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TPF-5(291) FINAL REPORT:

DIURNAL CHANGES IN ROUGHNESS

Prepared On Behalf Of	Date	Project Number
State Pooled Fund Study TPF-5(291)	October 2021	56A0418-008 (TPF-5(291)) 219.03.10 (NCE)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 BACKGROUND

The NCE team was awarded the Transportation Pooled Fund (TPF) Study 5(291) to investigate data from the Long-Term Pavement Performance (LTPP) Specific Pavement Study (SPS)-2 experiment for concrete pavement design factors, with the Washington State Department of Transportation as the Lead State. This pooled fund study included the investigation and proposal of a pavement preservation experiment utilizing existing test site conditions. Upon completion of the initial phase of the study, several SPS-2 Tech Days were conducted to broaden the pavement community's knowledge of the SPS-2 experiment and to garner input on analyses the community would find useful. The Pooled Fund Technical Advisory Committee (TAC) also provided recommendations for additional analyses.

As a result, five additional tasks were focused on SPS-2 test sections:

- Conducting a deterioration rate analysis
- Analyzing performance data
- Investigating sources of non-LTPP data
- Analyzing joint score and area of localized roughness (ALR) impacts on performance
- Updating previous SPS-2 analyses

Upon completion of these tasks, an additional eleven tasks were proposed. The purpose of this supplementary extension of TPF-5(291) was to conduct further analyses of existing data from the LTPP SPS-2 concrete pavement experiment. The focus of this set of tasks was to investigate the impact of non-experimental factors on pavement performance. The following tasks were completed:

- Identifying agency-specific trends
- Analyzing the impact of construction and materials issues
- Reviewing early SPS-2 failures
- Identifying lessons learned from state supplemental sections
- Analyzing the impacts of climate, traffic, and overall condition on deterioration rate
- Comparing SPS-8 and SPS-2 performance
- Assessing diurnal changes in roughness
- Evaluating service life
- Comparing mix-design performance
- Conducting Mechanistic Empirical Pavement Design Guide (MEPDG) sensitivity analysis of portland cement concrete/lean concrete base (PCC/LCB) bond
- Evaluating transverse joint opening width

This report presents the results of assessing diurnal changes in roughness.

2.0 OVERVIEW

Roughness is a commonly used measure to evaluate pavement performance. It generally, measures relative changes longitudinally in the pavement surface that in turn affect ride quality. The most common index of roughness being the international roughness index (IRI).

IRI is calculated from differences in a pavement elevation profile measured during a profile survey. LTPP used a few different profiling vehicles and technologies over the program's tenure. As part of each equipment change, a study was conducted by the FHWA Long Term Pavement Performance (LTPP) team to verify measurements taken with the new equipment did not significantly deviate from the old equipment. While multiple sources of variability exist regarding profile measurement, the focus of this analysis is assessing seasonal and diurnal changes to the pavements and the resulting impact on IRI measurements.

With daily and seasonal changes in temperature, concrete slabs are subject to the phenomenon of curling and warping. Curling describes when the edges of a concrete slab curl up or down. Slab curl is typically caused by a temperature differential between the top and bottom of the concrete slab. During the day, when the top of the slab is hotter than the bottom, there is differential expansion across the depth of the concrete material from temperature. The internal stress generated from the differential expansion causes the slab to curl down. At nighttime, the differential temperature is reversed with the top of slab being cooler than the bottom resulting from the pavement absorbing and storing heat during the day. Therefore, at nighttime the slab curls down. Accordingly, slab curl is a temporary state that follows a diurnal cycle and can affect the pavement roughness profile.

Warping, on the other hand, is a result of differential shrinkage of concrete material and is typically a permanent condition that occurs to a concrete slab over time. When moisture in the concrete slab evaporates, differential drying shrinkage causes internal stresses in the slab to induce deformation.

The intent of this study is to assess seasonal and diurnal variability on the LTPP SPS-2 test sections. To simplify the methodology, this analysis assumed diurnal and seasonal variations in IRI were affected by the temporary deformation caused by curling, rather than the permanent deformation caused by warping. Since warping is permanent and typically occurs over time, the deformation of the slab can be considered as part of the pavement's performance, noting it is separate from deterioration caused by traffic loading. This analysis focused on analyzing MRI measurements with respect to temperature gradient, which is subject to seasonal and diurnal changes. The following analyses were performed:

- Identifying available and useful data
- Characterizing diurnal and seasonal changes
- Identifying pattern in the temperature gradient cycle
- Interpreting the results roughness adjustment case studies

3.0 DATA AVAILABILITY

Profile surveys are performed regularly on LTPP test sections to measure roughness in the right and left wheel-paths of the pavement surface. Over time, measurements were also taken midlane, but those are not considered as part of this report. LTPP profiling equipment and technologies have changed over the long history of the program, with assessments at each change to ensure a standard of data quality was maintained. Equipment changes are not a source of significant variability in the time series measurements of roughness on LTPP test sections.

While LTPP profile surveys at SPS-2 sites were conducted frequently, aside from test sections included in the seasonal monitoring program (SMP), there was variability in the timing of test events over time. Because of this, seasonal and diurnal conditions of the pavement at the time of profile survey may significantly influence the roughness measurement, depending on how temperature and humidity gradients have affected the curl-and-warp state of concrete slabs. Figure 1 demonstrates how average air temperature at SPS-2 sites vary from survey to survey. When the climatic condition during profile surveys vary, roughness measurements can be confounded and changes in roughness over time may no longer be purely relative to the pavement condition.

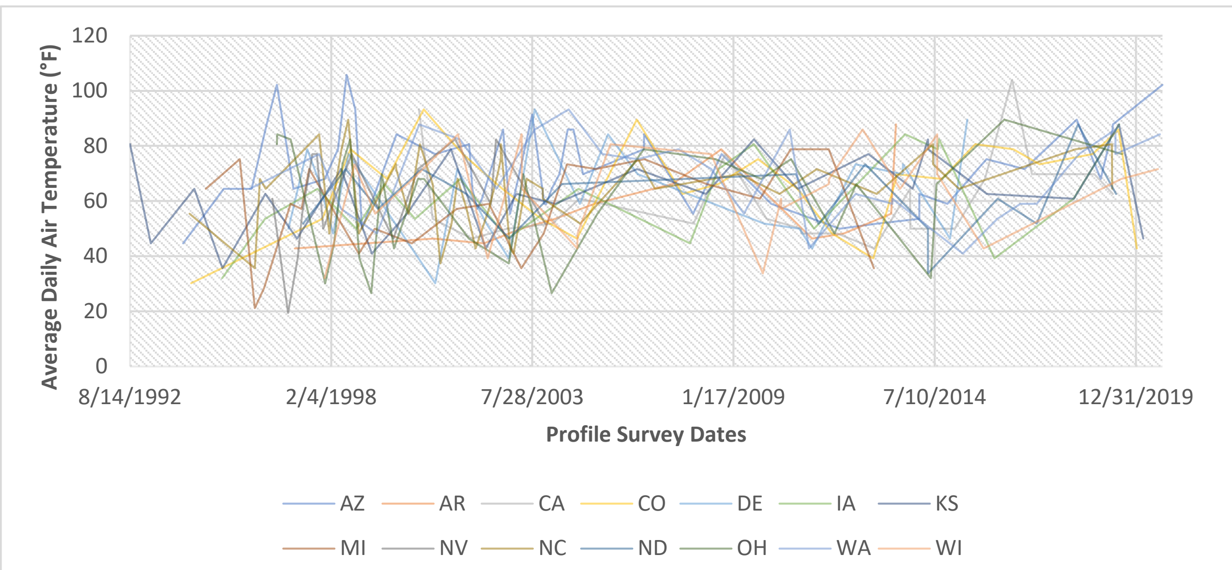

Figure 1. Average Air Temperature at Each Project at the Time of Profile Survey

As seen in Table 1, there were seven SPS-2 SMP sites in the LTPP program; one each in Arizona (040215), Nevada (320204), and Ohio (390204), and four in North Carolina (370201, 370205, 370208, and 370212). Average subsurface temperature measurements were recorded hourly using a thermistor (manufactured by MRC). Instrumentation of the PCC layer typically occurred sometime after its placement. The SMP monitoring data was collected for a period of one to nine years depending on the site. It should be noted that SMP monitoring would start and stop within these timeframes, based on LTPP Program Directives.

Table 1. Placement, Instrumentation, and Monitoring of SPS-2 SMP Sites.

State	SHRP ID	PCC Placement Date	PCC Instrumentation Date	Initialization of SMP Monitoring	Suspension of SMP Monitoring
AZ	040215	9/13/1993	8/25/1995	10/13/1995	10/7/2004
NV	320204	7/24/1995	10/9/1996	11/9/1996	9/9/1997
NC	370201	11/22/1993	5/9/1994	8/4/1994	12/10/2003
NC	370205	11/22/1993	5/9/1994	9/23/1994	4/30/2000
NC	370208	11/20/1993	5/9/1994	6/24/1997	4/30/2000
NC	370212	11/9/1993	5/9/1994	9/23/1994	4/30/2000
OH	390204	8/25/1995	2/12/1996	2/10/1998	9/1/1999

The SMP test sections were subject to more frequent profile measurements compared to typical (non-SMP) SPS-2 test sections. Figure 2 shows how seasonal variations affected roughness measurements at the Arizona SMP section 040215. In general, pavement roughness increases proportionally to accumulated traffic. Therefore, the various peaks and valleys seen in the roughness curves shown in Figure 2 were impacted by seasonal and diurnal conditions affecting the pavement rather than purely by changes in the pavement surface from damage. With consideration to traffic loading at this site, it can be observed that roughness steadily increased from 90 inch/mile to 110 inch/mile from 1994 to 2002, and then a slight increase in roughness to 120 inch/mile by 2020. The roughness indices shown in this figure include IRI in the left and right wheel-path, and the mean roughness index (MRI), which is the average roughness between left and right wheel-paths.

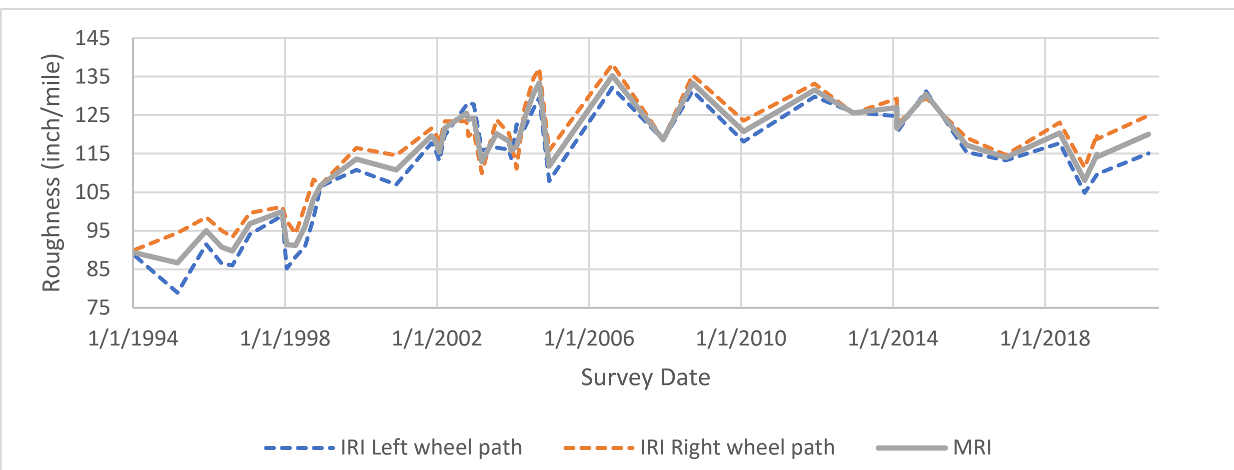

Figure 2. Section-Wide Roughness Measurements for Arizona 040215

4.0 CHARACTERIZING DIURNAL AND SEASONAL CHANGES

In the later years of the LTPP program diurnal profile measurements were taken for all SPS-2 sites on select visits. This study's intent was to develop a method of roughness correction that could also incorporate seasonal changes that can be applied to all visits or, even more broadly, to other LTPP jointed concrete test sections. Therefore, it was necessary investigate contributing factors to seasonal and diurnal changes, characterize how these factors may affect roughness, and correct for roughness variability.

