

Report No. ABTR/RD/TM –09/10	Subject Area Pavement Markings	Project No.	Report Date May, 2010
Title Performance of Waterborne, Low Temperature, Low VOC Traffic Paint (Environment Canada's VOC limits for Traffic Markings, effective October 2012)			Type of Report Final
Author(s) Joe Filice, R.E.T., Materials Technologist			No. of Pages 61
Performing Organization Name and Address Lafrentz Road Marking Zone 4, 1-26228 Township road 530A Acheson, Alberta T7X 5A7		Sponsoring Agency Name and Address Alberta Transportation Technical Standards Branch 2 nd Floor, 4999 – 98 Avenue Edmonton, AB T6B 2X3	
Supplementary Notes The author would like to thank the following individuals who assisted in this study: Roger Skirrow, Director, Geotechnical and Material Services Ron Stoski, Geotechnical and Material Services Chris Dechkoff, Lafrentz Road Marking			
Abstract Environment Canada's proposal to mandate a maximum Volatile Organic Compound (VOC) content for traffic markings (<150 g/l VOC) in the near future has prompted Alberta Transportation to investigate new paint formulations. Currently normal waterborne traffic paint meets the proposed environmental regulations. However normal waterborne traffic paint can only be used when the ambient temperature is >10°C. Alberta Transportation began to evaluate low temperature, low VOC traffic paint formulations on the departments test deck in the fall of 2005 and has continued to evaluate these new formulations yearly (fall of each year). These low temperatures, low VOC traffic paint formulations were applied during cold weather (0 to 2 degrees Celsius) to determine their effectiveness during cold weather application. A small scale field trial (Hwy 88) was undertaken in the fall of 2006 using approved low temperature, low VOC waterborne traffic paints that were qualified on the departments test deck in 2005/06. A larger scale field trial was undertaken in the fall of 2008 using approved low temperature, low VOC waterborne paint formulations which had qualified on test deck in 2007/08. These formulations were applied on highway 39:08 and highway 2A:26 on October 30 and 31 st , 2008 by Lafrentz Road Marking. The purpose of this evaluation was to determine the effectiveness of the low temperature, low VOC traffic paint formulations during cold weather application. The larger scale field evaluations of the 6 approved traffic paint formulations were conducted during the winter of 2009. Retro-reflectivity readings were taken at each test location using a 30m geometry field retro-reflectometer. The durability of the paint lines was also observed.			
Key Words Traffic paint Retro-reflectivity Waterborne Volatile Organic Compound (VOC)		Millicandelas (Mcd) Glass Bead Low Temperature Low VOC	Distribution Unlimited Project Co-ordinator Roger Skirrow, Director, Geotechnical and Material Services

ALBERTA TRANSPORTATION

DISCLAIMER

The opinions, findings and conclusions expressed in this report are those of the author. The contents do not necessarily reflect the official view or policies of the Government of Alberta. This report does not constitute a standard, specification or regulation.

The Government of Alberta does not endorse products or manufacturers. Trade or manufacturer's names appear herein only because they are considered essential to the object of this document.

TABLE OF CONTENTS

1.0	INTRODUCTION	2,3
2.0	OBJECTIVES	3
3.0	BACKGROUND	3, 4
4.0	RETRO_REFLECTIVITY	4
5.0	GLASS BEADS	4
6.0	RETRO-REFLECTOMETER EQUIPMENT DESCRIPTION	4, 5
7.0	PAVEMENT MARKING SERVICE LIFE	5
8.0	TEST DECK PERFORMANCE EVALUATION	
8.1	Test Deck Overview	5
8.2	Test Deck Results	6
9.0	FIELD TRIALS	
9.1	Background	6
9.2	Evaluation Review	7, 8
9.3	Observations	8, 9
10.0	CONCLUSIONS	9
11.0	RECOMMENDATIONS	9, 10
12.0	IMPLICATIONS OF RECOMMENDATIONS	10
	CHARTS ..Charts 1 & 2.....	7, 8
	APPENDIX A 2005 Test Deck Evaluation of Low Temp, Low VOC Traffic Paint Formulations)	11 to 22
	APPENDIX B Highway Trial Sites	23 to 28
	APPENDIX C Road Service Test (Paint Strip Evaluation – ASTM D713	29 to 30
	APPENDIX D Hwy 14 Test Deck and Application Equipment	31 to 33
	APPENDIX E Low Temperature, Low VOC Approved Formulations	34 to 36
	APPENDIX F Field Trial Evaluations	37 to 45
	APPENDIX G Field Trial Evaluations	46 to 61

NOTICE

This report is published without prejudice as to the Application of the findings and is disseminated in the interest of information exchange. Alberta Transportation does not endorse products or manufacturers. Trademarks and/or manufactures appear only where it is considered essential to the object of the report.

STUDY of the Performance of Low Temperature, Low VOC Traffic Paint (Compliance to Environment Canada's VOC regulations)

1.0 INTRODUCTION

Environment Canada's proposal to mandate a maximum Volatile Organic Compounds (VOC) content of 150 g/l for traffic paint markings prompted Alberta Transportation (AT) to evaluate new low VOC paint formulations. In the fall of 2005, AT was informed by IBIS Products Limited that they were formulating a low temperature waterborne paint system that would comply with Environment Canada's proposed regulations. AT informed IBIS that AT would be willing to apply low temperature traffic paint to our paint test deck for evaluation during the winter months.

IBIS supplied low temperature; low VOC traffic paints for application to Alberta's test deck in late October 2005. AMEC Earth & Environmental (AMEC) was hired to apply 3 test stripes (1 white and 2 yellow); these test stripes were applied in duplicate (Appendix A).

The new low temperature, low VOC waterborne traffic paints were applied to the AT test deck on November 5, 2005. The temperature at the time of application was 0°C. The evaluation consisted of general appearance, luminous directional reflectance (glass bead loss) and retro-reflective readings taken on each test line by using a 30 meter field retro-reflectometer. The three low temperature waterborne formulations were approved for use based on their road performance and were listed on the AT's approved products list in 2006.

Low temperature waterborne traffic paints have been applied to the AT test deck each fall since the initial 2005 application. To date (2010) seven (three white, four yellow) low temperature, low VOC waterborne traffic paint formulations have been approved for use during cold temperatures and are suitable for use above 0°C. These new low temperature formulations would have merit only during the shoulder season (early spring and late fall) and they do meet the proposed environmental regulations for low VOC's.

In addition to the test deck evaluations, low temperature waterborne paint formulations have been applied and evaluated on full scale highway projects, Highway 88:04, 38:08 and 2A:26 (see Appendix B).

2.0 OBJECTIVES

The objectives of the study were:

- To determine the durability and effectiveness of low temperature, low VOC waterborne traffic paint applied in cold temperatures.
- To verify the results from the Department's test deck against actual field performance.

3.0 BACKGROUND

Historically alkyd-based paint formulations have been used for the majority of pavement markings on Alberta highways. Alkyd-based paints contain 50% solvent by volume (>450 g/l VOC). They can provide good performance and can be applied over a wide range of temperatures (0°C +) and are generally economical. However new environmental regulations restrict the amount of VOC to less than 150 g/l, and alkyd paints are not able to meet this criteria. Waterborne-based paints have <150 g/l VOC and have been formulated to meet the pavement marking needs of AT. The majority of lane stripping done in Alberta now uses waterborne-based paint. The use of waterborne-based paint is typically restricted to temperatures >10°C, which restricts the window of time available for application of stripping paint in Alberta.

Limited use of alkyd paints during the colder spring and fall painting season has allowed AT to meet painting needs. Recently paint manufacturers have been developing waterborne paints that may be applied at colder temperatures and during periods of higher humidity.

AT has been evaluating low temperature, low VOC traffic paints on the departments test deck since the fall of 2005. AT has been working closely with Environment Canada's Traffic Marking Working Group, which consists of manufacturers and provincial government representatives, to develop a strategic plan for implementing the use of low VOC traffic markings.

As a member of the Traffic Marking Working Group, AT has provided significant input into the development of the strategic plan for reducing VOC levels in traffic markings. AT strongly recommended to Environment Canada that a cold weather exemption be taken into consideration for inclusion in the strategic plan. A seasonal exemption would allow Alkyd traffic paint to be used at least until a satisfactory compliant paint was developed.

The seasonal exemption request was accepted and has been included in the regulations for cold weather traffic paint application. Traffic markings in excess of 150 g/l VOC will not be allowed between May 1st and October 15th. For any traffic marking coating with a VOC concentration between 150 g/l and 450 g/l, the following statement

would be required on the paint containers label or lid: "Not for application for the period beginning on May 1st and ending on October 15th. No traffic paints allowed with a VOC >450 g/l. Alkyd paints will now be allowed during the shoulder season, October 16 to April 30.

Since the weather in Alberta can be colder than 10°C between May 1st and October 15th it is essential that the department source low temperature, low VOC (<150 g/l) traffic paints. Traffic paint manufacturers are formulating low VOC, low temperature waterborne and solvent borne paints and the department continues to test these new formulations as they become available.

4.0 RETRO-REFLECTIVITY

Visibility of traffic lines at night is greatly enhanced by the application of glass beads to the paint surface. The glass beads that protrude above the surface of the traffic markings reflect light from headlight beams back to the driver. The returned light is referred to as retro-reflectivity.

Retro-reflectivity is the scientific term that describes the ability of a surface to return light back to its source. Retro-reflectivity is measured by a retro-reflectometer in units of millicandelas (MCD) per square meter per lux ($\text{mcd}/\text{m}^2/\text{lux}$). This measures the intensity of reflected light per lux (one meter-candle or illumination provided by one standard candle at a distance of one meter) of light source. The American Society for Testing of Materials (ASTM) adopted the European Committee for Standardization (CEN) 30 meter geometry for measuring pavement marking retro-reflectivity. The 30 meter geometry means that retro-reflectivity is measured as if a driver views the marking 30 meters ahead of the vehicle. AT uses the 30 meter geometry retro-reflectometer during the evaluation process of pavement markings.

5.0 GLASS BEADS

The sole function of glass spheres (beads) in highway marking is to maximize the reflectivity of the markings, thus improving the driving environment and increasing highway safety. The beads cause the light beam to be focused and then returned to the driver's eyes by a process known as retro-reflection. Glass beads must meet AT's Specification for Glass Beads for Pavement Markings and is available at the following link: <http://www.transportation.alberta.ca/Content/docType254/Production/GB05.pdf>

6.0 RETRO-REFLECTOMETER EQUIPMENT DESCRIPTION

The 30 meter geometry Field Retro-reflectometer is a precision instrument designed to measure retro-reflective materials in field applications. This instrument provides accurate retro-reflectivity measurements over the range from 20 to 1200 $\text{mcd}/\text{Lux}/\text{m}^2$.

Retro-reflectivity is dependent on several factors:

- the number of glass beads (gradation)
- depth of embedment (60% embedment of glass bead in paint is optimum)

- quality of the glass bead (imperfections)
- type of pigment in the paint
- ability of paint to hold the bead (retention)
- wearing properties of the paint and beads

7.0 PAVEMENT MARKING SERVICE LIFE

The service life of a longitudinal traffic paint marking is the time it takes the retro-reflectivity value to reach its minimum threshold value, thereby requiring the marking to be refurbished or replaced (typical retro-reflective readings after the winter months (one season) can range from 40 Mcd to 100 Mcd).

When applying conventional alkyd or waterborne traffic paint in colder temperatures, the paint lines normally do not survive the winter months. The low temperature, low VOC traffic paint formulations applied on the trial projects have provided satisfactory performance over the winter months and have proven to be a good choice for application during colder temperatures. Pavement marking service life is predicted by success on controlled test deck application and validated through field trials.

8.0 TEST DECK PERFORMANCE EVALUATION

8.1 Test Deck Overview

A rating system is used to evaluate all paints prior to approving them for use on AT highways, including low temperature, low VOC waterborne and solvent borne paint formulations. AT uses the Road Service Test (Paint Stripe Evaluation – ASTM D713) (Appendix C) performed on asphalt concrete pavement (The Road Service Test is regarded as the most thorough method of assessing paint stripe durability). General Appearance and Bead Loss of all the paint stripes are the primary factors in the rating system.

