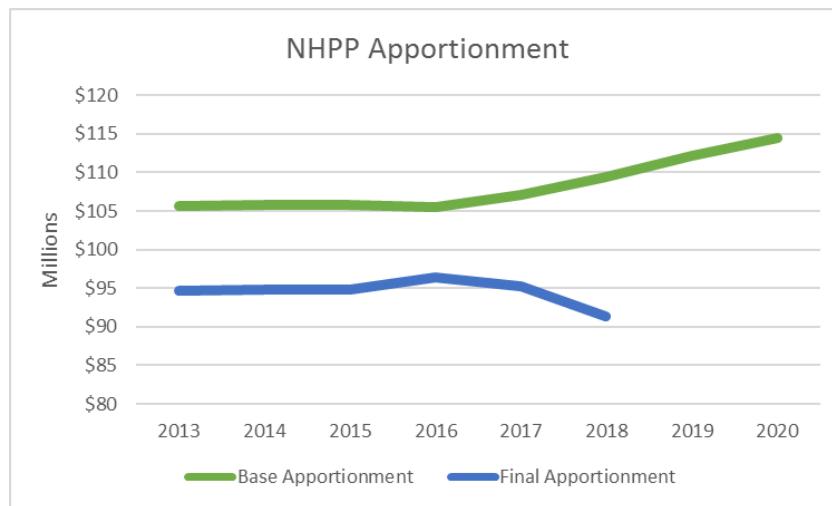
Adjustments in investment strategies can be done rather quickly as MaineDOT updates its workplan annually, as previously discussed.

Financial Plan (23 CFR 515.7 (d))

The primary source for asset management actions on the MaineDOT NHS is the National Highway Performance Program (NHPP) funding provided through the Federal Highway Administration. MaineDOT monitors the funding available in this program through federal authorizations of funding such as MAP-21 and the FAST Act. MaineDOT matches NHPP funds with state capital funding secured through bonding passed by the Maine Legislature and approved by the voters. As previously discussed the MTA financial plan/outlook can be seen in their 10-year plan at the link provided.

Projecting NHPP Funding

NHPP is the cornerstone of the FHWA surface transportation funding model. It provides funding for the NHS around the country. MaineDOT is the recipient of NHPP Apportionment on an annual basis in accordance with the most recent federal authorization. NHPP funding remains fairly predictable, however, the processes for securing these funds are often a combination of continuing resolutions and short term spending authorities. The graphic below shows the trend in NHPP Apportionment provided to the MaineDOT through recent authorizations:



The two lines represent the base apportionment which is determined by formula and the final apportionment which is determined after set asides, penalties, and apportionments not subject to obligation limitation. Maine is currently subject to two penalties under 23 USC sections 154 and 159. 2018 was the first year Maine was subject to the section 159 penalty.

Over the four-year period from 2016 to 2020 NHPP funding has grown at an average rate of 2%. Maine has yet to benefit from this growth due to penalties. There is a strong chance that Maine will become compliant with section 159 in the future through legislative or executive action. While these are apportionment levels, obligation limitation generally limits the amount of total apportionment to 88-92%.

MaineDOT has two primary mechanisms available to match NHPP federal funding; general obligation bonds or toll credits. MaineDOT is currently in year three of a 10-Year bonding plan at a level of \$80M dollars per year. MaineDOT has not used toll credits in the past to match NHPP funding as this would reduce the overall size of the program.

When projecting NHPP funding levels these and other factors are considered, the most relevant are listed below:

- Base apportionment amounts
- Recent trends and authorizations
- Applicability of penalties (154 & 159 currently)
- Revenue and financing proposals in Congress
- Availability of matching funds

NHS Funding Needs

Through the Life Cycle Planning process MaineDOT has developed acceptable treatments and triggers that have been built into the management systems. The management systems are then used to determine appropriate funding levels and investment strategies for NHS Bridges and Pavements. The needs and strategies for the NHS are very similar. There is no financial or SOGR gap identified in the Performance Gaps section of this plan.

