Connecticut Annual Pavement Report

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Date of the Report
November 9, 2021

Name of the performing organization
Connecticut Advanced Pavement Laboratory
Connecticut Transportation Institute
School of Engineering
University of Connecticut

Submitted to:
Connecticut Department of Transportation
Bureau of Engineering and Construction
Pavement Management Unit

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipients Catalog No.
4. Title and Subtitle Connecticut Annual Pavement Report		5. Report Date November 9, 2021 6. Performing Organization Code
7. Author(s) Donald A Larsen, PE, Alexander Bernier PE, James Mahoney		8. Performing Organization Report No. CAPLAB 11-2020
9. Performing Organization Name and Address University of Connecticut Connecticut Transportation Institute 270 Middle Turnpike, U-5202 Storrs, Connecticut 06269-5202		10. Work Unit No. (TRIS) N/A 11. Contract or Grant No. 13. Type of Report and Period Covered Final- CY 2019
12. Sponsoring Agency Name and Address Connecticut Department of Transportation 2800 Berlin Turnpike Newington, CT 06131-7546		14. Sponsoring Agency Code
15. Supplementary Notes A report generated in cooperation with the U.S. Department of Transportation and Federal Highway Administration		

16. Abstract

Presented herein is the second annual administrative report on pavements for the Connecticut Department of Transportation (CTDOT). This report provides a summary of the current condition (2019 data) of pavements for two roadway systems; 1) the entire CTDOT-maintained roadway network (including state NHS) and 2) the National Highway System (NHS) designated roads in Connecticut (state- and town-maintained NHS). Also described within are CTDOT's paving programs, condition projections, and targets, anticipated available funding, and projections of future activity in Connecticut resulting from the use of the CTDOT Pavement Management program. This annual report will be used to produce future Transportation Asset Management Plan (TAMP) updates on a yearly cycle.

17. Key Words	18. Distribution Statement		
Network Asset Management, Pavement Management, Pavement Preservation, Pavement Performance, State of Good Repair	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA. 22161		
19. Security Classif. (Of this report)	20. Security Classif.(Of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	83	N/A

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ACKNOWLEDGEMENTS

This report was prepared by the University of Connecticut, in cooperation with the Connecticut Department of Transportation and the United States Department of Transportation, Federal Highway Administration. The opinions, findings, and conclusions expressed in the publication are those of the author(s) and not necessarily those of the Connecticut Department of Transportation or the Federal Highway Administration. This publication is based upon publicly supported research and is copyrighted. It may be reproduced in part or in full, but it is requested that there be customary crediting of the source.

FOREWORD

Except where noted otherwise, the information presented in this document for mileage, pavement type distributions, pavement condition ratings, future condition performance projections, treatment costs, and vehicle miles of travel is determined using calendar year 2019 data. In several cases, 2018 data were used in alignment with the Connecticut Transportation Asset Management Plan (TAMP) Fact Sheet, published in 2020. Generally, the TAMP information was derived using calendar-year 2018 data. Construction data reflects information through the 2020 construction season.

METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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1. INTRODUCTION AND BACKGROUND

Purpose of Annual Report

Presented herein is the second annual administrative report on pavements for the Connecticut Department of Transportation, for the calendar year 2020. This report provides executive level management and outside parties with information about Connecticut's pavement conditions (both current and the past few years). This report provides a summary of the current condition of pavements for two roadway systems; 1) the entire CTDOT-maintained roadway network (including state NHS) and 2) the National Highway System (NHS) designated roads in Connecticut (state- and town-maintained NHS). Also described within are CTDOT's paving programs, funding, and projections of future activity in Connecticut resulting from the use of the Connecticut Department of Transportation (CTDOT) Pavement Management System (PMS). Except where otherwise noted, the current information presented in this document, such as pavement condition, treatment costs, etc. is derived from calendar year 2019 data.

Asset Management Objectives for Maintaining "State of Good Repair"

'Pavement' is the layered structure that comprises the road. Pavements are designed to support anticipated traffic loads and provide a safe and relatively smooth driving surface, to provide good ride quality. Maintaining pavements in a smooth and good condition lengthens their life, enhances safety, reduces road user operating costs, reduces vehicle delays, reduces fuel consumption, reduces air pollution, and minimizes pavement maintenance costs.

CTDOT employs a Pavement Management System (PMS) for the analysis of collected pavement-rating data and then reports on the current and projected conditions of the highway network. The PMS is also used to evaluate the effectiveness of planning and funding priorities and to provide guidance in the decision-making process.

Monitoring and measuring pavement conditions (as well as other transportation asset conditions) enables CTDOT to assess the performance of the transportation system, analyze deficiencies and predict future needs, allocate funding, and schedule projects to address what is known as the 'State of Good Repair' (SOGR). CTDOT has adopted a set of Transportation Asset Management (TAM) objectives that are in line with the vision and mission of the agency. The CTDOT TAM objectives are:

- Attain the best asset conditions achievable given available resources, while striving towards a State of Good Repair
- Deliver an efficient and effective program to optimize the life of our infrastructure
- Improve communication and transparency regarding decisions and outcomes
- Achieve and maintain compliance with Federal requirements regarding asset management

Performance measures, projections, targets, and goals were developed to help achieve CTDOT TAM objectives. These are being linked so that CTDOT can operate more effectively, and simultaneously make progress towards federal requirements and state goals. This also allows for the establishment of funding priorities and targets that are achievable.

History of Connecticut Roadways

Connecticut's official highway network was defined over 125 years ago upon establishing the first Connecticut Highway Commission. A road census conducted in 1895 identified 14,088 miles of roads in Connecticut, with only 463 miles being of stone or macadam composition at that time. By the end of 1895, 35 additional miles of road were built. (CTDOT 2019) From 1895 to 1950 approximately 35% of CTDOT's current network of paved roads were constructed. As is typically the case today, the majority of these pavements were built with a 20-year design life.

Based on the results of studies over the last 15 years, prioritizing repair work by "worst-first," which emphasizes treating pavements in poor condition, is finally recognized to be the least effective means of expending limited highway funds and maintaining a highway network. According to FHWA, state DOTs should consider applying treatments well before pavements reach threshold conditions of deterioration. Therefore, FHWA recommends that states should prioritize the distribution of highway funding to meet preservation needs before rehabilitation or reconstruction of roadways. (FHWA 2015)

In 2010, CTDOT began transitioning to a balanced program of pavement maintenance, preservation, overlays, and rehabilitation; the intent being to move away from the "worst first" strategy. CTDOT's preservation program strives to extend the life of pavements in good condition. Within its rehabilitation and resurfacing programs, CTDOT has been working to extend the useful life of pavements, through increased use of preservation treatments. The main objective is to keep road segments from slipping into a reconstruction-needed category, which typically costs four to five times higher per lane mile than, for instance, mill and fill (see Table 1-1 and Figure 1-1). By overlaying a road before it significantly deteriorates, 15 to 20 years of useful life can be added at a substantial cost savings over reconstruction. Once a road has deteriorated to the point that it must be reconstructed, the opportunity for preventive maintenance and preservation is lost.

Table 1-1 contains the relative costs of various treatments used for roadways in Connecticut. Preservation treatments, such as mill and fill, ultra-thin bonded overlays, and asphalt-rubber chip seals cost between 50 and 90 percent less, both on a unit cost and per-mile basis than more complex activities associated with rehabilitation and reconstruction. Figure 1-1 illustrates graphically the relationships between effectiveness, costs, and appropriate timing of various treatments.

Table 1-1 General Illustration of Treatments and 2019 Approximate Unit Costs for Showing Relative Life Cycles (see also Figure 1-1)*

FHWA Work Type	CTDOT Treatment	Expected Surface Life (years)	Approx. Cost per Year of Life, ($)
Initial Construction	New Construction	20	300,000
Reconstruction	Reconstruction Flexible	10-20	240,000
Reconstruction	Reconstruction Composite	10-20	260,000
Rehabilitation	Structural Rehabilitation	15	67,000
Preservation	Mill and Fill	8-10	61,000
Preservation	Ultra-thin bonded overlay	7	25,000
Preservation	Asphalt Rubber Chip Seal	5	20,000
Preservation	Crack and Joint Fill & Seal	3	8,333
Maintenance**	Pothole repair,	1-5	N/A
Maintenance**	Emergency overlays	1-3	100,000

* contains approximate costs only for illustrative purposes, as costs can vary significantly by project, location and timing.
**These items are not necessarily eligible for federal funds

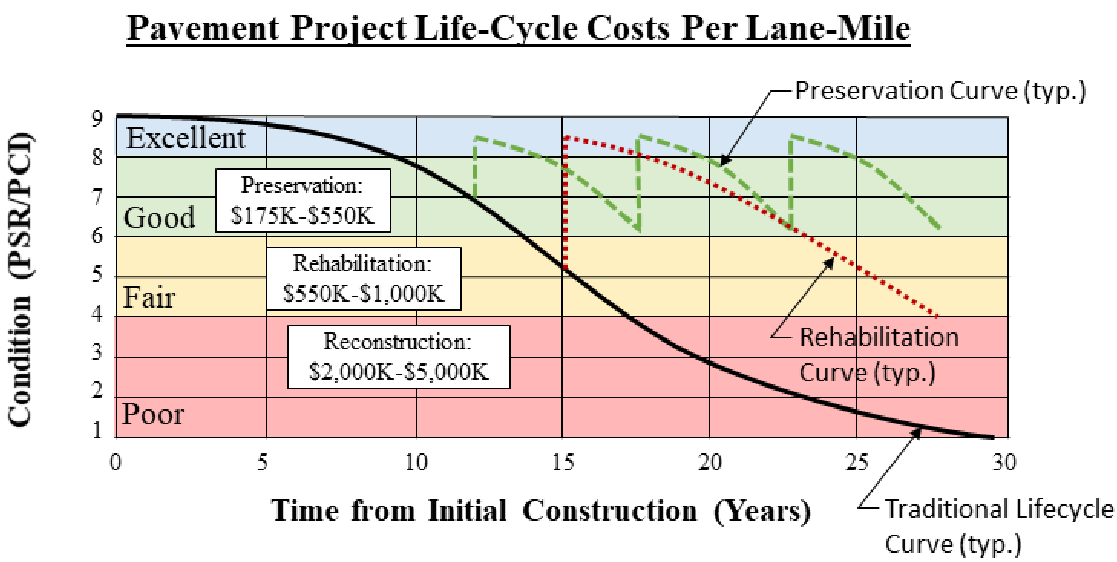


Figure 1-1 Illustration of General Costs and Appropriate Timing for Pavement Remediation (Lane-miles)

Note: The majority of existing state-maintained roads were designed with a 20-year structural design life. Through rehabilitation and resurfacing programs, CTDOT has managed to extend original expectations.

CTDOT Pavement Management System

CTDOT's PMS was first developed and implemented in the early 1980s. It has continually evolved since via incorporation of various existing and new paving programs such as the maintenance resurfacing program, pavement preservation, contract construction rehabilitation, use of prioritization and optimization routines for identifying candidate roadway sections for activity, performance prediction modeling, and cost estimating for budgeting.

Data Collection

Since the 1970s, CTDOT has been one of the pioneers and leaders in highway-speed road survey technology. This technology has evolved to become one of the most critically important and prominent tools in use by CTDOT and in many other state DOTs. The equipment enables the collection of highly technical, detailed, and complex pavement condition and infrastructure data, which is critical not only to planners and designers in the state but also required for reporting to FHWA for performance metrics. Pavement images and sensor data collected by two (2) specially equipped Fugro Roadware Automatic Road Analyzer 9000 (ARAN) vans (Figure 1-2) are processed to identify the presence of different types of pavement distress, including wheel path rutting, cracking, patching, raveling, faulting, as well as surface cross slope. (Faulting applies to concrete pavements only, which make up approximately 0.5% by centerline miles of CTDOT's pavement network.). The ARANs also provide 3D imaging using a Laser Crack Measurement System (LCMS), which includes two scanning lasers. This provides great detail in the measurement of cracking, Starting in 2015, the ARANs were updated to include sensors that feature laser line sensing (versus point laser sensing) located along each wheel path to collect longitudinal profiles used to compute roughness measures. In 2020, the existing CTDOT Van #9 was upgraded with LCMS®-2 technology, Solid State On-Board Memory, and a new Distance Measuring Instrument (DMI). This proved necessary due to the fact that Pavemetrics® – the producer of the sensor was discontinuing support of the LCMS®-1 units previously installed on Vans # 8 and #9. Table 1-2 lists the equipment components contained within the two current CTDOT ARAN vehicles (vans 8 and 9).

Data flows into the CTDOT PMS from several sources (Figure 1-3). Roadway inventory data (e.g., lane widths, route mileage, intersection locations) are merged with pavement condition data (e.g., level of distress present from annual ARAN survey), and activity data (e.g., maintenance, paving, or construction). The pavement condition data are collected by the Photolog Unit in the Bureau of Policy and Planning, Roadway Information Systems Section. The entire CTDOT-maintained road network, as well as municipally-owned segments of the NHS, are surveyed each year.

Figure 1-2 CTDOT Photolog Vehicle (One of Two Vehicles Currently Utilized)

Table 1-2 CTDOT ARAN 9000 Series Vans and Latest Equipment Installed on each (CTDOT 2018b))

CTDOT ARAN System Component	Component Description
Geographic Coordinates	Real-Time Differential GPS +POS LV Inertial Positioning System (1-meter accuracy) using OmniStar
Distance	Wheel-mounted Distance Measurement Instrument Measures linear distance within ± 0.005%
Roughness (IRI)/Longitudinal Profile	South Dakota Profiler RoLine – 4” Footprint Line Laser (Laser SDP/2) in Front Bumper Enclosure. Class 1 Profiler under ASTM E950, AASHTO R56-10 Certification & ASTM E1926
Crack Detection, Classification & Rating, Texture, Rutting & Transverse Profile	Pave3D Pavemetrics Laser Crack Measurement System (LCMS-1 or 2)
Right of Way (Front View) Imagery	SONY HD Camera w/90 Degree Field of View Lens

**Two current generation CTDOT vehicles are named ‘Van 8’, and ‘Van 9.’ The two vehicles are identical except for the chassis: Van 8: 2010 Dodge Sprinter; Van 9: 2015 Mercedes Benz Sprinter.*

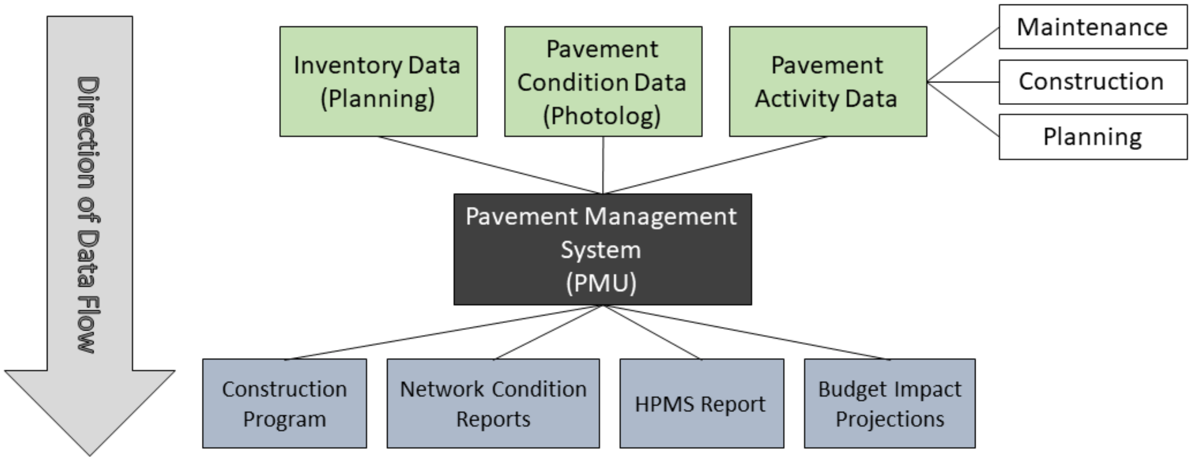


Figure 1-3 CTDOT Pavement Data Information Flow Chart

Pavement condition data are collected according to the CTDOT Data Quality Management Plan (DQMP) that was approved by FHWA on August 22, 2018. The DQMP addresses the following critical areas:

- Data collection equipment calibration and certification;
- Certification process for persons performing manual data collection;
- Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
- Data sampling, review and checking processes; and
- Error resolution procedures and data acceptance criteria.

Data Analysis

The condition data collected with the ARANs in the Photolog Unit are processed in the Pavement Management Unit and combined with existing meta-data specific to each roadway segment to calculate International Roughness Index (IRI) (roughness), rutting, cracking (structural and environmental), faulting, and cross slope and grade indices used for determining drainage adequacy. The above information is converted into representative indices used to calculate the Pavement Condition Index (PCI) described later in this report, as well as for data used to report the condition of the NHS. Condition ratings are collected every five linear meters along the roadway surface, aggregated by tenth-mile sections and then again by defined pavement-analysis sections, and ultimately stored in a Structured Query Language (SQL) database. Condition data are summarized by lane-miles for federal Highway Performance Monitoring System (HPMS) reporting, and FHWA subsequently uses the reported data to determine the Federal performance measures. Condition data are summarized by centerline miles (aka road or route miles) for State performance measures. In many cases, for comparison purposes, data are shown both ways in this annual report.

CTDOT uses a customized version of Deighton Total Infrastructure Management System (dTIMS®) software to analyze, present the current, and predict the future condition of both

CTDOT-maintained pavements and the designated NHS in Connecticut. The system was initially implemented in 1998 and has been upgraded since. It provides capabilities for storing, reporting, and viewing pavement inventory and condition information. Primary data sources for dTIMS and the PMS include basic road inventory data from the CTDOT Road Inventory System, pavement condition data collected each year with the photolog vans described earlier, and pavement treatment history information. In addition, dTIMS includes soil classification information by town (poor or good) provided by the CTDOT Soils and Foundation Unit. dTIMS is also used for analyzing alternative investment scenarios and for assisting with planning a single- or multi-year program of projects for pavements. More details about the dTIMS application and database are provided in Table 1-3:

Table 1-3 Deighton Total Infrastructure Management System (dTIMS®) (CTDOT 2019b)

Data Type	Description
Pavement Inventory	Width; Number of Lanes
Road Inventory	Functional Class; NHS Designation; Overlaps (parent routes carried); Divided/Undivided Status; Administrative District; Annual Average Daily Traffic (AADT); Percent Heavy Trucks
Pavement Construction History and Composition	Year of Original Construction; Pavement Type and Thickness; Year of Last Resurfacing
Soil Assessment	By Town
Detailed (0.1 mile) Pavement Condition	Cracking (Length and Orientation by Road Zone); Cross Slope; Roughness (IRI); Rutting; Faulting (on Concrete Pavements Only)
Summarized Pavement Condition	PCI (1-9 scale: based on IRI (ride quality), Rutting, Cracking, Disintegration, Drainage); Structural Index; Environmental Index; IRI
Pavement Activity	• Maintenance Vendor-in-Place (VIP) Projects (Initial, monthly, and final reports– includes milling and filling depth) • Construction Projects with greater than 300 tons of Hot Mix Asphalt (HMA)
Decision Tree Rules	Types of treatments recommended for pavement sections based on their condition indices
Unit Costs	Used to calculate costs for each of the pavement treatment types for unconstrained needs or scenario analysis;
Deterioration Performance Models	Used to predict changes in pavement condition over time for each pavement family (*)
Planned or Programmed Pavement Projects	Used within scenario analysis to assist in scheduling of future projects; also used to support the development of resource-constrained work programs

*Over 100 pavement families are defined in dTIMS according to climatic zone, pavement type, pavement thickness, traffic volume, and soil condition.

Transportation Asset Management Plan (TAMP)

Rather than continuing to rely solely on a traditional decentralized approach in which individual units such as Pavement Management, Office of Construction, Bridge Safety & Evaluation, and Traffic Engineering collect, store and report on data to meet their individual operational needs, CTDOT is moving toward an enterprise approach to make the best use of agency data for informed decision-making. The initial Transportation Asset Management Plan (TAMP) was published in July 2018 for roads, bridges, and other assets such as sign supports, traffic signals, and pavement markings. The FHWA and federal legislation direct that states maintain an asset management plan that is supported by a pavement management system. States are required to use pavement management systems, such as described earlier for CTDOT, which, in addition to other capabilities, collect, process, store, and update inventory and condition data. The TAMP is the federally-required plan intended to document transportation asset management practices and processes at CTDOT. Rules outlined in “Moving Ahead for Progress in the 21st Century Act” (MAP-21) and “Fixing America's Surface Transportation Act” (FAST) require reporting by all states for bridges and pavements contained on the NHS.