Each fall since 2005, various formulations of low temperature, low VOC waterborne and solvent borne traffic paint stripes were applied to a bituminous surface on AT's test deck by AMEC. Transverse paint lines of 15mil wet film thickness were put down side-by-side on the Highway 14 test deck using a standardized mechanical application process. (Appendix D photos of test deck). The application equipment for the paint test stripes and glass beads was provided by AMEC. Compared with the normal longitudinal applied traffic paint lines, transverse lines are crossed by vehicles more frequently which provide for accelerated wearing performance data.

Each stripe was evaluated by a four-member panel to determine its general appearance and luminous directional reflectance (bead loss). Retro-reflectivity readings were also taken along both wheel paths of each line (two readings per line in wheel path) using the 30m geometry Field Retro-reflectometer.

8.2 Test Deck Results

The Road Service Test evaluations and Retro-reflective readings were undertaken monthly from November through April. Based on these results seven approved low temperature, low VOC waterborne formulations were listed on the department approved products list in 2008 (Appendix E – Approved Product List).

The low temperature, low VOC solvent borne formulations did not perform and were considered failures on the 2008 test deck.

9.0 FIELD TRIALS

9.1 Background

In the fall of 2006, a field trial site Highway 88:04 was selected for low temperature, low VOC field evaluation. Waterborne formulations used were approved in the spring of 2006 based on their 2005 test deck performance.

In the fall of 2008, larger scale field trials were conducted on Highway 39:08 and 2A:26 to determine the approved formulations performance. Six trial sites were selected for the evaluation of the approved low temperature, low VOC waterborne traffic paint formulations; the trials used 3 white and 3 yellow formulations which were approved in the spring of 2007 based on their 2006 test deck performance. All of these formulations were applied by Lafrentz Road Marking of Edmonton, Alberta.

The longer term durability of the low temperature, low VOC waterborne formulations were conducted over the winter months. The final evaluations were conducted in the early spring of 2007 for highway 88 (appendix F) and early spring of 2009 for highways 2A and 39 (Appendix G). The following table shows the field trial location, application condition and evaluation schedule used for this study:

Table 1

Highway No.	Location	Formulation No.	Liters Used	Application Date	Ambient/Pavement Temperature	Relative Humidity/ Dry Time	Evaluation Dates
88:04	N. of H754	T44-5146(W) T44-5145(Y)	-	Oct. 24 & 25/06	4.0°C/6.0°C	57%/30min.	Oct 2006, Feb 13 & June 6/07
39:08	SH770N, RR41A	T44-0178(W)	973	Oct. 30/08	3.0°C/1.3°C	44%/30min.	Feb 3, April 7 & May 27/09
39:08/06	Jct. H22 to Jct. H20	T44-5145(Y)	1019	Oct. 30/08	3.8°C/2.8°C	44%/28min.	Feb 3, April 7 & May 27/09
39:08	RR54 to H770N	T44-5146(W)	1159	Oct.30/08	5.0°C/3.0°C	44%/25min.	Feb 3, April 7 & May 27/09
39:08	RR45 to H770N	T44-0185(Y)	1065	Oct. 30/08	5.0°C/3.2°C	44%/25min.	Feb 3, April 7 & May 27/09
2A:26	Leduc to CMA 11	T44-0406(W)	1274	Oct. 31/08	0.5°C/-4.5°C	44%/23min.	Feb 3, April 7 2009
2A:26	Leduc to CMA 11	T44-5275(Y)	1181	Oct. 31/08	0.5°C/-4.5°C	44%/23min.	Feb 3, April 7 2009

9.2 Evaluation Review

The following process was used to evaluate the low temperature, low VOC waterborne traffic paint formulations for the field trials:

1. Retro-reflective readings were taken at several locations along each trial site and were averaged using the 30m geometry retro-reflectometer.
2. The overall appearance and durability evaluation consisted of visual observation of the amount of paint wear and the amount of bead loss during the evaluation period.

The results were all documented and plotted for white and yellow paint formulations respectively. The low temperature waterborne traffic paint was compared to the normal waterborne paint applied in the area during the summer months.

When the low temperature, low VOC waterborne traffic paint formulations were compared to the normal waterborne paint applied earlier in the year on highway 39, their performance (retro-reflectivity and durability) was similar for the yellow lines and slightly lower for the white lines (Chart #2). However, if normal waterborne paint had been applied in colder temperatures ($<10^{\circ}\text{C}$), the paint lines would not have performed for very long on the pavement surface.

The following charts were generated as a result of the field study:

Chart #1 – (Hwy 39 & 2A) Initial retro-reflective readings

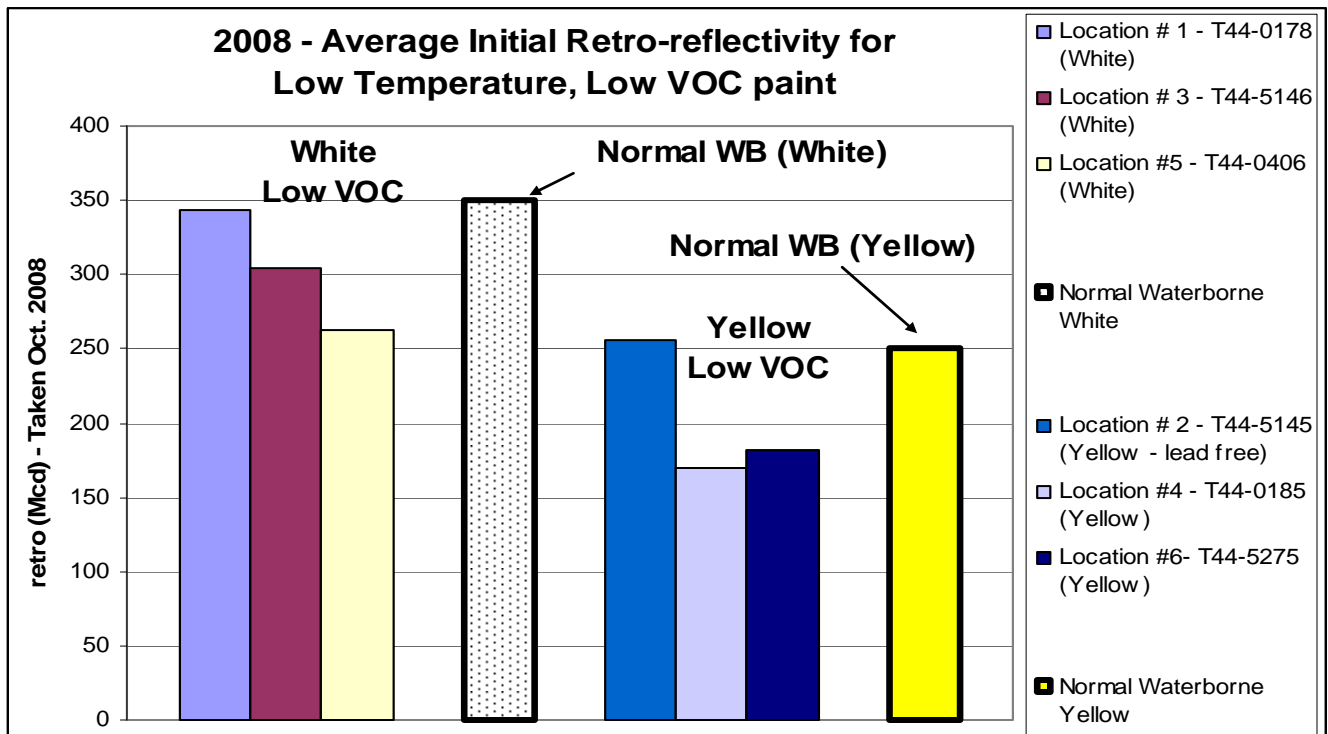
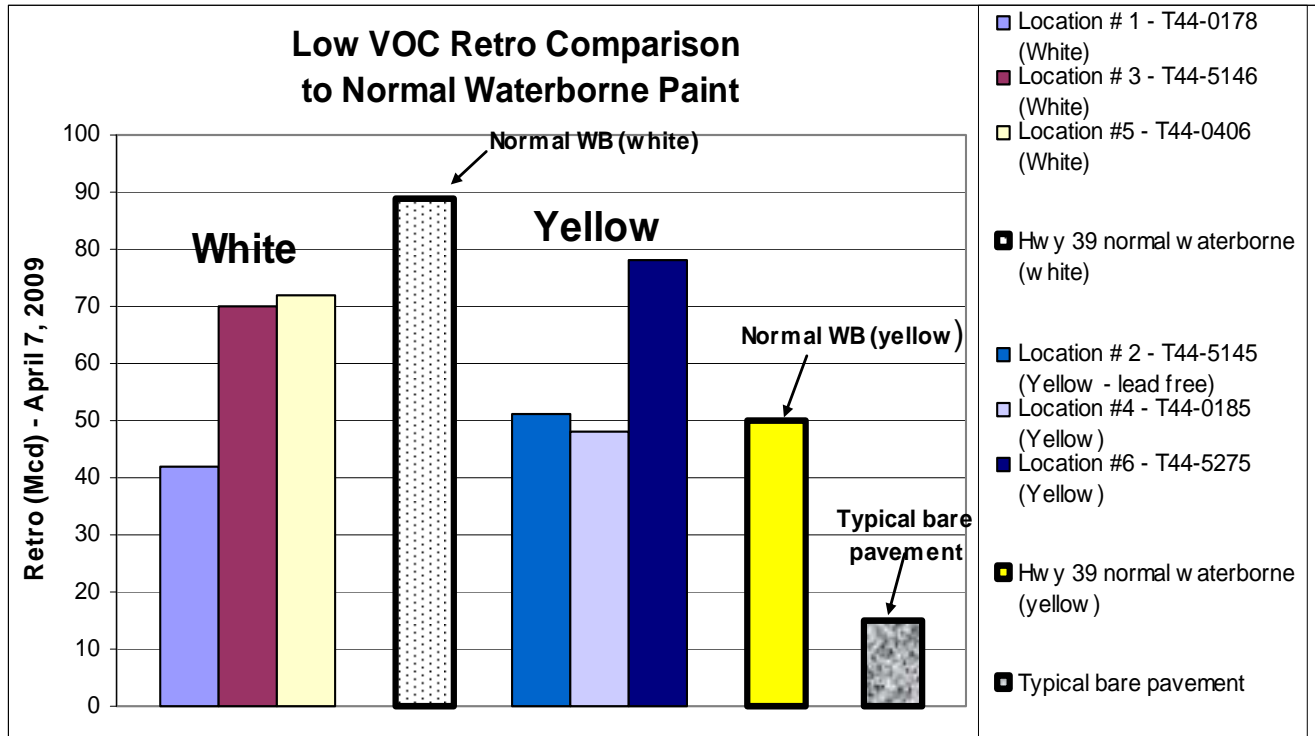


Chart #2 – (Hwy 39 & 2A) Final retro-reflective readings



9.3 OBSERVATIONS

Highway 88 Trial Site – applied in fall of 2006

The low temperature, low VOC waterborne paint formulations (T44-5146W) & T44-5145Y) used on this trial site were approved in 2006 based on their test deck performance.

The performance of these new paint formulations on this trial project has provided acceptable performance during the winter months of 2006/07. The retro-reflectivity and durability at this location was considered very good in relation to the amount of snowplowing during the winter of 2006/07 (see Appendix F)

The approved formulations used on this trial project have proven successful and have validated their test deck performance results. Note that traffic volumes are quite low on this trial project.

Highway 2A:06 & 39:08 Trial Sites – applied in the fall of 2008

The low temperature, low VOC waterborne paint formulations used on these trial sites were approved in 2007 based on their test deck performance.

The performance of these new paint formulations on this trial project provided acceptable performance during the winter months. The retro-reflectivity and durability at these locations was considered good when compared to normal waterborne paint applied in the area earlier in the year. In relation to the amount of snowplowing and high traffic volumes at these trial sites during the winter of 2008/09, the low temperature, low VOC waterborne paint formulations provided good delineation throughout the winter months (see Appendix G).

The approved formulations used on this trial project have proven successful and have validated the test deck performance results.

