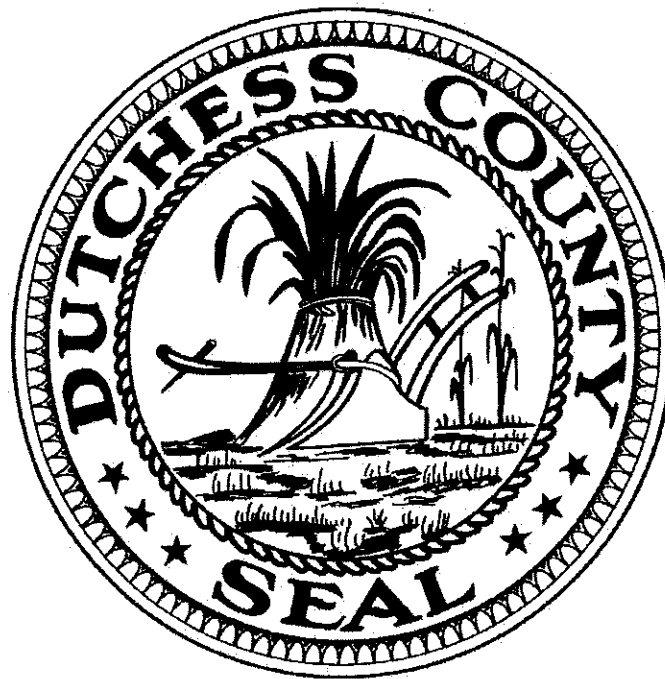


Cornell Local Roads Program

County of Dutchess, New York

Summer 2016



Anna Kern and George DeWitt

Dutchess County Highway Department

626 Dutchess Turnpike

Poughkeepsie, NY 12601

Village of Tivoli

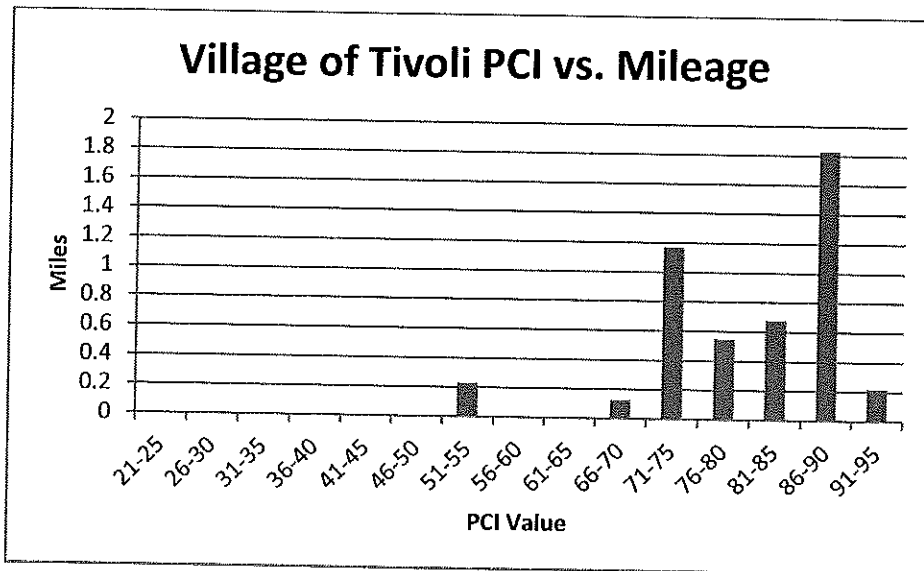
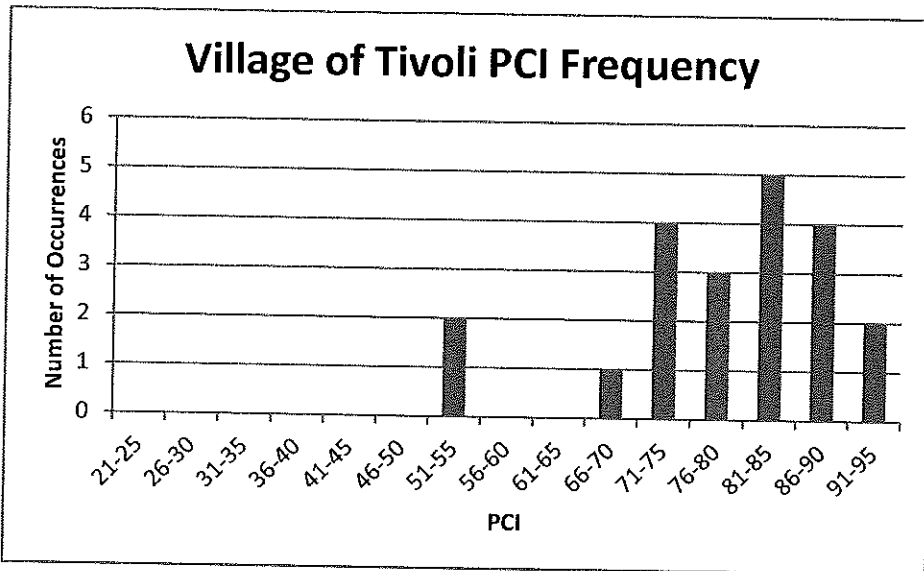
As part of Dutchess County's initiative to evaluate all of its Local Highway Inventory, the roads within your municipality have been surveyed. An Excel Spreadsheet containing this data has been attached as well as an overview of the survey process and project parameters, and an analysis of your road data.

