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January 22, 2024

Ms. Theresa Rago, President
Lake Shannon Association
PO Box 464
Hartland, Michigan 48353

Re: Pavement Evaluation for the Lake Shannon Association Roads

Dear Ms. Rago,

Thank you for the opportunity to provide this evaluation. The overall health of the Association's roads is generally very good however, as noted in the report, attention will be needed in the future.

As requested Boss Engineering has completed our evaluation of the existing asphalt pavement for all of the roads within the Association jurisdiction. The methodology utilizes the PASER (Pavement Surface and Evaluation Rating) rating system developed by the University of Wisconsin. This evaluation relies on a visual inspection of the pavement and results in a rating of between 1 and 10 with 10 being a brand-new pavement and 1 being a completely failed pavement. The evaluation system relies heavily on observation of the cracking that has occurred in the pavement. The frequency and type of cracking are strong indicators of the pavement condition and remaining life. For example, transverse cracking (edge to edge at consistent intervals along the road) is an indication of aging but not failure. Once block or "alligator" cracking begins that is a sign of pavement failure and remedial action such as removal and patching of the failed area should be done to limit the extent of the failure. We have utilized this rating system successfully on driveways, parking lots and roads.

In July and September of 2023 I drove all of the roads within the Association jurisdiction. The following table indicates all roads and their PASER rating. Once the PASER rating for a road drops below a 6 the street requires significant attention meaning resurfacing or reconstruction.

Ledgewood Drive-8
Driftwood Drive-8
Ore Knob Drive-8
Ore Knob Court-8
Parkwood Drive-8
Parkwood Court-8
Surfwood Drive-8
Sandwood-8

Starwood-8

*There are also several unnamed public drives extending from Driftwood

The Road Committee indicated all roads evaluated were paved in the fall of 2018. According to information obtained from the Road Commission the pavement thickness during this paving is 4 ½ inches. The new asphalt consists of 2 ½ inches of MDOT mix levelling course and 2 inches of MDOT wearing course. This pavement thickness is typical for residential roads with little truck traffic and should result in a 20 year pavement life with periodic minor maintenance such as crack sealing along the way. It is not uncommon for residential roads seeing relatively little truck traffic to have a service life beyond 20 years.

Over the course of the new pavement lifespan the Livingston County Road Commission would typically perform pothole patching and crack sealing as standard maintenance. The frequency and extent of this work is dependent on manpower and funding.

The Road Committee has expressed an interest in evaluation of more extensive maintenance during the life of the pavement which would then extend it beyond 20+ years to 30+ years. For this to occur there will need to be either a public/private partnership between the County Road Commission and the Lake Shannon Association or an entirely private funding by the Association.

Further discussion of the causes of asphalt pavement failure and potential maintenance options to delay the failure follow.

Asphalt pavement is considered a flexible pavement (as opposed to concrete which is considered a rigid pavement). Its properties allow for deflection without failure however too much deflection will result in cracking. An example of deflection is shrinkage of the material due to reduction of bitumen which is the liquid binder in the asphalt. Another example of deflection is a shallow depression that forms with no visible cracking. Sometimes this is a result of a very heavy truck parking in one location for an extended period of time. The strength of the pavement is reliant not only on the asphalt pavement itself but also the gravel base below it. The longevity of the pavement is also heavily influenced by the underlying natural soils. This layer of the pavement section is called the sub-grade. The more granular the sub-grade is the better the pavement will hold up over time due to greater resilience to the freeze thaw cycle. The granular sub-grade allows surface water that has penetrated cracks in the pavement and infiltrated through the gravel layer to continue infiltrating into the soil and not being held in the sub-grade like occurs with clay material.

The most significant contributing factor to asphalt pavement deterioration is the freeze thaw cycle that we experience in Michigan. Clay will naturally expand and contract as it

first freezes and then thaws and the higher the moisture content the greater percentage of expansion and contraction that will occur. As you can imagine when the material below the asphalt expands and contracts it impacts the asphalt because it is moving also. The result is the cracking we all see on our roads over time. Even roads built on sand sub-grades will experience this however at a significantly lower percentage of expansion and contraction thus resulting in a lower deflection rate of the asphalt and ultimately less cracking.

In short, the natural soils in the Lake Shannon area tend to be higher in clay content and thus the pavement tends to be more susceptible to the damaging effects of the freeze thaw cycle. Not only does pavement cracking exacerbate this but also water ponding at the edge of the road causes similar damage. These conditions place a higher importance on consistent maintenance to limit the ability of surface water to penetrate the pavement and saturate the clay sub-grade. The more cracks that form the quicker the degradation of the pavement. Please refer to Appendix A for photos taken during my site evaluation.

