Hot Mix Asphalt Research Investigation For Connecticut: Part E – Comparison of Field Performance Of Superpave and Traditional Marshall Mixes

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SPR 2250 – Part E

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Disclaimer

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Standard Conversions

SI* (MODERN 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
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
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16. Abstract
This research is part of the series of investigated topics surrounding hot mix asphalt in Connecticut. This research investigates the performance of sections of pavements designed using both the Marshall and Superpave mix design methods. Sixteen different pavement sections in Connecticut (eight Superpave and eight Marshall) were analyzed by means of site visits, photolog image analysis and numerical condition ratings. This research was intended to investigate whether there are difference(s) between the two differently designed types of pavement as far as their ability to withstand environmental distress, as well as traffic loading. Results showed no conclusive evidence that the two pavement types perform differently.

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Executive Summary

This research investigates the in-place long-term durability of Superpave mixes as compared with traditional Marshall mixes in Connecticut. One of the primary focuses of the Superpave mix design method was the mitigation of permanent deformation of the pavement that presented itself in the form of wheel path rutting. No studies were available which investigated the long-term field durability of Superpave mixes as the design process was so new. Several people from within ConnDOT expressed concern about the integrity of these new Superpave pavements in Connecticut.. The concern was the ability of Superpave mixes to adequately resist distresses caused by the freezing and thawing cycles in colder climates while resisting the permanent deformation of rutting.

Three analytical methods were used to investigate the performance of these new mixes in comparison with Marshall mixes. First, a list of pavement sections to be analyzed was obtained from each maintenance district within the Connecticut Department of Transportation (ConnDOT). The research team visited each pavement section and narrowed the list down to two Marshall sections and two Superpave sections per maintenance district for a total of 16 sections throughout the state.

Once the pavement sections were selected, they were photographed during the winter months and then photographed again one year later to analyze whether certain sections were deteriorating rapidly in comparison with others.

Another comparison took place by viewing the sections from year to year with the Connecticut Photolog images. This provided a better platform to analyze deterioration rates, as it covered from the time each section was resurfaced until the time of the analysis.

The last method of analyzing these sections for performance was viewing the ConnDOT Office of Maintenance Pavement Serviceability Ratings (PSR) over several years. The PSR ratings not only allowed the research team to gain the perspective of the quality of each section from the ConnDOT viewpoint, but it also gave a numerical platform for analysis of performance. These PSR values were analyzed to see the rate of decline in serviceability over several years. They were also used to compare the pavement sections in the areas in the state that experience the harshest weather with those sections located in other areas which do not typically experience as much harsh weather.

All of these analyses were conducted as a basis of comparison between the performance of Superpave mixes and Marshall mixes. Conclusions were made from this research that indicate no difference in the ability of the two differently

designed pavement types (Marshall and Superpave) to withstand environmental and/or traffic loading over a period of four to eight years.

Background

Superpave mix design methods were developed at the national level in a wide-scale effort to improve upon the quality, structural integrity and service life of hot-mix asphalt (HMA) roadways. Structural integrity was a primary focus during the development of the Superpave system as roadways constructed under traditional design methods frequently experienced permanent deformation that presented itself in the form of wheel path rutting. The Superpave mix design system promotes stone-on-stone contact to create a greater degree of internal friction within the pavement. This increased internal friction is intended to allow the denser and more angular stone matrix to absorb and distribute loading stress from traffic, while resisting rutting to a much more substantial degree than traditional mix designs. The PG asphalts used in Superpave were also developed to address temperature susceptibility (hot and cold) of in place asphalts, and to extend the range of temperatures that could be experienced by in-place pavements without detrimental results (i.e, less cracking induced by cold and stiffness, less rutting and shoving induced by heat and viscosity).

After development, the Superpave system was widely adopted by agencies all across the United States. Because the Superpave system wasn't developed until the 1990's, there were no available studies from which long-term performance of Superpave roadways could be examined, and there was no long-term research available comparing performance characteristics of traditionally designed pavements and pavements designed under the Superpave protocol.

Some pavements in Connecticut designed under the Superpave system have now been in service in excess of 10 years, and many of those surfaces have been overlaid. ConnDOT made the full switch from Marshall mixes to Superpave mixes in 2004. Concerns were expressed by ConnDOT regarding the durability of Superpave mixes, specifically with respect to excessive cracking. This research is intended to compare those pavements with similar pavements of the same age and traffic levels that were designed using the traditional Marshall method.

Objectives

The objective of this research was to examine and compare performance characteristics of Superpave mixes and mixes designed using the Marshall method throughout the state of Connecticut. Three different data collection methods, including field evaluations of several roadways constructed in Connecticut, were used to provide insight as to how the two different pavement design types perform in the field, with respect to each other. This information provided long-term performance data comparing the two methods and was as a tool in future long-term performance comparisons, which were conducted.

Reviewed Literature

Long-term, in-depth comparisons of field evaluations between Marshall and Superpave mix designs, from a perspective other than rutting, were difficult to find. Another confounding issue in finding studies for comparison are the various adjustments made to Marshall mix requirements by the individual states. There was, however, a study conducted in Alabama (*Watson et al, 2005*) that examined performance measures between Superpave mixes and Marshall mixes on similar projects, for the purpose of optimizing the number of gyrations used in the Superpave mix design process. Although the Alabama research was conducted for different reasons, it lends itself well to this investigation in light of the fact that it makes some similar comparisons.

Twenty-five Marshall mix pavement sections and 25 Superpave pavement sections throughout Alabama were selected for analysis. Among several performance measures that were examined are rut depth, crack severity and crack intensity. At the time of analysis, both sets of sections averaged approximately four years old, and both sets had a reasonably similar average daily traffic (ADT).

Average rut depths from the Marshall projects were compared with average rut depths from the Superpave projects. Watson et al. indicate that that there was no difference in the rutting performance between the projects constructed under the differing mix designs at the time of the comparison (i.e., at average four years age).

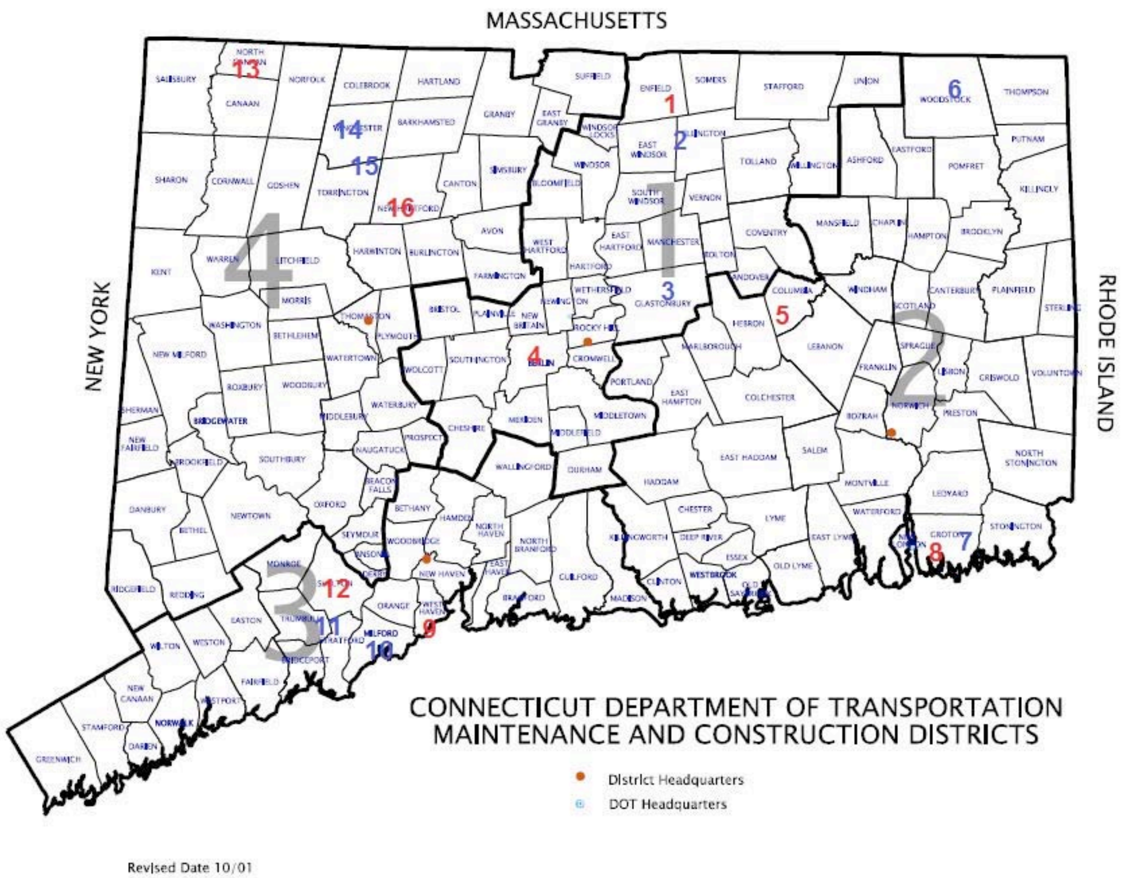
When results of cracking severity and intensity were compared between the projects, the authors indicated only a 0.03 LF/SF (linear feet of cracking per square foot of pavement) average difference between the two sets of data. It was also noted that only seven Marshall projects and six Superpave projects exhibited any cracking distress, which was another indication the surfaces were performing similarly.