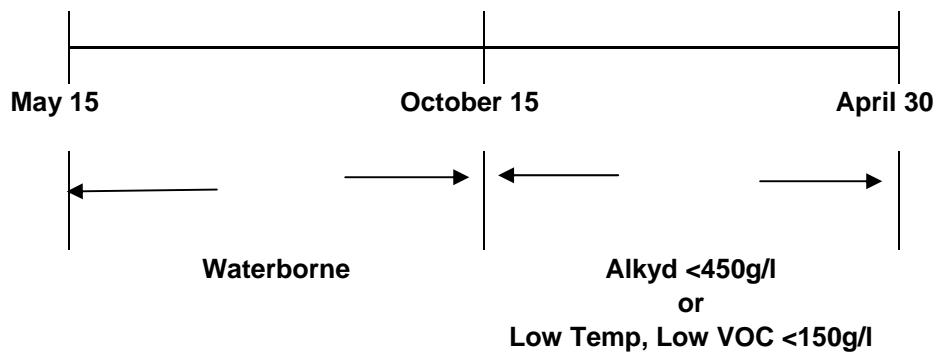
10.0 CONCLUSIONS

1. The low temperature, low VOC waterborne traffic paint formulations approved based on their test deck performance have proven successful on larger scale projects. The low temperature, low VOC waterborne paint formulations provided good delineation after one winter season.
2. Low temperature, low VOC waterborne traffic paint formulations have met Environment Canada's new VOC regulations for Traffic Markings (VOC's of 150g/l or less) and are available for use in colder temperatures ($>0^{\circ}\text{C}$ and $<10^{\circ}\text{C}$).

11.0 RECOMMENDATIONS

1. Use low temperature, low VOC waterborne traffic paint formulations between temperatures of greater than 0°C and lower than 10°C within Environment Canada's VOC regulations limits (May 1 to October 15).
2. Use normal waterborne traffic paint formulations when the temperature is greater than 10°C . Application and performance of Low Temperature, Low VOC waterborne formulation applied above 10°C has not been evaluated.
3. When applying traffic paint outside the Environment Canada's VOC regulations limit (October 16th to April 30th), a seasonal exemption is allowed with VOC concentration between 150g/l and 450g/l (Alkyd paint), however Low Temperature, Low VOC paint could be used in this time interval depending on temperature.
4. The timeline for Environment Canada's VOC regulations are as follows:
 - Final regulations published in October 2009
 - Final regulations to take effect in October 2012
5. Environment Canada's Traffic paint regulations after October 2012:
 - May 1st to October 15th: VOC content limits $<150\text{g/l}$
 - October 16th to April 30th: VOC content limits $>150\text{g/l}$ to 450g/l

Timeline Schematic



Alberta Transportation will continue to evaluate low VOC traffic paint formulations as the paint manufacturers are trying to develop low VOC alkyd paints as well as better waterborne formulations.

12.0 IMPLICATIONS OF RECOMMENDATIONS

- Low temperature, low VOC waterborne traffic paint formulations may initially be more expensive than the normal waterborne formulations due to smaller quantities ordered.
- Contractors/applicators need to be familiar with the different traffic paint formulations available to meet Environment Canada's VOC regulations that will take effect in October 2012.
- Extra attention is required to monitor paint type that is required during the year to ensure correct formulation is being used.

Appendix 'A'

2005 Test Deck evaluation of Low Temperature, Low VOC Traffic Paint Formulations

Evaluation of Low Temperature, Low VOC Traffic Paint

Introduction

Environment Canada's proposal to mandate a maximum Volatile Organic Compounds (VOC) content for traffic paint markings (150 g/l) has prompted Alberta Infrastructure and Transportation (AIT) to investigate new paint formulations. In October of 2005, IBIS Products Limited informed AIT that they were in the process of formulating a low temperature waterborne paint system. AIT informed IBIS that we would be willing to apply low temperature traffic paint to our test deck.

IBIS formulated low temperature, low VOC traffic paint for application to Alberta's test deck in late October 2005. IBIS shipped several liters of the low temperature traffic paint to AMEC for testing and application to the departments test deck. AMEC Earth & Environmental was hired to apply the 3 test stripes (1 white and 2 yellow), the test stripes were applied in duplicate (see photograph). One of the yellow paints submitted by IBIS is lead free.

Low temperature, low VOC waterborne traffic paint was applied to the (AIT) test deck on November 5, 2005. The temperature at the time of application was 0° C. The recommended temperature for application of IBIS's low temperature waterborne paint is above 2°C.

Road Performance Evaluation

The test deck is located on highway 16, east of Elk Island Park entrance, on the east bound outside lane. The road performance evaluation was based on the ASTM Test Method D713: Conducting Road Service Tests on Fluid Traffic Marking Materials.

The test stripes were evaluated for a total of six months (Nov. 2005 to April 2006). Based on the results of the road evaluation, a service factor 'R' for both general appearance and luminous directional reflectance was determined as follows:

$$R = \frac{r_1 t_1 + r_2 t_2 + r_3 t_3 + \dots + r_n t_n}{t_1 + t_2 + t_3 + \dots + t_n}$$

Where R = Service factor or R value
 R_n = Average rating on a particular date
 T_n = Time lapse between successive ratings

A weighted service factor was calculated using a 50% weighting for general appearance and a 50% weighting for luminous directional reflectance.

The weighted service factors for both white and yellow samples are shown in Charts 1 and 2. The "R" values for general appearance and bead loss are shown in Charts 3, 4, 5 and 6. The weighted "R" values for each site visit are plotted and shown on Graphs 1 and 2.

Retro-reflectivity readings were also taken on each test stripe using the Mirolux-30 field retro-reflectometer. Retro-reflectivity readings are shown on Graphs 3, 4, 5, and 6. Retro-reflective readings in the wheel path dropped off after 43 days (Graphs 3 and 5). However the retro-reflectivity outside the wheel path remained fairly constant after 43 days (Graphs 4 and 6).

Approved Traffic Paint Formulations

Based on the road performance evaluation of the low temperature, low VOC waterborne traffic paints the following formulations have been approved for use in Alberta:

- IBIS T44-5146 (White)
- IBIS T44-5145 (Yellow)
- IBIS T44-5147 (Yellow) lead free

The three low temperature, low VOC traffic paints achieved the 6.5 threshold rating considered the cut-off value for accepting new traffic paint formulations.

These three low temperature formulations would have merit during the shoulder season (early spring and late fall) and they do meet the proposed environmental regulations for low VOC's.

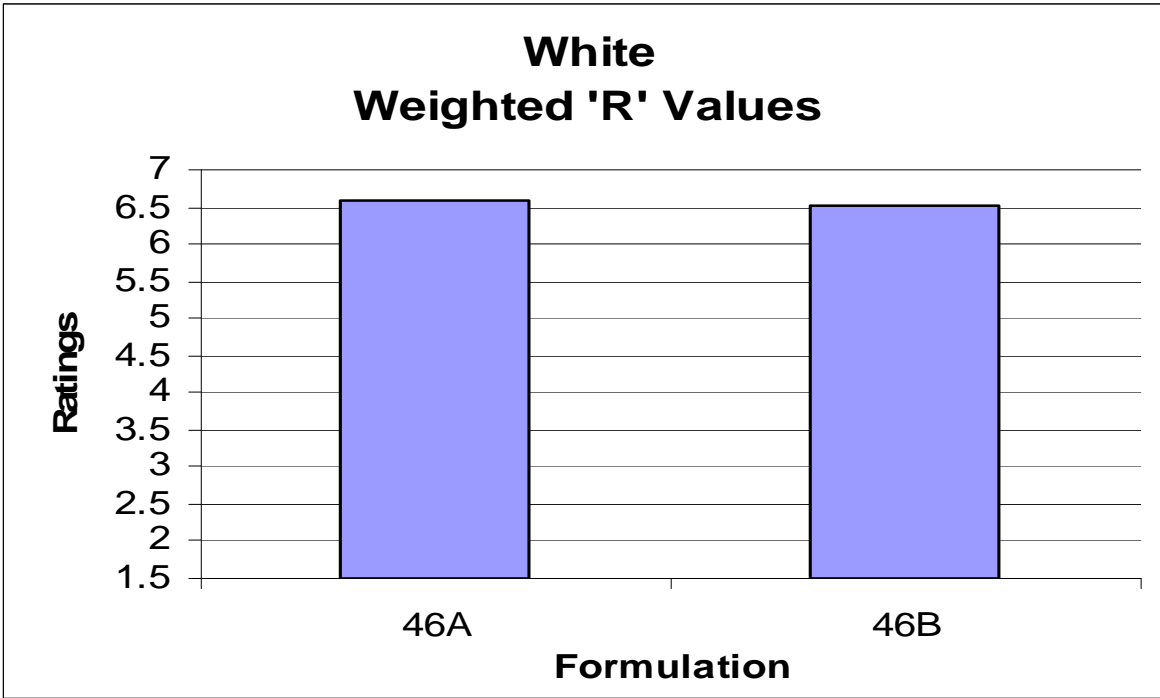
Note: The above noted traffic paint formulations were applied at 0°C, longer dry times are expected at these conditions.

Prepared by Joe Filice (780-415-1022)

cc: Roger Skirrow, Moh Lali, Allan Kwan, Steve Otto
Construction Managers
Operations Managers

Chart 1

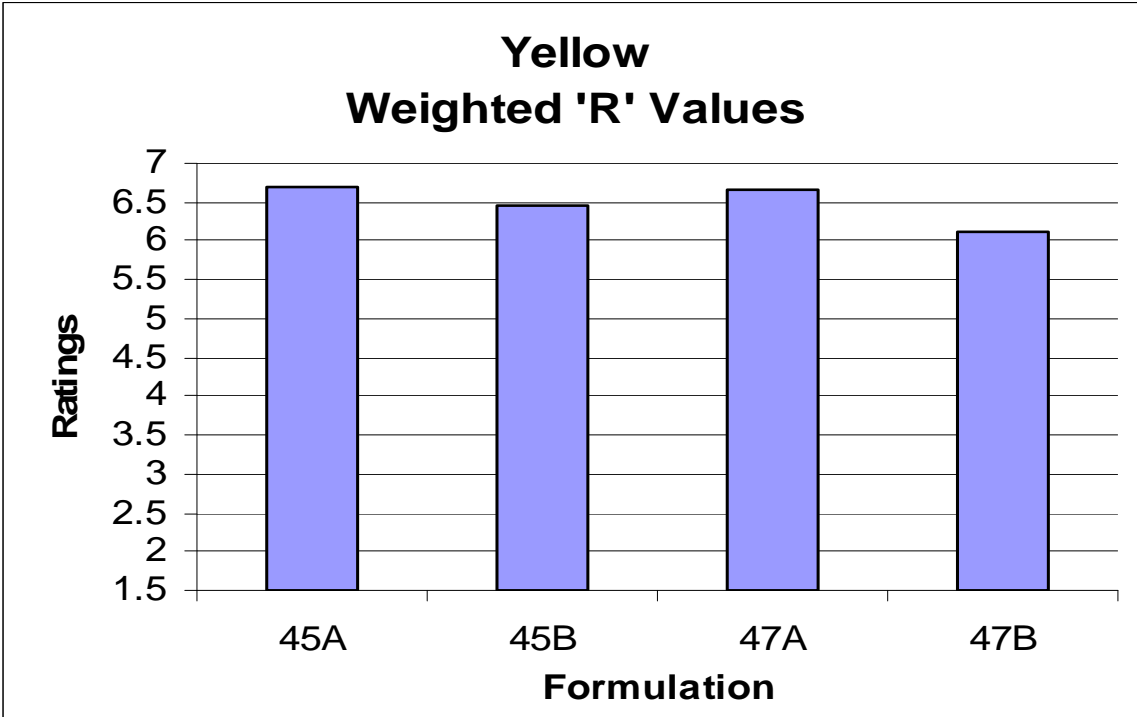
**Low VOC, Low Temperature Waterborne Traffic Paint
2005/06 Test Deck**



Test Deck No.	46A	46B
Weighted R	6.59	6.52
Formulation	T44-5146	T44-5146
Supplier	IBIS	IBIS
Vehicle	Waterborne	Waterborne

