City of Linden, Texas

Pavement Management Plan

Prepared for:

City of Linden, Texas

Mayor – Lynn Reynolds

Mayor Pro-Tem – Mike Berry

City Aldermen

Mary Dowd
Chuck Evans
James Johnson
Frank Lanier

City Staff

Lee Elliott, City Administrator
Allie Anderson, Assistant City Administrator
Robert Luzio, Public Works Director
Michael Riley, Street Foreman

Prepared by:

A. L. FRANKS ENGINEERING
118 East Broad Street
Texarkana, Arkansas

TABLE OF CONTENTS

SECTION I

EXECUTIVE SUMMARY

A municipal street department's major goal is to use public funds to provide a comfortable, safe and economical road surface. It requires balancing priorities and making decisions in order to manage pavements with finite resources. Experience has shown that there are three useful steps in managing local roads:

1. Inventory all local roads and streets.
2. Periodically evaluate the condition of all pavements.
3. Use the condition evaluations to set priorities for projects and select alternative treatments.

A comprehensive pavement management system involves collecting data and assessing several road characteristics of pavement condition and usage. Planners can combine this condition data with economic analysis to develop short-range and long-range plans for a variety of budget levels.

The City of Linden, Texas authorized A. L. Franks Engineering to develop a pavement management plan for all streets within the City Limits. A visual survey was conducted of each street segment using a modified version of the Pavement Surface Evaluation and Rating (PASER) pavement evaluation system to determine existing surface type, length and width, structural condition and general rideability. This information, was used to develop a rating system to prioritize improvements based on need. Unit costs per linear foot of roadway were applied to develop a plan for street improvements to repair or rebuild the streets as necessary. Detailed costs for the plan are included in this report.

SECTION II

INTRODUCTION

A. AUTHORIZATION OF THE REPORT

This report was authorized by the City of Linden, Texas in August of 2021. A. L. Franks was instructed to conduct a visual survey of all streets within the City, develop a rating system for the streets based on need and develop a pavement management plan with associated costs for each street.

B. PURPOSE AND SCOPE

The purpose of the study is to provide a master pavement management plan for the City of Linden to use for budgetary and scheduling needs. This report presents the recommended priority listing, estimated construction costs and a recommendations for drainage and paving improvements.

C. ACKNOWLEDGEMENTS

The cooperation of the City of Linden Management, Staff and Board of Aldermen along with Linden Public Works Staff in reviewing preliminary stages of the study and providing technical information related to the completion of this report is gratefully acknowledged.

SECTION III
METHODOLOGY

A. STREET PRIORITIZATION METHODOLOGY

The pavement condition survey is a visual inspection of each segment of a city street system. The survey provides measures to assess the magnitudes of various types of pavement distress. The inspection does not generally assess subgrade conditions, rather it is intended only to evaluate pavement surface conditions.

A modified version of the Pavement Surface Evaluation and Rating (PASER) system was used to evaluate the Linden City streets. The PASER scale is a 1-10 rating system for road pavement condition that uses visual inspection to evaluate pavement surface conditions. PASER ratings provide a basis for comparing the quality of roadway segments. The advantage to this method is that roads may be assessed quickly by a windshield survey.

Standard practice is to drive the section, at low speeds (approximately 5mph), and note the general condition of the entire section. A rating is then assigned based on the overall average condition of the section and recorded on the appropriate rating forms. If conditions vary significantly between lanes, the rating shall be based upon the condition of the worst lane. In any instance where additional information was needed, a closer inspection was made on foot.

B. DRAINAGE EVALUATION

A main cause of road damage, and problems with the serviceability of road networks, is excess water filling the pores of road materials in the road and in the subgrade soils. Poor drainage is the cause of rutting, cracking, potholes, erosion, washouts, heaving, flooding, and premature failure of roadway. Sustained contact of water with asphalt pavement cause failure due to stripping of bitumen from aggregate leading to road surface failure. In freezing

temperature water in pores may freeze and damage the pavement by frost action.

Poor drainage is also a traffic safety risk. Water may accumulate on the road creating a risk of hydroplaning during rain events. A wet surface reduces friction which leads to longer braking distances. Undrained surface water can freeze during the night during winter months and cause unsafe ice to accumulate on streets.

No street repairs or construction can be undertaken until all drainage failure have been corrected. All culverts must be appropriately installed with appropriate culvert size, type, alignment, and end treatments. Ditches must be maintained and repaired to ensure the shape, side slope, fall, lining materials, capacity, and depth are adequate to move water off of the road as quickly as possible.

A. L. Franks personnel made notes and photographed all problematic drainage issues observed during the assessment process. In nearly all case where road surface failures were observed inadequate drainage was identified as the primary contributing factor.

C. ADMINISTRATIVE INPUT

A series of meetings was held with City staff representative to discuss the personal knowledge of immediate needs within the city related to access to public services, schools, and emergency services. All comments were incorporated into the recommendations in conjunction with the data base priority listing to develop the pavement management plan. The information was extremely helpful in developing a comprehensive and workable plan for the City of Linden.

D. MAINTENANCE SCHEDULE

Maintenance scheduling is a function of the pavement condition. Pavement condition is considered to include measure of skid resistance, ride quality, structural capacity and surface distress. Surface distress includes raveling, cracking, and channeling (rutting) or other forms of asphalt pavement distortion. Evaluating pavement condition involves assessing the current state of these distress conditions and estimating their future state, or the time when the distress will reach a critical or terminal level; at this time an overlay or rebuild will usually be required.

The key factor in a maintenance program that will extend the useful life of a pavement structure is identifying the cracks, depressions and other deficiencies before they become severe enough for a complete overlay. There are options available such as slurry seal, chip seal, asphalt repair and patching that will postpone a critical or terminal level of condition at a relatively low cost.

SECTION IV
RECOMMENDED IMPROVEMENTS

A. DRAINAGE RECOMMENDATIONS

A. L. Franks recommends that the City of Linden immediately begin a drainage rehabilitation program as part of ongoing street maintenance operations. Nearly all streets identified as failing in this report are in need of drainage improvements, primarily ditch cleanout and reprofiling. The Linden Street Department is in the best position to identify failing culverts and drainage structures during rain events.

In addition, any road reconstruction activities should account for costs associated with drainage rehabilitation as a part of any budgetary planning. The best time to perform ditch and culvert repairs is immediately prior to road construction activities. Performing substantial road repairs without addressing failing drainage will result in a significant reduction in the lifespan of the repairs and increased costs moving forward.

B. PAVING RECOMMENDATIONS

The following present a list detailing pavement condition ratings (Table 1) and of the recommended improvement costs for the street segments currently identified as failing (Table 2). A breakdown of street improvement construction costs are included in Appendix A to show the relative construction costs of various improvement options and to provide the basis for the estimated construction costs in this report. These costs were taken from a selection of recently completed paving projects overseen by A. L. Franks Engineering and converted to a linear foot price for the various widths of street cross-section.

The total linear feet of improvement and the total cost of improvement must be viewed in combination to get a true indicator of the equity in the proposed program. This is primarily because of the unit cost per foot variations for the required improvements. Some areas of the City have poorer soil conditions than others and, as a result, have streets in worse condition. This results in a higher cost per foot for improvements in a concentrated location. Specific streets may require milling and/or soil stabilization prior to overlay which could cause significant variance in the costs per linear foot of improvements.

Contact has been made with Linden Public Works concerning a coordination of improvement efforts with water or sewer upgrades and street repairs. Prior to the City initiating design of proposed improvements, a detailed investigation of the proposed water and sewer projects will need to be made. This will work toward eliminating major utility work on newly improved streets.