There are several options for maintenance of asphalt pavements that are routinely utilized. The four most common are crack sealing, chip seal or chip and seal (sometimes referred to as slurry seal), overlay and mill and overlay. As expected the most economical is crack sealing followed by chip and seal (slurry seal). For the overlay or mill and overlay the economics are driven by the thickness of the overlay and the thickness of the milling. For example, a 2" asphalt pavement overlay (where the new asphalt is placed directly on the existing asphalt) is going to be cheaper than a 2" mill and overlay because you will have two processes occurring and the same amount of asphalt placed.

Typical road maintenance begins with crack sealing. As noted, this is the most economical maintenance option and is very effective in limiting infiltration of surface water into cracks that have formed in newer pavements. A limited amount of crack sealing has already been completed on the Association roads by the Road Commission.

The next most economical maintenance process is the chip and seal. This involves placing a layer of bitumen on the existing road and then a layer of aggregate which will bond with the bitumen over a period of time to form a new layer of pavement approximately $\frac{3}{4}$ to 1 inch thick. A fog seal (layer of asphalt emulsion) is then applied. This will provide a new driving surface and will seal any existing cracks in the pavement. The Road Commission does both single and double chip and seals on their roads. A byproduct of the chip and seal will be elimination of the oxidized aggregate that has caused the rust colored staining of the existing asphalt.

If the pavement has deteriorated to the point that a slurry seal may not be effective then an asphalt overlay or a mill and overlay will be the appropriate course of action. As you would expect these options are the most expensive however are also the most effective in restoring the pavement for an extended period of time.

A very thorough discussion of these maintenance methods as well as others can be found in a publication by Michigan Technological University titled "Best Management Practices on Asphalt Pavement Maintenance". Please refer to Appendix B for an order of magnitude comparison of the different pavement maintenance options discussed above.

What is best for Lake Shannon? Fortunately, as noted at the beginning of the report, the Lake Shannon roads are in very good condition. The Road Committee's proactive approach to preservation of the roads at this point in their expected lifespan is a significant benefit to all members of the Association. Before further discussion of maintenance it should be noted that all homeowners can plan a part in the process by maintaining their ditches to promote positive drainage, keeping gravel shoulders in place and functioning properly and not allowing contractors to park heavy equipment on roads for extended periods of time. Every year, or two years at the most, the Association should consider crack sealing beginning in 2024. The roads are at a point that significant benefit can be provided to those areas needing attention without major capital outlay. As you are aware all of the roads are public roads and will require Road Commission approval for any work to be completed.

Eventually there will be areas of deterioration that will require more attention than crack sealing can provide. Depending on the extent of these areas there could be several options available. Selective removal and replacement of limited lengths of the road could be done if the areas are minimal. Continued crack sealing will then be necessary on the remainder of the roads. Slurry seal will be the next most economical option to consider. This will give all of the road a new driving surface for an expected extension of pavement life by approximately 7 to 10 years. If the slurry seal is not utilized and continued degradation occurs then the options will be either the pavement overlay or mill and overlay. Each of these will be expected to prolong the pavement life by approximately 7 to 10 years also although at a more significant cost than slurry seal. In short, an aggressive crack sealing program at this point in time will pay the largest dividends for extension of pavement life. Eventually either a slurry seal or overlay will be required. A detailed PASER evaluation of the roads should occur every 3 years to identify any additional action that may be necessary.

The draft report dated October 25, 2023 was discussed in a meeting with the Road Committee on November 28, 2023. All members clearly recognize the value gained with regular maintenance of the road which leads to extended life.

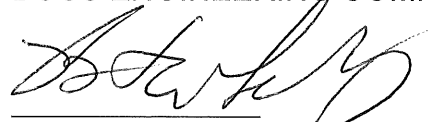
Another item discussed with the Road Committee has been the rust staining of the roads at Lake Shannon. The oxidation of higher iron content aggregates results in the staining at the surface and "popping" of the aggregate as it expands resulting in a hole in the surface of the pavement. Boss Engineering, Jim Greiner and Bob Donald are continuing

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discussions with the Road Commission representative in regard to this matter and will keep the Board apprised of the status.

We appreciate the opportunity to provide this report and would be pleased to answer any questions you may have.

Respectfully submitted,
BOSS ENGINEERING COMPANY

A handwritten signature in black ink, appearing to read "Brent W. LaVanway", written over a horizontal line.