In addition to NHS-required information for pavement and bridge assets, CTDOT has opted to include traffic signals, signs, sign supports, pavement markings, and highway building assets in its TAMP. Additional assets including guiderail, illumination, and others will also be included in future versions of CTDOT’s TAMP.

Specific to pavement assets, the CTDOT TAMP includes:

- Inventory and condition
- Data management
- Asset valuation
- Performance measures
- Performance targets
- Performance gap analysis
- Life cycle planning
- Risk management
- Financial planning, and
- Investment strategies

The Connecticut TAMP addresses assets on the two previously-noted overlapping highway systems: CTDOT-maintained roads and the NHS designated routes. Even though the NHS in Connecticut is primarily composed of CTDOT-maintained roads, 159 lane miles of NHS town roads are maintained by local municipalities.

2. CONNECTICUT ROADWAY NETWORK CONDITIONS

Overview of Network Mileage

According to (FHWA 2015), in 2012, the Nation’s public road network included 4,109,418 miles of roadways: 223,257 miles of this network (5 percent) are designated as the National Highway System (NHS); with a subset of 47,714 miles comprising the Interstate System (Interstates). The Interstates (1.16 percent of the nation’s centerline miles) carry 25 percent of the total Vehicle Miles Traveled (VMT) in the United States.

Statistics on the extent and length of Connecticut’s roadway network, in both centerline (road) miles and lane-miles, are provided in Table 2-1, below. Although Connecticut is the third smallest state in terms of area, it is ranked 44th for length of network centerline road mileage (USDOT 2017a).

Table 2-1 Connecticut Centerline (Roadway) Miles and Lane-Miles* (2019)

Classification	**Centerline (Road) Miles**	**Lane-Miles****
CTDOT Maintained NHS	**1,406**	**5,017**
Interstate	**346**	**1,882**
Non-interstate NHS (state only)	**1,060**	**3,136**
CTDOT Maintained Non-NHS	**2,310**	**5,527*****
Total CTDOT maintained routes and roads (excluding ramps)	**3,716**	**9,831**
Municipal NHS	**56**	**159**
Total Municipal Roads	**17,446**	**~35,300**
Total Municipal and CTDOT Roads	**21,162**	**~45,159**

* All figures have been rounded to the nearest whole mile. These mileages are from CTDOT Bureau of Policy and Planning Public Road Mileage as officially reported to the FHWA on Dec 31, 2019. The exact mileage on the ground, used for inventory, measured with automated equipment, and analyzed with software varies slightly from these reported figures. These totals exclude 110 centerline miles of Federal roads and 305 centerline miles of state park, state forest, and state institution roads.
**Lane-miles are defined as centerline (road) miles multiplied by the number of lanes. These miles do not count shoulders as lanes.
***State Routes and Roads Lane Miles includes 249 lane miles of bridges and 464 lane miles of ramps.

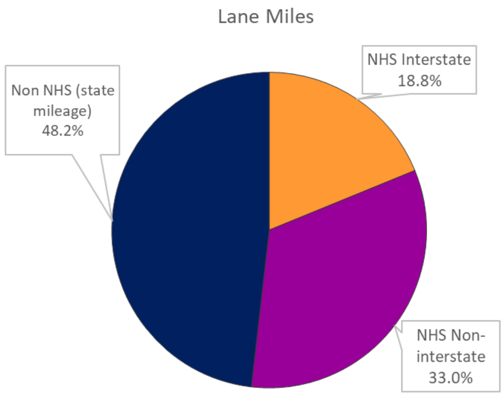
Table 2-2 provides the number of centerline miles and lane-miles in Connecticut within each of the four CTDOT-designated highway maintenance districts. For reference, maps showing CTDOT districts, as well as regional planning agencies within Connecticut can be found in Appendix 4.

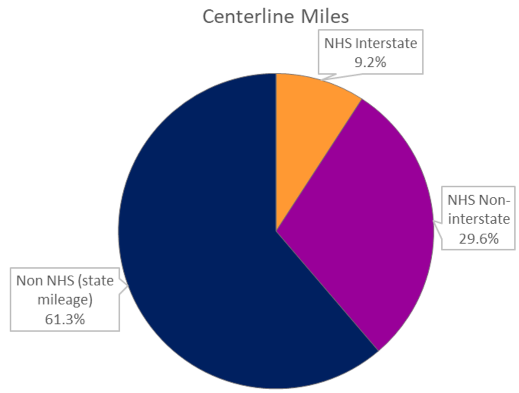
Table 2-2 Centerline (Road) Miles and Lane-Miles by CTDOT District (2019)*

	Centerline (Road) Miles	Lane-Miles
District 1	792	2,455
District 2	1,132	2,692
District 3	706	2,190
District 4	1,086	2,494
Total**	3,716	9,831

Notes:* These mileages are from CTDOT Bureau of Policy and Planning Public Road Mileage
** The mileage varies slightly from these totals due to rounding.

Figure 2-1 below shows the relative distribution of NHS and non-NHS roadways in Connecticut as of December 31, 2019, the latest available year-end dataset. This excludes Federal roads, and CTDOT maintained bridges and ramps.





Connecticut	*Centerline (Road) Miles*	*Lane-Miles*
NHS Interstate	346	1,882
NHS Non-interstate	1,115	3,295
Total NHS (state + town)	1,462	5,177
Non NHS (state mileage)	2,310	4,813
Total NHS (town + state) + Non NHS (state mileage)	3,772	9,990

Figure 2-1 Distribution of all NHS and CTDOT Maintained non-NHS Roadways in Connecticut (2019)

The average surface age from 2008 through 2018 of the CTDOT-Maintained network can be seen in Figure 2-2 CTDOT-Maintained Network Average Surface Age Over Time. It is noteworthy that the scale of the y-axis is only 8.6 to 10, in that the fluctuation in age is relatively tight. In fact, a regression model of age versus time suggests a trend line slope of 0.05, indicating that CTDOT's network pavement surface is getting younger at a rate of 0.17 years per year.

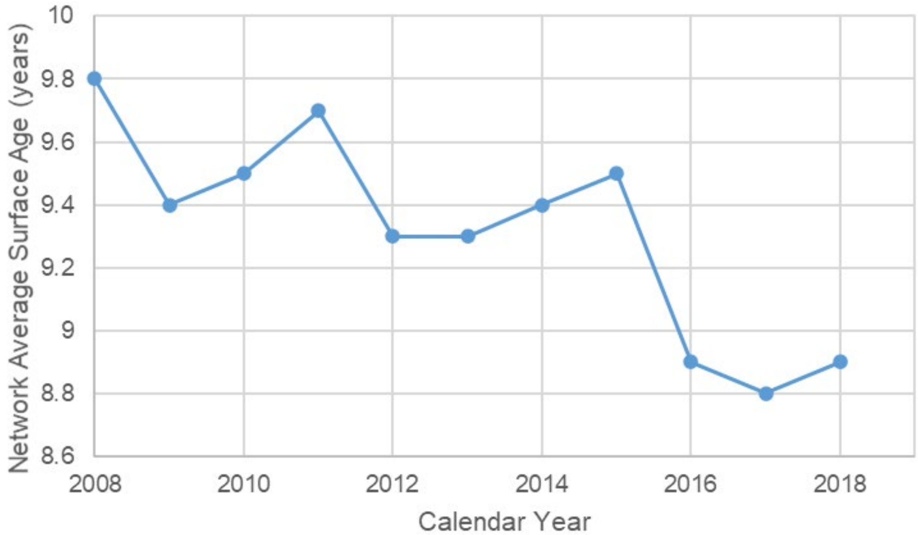


Figure 2-2 CTDOT-Maintained Network Average Surface Age Over Time (2008-2019)

<u>Functional Classification System for Roadways</u>

The FHWA defines the highway functional classification system in the 2016 HPMS Field Manual (USDOT 2016 & FHWA 2013). *Access control is a major factor in defining the functional classification system.* However, the use of the word "access" in this context refers to the ability to access the roadway (not the abutting land use). The functional classification system groups roadways into a so-called "logical series of decisions" based upon the character of travel service the roads provide. Detailed definitions for the seven rural and urban functional classification categories can be found in Appendix 7.

The centerline miles of state-maintained roadways in Connecticut as categorized by the federal functional classification system are given in Table 2-3 below.

Table 2-3 CTDOT Centerline (Road) Miles* by Functional Classification (Rural and Urban)(2019)**

	Functional Classification & Code							
CODE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
CLASS	*Interstate*	*Other Freeways & Expressways*	*Other Principal Arterial*	*Minor Arterial*	*Major Collector*	*Minor Collector*	*Local*	***Total***
RURAL	29	36	121	216	738	22	7	1,169
URBAN	318	244	658	939	366	10	13	2,547
TOTAL	347	279	779	1,155	1,104	32	20	3,716

* Mileage excludes ramps

** Mileages from CTDOT Bureau of Policy and Planning Public Road Mileage. Columns may not total due to rounding.

Vehicle Miles of Travel

Vehicle Miles Traveled (VMT) can be used to normalize network travel with the population. Due to high population density, Connecticut ranks as 37th overall in the U.S. for vehicle miles of travel on the network (USDOT 2017c). Eighty-two percent of total mileage in Connecticut is composed of locally maintained roads (17,446 road miles, see Table 2-1). These local roads, however, carry only 24 percent of the total VMT. Seventy-six percent of motor vehicle travel occurs on the CTDOT-maintained network of roads, which represents less than 18 percent (3,716 road miles) of total mileage in Connecticut.

Total annual and daily VMT on CTDOT roadways for selected years between 2010 and 2019 are given in Table 2-4 below.

Table 2-4 Total Annual & Daily VMT on Connecticut Roadways (2010 to 2019)*

Year	***CTDOT Annual VMT** (in millions of miles traveled)*		***CTDOT Average Daily VMT** (in millions of miles traveled)*	
	NHS only	***Entire Network***	***NHS only***	***Entire Network***
2019	18,928	23,954	***51.86***	***65.63***
2018	18,889	23,924	51.75	65.55
2017	18,762	23,779	51.40	65.15
2016	18,766	23,844	51.42	65.33
2015	18,788	23,849	51.47	65.34
2010	16,382	23,584	44.99	64.62

*All data from Policy and PlanningAnnual Vehicle Miles traveled equals average daily traffic multiplied by miles of roadway multiplied by the number of days per year (365) for each roadway category (e.g., interstate) then summed for all categories, excluding local roads.

Distribution of Pavement Surface Type

The distribution of roadway mileage by pavement type in Connecticut for both lane-miles and centerline miles is shown in Figure 2-3 below. This demonstrates that the predominant pavement surface type is flexible (asphalt concrete), representing approximately 59% and 70% of road miles and lane-miles, respectively. Most of the remainder of the pavement network is composite pavement, defined as Portland Cement Concrete (PCC) overlaid with bituminous (asphalt concrete) pavement. The amount of PCC (rigid pavement) remaining uncovered in Connecticut is less than 1% of the network.

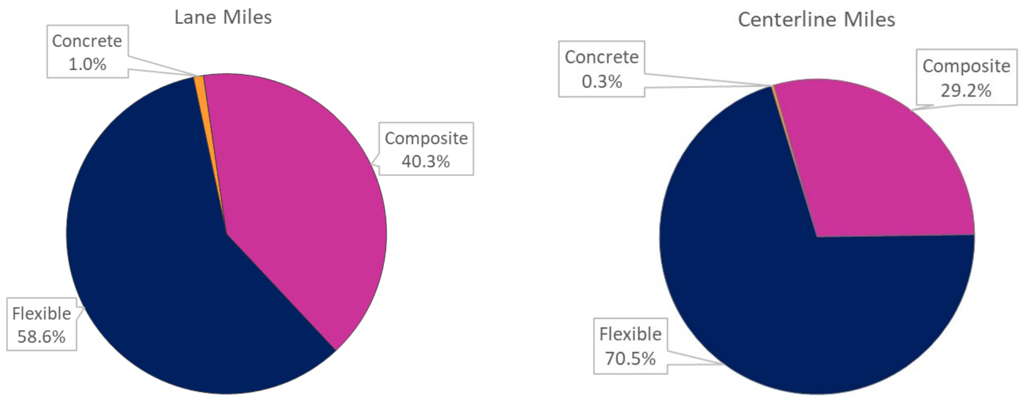


Figure 2-3 Distribution of CTDOT Pavement Network Surface Type by Centerline and Lane-Miles

Condition of Statewide CTDOT-maintained Roadway Network

CTDOT's internal performance measure for the overall category of CTDOT-maintained roads is the percentage of centerline miles in a state of good repair (SOGR)**.** SOGR was adopted by CTDOT in 2018 as the measure for all state assets reported in the TAMP.

The SOGR (also defined as SGR) is a term that was initially used by the Federal Transit Administration. According to "Transit Asset Management Practices" (FTA, 2010), SGR is defined as "a state in which a transit agency preserves its physical assets in compliance with a policy that minimizes asset life-cycle costs while preventing adverse consequential impacts to its service." In 2013, the American Public Transportation Association (APTA) developed a much simpler definition for SGR: "SGR is a condition in which assets are fit for the purpose for which they were intended" (APTA, 2013). SOGR has also been adopted by FHWA following the FAST Act, and as defined in Code of Federal Regulations 23 CFR 490.313, National Performance Management Measures, (April 2017) and is now required to be included in the TAMP.

CTDOT currently uses a composite rating system, referred to as the Pavement Condition Index (PCI) to express the condition of CTDOT-maintained pavements. A PCI is calculated for each 0.1-mile segment based on five pavement characteristic sub-indices; the overall PCI is a weighted average. The weights for the constituent indices which comprise the overall PCI are shown in Table 2-5 and described below.

Table 2-5 Relative Weights of Pavement Characteristics (Metrics) used in PCI

Index_Roughness [IRI] (10%)
Index_Rutting (15%)
Index_Cracking (25%)
Index_Disintegration (30%)
Index_Drainage (20%)

Index Roughness (based on International Roughness Index), Index_rutting and Index_cracking are similar to the FHWA metrics described later for the NHS. Index_Disintegration is the wearing away of the pavement surface caused by age, traffic, and weather exposure. In the CTDOT PMS, Index_disintegration is currently calculated using pavement age as a proxy for factors that are more challenging to interpret using automated data collection techniques. Drainage refers to the ability of the surface of the roadway to properly transport rainwater from the pavement structure. CTDOT uses information collected on pavement transverse cross slope and longitudinal grade to compute the index_drainage metric.

The PCI and each constituent index are scales from 1.0 to 9.0, where a pavement without defects would be scored as 9.0. A pavement section for which the PCI is calculated at 6.0 or higher is classified as being in a SOGR (see Figure 2-4). The numerical relationship of the PCI score for defining Good, Fair, or Poor roadways is also indicated in Figure 2-4.

Figure 2-4 PCI Ratings used to define SOGR and Pavement Condition

Figure 2-5 illustrates the difference in Connecticut road surfaces rated as being good, fair and poor. These are for illustration purposes only, since some elements of the PCI, namely roughness (IRI), and drainage are typically not a ‘visible’ condition, yet can affect the overall PCI rating.

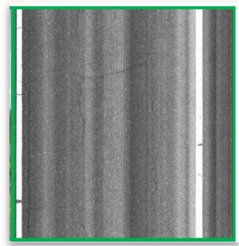
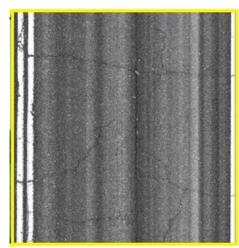
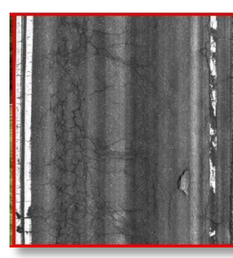
Good (PCI ≥ 6) Sample Section: CT Route 20 Mile point: 7.564 Sample PCI: 6.9	Pavements in Good condition exhibit minimal quantities of the measured distresses and low to moderate distress severities. A Good pavement requires a pavement preservation project to maintain or improve the pavement condition and delay costlier treatments.	 
Fair (4≤ PCI <6) Sample Section: CT Route 41 Mile Point: 9.890 Sample PCI: 5.4	Pavements in Fair condition exhibit moderate to large quantities of the measured distresses and a range of distress severities. A Fair pavement tends to be beyond the scope of a preservation project and requires a pavement rehabilitation project when the PCI values are at the lower-end of the PCI range in order to improve the pavement condition.	 
Poor (PCI < 4) Sample Section: CT Route 179 Mile Point: 9.310 Sample PCI: 3.5	Pavements in Poor condition exhibit large quantities of the measured distresses and high distress severities; in particular, structural failures. A Poor pavement is beyond the scope of a preservation project and requires either a major rehabilitation project or reconstruction to improve the pavement condition.	 

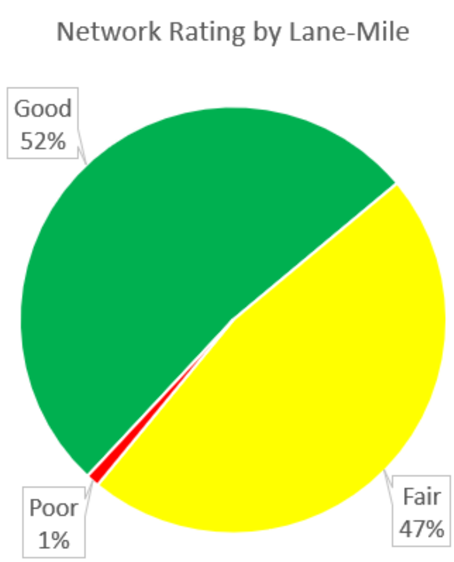
Figure 2-5 Illustrative Comparison of Good, Fair and Poor CTDOT-maintained Roads

The centerline miles of CTDOT-maintained roads in good, fair and poor condition are tabulated for all sections at 0.1-mile increments to determine the overall percentage of pavement in good, fair and poor condition. The results for 2019 conditions are shown in Table 2-6 below. The percentage of sections on the CTDOT maintained roads in 2019 that are in a SOGR (i.e., PCI ≥ 6 and rating of 'good') is 63.3%. It is worth noting again that these figures are for CTDOT-maintained roads only, therefore the condition of the 17,446 miles of municipal roads are not included in these percentages, nor are conditions for federal roads or state roads (parks, forests and institutions) that are not maintained by CTDOT. For a side-by-side comparison of the condition of the CTDOT-maintained roads by centerline mile versus lane-mile, see Figure 2-6.

Table 2-6 Connecticut Inventory and Conditions (2019) of CTDOT-Maintained Roadways Using the PCI by Centerline Miles (Excludes Towns)

Route Category	*Centerline Miles Good*	*% Good**	*Centerline Miles Fair*	*% Fair**	*Centerline Miles Poor*	*% Poor**	*Total Centerline Miles*
INTERSTATE	309	89.3%	35	10.2%	2	0.5%	346
NON INTERSTATE NHS	732	69.1%	304	28.7%	23	2.2%	1,060
NHS	1,043	74.2%	339	24.1%	25	1.8%	1,406
NON_NHS	1,312	56.8%	889	38.5%	109	4.7%	2,310
ENTIRE_NETWORK	2,353	63.3% SOGR	1,229	33.1%	134	3.6%	3,716

Notes: *These Good, Fair, and Poor percentages were calculated using CTDOT's Pavement Condition Index.



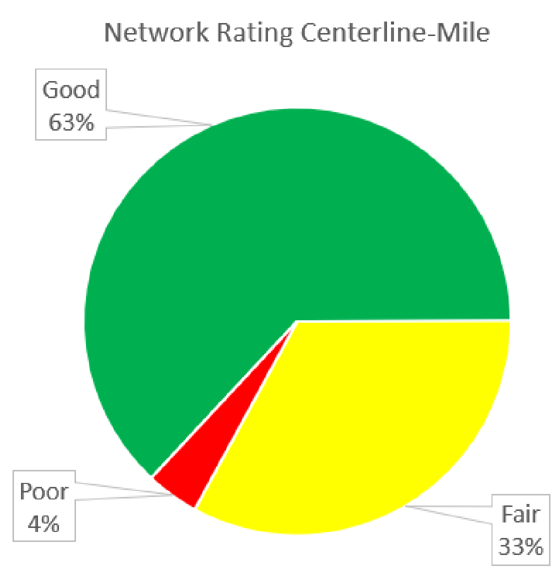


Figure 2-6 Conditions of CTDOT-Maintained Roadways (2019) Using the PCI, by Lane Mile and Centerline Miles (Excludes Town Roads)

Historical Pavement Data

Highway Performance Monitoring System data for the state of Connecticut was plotted as good/fair/poor from the year 2000 to present (**Figure 2-7**. It is important to note large technological leaps and adaptations to reporting requirements occurred across these two decades of pavement data. In general, the categorical conditions are trending in the right direction (increase in good, decrease in fair and poor).

