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Report on Pavement Investigation

Designation:	Stardust Pavement Evaluation
Location:	Stardust Trail Flagstaff, AZ
Client:	Peak Engineering
Project Number:	220184SF
Date:	September 6, 2022

Registered Professional Engineer (Civil)
CERTIFICATE NO.
43813
TODD B.
HANKE
Date Signed 9/6/2022
ARIZONA, U.S.A.

3331 East Wood Street ■ Phoenix, AZ 85040 ■ Phone (602) 997-6391 ■ Fax (602) 943-5508
2026 North 3rd Street ■ Flagstaff, AZ 86004 ■ Phone (928) 526-6681 ■ Fax (928) 526-6685
3125 East 47th Street ■ Tucson, AZ 85713 ■ Phone (520) 514-9411 ■ Fax (520) 514-9474

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APPENDIX

1.0 INTRODUCTION

1.1 PROJECT INFORMATION

This report presents the results of a subsoil investigation carried out along approximately 8,000 feet of Stardust Trail between the intersections of Yancey Lane at the south and E. McGee Rd. at the north. Stardust Trail is located Doney Park, approximately 8 miles northeast of Flagstaff, AZ.

At this time, it is our understanding that design and construction will consist of either conducting a mill and overlay or performing a full reconstruction with new asphaltic concrete (AC) and possible reuse of the existing aggregate base or old asphalt surface. Traffic loads are expected to be moderate, consisting of primarily passenger vehicles and occasional heavy truck traffic (delivery, garbage, etc.).

1.2 FIELD AND LABORATORY INVESTIGATION

On February 14th, 2022 six pavement borings were drilled at the approximate locations shown on the attached Soil Boring Location Plan. All exploration work was carried out under the full-time supervision of our staff geologist who recorded subsurface conditions and obtained samples for laboratory testing. The borings were advanced with a CME-75 truck mounted drill rig using a 7-inch diameter hollow stem auger. Detailed information regarding the soil borings and samples obtained can be found on an individual Log of Test Borings prepared for each location.

Laboratory testing consisted of grain-size distribution and plasticity (Atterberg Limits) tests for classification and pavement design parameters. Select 'undisturbed' samples obtained using a driven ring sampler were tested for natural water content and in-situ dry density. All field and laboratory data are presented in the Appendix of this report.

2.0 SITE CONDITIONS

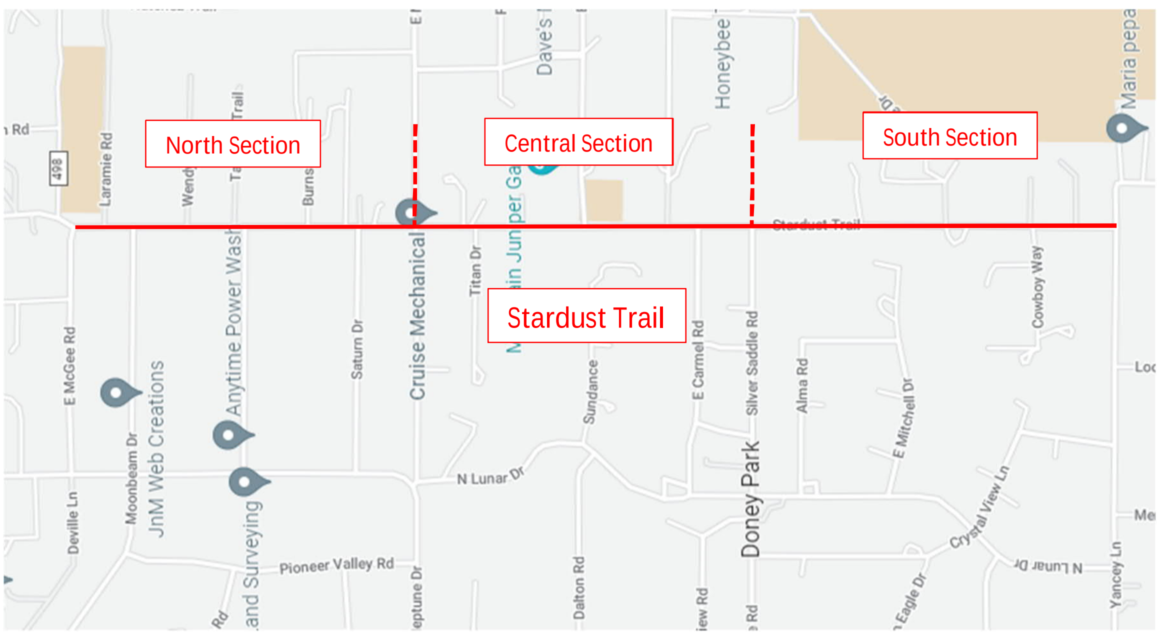
2.1 PROPERTY DESCRIPTION

The subject roadway (Stardust Trail) is located within Doney Park and serves as a primary ingress and egress roadway for the surrounding community. The total length of the project is approximately 8,000 lineal feet. The road currently services primarily residential access to single family homes and is oriented in a north and south direction. The approximate limits of the project are shown in **Figure 2.1.1.** The southern limit of the project is the intersection of Stardust Trail and Yancey Lane and the northern limit of the project is the intersection of Stardust Trail and E McGee Road. Based on initial observations of the condition of the roadway and for the purposes of our analysis, the roadway was subdivided up in to three sections as shown in **Figure 2.1.1** (North, Central, and South).

The northern and central section of the road, extending from McGee Road to Silver Saddle Road (a distance of approximately 5,250 lineal feet) consists of two lanes (one lane in each direction) with a wide paved shoulder on the west edge, extending from Wendy's Way to E Neptune Dr. (a distance of approximately 1,775 lineal feet). For the remainder of this section the shoulders consist of wide graded unpaved areas, extending approximately 15-20 feet from either edge of the road. The paved shoulder appears to act as a parking area, snow disposal area, and storm water drainage pathway. The surrounding area generally consists of weeds and grass and sits slightly lower than the road elevation. The paving history is unknown, however based on available information it appears that the road is likely composed of old surface treatments, chip seal treatments, and thin overlays. From the provided data, and observations of the pavement, it doesn't appear that this section of road contained a traditional asphalt road pavement section.

The southern section of roadway, extending from Silver Saddle Road to Yancey, consists of two lanes with unpaved shoulders. Paving operations here occurred more recently, and the roadway is generally in good condition over this length with only some localized areas exhibiting distress. Buried utilities were noted to run adjacent to the roadway with frequent lateral services crossing the roadway. The roadway contained no curbs, and runoff will flow along the pavement or into roadside ditches and/or the large drainage channel on the west edge of the road. In general, the road was noted to sit several feet higher than the adjoining properties, only matching grades where driveway access was required.

Figure 2.1.1 – Project Limits.