Among the conclusions made by the authors were that both mix sets were performing well with minimal rutting and cracking after they had been in service approximately four years. The authors stated that the cracking resistance for both types of mixes appeared to be similar.

Pavement Section Selection

The research team consulted with ConnDOT to identify pavement sections throughout Connecticut that would lend themselves well to making mixture performance comparisons. Although Connecticut is a relatively small state, there are notable differences in climatic conditions within the state due to the variable geography and relative proximity to the Atlantic Ocean. Connecticut elevations range from zero feet above mean sea level at Long Island Sound to almost 2500 feet near the northern border of the state. Since environmental distresses were of concern for this research, it was decided that road segments would be investigated in all four Districts of Connecticut (See Figure 1). In Figure 1 there are four large-font gray numbers (1 through 4) that correspond to the four ConnDOT maintenance districts. There are then 16 smaller-font numbers (1 through 16) that identify the location of the pavement sections being analyzed for this research. There are two blue numbers and two red numbers in each of the four districts in Figure 1. The blue numbers indicate Superpave sections and the red numbers indicate Marshall sections. The process for selecting each section is described below.

Figure 1. Connecticut Department of Transportation Maintenance Districts



Map Image Courtesy Connecticut Department of Transportation

The research team requested ConnDOT to identify several candidate pavement sections for this research from each of the four districts. Maintenance personnel from each District provided a list of pavement sections and these are included in Appendix B for each District. Half of the sections were Superpave and the other half were Marshall. Half the sections were listed as performing well and the other half listed as displaying some premature distress. The research team then visited each of the sites and selected two Superpave sections as well as two Marshall sections in each District to analyze for comparison purposes for this research. Half of the sections chosen were listed as performing well, and half were listed as showing premature distress so there was an equal breakdown of pavement types and condition. The selected sections are listed in Table 1 and the corresponding number for that section depicted geographically in Figure 1 above. The number and color logic for the pavement sections in Table 1 are the same as for the graphic in Figure 1, and the map section numbers in Table 1 can be found graphically in Figure 1.

Table 1. Pavement Sections

District	Project	Route	Town	Begin Log Mile	End Log Mile	SuperPave or Marshall	Pavement Location on Map
1	171-293H	191	Enfield	5.83	9.30	Marshall	1
1	171-293I	140	Ellington	8.63	13.70	SuperPave	2
1	171-303C	94	Glastonbury	0.62	8.53	SuperPave	3
1	171-292E	372	Berlin	5.29	7.46	Marshall	4
2	172-327F	66	Columbia	27.36	32.33	Marshall	5
2	172-337I	169	Woodstock	32.63	38.25	SuperPave	6
2	172-338L	184	Groton	2.70	6.09	SuperPave	7
2	172-338H	117	Groton	0.00	2.56	Marshall	8
3	173-357I	162	West Haven	5.29	8.25	Marshall	9
3	173-	162	Milford	1.30	3.39	SuperPave	10

	358G						
3	173-348L	SR 714	Shelton	0.32	2.20	**SuperPave**	**11**
3	173-334D	SR 714	Shelton	2.20	5.00	**Marshall**	**12**
4	174-311D	44	North Canaan	8.83	11.52	**Marshall**	**13**
4	174-311E	44	Winchester	23.60	26.84	**SuperPave**	**14**
4	174-311F	44	Winchester	28.89	34.43	**SuperPave**	**15**
4	174-319G	44	New Hartford	34.43	38.25	**Marshall**	**16**

It should be noted that during selection of pavement sections, the current condition of the roadway was taken into account. Whether the road was milled entirely, spot milled, or not milled at all was also taken into consideration. As a result, there were four Marshall sections and four Superpave sections which were spot milled. There were two Marshall sections and two Superpave sections that were milled entirely. And there were two Marshall sections and two Superpave sections that were not milled. All of the pavement sections were resurfaced between 2001 and 2003.

Work Plan

It was decided by the research team that three different methods should be used to conduct comparisons of performance amongst the sixteen pavements.

First, a minimum of two field visits were conducted to each section. The initial visit served several purposes: to identify any performance issues which may be present; to analyze the general condition of the roadway; and to collect images of transverse cracks which were just developing and had not yet stretched from curb to curb. The second visit to each of those sites one year later gave insight as to how much each of the selected transverse cracks had progressed. The rate of development of the cracks would then be compared for the different mixes.

The second mode of comparison took place utilizing the ConnDOT photolog of each roadway section, to analyze the progression of the pavement deterioration over the years from the time they were resurfaced. The rate of noticeable deterioration was then compared for the Marshall and Superpave pavement types.

The third and perhaps the most valuable mode of comparison was the Pavement Serviceability Rating (PSR) for each roadway section. The PSR rating is a yearly rating of the roadway conducted by ConnDOT District Maintenance personnel, which categorizes the roadway condition based on several different factors. It was the opinion of the research team that an analysis of the PSR ratings over the years following the most recent pavement placement would yield the best comparison. The District Personnel who conduct the ratings are trained and quite familiar with the roadway sections being analyzed. Even though there is a degree of subjectivity to these observational evaluations, the research team feels these PSR ratings form a good basis for comparison from a numerical platform. In addition to making comparisons of the PSR ratings between Marshall mix sections and Superpave sections for the entire state, the research team also evaluated the difference in performance of the two mixes based on their geographical location within the state. These comparisons also utilized the PSR values for each of the pavement sections.

Road Section Site Visits

The first visit to each of the sections of pavement occurred during the winter of 2007 and 2008 and the second visit took place during the winter of 2008 and 2009. The winter months were chosen for field visits, as any transverse cracks would be more open and visible at that time, compared to the hot summer months. A general overview of the condition of the roadway was conducted at each site, and several photographs were taken of the overall pavement condition.

The research team identified at least one partially developed transverse crack per section. These partially developed cracks were cracks that had not yet progressed from curb to curb. Images were taken of these cracks in each of the 16 sections. The cracks were also spatially referenced for future visits.

During the second visit to each of the site sections, a general overview of the condition of the roadway was made, and several photographs of the pavements were again taken. Also during the second visit, the partially developed crack which was selected and photographed during the first visit was located and re-photographed for comparison purposes. A Year 1 and Year 2 comparison example is shown for both a Superpave section (Rt. 140 in Ellington) as well as a Marshall section (Rt. 66 in Columbia) in Figures 2 and 3 respectively.

Figure 2. SuperPave 1 Year Transverse Crack Progression (Rt 140, Ellington)

Winter '08 & 09 Transverse Crack   Winter '09 & 10' Transverse Crack

Figure 3. Marshall 1 Year Transverse Crack Progression (Rt 66, Columbia)

Winter ’08 &’09 Transverse Crack Winter ’09 &’10 Transverse Crack

The images were taken at slightly different angles, which may give the viewer a false impression that the cracks exhibited some change over the course of the year. In fact, none of the cracks in the 16 pavement sections examined for this research study exhibited any noticeable change over the course of one year.

The main reason behind performing the crack progression analysis over the course of just one year was to examine if there was an accelerated rate of deterioration at any of the sections. It was the opinion of the research team that if a visually noticeable difference existed between the rate of deterioration from one pavement type to the other after just one year, it could be stated that one pavement type may be underperforming relative to the other. This was not observed for either pavement type during the site visits. There are several images that were taken of these sections; however, only a few of them are included in this report. They are all taken from different angles and lighting as seen in Figures 2 and 3. They do not lend themselves well to making crack progression analyses. It is the opinion of the research team that the photolog analysis in the following section provides a better basis for comparison, as it covers more time than simply one year.

Photolog Analysis

The Connecticut Advance Pavement Laboratory (CAP Lab) has access to the Connecticut DOT photolog. This access lent itself well to making further visual analyses between the performance of the pavement sections without the need to physically visit the sites each year. This also provided the research team with the capability of analyzing different sections of the roadways over each year of their life for each of the wearing surfaces.

The research team reviewed each year (photolog pass) of each individual section to get a general perspective of how the section resisted weathering and traffic from the time it was resurfaced up until the time of this analysis.

The research team selected two random locations from each of the projects shown in Table 1. The amount of pavement in each of the images that can be seen clearly is likely limited to within 50 feet. Beyond that distance it is difficult to identify pavement distresses. The research team made every attempt to avoid areas where construction/utility cuts had been made or where there were forms of distress that did not represent the general condition of the pavement for that particular roadway section as these types of areas often are the result of a defect from the placement of the pavement. Images from each photolog year were collected for each of the selected locations for the roadway sections. These years spanned the year prior to resurfacing up until the year of analysis (2009). The number of years was then recorded from the year of resurfacing until that section began to show signs of distress in the form of cracking. There were four roadway sections per pavement type which were spot milled. The reader should keep in mind that the exact locations of the spot milling within the spot milled sections is unknown. During the analysis for the onset of visual distress, the research team was looking primarily for cracking. A breakdown of the average time prior to the initial visible distress is shown in Table 2.

Table 2. Average Time Prior to Visible Distress (Photo Log)

Pavement Type	Not Milled	Spot Milled	Milled Entirely
Superpave	3.75	3.5	3.5
Marshall	4	3.5	2.75

Figures 4 – 15 show the progress of two pavement sections, the first column Marshall and the second Column Superpave. Both sections were resurfaced in 2003. The sections are located spatially approximately 15 miles apart and in the northwest corner of the state, which experiences the harshest weather. Both were spot milled, making them interesting candidates for comparison, since there are many variables held constant.

