# TRAIL PAVEMENT CONDITION ASSESSMENT

NOVEMBER 2015

PREPARED FOR:
INGHAM COUNTY PARKS DEPARTMENT
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## 1.0 EXECUTIVE SUMMARY

The Mannik & Smith Group, Inc. (MSG) was selected to develop an Asset Management Plan (AMP) for Ingham County's nonmotorized trail system, which consists of all bicycle and multi-use paths separate from roadways within the County. These are primarily concentrated in the northwest quadrant of the County, particularly in the cities of Lansing, East Lansing, and Mason, and the townships of Delhi and Meridian.

The Asset Management Process includes:

- Assessment of current pavement conditions
- Create a 'Mix of Fixes' strategy, develop cost estimates and identify funding sources
- Forecasting of future conditions and development of performance measures and targets
- Conduct tradeoff analysis and identify candidate projects
- Set priorities and develop a multi-year program
- Report results

The Asset Management Plan is a tangible document that shows the strategic asset management vision for the County's 'nonmotorized trails,' which becomes an effective communication tool for public officials and the general public. The nonmotorized pathways in Ingham County are typically owned and maintained by the municipalities in which they are located.

Ingham County's nonmotorized trails were evaluated by MSG utilizing a modified PASER pavement rating system, as well as additional factors which included drainage condition, pavement base condition, and shoulder condition. These factors were combined into a formula developed by MSG's roadway engineers to determine a priority ranking for the overall nonmotorized trail system in Ingham County. From these priority ratings, and utilizing the estimated costs for the recommended scope of work, a nonmotorized trail improvement plan was developed.

Pavement Asset Management is a tool to be used in conjunction with the prioritization by the local community. The desired pavement surface condition and rideability of the pavement should be used as a guide in establishing maintenance and funding levels. Asset Management plans should be viewed as a guide that can, and should be, modified to meet the priorities of the local communities and Ingham County, in order to suit the needs of recreation, tourism, corridor connections, and development.

The Asset Management Plan is a living document, and will change as pavement conditions vary through continued deterioration, maintenance improvements, resurfacing, and reconstruction, as well as when the priorities may be modified by the county or local stakeholders.

## 2.0 INTRODUCTION

The Mannik & Smith Group, Inc. (MSG) was selected to provide a complete inventory and analysis of the existing nonmotorized trail network located within the boundaries of Ingham County. MSG staff performed field reviews of each trail segment, noting existing conditions and making recommendations for repairs. Along with dimensional parameters logged in the field, cost estimates were then assembled for each segment and the entire network.

Field work and suggested repair analysis was conducted in accordance with the principles of asset management planning. The process used was similar in scope and nature to the biennial assessment of all public road segments which comprise the Federal Aid network in Michigan. In order to provide a better understanding of the scope of MSG's work plan, it is important to first give a brief overview of asset management.

P.A. 499 of 2002 defined "Asset Management" as an "ongoing process of maintaining, upgrading and operating physical assets cost-effectively, based on a continuous inventory and condition assessment." The State of Michigan formed the Transportation Asset Management Council, or TAMC, and charged it with "advising the State Transportation Commission on a statewide asset management strategy and the processes and necessary tools needed to implement such a strategy." While nonmotorized trails are not a part of this statewide assessment, a similar process was used to assess the trails.

The Asset Management <u>Process</u> includes:

- Assessment of current pavement conditions,
- Creating a 'Mix of Fixes' strategy, development of cost estimates and identifying funding sources,
- Forecasting of future conditions and development of performance measures and targets,
- Conducting tradeoff analysis and identify candidate projects,
- Prioritizing repairs and developing a multi-year maintenance and construction program, and
- Reporting results.

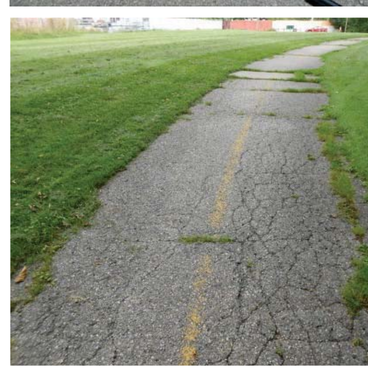
The Asset Management <u>Plan</u> is a tangible document that shows the strategic asset management **vision** of each agency's (or municipality's) assets, which becomes an effective communication tool for local officials and the general public. The nonmotorized pathways are owned, maintained, and reconstructed by the municipalities in which they are located.

