

## TECHNICAL MEMORANDUM

**TO:** JOHN NOWAK, PE – CITY OF SCHERTZ  
**FROM:** STEPHEN ANIOL, PE – KIMLEY-HORN  
**SUBJECT:** PAVEMENT PRESERVATION METHODS  
**DATE:** DECEMBER 9, 2020

To support the City's effort in establishing appropriate construction methods for the Street Preservation and Maintenance (SPAM) program, Kimley-Horn is providing this technical memorandum (TM) to outline common applications specific to pavement preservation. Kimley-Horn staff, including the project team selected to provide condition assessment, design plans, bid and construction services for the 2020 Roadway Improvements work order, has experience with many of these applications, including functionality, life cycle, effectiveness, benefits in comparison to each other, and budgetary cost. The purpose of this TM is to provide detailed information related to multiple pavement preservation methods, to support Council's effort in establishing policy requirements for the future of the SPAM program. The following preservation methods are considered common applications and will be discussed in detail throughout this TM:

- Fog Seal
- Chip Seal
- Scrub Seal
- Micro Surface
- Slurry Seal
- Cape Seal

## PRESERVATION INTRODUCTION

Implementation of an annual street preservation and maintenance program is critical to extending the useful service life of a flexible pavement section, which is typically comprised of an asphaltic or flexible base course followed by an asphaltic surface course, or riding surface. Preservation refers to treatment of an existing surface course, and when applied properly, both in application and time, can significantly delay the need for more extensive and costly street repairs. Street preservation is a great and relatively inexpensive tool to gain additional years out of an individual street before more substantial and costly repairs are required.

There are multiple pavement assessment programs and scoring systems available that will scan the existing roadway's surface characteristics, and using Artificial Intelligence, will assign a score to the individual street. The City's current program utilizes a scoring method identified as a pavement condition index (PCI), which is widely used by neighboring communities. It is extremely important that a PCI score be recorded for every block of every street, due to the fact that street characteristics can change substantially from block to block, ultimately affecting the individual PCI scores and recommended street preservation or maintenance application.

Streets that typically fall within a preservation category will have a minimum PCI score of 70, and will normally exhibit minor structural flaws (i.e. base repair areas or subgrade failures) that require correction. The surface course may exhibit variable levels of cracking, most of which can be addressed by "crack sealing" or using a rejuvenator emulsion to fill in the cracks (reference scrub seal application below). The

cost of completing the necessary structural repairs and pavement preservation should not exceed the cost to complete a mill and overlay. As the street list is developed for the pavement preservation program, follow up visual inspections and condition assessments should be completed per street to confirm candidacy, and to document and quantify necessary street repairs. This will help refine the proposed street preservation list and confirm the proposed construction fits within the allocated SPAM program budget.

A street block that records a PCI score of less than 70 will have heavier surface (longitudinal and alligator) cracking and/or more substantial structural flaws that require correction, and completing these repairs combined with a street preservation application is not cost effective. These streets would require either a mill and overlay with spot base repairs, reclamation, or complete reconstruction, and the proper application should be confirmed based on the recorded PCI score and a follow up visual inspection.

## PRE-PRESERVATION MAINTENANCE

Completing a condition assessment for each street proposed to receive a preservation application is critical to properly identifying street repairs that should be corrected in advance of performing the actual preservation. The level of repairs are variable and include crack sealing, installation of a thin wearing course over light alligator cracking that has not fully developed, completing a mill and overlay for areas of heavier surface cracking that does not show signs of base course distress, full depth structural repairs to include replacement of the base course (i.e. base repair), and occasionally subgrade treatment for areas that have visible subgrade failure. Selecting the proper repair method and completing the repair in advance of applying the preservation material directly affects the lifespan of the end product.

Pre-preservation maintenance should be completed prior to applying the preservation material, and that timeline is contingent on the required repair. Crack sealing will be required on almost every street. Streets with reported high PCIs will typically have minor surface cracking and lower PCIs will exhibit heavier surface cracking. It is important that all cracks be sealed prior to preservation. There are different crack seal materials available for use, but one that is most commonly used for asphalt streets is an asphalt rubber product that comes in solid form. This product is heated and melted in place and when done properly, forms an adhesive and flexible material over the asphalt surface that resists temperature cracking and water intrusion. All cracks shall have sediment and vegetation completely removed prior to installation to optimize product performance. Likewise, cracking that extends into the base course or subgrade are signs of base and subgrade failures, and performance of the crack seal product will be substantially reduced, if not completely ineffective. It is not recommended to apply crack seal material to these areas, rather, they should be properly excavated, treated and a new pavement section installed back in place. Crack sealing should be completed at a minimum 2-months in advance of the preservation material placement to allow for proper cure time. If installed during winter months where surface and pavement temperatures are consistently cooler, more lead time should be allocated for crack seal curing. If proper cure time is not provided for crack seal treatment, street cracks may open back up or the crack seal material may bleed through the preservation material and reduce overall effectiveness and life expectancy of the street preservation.