Chart 2

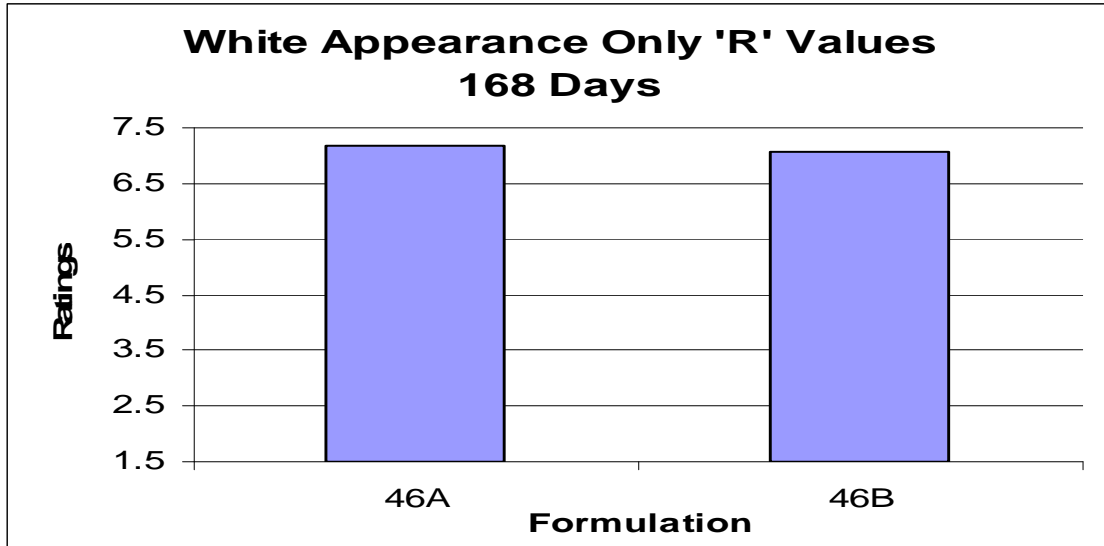
**Low Temp, Low VOC Waterborne Traffic Paint
2005/06 Test Deck**



Test Deck No.	45A	45B	47A	47B
Weighted R	6.68	6.47	6.65	6.13
Formulation	T44-5145	T44-5145	T44-5147	T44-5147
Supplier	IBIS	IBIS	IBIS	IBIS
Vehicle	Waterborne	Waterborne	Waterborne	Waterborne

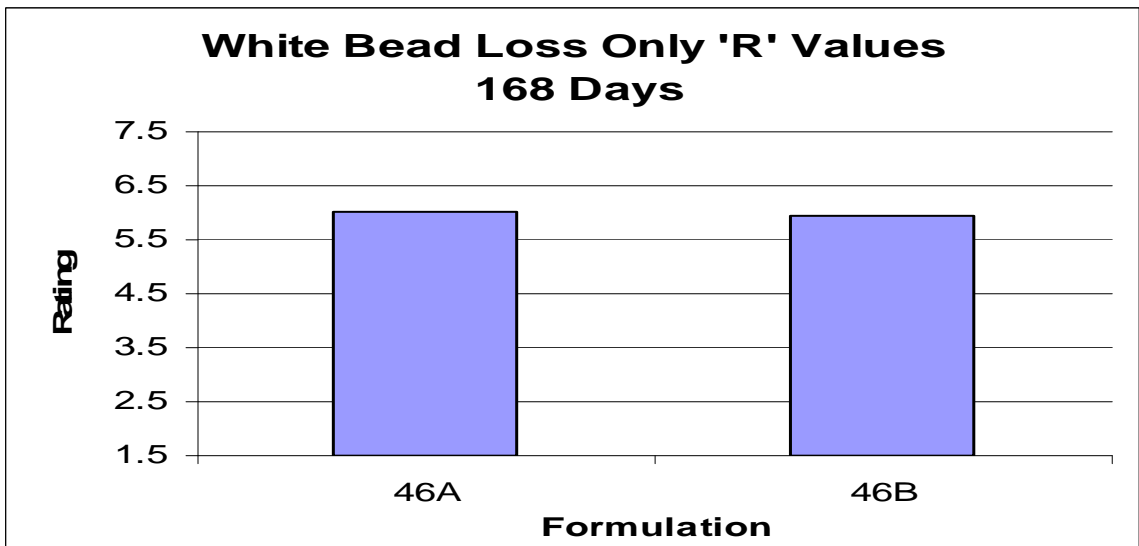
Appearance Only 'R' Values
168 Days (White)

Chart 3



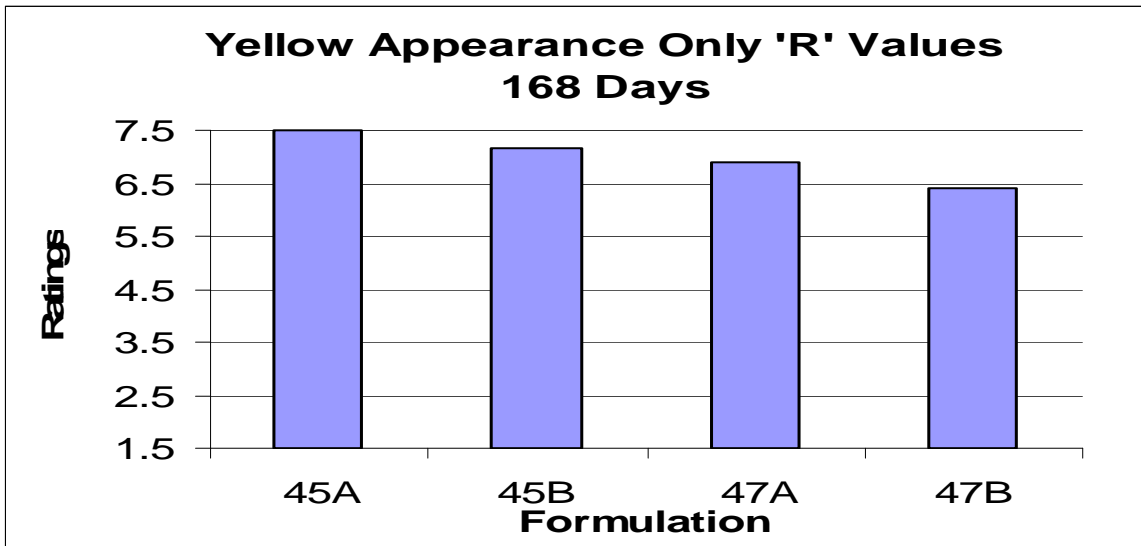
Bead Loss Only 'R' Values
168 Days (White)

Chart 4



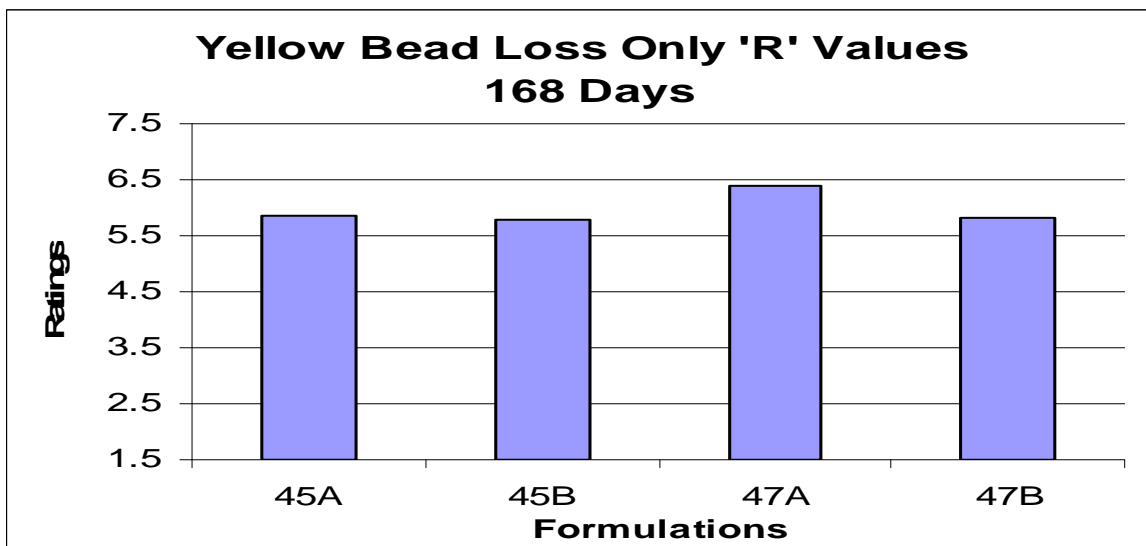
Appearance Only 'R' Values
168 Days (Yellow)

Chart 5



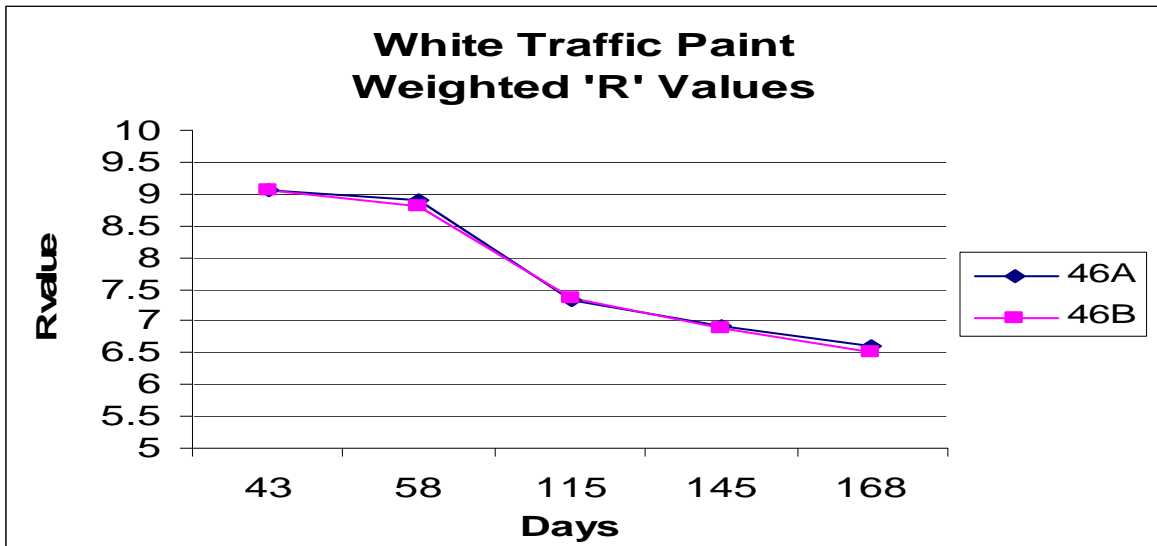
Bead Loss Only 'R' Values
168 Days (Yellow)