MSG has utilized the PASER rating system for pavement surfaces and a proprietary scale for defining the conditions of the pavement base, drainage capability, and shoulder condition of each segment. PASER is an acronym for <u>PA</u>vement <u>S</u>urface <u>E</u>valuation and <u>R</u>ating system, which was developed by the University of Wisconsin–Madison Transportation Information Center. Michigan has chosen to use the PASER rating scale for pavement surfaces, though there are a number of other rating methodologies widely available. In the PASER system, pavement segments are assigned ratings of 1 to 10, with 1 being the lowest rating, or totally failed condition, and 10 being the highest rating, or brand-new condition. This report will not go into the details of the PASER rating system other than to identify it as a useful tool to evaluate the trail system. Pavement segments must be regularly reviewed following their initial assessment in order to document changes in conditions, which will also permit the agency to develop life-cycle curves and further analyze the trail network's response to various repair methods.

**Trail Segment PASER Rating System Examples**

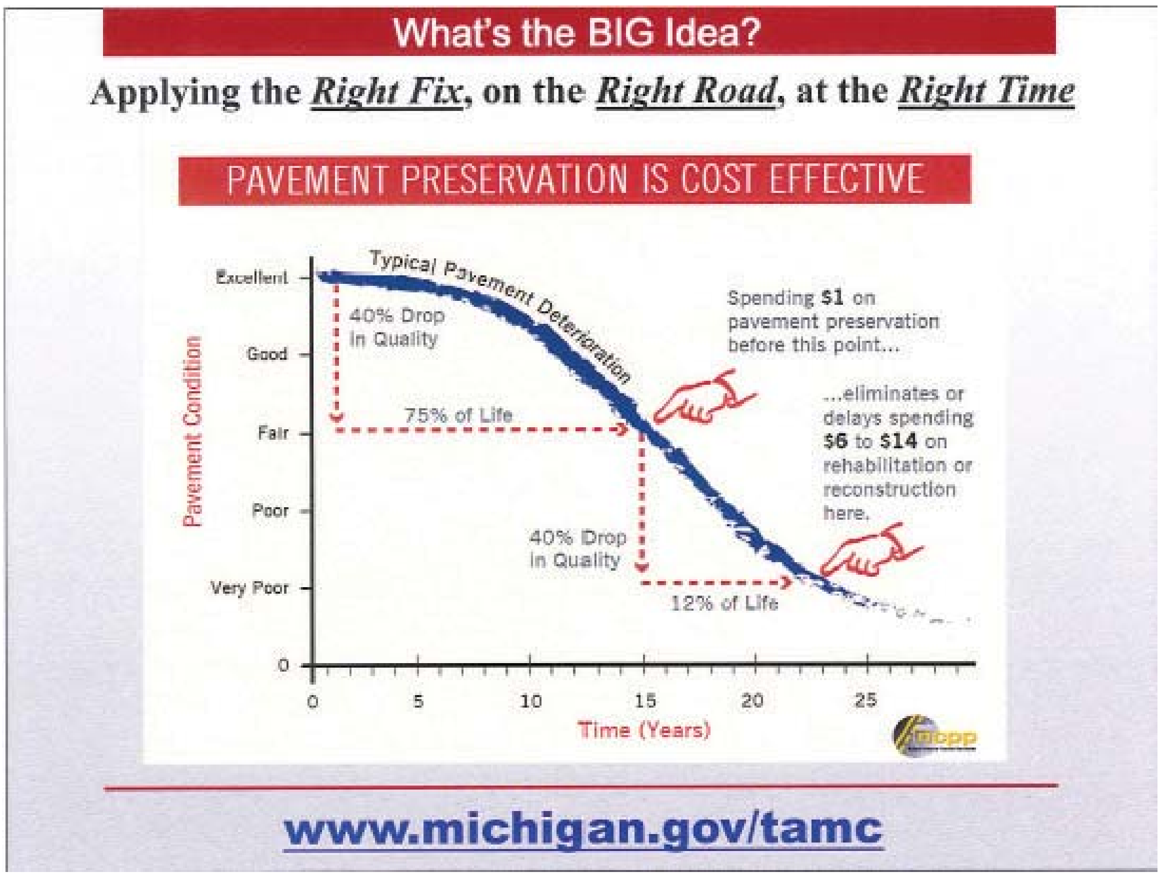
PASER = 8 to 10 – Good
Routine Maintenance
(crack seal, minor patching)