TABLE 1

Summary of Street Evaluation

Street Name	Street Segment	PASER Rating	Notes	Segment Length (ft)
Arkansas	Full Length	6		
Banger	Kaufman -Main	***1***	Road is failing, poorly drained	600
Barker	Hwy 59 - Lee	3	Oil dirt topcoat	
Barker	Crow - Louisiana	4		
Barker	Lee - Crow	5	Very shallow ditches	
Bellwood	Full Length	***1***	Road shows evidence of frequent inundation	1,340
Blaylock	Houston - Frazior	***1***	Street serves police and EMS	500
Blaylock	Frazior - Vance	4	Street serves police and EMS	
Boone	Washington - Broad	***1***	Completely decayed, still driveable due to adequate drainage	1,120
Boone	Broad - Hwy 8	2	Badly decayed but relatively driveable due to drainage	
Broad	Boon - Hamilton	4	Drainage is very poor; all ditches need to be reprofiled	
Broad	Hamilton - Smithland	4	Ditches need to be reworked; Oak St. intersection has completely failed	
Bronco	Full Length	3	Overall road condition is good except for 100-yard section at north.	
Cambell	Taylor-Church	***1***	Oil-dirt over patches, intersection with Kaufman has failed extensively	940
Cambell	Oak - Taylor	3		
Cambell	Hamilton - Oak	4		
Crow	Full Length	5	Culvert is undersized and culvert crossing floods	
Dayton	Full Length	***1***	Street has completely failed, soil emerging through pavement, very poor drainage	1,020
Denson	Foster - Hamilton	4	Poor drainage somewhat mitigated by high ground	
Dogwood	Full Length	6		
Dorsey	Full Length	5		
Early	Full Length	***1***	Road failure due to poor drainage	590
Segment lengths for PASER Grade 1 roads are estimates only and include all intersections. As such, intersections of intersecting Grade 1 roads may be counted twice. At such time as a formal construction estimate is made all pricing will be based on actual ground measurements.				

TABLE 1

Summary of Street Evaluation (cont.)

Street Name	Street Segment	PASER Rating	Notes	Segment Length (ft)
East Kipp	Full Length	4		
Florida	Full Length	7		
Frazior	Park - Hamilton	*1*	Road failure caused by lack of any drainage structure; road is low point is segment	630
Frazior	Hamilton - Main	3	Ditches are completely silted in, need to be reprofiled	
Frazior	Main - Blalock	5		
Graham	Smithland - Taylor	*1*	Small section of road needs to be rebuilt	270
Graham	Church - Blizzard	*1*	Several portions have failed completely, soil is emerging through road	820
Graham	Taylor - Church	5	Drainage from north to south flows across road in several places	
Grubbs	See Note	6	Only portion maintained by the city was evaluated	
Hampton	Highway 59 - Nelson	5		
James Clark	Full Length	2	South end of segment has completely failed, raveling is particularly bad	
Lakeside	Full Length	5	Short segment along lake has failed due to inundation from lake overflow	
Louisiana	Full Length	5		
Macedonia	Full Length	6		
Meadow Loop	Full Length	3		
Mockingbird	Full Length	6		
Morse	Highway 59 - Nelson	2	Drainage is across street	
Morse	Nelson - Texas	3	Partially surfaced with chip and seal	
Nelson	Barker - Morse	*1*	Drainage along this segment has completely silted in, ditches need to be deepened	870
Nelson	Hwy 59 - Barker	4	Shallow ditches	
Nelson	Morse - Hampton	5		

Segment lengths for PASER Grade 1 roads are estimates only and include all intersections. As such, intersections of intersecting Grade 1 roads may be counted twice. At such time as a formal construction estimate is made all pricing will be based on actual ground measurements.

TABLE 1

Summary of Street Evaluation (cont.)

Street Name	Street Segment	PASER Rating	Notes	Segment Length (ft)
North Church	Frazior - Houston	3	Southern half of segment has completely failed and would score 1/10	
North Foster	Northloop - Houston	***1***		1,990
North Hamilton	Houston - Broad	5	Drainage from east to west across street needs to be captured	
North Kaufman	Vance - Houston	6	200 ft segment north of Vance not rated as it appears to have not been completed	
North Oak	Frazior - Vance	***1***	The worst condition street in Linden? Water is funneled down steep street	590
North Oak	Vance - North Loop	3	Oil dirt surface, failing at driveway turn ins	
North Smithland	Northloop - Broad	***1***	Very poor drainage, road has completely failed	1,130
North Smithland	Broad - Houston	5		
Northcutt	Full Length	6		
Northloop	Oak - Main	3	Drainage is very poor and road shows signs of the beginning of erosion	
Oklahoma	Full Length	6		
Owens	Full Length	5	Needs ditches recut	
Park	Full Length	4	Oil dirt surface over old asphalt	
Pecan	Full Length	5		
Pine	Wills -Hamilton	2	Deteriorates from W to E, signs of inundation at culvert	
Rush	Foster - Highway 125	***1***	Segment has completely failed with soil emergent in several places	720
Rush	Hamilton - Foster	3	Foster intersection has completely failed, very poor drainage	
Sargent	Full Length	***1***	Has degraded to an unmaintained gravel street	580
South Church	Rush - Cambell	***1***	Has thin oil-dirt overlay, subgrade is failing	280
South Foster	Houston - Cambell	2	Road is usable but will not survive another winter	
South Foster	Cambell - West	3	Road is usable but will not survive another winter	

Segment lengths for PASER Grade 1 roads are estimates only and include all intersections. As such, intersections of intersecting Grade 1 roads may be counted twice. At such time as a formal construction estimate is made all pricing will be based on actual ground measurements.

TABLE 1

Summary of Street Evaluation (cont.)

Street Name	Street Segment	PASER Rating	Notes	Segment Length (ft)
South Hamilton	Cambell - Hwy 8	***1***	More patches than original asphalt	1,570
South Hamilton	Houston - Cambell	3	Drainage quality decreases to south	
South Kaufman	Dennison - Bangor	***1***	Segment has failed so badly that it is unsafe to drive the speed limit, poor drainage	850
South Kaufman	Bangor - Kildare	3	Drainage has slightly improved due to slope.	
South Kaufman	Houston - Dennison	4	Dennison is not a real street, as mapped it does mark a change in street quality	
South Oak	Houston - Cambell	***1***	All of the intersections have failed, soil is emerging through street	530
South Oak	Cambell - Foster	2	All of the intersections have failed	
Taylor	Frazior - Cambell	2	usable portions of road have thin chip-seal overlay, poor drainage	
Texas	Kildare - Barker	***1***	Ditches need to be deepened, culvert crossing floods	1,360
Texas	Barker - Park	4	Road has been preserved by surface coating of oil dirt	
Thomas	Will - Hamilton	***1***	Street at culvert crossing has washed out due to failed culvert	950
Thomas	Hamilton - Oak	3	Appears to have oil-dirt surface coat	
Vance	Main - Blaylock	3	Ditches on both sides of road need to be reprofiled	
Vance	Oak - Main	4	Water drains across road due to ditches being silted in	
Virginia	Full Length	7		
Washington	Full Length	2	Road is badly decayed but elevation provides adequate drainage	
West	Full Length	3	Short segment from Foster to City Yard is 1/10	
West Kipp	Full Length	5		
Wills	Thomas - Houston	***1***	Road abandoned as a paved road and is now gravel, poor drainage is incising road	1,070
Woodward	Full Length	5	Road and drainage ditches are being overwhelmed by encroaching bamboo	

Segment lengths for PASER Grade 1 roads are estimates only and include all intersections. As such, intersections of intersecting Grade 1 roads may be counted twice. At such time as a formal construction estimate is made all pricing will be based on actual ground measurements.

TABLE 2

City of Linden, Texas
PASER Grade 1 Street Segment Reconstruction Costs

Street Name	Street Segment	Segment Length (ft)	Drainage $13/ft	Rebuild $59/ft (16ft wide)
Banger	Kaufman -Main	600	$15,600	$35,400
Bellwood	Full Length	1,340	$34,840	$79,060
Blaylock	Houston - Frazior	500	$13,000	$29,500
Boone	Washington - Broad	1,120	$29,120	$66,080
Cambell	Taylor-Church	940	$24,440	$55,460
Dayton	Full Length	1,020	$26,520	$60,180
Early	Full Length	590	$15,340	$34,810
Frazior	Park - Hamilton	630	$16,380	$37,170
Graham	Smithland - Taylor	270	$7,020	$15,930
Graham	Church - Blizzard	820	$21,320	$48,380
Nelson	Barker - Morse	870	$22,620	$51,330
North Foster	Northloop - Houston	1,990	$51,740	$117,410
North Oak	Frazior - Vance	590	$15,340	$34,810
North Smithland	Northloop - Broad	1,130	$29,380	$66,670
Rush	Foster - Highway 125	720	$18,720	$42,480
Sargent	Full Length	580	$15,080	$34,220
South Church	Rush - Cambell	280	$7,280	$16,520
South Hamilton	Cambell - Hwy 8	1,570	$40,820	$92,630
South Kaufman	Dennison - Bangor	850	$22,100	$50,150
South Oak	Houston - Cambell	530	$13,780	$31,270
Texas	Kildare - Barker	1,360	$35,360	$80,240
Thomas	Will - Hamilton	950	$24,700	$56,050
Wills	Thomas - Houston	1,070	$27,820	$63,130

* Drainage cost is estimated as a worst-case scenario, in that both sides of each road will require drainage work for the entire length.