Each road has a Road Identification Number (RIN) which is that road's New York State issued DOT ID followed by a dash and its section number. The sections are generally broken up by intersections, jurisdiction lines, or pavement change. Road sections are numbered from the beginning to the end of the road, not restarting when changing municipality. Some sections of road have been updated with new data as to where sections begin and end, or surface type changes. This data was entered manually as it was not provided by New York State, or because the road information was no longer accurate as is the case of dirt roads becoming paved.

Each section of road is rated on severity and frequency of alligator cracks, longitudinal and transverse cracks, rutting, edge cracking, severity of bleeding and raveling, drainage issues, roughness, and frequency of potholes or bad patching. These factors are what give each road section a Pavement Condition Index (PCI). All roads have been rated on the same criteria so these PCIs were obtained fairly and objectively. Only public asphalt roads within your municipality's jurisdiction have been rated. Roads that are concrete, unpaved, private, or are said to be asphalt but exist only as an entry in the database do not have ratings because of these factors. Roads that are not listed in New York State's Local Highway Inventory also have not been rated. Asphalt roads have a Surface ID of 4, Concrete 5, and Unpaved 2.

The PCI assigns a numerical value to the condition of the road. These values range from 8 to 94, with 94 being a newly paved road and 8 being a road that is deteriorated beyond recognition. These values can be used to compare the condition of the roads, and decide which are in greatest need of repair.