Installation of a thin asphalt wearing course or completion of structural repairs require less cure time than that of a crack seal, but more time is required to complete the repairs. A typical rule of thumb for cure time is to allow for two weeks after completion. The time required to complete repairs is variable, but a Contractor can typically complete base repairs on a given street within 1-3 days. Subgrade treatments will require slightly more time for construction than a standard base repair (approximately 1-2 additional weeks), and is dependent on whether cement or lime treatment is recommended. These timeframes are ultimately contingent on the extent of repairs and length of the individual street. Preservation projects tend to have smaller amounts of repair required because the streets have relatively higher PCIs, and if streets scheduled for preservation can be grouped together, it is possible that multiple streets can have repairs completed within the same day. It should be noted that base repairs and subgrade treatment has more of an impact

to local traffic than that of crack sealing, but this short time impact should not deter away from completing the required street repairs.

With street preservation being a seasonal application, if the program is scheduled and bid appropriately, crack sealing and street repairs can be completed during the winter months. This will allow for appropriate cure times and the possibility of being on the front end of a Contractor's completion schedule.

## PRESERVATION METHODS

### Fog Seal

Fog seals are the least expensive preservation method on the market, and are typically applied to pavements with a higher PCI score to help rejuvenate the existing surface course. Fog seals are comprised of an emulsified asphalt material, which includes a dilution of oil and water amongst other materials. The fog is applied as a thin layer to the street via spray nozzles on a distributor truck, and is a very quick application in which multiple Contractors are available to complete this work. The life expectancy for a fog seal is the shortest out of the available preservation methods, and is typically in the range of 1-2 years. Overall, life expectancy for a fog seal is heavily dependent on traffic volume, and streets that experience low traffic volumes typically perform the best. Even in these scenarios wearing will be noticeable within 1 year, but a fog seal still provides the preservation benefit for a short duration. If fog seals are selected as a preservation method, the re-application frequency would be increased to 1-2 years. Fog seals are not recommended for collector or arterial designated streets because of the heavy traffic volumes, in which the life expectancy is substantially reduced.

Fog seals are applied quickly and a Contractor can complete multiple streets within a day. As is typical for all preservation methods, traffic must be completely removed from the roadway for the project limits. Streets are typically completed half at a time (in the travel direction) to allow for continued one-way traffic. The half that is completed requires a minimum 24-hour cure time before traffic can enter the completed street section. Fog seal can be applied to a cluster of streets within a neighborhood in a period of 1 week, ultimately depending on weather.

The appearance of a completed fog seal will appear as a new surface course from a distance, as the emulsified asphalt seal exhibits the same color as new pavement. When standing on top of the pavement crack seal material will be immediately visible, although slightly less noticeable due to the new fog application. As the fog seal weathers and wears down the crack seal will become more visible.

### Chip Seal

Chip seal, also known as a seal coat, is similar to a fog seal application but goes one step further and adds a layer of small aggregate (known as chips) on top of the asphalt emulsification. A chip seal application is very common and is a great preservation tool that includes an added layer of protection to the existing pavement. Similar to a fog seal, the asphalt emulsion is applied via spray nozzles with a distributor truck, and is followed up with an overlay of an approved aggregate that is rolled into the emulsion. It is common that a single layer of aggregate be utilized for the chip seal, and this is known as a one course chip seal. There are often times that a second layer (course) of smaller aggregate be applied over top of the first course, and this requires an additional application of asphalt emulsion prior to overlaying the second course. This is known as a two course chip seal.

Similar to a fog seal, a chip seal can be completed quickly and the Contractor can cover a significant amount of street area within a single day. One of the added benefits of a chip seal is that due to the installation of aggregate over top of the asphalt emulsion, the Contractor can complete the full width of multiple streets in

a single day. Vehicular traffic will help performance of the chip seal as the weight of vehicles helps push the chips further into the asphalt emulsion, further securing the bond between the two.

