Reclaimed Base Course Stabilized With Calcium Chloride
Brandon-Goshen, VT. Route 73
Final Report

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Reporting on Work Plan 93-R-6

State of Vermont
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Materials and Research Section

Prepared by:

Wendy M. E. Kipp
Research Technician

Jennifer M. V. Fitch
Jennifer M. V. Fitch, P.E.
Research Engineer

Reviewed By:

William E Ahearn, P.E.
Materials and Research Engineer

Date: June 6, 2008

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16. Abstract

This report documents the evaluation of a reclaimed base course stabilized with calcium chloride pavement project located on Vermont Route 73 in the towns of Brandon and Goshen. This was a 2.727 mile reconstructed section of highway, and consisted of two sections of roadway. Three full width test sites, each 100ft in length, were established in each of the two sections. Each test site had control sections and experimental areas.

Cracking, rutting, and roughness were documented to describe the pavement and its condition. These results are presented herein with recommendations on possible further research studies on this topic.

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INTRODUCTION

With a growing number of pavements in need of reconstruction or rehabilitation and ever increasing construction costs State Transportation Agencies are seeking out cost effective long-lasting treatments. Typically, overlays of existing pavements are intended to increase load carrying capacity or to correct surface defects such as cracking. While effective, overlays are unable to address inadequate roadbase strength. An alternate method, known as full depth reclamation (FDR), produces a new base by pulverizing the existing asphalt pavement and mixing it with some underlying subbase materials. This varies from full reconstruction methods which typically involve complete removal and replacement of the existing pavement layer(s) and base course. The use of in-place materials reduces the overall cost of pavement rehabilitation by the preservation of aggregates. Additionally, FDR reduces the impact on the environment and preserves energy in comparison to traditional methods.

In accordance with the Vermont Agency of Transportation's "2006 Standard Specifications for Construction" the standard FDR process, otherwise known as reclaimed stabilized base (RSB), consists of a series of steps that include pulverizing the existing pavement layers together with the underlying base course material to a standard depth of 6 to 12 inches. Water and additives are blended with the pulverized section, which is then graded and compacted to a specified density. Pulverizing and mixing operations are typically achieved through the use of a road reclaiming machine.

Additional structural strength may be achieved by incorporating mechanical, chemical or bituminous stabilizers. According to a recent Transportation Research Record (TRR) publication, chemical stabilizers include "portland cement, calcium chloride, hydrated lime, and coal fly ash. Calcium chloride ($CaCl_2$) is a hygroscopic chemical, meaning it absorbs moisture. This moisture facilitates compaction and then imparts strength through increased in-place densities. Calcium chloride is the least expensive of the stabilizers and has been shown to reduce frost heaving. It works best in well-graded nonplastic soils containing about 10 percent – 75 micron size material" (Kearney, 204). It is manufactured by combining two naturally occurring raw materials, high quality limestone and salt brine. (General Chemical).

In an effort to assess the performance and cost effectiveness of reclaimed base course stabilized with calcium chloride in a cold weather climate, the Vermont Agency of Transportation (VTrans) constructed the referenced experimental treatment along VT Route 73 in the towns of Brandon and Goshen in 1994. Two test sections, approximately 1000 feet in length, were established to document cracking, rutting and ride roughness. Each section contained one lane stabilized with calcium chloride and water and the other compacted with water only. This enabled a side by side comparison with an inherent assumption regarding homogeneity in the pavement, subbase and base materials. Pavement studies to characterize the current condition of the various treatments were conducted prior to and following construction on an annual basis. The following report summarizes the findings from annual data collection efforts and subsequent recommendations.

PROJECT DESCRIPTION

The reconstruction project occurred in 1994 along a 5.162 mile segment of VT Route 73 in the town of Brandon and Goshen, project STP 9405(1)S. The project limits began at the intersection of VT Route 53 and VT Route 73 in Brandon and continued easterly to MM 3.610 in Goshen. According to the construction plans, the work consisted of reclaiming and stabilizing the existing highway base, and application of a wearing course, new pavement markings and other incidental items.

The entire length of this project received the reclaimed stabilized base treatment with the exception of bridge locations. It is important to note that specifications regarding the referenced treatment were not included in the Agency's Standard Specifications for Construction until 2006. The treatment included pulverizing to a depth of 6" along the entire roadway width along with grading and compaction. Two lifts of bituminous concrete pavement were applied as follows: 2" of a type II Marshall binder course containing a nominal aggregate size of ¾" and 1.5" of a type III Marshall wearing course containing a nominal aggregate size of ½".

In order to conduct a comparative analysis, two distinct test sections were selected at MM 1.60 to MM 1.80 (Test Section 1) and MM 2.20 to MM 2.40 (Test Section 2) in the town of Goshen. The length of each test section was 1056 feet. Calcium chloride was applied to the westbound lane between MM 1.60 to MM 1.80 and the eastbound lane between MM 2.20 and MM 2.40. The other lanes were stabilized with water only. Project notes indicate that a 35% solution of calcium chloride ($CaCl_2$) was sprayed onto and thoroughly mixed with the pulverized material at an application rate of 0.75 gal/SY. Following compaction of the new base course, an additional .25 gal/SY of the calcium chloride solution was applied to the surface prior to the placement of the binder course. Please note that calcium chloride was used as a stabilizing agent throughout the entire project length with the exception of the specific test sections. Table 1, provided below, displays the limits of each treatment as well as the number of test sites identified within each section.

Brandon-Goshen, STP 9405(1)S Project				
Town:	**Test Section Limits:**	**Lane Designation:**	**Stabilizing Agent(s):**	**Number of Test Sites:**
Goshen	MM 1.6 to MM 1.8	Eastbound	Water	3
		Westbound	Water and Calcium Chloride	
	MM 2.2 to MM 2.4	Eastbound	Water and Calcium Chloride	3
		Westbound	Water	

Table 1 – Experimental Treatment Summary

A summary of construction and compliance test results were previously published in VTrans report, 95-3, entitled, "Reclaimed Base Course Stabilized with Calcium Chloride, Brandon/Goshen, VT 73." Compaction testing was performed throughout the entire length of the project. Preliminary tests indicated inadequate compaction. The reclaiming process was stopped until adequate compaction could be achieved. Areas of inadequate compaction were regraded and compacted. Exact locations of inadequate compaction are unknown. Cores extracted from the wearing and binder course yielded good results with only two failing samples. The failures were due to poor gradation and high percentage of air voids. In addition, aggregate from the reclaimed base were tested onsite on June 22, 1994. This material passed all sieves, although the percentage passing the #200 sieve was at the upper limit. The initial Internal Roughness Index (IRI) readings indicated an IRI of 108 and 100 in/mile for the calcium chloride stabilized section and water stabilized sections, accordingly. These results are sufficiently high that a vehicle passenger will note roughness of ride on the new pavement section.

HISTORICAL INFORMATION

As with any surface treatment, the overall success of a pavement is often dictated by the underlying structure. Insufficient lateral support may cause fatigue cracking or rutting. An impervious media coupled with surface cracks allows for further water infiltration facilitating freeze-thaw cracking which can compound thermal cracking. Therefore, it is important to examine the history of the surface treatment as well as the underlying soils that support the overall roadway structure.

According to historical data, the subbase of consists of 15 to 18" of gravel. There is little information regarding the original construction of the pavement in 1960 where the test sites are located. During this timeframe an undetermined thickness of surface treated gravel was applied. This was constructed of a single tack consisting of refined tar and blade mix, pea stone seal with cutback asphalt. Historical records show that there were three rehabilitation projects in years following the original construction. The pavement received a ½" of blade mix in 1971, a 1" plant mix in 1978, and a bituminous seal in 1984. Like the surface treated gravel, the thickness of bituminous seal is unknown. The preexisting pavement profile is provided Figure 1.

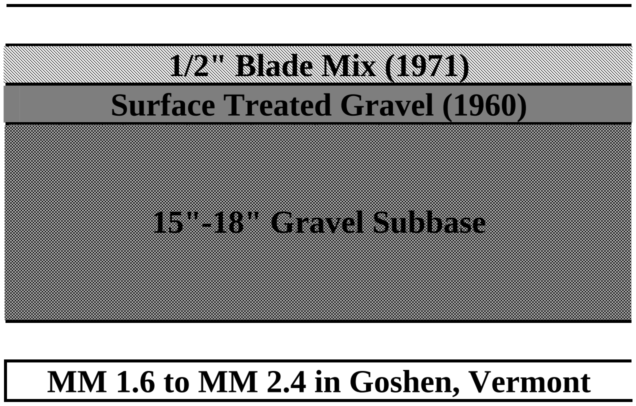

Figure 1 –Goshen Historical Pavement Treatments

According to the US Department of Agriculture Web Soil Survey, the soils underlying the roadway are "gravelly, sandy to stony loam" and are classified as "Excessively Drained." No frequent flooding or ponding has been noted in this location. Even though the drainage capacities are sufficient, many of these types of soils are moderately susceptible to frost action, therefore freeze-thaw cycles may be a factor potentially resulting in thermal cracking.

PERFORMANCE

Cracking, rutting, and IRI values are often utilized to assess the performance and service life of pavement treatments or in this case differing rehabilitation efforts. It has been shown that the surface condition of a pavement is directly correlated to its structural condition and is a non-linear system that can be characterized by varying rates of deterioration. The following is an examination of the surface condition of both experimental and control pavements.

Pavement condition surveys of each test section were conducted throughout the study duration period in accordance with the "Distress Identification Manual for the Long-Term Pavement Performance Program" published in May of 1993 by the SHRP. Crack data is collected by locating the beginning of each test section, often keyed into mile markers or other identifiable land marks. The test section is then marked at intervals of ten feet from the beginning of the test section for a length of 100'. Pavement surveys start at the beginning of a test section and the locations and length of each crack are hand drawn onto a data collection sheet. Once in the office, the information is processed and the total length of transverse, longitudinal, centerline and miscellaneous cracking is determined and recorded into the associated field on the survey form. For this analysis, failure criterion is met when the amount of post construction cracking is equal to or greater than the amount of preconstruction cracking. Please note that all recorded crack data is provided in Appendix A.

CRACKING

There are several causes for cracking in flexible pavements, including inadequate structural support such as the loss of base, sub-base or sub-grade support, an increase in loading, inadequate design, poor construction, or poor choice of materials. For this analysis, longitudinal, transverse and reflective cracking were examined. Longitudinal cracks run parallel to the laydown direction and are usually a type of fatigue or load associated failure. Transverse cracks run perpendicular to the pavement's centerline and are usually a type of critical-temperature failure or thermal fatigue that may be induced by multiple freeze-thaw cycles. Reflection cracks occur from previous cracking that may exist within the base course, sub-base or sub-grade material and continue through the wearing course. In all cases, cracks allow for moisture infiltration and can result in structural failure over time.

I. Fatigue Cracking

The following assessment began with examining longitudinal or fatigue cracking. As indicated by the "Distress Identification Manual", fatigue cracking occurs in areas subjected to repeated traffic loading, or wheel paths, and may be a series of interconnected cracks in early stages of development that progresses into a series of chicken wire/alligator cracks in later stages as shown in Figure 2. For this investigation, the wheel paths were determined to be three feet in width with the center of the left wheel path and right wheel path 3.5' and 8.5', respectively from the centerline on either side of the roadway.

Figure 2 – Typical Fatigue Cracking

An important parameter considered during the pavement design process is a wheel load characterized as an ESAL, or equivalent single axle load. An ESAL is defined by

Clemson University as "the effect on pavement performance of any combination of axle loads of varying magnitude equated to the number of 80-kN (18,000-lb.) single-axle loads that are required to produce an equivalent effect." Basically, pavements are designed to structurally support traffic loads which are often calculated by average annual daily traffic (AADT) or ESALs with regards to roadway use. ESAL information was not available for this investigation. Figure 3 provided below contains a comparison between the average onset and rate of cumulative fatigue cracking of the experimental and control sections in association with preconstruction conditions.

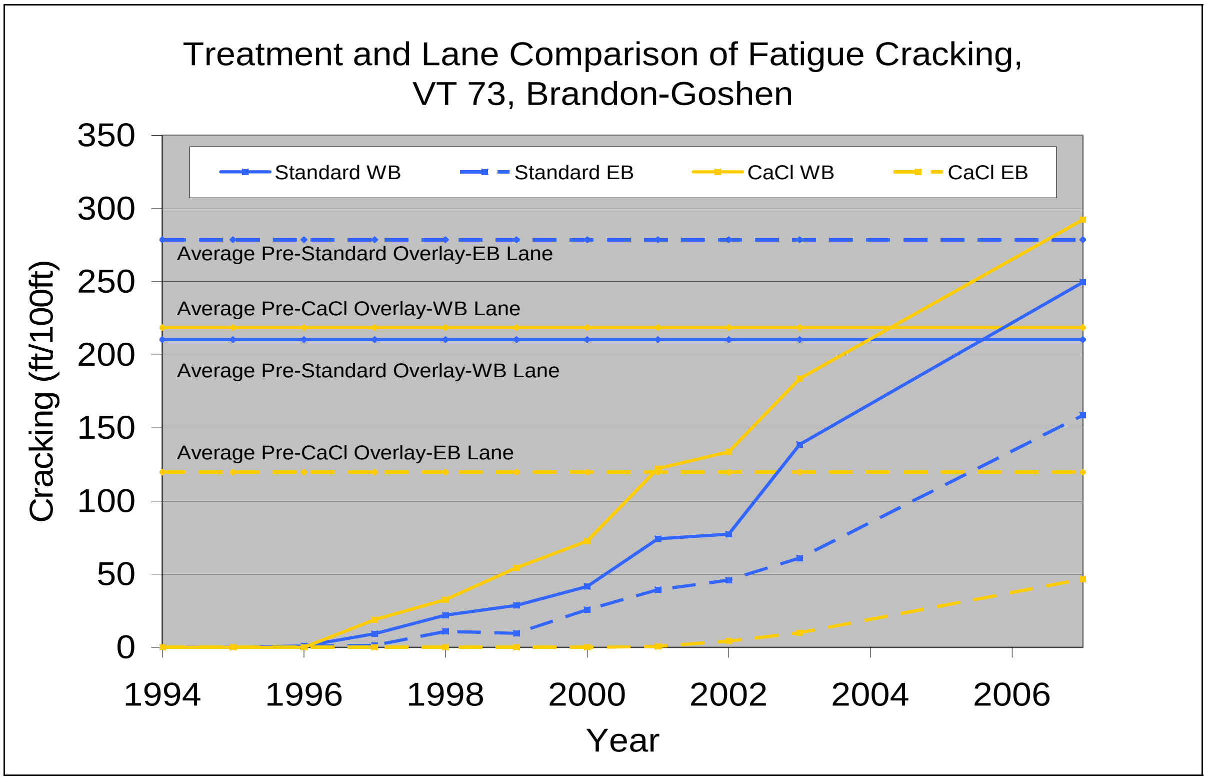

Figure 3 – Fatigue Cracking Comparison

It is interesting to consider the amount of fatigue related distress prior to construction. While the westbound lane appears to be relatively homogenous throughout the test sections, the eastbound is highly variable. The causations for this phenomenon are unknown. Fatigue distresses are typically caused by inadequate lateral support due to the underlying pavement structure and soils or an inability to carry loads in excess of design loads. An investigation of AADT and truck traffic recorded throughout the investigation by the Traffic Research Section following construction does reveal some variation in the amount of vehicles and percentage of truck traffic within and between test sections as shown in Table 2. In general there is a greater amount of traffic between MM 2.2 and MM 2.4; however the amount of truck related traffic is roughly equivalent. It is important to note that preconstruction traffic stream data was not available. If the traffic stream is assumed to be the same prior to and following construction, varying lateral support along the eastbound lane is suspected.

A further examination of the onset and rate of fatigue related distresses following construction reveals comparable responses between the westbound and eastbound lanes, respectively. The slopes are not constant, with higher amplitudes resultant of increased failure rates. As expected, this may be attributed to the traffic stream during this time period. In addition, the amount of fatigue distresses may have been influenced by nearby timber harvesting operations in the Green Mountain National Forest. The Commercial Vehicle Permit Unit was contacted for historical permit information. However, permits provided for logging purposes do not impose any routing regulations. Therefore it is not possible to confirm the presence of heavy log truck traffic. Correspondence from the Forest Service does confirm logging operations in the early 1990's. However, specific documentation is limited. Fatigue distresses may have been influenced by braking forces associated with an intersection at Goshen Four Corners immediately upstation of the test section between MM 1.6 and MM 1.8 and downstation of the test section between MM 2.2 and MM 2.4. If the breaking theory is true, fatigue cracking would be more predominate in the two westbound test sections as traffic descends down Brandon Gap as shown in Figure 3. It is impressive to note that the experimental pavement treatment constructed along the eastbound lane did not display any fatigue distresses until 2001, seven years following construction. Conversely fatigue cracking within the two standard sections along the east and westbound lanes was first observed in 1996, only two years following construction. However, the overall performance of each test section is highly variable making inferences difficult. This may be attributed to construction sequence and increasing familiarity with associated equipment. Averaging indicates that the experimental sections met or exceeded preconstruction levels while the standard sections displayed 85% of preconstruction values in 2007, thirteen years following construction. Additional fatigue and longitudinal crack data can be found in Appendix B and C.

Year	**MM 1.6 to MM 1.8**				**MM 2.2 to 2.4**			
	Experimental - WB		**Standard - EB**		**Standard - WB**		**Experimental - EB**	
	AADT	**% Trucks**	**AADT**	**% Trucks**	**AADT**	**% Trucks**	**AADT**	**% Trucks**
1998	433	25%	431	25%	549	17%	549	19%
2000	274	28%	293	33%	325	27%	339	28%
2002	434	27%	450	28%	519	36%	477	33%
2004	257	33%	259	34%	252	41%	253	42%
2006	232	33%	233	33%	339	39%	170	38%

Table 2 – Traffic Stream Comparison

II. Transverse (Thermal) Cracking

The formation of transverse cracking is largely due to climatic conditions and is often induced by freeze-thaw cycles or maximum low temperature shrinkage cracking. Transverse cracking of asphalt pavements is a predominant problem in New England because of the cold winter climate and multiple freeze-thaw cycles. In addition to a comparison of the cumulative transverse cracking between the experimental and control sections, monthly average minimum temperatures were attained from WeatherUnderground.com referencing a weather station in Rutland, VT, and are provided in Figure 4. Unlike AADT, temperature remains a constant variable across all test sections.