* Road widths are estimated at 16' wide based on average widths, measured in the field.

Appendix A

Street Improvement

Construction Cost

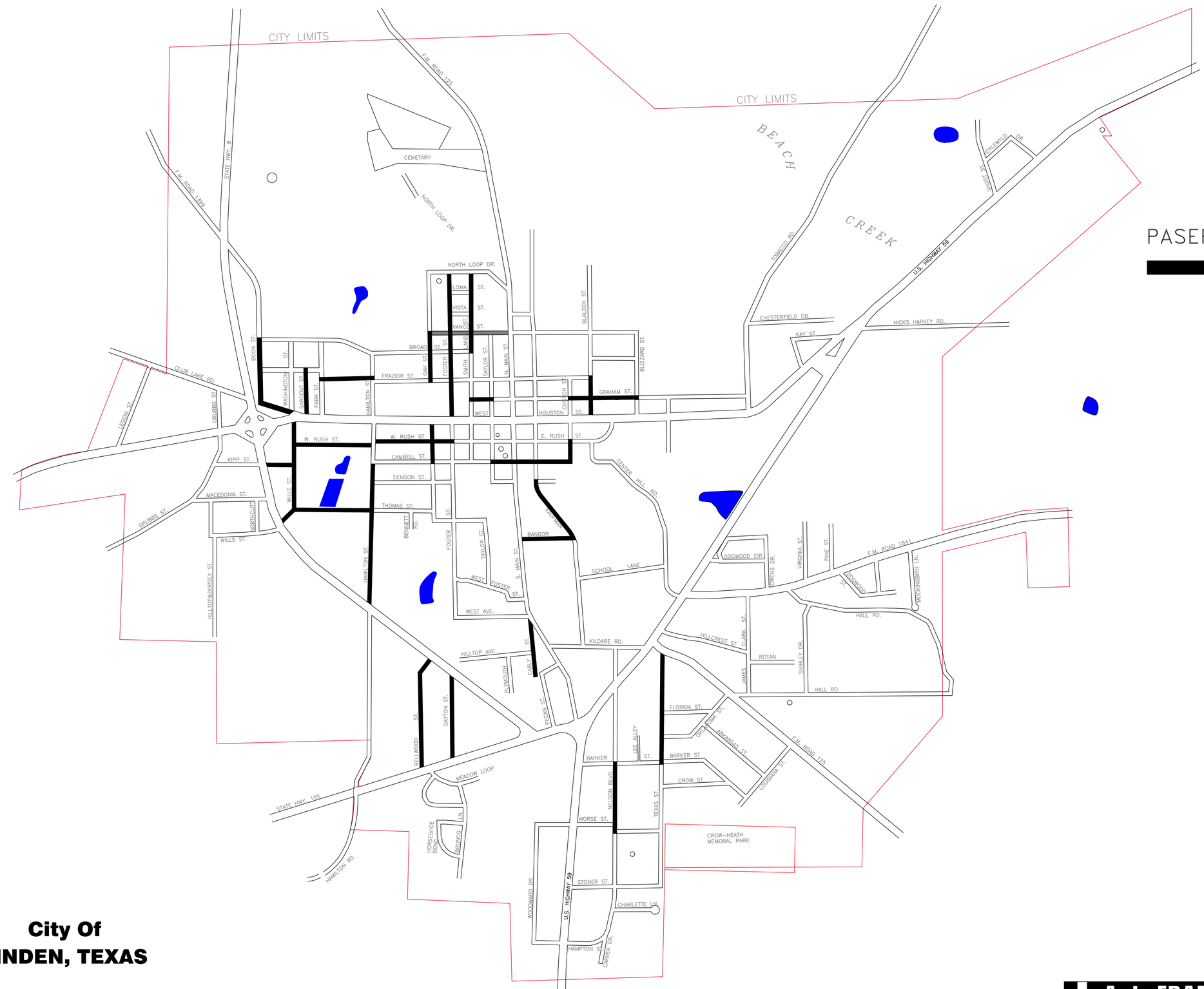
Appendix A

Street Improvement Construction Costs

Construction Option	Estimated Cost Per Linear Foot		
	Unit Rate/Sq ft	16' Width	20' Width
Milling of Existing Asphalt	$ 0.34	$ 5.44	$ 6.80
Subgrade Soil Cement Stabilization	$ 1.39	$ 22.24	$ 27.80
2" Asphalt Overlay	$ 1.95	$ 31.20	$ 39.00
Total Repaving Cost per Linear Foot	$ 3.68	$ 58.88	$ 73.60
Additional Costs			
Cleaning and Regrading Ditches	$8.00 to $15.00 / Linear Foot		
Replace Damaged or Undersized Culverts	$50-$150 / Linear Foot		
Pavement Striping	$ 0.25 / Linear Foot ($500 minimum)		
Hot Poured Rubberized Crack Seal	$ 1.10 / Linear Foot ($500 minimum)		
Clean and Apply 2 Coats Sealer	$ 2.50 / Sq Yd ($500 minimum)		