4.1 Diurnal Air and Subsurface Temperatures

Figure 3 shows hourly measurements of air temperature and subsurface pavement temperature. The air temperature measurements show the test section goes through two phases: a warming period and a cooling period. In this example, the warming period lasts from the 8th hour to the 18th hour. The warming overlaps with the period of sun exposure, where air temperatures continue to build, peaking at the 16th hour, and subsequently abating. During the cooling period, air temperature continues to decrease from the 18th hour to the 23rd hour, after which it maintains a minimum temperature until the 8th hour of the next day. The temperature sensor at depth 0.5 inch (close to the pavement's surface) reacts very quickly to the ambient air temperature, absorbing heat during the warming period and continuing to dissipate as the warming period ends—through until the end of cooling period.

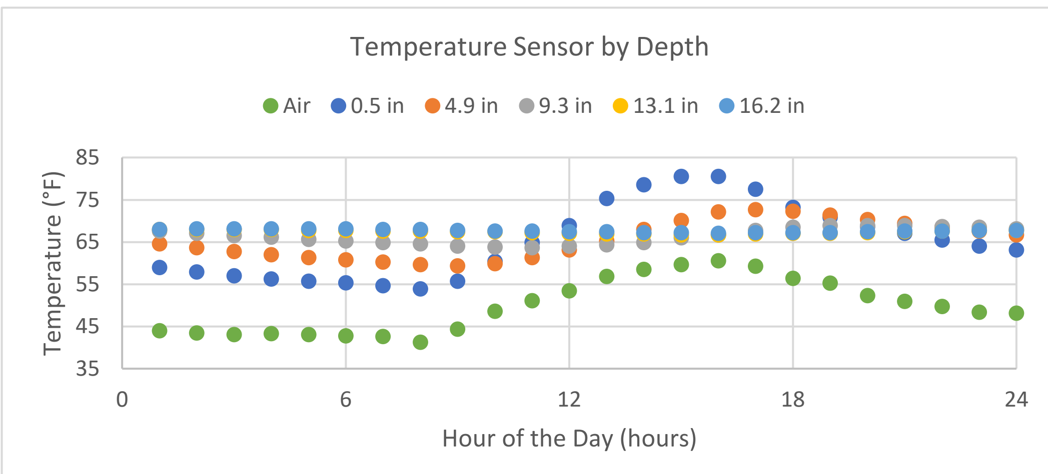

Figure 3. Air and Pavement Subsurface Temperature for Arizona 0215 on 12/05/1995.

At every temperature sensor of subsequent depth (away from the surface of the pavement), there is a lag in temperature absorption and dissipation reaction relative to the preceding depth. This lag demonstrates the transfer of heat as it either penetrates or dissipates in and out of the pavement. The two times in the day where the temperatures at surface and bottom of the pavement will converge to have the same temperature throughout the slab—resulting in a temperature gradient of zero. These two points of convergence occur approximately at hours 11 and 20. At the point of convergence, the asymmetry of internal stresses in the top and bottom of the slab shifts and the slab begins to transition from curl-up to the curl-down state or vice versa.

Temperature gradient is the change in temperature over the depth of the slab from its surface to the bottom of the slab. The pavement surface is directly exposed to the sun and typically corelates with exposure to solar radiation; from sunrise, peaking at midday, and decreasing until sunset. The bottom of the slab is not directly exposed to solar radiation, but is exposed to heat permeating from the surface of the slab during sun. While the warming period starts from sunrise to its peak at midday, the cooling period typically starts after the midday to sunset and into the night. Because of this, the cooling period can be divided into sub-phases: daytime cooling, nighttime cooling.

The pavement structure of section 040215 consists of 11-inch, low strength PCC slab over a 6.3-inch granular base. This puts the temperature sensor at 16.2 inches just above the subgrade. The temperature at depth 16.2 inch in Figure 3 changes very little during this diurnal cycle. However, this does not mean that the lower depths of the pavement are unaffected by the warming and cooling periods of the diurnal cycle. Figure 4 shows how the lower depths of the pavements (sub-roadbed temperature) has a consistent seasonal variation that is closely driven by the amount of sun exposure the pavement received throughout the year.

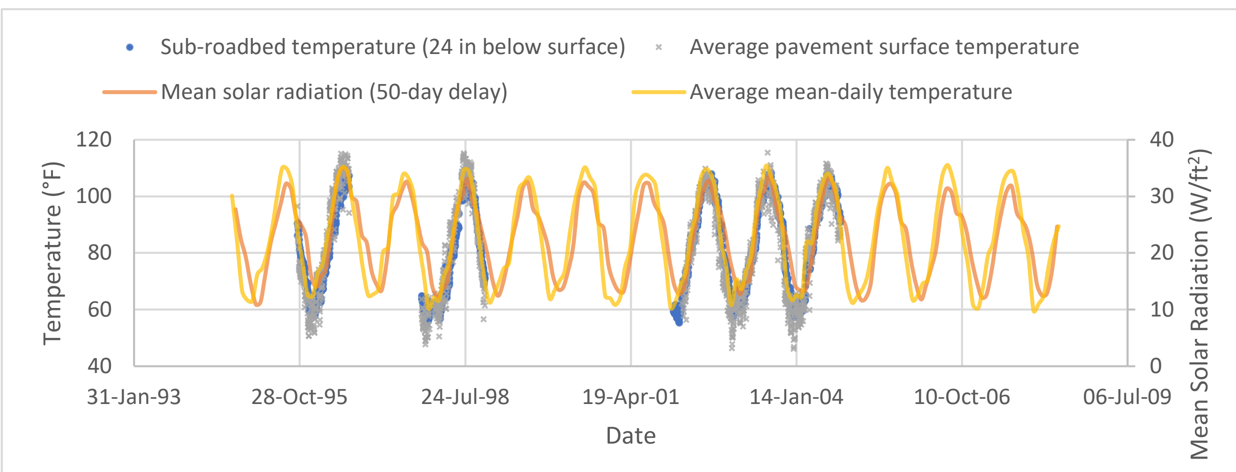

Figure 4. Comparison of Temperature at 24-inches below the Surface to the Mean Solar Radiation at Arizona 0215

In Figure 4, linear regression was used to estimate the sub-roadbed temperature at a depth of 24 inches from the pavement surface and the mean-daily temperature at the surface. While the temperature data has some gaps, the sinusoidal pattern represents the seasonal variation component of this pavement's temperature gradient. The amplitude of this sinusoidal pattern should be indicative of this pavement's ability to retain and diffuse heat.

The mean-daily pavement surface temperature Figure 4 is very close to the same value as the sub-roadbed temperature at any given time of the day. This implies that while sub-roadbed temperature did not fluctuate much during the diurnal cycle, daily warming and cooling does contribute to long-term (seasonal) changes as seen in the sub-roadbed temperatures.

Expectedly, the average pavement surface temperature (computed from subsurface temperature sensors) lines up with the mean-daily temperature (from automated weather system). Interestingly, the mean solar radiation from approximately 50 days prior also lines up with mean-daily temperature, average pavement surface temperature, and sub-roadbed temperature.

Figure 5 shows a simplification of the diurnal cycle's effect on pavement temperature gradient. The follow assumptions are used to describe temperature gradient with respect to seasonal and diurnal factors:

- If hourly pavement surface temperature measurements are not available, hourly air temperature adjusted by the mean-daily temperature should provide a close approximation.
- Temperature at the bottom of the pavement is assumed to be change at rate proportionally smaller to the rate of change of the pavement surface.
- Based on the thermal conductivity of the pavement layer, the warming period for the bottom the pavement will be delayed by a fixed amount of time from the warming period of the top layer.

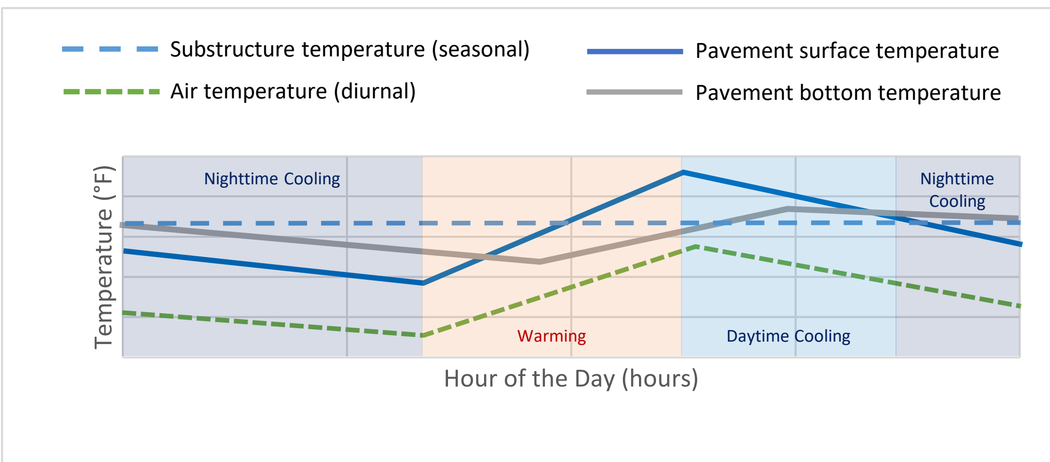

Figure 5. Simplified Temperature Gradient Diurnal Cycle

4.2 Concept for Correcting for Temperature Gradient

As temperature gradient changes throughout the day, so does the curl-state of the pavement slab; and as the curl-state changes, so does the amount of roughness. Ideally, to know the true roughness of the pavement, the profile measurement should be taken at a time of day when the slab in a neutral or consistent state of curl. Although finding the right timing could also be a challenge. As the nighttime cooling phase transitions to the warming phase, the slab transitions from a state of curl-up to curl-down. When the warming phase transitions to the daytime cooling phase, the slab transitions from a state of curl-down to curl-up. While the slab theoretically achieves a neutral curl-state, at some point during these transitions, it is unclear how dynamic the change in curling state is.

All of this assumes that other climatic factors are neutral; in reality, cloud cover or precipitation adds an element that would confound this simplified diurnal cycle. However, in theory, if roughness measurements can be assumed to correlate to the temperature gradient, then estimating the time when the warming phase transitions to the cooling phase would result in a roughness measurement that represents the neutral curl-state of the slab.

Profile surveys at LTPP test sections consists of multiple runs at varying time intervals, therefore an MRI measurement at an approximate transition point in the curl-state maybe possible using linear regression within the defined warming and cooling (daytime/nighttime) phases.

4.3 Seasonal Variations in Warming and Cooling Phases

Figure 6 shows a summary of average time of day that marks the beginning and end of warming and cooling periods at every SPS-2 project. On each SPS-2 project, the warming period is longer during the summer months of June and September, as compared to the winter months of December and March. The warming period tends to be shifted by an hour in the months of Marchand September, which is likely due daylight savings adjustment. This shift is not seen in Arizona where daylight savings is not observed. The average warming periods from state to state are typically very similar, and it can be inferred the warming period is largely dependent on sun exposure. However, the averages do not capture the variability of warming periods from day to day. The warming periods on certain days could be more atypical due to climatic conditions, which can then consequentially affect the temperature gradient and its effect on curl and warp.