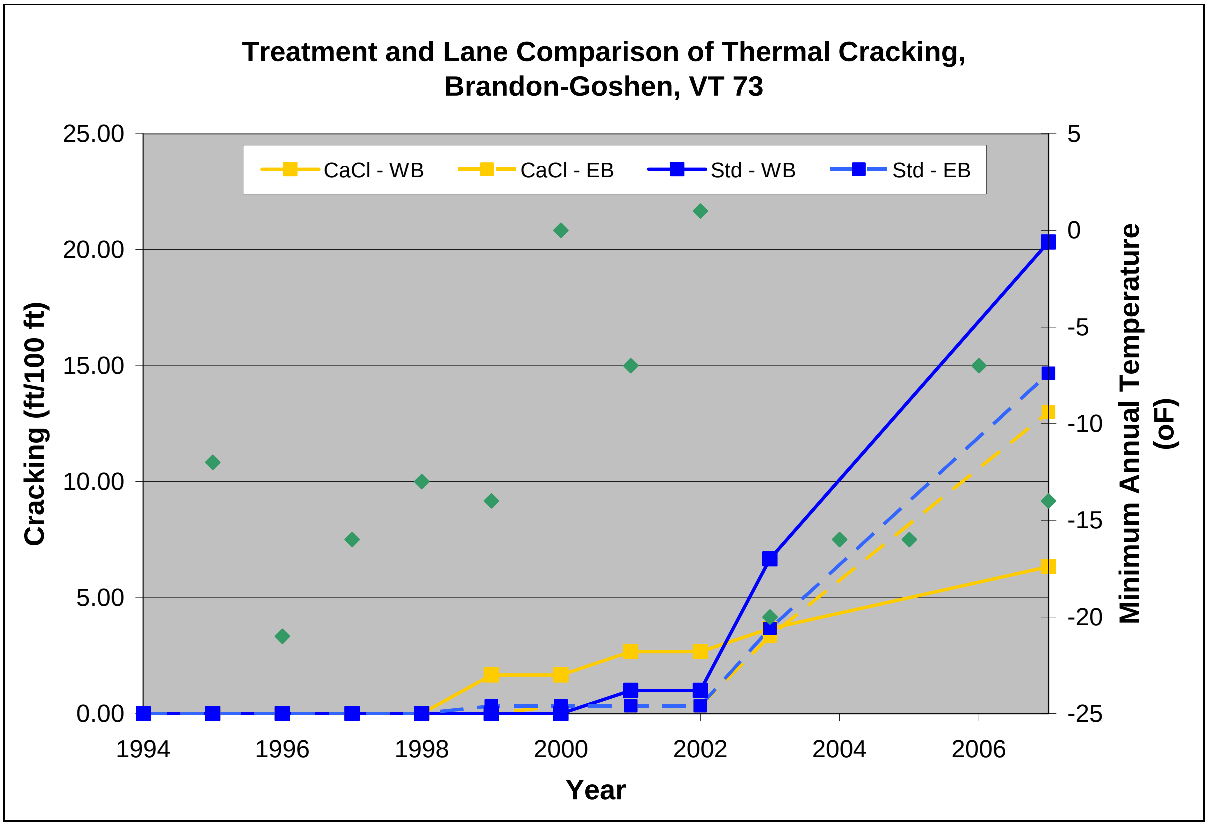

Figure 4 – Thermal Cracking Comparison

Very little to no thermal cracking was observed during the preconstruction pavement surveys. An average of 1' to 2' of thermal cracking was recorded in the experimental and standard sections, respectively. This is somewhat counterintuitive as the soils throughout this area are supposedly moderately susceptible to frost action. The lack of thermal cracking may be attributed to the drainage capabilities of the underlying soil profile.

The occurrence of thermal cracking was first observed in 1999 between MM 1.6 and MM 1.8 in both the standard and control section. The rate of thermal cracking appears to steadily increase from 2002 through 2007 across all test sites and does not appear to be a function of annual minimum temperatures. As the amount of thermal cracking prior to construction is relatively consistent across all test sites, performance will be assessed as the amount and rate of cumulative thermal pavement distress. In this case, the experimental sections outperform the control section regardless of location. The large variation of thermal cracking in the westbound lane contradicts the large variation in fatigue cracking in the eastbound lane, as described in the previous section. The causations for this phenomenon are unknown. As calcium chloride is intended to reduce frost heaving, it may be due to inconsistencies of application during construction. However this is a theory and cannot be verified through daily work reports. Overall, the performance of both sections is impressive with a maximum average amount of 20' of thermal cracking in the westbound lane following 13 years of service. Additional transverse (thermal) crack data is located in Appendix D.

III. Reflective Cracking

According to Dr. Beatriz Martin-Perez of the National Research Council of Canada, reflective cracking is defined as “the propagation of cracks from the existing pavement into the layer of pavement added (overlay) during rehabilitation.” As stated within the “Project Description” section above, the experimental section included the reclamation of preexisting pavement to a depth of 6”. Since this process involves the removal of the preexisting pavement it is less likely to observe reflective cracking with a reclaimed stabilized base as compared to a standard overlay. Reflective cracking was deciphered by overlaying the preconstruction data on top of the post construction data and counting the length of cracks that appear to be similar in location and overall length. However, there is a great deal of variability within the pavement surveys due to the nature of the data collection process, typically involving a large variation in field personnel, who may have differing personal interpretations.

The onset and rate of reflective cracking is a function of the amount of preconstruction cracking. This means an area with a greater amount of cracking prior to construction would display a greater amount of reflective cracking following construction. The average amount of preconstruction cracking within the standard and experimental sections was 549 and 482 feet, respectively. Therefore, it is easy to presume that the amount of reflective cracking in the control section would be greater over time. This theory presumes however that all of the cracks observed within the wearing course descend beyond 6” below the pavement surface, otherwise known as bottom up cracking, and does not account for any top down cracking. The propagation of total reflective cracking over time by treatment in comparison to the pre-construction total cracking is displayed in Figure 5.

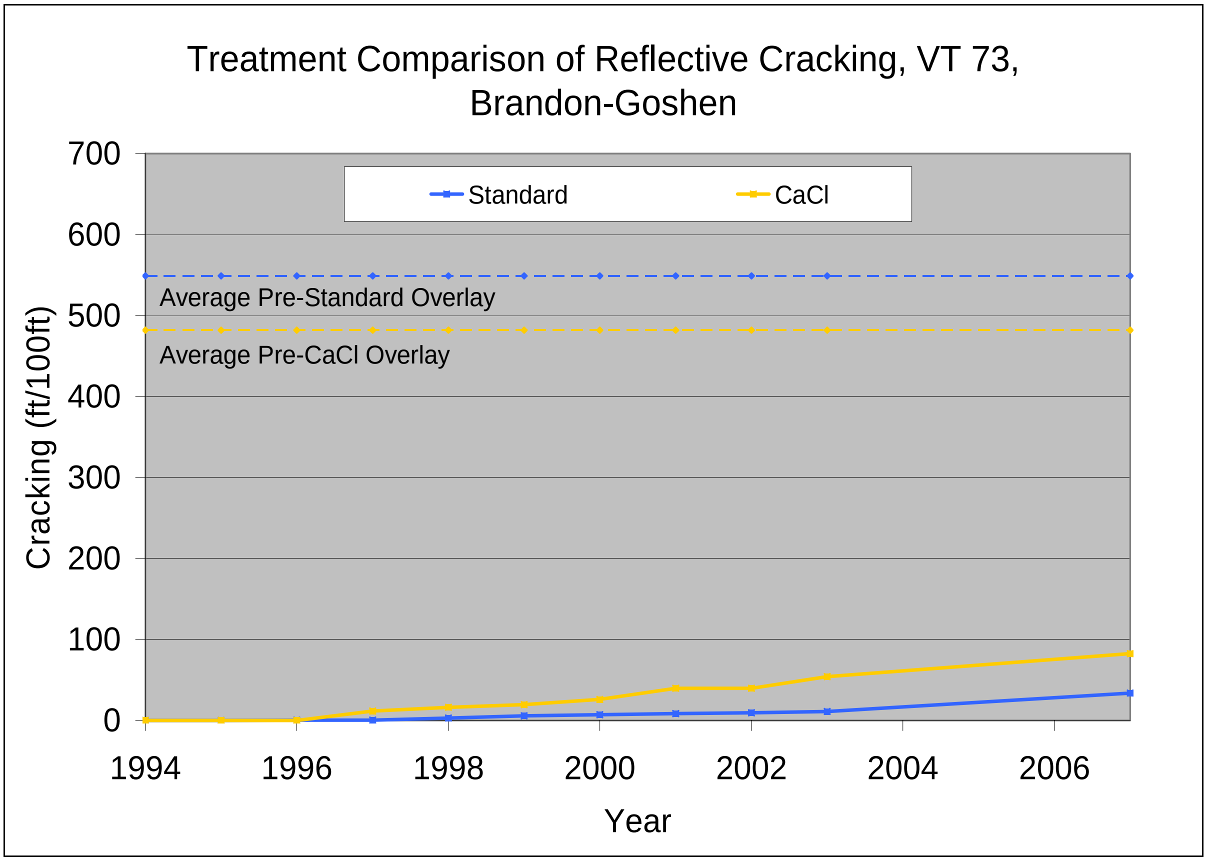

Figure 5 – Reflective Cracking Treatment Comparison

The experimental sections displayed a greater amount of reflective cracking over time as compared to the control sections. Given a greater amount of total cracking in the control sections prior to construction, one would have anticipated a direct correlation such that more reflective cracking would have been anticipated in the control section. Therefore, it is easy to conclude that the addition of $CaCl_2$ does not mitigate reflective cracking. However, given the results from the fatigue and thermal analysis above and suspected problems within the westbound lane, a plot of each test section is provided in Figure 6 below.

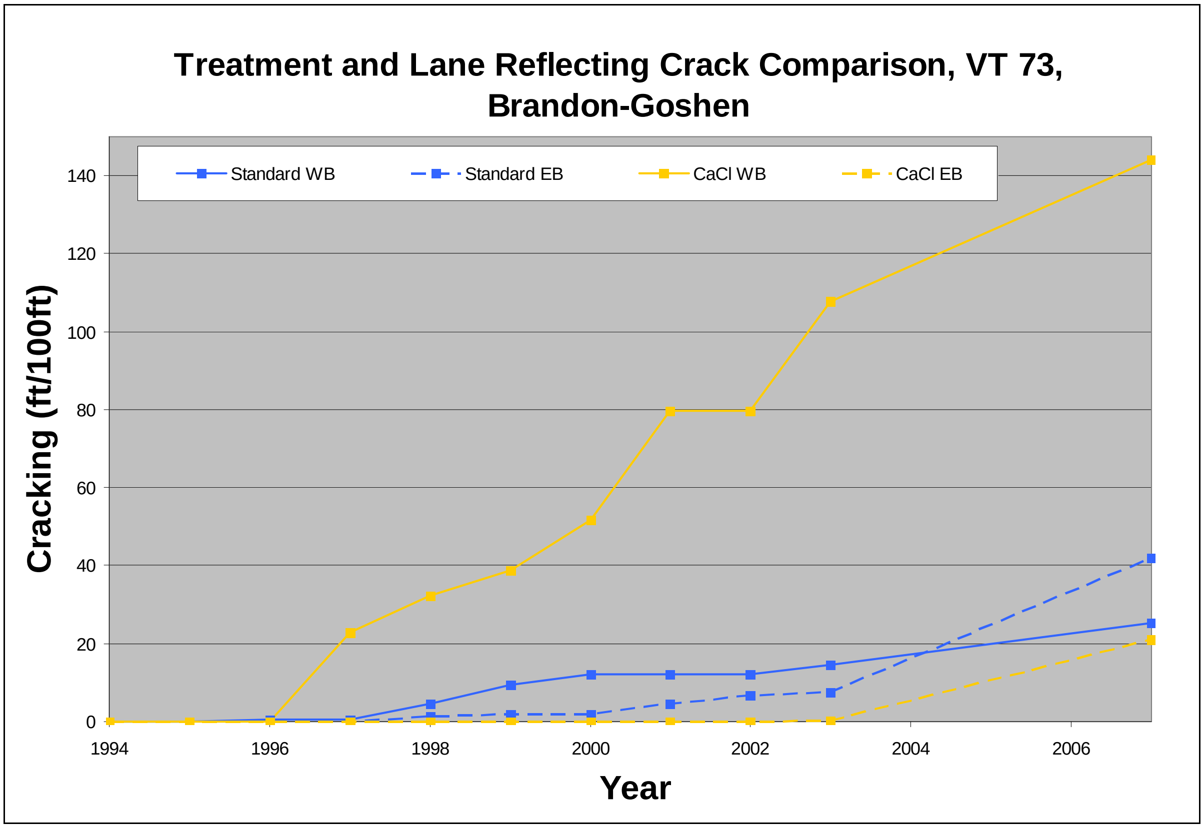

Figure 6 – Reflective Cracking - Treatment and Lane Comparison

The results from Figure 6 are quite interesting again indicating some type of instability of the experimental sections within the westbound lane. The responses from the control sections are fairly consistent regardless of location. This further supports a theory problems associated with constructability. The reclaiming process does require optimum moisture content for proper compaction. Any additives must be incorporated carefully to ensure adequate mixing which requires a second pass of a reclaiming machine. If any of these parameters are not executed properly, the new roadway base will not perform properly resulting in premature cracking and rutting. If data from the experimental sections within the westbound lane are discounted, it would appear that the addition of $CaCl_2$ assists to mitigate reflective cracking as the amount of reflective cracking from the experimental sections is less than the amount of reflective cracking within the control sections. It is important to note that the experimental section stabilized with CaCl2 did not display reflective cracking until 2003, nine years following construction. Comparatively, reflective cracking was observed in 1997, only four years following construction within the control test sections.

In order to examine the propagation of reflective cracking as a function of total cracking per year, a graph of the total amount of reflective cracking divided by the amount of total cracking is provided in Figure 7.

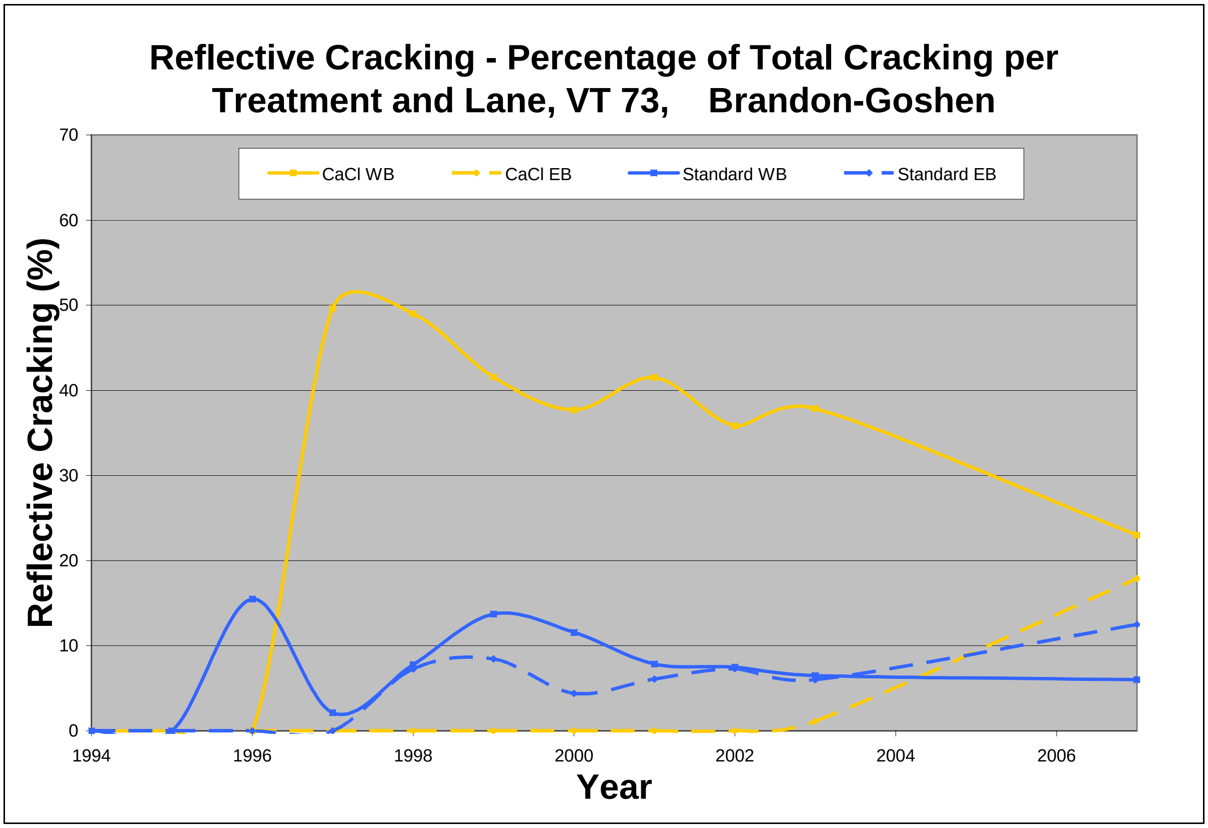

Figure 7 – Percentage of Reflective Cracking - Treatment and Lane Comparison

Once again, the westbound lane within the experimental limits displays unexplainable results due to previous assumed factors. When all other sections are considered, the results show that until 2005, the $CaCl_2$ exhibited a lesser amount of reflective cracking as a percentage of the total cracking than that of the standard treatment. It should be noted that there is a fairly steep inclining slope from 2003 and 2007, indicating if studied longer, results would likely increase at this rate. However, due to lack of data, in 2004, 2005, and 2006, the slope should not be considered accurate. Remaining reflective crack data is located in Appendix E.

RUTTING

Rutting is generally caused by permanent deformation within any of the pavements layers or subgrade and is usually caused by consolidation or lateral movement of the materials due to traffic loading. Throughout the duration of the investigation a rut gauge was utilized to quantify the overall depth of rut within each test section. This was done by collecting rut measurements at 50’ foot intervals from the beginning to the end of each test section. The measurement was collected by extending a string across the width of the road and measuring the vertical length between the string and the deepest depression within all wheel paths identified along the length of the string. All measurements were recorded onto a standard field form in 1/8” intervals. It is important to note that this procedure is highly subjective due to the nature of the data collection procedure. Table 3 displays the rut data that was collected through the duration of the investigation.

Average Rutting Reading for VT Route 73, Brandon-Goshen (Inches)								
Year	**$CaCl_2$**				**Standard**			
	WESTBOUND (MM 1.6-1.8)		**EASTBOUND (MM 2.2-2.4)**		**WESTBOUND (MM 2.2-2.4)**		**EASTBOUND (MM 1.6-1.8)**	
	Outer Wheel Path	**Inner Wheel Path**	**Outer Wheel Path**	**Inner Wheel Path**	**Outer Wheel Path**	**Inner Wheel Path**	**Outer Wheel Path**	**Inner Wheel Path**
Precon.	0.54	0.51	0.47	0.50	0.57	0.42	0.35	0.49
1994	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	0.00	0.04	0.00	0.01	0.00	0.08	0.00	0.00
1996	0.00	0.11	0.01	0.06	0.00	0.15	0.00	0.03
1997	0.00	0.11	0.04	0.10	0.03	0.15	0.00	0.03
1998	0.07	0.17	0.07	0.08	0.08	0.22	0.11	0.01
1999	0.14	0.25	0.07	0.28	0.21	0.32	0.14	0.17
2000	0.11	0.32	0.11	0.18	0.18	0.38	0.15	0.14
2001	0.17	0.38	0.15	0.17	0.19	0.44	0.17	0.18
2002	0.22	0.40	0.17	0.25	0.25	0.40	0.14	0.15
2003	0.39	0.50	0.19	0.32	0.36	0.54	0.21	0.19
2007	0.68	0.75	0.33	0.35	0.68	0.78	0.36	0.38
% of Precon.	**126**	**146**	**71**	**69**	**120**	**187**	**104**	**77**

Table 3 – Rut Summary

In general, the overall depth of rutting increases throughout all test sections on an annual basis. However, some of the data appears to be erroneous as the depth of rut decreases significantly in some of the test locations. According to the project history extracted from the "Pavement Management Database", there was no record of a "rut fill" at any point during the investigation period. Therefore, this data was excluded from the subset.