Brent W. LaVanway, P.E.
President, Director of Engineering

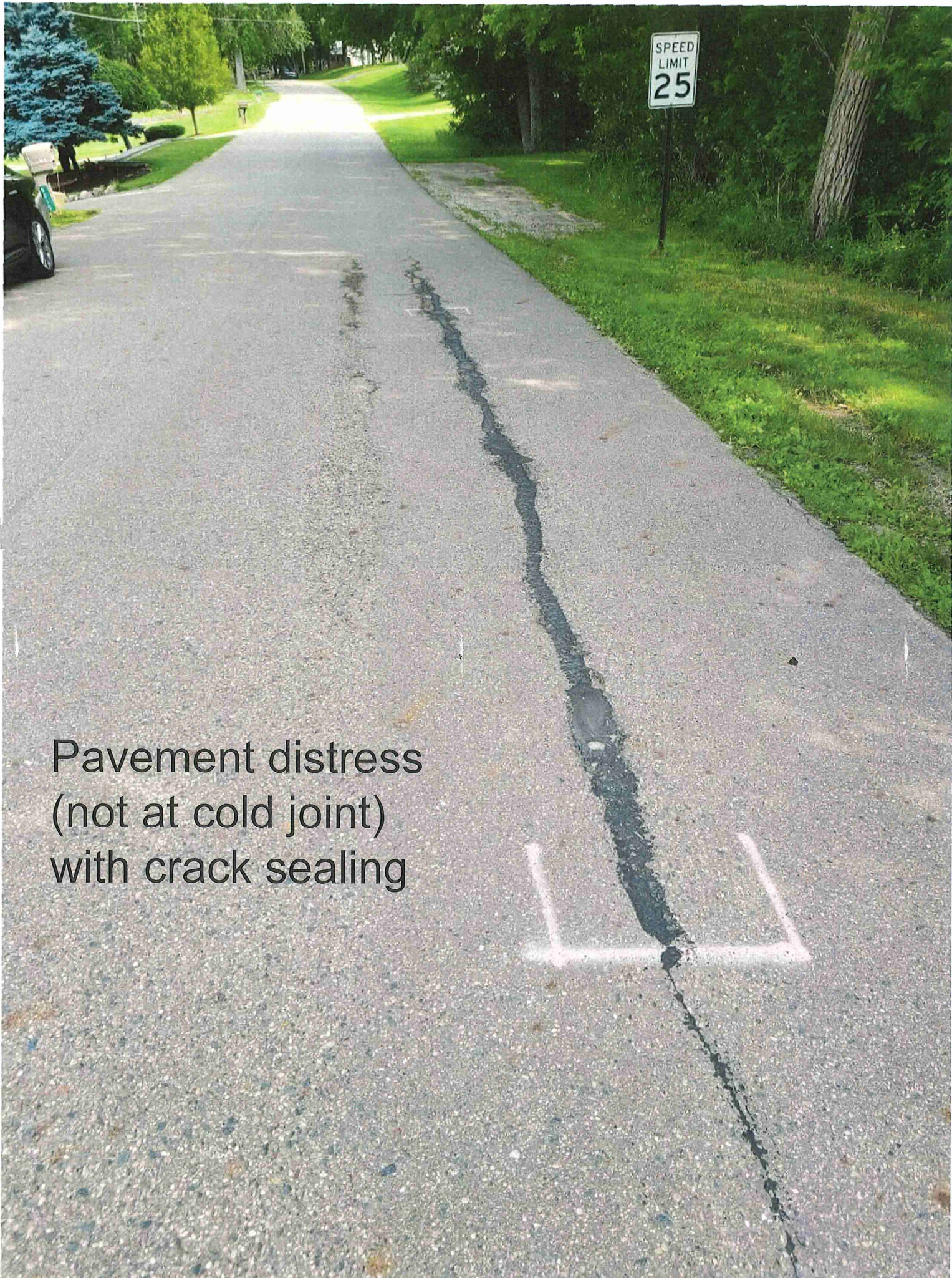
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Appendix A