Based on the field investigation, the existing pavement generally consists of 3- to 5-inches of asphaltic concrete (AC) type of surface, over approximately 4- to 9-inches of aggregate base (AB). Most of the road contained an existing surface treatment consisting of a chip seal, which made it more difficult to confirm the exact conditions of the pavement. All pavement borings were advanced through the existing roadway pavement with the auger drill and patched with hot mix asphalt after completion of the boring. Note, the measured thickness of the roadway pavement structure was done through small diameter borings and is approximate, and could vary by location. In addition, as discussed above, the it appears that there have been a number of different sections constructed over the years, which may have included thin overlays and numerous surface treatments. If available, historical paving records should be reviewed to determine exactly how the various sections of this road were constructed. In addition, depending on the rehabilitation option selected, it may be beneficial to obtain additional cores of the pavement surface to confirm the method of construction. For example this may help determine the optimum milling depth of the pavement to ensure removal of any deteriorated pavement. In addition, coring operations will provide more accurate thickness measurements which may help in estimating project quantities. Due to the lack of information regarding the existing pavement structure and history, the contract agreement should be written to address these potential unknowns to allow for additional removals or import of additional materials based on the site conditions at the time of construction.

As discussed, detailed pavement construction and maintenance history is not known. Based on the field data to date, it is unclear when the paving occurred, or if the AC section represents many years of surface additions and recoating. There is evidence for different surface treatments and repair within the three referenced zones (north, central, south), extending from the north to Neptune Drive, from Neptune to Silver Saddle, and from Silver Saddle to the south. Verbal communication with a local resident suggests that the central section between Neptune and Silver Saddle may have never been paved with HMA but consists of asphalt millings followed by crack sealing and chip seals. Refer to the following Figures showing the general condition of the three different sections.

Figure 2.1.2 – Northern Section

Figure 2.1.3 – Central Section

Figure 2.1.4 – Southern Section

The primary distress observed was transverse and longitudinal shrinkage cracking, which is typical in all asphalt pavements. In many areas in the north and central sections, longitudinal cracking has progressed to block and alligator cracking. The alligator cracking is possibly a sign of subgrade destabilization. Lacking a paved shoulder, there is also cracking along the edge of the pavement, likely a result of moisture fluctuations and lack of lateral support along the edges of the pavement. In general the types of distress observed are typical of aging asphalt based pavements. As the asphalt binder (oil) ages, the mix becomes stiffer (less flexible) to the point where the pavement can no longer tolerate the daily shrinkage forces that result from temperature changes. These types of cracks do not typically represent structural failure. However overtime, as moisture enters into the base and subgrade, through the cracks, the pavement can further deteriorate and result in the formation of “alligator” cracking **(Figure 2.1.2 & 2.1.3)**. This type of progression appears to have occurred extensively in the north and central sections. Some minor evidence of rutting and warping of the road surface was also observed. Maintenance history was unavailable, however based on the field observations and the general condition of the pavement, it appears that some effort to maintain the pavement has been made by placement of a chip seal and some crack sealing.

2.2 SUBSURFACE CONDITIONS

2.2.1 Field Results

S&A obtained information about the roadway pavement structure and subsurface conditions at the site by conducting six pavement borings, as shown on the Soil Boring Location Plan in the Appendix. Subsurface conditions across the site are generally consistent. Below the pavement structure the subsoils generally consisted of very loose, dark brown, silty sands and gravels to the maximum depth investigated of 5 feet. The Standard Penetration Resistance Tests (SPT) values ranged from 3 to 12 blows per foot (bpf). Based on the advancement of the auger, general observations, and the SPT values, the soils were classified as being in a very loose to loose state. Based on visual and tactile observation, the upper soils were typically in a moist state, below to near the plastic limit, at the time of investigation. Groundwater was not encountered during this investigation. Refer to the individual boring logs included in the Appendix for additional details.

2.2.2 Laboratory Results

Laboratory testing indicates liquid limits generally in the range of 22 to 30 percent, with plasticity indices ranging from 4 to 11 percent. Two of the tested samples were classified as non-plastic. Measured in-place moisture contents were on the order of 11 to 13 percent. In-situ dry densities of the upper soils were noted to be in the range of 95 to 109 pcf at the time of investigation. Based on the sieve, PI data, and ADOT correlations, the correlated R-values (Rc) range from 40 to 91. Based on the observed conditions and laboratory testing, an R_{mean} of 50 was selected and used for evaluation of the pavement capacity and design of new pavements, where required. This values assumes that the existing native soils (or imported materials that are of similar quality) will be used to support any new roadway pavement. The slightly reduced R-value was used based on the variability of the soils data and a correction factor applied based on the standard deviation.

3.0 ANALYSIS

This report herein assumes that the information contained in Section 1.1 Project Information is accurate and that no significant grade changes will be made. Analysis of the field and laboratory data indicates that subsoils at the site are considered suitable for support of the proposed roadway improvements. The main concern from a geotechnical standpoint is the potential to uncover wet and unstable subgrade conditions and proper moisture conditioning of the subgrade soils where removal and replacement or widening may occur. In order to minimize this risk, the recommendations in this report focus on maximizing the reuse of the existing pavement.

As indicated above, the pavement in the north and central section is generally in fair to poor condition and pavement in the southern section is in fair to good condition. Based on available information, the north and central sections may have been constructed over a number of years using various surface treatments. Structurally, it appears that the pavement is performing adequately, given the assumed low traffic volumes. However, there is some evidence of rutting along portions of the road and some of the longitudinal and transverse cracking has further progressed into alligator cracking. This is likely due to moisture infiltration and the very loose subgrade conditions. While difficult to evaluate due to the chip seal surface, it appears that much of the distress observed in the pavement is related to primarily due to environmental factors (oxidation, ponding, and moisture infiltration) and less related to being overloaded, with the exception of some of the northern and central sections of the road where there is alligator cracking present.

The pavement is exhibiting some drying shrinkage cracking typical of aging pavements. Some of these cracks (the transverse cracks in particular) are quite wide, on the order of 2 inches. Observation of any roadway will reveal similar cracks over time. If left unchecked, these cracks will continue to progress over time to alligator cracking, as was observed throughout the north and central sections. The pavement surface also appears to have some undulations which may be impacting the ride quality of the road. A more thorough review of the pavement maintenance and repair history would be very valuable information. If available, it may result in adjustment to the recommendations made herein, especially in the northern and central portions of the project where the road may have been constructed over time by adding additional surface treatments or thin overlays.

Based on our findings and laboratory results, the silty-clayey sands are sufficient for support of the pavement section, but may become unstable if subjected to excess moisture. There was minimal evidence of load related failures in the roadway and the primary concerns are related to the aging of the asphalt surface and water infiltration into the subgrade. Based on these conditions, options to consider include full depth replacement of the asphalt surface (with or without reuse of AB, or possibly pulverizing the existing AC and mixing with the existing AB), a limited depth of milling of the surface (with or without feathered edges) to (at a minimum) remove the chip seal surface and conducting a 1.0- to 2.0-inch AC overlay, or to perform a surface seal, such as a micro seal or chip seal surface with minor crack repairs. The latter option (surface seal, micro seal, or chip seal) should only be considered for the south section where there is minimal evidence of alligator cracking or large failures.