R/N	Name	From Road	To Road	Begin	End	Length	Width	Lanes	Surface	Survey Date	PCI	Municipality
186630-01	BOYD HILL LA	CLAY HILL RD	DEAD END	0	0.19	0.19	18	2	4	21-Jul-16	92	Village of Tivoli
186631-01	CLAY HILL RD	BROADWAY	RT9G	0	0.54	0.54	24	2	4	21-Jul-16	74	Village of Tivoli
186632-01	DEMBOSKI LA	BROADWAY	DEAD END	0	0.15	0.15	20	2	4	21-Jul-16	52	Village of Tivoli
186633-01	DIANA ST	RAILROAD	BROADWAY	0	0.03	0.03	20	2	4	21-Jul-16	92	Village of Tivoli
186634-01	ELIZABETH DR	WOODS RD	LISA LA	0	0.3	0.3	30	2	4	21-Jul-16	80	Village of Tivoli
186635-01	FEROE AV	BROADWAY	MONTGOMERY ST	0	0.16	0.16	12	2	4	22-Jul-16	73	Village of Tivoli
186636-01	FLORA	BROADWAY	BROADWAY	0	0.08	0.08	20	2	2			Village of Tivoli
186637-01	FRIENDSHIP ST	DEAD END	BROADWAY	0	0.08	0.08	11	2	4	21-Jul-16	54	Village of Tivoli
186637-02	FRIENDSHIP ST	BROADWAY	DEAD END	0.08	0.13	0.05	28	2	4	21-Jul-16	85	Village of Tivoli
186638-01	GREENTREE R	WOODS RD	ELIZABETH DR	0	0.28	0.28	28	2	4	21-Jul-16	73	Village of Tivoli
186639-01	KATHERINE LA	PINE ST	DEAD END	0	0.1	0.1	22	2	2			Village of Tivoli
186640-01	LISA LA	MEMORIAL DR	ELIZABETH DR	0	0.26	0.26	28	2	4	21-Jul-16	83	Village of Tivoli
186641-01	LOTHROP LA	GREENTREE RD	ELIZABETH DR	0	0.19	0.19	26	2	4	21-Jul-16	77	Village of Tivoli
186642-01	MADALIN CT	GREENTREE RD	GREENTREE RD	0	0.04	0.04	22	2	4	21-Jul-16	84	Village of Tivoli
186643-01	MEMORIAL DR	LOTHROP LA	DEAD END	0	0.18	0.18	28	2	4	21-Jul-16	83	Village of Tivoli
186644-01	MONTGOMERY ST	BROADWAY	TN LN	0	0.54	0.54	22	2	4	22-Jul-16	90	Village of Tivoli
186645-01	MONUMENT HILL	B WAY	B WAY	0	0.1	0.1	15	2	2			Village of Tivoli
186646-01	NORTH RD	BROADWAY	TOWN LINE	0	0.6	0.6	20	2	4	22-Jul-16	88	Village of Tivoli
186647-01	PINE ST	BROADWAY	NORTH RD	0	0.19	0.19	23	2	4	22-Jul-16	74	Village of Tivoli
186648-01	PUBLIC WORKS DR	MONTGOMERY ST	DEAD END	0	0.13	0.13	19	2	4	22-Jul-16	67	Village of Tivoli
186649-01	SPRING ST	MONTGOMERY ST	DEAD END	0	0.15	0.15	23	2	4	22-Jul-16	81	Village of Tivoli
186650-01	WASHBURN AV	MONTGOMERY ST	DEAD END	0	0.06	0.06	20	2	4	22-Jul-16	80	Village of Tivoli
186651-01	WOODS RD	BROADWAY	TN LN	0	0.61	0.61	26	2	4	21-Jul-16	90	Village of Tivoli
261951-01	TIVOLI COMMONS	BROADWAY	BROADWAY	0	0.08	0.08	14	2	4	22-Jul-16	90	Village of Tivoli

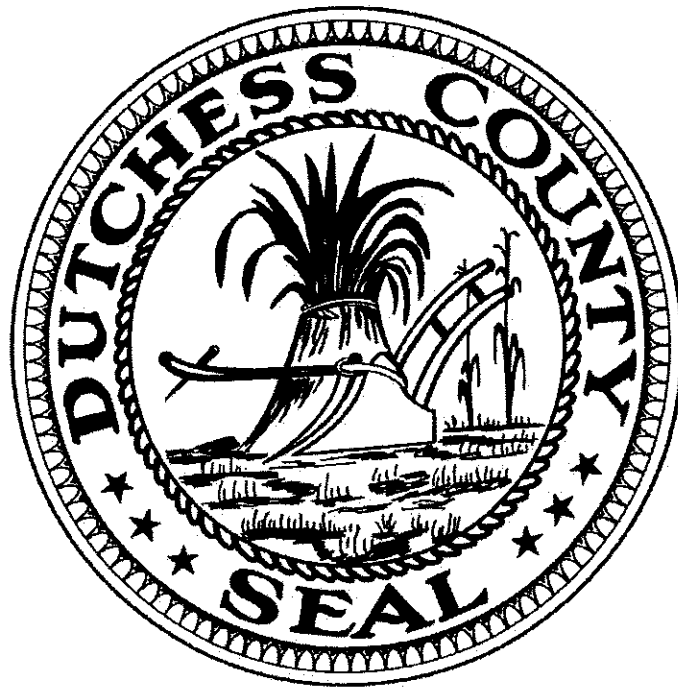


Municipality	Average PCI	Weighted Avg. PCI
Village of Tivoli	79.1	81.2

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Executive Summary:

What is Cornell Local Roads Program (CLRP)?

