SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers

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REPORT ON PAVEMENT EVALUATION

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14388
GREGG ALAN
CREASER
Date Signed 6/4/15
ARIZONA, U.S.A.
Expires 06/30/17

DESIGNATION: Bella Vista Road Pavement Evaluation

LOCATION: Bella Vista Road and Hunt Highway
Pinal County, Arizona

CLIENT: Pinal County Department of Public Works

PROJECT NO: 131275SA

DATE: June 4, 2015

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 GENERAL SITE CONDITIONS 1

2.1 General Site Conditions 1
2.2 Pavement Conditions 2
2.3 General Subsurface Conditions 2

3.0 ANALYSIS AND RECOMMENDATIONS 3

3.1 Analysis 3
3.2 Remove and Replace 4
3.3 Mill and Overlay Pavement Design 7
3.4 Full Depth Reclamation 8
3.5 Seal Coat/Surface Seal 10
3.6 Crack Sealing Procedure 11
3.7 Costs and Associated Life 11

4.0 GENERAL 13

APPENDIX – Field and Laboratory Data

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1.0 INTRODUCTION

This report presents the results of a Geotechnical Pavement Investigation conducted for roadway improvements along Bella Vista Road between Hunt Highway and Gantzel Road in Pinal County, Arizona. The roadway improvements may consist of either full reconstruction or another form of rehabilitation, which may include partial removal or surface treatments.

The purpose of this investigation is to determine the existing pavement section and make recommendations for pavement replacement and/or rehabilitation of the roadway as dictated by the current conditions, the available funds for the project and the desired life. This investigation involved a visual observation of the surface condition, a limited number of pavement cores, to determine the current pavement structure, and obtaining samples of the shallow subgrade soils. This section of Bella Vista Road is approximately 1 mile in length. It is assumed that the roadway acts as an arterial collector street connecting Hunt Highway and Gantzel Road. The pavement structure needs to be designed to accommodate moderate to heavy volume of passenger traffic, school busses, occasional farm equipment, weekly refuse trucks, and limited heavy service truck traffic.

2.0 GENERAL SITE CONDITIONS

2.1 General Site Conditions

This portion of Bella Vista Road travels east/west through primarily a residential/retail area. Housing developments are located on the north and south sides, a small retail center and substation are located at the southwest end of the alignment and a farm field at the northeast end. The roadway is bounded on the north and south by asphalt shoulder, curb and gutter. The only exception is in the area adjacent to the farm field, where the shoulder is dirt. The roadway primarily consists of 2 lanes in each direction with a center turn lane. There is only 1 lane west bound from Gantzel for approximately 1,200 feet. Traffic during our investigation consisted of occasional personal vehicles (light cars and trucks) however it is likely that heavy farm vehicles and light truck traffic frequent the roadway during various times of the year. We assume that this roadway functions as a collector roadway.

2.2 Pavement Conditions

The roadway can be broken into two separate areas based on the current surface condition. The middle section of the roadway, which includes the center turn lane and portions of the adjacent high speed lanes in either direction, appears to be the original roadway with significantly more distress. The remainder of paved surface from the high speed lane to the curb appears to be newer asphalt and is in good condition. This variation is evidenced at boring location B-3, which showed 5 inches of asphalt in the newer pavement (outer lane) and 3 inches of asphalt in the older pavement in the center turn lane. It is probable that the developers were responsible for only widening the street and adding the curb and sidewalk, but the original pavement remains in the center of the roadway. In general, the middle section is in a state of severe distress or failure. The pavement is exhibiting significant drying shrinkage block cracking typical of aged asphalt pavements. The block cracked pavement has deteriorated to "alligator" cracking and fatigue cracking. The significant amount of cracking is resulting in occasional pot holes in a several areas. This type of distress is typically an indication of overstressing of the pavement and possible subgrade failure. This is typical of progressive failure and can be in part due to lack of maintenance, which allows water to enter the subgrade resulting in loss of support. Although the center portion of the roadway is still serviceable it will continue to degrade over time, resulting in higher maintenance costs. The curb lanes are newer and performing better and require less maintenance or rehabilitation.

Based on the field observations it appears that an effort to maintain the pavement was done which included "band-aid" crack fills and a chip seals. The chip seal has raveled off in several areas.

2.3 General Subsurface Conditions

The pavement was cored and base/subgrade sampled at a total of 5 locations along the alignment. The approximate locations are shown on the Boring Location Plan in the Appendix. The pavement thickness was high variability in the structural sections where cored. The thickness of the asphalt measured between 2 to 5 inches. The older, middle section, of roadway appears to be thinner than the new pavement along the curb lanes. Below the asphalt is between 6 to 11 inches of aggregate base course (ABC). The subgrade soils consisted of sandy lean clay, clayey sand, silty sand, and silty clayey sand. No groundwater was encountered during this investigation. Based on visual and tactile observation, the soils were in a 'dry' to 'dry to moist' state at the time of investigation.