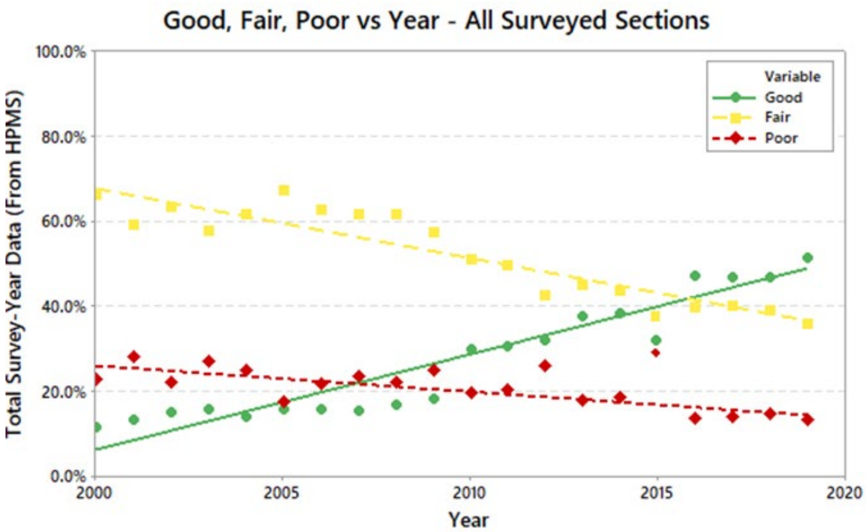


Figure 2-7 FHWA records for 2000-2009 and CTDOT records 2010-2019

Figure 2-8 on the other hand breaks IRI data into functional class groupings across the decade of available internal data for CT DOT. By separating the IRI into these functional classes, it can be seen that interstates (functional class 1) has been maintained at a relatively stable level with the largest increase in 'good' pavement occurring in functional classes 2 and 3.

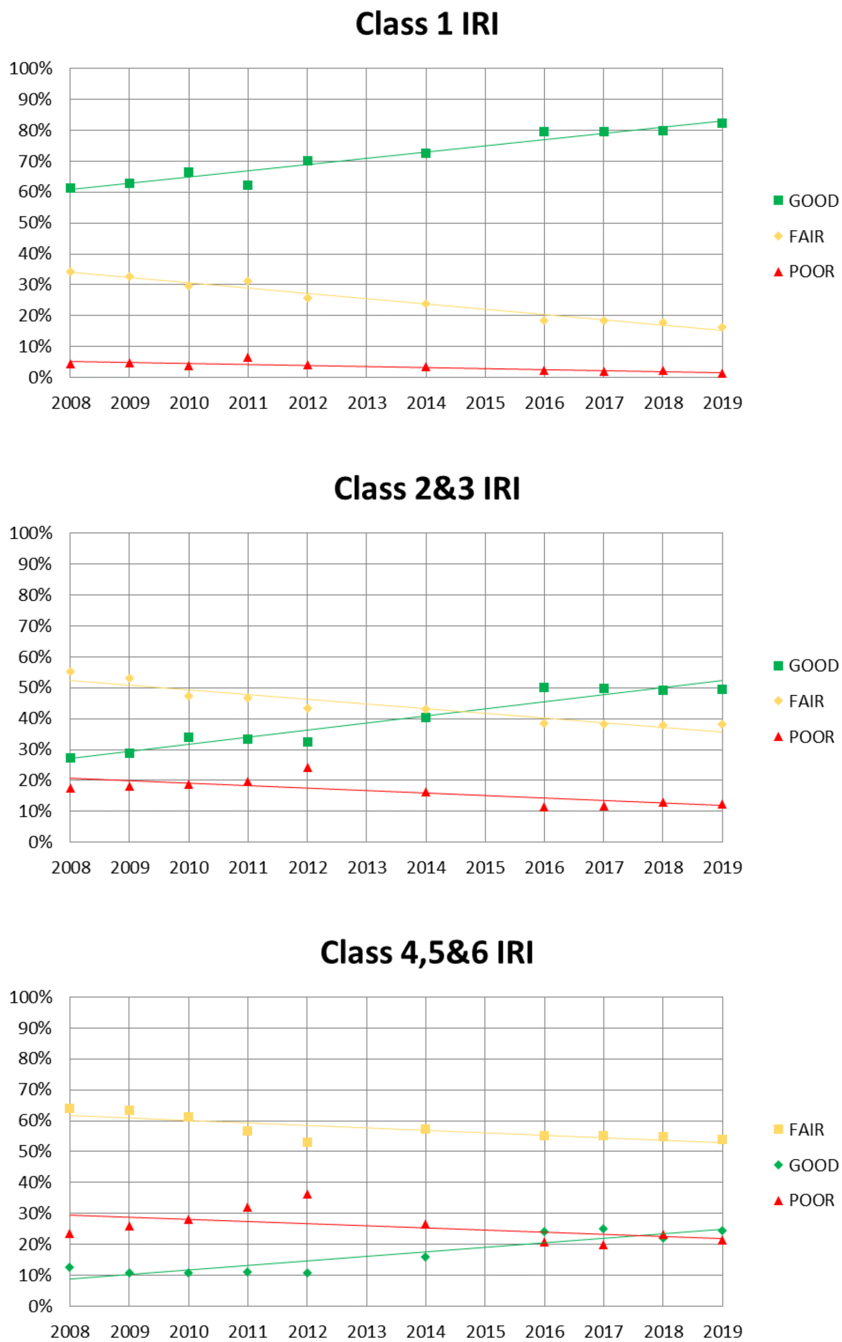


Figure 2-8 Historical IRI Data by Functional Class Grouping 2008-2019

Condition of National Highway System (NHS) in Connecticut

The FHWA defines the National Highway System (NHS) as consisting of the Interstate Highway System and other roads important to the nation's economy, defense, and mobility. The NHS was developed by the U.S. Department of Transportation in cooperation with states, local officials, and metropolitan planning organizations (MPOs). For Connecticut, the NHS includes interstates, other principal arterials, strategic highway network (STRAHNET), major strategic highway network connectors, and intermodal connectors. Examples of these designations as well as a map of Connecticut NHS routes can be found in Appendix 4.

For flexible (asphalt concrete), composite (PCC overlaid with asphalt concrete), and rigid (PCC surface) pavements, the performance metrics shown in Table 2-7 are used to calculate the pavement condition performance measures used for the NHS.

Table 2-7 NHS Performance Measure Metrics for Flexible, Composite and Rigid* Pavements

Performance Metric	**Pavement Type**		
	Flexible	*Composite*	*Rigid**
Ride Quality (International Roughness index-IRI)	Pavement roughness experienced by road users traveling over the pavements computed from a single longitudinal profile.	Same as Flexible	Same as Flexible
Rutting	The depth of ruts (longitudinal surface depression) within and along the wheelpath**).	Same as Flexible	Not Applicable
Cracking	The percentage of cracked pavement surface. The percentage of the total area exhibiting all severities of visible fatigue type cracking, in the wheelpath.**	Same as Flexible	The percentage of slabs in the section that exhibits transverse cracking
Faulting	Not Applicable	Not Applicable	Average vertical misalignment of adjacent slabs

* In Connecticut less than 0.5% of center-line mileage is composed of rigid surface (see Figure 2-6)
** There is a left and a right wheelpath, with each wheelpath being 1 meter wide, and the center of each wheelpath being separated by 70 inches.

For each of the above performance metrics, FHWA has established thresholds for good, fair, and poor condition (see Table 2-8). The performance metrics are used to calculate the FHWA performance measures for pavement condition. Conditions are assessed using these criteria for each 1/10-mile long pavement section. Unlike the CTDOT maintained network, which is summarized by centerline miles, the NHS condition is summarized and reported by lane-miles, per the requirement of FHWA.

The FHWA performance measures can be transcribed into a good-fair-poor rating as well (Figure 2-9). An individual section is rated as being in good overall condition if all of the metrics for that section are rated as good. An individual section is rated in poor condition when two or more metrics are rated as poor. For all other combinations, the individual sections are rated as fair.

FHWA Good/Fair/Poor Criteria for Performance Measures	
Condition Rating	Constituent Ratings (IRI, Cracking, Rutting)
Good	All three metrics rated “Good”
Fair	Up to one metric rated “poor”
Poor	≥ 2 metrics rated “Poor”

Figure 2-9 FHWA Performance Measure Criteria for Good/Fair/Poor Ratings

Table 2-8 Pavement Condition Thresholds for MAP21 Reporting used on the NHS in Connecticut

Metric	Good	Fair	Poor
IRI (in./mile)	<95	95-170	>170
Rutting (in.)	<0.20	0.20-0.40	>0.40
Cracking (%)			
-Asphalt	<5	5-20	>20
-Jointed Concrete	<5	5-15	>15
Cont. Reinforced Conc.	<5	5-10	>10
Faulting (in.)	<0.10	0.10-0.15	>0.15

The lane miles in good, fair, and poor condition are tabulated for all NHS sections to determine the overall percentage of pavement on the NHS in good, fair, and poor condition. Again, all of the methodology for the NHS described above is that prescribed by the FHWA in MAP21.

The resultant overall conditions for the NHS in 2019 are shown in Table 2-9.

Additional detail about the condition of the NHS, broken down into interstate and non-interstate NHS in Connecticut, using the categories delineated by FHWA is given in Figure 2-10. Specifically, CTDOT has adopted the FHWA’s pavement condition performance measures for the NHS pavements.

Table 2-9 Overall Connecticut NHS Inventory and Conditions (2019) (Includes State and Town NHS)(FHWA 2020)

	Lane miles	Good	Fair	Poor
NHS Pavement*	5,177	50.25%	47.4%	2.35%

*Note: "Missing, invalid or unsolved lane-miles are excluded from calculations to determine G, F, P percentages. Lane miles on the full extent basis coded as bridges in HPMS are also excluded from the calculations but are included in the total lane-miles.

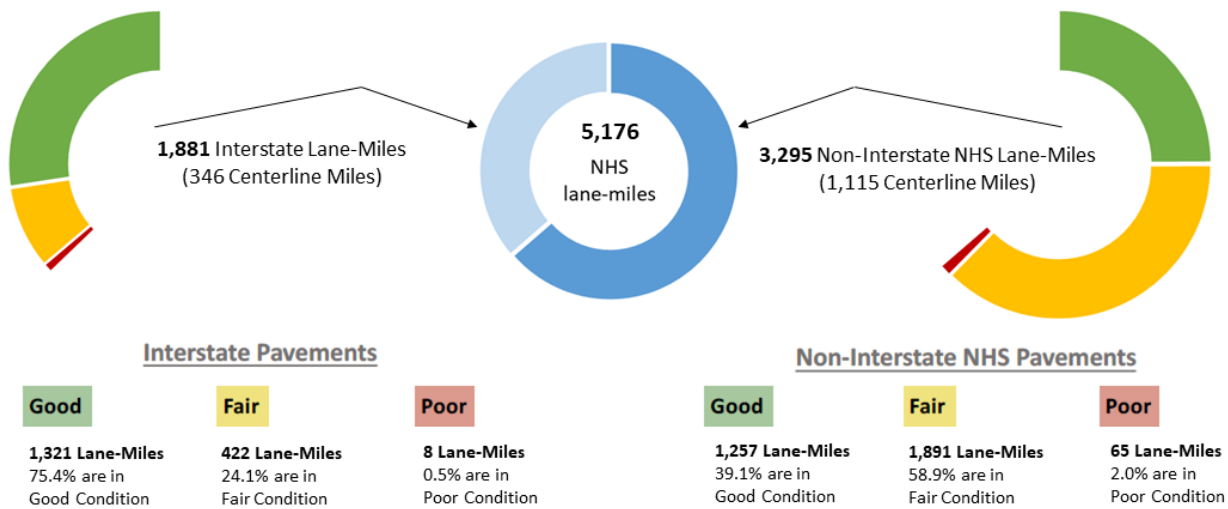


Figure 2-10 Connecticut NHS Pavement Inventory and Conditions as Required for FHWA Reporting (Based on 6/2020 CTDOT Asset Fact Sheet)

Condition of Roads by VMT

The Vehicle Miles Traveled on roads of various levels of condition can be an indicator of the roadway users' (motorists') experience. If, for example, a majority of travel occurs on poor condition roads, then the user experience is presumed to be less than satisfactory. On the other hand, a large amount of travel on roads in a SOGR is desirable, as it will contribute to lower overall user costs for the motorist. Since the larger amount of travel occurs on interstates and expressways in Connecticut, keeping those facilities in SOGR benefits the greatest number of users. Yet this cannot be the only consideration for network upkeep, otherwise, those living in more rural areas (e.g., Norfolk or Woodstock) would be traveling on generally poorer roads than either the through-state motorists or those residing in urban areas. An equitable balance must be achieved for the entire roadway network.

Tables 2-10 and 2-11, and Figure 2-11 show the distribution of VMT driven on pavements throughout a range of IRI roughness values, grouped into three levels: good (<95 in/mile), fair (95-170 in/mile) and poor (>170 in/mile). The resultant graphics indicate that the greatest amount of VMT driven on poor roads occurs on Non-NHS State-maintained roads. And as expected, the largest amount of VMT driven on good roads occurs on the Interstate System, as great as 79% in

2018. In Figure 2-11, it can be seen that when all state-maintained roads are examined as a group, approximately 66% of VMT is driven on good roads (IRI < 95 in/mile).

Table 2-10 Percent of VMT driven on poor pavement (IRI >170 in/mi) (2016-2018)

YEAR	Interstate	Non-Interstate NHS	Non-NHS State-Maintained Roads	All State-Maintained Roads
2016	2.70%	7.30%	19.20%	6.40%
2017	2.60%	7.50%	19.50%	6.40%
2018	2.50%	7.80%	21.90%	6.80%

Table 2-11 Percent of VMT driven on good pavement (IRI <95 in/mi) (2015-2018)

YEAR	Interstate	Non-Interstate NHS	Non-NHS	All Roads
2016	78.00%	62.40%	25.80%	65.90%
2017	78.00%	62.60%	24.10%	65.90%
2018	79.20%	62.30%	23.20%	66.20%

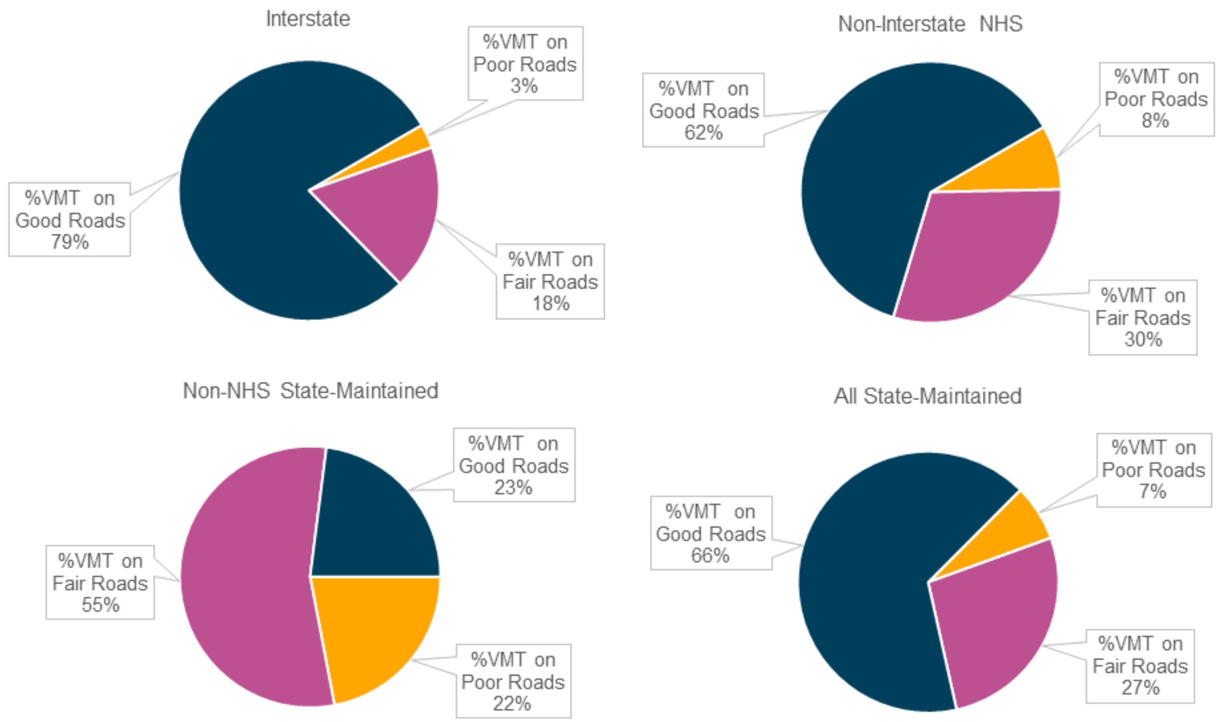


Figure 2-11 Percent of VMT driven on Good (IRI<95 in/mi), Fair (95≤IRI≤170 in/mi), or poor pavement (IRI >170 in/mi) (2018)

Historical Presentation of Pavement Performance Measures

Prior to the advent of the TAMP, and even before MAP21 was enacted, CTDOT reported the following two pavement performance measures as representative of the condition of the road network:

- Percent of State Maintained Roads with Acceptable or Better Ride Quality ≤170 in/mi (NHS)
- Percent of State Maintained Roads with Acceptable or Better Ride Quality ≤170 in/mi (Entire Network)

The definition of acceptable or better (≤170 in/mi) is utilized by FHWA for reporting the HPMS ride quality in their Highway Statistics Series reports (USDOT 2017). Since 2009, these along with many other transportation system measures have also been reported at CTDOT's performance measures website at *https://www.ct.gov/dot/cwp/view.asp?a=3815&q=448402*.

The above-cited pavement measures are based on ride quality only. Ride quality refers to the pavement's smoothness over a measured section of roadway. If a roadway isn't smooth often it is alternatively referred to as rough; thus, smoothness and roughness are used interchangeably when referring to measured ride quality.

The roadway characteristic known as the International Roughness Index (IRI), which is obtained from longitudinal profile measurements along the two-wheel paths of a travel lane, is used as a measurement for ride quality and is a well-established indicator of current roadway pavement condition as experienced by road users. In Connecticut, this is obtained with the CTDOT ARAN vehicles. The left wheelpath and right wheelpath IRI values are averaged to determine the IRI metric for the individual roadway segment being considered. The ride quality using IRI is reported as the change of height (inches) per mile of roadway, where a lower measured value indicates a smoother road.

To compute the CTDOT performance measures, the percentage of roadway centerline-miles having an IRI of less than or equal to 170 in/mile is calculated. That percentage represents the Percent of State Maintained Roads with Acceptable or Better Ride Quality.

Figure 2-12 below shows the condition of the CTDOT maintained network and the NHS elements of the network over the past nine years. Based on IRI alone the condition of both networks has improved every year since 2012. Note the PCI is not included in these particular graphs. In addition, the Ride Quality (IRI) values reported in this graphic use a 3-year moving average.

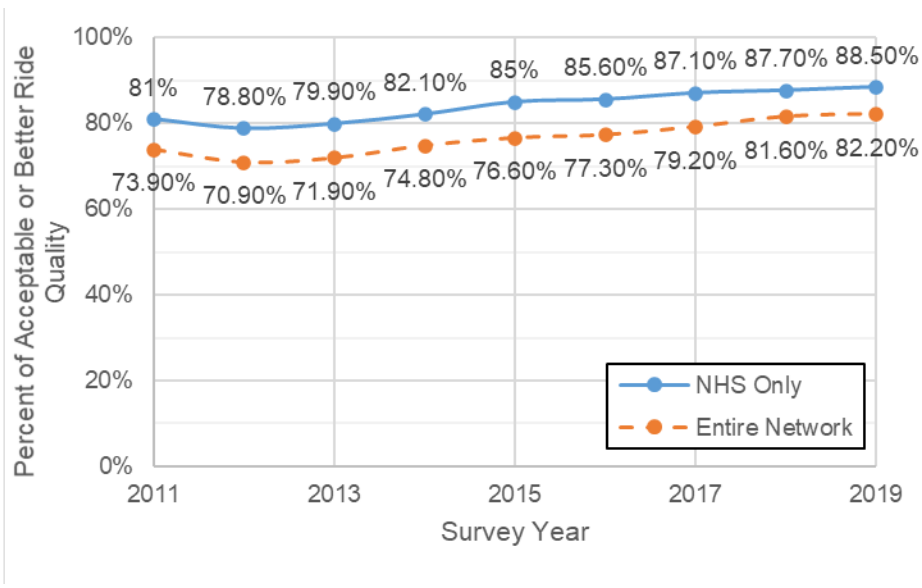


Figure 2-12 Ride Quality (IRI) Using 3-year Moving Average for the NHS Systems, and the Entire CTDOT-maintained Network, for Calendar Years 2011 through 2019.