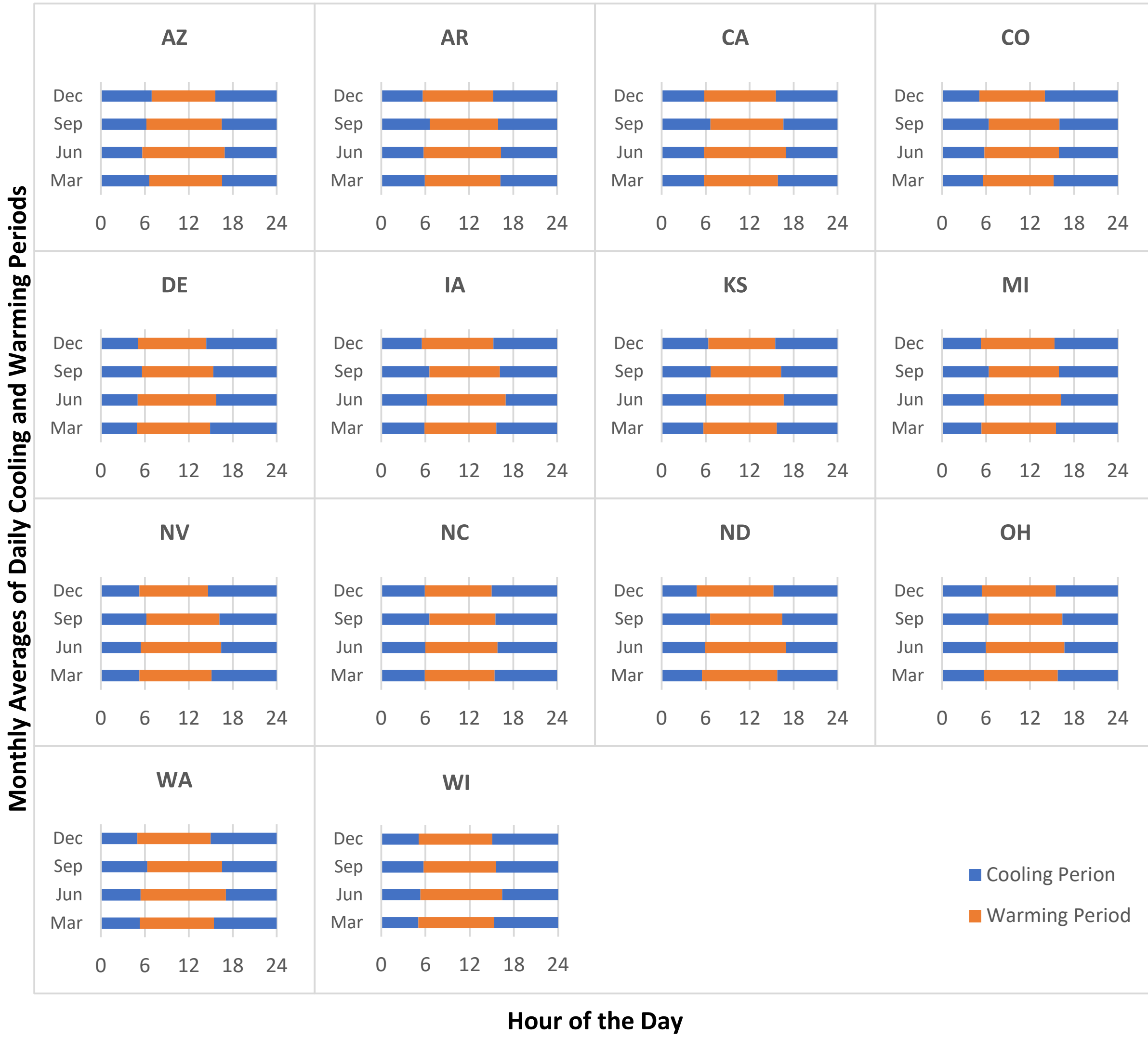

Figure 6. Average Warming and Cooling Periods by SPS-2 Project and Month.

4.4 Diurnal Phases of Temperature Gradient

Figure 7 shows the relationship between temperature gradient (ΔT), the air temperature, and the internal pavement temperature at SMP site 040215. The hourly changes in air temperature were closely correlated to the hourly temperature changes near the pavement surface (at a depth of 0.5 inches). Although, the pavement surface temperature is generally warmer than the air temperature, the points of inflection in the temperature curve are the same—the same inflection is also seen in the temperature gradient. This means the time of neutral curl-state, which is assumed to occur between the inflection points when temperature gradient is zero. The warming and cooling phases of temperature gradient could be estimated from either the inflection points of the air temperature or the surface temperature.

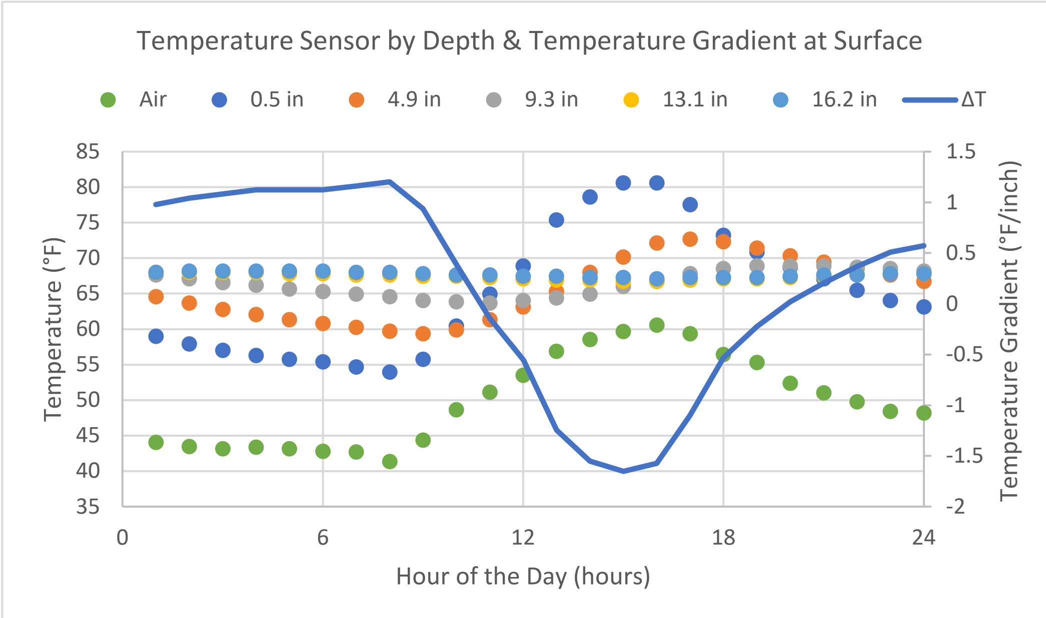

Figure 7. Temperature Gradient for Arizona 040215 on 12/05/1995.

Both Figure 7 and Figure 8 show pavement surface temperature has a somewhat inverse relationship with temperature gradient. Figure 8 shows the daily cyclical changes in temperature gradient transitioning through three phases. These three phases can be categorized as the warming phase, daytime-cooling phase, and the nighttime-cooling phase, which coincide with the warming and cooling periods of the pavement surface. The warming phase begins at sunrise and steadily increases as solar radiation increases. During the warming phase, the temperature gradient quickly decreases. When the pavement surface temperature peaks, typically an hour or two after peak solar radiation, the warming phase ends, and transitions to the daytime cooling phase. During daytime cooling, the temperature gradient quickly increases. An hour or two after sundown, the temperature gradient transitions to a nighttime cooling phase, where it continues to increase at a more gradual rate (as seen in hours 16 to 24 of Figure 7).

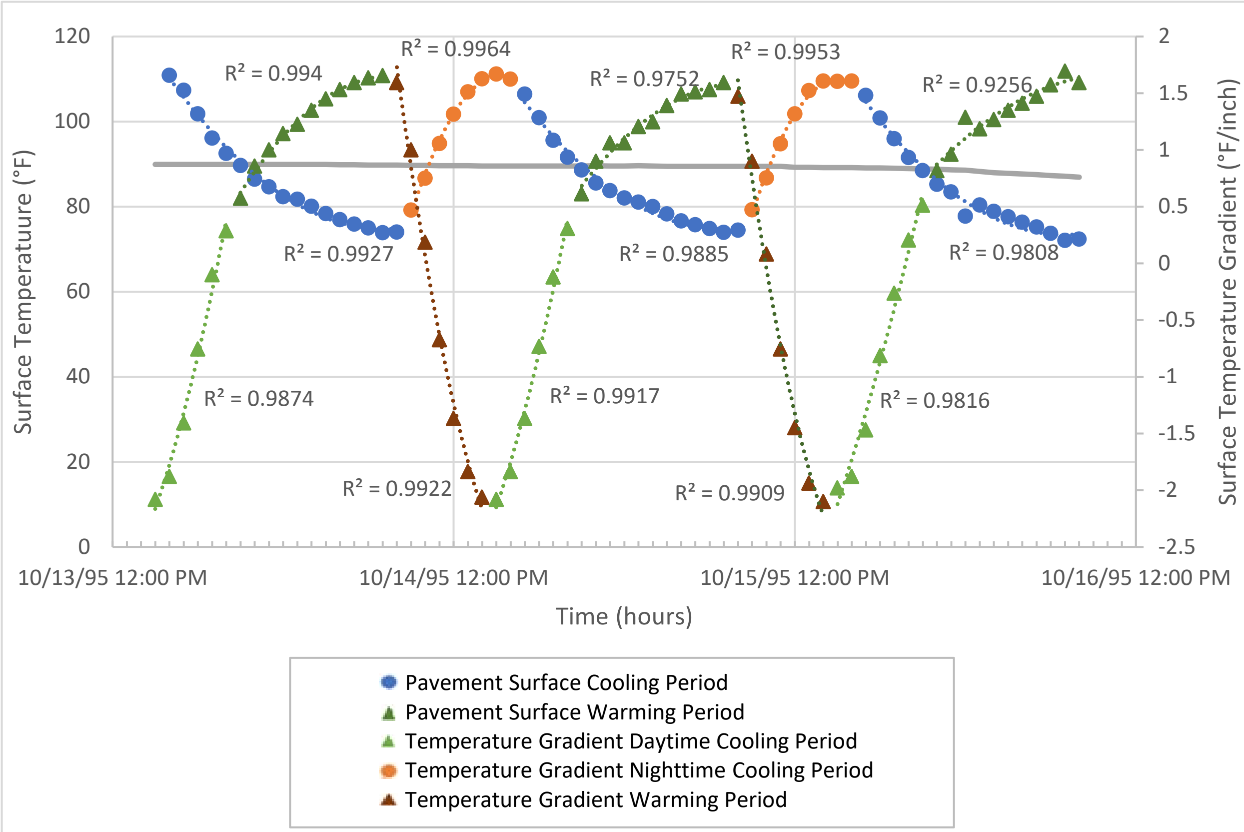

Figure 8. Impact of Pavement Surface Temperature on Temperature Gradient for Arizona 040215.

5.0 RELATIONSHIP BETWEEN TEMPERATURE GRADIENT AND MRI

Figure 9 shows MRI measurements at the SMP site 040215. The MRI measurements have been categorized into bins in increments of 1°F per inch. This figure demonstrates the effect temperature gradient has on MRI during the diurnal cycle. MRI measurements taken at higher temperature gradients typically correlate to higher measurement of MRI. From this figure, it can be perceived that the true MRI of 0402015 is somewhat linear. The MRI trends without regard to temperature gradient may appear non-linear to from the seasonal and diurnal variability.