It should be noted that only a limited number of core samples were obtained, therefore depending on the rehabilitation or reconstruction option selected, the contractor must be aware that variations to the thickness of the asphalt and aggregate base are likely and the contract should be written to address additional removals or import of additional materials based on the site conditions at the time of construction.

Laboratory testing indicates that liquid limits range from 23 to 33 percent with plasticity indices on the order of 3 to 14. The percent passing the #200 sieve is 25 to 57 percent. A laboratory performed R-Value test on a composite sample from each boring indicted an R-Value of 63. However, using ADOT Tables, a correlated R-value of 39 was obtained. The correlated R-value of 39 will be used for the design of new pavements were applicable.

3.0 ANALYSIS AND RECOMMENDATIONS

3.1 Analysis

As indicated, the middle section of roadway is in a poor condition with a number of failed areas as identified by excessive "alligator" cracking and pot holes. In addition the pavement is exhibiting drying shrinkage block cracking typical of aged asphalt pavements. The crack pattern suggests typical block cracking. Block cracking is normal in asphalt pavements. It is usually the result of volume change of the fine aggregate asphalt mixes that have a high content of low penetration asphalt and adsorptive aggregates. As the asphalt oil ages, the mix becomes stiffer (less flexible) to the point where the pavement cannot tolerate the daily shrinkage forces that result from temperature changes. These types of cracks typically do not represent structural failure. However, as the pavement deteriorates, water can enter the subgrade resulting in poor subgrade support and progressive failure as observed in this roadway.

Based on the current conditions of the pavement our primary recommendations are to conduct major rehabilitation and/or reconstruction of the middle (older) portion of the roadway. This may consist of full depth removal and replacement with a new pavement structural section that meets the current traffic volumes or an alternative means for reconstruction, such as full depth reclamation, which reuses as much of the existing asphalt and aggregate base as possible. Either of these options can be designed to accommodate a full 20 year design life, with routine maintenance.

The outer, curb lanes, appear in much better condition and have a thicker structural section, which would be more common for a road of this classification. For the outer portion of the roadway, minor surface maintenance or rehabilitation would be required. This may consist of maintenance type work, such as slurry seals or seal coats, or it could be more involved and consist of rehabilitation type work, such as a mill and overlay.

The selection of which of the options to choose from will depend on available funding and the desire to extend the life of the pavement. **Pinal County should determine which option best meets their desires and budget.** With these options, the construction of the road can be staged such that the end product provides a nice uniform pavement appearance. For example, the center portion of the road can be

fully reconstructed initially, leaving the final lift of asphalt off the surface, then go back and overlay the outer lanes and pave the remainder of the center lane all at the same time with the same asphalt mix. Or in the case of a seal coat or a slurry seal, apply to the entire roadway after reconstruction of the middle section of road.

It must 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, it has been our experience of late that with the new asphalt binders that are available, we are seeing the onset or earlier aging and cracking. These require routine maintenance to prevent accelerated deterioration. Accordingly, it is highly recommended to establish a maintenance program where the cracks are routinely filled as they appear beginning at about the second year of life. 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, extending the service life.

3.2 Remove and Replace

The primary option for the middle portion of the roadway would be to conduct removal and replacement, providing a new pavement structural section that can support the current traffic loading. It would be preferable to remove the complete pavement section (aggregate base and asphalt) and provide a new complete section. This will allow for remediation of any potential subgrade issues as a result of moisture infiltration.

As a cost saving alternative, it may be possible to just remove the asphalt surface and a small portion of aggregate base, to allow for a slightly thicker section of asphalt. In addition, if the roadway crown can be built up slightly, a thicker section of asphalt can be placed back, then tapering the thickness to match the outside edges at the gutter.

If the desire is to reuse the in-place aggregate base, the removal and replacement will require complete removal of the existing asphalt surfacing and replacing with a new structural section of asphalt surface on the existing aggregate base. This process will likely disturb the underlying aggregate base course (ABC) and possibly subgrade. After removal of the surface, the exposed base will require fine grading and re-compaction. It is recommended to remove additional aggregate base to provide a thicker section of asphalt concrete surface as necessary. The goal would be to leave as much of the existing aggregate base in place only reducing either the asphalt surface or the aggregate base slightly where there is a need to tie into fixed grades such as curbs, gutters or adjacent pavements. The exposed aggregate base should be re-compacted to at least 100 percent dry density as determined by ASTM D698.