Figure 4. Rt. 44 N. Canaan 2004 (Marshall)

Figure 5. Rt. 44 N. Canaan 2005 (Marshall)

Figure 6. Rt. 44 N. Canaan 2006 (Marshall)

Figure 7. Rt. 44 N. Canaan 2007 (Marshall)

Figure 8. Rt 44 N. Canaan 2008 (Marshall)

Figure 9. Rt 44 N. Canaan 2009 (Marshall)

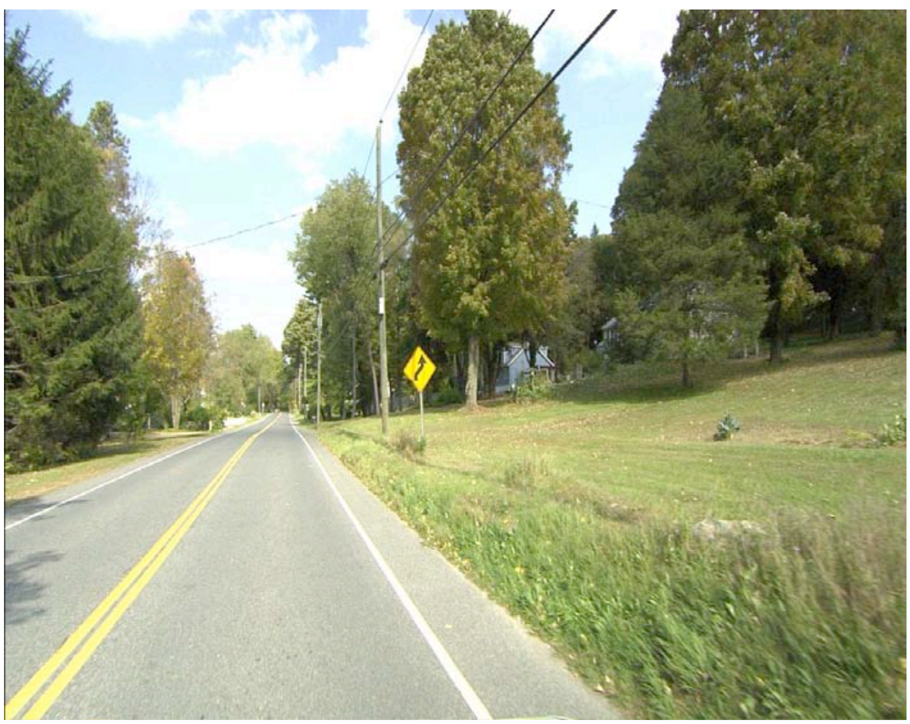


Figure 10. Rt. 44 Winchester/Colebrook 2004 (Superpave)

Figure 11. Rt. 44 Winchester/Colebrook 2005 (Superpave)

Figure 12. Rt. 44 Winchester/Colebrook 2006 (Superpave)

Figure 13. Rt. 44 Winchester/Colebrook 2007 (Superpave)

Figure 14. Rt. 44 Winchester/Colebrook 2008 (Superpave)

Figure 15. Rt. 44 Winchester/Colebrook 2009 (Superpave)

In general there was very little difference in the length of time until either type of pavement displayed any sign of visual distress, the images above show that in this particular comparison that was not the case, as cracking was visible in the Superpave section four years prior to the Marshall section. The analysis used a small sample size relative to the number of photolog images available. There were 2 randomly selected locations on each of the 16 projects used in the analysis. This gave anywhere from 7 to 10 images per location and 284 images in total were analyzed.

Table 2 shows extremely small differences between the average times until distress was observed for each pavement type regardless of milling. Where there was more milling done, it may be indicative of a pavement structure that was more distressed to start. The results as reflected in Table 2 do not indicate a significant difference in performance between the two pavement design types.

Pavement Serviceability Rating Analysis

During the timeframe covered by this research, one of the condition rating methods employed by ConnDOT, was called the pavement serviceability rating (PSR) system (See Appendix A). The PSR was conducted on every road each year and treatment priority was assigned to roadway sections based upon these ratings. The continuity in the ratings comes from those performing the analysis. The District Maintenance Planners and the District Maintenance Superintendents/Designees performed the ratings each year. This provided continuity in that the same person was rating the roadways year after year and that they were familiar with the roadway as well.

The PSR rating is based on a scale of 0 – 10. It is stated in the PSR system instructions that the numbers 0 and 10 do not apply. The reasoning for this is that a score of 0 would indicate that a road is impassable and that no road section should ever be in this condition. On the other hand a score of 10 would indicate perfection, and since no road will ever be truly perfect, 10 is not a score that is achievable. The end result of a roadway rating was a number, 1 – 9, which corresponds to a descriptive condition according to Table 3.

Table 3. PSR Rating Conditions

Numerical Rating Range	Descriptive Roadway Condition
1 ≤ 2	Unacceptable
2 ≤ 4	Poor
4 ≤ 6	Fair
6 ≤ 8	Good
8 ≤ 9	Excellent

The ratings are based on five different components related to the quality of the pavement. Each individual component is given a whole number score between 1 and 9 as described above. The weighted average of those scores is then rounded to the nearest tenth. Those five components and their respective weights are shown in Table 4.

Table 4. PSR Component Weights

Quality Component	Component Weight
Cracking	25
Distortion	15
Disintegration	30
Drainage	20
Riding Quality	10

The entire manual for PSR rating is contained in Appendix A.

It should be noted that it is not the value of the PSR for each section per year that is of direct interest for this research. A lower (i.e., less than 9) PSR immediately after resurfacing could be the result of construction methods. PSR values for all of the sections for one single year (regardless of the year) bear no information on the ability of that pavement to withstand distress over time, and examinations of this sort were not considered for this research. Instead, what is of concern for this research, is the absolute value of the slope of the PSR plots over time which is a measure of the rate of change of the pavement condition. The higher this number, the more rapidly the pavement is becoming distressed over time, thus indicating a lessened performance of that pavement section. Conversely, the lower the slope value, the better the performance.

Table 5 shows the PSR ratings from 1999 until 2008 for all of the sections included in this research study. The PSR values shown in bold print with blue (Superpave) or red (Marshall) font are those of concern because they indicate the period of time from resurfacing until present.

Table 5. PSR Record 1999 - 2008

				Beg	End	Log	Year	PSR									
Pro #	Rt	Town(s)	Termini	Log Mile	Log Mile	Length	Paved	99	00	01	02	03	04	05	06	07	08
			DISTRICT 1														
171-293H	191	East Windsor	Rt 140 to Rt 190	5.82	9.30	3.48	2001	6.3	6.3	**8.7**	**8.7**	**8.7**	**8.4**	**7.6**	**7.4**	**7.7**	**7.4**
		Enfield															
171-293I	140	East Windsor	Rt 191 to Rt 83	8.63	13.70	5.07	2001	7.0	6.9	**9.0**	**9.0**	**9.0**	**9.0**	**9.0**	**8.9**	**8.4**	**8.0**
		Ellington															
171-303C	94	Glastonbury	SR 910 to Hebron TL (Omit Hyst La)	0.62	8.57	7.95	2002	6.9	5.9	5.4	**9.0**	**9.0**	**8.6**	**8.6**	**8.2**	**8.1**	**8.1**
171-292E	372	New Britain	Ten Acre Rd to Rt 71	5.29	7.46	2.17	2001	6.6	5.8	**9.0**	**8.9**	**8.9**	**8.8**	**8.6**	**8.3**	**8.3**	**8.0**
		Berlin															
			DISTRICT 2														
172-327F	66	Columbia	Hebron TL to Rt 6	27.36	32.33	4.97	2001	5.6	5.6	**9.0**	**8.4**	**8.4**	**8.1**	**8.0**	**7.5**	**7.2**	**7.0**
172-337I	169	Woodstock	Childs Hill Rd to Mass SL	32.63	38.25	5.62	2002	6.0	5.7	5.5	**9.0**	**8.5**	**8.5**	**8.5**	**7.6**	**7.4**	**6.8**
172-338L	184	Groton	Rt 117 to Rt 27	2.70	6.09	3.39	2002	6.3	6.0	5.6	**9.0**	**8.5**	**8.4**	**8.4**	**8.4**	**8.4**	**7.9**
172-338H	117	Groton	Rt 1 to Rt 117	0.00	2.56	2.56	2002	6.8	6.5	6.0	**9.0**	**8.7**	**8.4**	**8.2**	**8.2**	**8.0**	**7.5**
			DISTRICT 3														
173-357I	162	West Haven	Milford TL to Kelsey Ave	5.29	8.25	2.96	2003	6.7	6.2	5.4	4.7	**9.0**	**8.6**	**8.2**	**7.9**	**7.2**	**7.0**
173-358G	162	Milford	River St to Eels Hill Rd	1.26	3.35	2.09	2003	6.4	6.2	5.4	4.9	**9.0**	**8.8**	**8.5**	**8.5**	**8.0**	**7.8**
173-348L	714	Shelton	.32 Mi E/O Huntington St to .06 Mi S/O Long Hill Cross	0.32	2.20	1.88	2002	5.6	5.6	5.6	**8.9**	**8.6**	**8.2**	**7.8**	**7.7**	**7.2**	**7.0**
173-334D	714	Shelton	.02 Mi/ S/O Long Hill Rd to Rt 108	2.20	5.00	2.80	2001	6.0	5.5	**8.0**	**7.6**	**7.1**	**6.6**	**6.5**	**5.9**	**5.7**	**5.7**
			DISTRICT 4														
174-311D	44	North Canaan	Salisbury TL to Rt 7S	8.83	11.52	2.69	2003	6.3	5.8	5.5	5.5	**8.6**	**8.0**	**8.0**	**8.0**	**7.8**	**7.2**
174-311E	44	Winchester	Colebrook TL to Loomis St	23.60	26.84	3.24	2003	5.8	5.8	5.6	5.5	**8.4**	**8.0**	**8.0**	**7.8**	**7.5**	**7.0**
174-311F	44	Winchester	Rt 183 E/Jet to Rt 219	28.89	34.43	5.54	2003	6.3	6.3	5.7	5.7	**8.6**	**8.0**	**8.0**	**7.8**	**7.5**	**7.0**
		Barkhamsted															
		New Hartford															
174-319G	44	New Hartford	Rt 219 to .49 Mi W/O Rt 179	34.43	38.25	3.82	2004	6.2	6.2	5.7	5.7	5.7	**8.6**	**8.0**	**7.8**	**7.8**	**7.3**

The slope was obtained by subtracting the 2008 PSR value from the PSR value at the year of resurfacing and dividing that calculated value value by the number of years that had passed. The values of those slopes are shown in Table 6.