As discussed earlier in this plan MaineDOT prioritizes the NHS very high when doing resource allocation on an annual basis. The current conditions of the NHS are the results of past investment and clearly show a system that is in fair to good condition. The following table is a summary of past investment levels for Pavement and Bridge work:

MaineDOT NHS Investment History			
Year	Bridge	Highway	Total
2013	\$10.9	\$50.1	\$61.0
2014	\$99.4	\$43.0	\$142.4
2015	\$39.7	\$64.4	\$104.1
2016	\$33.7	\$66.8	\$100.5
2017	\$18.2	\$66.6	\$84.8
2018	\$17.0	\$78.3	\$95.3
Totals	\$208.0	\$319.1	\$527.1
Average	\$36.5	\$61.5	\$98.0

In recent history, the highway investment level has been skewed by large amounts of Highway Reconstruction. Since the Roads Report of 2016 very little new reconstruction has been identified and MaineDOT is focused on delivering previously programmed work and preservation. It is important to note that the investment levels above correspond with the asset management work associated with maintaining the existing system and does not include capacity or safety improvements on the NHS. This is meant to be a direct comparison with what the management systems are recommending going forward except for Highway Reconstruction as indicated above.

NHS Highways and Bridges Financial Tables

The following table shows the anticipated funding in NHPP and Grants along with the 10-year investment strategies to maintain or improve conditions, meet the targets established and move the NHS in Maine towards the SOGR, investment levels are based on project delivery.

MaineDOT NHS Financial Summary													
Funding Category	Source	Comments	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Resources (\$M)													
	Federal NHPP Apportionment	Assumed 1% growth beyond 2020 & no 159 Penalty past 2018	\$91.3	\$101.8	\$103.8	\$104.9	\$105.9	\$107.0	\$108.0	\$109.1	\$110.2	\$111.3	\$112.4
	Federal NHPP Obligation	Assumed 90% Obligation	\$82.2	\$91.6	\$93.4	\$94.4	\$95.3	\$96.3	\$97.2	\$98.2	\$99.2	\$100.2	\$101.2
	State Bond Match	Assumed 80/20 program split	\$20.5	\$22.9	\$23.4	\$23.6	\$23.8	\$24.1	\$24.3	\$24.6	\$24.8	\$25.0	\$25.3
	INFRA/BUILD				\$25.0	\$47.0							
Total Resources			\$102.7	\$114.5	\$141.8	\$165.0	\$119.2	\$120.4	\$121.6	\$122.8	\$124.0	\$125.2	\$126.5
Investment Strategies	Asset Type	Investment Strategy											
	Highways												
		Preventative Maintenance	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5	\$1.5
		Preservation	\$24.4	\$30.0	\$28.5	\$10.0	\$10.7	\$19.6	\$29.2	\$35.0	\$26.4	\$35.4	\$36.6
		Rehabilitation	\$32.0	\$31.9	\$10.5	\$30.9	\$29.7	\$21.3	\$11.5	\$4.3	\$14.2	\$2.3	\$0.6
		Reconstruction	\$13.4	\$15.0	\$35.0	\$5.3	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
		Initial Construction					\$35.0						
	Highway Subtotal		\$71.3	\$78.4	\$75.4	\$82.7	\$41.9	\$42.4	\$42.2	\$40.8	\$42.0	\$39.2	\$38.7
	Bridges												
		Preventative Maintenance	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0
		Preservation	\$34.8	\$5.9	\$3.4	\$4.1	\$8.2	\$7.1	\$3.8	\$11.0	\$15.3	\$34.3	\$23.3
		Rehabilitation	\$1.6	\$3.8	\$11.9	\$5.7	\$13.1	\$26.7	\$0.0	\$29.0	\$15.9	\$5.7	\$8.0
		Reconstruction/Replacement	\$3.2	\$24.4	\$33.1	\$30.0	\$16.9	\$4.8	\$36.2	\$0.0	\$5.1	\$0.0	\$8.0
		Initial Construction			\$15.0	\$20.0							
	Bridge Subtotal		\$41.6	\$36.1	\$65.4	\$61.8	\$40.1	\$40.6	\$42.0	\$42.0	\$38.4	\$42.0	\$41.2
Investment Totals			\$112.9	\$114.5	\$140.8	\$144.5	\$82.0	\$83.0	\$84.2	\$82.8	\$80.4	\$81.2	\$79.9
Remaining Balance			-\$10.2	\$0.0	\$1.0	\$20.5	\$37.1	\$37.4	\$37.4	\$40.0	\$43.6	\$44.0	\$46.6

Asset Valuation

MaineDOT utilizes asset valuation to analyze the value of the overall NHS pavement and bridge assets. The methodology for this is based on two basic valuation concepts, replacement value and current value. The two sections below describe the components of the value analysis for Highway and Bridge.