The Cornell Local Roads Program (CLRP) is a training program instituted by the State of New York to provide local municipalities with the training needed to properly manage and maintain the roads under their jurisdiction. CLRP has designed a computer program (CAMP-RS) to digitize the road condition data in an effective, user-friendly platform. The Pavement Internship Training, that CLRP offers, is designed to train college students in the CAMP-RS software and provide them with the tools needed to survey the roads within their municipality. During the ten week internship program, interns are expected to develop an inventory, conduct road evaluations, and prepare a final report of the management plan for the local roads and streets.

Training

Training was held on Cornell's campus in Ithaca, New York. Over the course of three days, we were educated on road design, construction, and maintenance. Proper flagging techniques were taught, as well as asphalt paving principles, pavement maintenance options, and how to operate the CAMP-RS software.

Results

Over the course of the summer 5,275 roads were entered into the CAMP-RS database. 3,029 of these entries and 945 miles of road were evaluated, totalling roughly 50% of the total 2,050 miles of road under Dutchess County's jurisdiction. This number exceeded the original goal to cover 550 miles of paved road by the end of the summer. 10 towns, 3 villages, and 2 cities were provided with the surveys of their roads as well as a detailed report outlining the condition of their roads. These reports also explained the meaning and method by which the Pavement Condition Index (PCI) value was calculated for each road. As a whole, the CLRP internship program was successful in meeting its goals and provided us, as interns, with meaningful experience.

Process and Project Parameters:

Dutchess County has 2,050.3 recorded miles of total local roadways, ranging from unpaved roads in rural areas to urban city streets. The long term goal of this internship program is to survey the entire county over three summers. The goal for the first summer was to cover 550 miles of centerline road in the areas of highest population density in the South West region of the county. This area included the following municipalities: Town of Pleasant Valley, Town of Poughkeepsie, Town of Fishkill, Village of Fishkill, Village of Wappingers Falls, City of Beacon, and City of Poughkeepsie.

In comparison with the other municipalities participating in CLRP training, this was the largest amount of centerline miles being taken on in one summer. This being the case, a more effective method of surveying needed to be implemented. The standard process of surveying roads was to use physical printed survey sheets to record the road information and condition while in the field, and then input this data into the database upon returning to the office. Since we had two full time interns assigned to this project, we chose to bring a laptop in the car while we surveyed roads. The road inventory was imported into the laptop before going to survey, and the condition data was entered into the database as we inspected each road. This method saved paper and a lot of time.

Surveying Roads:

Inventory Data

The road inventory was taken from the New York State Department of Transportation Local Highway Inventory. This list included county, city, town, and village roads within Dutchess County. State roads and private roads were not in our jurisdiction and, therefore, were not surveyed. By using New York State's official inventory, we did not have to input all 5,275 entries manually. We were also able to identify and correct errors in the State's inventory over the course of the summer. An example of the inventory data can be found in Appendix B. After compiling the inventory data into individual database for each town, village, and city, the process of surveying began.

Data Collection

The task of surveying the roads was approached one municipality at a time. Each municipality was divided into sections by the county roads that crossed it. These county roads were rated first, and then the smaller local roads within the sections were rated. This method

made the task easier, and allowed for fewer missed roads after each municipality was completed. The roads were rated while driving, which minimized the need to stop. While grading rural areas, like the Town of North East, this enabled us to cover over 50 miles of centerline road per day.

Condition Data

Each road was graded using the same criteria in order to keep ratings consistent. This criteria was determined using the Surface Condition Survey Sheet (as shown in Appendix A), provided by CLRP. The Surface Condition Survey Sheet allows for an organized recording of the condition of 100 percent of the street system. Its purpose is to identify existing distresses in a road surface which affects the performance of the road. This yields information that highlights structural or material defects which lead to deterioration of road performance and eventual failure.