Appendix B

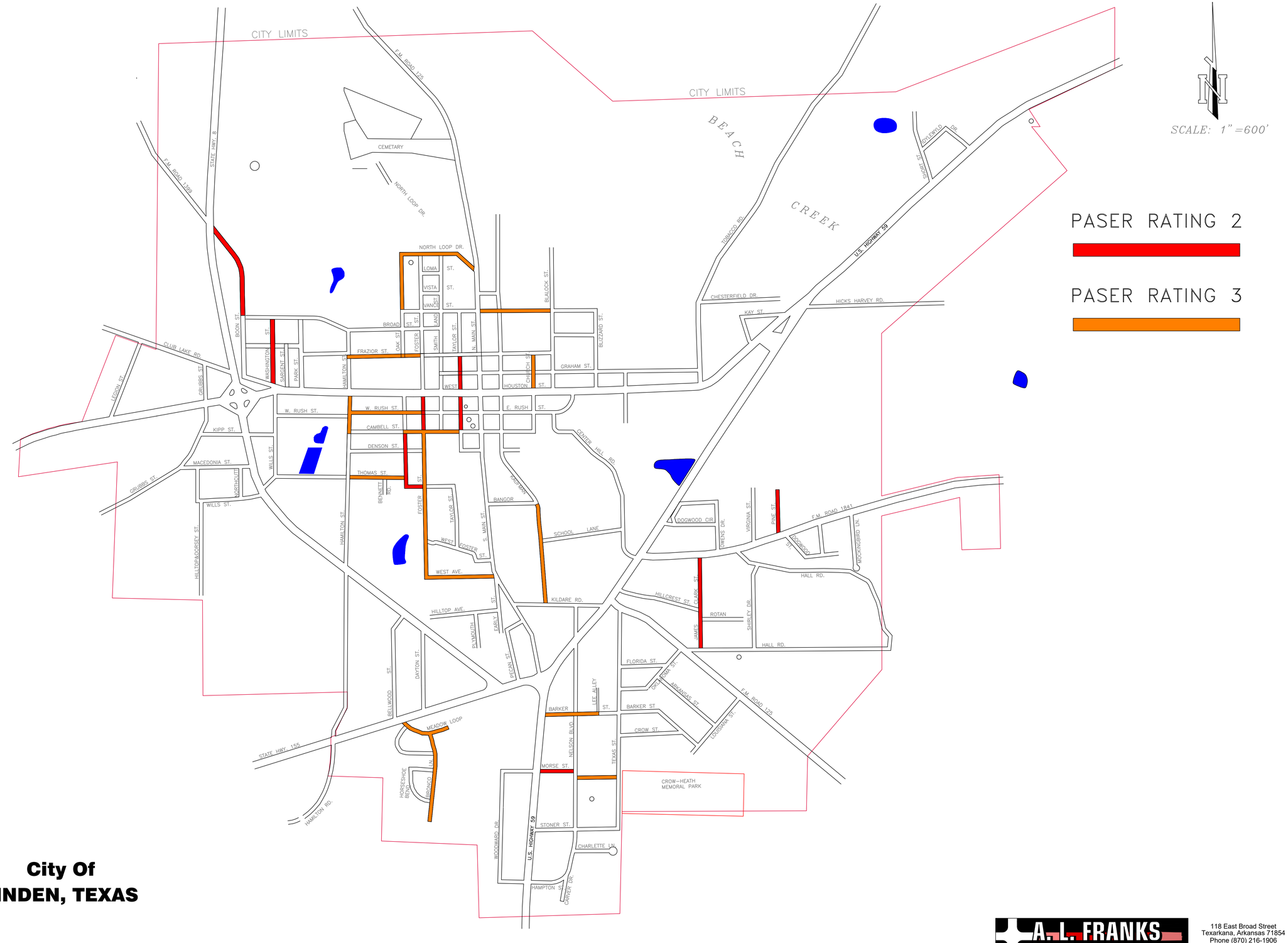
Mapping



PASER RATING 1

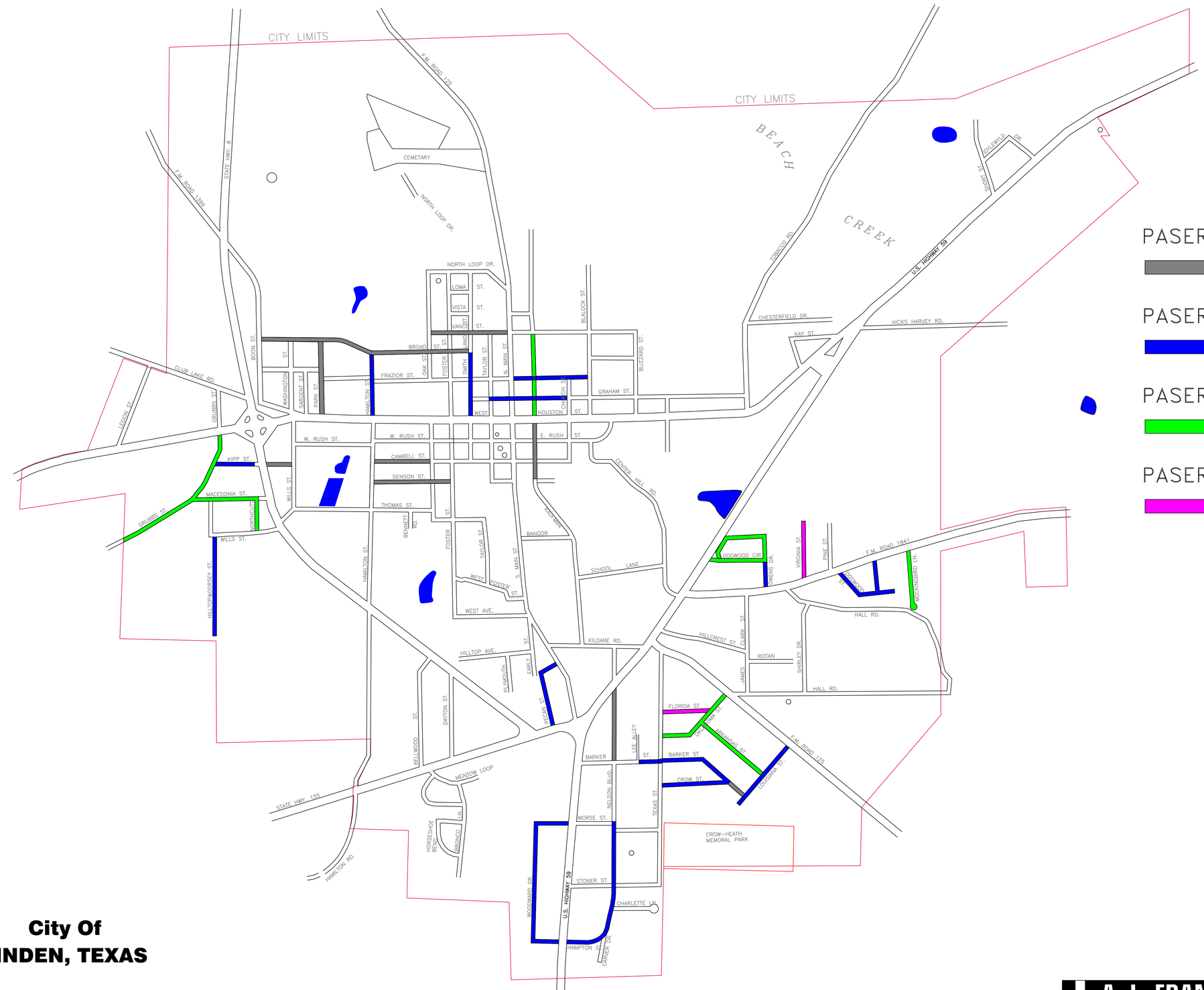
City Of
LINDEN, TEXAS

A.L. FRANKS ENGINEERING
118 East Broad Street
Texarkana, Arkansas 71854
Phone (870) 216-1906
Fax (870) 216-1907



City Of
LINDEN, TEXAS

A.L. FRANKS ENGINEERING
118 East Broad Street
Texarkana, Arkansas 71854
Phone (870) 216-1906
Fax (870) 216-1907



SCALE: 1" =600'

PASER RATING 4

PASER RATING 5

PASER RATING 6

PASER RATING 7

City Of
LINDEN, TEXAS

A.L. FRANKS ENGINEERING
118 East Broad Street
Texarkana, Arkansas 71854
Phone (870) 216-1906
Fax (870) 216-1907

Appendix C

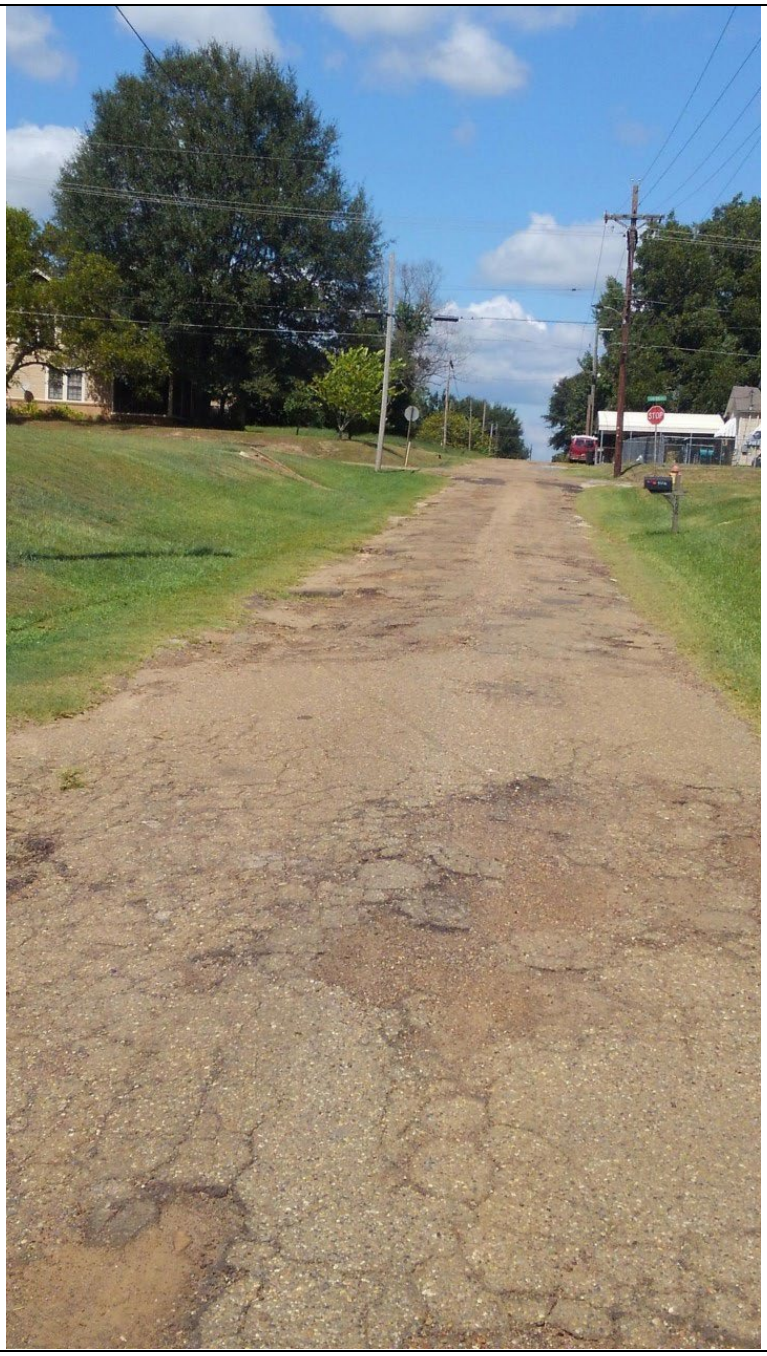
Images

Wills Street has been converted to a maintained gravel road. Note erosion beginning to incise int street at center of image.