Highways

Replacement Value = Reconstruction Unit Cost * Lane Miles

Current Value = Non-Depreciable Costs + Depreciable Costs

Non-Depreciable Costs = (Reconstruction Unit Cost – Rehabilitation Unit Cost)*Lane Miles

Depreciable Costs = (Rehabilitation Unit Cost * Current Pavement Condition Rating/4.85)*Lane Miles

In these calculations, the theory is that there is a portion of the highway that does not depreciate, primarily the right-of-way and any horizontal and vertical alignment improvements when the roadway was constructed. The portion of highway that does depreciate is discounted at a rate equivalent to the ratio of the current pavement condition rating to what a new pavement condition rating would be.

Maine's NHS highway valuation was estimated using this methodology and unit prices for like roadways by Functional Class and Urban vs Rural setting. Using this methodology Maine's NHS highway system is valued at \$10.41 billion with a current value of \$9.49 billion.

Bridges

Replacement Value = Deck Area*Unit Cost of Replacement

Current Value = Replacement Value*(Condition Index)*Age Discount Factor

Condition Index = Health Index as Calculated by dTIMS and is a 0-1 value.

Age Discount Factor = $1 - (0.5 * \text{Bridge Age} / 75)$

The bridge calculations are done very similar to the highway. The current value is discounted by the current condition and the age of the bridge. A new bridge should be at replacement value while a bridge with a perfect health index that is 75 years old would have a current value $\frac{1}{2}$ the replacement value.

Maine's NHS bridge valuation was estimated using this methodology and unit prices for bridges statewide by square foot of deck area. Using this methodology Maine's NHS bridge system is valued at \$4.06 billion with a current value of \$2.71 billion.

Measuring Value and Depreciation

The valuation model can then be used to check that a value that is equivalent to the depreciation of the network is re-invested in the network on an annual basis. The equation for this investment level at the network level would be:

Depreciation = Investment

Annual Highway Depreciation = Rehabilitation Value * $((\text{PCR Year 1} - \text{PCR Year 0}) / 4.85)$

Annual Bridge Depreciation = Replacement Value * (Health Index Year 1 - Health Index Year 0) * $(1 - 0.5 * 1 / 75)$

Additionally, a Depreciation Index can be calculated and tracked as another overall indicator:

DI = Current Depreciation/Total Max Allowable Depreciation

For 2018 the following Depreciation Indices were calculated:

Highway – 0.74

Bridge – 0.58

Performance Gap Analysis (23 CFR 515.7 (a))

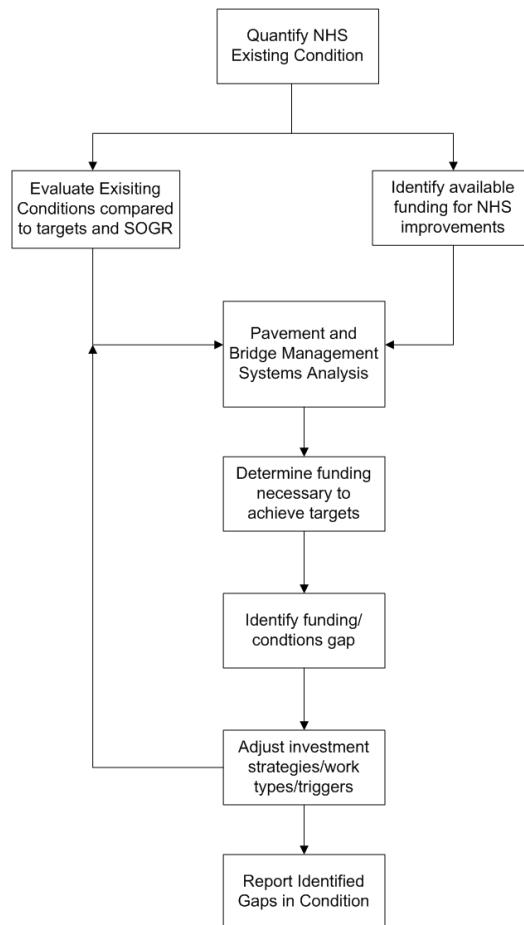
Throughout this document the key components of a gap analysis have been developed and the processes for which they were developed have been documented. These key components are:

- Existing system condition and performance

- Definition and quantification of a SOGR
- Targets for 2 and 4 year timeframes
- Pavement and Bridge Management Systems
- Financial Plan and available resources
- Investment strategies for reaching targets

Gap Identification

The process for identifying gaps is iterative in nature and requires looking at multiple funding levels and alternative work strategies in order to maximize Highway and Bridge network conditions. MaineDOT relies on the management systems to perform this analysis. The process flow below is a simplistic representation of this process:



Gap quantification

It is MaineDOT's opinion that we have the data and management systems available and configured to identify gaps in present condition vs targets and the SOGR definition developed. MaineDOT has the

ability as illustrated to consider multiple funding scenarios, develop numerous strategies and select strategies that minimize the life cycle costs of assets.

In the life cycle section of the TAMP the current conditions, targets, and SOGR were presented. In the Investment Strategies section strategies were selected that produced network conditions that lead to meeting the targets established and supporting progress towards MaineDOT's definition of SOGR. Based on the targets established and the SOGR defined MaineDOT is projecting that asset condition targets will be able to be achieved based on forecasted resources.

Performance Gaps

As described earlier in this plan the NHS is performing reliably. With the interstate being 100% reliable statewide and in the individual MPOs. The non-interstate NHS does show some areas of concern in the southern regions of the state, particularly the PACTS and KACTS areas. While these are noticeably lower reliability, that condition is somewhat expected due to the urban nature of the regions. Many of these sections are known areas of congestion that are continuously being monitored. The Department is in the process of completing a Traffic and Mobility AMFS and effectiveness evaluation which recommends significant improvements to both process and infrastructure affecting mobility on the NHS.

Additionally, MaineDOT has a number of efforts underway to maintain efficient mobility performance around the state, a few examples of these are:

I-295 Corridor Update Brunswick to Scarborough – This study looks at the congestion, safety and incident management along this vital corridor of NHS interstate and analyzes a number actions ranging from ITS to added capacity. The study can be found at:

<https://www1.maine.gov/mdot/docs/2018/mainedot-I-295-corridor-update-report.pdf>

Wiscasset Downtown Improvements – This capital improvement project addresses traffic flow through this US 1 downtown that is part of the NHS. This project will address safety, mobility, pedestrian, and parking issues identified. More information can be found at the link below:

<https://www1.maine.gov/mdot/projects/wiscasset/downtown/>

I-395/Route 9 Connector Project – project to complete a “missing link” between I-395 and Route 9 in north central Maine. The new road will provide a regional solution to problems of transportation system connection, safety, and mobility. The greater Bangor/Brewer area is the economic and employment center for the north central region of the state. It’s also a hub for the movement of goods because of its proximity to the interstate highway system and Canadian markets.

<https://www1.maine.gov/mdot/projects/I395rt9connector/>

In addition to mobility performance there are a number of safety initiatives that are ongoing. MaineDOT maintains crash data in conjunction with the Bureau of Public Safety. This data is used in a number of efforts some of which are highlighted below:

Highway Safety Plan – MaineDOT is a key contributor in the development and implementation of the Highway Safety Plan that can be found at the link below:

<https://www.maine.gov/dps/bhs/publications/documents/FFY18HSPWebsite.pdf>

Highway Safety Improvement Program – MaineDOT programs and delivers nearly \$14M in safety specific projects per year. This program is data driven based on crash history and anticipated results of proposed improvements. Maine's 2016 annual report can be found at:

<https://safety.fhwa.dot.gov/hsip/reports/pdf/2017/me.pdf>

Strategic Highway Safety Plan - As part of the HSIP MaineDOT partners with FHWA to develop a Strategic Highway Safety Plan. This plan is an umbrella document for all safety strategies, including roadway/engineering strategies (rumble strips, intersection improvements, etc). The latest plan can be found at:

https://www1.maine.gov/mdot/safety/docs/Strategic-Highway-Safety-Plan_2017.pdf

This is not an all-inclusive list but does give good examples of mobility and safety projects, initiatives and studies that are on-going in identified areas that effect the NHS performance. Through continuous monitoring of performance data MaineDOT initiates both systemic, asset class, and asset specific initiatives to maintain and improve performance in order to achieve performance management targets regardless of their physical condition.