Surface Condition Surveys were available for Asphalt Treatment, Surface Treatment, Concrete, and Unpaved roadways. Only asphalt roads were surveyed for this project. The document separates the distresses in asphalt into the following eight categories:

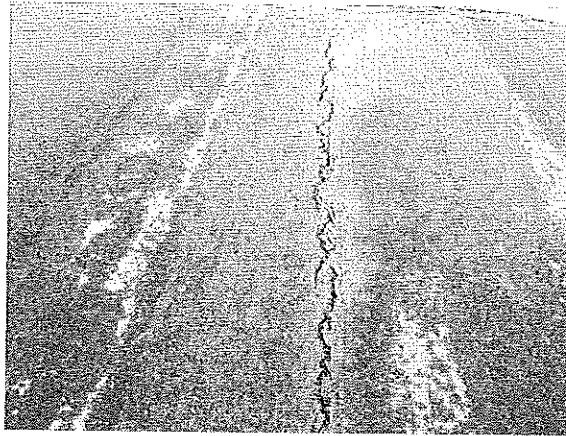
- Alligator Cracking
- Longitudinal/Transverse Cracking
- Edge Cracking
- Potholes/Patching
- Roughness
- Rutting
- Bleeding/Raveling
- Drainage

The following explanation was provided by the Cornell Asset Management Program - Roads and Streets 2014 User Guide.

Longitudinal/Transverse Cracking

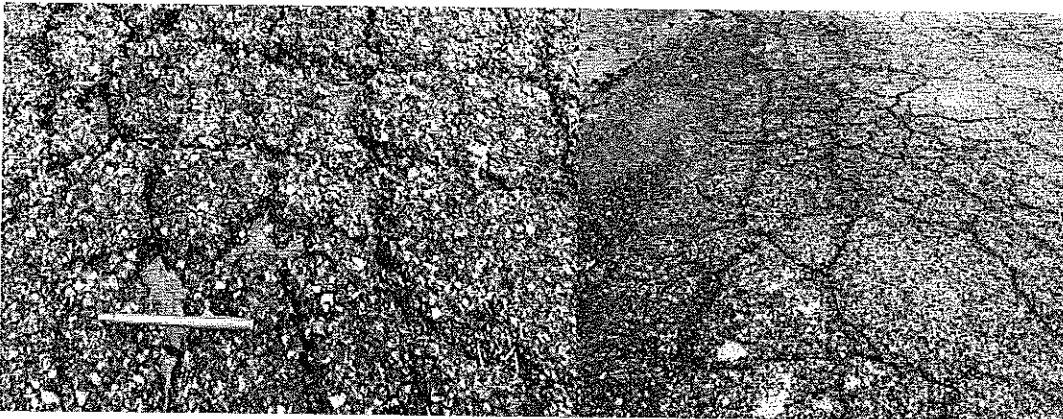
Longitudinal cracks are cracks that run parallel to the roadway centerline. Longitudinal cracks are usually found at construction joints and between lanes. Transverse cracks run perpendicular to the roadway centerline. Transverse cracks are generally spaced at regular intervals and caused by expansion and contraction of the road surface material.

Both types of cracks can also be reflective, appearing above joints and cracks in underlying pavements.



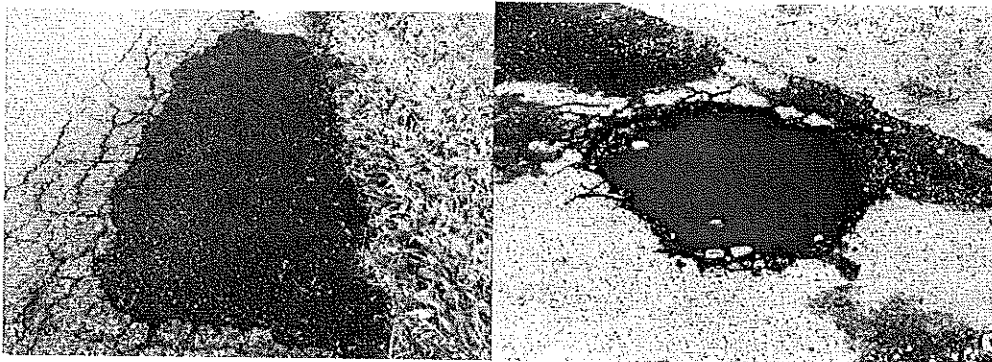
Alligator Cracking

Alligator cracking refers to interconnected crack patterns that resemble alligator skin or chicken wire. Pavement pieces range in size from one to six inches on a side.