Chip seals also help cover streets that have a lower PCI score on the preservation range, in which surface cracking is more prevalent and crack seal can be a visual nuisance. While a chip seal covers the existing surface and has the ability to more easily hide cracks, it is still recommended that cracks be completely sealed in advance to properly protect the underlying pavement section. Failure to do so will increase the likelihood that reflective cracking will appear through the chip seal, reducing the ultimate life expectancy and increasing the need for either re-application or a maintenance repair.

The life expectancy for a chip seal is in the 6-8 year range, but there are many factors that can affect performance and impact effectiveness, including:

- For a chip seal project it is critical that the street be properly prepared and swept, including necessary maintenance repairs being completed in advance of the chip seal application. Failure to do so can lead to performance issues in which both the emulsion and chips will peel off, leaving the existing street surface visible. Vegetation within surface cracks or along the curb line should also be completely removed in advance of the chip seal.
- Failure to crack seal the existing pavement will lead to reflective cracking from the existing surface course, and will reduce the effectiveness of the completed chip seal
- Low volume streets tend to perform worse than higher volume streets as the lack of traffic does not push the chips further into the asphalt emulsion, and leads to chips “popping off,” followed by the emulsion peeling off. At this point the existing street surface will be visible and not protected.
- Streets with many driveways and cul-de-sacs often perform worse than straight sections, as the turning movements from vehicles and garbage trucks tend to loosen the chips over time, eventually popping off and exposing the existing street surface. This creates a situation where loose aggregate is present, requiring a more frequent street sweeping program be implemented by the City.
- Chip seals perform well in high traffic scenarios for reasons noted above, with an added benefit of the traffic “polishing” the top of the aggregate creating a smoother riding surface over time.

A major complaint with the chip seal application is that within residential neighborhoods that experience low traffic volumes, chips continuously pop off and create a rougher riding surface that is less appealing to pedestrian traffic. The City may implement a more frequent street sweeping program to remove excess chips and that will to some degree address this complaint. However, the overall riding surface remains rough for a longer period of time, and it often takes years for the chips to polish off for streets with low volume traffic.

If applied properly a chip seal is an effective preservation method in terms of both cost and functionality, but uses should be verified to determine if the location is suitable for the application.

### **Scrub Seal**

A scrub seal is essentially the same type of preservation as a chip seal, but the asphalt emulsion utilized includes a pavement rejuvenator that increases the bond between the chips and existing surface and also serves as a crack sealing agent. Completing a scrub seal eliminates the need to crack seal in advance of the chip seal, as the emulsion is broomed along the street and is forced into the existing cracks. This emulsion adds a little extra cost overall as compared to emulsion used for fog seal, but there are offset savings because crack sealing is not required in advance. Scrub seals are better suited for streets with heavier surface cracking, where crack sealing is not recommended due to the close proximity of existing cracks. Scrub seals would be considered a better option for older street surfaces, where the rejuvenator helps increase the bond between chips and existing surface and also serves as a crack sealant.

The life expectancy is similar to that of a chip seal, with the main benefit being the use of a rejuvenator emulsion. Factors that impact life expectancy and effectiveness are also consistent with what is described under chip seal. Additionally, with a scrub seal maintaining the same surface characteristics as a chip seal, the common complaint of being less appealing to residential streets and pedestrian traffic is also present.

### **Micro Surface**

Micro Surfacing, also known as micro surface or a micro seal, is a separate preservation method as compared to a fog or chip seal, but has close comparisons to a slurry seal. Performance is similar to that of a slurry or chip seal, and is in the range of 6-10 years. Micro surface is comprised of a polymer modified asphalt emulsion that is mixed with sand and extremely fine, angular aggregate, and once installed and cured looks as if a new surface course has been placed. A micro surface can be installed on all street types with both low and high traffic volumes. Depending on street classification different application thicknesses are installed, with the main difference being the size of the aggregate and mix thickness specified. Consistent with a chip and slurry seal, residential streets perform on the higher end of the life expectancy chart, with commercial type streets typically on the lower end of the life expectancy chart. However, micro surface projects are routinely completed in high traffic volume locations such as arterial streets and highways, and are proven to be a durable product as compared to the overall installation cost. Additionally, streets with higher PCI scores routinely perform on the upper end of the expected service life, whereas streets with PCI scores on the lower end of the preservation spectrum often yield a reduced life expectancy.