For construction of a complete new pavement section the existing asphalt concrete and aggregate base should be completely removed along with additional subgrade soils as needed to provide space for the new pavement structural section. Once removal is complete the exposed subgrade should be compacted to at least 95 percent dry density as determined by ASTM D698.

While no obvious signs of wet or unstable soils were found in the limited boring locations, it is not uncommon to find overly moist soils (above optimum). These conditions can result in pumping issues and will impact obtaining compaction of the subgrade. If isolated zones of unstable or soft subgrade are found during site grading, there are several options available to help stabilize these conditions. The first option would be to remove the unstable soils to a depth on the order of 2 feet below the finished subgrade; deeper excavations may be required if the loose areas extend deeper. The soils may be set aside to dry (if necessary) and be re-compacted once they have dried sufficiently, or other local soils or asphalt millings from the existing roadway may be used.

As an alternate to complete removal of the soils, the soils can be, mixed with either a chemical lime slurry or dry cement. Since using lime or cement is only to dry and stabilize the soils, not part of the structural design, it is recommended to follow M.A.G. 309 for lime stabilization and M.A.G. 311. For cement stabilization using a standard proctor (ASTM D-698) for compaction requirements. It is recommended that a minimum of 8 inches of cement or lime stabilized soils be used below the pavement structural section.

Limited subgrade soil information indicated that the subgrade soils are clayey sands and silty clayey sand with trace to little amounts of gravel. These soils typically provide moderate support for pavements provided the soils do not experience an increase in moisture. Traffic data was not provided for a detailed analysis. **Several pavement sections have been provided for comparison. The County should choose the appropriate section to meet the anticipated traffic volume and life expectancy.** The section capacity is reported as daily ESALs, (Equivalent 18 kip Single Axle Loads). Each heavy truck such as refuse trucks or delivery trucks apply about 1 ESAL per vehicle.

Pavement Design Parameters:

Life:	20 years
Reliability:	90%
Overall Std. Deviation:	0.35
Structural Coefficient:	
AC	0.44
Aggregate Base	0.12
Initial Serviceability:	4.1
Terminal Serviceability:	2.6
Avg. R value:	39 (per ADOT Correlation)
M_R:	23,800 (per AASHTO design)

Table 3.2.1 Pavement Sections

Area of Placement	18-kip ESALs		Flexible		
	Daily	Total	AC (0.44)	ABC (0.12)	SN
Bella Vista Road	192	1,400,160	3.5”	6.0” (3)	2.26
	330	2,411,200	4.0”	6.0” (3)	2.48
	518	3,786,000	5.0”	4.0”	2.68

Notes:
1. Designs are based on AASHTO design equations and ADOT correlated R-values.
2. 4.0” AC on 6” AB is the recommended minimum section based on the street classification and use.
3. We assumed a minimum 6 inches of ABC will remain in place if the partial removal option is selected. Where the existing ABC is thicker than 6 inches, the capacity will be greater.

These designs assume that all subgrades are prepared in accordance with this report and in accordance with state and local specifications, 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.

Pavement base course material should be aggregate base per M.A.G. Section 702 Specifications. Asphalt concrete materials and mix design should conform to M.A.G. 710. 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 M.A.G. Section 321 and local municipality standards. The asphalt supplier should be informed of the pavement use and be 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.

3.3 Mill and Overlay Pavement Design

At this time, full depth replacement is not required for the newer paved curb lanes and would not provide the best use of funds. Simply adding another conventional asphalt overlay does not appear to be possible due to the need to meet the current grades of fixed points such as curbs, driveways and sidewalks. This option would be considered an intermediate fix which would probably add about **5 to 10 more years** to the roads life depending on the procedures used to prepare the surface and the routine maintenance schedule. This option is more part of a continued maintenance in an attempt at maintaining and extending the life of the pavement. With this option full depth repairs will be required on the older middle section of the roadway and areas that appear to be failing.

If a standard overlay cannot be completed due to fixed grade points, it is recommended to conduct a traditional mill and overlay. This can be done by either conducting a full width mill and overlay or by conducting an edge mill along the curb and other fixed grade points to provide space for the overlay. In the case of a full width mill and overlay it is recommended that the entire roadway (outer lanes) be milled at least 1.5 inches. For the edge mill option, it is recommended to mill to a depth of 1-inch below the lip of the gutter, feathering to zero inches at a distance of 8-feet away from the gutter. Using the taper option will allow for a slightly thicker section of asphalt to be placed back, adding to the structural capacity of the roadway.

In order to integrate the overlay process into the middle portion of the roadway and provide a uniform surface, the details for the new pavement in middle section, that is to be replaced, should be shown to keep the surface lower by the same 1 to 1.5 inches to eliminate the need to remove any new pavement. Due to the condition of the pavement, some pop-out and/or other damage should be expected, especially along the edge of the older pavement near the center of the road. The budget and specifications should include allowance to make these repairs prior to overlay.