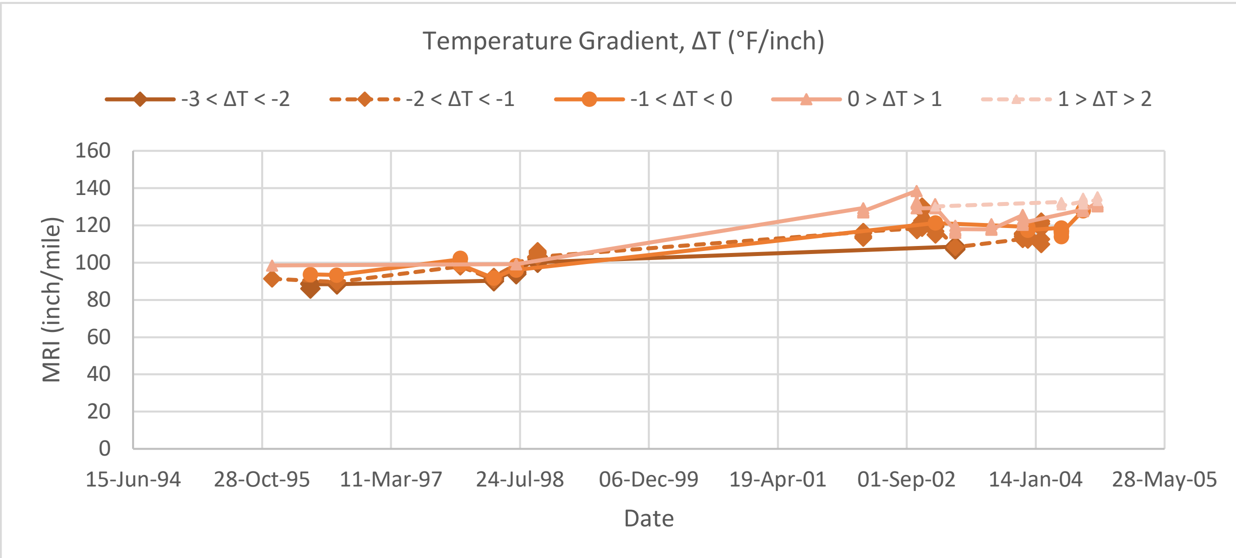

Figure 9. MRI for Arizona 040215 by Bins for Temperature Gradient

5.1 Estimating Temperature Gradient from FWD Testing

Non-SMP LTPP test sections are not instrumented with temperature sensors at varying depths, therefore information on temperature and their inflection points is not typically available. Using hourly air temperature from virtual weather stations was not reliable to estimate the seasonal inflection points of temperature gradients during the diurnal cycle. Ideally, to estimate roughness for the neutral curl-state, there was need to model temperature gradient for every test section and determine the time of day for any given day of the year where temperature gradient would be zero (ΔT=0).

For non-SMP test sections, an alternative means for estimate temperature gradients was needed. Temperature gradients were calculated from temperature measurements (at varying depths) taken during failing weight deflectometer (FWD) testing. Figure 10 shows the correlation to FWD temperature gradients and MRC temperature gradients. The graph suggests that FWD temperature gradients have some variability, but may be useful to calculate temperature gradients for non-SMP LTPP test sections.

However, FWD testing on LTPP test section are typically performed on different dates than profile testing, and also could have been collected at varying times of the day. FWD testing was not performed with the intention of capture temperature gradients and specific seasonal and diurnal intervals. Therefore, modeling temperature gradients at non-SMP test sections to use in conjunction with profile data proved to be a challenge. Although, the research team had some success in developing a sinusoidal model for air temperature at SPS-2 sites, they were not successful in developing a model for temperature gradient because of the inconsistency and availability of the temperature gradient measurements.

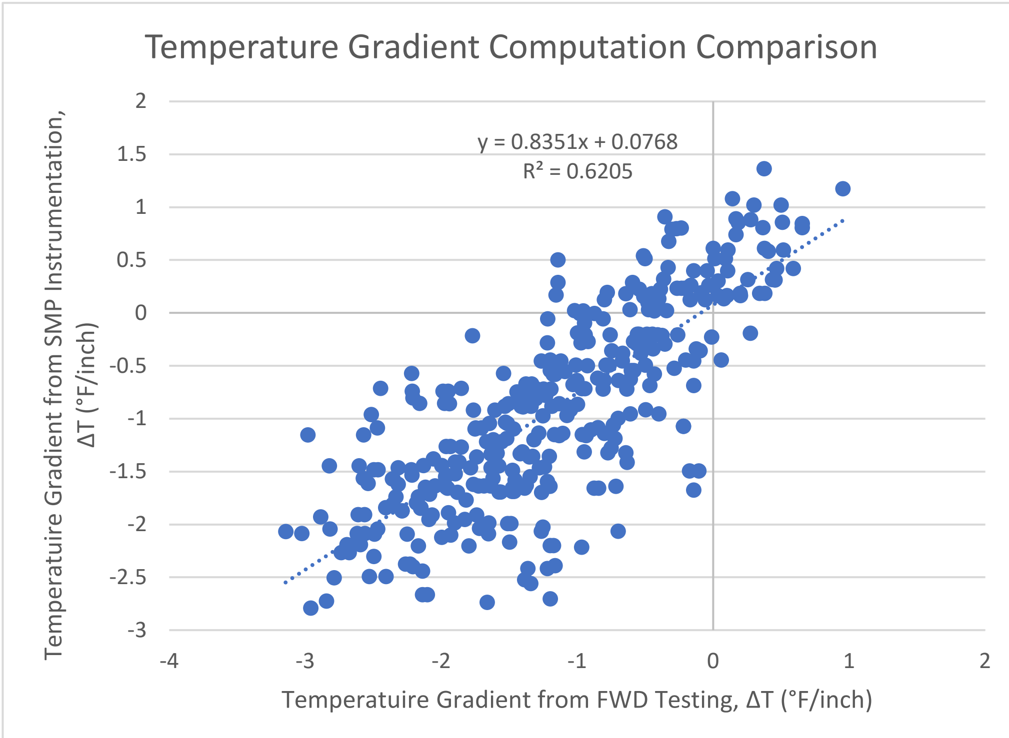

Figure 10. Comparison of Temperature Gradient Calculated from SMP Instrumentation and FWD Testing for Arizona 0215.

Figure 11 shows the temperature gradients from FWD testing for non-SMP test section Ohio 390201. The data demonstrate some potential in modeling temperature gradient. FWD testing performed in the same season had trends in hourly temperature gradient that coincided with each other. For example, the temperature gradient pattern in April 2001 was very similar to the pattern in April 2003. However, as seen in many sites (including this example of section 390201), the seasonal trends in the temperature gradient cycle become inconsistent in the winter months. In Figure 11, the temperature gradient pattern in September 1999 and September 2004 were very different. The pattern in September 2004 was more like the pattern for December 1996. The pattern for July 1997, which shows measurements during the daytime cooling phase, was reasonable as longer days were expected in summer months. The following were some challenges in modeling this data:

- Inconsistent FWD temperature gradient patterns in winter months.
- Estimating the beginning and end of warming and cooling phases to apply linear regression to temperature gradients.

- Accounting for outlier measurements in the temperature gradient patterns.
- Accounting for atypical weather condition during measurement, such as: cloud cover, relative humidity, precipitation, accumulated moisture in the subgrade, snow cover, frozen state of the subgrade, instrument variability, temperature depth variability, rater variability, etc.

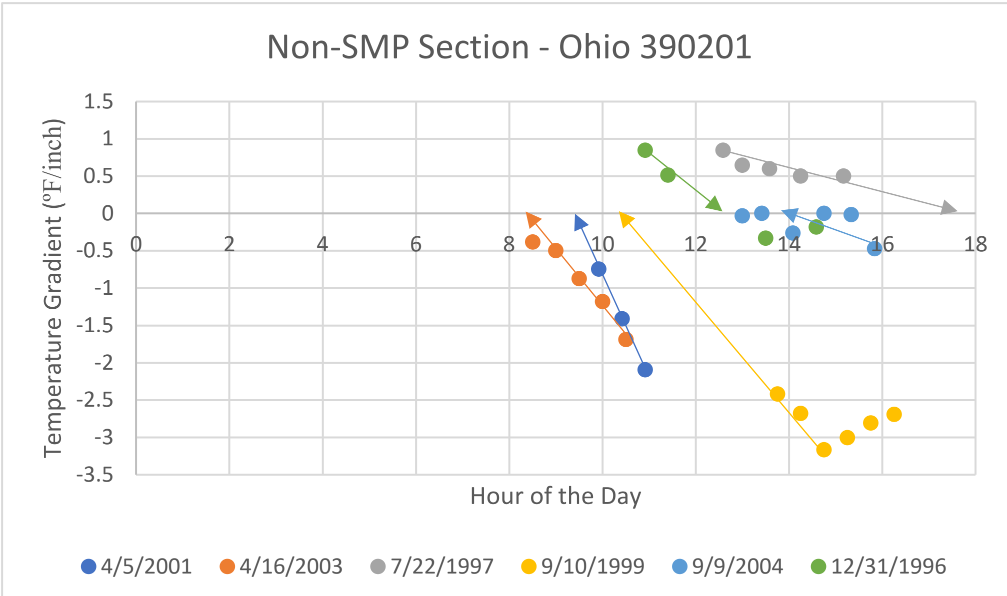

Figure 11. FWD Temperature Gradients at Ohio 390201.

6.0 SMP CASE STUDY FOR NEUTRAL CURL-STATE MRI

For the reasons stated earlier, it was difficult to estimate temperature gradient for non-SMP SPS-2 test sections during profile survey runs. However, SMP SPS-2 test sections, while in the SMP program, were monitored continuously through instrumentation. Therefore, profile survey conducted when SMP data was available should have a temperature gradient associated with each profile run. A list of MRI measurements for profile runs of SMP test sections are included in Appendix A with the corresponding temperature gradient according to MRC thermistor readings.

Using linear regression, the neutral curl-state MRI was estimated. To simply the procedure, the boundaries of the linear regression were confined to the date, as follows:
Nighttime cooling phase: midnight to time of maximum ΔT
Warming phase: time of maximum ΔT to time of minimum ΔT
Daytime cooling phase: time of minimum ΔT to midnight

6.1 Findings

At least two profile runs must occur within the defined phase boundaries to perform the linear regressions. Because there was a need to overlap the profile runs with the available MRC temperature gradient measurement, the adjusted (neutral curl-state) MRI within the monitoring period of the SMP program could be compared the unadjusted average MRI.

Time-series graph for comparing the adjusted MRI and the unadjusted average MRI can be found in Appendix B. For some SMP SPS-2 test sections, there too few of adjusted MRI value to use for comparison to the unadjusted MRI. However, with the available sections, adjusted MRI did not adequately remove the variability as compared to the unadjusted MRI.

From these results, it can be concluded that using linear regression to equate MRI to a measurement at zero temperature gradient was not sufficient to correct its seasonal and diurnal variability. This suggests either the methodology was incorrect or there were other factors that contributed to the variability beyond temperature gradient, such as: amount of seasonal sun exposure, seasonal variation in air temperature, diurnal and seasonal moisture exposure, or the condition of the pavement.