In examining the data sets, the standard reclaim sections displayed a greater amount of rutting than the experimental sections at an average rate of 122 percent of preconstruction rutting across the full lane width as compared to 103 percent within the referenced $CaCl_2$ sections thirteen years following construction. Overall, this is somewhat significant at a 19 percent increase in rutting within the control sections and may have been caused by several factors including inadequate compaction or excessive loading. Another important observation concerns the greater amount of rutting within the inner wheels paths as compared to the outer wheel paths at 120 and 105 percent of preconstruction rutting, respectfully, for both the experimental and control sections. Typically, additional consolidation would be expected to occur under the outer wheel paths resulting from reduction in structural support. Upon further examination, the experimental sections outperformed the control sections for both inner and outer wheel path rutting at 108 percent and 132 percent of preconstruction inner wheel path rutting and 98 percent and 112 percent of preconstruction outer wheel path rutting for the experimental and control sections, respectively. The most significant finding is the greater amount of rutting within the westbound lane as compared to the eastbound lane at 144 percent and 80 percent, respectively. This coincides with the fatigue cracking evaluation and may be attributed to frequent vehicular braking, increased truck loading, poor aggregates, poor construction practices, moisture damage, and post-construction pavement compaction by traffic loading. Additional rut data is located in Appendix F.

IRI

IRI, or International Roughness Index, is utilized to characterize the longitudinal profile within wheel paths and constitutes a standardized measurement of smoothness. According to Better Roads Magazine, "the pavement's IRI in inches per mile measures the cumulative movement of the suspension of the quarter-car system divided by the traveled distance. This simulates ride smoothness at 50 miles per hour." IRI values were collected on an annual basis from 1994-2007 with the exception of 1999, 2005, and 2006 through the Pavement Management Section of VTrans utilizing road profilers. The pre-construction IRI data was also not available for comparison. Please note that the data was collected by different vendors through the investigation which resulted in poor correlation between collection events. Figure 8 displays the IRI data for both the experimental and standard overlay sections.

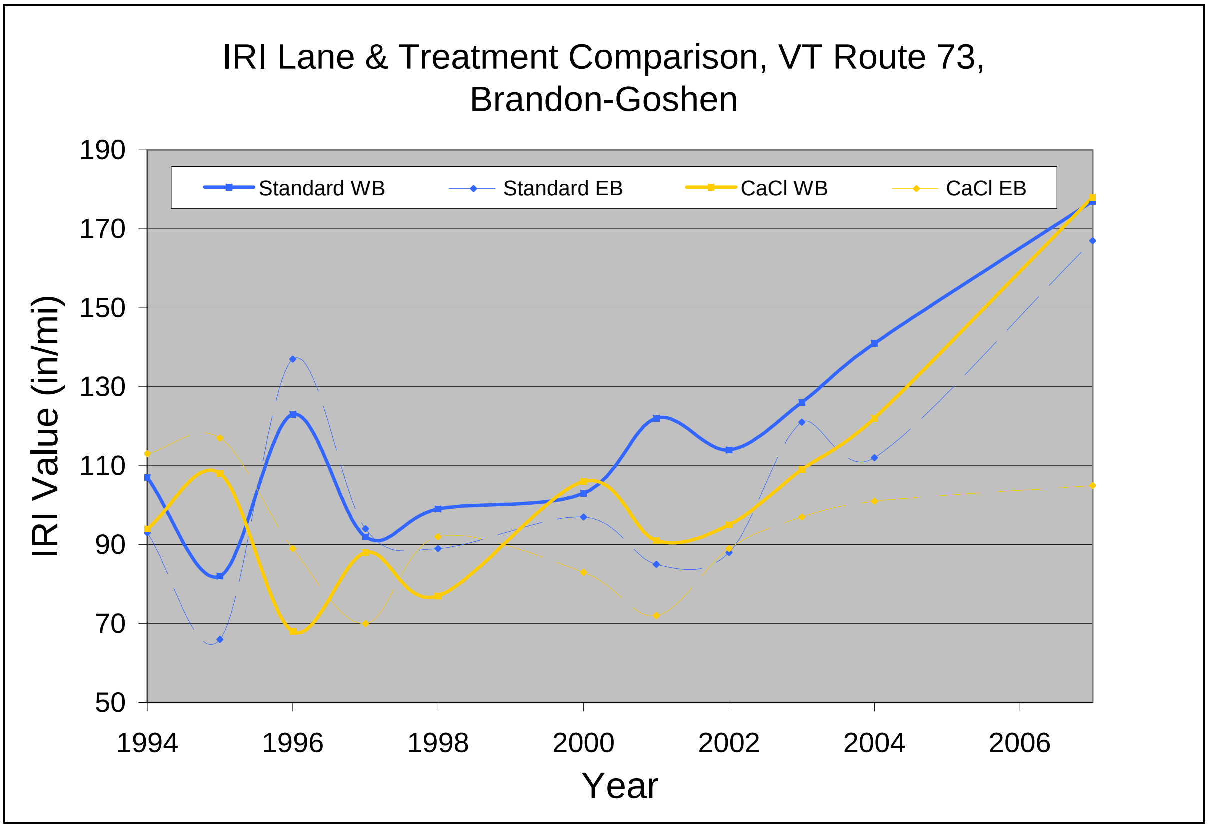

Figure 8 – IRI Summary

There are some discontinuities within the data set. Usually IRI values are at a minimum immediately following construction as the pavement condition is optimum and will then degrade over time. Therefore, it was anticipated the there would be an upward trend throughout the years of data collection. However, in this project the IRI values fluctuated at various times throughout the project. These discrepancies are most likely caused by a variation in testing equipment and calibration methods. It may also be a response from the underlying pavement condition due to frozen conditions increasing the IRI values. However, all IRI values were collected from June through August when the underlying structure would not be subjected to freezing conditions.

Although there are some inconsistencies in data, there is a general upward trend in the IRI values for both the experimental and control sections. Both overlays had initial roughness values of 100 in 1994. In 2007, the standard overlay had a value of 172 in/mile and the experimental was at 141.5 in/mile. By these results one can conclude that the $CaCl_2$ overlay seems to exhibit less average increase in roughness than the standard overlay. According to a figure published in “The Little Book of Profiling, Basic Information about Measuring and Interpreting Road Profiles”, these values fall in the higher range of newer pavements and the lower range of the ‘Older Pavement’ range. The next level is at 300 in/mi. At this point the pavement is considered to have surface imperfections. Projections indicate that the standard overlay will reach this minimum much more readily as compared to experimental section. At the rate of increase, the standard overlay will reach this point much quicker then the experimental. It is important to note that these results are based on the average of two data points per treatment. There was one value taken per three test sections. Additional IRI data is located in Appendix G.

STATISTICAL SIGNIFICANCE:

In order to quantify the statistical significance of the findings above, a non-parametric test was utilized for assessing whether two samples of observations come from the same distribution, known as the Mann-Whitney-Wilcoxon Test. This test does not rely on the assumption of normality and can be applied to small sample sizes. The null hypothesis assumes that the two samples are drawn from a single population and that their probability distributions are the same. The various forms of cracking (total, fatigue, thermal and reflective), as well as rutting were evaluated prior to and thirteen years following construction utilizing an alpha value of 0.05, a common value in statistics. In all cases, the control and experimental populations were found to be equivalent. This means that there is no statistically significant difference in the pavement cracking or rutting prior to or thirteen years following construction and basically implies that both treatments performed similarly. A copy of all nonparametric test data is supplied in Appendix H.

COST:

The cost for the reclamation process on this project was $0.80/yd^2 , with additional costs of $1.00/yd^2 for the $CaCl_2$ stabilizer. This resulted in a total cost of $1.80/ yd^2 for the road reclaimation stabilized with $CaCl_2$. Gorman Brothers, a regional contractor, was contacted for current pricing. According to their records, pricing has not changed.

SUMMARY:

In an effort to assess the performance of various rehabilitation techniques, the Vermont Agency of Transportation constructed a 5.162 mile segment of reclaimed base stabilized with calcium chloride ($CaCl_2$) along VT 73 in the towns of Brandon and Goshen in 1994. Reported advantages of $CaCl_2$ are that it enables a roadway to resist change by strengthening the road base, reduces the incidence and magnitude of frost heaving and pavement break-up, maximizes compaction, adds durability, and optimizes overall base stabilization. Unlike full reconstruction methods, which typically involve the removal and replacement of the existing pavement layer, this method utilizes the preexisting in-place bituminous pavement to construct a new bituminous layer during roadway rehabilitation, simultaneously reducing costs, and preserving energy.

In order to conduct a comparative analysis, two distinct test sections were selected at MM 1.60 to MM 1.80 (Test Section 1) and MM 2.20 to MM 2.40 (Test Section 2) in the town of Goshen. The length of each test section was 1056 feet. Calcium chloride was applied to the westbound lane between MM 1.60 to MM 1.80 and the eastbound lane between MM 2.20 and MM 2.40. The other lanes were stabilized with water only. Pavement studies to characterize the current condition of the various treatments were conducted prior to and following construction on an annual basis.

With respect to data collection efforts, the experimental calcium chloride stabilization treatment faired quite equally and in some cases better to the standard overlay. However due to the excessive cracking totals in the westbound lane, it was necessary to evaluate each treatment per lane, which showed unusual results. In terms of fatigue cracking, the experimental sections met or exceeded preconstruction levels while the standard sections displayed 85% of preconstruction values in 2007, thirteen years following construction. Conversely, the experimental sections stabilized with $CaCl_2$ outperform the control section with respect to thermal cracking. This corroborates findings from previous studies and proves that the incorporation of $CaCl_2$ reduces the impact of frost heaves. If data from the westbound lane is discounted, evidence suggests that the addition of $CaCl_2$ may also help to mitigate reflective cracking. The eastbound lane exhibited no reflective cracking until 2003, nine years after construction when the standard treatment displayed reflective cracking in 1997, four years following construction.

The standard reclaim sections displayed a greater amount of rutting than the experimental sections at an average rate of 122 percent of preconstruction rutting across the full lane width as compared to 103 percent within the referenced $CaCl_2$ sections thirteen years following construction. Overall, this is somewhat significant at a 19 percent increase in rutting within the control sections and may have been caused by several factors including inadequate compaction or excessive loading. Upon further examination, the experimental sections outperformed the control sections for both inner and outer wheel path rutting at 108 percent and 132 percent of preconstruction inner wheel path rutting and 98 percent and 112 percent of preconstruction outer wheel path rutting for the experimental and control sections, respectively. Finally, the experimental sections displayed the least amount of ride roughness as compared to the standard sections on average.

Overall, there does appear to be inadequate lateral support within the westbound lane regardless of treatment type. This theory is supported by results from the fatigue, reflective cracking and rutting analysis. Fatigue cracking exceeded preconstruction levels within the westbound lane between 2004 and 2005 while the eastbound lane has yet to meet or exceed failure criteria. In general, reflective cracking is more pronounced within the westbound lane in comparison to the eastbound lane. However, this result may be slightly skewed due to the excessive amount of reflective cracking from the experimental section. The most noteworthy finding is the greater amount of rutting within the westbound lane as compared to the eastbound lane at 144 percent and 80 percent, respectively. This coincides with the fatigue and reflective cracking evaluations and may be attributed to frequent vehicular braking, increased truck loading, poor aggregates, poor construction practices, moisture damage, and post-construction pavement compaction by traffic loading.

With consideration to the suspected inadequate lateral support within the westbound lanes, it would appear that the use of CaCl2 within the reclamation process is effective in reducing frost heave and other forms of pavement distress. Given the variation of results throughout the length and duration of the project, future projects using this particular stabilizing agent should be monitored closely for performance prior to fully implementing this technology.

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Appendix A

Total Cracking- Westbound Lane

PAVEMENT PERFORMANCE EVALUATION WESTBOUND LANE								
	With $CaCl_2$ Treatment				Without $CaCl_2$ Treatment			
	MM 1.60 TS 1	MM 1.65 TS 2	MM 1.72 TS 3	Average w/ $CaCl_2$	MM 2.24 TS 4	MM 2.33 TS 5	MM 2.37 TS 6	Average w/o $CaCl_2$
Pre-Construction								
Total Cracking	462	756	588	602.00	366	500	626	497.33
Fatigue	178	250	228	218.67	154	263	214	210.33
Thermal	4	0	0	1.33	3	0	9	4.00
Reflective	NA	NA	NA	NA	NA	NA	NA	NA
Other-Longitudinal	280.00	506.00	360.00	382.00	209.00	237.00	403.00	283.00
1994								
Total Cracking	0	0	0	0.00	0	0	0	0.00
Fatigue	0	0	0	0.00	0	0	0	0.00
Thermal	0	0	0	0.00	0	0	0	0.00
Reflective	0	0	0	0.00	0	0	0	0.00
Other-Longitudinal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995								
Total Cracking	0	0	0	0.00	0	0	0	0.00
Fatigue	0	0	0	0.00	0	0	0	0.00
Thermal	0	0	0	0.00	0	0	0	0.00
Reflective	0	0	0	0.00	0	0	0	0.00
Other-Longitudinal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996								
Total Cracking	0	0	0	0.00	0	13	0	4.33
Fatigue	0	0	0	0.00	0	3	0	1.00

Thermal	0	0	0	0.00	0	0	0	0.00
Reflective	0	0	0	0.00	0	2	0	0.67
Other-Longitudinal	0.00	0.00	0.00	0.00	0.00	10.00	0.00	3.33
1997								
Total Cracking	82	57	0	46.33	30	20	45	31.67
Fatigue	21	36	0	19.00	12	7	9	9.33
Thermal	0	0	0	0.00	0	0	0	0.00
Reflective	51	18	0	23.00	0	2	0	0.67
Other-Longitudinal	61.00	21.00	0.00	27.33	18.00	13.00	36.00	22.33
1998								
Total Cracking	103	75	20	66.00	50	26	104	60.00
Fatigue	34	47	17	32.67	21	9	36	22.00
Thermal	0	0	0	0.00	0	0	0	0.00
Reflective	73	22	2	32.33	0	4	10	4.67
Other-Longitudinal	69.00	28.00	3.00	33.33	29.00	17.00	68.00	38.00
1999								
Total Cracking	107	110	62	93.00	50	26	128	68.00
Fatigue	37	72	54	54.33	21	9	56	28.67
Thermal	0	5	0	1.67	0	0	0	0.00
Reflective	75	27	14	38.67	0	4	24	9.33
Other-Longitudinal	70.00	33.00	8.00	37.00	29.00	17.00	72.00	39.33
2000								
Total Cracking	169	180	62	137.00	82	39	190	103.67
Fatigue	41	123	54	72.67	21	9	95	41.67
Thermal	0	5	0	1.67	0	0	0	0.00
Reflective	77	64	14	51.67	0	4	8	4.00
Other-Longitudinal	128.00	52.00	8.00	62.67	61.00	30.00	95.00	62.00
2001								
Total Cracking	215	214	147	192.00	109	74	275	152.67

Fatigue	80	151	136	122.33	33	35	155	74.33
Thermal	0	8	0	2.67	0	3	0	1.00
Reflective	102	91	46	79.67	0	4	8	4.00
Other-Longitudinal	135.00	55.00	11.00	67.00	76.00	36.00	120.00	77.33
2002								
Total Cracking	290	228	149	222.33	114	78	288	160.00
Fatigue	93	161	147	133.67	36	35	161	77.33
Thermal	0	8	0	2.67	0	3	0	1.00
Reflective	102	91	46	79.67	0	4	8	4.00
Other-Longitudinal	197.00	59.00	2.00	86.00	78.00	40.00	127.00	81.67
2003								
Total Cracking	350	315	188	284.33	179	81	416	225.33
Fatigue	155	222	174	183.67	83	35	298	138.67
Thermal	0	11	0	3.67	12	8	0	6.67
Reflective	134	142	47	107.67	0	4	16	6.67
Other-Longitudinal	195.00	82.00	14.00	97.00	84.00	38.00	118.00	80.00
2004								
Total Cracking	350	315	188	284.33	179	81	416	225.33
Fatigue	155	155	174	161.33	83	35	298	138.67
Thermal	0	11	0	3.67	12	8	0	6.67
Reflective	134	142	142	139.33	0	4	16	6.67
Other-Longitudinal	195.00	149.00	14.00	119.33	84.00	38.00	118.00	80.00
2007								
Total Cracking	727	454	306	495.67	421	230	613	421.33
Fatigue	347	306	224	292.33	221	134	394	249.67
Thermal	0	17	2	6.33	32	9	20	20.33
Reflective	161	204	67	144.00	0	32	26	19.33
Other-Longitudinal	380.00	131.00	80.00	197.00	168.00	87.00	199.00	151.33

Total Cracking – Eastbound Lane

PAVEMENT PERFORMANCE EVALUATION EASTBOUND LANE								
	Without $CaCl_2$ Treatment				With $CaCl_2$ Treatment			
	MM 1.60 TS 1	MM 1.65 TS 2	MM 1.72 TS 3	Average w/o $CaCl_2$	MM 2.24 TS 4	MM 2.33 TS 5	MM 2.37 TS 6	Average w/ $CaCl_2$
Pre-Construction								
Total Cracking	**567**	**647**	**588**	**600.67**	**556**	**252**	**277**	**361.67**
Fatigue	**205**	**331**	**300**	**278.67**	**164**	**83**	**112**	**119.67**
Thermal	**0**	**0**	**0**	**0.00**	**2**	**0**	**0**	**0.67**
Reflective	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Other-Longitudinal	**362.00**	**316.00**	**288.00**	**322.00**	**390.00**	**169.00**	**165.00**	**241.33**
1994								
Total Cracking	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Fatigue	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Thermal	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Reflective	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Other-Longitudinal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1995								
Total Cracking	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Fatigue	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Thermal	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Reflective	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Other-Longitudinal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1996								