A simple 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 1-2 years from placement of the overlay.

If standard conventional mix asphalt is to be used, replace the pavement with at least 1.5 inch of new hot asphalt concrete. It is recommended that Maricopa Association of Governments (MAG) Standard Specification Section 710 be specified. Depending on the final overlay thickness a ½ or ¾ inch mix designation should be used, using the Marshall mix design for heavy traffic. While the ¾ inch mix has a somewhat rougher texture, it offers more stability and resistance to scuffing, particularly in truck turning areas. Pavement should be installed per the quality standard of MAG Standard Specification Section 322. Life expectancy is on the order of **5 to 10 years** with maintenance. Deleting the major crack repairs is possible with this option but early reflective cracking should be expected. This will increase maintenance requirements.

As an alternative to the standard asphalt overlay, an asphalt rubber overlay could be considered. The asphalt rubber will be less prone to reflective cracking, but will not perform well in areas that contain sharp turning movements. If selected, the asphalt rubber overlay should be installed in accordance with MAG Standard Specification Sections 325 for the use of the rubberized asphalt. These specifications should be modified to meet the requirements of this project.

3.4 Full Depth Reclamation

Full depth reclamation would be another good alternative for the center (older) portion of the road and would provide a similar life expectancy as the complete removal and replacement option. This option would help provide a new pavement section for the roadways while minimizing importing or exporting the existing material. Full depth reclamation consists of milling/pulverizing the existing pavement (including aggregate base) in place. This material, after milling, should be similar in gradation to a traditional M.A.G. specified aggregate base. The material can then be graded as necessary to provide space for the new asphalt surface. This will also allow an opportunity to conduct minor re-grading, to help with any potential drainage issues. **Once grades have been determined the milled/pulverized material is then mixed with cement to provide for a cement treated base.** This can then be overlaid with a new asphalt surface.

Our investigation revealed that there is a range of asphalt thickness from 2.25 inches to 5.0 inches of asphalt surface on at least 6.0 inches of aggregate base. Based on this variation we are assuming that the nominal thickness of cement treated base of approximately 6 inches can be obtained.

Table 3.3.1 Full Depth Reclamation

Area of Placement	Daily 18-kip ESALs	Total 18-kip ESALs	AC (In.)	CTB (In.)	SN	Total Thickness (in.)
Bella Vista Road	330	2,411,000	2.5”	6.0”	2.48	8.5”
	541	3,952,000	3.0”	6.0”	2.70	9.0”

Notes
1. Designs are based on AASHTO design equations and ADOT correlated R-values.
2. A structural coefficient of 0.23 was assigned for the Cement Treated Base with a 7 day compressive strength of 400 psi (± 100 psi).

For this option it would be necessary to conduct a mix design to determine the compressive strength of the stabilized base (a recommended target value of 400 psi ± 100 psi at 7 days is recommended). A slightly lower strength cement treated base is recommended to help reduce the potential for reflective cracking in the surface. Typically the cement will be mixed at a percentage of 4-6% depending on the material mixture. The mix design will determine the recommended cement content to meet the required strength requirement. Additional precautions to reduce reflective cracking of the pavement from the cement treated base include placing a thin layer (2-3 inches) of aggregate base material between the cement treated soils and the asphalt surface. Micro-cracking the cement treated base with a smooth drum vibratory roller after the CTB has set up is also a method used to reduce the potential for reflective cracking in the asphalt surface. Proper curing procedures will also further reduce the potential for reflective cracking in the asphalt.

Asphalt concrete materials and mix design should conform to M.A.G. 710. 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 M.A.G. 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.

3.5 Seal Coat/Surface Seal

The outside lanes of the roadway contain a slightly thicker and newer section of pavement. These pavement sections appear closer to what would be expected for this classification of roadway. This newer pavement is generally performing adequately for the current loading conditions. The surface is experiencing minimal signs of aging (oxidation, stripping, and the early signs of longitudinal and transverse cracking), therefore a cost saving alternative would be to conduct surficial maintenance in this area, such as a slurry seal or seal coat. As these surface treatments do not typically contain an aggregate (sand only), 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 with a compatible (SS-1h) prime coat.

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. 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, product specification sheets and examples of roadways where this seal has been applied. The owner should then visit those applications to make sure that is the type of finish is acceptable. For example a thin ‘spray’ applied fog seals may not hide the patches completely or it may take several applied coats if that is the desire. We would be glad to accompany the owner.