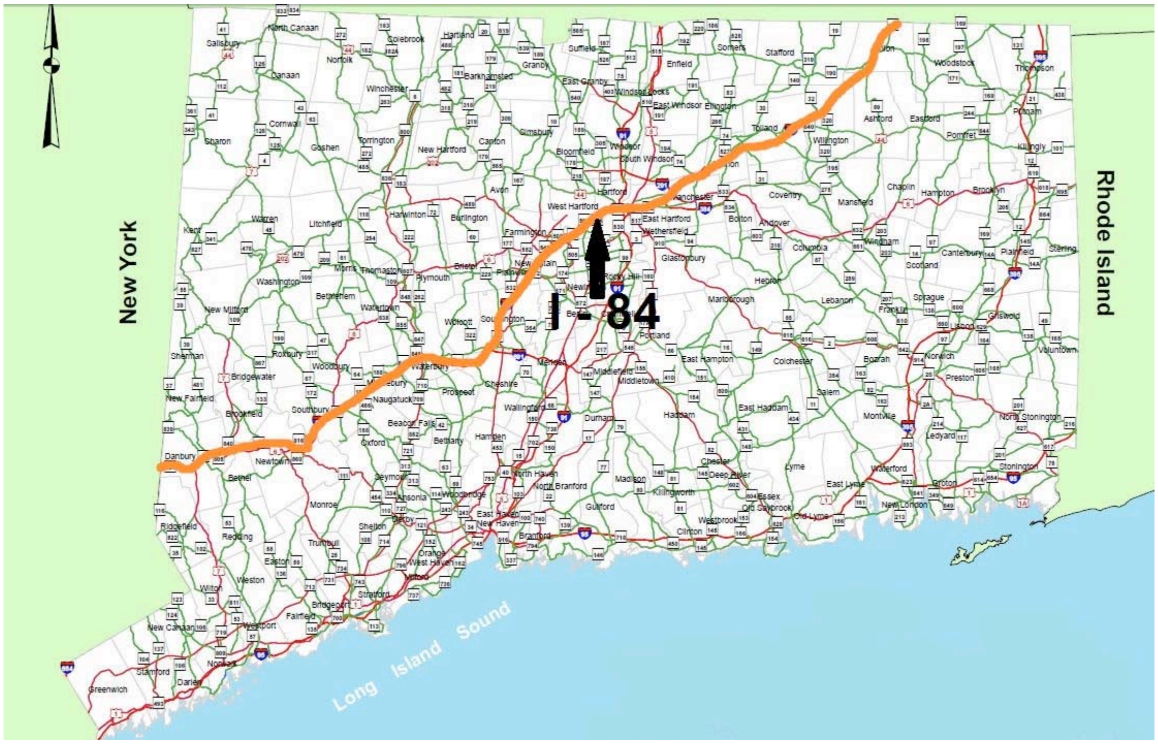
Table 6. Slope of PSR Values Resurfacing through 2008

Superpave Section		Slope (PSR)		Marshall Section		Slope (PSR)
Rt #	Town			Rt #	Town	
140	Ellington	0.14		191	Enfield	0.19
94	Hebron	0.15		372	N. Britain	0.14
169	Woodstock	0.37		66	Columbia	0.29
184	Groton	0.18		117	Groton	0.25
162	Milford	0.24		162	West Haven	0.40
SR 714	Shelton (1)	0.32		714	Shelton (2)	0.33
44	Win/Bar	0.32		44	N. Canaan	0.28
44	Win/Col	0.28		44	N. Hartford	0.33
Average		**0.25**		**Average**		**0.28**

As shown by the slope values in Table 6, it may be easily concluded that neither of the pavement types outperformed the other. The difference in the average range of values between pavement types is only 0.03. The average rate of deterioration between Superpave and Marshall mixes does not appear to vary by a significant amount.

In addition to the comparisons of PSR slope values, the research team investigated whether there were any performance differences based upon the geographical locations of the pavement sections within the state. It was decided that the best way to divide the state into “more severe” and “less severe” winter weather areas, was to use Interstate 84 as the dividing line. Figure 16 shows the delineation of the state by Interstate 84.

Figure 16. Interstate 84 Geographical Delineation



Typically with weather patterns experienced in Connecticut, the more severe winter storms and cold weather occur in the areas north of Interstate 84 while the areas south of Interstate 84 and along the coast generally see less severe weather and thermal patterns.

The research team organized the pavement sections into north or south of Interstate 84, as well as into Superpave or Marshall groups. The respective PSR slopes were then categorized for each group as shown in Table 7 with the averages.

Table 7. PSR Geographical Comparisons

Superpave North of I-84		Marshall North of I-84		Superpave South of I-84		Marshall South of I-84	
Town/ Rt. #	**PSR Slope**	**Town/ Rt. #**	**PSR Slope**	**Town/ Rt. #**	**PSR Slope**	**Town/ Rt. #**	**PSR Slope**
44 Win./ Col	**0.28**	44 N. Canaan	**0.28**	162 Milford	**0.24**	714 Shelton	**0.33**
44 Win./ Bar	**0.32**	44 N. Hartford	**0.33**	714 Shelton	**0.32**	162 W. Haven	**0.40**
169 Woodstock	**0.37**	191 Enfield	**0.19**	184 Groton	**0.18**	117 Groton	**0.25**
140 Ellington	**0.14**			94 Hebron	**0.15**	66 Columbia	**0.29**
						372 N. Britain	**0.14**
Average	**0.28**	**Average**	**0.27**	**Average**	**0.22**	**Average**	**0.28**

As seen in the averages at the bottom of Table 7, there is no indication of a difference between the average performance of the Marshall sections and the Superpave sections in the colder areas of the state. This is particularly evident when viewing the PSR slope values for the sections of pavement along Rt. 44 in the northwest portion of the state. Those values are nearly identical between Marshall and Superpave sections. The Superpave sections within the zone south of I-84 appear to have a lower rate of distress as compared to the Marshall mixes in the same zone.

Conclusions

In light of the three different methods used to compare the performance of Superpave pavements and Marshall pavements, the research team found no conclusive evidence of a difference in the pavements' ability to resist distress from either traffic loading or weather patterns. It should be noted that there were no instances of significant rutting or wheel path fatigue observed during any of the site visits to the entire paving project or during the photolog analysis on the selected sections.

The results shown in Tables 2, 6, and 7, as well as the results of examinations of numerous photolog images and analysis from the field visits, do not indicate that there is any significant difference in performance between Marshall pavements and Superpave pavements placed in Connecticut from 2001 through 2003.

The reader should take into consideration that visual analysis of pavements involves a small amount of interpretation. The images from the photolog and site visits were analyzed visually by the research team, and conclusions were taken from these analyses.

What also needs to be considered for any future evaluations are the changes that have taken place with the ConnDOT specifications from the time of implementation of Superpave in 2004 through current practice. It is more difficult to evaluate performance of pavement types amidst ongoing specification changes. There are some specification changes that have taken place since the period covered by this report ended, such as increases in the amount of allowable RAP content, the elimination of Superpave traffic level 4, minimum asphalt content specifications, maximum voids in the mineral aggregate specifications and changes in the specified low temperature performance grade of asphalt, just to name a few.

References

Watson, Donald E., Ray Brown and Jason Moore. *Comparison of Superpave and Marshall Mix Performance in Alabama.* Transportation Research Record: Journal of the Transportation Research Board, No. 1929. Washington D.C., 2005, pp. 133-140.

Pavement Serviceability Rating System. Bureau of Highways. Connecticut Department of Transportation. 1982.

Bituminous Concrete. Section 4.06 Standard Specifications for Roads, Bridges and Incidental Construction. Connecticut Department of Transportation. 2004 – 2011.

Bituminous Concrete Materials. Section M.04. Standard Specifications for Roads, Bridges and Incidental Construction. Connecticut Department of Transportation. 2004 – 2011.