Total Cracking	**7**	**0**	**0**	**2.33**	**0**	**0**	**0**	**0.00**
Fatigue	**3**	**0**	**0**	**1.00**	**0**	**0**	**0**	**0.00**
Thermal	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
	0	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Reflective								
Other-Longitudinal	**4.00**	**0.00**	**0.00**	**1.33**	**0.00**	**0.00**	**0.00**	**0.00**
1997								
Total Cracking	**16**	**0**	**0**	**5.33**	**0**	**0**	**0**	**0.00**
Fatigue	**4**	**0**	**0**	**1.33**	**0**	**0**	**0**	**0.00**
Thermal	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
	0	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
Reflective								
Other-Longitudinal	**12.00**	**0.00**	**0.00**	**4.00**	**0.00**	**0.00**	**0.00**	**0.00**
1998								
Total Cracking	**33**	**14**	**8**	**18.33**	**0**	**0**	**0**	**0.00**
Fatigue	**16**	**14**	**3**	**11.00**	**0**	**0**	**0**	**0.00**
Thermal	**0**	**0**	**0**	**0.00**	**0**	**0**	**0**	**0.00**
	2	**2**	**0**	**1.33**	**0**	**0**	**0**	**0.00**
Reflective								
Other-Longitudinal	**17.00**	**0.00**	**5.00**	**7.33**	**0.00**	**0.00**	**0.00**	**0.00**
1999								
Total Cracking	**38**	**19**	**14**	**23.67**	**0**	**0**	**0**	**0.00**
Fatigue	**16**	**4**	**9**	**9.67**	**0**	**0**	**0**	**0.00**
Thermal	**1**	**0**	**0**	**0.33**	**0**	**0**	**0**	**0.00**
	4	**2**	**0**	**2.00**	**0**	**0**	**0**	**0.00**
Reflective								
Other-Longitudinal	**21.00**	**15.00**	**5.00**	**13.67**	**0.00**	**0.00**	**0.00**	**0.00**
2000								
Total Cracking	**50**	**51**	**35**	**45.33**	**0**	**0**	**1**	**0.33**
Fatigue	**22**	**24**	**31**	**25.67**	**0**	**0**	**0**	**0.00**
Thermal	**1**	**0**	**0**	**0.33**	**0**	**0**	**1**	**0.33**
	4	**0**	**0**	**1.33**	**0**	**0**	**0**	**0.00**
Reflective								
Other-	**27.00**	**27.00**	**4.00**	**19.33**	**0.00**	**0.00**	**0.00**	**0.00**

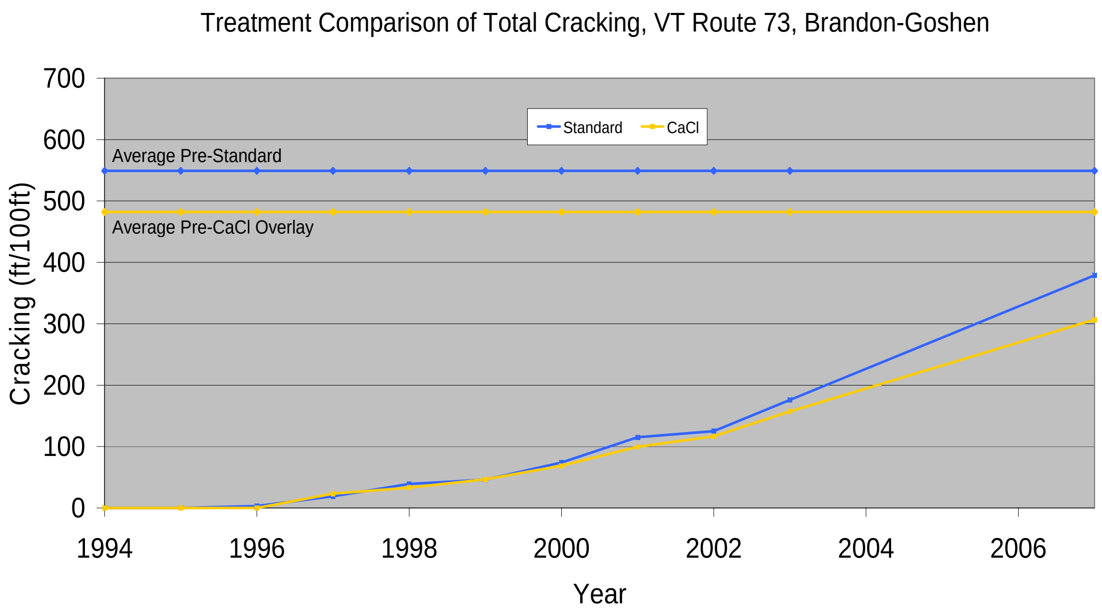
Longitudinal								
2001								
Total Cracking	**75**	**75**	**81**	**77.00**	**0**	**0**	**22**	**7.33**
Fatigue	**30**	**24**	**64**	**39.33**	**0**	**0**	**2**	**0.67**
Thermal	**1**	**0**	**0**	**0.33**	**0**	**0**	**1**	**0.33**
Reflective	**12**	**0**	**0**	**4.00**	**0**	**0**	**0**	**0.00**
Other-Longitudinal	**44.00**	**51.00**	**17.00**	**37.33**	**0.00**	**0.00**	**19.00**	**6.33**
2002								
Total Cracking	**100**	**78**	**96**	**91.33**	**7**	**4**	**22**	**11.00**
Fatigue	**32**	**25**	**81**	**46.00**	**7**	**4**	**2**	**4.33**
Thermal	**1**	**0**	**0**	**0.33**	**0**	**0**	**1**	**0.33**
Reflective	**18**	**0**	**0**	**6.00**	**0**	**0**	**0**	**0.00**
Other-Longitudinal	**67.00**	**53.00**	**15.00**	**45.00**	**0.00**	**0.00**	**19.00**	**6.33**
2003								
Total Cracking	**109**	**97**	**177**	**127.67**	**36**	**18**	**35**	**29.67**
Fatigue	**32**	**35**	**116**	**61.00**	**11**	**12**	**7**	**10.00**
Thermal	**10**	**1**	**0**	**3.67**	**9**	**0**	**1**	**3.33**
Reflective	**18**	**0**	**3**	**7.00**	**0**	**1**	**0**	**0.33**
Other-Longitudinal	**67.00**	**61.00**	**61.00**	**63.00**	**16.00**	**6.00**	**27.00**	**16.33**
2004								
Total Cracking	**109**	**99**	**193**	**133.67**	**40**	**18**	**43**	**33.67**
Fatigue	**32**	**35**	**120**	**62.33**	**11**	**11**	**7**	**9.67**
Thermal	**10**	**1**	**0**	**3.67**	**13**	**4**	**1**	**6.00**
Reflective	**18**	**0**	**3**	**7.00**	**0**	**1**	**0**	**0.33**
Other-Longitudinal	**67.00**	**63.00**	**73.00**	**67.67**	**16.00**	**3.00**	**35.00**	**18.00**
2007								
Total Cracking	**428**	**275**	**306**	**336.33**	**136**	**93**	**123**	**117.33**
Fatigue	**187**	**126**	**163**	**158.67**	**30**	**55**	**55**	**46.67**

Thermal	**42**	**1**	**1**	**14.67**	**32**	**3**	**4**	**13.00**
Reflective	**33**	**14**	**77**	**41.33**	**10**	**23**	**30**	**21.00**
Other-Longitudinal	**199.00**	**148.00**	**142.00**	**163.00**	**74.00**	**35.00**	**64.00**	**57.67**

Average Total Cracking Comparison

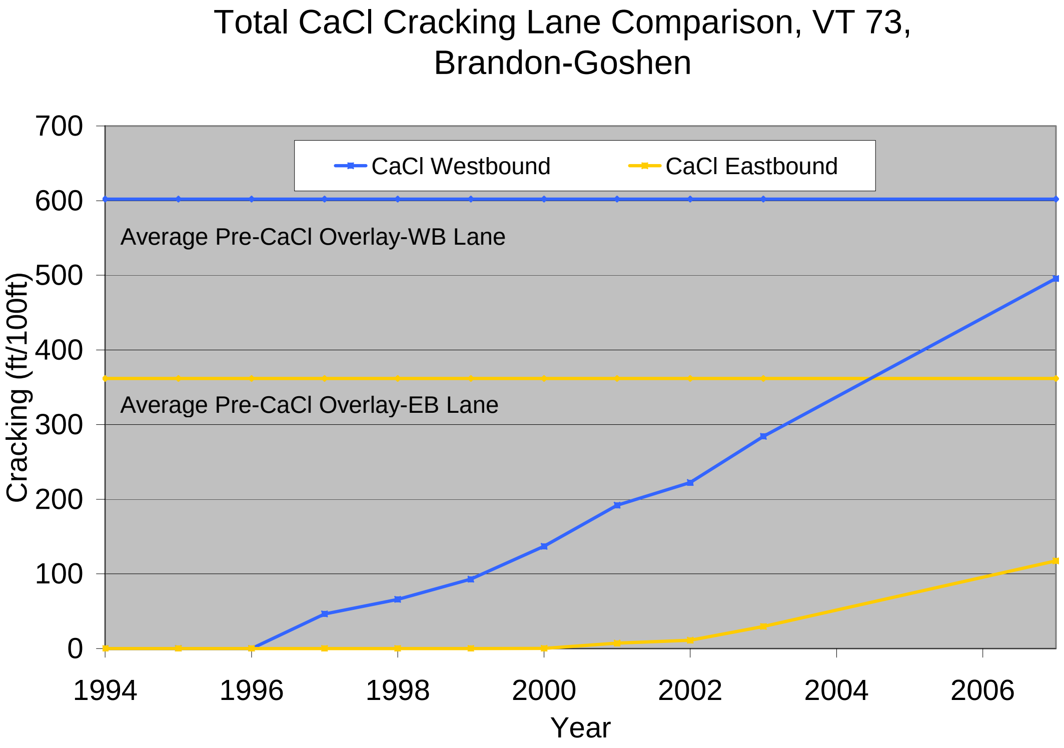
Average Total Cracking Comparison						
Year	**$CaCl_2$ Westbound**	**$CaCl_2$ Eastbound**	**Standard Westbound**	**Standard Eastbound**	**Overall Westbound**	**Overall Eastbound**
1994	0.00	0.00	0.00	0.00	0.00	0.00
1995	0.00	0.00	0.00	0.00	0.00	0.00
1996	0.00	0.00	4.33	2.33	2.17	1.17
1997	46.33	0.00	31.67	5.33	39.00	2.67
1998	66.00	0.00	60.00	18.33	63.00	9.17
1999	93.00	0.00	68.00	23.67	80.50	11.83
2000	137.00	0.33	103.67	45.33	120.33	22.83
2001	192.00	7.33	152.67	77.00	172.33	42.17
2002	222.33	11.00	160.00	91.33	191.17	51.17
2003	284.33	29.67	225.33	127.67	254.83	78.67
2007	495.67	117.33	421.33	336.33	458.50	226.83

Total Comparison



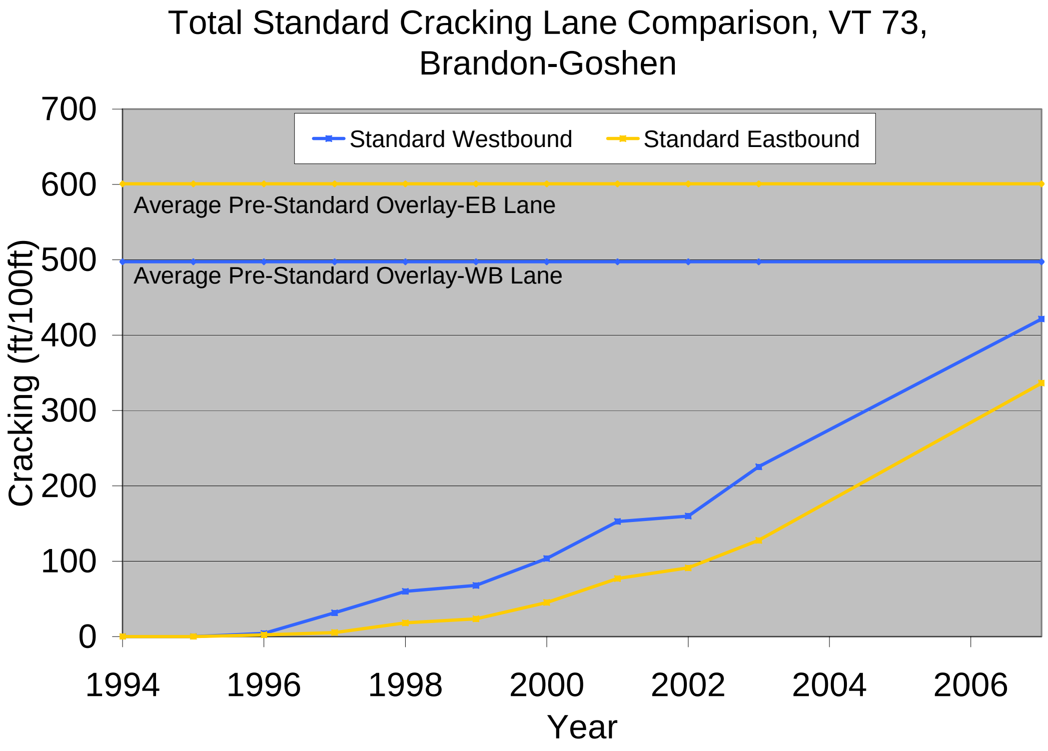
Total Cracking – $CaCl_2$ Lane Comparison

Average $CaCl_2$ Total Comparison				
Year	**$CaCl_2$ Westbound**	**Pre-WB**	**$CaCl_2$ Eastbound**	**Pre-EB**
1994	0.00	602.00	0.00	361.67
1995	0.00	602.00	0.00	361.67
1996	0.00	602.00	0.00	361.67
1997	46.33	602.00	0.00	361.67
1998	66.00	602.00	0.00	361.67
1999	93.00	602.00	0.00	361.67
2000	137.00	602.00	0.33	361.67
2001	192.00	602.00	7.33	361.67
2002	222.33	602.00	11.00	361.67
2003	284.33	602.00	29.67	361.67
2007	495.67	602.00	117.33	361.67



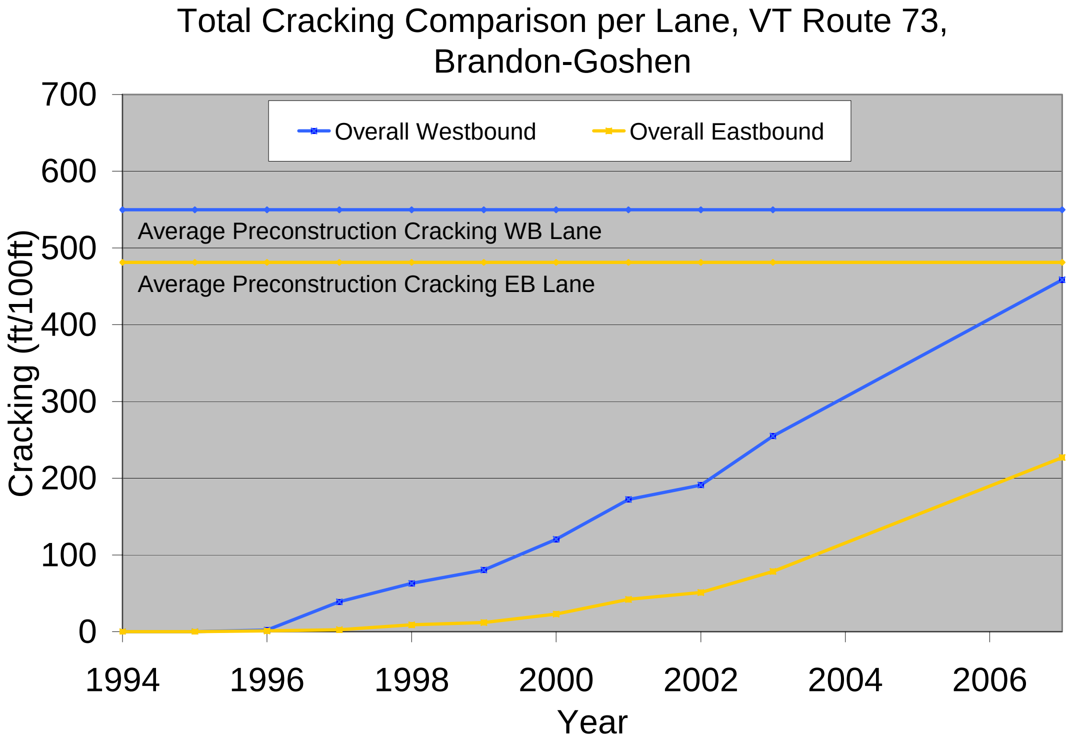
Total Cracking – Standard Lane Comparison

Average Standard Total Comparison				
Year	**Standard Westbound**	**Pre-WB**	**Standard Eastbound**	**Pre-EB**
1994	0.00	497.33	0.00	600.67
1995	0.00	497.33	0.00	600.67
1996	4.33	497.33	2.33	600.67
1997	31.67	497.33	5.33	600.67
1998	60.00	497.33	18.33	600.67
1999	68.00	497.33	23.67	600.67
2000	103.67	497.33	45.33	600.67
2001	152.67	497.33	77.00	600.67
2002	160.00	497.33	91.33	600.67
2003	225.33	497.33	127.67	600.67
2007	421.33	497.33	336.33	600.67



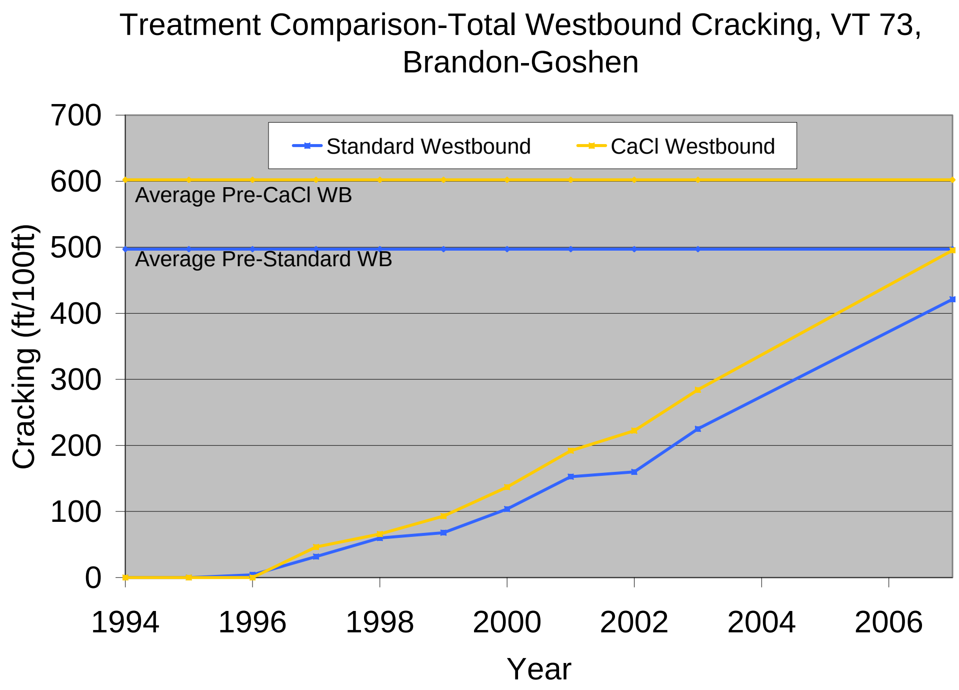
Total Cracking – Overall Lane Comparison