Performance Projections for the Future

As defined in federal regulation 23 CFR 490.313, the FHWA requires states to include targets (as well as the measures discussed previously) for the condition of NHS pavements reported in the TAMP. Connecticut performance targets have been set to be aligned with both the federal requirements and state goals and objectives, **and are based on anticipated funding levels projected to be available** for transportation. The targets help guide Connecticut in allocating resources to projects and programs, to make progress toward the goals.

Using the measures of condition defined by FHWA, consistent with state asset management objectives, all State DOTs must also specify their desired "state of good repair" for the 10-year analysis period of the TAMP. The desired SOGR must also support progress toward achieving goals.

As part of the federal rule (23 CFR Part 490), states must set two and four-year asset condition performance targets. These targets must be included in the TAMP, as well as be reported separately to FHWA. States are also required to maintain NHS pavements to meet federally-established minimum condition levels. **The federal minimum condition level for pavements is to ensure that no more than five percent of pavement lane miles on the Interstate system are in poor condition**. Finally, for the TAMP the FHWA also requires that states establish a performance gap analysis process.

Federal Minimum Condition Level for Interstate System Highway Pavements
Maximum of 5% of pavement lane-miles in poor condition

Figure 2-13 Federal Minimum Condition Level for Interstate Pavements

Two and Four Year Performance Targets

Anticipated two- and four-year performance targets for CTDOT-maintained roads are shown in Table 2-12. This table shows the percentage of road mileage projected to be in a SOGR in the target year. Two- and four-year performance targets for Connecticut's designated NHS pavements are shown in Table 2-13. **Note that these target values are not necessarily desirable target values but instead are predictions of what is likely to occur based on projected funding (assuming no changes in funding over the projection period).**

Table 2-12 Performance Projections for CTDOT-Maintained Roads (Percent of Centerline Miles Projected to be in SOGR)

CTDOT Maintained Roads	**State of Good Repair**	
	2-Year Projection (2019 Data)	**4-Year Projection (2021 Data)**
Pavement (Centerline Miles)	66.7%	58.7%

Table 2-13 Performance Targets for Connecticut NHS (Percent of Lane-miles Projected to be in Good and Poor Condition)

	2-Year Targets (2020)		Actual (2020) 2019 Data		4-Year Targets (2022)	
	Good	Poor	Good	Poor	Good	Poor
Interstate Pavements						
Projections made in 2018 (lane-miles)	65.5%	2.0%			64.4%	2.6%
Actual Performance Using 2019 Data (lane-miles)			74.2%	0.1%		
Projections using 2019 Data (lane-miles)					73.9%	0.1%
Proposed 2020 Change to 2022 Target (lane-miles)					**70%**	**2.5%**
Non-Interstate NHS Pavements						
Projections made in 2018 (lane-miles)	36.0%	6.8%			31.9%	7.6%
Actual Performance Using 2019 Data (lane-miles)			37.2%	16.9%		
Projections using 2019 Data (lane-miles)					33.1%	2.1%
Proposed 2020 Change to 2022 Target (lane-miles)					**30%**	**5%**

NOTE: Performance targets were also submitted to FHWA by CTDOT via a report called "Transportation Performance Management - State Biennial Performance Report for Performance Period 2018-2021- 2020-MID PERFORMANCE PERIOD (MPP) PROGRESS REPORT." (CTDOT 2020b)

Ten Year Performance Goals

The ten-year Performance Goal for SOGR on CTDOT-maintained roads is presented in Table 2-14. The 10-year performance goals, based on national measures for NHS, are presented in Table 2-15. Table 2-15 shows the desired percentage of NHS in good and poor condition. The values shown in the table were determined based on a review of a set of performance projections performed at varying funding levels. The values reflect federal requirements and state goals and, if achieved, will satisfy the minimum NHS condition levels defined by FHWA. CTDOT recognizes adjustments to these long-term goals (for both NHS and the CTDOT network) will be needed over time as the asset management process matures and funding strategies change with future needs.

Table 2-14 10-Year Performance Goal, SOGR, CTDOT-maintained Roads

	SOGR
Pavement (Centerline Miles)	*80.0%*

Table 2-15 10-Year Federal PM Goals, Good and Poor, NHS Pavements

	Good	*Poor*
Interstate Pavement (lane miles)	*75.0%*	*<5.0%*
Non-Interstate NHS Pavement (lane miles)	*50.0%*	*<8.0%*

3. RECAP OF ANNUAL EFFORTS (2020)

Valuation of Total Pavement Assets

FHWA requires state DOTs to include an estimate of asset value for NHS pavements. The financial plan must also calculate the investment needed to maintain asset value. FHWA has acknowledged that there are many ways to estimate asset value and are leaving it to State DOT's to select their methodology. CTDOT chose to take a replacement value approach to calculate asset valuation. The asset valuation uses the asset inventory unit multiplied by the unit replacement cost and the non-asset related project cost factor that results in the replacement value. The replacement value is equal to the asset valuation for the asset. Unfortunately, this method of asset valuation does not reflect changes in asset condition. CTDOT is using this asset valuation data strictly as a means to fulfill federal requirements and communicate the importance of investment relative to the magnitude of the value of the assets. It is anticipated that non-asset related cost factors will be refined for future TAMP updates to account for costs related to design, rights of way, project administration, utilities, maintenance, protection of traffic, etc.

As shown in Table 3-1, the total replacement value for Connecticut's NHS roads (interstate and non-interstate) and for the CTDOT maintained roads that are not NHS, i.e., estimated value for the 3,719 centerline miles of CTDOT-maintained pavement, is $10,972,500,000. (CTDOT 2020a)

Table 3-1 Pavement Asset Valuation Estimates* (CTDOT 2020a)

Pavement Asset	**Inventory Unit (Square Yards)**	**Asset Valuation Replacement Cost**
CTDOT Maintained Pavement (includes NHS)	~104,500,000	$10,972,500,000

** NOTES: The unit replacement cost used in the calculation is $105/sy, and the non-asset related cost factor used is 1.0.*

Pavement Treatments Specified by CTDOT

Generally speaking, the pavement program categories used in Connecticut are:

- **Preservation** -- Keeping good roads good -- "apply the right treatment on the right road at the right time" To be effective, preservation treatments should be applied to roads in good condition without serious structural deficiencies.
- **Structural Overlays** –resurfacing program that could include mill and replace, straight overlay, or mill and fill
- **Rehabilitation** - restores pavements, in poor or fair condition, that have significant structural deficiencies.
- **Reconstruction** - removes the entire existing pavement structure to subgrade and replaces it with new materials.
- **New Construction** – New alignment or brand new full design of non-existing road
- **Other** Specialized Treatments or activities -- for less common situations encountered, or for unique projects special treatments or combinations of treatments are developed, such as Rubblization, full-depth reclamation, diamond grinding, and others

As there are multiple sources of funds for any given pavement treatment type, neither the pavement program listed above nor the sources of funding can be used to directly define pavement treatments deployed in the state. Sources of funds are discussed later in this report.

Table 3-2 contains a list of pavement treatments by program category that have been prescribed by CTDOT for DOT projects. There is, however, overlap between some treatments for certain categories. For example, specialized treatments can be used for preservation, rehabilitation, or reconstruction, and overlays for preservation and reconstruction depending upon the complexity of a specific project. There are several other treatments, such as slurry seals, fog seals, crack and seat, whitetopping, cold in-place recycling that are not specified routinely in CTDOT, and, therefore, are not included in Table 3-2. These other treatments, however, are considered and evaluated individually for possible implementation in Connecticut, typically via research studies.

Table 3-2 Connecticut Typical Pavement Treatments by Program Category

Program	***Treatment***
Maintenance	Pothole Patching
	Emergency Overlays and Repairs
Preservation	Crack Seal
	Crack Seal or Crack Fill
	Asphalt Rubber Chip Seal
	Ultra-Thin Bonded Overlay
Rehabilitation	Mill and Fill
	Microsurfacing
	Structural Overlay
	Functional Overlay
Reconstruction	Structural + Joint Repairs
	Light, Medium, Heavy (Flexible)
	Light, Medium, Heavy (Composite)
	Widening
New Construction Other Special	New Construction
	Rubblization
	Diamond Grinding
	Full Depth Reclamation
	In-Place Recycling

<u>Maintenance Resurfacing Paving Program</u>

A fairly substantial number of CTDOT miles of paving is accomplished each year under a paving program called the Maintenance Resurfacing Program which was initiated approximately 40 years ago. These projects are primarily state-funded using state bond financing. Although this has traditionally been an annual paving program developed approximately 18 months before the actual paving, PMU is currently developing multi-year programs, which involve pavement preservation projects as well (see also next section), and allow for better and more efficient planning and programming by utilizing models that include Cost-Benefit Analysis.

The original premise behind the Maintenance Resurfacing program, when it was established around 1981, was to overlay 10 percent (approximately 350 centerline miles) of the state-maintained road network each year. The actual miles paved has varied over the years based on fluctuations in available funding and CTDOT resources for planning and oversite of the program. The paving generally occurs between April 1st and November 30th, each year. This paving program was traditionally developed and overseen entirely in the CTDOT Office of Maintenance.

For calendar year 2020, paving was planned for approximately 437-lane-miles on 78 sections of 61 state roads. During the previous calendar year (2019) approximately 422 lane-miles were resurfaced. Generally, the pavement overlay is placed at 1.5 to 3 inches thick, including in some cases a leveling course followed by the surface layer. The amount budgeted for these 437 lane-miles (178 centerline miles) is approx. $69 million. A summary of the 2020 Resurfacing program is contained below in Table 3-3. The complete list of route segments planned to be paved during 2020 can be found in Appendix 2.

Table 3-3 Summary of Planned Maintenance Resurfacing Paving Program[1] (2020)

Treatment Type	Location	Number of state roads	Centerline Miles	Lane-Miles*	Approx. Material Quantities (tons)**	Approx. Cost ($million)***
Overlay	District 1	20	40.53	105.68	217,000	17.4
Overlay	District 2	12	44.96	103.42	217,700	17.4
Overlay	District 3	14	34.42	94.30	174,200	13.9
Overlay	District 4	15	57.65	133.60	248,400	19.9
Grand Total		**61**	**177.56**	**437.0**	**857,300**	**68.6**

Notes: [1] This Table is based on the CTDOT Resurfacing Program status as of September 1, 2020.
* Mileage excludes ramps
** An estimated average cost of $80/ton is used to calculate approx. quantities. However, before calculating the quantities the approximate cost was reduced by 30% to exclude safety improvement costs that are not directly related to paving.
***These are estimated costs from bids rather than actual payments.

CTDOT Pavement Preservation Program

As noted earlier pavement preservation is the preferred prioritization program, in that every mile of road that is preserved defers the higher cost of rehabilitation. Additionally, using network preservation techniques, it is easier to keep the condition of the roads in an SOGR and lower the highway user costs with smoother pavements. CTDOT has begun to prioritize and implement preservation projects utilizing a 3-year condition/funding projection. Three types of preservation treatments have been employed to-date; asphalt-rubber chip seals, ultra-thin bonded overlays, and mill and fill (overlay). The 2020 Pavement Preservation Program (PPP) included two ultra-thin bonded overlay projects valued at approximately $17 million: a 40-lane-mile treatment on I-84 and I-384 in East Hartford and Manchester, and a 40-lane-mile treatment on I-395 in Montville and Norwich. In addition to being low-cost preservation treatments that will extend the overall life of the pavement, the ultra-thin overlay will also increase skid resistance and decrease stormwater spray at the tire-pavement interface compared to traditional overlays. The 2020 PPP also included two Asphalt Rubberized Chip Seal (ARCS) projects valued at approximately $5 million: 40-lane-miles in eastern Connecticut (CTDOT District 2) and 10-lane-miles in northwestern Connecticut (CTDOT District 4). These cost-effective surface treatments are expected to last approximately ten years before these roadways need to be treated or resurfaced, which improves the overall life-cycle performance of the pavements. Like the ultra-thin treatments, the ARCS treatments will also improve the skid resistance of pavements.

Table 3-4 below contains a list of the locations where pavement preservation was planned to be utilized during 2020. A complete list of preservation projects for the years 2019 (226 lane-miles) and 2020 (216.5 lane-miles) can be found in Appendix 3.

Table 3-4 Summary of Planned Pavement Preservation Program (2020)

Treatment Type*	Location	Number of state roads	Centerline Miles	Lane-Miles**	Material Quantities	Approx. Cost ($million)
UTBO	District 1 Project 171-453	2	4.49	39.93	433,455 SY of UTBO[1]	9.86[1]
	District 2 Project 172-494	2	10.27	43.50	415,555 SY of UTBO[2]	6.64[2]
ARCS	District 2 Project 172-493	5	21.39	40.38	380,260 SY of ARCS[3]	3.84[3]
	Districts 3 & 4 Project 174-437	2	5.07	10.06	96,170 SY Of ARCS[4]	1.02[4]
Mill and Overlay	Districts 1 & 4 Project 170-3556	2	8.67	48.62	595,987 SY Includes mainline and ramps[5]	16.9[5]
	Districts 2 & 4 Project 170-3546	3	11.13	34.04	319,146 SY Includes mainline and ramps[5]	8.9[5]
GRAND TOTAL		16	61.02	216.53	2,240,573	47.27

*Notes:*UTBO=Utra-thin bonded Polymer Modified Asphalt (PMA)overlay*
ARCS=Asphalt-rubber chip seal
Mill and Fill = 2-3in.
*** Mileage excludes ramps except where noted*

1. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000---2020-3-Low-Bids/0171-0453.pdf*
2. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000---2020-3-Low-Bids/0172-0494.pdf*
3. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000---2020-3-Low-Bids/0172-0493.pdf*
4. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000---2020-3-Low-Bids/0174-0437.pdf*
5. *From preliminary quantities and estimates by Pavement Design*

Budget and Funding Sources (2017-2020)

Transportation funding in Connecticut comes primarily from federal and state gas tax revenues. The federal gas tax is the main revenue stream for federal highway programs through the Highway Trust Fund. In recent years the Highway Trust Fund has been supported with transfers from the General Fund. Connecticut's state gas tax revenue, gross receipts tax on petroleum products, a portion of the new car sales tax revenue, and other fees are directed to a transportation-related state account, the Special Transportation Fund (STF), which is used to fund a wide variety of transportation programs. This includes asset management activities through the Fix-it-First legislative authorization, among others. Connecticut sells bonds to finance transportation projects and pays the debt service using revenue from the STF.

Funding for roadway maintenance and improvements in Connecticut comes from three programs: The STF (described above), a second program that specifically gives priority to roadways in poor condition, and a third program that funds projects by addressing maintenance and preservation needs, as well as system expansion.

The 2018 TAMP assumed that 58% of the Maintenance Resurfacing pavement projects would take place on the NHS during the 10-year period of the TAMP. (CTDOT 2018a) The basis for this assumption is that of the Maintenance Resurfacing pavement projects that took place from 2011 to 2015, on average 58% were on the NHS. The 2018 TAMP also assumed that 85% of pavement preservation projects would take place on the NHS during the 10-year period of the TAMP. The basis for this assumption is as follows: From 2009 to 2015 about 96% of pavement preservation projects took place on the NHS. However, future preservation program expenditures are expected to focus on non-NHS preservation treatments in the near term.

Applying 58% to CTDOT's expected $69M in Maintenance Resurfacing funding and 85% to $25M in preservation funding yields a result of $61M future annual spending on NHS pavements. An additional $33M is projected to be available for non-NHS state roads each year. These figures are shown in Table 3-5, with all values reported based on 2019 dollars. Due to a continued focus on the pavement preservation program, the mix of preservation and maintenance resurfacing is projected to vary over the next 10 years as shown in more detail in Table 3-5, "Funding Uses", adapted from the 2019 TAMP. Even with the variations indicated, the totals (maintenance and preservation) are still projected to be $94M (2018 dollars) each year, with an additional $25M for rehabilitation (i.e., total $130 million).

Table 3-5 Funding Uses

	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Treatment	*Actual*		*Planned*			*Estimated*				
Initial Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Resurfacing	$ 69.0	$ 71.4	$ 56	$ 51	$ 47	$ 43	$ 38	$ 34	$ 29	$ 25
Preservation	$ 39.8	$ 47.3	$ 38	$ 43	$ 47	$ 51	$ 56	$ 60	$ 65	$ 69
Rehabilitation*	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25
Reconstruction (Replacement)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 134	$ 144	$ 119	$ 119	$ 119	$ 119	$ 119	$ 119	$ 119	$ 119
Project work recommended outside of the pavements analysis	*$ 83*	*$ 37*	*$ 110*	*$ 24*	*$ 31*	*$ 42*	*$ 48*	*$ 60*	*n/a*	*n/a*

**Estimates based on projects with multi-disciplinary work items, cost multipliers, and incidental [temporary] pavement quantities make the actual investment to the network difficult to quantify.*

Life-Cycle Planning

Life cycle planning (LCP) strategies for pavement are developed using predictive models for how pavements will deteriorate if no treatments are performed, as well as how they deteriorate under different treatment strategies. A treatment strategy is a sequence of maintenance, preservation, and rehabilitation events selected over the analysis period (which is adjustable, but can be as long as 30 years) based on inputs like funding constraints and priorities, as well as indicated distresses and pavement section work history. CTDOT creates models for pavement condition and deterioration using the Deighton dTIMS PMS. As noted earlier in this report, dTIMS is CTDOT's primary tool for storing, managing, analyzing, and reporting pavement condition information. The dTIMS model predicts future pavement conditions from current conditions using individual condition indices (transformations of distress measurements), which are understood by pavement managers to reflect pavement performance and consequently enable the application of treatments and prediction of performance.

CTDOT uses dTIMS as a primary component of its LCP strategy for pavements and to perform network condition projections. After planned pavement rehabilitation projects are committed, analyses/budget scenarios are run so dTIMS can select preservation treatments with a projected budget for preservation over 10 years. This allows for the comparison of the outcomes achieved with actual programming practice versus the outcomes possible with a strategy that optimizes life-cycle cost.

Performance Projections Based on Various Funding Levels

In what is called a scenario analysis, dTIMS is used to examine what treatments each pavement segment is eligible to receive for each year in the future, and develops possible strategies for each road segment over the scenario time horizon. These strategies are driven by the performance curves and the amount of improvement assigned to each treatment. Each strategy calculates an incremental benefit/cost value that represents the maximum benefit-to-cost ratio. dTIMS then compares across strategies to select an optimal set of treatments based on benefit/cost. Benefits are normalized using annual average daily traffic volumes (AADT), recognizing that, in this way, benefits will accrue to a larger number of users. As indicated earlier in Table 2-14 and Table 2-15, network condition projections using a stagnant total annual funding level of $119 million for pavement projects in CTDOT are anticipated to lead to declining conditions in the future. In fact, if the present level of funding is maintained and not increased, it can be expected to lead to a decline of both the SOGR rating for the CTDOT-maintained network and the percent of good roads for the NHS. This will also result in an increase of roads in poor condition, which will cause the overall network condition to approach the NHS threshold shown in Figure 2-13. This is indicated in the four-year target projections (see Table 2-14 and Table 2-15).

For the June 2020 CTDOT Pavement Asset Facts Sheet, a 10-year projection using three levels of funding was calculated to illustrate the long term sensitivity of the network condition to varying funding levels between zero and an elevated 'preferred' level. This is reproduced below as Figure 3-1, for the entire CTDOT maintained network. The three scenarios presented are

- zero funding,

- current funding ($130 million/year) and
- preferred funding ($475 million/year) as determined with the PCI system (see section 2 of this report).

Note that in Figure 3-1 the preferred funding ($475M) includes reconstruction, whereas the current funding ($130M based on the 2019 consistency review) only includes maintenance, preservation and rehabilitation.