Water drains from west to east across South Oak. Note completely silted in culvert.

Damage on South Kaufman Street is concentrated on side of street that conveys surface water. Kaufman Street is effectively acting as a stormwater conveyance to Beach Creek tributary.

Graham Street (facing west) - drainage from north to south



Smithland (facing south) note the street is lower than surrounding topography and thus is acting as stormwater conveyance.

Appendix D

PASER Documents

Pavement Surface Evaluation and Rating

PASER Manual

Asphalt Roads

Transportation Information Center
University of Wisconsin–Madison

Contents

This manual is intended to assist local officials in understanding and rating the surface condition of asphalt pavement. It describes types of defects and provides a simple system to visually rate pavement condition. The rating procedure can be used as condition data for the Wisconsin DOT local road inventory and as part of a computerized pavement management system like PASERWARE.

The PASER system described here and in other T.I.C. publications is based in part on a roadway management system originally developed by Phil Scherer, transportation planner, Northwest Wisconsin Regional Planning Commission.

Produced by the T.I.C. with support from the Federal Highway Administration, the Wisconsin Department of Transportation, and the University of Wisconsin-Extension. The T.I.C., part of the nationwide Local Technical Assistance Program (LTAP), is a Center of the College of Engineering, Department of Engineering Professional Development, University of Wisconsin–Madison.

432 North Lake Street
Madison, WI 53706

phone 800/442-4615
fax 608/263-3160
e-mail tic@epd.engr.wisc.edu
URL http://tic.engr.wisc.edu

Printed on recycled paper.

Pavement Surface Evaluation and Rating

PASER Manual

Asphalt Roads

Donald Walker, T.I.C. Director, *author*
Lynn Entine, Entine & Associates, *editor*
Susan Kummer, Artifax, *designer*

Transportation Information Center
University of Wisconsin–Madison

Pavement Surface Evaluation and Rating

Asphalt PASER Manual

A local highway agency's major goal is to use public funds to provide a comfortable, safe and economical road surface—no simple task. It requires balancing priorities and making difficult decisions in order to manage pavements. Local rural and small city pavements are often managed informally, based on the staff's judgment and experience. While this process is both important and functional, using a slightly more formalized technique can make it easier to manage pavements effectively.

Experience has shown that there are three especially useful steps in managing local roads:

1. Inventory all local roads and streets.
2. Periodically evaluate the condition of all pavements.
3. Use the condition evaluations to set priorities for projects and select alternative treatments.

A comprehensive pavement management system involves collecting data and assessing several road characteristics: roughness (ride), surface distress (condition), surface skid characteristics, and structure (pavement strength and deflection). Planners can combine this condition data with economic analysis to develop short-range and long-range plans for a variety of budget levels. However, many local agencies lack the resources for such a full-scale system.

Since surface condition is the most vital element in any pavement management system, local agencies can use the simplified rating system presented in this ***Asphalt PASER Manual*** to evaluate their roads. The PASER ratings combined with other inventory data (width, length, shoulder, pavement type, etc.) from the WisDOT local roads inventory (WISLR) can be very helpful in planning future budgets and priorities.

WISLR inventory information and PASER ratings can be used in a computerized pavement management system, PASERWARE, developed by the T.I.C and WisDOT. Local officials can use PASERWARE to evaluate whether their annual road budgets are adequate to maintain or improve current road conditions and to select the most cost-effective strategies and priorities for annual projects.

PASER Manuals for gravel, concrete, and other road surfaces, with compatible rating systems are also available (page 29). Together they make a comprehensive condition rating method for all road types. PASER ratings are accepted for WISLR condition data.

Asphalt pavement distress

PASER uses visual inspection to evaluate pavement surface conditions. The key to a useful evaluation is identifying different types of pavement distress and linking them to a cause. Understanding the cause for current conditions is extremely important in selecting an appropriate maintenance or rehabilitation technique.

There are four major categories of common asphalt pavement surface distress:

Surface defects
Raveling, flushing, polishing.

Surface deformation
Rutting, distortion—rippling and shoving, settling, frost heave.

Cracks
Transverse, reflection, slippage, longitudinal, block, and alligator cracks.

Patches and potholes

Deterioration has two general causes: environmental due to weathering and aging, and structural caused by repeated traffic loadings.

Obviously, most pavement deterioration results from both environmental and structural causes. However, it is important to try to distinguish between the two in order to select the most effective rehabilitation techniques.

The rate at which pavement deteriorates depends on its environment, traffic loading conditions, original construction quality, and interim maintenance procedures. Poor quality materials or poor construction procedures can significantly reduce the life of a pavement. As a result, two pavements constructed at the same time may have significantly different lives, or certain portions of a pavement may deteriorate more rapidly than others. On the other hand, timely and effective maintenance can extend a pavement's life. Crack sealing and seal coating can reduce the effect of moisture in aging of asphalt pavement.

With all of these variables, it is easy to see why pavements deteriorate at various rates and why we find them in various stages of disrepair. Recognizing defects and understanding their causes helps us rate pavement condition and select cost-effective repairs. The pavement defects shown on the following pages provide a background for this process.

Periodic inspection is necessary to provide current and useful evaluation data. It is recommended that PASER ratings be updated every two years, and an annual update is even better.

SURFACE DEFECTS

Raveling

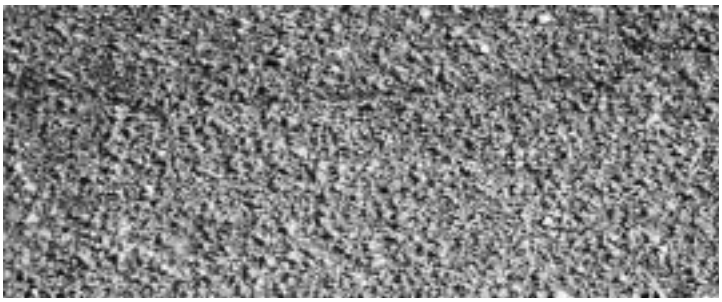
Raveling is progressive loss of pavement material from the surface downward, caused by: stripping of the bituminous film from the aggregate, asphalt hardening due to aging, poor compaction especially in cold weather construction, or insufficient asphalt content. Slight to moderate raveling has loss of fines. Severe raveling has loss of coarse aggregate. Raveling in the wheelpaths can be accelerated by traffic. Protect pavement surfaces from the environment with a sealcoat or a thin overlay if additional strength is required.

Flushing

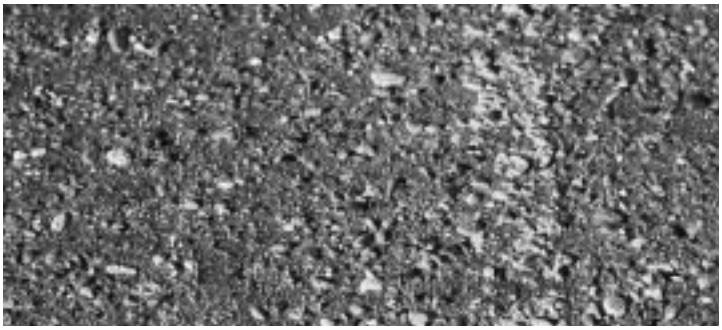
Flushing is excess asphalt on the surface caused by a poor initial asphalt mix design or by paving or sealcoating over a flushed surface. Repair by blotting with sand or by overlaying with properly designed asphalt mix.

Polishing

Polishing is a smooth slippery surface caused by traffic wearing off sharp edges of aggregates. Repair with sealcoat or thin bituminous overlay using skid-resistant aggregate.