3.6 Crack Sealing Procedure

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 using high-pressure air, sandblasting, wire brushing, hot air blasting or high-pressure water. This is a key step to crack sealing of filling. If the crack is not thoroughly cleaned, the sealant will not adhere to the sides. Sand blasting, although the best at cleaning, 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 the sealing operation 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.

3.7 Costs and Associated Life

Based on the current condition of the roadway, there are a number of means and methods for conducting the rehabilitation and maintenance of the pavement. As discussed, the entire roadway does not require full reconstruction and it would likely not be a good use of the County's funds. Instead, we are proposing to conduct reconstruction of the old and failing pavement in the center portion of the road by either full depth reconstruction or reclamation with cement. This will provide a 20+ year design life with regular routine maintenance. The outer lanes (newer pavement), are performing adequately and appears to have sufficient pavement for the current loading conditions, therefore reconstruction is not necessary and

surficial maintenance can be conducted. Options for either a mill and overlay or surface seal/seal coat are provided. The mill and overlay will add approximately 7 to 10 years to the pavement, while the slurry seals/seal coats will typically have a life span of 2 to 5 years.

Due to the number of options up for consideration, putting a cost together for each scenario would be difficult, however once a decision has been made or the options have been narrowed down some, Speedie & Associates and can aid in providing a cost comparison versus life of the different options. For reference, the following table provides some typical unit rates for various types of repairs.

Table 3.7.1 Unit Costs for Various Repairs

Repair Type	Unit Cost
Fog Seal	$0.25/SY
Plastic Seal	$0.40/SY
TRMSS Seal	$0.60/SY
Slurry Seal	$2.20/SY
1.5” Rubber Overlay	$9.00/SY
1.5” Mill and Overlay	$3.50/SY
New Construction Collector	$25.00/SY

Once a decision has been made on which options are being considered from this project, additional analysis regarding the costs can be made. The costs provided in the table represent typical unit rates based on our recent experience with similar jobs and what other agencies are paying for these types of treatments.

4.0 GENERAL

Our analysis of data and the recommendations presented herein are based on the assumption that soil/pavement conditions do not vary significantly from those observed at the surface. 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 Soils 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, INC.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
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KEITH R.
GRAVEL
Date Signed 6/4/15
ARIZONA, U.S.A.
Expires 03/31/17

Keith R. Gravel, P.E.

Registered Professional Engineer (Civil)
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ARIZONA, U.S.A.
Expires 06/30/17

Gregg Creaser, P.E.