PASER = 5 to 7 – Fair
Preventive Maintenance
(crack seal, patching, surface treatment, concrete joint repair)



PASER = 1 to 4 – Poor
Rehab/Reconstruction
(Resurface, structural overlay, complete reconstruct)

The chart that follows demonstrates a typical pavement deterioration curve with pavement condition being shown on the left hand, or 'y' axis, and the length in time (in years) across the bottom, or 'x' axis. The purpose of this chart is to demonstrate the benefits of providing lower-cost maintenance at critical times within the traditional pavement life cycle. If the right maintenance is provided at the right time, it will significantly delay the need for more intense, and costly, maintenance activities or the 'budget busting' cost of full reconstruction. Typical maintenance activities include crack sealing, sealcoat surfacing (also known as chip seals), microsurfacing, slurry sealing, thin lift overlays, milling and resurfacing, and other 'fixes' that preserve the existing pavement and provide a greater life span – as well as a better riding surface and public perception.




In general, the chart shows that there is approximately a 40% drop in pavement quality over a period of 75% of the pavement life cycle, which is typically defined (and engineered) in the industry as 20 years. If maintenance activities are not performed either prior to or by this time, there is a significant deterioration in the remaining years, estimated as an additional 40% deterioration in only 12% of the life cycle. The goal is to delay the eventual need for more significant rehabilitation or reconstruction as long as possible, and thereby preserving precious funding dollars and stretching them over a greater segment of the overall trail system.

An additional chart has been provided that demonstrates the benefits of maintaining the trail system and extending the life cycle of the pavement through the use of the 'Mix of Fixes' available versus letting a trail continue to deteriorate to the point of reconstruction with limited or no maintenance.

MSG was charged with evaluating the nonmotorized trail system in the county, and, utilizing the PASER rating system, determining the overall condition rating for the Ingham County nonmotorized trail network. One of the more significant modifications made by MSG was the inclusion of a drainage system evaluation, which is critical to the overall life of a pavement. High water tables, present in many areas, contribute significantly to the degradation of the pavement, especially when coupled with flat slopes and many marginal drainage outlets. Fortunately for Ingham County, many areas of the community have gently rolling hills and channelized drainage conveyances. However, lowland areas often used for nonmotorized trails are subject to seasonal inundation by flood waters. This can also increase the rate of deterioration. Traffic from service vehicles, such as during snow removal or maintenance operations, present much higher and more concentrated loads than are typically experienced by these pavements, particularly in the spring when the frost is coming out of the ground. This time of year is when road agencies typically enforce periods of reduced loading, or implementation of 'frost laws,' to reduce the damage caused by vehicles with heavy axle loads.

Another added factor considered in the MSG evaluation of the trail network was the base condition, or underlying structure, supporting the surfacing materials. The base is analogous to the foundation of the pavement, and without a structurally sound base, the pavement will deteriorate much more quickly and the repairs will be more costly. Techniques for improvement of the base include base crushing and shaping, full-depth recycling with the addition of asphalt emulsion or cement, base widening, and reconstruction. Ingham County has many areas of sandy soils underlying the trail system, which aids in drainage and support of the trail base. Areas of silty or clayey soils, which retain moisture, are particularly susceptible to significant 'frost heaving,' which accelerates pavement failure.

The remaining factor added by MSG in the field review included the shoulder condition. A shoulder, from a structural perspective, should be wide enough to support the adjacent pavement and to receive vehicle tire loading should a vehicle drive onto the shoulder area. In addition, a shoulder should be graded in such a way that drainage from the pavement surface flows freely to the drainage system along the trail. When shoulders are not maintained, drainage is trapped along the edge of the pavement which further accelerates pavement deterioration.