These options should be combined with localized full depth patching and AC replacement of deteriorated sections. If the deteriorated sections are not repaired, it can be expected that the cracking will reflect through to the surface within a few years. Widening of paved shoulder areas, if performed, should occur prior to mill and overlay or chip seal so the new surface can be placed across the entire width of roadway simultaneously, providing a more uniform aesthetic. While a surface seal, such as a fog coat or slurry seal may extend the lifetime of the road for a small amount of time, it is not the primary recommendation made herein. If chosen, such a treatment will not greatly extend the lifetime of the pavement.

At this time, given the condition of the roadway and the potential to uncover unstable subgrade conditions (loose soils may extend greater than 5 feet deep), full or partial depth reconstruction should be considered with caution, especially in the extensively deteriorated sections north of Silver Saddle. This type of major rehabilitation will likely encounter unstable soils, which may need additional means of stabilization, such as geogrid or cement, which would likely result in significant additional earthwork and cost. The goal should be to reuse as much of the existing pavement structure as possible to limit the exposing the unstable subgrade soils. For the section south of Silver Saddle, the focus should be on rejuvenating the surface, protecting the existing asset and improving the ride quality of the road surface.

The native soils present some concerns regarding their destabilization if subjected to excess moisture. Groundwater is not expected to be a factor in the design or construction of the proposed improvements or any proposed underground utilities. Excavation operations for shallow utilities should be relatively straightforward.

It should be noted that all new asphalt pavements will eventually crack. Cracking in asphalt pavement is typical and should be expected over the life of the pavement. In fact, recent experience has shown that some of the new asphalt binders that are available are more prone to the onset of early aging and cracking. While these cracks are not a result of structural failure, they do require routine maintenance to prevent accelerated deterioration from water infiltration. Accordingly, a regular maintenance program where the cracks are routinely filled is strongly recommended. Additional details and discussion are provided in Section 4.4.4 On-Going Pavement Maintenance.

4.0 RECOMMENDATIONS

4.1 SITE PREPARATION

As discussed, most of the pavement is in fair condition, with portions of the northern and central sections being in poor condition and experiencing areas of structural failure. As a result, the primary recommendation is to conduct isolated full depth repairs of the heavily alligator cracked areas and perform a mill and overlay or for the section south of Silber Saddle, apply a surface treatment (seal coat/chip seal) to provide a new riding surface.

For milling and overlay, the entire pavement surface should be milled to remove at least 1 to 2 inches of the existing pavement. This should remove the existing chip seal and deteriorating surface layer. If the option is selected to raise the road centerline and increase the crown of the road, any existing surface treatments (chip seals) should be milled/removed from the surface and the depth of milling should be increased by feathering toward the outside edges of the pavement. Note, the profile of the pavement in the northern and central sections is unknown. Insufficient data is available based solely on the boring data as to what the asphalt pavement structure consists of. **It is highly recommended to consider conducting cores in this area to verify the pavement structure makeup (unless historical information can be provided).** This may dictate that ideal depth of any milling. Without this information there is a possibility that the milling operations could encounter a significant amount of pop-outs or other conditions not observed in the bore hole, which may result in changed conditions during construction.

Prior to placement of the overlay or surface treatment, the existing pavement surface should be repaired using a combination of Full Depth Patching and Crack Sealing, as outlined in Sections 4.4.2 and 4.4.3 of this report.

An asphalt overlay will eventually result in a similar crack pattern as the old cracks reflect through to the surface. Prior to overlaying, consideration can be given to installing a crack reducing interlayer product. This could consist of a Petromat® 4597 (www.geotextile.com) paving fabric or approved equal. Petromat ® is a non-woven polypropylene geofabric that is embedded in an asphalt tack coat on top of the old pavement prior to overlay. When overlaid, the heat of the new asphalt allows the asphalt binder to penetrate the fabric creating a stress absorbing layer that also adds protection against water intrusion through new cracks as they form. Alternates to using a Petromat could include GlasGrid or PavePrep products which have self-adhesive and can be placed over the crack to aid in reducing reflective cracking. Without one of the above products, reflective cracking could begin to appear within 2-3 years from placement of the overlay. While these products work well in slowing the onset of reflective cracking, they can provide challenges for future rehabilitation or reconstruction as they cannot be milled. If more cracking can be tolerated and the plan is to conduct future mill and overlays, it is recommended to not use a fabric interlayer and repair cracks prior to overlaying.

If selected, for total new construction, the entire area to be occupied by the proposed roadway should be stripped of all existing asphalt, aggregate, loose soils, vegetation, and debris. Care should be taken during excavation to avoid impacting existing buried utilities, some of which may need to be reinforced or rerouted depending on what is discovered during excavation and the proposed alignment of the roadway. Based on the information to date and given the road condition and usage, full reconstruction is not deemed necessary, unless it is discovered that a thicker pavement structure will be required to meet the anticipated traffic or there is a need for complete removal of the northern and central sections. Total new construction will have an increased risk of disturbing the relatively loose native subgrade soils, which may require additional earthwork or alternative means to stabilize.

Depending on the option selected, it may be possible to reuse the existing asphalt surface (if milled) as a sub-base in arears where full depth replacement is required or along the shoulders if left unpaved. For this option the existing pavement may be cold-milled in-place or pulverized to a gradation similar to that of an aggregate base course (AB) and stockpiled for reuse under paved areas as a grade stabilized aggregate (GSA) sub-base. Fill placement and quality should be as defined in the "Fill and Backfill" section of this report.

In areas where full depth replacement is to occur, the exposed subgrade should be scarified to a depth of 8 inches, moisture conditioned to optimum (±2 percent) and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698. Moisture conditioning may involve wetting or drying depending on soil conditions. It may be necessary to compact on the dry side of optimum as the fine sandy soils may become unstable at elevated moisture content. The reduced moisture content under concrete pavements (if any) should only be used upon approval of the engineer in the field.

If asphalt deterioration is evident above culverts or utility trenches, these areas may require excavation and replacement of fill surrounding the underground elements. Fill specifications and backfill requirements for such cases are outlined below

4.2 Site Drainage

Attention must be paid to provide proper drainage to limit the potential for water infiltration of deeper subgrade soils. The graded sub-base material as well as the roadway should slope to either side to accommodate runoff, and drainage ditches should be constructed to ensure that storm water does not pond at the edge of the pavement. The aggregate base should daylight in the sloped area outside the shoulder to allow for drainage of free water that seeps through cracks in the pavement. Increasing of the crown height should be considered for areas with marginal or poor drainage off the existing roadway. Formal evaluation of the roadway crown was not conducted. The civil designer should conduct their own evaluation of the condition of the roadway geometry to determine if increasing the crown of the road will be acceptable.