7.0 BUILT-IN SLAB CURL

Curl-and-warp generally describe deformation of concrete slabs over time. Curling is temporary deformation and warping a permanent one that occurs over the course of the life of a jointed plain concrete (JCP) pavement. Built-in curl, instead, describes permanent deformation because of the curing process during construction. The mechanism for built-in curl is different from warping, in that it occurs though autogenous shrinkage rather than drying shrinkage.

There is some debate as to whether built-in curl is actually permanent, and if so, how much does it contribute to pavement roughness in the long-term. The built-in curl may reduce in the short-term due to concrete creep. Its significance is typically associated with the quality of construction rather than long-term pavement performance. Often, newly constructed pavements are subject to smoothness requirements which can be affected by built-in curl for JPC pavements. For example, while reviewing the SPS-2 construction report, it was found the contractor, after profiling, used diamond grinding on some test sections to meet the smoothness requirement.

The latest version of AASHTOWare PavementME Design (PMED) software has an input for effective temperature differential during construction to model the built-in curl of JCP pavements. After, extensive review, information about the effective temperature difference between the top and bottom of the slab during construction could be found for SPS-2 test sections. Even among the SMP SPS-2 test sections, instrumentation of temperature probes in the PCC occurred several months after construction and the construction reports did not record anything other than ambient air temperature during construction. PMED use of effective temperature difference as a mechanism for permanent built-in curl suggests temperature differential as the mechanism instead of autogenous shrinkage.

8.0 SUMMARY OF FINDINGS

This investigation into the diurnal and seasonal and diurnal changes in this study was quite challenging, not only in terms of identifying contributing environmental factors to roughness variation, but also in developing an effective methodology given the available data and the scope of the study.

In this study, MRI from profile runs were adjusted using linear regression with the correlating temperature gradients from SMP monitoring. The MRI value was linearly adjusted to the time of day when temperature gradient would be equal to zero. The comparison was performed as case study on seven SMP SPS-2 test sections.

Ultimately, this study was not able to adjust the MRI value sufficiently to significantly reduce the variability seen in the average MRI. There likely were additional factors contributing to the variability that this study was not able to fully explore. Future consideration for a new adjustment procedure should consider the following factors:

- Amount of seasonal sun exposure
- Seasonal variation in air temperature
- Diurnal and seasonal moisture exposure
- Condition of the pavement

While this study was not able to develop temperature gradient models using FWD temperature measurements, the potential to do so remains where such data is available. The investigators did determine that FWD-based temperature gradients correlate with the MRC temperature gradients from instrumented SMP sites. The FWD temperature gradient data was sparse, but the expected pattern for diurnal changes in temperature gradient was present.

Appendix A

SMP SPS-2 Profile Runs

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
AZ	040215	12/5/95 9:14	98.50	0.75	WP
AZ	040215	12/5/95 14:56	91.50	-1.59	WP
AZ	040215	5/2/96 9:30	93.70	-0.14	WP
AZ	040215	5/2/96 14:58	87.70	-2.96	WP
AZ	040215	5/2/96 15:18	87.70	-2.92	NCP
AZ	040215	5/2/96 15:33	87.70	-2.77	NCP
AZ	040215	8/12/96 9:40	91.00	-0.53	WP
AZ	040215	8/12/96 11:26	91.00	-1.91	WP
AZ	040215	8/12/96 14:15	88.40	-3.18	NCP
AZ	040215	12/4/97 11:06	100.10	-0.33	WP
AZ	040215	12/4/97 11:40	100.10	-0.58	WP
AZ	040215	12/4/97 12:13	100.10	-0.83	WP
AZ	040215	12/4/97 12:27	100.10	-0.90	WP
AZ	040215	12/4/97 12:44	100.10	-1.07	WP
AZ	040215	4/13/98 10:13	91.50	-0.97	WP
AZ	040215	4/13/98 10:21	91.50	-1.05	WP
AZ	040215	4/13/98 10:24	91.50	-1.09	WP
AZ	040215	4/13/98 10:27	91.50	-1.13	WP
AZ	040215	4/13/98 10:29	91.50	-1.16	WP
AZ	040215	4/13/98 15:19	90.90	-2.81	NCP
AZ	040215	4/13/98 15:22	90.90	-2.73	NCP
AZ	040215	4/13/98 15:25	90.90	-2.71	NCP
AZ	040215	4/13/98 15:27	90.90	-2.70	NCP
AZ	040215	4/13/98 15:30	90.90	-2.68	NCP
AZ	040215	7/9/98 8:22	97.60	0.00	WP
AZ	040215	7/9/98 8:28	97.60	-0.06	WP
AZ	040215	7/9/98 8:33	97.60	-0.12	WP
AZ	040215	7/9/98 8:38	97.60	-0.18	WP
AZ	040215	7/9/98 8:45	97.60	-0.19	WP
AZ	040215	7/9/98 12:10	94.60	-2.56	WP
AZ	040215	7/9/98 12:15	94.60	-2.60	WP
AZ	040215	7/9/98 12:18	94.60	-2.63	WP
AZ	040215	7/9/98 12:22	94.60	-2.58	WP
AZ	040215	7/9/98 12:25	94.60	-2.60	WP
AZ	040215	9/30/98 11:58	105.10	-1.56	WP
AZ	040215	9/30/98 12:02	105.10	-1.60	WP
AZ	040215	9/30/98 12:06	105.10	-1.64	WP
AZ	040215	9/30/98 12:10	105.10	-1.68	WP