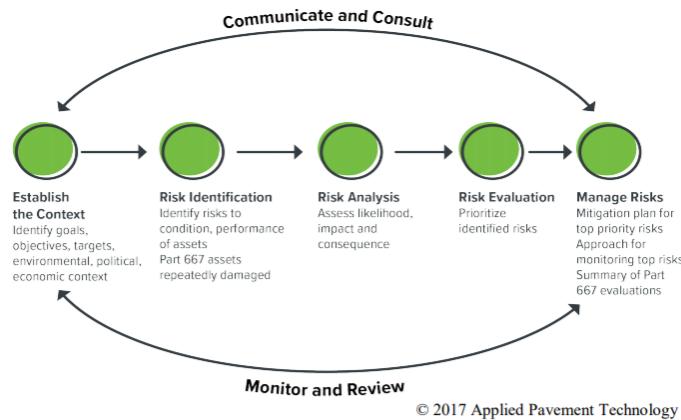
Risk Management (23 CFR 515.7 (c))

Risk management is an underlying component to any plan. The successful management of the existing system as outlined in goal one of the MaineDOT strategic plan requires that risks of many different kinds be managed on a continuous basis.

Within MaineDOT the owner of risk management for the TAMP is the Asset Management Council. The Asset Management Council will manage and implement the process as described in the sections below with approval of key components, including risk priority, by the Core Management Team.

Risk Management Process

The following diagram is a generalization of the process as presented by FHWA Office of Asset Management “*Incorporating Risk Management Into Transportation Management Plans*” and the AASHTO “*Guide for Enterprise Risk Management*”



The basic steps are achieved in the context of the MaineDOT Strategic Plan and the OneDOT process outlined earlier in this document. This diagram highlights the basic steps for risk management:

- Identify Risks to this Plan
- Analyze for Likelihood, Impact, Consequences
- Evaluate for Prioritization
- Mitigate/Monitor

Identifying Risks

Risk identification will be completed by the Asset Management Council and will be classified in one of three categories:

1. Department Risk – Strategic risks that affect the mission, vision, and goals of the department including those outlined in the TAMP.
2. Delivery Risk – risks such as financial shortfalls, that affect the ability of the department to deliver the work plan.
3. Asset Risk – risks that are operational and directly affect an individual asset or class of assets including those at risk of being repeatedly damaged (per 23 CFR 667).

Analyzing Risks

The analysis of risk was completed using a likelihood versus impact evaluation as displayed below as a risk consequence matrix. As depicted through the color coding the risks are classified as follows:

- High > 50
- Medium 25 -49

- Low < 25

		MaineDOT Risk Assessment Scales									
		Impact									
Likelihood		1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10	
2	2	4	6	8	10	12	14	16	18	20	
3	3	6	9	12	15	18	21	24	27	30	
4	4	8	12	16	20	24	28	32	36	40	
5	5	10	15	20	25	30	35	40	45	50	
6	6	12	18	24	30	36	42	48	54	60	
7	7	14	21	28	35	42	49	56	63	70	
8	8	16	24	32	40	48	56	64	72	80	
9	9	18	27	36	45	54	63	72	81	90	
10	10	20	30	40	50	60	70	80	90	100	

This analysis will allow the department to quickly hone in on the top priority risks.

Prioritizing Risks

Through the risk consequence matrix, the Core Management Team evaluated and prioritized risks within the identified categories. Through this process MaineDOT will develop and formalize its risk tolerance culture and assign leads for each.

Action for Mitigation/Monitoring Risks

When risks are prioritized the Asset Management Council developed the mitigation and/or monitoring actions for each of the high-level risks. Mitigation and monitoring actions are assigned to the appropriate asset committee or work unit for implementation with periodic reporting and review to the lead core team member.