Average Total Comparison				
Year	**Overall Westbound**	**Pre-WB**	**Overall Eastbound**	**Pre-EB**
1994	0	550	0	481
1995	0	550	0	481
1996	2	550	1	481
1997	39	550	3	481
1998	63	550	9	481
1999	81	550	12	481
2000	120	550	23	481
2001	172	550	42	481
2002	191	550	51	481
2003	255	550	79	481
2007	459	550	227	481

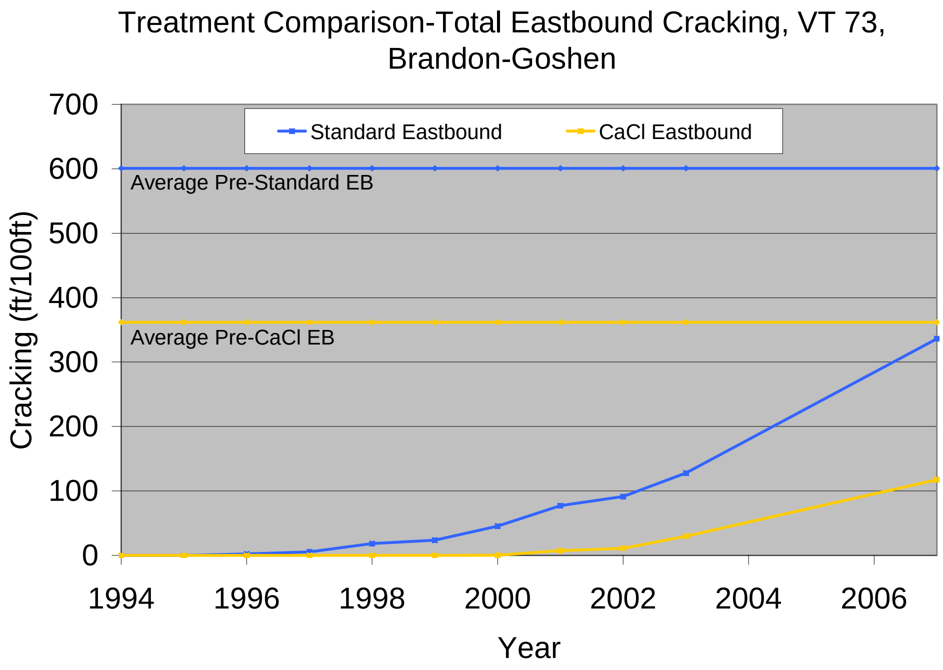


Treatment Comparison Per Lane

Westbound



Eastbound



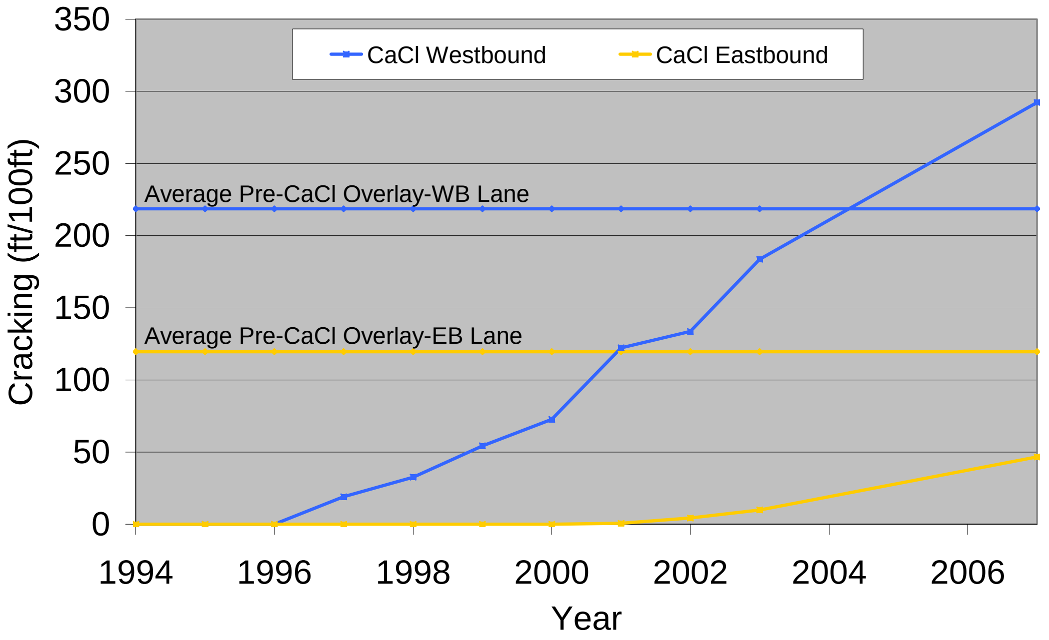
Appendix B

Fatigue Cracking Treatment Comparison

Year	**Standard**	**$CaCl_2$**	**Pre-Standard**	**Pre- $CaCl_2$**
1994	0	0	245	169
1995	0	0	245	169
1996	1	0	245	169
1997	5	10	245	169
1998	17	16	245	169
1999	19	27	245	169
2000	34	36	245	169
2001	57	62	245	169
2002	62	69	245	169
2003	100	97	245	169
2007	**204**	**170**	**245**	**169**

Fatigue Cracking Comparison – $CaCl_2$

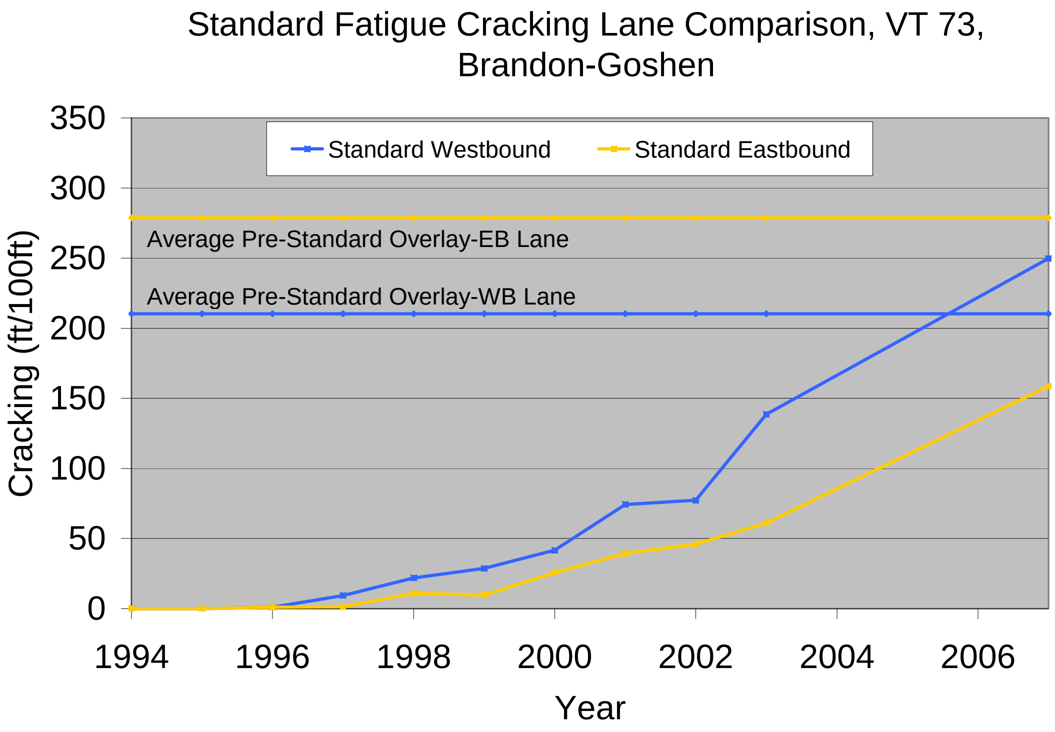
Average Fatigue Comparison				
Year	**$CaCl_2$ Westbound**	**Pre-WB**	**$CaCl_2$ Eastbound**	**Pre-EB**
1994	0	219	0	120
1995	0	219	0	120
1996	0	219	0	120
1997	19	219	0	120
1998	33	219	0	120
1999	54	219	0	120
2000	73	219	0	120
2001	122	219	1	120
2002	134	219	4	120
2003	184	219	10	120
2007	292	219	47	120



CaCl Fatigue Cracking Lane Comparison, VT 73, Brandon-Goshen

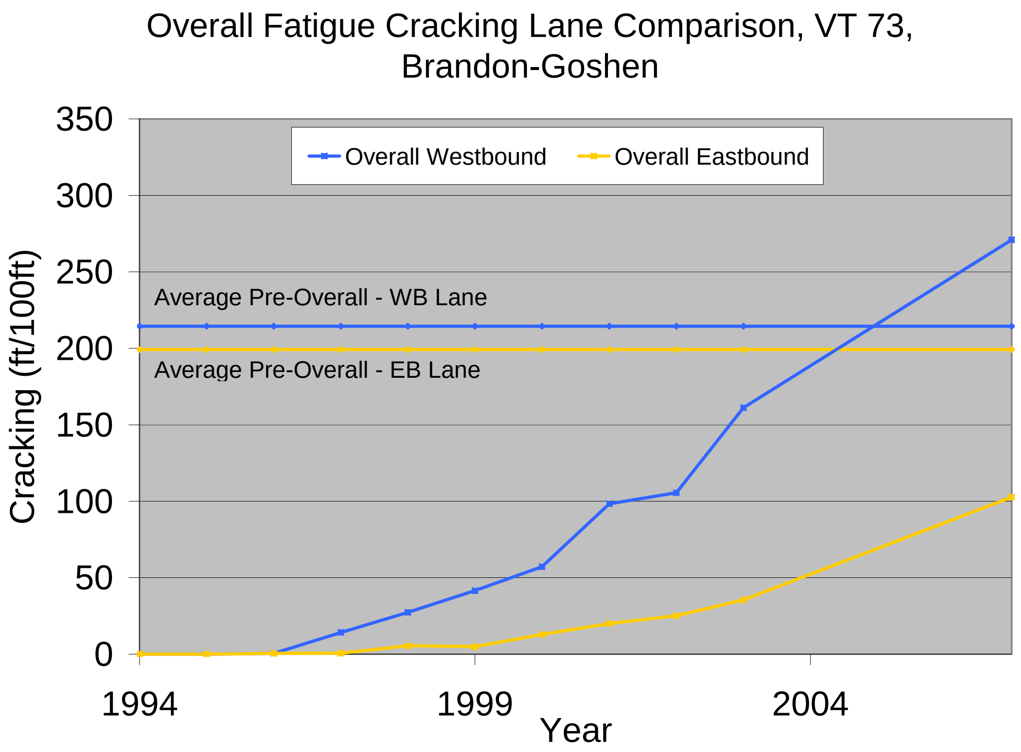
Fatigue Cracking Comparison – Standard

Average Fatigue Comparison				
Year	**Standard Westbound**	**Pre-WB**	**Standard Eastbound**	**Pre-EB**
1994	0	210	0	279
1995	0	210	0	279
1996	1	210	1	279
1997	9	210	1	279
1998	22	210	11	279
1999	29	210	10	279
2000	42	210	26	279
2001	74	210	39	279
2002	77	210	46	279
2003	139	210	61	279
2007	250	210	159	279

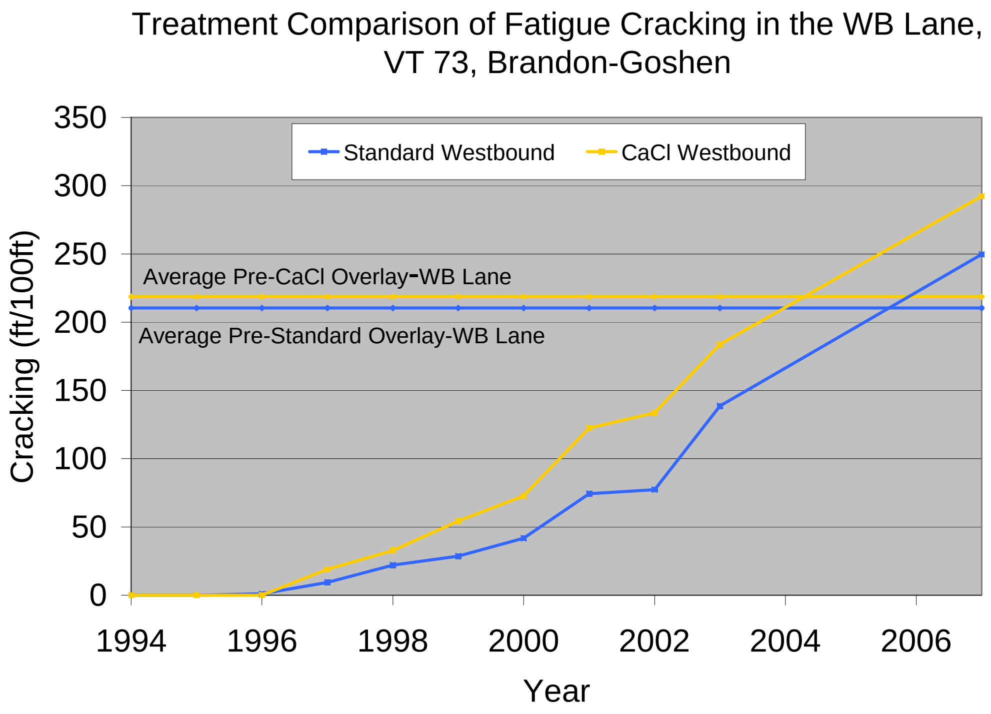


Fatigue Cracking Comparison – Overall

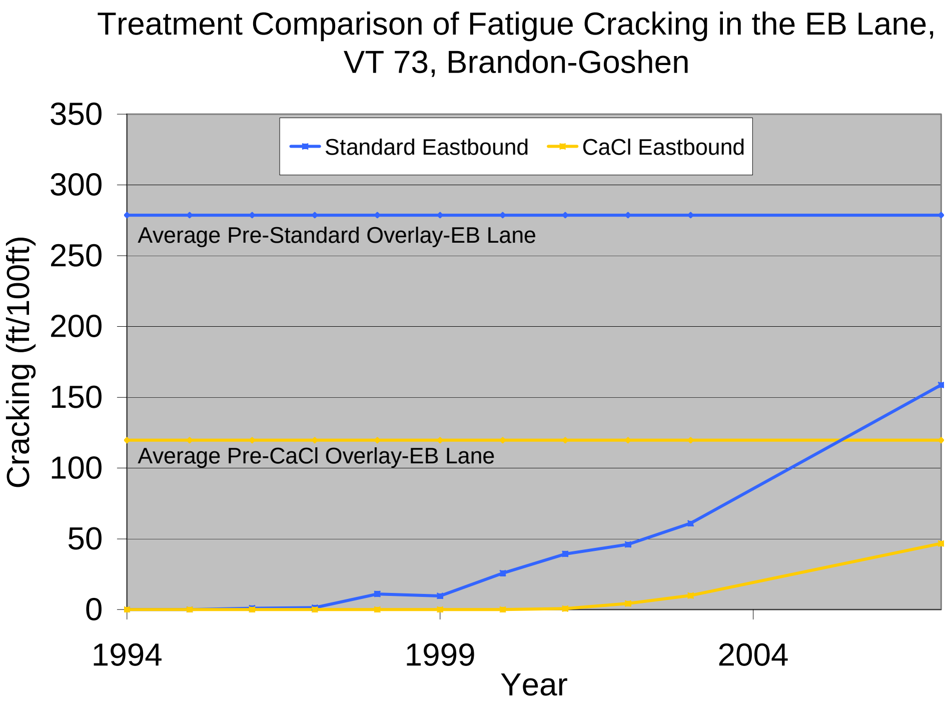
Average Fatigue Comparison				
Year	**Overall Westbound**	**Pre-WB**	**Overall Eastbound**	**Pre-EB**
1994	0	215	0	199
1995	0	215	0	199
1996	1	215	1	199
1997	14	215	1	199
1998	27	215	6	199
1999	42	215	5	199
2000	57	215	13	199
2001	98	215	20	199
2002	106	215	25	199
2003	161	215	36	199
2007	271	215	103	199



Fatigue Cracking Westbound Lane Treatment Comparison



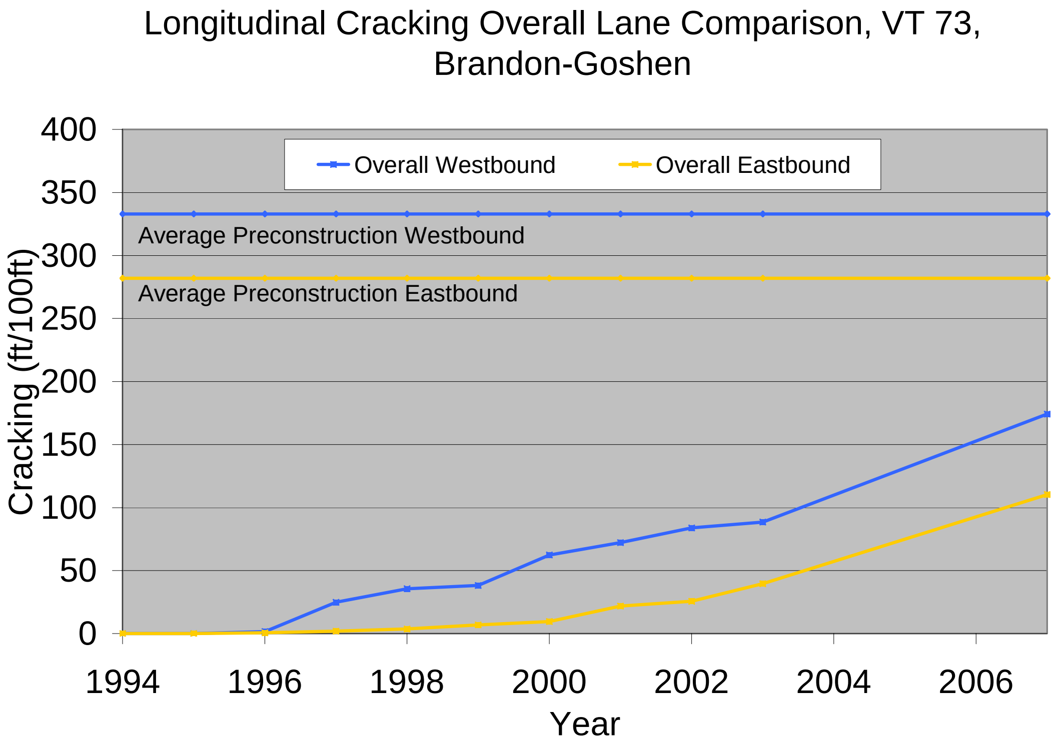
Fatigue Cracking Eastbound Lane Treatment Comparison