◄ **Slight raveling. Small aggregate particles have worn away exposing tops of large aggregate.**

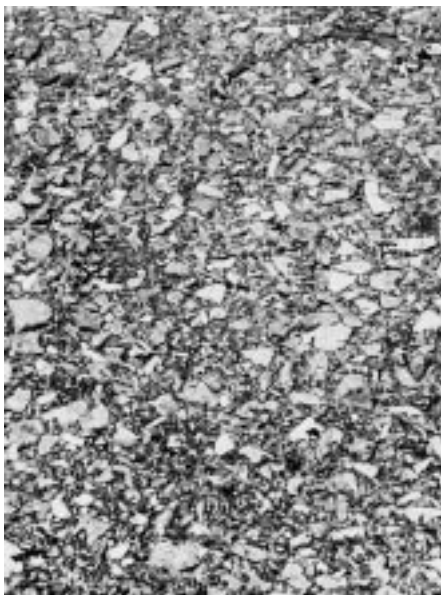


◄ **Moderate to severe raveling. Erosion further exposes large aggregate.**

◄ **Severe raveling and loss of surface material.**

Polished, worn aggregate needs repair. ▼

► **Flushing. Dark patches show where asphalt has worked to surface.**



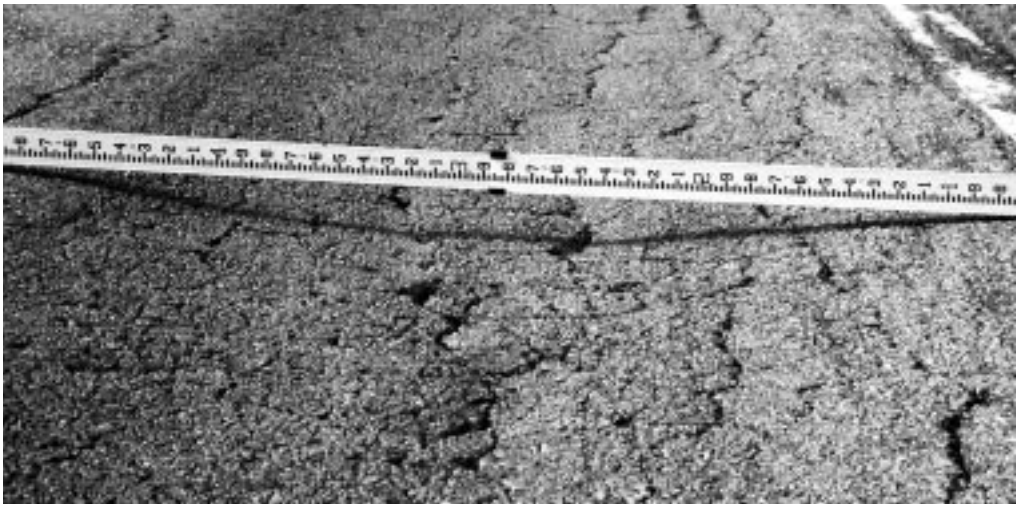
SURFACE DEFORMATION

Rutting

Rutting is displacement of material, creating channels in wheelpaths. It is caused by traffic compaction or displacement of unstable material. Severe rutting (over 2") may be caused by base or subgrade consolidation. Repair minor rutting with overlays. Severe rutting requires milling the old surface or reconstructing the roadbed before resurfacing.

◄ **Even slight rutting is evident after a rain.**

◄ **Severe rutting over 2" caused by poor mix design.**



◄ **Severe rutting caused by poor base or subgrade.**

Distortion

Shoving or rippling is surfacing material displaced crossways to the direction of traffic. It can develop into washboarding when the asphalt mixture is unstable because of poor quality aggregate or improper mix design. Repair by milling smooth and overlaying with stable asphalt mix.

Other pavement distortions may be caused by settling, frost heave, etc. Patching may provide temporary repair. Permanent correction usually involves removal of unsuitable subgrade material and reconstruction.

▼ **Heavy traffic has shoved pavement into washboard ripples and bumps.**

► **Severe settling from utility trench.**

► **Frost heave damage from spring break-up.**

▼ **Widely spaced, well-sealed cracks.**

CRACKS

Transverse cracks

A crack at approximately right angles to the center line is a transverse crack. They are often regularly spaced. The cause is movement due to temperature changes and hardening of the asphalt with aging.

Transverse cracks will initially be widely spaced (over 50'). Additional cracking will occur with aging until they are closely spaced (within several feet). These usually begin as hairline or very narrow cracks; with aging they widen. If not properly sealed and maintained, secondary or multiple cracks develop parallel to the initial crack. The crack edges can further deteriorate by raveling and eroding the adjacent pavement.

Prevent water intrusion and damage by sealing cracks which are more than ¼" wide.

◄ **Sealed cracks, a few feet apart.**

▲ **Tight cracks less than ¼" in width.**

▲ **Open crack – ½" or more in width.**

▲ **Water enters unsealed cracks softening pavement and causing secondary cracks.**

▲ **Pavement ravels and erodes along open cracks causing deterioration.**

Reflection cracks

Cracks in overlays reflect the crack pattern in the pavement underneath. They are difficult to prevent and correct. Thick overlays or reconstruction is usually required.

► **Concrete joints reflected through bituminous overlay.**

Slippage cracks

Crescent or rounded cracks in the direction of traffic, caused by slippage between an overlay and an underlying pavement. Slippage is most likely to occur at intersections where traffic is stopping and starting. Repair by removing the top surface and resurfacing using a tack coat.

► **Crescent-shaped cracks characteristic of slippage.**

► **Loss of bond between pavement layers allows traffic to break loose pieces of surface.**

Centerline crack (still tight). ►

Edge cracking from weakened subbase and traffic loads. ▼

Longitudinal cracks

Cracks running in the direction of traffic are longitudinal cracks. Center line or lane cracks are caused by inadequate bonding during construction or reflect cracks in underlying pavement. Longitudinal cracks in the wheel path indicate fatigue failure from heavy vehicle loads. Cracks within one foot of the edge are caused by insufficient shoulder support, poor drainage, or frost action. Cracks usually start as hairline or vary narrow and widen and erode with age. Without crack filling, they can ravel, develop multiple cracks, and become wide enough to require patching.

Filling and sealing cracks will reduce moisture penetration and prevent further subgrade weakening. Multiple longitudinal cracks in the wheel path or pavement edge indicate a need for strengthening with an overlay or reconstruction.

► First stage of wheelpath cracking caused by heavy traffic loads.

Load-related cracks in wheel path plus centerline cracking. ▼

Multiple open cracks at center line, wheelpaths and lane center. ▼

Block cracks

Block cracking is interconnected cracks forming large blocks. Cracks usually intersect at nearly right angles. Blocks may range from one foot to approximately 10′ or more across. The closer spacing indicates more advanced aging caused by shrinking and hardening of the asphalt over time. Repair with sealcoating during early stages to reduce weathering of the asphalt. Overlay or reconstruction required in the advanced stages.

► **Large blocks, approximately 10′ across.**

► **Intermediate-size block cracking, 1′-5′ across with open cracks.**

▲ **Extensive block cracking in an irregular pattern.**

► **Severe block cracking – 1′ or smaller blocks. Tight cracks with no raveling.**

Alligator cracks

Interconnected cracks forming small pieces ranging in size from about 1" to 6". This is caused by failure of the surfacing due to traffic loading (fatigue) and very often also due to inadequate base or subgrade support. Repair by excavating localized areas and replacing base and surface. Large areas require reconstruction. Improvements in drainage may often be required.

◄
Alligator crack pattern. Tight cracks and one patch.

◄
Characteristic "chicken wire" crack pattern shows smaller pavement pieces and patching.

◄
Open raveled alligator cracking with settlement along lane edge most likely due to very soft subgrade.

PATCHES AND POTHOLES

Patches

Original surface repaired with new asphalt patch material. This indicates a pavement defect or utility excavation which has been repaired. Patches with cracking, settlement or distortions indicate underlying causes still remain. Recycling or reconstruction are required when extensive patching shows distress.

► **Typical repair of utility excavation. Patch in fair to good condition.**

► **Edge wedging. Pavement edges strengthened with wedges of asphalt. Patch is in very good condition.**

► **Extensive patching in very poor condition.**

Potholes

Holes and loss of pavement material caused by traffic loading, fatigue and inadequate strength. Often combined with poor drainage. Repair by excavating or rebuilding localized potholes. Reconstruction required for extensive defects.

◄
Small pothole where top course has broken away.

◄
Multiple potholes show pavement failure, probably due to poor subgrade soils, frost heave, and bad drainage.

◄
Large, isolated pothole, extends through base. Note adjacent alligator cracks which commonly deteriorate into potholes.