MSG has developed a formula which includes evaluation of the above-referenced factors to determine a priority rating for each segment of the nonmotorized trail network. This priority rating number was then used to determine, theoretically, which trail segments should be addressed sooner than those with lower priority ratings. Of course, other considerations, such as imminent maintenance requirements, connections between isolated or orphaned trail segments, political motivation, and completion of trail corridors will ultimately determine the final selection of trail improvements for each upcoming year.

As part of the trail network condition survey by MSG, photos were taken for each segment of trail, with segments being broken by other physical features. Examples of the dividing points include intersections with roads and other trails, waterways, break points between isolated trail segments, and major changes in pavement condition, such as those caused by construction at different times. Each trail segment may have areas which are not represented by the selected photos, but generally, the photo log depicts the condition of the majority of each trail segment. This photo log documentation is included in the appendices of this document, and each trail segment is clearly labeled for future reference and comparison.

Once the pavement condition ratings were complete, MSG reviewed the potential list of fixes that could be utilized for each trail segment. The mix of fixes, as noted earlier, ranges from minor to major, from crack filling to reconstruction. Along with each type of maintenance fix, an estimated cost was provided based on actual widths of the segments and lengths calculated from Geographic Information Systems (GIS) basemaps. It should be noted that these costs can and will vary from segment to segment depending on other factors, such as pavement markings, permanent signage, available detour routes, drainage issues, culverts, and the depth of engineering required for each repair. Engineering costs can range from a couple of hours to a complete pavement section design, depending on history and location. It is reasonable to expect that many trail segments were not 'designed' in the first place, and were simply constructed by paving a consistent width of asphalt between two points. This could be particularly true of older trail segments.

Pavement asset management is a tool to be used in conjunction with prioritization by the local community. How much weight is given to lower volume segments is a choice the community must make. The desired pavement surface condition and rideability of the nonmotorized trails should be used as a guide in establishing maintenance and funding levels. Asset management plans should be viewed as a guide that can, and should, be modified to meet the priorities of the community in order to suit the needs of recreation, tourism, corridor connections, and development.

The asset management plan is a living document and will change as pavement conditions vary through continued deterioration, maintenance improvements, resurfacing and reconstruction, as well as when priorities and funding levels may be adjusted by the community.

# 3.0 PROJECT TASKS

## 3.1 Asset Management Report

The initial project activity was acquiring ratings for each trail segment. Ratings were gathered on trails throughout the county, but due to the location of the existing network, the field work was concentrated in the northwest quadrant of the county.

Each trail segment was individually cataloged and rated. The rating scheme can be described as a "modified PASER system," or based on the PASER ratings developed at the University of Wisconsin–Madison Transportation Information Center.

The PASER system provides ratings from 1 to 10 for multiple pavement surface types, such as asphalt, concrete, brick, sealcoat, and graded earth. PASER is an acronym for PAvement Surface Evaluation and Rating. It is an aggregated score based upon a number of surface distresses; it is important to remember that the PASER system only considers *surface* distress. Our modified system also adds ratings of the trail base, drainage system, and shoulder condition as well, as all of these factors play a role in the long-term viability of any surface improvement.

Following are descriptions of the distresses considered when establishing ratings for the trail segments. However, it is important to note that the PASER system has been developed for *roadway* pavement and not necessarily for nonmotorized trails. While the distresses are the same, the speed at which they develop and progress and the intensity of the failures are generally reduced. However, as pedestrians and bicycles comprise the majority of users, any distresses which affect the ride and safety of the pavement surface are much more important to address earlier in the life cycle.