Appendix C

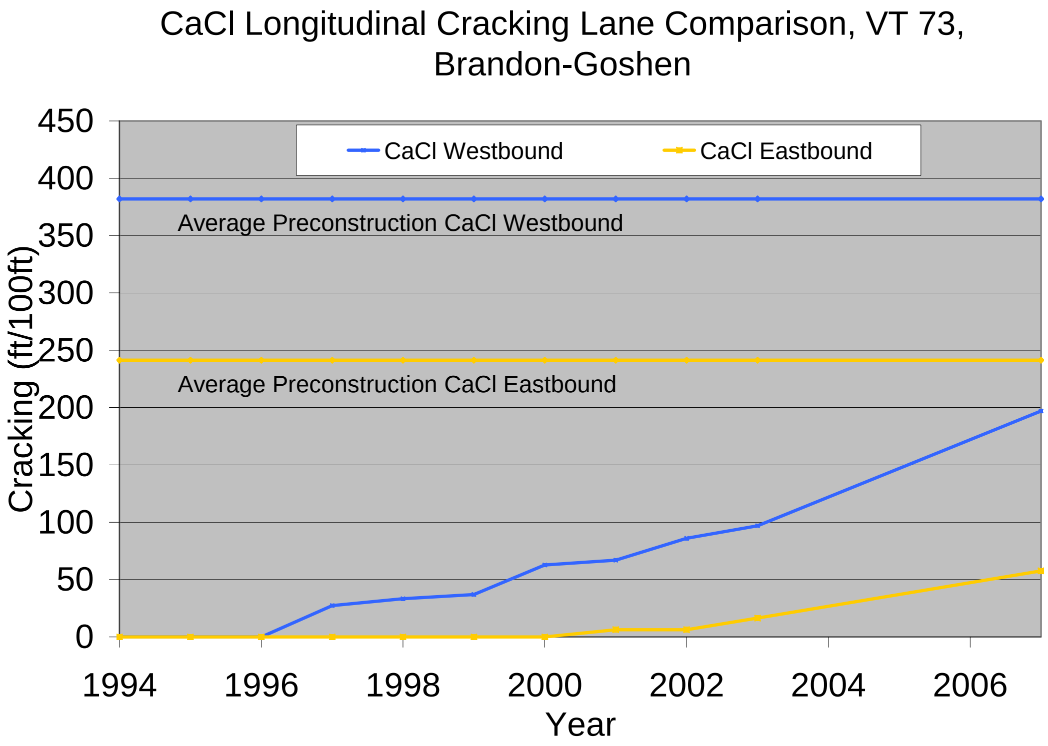
Overall Longitudinal Cracking

Average Longitudinal Comparison				
Year	**Overall Westbound**	**Pre-WB**	**Overall Eastbound**	**Pre-EB**
1994	0	333	0	282
1995	0	333	0	282
1996	2	333	1	282
1997	25	333	2	282
1998	36	333	4	282
1999	38	333	7	282
2000	62	333	10	282
2001	72	333	22	282
2002	84	333	26	282
2003	89	333	40	282
2007	174	333	110	282



$CaCl_2$ Longitudinal Cracking

Average Longitudinal Comparison				
Year	**$CaCl_2$ Westbound**	**Pre-WB**	**$CaCl_2$Eastbound**	**Pre-EB**
1994	0	382.00	0	241
1995	0	382.00	0	241
1996	0	382.00	0	241
1997	27	382.00	0	241
1998	33	382.00	0	241
1999	37	382.00	0	241
2000	63	382.00	0	241
2001	67	382.00	6	241
2002	86	382.00	6	241
2003	97	382.00	16	241
2007	197	382.00	58	241

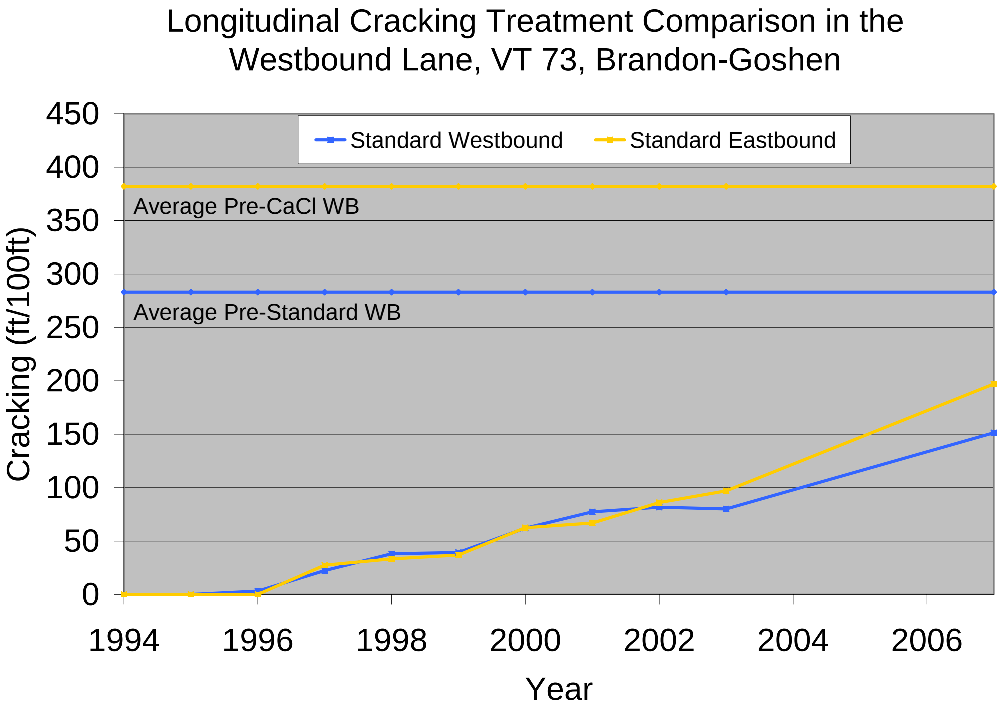


Standard Longitudinal Cracking

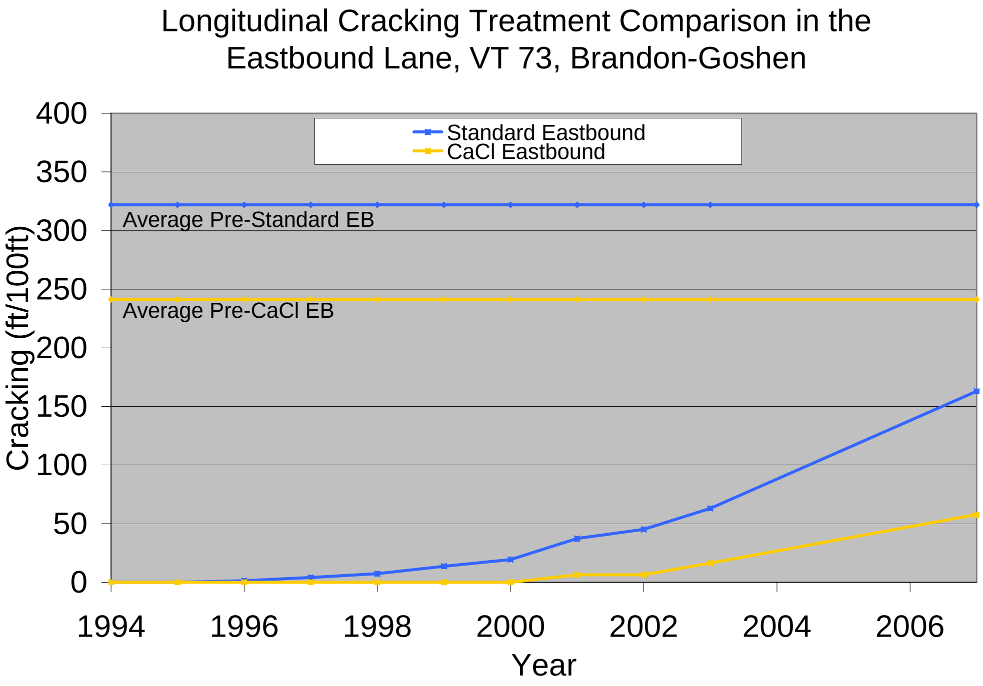
Average Longitudinal Comparison				
Year	**Standard Westbound**	**Pre-WB**	**Standard Eastbound**	**Pre-EB**
1994	0	283	0	322
1995	0	283	0	322
1996	3	283	1	322
1997	22	283	4	322
1998	38	283	7	322
1999	39	283	14	322
2000	62	283	19	322
2001	77	283	37	322
2002	82	283	45	322
2003	80	283	63	322
2007	151	283	163	322

Longitudinal Cracking Treatment Comparison Per Lane

Westbound

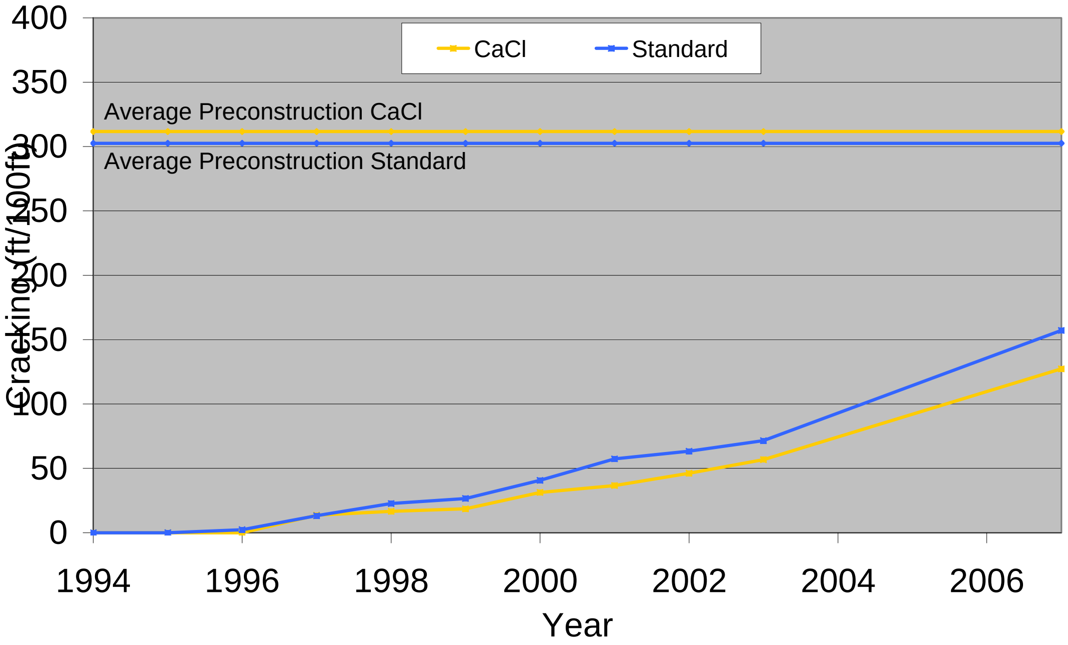


Eastbound



Treatment Comparison Longitudinal Cracking

Longitudinal Cracking Treatment Comparison, VT 73, Brandon-Goshen

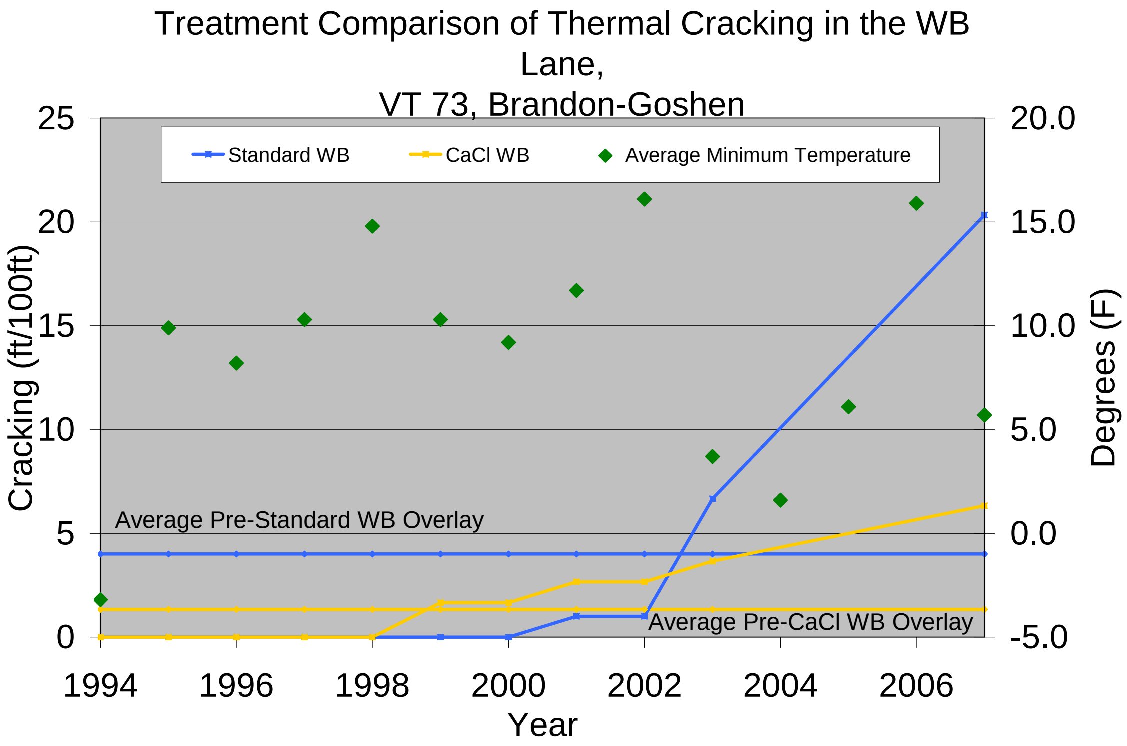


Appendix D

Overall Thermal Cracking Comparison Per Lane

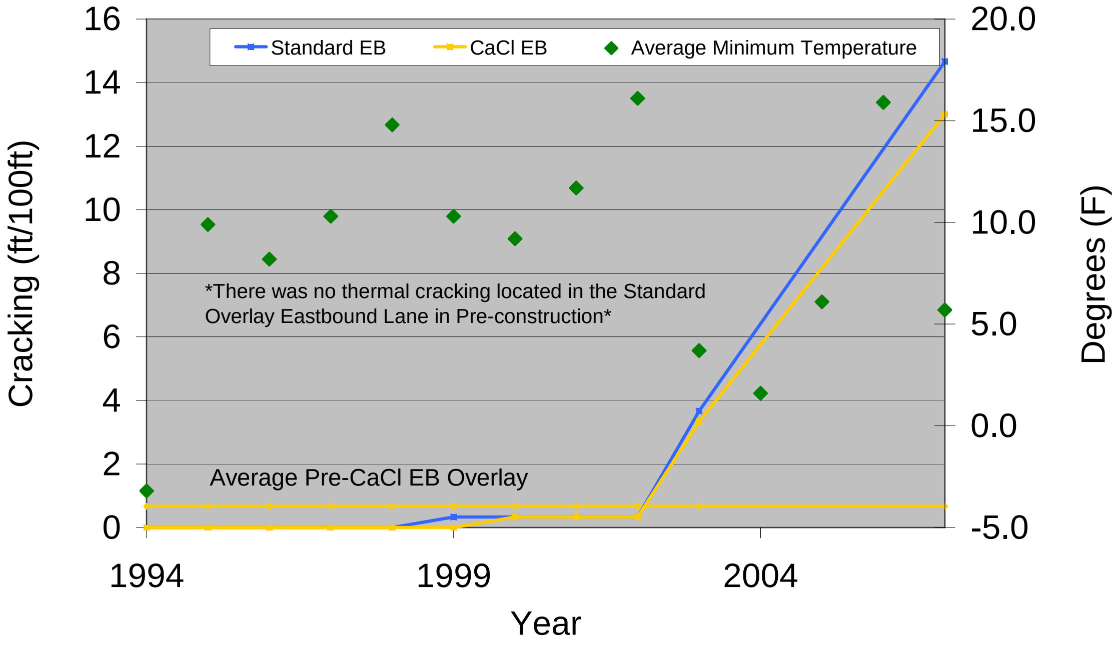
Average Thermal Comparison				
Year	**Overall Westbound**	**Pre-WB**	**Overall Eastbound**	**Pre-EB**
1994	0	3	0	0
1995	0	3	0	0
1996	0	3	0	0
1997	0	3	0	0
1998	0	3	0	0
1999	1	3	0	0
2000	1	3	0	0
2001	2	3	0	0
2002	2	3	0	0
2003	5	3	4	0
2007	13	3	14	0

Westbound


Treatment Comparison of Thermal Cracking in the WB Lane,
VT 73, Brandon-Goshen
Standard WB
CaCl WB
Average Minimum Temperature
Average Pre-Standard WB Overlay
Average Pre-CaCl WB Overlay
Cracking (ft/100ft)
25
20
15
10
5
0
Degrees (F)
20.0
15.0
10.0
5.0
0.0
-5.0
1994
1996
1998
2000
2002
2004
2006
Year

Eastbound

Treatment Comparison of Thermal Cracking in the EB Lane, VT 73, Brandon-Goshen

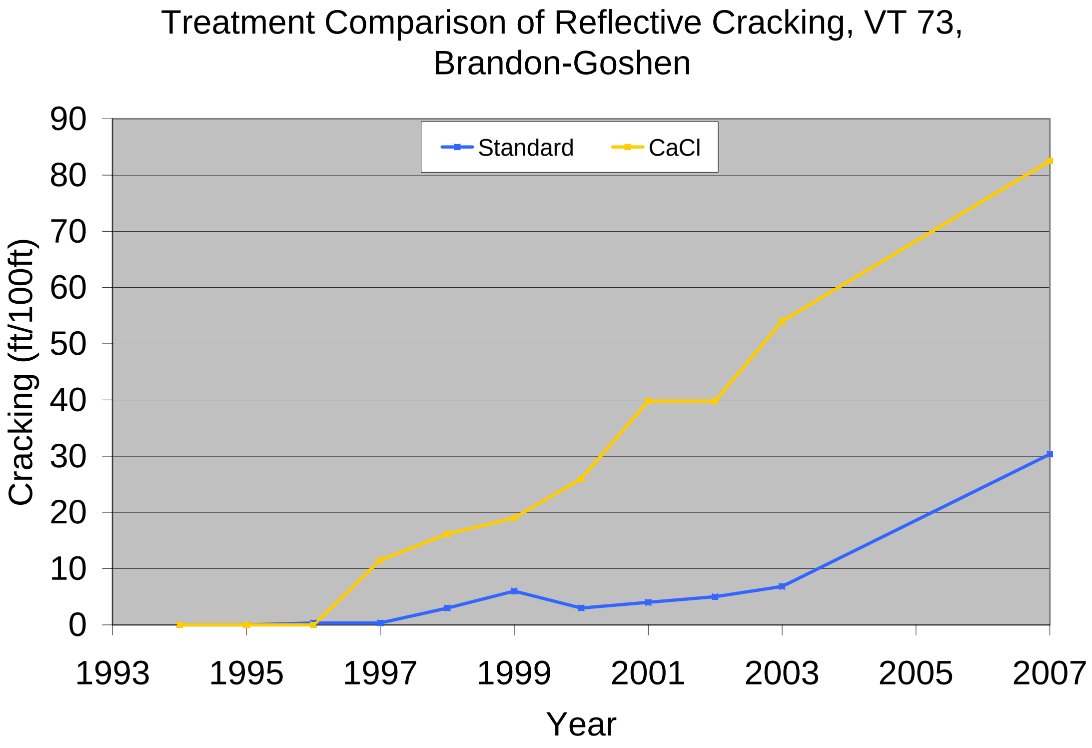


There was no thermal cracking located in the Standard Overlay Eastbound Lane in Pre-construction