[1] NCP – nighttime cooling phase
WP – warming phase
DCP – daytime cooling phase

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
AZ	040215	9/30/98 12:14	105.10	-1.72	WP
AZ	040215	9/30/98 14:35	101.50	-2.13	NCP
AZ	040215	9/30/98 14:39	101.50	-2.13	NCP
AZ	040215	9/30/98 14:43	101.50	-2.21	NCP
AZ	040215	9/30/98 14:47	101.50	-2.19	NCP
AZ	040215	9/30/98 14:50	101.50	-2.18	NCP
AZ	040215	3/15/02 9:40	128.00	0.68	WP
AZ	040215	3/15/02 9:53	128.00	0.54	WP
AZ	040215	3/15/02 10:00	128.00	0.46	WP
AZ	040215	3/15/02 10:03	128.00	0.43	WP
AZ	040215	3/15/02 10:07	128.00	0.39	WP
AZ	040215	3/15/02 14:30	115.30	-1.44	WP
AZ	040215	3/15/02 14:34	115.30	-1.45	WP
AZ	040215	3/15/02 14:41	115.30	-1.52	WP
AZ	040215	3/15/02 14:45	115.30	-1.52	WP
AZ	040215	3/15/02 14:49	115.30	-1.52	WP
AZ	040215	10/9/02 8:42	133.00	0.81	WP
AZ	040215	10/9/02 9:10	133.00	0.55	WP
AZ	040215	10/9/02 9:15	133.00	0.51	WP
AZ	040215	10/9/02 9:20	133.00	0.46	WP
AZ	040215	10/9/02 9:33	133.00	0.30	WP
AZ	040215	10/9/02 13:46	118.20	-1.82	WP
AZ	040215	10/9/02 13:53	118.20	-1.83	WP
AZ	040215	10/9/02 13:59	118.20	-1.85	WP
AZ	040215	10/9/02 14:09	118.20	-1.87	WP
AZ	040215	10/9/02 14:34	118.20	-1.84	WP
AZ	040215	10/30/02 13:06	123.90	-1.26	WP
AZ	040215	10/30/02 13:16	123.90	-1.30	WP
AZ	040215	10/30/02 13:26	123.90	-1.28	WP
AZ	040215	10/30/02 13:48	123.90	-1.40	WP
AZ	040215	10/30/02 14:07	123.90	-1.44	WP
AZ	040215	12/20/02 9:05	130.00	1.05	WP
AZ	040215	12/20/02 9:18	130.00	0.99	WP
AZ	040215	12/20/02 9:22	130.00	0.87	WP
AZ	040215	12/20/02 9:27	130.00	0.83	WP
AZ	040215	12/20/02 9:43	130.00	0.81	WP
AZ	040215	12/20/02 13:23	118.50	-0.96	WP
AZ	040215	12/20/02 13:39	118.50	-1.02	WP
AZ	040215	12/20/02 13:52	118.50	-1.11	WP
AZ	040215	12/20/02 13:59	118.50	-1.13	WP
AZ	040215	12/20/02 14:07	118.50	-1.15	WP
AZ	040215	3/7/03 9:28	117.70	0.35	WP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
AZ	040215	3/7/03 9:31	117.70	0.32	WP
AZ	040215	3/7/03 9:39	117.70	0.24	WP
AZ	040215	3/7/03 9:42	117.70	0.29	WP
AZ	040215	3/7/03 9:53	117.70	0.17	WP
AZ	040215	3/7/03 13:56	108.10	-2.00	WP
AZ	040215	3/7/03 13:59	108.10	-2.00	WP
AZ	040215	3/7/03 14:02	108.10	-2.01	WP
AZ	040215	3/7/03 14:05	108.10	-2.02	WP
AZ	040215	3/7/03 14:12	108.10	-2.04	WP
AZ	040215	7/25/03 8:34	118.60	0.39	NCP
AZ	040215	7/25/03 8:38	118.60	0.34	NCP
AZ	040215	7/25/03 8:57	118.60	0.12	NCP
AZ	040215	7/25/03 9:02	118.60	0.06	WP
AZ	040215	7/25/03 9:06	118.60	0.01	WP
AZ	040215	11/24/03 9:32	122.30	0.77	WP
AZ	040215	11/24/03 9:36	122.30	0.73	WP
AZ	040215	11/24/03 9:57	122.30	0.54	WP
AZ	040215	11/24/03 10:10	122.30	0.37	WP
AZ	040215	11/24/03 10:17	122.30	0.28	WP
AZ	040215	11/24/03 14:27	114.10	-1.46	NCP
AZ	040215	11/24/03 14:35	114.10	-1.46	NCP
AZ	040215	11/24/03 14:41	114.10	-1.60	NCP
AZ	040215	11/24/03 14:51	114.10	-1.55	NCP
AZ	040215	11/24/03 15:03	114.10	-1.50	NCP
AZ	040215	12/14/03 10:32	118.40	-0.03	WP
AZ	040215	12/14/03 10:36	118.40	-0.07	WP
AZ	040215	12/14/03 10:41	118.40	-0.12	WP
AZ	040215	12/14/03 10:47	118.40	-0.19	WP
AZ	040215	12/14/03 11:10	118.40	-0.46	WP
AZ	040215	12/14/03 15:16	113.30	-1.63	NCP
AZ	040215	12/14/03 15:29	113.30	-1.50	NCP
AZ	040215	12/14/03 15:35	113.30	-1.47	NCP
AZ	040215	12/14/03 15:42	113.30	-1.51	NCP
AZ	040215	12/14/03 15:55	113.30	-1.42	NCP
AZ	040215	2/4/04 13:47	116.90	-1.81	WP
AZ	040215	2/4/04 13:57	116.90	-1.85	WP
AZ	040215	2/4/04 14:19	116.90	-1.93	WP
AZ	040215	2/4/04 14:29	116.90	-1.85	WP
AZ	040215	2/4/04 15:01	116.90	-1.93	NCP
AZ	040215	4/22/04 5:05	131.80	1.21	NCP
AZ	040215	4/22/04 5:14	131.80	1.22	NCP
AZ	040215	4/22/04 5:19	131.80	1.22	NCP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
AZ	040215	4/22/04 5:34	131.80	1.21	NCP
AZ	040215	4/22/04 5:38	131.80	1.22	NCP
AZ	040215	4/22/04 9:53	116.50	-0.65	WP
AZ	040215	4/22/04 10:01	116.50	-0.75	WP
AZ	040215	4/22/04 10:11	116.50	-0.88	WP
AZ	040215	4/22/04 10:20	116.50	-0.99	WP
AZ	040215	4/22/04 10:24	116.50	-0.98	WP
AZ	040215	7/15/04 4:17	133.10	1.23	NCP
AZ	040215	7/15/04 4:24	133.10	1.20	NCP
AZ	040215	7/15/04 4:30	133.10	1.21	NCP
AZ	040215	7/15/04 4:33	133.10	1.21	NCP
AZ	040215	7/15/04 4:44	133.10	1.23	NCP
AZ	040215	7/15/04 9:07	128.10	0.22	WP
AZ	040215	7/15/04 9:15	128.10	0.15	WP
AZ	040215	7/15/04 9:26	128.10	0.01	WP
AZ	040215	7/15/04 9:35	128.10	-0.08	WP
AZ	040215	7/15/04 9:40	128.10	-0.05	WP
AZ	040215	9/9/04 3:52	135.10	1.01	NCP
AZ	040215	9/9/04 4:01	135.10	1.03	NCP
AZ	040215	9/9/04 4:14	135.10	1.05	NCP
AZ	040215	9/9/04 4:16	135.10	1.06	NCP
AZ	040215	9/9/04 4:21	135.10	1.05	NCP
AZ	040215	9/9/04 8:37	131.50	0.39	WP
AZ	040215	9/9/04 8:44	131.50	0.43	WP
AZ	040215	9/9/04 8:58	131.50	0.23	WP
AZ	040215	9/9/04 9:03	131.50	0.16	WP
AZ	040215	9/9/04 9:05	131.50	0.14	WP
NV	320204	12/3/96 10:39	129.70	-0.36	WP
NV	320204	12/3/96 10:53	129.70	-0.46	WP
NV	320204	12/3/96 11:01	129.70	-0.52	WP
NV	320204	12/3/96 11:07	129.70	-0.57	WP
NV	320204	12/3/96 11:13	129.70	-0.61	WP
NV	320204	12/3/96 15:36	129.20	-0.74	NCP
NV	320204	12/3/96 15:42	129.20	-0.75	NCP
NV	320204	12/3/96 15:47	129.20	-0.73	NCP
NV	320204	12/3/96 15:52	129.20	-0.70	NCP
NV	320204	12/3/96 15:57	129.20	-0.68	NCP
NV	320204	3/8/97 6:52	131.20	0.67	WP
NV	320204	3/8/97 7:02	131.20	0.65	WP
NV	320204	3/8/97 7:06	131.20	0.64	WP
NV	320204	3/8/97 7:10	131.20	0.63	WP
NV	320204	3/8/97 7:13	131.20	0.63	WP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NV	320204	3/8/97 12:45	117.90	-2.77	WP
NV	320204	3/8/97 12:49	117.90	-2.80	WP
NV	320204	3/8/97 13:01	117.90	-2.89	WP
NV	320204	3/8/97 13:04	117.90	-2.91	WP
NV	320204	3/8/97 13:08	117.90	-2.94	WP
NV	320204	4/22/97 9:53	109.90	-1.04	WP
NV	320204	4/22/97 10:12	109.90	-1.35	WP
NV	320204	4/22/97 10:20	109.90	-1.49	WP
NV	320204	4/22/97 10:36	109.90	-1.54	WP
NV	320204	4/22/97 10:45	109.90	-1.75	WP
NV	320204	8/2/97 8:41	127.60	0.72	WP
NV	320204	8/2/97 8:46	127.60	0.64	WP
NV	320204	8/2/97 8:51	127.60	0.56	WP
NV	320204	8/2/97 8:56	127.60	0.47	WP
NV	320204	8/2/97 9:01	127.60	0.39	WP
NV	320204	8/2/97 13:13	111.10	-3.23	WP
NV	320204	8/2/97 13:17	111.10	-3.26	WP
NV	320204	8/2/97 13:22	111.10	-3.22	WP
NV	320204	8/2/97 13:26	111.10	-3.25	WP
NV	320204	8/2/97 13:31	111.10	-3.29	WP
NC	370201	10/7/97 7:38	105.90	0.66	NCP
NC	370201	10/7/97 7:48	105.90	0.68	NCP
NC	370201	10/7/97 7:58	105.90	0.68	NCP
NC	370201	10/7/97 8:08	105.90	0.67	WP
NC	370201	10/7/97 8:18	105.90	0.67	WP
NC	370201	10/7/97 13:55	85.00	-2.26	WP
NC	370201	10/7/97 14:12	85.00	-2.36	WP
NC	370201	10/7/97 14:30	85.00	-2.37	WP
NC	370201	10/7/97 14:48	85.00	-2.49	WP
NC	370201	10/7/97 15:30	85.00	-2.47	WP
NC	370201	1/17/98 8:48	85.80	0.60	WP
NC	370201	1/17/98 9:00	85.80	0.57	WP
NC	370201	1/17/98 9:10	85.80	0.55	WP
NC	370201	1/17/98 9:20	85.80	0.52	WP
NC	370201	1/17/98 9:30	85.80	0.44	WP
NC	370201	2/18/98 7:18	84.20	0.70	WP
NC	370201	2/18/98 7:28	84.20	0.67	WP
NC	370201	2/18/98 7:38	84.20	0.66	WP
NC	370201	2/18/98 7:48	84.20	0.66	WP
NC	370201	2/18/98 7:58	84.20	0.64	WP
NC	370201	2/18/98 13:23	85.00	-0.87	NCP
NC	370201	2/18/98 13:40	85.00	-1.01	NCP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NC	370201	2/18/98 13:57	85.00	-0.98	NCP
NC	370201	2/18/98 14:13	85.00	-0.94	NCP
NC	370201	2/18/98 14:47	85.00	-0.81	NCP
NC	370201	5/19/98 8:14	86.30	0.01	WP
NC	370201	5/19/98 8:23	86.30	-0.15	WP
NC	370201	5/19/98 8:33	86.30	-0.22	WP
NC	370201	5/19/98 8:43	86.30	-0.18	WP
NC	370201	5/19/98 9:02	86.30	-0.37	WP
NC	370201	5/19/98 10:36	84.60	-1.47	WP
NC	370201	5/19/98 10:52	84.60	-1.66	WP
NC	370201	5/19/98 11:55	84.60	-2.43	WP
NC	370201	5/19/98 12:05	84.60	-2.55	WP
NC	370201	5/19/98 13:38	84.60	-3.37	WP
NC	370201	5/19/98 14:43	83.60	-3.80	WP
NC	370201	5/19/98 14:54	83.60	-3.83	WP
NC	370201	5/19/98 15:03	83.60	-3.86	WP
NC	370201	5/19/98 15:13	83.60	-3.90	WP
NC	370201	5/19/98 15:22	83.60	-3.84	WP
NC	370201	7/24/98 8:07	87.50	0.60	WP
NC	370201	7/24/98 8:16	87.50	0.56	WP
NC	370201	7/24/98 8:26	87.50	0.47	WP
NC	370201	7/24/98 8:36	87.50	0.42	WP
NC	370201	7/24/98 8:45	87.50	0.43	WP
NC	370201	7/24/98 11:14	84.70	-0.70	WP
NC	370201	7/24/98 11:46	84.70	-0.99	WP
NC	370201	7/24/98 12:02	84.70	-1.15	WP
NC	370201	7/24/98 12:19	84.70	-1.32	WP
NC	370201	7/24/98 12:36	84.70	-1.41	WP
NC	370201	11/4/98 8:45	106.30	0.49	WP
NC	370201	11/4/98 8:56	106.30	0.48	WP
NC	370201	11/4/98 9:07	106.30	0.46	WP
NC	370201	11/4/98 9:18	106.30	0.45	WP
NC	370201	11/4/98 9:40	106.30	0.41	WP
NC	370201	11/4/98 14:03	100.90	-0.07	NCP
NC	370201	11/4/98 14:17	100.90	-0.05	NCP
NC	370201	11/4/98 14:26	100.90	-0.03	NCP
NC	370201	11/4/98 14:45	100.90	0.00	NCP
NC	370201	11/4/98 14:55	100.90	0.01	NCP
NC	370201	11/10/99 23:54	92.60	0.37	NCP
NC	370201	11/11/99 0:04	92.60	0.38	NCP
NC	370201	11/11/99 0:14	92.60	0.38	NCP
NC	370201	11/11/99 0:24	92.60	0.41	NCP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NC	370201	11/11/99 0:34	92.60	0.43	NCP
NC	370201	3/13/00 17:03	89.90	-0.76	#Error
NC	370201	3/13/00 17:14	89.90	-0.70	#Error
NC	370201	3/13/00 17:25	89.90	-0.62	#Error
NC	370201	3/13/00 17:36	89.90	-0.54	#Error
NC	370201	7/6/00 12:30	87.40	-1.30	WP
NC	370201	11/8/00 11:16	94.50	-0.38	WP
NC	370201	11/8/00 11:28	94.50	-0.44	WP
NC	370201	1/23/01 7:49	102.90	0.83	WP
NC	370201	1/23/01 8:38	102.90	0.80	WP
NC	370201	1/23/01 14:49	94.00	-1.41	WP
NC	370201	1/23/01 15:42	94.00	-1.46	WP
NC	370201	7/14/01 7:11	98.30	0.96	WP
NC	370201	7/14/01 8:00	98.30	0.78	WP
NC	370201	7/14/01 9:11	93.40	0.24	WP
NC	370201	7/14/01 9:19	93.40	0.16	WP
NC	370201	7/14/01 13:31	90.60	-2.00	WP
NC	370201	7/14/01 13:39	90.60	-2.04	WP
NC	370201	10/11/01 6:56	101.80	0.42	WP
NC	370201	10/11/01 8:45	99.10	0.28	WP
NC	370201	10/11/01 8:54	99.10	0.25	WP
NC	370201	10/11/01 14:03	91.00	-1.37	NCP
NC	370201	10/11/01 14:57	91.00	-1.39	NCP
NC	370201	1/10/02 7:00	100.10	0.45	NCP
NC	370201	1/10/02 7:38	100.10	0.42	NCP
NC	370201	1/10/02 13:07	92.20	-1.64	WP
NC	370201	1/10/02 13:18	92.20	-1.69	WP
NC	370201	1/10/02 14:00	92.20	-1.76	NCP
NC	370201	5/23/02 8:31	100.90	0.69	WP
NC	370201	5/23/02 10:07	92.50	-0.28	WP
NC	370201	5/23/02 11:02	92.50	-0.93	WP
NC	370201	5/23/02 13:43	90.20	-2.23	WP
NC	370201	8/16/02 6:08	103.40	0.62	WP
NC	370201	8/16/02 13:30	94.00	-0.70	WP
NC	370201	9/18/02 6:25	99.60	0.49	WP
NC	370201	9/18/02 6:54	99.60	0.50	WP
NC	370201	9/18/02 7:02	99.60	0.50	WP
NC	370201	9/18/02 7:11	99.60	0.50	WP
NC	370201	9/18/02 7:20	99.60	0.49	WP
NC	370201	9/19/02 17:48	94.60	-0.80	NCP
NC	370201	9/19/02 18:15	94.60	-0.63	NCP
NC	370201	9/19/02 19:15	94.60	-0.28	NCP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NC	370201	9/19/02 19:27	94.60	-0.24	NCP
NC	370201	9/19/02 19:41	94.60	-0.13	NCP
NC	370201	12/18/02 6:55	95.30	0.28	WP
NC	370201	12/18/02 7:12	95.30	0.28	WP
NC	370201	12/18/02 7:20	95.30	0.28	WP
NC	370201	12/18/02 7:37	95.30	0.27	WP
NC	370201	12/18/02 7:46	95.30	0.28	WP
NC	370201	12/18/02 12:54	94.40	-0.45	WP
NC	370201	12/18/02 13:03	94.40	-0.45	WP
NC	370201	12/18/02 13:12	94.40	-0.45	WP
NC	370201	12/18/02 13:21	94.40	-0.44	WP
NC	370201	12/18/02 13:30	94.40	-0.44	WP
NC	370201	1/22/03 7:20	99.90	0.88	NCP
NC	370201	1/22/03 7:29	99.90	0.86	NCP
NC	370201	1/22/03 7:38	99.90	0.85	NCP
NC	370201	1/22/03 7:47	99.90	0.86	NCP
NC	370201	1/22/03 8:01	99.90	0.86	WP
NC	370201	1/22/03 12:51	92.60	-1.01	WP
NC	370201	1/22/03 13:00	92.60	-1.03	WP
NC	370201	1/22/03 13:09	92.60	-1.04	WP
NC	370201	1/22/03 13:19	92.60	-1.06	WP
NC	370201	1/22/03 13:28	92.60	-1.03	WP
NC	370201	1/22/03 16:12	94.70	-0.69	NCP
NC	370201	1/22/03 16:27	94.70	-0.57	NCP
NC	370201	1/22/03 17:22	94.70	-0.27	NCP
NC	370201	1/22/03 17:47	94.70	-0.09	NCP
NC	370201	1/22/03 17:53	94.70	-0.06	NCP
NC	370205	1/6/96 5:46	114.80	0.60	NCP
NC	370205	1/6/96 8:16	114.80	0.62	NCP
NC	370205	2/18/98 13:23	115.80	-2.13	NCP
NC	370205	2/18/98 13:57	115.80	-2.20	NCP
NC	370205	2/18/98 14:13	115.80	-2.08	NCP
NC	370205	2/18/98 14:30	115.80	-1.83	NCP
NC	370205	2/18/98 14:47	115.80	-1.74	NCP
NC	370205	7/24/98 11:14	115.30	-2.28	WP
NC	370205	7/24/98 11:31	115.30	-2.55	WP
NC	370205	7/24/98 12:02	115.30	-2.98	WP
NC	370205	7/24/98 12:19	115.30	-3.25	WP
NC	370205	7/24/98 12:54	115.30	-3.71	WP
NC	370205	11/4/98 8:45	130.80	0.93	WP
NC	370205	11/4/98 8:56	130.80	0.91	WP
NC	370205	11/4/98 9:07	130.80	0.88	WP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NC	370205	11/4/98 9:18	130.80	0.86	WP
NC	370205	11/4/98 9:40	130.80	0.80	WP
NC	370205	11/10/99 23:54	117.80	0.77	NCP
NC	370205	11/11/99 0:04	117.80	0.78	NCP
NC	370205	11/11/99 0:14	117.80	0.79	NCP
NC	370205	11/11/99 0:24	117.80	0.81	NCP
NC	370205	11/11/99 0:34	117.80	0.82	NCP
NC	370205	3/13/00 14:35	121.90	-2.62	NCP
NC	370205	3/13/00 14:46	121.90	-2.64	NCP
NC	370205	3/13/00 17:03	121.90	-0.75	NCP
NC	370205	3/13/00 17:14	121.90	-0.57	NCP
NC	370205	3/13/00 17:36	121.90	-0.24	NCP
NC	370208	7/24/98 12:02	108.80	-1.09	WP
NC	370208	7/24/98 12:19	108.80	-1.29	WP
NC	370208	7/24/98 12:54	108.80	-1.63	WP
NC	370208	7/24/98 14:35	108.80	-2.12	WP
NC	370208	7/24/98 14:47	108.80	-2.24	WP
NC	370208	11/4/98 8:45	127.30	0.43	WP
NC	370208	11/4/98 8:56	127.30	0.42	WP
NC	370208	11/4/98 9:07	127.30	0.40	WP
NC	370208	11/4/98 9:18	127.30	0.39	WP
NC	370208	11/4/98 9:40	127.30	0.36	WP
NC	370208	11/10/99 23:54	113.80	0.09	NCP
NC	370208	11/11/99 0:14	113.80	0.11	NCP
NC	370208	11/11/99 0:24	113.80	0.13	NCP
NC	370208	11/11/99 0:34	113.80	0.14	NCP
NC	370208	11/11/99 1:04	113.80	0.14	WP
NC	370208	3/13/00 14:02	105.40	-2.58	WP
NC	370208	3/13/00 14:14	105.40	-2.60	WP
NC	370208	3/13/00 14:24	105.40	-2.54	WP
NC	370208	3/13/00 14:35	105.40	-2.55	WP
NC	370208	3/13/00 14:46	105.40	-2.61	WP
NC	370212	1/6/96 5:46	67.00	0.18	NCP
NC	370212	1/6/96 8:16	67.00	0.20	NCP
NC	370212	2/18/98 13:23	69.70	-1.30	NCP
NC	370212	2/18/98 13:40	69.70	-1.46	NCP
NC	370212	2/18/98 13:57	69.70	-1.43	NCP
NC	370212	2/18/98 14:47	69.70	-1.30	NCP
NC	370212	2/18/98 15:04	69.70	-1.23	NCP
NC	370212	7/24/98 11:31	68.20	-0.69	WP
NC	370212	7/24/98 11:46	68.20	-0.80	WP
NC	370212	7/24/98 12:02	68.20	-0.97	WP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
NC	370212	7/24/98 12:36	68.20	-1.31	WP
NC	370212	7/24/98 12:54	68.20	-1.49	WP
NC	370212	11/4/98 8:45	76.10	0.53	WP
NC	370212	11/4/98 8:56	76.10	0.52	WP
NC	370212	11/4/98 9:07	76.10	0.51	WP
NC	370212	11/4/98 9:18	76.10	0.50	WP
NC	370212	11/4/98 9:40	76.10	0.47	WP
NC	370212	11/10/99 23:54	70.50	0.34	NCP
NC	370212	11/11/99 0:04	70.50	0.35	NCP
NC	370212	11/11/99 0:14	70.50	0.36	NCP
NC	370212	11/11/99 0:24	70.50	0.37	NCP
NC	370212	11/11/99 0:34	70.50	0.38	NCP
NC	370212	3/13/00 14:02	68.10	-1.65	WP
NC	370212	3/13/00 14:14	68.10	-1.69	WP
NC	370212	3/13/00 14:24	68.10	-1.63	WP
NC	370212	3/13/00 14:35	68.10	-1.64	WP
NC	370212	3/13/00 14:46	68.10	-1.72	WP
OH	390204	3/7/98 6:12	56.00	0.85	WP
OH	390204	3/7/98 6:15	56.00	0.85	WP
OH	390204	3/7/98 6:18	56.00	0.85	WP
OH	390204	3/7/98 6:20	56.00	0.85	WP
OH	390204	3/7/98 6:23	56.00	0.83	WP
OH	390204	3/7/98 11:20	52.30	-1.07	WP
OH	390204	3/7/98 11:23	52.30	-1.09	WP
OH	390204	3/7/98 11:26	52.30	-1.12	WP
OH	390204	3/7/98 11:28	52.30	-1.14	WP
OH	390204	3/7/98 11:31	52.30	-1.17	WP
OH	390204	3/7/98 15:06	54.60	-2.43	NCP
OH	390204	3/7/98 15:08	54.60	-2.43	NCP
OH	390204	3/7/98 15:11	54.60	-2.42	NCP
OH	390204	3/7/98 15:14	54.60	-2.42	NCP
OH	390204	3/7/98 15:17	54.60	-2.42	NCP
OH	390204	5/28/98 6:19	55.00	1.06	WP
OH	390204	5/28/98 6:23	55.00	1.02	WP
OH	390204	5/28/98 6:26	55.00	1.02	WP
OH	390204	5/28/98 6:29	55.00	1.02	WP
OH	390204	5/28/98 6:32	55.00	1.01	WP
OH	390204	5/28/98 15:06	53.60	-2.78	NCP
OH	390204	5/28/98 15:10	53.60	-2.78	NCP
OH	390204	5/28/98 15:13	53.60	-2.78	NCP
OH	390204	5/28/98 15:16	53.60	-2.78	NCP
OH	390204	5/28/98 15:20	53.60	-2.79	NCP