## 3.2 Asphalt Pathways

For trails with an asphalt surface, the key distresses considered when formulating a PASER rating are as follows:

- Rutting – Rutting is the displacement of material which causes channels, or ruts, to form. These low areas can collect water, presenting a hazard when it freezes in winter. It is caused by a lack of compaction during installation, a poor asphalt mix design, or displacement of unstable material. Minor rutting can be repaired by microsurfacing or by overlays. Severe rutting requires the surface to be milled or removed before resurfacing.
- Flushing is the migration of excess asphalt binder to the surface caused by a poor initial asphalt mix, or by paving or sealcoating an already flushed surface. Flushing can be resolved by blotting with sand or by overlaying with an asphalt mix that was designed appropriately for the conditions.
- Polishing is caused by traffic wearing down the sharp edges of the aggregate at the surface. This causes the pavement to become smooth and slippery, particularly during periods of rain. Polished trails can be rectified by placing a thin-lift overlay.
- Raveling consists of the pavement surface slowing peeling away from the structure of the trail. It begins with stripping of the bituminous film surrounding the aggregate and progresses into fine aggregate or sand loss, followed by loss of the coarse aggregate. It can be caused by age-related hardening of the asphalt binder, poor compaction during construction, especially during cold weather, or too little asphalt binder in the mix.
- Transverse cracking are cracks that extend across the shorter axis of the pavement, often regularly spaced. They are caused by the aging of the asphalt binder, rendering it more brittle than when it was installed and by the expansion and contraction caused by thermal changes. They are initially widely spaced, but additional cracking will occur as the pavement ages until they occur at an interval less than the surface width. They begin as hairline cracks, but evolve into wider cracks as

they age. Secondary or multiple cracks can occur parallel to the initial cracks. Once near the trail width in spacing, transverse cracking can become block cracking. Transverse cracking is best resolved early in its progression by overband crack filling and at later stages by a surface treatment such as a thin-lift overlay.

- Longitudinal cracking run in the direction of the trail. Paving joint cracks are caused by inadequate bonding of the hot asphalt mix during placement or by an insufficient bond coat. They can also be caused by underlying pavement cracks reflecting through a new overlay if the surface is placed on a cracked asphalt or concrete surface. Cracks at the outside of the pavement are caused by insufficient shoulder support, poor drainage, or frost action.
- Block cracking is characterized by interconnected transverse and longitudinal cracks forming large blocks. The blocks begin as the spacing of transverse cracks approaches the trail width, at which point a crack will form in the shortest dimension dividing the piece in half, then half again and so on. Progression of the cracking indicates the asphalt continues shrinking and hardening over time. As the cracking progresses, overlays and reconstruction constitute the most affordable repair methods.
- Alligator cracking is an indication that a trail has reached its design life, been subjected to more intense service or maintenance vehicle loading than it was designed for, or was not constructed on a stable and firm subgrade. It consists of many small pieces of pavement, ranging from one to six inches, separated by cracks in a random pattern like an alligator skin. It is often prevalent on the outside edges of pavement surfaces which may have been widened to accommodate greater widths. Once a pavement shows such cracking, overlays will only serve to delay the failure of the pavement structure and it will ultimately have to be reconstructed to provide a stable base and subgrade.

## 3.3 Concrete Pathways

The length of concrete trails in the county is very limited. They are generally confined to decorative, urban portions of longer trail segments, such as the River Trail in the heart of downtown Lansing.

For these trails, the key distresses considered when formulating a PASER rating are:

- Wear and polishing, which are caused by wearing off the mortar at the surface of the pavement and exposing the now-polished coarse aggregate in the pavement. This can be exacerbated when softer stone types are used. Slight ruts can form and water can collect, causing slippery conditions in winter. Pavements which are worn or polished can be overlaid with asphalt or ground with diamond blades to restore skid resistance and remove ruts.
- Map cracking is a pattern of fine cracks at random alignments and intervals, generally superficial and not causing any long-term performance problems. It can be caused by improper curing or overworking during the finishing operation. Depending on severity, the surface may spall or scale off. Should this occur, an asphalt overlay or partial-depth patching may be required.
- Pop-outs occur when absorbent aggregates are present near the surface and break apart or separate during freeze-thaw conditions. It is often only superficial and does not affect the life of the pavement. It can be mitigated by selecting proper aggregates for the concrete mix.
- Scaling is a surface deterioration that causes the loss of fine aggregate and mortar at the surface. It most often occurs in concrete that is not adequately air-entrained and is therefore subject to freeze-thaw action. It can also occur over larger areas when poor-quality concrete is incorporated into the project or too much water is utilized when the pavement is being finished, where the entrained air is actually lost from the surface. Asphalt overlays are more common repairs.
- Shallow reinforcement is not caused by environmental action, but rather the placement of steel reinforcement too close to the pavement surface during construction. Corrosion of the steel

reinforcement can create forces that break and dislodge areas of concrete, which can be anticipated by rust stains on the surface before the spalling occurs. Repairs are difficult and extensive due to the nature of the distress and will involve replacement of the steel along with partial- or full-depth concrete repair. Short-term fixes are limited to patching with asphalt.