Average Pre-CaCl EB Overlay

Appendix E

Reflective Cracking Treatment Comparison



Appendix F

Rutting Data – Westbound Lane

RUTTING EVALUATION WESTBOUND LANE												
	With $CaCl_2$ Treatment						Without $CaCl_2$ Treatment					
	MM 1.60 TS 1		MM 1.65 TS 2		MM 1.72 TS 3		MM 2.24 TS 4		MM 2.33 TS 5		MM 2.37 TS 6	
	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path
Pre-Construction												
0+00	**0.625**	**0.750**	**0.375**	**0.250**	**0.125**	**0.125**	**0.250**	**0.375**	**0.625**	**1.000**	**0.875**	**0.250**
0+50	**0.500**	**0.375**	**0.875**	**0.625**	**0.375**	**0.625**	**0.500**	**0.125**	**0.375**	**0.375**	**0.625**	**0.375**
1+00	**0.125**	**0.250**	**1.250**	**0.750**	**0.625**	**0.875**	**0.875**	**0.500**	**0.250**	**0.125**	**0.750**	**0.625**
Average Rut	**0.417**	**0.458**	**0.833**	**0.542**	**0.375**	**0.542**	**0.542**	**0.333**	**0.417**	**0.500**	**0.750**	**0.417**
Average Rut OWP	**0.542**						**0.569**					
Average Rut IWP	**0.514**						**0.417**					
1994												
0+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
0+50	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
1+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Average Rut	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Average Rut OWP	**0.000**						**0.000**					
Average Rut IWP	**0.000**						**0.000**					
1995												
0+00	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**
0+50	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**
1+00	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**
Average Rut	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**
Average Rut OWP	**0.000**						**0.000**					
Average Rut IWP	**0.042**						**0.083**					
1996												
0+00	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.250**
0+50	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.250**
1+00	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.250**
Average Rut	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.083**	**0.000**	**0.083**	**0.000**	**0.125**	**0.000**	**0.250**
Average Rut OWP	**0.000**						**0.000**					
Average Rut	**0.111**						**0.153**					

IWP												
1997												
0+00	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.125**	**0.125**
0+50	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.125**	**0.250**
1+00	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.250**
Average Rut	**0.000**	**0.125**	**0.000**	**0.125**	**0.000**	**0.083**	**0.000**	**0.125**	**0.000**	**0.125**	**0.083**	**0.208**
Average Rut OWP	**0.000**						**0.028**					
Average Rut IWP	**0.111**						**0.153**					
1998												
0+00	**0.250**	**0.500**	**0.125**	**0.250**	**0.125**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.375**	**0.250**
0+50	**0.000**	**0.250**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.125**	**0.250**	**0.250**	**0.375**
1+00	**0.000**	**0.125**	**0.000**	**0.125**	**0.125**	**0.000**	**0.000**	**0.125**	**0.000**	**0.250**	**0.000**	**0.375**
Average Rut	**0.083**	**0.292**	**0.042**	**0.167**	**0.083**	**0.042**	**0.000**	**0.125**	**0.042**	**0.208**	**0.208**	**0.333**
Average Rut OWP	**0.069**						**0.083**					
Average Rut IWP	**0.167**						**0.222**					
1999												
0+00	**0.250**	**0.625**	**0.125**	**0.375**	**0.250**	**0.250**	**0.125**	**0.250**	**0.250**	**0.250**	**0.250**	**0.375**
0+50	**0.250**	**0.375**	**0.000**	**0.250**	**0.000**	**0.000**	**0.125**	**0.375**	**0.125**	**0.250**	**0.625**	**0.500**
1+00	**0.250**	**0.375**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.250**	**0.125**	**0.250**	**0.125**	**0.375**
Average Rut	**0.250**	**0.458**	**0.083**	**0.208**	**0.083**	**0.083**	**0.125**	**0.292**	**0.167**	**0.250**	**0.333**	**0.417**
Average Rut OWP	**0.139**						**0.208**					
Average Rut IWP	**0.250**						**0.319**					
2000												
0+00	**0.250**	**0.625**	**0.125**	**0.375**	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.250**	**0.125**	**0.500**
0+50	**0.250**	**0.375**	**0.000**	**0.375**	**0.000**	**0.125**	**0.125**	**0.375**	**0.125**	**0.250**	**0.375**	**0.875**
1+00	**0.250**	**0.375**	**0.000**	**0.250**	**0.000**	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.375**
Average Rut	**0.250**	**0.458**	**0.042**	**0.333**	**0.042**	**0.167**	**0.125**	**0.292**	**0.167**	**0.250**	**0.250**	**0.583**
Average Rut OWP	**0.111**						**0.181**					
Average Rut IWP	**0.319**						**0.375**					
2001												
0+00	**0.250**	**0.875**	**0.125**	**0.500**	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.375**	**0.125**	**0.625**
0+50	**0.375**	**0.375**	**0.000**	**0.375**	**0.125**	**0.125**	**0.250**	**0.375**	**0.125**	**0.250**	**0.375**	**1.250**
1+00	**0.375**	**0.375**	**0.125**	**0.375**	**0.000**	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.375**
Average Rut	**0.333**	**0.542**	**0.083**	**0.417**	**0.083**	**0.167**	**0.167**	**0.292**	**0.167**	**0.292**	**0.250**	**0.750**
Average Rut OWP	**0.167**						**0.194**					
Average Rut IWP	**0.375**						**0.444**					
2002												

0+00	**0.250**	**0.875**	**0.125**	**0.500**	**0.000**	**0.250**	**0.250**	**0.125**	**0.125**	**0.375**	**0.375**	**0.375**
0+50	**0.500**	**0.500**	**0.250**	**0.375**	**0.125**	**0.250**	**0.250**	**0.375**	**0.125**	**0.250**	**0.625**	**1.125**
1+00	**0.375**	**0.250**	**0.250**	**0.500**	**0.125**	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.500**
Average Rut	**0.375**	**0.542**	**0.208**	**0.458**	**0.083**	**0.208**	**0.208**	**0.250**	**0.125**	**0.292**	**0.417**	**0.667**
Average Rut OWP	**0.222**						**0.250**					
Average Rut IWP	**0.403**						**0.403**					
2003												
0+00	**0.625**	**1.125**	**0.250**	**0.500**	**0.250**	**0.375**	**0.500**	**0.375**	**0.375**	**0.375**	**0.375**	**0.625**
0+50	**1.000**	**0.625**	**0.250**	**0.500**	**0.125**	**0.125**	**0.500**	**0.500**	**0.125**	**0.375**	**0.750**	**1.250**
1+00	**0.500**	**0.375**	**0.375**	**0.625**	**0.125**	**0.250**	**0.250**	**0.375**	**0.125**	**0.250**	**0.250**	**0.750**
Average Rut	**0.708**	**0.708**	**0.292**	**0.542**	**0.167**	**0.250**	**0.417**	**0.417**	**0.208**	**0.333**	**0.458**	**0.875**
Average Rut OWP	**0.389**						**0.361**					
Average Rut IWP	**0.500**						**0.542**					
2004												
0+00	**0.500**	**1.125**	**0.250**	**0.625**	**0.250**	**0.250**	**0.375**	**0.250**	**0.375**	**0.125**	**0.375**	**1.000**
0+50	**1.500**	**0.750**	**0.375**	**0.750**	**0.000**	**0.125**	**0.500**	**0.375**	**0.125**	**0.250**	**0.750**	**1.375**
1+00	**0.375**	**0.375**	**0.375**	**0.750**	**0.125**	**0.250**	**0.250**	**0.250**	**0.125**	**0.250**	**0.375**	**0.625**
Average Rut	**0.792**	**0.750**	**0.333**	**0.708**	**0.125**	**0.208**	**0.375**	**0.292**	**0.208**	**0.208**	**0.500**	**1.000**
Average Rut OWP	**0.417**						**0.361**					
Average Rut IWP	**0.556**						**0.500**					
2007												
0+00	**0.625**	**1.500**	**0.625**	**0.625**	**0.250**	**0.250**	**0.875**	**0.500**	**0.250**	**0.375**	**1.500**	**1.125**
0+50	**2.000**	**1.125**	**0.375**	**1.500**	**0.125**	**0.125**	**1.250**	**0.625**	**0.500**	**1.000**	**0.625**	**2.000**
1+00	**1.125**	**0.250**	**0.500**	**1.125**	**0.500**	**0.250**	**0.375**	**0.250**	**0.500**	**0.625**	**0.250**	**0.500**
Average Rut	**1.250**	**0.958**	**0.500**	**1.083**	**0.292**	**0.208**	**0.833**	**0.458**	**0.417**	**0.667**	**0.792**	**1.208**
Average Rut OWP	**0.681**						**0.681**					
Average Rut IWP	**0.750**						**0.778**					

Rutting Data – Eastbound Lane

RUTTING EVALUATION EASTBOUND LANE												
	Without $CaCl_2$ Treatment						With $CaCl_2$ Treatment					
	MM 1.60 TS 1		MM 1.65 TS 2		MM 1.72 TS 3		MM 2.24 TS 4		MM 2.33 TS 5		MM 2.37 TS 6	
	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path
Pre-Construction												
0+00	**0.250**	**0.250**	**0.125**	**0.375**	**0.250**	**0.125**	**0.875**	**0.750**	**0.375**	**0.625**	**0.375**	**0.500**
0+50	**0.375**	**0.500**	**0.375**	**0.250**	**0.250**	**0.625**	**0.875**	**0.500**	**0.125**	**0.375**	**0.375**	**0.500**
1+00	**0.375**	**0.625**	**0.750**	**0.750**	**0.375**	**0.875**	**0.500**	**0.375**	**0.125**	**0.250**	**0.625**	**0.625**
Average Rut	**0.333**	**0.458**	**0.417**	**0.458**	**0.292**	**0.542**	**0.750**	**0.542**	**0.208**	**0.417**	**0.458**	**0.542**
Average Rut OWP	**0.347**						**0.472**					
Average Rut IWP	**0.486**						**0.500**					
1994												
0+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
0+50	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
1+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Average Rut	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Average Rut OWP	**0.000**						**0.000**					
Average Rut IWP	**0.000**						**0.000**					
1995												
0+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
0+50	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
1+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**
Average Rut	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.042**
Average Rut OWP	**0.000**						**0.000**					
Average Rut IWP	**0.000**						**0.014**					

1996												
0+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**
0+50	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**
1+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.125**	**0.000**	**0.125**
Average Rut	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.083**	**0.000**	**0.000**	**0.042**	**0.042**	**0.000**	**0.125**
Average Rut OWP	**0.000**						**0.014**					
Average Rut IWP	**0.028**						**0.056**					
1997												
0+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.250**
0+50	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.125**	**0.125**
1+00	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.125**	**0.250**
Average Rut	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.083**	**0.000**	**0.000**	**0.042**	**0.083**	**0.083**	**0.208**
Average Rut OWP	**0.000**						**0.042**					
Average Rut IWP	**0.028**						**0.097**					
1998												
0+00	**0.250**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.125**	**0.250**	**0.125**
0+50	**0.250**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.125**	**0.125**	**0.125**
1+00	**0.250**	**0.000**	**0.125**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.250**	**0.250**
Average Rut	**0.250**	**0.000**	**0.083**	**0.000**	**0.000**	**0.042**	**0.000**	**0.000**	**0.000**	**0.083**	**0.208**	**0.167**
Average Rut OWP	**0.111**						**0.069**					
Average Rut IWP	**0.014**						**0.083**					
1999												
0+00	**0.250**	**0.000**	**0.000**	**0.250**	**0.250**	**0.125**	**0.000**	**0.250**	**0.000**	**0.250**	**0.125**	**0.375**
0+50	**0.000**	**0.250**	**0.250**	**0.250**	**0.250**	**0.000**	**0.000**	**0.250**	**0.000**	**0.250**	**0.125**	**0.500**
1+00	**0.125**	**0.000**	**0.125**	**0.375**	**0.000**	**0.250**	**0.000**	**0.125**	**0.125**	**0.125**	**0.250**	**0.375**
Average Rut	**0.125**	**0.083**	**0.125**	**0.292**	**0.167**	**0.125**	**0.000**	**0.208**	**0.042**	**0.208**	**0.167**	**0.417**
Average Rut OWP	**0.139**						**0.069**					
Average Rut IWP	**0.167**						**0.278**					
2000												
0+00	**0.125**	**0.125**	**0.125**	**0.250**	**0.125**	**0.125**	**0.000**	**0.125**	**0.000**	**0.250**	**0.125**	**0.250**
0+50	**0.125**	**0.250**	**0.250**	**0.125**	**0.250**	**0.000**	**0.000**	**0.125**	**0.125**	**0.125**	**0.250**	**0.250**
1+00	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.000**	**0.125**	**0.125**	**0.250**	**0.375**
Average Rut	**0.125**	**0.167**	**0.167**	**0.167**	**0.167**	**0.083**	**0.042**	**0.083**	**0.083**	**0.167**	**0.208**	**0.292**

Average Rut OWP	**0.153**						**0.111**					
Average Rut IWP	**0.139**						**0.181**					
2001												
0+00	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.125**	**0.125**	**0.125**	**0.000**	**0.250**	**0.125**	**0.250**
0+50	**0.125**	**0.250**	**0.250**	**0.250**	**0.250**	**0.000**	**0.000**	**0.125**	**0.250**	**0.125**	**0.375**	**0.250**
1+00	**0.125**	**0.250**	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.000**	**0.125**	**0.125**	**0.250**	**0.250**
Average Rut	**0.125**	**0.250**	**0.167**	**0.208**	**0.208**	**0.083**	**0.083**	**0.083**	**0.125**	**0.167**	**0.250**	**0.250**
Average Rut OWP	**0.167**						**0.153**					
Average Rut IWP	**0.181**						**0.167**					
2002												
0+00	**0.125**	**0.250**	**0.000**	**0.125**	**0.250**	**0.125**	**0.125**	**0.250**	**0.125**	**0.375**	**0.125**	**0.375**
0+50	**0.125**	**0.250**	**0.125**	**0.250**	**0.250**	**0.125**	**0.125**	**0.125**	**0.125**	**0.250**	**0.375**	**0.250**
1+00	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.000**	**0.125**	**0.000**	**0.125**	**0.125**	**0.250**	**0.500**
Average Rut	**0.125**	**0.208**	**0.083**	**0.167**	**0.208**	**0.083**	**0.125**	**0.125**	**0.125**	**0.250**	**0.250**	**0.375**
Average Rut OWP	**0.139**						**0.167**					
Average Rut IWP	**0.153**						**0.250**					
2003												
0+00	**0.125**	**0.250**	**0.125**	**0.125**	**0.375**	**0.125**	**0.125**	**0.125**	**0.125**	**0.500**	**0.250**	**0.500**
0+50	**0.125**	**0.375**	**0.250**	**0.375**	**0.250**	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.375**	**0.500**
1+00	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.125**	**0.125**	**0.125**	**0.125**	**0.250**	**0.375**	**0.375**
Average Rut	**0.125**	**0.250**	**0.208**	**0.208**	**0.292**	**0.125**	**0.125**	**0.167**	**0.125**	**0.333**	**0.333**	**0.458**
Average Rut OWP	**0.208**						**0.194**					
Average Rut IWP	**0.194**						**0.319**					
2004												
0+00	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.125**	**0.000**	**0.125**	**0.000**	**0.250**	**0.250**	**0.500**
0+50	**0.125**	**0.250**	**0.250**	**0.250**	**0.125**	**0.250**	**0.000**	**0.125**	**0.125**	**0.125**	**0.375**	**0.250**
1+00	**0.125**	**0.125**	**0.250**	**0.125**	**0.250**	**0.125**	**0.125**	**0.125**	**0.125**	**0.125**	**0.375**	**0.500**
Average Rut	**0.125**	**0.167**	**0.250**	**0.167**	**0.208**	**0.167**	**0.042**	**0.125**	**0.083**	**0.167**	**0.333**	**0.417**
Average Rut OWP	**0.194**						**0.153**					
Average Rut IWP	**0.167**						**0.236**					
2005												
0+00	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**

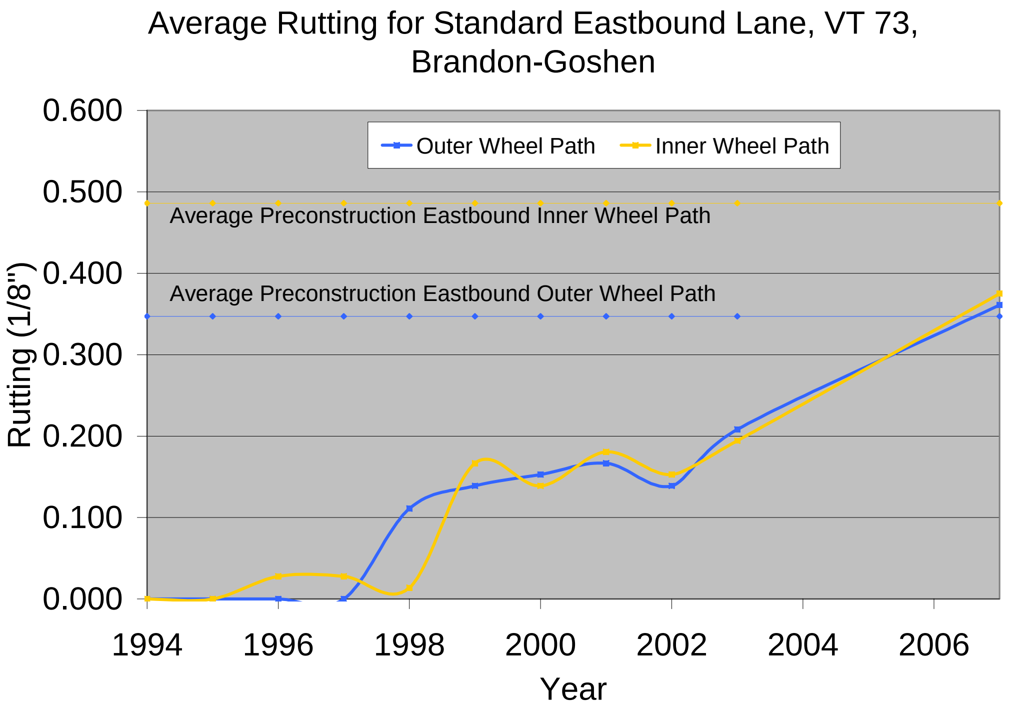
	Data	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**	**Data**
0+50	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
1+00	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
Average Rut	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
2006												
0+00	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
0+50	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
1+00	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
Average Rut	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**	**No Data**
2007												
0+00	**0.375**	**0.250**	**0.375**	**0.500**	**0.375**	**0.375**	**0.250**	**0.250**	**0.125**	**0.250**	**0.750**	**0.500**
0+50	**0.250**	**0.625**	**0.750**	**1.000**	**0.375**	**0.250**	**0.125**	**0.250**	**0.375**	**0.250**	**0.375**	**0.625**
1+00	**0.125**	**0.125**	**0.250**	**0.125**	**0.375**	**0.125**	**0.250**	**0.125**	**0.375**	**0.375**	**0.375**	**0.500**
Average Rut	**0.250**	**0.333**	**0.458**	**0.542**	**0.375**	**0.250**	**0.208**	**0.208**	**0.292**	**0.292**	**0.500**	**0.542**
Average Rut OWP	**0.361**						**0.333**					
Average Rut IWP	**0.375**						**0.347**					