Pre-preservation maintenance requirements as listed above should be completed in advance of a micro surface, consistent with all preservation methods. Failure to do so will lead to reduced effectiveness of the micro surface and a lower life expectancy. Cracks in the existing pavement surface that were sealed prior to placing the micro surface will eventually open and reflect through the new material, so it is important to continue and crack seal streets previously preserved. This is the case for all preservation type projects, not just specific to a micro surface.

A significant benefit with a micro surface is the final product, which is a smoother riding surface similar to that of a new asphalt surface course. A micro surface is slightly more costly as compared to a chip seal, but ultimately yields a smoother riding surface and slightly longer life expectancy.

Another added benefit for a micro-surface is the ability to fill in minor depressions along a street, as the mix design allows for up to 1.5-inch of material before experiencing negative impacts from traffic. These depressions can be related to rutting or general low spots, and are typically filled in with multiple lifts of micro surface in advance of the full street width application. The number of intermediate lifts to fill ruts or minor depressions will be dependent on the depression depth.

Micro surface projects will typically close full street widths at a time to allow for more efficient construction, and traffic can typically enter the completed street section within a 4 to 8-hour period. Street clusters are preferred and if scheduled appropriately, a modest size neighborhood can be completed within a one to two week period.

A common challenge for micro surface projects is that specialized equipment is required to complete construction, and there are limited vendors available to complete this work. This often times results in higher bid prices due to less competition, and competition with other municipalities or government entities to get on the vendor's schedule. However, setting contract procurement during the fall to winter months and coordinating with the vendors in advance to understand their schedule helps offset both of these challenges.

Another negative with a micro surface is at areas that require hand work, specifically intersections and cul-de-sacs. These locations historically do not turn out as clean or visually accepting as a new asphalt surface course, and is a common complaint for streets within residential neighborhoods. It is important to specify

the appropriate application rate for a micro surface, and if specified correctly, the hand work at intersections and cul-de-sacs will be improved. Even with appropriate application rates the use of hand work at these areas yields a final product that can be less than desirable.

Overall, a micro surface is a great preservation method that performs well over time, has an acceptable life expectancy, can be installed for both residential and commercial type streets, and is more visually appealing to most areas within residential neighborhoods.

### **Slurry Seal**

Slurry Seal is very in close in nature to a micro surface in almost every aspect. The following items represent similarities and minor differences for slurry seal products as compared to a micro surface:

#### *Similarity*

- Utilizes specialized equipment with distributor box
- May or may not include polymer modified emulsion
- Smoother riding surface as compared to chip seal
- Application rate, traffic control and cure time

#### *Minor Differences*

- Life expectancy in the order of 5-8 years
- Aggregate size smaller
- Not recommended to fill in ruts or small pavement depressions
- Will not perform as well in commercial locations or areas of high traffic due to smaller aggregate
- Cost for slurry seal slightly cheaper than micro surface
- Installation better within intersections and cul-de-sacs as compared to micro surface, but still will not be as visually accepting due to the required hand work

Similar to a micro surface application, a slurry seal is a great preservation method that performs well over time, has an acceptable life expectancy, and is more visually appealing to most areas within residential neighborhoods.

### **Cape Seal**

A cape seal is a combination of a chip or scrub seal and a micro surface. The chip or scrub seal is installed first, followed up by a micro surface, which ultimately creates the “cape” seal. The main benefits a cape seal provides is a second layer/course of preservation and a smooth riding surface that covers the rougher chip seal surface. Due to the multiple layers of seal material the cost of a cape seal is about equal to the combined cost of a chip seal and micro surface. Overall life expectancy is in the range of 8-10 years. Although not much different than that of a chip seal or micro surface, the lower end of the life expectancy range is higher than both. This allows for greater life expectancy for streets on the lower end of the pavement preservation PCI range.

## **BUDGETARY COST**

To provide an approximate cost comparison between the preservation methods discussed within this TM, Kimley-Horn has reviewed recent price trends and contacted vendors to obtain approximate unit pricing. These unit prices are based on an approximate quantity of 250,000 square yards, which is about two thirds of the total area for streets listed in the latest Street Preservation Recommendation List TM provided by Kimley-Horn (submitted on November 18, 2020). The following table represents an approximate cost

comparison between the different preservation methods, and includes the cost to complete a 2-inch mill and overlay for the same street area:

<b>PAVEMENT PRESERVATION</b>		
Approximate Unit Price Comparison		
<b>Method</b>	<b>Unit Cost (per SY)</b>	<b>Total Cost (per 250,000 SY)</b>
Fog Seal	\$ 0.70	\$ 175,000.00
Chip Seal	\$ 2.80	\$ 700,000.00
Scrub Seal	\$ 3.80	\$ 950,000.00
Micro Surface	\$ 3.80	\$ 950,000.00
Slurry Seal	\$ 3.50	\$ 875,000.00
Cape Seal	\$ 6.60	\$ 1,650,000.00
Scrub Cape Seal	\$ 7.60	\$ 1,900,000.00
Mill and Overlay (2-inch depth)	\$ 14.00	\$ 3,500,000.00

It is important to note that the cost comparison presented above is specific to the preservation material only, and the mill and overlay includes both a full width street mill and overlay at a 2-inch depth. The cost to prepare the street, crack seal the existing street surface and complete necessary base repairs is not inclusive, and would be an equal addition to each preservation method. Further refinements would occur during the bid phase when interested Contractors have the opportunity to study the project area and adjust per current market conditions.

## ADDITIONAL CONSIDERATIONS

- Condition Assessment
  - As noted above, completing a condition assessment for each street and documenting street repairs is important for several reasons:
    - First, the visual inspection allows for confirmation of the reported PCI score and whether or not the street is suitable for a preservation
    - Second, measuring repair areas and documenting street repair quantities creates a comparison of total repair per street area, and if that percentage exceeds the repair threshold that would bump it out of the preservation category
    - Allows for cost development per project and comparison to overall budget
    - Provides an opportunity to develop repair schematics, which can then be incorporated into the bid plans for use by the Contractor. This provides Contractor guidance and location of approximate repairs, allowing them to be more competitive during the bid phase (i.e. incorporating less risk into bid prices due to less unknowns)
- Material Selection and Performance
  - It is important that the proper material type be specified for the selected preservation method, and this correlates to the individual street's current condition. The life expectancy for each application presented above is considered the industry standard based on a PCI score of 70 and above. In the event the City elects to move forward with a street that has a lower PCI score (i.e. less than 70, also considered a stop-gap measure), it should be assumed that even with proper repairs the expected service life could be substantially reduced.

- Tree Pruning
  - While performing visual inspections and condition assessments for each street, it is important to note overhanging trees with less than 14-foot of clearance from the overhang to the top of pavement. For these locations, it is recommended that tree pruning be completed in advance by City crews or separate contract forces, so when the preservation contractor mobilizes they can focus on what they do best, which is completing the street preservation.
  - If the City elects to require the preservation contractor to perform necessary tree pruning, it is imperative that specific language be included in the plans and specifications that details pruning requirements. This can be included in the contract as a subsidiary (no-pay) or specific bid item. Also, including the proposed street list in the contract documents will afford the Contractor the opportunity to evaluate required tree pruning, allowing them to accurately capture costs in their bid. This reduces risk and unknowns for the Contractor and will yield a more competitive bid for the City.
- Bulk Quantity & Project Location
  - Developing a repair program that provides sufficient quantity in close proximity to each other will induce more competitive bids between interested Contractors
  - Lower quantities and projects that are spread out creates an opposite effect, and will result in higher bid prices
- Street Repairs associated with Preservation Contracts
  - Depending on which preservation method is selected, it is important to consider the availability of the Contractor to complete street repairs using in house forces, or whether they will sub-contract the work to a Contractor better suited for street repairs. Based on our knowledge of the preservation materials, this is more of a specific concern to a micro surface or cape seal contract, as the two Contractors who perform this work across the region sub-contract out all street repair work. If there are large quantities of repair work included in the preservation contract, substantial markup will be added by the General Contractor to manage the sub-contractor. This eats into the overall program budget and ultimately reduces the number of streets that can be preserved each year.
  - If a specific area designated for preservation has a large amount of repair quantities, the City should consider bidding out the repair work out as a separate contract. By doing so, this allows local Contractors to bid the work and will ultimately yield better bid prices for both street repairs and pavement preservation.
- Scheduling
  - Depending on the preservation method selected, there is a smaller selection of Contractors who have the specialize equipment available to complete this work. With pavement preservation being a seasonal application, typically April through November, it is important to schedule and bid preservation contracts during the fall and early winter months. This will enable the City to be on the front end of the Contractor's schedule. By bidding during the fall and early winter months the selected Contractor will be able to crack seal and complete street repairs during the later winter months, allowing for appropriate cure time, and would then be followed up by the pavement preservation in the early part of the preservation season.