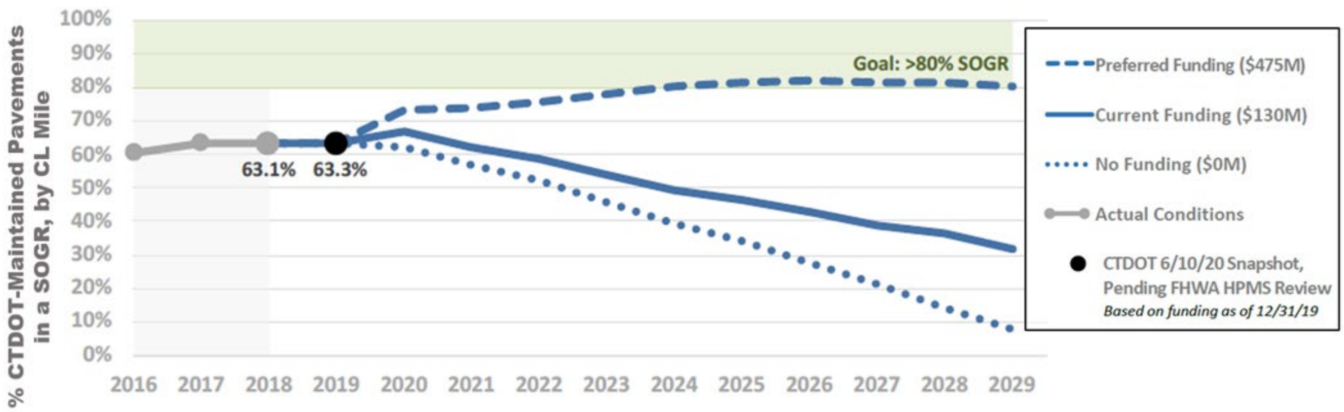


Figure 3-1 Connecticut Pavement Performance Projections for the CTDOT Maintained Network (from June, 2020 CTDOT Asset Fact Sheet)

Table 3-6 CTDOT Maintained Network Performance Projections at Current Funding Level ($119M Budget)

Year	**2020**	**2021**	**2022**	**2023**	**2024**	**Goal**
SOGR	**66.7%**	**62.3%**	**58.7%**	**53.9%**	**49.4%**	**80.0%**

Table 3-7 NHS Performance Projections at Current Funding Level ($119M Budget)

Year	**2020**	**2021**	**2022**	**2023**	**2024**	**Goal**
Interstate Good	**74.2%**	**75.1%**	**73.9%**	**72.8%**	**52.2%**	**75.0%**
Interstate Poor	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**<5.0%**
Non-Int NHS Good	**38.1%**	**36.4%**	**33.1%**	**27.0%**	**15.2%**	**50.0%**
Non-Int NHS Poor	**1.5%**	**1.7%**	**2.1%**	**2.4%**	**3.0%**	**<8.0%**

In the zero funding, it can be seen that the network condition will decline rapidly but at a steady rate. Even under the ‘current’ funding level, the network is predicted to decline significantly over the next ten years reaching a SOGR of 30% by 2029, well below the SOGR goal of 80%. Again using 2018 data, the level of funding required to reach the ten-year target for SOGR at 80% has been estimated at $475 million/year (total of reconstruction, maintenance, and preservation).

4. OTHER DOT PAVEMENT-RELATED ACTIVITIES (2018-2020)

Strategies to improve MAP-21 pavement performance metrics (crack percent, smoothness, and rutting) continue to be employed. These strategies include the use of polymer modified asphalt (PMA); deployment of pre-treatment repairs such as surface patching and crack filling of existing pavement before paving; the application of thin preservation treatments (ultra-thin overlays and rubberized chip seals) and for selected pavement sections, and incorporation of specifications for improved pavement smoothness and uniformity. The continued specified use of material transfer vehicles (MTVs) during paving operations and a requirement for contractors to obtain pavement cores for the determination of asphalt concrete pavement density have resulted in more pavements that are smooth, dense, and uniform. Undoubtedly, the above specification improvements, which were developed over years of collaboration with industry, are bearing positive outcomes.

New Technology

As noted previously, Connecticut has demonstrated its desire to be a leader in adopting and using automated technology for road inventory and analysis, i.e., products that eventually led the CTDOT to purchase and use ARANs for network data collection. CTDOT has been collecting network-level roadway images and data since the early 1970s.

To this end, the Photolog Unit at CTDOT will be upgrading and replacing survey vans currently in use to conform with the newest pavement laser scanning technology accepted nationally (LCMS-2). This new equipment will have the capacity to collect 3-dimensional surface texture data at highway speeds to an accuracy of 1 mm.

In 2019, the University of Connecticut in partnership with CTDOT continued its evaluation of traffic speed deflectometry data on 1,000 miles of state roadway. The state of Connecticut has one of the largest multi-year continuous deflection survey datasets in the nation at this time. Figure 4-1 below is excerpted from the interface developed by the company that developed the Traffic Speed Deflectometer Device(TSDD) used in Connecticut. CAP Lab researchers and CTDOT pavement engineers are working with this data and seeing how it can be best integrated at both project- and network-level (see additional later discussion under “Research Initiatives…”).

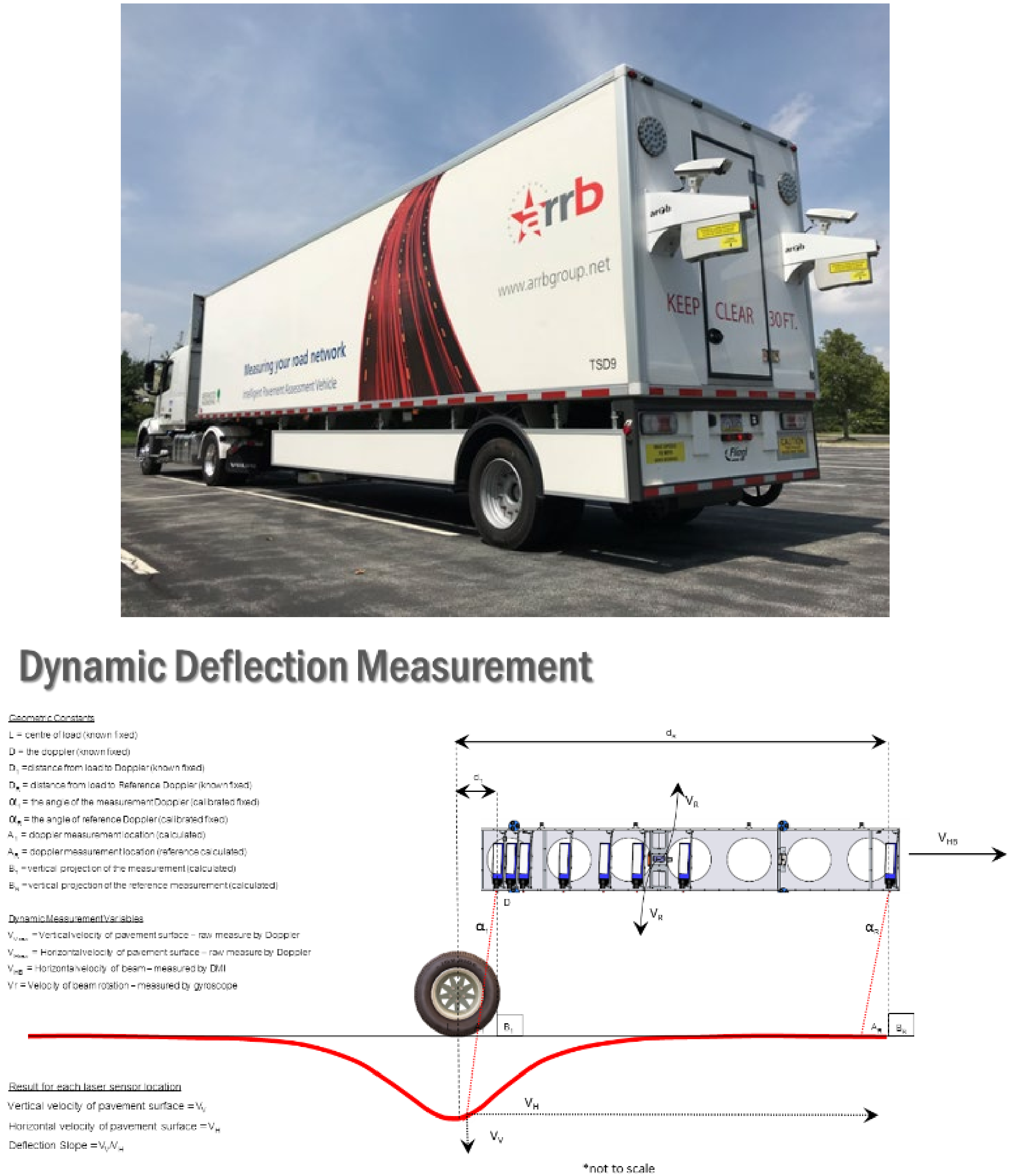


Figure 4-1 Image of TSD device and concept of dynamic deflection measurement. (http://arrbgroup.net/services/pavement-structural-assessment/#lightbox/0/)

Another on-going technological development in the state pertaining to the improvement of the pavement network is the implementation of Uniform Compaction (UC) devices. This technology employs temporal location data for the equipment used to place and compact Asphalt Concrete Pavements (pavers and rollers,). This technology collects additional information such as pavement temperature (asphalt must be compacted while hot), and vehicle speed. While the equipment operators can be aided by this data in the field, it also provides the state with an additional layer of quality assurance in the placement of asphalt pavements that is comprehensive and previously un-quantifiable.

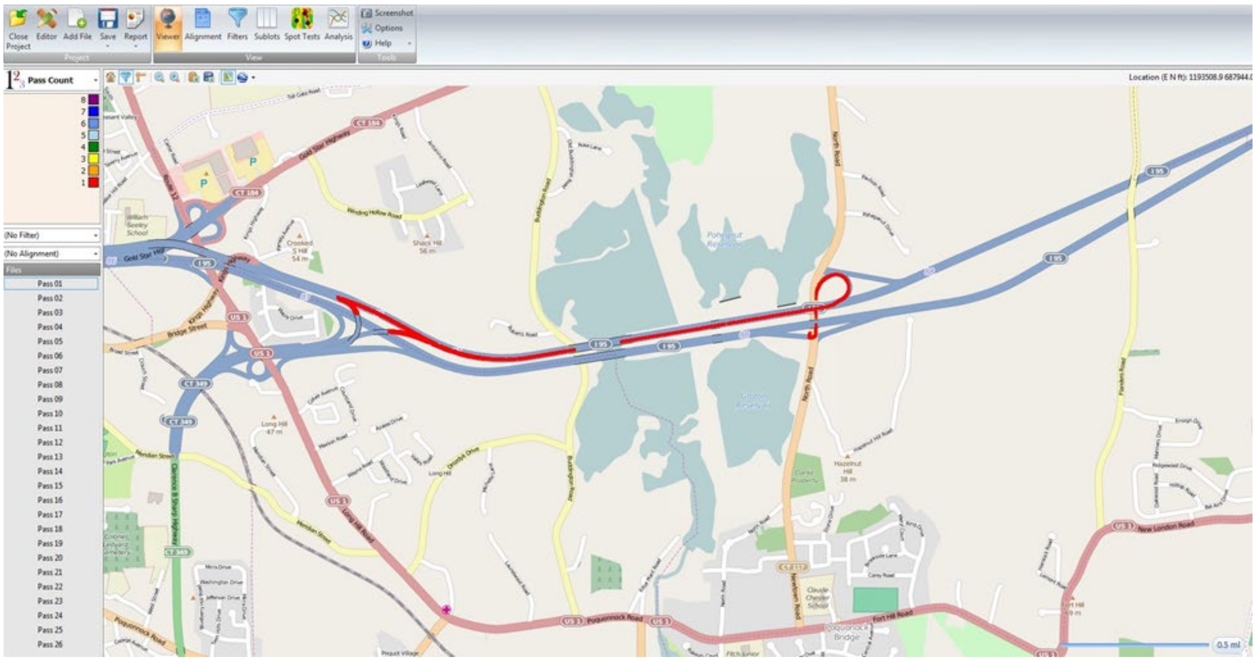


Figure 4-2 Example of VETA Software Output, I-95 Groton

<u>Research Initiatives in Pavement Management, Maintenance, and Preservation</u>

<u>Traffic Speed Deflectometer Device for Existing Pavement Structure Data</u>

The Traffic-Speed Deflectometer Device (TSDD) contains a known load on the trailer of an articulated 53-foot truck that travels at highway speeds. A "measurement beam" inside the trailer continually records the deflection slopes of the pavement. Other variables (such as cracking, roughness, rutting, and right-of-way imaging) are also simultaneously collected. The advantage of the TSDD is that it is a non-destructive, continuous measurement device that does not cause traffic disruptions (this is in comparison to more widely-accepted methodologies which are discrete and require traffic lane closures). The TSDD can survey approximately 300 miles of road per day. The TSDD system, in theory, has great potential, particularly at the network level, to supplement known historical information about roadways. For example, layer thickness and structure integrity (both of which are useful for determining the needs of future rehabilitation), as well as the adequacy of previous overlays that may have been placed with little knowledge of the underlying conditions, can be determined with the TSDD.

The data derived from the fieldwork was analyzed as part of the project. This dataset provided valuable information to quantify the condition of the road structures over which an overlay had been placed. A more detailed review of selected sites is also being performed to determine if information available for selected sections of road from the historical record using Digital Highway (and other sources) reasonably matches the data collected from the TSDD. Cores obtained at various projects over approximately the past five years are also being used to validate TSDD section information at selected sites (see the previous discussion also).

Sustainability
The first-annual report identified Warm Mix Asphalt Modification, Recycling, Reclaimed Asphalt Pavement, Reclaimed Asphalt Shingles and Polymer Modification as materials and methodologies which improve the sustainability of pavements across Connecticut either with longer-lasting materials or diversions of materials that would otherwise be a waste product. In fact, any action taken to improve the *in-situ* performance of pavement can be attributed to improve its sustainability. To that end, the CTDOT/CAP Lab effort to update and enhance the modeling methods for pavement management to optimize project selection and improve the overall performance of the network while extending the service life of pavements where appropriate will contribute significantly to the sustainability of the State's roadway network.

5. ON-GOING EFFORTS AND STATE FY21 OUTLOOK

Projected Pavement Improvement Activities for FY21 and Beyond

A list of known, as well as possible, future activities related to improving pavements in Connecticut is provided in Table 5-1

Table 5-1 Pavement Improvement Activities for State FY21 and Beyond

A	Develop a comprehensive 3-year program identifying Preservation and Maintenance Resurfacing projects by year, to be updated annually.
B	Develop a 10-year Reconstruction and Rehabilitation program identifying projects by year, to be updated annually.
C	Refine pavement analysis methodology, including improvements in forecasting future conditions of pavements
D	Improve tracking of paving work of all kinds including maintenance activities.
E	Re-evaluate and update pavement performance target goals
F	Analyze new and expanded data from cores, trenching, and the use of non-destructive testing procedures, such as the Traffic Speed Deflectometer described previously, that could provide more information about history and hidden underlying conditions.
G	Further evaluation of the effect of new construction materials, such as polymer-modified asphalts, and techniques, such as UC equipment, on pavement performance.
H	Coordinate with FHWA and adjacent states to improve reporting methods for pavement performance, including for HPMS
I	Improve ability to demonstrate the impact of funding variability on future pavement conditions using dTIMS and other modeling programs
J	Utilize and improve upon optimization models for the selection and programming of paving projects
K	Perform pavement forensic studies (detailed investigation for a pavement that is not performing as well as desired, or alternatively for ones that are performing much better than expected)
L	Implement modernization to the pavement condition index (PCI) score currently used for CTDOT-maintained roadways
M	Implement the pavement design handbook for use by consultants and internal staff to standardize handling of pavement designs for CTDOT roads.
N	Accumulate better quality condition data over time to provide a better understanding of the cost-effectiveness of different pavement treatment strategies.
O	Populate a database structure table to record core tests, non-destructive tests, photographs, construction data, material data and inspector notes for project level analysis of Pavement Preservation projects.
P	Participate in development of CTDOT Enterprise TED
R	Prepare additional roadway condition/needs reports for legislature or other jurisdiction, upon request

6. SUMMARY AND CONCLUSIONS

In future iterations, this CTDOT Annual Pavement Report will be the prerequisite document used to update the 2022 CTDOT Transportation Asset Management Plan (TAMP) and the annual updates to the Pavement Asset Fact Sheet. Due to the timing of annual seasonal data collection, the data presented in each TAMP will be from two years prior to publication, for each annual update. To serve that purpose, the data in this 2020 pavement report is from the year 2019, except where specifically noted otherwise.

Based on the results of studies over the past 15 years, it is now recognized that prioritizing repair work by “worst-first,” (which emphasizes treating pavements in poor condition), is the least effective means of maintaining a large highway network.. Keeping pavements smooth, and in good condition, lengthens their life, enhances safety, helps reduce road users’ operating costs, and reduces vehicle emissions. Through its various rehabilitation and resurfacing programs, CTDOT strives to extend the useful life of pavements. In particular, the increased use of pavement preservation treatments, state-of-the-art condition surveys, and forecasting employing deterioration modeling supports the concept of maintaining a State of Good Repair (SOGR).

CTDOT has over forty-five years of experience in the use of photolog technology. Many other state DOTs have traditionally looked to Connecticut as a leader in this field. Implementation of photolog technology and adoption of state-of-the-art upgrades makes this technology a critically important and prominent tool for CTDOT. Data collection vehicles were extensively updated in 2015 to provide greater detail in the measurement of cracking and roughness. Upgrades continued in 2020, such that CTDOT’s ARAN vehicles enable the collection of the most current, complex, detailed, and highly technical pavement condition and infrastructure data possible. These updates also support refinements to CTDOT’s condition indices that are currently under development at the Connecticut Transportation Institute within UConn’s School of Engineering. In addition, CTDOT as a whole is moving towards an enterprise data approach for asset management (including pavements) in order to make the best use of agency data for informed decision-making.

Although Connecticut is geographically a small state, the relatively high population density leads to Connecticut’s roadway network to be ranked at 37th for travel volumes (vehicle miles traveled). This high traffic level, as well as a relatively severe climate, hasten the wear and tear on Connecticut’s roadways. Therefore, keeping roads in SOGR requires a significant level of resources.

During 2020, CTDOT programmed the paving of 238.58 centerline miles of roadway through its Pavement Preservation and Maintenance Resurfacing programs (Table 3-3 and Table 3-4). The two programs addressed 216.5 and 437 lane miles of pavement, respectively, to keep them in a SOGR. The costs for pavement placement and peripherally-related activities was approximately $146 million, which also includes safety improvements in some cases for the maintenance resurfacing program.

One way to show the effects of pavement conditions on highway users is to present the amount of vehicle miles traveled (VMT) (derived from traffic volumes) on pavements in various conditions. Thus, VMT on roads of various levels of condition can be an indicator of the roadway users’ (motorists') experience. If, for example, a majority of travel occurs on poor condition roads, then the user experience is presumed to be less than satisfactory. On the other hand, a large amount of travel on SOGR roads would be expressed as being more desirable, as well as likely having lower overall user costs for the motorist. Since the larger amount of travel occurs on interstates and expressways in Connecticut, keeping those facilities in SOGR benefits the greatest number of users.

According to the American Society of Civil Engineers (ASCE) in their 2017 Infrastructure Report Card publication, the United States has underfunded its highway system for many years, resulting in a $420 billion backlog for repairing existing highways. (ASCE 2017) In a more recent update, ASCE states that the funding gap required to rehabilitate pavement and make other operational condition improvements in the U.S. is $12 billion annually or nearly $238 billion over 20 years. "In other words, spending on highways must increase 29 percent over current spending levels to address the current backlog and anticipated future backlogs." (ASCE 2020)

For Connecticut to be able to reach and maintain pavement conditions that meet the ten-year goals noted above, CTDOT would need to expend an estimated $4.5 billion on pavements between 2020 and 2030. At the current projected level of spending for pavements, which is anticipated to be in the area of $1.2 billion over the next ten years, it is anticipated that the condition of Connecticut's pavements will actually decline over this period. Although this problem is not unique to Connecticut, as most states have less than the required resources to maintain a SOGR, it is a critical shortcoming that is predicted to become more apparent in future years.

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APPENDIX 1. ACRONYMS/DEFINITIONS/GLOSSARY

AADT – (Annual Average Daily Traffic) - The total yearly traffic volume on a given highway segment divided by the number of days in a year. AADT is expressed in vehicles per day, and in limited cases is measured directly, but for many roads is estimated from a traffic samples collected over a 24 to 48 hour time period.

ARAN – (Automatic Road Analyzer) – Vendor-built data collection vehicle used in Connecticut and several other states to collect roadway condition data at highway speeds.

Centerline (Road or Route) Mile – A mile of highway, without considering the number of lanes in the facility.

Cracking – A fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement. CTDOTs method of identifying and extracting flexible pavement cracking data is from AASHTO **PP67-16 "**Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods," and AASHTO **R55-10** "Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces," 2013 2017. On flexible pavements, fatigue-type cracking is identified and used for performance measurement on the NHS. However, cracking on rigid pavements is reported as the percentage of slabs within the section that exhibit transverse cracking.

dTIMS CT® – Proprietary customizable asset management software used by many States. dTIMS-CT was purchased by CDOT for the purpose of calculating benefit/cost analyses used to recommend projects. dTIMS provides assistance in making funding decisions by finding the optimal set of strategies to apply to a network under a given set of constraints such as costs. dTIMS also provides a mechanism for analyzing a variety of maintenance, rehabilitation, and reconstruction treatments over a period of time and assists in the selection of the most cost-effective treatments for a range of budget scenarios.