4.3 Fill and Backfill

Native soils are suitable for use in grading fills. If any import is required it should be equal to or better than the native soil properties. In general, import material should meet the following specifications.

4.3.1.1 Fill Specification

Specification	Fill beneath roadway
Passing 3"/75mm	100%
Passing #200/0.075mm	<40%
Liquid Limit	<30%
Plasticity Index	<10%
Swell [1]	<1.5
Correlated R-Value [2]	50

Notes:

1. Swell potential when compacted to 95 percent of maximum dry density (ASTM D-698) at a moisture content of 2 percent below optimum, confined under a 100 psf surcharge, and inundated.
2. Imported soils placed below the roadway should have a Correlated R-value of 50 or greater using the Plasticity Index and Percent Passing the #200 sieve as outlined in the ADOT Pavement Design Manual.

Clean Cinders are not acceptable beneath roadways. Although "clean" cinders often meet our fill specifications, they may pose difficulties during construction. Due to their granular nature and lack of sufficient fines, "clean" cinders are a free draining material. As a result, they may be difficult to properly moisture condition and water may infiltrate the cinders and saturate the underlying soils. This could result in an unstable support for AC sections. Excess water, as a result of moisture conditioning, is often observed at the interface between the fill and underlying less permeable material, leading to excess moisture in the silty sands and the potential for increased settlement. If a cinder based product is used for import fill beneath the roadway, consideration should be given to a “dirty” cinder product that meets the fill criteria for placement beneath foundations.

Depending on final grades and the proposed pavement repair option, silty fine-sand soils may be exposed and may be sensitive to excessive moisture content and will become unstable at elevated moisture content. Accordingly, it may be necessary to compact soils on the dry side of optimum, especially in asphalt pavement areas.

Imported common fill for use in site grading should be examined by a Soils Engineer to ensure that it is of low swell potential and free of organic or otherwise deleterious material. Fill should be placed on subgrade which has been properly prepared and approved by a Soils Engineer. Fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±2 percent. Granular fill (ASTM Classification GW, GP, SW, SP) can be placed on the dry side of optimum at the discretion of the geotechnical engineer on record.

Fill should be placed in horizontal lifts of 8-inch thickness (or as dictated by compaction equipment) and compacted to the percent of maximum dry density per ASTM D-698 as set forth below. Frozen material shall not be placed, nor shall fill be placed upon frozen grade.

4.3.1.2 Compaction Specifications

Pavement Subgrade/Fill	
Native/Import Fill	95%
Aggregate Base Course	
Below Concrete Slabs (sidewalks, multi-use path, etc.)	95%
Below Asphalt Paving	100%
Utility Trench Backfill	
Utility Trench Backfill	95%
Landscaped Areas	
Miscellaneous fill	90%
Utility Trench - > 1.0’ Below Finished Grade	85%
Utility Trench - < 1.0’ Below Finished Grade	90%

4.4 PAVEMENT

The primary recommendation for this project will be full or partial depth reconstruction of the road surface, a mill and overlay, or possibly a surface treatment (south section). With the latter two options a limited amount of full depth repair is recommended to remove any of the failed areas.

S&A was provided a draft traffic study conducted by Lee Engineering, dated February 2, 2022. The traffic study was conducted within the southern section of the project, between Silver Saddle Road and Yancey Lane. The traffic study included and evaluation included conducting traffic counts for a 24-hour period (January 13, 2022) and evaluation of the potential functional class of the roadway.

The functional class is used in evaluating the roadway geometry as well as the pavement structural section requirements per Coconino County.

The traffic study indicated a total daily traffic volume of approximately 500 vehicles (for both directions). The traffic volume was split relatively evenly between northbound and southbound. Note that the study was only completed within the southern section of the project. For the purposes of this analysis it is assumed that the northern and central section would experience similar traffic volumes. While not included in the traffic study, it is assumed that the majority of the traffic is light cars and trucks and less frequent heavy truck traffic (garbage collection, moving, construction traffic, and delivery vehicles). The traffic study report also recommends that Stardust Trail should have a functional classification as a Minor Collector, however it could also be considered as Local Street. Based on this, the analysis and inputs used to evaluate the roadway capacity are based on the minor collector classification as outlined in Coconino County's Engineering Design and Construction Manual.

If earthwork and site work in paved areas is carried out to finish subgrade elevation as set forth herein, the subgrade will provide adequate support for new pavements, where required. The section capacity is reported as daily ESALs, Equivalent 18 kip Single Axle Loads. Typical heavy trucks impart 1.0 to 2.5 ESALs per truck depending on load. It takes approximately 1200 passenger cars to impart 1 ESAL. In residential subdivisions, the worst offender, construction traffic, is often over looked. The designer/owner should choose the appropriate sections to meet the anticipated traffic volume and life expectancy. For the purposes of this analysis and the evaluation of the pavement, it is assumed that these roads would be classified as Minor Collector as discussed above and outlined by the Coconino County Engineering Design and Construction Manual. The following inputs were used to evaluate the pavement:

General Pavement Design Parameters:

Assume:	One 18 kip Equivalent Single Axle Load (ESAL)/Truck
Analysis Period:	40 years
Road Classification:	Minor Collector
Initial Serviceability:	4.5
Terminal Serviceability:	3.0
Reliability Level:	85%
Min. AC Section:	5-inches
Min. AB Section:	10-inches

Traffic Volume Parameters:

Growth Rate (compound):	2 percent
Percent Truck Traffic:	6 percent
Vehicles Per Day:	500 (traffic study)
Directional Distribution:	50 percent
Lane Distribution:	100 percent
Truck Equiv. Factor:	0.70
Total ESALs (40 years):	235,635
Daily ESALs (40 years):	16

Pavement and Subgrade Soil Profile:

Structural Coefficient (AC):	0.42
Structural Coefficient (AB):	0.12
Average % Passing #200 sieve:	24%
Plasticity Index:	4%
Design R-value:	50 (per ADOT procedures)
M_R:	14,985 (per AASHTO design)

4.4.1 Pavement Sections

Asphalt Concrete Pavement (Flexible)				
Option (1)	Thickness, in.		Daily 18-kip ESALs	Total 18-kip ESALs (7)
	AC	AB		
A (2)	4.0	5.0	37	545,700
B (3)	4.0	8.0	88	1,282,600
C (4)	5.0	10.0	318	4,650,600
D (5)	5.0	5.0	100	1,461,300

Notes:
1. Designs are based on AASHTO design equations, ADOT correlated R-Values, and Coconino County design parameters.
2. Represents approximate existing section.
3. Represents minimum Coconino County requirements for Local Urban Roadway.
4. Represents minimum Coconino County requirements for Minor Collector.
5. Represents milling off 1-inch and replacing with 2-inches (increasing the pavement structural section).
6. Full depth asphalt or increased asphalt thickness can be increased by adding 1.0-inch asphalt for each 3 inches of base course replaced for asphalt 4 inches or greater in thickness.
7. Total 18-kip ESALs based on a 40 year analysis period per Coconino County guidelines.