- Spalling consists of the loss of pieces of varying size from the surface, or from the edges of cracks or joints. Freeze-thaw processes can break the pieces loose, or they can be caused by poor-quality materials. Spalling can vary from small pieces in isolated areas to deep, extensive loss. Repairs are dependent on the degree of failure, ranging from partial- to full-depth repair.
- Joints in concrete pavement are generally well-sealed at the time of construction, but can deteriorate based on the level of maintenance applied to them as time goes on. As water penetrates the joint, cracks and spalls occur which can then migrate into the slabs. Once below slabs, the expansion of the water can force slabs without load transfer devices or unreinforced portions of slabs upward, causing faulting. As a result, the most cost-effective maintenance for concrete pavements is maintenance of joint sealants.
- D-cracks are similar to scaling and pop-outs. Poor quality aggregates absorb moisture, break apart and cause deterioration. However, D-cracks generally start in the bottom of slabs and move upward. This distress manifests itself as many eroding cracks, often located in the corners of slabs. It can be an early indicator of severe slab deterioration without affordable repair options.
- Meander cracks occur randomly throughout pavement slabs or cross them diagonally. They are generally caused by differential settlement due to unstable soils or drainage problems, or by utility trenches beneath the surface. Frost heave and the freeze-thaw process can also cause or intensify them. They are usually localized and do not present concerns for the durability of the entire pavement. Sealing will help mitigate any future problems, but severe meander cracks should be repaired by replacing the slab.
- Blowups occur when poorly sealed joints become filled with incompressible materials and the slab is warmed by the environment. Since the materials in the joint cannot accommodate the slab expansion, concrete is crushed and buckled upward. These failures can be prevented by the addition of pressure relief cuts, especially in older pavements with long joint spacing, but joints which have already blown up must be removed and repaired.
- Faulting is caused by differential settlement at transverse pavement joints. It is essentially a drop off caused by one slab moving relative to another due to the pumping of subgrade soils and the creation of voids.

## 4.0 CONCLUSION

Based on the distresses observed during the field review, we estimate that the total cost which would be experienced in one year, should every suggested repair for all trail segments be completed immediately, is $385,070. This is based on the assumption that each discrete pavement segment experiences that same repair, and not isolated areas of more intense repairs, and that the work is completed within the next year.

The cost to upgrade trails which have been constructed narrower than the AASHTO-recommended minimum width of 10 feet was also estimated. Using a unit price of $3.00 per square foot of additional width, the estimated total cost to widen all trails and complete the recommended improvements is $700,130. This assumes a pavement section of 3 inches of asphalt and 6 inches of aggregate base.

A multi-year asset management program could also be assembled, taking into account the use of various repair methods among the pathways. This could begin with lower-cost maintenance in early years, progressing into a mix of lower cost and higher-cost fixes in the middle years, followed by the remaining high-cost fixes in the last years of the program until all repairs have been addressed. It will be important to remember that low-cost repairs add additional years of life to the pavement for a far lower annual cost than waiting for that segment to require reconstruction, and as such, maximize the volume of preventative maintenance performed each year while slowly 'chipping away' at high-cost rebuilds.

Construction costs are difficult to predict, but are dependent on a number of factors. These include contractor availability, schedule restrictions, accessibility and work zone restrictions, the time of year in which bidding occurs, bonding requirements, and other factors. Generally speaking, a higher quantity of a given type of work on a project will result in lower costs per unit of work, such as ton or square yard. Grouping multiple trails or segments into one project, when similar work is proposed, generally results in more cost-efficient construction.

Further review of any trail segments where work is desired is highly suggested, and it is important to realize that the asset management plan is a framework, a guide, and a living document. It must be maintained and updated regularly to reflect in-field conditions in realtime.