Faulting – A difference in elevation across a joint or crack in slabs of PCC pavement. Usually the approach slab is higher than the leave slab causing a drop off of the departure end of one slab onto the leading edge of the next slab. Faulting adversely affects the ride quality (smoothness) of the surface of pavements.

FAST Act– (Fixing Americas Surface Transportation). a federal funding and authorization bill from 2015 to govern United States federal surface transportation spending.

Flexible Pavement – Pavement constructed with asphalt concrete, also known as 'bituminous,' 'flexible' HMA, or 'black' pavement.

Functional Classification – the process by which streets and highways are grouped into systems according to the character of traffic service that they are intended to provide. Each roadway is classified in two ways. First by whether it is 'urban' or 'rural.' Then into one of three groups according to its function within the network. The three groups as defined by the FHWA are: arterial, collector, and local.

FY State – (State Fiscal Year) – Administrative year used in Connecticut government covering period of July 1 through June 30.

FY Federal– (Federal Fiscal Year) - Administrative year used in federal government covering period of October 1 through September 30.

HMA – (Hot Mix Asphalt) - A combination of stone, sand, or gravel bound together by asphalt cement, also called 'bituminous,' 'flexible' or 'black' pavement.

HPMS – (Highway Performance Monitoring System) - According to FHWA, the HPMS is a national level highway information system that includes data on the extent, condition, performance, use and operating characteristics of the nation's highways.

IRI – (International Roughness Index) - A standardized method of measuring the roughness of the pavement surface developed by the World Bank and expressed in inches per mile or centimeters per kilometer. It can also be termed a measure of highway smoothness. The lower the number, the smoother the road surface.

Lane Mile – A pavement measuring one mile long and one lane wide is an example of a lane mile. Other examples: a one mile stretch of a two-lane road equals two lane miles; a ten mile section composed of four lanes is measured as forty lane miles.

MAP21 – (Moving Ahead for Progress in the 21st Century Act) a federal funding and authorization bill from 2012 to govern United States federal surface transportation spending.

NHS (National Highway System) – includes the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility. The NHS routes in Connecticut were designated by the US Department of Transportation in cooperation with CTDOT, local officials, and metropolitan planning organizations.

Pavement Preservation – the FHWA defines pavement preservation as work that is planned and performed to improve or sustain the condition of the transportation facility in a state of good repair. Preservation activities generally do not add capacity or structural value, but do restore the transportation facility's overall condition.

Pavement Rehabilitation – Measures to improve, strengthen or salvage existing deficient pavements which allow service to continue with only routine maintenance. Deficient pavements exhibit distress in excess of what can be handled through routine maintenance or preservation. Rehabilitation extends the life by 10 or more years.

PCC (Portland Cement Concrete) – Pavement constructed with PCC, also known as 'concrete' or 'rigid' pavement.

PCI – (Pavement Condition Index) An index developed specifically within and for CTDOT. The CTDOT PCI is composed of five weighted metrics: IRI (10%), Rutting (15%), Cracking (25%), Disintegration (30%), Drainage (20%). Note: this index is not equivalent to the PCI developed by the US Army Corps of Engineers, which is now ASTM D6433-11: "Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys."

Performance Curves – A performance curve is a deterioration model based on data collected over a period of time. Performance curves can be used to estimate future conditions and the time period to reach certain threshold values.

PMS – (Pavement Management System) -- AASHTO defines pavement management as "the effective and efficient directing of the various activities involved in providing and sustaining pavements in a condition acceptable to the traveling public at the least life cycle cost" [18] The FHWA defines pavement management systems as providing an ability to: Identify and prioritize maintenance and rehabilitation needs; evaluate the cost effectiveness of various strategies; and recommend projects and treatments under various budget scenarios.

Preventative Maintenance – According to the definition of the AASHTO Standing Committee on Highways in 1997, it is "a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity)."

Rigid pavement – Pavement constructed with Portland Cement Concrete (PCC), also known as 'concrete' or 'PCC' pavement.

Rutting – A longitudinal depression in the wheel path caused by the consolidation or lateral movement of either roadbed or surface material under heavy loads. The two types of rutting are mix rutting and subgrade rutting. Mix rutting occurs when the pavement surface exhibits wheelpath depressions as a result of compaction/mix design problems. Subgrade rutting occurs when the roadbed exhibits wheelpath depressions due to loading.

SOGR (SGR) (State of Good Repair) –A condition in which pavements both individually and as a system are functioning as designed and can be sustained through regular maintenance, preservation and replacement programs. Currently, in CTDOT roads designated as SOGR have a condition score (PCI) of 6 or higher on a scale of 1 to 9.

STF – (Special Transportation Fund) – a dedicated fund used to finance Connecticut's transportation infrastructure program and operate CTDOT

TAM (Transportation Asset Management) -- Transportation Asset Management is a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives. [19]

TED – (Transportation Enterprise Database) CTDOT SQL Server data warehouse that contains geospatial information

TSDD (Traffic Speed Deflectometer Device) A roadway survey device which collects structural deflection data as it traverses a pavement's surface at normal speeds. Continuous measurements are made of the deflection basin from a partially-loaded tractor trailer at one of the rear wheel paths.

UC (Uniform Compaction)/IC (Intelligent Compaction): Intelligent Compaction (IC) uses real-time GPS to track paving equipment during the placement and compaction of the pavement. A monitor is mounted on the rolling equipment that provides instantaneous information to the operator, including where the roller has been, how many roller passes have taken place in that location, roller speed and the temperature of the pavement. IC also utilizes accelerometers mounted to the rollers to measure the pavement's stiffness. Uniform Compaction (UC) is Intelligent Compaction excepting the use of the accelerometers. UC is used to ensure that the pavement receives approximately the same amount of compactive effort in all locations, at the appropriate temperatures and speeds.

VIP (Vendor-in-Place) Connecticut's maintenance resurfacing program was formerly called the vendor in place paving program.

VMT (Vehicle Miles Traveled) – the amount of travel by vehicles on a specified network of roads, (such as within a geographic region), over a given period of time, typically a one-year period. VMT can be calculated as the sum of the length of sections of a highway network multiplied by the Annual Average Daily Traffic per section.

Worst First – Giving roadway pavement rated the poorest (or lowest score) the highest priority for repairs.

APPENDIX 2. LIST OF MAINTENANCE RESURFACING PAVING PROJECTS (2020)

Districts 1 and 2

DIST	RTE	DIR	TOWNS	TERMINI	BEG MI	END MI	LaneMile	DEPTH	EST. COST
1	5	N+S	ENFIELD	END OP ROUTE 190 TO MASS SL	52.06	54.59	4.76	2.00	$ 2,023,000.00
1	44	E+W	MANCHESTER,EAST HARTFORD	MARY ST (ONE-WAY SB) TO ACC TO WB 1-84 (302A)	58.17	59.15	1.24	2.00	$ 527,000.00
1	83	N+S	ELLINGTON,SOMERS	S JCT RTE 140 (MAPLE ST) TO RTE 190	18.36	23.80	5.46	2.00	$ 2,320,500.00
1	178	E+W	BLOOMFIELD	RTE. 185 TO RTE. 189	0.00	1.69	1.88	2.00	$ 799,000.00
1	190	E+W	UNION	.02 MI EO END OP 1-84 TO RTE. 171 (BIGELOW HOLLOW RD)	26.34	28.27	1.93	2.00	$ 820,250.00
1	171	E+W	UNION	UNION TOWN GARAGE TO ROUTE 190	2.62	2.74	0.12	2.00	$ 51,000.00
1	190	E+W	UNION	STAFFORD TL TO ACC TO .02 MI EO END OP I-84	23.37	26.34	2.97	2.00	$ 1,262,250.00
1	220	E+W	ENFIELD	SSR 404 (TAYLOR RD) TO MASS SL	4.38	5.78	1.40	2.00	$ 595,000.00
1	533	N+S	BOLTON,VERNON	.03 MI NO BOX MTN RD TO GRADY ROAD	0.86	1.95	1.09	2.00	$ 463,250.00
1	534	E+W	MANCHESTER	RTE. 83 TO BOLTON TL	0.00	2.81	2.89	2.00	$ 1,228,250.00
1	534	E+W	BOLTON	MANCHESTER TL TO RTE. 85	2.81	4.45	1.64	2.00	$ 697,000.00
1	85	N+S	BOLTON	SR 534 CAMP MEETING RD TO BOLTON CENTER RD	35.05	35.81	0.76	2.00	$ 323,000.00
1	5	N+S	MERIDEN	WALLINGFORD TL TO CONN FR EAST MAIN ST #1	15.07	17.06	2.54	2.00	$ 1,079,500.00
1	44	E+W	HARTFORD	SCARBOROUGH ST TO .02 MI EO OP CENT NE RR BRIDGE 04397	51.32	51.58	0.66	2.00	$ 280,500.00
1	70	E+W	CHESHIRE	E JCT OLD WATERBURY RD TO MOUNTAIN RD	0.79	2.24	1.55	2.00	$ 658,750.00
1	71	N+S	MERIDEN,BERLIN	END OP I-691 TO .02 MI NO N JCT BUTLER ST	4.56	6.28	2.01	2.00	$ 854,250.00
1	72	N/B	PLAINVILLE	NB ACC FR RTE 372 TO RTE 372 (FORESTVILLE AVE) INC RAMP	4.32	6.34	3.03	3.00	$ 1,931,625.00
1	72	S/B	PLAINVILLE	SB ACC WB 84 TO RTE 372 (FORESTVILLE AVE) INC RAMPS	4.13	6.34	2.67	3.00	$ 1,702,125.00
1	72	N+S	BRISTOL	MAIN ST #2 TO RTE 69 (WEST ST)	9.48	9.88	0.55	2.00	$ 233,750.00
1	84	W/B	EAST HARTFORD	WB ACC FR SR 518 (ROBERTS ST) TO X56 NB SR 500 INC RAMP	63.63	64.39	2.24	3.00	$ 1,428,000.00
1	91	N/B	CROMWELL	MIDDLETOWN TL TO END OP NORTH ROAD (INC RAMPS)	25.83	26.49	1.47	3.00	$ 937,125.00
1	91	S/B	CROMWELL	MIDDLETOWN TL TO BGN OP NORTH ROAD (INC RAMPS)	25.83	26.48	1.63	3.00	$ 1,039,125.00
1	99	N+S	WETHERSFIELD	OXFORD ST TO HARTFORD TL (INC RAMPS TO RTE 15)	10.06	10.64	1.65	2.00	$ 701,250.00
1	157	N+S	MIDDLETOWN	MIDDLEFIELD TL TO RTE. 66 (WASHINGTON ST)	5.22	6.86	1.64	2.00	$ 697,000.00
1	173	N+S	WEST HARTFORD	RTE. 71 (NEW BRITAIN AVE) TO BEECHWOOD RD	5.84	6.17	0.76	2.00	$ 323,000.00
1	322	E+W	SOUTHINGTON	ACC TO EB I-84 TO .09 MI W/O RTE 10 (CHESHIRE RD)	6.27	7.25	1.39	2.00	$ 590,750.00
1	571	E+W	BERLIN	RT 71A (HIGH RD) TO EB RT 9 SB (KOREAN WAR VET MEM HWY)	0.00	1.52	2.91	2.00	$ 1,236,750.00
									$ 24,803,000.00
2	395	N+S	THOMPSON	PUTNAM TL TO THE MASS SL (INC RAMPS)	47.78	54.69	13.66	3.00	$ 8,708,250.00
2	12	N+S	CANTERBURY,PLAINFIELD	CANTERBURY TL TO OP MILL BK	23.44	26.29	2.85	2.00	$ 1,211,250.00
2	66	E+W	WINDHAM	SR 661 TO TUCKIE RD	36.21	38.24	2.03	2.00	$ 862,750.00
2	97	N+S	POMFRET	OP VINTON BK TO RT 169	27.29	29.14	1.85	2.00	$ 786,250.00
2	644	E+W	POMFRET	RT 97 (DEERFIELD RD) TO US 44 & RT 169 (POMFRET ST)	0.00	0.75	0.75	2.00	$ 318,750.00
2	165	E+W	NORWICH,PRESTON	RTE. 2 TO RTE. 164	0.00	5.16	5.16	2.00	$ 2,193,000.00
2	605	N+S	PRESTON	RTE 165 TO RTE 164	0.00	0.30	0.3	2.00	$ 127,500.00
2	201	N+S	NORTH STONINGTON	STONINGTON TL TO RTE. 2	1.94	4.13	2.19	2.00	$ 930,750.00
2	627	E+W	NORTH STONINGTON	RTE. 201 TO RTE. 2	0.00	0.91	0.91	2.00	$ 386,750.00
2	156	E+W	EAST HADDAM,LYME,OLD LYME	RTE. 82 TO WB JCT US 1	0.00	8.44	8.44	2.00	$ 3,587,000.00
2	153	N+S	WESTBROOK	US 1 TO THE ESSEX TL	0.00	3.02	3.02	2.00	$ 1,283,500.00
2	213	N+S	WATERFORD,NEW LONDON	RTE. 156 TO US 1	0.00	6.66	6.66	2.00	$ 2,830,500.00
2	12	N+S	LISBON,GRISWOLD	ACC TO NB I-395 TO CANTERBURY TL	19.55	23.44	3.89	2.00	$ 1,653,250.00
									$ 24,879,500.00

Districts 3 and 4

DIST	RTE	DIR	TOWNS	TERMINI	BEG MI	END MI	LaneMile	DEPTH	EST. COST
3	110	N+S	STRATFORD,SHELTON	.08 MI N/O FREEMAN BK TO .19 MI N/O CONSTITUITION BLVD	3.00	6.68	4.49	2.00	$ 1,908,250.00
3	1	N+S	BRANFORD	EAST HAVEN TL TO ORCHARD HILL RD	52.16	53.49	2.80	2.00	$ 1,190,000.00
3	122	N+S	WEST HAVEN	SR 745 TO .21 MI N/O RUDEN ST	0.00	0.79	1.00	2.00	$ 425,000.00
3	121	N+S	MILFORD,ORANGE	RTE. 1 TO ROUTE 34 (OMIT LOG MI 4.01-4.07 BR00765)	0.00	5.66	5.61	2.00	$ 2,384,250.00
3	80	E+W	NORTH BRANFORD	.01 MI W/O CHAPEL ST TO GUILFORD TL	6.41	8.08	1.67	2.00	$ 709,750.00
3	150	N+S	WALLINGFORD	SOUTH ELM ST TO .05 MI S/O RIVER RD	4.65	5.70	1.21	2.00	$ 514,250.00
3	68	E+W	CHESHIRE,WALLINGFORD	RTE 70 (SOUTH MERIDEN RD) TO BGN AMTRAK & US 5 (01867)	10.76	14.59	5.05	2.00	$ 2,146,250.00
3	1	N+S	NEW HAVEN	WEST HAVEN TL TO .04 MI S/O UNION AVE(LOCAL)	46.53	47.80	1.65	2.00	$ 701,250.00
3	10	N+S	CHESHIRE	HAMDEN TL TO .10 MI N/O KINGS RD	13.97	15.36	1.44	2.00	$ 612,000.00
3	25	N+S	BRIDGEPORT,TRUMBULL	.08 MI S/O NB-UP S/B RT 8 TO .05 MI N/O OP FFD MEM RD	3.85	4.47	2.28	2.00	$ 969,000.00
3	95	N+S	MILFORD	.01 MI S/O BGN BR 00152 TO .01 MI N/O END BR 00152	40.24	40.28	0.12	2.00	$ 51,000.00
3	1	N+S	MILFORD	SCHOOL HSE RD TO W RIVER ST (ONEWAY)(OMIT 38.34-38.84)	37.03	39.03	2.99	2.00	$ 1,270,750.00
3	106	N+S	WILTON	NEW CANAAN TL TO BELDEN HILL RD	9.10	11.03	1.93	2.00	$ 820,250.00
3	136	N+S	DARIEN,NORWALK	US 1 (BOSTON POST RD) TO HIGHLAND AVE #2	0.00	2.32	2.34	2.00	$ 994,500.00
3	1	N+S	WESTPORT,FAIRFIELD	SSR 476 (NB) SHERWOOD ISLAND CONNECTOR TO KINGS LANE	20.81	23.52	5.47	2.00	$ 2,324,750.00
3	113	N+S	STRATFORD	.03 MI N/O DR TO SIKORSKY AIRPORT TO US 1 (NB)	4.19	6.48	3.20	2.00	$ 1,360,000.00
3	104	N+S	STAMFORD	RTE 137 TO STILLWATER RD	0.00	1.25	2.61	2.00	$ 1,109,250.00
3	95	S/B	BRIDGEPORT	.04 MI S/O BR# 00110 TO END OP METRO NO. RR BR # 00111	29.22	29.81	1.31	1.50	$ 417,562.50
									$ 19,908,062.50
4	167	N+S	FARMINGTON,AVON, SIMSBURY	RT 4 TO US 44	0.00	4.96	5.01	2.00	$ 2,129,250.00
4	827	N+S	KENT	NEW MILFORD TL TO RT 341	0.00	3.44	3.46	2.00	$ 1,470,500.00
4	128	E+W	SHARON,CORNWALL	US 7 TO RT 4	0.00	4.03	4.10	2.00	$ 1,742,500.00
4	7	N+S	SHARON,SALISBURY	RT 128 TO BGN HOUSATONIC RR	64.20	69.12	4.92	2.00	$ 2,091,000.00
4	44	E+W	SALISBURY	NEW YORK SL TO W JCT RT 41	0.00	3.06	3.06	2.00	$ 1,300,500.00
4	183	N+S	TORRINGTON,WINCHESTER	RTE. 4 TO US 44	0.00	8.21	8.46	2.00	$ 3,595,500.00
4	7	N/B	BROOKFIELD	UP SILVERMINE RD TO US 202 (FEDERAL RD)	29.49	31.82	9.48	2.00	$ 4,029,000.00
4	68	E+W	PROSPECT,CHESHIRE	RTE. 69 TO RTE. 70 (WATERBURY RD)	4.28	7.67	3.42	2.00	$ 1,453,500.00
4	55	E+W	SHERMAN,NEW MILFORD	NEW YORK SL TO US 7 (KENT RD)	0.00	2.64	2.64	2.00	$ 1,122,000.00
4	39	N+S	SHERMAN	NEW FAIRFIELD TL TO RTE 37 & RTE 39	14.51	18.37	3.87	2.00	$ 1,644,750.00
4	4	E+W	BURLINGTON	RTE. 69 (SB) (MILFORD ST) TO RTE. 179 (CANTON RD)	33.45	36.24	2.93	2.00	$ 1,245,250.00
4	489	N+S	BURLINGTON	BELDEN RD #1 TO RT 4	0.00	0.17	0.17	2.00	$ 72,250.00
4	6	E+W	BRISTOL	PLYMOUTH TL TO SHERMAN ST	44.64	46.50	2.10	2.00	$ 892,500.00
4	6	E+W	DANBURY,BETHEL,NEWTOWN	SR 911 TO W JUNCTION RTE. 25 MAIN ST	8.44	11.56	3.95	2.00	$ 1,678,750.00
4	911	W/B	DANBURY	US 6 WB (NEWTOWN RD) TO US 6 E/B	0.00	0.14	0.30	2.00	$ 127,500.00
4	822	E+W	RIDGEFIELD	NEW YORK SL TO RTE. 35 (MAIN ST)	0.00	3.62	3.62	2.00	$ 1,538,500.00
4	317	E+W	ROXBURY	RTE. 67 (SOUTHBURY RD) TO WOODBURY TL	0.00	2.73	2.73	2.00	$ 1,160,250.00
4	816	E+W	NEWTOWN	US 6 (CHURCH HILL RD) TO WASHINGTON ST	0.00	0.57	0.57	2.00	$ 242,250.00
4	6	E+W	NEWTOWN	RTE. 25 TO CONNERS RD	14.26	15.00	0.91	2.00	$ 386,750.00
4	846	E+W	WATERBURY	NB ACC TO RT 8 TO RT 73	0.23	1.30	1.10	2.00	$ 467,500.00
									$ 28,390,000.00

APPENDIX 3. PAVEMENT PRESERVATION PROJECTS (CURRENT AND PAST)

Appendix 3A. List of Pavement Preservation Projects (2020)

NOTE: Some of the projects listed for 2020 are carried forward from 2019, as they were either not completed or not started even though scheduled in 2019.