State	SHRP ID	Profile Run Date-Time	MRI	*ΔT*	*ΔT* Phase[1]
OH	390204	8/13/98 3:22	55.10	1.16	NCP
OH	390204	8/13/98 3:26	55.10	1.16	NCP
OH	390204	8/13/98 3:30	55.10	1.17	NCP
OH	390204	8/13/98 3:34	55.10	1.17	NCP
OH	390204	8/13/98 3:37	55.10	1.17	NCP
OH	390204	8/13/98 7:29	55.50	1.23	WP
OH	390204	8/13/98 7:31	55.50	1.22	WP
OH	390204	8/13/98 7:35	55.50	1.22	WP
OH	390204	8/13/98 7:37	55.50	1.22	WP
OH	390204	8/13/98 7:39	55.50	1.22	WP
OH	390204	3/10/99 6:25	61.90	0.62	WP
OH	390204	3/10/99 6:29	61.90	0.62	WP
OH	390204	3/10/99 6:32	61.90	0.62	WP
OH	390204	3/10/99 6:36	61.90	0.62	WP
OH	390204	3/10/99 6:39	61.90	0.62	WP
OH	390204	3/10/99 14:00	50.70	-1.53	NCP
OH	390204	3/10/99 14:08	50.70	-1.54	NCP
OH	390204	3/10/99 14:11	50.70	-1.54	NCP
OH	390204	3/10/99 14:15	50.70	-1.55	NCP
OH	390204	3/10/99 14:19	50.70	-1.56	NCP