Appendix A. PSR Manual

C. Kissane

CONNECTICUT DEPARTMENT OF TRANSPORTATION

BUREAU OF HIGHWAYS

PAVEMENT SERVICEABILITY RATING SYSTEM

PROJECT SUPERVISOR

David C. Miller

1982

INDEX

INTRODUCTION

Connecticut's Pavement Serviceability Rating System was developed by the Office of Maintenance, Bureau of Highways within the Connecticut Department of Transportation and in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Funding was provided for the project through the Transportation Planning Work Program, utilizing both State and Federal funds.

The Rating System was developed specifically to satisfy the needs and concerns relevant to the maintenance and upkeep of Connecticut's State Highway Network. The components of the system, system definitions and the application of the system are explained on the following pages.

PAVEMENT SERVICEABILITY RATING SYSTEM

The Pavement Serviceability Rating System (PSR) provides a systematic method of numerically categorizing the condition and present level of serviceability of pavements. This system provides for the rating of five components which affect and/or determine serviceability within five descriptive ratings integrated with numeric ratings on a scale of 1 to 9. The integration of descriptions with numeric ratings facilitates data handling and provides additional latitude in determining a quality level.

The descriptive ratings and their definitions are:

<u>EXCELLENT</u> Excellent roads would be new construction, reconstruction or exceptionally good overlays.

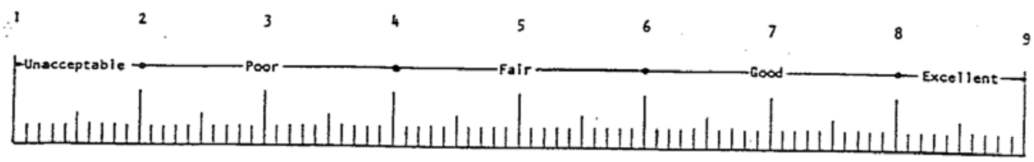
<u>GOOD</u> Good roads would require minor incidental work to preserve their life span.

<u>FAIR</u> Fair roads would require a moderate amount of maintenance to preserve their life span.

<u>POOR</u> Poor roads would require extensive maintenance work or a betterment to extend their life span.

<u>UNACCEPTABLE</u> Unacceptable roads would require partial or total reconstruction to reestablish a serviceable life span.

The relationship of the numeric ratings to the descriptive ratings is depicted by the following scale. This scale will aid in understanding PSR and should be kept in mind.



As noted above, pavements will be rated on five components which affect and/or determine serviceability. These components and their definitions are:

CRACKING 25% — The breaking or separation of the pavement surface. Cracking will be evident in the following forms: Longitudinal, Transverse, Reflection, Contraction-Shrinkage, Alligator, Map.

DISTORTION 15% — The deformation of the pavement from the plan in which it was originally constructed. Distortion will be evident in the following forms; Depressions, Rutting, Corrugation, Frost Heaves, Shoving.

DISINTEGRATION 30% — The wearing away or fragmentation of the pavement. Disintegration will be evident in the following forms: Polishing, Weathering-Oxidation, Scaling, Spalling, Raveling, Potholes.

DRAINAGE 20% — The containment and removal of surface and subsurface water from the pavement area. Drainage of off-pavement areas is not to be a consideration except where it has a direct effect on the pavement. Lack of drainage system maintenance (i.e. - failure to clean structures, pipes and waterways) should not cause a deficient rating if the system is adequate with proper maintenance.

<u>Riding Quality</u> 10% — The smoothness or roughness of ride as experienced by occupants of an average passenger vehicle.

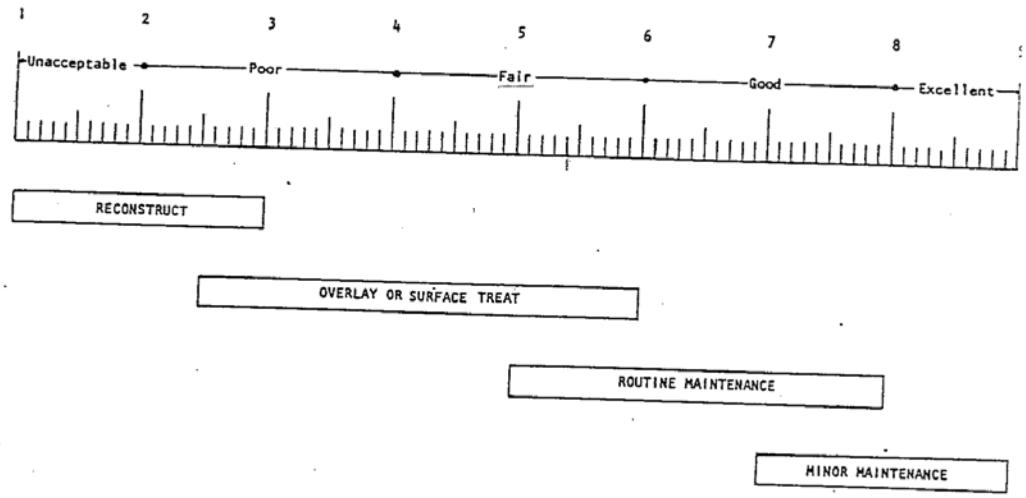
With an individual rating being made for each of the five components, the severity and the frequency at which a component is experienced will determine the numeric rating assigned. Noticeable differences in ratings between components can and are expected to be revealed in some cases.

The actual PSR for a road segment will be calculated by computer on the basis of a weighted average of the individual component ratings. The weight applied to each component is: Cracking 25%, Distortion 15%, Disintegration 30%, Drainage 20%, Riding Quality 10%. Although the numeric scale is referenced as 1 to 9, the scale is theoretically 0 to 10. Since 10 represents total perfection, and since no road section will ever actually achieve this rating, 10 is not considered in the system. Conversely, a rating of 0 would represent an impassable condition, and since no road should ever require this rating, 0 is not included in the system. Therefore, the actual ratings of the components can only be a whole number of 1 to 9. The PSR calculated by computer will be rounded to tenths, providing additional definition between each road section.

Definitions of the descriptive rating categories incorporating the rating components are as follows:

EXCELLENT	Excellent pavements would not show any signs of Cracking, Distortion, Disintegration or Drainage problems and would have a high Riding Quality.
GOOD	Good pavements could show signs of Cracking in isolated areas; any distortion in the form of rutting would be minor; Disintegration would not be evident except for an isolated pothole or minor surface scaling; Drainage and Riding Quality would be acceptable.
FAIR	Fair pavements would have definite signs of Cracking in general areas and/or evidence of Distortion in the form of frost heaves, shoving or rutting, and/or evidence of Disintegration in the form of frequent potholes, polishing and spalling; Drainage and Riding Quality would be inferior.
POOR	Poor pavements would have substantial evidence of Cracking, Distortion and Disintegration; remedial Drainage work would probably be required, and the Riding Quality would be poor.
UNACCEPTABLE	Unacceptable pavements would manifest near total or total loss of pavement surface. Drainage deficiencies in most cases would be readily evident.

In general terms, the type of work required on a road segment may be determined by interpreting the PSR as follows:

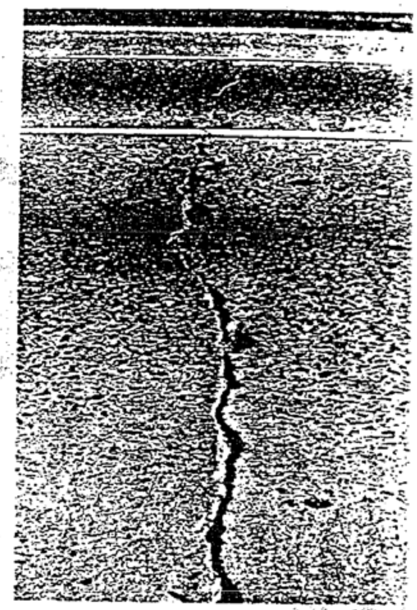


On the following three pages there are some pictorial examples of Cracking, Distortion, Disintegration and Drainage.

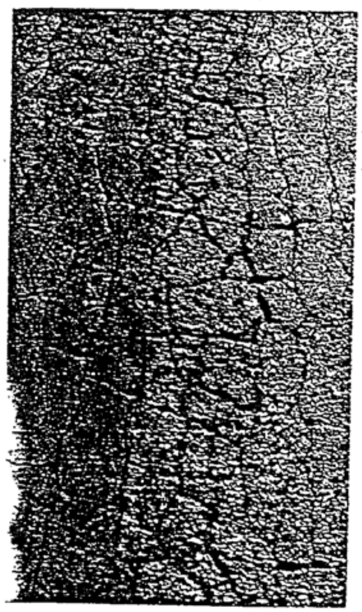
(7)

CRACKING

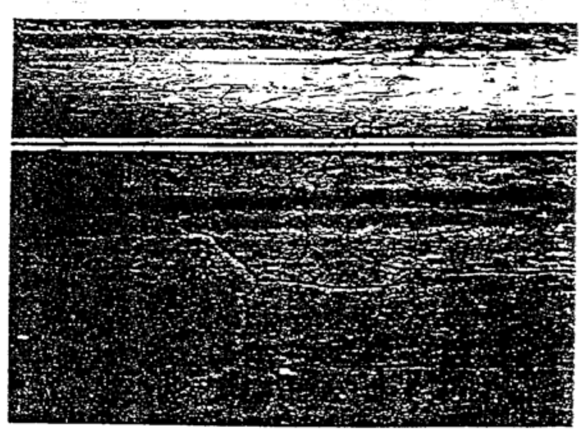
REFLECTIVE CRACKING



TRANSVERSE CRACKING



ALLIGATOR CRACKING

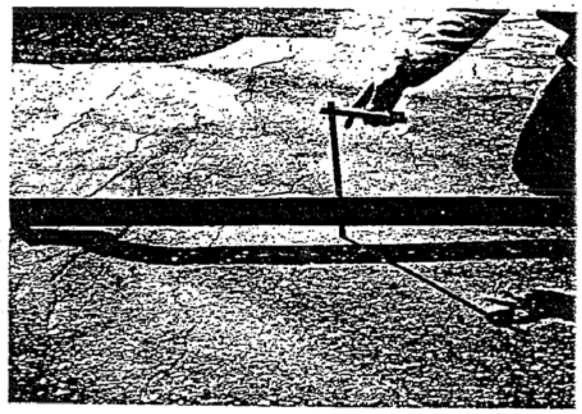


MAP CRACKING

(8)