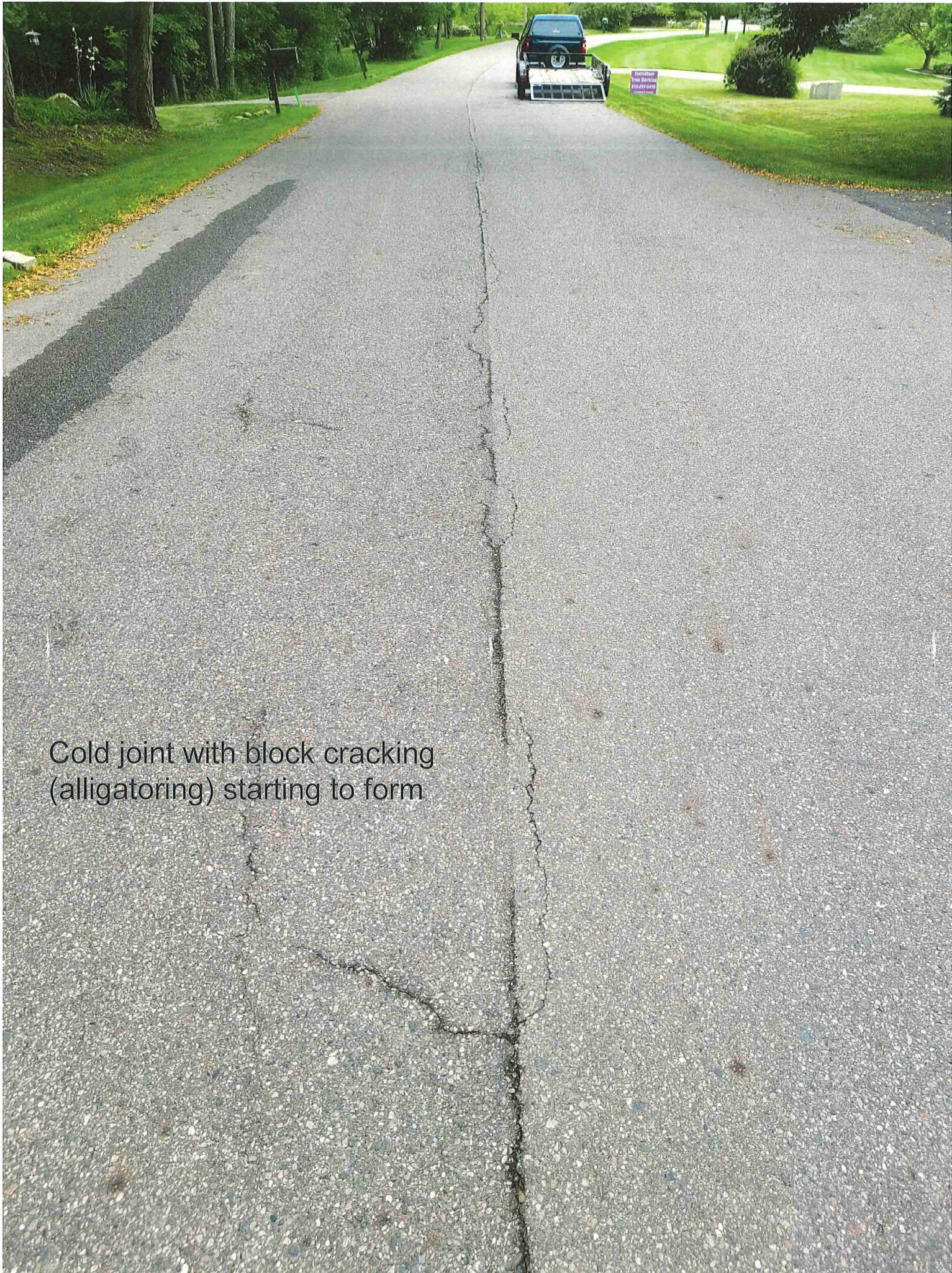
Pictures



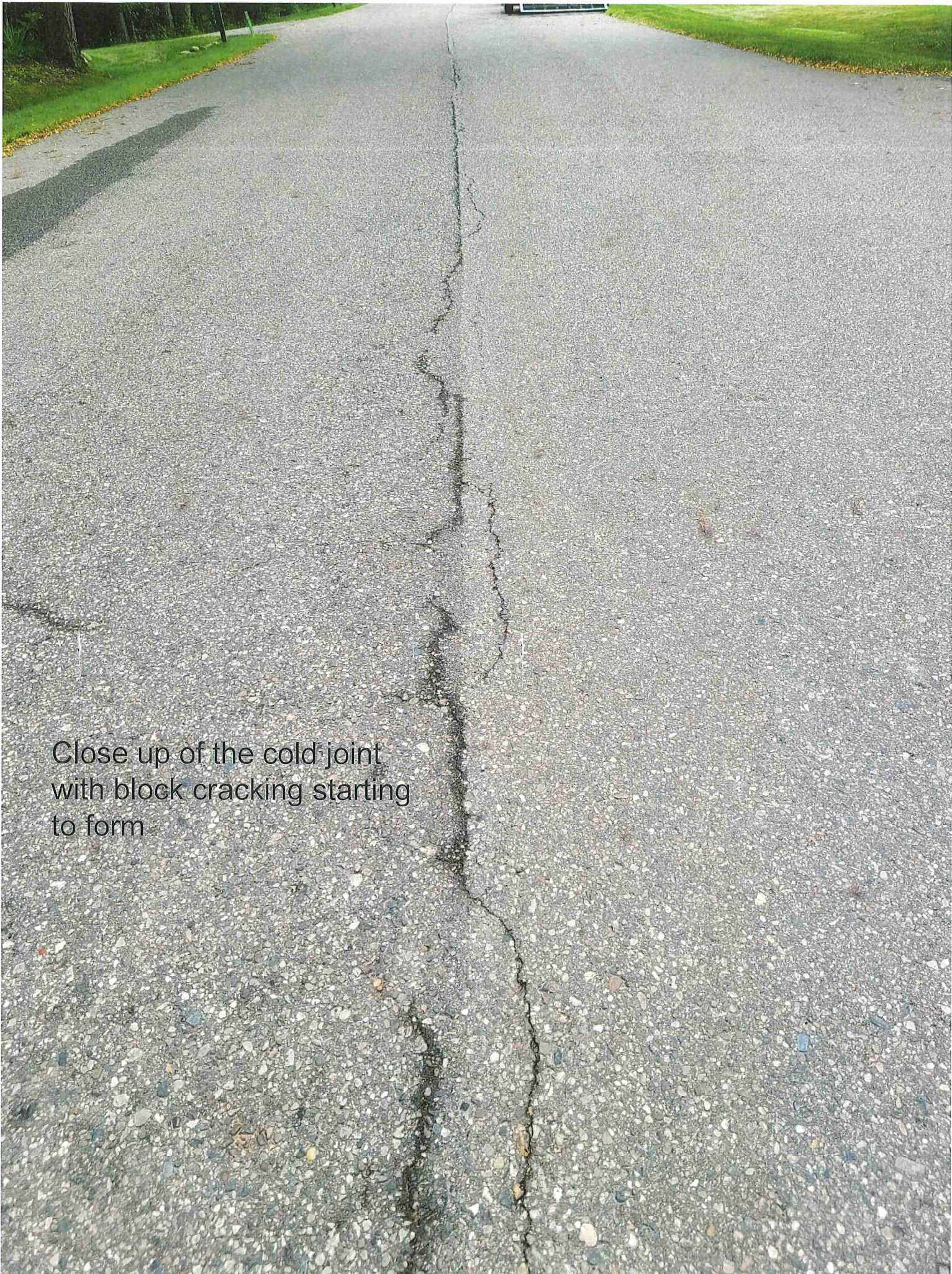
Beginning of
pavement
separation at
cold joint



Pavement distress
(not at cold joint)
with crack sealing



Cold joint with block cracking (alligatoring) starting to form



Close up of the cold joint
with block cracking starting
to form



Evidence of excessive moisture at edge of road due to improper grading

Appendix B

Maintenance Estimates
based on 2023 Dollars

2023 Dollars

	SY	Unit Price		Total
Crack Sealing	79,216	\$	0.25	\$ 19,804.00
Single chip & fog coat	79,216	\$	2.44	\$ 193,287.04
Double chip & fog coat	79,216	\$	4.01	\$ 317,656.16
2" Overlay	79,216	\$	10.62	\$ 841,273.92
2" Mill & 2" Overlay	79,216	\$	12.37	\$ 979,901.92

* Amount suggested for crack sealing per year

** Unit prices per 2023 Road Commission construction bids

*** Quantities are from the 2018 Road Commission paving project

Appendix C

2023 Road Commission
Chip & Seal Projects

2023 Single Chip and Fog locations:

- Antcliff/Cohoctah/Oak Grove Roads-Gannon Rd to Co Line
- Owosso Rd – Allen Rd to Chase Lake Rd
- Bradley Rd – Unadilla Twp line to Iosco Rd
- Bull Run Rd – Unadilla Twp line to Mason Rd

2023 Double Chip and Fog locations:

- Cedar Lake Rd – Norton Rd to Jewell Rd
- Coon Lake Rd – Pinckney Rd to Genoa Twp line