Mill and Overlay (2020)

Mill and Overlay (District 1, Project No. 170-3556)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
84	E	TOLLAND	.29 MI E/O UP OLD CATHOLE RD TO TOLLAND - WILLINGTON TL	82.17	84.53	6.30	39.14
		WILLINGTON	TOLLAND - WILLINGTON TL TO .01 MI W/O BGN OP RTE 32 (RIVER RD)	84.53	85.56		
	W	VERNON	WB-END OP RTE 31 TO VERNON - TOLLAND TL	77.31	77.42		
		TOLLAND	VERNON - TOLLAND TL TO TOLLAND - WILLINGTON TL	77.42	84.54		
		WILLINGTON	TOLLAND - WILLINGTON TL TO .38 MI W/O BGN OP ROARING BK	84.54	86.51		

Mill and Overlay (District 2, Project No. 170-3546)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
349	N/S	GROTON	SHENNECOSSETT RD TO SR 649 (RAINVILLE AVE)	0.00	2.30	2.30	5.94
			SR 649 (RAINVILLE AVE) TO 0.11 MI S/O END RTE 349	2.30	4.06	1.76	7.69

202	N/S	LITCHFIELD	0.08 MI N/O OP BANTAM RV TO LITCHFIELD - TORRINGTON TL	39.27	41.70	3.96	8.56
		TORRINGTON	LITCHFIELD - TORRINGTON TL TO 0.05 MI N/O OP GULF STREAM	41.70	43.23		

Mill and Overlay (District 4, Project No. 170-3556)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
7	N	BROOKFIELD	.01 MI N/O UP SILVERMINE RD TO US 202 (FEDERAL RD)	29.50	31.82	2.37	9.48
	S	BROOKFIELD	.02 MI S/O UP SILVERMINE RD TO US 202 (FEDERAL RD)	29.47	31.89		

Mill and Overlay (District 4, Project No. 170-3546)

187	N/S	BLOOMFIELD	0.23 MI S/O RTE 305 (OLD WINDSOR RD) TO BLOOMFIELD - WINDSOR TL	4.92	6.88	3.11	11.86
		WINDSOR	BLOOMFIELD - WINDSOR TL TO WINDSOR - BLOOMFIELD TL	6.88	7.75		
		BLOOMFIELD	WINDSOR - BLOOMFIELD TL TO 0.16 MI N/O JCT RTE 189	7.75	8.03		
Mill & Fill Project Totals						**19.80**	**82.67**

Ultra-Thin Bonded Overlays (2020)

Ultra-Thin Bonded Overlays (2020) (District 1)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES

84	E	EAST HARTFORD	EB-END OP RTE 15 TO EAST HARTFORD - MANCHESTER TL	64.46	67.42	3.17	32.22
		MANCHESTER	EAST HARTFORD - MANCHESTER TL TO .04 MI E/O END OP HOCKANUM RV	67.42	67.56		
	W	EAST HARTFORD	.09 MI E/O WB ACC FR SR 518 (ROBERTS ST) (118) TO EAST HARTFORD - MANCHESTER TL	64.42	67.42		
		MANCHESTER	EAST HARTFORD - MANCHESTER TL TO .09 MI E/O WB ACC FR I-291 (TR 803)	67.42	67.67		
384	E	EAST HARTFORD	EB-JCT I-84 EB (WILBUR CROSS HWY) TO EAST HARTFORD - MANCHESTER TL	0.00	1.04	1.31	7.71
		MANCHESTER	EAST HARTFORD - MANCHESTER TL TO .05 MI E/O EB-END HOV LANE (700)	1.04	1.41		
	W	EAST HARTFORD	WB-JCT I-84 WB (WILBUR CROSS HWY) TO EAST HARTFORD - MANCHESTER TL	0.00	1.04		
		MANCHESTER	EAST HARTFORD - MANCHESTER TL TO .11 MI W/O WB EXIT TO EB I-291 (TR 801)	1.04	1.21		

Ultra-Thin Bonded Overlays (2020) (District 2)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES

395	N	MONTVILLE	.02 MI S/O UP GALLIVAN LA TO MONTVILLE - NORWICH TL	9.26	10.44	8.27	39.58
		NORWICH	MONTVILLE - NORWICH TL TO BGN OP RTE 97 & SHETUCKET RV	10.44	18.17		
	S	MONTVILLE	.02 MI S/O UP GALLIVAN LA TO MONTVILLE - NORWICH TL	9.26	10.44		
		NORWICH	MONTVILLE - NORWICH TL TO .12 MI S/O UP LAWLER LA	10.44	16.88		
668	E/W	CANTERBURY	RTE 169 (SOUTH CANTERBURY RD) TO RTE 12 (JEWETT CITY RD)	0.00	2.00	2.00	3.92
Ultra Thin Bonded Project Totals						**14.75**	**83.43**

Asphalt-Rubber Chip Seals (2020)

Asphalt Rubber Chip Seals (2020) (District 2)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
21	N/S	PUTNAM	US 44 (PROVIDENCE PIKE) TO PUTNAM - THOMPSON TL	3.75	4.12	1.92	3.58
		THOMPSON	PUTNAM - THOMPSON TL TO END RTE 21 (RTE 193)	4.12	5.67		
49	N/S	NORTH STONINGTON	RTE 216 (CLARKS FALLS RD) TO NORTH STONINGTON - VOLUNTOWN TL	4.13	8.31	8.92	17.58
		VOLUNTOWN	NORTH STONINGTON - VOLUNTOWN TL TO RTE 165 (SHETUCKET TURNPIKE)	8.31	13.05		

89	N/S	MANSFIELD	RTE 195 (STORRS RD) TO 1.33 MI N/O MULBERRY RD	0.00	3.25	3.25	6.49
163	N/S	MONTVILLE	RTE 82 (NORWICH SALEM TPKE) TO MONTVILLE - BOZRAH TL	7.45	8.26	3.40	6.78
		BOZRAH	MONTVILLE - BOZRAH TL TO .18 MI N/O SCOTT HILL RD	8.26	10.85		
201	N/S	GRISWOLD	.01 N/O RTE 138 (VOLUNTOWN RD) TO .04 MI N/O EXIT FR SB I-395 (037)	14.32	18.22	3.90	5.94

Asphalt Rubber Chip Seals (2020) (District 3)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
111	N/S	MONROE	.44 MI S/O EAST VILLAGE RD TO 1.32 MI S/O RTE 34 (ROOSEVELT DR)	8.86	10.39	1.54	3.00

Asphalt Rubber Chip Seals (2020) (District 4)

RTE	DIR	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
47	N/S	WOODBURY	.01 MI S/O RTE 132 (WEEKEEPEEMEE RD) TO WOODBURY - ROXBURY TL	1.32	4.85	3.53	7.06
Asphalt Rubber Chip Seal Project Totals						**26.46**	**50.43**

Appendix 3B. List of Pavement Preservation Projects (2019)

Mill and Overlay (2019)

MILL AND OVERLAY							
DISTRICT 1							
ROUTE	**DIRECTION**	**TOWN**	**LOG TERMINI**	**START MILE POINT**	**END MILE POINT**	**CENTERLINE MILES**	**LANE MILES**
91	N	WINDSOR	NB-END OP CAPEN ST TO WINDSOR - WINDSOR LOCKS TL	44.12	48.58	13.30	56.53
		WINDSOR LOCKS	WINDSOR - WINDSOR LOCKS TL TO WINDSOR LOCKS - EAST WINDSOR TL	48.58	49.77		
		EAST WINDSOR	WINDSOR LOCKS - EAST WINDSOR TL TO 0.19 MI S/O NB EXIT TO RTE 140 (104)	49.77	50.77		
	S	WINDSOR	SB-END OP CAPEN ST TO WINDSOR - WINDSOR LOCKS TL	44.12	48.58		
		WINDSOR LOCKS	WINDSOR - WINDSOR LOCKS TL TO WINDSOR LOCKS - EAST WINDSOR TL	48.58	49.77		
		EAST WINDSOR	WINDSOR LOCKS - EAST WINDSOR TL TO .01 MI S/O SB EXIT TO US 5 (103)	49.77	50.77		
MILL AND OVERLAY TOTALS						**13.30**	**56.53**

Ultra-Thin Bonded Overlays (2019) (District 2)

ULTRA THIN BONDED PMA (DISTRICT 2)							
ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE	END MILE	CENTER LINE	LANE MILE
2	E	COLCHESTER	.06 MI E/O EB ACC FR RTE 354 (050) TO COLCHESTER - LEBANON TL	25.35	28.53	9.93	20.64
		LEBANON	COLCHESTER - LEBANON TL TO .13 MI E/O EB EXIT TO SCOTT HILL RD (056)	28.53	30.79		
	W	COLCHESTER	.25 MI E/O WB EXIT TO RTE 354 (049) TO COLCHESTER - LEBANON TL	25.52	28.53		
		LEBANON	COLCHESTER - LEBANON TL TO .32 MI E/O WB-END OP CAMP MOOWEEN RD	28.53	30.01		
9	N	ESSEX	.05 MI S/O NB-BGN OP RTE 153 & 154 TO ESSEX - DEEP RIVER TL	3.83	5.47	14.50	35.16
		DEEP RIVER	ESSEX - DEEP RIVER TL TO DEEP RIVER - CHESTER TL	5.47	7.72		
		CHESTER	DEEP RIVER - CHESTER TL TO .06 MI S/O UP EB RTE 82 & RTE 82 TR 801	7.72	10.63		
	S	ESSEX	.03 MI S/O SB-BGN OP RTE 153 (PLAINS RD) TO ESSEX - DEEP RIVER TL	3.84	5.47		
		DEEP RIVER	ESSEX - DEEP RIVER TL TO DEEP RIVER - CHESTER TL	5.47	7.72		
		CHESTER	DEEP RIVER - CHESTER TL TO CHESTER - HADDAM TL (SB)	7.72	11.54		
395	N	WATERFORD	.03 MI N/O OP OIL MILL BK (8' RC BOX) TO WATERFORD - MONTVILLE TL	0.61	4.98	9.83	21.78
		MONTVILLE	WATERFORD - MONTVILLE TL TO .06 MI N/O NB-JCT SR 693 (MONTVILLE CON)	4.98	5.58		
	S	WATERFORD	.10 MI N/O OP OIL MILL BK (8' RC BOX) TO WATERFORD - MONTVILLE TL	0.68	4.98		
		MONTVILLE	WATERFORD - MONTVILLE TL TO .08 MI N/O SB-JCT SR 693 (MONTVILLE CON)	4.98	5.54		
TOTALS						34.26	77.58

Ultra-Thin Bonded Overlays (2019) (District 4)

ULTRA THIN BONDED PMA (DISTRICT 4)							
ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
6	E/W	WOODBURY	RTE 47 (WASHINGTON RD) TO WOODBURY - WATERTOWN TL	27.60	32.36	4.76	9.52
8	N	TORRINGTON	.05 MI S/O NB-BGN OP KENNEDY DR TO TORRINGTON - WINCHESTER TL	51.74	55.98	13.29	31.53
		WINCHESTER	TORRINGTON - WINCHESTER TL TO NB-JCT US 44 & RTE 8 (SOUTH MAIN ST)	55.98	58.51		
	S	TORRINGTON	.01 MI S/O SB-BGN OP KENNEDY DR TO TORRINGTON - WINCHESTER TL	51.79	55.98		
		WINCHESTER	TORRINGTON - WINCHESTER TL TO SB-JCT US 44 (SOUTH MAIN ST)	55.98	58.31		
TOTALS						**18.05**	**41.05**

Asphalt Rubber Chip Seals (2019) (District 2)

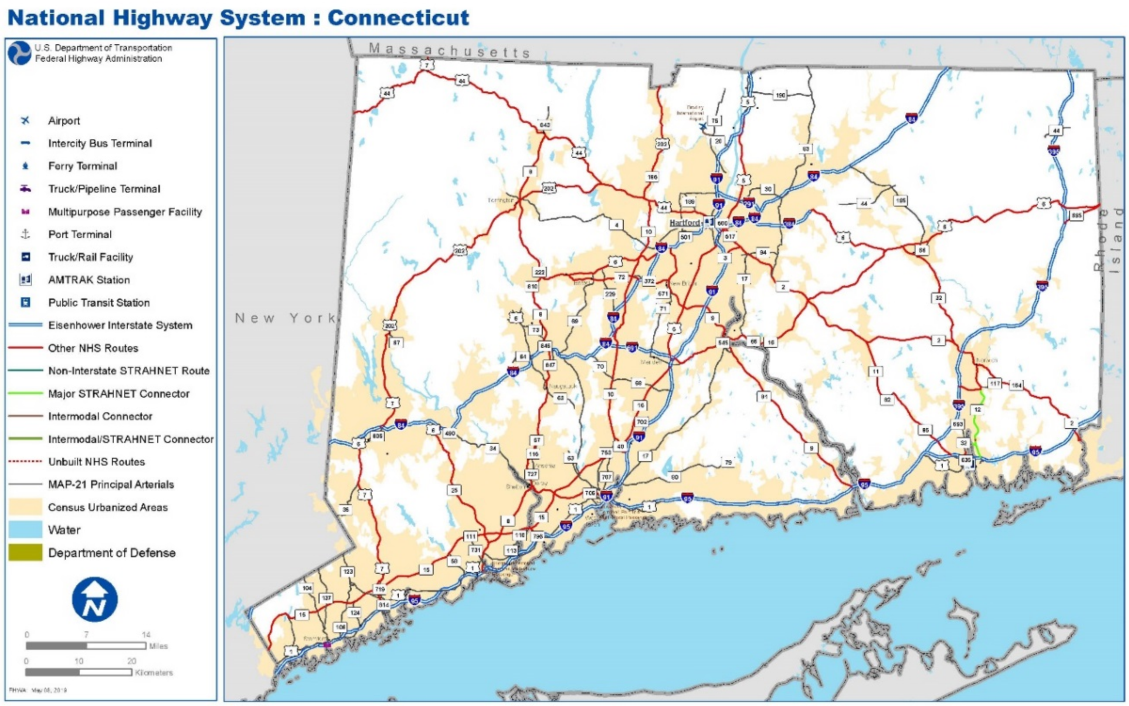
ASPHALT RUBBER CHIP SEAL (DISTRICT 2)							
ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
149	N/S	COLCHESTER	.08 MI N/O SSR 429 (PECK LA) TO END RTE 149	8.65	11.70	3.05	5.84
165	E/W	PRESTON	.07 MI W/O RTE 164 (PRESTON PLAINS RD) TO PRESTON - GRISWOLD TL	5.09	7.87	5.08	10.16
		GRISWOLD	PRESTON - GRISWOLD TL TO .02 MI E/O RTE 201 (GLASGO RD)	7.87	10.17		
171	E/W	EASTFORD	UNION - EASTFORD TL TO EASTFORD - WOODSTOCK TL	6.93	8.54	2.57	5.14
		WOODSTOCK	EASTFORD - WOODSTOCK TL TO .03 MI W/O W JCT RTE 198 (EASTFORD RD)	8.54	9.50		
201	N/S	STONINGTON	RTE 184 (PROVIDENCE TPKE) TO STONINGTON - NORTH STONINGTON TL	0.00	1.94	1.94	3.88
203	N/S	WINDHAM	RTE 32 (WINDHAM RD) TO RTE 14 (BRICK TOP RD)	0.00	2.52	2.52	5.04
77	N/S	GUILFORD	.7 MI N/O RTE 80 (BRANFORD RD) TO LAKE DR #2	6.16	7.61	1.45	2.90
TOTALS						**16.61**	**32.96**

Asphalt-Rubber Chip Seals (2019) (District 4)

ASPHALT RUBBER CHIP SEAL (DISTRICT 4)							
ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
4	E/W	GOSHEN	.49 MI W/O MILTON RD TO GOSHEN - TORRINGTON TL	15.36	19.70	4.34	8.67
39	N/S	SHERMAN	RTE 37 (BARNES HILL RD) TO END RTE 39 (RTE 55)	18.37	22.76	4.39	8.78
TOTALS						**8.73**	**17.45**

APPENDIX 4. REFERENCE MAPS

Appendix 4A. Map of Connecticut: National Highway System (as of May 2019)

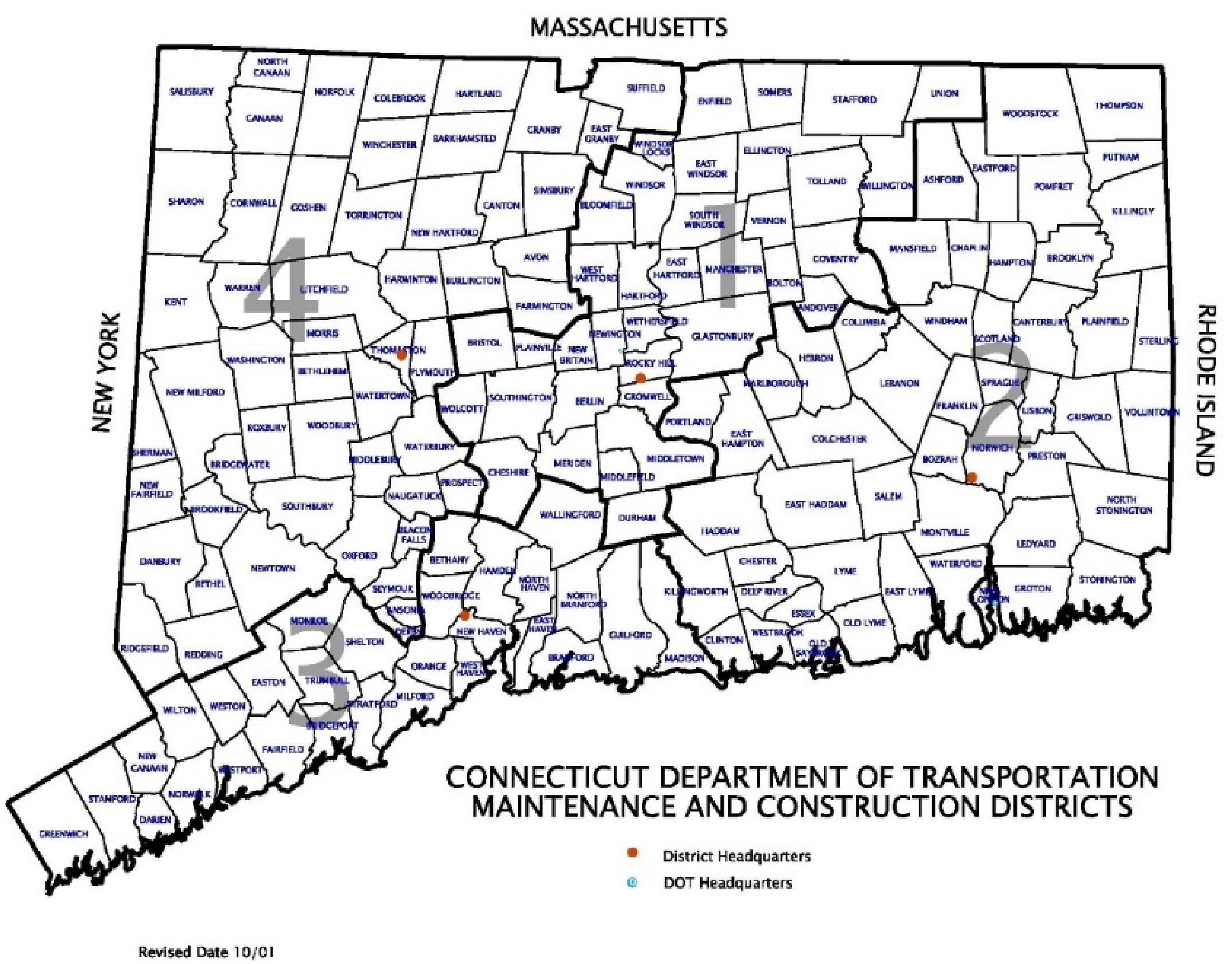


Examples of NHS categories

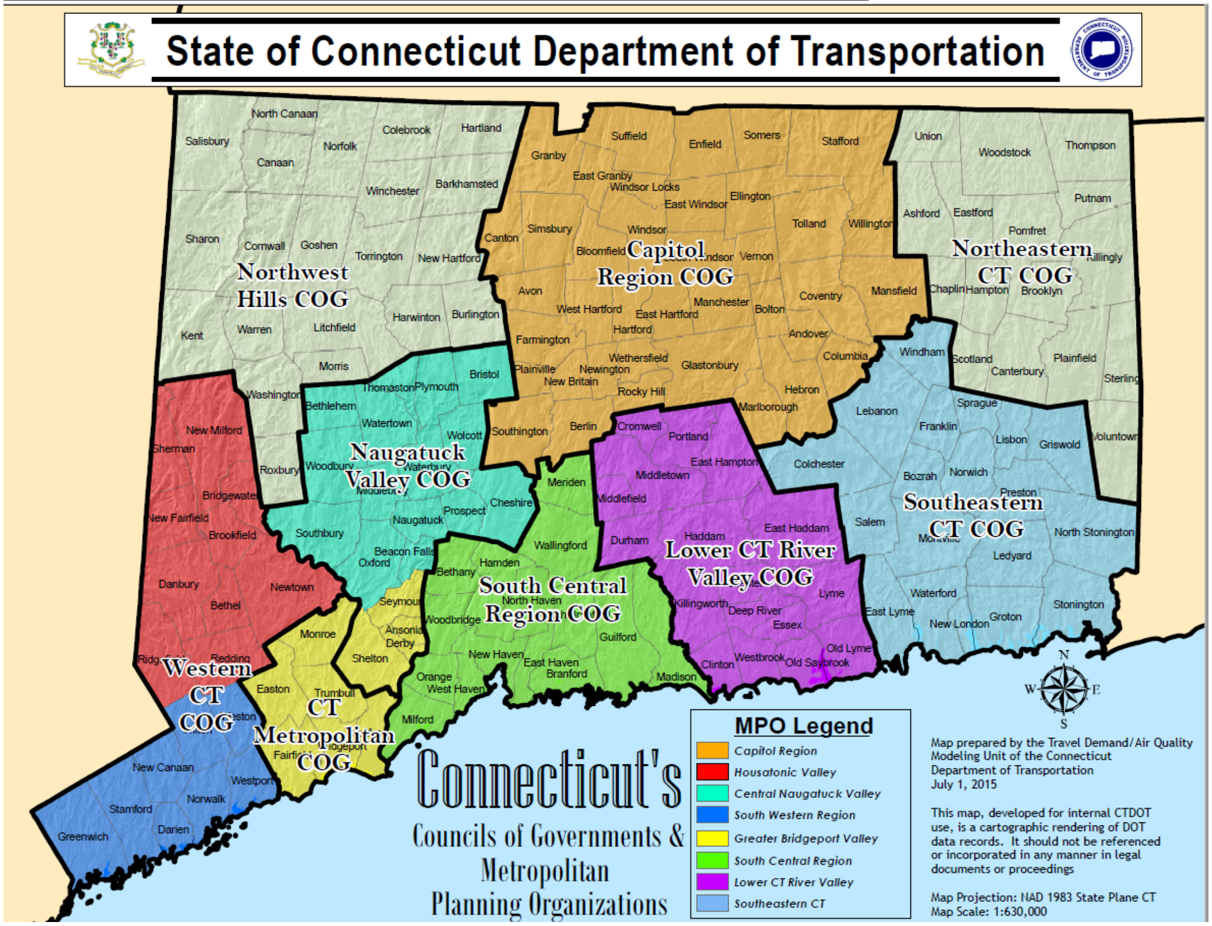
- ***Interstate:*** *The Dwight D. Eisenhower National System of Interstate and Defense Highways. e.g., I-91, I-84, I-95, I-395, I-291, I-691*
- ***Other Principal Arterials:*** *These are highways in rural and urban areas which provide access between an arterial and a major port, airport, public transportation facility, or other intermodal transportation facility. e.g., Rt 20, U.S. 6, U.S. 44, Rt 9*
- ***Non-interstate Strategic Highway Network (STRAHNET):*** *This is a network of highways which are important to the United States' strategic defense policy and which provide defense access, continuity and emergency capabilities for defense purposes. e.g., I-395,*
- ***Major STRAHNET Connectors:*** *These are highways which provide access between major military installations and highways which are part of the Strategic Highway Network. e.g. Rt 12*