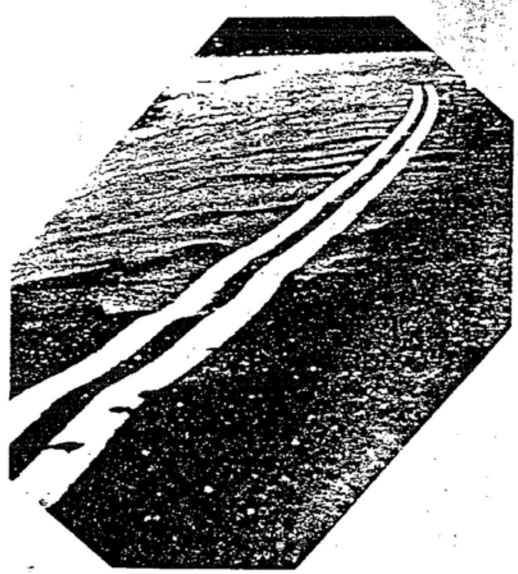
DISTORTION

CORRUGATIONS



DEPRESSIONS

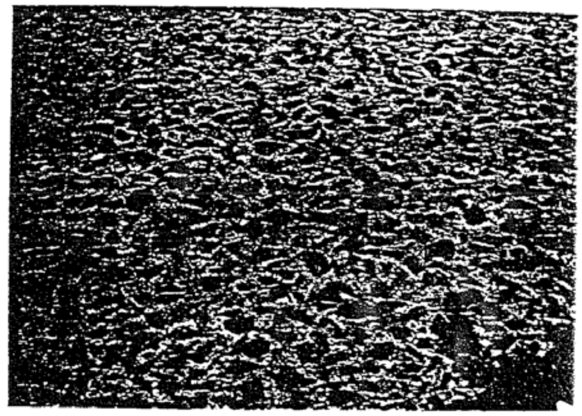
RUTTING



SHOVING

DISINTEGRATION & DRAINAGE

SCALING



POLISHING

POTHOLES FROM RAVELING

DEFICIENT DRAINAGE

SURVEY AND RATING PROCEDURES

The survey is to be conducted annually by a District Maintenance Planner and the District Maintenance Superintendent or his designee. These personnel are experienced in conducting annual needs surveys. This experience will be an asset in providing a balance of ratings between road sections. In conducting the PSR survey, each road section should be driven twice. The initial pass will provide an opportunity to review the PSR section length and termini, review the general condition of the section, as well as provide for reviewing and updating the pavement data. Prior to actually rating a road, an approximate section limit should be determined. After the initial survey, the prior years' data will be available for a base reference. The second pass should be dedicated to determining the actual PSR component ratings.

The rating will consist of assigning a number to each of the five components which relate to serviceability.

All components, including the most serious drainage conditions, will be obvious to the team by riding the road being surveyed. To properly and completely rate drainage, will require prior knowledge of relevant road conditions.

Section limits will be determined by the predominant characteristic of a segment of road, considering the five rating components and overall width, surface type, surface age. The specific section limits can be determined as the rating is determined. Generally, no section should be shorter than 0.50 miles, except for SR's with total lengths under .50 miles or when significant characteristics make a shorter length essential. Sections may extend for any length determined by predominant characteristics as previously noted. Section termini are to generally relate to the highway log book. Nondiscript termini such as project numbers should be avoided.

The rating will be made after the team rides the road section, at a reasonable speed, reviewing and discussing the five components which constitute serviceability. The ratings should be a consensus of opinions of the team and recorded on the code sheet.

As previously described, ratings of 0 or 10 will not apply. Accordingly, provisions have been made on the code sheet for a single digit rating only. On this basis, the actual ratings for the five components will be represented by a whole number of 1 to 9; decimals are not to be used.

Coding of Data

The sample code sheet Exhibit I has been set up to allow for the rating of multiple sections on one sheet. Care has been taken to insure compatability of the PSR data with the data maintained by the Engineering Data and Inventory Section. This will be essential for anticipated future integration of information from both systems.

When coding data for a road section, it is essential to see that all information necessary is coded. When coding cumulative mileage, the data is to be coded so that the decimal point position is implied between columns 25 and 26. Interstate routes will be identified by coding an I in column 4. The coding of the description should start in column 33, and all other data should be right justified.

Multi-lane divided highways (four (4) or more lanes) will be inventoried in both directions - i.e., log direction and reverse direction; all other roads will be inventoried in one direction. Although multiple sections can be listed on a code sheet, a new code sheet should be started for each route. To facilitate coding of data for both directions of a divided highway, care must be taken in selecting termini compatible with both directions. The coding of data for contiguous highways and data for log direction of divided highways should start at the top of the page. The coding of data for reverse direction of divided highways should be coded on the same sheet used for log direction coding.

The first entry will represent the beginning of a section and will increment in log mile direction from the top of the page down. The PSR component ratings are to be coded with the data for the beginning of the section. The second entry on the sheet will represent the end of the section and the beginning of the next section if the end of the route has not been reached or if the District line has not been reached. When the District line or end of a route is reached, only the identifier portion of the code sheet will be coded. When a route crosses a District line, this point will be coded by each District independently. This duplicate data will be used for referencing only and will not be included in the data file.

For overlap sections, complete data will be coded for the predominant route only. Data for the subordinate route shall only be: Town number, route number, cumulative miles, description and zeros (0) for the component ratings for log direction PSR.

It must be remembered that the last line of each route will not contain any rating data. Only town number, route number, cumulative miles and description will be coded on these lines.

In addition to PSR related data, information is also recorded for the following items:

Present Surface Type - Columns 10 & 14

A = Overlaid pavement

B = Portland cement concrete pavement original construction

C = Bituminous concrete pavement original construction

D = Surface treated pavement

Surface Age - Columns 11-12 and 15-16

Last two digits of year work completed

Proposed next treatment type - Columns 13 & 17

E = Liquid surface

F = 3/4"-1" thin overlay

G = $1\frac{1}{2}$" overlay

H = 2" overlay

I = $2\frac{1}{2}$" overlay

J = 3" overlay

K = Reconstruct

Data is also contained in the file regarding the ADT range of each section, the Federal system classification of each section and the functional class of each section.

APPENDIX

(A1)

TOWN NUMBER	NUMBER	ALT	LOG DIRECTION			REV DIRECTION			ADT			CUM MILES	FEDERAL SYSTEM	FUNCTIONAL CLASS	DISTRICT	SECTION	DESCRIPTION	PSR LOG DIRECTION					PSR REV DIRECTION				
			SURFACE TYPE	SURFACE AGE	NEXT-TREAT. TYPE	SURFACE TYPE	SURFACE AGE	NEXT-TREAT. TYPE	LOW	-	HIGH							CRACKING	DISTORTION	DISINTEGRATION	DRAINAGE	RIDING QUALITY	CRACKING	DISTORTION	DISINTEGRATION	DRAINAGE	RIDING QUALITY
1 2 3	4 5 6 7	8 9	10	11 12	13	14	15 16	17	18 19	20	21 22	23 24 25 26 27 28	29	30	31	32	33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58	59	60	61	62	63	64	65	66	67	68

(A2)

RE LT.L PSR.1
ELT 8R1 S7401C 05/12/82 12:30:20 (h)