Chart 6



White Traffic Paint
Weighted 'R' Values

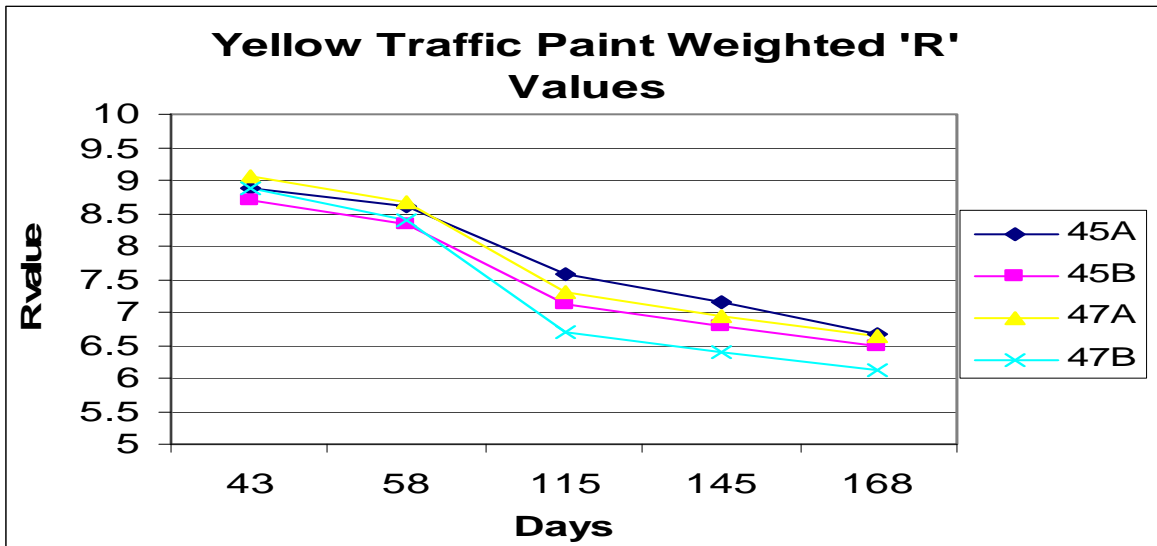
Graph 1



	46A	46B
Days	IBIS T44-5146	IBIS T44-5146
43	9.07	9.07
58	8.89	8.79
115	7.33	7.35
145	6.92	6.89
168	6.59	6.52

**Yellow Traffic Paint
Weighted 'R' Values**

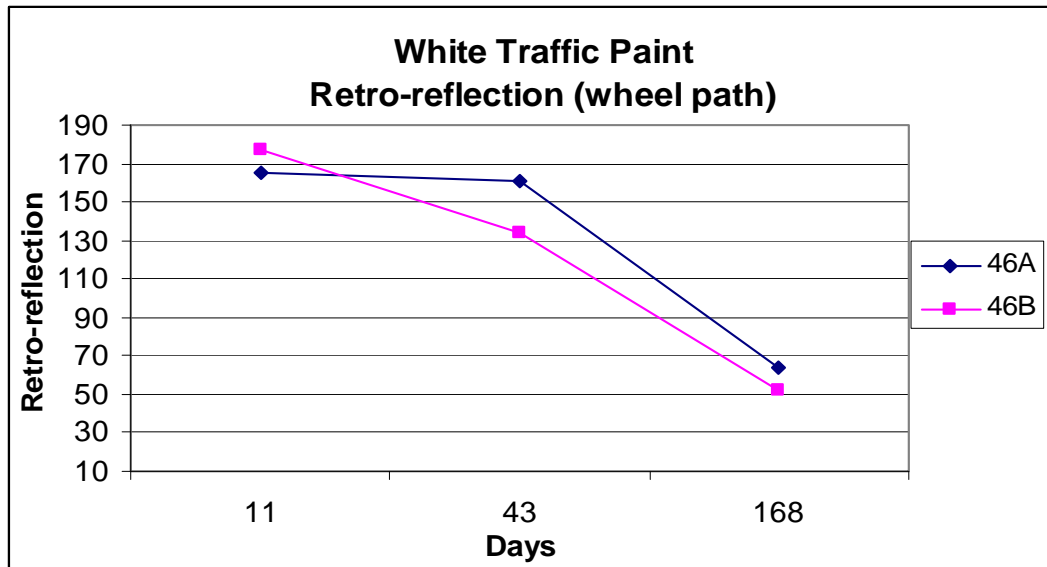
Graph 2



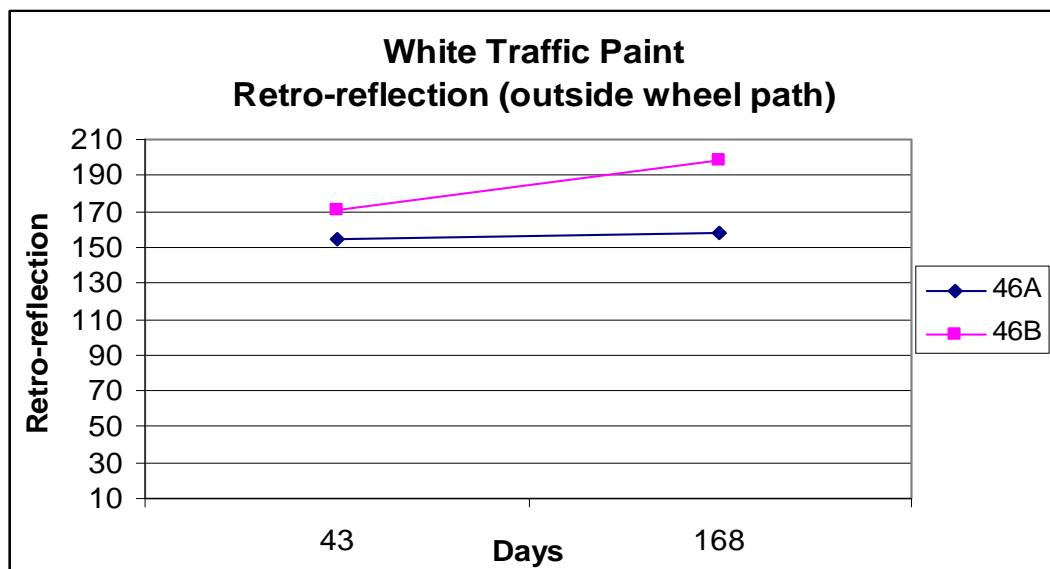
Days	45A	45B	47A	47B
	IBIS T44-5145	IBIS T44-5145	IBIS T44-5147	IBIS T44-5147
43	8.89	8.7	9.07	8.89
58	8.62	8.34	8.67	8.38
115	7.57	7.11	7.31	6.7
145	7.15	6.8	6.94	6.38
168	6.68	6.47	6.65	6.13

Retro-reflection White Traffic Paint

Graph 3

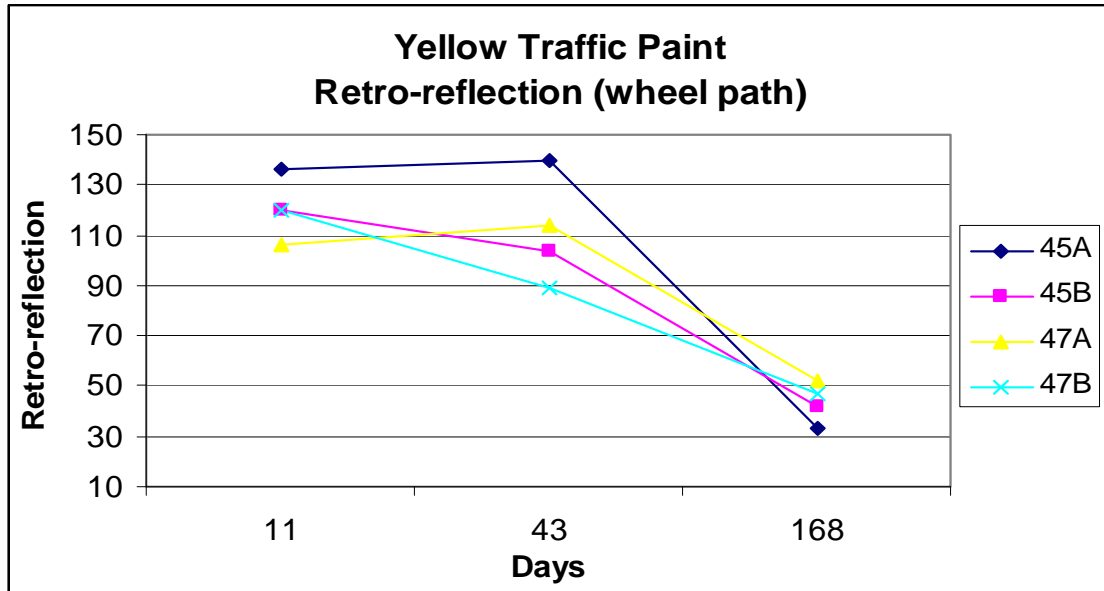


Graph 4

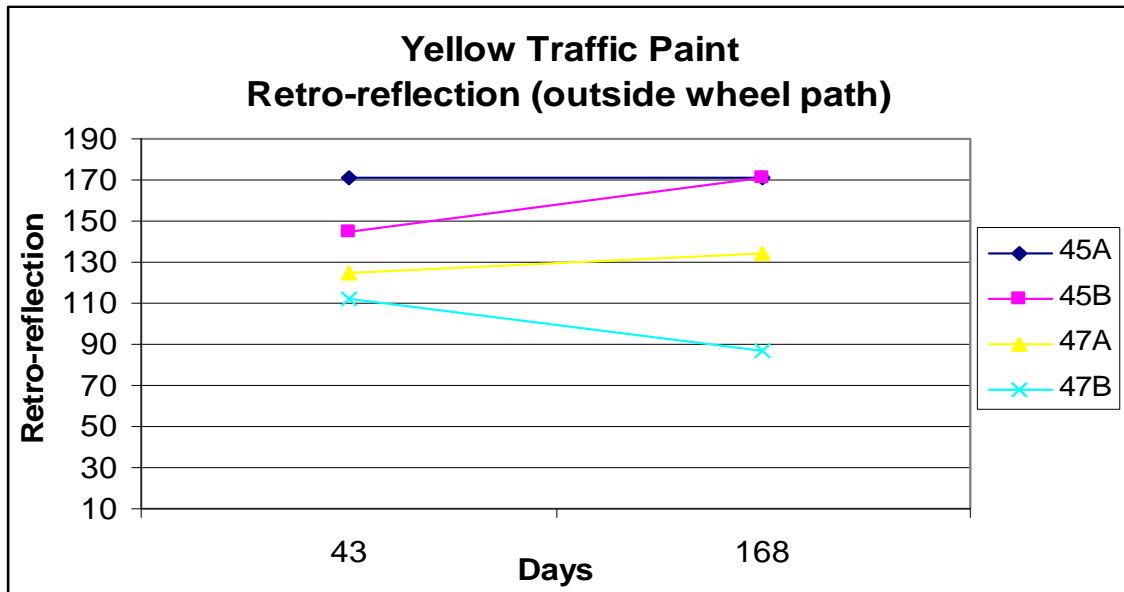


Retro-reflection Yellow Traffic Paint

Graph 5



Graph 6



Test Deck



November 2005



April 2006

Appendix 'B'

Highway Trial Sites

Hwy. 88, Low Temperature, Low VOC Waterborne Traffic Paint

Location: Highway 88
Applied: October 24 & 25
Evaluated: October 24, 2006

Kilometer 82



White edge line retro's SB – 268, 266, 275, 266, 275, 266, 256, 258, 262, 270, 259, 270, 259, 266, 264



Yellow centerline retro's – 185, 178, 181, 181, 185, 174, 173
Prepared: Joe Filice, cc: Roger Skirrow

Highway 39 - 2008 Low Temperature, Low VOC Traffic Paint Trials

Locations:

Location #1

Hwy. 39:08, SH770N Pigeon Lake Turn at RR 41A (westbound edge line by gas station)

Formulation #T44-0178 (White)

Liters used: 973

Applicator: Lafrentz

Application Date: October 30, 2008

Pavement Temperature:	1.3°C	Ambient Temperature:	3.0°C
Relative Humidity:	44%	dry Time:	30 min.

Retro-reflectivity – 332, 339, 333, 350, 343, 364 – Average – **344 Mcd**

Location #2

Hwy. 39:08 & 39:06, centerline Jct. Hwy 22 to Jct. Hwy 20, Jct. Hwy 20 – RR45

Formulation #T44-5145 (Yellow, lead free)

Liters used: 1019

Applicator: Lafrentz

Application Date: October 30, 2008

Pavement Temperature:	2.8°C	Ambient Temperature:	3.8°C
Relative Humidity:	44%	dry Time:	28 min.

Retro-reflectivity – 243, 266, 257, 264, 247, 258 – Average – **256 Mcd**
(Readings taken on Hwy 39 centerline just before RR 53 sign, measured going east)

Location #3

Hwy. 39:08, edge line starting east bound after RR54 to SH 770N, including 60:02, Jct. Hwy 60 to Jct. Hwy 19 going northbound edge lines and turn lanes. Also, 2A:26, Leduc to CMA 11 boundary southbound interchanges (turn lanes).

Formulation #T44-5146 (White)

Liters used: 1159

Applicator: Lafrentz

Application Date: October 30, 2008

Pavement Temperature:	3.0°C	Ambient Temperature:	5.0°C
Relative Humidity:	44%	dry Time:	25 min.

Retro-reflectivity – 303, 302, 312, 310, 300, 302 – Average – **305 Mcd**
(Readings taken on Hwy 39 edge line just before RR41A going eastbound before the 2 large tanks entrance)

Location #4

Hwy. 39:08, centerline starting east bound just after RR45 (White picket fence) to SH770N, including 60:02 Jct. hwy 60 to Jct. Hwy 19 going northbound centerlines. Also, 2A:26 northbound from CMA 11 Boundary.

Formulation #T44-0185 (Yellow)

Liters used: 1065

Applicator: Lafrentz

Application Date: October 30, 2008

Pavement Temperature:	3.2°C	Ambient Temperature:	5.0°C
Relative Humidity:	44%	dry Time:	25 min.

Retro-reflectivity – 303, 302, 312, 310, 300, 302 – Average – **170 Mcd**
(Readings taken on Hwy 39 centerline just before RR41A going east bound before the 2 large tanks entrance)

Location #5

Hwy. 2A:26 Leduc to CMA 11 Boundary northbound edge line. Also at Hwy 28:02 CMA 9.

Formulation #T44-0406 (White)

Liters used: 1274

Applicator: Lafrentz

Application Date: October 31, 2008

Pavement Temperature:	-4.5°C	Ambient Temperature:	0.5°C
Relative Humidity:	44%	dry Time:	23 min.