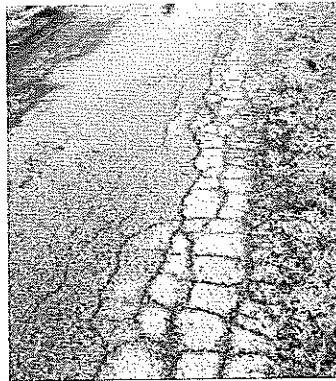
Patching/Potholes

Patching refers to areas where the original pavement has been removed and subsequently replaced but is showing deterioration. Potholes are areas where portions of the road pavement have broken and loss of pavement has resulted in a bowl shaped depression.



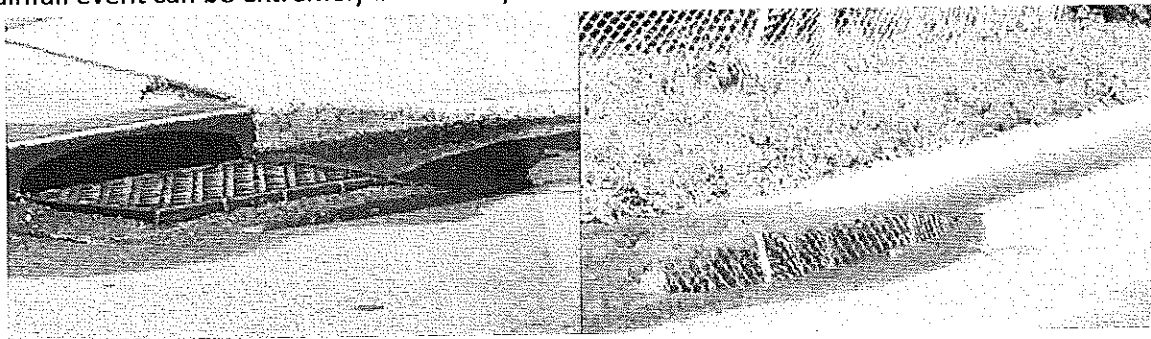
Edge Cracking

Edge cracking refers to cracks adjacent and parallel to the edge of the pavement. While generally confined to the outer one to two feet of pavement, edge cracking can progress into the travel lane.



Drainage

Drainage severities are judged by the ability for runoff to flow from the paved area to a location that does not influence roadway conditions. Visual indicators of drainage problems include accumulation of debris and sand and high water marks. (Evaluation during or after a rainfall event can be extremely beneficial.)



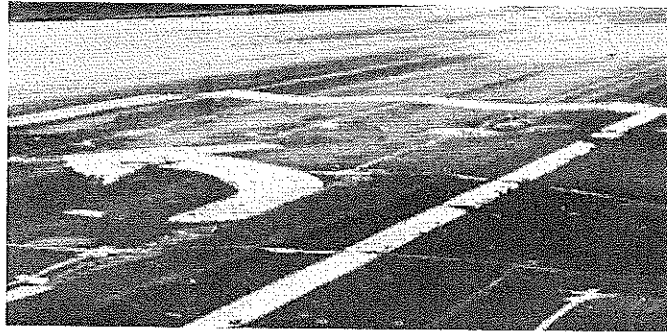
Roughness

Pavement roughness is defined as irregularities in roadway surface which adversely affects the comfort of the ride.