1.	08	56	001	A75G	17-1900000023 34NEW YORK. STATE LINE	56676
2.	08	56	001	A74G	17-1800174023 34DEARFIELD DRIVE	55676
3.	08	56	001	A72F	17-1800234023 34MAPLE ST	77677
4.	08	56	001	A60G	18-1900321023 34INDIAN FIELD RD	55675
5.	08	56	001	A59G	11-1800421023 34BR OP MIANUS RIVER	44474
6.	08	56	001	A60G	09-1200520023 34FERRIS DR	45475
7.	08	135	001	A76G	09-2100671023 34GREENWICH AVE	66677
8.	08	135	001	B55H	10-1500785023 34LAFAYETTE ST	55475
9.	08	135	001	A60G	10-1300860023 34ROUTE JCT 106	46476
10.	08	35	001	A63H	13-1801117023 34UNDER PASS I-95	45475
11.	08	35	001	B24H	13-1801156023 34RT 136	45354
12.	08	35	001	A63H	13-1801252023 34ACC TO WB I-95	45475
13.	08	102	001	A63F	14-1601424023 34SCRIBNER AVE	66676
14.	08	102	001	A70G	14-1801596023 34WILTON AVE	55575
15.	08	102	001	A62G	16-1801694023 34ROUTE JCT 53	56576
16.	08	158	001	A76G	16-1801908023 34ROUTE JCT 33	66676
17.	08	50	001	A71G	16-1702277023 32WESTPORT-FAIRFIELD TL	66666
18.	08	50	001	B27I	07-1702560023 32ELLIOTT ST	44354
19.	08	50	001	B40H	07-1502614023 32BR OP RR	77476
20.	08	50	001	B40I	07-1302720023 32EB UP I95	56375
21.	08	15	001	A69G	12-1302820023 32FAIRFIELD-BRIDGEPORT TL	55565
22.	08	15	001	A69G	13-1402869023 32RT 58	77777
23.	08	15	001	A66G	11-1402918023 32PARK AVE	53364
24.	08	15	001	A72G	11-2702996023 32MAIN ST SR 731	76776
25.	08	15	001	A75GA75H	20-2703139023 32BEGIN SEP RDWYS	676776 7677
26.	08	15	001	A75G	11-1603193023 32END SEP RDWYS	77787
27.	08	138	001	A73G	10-1703293023 32BRDGEPORT-STRATFORD TL	66676
28.	08	138	001	A73G	12-3403420023 32RT 113	77778
29.	08	83	001	A76G	13-2601534023 32STRATFORD-MILFORD TL	78777
30.	08	83	001	A73G	12-2303733023 32RT 162	77777
31.	08	83	001	A76G	17-2303980023 32CHERRY ST	78777
32.	06	83	001	A66G	14-1704042023 33CEDARHURST LA	55475
33.	08	83	001	A74G	14-1504075023 33ROSES MILL RD	78777
34.	08	83	001	A66H	14-2004105023 33.55 MILE W/O ORANGE TL	45565
35.	08	106	001	A66H	17-1704321023 33RT 114	65566
36.	08	156	001	A66H	16-1704446023 33ORANGE-WEST HAVEN TL	44354
37.	08	156	001	A68H	16-2104503023 33.57 MILE E/O ORANGE TL	45555
38.	08	092	001	A68H	06-2104653023 33W HAVEN-NEW HAVEN TL	45475
39.	08	092	001	A68H	06-0704768023 33CHURCH ST SO	56686
40.	08	92	001	A62H	05-0604805023 33BR OP RR	44464
41.	08	92	001	A62H	06-1404873023 33EAST ST	42343
42.	08	92	001	A62H	06-0604939023 33WB RRX2	33363
43.	08	92	001	A62G	14-2605002023 33TOWNSEND AV SR704	34364
44.	08	43	001	A72G	18-2405156023 33RT 142 W JCT	67787
45.	08	14	001	A66G	11-2505366023 33UP RR	56665
46.	08	14	001	A81G	07-1705492023 33.3MI W/O CHESTNUT ST	99979
47.	06	14	001	A64G	07-1705584023 33500FT E0 MILLPLAIN RD	44363
48.	08	14	001	A78G	06-0905766023 33LEETES ISLAND RD	78788
49.	08	59	001	A77G	08-1105895023 23NO BRANFORD-GUILFORD TL	78888
50.	07	59	001	A77F	10-1406284023 23RT 77 CHURCH ST	45565
51.	08	59	001	A65G	10-1406414023 33RT 146 EB LEG	56656
52.	08	75	001	A73H	06-1006501023 23OLD POST RD 2	56666
53.	08	75	001	A72G	06-1006762023 23RT 79	56666
54.	06	27	001	A72G	06-1307043023 23MADISON-CLINTON TL	56666
55.	08	154	001	C73H	06-0707373023 23CLINTON-WESTBROOK TL	45555

CONNECTICUT DEPT. OF TRANSPORTATION, BUREAU OF HIGHWAYS
1982 PAVEMENT SERVICEABILITY LOG
STATEWIDE SUMMARY

PAGE 1

ROUTE NO.	DESCRIPTION FROM TOWN	TERMINI	CUM. MILE	DESCRIPTION TO TOWN	TERMINI	CUM. MILE	SECT LENGTH	CONDR RIIRI ASSAD CTII KONNO NRTAA GT GL LOG	CONDR RIIRI ASSAD CTII KONNO NRTAA GT GL REV	RATING LOG DIR	RATING REV DIR
1	GREENWICH	NEW YORK STATE LINE	0.00	GREENWICH	DEARFIELD DRIVE	1.74	1.74	56676		5.9	
1	GREENWICH	DEARFIELD DRIVE	1.74	GREENWICH	MAPLE ST	2.34	0.60	55676		5.8	
1	GREENWICH	MAPLE ST	2.34	GREENWICH	INDIAN FIELD RD	3.21	0.87	77677		6.7	
1	GREENWICH	INDIAN FIELD RD	3.21	GREENWICH	BR OP MIANUS RIVER	4.21	1.00	55675		5.7	
1	GREENWICH	BR OP MIANUS RIVER	4.21	GREENWICH	FERRIS DR	5.20	0.99	44474		4.6	
1	GREENWICH	FERRIS DR	5.20	STAMFORD	GREENWICH AVE	6.71	1.51	45475		4.8	
1	STAMFORD	GREENWICH AVE	6.71	STAMFORD	LAFAYETTE ST	7.85	1.14	66677		6.3	
1	STAMFORD	LAFAYETTE ST	7.85	STAMFORD	ROUTE JCT 106	8.60	0.75	55475		5.1	
1	STAMFORD	ROUTE JCT 106	8.60	DARIEN	UNDER PASS I-95	11.17	2.57	46476		5.1	
1	DARIEN	UNDER PASS I-95	11.17	DARIEN	RT 136	11.56	0.39	45475		4.8	
1	DARIEN	RT 136	11.56	DARIEN	ACC TO WB I-95	12.52	0.96	45354		4.0	
1	DARIEN	ACC TO WB I-95	12.52	NORWALK	SCRIBNER AVE	14.24	1.72	45475		4.8	
1	NORWALK	SCRIBNER AVE	14.24	NORWALK	WILTON AVE	15.96	1.72	66676		6.2	
1	NORWALK	WILTON AVE	15.96	NORWALK	ROUTE JCT 53	16.94	0.98	55575		5.4	
1	NORWALK	ROUTE JCT 53	16.94	WESTPORT	ROUTE JCT 33	19.08	2.14	56576		5.6	
1	WESTPORT	ROUTE JCT 33	19.08	FAIRFIELD	WESTPORT-FAIRFIELD TL	22.77	3.69	66676		6.2	
1	FAIRFIELD	WESTPORT-FAIRFIELD TL	22.77	FAIRFIELD	ELLIOTT ST	25.60	2.83	66666		6.0	
1	FAIRFIELD	ELLIOTT ST	25.60	FAIRFIELD	BR OP RR	26.14	0.54	44354		3.9	
1	FAIRFIELD	BR OP RR	26.14	FAIRFIELD	EB UP I95	27.20	1.06	77476		6.0	
1	FAIRFIELD	EB UP I95	27.20	BRDGEPORT	FAIRFIELD-BRIDGEPORT TL	28.20	1.00	56375		4.9	
1	BRDGEPORT	FAIRFIELD-BRIDGEPORT TL	28.20	BRDGEPORT	RT 58	28.69	0.49	55565		5.2	
1	BRDGEPORT	RT 58	28.69	BRDGEPORT	PARK AVE	29.18	0.49	77777		7.0	
1	BRDGEPORT	PARK AVE	29.18	BRDGEPORT	MAIN ST SR 731	29.96	0.78	53364		4.2	
1	BRDGEPORT	MAIN ST SR 731	29.96	BRDGEPORT	BEGIN SEP RDWYS	31.39	1.43	76776		6.7	
1	BRDGEPORT	BEGIN SEP RDWYS	31.39	BRDGEPORT	END SEP RDWYS	31.93	0.54	67677	67677	6.4	6.4
1	BRDGEPORT	END SEP RDWYS	31.93	STRATFORD	BRDGEPORT-STRATFORD TL	32.93	1.00	77787		7.2	
1	STRATFORD	BRDGEPORT-STRATFORD TL	32.93	STRATFORD	RT 113	34.20	1.27	66676		6.2	
1	STRATFORD	RT 113	34.20	MILFORD	STRATFORD-MILFORD TL	35.34	1.14	77778		7.1	
1	MILFORD	STRATFORD-MILFORD TL	35.34	MILFORD	RT 162	37.33	1.99	78777		7.1	
1	MILFORD	RT 162	37.33	MILFORD	CHERRY ST	39.80	2.47	77777		7.0	
1	MILFORD	CHERRY ST	39.80	MILFORD	CEDARHURST LA	40.42	0.62	78777		7.1	
1	MILFORD	CEDARHURST LA	40.42	MILFORD	ROSES MILL RD	40.75	0.33	55475		5.1	
1	MILFORD	ROSES MILL RD	40.75	MILFORD	.55 MILE W/O ORANGE TL	41.05	0.30	78777		7.1	
1	MILFORD	.55 MILE W/O ORANGE TL	41.05	ORANGE	RT 114	43.21	2.16	45565		4.9	
1	ORANGE	RT 114	43.21	W HAVEN	ORANGE-WEST HAVEN TL	44.46	1.25	65566		5.5	
1	W HAVEN	ORANGE-WEST HAVEN TL	44.46	W HAVEN	.57 MILE E/O ORANGE TL	45.03	0.57	44354		3.9	
1	W HAVEN	.57 MILE E/O ORANGE TL	45.03	NEW HAVEN	W HAVEN-NEW HAVEN TL	46.53	1.50	45555		4.7	
1	NEW HAVEN	W HAVEN-NEW HAVEN TL	46.53	NEW HAVEN	CHURCH ST SQ	47.68	1.15	45475		4.8	
1	NEW HAVEN	CHURCH ST SQ	47.68	NEW HAVEN	BR OP RR	48.05	0.37	56686		6.1	
1	NEW HAVEN	BR OP RR	48.05	NEW HAVEN	EAST ST	48.73	0.68	44464		4.4	