These pavement sections assume that all subgrades (where required) are prepared in accordance with the recommendations contained in the “Site Preparation” and “Fill and Backfill” sections of this report, and paving operations carried out in a proper manner. If pavement subgrade preparation is not carried out immediately prior to paving, the entire area should be proof-rolled at that time with a heavy pneumatic-tired roller to identify locally unstable areas for repair. Site drainage should be designed to ensure positive drainage of the base and sub-base materials. Improper grading of sub-base materials will drastically reduce the overall life of the pavement.

Pavement base course material should be aggregate base per MAG Section 702 Specifications. Asphalt concrete materials and mix design should conform to MAG 710 (and any

Coconino County modifications) using the Marshall mix design criteria and PG 58-28 for the asphalt grade. Reducing the air void content to 3 percent will aid in reducing thermal cracking typical in the area. It is recommended that a ½ inch or ¾ inch mix designation be used for the pavements. While a ¾ inch mix may have a somewhat rougher texture, it offers more stability and resistance to scuffing, particularly in truck turning areas. Pavement installation should be carried out under applicable portions of MAG Section 321 and municipality standards. The asphalt supplier should be informed of the pavement use and required to provide a mix that will provide stability and be aesthetically acceptable. Some of the newer M.A.G. mixes are very coarse and could cause placing and finish problems. A mix design should be submitted for review to determine if it will be acceptable for the intended use. Where/if required, pavement base course material should be aggregate base per MAG Section 702 Specifications (and any Coconino County modifications). Additional details and discussion on the mill and overlay, surface treatments, and patching are outlined in the following sections.

4.4.1 Surface Treatments

For the south section of the roadway, between Silver Saddle and Yancey, the majority of the pavement is performing adequately. The primary forms of distress are related to the aging of the pavement. Based on these conditions, one option for rehabilitation of the pavement would be to conduct a surface treatment, which would be considered more of a maintenance item. This could consist of a slurry seal or a chip seal. These procedures are primarily used as part of a maintenance routine and would be required every 3-7 years. Note, the current pavement structure does not meet the Coconino County minor collector roadway classification that is proposed by the traffic study, although based on the traffic analysis, the section appears to be sufficient.

As these surface treatments do not typically contain an aggregate (except chip seals), they are not capable of spanning over large open cracks or heavily cracked pavements. Therefore, prior to conducting one of these treatments it would be required that all heavily cracked areas and large cracks be repaired by full depth patching, crack sealing or filling, or milling and patching in the case of large open cracks that cannot be crack sealed/filled. These products need to be applied to a clean pavement surface or a surface treated with a compatible (SS-1h) prime coat. We would anticipated that no more than about 5 percent of the pavement in these areas would require full depth patching.

If selected, the slurry seal should consist of MAG Standard Specification Section 332 Type II Slurry Seal. A slurry seal is a mixture of slow-setting asphalt emulsion, fine aggregate, mineral filler, and water that can be used in both preventative and corrective maintenance activities. A slurry seal will help seal surface cracks and improve skid resistance. It will also help reduce surface distress caused by oxidation aging of the asphalt. The mixture is prepared in the form of water-based slurry and is applied in an average thickness of 1/8 to ¼ inch. This thin surface treatment will not retard reflective cracking. Conventional slurry seal life expectancy is on the order of 2 to 5 years.

Another more economical option to slurry seal is a proprietary micro-seal coat that contains mineral aggregate, asphalt rubber and/or other fillers. As noted above, reflective cracking will appear through these types of surface treatments. It is our opinion that due to the amount of cracking, a seal coat with some aggregate and/or filler would provide adequate cover for these better areas. There are a number of different products (such as MasterSeal MTR or MTR Plus with at least 200 pounds of aggregate per 100 gallons added or equal product) that are available for this type of treatment and many contractors specialize in one type of product. Therefore, the final product selection will partially depend on which contractor does the repair work. For these types of proprietary seal coats, it is recommended that the contractor provide a recommendation for the conditions present, as well as product specification sheets and examples of roadways where this seal has been applied. The owner should then visit those applications to make sure that the type of finish is acceptable. For example, thin ‘spray’ applied fog seals may not hide patches completely, and may take several applied coats if that is the desire.

Alternatively, a chip seal surface treatment, such as what is used more recently, could also be considered. If selected, the asphalt chip seal should follow the recommendations outlined in MAG Specification Section 330.

With a surface treatment it is recommended to repair any areas that have significant cracking using full depth repairs, and that cracks should be filled/sealed to prevent moisture infiltration and further deterioration of the pavement surface. It may also be necessary to remove or clean the surface of any existing surface treatments to ensure that there is a proper bond when applied.

4.4.2 Mill & Overlay

As an alternate to conducting a surface treatment, it may be more feasible to consider partial removal and replacement to provide a new riding surface. This option is provided for the south section, and those areas north of Silver Saddle where deterioration is not as extensive. This can be accomplished by conducting a limited depth of milling and then overlaying the pavement with a new asphalt surface. For this option, it is recommended to mill 1 to 2 inches to remove the upper chip seal and deteriorated surface. The pavement can then be overlaid with 1 to 2 inches of new asphalt. An alternative is to decrease mill depth from the edge towards the centerline of the roadway (feathering) to increase crown height and improve transverse drainage off of the roadway. For the feathering option, the milling depth should be sufficient to remove pre-existing chip seal or overlays along the crown, with depth of milling increasing toward the roadway edge. Following feathered milling, two inches of asphalt should be placed over the entire roadway section. Due to the limited data in the northern and central sections regarding the pavement history, it is recommended to consider conducting pavement cores to verify the asphalt structure. This will help in determining the ideal depth of milling or confirm that milling will not cause any further issues.

In order to achieve good performance for the overlay or seal coat options, it will be necessary to properly prepare any of the cracks, including routing out the cracks to the width to depth ratio recommended by the crack filler manufacturer. Clean the cracks by routing and using high-pressure air, sandblasting, wire brushing, hot air blasting or high-pressure water. This is a key step to crack sealing or filling. If the crack is not thoroughly cleaned, the sealant will not adhere to the sides. Sand blasting, although the best for cleaning the cracks, is the most labor intensive. Hot air blasting is done using a hot compressed-air (HCA) lance, or heat lance, connected to an air compressor. This method helps dry the crack and if sealing closely follows the hot air drying, the heated crack surface helps the sealant adhere to the crack. The hot air lance produces super-heated air and will burn the crack surface if left in one place too long. If high-pressure water is used, the crack must be thoroughly dried before sealing.