Risk Register

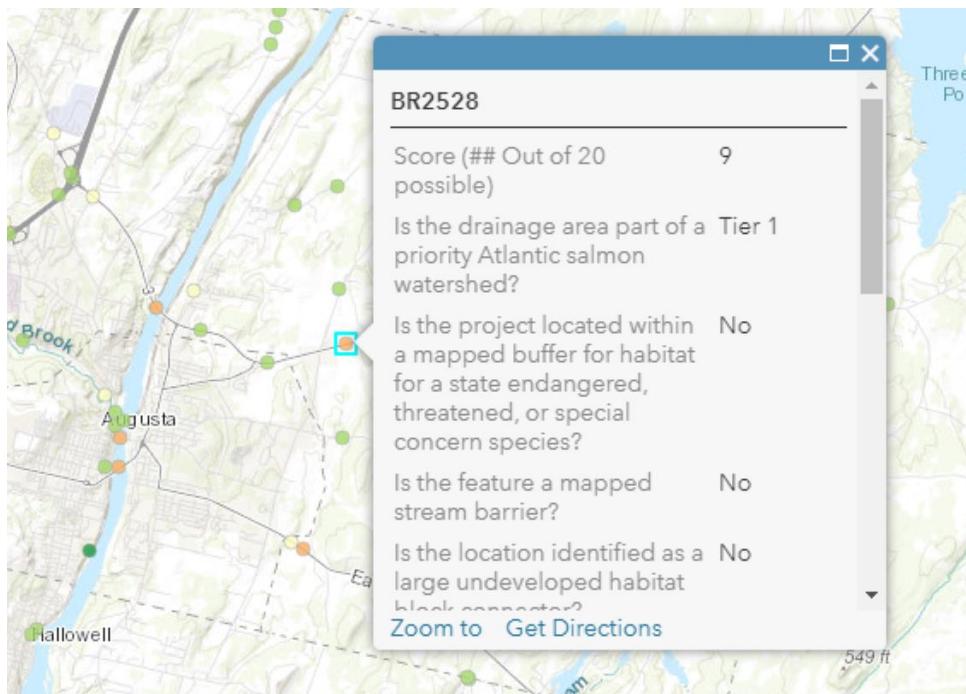
The following are the risks considered to be high as identified in the complete risk register contained in Appendix F.

MaineDOT TAMP Risk Register								
Risk Category	Event	Likelihood 1-10	Impact 1-10	Total	Rating H-M-L	Monitoring	Mitigation	Core Team Lead
Department Risk								
<i>Policy/Legislative Action</i>								
	Change in Administration significantly changes strategic direction	8	8	64	High	Monitoring of all candidates policy and transportation positions	Rely heavily on Asset Management Plans and Procedures to direct funding appropriately	COO
	Federal Grant Programs are eliminated or altered in a way Maine does not compete well	8	8	64	High	Monitor Federal Reauthorization Bills	Maximize the amount of grants received in the near term and highlight to policy makers this is not reliable revenue	Deputy Commissioner/Planning Director
	Bond Levels are changed by Legislature or not approved by voters	5	10	50	High	Executive engagement on bond packages, annual review of passing % and annual customer survey polls	Seek alternate funding streams, PR and information campaigns, rely on Highway Corridor Priority system, defer projects when necessary, provide temporary holding actions (LCP) for pavement and Post Bridges for loads required for safety when necessary	Deputy Commissioner/CFO
<i>Organizational/Staffing</i>								
	Workforce shortage at the crew level	10	8	80	High	Continuous reporting on vacancies and trends	Partnering with Community College System, Pay increases, incentives, private contracting	COO/HR Director
MaineDOT Work Plan Delivery Risk								
<i>Environmental</i>								
	Natural Disaster significant enough to consume workplan resources that impact NHS	4	10	40	Medium	TMC capabilities, MEMA relationship, Cost Tracking for FEMA reimbursement	TMC capabilities, MEMA relationship, Cost Tracking for FEMA reimbursement, building Resiliency into Infrastructure	M&O Director
<i>External Contracting</i>								
	Bid Prices consistently higher than estimates by >10%	8	9	72	High	Weekly bid tracking and reporting	Rely on Highway Corridor Priority system, defer projects when necessary, provide temporary holding actions (LCP) for pavement and Post Bridges for loads required for safety when necessary	COO/BPD Director
	Lack of Bidders/Contractors/capacity	10	7	70	High	Monthly/Quarterly meetings with industry organizations	Constant communication with industry, be predictable and reliable so investments can be made, package work to be right sized for the entire contracting community	COO/BPD Director
	Shortage of ROW Appraisers	9	8	72	High	HR/BPD monitoring of market and job respondents data	Possible look at pay scale for classification, community college coordination, realtors association communication	BPD Director/HR Director
<i>Commodities/Material Processing</i>								
	Lack of availability of liquid asphalt	9	8	72	High	Weekly monitoring of Asphalt Index	Specification modification, bulk purchasing, communication with providers	BPD Director
	Spikes in Asphalt pricing	9	6	54	High	Weekly monitoring of Asphalt Index	Specification modification, bulk purchasing, Asphalt escalator	BPD Director