APPENDIX

FIELD AND LABORATORY INVESTIGATION

BORING LOCATION PLAN

LOG OF TEST BORINGS

TABULATION OF TEST DATA

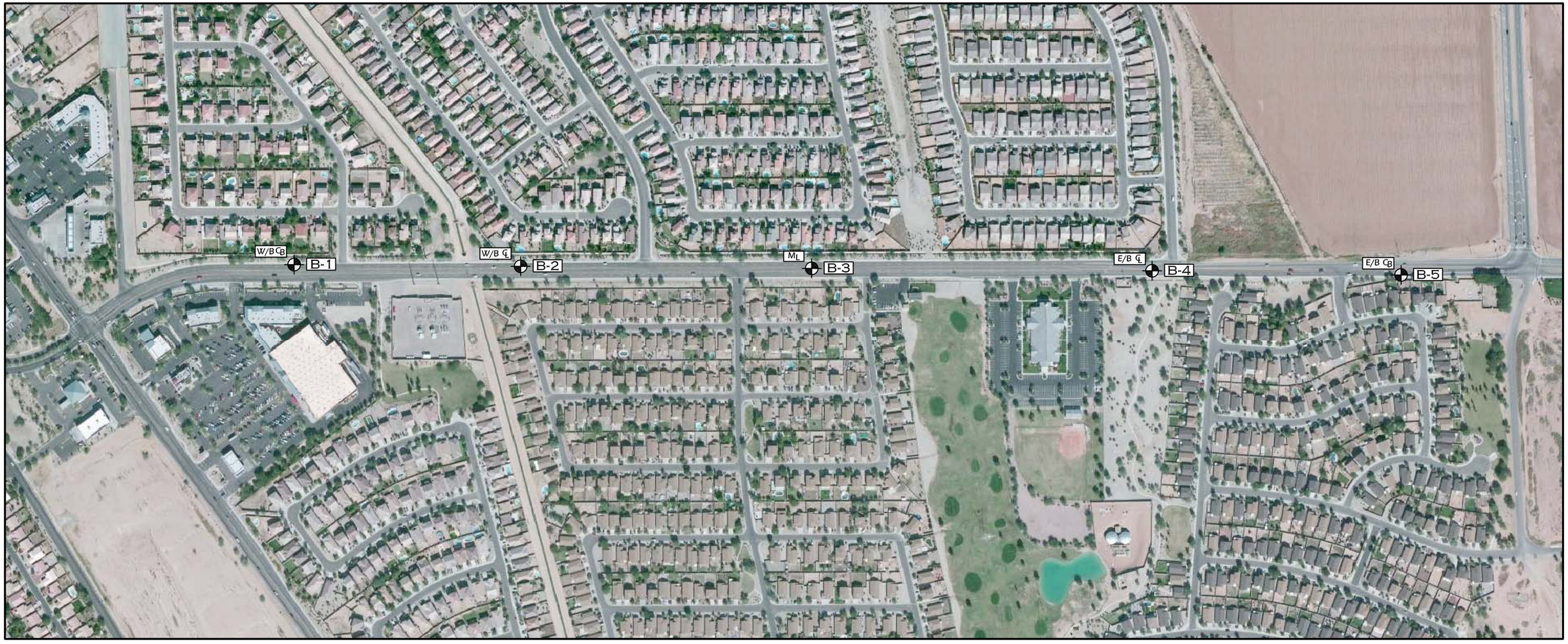
MOISTURE-DENSITY RELATIONS

R-VALUE

FIELD AND LABORATORY INVESTIGATION

On October 25, 2013, five pavement core test locations were drilled at the approximate locations shown on the boring Location Plan. All exploration work was carried out under the full-time supervision of our Project Engineer, who recorded the asphalt, aggregate base and subgrade conditions. The samples locations were cored and tested using a jeep mounted 8 inch solid stem auger.

Laboratory testing consisted of moisture content, grain-size distribution and plasticity (Atterberg Limits) tests for classification and pavement design parameters. Field and laboratory data is presented in this appendix.



- APPROXIMATE SOIL BORING LOCATIONS

N

LEGEND	
W/B CB	WESTBOUND CURB LANE
W/B CL	WESTBOUND CENTER LANE
ML	MEDIAN LANE
E/B CB	EASTBOUND CURB LANE
E/B CL	EASTBOUND CENTER LANE

IMAGE COURTESY OF: MARICOPA COUNTY ASSESSOR

SOIL BORING LOCATION PLAN

SHEET: 1 OF 1	DR: TSW	CHK: XXX	REV: XXX	DATE:10/30/13	PROJECT NO. 131275SA

BELLA VISTA ROAD PAVEMENT EVALUATION
BELLA VISTA ROAD & E. HUNT HIGHWAY
PINAL COUNTY, ARIZONA

SPEEDIE AND ASSOCIATES
GEOTECHNICAL/ENVIRONMENTAL/MATERIALS ENGINEERS
3331 E. WOOD ST. PHOENIX, ARIZONA 85040 (602) 997-6391

Rig Type: **Jeep Mounted**
Boring Type: **Solid 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	3 1/8" Asphalt Concrete					
0.3	6" Aggregate Base					
0.8	Brown SILTY, CLAYEY SAND (SC/SM-Dry) with Trace Gravel					
3.0	End of Boring	BS-1	3.0	4.1	NT	
5						

Boring Date: **10-25-13**
Field Engineer/Technician: **B. Amos**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

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

Bella Vista Road Pavement Evaluation

Hunt Highway to Gantzel Road

Pinal County, Arizona

Project No.: **131275SA**

_SPEEDIE 131275SA.GPJ GENGEO.GDT 11/5/13

Rig Type: **Jeep Mounted**
Boring Type: **Solid 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	2 1/8" Asphalt Concrete					
0.2	6" Aggregate Base					
0.7	Brown CLAYEY SAND (SC-Dry to Moist) with Little Gravel					
3.0		BS-1	3.0	7.8	NT	
	End of Boring					
5						

Boring Date: **10-25-13**
Field Engineer/Technician: **B. Amos**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

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

Bella Vista Road Pavement Evaluation

Hunt Highway to Gantzel Road

Pinal County, Arizona

Project No.: **131275SA**

_SPEEDIE 131275SA.GPJ GENGEO.GDT 11/5/13

Rig Type: **Jeep Mounted**
Boring Type: **Solid 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	Old Pavement 3" Asphalt Concrete New Pavement 5" Asphalt Concrete					
0.4	11" Aggregate Base					
1.3	Brown SANDY LEAN CLAY (CL-Dry to Moist) with Trace Gravel					
3.0	End of Boring	BS-1	3.0	10.4	NT	
5						

Boring Date: **10-25-13**
Field Engineer/Technician: **B. Amos**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