After removing the old sealant and/or cleaning the cracks, check them for depth. Generally, if they are over 20 mm (3/4 in.) deep, a backer rod may be used to conserve sealant. The backer rod should be a compressible, non-shrinking, non-absorbent material with a melting point higher than the sealant temperature. The backer rod should be about 25% wider than the crack so it doesn't slip down, or float out after installing the sealant.

Immediately before applying the sealant, inspect the cracks to ensure they are clean, dry and any backer material is properly installed. If the cracks have been left unsealed for any period of time, clean them out with compressed air before sealing them.

The sealant should be applied from the bottom to the top of the crack to prevent air bubbles from forming and creating a weak spot in the sealant. It is desirable to use a sealant kettle that has an injection wand for the best results. To prevent tracking, the sealant should be left about 3 to 6 mm (1/8 to 1/4 in.) below the top of the crack. Use a squeegee to remove any excess sealant on the pavement surface. For this area, it is recommended to use to Crafco Polyflex Type 3 or Type 4 or approved equal.

4.4.3 Full Depth Replacement and/or Patching

Patching of failed areas or pop-outs will likely be required as part of the pavement rehabilitation. This may be done to address the failed areas prior to placement of a surface treatment or as a result of pop-outs after the milling process has been completed. Full depth patching should be completed prior to conducting any crack filling. For the area north of Silver Saddle, this is the primary recommendation.

Simply stated, this patching procedure removes the material in the failed area and replaces it with a new asphalt pavement. Although the operation is not difficult, some of the necessary fine points are often not attended to. These fine points often determine whether the completed patch will be a temporary expedient or an integral part of the functional pavement system.

In those areas where the pavement has failed/needs repair, the area to be patched should be painted to delineate the areas to be removed. The markings should extend at least 1 foot outside of the distressed area. The outline should be as nearly rectangular as possible preferably with two of the sides at right angles to the direction of traffic. Cut the outline of the patch with a pavement saw or pneumatic hammer.

Excavate as much pavement as necessary, including AB if required to reach firm support. On this project, the minimum depth of removal should be a depth of ±4 inches from existing road grade (±2 inches if performed after milling) to remove a portion of the failed pavement to expose the AB section. For the patch to be an integral part of the pavement, its foundation must be at least as strong as the original pavement. After removal of previous material, the subgrade/sub-base should be examined to document stable conditions.

The faces of the excavation should be straight, vertical and solid. Trim and compact the exposed subgrade. Prior to placing new base course (if required), the exposed grade should be scarified to a depth of 8 inches, moisture conditioned to optimum (±2 percent) and compacted to at least 100 percent of maximum dry density as determined by ASTM D-698. Apply a tack coat to the vertical edges of the excavation and a prime or tack coat to the base of the excavation.

Replace the milled pavement with at least 2 inches of asphalt mixture (or match the existing section if thicker). It is recommended that a ½ inch or ¾ inch mix designation be used for the pavements.

Shovel the patching mixture directly from the truck and place the mixture against the edges first. Spread the mixture carefully to avoid segregation. Avoid pulling material from the center of the patch to the edges. If more material is needed at the edge, it should be deposited there, and any excess raked away. The quantity of material used should be enough to ensure that, after compaction, the patch surface is flush with the adjacent pavement, not humped or depressed. The maximum lift thickness depends upon the type of asphalt mixture and the available compaction equipment. Hot asphalt mixture should be placed in lifts as thick as practical to increase heat retention and facilitate compaction.

From a compaction standpoint, hot mix asphalt patches can be backfilled in at least two lifts. Compact each lift of the patch thoroughly. The type of equipment will depend on the size of patch. A vibratory plate compactor may be sufficient for the small patches, while a vibratory compactor is more effective for larger areas and will be necessary for thicker lifts. For the patch surface, compact the edges first, overlapping 6 inches onto the edge of the patch. Continue compaction from the low side to the high side, with each pass lapping an additional 6 inches onto the un-compacted material.

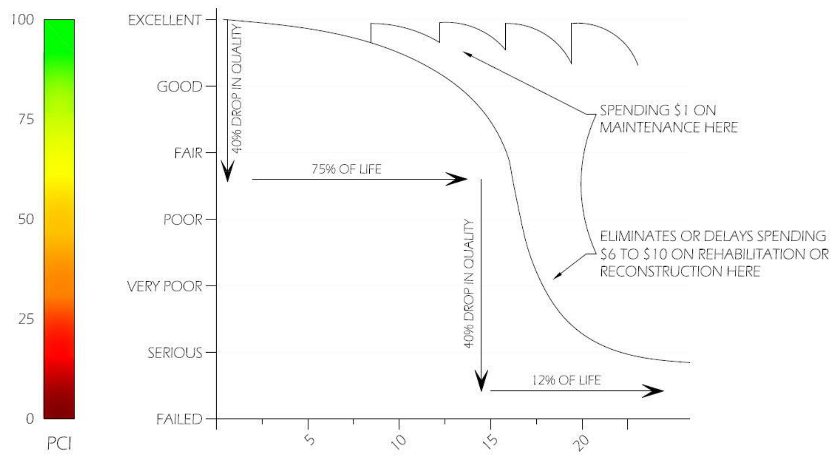
After compacting, the surface of the patch should be at the same grade as the surrounding milled pavement. Check the vertical alignment and smoothness of the patch with a straight edge. Replacement should be performed prior to the overlay, so the upper two inches of asphalt can be emplaced as a single, coherent lift.

4.4.4 On-Going Pavement Maintenance

In order to achieve an extended life in the pavement, it is highly recommended that a maintenance plan be used to address the aging process of the pavement. This will allow for a lower operational cost, while extending the life of the pavement.

It has been well documented that proper maintenance will prolong the life of the pavement at a lower cost than letting the pavement age with no maintenance. **Figure 4.4.4.1** shows how spending money on pavement preservation at the correct time will be a more cost effective means for extending the life of the pavement. As long as the pavement remains in a fair to excellent state, the cost of pavement preservation is relatively small. However, as the pavement deteriorates into the fair to poor range, the pavement life becomes significantly shorter and there is a change from preservation to pavement rehabilitation and reconstruction (at a significantly higher cost).

Figure 4.4.4.1 – Life Cycle Cost Analysis



Once the pavement enters into this middle zone, light pavement preservation techniques, such as seal coats, crack sealing, etc. become a poor use of funds and the process results in chasing the distress rather than permanently fixing it. This will result in the owner spending more money just to maintain the current, and likely unsatisfactory, pavement condition. **Figure 4.4.4.1** provides a Pavement Condition Index (PCI) rating, which is a visual condition scale rating from 0 to 100, with 100 being a brand new pavement and 0 being a completely failed pavement. The PCI is one of several standardized methods for rating a pavement based on a visual condition survey of the pavement. The rating procedure uses the pavement distress type and severity to calculate an index score (PCI) for the pavement.