- ***Intermodal Connectors:*** *These highways provide access between major intermodal facilities and the other four subsystems making up the National Highway System.*

Appendix 4B. Map of Connecticut: Maintenance/ Construction Districts



Appendix 4C. Map of Connecticut Regional Planning Agencies



APPENDIX 5. GOOD-FAIR-POOR (G-F-P) PAVEMENT RATINGS IN CONNECTICUT FOR 2017, 2018 AND 2019

NOTES:

1.Unlike data published by FHWA for HPMS, the data in the following tables includes bridges and some ramps serving as mainline routes.

2. For 2019, there is a difference in total centerline miles and lane miles compared to 2018 data because 2019 queries were based on the current year condition data only, whereas 2018 data had missing values filled in from older/previous years.

OVERALL G-F-P Ratings by Lane-Miles

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMilesGood Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1426.5	69.60%	620.6	30.30%	3.8	0.20%	2051
NON_INTERSTATE NHS	1329.6	39.50%	1928.3	57.30%	105.6	3.10%	3363
NHS	2756.1	50.90%	2548.9	47.10%	109.4	2.00%	5414
NON_NHS	1058.3	21.60%	3583.3	73.30%	249.5	5.10%	4891
ENTIRE_NETWORK	3814.3	37.00%	6132.2	59.50%	358.9	3.50%	10305

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1459.7	71.2%	583.2	28.4%	8.2	0.4%	2051
NON_INTERSTATE NHS	1416.9	41.1%	1970.1	57.2%	58.3	1.7%	3455
NHS	2876.6	52.3%	2553.3	46.5%	66.5	1.2%	5506
NON_NHS	1005.0	20.3%	3768.0	76.3%	167.0	3.4%	4962
ENTIRE_NETWORK	3868.5	37.1%	6332.1	60.7%	234.3	2.2%	10469

Pavement GFP (Lane Miles) for 2017							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1443.6	70.3%	599.9	29.2%	8.9	0.4%	2054
NON_INTERSTATE NHS	1346.8	40.0%	1916.8	57.0%	102.1	3.0%	3424
NHS	2790.4	51.5%	2516.8	46.5%	110.9	2.0%	5478
NON_NHS	1029.3	20.9%	3641.9	73.9%	254.8	5.2%	5009
ENTIRE_NETWORK	3819.7	36.9%	6158.7	59.5%	365.7	3.5%	10488

Ride Quality (IRI) G-F-P Ratings by Lane-Miles

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1686.9	82.3%	332.6	16.2%	31.5	1.5%	2051
NON_INTERSTATE NHS	1574.4	46.8%	1304.5	38.8%	484.6	14.4%	3363
NHS	3261.3	60.2%	1637.0	30.2%	516.0	9.5%	5414
NON_NHS	1174.9	24.0%	2657.7	54.3%	1059.2	21.7%	4892
ENTIRE_NETWORK	4436.2	43.0%	4294.7	41.7%	1575.2	15.3%	10306

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1651.0	80.5%	356.8	17.4%	43.3	2.1%	2051
NON_INTERSTATE NHS	1580.3	45.9%	1342.6	39.0%	522.3	15.2%	3455
NHS	3231.3	58.8%	1699.4	30.9%	565.7	10.3%	5506
NON_NHS	1091.7	22.1%	2689.2	54.4%	1160.5	23.5%	4962
ENTIRE_NETWORK	4323.0	41.4%	4388.6	42.0%	1726.2	16.5%	10469

Pavement GFP (Lane Miles) for 2017							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1637.8	79.8%	370.4	18.1%	44.1	2.1%	2054
NON_INTERSTATE NHS	1551.2	46.1%	1335.0	39.6%	482.1	14.3%	3424
NHS	3189.0	58.8%	1705.4	31.5%	526.2	9.7%	5478
NON_NHS	1157.9	23.5%	2752.8	55.9%	1017.5	20.6%	5009
ENTIRE_NETWORK	4346.9	42.0%	4458.2	43.1%	1543.7	14.9%	10488

Rutting G-F-P Ratings by Lane-Miles

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles % Good	LaneMilesFair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1823.0	90.3%	192.9	9.6%	2.6	0.1%	2018
NON_INTERSTATE NHS	2871.3	84.9%	493.9	14.6%	17.7	0.5%	3383
NHS	4694.3	86.9%	686.8	12.7%	20.3	0.4%	5401
NON_NHS	4011.0	80.9%	916.4	18.5%	32.7	0.7%	4960
ENTIRE_NETWORK	8705.3	84.0%	1603.2	15.5%	52.9	0.5%	10361

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1772.9	88.3%	223.8	11.1%	12.3	0.6%	2051
NON_INTERSTATE NHS	2935.1	86.0%	459.7	13.5%	17.4	0.5%	3455
NHS	4708.0	86.8%	683.4	12.6%	29.7	0.5%	5506
NON_NHS	4139.0	83.5%	781.3	15.8%	39.5	0.8%	4962
ENTIRE_NETWORK	8847.0	85.2%	1464.8	14.1%	69.2	0.7%	10469

Pavement GFP (Lane Miles) for 2017							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1803.2	89.6%	195.6	9.7%	12.8	0.6%	2054
NON_INTERSTATE NHS	2910.6	86.2%	436.6	12.9%	30.8	0.9%	3424
NHS	4713.9	87.5%	632.2	11.7%	43.6	0.8%	5478
NON_NHS	4264.5	85.2%	711.4	14.2%	30.7	0.6%	5009
ENTIRE_NETWORK	8978.4	86.4%	1343.5	12.9%	74.3	0.7%	10488

Cracking G-F-P Ratings by Lane-Miles

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles % Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1723.9	84.0%	284.0	13.8%	44.3	2.2%	2052
NON_INTERSTATE NHS	2283.9	66.6%	910.0	26.5%	233.8	6.8%	3428
NHS	4007.8	73.1%	1194.0	21.8%	278.1	5.1%	5480
NON_NHS	2896.5	58.4%	1600.4	32.3%	464.5	9.4%	4961
ENTIRE_NETWORK	6904.3	66.1%	2794.3	26.8%	742.7	7.1%	10441

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1814.5	88.5%	219.5	10.7%	17.1	0.8%	2051
NON_INTERSTATE NHS	2562.3	74.2%	792.8	22.9%	100.2	2.9%	3455
NHS	4376.8	79.5%	1012.3	18.4%	117.3	2.1%	5506
NON_NHS	3040.2	61.3%	1659.7	33.5%	260.4	5.2%	4962
ENTIRE_NETWORK	7417.1	70.9%	2672.0	25.5%	377.6	3.6%	10469

Pavement GFP (Lane Miles) for 2017							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1789.8	87.1%	223.3	10.9%	41.1	2.0%	2054
NON_INTERSTATE NHS	2292.4	67.0%	899.0	26.3%	230.0	6.7%	3424
NHS	4082.2	74.6%	1122.3	20.5%	271.1	5.0%	5478
NON_NHS	2773.5	55.4%	1706.2	34.1%	527.1	10.5%	5009
ENTIRE_NETWORK	6855.6	65.4%	2828.5	27.0%	798.1	7.6%	10488

OVERALL G-F-P Ratings by Centerline Miles

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLine Miles Good Miles	CTLineMiles% Good	CTLine Miles Fair Miles	CTLine Miles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	251.3	72.5%	94.7	27.3%	0.6	0.2%	347
NON_INTERSTATE NHS	378.3	36.4%	625.1	60.1%	36.6	3.5%	1040
NHS	629.6	45.4%	719.8	51.9%	37.2	2.7%	1387
NON_NHS	502.0	21.9%	1677.6	73.0%	117.4	5.1%	2297
ENTIRE_NETWORK	1131.5	30.7%	2397.4	65.1%	154.6	4.2%	3684

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	254.0	73.3%	90.7	26.2%	1.8	0.5%	347
NON_INTERSTATE NHS	401.1	38.0%	633.9	60.0%	20.8	2.0%	1059
NHS	655.1	46.7%	724.6	51.7%	22.6	1.6%	1406
NON_NHS	477.6	20.6%	1761.9	76.0%	78.0	3.4%	2326
ENTIRE_NETWORK	1132.7	30.5%	2486.5	66.8%	100.6	2.7%	3732

Pavement GFP (Centerline Miles) for 2017							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	252.2	72.9%	91.8	26.5%	2.0	0.6%	347
NON_INTERSTATE NHS	370.6	36.0%	624.1	60.7%	33.8	3.3%	1046
NHS	622.8	45.3%	715.9	52.1%	35.8	2.6%	1393
NON_NHS	487.1	21.1%	1704.4	73.8%	117.0	5.1%	2341
ENTIRE_NETWORK	1109.9	30.1%	2420.3	65.7%	152.8	4.1%	3734

Ride Quality (IRI) G-F-P Ratings by Centerline Miles

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	289.6	83.6%	52.2	15.1%	4.8	1.4%	347
NON_INTERSTATE NHS	448.8	43.2%	436.9	42.0%	154.3	14.8%	1040
NHS	738.4	53.3%	489.0	35.3%	159.1	11.5%	1387
NON_NHS	556.4	24.2%	1250.2	54.4%	490.5	21.4%	2297
ENTIRE_NETWORK	1294.8	35.1%	1739.2	47.2%	649.7	17.6%	3684

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	280.0	80.8%	59.3	17.1%	7.2	2.1%	347
NON_INTERSTATE NHS	446.2	42.3%	445.9	42.2%	163.7	15.5%	1059
NHS	726.2	51.8%	505.2	36.0%	170.9	12.2%	1406
NON_NHS	518.1	22.3%	1268.0	54.7%	532.1	23.0%	2326
ENTIRE_NETWORK	1244.3	33.4%	1773.2	47.7%	703.0	18.9%	3732

Pavement GFP (Centerline Miles) for 2017							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	280.5	81.1%	58.7	17.0%	6.8	2.0%	347
NON_INTERSTATE NHS	431.0	41.9%	446.8	43.4%	151.4	14.7%	1046
NHS	711.5	51.7%	505.5	36.8%	158.2	11.5%	1393
NON_NHS	547.1	23.7%	1297.2	56.2%	465.0	20.1%	2341
ENTIRE_NETWORK	1258.6	34.2%	1802.7	48.9%	623.2	16.9%	3734

Rutting G-F-P Ratings by Centerline Miles

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles % Fair	CTLineMiles Poor Miles	CTLineMiles % Poor	Total CTLineMiles Miles
INTERSTATE	311.66	91.0%	30.3	8.8%	0.51	0.1%	342
NON_INTERSTATE NHS	895.4	85.1%	152.3	14.5%	5.1	0.5%	1053
NHS	1207.0	86.5%	182.6	13.1%	5.6	0.4%	1395
NON_NHS	1886.9	81.2%	422.1	18.2%	15.7	0.7%	2325
ENTIRE_NETWORK	3093.9	83.2%	604.6	16.3%	21.3	0.6%	3720

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles % Poor	Total CTLineMiles Miles
INTERSTATE	299.2	88.0%	38.5	11.3%	2.3	0.7%	347
NON_INTERSTATE NHS	913.2	86.7%	135.2	12.8%	4.4	0.4%	1059
NHS	1212.3	87.0%	173.7	12.5%	6.7	0.5%	1406
NON_NHS	1947.5	83.8%	358.7	15.4%	18.3	0.8%	2326
ENTIRE_NETWORK	3159.9	85.0%	532.4	14.3%	25.0	0.7%	3732

Pavement GFP (Centerline Miles) for 2017							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles % Poor	Total CTLineMiles Miles
INTERSTATE	307.79	90.5%	30.21	8.9%	2	0.6%	347
NON_INTERSTATE NHS	904.6	87.1%	125.8	12.1%	8.2	0.8%	1046
NHS	1212.3	87.9%	156.0	11.3%	10.2	0.7%	1393
NON_NHS	2003.0	85.6%	323.3	13.8%	13.6	0.6%	2341
ENTIRE_NETWORK	3215.3	86.5%	479.3	12.9%	23.8	0.6%	3734

Cracking G-F-P Ratings by Centerline Miles

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	296.27	85.5%	46.19	13.3%	4.21	1.2%	347
NON_INTERSTATE NHS	679.9	64.2%	296.3	28.0%	83.4	7.9%	1060
NHS	976.2	69.4%	342.5	24.4%	87.6	6.2%	1406
NON_NHS	1353.4	58.2%	753.7	32.4%	218.3	9.4%	2325
ENTIRE_NETWORK	2329.6	62.4%	1096.1	29.4%	305.9	8.2%	3732

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	310.8	89.7%	33.4	9.6%	2.3	0.7%	347
NON_INTERSTATE NHS	761.5	71.9%	260.0	24.5%	37.9	3.6%	1059
NHS	1072.3	76.3%	293.4	20.9%	40.2	2.9%	1406
NON_NHS	1426.0	61.3%	777.5	33.4%	121.4	5.2%	2326
ENTIRE_NETWORK	2498.4	67.0%	1070.8	28.7%	161.6	4.3%	3732

Pavement GFP (Centerline Miles) for 2017							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	303.1	87.5%	37.5	10.8%	5.9	1.7%	347
NON_INTERSTATE NHS	666.8	63.8%	297.5	28.5%	81.0	7.7%	1046
NHS	969.9	69.7%	335.0	24.1%	86.9	6.2%	1393
NON_NHS	1303.3	55.7%	794.0	33.9%	242.7	10.4%	2341
ENTIRE_NETWORK	2273.2	60.9%	1129.0	30.3%	329.6	8.8%	3734

APPENDIX 6. TYPICAL AVERAGE CTDOT PAVEMENT TREATMENT COSTS BASED ON RECENTLY BID PROJECTS

Table 5-6. Pavement Treatment Costs using Estimator

Treatment	Unit	Unit Cost
Ultra Thin Treatment	SY	$7.57
Mill and Fill /Maintenance Resurfacing (2 in.)	SY	$22.13
Mill and Fill (2 inches)	SY	$22.13
Mill and Fill (3 inches)	SY	$33.33
Rubblization	SY	$134.74
Structural Rehabilitation + Joint Repair	SY	$57.24
Structural Rehabilitation	SY	$56.05
Reclamation	SY	$45.73
Reconstruction (light, flexible)	SY	$82.87
Reconstruction (medium, flexible)	SY	$98.70
Reconstruction (heavy, flexible)	SY	$118.79
Reconstruction (light, composite)	SY	$91.41
Reconstruction (medium, composite)	SY	$107.67
Reconstruction (heavy, composite)	SY	$128.62
Diamond Grinding	SY	$45.32
Diamond Grinding + Joint Repair	SY	$51.30
Concrete Pavement Repairs and Structural Overlay	SY	$48.47
Rubberized Chip Seal	SY	$7.69
Thin Overlay	SY	$16.35
Microsurfacing	SY	$7.28

APPENDIX 7. HIGHWAY FUNCTIONAL CLASSIFICATION DEFINITIONS AND CHARACTERISTICS [21]

Functional Class	Definition	Context
ARTERIALS		
Class 1 -- Interstates	All routes that comprise the Dwight D. Eisenhower National System of Interstate and Defense Highways	Interstates are the highest classification of Arterials and were designed and constructed with mobility and long-distance travel in mind. Roadways in this functional classification category are officially designated as Interstates by the U.S. Secretary of Transportation
Class 2 -- Other Freeways and Expressways	Contain directional travel lanes that are usually separated by some type of physical barrier, and their access and egress points are limited to on- and off-ramp locations or a very limited number of at-grade intersections.	Like Interstates, these roadways are designed and constructed to maximize their mobility function, and abutting land uses are not directly served by them.
Class 3 --Other Principal Arterials	Serve major centers of metropolitan areas, provide a high degree of mobility and can also provide mobility through rural areas.	Unlike Interstates and Other Freeways, abutting land uses can be served directly. Forms of access for Other Principal Arterial roadways include driveways to specific parcels and at-grade intersections with other roadways.
Class 4 -- Minor Arterials	Provide service for trips of moderate length, serve geographic areas that are smaller than their higher Arterial counterparts and offer connectivity to the higher Arterial system.	In an urban context, they interconnect and augment the higher Arterial system, provide intra-community continuity and may carry local bus routes. In rural settings, Minor Arterials should be identified and spaced at intervals consistent with population density, so that all developed areas are within a reasonable distance of a higher level Arterial. Additionally, Minor Arterials in rural areas are typically designed to provide relatively high overall travel speeds, with minimum interference to through movement.
NON ARTERIALS		
Class 5 -- Major Collectors	Gather traffic from Local Roads and funnel them to the Arterial network. Urban major collectors Serve both land access and traffic circulation in *higher* density residential, and commercial/industrial areas.	Generally, Major Collector routes are longer in length; have lower connecting driveway densities; have higher speed limits; are spaced at greater intervals; have higher annual average traffic volumes; and may have more

Functional Class	**Definition**	**Context**
	Rural major collectors provide service to any county seat not on an Arterial route, to the larger towns not directly served by the higher systems and to other traffic generators of equivalent intra-county importance such as consolidated schools, shipping points, county parks and important mining and agricultural areas	travel lanes than their Minor Collector counterparts.
Class 6 -- Minor Collectors	Gather traffic from Local Roads and funnel them to the Arterial network.	Urban Minor Collectors serve both land access and traffic circulation in *lower* density residential and commercial/industrial areas. Rural minor collectors are spaced at intervals, consistent with population density, to collect traffic from Local Roads and bring all developed areas within reasonable distance of a Collector.
Class 7 -- Local Roads	Provide direct access to abutting land, and are often designed to discourage through traffic.	Locally classified roads account for the largest percentage of all roadways in terms of mileage. They are not intended for use in long distance travel. Local Roads are often classified by default; once all Arterial and Collector roadways have been identified, all remaining roadways are classified as Local Roads