Retro-reflectivity – 249, 263, 267, 259, 268, 271 – Average – **263 Mcd**
(Readings taken at intersection of Hwy 2A and Township Road 492 north bound edge line on Hwy 2A, 4th electrical pole from TWP Road 492)

Location #6

Hwy. 2A:26 Leduc to CMA 11 boundary, northbound center lines. Also some put down on CMA 9, Hwy 28:02. All centerlines on 28:02 Jct. SH 803 to Jct. Hwy 28:04 and 28A:03, Jct. Hwy 28 to Jct. Hwy 37.

Formulation #T44-5275 (Yellow)

Liters used: 1181

Applicator: Lafrentz

Application Date: October 31, 2008

Pavement Temperature:	-4.5°C	Ambient Temperature:	0.5°C
Relative Humidity:	44%	dry Time:	23 min.

Retro-reflectivity – 178, 173, 180, 172, 194, 193 – Average – **182 Mcd**
(Readings taken at intersection of Hwy 2A and Township Road 492 northbound center line on Hwy 2A, 4th electrical pole from TWP Road 492)

Location #1, Hwy 39, low temperature, Low VOC traffic paint application



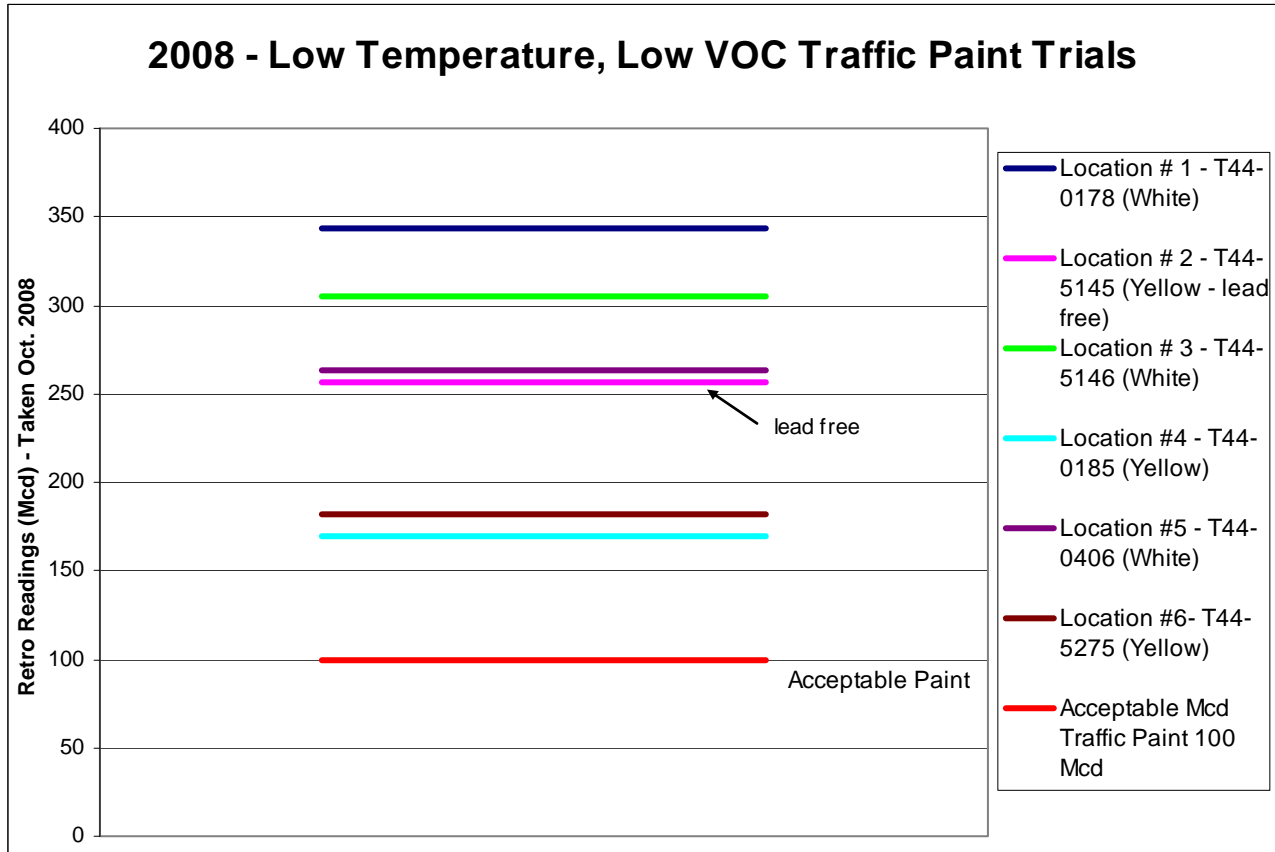
The application went very well. A close-up reveals that the paint splatters a little, however it looks good.

These trial areas will be monitored throughout the winter months. Retro-reflective readings will be taken in the spring to determine the lines durability.

Six of the seven approved low Temperature, low VOC traffic paint formulations were applied on October 30 and 31 2008. The seventh formulation will hopefully be applied in early spring with a few other formulations.

See graph below for the initial average retro-reflective readings of the various formulations applied

Traffic Markings Comparison Chart



Prepared by Joe Filice

cc: Roger Skirrow
Moh Lali

Appendix 'C'

Road Service Test (Paint Strip Evaluation – ASTM D713)

**ROAD SERVICE TESTS
ASTM D713**

FACTOR RATED	DESCRIPTION
a) General Appearance – 50% Rated out of 10.	Includes: -Abrasion -Bleeding -Chipping -Colour -Cracking -Dirt Retention -Hiding Power -Wrinkling -Other Failure Types As viewed from 2 – 4m, comparing worn and unworn areas, as well as comparing the stripe to panel at the same time, with the same paint thickness and subsequently stored in a cool, dry location.
b) Luminous Directional Reflectance -50% Rated out of 10.	Includes: -Bead Loss -Paint Reflectance As measured either visually, in sunlight or in an artificial light beam at night, or by a directional reflectance meter.

Total = 100%

RATING OF SUBJECTIVE TESTS

c) Changes or Undesirable Feat.	*% Lost	Desirable Feat.	*% Retained	Rating
None	0	Perfect	100	10
Slight Trace	1	Excellent	99	9
Trace	2 – 4	Very Good	96 – 98	8
Slight	5 – 7	Good	93 – 95	7
Slight to Moderate	8 – 12	Fairly Good	88 – 92	6
Moderate	13 – 18	Fair	82 – 87	5
Moderate to Marked	19 – 25	Fairly Poor	75 – 81	4
Marked	26 – 34	Poor	66 – 74	3
Very Marked	35 – 47	Bad	53 – 65	2
Severe	48 – 68	Very Bad	32 – 52	1
Complete Failure	68 – 100	None	0 - 31	0

*** AS ESTIMATED BY RATING PANEL**

Appendix 'D'

Highway 14 Test deck and Application Equipment

Highway 14 Test Deck – Low Temp. Traffic Paint applied on November 3, 2007 White
Application temperature: 2⁰C to 4⁰C



Application Equipment



Application of paint and glass beads



Completed application of cold temperature traffic paints (white and yellow)

Appendix 'E'

Low Temperature, Low VOC Approved Formulations

WHITE PAINT – LOW TEMPERATURE WATERBORNE

				SUPPLIER NAME		
				ENNIS PAINT Ontario	ENNIS Paint Quebec	
TEST METHOD			TOLERANCE	T44-5146	172-178	172-406 ²
Hiding Power	CGSB 1-GP-71(14.7)	(m ² /l)	±10 %	4.1	4.3	4.1
Specific Gravity	ASTM D 1475	(25/25°C)	±0.025	1.644	1.640	1.555
Skinning	CGSB 1-GP-71(10.1)		NON	NON	NON	NON
Accelerated Storage Stability	ASTM D1309	(0-10)	±1	8	6	0
BYK Gardner Color Guide Model #6805	ASTM E313	Brightness	±5 %	85.39	83.30	80.60
		Yellowness (White)	±10%	2.84	4.63	14.05
Bleeding	ASTM D868, D969	(contrast)	±1	8	8	8
Abrasion Resistance	ASTM D968	(l/mil)	90 - 120 %	27.3	19.6	24.9
Flexibility	ASTM D522	(mm)	±20 %	12		12
Drying Time(minutes)	ASTM D1640	Set to Touch	±2 min.	6.0	5.0	6.5
	ASTM D711	Dry to Traffic *	±20 %	*	*	*
Viscosity	ASTM D562	(Krebs)	±5	80	85	83
Non-Volatile Content	CGSB 1-GP-71(17.1)	(% wt.)	±2 % (absolute)	77.5	77.7	76.5
Pigment Content	CGSB 1-GP-71(21.1)	(% wt.)	±2 % (absolute)	60.9	59.2	58.3
Non-Volatile Vehicle	CGSB 1-GP-71(19.1)	(% wt.)	±2 % (absolute)	16.6	18.5	18.2
Particle Coarseness	ASTM D185	(% retained 45 µm)	±0.3 % (absolute)	0.02	0.04	0.26
Fineness of Grind	ASTM D1210	(Hegman)	±1	4.25	3.00	3.75
Water Resistance	ASTM D870		±1	9	8	8
Water Content	CGSB 1-GP-71(24.1)	(%)	±0.2 % (absolute)	21.0	19.00	18.0
Gloss	ASTM D523	(60°)	±3	3.0	3.0	2.9
Colour (Yellow)	CGSB 1-GP-12C	(505-308)	Match	-	-	-
Six Month Settlement	ASTM D869	(0-10)	5 min	9	7	5
Flash Point	CGSB 1-GP-71(3.1)			>93°C	13	>15°C

* Dry to Traffic requirements are relative to the pre-qualified tender sample at the time of testing (WB) Waterborne

Long dry times are expected when applying these formulations in colder temperatures (<10°C)

¹ Additional effort may be required to control tracking due to longer dry time.

² Winter storage may be a problem.

YELLOW PAINT – LOW TEMPERATURE WATERBORNE

TEST METHOD				SUPPLIER NAME			
				ENNIS Paint Ontario		ENNIS Paint Quebec	
		TOLERANCE	T44-5275	T44-5145 ²	172-184	172-185	
Hiding Power	CGSB 1-GP-71(14.7)	(m ² /l)	±10 %	4.2	4.5	4.0	4.1
Specific Gravity	ASTM D 1475	(25/25°C)	±0.025	1.580	1.618	1.566	1.637
Skinning	CGSB 1-GP-71(10.1)		NON	NON	NON	NON	NON
Accelerated Storage Stability	ASTM D1309	(0-10)	±1	8	8	6	6
BYK Gardner Color Guide Model #6805	ASTM E313	Brightness	±5 %	48.80	47.17	46.98	46.11
		Yellowness (White)	±10%	88.27	88.40	84.82	90.79
Bleeding	ASTM D868, D969	(contrast)	±1	9	9	9	9
Abrasion Resistance	ASTM D968	(l/mil)	90 - 120 %	39.7	32.1	20.1	20.7
Flexibility	ASTM D522	(mm)	±20 %	11	12	12	13
Drying Time(minutes)	ASTM D1640	Set to Touch	±2 min.	6.0	6.5	5.0	5.0
	ASTM D711	Dry to Traffic *	±20 %	*	-	*	*
Viscosity	ASTM D562	(Krebs)	±5	80	80	81	83
Non-Volatile Content	CGSB 1-GP-71(17.1)	(% wt.)	±2 % (absolute)	76.9	77.9	75.9	77.1
Pigment Content	CGSB 1-GP-71(21.1)	(% wt.)	±2 % (absolute)	58.6	61.0	55.7	58.2
Non-Volatile Vehicle	CGSB 1-GP-71(19.1)	(% wt.)	±2 % (absolute)	18.3	16.9	20.2	18.9
Particle Coarseness	ASTM D185	(% retained 45 µm)	±0.3 % (absolute)	0.02	0.02	0.06	0.09
Fineness of Grind	ASTM D1210	(Hegman)	±1	4.00	4.00	3.50	3.00
Water Resistance	ASTM D870		±1	8	9	9	8
Water Content	CGSB 1-GP-71(24.1)	(%)	±0.2 %(absolute)	21.0	21.8	21.40	19.40
Gloss	ASTM D523	(60°)	±3	2.0	2.0	2.0	2.0
Colour (Yellow)	CGSB 1-GP-12C	(505-308)	Match	Slightly Lighter	Slightly Lighter	Slightly Lighter	Slightly Lighter
Six Month Settlement	ASTM D869	(0-10)	5 min	9	9	7	7
Flash Point	CGSB 1-GP-71(3.1)			>93°C	>93°C	15°C	15°C

* Dry to Traffic requirements are relative to the pre-qualified tender sample at the time of testing
(WB) Waterborne

Long dry times are expected when applying these formulations in colder temperatures (<10°C)

¹ Additional effort may be required to control tracking due to longer dry time.