As discussed, all new asphalt pavements will eventually crack. Cracking in asphalt pavement is typical and should be expected over the life of the pavement. All pavements will age at different rates dues to numerous variables, including factors such as loading condition, environmental conditions, and moisture infiltration or drainage issues. Accordingly, it is highly recommended to establish a maintenance program that addresses this aging process. In general terms it is recommended that the cracks are routinely filled as they appear. Cracking for an overlay will typically result from reflective cracking of the surface below. These cracks will typically reflect through at a rate of approximately 1 year per inch of overlay thickness. This rate will depend on multiple factors, including things such as the mix design, severity of previous cracks, and construction techniques. In general it should be anticipated that cracks will typically begin to appear around the second to third year of life, so the maintenance program should include a budget item to conduct crack sealing on a routine basis. The amount of crack sealing that is required will depend on how the pavement is aging. Once cracks are sealed, they will typically not need to be sealed for another 4 to 5 years. Therefore, the budget estimates should assume that approximately 25 percent of the pavement areas will need isolated crack sealing every year. It is also recommended that surface fog seal coats be considered beginning at about year 5 and every 5 years after. This will help preserve the pavements surface as well as minimize the effects from moisture infiltration. Depending on the progression of the aging, more costly surface treatments such as thin overlays, chip seals, or slurry seals should be anticipated at the 10 to 15 year point of the pavement’s life.

It is recommended that once the repairs have been completed, an initial pavement condition index survey be completed on all of the new pavements. This survey should be completed at an age of around 4 years, as the pavement will start showing signs of aging near this age. The pavement condition survey will allow for better prediction modeling of the aging process, which will in turn allow for better planning of maintenance and help refine the operation and maintenance budget of the roadway to maximize the life. The pavement condition surveys can then be conducted every 3 to 5 years thereafter to help determine how the pavement is aging. A 10 year maintenance plan can be created with each one of these surveys to help for budgeting over a 10 year period.

4.5 UTILITY INSTALLATION

It is assumed that the primary objective of this project will be the replacement/resurfacing of the roadway, however it is possible that utilities may need to be relocated, replaced, or modified, depending on the final design. Trench excavations for utilities likely can be accomplished by conventional trenching equipment. Trench walls may not stand near vertical for the short periods of time required to install shallow utilities and some sloughing may occur in looser and/or sandier soils requiring laying back of side slopes and/or temporary shoring. If trenches are greater than shoulder-height, precautions must be taken to protect workmen. All trenches should be in accordance with OSHA Excavation Standard 1926 Subpart P.

Pipe bedding and shading should be per MAG Specification Section 601.4 (and any Coconino County modifications). The native soils may be used for trench backfill (above any required bedding) and roadway fill provided that material larger than 3 inches is removed or reduced in size. Material used for backfill of trenches should be moisture-conditioned, placed in 8 inch lifts and mechanically compacted. Water settling is not recommended. Compaction requirements are summarized in Section 4.3 Fill and Backfill of this report.

5.0 CONCLUSION

The scope of this investigation does not include any considerations of hazardous releases or toxic contamination of any type. Our analysis of data and the recommendations presented herein are based on the assumption that soil conditions do not vary significantly from those found at specific sample locations. Our work has been performed in accordance with generally accepted engineering principles and practice; this warranty is in lieu of all other warranties expressed or implied.

We recommend that a representative of the Geotechnical Engineer observe and test the earthwork and pavement repair portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report.

If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Respectfully submitted,

SPEEDIE & ASSOCIATES, LLC

Registered Professional Engineer (Civil)
CERTIFICATE NO.
43813
TODD B.
HANKE
Date Signed 9/6/2022
ARIZONA, U.S.A.

Erin Piechota

Todd B. Hanke, P.E.

APPENDIX

SOIL BORING LOCATION PLAN

SOIL LEGEND

LOG OF TEST BORINGS

TABULATION OF TEST DATA

— APPROXIMATE SOIL BORING LOCATIONS

Drawing Courtesy of Google Earth Inc.

SOIL BORING LOCATION PLAN					Stardust Trail Repaving Stardust Trail N/o Silver Saddle Flagstaff, Arizona	SPEEDIE AND ASSOCIATES GEOTECHNICAL/ENVIRONMENTAL/MATERIALS ENGINEERS 4025 E. HUNTINGTON, SUITE 140 FLAGSTAFF, ARIZONA 86004
DR:GSE	CHK:CWS	REV:	DATE: 3/8/2022	PROJECT NO. 220184SF		

TMPLT 2000.CAD 10/23/00

SOIL LEGEND

SAMPLE DESIGNATION	DESCRIPTION	
AS	**Auger Sample**	A grab sample taken directly from auger flights.
BS	**Large Bulk Sample**	A grab sample taken from auger spoils or from bucket of backhoe.
S	**Spoon Sample**	Standard Penetration Test (ASTM D-1586) Driving a 2.0 inch outside diameter split spoon sampler into undisturbed soil for three successive 6-inch increments by means of a 140 lb. weight free falling through a distance of 30 inches. The cumulative number of blows for the final 12 inches of penetration is the Standard Penetration Resistance.
RS	**Ring Sample**	Driving a 3.0 inch outside diameter spoon equipped with a series of 2.42-inch inside diameter, 1-inch long brass rings, into undisturbed soil for one 12-inch increment by the same means of the Spoon Sample. The blows required for the 12 inches of penetration are recorded.
LS	**Liner Sample**	Standard Penetration Test driving a 2.0-inch outside diameter split spoon equipped with two 3-inch long, 3/8-inch inside diameter brass liners, separated by a 1-inch long spacer, into undisturbed soil by the same means of the Spoon Sample.
ST	**Shelby Tube**	A 3.0-inch outside diameter thin-walled tube continuously pushed into the undisturbed soil by a rapid motion, without impact or twisting (ASTM D-1587).
--	**Continuous Penetration Resistance**	Driving a 2.0-inch outside diameter "Bullnose Penetrometer" continuously into undisturbed soil by the same means of the spoon sample. The blows for each successive 12-inch increment are recorded.