Appendix B - Roadway Sections Provided by ConnDOT District

HMA SUPERPAVE STUDY

DISTRICT 1

PROJECT NO.	*YEAR*	*VENDOR*	*ROUTE*	1 *TERMINI*	*BGN* **LOG MILE**	*END* **LOG MILE**	**MILES**	*MATERIAL*	*MILLED*	*LEVELED*	*PRESENT CONDITION*
				SATISFACTORY SUPERPAVE							
1 171-293 I	2001	Galasso	140	Rte. 191 N leg to Rte. 83 Bgn Ovlp	8.63	13.70	5.07	Level 2 S.P.	Yes, spot	Yes, entire	Very good ,very little crackir
2 171-292 H	2001	Tilcon	15	.15 mile n/o Rte.173 to .22 mile	74.41	76.16	1.75	Level 3 S.P.	Yes, entire	Yes, entire	Good, some reflective crack
				s/o Rte. 287							(concrete under bituminous
				PREMATURE SUPERPAVE							
1 171-303 C	2002/2003	Tilcon	94	SR 910 (Oak St.) to the Hebron TL	0.62	8.53	7.91	Level 2 S.P.	Yes, spot	Yes, spot	Fair, cracking, shoving and
											Oak St. to Harvest Ln.
2 171-303 J	2002	Tilcon	322	I-84E on ramp to I-691	6.27	9.80	3.53	Lev.2&4 SP	Yes, spot	Yes, spot	Fair, cracking and segregati
											Some rutting and shoving b
				SATISFACTORY MARSHALL MIX							
1 171-303 E	2002	Tilcon	173	Rte. 15 to Rte. 175	0.00	2.64	2.64	Class 1	Yes, spot	Yes, spot	Good , very little cracking o
2 171-293 H	2001	Tilcon	191	End Ovlp Rte. 140 to Rte. 190	5.83	9.30	3.47	Class 1	Yes, spot	Yes, entire	Good , very little cracking o
				PREMATURE MARSHALL MIX							
1 171-292 E	2001	Tilcon	372	Ten Acre Rd. to Rte. 71	5.29	7.46	2.17	Class 1	Yes, spot	Yes, spot	Fair, cracking, quite a bit of
2 171-292 F	2001	Tilcon	175	Wethersfield TL to Rte. 99	3.84	6.19	2.35	Class 1	Yes, spot	Yes, spot	Fair, cracking, quite a bit of
						TOTAL	28.89				

	PROJECT NO.	YEAR	VENDOR	ROUTE	DISTRICT 2 TERMINI	BGN LOG MILE	END LOG MILE	2-LN MILES	MATERIAL	MILLED Y/N	LEVELED Y/N	PRESENT CONDITION
					SATISFACTORY SUPERPAVE							
1	172-345 A	2003	Tilcon	2 E/W	Bozrah - .60 Mi e/o Lebanon TL	31.76	35.19	6.86	SP 3	Yes	Yes	Excellent
					to Norwich TL							
2	172-338 L	2002	Tilcon	184	Groton - Rt 117 to Rt 27	2.70	6.09	3.39	SP 2	No	No	Excellent
					PREMATURE SUPERPAVE							
1	172-337 I	2002	Tilcon	169	Woodstock-Childs Hill Rd - Mass SL	32.63	38.25	5.62	SP 2	No	No	Good- requires crack sealing-cold sealed 200
2	172-345 C	2003	Tilcon	6 E/W	Columbia/Coventry/Windham/Mansfield	87.77	93.15	10.76	SP 3	Yes	Yes	Good
					Rt 66 to Rt 6							
					SATISFACTORY MARSHALL MIX							
1	172-338 H	2002	Tilcon	117	Groton - Rt 1 - Rt 184	0.00	2.56	2.56	Class 1	Yes	Yes	Excellent
2	172-338 F	2002	Tilcon	32	Montville - op Stoney Br to	6.78	9.80	3.02	Class 1	No	No	Excellent
					Norwich TL							
					PREMATURE MARSHALL MIX							
1	172-327 F	2001	Tilcon	66	Columbia - Hebron TL - US 6	27.36	32.33	4.97	Class 1	No	Yes	Good - requires crack sealing
2	172-337 E	2002	Tilcon	82	Salem - .30 mi w/o Shingle Mill Rd	16.86	17.43	0.57	Class 1	No	No	Good - requires crack sealing
					to .14 e/o Hagen Road							

PROJECT NUMBER	YEAR	VENDOR	ROUTE	TOWN / TERMINI	BEGIN LOG	END LOG	LOG LENGTH	MATERIAL	MILLED	LEVELED	PRESENT CONDITION
				SATISFACTORY SUPERPAVE							
1 173-334 E1	2001	O & G	15 N/S	Milford.... Orange Town Line to Exit 54	38.21	39.55	1.34	L3 - SP	Yes	Yes	PSR 8.0 (Excellent)
2 173-358 G	2003	O & G / Waters	162	Milford....River Street to Eels Hill Road	1.30	3.39	2.09	L2 - SP	Yes	Yes	PSR 8.5 (Excellent)
				PREMATURE SUPERPAVE							
1 173-358 K	2003	O & G / Waters	25	Trumbull - Monroe.... .20 mile N/O Route 111 to Fairmount Road	10.07	13.83	3.76	L2 - SP	Yes	Yes	PSR 8.0 / Roadway structurally sound. Some areas of segregation. Required remedial cold seal in 2004 Late season pave.
2 173-348 L	2002	O & G / Waters	SR 714	Shelton.....04 mile S/O Long Hill Cross Road to Huntington Street (End Maint.)	0.32	2.20	1.88	L2 - SP	Yes	Yes	PSR 7.8 / Limited J & C needs
3 173-335 H	2001	O & G / Waters	108	Stratford..... Route 1 to .06 S/O Silver Lane	0.00	2.41	2.41	L2 - SP	No	Yes	PSR 7.6 / Needs joint seal
				SATISFACTORY MARSHALL MIX							
1 173-357 I	2003	Tilcon / Waters	162	West Haven.... Milford Town Line to Kelsey Avenue	5.29	8.25	2.96	Class 1	Yes	Yes	PSR 8.2 (Excellent) No J & C needs at this time
2 173-334 C	2001	Tilcon	103	North Haven.....Route 17 to SR 729	1.47	5.15	3.68	Class 1	Yes	Yes	PSR 7.4 / Limited J & C needs
				PREMATURE MARSHALL MIX							
1 173-334 D1	2001	O & G / Waters	SR 714	Shelton......04 mile S/O Long Hill Cross Road to Route 108	2.20	5.00	2.80	Class 1	No	Yes	PSR 6.5 / Severe cracking @ north end of termini (near Rt. 108).
2 173-334 G	2001	O & G / Waters	67	Woodbridge... Route 63 to Bethmour Road	29.07	31.00	1.93	Class 1	No	Yes	PSR 7.3

PROJECT NUMBER	YEAR	VENDOR	ROUTE	TOWN / TERMINI	BEGIN LOG	END LOG	LOG LENGTH	MATERIAL	MILLED	LEVELED	PRESENT CONDITION
			SATISFACTORY SUPERPAVE								
1 174-311-C	2003	LANE	41	SHARON-SALISBURY/ WESTWOODS RD TO RT. 44	3.40	9.68	6.26	SP-2	SPOT	SPOT	GOOD
2 174-311-E	2003	GALASSO	44	WINCHESTER/ COLEBRROK T/L TO DIVISION ST	23.60	26.84	3.14	SP-2	SPOT	SPOT	GOOD
			PREMATURE SUPERPAVE								
1 174-295-A	2001	O & G	8	HARWINTON-TORRINGTON EXIT 42 TO EXIT 45	47.00	51.79	4.79	SP-3	YES	YES	POOR SEVERE CRACKING
2 174-311-F	2003	GALASSO	44	WINCHESTER/BARKHAMSTED RT. 183 TO RT. 219	28.89	34.43	5.54	SP-2	SPOT	SPOT	PREMATURE CRACKING
			SATISFACTORY MARSHALL MIX								
1 174-311-D	2003	LANE	44	NORTH CANAAN/ SALISBURY T/L TO RT. 7 SOUTH	8.83	11.52	2.69	CL-1	SPOT	SPOT	VERY GOOD
2 174-289-C	2000	O & G	63	GOSHEN/ LITCH/GOSHEN T/L TO WESTSIDE RD	38.13	42.03	3.90	CL-1	SPOT	SPOT	GOOD
3 174-319-F	2004	GALASSO	44	WINCHESTER/ DIVISION ST TO RT. 183 SOUTH	27.22	28.88	1.67	CL-1	SPOT	SPOT	GOOD
			PREMATURE MARSHALL MIX								
1 174-319-G	2004	GALASSO	44	NEW HARTFORD TO CANTON	34.43	38.25	3.82	CL-1	SPOT	SPOT	PREMATURE CRACKING
				RT. 219 TO .49 MILES W/O RT. 179							