² Waterborne lead free

Appendix 'F'

Field Trial Evaluations

Highway 88 – February 13, 2007

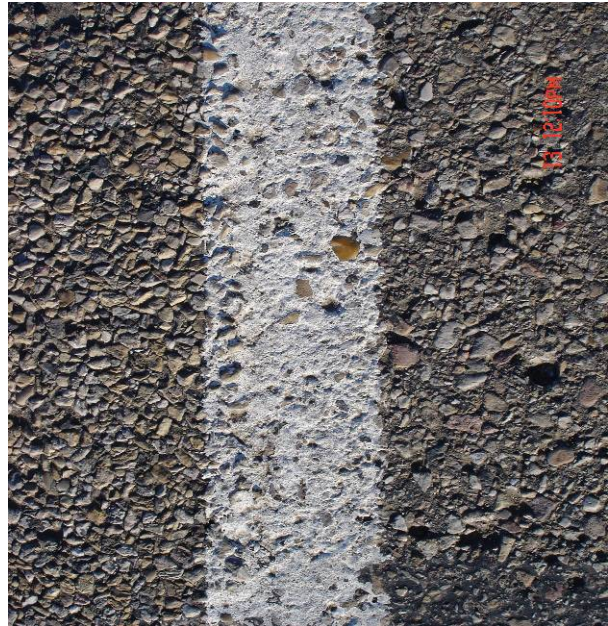
Highway 88 – June 6, 2008

Highway 88, Low Temperature, Low VOC Waterborne Traffic Paint

Location: Highway 88
Applied: October 24 & 25
Evaluated: February 13, 2007

Kilometer 8.0

White edge line on east side of road



Retro readings: ranged from 112 to 136 with an average of 123 mcd's
Yellow centerline



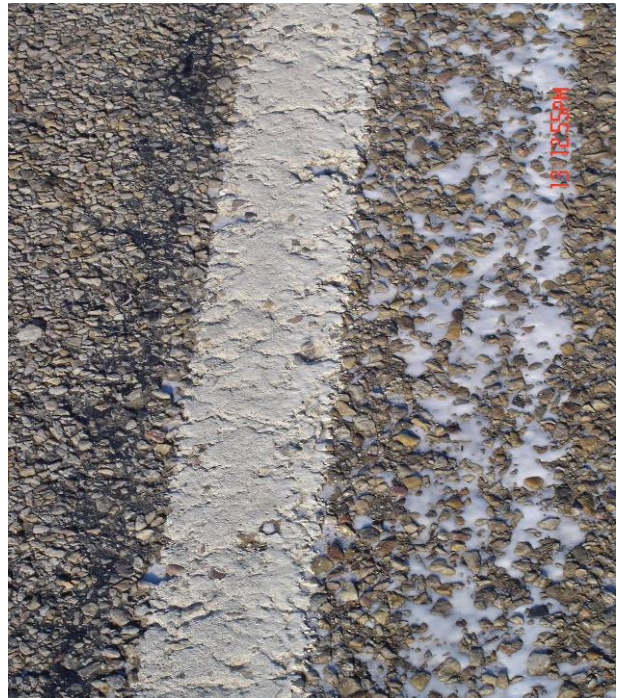
Retro readings: ranged from 59 to 67 with an average of 64 mcd's. The yellow line was applied in grooved centerline rumble strips. The yellow line is still visible after a harsh winter with lots of snow plowing.
White edge line on the west side of road



Retro readings: ranged from 100 to 132 with an average of **122 mcd's**.

Kilometer 17.0

White edge line on east side of road



Retro readings: ranged from 106 to 145 with an average of **132 mcd's**.

Yellow centerline



Retro readings: average of **65 mcd's**.

White edge line on the west side of road

No photographs taken. The retro readings ranged from 103 to 127 for an average of **115 mcd's**

Kilometer 72.0

No photographs taken.

White edge line on the east side of road

Retro readings ranged from 114 to 141 with an average of **121 mcd's**

Yellow centerline

Retro readings ranged from 98 to 107 with an average of 103 **mcd's**

White edge line on the west side of road

Retro readings ranged from 154 to 169 with an average of **163 mcd's**

Summary

The low temperature, low VOC waterborne traffic paint lines are performing very well at this location. The lines are holding the glass beads very well, which is remarkable considering the amount of snowplowing this season. The paint formulations on this trial project were approved in 2006 based on their test deck performance.

Joe Filice

Highway 88, Low Temperature, Low VOC Waterborne Traffic Paint

Location: Highway 88
Applied: October 24 & 25
Evaluated: June 6, 2007

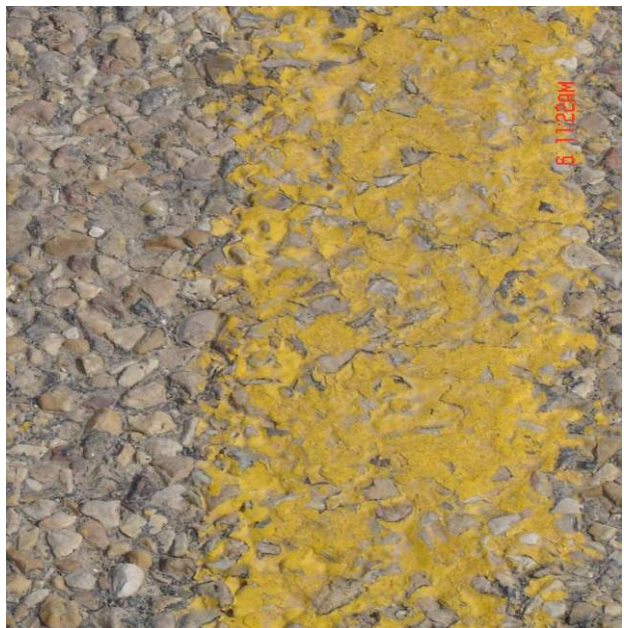
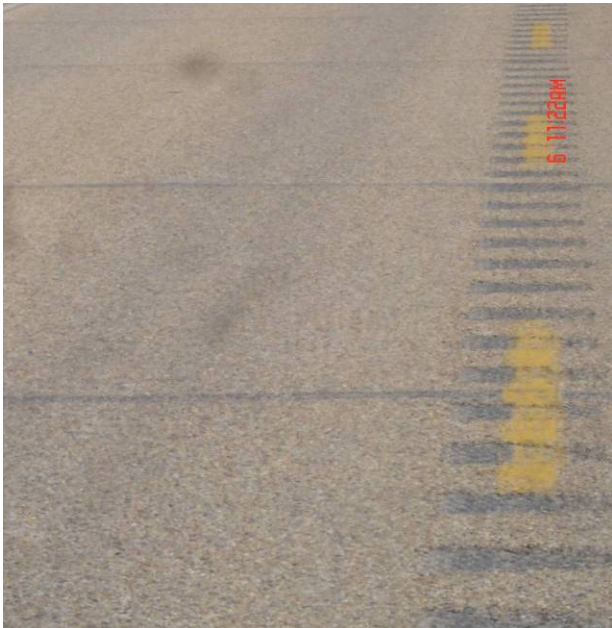
Kilometer 8.0

White edge line on east side of road



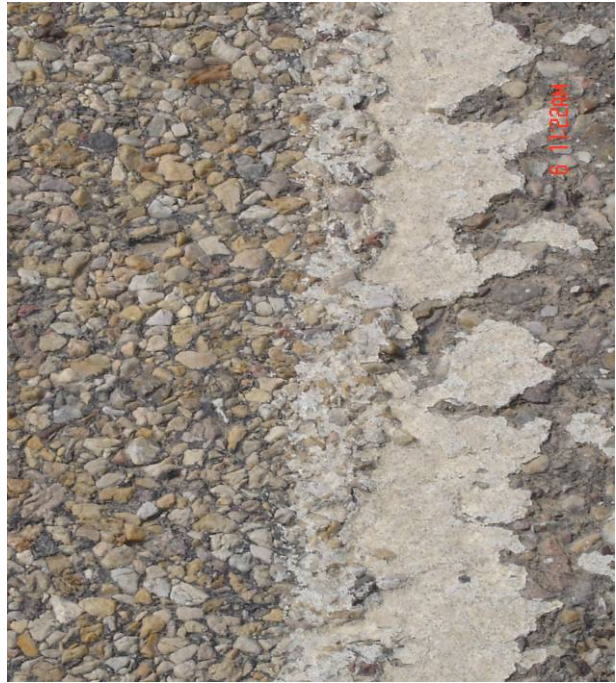
The white edge paint shows some wear; however it is still providing good delineation with good retro-reflective readings after one winter. Retro readings: ranged from 98 to 120 with an average of **108 mcd's**

Yellow centerline



Retro readings: ranged from 36 to 43 with an average of 40 **mcd's**. The yellow line was applied in grooved centerline rumble strips. The yellow line is still visible after a harsh winter with lots of snow plowing.

White edge line on the west side of road



Retro readings: ranged from 79 to 110 with an average of **83 mcd's**.

Kilometer 17.0

White edge line on east side of road



Retro readings: ranged from 172 to 194 with an average of **181 mcd's**.

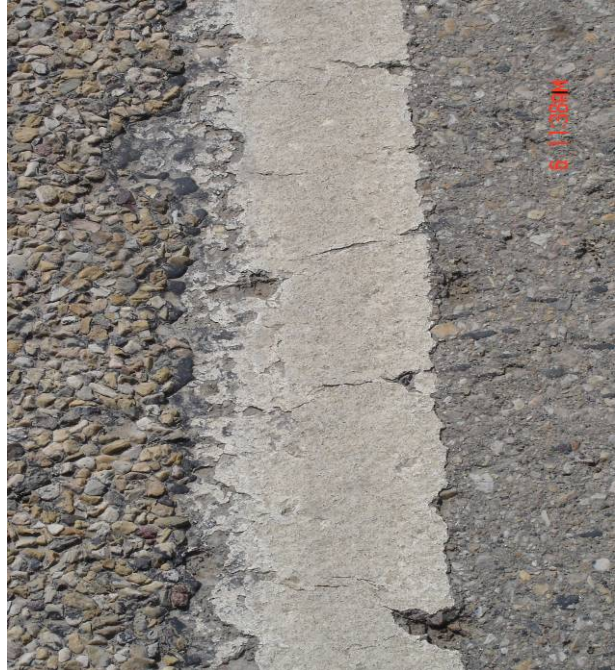
Reto-reflective readings at this location are excellent. The line held up very well over the winter with excellent glass bead retention.

Yellow centerline



Retro readings: ranged from 34 to 45 with an average of **39 mcd's**. Retro readings are low mainly due to the fact that the paint is in the centerline rumble strip.

White edge line on the west side of road



Retro readings ranged from 92 to 125 for an average of **113 mcd's**

Kilometer 27.0

White edge line on the east side of road



Retro readings ranged from 127 to 152 with an average of **140 mcd's**. Paint line in very good shape. Yellow centerline



Retro readings ranged from 37 to 55 with an average of 46 mcd's

White edge line on the west side of road



Retro readings ranged from 113 to 136 with an average of 122 mcd's

Summary

The low temperature, low VOC waterborne traffic paint lines are performing very well at this location. The lines are holding the glass beads very well, which is remarkable considering the amount of snowplowing this past winter. The yellow centerline retro readings are much lower than the white edge lines. The main reason for this is that the yellow centerline paint was applied directly into the centerline rumble strips.

The paint formulation on this trial project was approved in 2006 based on its test deck performance. As can be seen from the photographs, this low temperature waterborne traffic paint has been successful.

Joe Filice

Appendix 'G'

Field Trial Evaluations

Highway 39 – April 7, 2009
Highway 39 – May 27, 2009

Highway 2A:26 – April 7, 2009

Low Temperature, Low VOC Traffic Paint Trials

Location #1

Hwy. 39:08, SH770N Pigeon Lake Turn at RR 41A (westbound edge line by gas station)

Formulation #T44-0178 (White)

Liters used: 973

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 1.3°C, Ambient Temperature: 3.0°C, Relative Humidity: 44%, Dry Time: 30 min.