Appendix B

TIME SERIES PLOTS OF CASE STUDIES

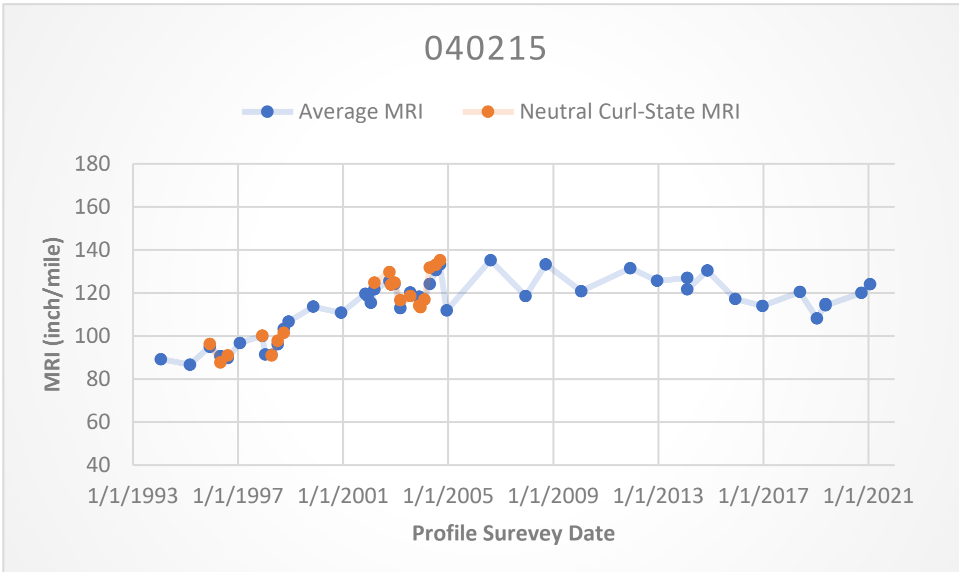

Figure B 1. Comparison of Average MRI and Neutral Stat MRI of 040215

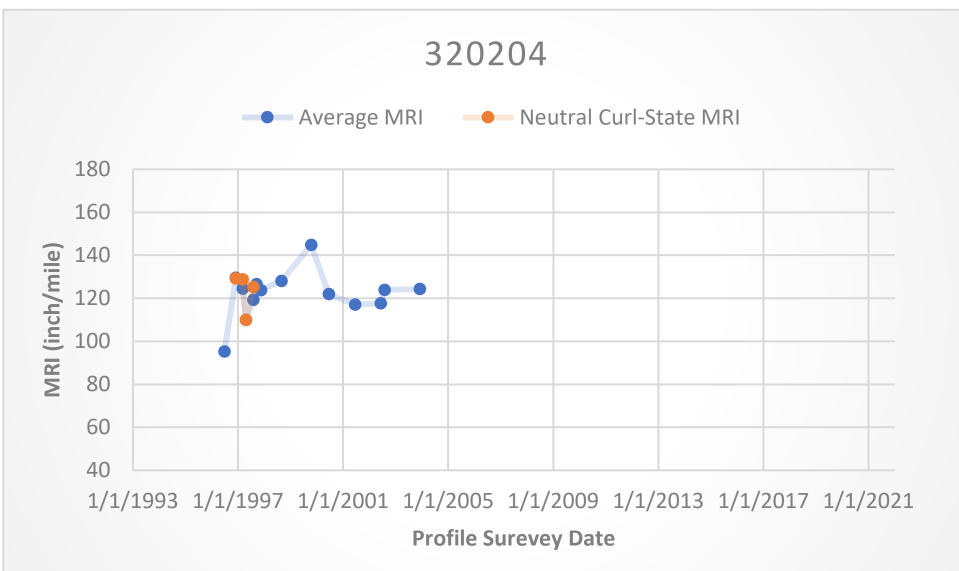

Figure B 2. Comparison of Average MRI and Neutral Stat MRI of 320204

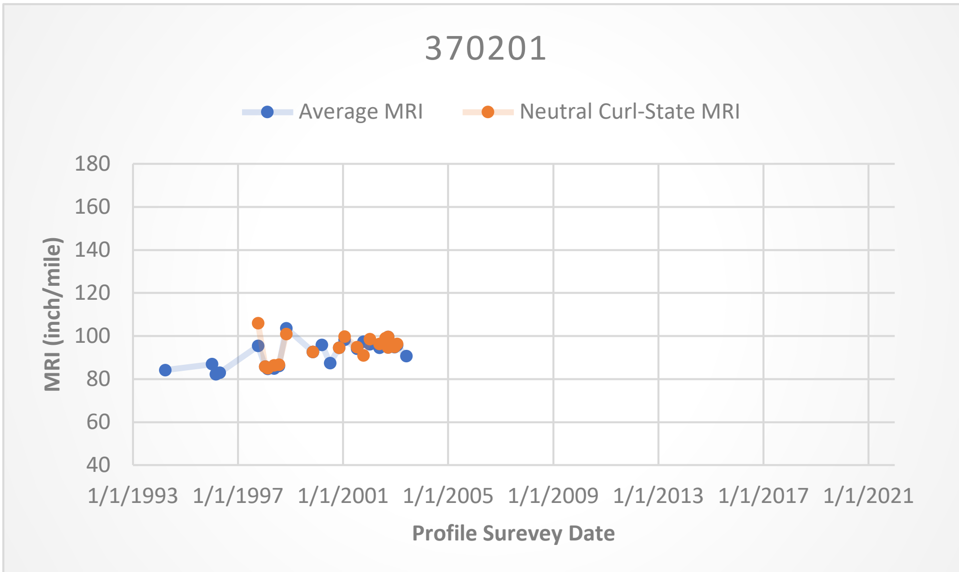

Figure B 3. Comparison of Average MRI and Neutral Stat MRI of 370201

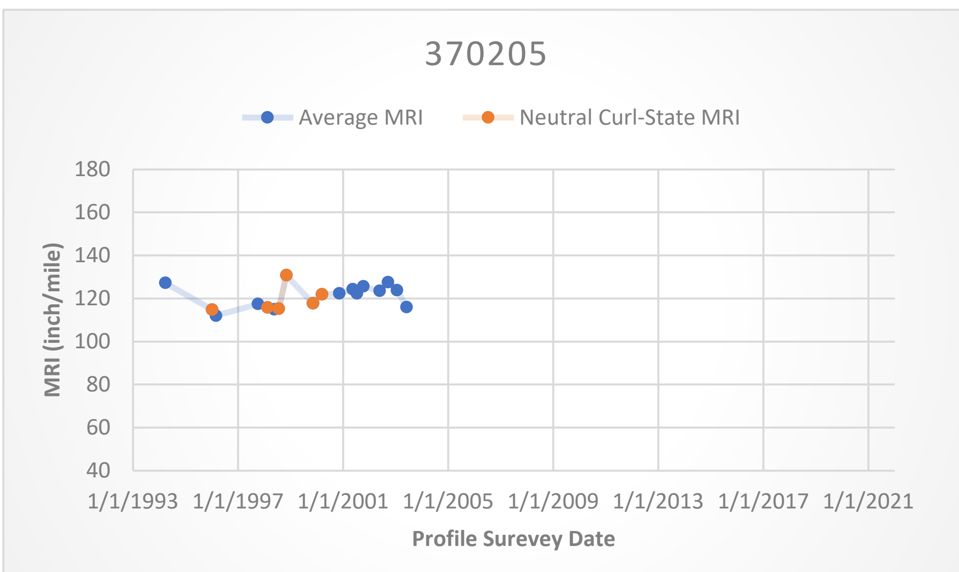

Figure B 4. Comparison of Average MRI and Neutral Stat MRI of 370205

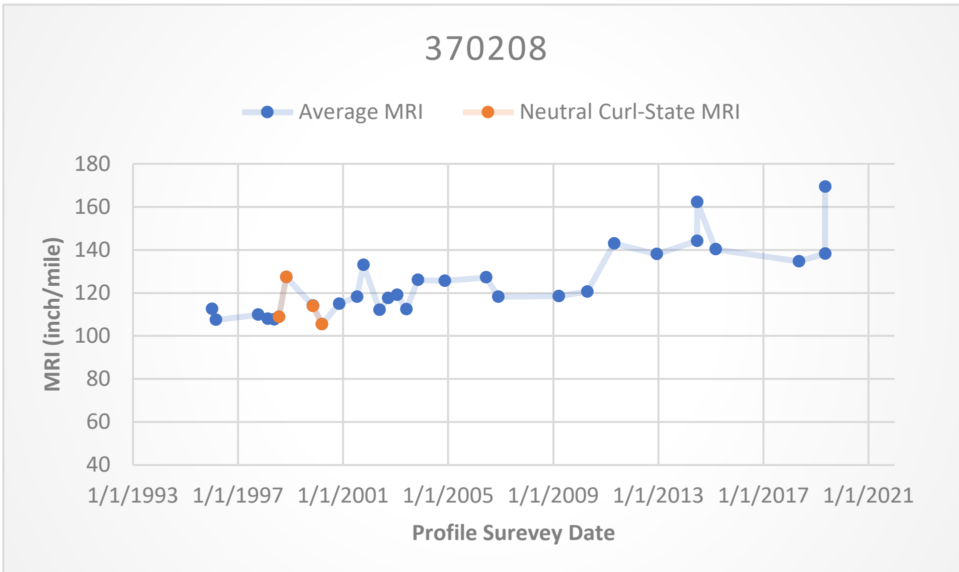

Figure B 5. Comparison of Average MRI and Neutral Stat MRI of 370208

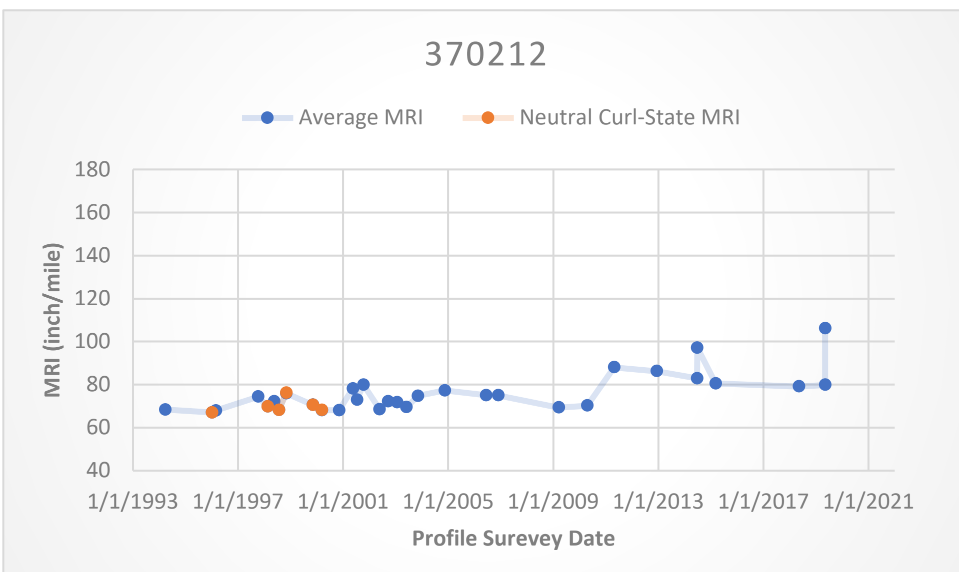

Figure B 6. Comparison of Average MRI and Neutral Stat MRI of 370212

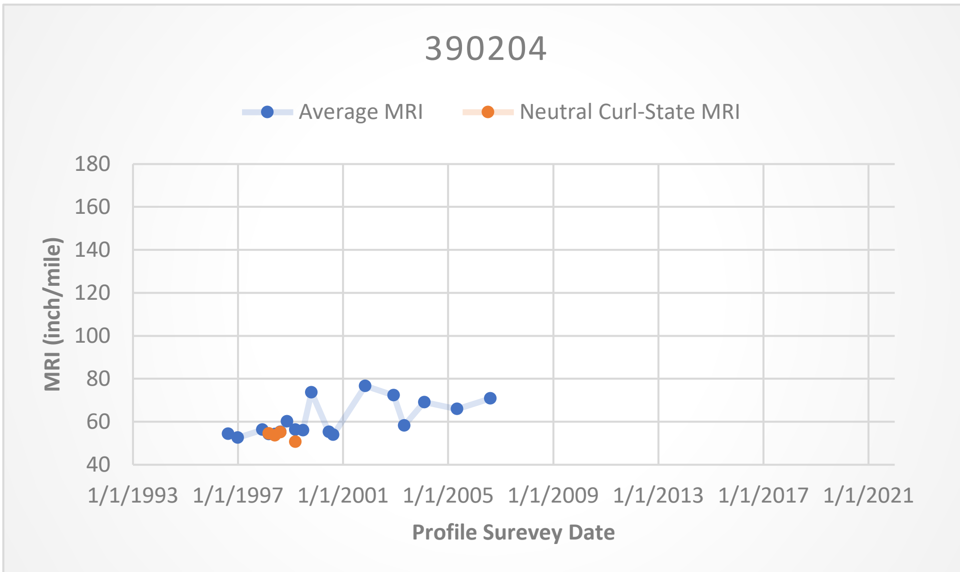

Figure B 7. Comparison of Average MRI and Neutral Stat MRI of 390204