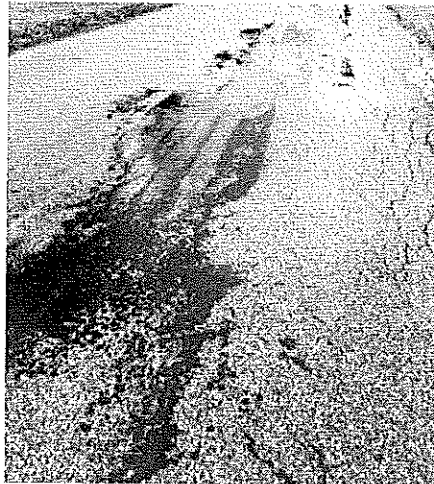
Rutting

Rutting refers to channels in the wheel paths. Rutting causes water to drain along the road surface rather than drain to the edge of the road.



Bleeding

Bleeding refers to the excess asphalt material on the surface of the roadway. Bleeding can be a safety problem due to decreased skid resistance.



Raveling

Raveling is the wearing away of the pavement surface caused by the dislodging of the surface aggregate particles and the loss of asphalt binder. Raveling includes the loss of fines to the loss of coarse aggregate. The surface becomes characterized as very rough and pitted with the obvious loss of aggregate.









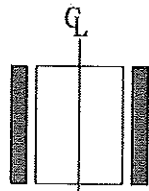
Most of the above categories are rated by both severity of the distress, and extent of distress. Potholes/Patching are only rated by extent, and Bleeding/Raveling and Drainage are only rated by severity. The definitions for Severity and Extent as defined by the CAMP-RS User Manual are shown in the table below.

Severity:	Extent:
<p><i>Low</i></p> <p>Present but not causing immediate problems</p>	<p><i>Low</i></p> <p>Isolated to a few locations</p>
<p><i>Moderate</i></p> <p>Needs attention before it becomes a problem</p>	<p><i>Moderate</i></p> <p>Between 10 to 30 percent of the road is affected by the distress</p>
<p><i>High</i></p> <p>Maintenance is needed immediately as the feature is a problem</p>	<p><i>High</i></p> <p>More than 30 percent of the road segment is affected.</p>

Appendix A:

Sample Pavement Condition Survey

CAMP-RS Asphalt Pavement Condition Survey

Street: _____ Distance: _____ Section #: _____ Start: _____ Start: _____ End: _____ End: _____ Length: _____	Name: _____ Date: _____ Weather: _____ Temp (F°/C°): _____																																		
<p>LONGITUDINAL/ TRANSVERSE CRACKING</p>  <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border: 1px solid black; padding: 2px;">NO Defects</td> <td colspan="3" style="border: 1px solid black; padding: 2px;">EXTENT Low Med High</td> </tr> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td style="border: 1px solid black; padding: 2px;">Low</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">3</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">Med</td> <td style="border: 1px solid black; padding: 2px;">4</td> <td style="border: 1px solid black; padding: 2px;">5</td> <td style="border: 1px solid black; padding: 2px;">6</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">High</td> <td style="border: 1px solid black; padding: 2px;">7</td> <td style="border: 1px solid black; padding: 2px;">8</td> <td style="border: 1px solid black; padding: 2px;">9</td> </tr> </table>	NO Defects	EXTENT Low Med High			SEVERITY	Low	1	2	3	Med	4	5	6	High	7	8	9	<p>ALLIGATOR CRACKING</p>  <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border: 1px solid black; padding: 2px;">NO Defects</td> <td colspan="3" style="border: 1px solid black; padding: 2px;">EXTENT Low Med High</td> </tr> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td style="border: 1px solid black; padding: 2px;">Low</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">3</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">Med</td> <td style="border: 1px solid black; padding: 2px;">4</td> <td style="border: 1px solid black; padding: 2px;">5</td> <td style="border: 1px solid black; padding: 2px;">6</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">High</td> <td style="border: 1px solid black; padding: 2px;">7</td> <td style="border: 1px solid black; padding: 2px;">8</td> <td style="border: 1px solid black; padding: 2px;">9</td> </tr> </table>	NO Defects	EXTENT Low Med High			SEVERITY	Low	1	2	3	Med	4	5	6	High	7	8	9
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<p>EDGE CRACKING</p>  <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border: 1px solid black; padding: 2px;">NO Defects</td> <td colspan="3" style="border: 1px solid black; padding: 2px;">EXTENT Low Med High</td> </tr> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td style="border: 1px solid black; padding: 2px;">Low</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">3</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">Med</td> <td style="border: 1px solid black; padding: 2px;">4</td> <td style="border: 1px solid black; padding: 2px;">5</td> <td style="border: 1px solid black; padding: 2px;">6</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">High</td> <td style="border: 1px solid black; padding: 2px;">7</td> <td style="border: 1px solid black; padding: 2px;">8</td> <td style="border: 1px solid black; padding: 2px;">9</td> </tr> </table>	NO Defects	EXTENT Low Med High			SEVERITY	Low	1	2	3	Med	4	5	6	High	7	8	9	<p>PATCHING / POTHOLES</p>  <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border: 1px solid black; padding: 2px;">NO Defects</td> <td colspan="2" style="border: 1px solid black; padding: 2px;">EXTENT</td> </tr> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">Low</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">Medium</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">3</td> <td style="border: 1px solid black; padding: 2px;">High</td> </tr> </table> <p style="font-size: small; margin-top: 5px;">Do not include potholes</p>	NO Defects	EXTENT		SEVERITY	1	Low	2	Medium	3	High							
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<p>DRAINAGE</p>  <table style="margin-left: auto; margin-right: auto;"> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td colspan="2" style="border: 1px solid black; padding: 2px;">CONDITION</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">Good</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">4</td> <td style="border: 1px solid black; padding: 2px;">Fair</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">7</td> <td style="border: 1px solid black; padding: 2px;">Poor</td> </tr> </table>	SEVERITY	CONDITION		1	Good	4	Fair	7	Poor	<p>ROUGHNESS</p> <p style="font-size: x-small;">Check road for presence of the following:</p> <ul style="list-style-type: none"> - uneven surface - rips - heaves - frost heaves <table style="margin-left: auto; margin-right: auto;"> <tr> <td rowspan="3" style="border: 1px solid black; padding: 2px; text-align: center;">SEVERITY</td> <td colspan="2" style="border: 1px solid black; padding: 2px;">CONDITION</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">Good</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">4</td> <td style="border: 1px solid black; padding: 2px;">Fair</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">7</td> <td style="border: 1px solid black; padding: 2px;">Poor</td> </tr> </table>	SEVERITY	CONDITION		1	Good	4	Fair	7	Poor																
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Appendix B:

Sample Inventory Sheet

PAVEMENT INVENTORY SURVEY:		NAME: _____	DATE: _____
ROAD NAME: _____		INVENTORY #: _____	
SECTION DESCRIPTION: FROM: _____ TO: _____		DISTANCE: START: _____ FT END: _____ FT LENGTH: _____ FT	
# LANES: _____	WIDTH (FT): _____	SHOULDER WIDTH (FT): _____	MEASURED ROW: _____ FEET
SURFACE: _____	<small>1. CONC; 2. UNPAVED; 3. SURFACE TREATED; 4. ASPHALT; 5. XX</small>		TRAFFIC: _____ 1 - 5
SHOULDER: _____			IMPORTANCE: _____ 1 - 5
		US/METRIC	US/ME
COMMENTS: _____ _____ _____ _____			

IMPORTANCE:		TRAFFIC	
1	Very Low	1	Very Low
2	Low	2	Low
3	Medium	3	Medium
4	High	4	High
5	Very High	5	Very High

SHOULDERS:		SURFACE TYPE	
1	Paved - Asphalt	1	Other
2	Gravel	2	Unpaved
3	Earth	3	Surface Treated
4	Vegetation	4	Asphalt
5	None	5	Concrete
6	Curb, Asphalt	6	Brick
7	Curb, Concrete		
8	Curb, Granite		
9	Paved, Concrete		

MEASUREMENT UNITS:			
LF	Linear Feet	LM	Linear Meter
SF	Square Feet	SM	Square Meter
SY	Square Yards		