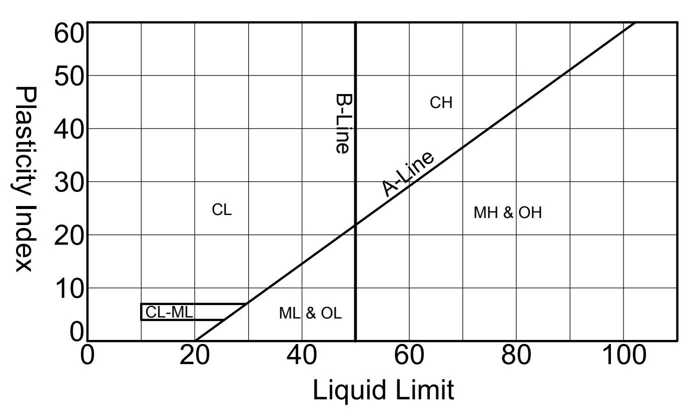
CONSISTENCY			RELATIVE DENSITY	
Clays & Silts	Blows/Foot	Strength (tons/sq ft)	Sands & Gravels	Blows/Foot
Very Soft	0 - 2	0 - 0.25	Very Loose	0 - 4
Soft	2 - 4	0.25 - 0.5	Loose	5 - 10
Firm	5 - 8	0.5 - 1.0	Medium Dense	11 - 30
Stiff	9 - 15	1 - 2	Dense	31 - 50
Very Stiff	16 - 30	2 - 4	Very Dense	> 50
Hard	> 30	> 4		

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL OR MODIFIED SYMBOLS MAY BE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS OR TO PROVIDE A BETTER GRAPHICAL PRESENTATION OF THE SOIL

MATERIAL SIZE	PARTICLE SIZE			
	Lower Limit		Upper Limit	
	mm	Sieve Size ◆	mm	Sieve Size ◆
SANDS				
Fine	0.075	#200	0.42	#40
Medium	0.420	#40	2.00	#10
Coarse	2.000	#10	4.75	#4
GRAVELS				
Fine	4.75	#4	19	0.75" ×
Coarse	19	0.75" ×	75	3" ×
COBBLES	75	3" ×	300	12" ×
BOULDERS	300	12" ×	900	36" ×

◆U.S. Standard ×Clear Square Openings



Rig Type:	CME-75
Boring Type:	**Hollow Stem Auger**
Surface Elevation:	**N/A**

Depth (feet)	Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0–25–50)
0	4" ASPHALT on 5" AGGREGATE BASE					
0.8	Very Loose Brown SILTY SAND (SM-Moist) Trace Gravel					
		SS-1	3.5	NT	NT	●
4.5	Loose Brown SILTY GRAVEL (GM-Moist) with Sand	AS-2	4.5	NT	NT	
5.0	End of Boring	AS-3	5.0	NT	NT	

Boring Date:	**2-14-22**
Field Engineer/Technician:	**G. Epstein**
Driller:	**O. Mariscal**
Contractor:	**Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-1**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

Depth (feet)	Graphic Log	Rig Type: CME-75 Boring Type: Hollow Stem Auger Surface Elevation: N/A Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 – 25 – 50)
0		3" ASPHALT on 6" AGGREGATE BASE					
0.8		Very Loose Brown SILTY SAND (SM-Moist) Trace Gravel					
3.5		Very Loose Dark Brown GRAVELLY SAND (SP-Moist) with Silt					
5.0		End of Boring	BS-1	5.0	NT	NT	

Boring Date: **2-14-22**
Field Engineer/Technician: **G. Epstein**
Driller: **O. Mariscal**
Contractor: **Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-2**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

Depth (feet)	Graphic Log	Rig Type: CME-75 Boring Type: Hollow Stem Auger Surface Elevation: N/A Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 / 25 / 50)
0		5" ASPHALT on 6" AGGREGATE BASE					
		0.9					
		Very Loose Brown GRAVELLY SAND (SP-Moist) with Silt					
		2.5					
		Very Loose Brown SILTY SAND (SM-Moist) Trace Gravel	RS-1	3.0	NT	NT	●
5		5.0					
		End of Boring					

Boring Date: **2-14-22**
Field Engineer/Technician: **G. Epstein**
Driller: **O. Mariscal**
Contractor: **Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-3**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

Depth (feet)	Graphic Log	Rig Type: CME-75 Boring Type: Hollow Stem Auger Surface Elevation: N/A Visual Classification		Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 – 25 – 50)
0		4" ASPHALT on 5" AGGREGATE BASE	0.8					
		Very Loose Brown GRAVELLY SAND (SP-Moist) with Silt	4.0	SS-1	3.5	NT	NT	●
		Very Loose Brown SILTY SAND (SM-Moist) Trace Gravel	5.0					
5		End of Boring						

Boring Date: **2-14-22**
Field Engineer/Technician: **G. Epstein**
Driller: **O. Mariscal**
Contractor: **Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-4**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

Rig Type:	**CME-75**	
Boring Type:	**Hollow Stem Auger**	
Surface Elevation:	**N/A**	

Depth (feet)	Visual Classification	Depth	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0–25–50)
0	4" ASPHALT on 4" AGGREGATE BASE	0.8					
	Very Loose Dark Brown FINE TO MEDIUM SAND (SW-Moist)	3.3	SS-1	3.5	NT	NT	● (≈4)
	Soft Reddish Brown SANDY SILT (ML-Moist) Trace Gravel	5.0	AS-2	5.0	NT	NT	
5	End of Boring						

Boring Date:	**2-14-22**
Field Engineer/Technician:	**G. Epstein**
Driller:	**O. Mariscal**
Contractor:	**Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-5**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

Depth (feet)	Rig Type: CME-75 Boring Type: Hollow Stem Auger Surface Elevation: N/A Visual Classification		Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 – 25 – 50)
0	4" ASPHALT on 9" AGGREGATE BASE	1.1					
	Very Loose Brown SILTY SAND (SM-Moist)	3.0	RS-1	3.0	NT	NT	●
	Soft Brown SANDY SILT (ML-Moist) Trace Gravel	5.0					
5	End of Boring						

Boring Date: **2-14-22**
Field Engineer/Technician: **G. Epstein**
Driller: **O. Mariscal**
Contractor: **Resilient**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B-6**

Stardust Repaving

Stardust Trail

Flagstaff, Arizona

Project No.: **220184SF**

_SPEEDIE 220184SF.GPJ GENGEO.GDT 3/7/22

TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
B-1	SS-1	SS	2.0 - 3.5	NT	NT	29.6	63	81	93	100	NP	NP	NP	SM	SILTY SAND
B-2	BS-1	BULK	0.8 - 5.0	NT	NT	31.3	49	68	83	100	23	19	4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
B-3	RS-1	RING	2.0 - 3.0	12.8	95.4	17.6	31	53	74	100	22	17	5	SC-SM	SILTY, CLAYEY SAND with GRAVEL
B-5	SS-1	SS	2.0 - 3.5	NT	NT	6.1	34	91	99	100	NP	NP	NP	SW-SM	WELL-GRADED SAND with SILT
B-6	RS-1	RING	2.0 - 3.0	11.3	108.9	36.0	79	91	97	100	30	19	11	SC	CLAYEY SAND

Sieve analysis results do not include material greater than 3". Refer to the actual boring logs for the possibility of cobble and boulder sized materials.

NT=Not Tested

Sheet 1 of 1

Stardust Repaving
Stardust Trail
Flagstaff, Arizona
Project No. 220184SF

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