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

Bella Vista Road Pavement Evaluation

Hunt Highway to Gantzel Road

Pinal County, Arizona

Project No.: **131275SA**

SPEEDIE 131275SA.GPJ GENGEO.GDT 11/5/13

Rig Type: **Jeep Mounted**
Boring Type: **Solid 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	2 1/2" Asphalt Concrete					
0.2	7" Aggregate Base					
0.8	Brown SILTY SAND (SM-Dry) with Trace Gravel					
3.0	End of Boring	BS-1	3.0	4.8	NT	
5						

Boring Date: **10-25-13**
Field Engineer/Technician: **B. Amos**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

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

Bella Vista Road Pavement Evaluation

Hunt Highway to Gantzel Road

Pinal County, Arizona

Project No.: **131275SA**

_SPEEDIE 131275SA.GPJ GENGEO.GDT 11/5/13

Depth (feet)	Graphic Log	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 Concrete					
		0.3					
		7" Aggregate Base					
		0.9					
		Boring Stopped Due to Water Line in Close Proximity					
5							

Rig Type: **Jeep Mounted**
Boring Type: **Solid Stem Auger**
Surface Elevation: **N/A**

Boring Date: **10-25-13**
Field Engineer/Technician: **B. Amos**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

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

Bella Vista Road Pavement Evaluation

Hunt Highway to Gantzel Road

Pinal County, Arizona

Project No.: **131275SA**

SPEEDIE 131275SA.GPJ GENGEO.GDT 11/5/13

MOISTURE-DENSITY RELATIONS

PROJECT: Bella Vista Road Pavement Evaluation — PROJECT NO.: 131275SA

LOCATION: Hunt Highway to Gantzel Road — DATE: 10/25/13

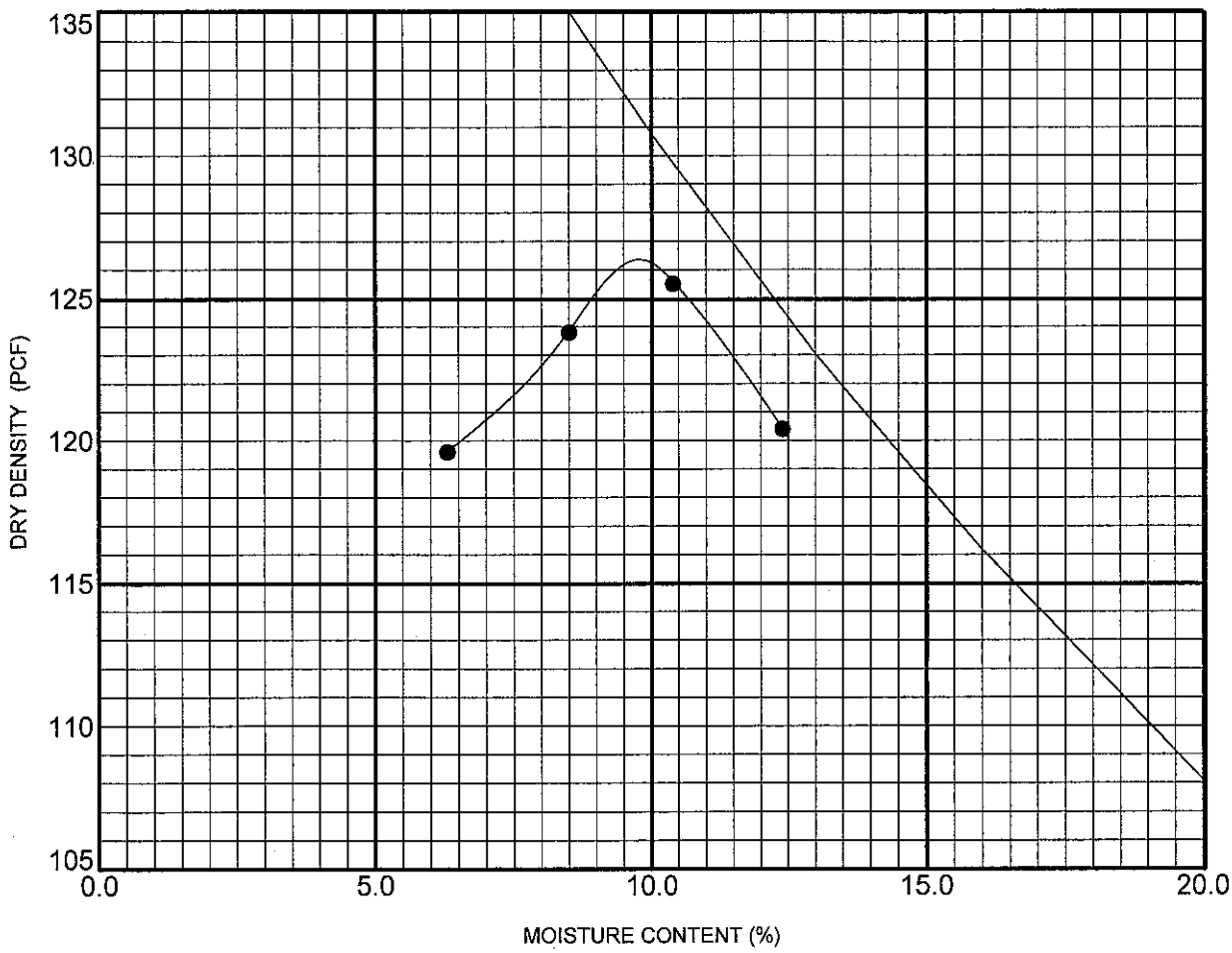
BORING NO.: COMP-1 SAMPLE NO.: BS-1 SAMPLE DEPTH: 1 to 3 — LABORATORY NO.:

METHOD OF COMPACTION: D698A

LIQUID LIMIT: PLASTIC LIMIT: PLASTICITY INDEX:

CLASSIFICATION: ASTM SOIL DESCRIPTION:

MAXIMUM DRY DENSITY: **126.2 PCF** OPTIMUM MOISTURE CONTENT: **10.0%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 131275SA.GPJ 11/5/13

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	BS-1	BULK	0.7 - 3.0	4.1	NT	25	64	87	94	100	26	19	7	SC-SM	SILTY, CLAYEY SAND
B-2	BS-1	BULK	0.8 - 3.0	7.8	NT	45	65	78	87	100	33	19	14	SC	CLAYEY SAND
B-3	BS-1	BULK	1.3 - 3.0	10.4	NT	57	77	91	96	100	32	18	14	CL	SANDY LEAN CLAY
B-4	BS-1	BULK	0.9 - 3.0	4.8	NT	49	75	87	93	100	23	20	3	SM	SILTY 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

Bella Vista Road Pavement Evaluation
Hunt Highway to Gantzel Road
Pinal County, Arizona
Project No. 131275SA

SPEEDIE AND ASSOCIATES

TABULATION OF TEST DATA 131275SA.GPJ GENGEO.GDT 11/5/13

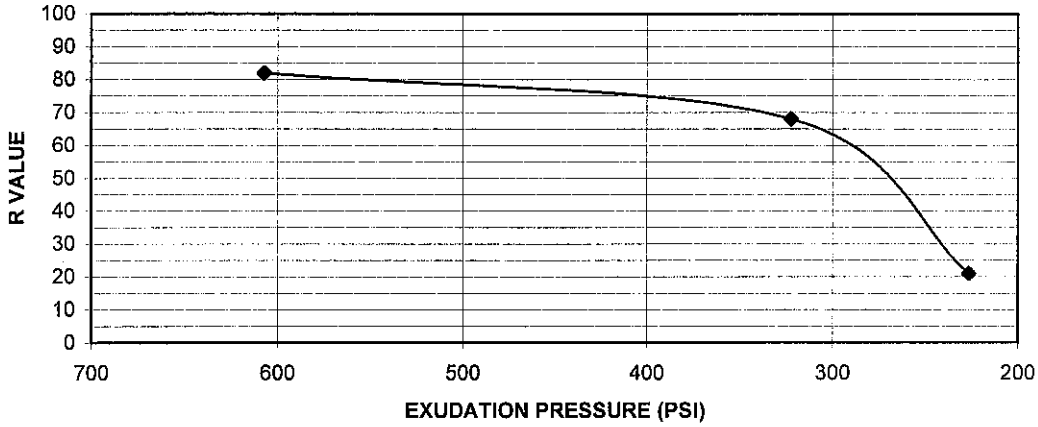
SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers
3331 EAST WOOD STREET • PHOENIX, ARIZONA 85040

Resistance R-Value and Expansion Pressure of Compacted Soils

PROJECT:	**Bella Vista Road Pavement Evaluation**	**JOB NO:**	**131275SA**
LOCATION:	**Bella Vista Road and Hunt Highway**	**LAB NO:**	**MW168**
SAMPLE SOURCE:	**COMP B2 & B3**	**REPORT DATE:**	**11/1/2013**

R VALUE CALCULATION - AASHTO T190

SPECIMEN I.D.	**A**	**B**	**C**
Moisture content	8.7%	9.2%	10.2%
Compaction Pressure (psi)	350	350	350
Specimen Height (inches)	2.48	2.49	2.53
Dry Density (pcf)	130.6	130.4	129.2
Ph @ 1000 (lb)	9.0	16.0	50.0
Ph @ 2000 (lb)	20.0	34.0	109.0
Displacement	3.76	4.46	4.31
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	607	322	227
R Value	82	68	21
Corrected R Value	82	68	21



R VALUE AT 300 PSI = 63