Assigning Risk Ratings at the Asset Level – TRAPPD

Bridge & Large Culvert

The department has undertaken significant steps to assigning risk scores to individual assets. A GIS based risk evaluation tool, Transportation Risk Assessment for Planning and Project Delivery (TRAPPD), was developed by the MaineDOT Environmental Office. TRAPPD utilizes existing data sources to evaluate multiple risks at the asset level. Currently this tool is in production and being utilized in the management of bridge and large culvert assets. The evaluation matrix can be found in Appendix E of this plan. The matrix currently consists of 12 questions that span the range of risks including budget, process, schedule, events, and safety. Scoring is applied to the individual questions and the summation of these scores is used along with asset condition and performance to evaluate the overall priority and risk associated with the asset. These scores are calculated for every structure in the state and accessible through a mapping interface. An example of which is below:



The twelve questions included in TRAPPD for bridges and large culverts are listed below:

1. Is the drainage area part of a priority Atlantic Salmon Watershed?
2. Is the asset located within a mapped buffer for habitat for a state endangered or threatened species or special concern species?
3. Is the asset associated with a mapped stream barrier?
4. Is the location identified as a large undeveloped habitat block connector?
5. Is the existing asset greater than or equal to the calculated bank full width?
6. What is the drainage area of the asset?
7. Is the asset located within an identified FEMA 100-year flood plain?
8. Is the asset subject to coastal threats of sea level rise and/or storm surge?
9. What percentage of the drainage area of the asset is developed/impervious surface?
10. Is the asset within the watershed of an urban impaired stream or within a MS4 Community?
11. Is the asset an eligible historic resource or within a historic district pursuant to Section 106?
12. Is the road a sole access, evacuation route or access for emergency response vehicles?

Highway

It has been the department's experience with TRAPPD that the key to successfully flagging risk at the asset level is not a composite scoring system however an informational system that communicates potential risks for each asset. To that end MaineDOT has worked to develop and organize GIS based data to overlay with highway assets or potential highway project candidates. The key questions for highway analysis of risk are below:

1. Is the highway section within a priority Atlantic Salmon Watershed?
2. Is the asset located within a mapped buffer for habitat for a state endangered or threatened species or special concern species?
3. Is the asset subject to coastal threats of sea level rise under low, medium or high scenarios?
4. Is the asset a high crash location?
5. Is the asset within an MS4 community?
6. Is the highway right of way sufficient for intended use/improvements?
7. Is the highway within a historic district or have historic properties located along it?
8. Is the highway of severe slope making it subject to flash flooding?
9. Does the highway have identified unstable or potentially unstable slopes within the ROW?
10. Is the road a sole access, evacuation route or access for emergency response vehicles?

These questions are easily answered when reviewing highway assets within the mapping environment at MaineDOT.

23 CFR 667

MaineDOT has completed the requisite review of the NHS and found no infrastructure that has required two or more permanent repairs in the given timeframe. Our review included:

1. Review of federally declared emergency events from the FEMA.gov website
2. Review of MaineDOT emergency actions/event reports 2002-2018
3. Review of the MaineDOT financial system which captures expenditures made under ER fund sources
4. Review of the MaineDOT project management system for key terms pertaining to storm or emergency damage
5. Review of MaineDOT MATS systems emergency repair special events with NHS locations
6. Discussions with MaineDOT senior engineers with experience predating the required time period.

As you well know this is not an easy undertaking, the data some of which is over 20 years old is not always reliable in a single system, however, the cross-reference of multiple sources is the best evaluation possible. MaineDOT feels the steps taken would identify infrastructure that has required permanent repair and reconstruction on two or more occasions on the NHS within the time period. This evaluation reinforces the standards of the NHS and the resiliency built into these standards as it pertains to Maine's historic level of exposure to emergency level natural events. MaineDOT has the systems in place going forward to monitor investments in infrastructure as a result of these occurrences.