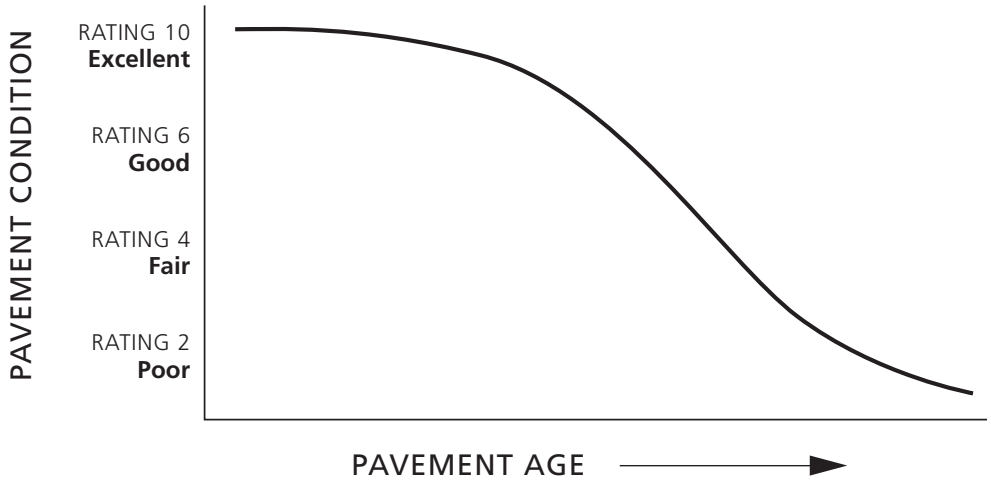
Rating pavement surface condition

With an understanding of surface distress, you can evaluate and rate asphalt pavement surfaces. The rating scale ranges from **10–excellent** condition to **1–failed**. Most pavements will deteriorate through the phases listed in the rating scale. The time it takes to go from excellent condition (10) to complete failure (1) depends largely on the quality of the original construction and the amount of heavy traffic loading.

Once significant deterioration begins, it is common to see pavement decline rapidly. This is usually due to a combination of loading and the effects of additional moisture. As a pavement ages and additional cracking develops, more moisture can enter the pavement and accelerate the rate of deterioration.

Look at the photographs in this section to become familiar with the descriptions of the individual rating categories. To evaluate an individual pavement segment, first determine its general condition. Is it relatively new, toward the top end of the scale? In very poor condition and at the bottom of the scale? Or somewhere in between? Next, think generally about the appropriate maintenance method. Use the rating categories outlined below.

Finally, review the individual pavement distress and select the appropriate surface rating. Individual pavements will ***not*** have all of the types of distress listed for any particular rating. They may have only one or two types.



In addition to indicating the surface condition of a road, a given rating also includes a recommendation for needed maintenance or repair. This feature of the rating system facilitates its use and enhances its value as a tool in ongoing road maintenance.

RATINGS ARE RELATED TO NEEDED MAINTENANCE OR REPAIR

Rating 9 & 10	No maintenance required
Rating 8	Little or no maintenance
Rating 7	Routine maintenance, cracksealing and minor patching
Rating 5 & 6	Preservative treatments (sealcoating)
Rating 3 & 4	Structural improvement and leveling (overlay or recycling)
Rating 1 & 2	Reconstruction

Rating system

Surface rating	*Visible distress**	*General condition/ treatment measures*
10 Excellent	None.	New construction.
9 Excellent	None.	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40′ or greater). All cracks sealed or tight (open less than ¼″).	Recent sealcoat or new cold mix. Little or no maintenance required.
7 Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open ¼″) due to reflection or paving joints. Transverse cracks (open ¼″) spaced 10′ or more apart, little or slight crack raveling. No patching or very few patches in excellent condition.	First signs of aging. Maintain with routine crack filling.
6 Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open ¼″–½″), some spaced less than 10′. First sign of block cracking. Sight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.
5 Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open ½″) show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin non-structural overlay (less than 2″)
4 Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (½″ deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2″ or more).
3 Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (1″ or 2″ deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2 Very Poor	Alligator cracking (over 25% of surface). Severe distortions (over 2″ deep) Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1 Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

** Individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types.*

RATING 10 & 9

EXCELLENT —
No maintenance required

Newly constructed or recently overlaid roads are in excellent condition and require no maintenance.

► **RATING 10**
New construction.

► **RATING 9**
Recent overlay, rural.

► **RATING 9**
Recent overlay, urban.

RATING 8

VERY GOOD —
Little or no maintenance required

This category includes roads which have been recently sealcoated or overlaid with new cold mix. It also includes recently constructed or overlaid roads which may show longitudinal or transverse cracks. All cracks are tight or sealed.

◄ **Recent chip seal.**

◄ **Recent slurry seal.**

▲ **New cold mix surface.**

▼ **Widely spaced, sealed cracks.**

RATING 7

GOOD —
Routine sealing recommended

Roads show first signs of aging, and they may have very slight raveling. Any longitudinal cracks are along paving joint. Transverse cracks may be approximately 10′ or more apart. All cracks are ¼″ or less, with little or no crack erosion. Few if any patches, all in very good condition. Maintain a crack sealing program.

► **Tight and sealed transverse and longitudinal cracks. Maintain crack sealing program.**

► **Tight and sealed transverse and longitudinal cracks.**

► **Transverse cracks about 10′ or more apart. Maintain crack sealing program.**

RATING 6

GOOD —
Consider preservative treatment

Roads are in sound structural condition but show definite signs of aging. Seal-coating could extend their useful life. There may be slight surface raveling. Transverse cracks can be frequent, less than 10′ apart. Cracks may be 1/4–1/2″ and sealed or open. Pavement is generally sound adjacent to cracks. First signs of block cracking may be evident. May have slight or moderate bleeding or polishing. Patches are in good condition.

◄ **Slight surface raveling with tight cracks, less than 10′ apart.**

◄ **Transverse cracking less than 10′ apart; cracks well-sealed.**

▼ **Large blocks, early signs of raveling and block cracking.**

▼ **Open crack, 1/2″ wide; adjoining pavement sound.**

▼ **Moderate flushing.**

RATING 5

FAIR —
Preservative maintenance treatment required

Roads are still in good structural condition but clearly need sealcoating or overlay. They may have moderate to severe surface raveling with significant loss of aggregate. First signs of longitudinal cracks near the edge. First signs of raveling along cracks. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Any patches or edge wedges are in good condition.

▼ **Block cracking with open cracks.**

► **Moderate to severe raveling in wheel paths.**

▼ **Severe flushing.**

▲ **Wedges and patches extensive but in good condition.**

RATING 4

FAIR —
Structural improvement required

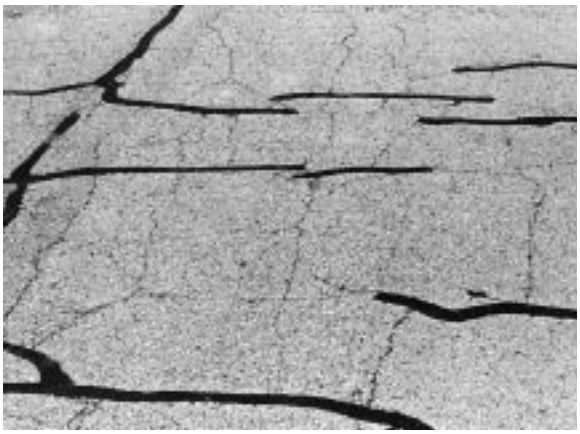
Roads show first signs of needing strengthening by overlay. They have very severe surface raveling which should no longer be sealed. First longitudinal cracking in wheel path. Many transverse cracks and some may be raveling slightly. Over 50% of the surface may have block cracking. Patches are in fair condition. They may have rutting less than 1/2" deep or slight distortion.

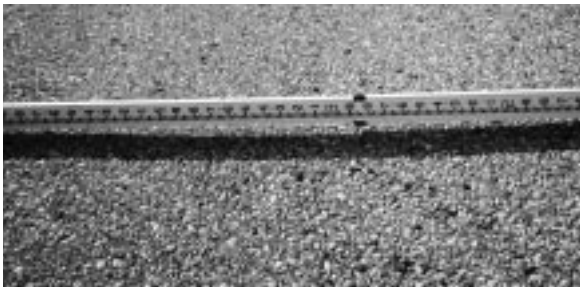
Severe raveling with ▼ extreme loss of aggregate.

Load cracking and slight ▼ rutting in wheel path.

◄ Longitudinal cracking; early load-related distress in wheel path. Strengthening needed.

▼ Slight rutting; patch in good condition.





▼ Extensive block cracking. Blocks tight and sound.

◄ Slight rutting in wheel path.

RATING 3

POOR—
Structural improvement required

Roads must be strengthened with a structural overlay (2" or more). Will benefit from milling and very likely will require pavement patching and repair beforehand. Cracking will likely be extensive. Raveling and erosion in cracks may be common. Surface may have severe block cracking and show first signs of alligator cracking. Patches are in fair to poor condition. There is moderate distortion or rutting (1-2") and occasional potholes.