Average Rutting – Per Treatment, Lane, and Wheel Path

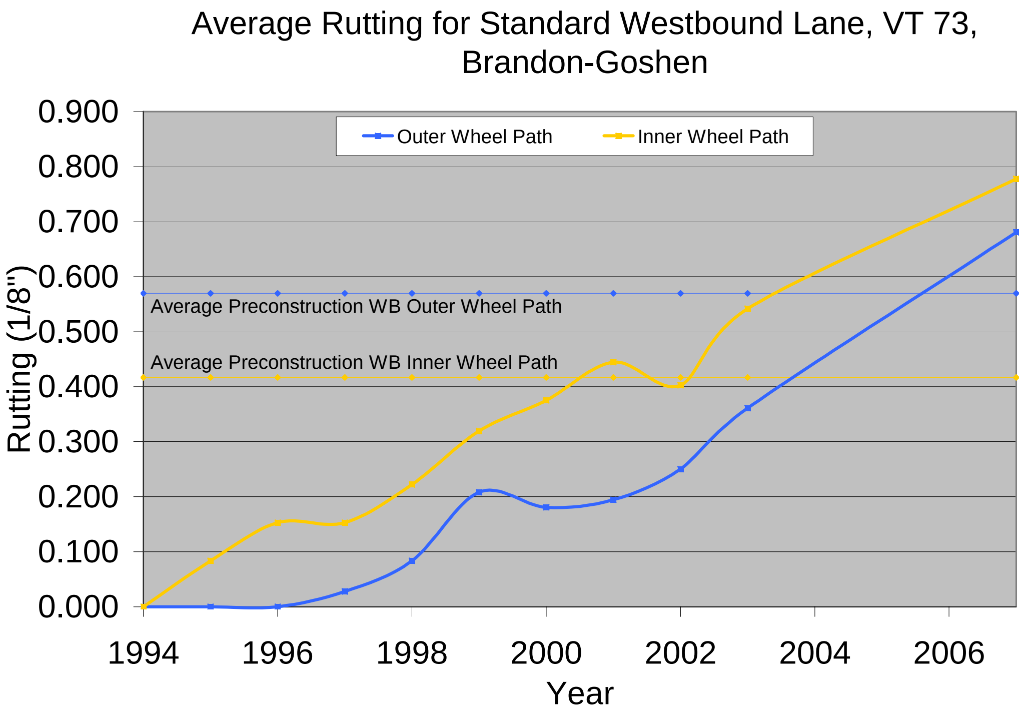
Average Rutting Reading for VT Route 73, Brandon-Goshen (Inches)								
Year	$CaCl_2$				STANDARD			
	WESTBOUND		EASTBOUND		WESTBOUND		EASTBOUND	
	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path	Outer Wheel Path	Inner Wheel Path
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.000	0.042	0.000	0.014	0.000	0.083	0.000	0.000
1996	0.000	0.111	0.014	0.056	0.000	0.153	0.000	0.028
1997	0.000	0.111	0.042	0.097	0.028	0.153	0.000	0.028
1998	0.069	0.167	0.069	0.083	0.083	0.222	0.111	0.014
1999	0.139	0.250	0.069	0.278	0.208	0.319	0.139	0.167
2000	0.111	0.319	0.111	0.181	0.181	0.375	0.153	0.139
2001	0.167	0.375	0.153	0.167	0.194	0.444	0.167	0.181
2002	0.222	0.403	0.167	0.250	0.250	0.403	0.139	0.153
2003	0.389	0.500	0.194	0.319	0.361	0.542	0.208	0.194
2004	0.417	0.556	0.153	0.236	0.361	0.500	0.194	0.167
2005	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
2006	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
2007	0.681	0.750	0.333	0.347	0.681	0.778	0.361	0.375
Percent of Preconstruction	126	146	71	69	120	187	104	77
Average Rutting Percentage	103				122			
Average Rutting Percentage Westbound Lane	144							
Average Rutting Percentage Eastbound Lane	80							
Average Rutting Percentage Wheel Paths	**WB-Outer**		**WB-Inner**		**EB-Outer**		**EB-Inner**	
	123		166		87		73	

Average Rutting Per Lane

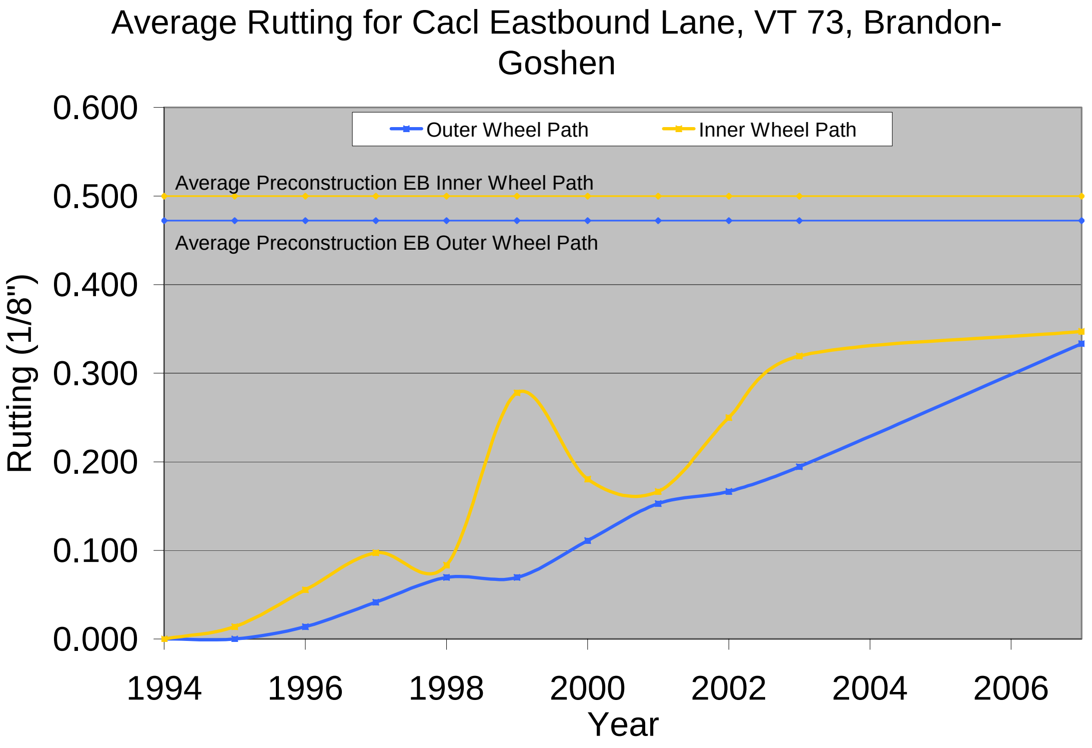
Standard Eastbound



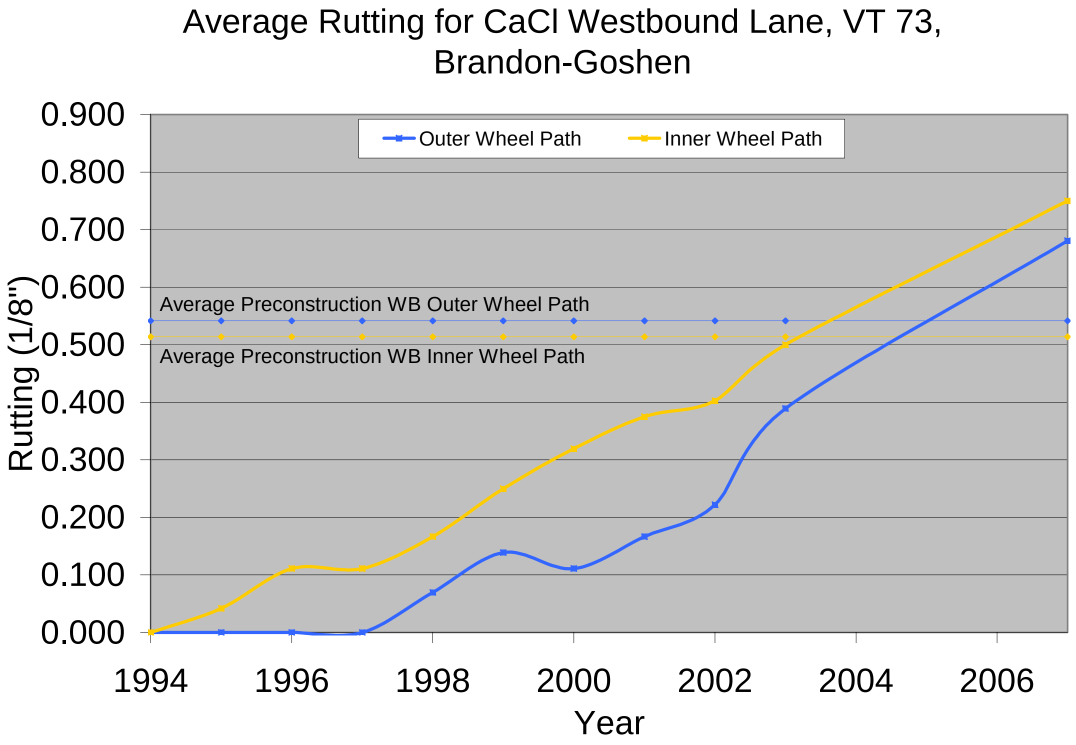
Standard Westbound



$CaCl_2$ Eastbound



$CaCl_2$ Westbound

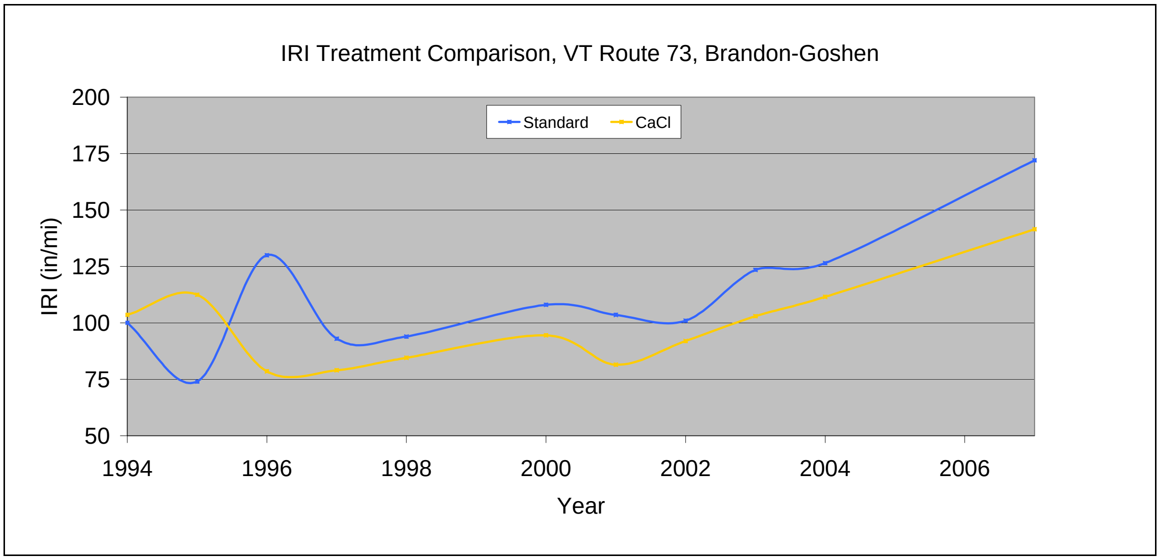


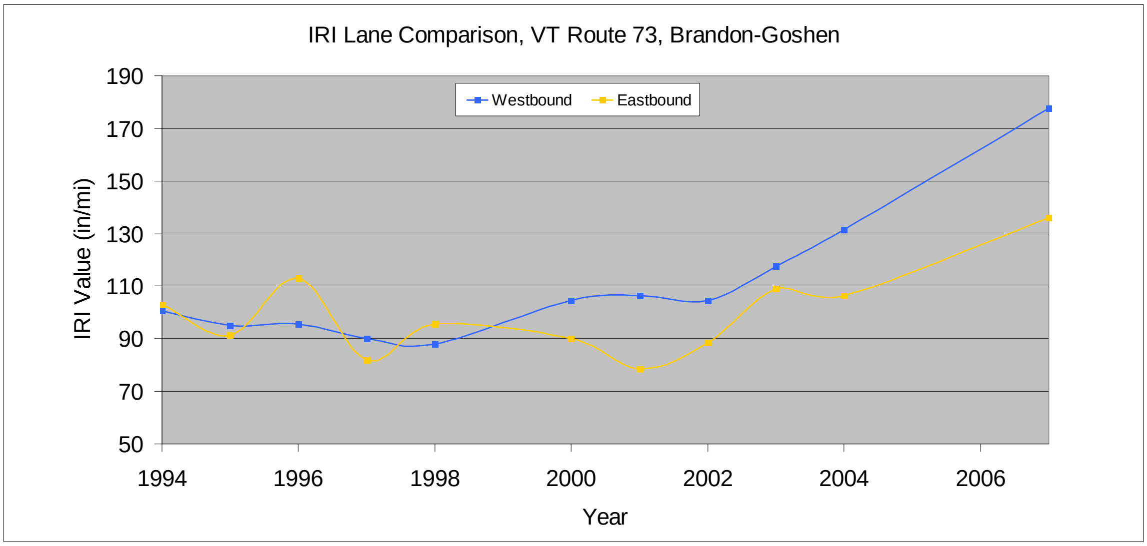
Appendix G

IRI Data Per Lane

IRI			
* Please Note: **$CaCl_2$** is located WB 1.6-1.8 and EB 2.2-2.4 & Non **$CaCl_2$** is located WB 2.2-2.4 and EB 1.6-1.8 *			
Year	**Lane**	**MM**	**Value**
1994	WB	1.6-1.8	94
		2.2-2.4	107
1994	EB	1.6-1.8	93
		2.2-2.4	113
1995	WB	1.6-1.8	108
		2.2-2.4	82
1995	EB	1.6-1.8	66
		2.2-2.4	117
1996	WB	1.6-1.8	68
		2.2-2.4	123
1996	EB	1.6-1.8	137
		2.2-2.4	89
1997	WB	1.6-1.8	88
		2.2-2.4	92
1997	EB	1.6-1.8	94
		2.2-2.4	70
1998	WB	1.6-1.8	77
		2.2-2.4	99
1998	EB	1.6-1.8	89
		2.2-2.4	92
1999	WB	1.6-1.8	No Data
		2.2-2.4	No Data
1999	EB	1.6-1.8	No Data
		2.2-2.4	No Data
2000	WB	1.6-1.8	106
		2.2-2.4	103
2000	EB	1.6-1.8	97
		2.2-2.4	83
2001	WB	1.6-1.8	91
		2.2-2.4	122
2001	EB	1.6-1.8	85
		2.2-2.4	72
2002	WB	1.6-1.8	95
		2.2-2.4	114
2002	EB	1.6-1.8	88
		2.2-2.4	89
2003	WB	1.6-1.8	109
		2.2-2.4	126
2003	EB	1.6-1.8	121
		2.2-2.4	97
2004	WB	1.6-1.8	122
		2.2-2.4	141
2004	EB	1.6-1.8	112
		2.2-2.4	101

2005	WB	1.6-1.8 2.2-2.4	No Data No Data
2005	EB	1.6-1.8 2.2-2.4	No Data No Data
2006	WB	1.6-1.8 2.2-2.4	No Data No Data
2006	EB	1.6-1.8 2.2-2.4	No Data No Data
2007	WB	1.6-1.8 2.2-2.4	178 177
2007	EB	1.6-1.8 2.2-2.4	167 105





Appendix H

Statistical Analysis of Pre and Post-construction Populations

<u>Preconstruction – Population Assessment</u>

Mann-Whitney Test and CI: Control, Experimental (Total Cracking)

```
              N  Median
Control       6   577.5
Experimental  6   509.0


Point estimate for ETA1-ETA2 is 64.5
95.5 Percent CI for ETA1-ETA2 is (-168.0,315.1)
W = 44.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4233
The test is significant at 0.4225 (adjusted for ties)
```

Mann-Whitney Test and CI: Control, Experimental (Fatigue Cracking)

```
              N  Median
Control       6   238.5
Experimental  6   171.0


Point estimate for ETA1-ETA2 is 76.5
95.5 Percent CI for ETA1-ETA2 is (-23.0,167.0)
W = 49.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1282
```

Mann-Whitney Test and CI: Control, Experimental (Thermal Cracking)

```
              N  Median
Control       6   0.000
Experimental  6   0.000


Point estimate for ETA1-ETA2 is 0.000
95.5 Percent CI for ETA1-ETA2 is (-2.002,4.999)
W = 40.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.9362
The test is significant at 0.9241 (adjusted for ties)
```

<u>Post construction – Population Assessment</u>

Mann-Whitney Test and CI: Control, Experimental (Total Cracking)

```
              N  Median
Control       6   363.5
Experimental  6   221.0


Point estimate for ETA1-ETA2 is 129.5
95.5 Percent CI for ETA1-ETA2 is (-224.0,307.0)
W = 43.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5218
The test is significant at 0.5211 (adjusted for ties)
```

Mann-Whitney Test and CI: Control, Experimental (Fatigue Cracking)

```
              N  Median
Control       6   175.0
Experimental  6   139.5


Point estimate for ETA1-ETA2 is 75.0
95.5 Percent CI for ETA1-ETA2 is (-159.9,166.1)
W = 42.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6889
The test is significant at 0.6884 (adjusted for ties)
```

Mann-Whitney Test and CI: Control, Experimental (Thermal Cracking)

```
              N  Median
Control       6   20.50
Experimental  6    3.50


Point estimate for ETA1-ETA2 is 8.00
95.5 Percent CI for ETA1-ETA2 is (-8.00,40.00)
W = 44.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4233
The test is significant at 0.4217 (adjusted for ties)
```

Mann-Whitney Test and CI: Control, Experimental (Reflective Cracking)

```
              N  Median
Control       6    32.5
Experimental  6    48.5


Point estimate for ETA1-ETA2 is -23.0
95.5 Percent CI for ETA1-ETA2 is (-160.0,22.0)
W = 35.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5752
```

Mann-Whitney Test and CI: Control, Experimental (Rutting)

```
              N  Median
Control       4   112.0
Experimental  4    98.5


Point estimate for ETA1-ETA2 is 20.5
97.0 Percent CI for ETA1-ETA2 is (-69.0,118.0)
W = 20.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6650
```