► **Many wide and raveled cracks indicate need for milling and overlay.**

► **2" ruts need mill and overlay.**

► **Open and raveled block cracks.**

RATING 3

POOR — (continued)
Structural improvement required

◄ **Alligator cracking. Edge needs repair and drainage needs improvement prior to rehabilitation.**

▼ **Distortion with patches in poor condition. Repair and overlay.**

RATING 2

VERY POOR—
Reconstruction required

Roads are severely deteriorated and need reconstruction. Surface pulverization and additional base may be cost-effective. These roads have more than 25% alligator cracking, severe distortion or rutting, as well as potholes or extensive patches in poor condition.

► **Extensive alligator cracking. Pulverize and rebuild.**

▲ **Severe rutting. Strengthen base and reconstruct.**

▲ **Patches in poor condition, wheelpath rutting. Pulverize, strengthen and reconstruct.**

► **Severe frost damage. Reconstruct.**

RATING 1

FAILED —
Reconstruction required

Roads have failed, showing severe distress and extensive loss of surface integrity.

◄
Potholes from frost damage. Reconstruct.

◄
Potholes and severe alligator cracking. Failed pavement. Reconstruct.

◄
Extensive loss of surface. Rebuild.

Practical advice on rating roads

Inventory and field inspection

Most agencies routinely observe roadway conditions as a part of their normal work and travel. However, an actual inspection means looking at the entire roadway system as a whole and preparing a written summary of conditions. This inspection has many benefits over casual observations. It can be helpful to compare segments, and ratings decisions are likely to be more consistent because the roadway system is considered as a whole within a relatively short time.

An inspection also encourages a review of specific conditions important in roadway maintenance, such as drainage, adequate strength, and safety.

A simple written inventory is useful in making decisions where other people are involved. You do not have to trust your memory, and you can usually answer questions in more detail. Having a written record and objective information also improves your credibility with the public.

Finally, a written inventory is very useful in documenting changing roadway conditions. Without records over several years it is impossible to know if road conditions are improving, holding their own, or declining.

Annual budgets and long range planning are best done when based on actual needs as documented with a written inventory.

The Wisconsin DOT local road inventory (WISLR) is a valuable resource for managing your local roads. Adding PASER surface condition ratings is an important improvement.

Averaging and comparing sections

For evaluation, divide the local road system into individual segments which are similar in construction and condition. Rural segments may vary from ½ mile to a mile long, while sections in urban areas will likely be 1-4 blocks long or more. If you are starting with the WISLR Inventory, the segments have already been established. You may want to review them for consistent road conditions.

Obviously, no roadway segment is entirely consistent. Also, surfaces in one section will not have all of the types of distress listed for any particular rating. They may have only one or two types. Therefore, some averaging is necessary.

The objective is to rate the condition that represents the majority of the roadway. Small or isolated conditions should not influence the rating. It is useful to note these special conditions on the inventory form so this information can be used in planning specific improvement projects. For example, some spot repairs may be required.

Occasionally surface conditions vary significantly within a segment. For example, short sections of good condition may be followed by sections of poor surface conditions. In these cases, it is best to rate the segment according to the worst conditions and note the variation on the form.

The overall purpose of condition rating is to be able to compare each segment relative to all the other segments in your roadway system. On completion you should be able to look at any two pavement segments and find that the better surface has a higher rating.

Within a given rating, say 6, not all pavements will be exactly the same. However, they should all be considered to be in better condition than those with lower ratings, say 5. Sometimes it is helpful in rating a difficult segment to compare it to other previously rated segments. For example, if it is better than one you rated 5 and worse than a typical 7, then a rating of 6 is appropriate. Having all pavement segments rated in the proper relative order is most important and useful.

Assessing drainage conditions

Moisture and poor pavement drainage are significant factors in pavement deterioration. Some assessment of drainage conditions during pavement rating is highly recommended. While you should review drainage in detail at the project level, at this stage simply include an overview drainage evaluation at the same time as you evaluate surface condition.

Urban drainage.

RATING: Excellent

Good rural ditch and driveway culvert. Culvert end needs cleaning.

RATING: Good

High shoulder and no ditch lead to pavement damage. Needs major ditch improvement for a short distance.

RATING: Fair

No drainage leads to failed pavement.

RATING: Poor

Consider both pavement surface drainage and lateral drainage (ditches or storm sewers). Pavement should be able to quickly shed water off the surface into the lateral ditches. Ditches should be large and deep enough to drain the pavement and remove the surface water efficiently into adjacent waterways.

Look at the roadway crown and check for low surface areas that permit ponding. Paved surfaces should have approximately a 2% cross slope or crown across the roadway. This will provide approximately 3" of fall on a 12' traffic lane. Shoulders should have a greater slope to improve surface drainage.

A pavement's ability to carry heavy traffic loads depends on both the pavement materials (asphalt surfacing and granular base) and the strength of the underlying soils. Most soils lose strength when they are very wet. Therefore, it is important to provide drainage to the top layer of the subgrade supporting the pavement structure.

In rural areas, drainage is provided most economically by open ditches that allow soil moisture to drain laterally. As a rule of thumb, the bottom of the ditch ought to be at least one foot below the base course of the pavement in order to drain the soils. This means that minimum ditch depth should be about 2' below the center of the pavement. Deeper ditches, of course, are required to accommodate roadway culverts and maintain the flow line to adjacent drainage channels or streams.

You should also check culverts and storm drain systems. Storm drainage systems that are silted in, have a large accumulation of debris, or are in poor structural condition will also degrade pavement performance.

The T.I.C. publication, ***Drainage Manual: Local Road Assessment and Improvement,*** describes the elements of drainage systems, depicts them in detailed photographs, and explains how to rate their condition. Copies are available from the Transportation Information Center.

Planning annual maintenance and repair budgets

We have found that relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps local officials use the rating system. However, an individual surface rating should not automatically dictate the final maintenance or rehabilitation technique.

You should consider future traffic projections, original construction, and pavement strength since these may dictate a more comprehensive rehabilitation than the rating suggests. On the other hand, it may be appropriate under special conditions to do nothing and let the pavement fully deteriorate, then rebuild when funds are available.

Summary

Using local road funds most efficiently requires good planning and accurate identification of appropriate rehabilitation projects. Assessing roadway conditions is an essential first step in this process. This asphalt pavement surface condition rating procedure has proved effective in improving decision making and using highway funds more efficiently. It can be used directly by local officials and staff. It may be combined with additional testing and data collection in a more comprehensive pavement management system.

Transportation Information Center Publications

Pavement Surface Evaluation and Rating (PASER) Manuals

Asphalt PASER Manual, 2002, 28 pp.

Brick and Block PASER Manual, 2001, 8 pp.

Concrete PASER Manual, 2002, 28 pp.

Gravel PASER Manual, 2002, 20 pp.

Sealcoat PASER Manual, 2000, 16 pp.

Unimproved Roads PASER Manual, 2001, 12 pp.

Drainage Manual
Local Road Assessment and Improvement, 2000, 16 pp.

SAFER Manual
Safety Evaluation for Roadways, 1996, 40 pp.

Flagger's Handbook (pocket-sized guide), 1998, 22 pp.

Work Zone Safety, Guidelines for Construction, Maintenance, and Utility Operations, (pocket-sized guide), 1999, 55 pp.

Wisconsin Transportation Bulletins

#1 Understanding and Using Asphalt
#2 How Vehicle Loads Affect Pavement Performance
#3 LCC—Life Cycle Cost Analysis
#4 Road Drainage
#5 Gravel Roads
#6 Using Salt and Sand for Winter Road Maintenance
#7 Signing for Local Roads
#8 Using Weight Limits to Protect Local Roads
#9 Pavement Markings
#10 Seal Coating and Other Asphalt Surface Treatments
#11 Compaction Improves Pavement Performance
#12 Roadway Safety and Guardrail
#13 Dust Control on Unpaved Roads
#14 Mailbox Safety
#15 Culverts-Proper Use and Installation
#16 Geotextiles in Road Construction/Maintenance and Erosion Control
#17 Managing Utility Cuts
#18 Roadway Management and Tort Liability in Wisconsin
#19 The Basics of a Good Road
#20 Using Recovered Materials in Highway Construction
#21 Setting Speed Limits on Local Roads

Transportation Information Center
University of Wisconsin–Madison

432 North Lake Street
Madison, WI 53706
phone 800/442-4615
fax 608/263-3160
e-mail tic@epd.engr.wisc.edu
URL http://tic.engr.wisc.edu

Transportation Information Center
University of Wisconsin–Madison

PASER

Asphalt Roads