Retro-reflectivity readings: – 44, 50, 41, 38, 42, 47, 39, 37, 43 – Average – **42 Mcd** (April 7, 2009)



North edge line looking west



Close-up: durability of line is very fair

Formulation T44-0178 (white) is performing fairly well. As can be seen from the close-up, the paint is showing some wear and has poor bead retention. This is typical after a winter season. The paint line is pretty well intact and functioning as intended.

The retro-reflective readings are low; this is attributed to the glass bead loss which is typical for traffic paint after the winter season. However this formulation has made it through the winter intact and is highly visible to the motorist.

Location #2

Hwy. 39:08 & 39:06, centerline Jct. Hwy 22 to Jct. Hwy 20, Jct. Hwy 20 – RR45

Formulation #T44-5145 (Yellow, lead free)

Liters used: 1019

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 2.8°C, Ambient Temperature: 3.8°C, Relative Humidity: 44% , dry Time: 28 min.

Retro-reflectivity readings: 49, 52, 54, 54, 50, 46, 55, 54, 45, 54 – Average – **51 Mcd** (April 7, 2009)
(Readings taken on Hwy 39 centerline just before RR 53 sign, measured going east)



Centerline skip line looking east



Close-up: very good durability

Formulation T44-5145 (yellow, lead free) is showing very good durability and is 100% intact. The retro-reflectivity and glass bead retention is good after one winter season. The yellow line is highly visible and providing very good delineation.

Location #3

Hwy. 39:08, edge line starting east bound after RR54 to SH 770N

Formulation #T44-5146 (White)

Liters used: 1159

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 3.0°C, Ambient Temperature: 5.0°C, Relative Humidity: 44% , Dry Time: 25 min.

Retro-reflectivity – 69, 62, 63, 58, 58, 64, 62, 73, 73, 71, 87, 92, 76, 77 – Average – **70 Mcd** (April 7, 2009)

(Readings taken on Hwy 39 edge line just before RR41A going eastbound before the 2 large tanks entrance)



South edge line looking east



Close-up: some chipping, durability is good

Formulation T44-5146 (white) looks good and is performing well. Line is very visible and is in great shape after one winter season. Other than some minor chipping observed for this formulation, it is considered a success.

Location #4

Hwy. 39:08, centerline starting east bound just after RR45 (White picket fence) to SH770N

Formulation #T44-0185 (Yellow)

Liters used: 1065

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 3.2°C, Ambient Temperature: 5.0°C,
Relative Humidity: 44% , Dry Time: 25 min.

Retro-reflectivity – 37, 46, 66, 46, 59, 48, 46, 47, 41– Average – **48 Mcd** (April 7, 2009)
(Readings taken on Hwy 39 centerline just before RR41A going east bound before the 2 large tanks entrance)



Centerline skip looking east



Close-up, durability is very good

Formulation T44-0185 (yellow), durability looks good and line is performing well. Some snowplow scraping was observed for this formulation. This formulation is also considered a success.

Location #5

Hwy. 2A:26 Leduc to CMA 11 Boundary northbound edge line.

Formulation #T44-0406 (White)

Liters used: 1274

Applicator: Lafrentz

Application Date: October 31, 2008, Pavement Temperature: -4.5°C, Ambient Temperature: 0.5°C, Relative Humidity: 44% , Dry Time: 23 min

Retro-reflectivity – 73, 76, 61, 69, 68, 74, 74, 79, 69, 80, 71 – Average – **72 Mcd** (April 7, 2009)
(Readings taken at intersection of Hwy 2A and Township road 492, north bound edge line on Hwy 2A, 4th electrical pole from TWP Road 492)



East edge line looking north



Close-up: durability is very good

Formulation T44-0406 (white), durability looks very good and line is performing well. Retro-reflective readings are very good after one winter. Edge line is providing very good delineation after the winter months.

Location #6

Hwy. 2A:26 Leduc to CMA 11 boundary, northbound center lines.

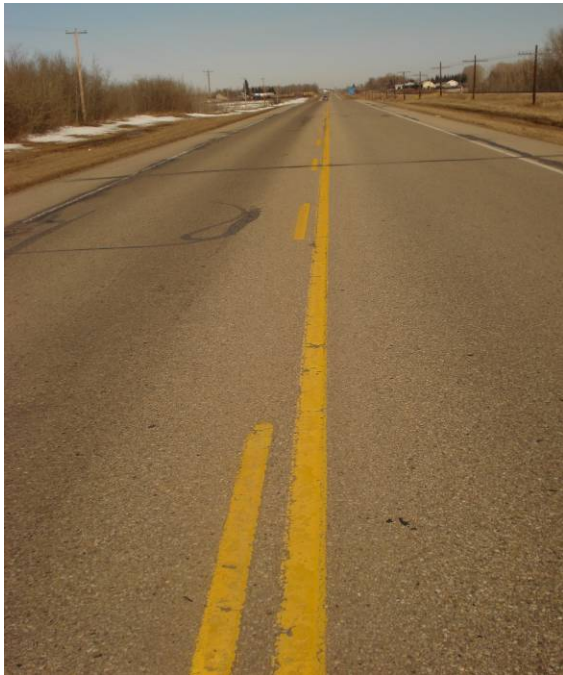
Formulation #T44-5275 (Yellow)

Liters used: 1181

Applicator: Lafrentz

Application Date: October 31, 2008, Pavement Temperature: -4.5°C, Ambient Temperature: 0.5°C
Relative Humidity: 44% , Dry Time: 23 min.

Retro-reflectivity – 75, 70, 91, 95, 95, 56, 77, 81, 59 – Average – **78 Mcd** (April 7, 2009)



Centerline looking north



Close-up: durability looks very good

Formulation T44-5275 (yellow), durability is very good at this location. Retro-reflective readings are very good for yellow traffic paint after one winter. Centerline is providing very good delineation after the winter months.

Normal Waterborne Traffic Paint (comparison)

Highway 39, West of Calmar

Application Date: summer of 2008

White Retro-reflectivity – 93, 93, 85, 81, 84, 97 – Average – **89 Mcd** (April 7, 2009)

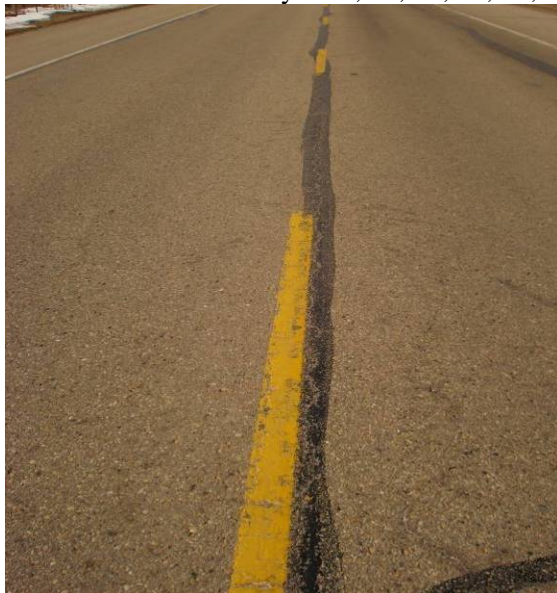


South edge line looking east

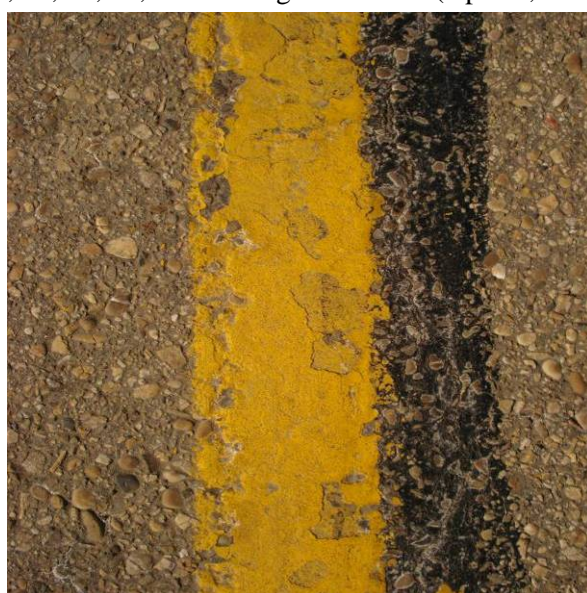


Close-up: durability is good, some minor chipping Observed, good glass bead retention

Yellow Retro-reflectivity – 41, 54, 55, 42, 55, 47, 53, 54, 51, 47– Average – **50 Mcd** (April 7, 2009)



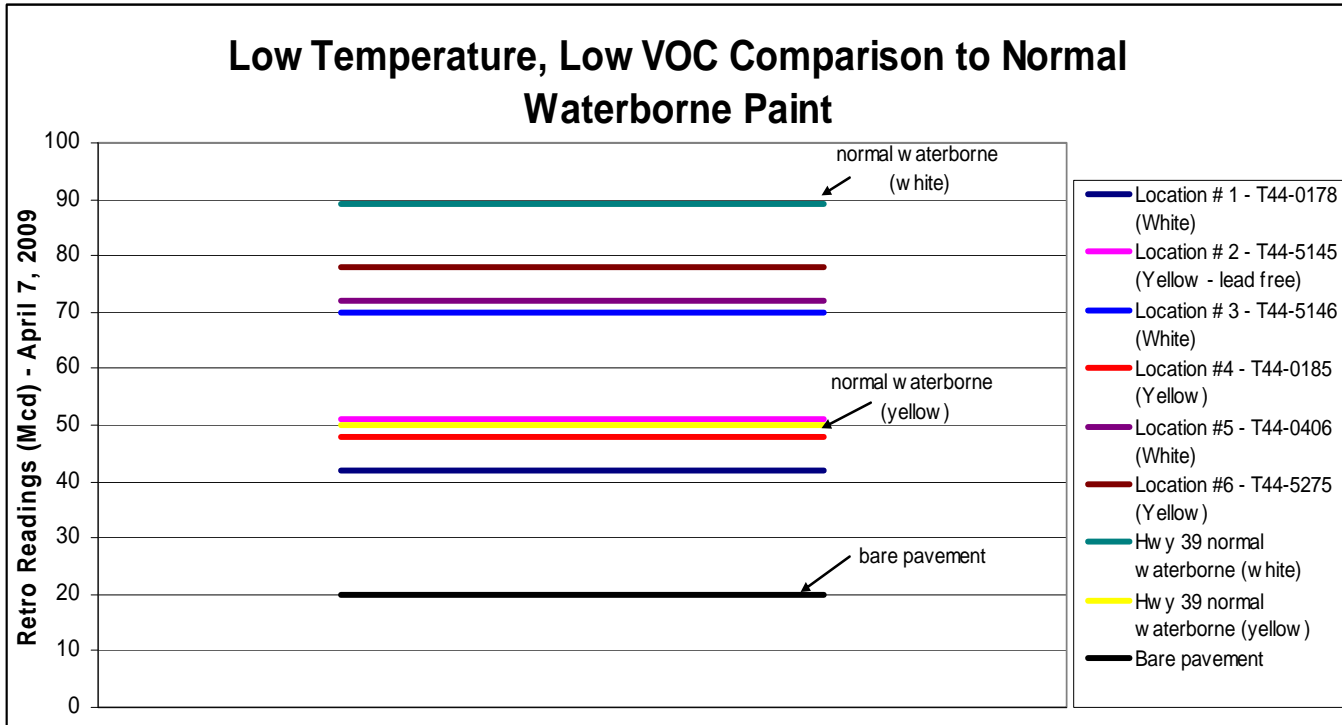
Yellow centerline



close-up, line has some minor chipping, otherwise in good shape

The normal waterborne formulations (white & yellow) are performing similarly to the low temperature, low VOC formulations after the winter months. The normal white waterborne paint had a slightly higher average retro-reflectivity. See the following graph for comparison of retro-reflective readings of low VOC paint to normal waterborne paint.

Traffic Markings Comparison Chart



Summary

The low temperature, low VOC traffic paint formulations applied at various locations on October 30 and 31st, 2008 are performing well. Retro-reflectivity and durability of all the low temperature, low VOC formulations is good after a long harsh winter.

When comparing the low temperature, low VOC traffic paint formulations to normal waterborne paint applied on highway 39, their performance (retro-reflectivity and durability) is similar (see above chart). Retro-reflective readings and paint durability have determined that the low temperature, low VOC formulations have the ability to perform over the winter months.

The approved formulations based on their success on the departments test deck in 2007 (applied at 0° C) have proven successful on the 2008 low temperature, low VOC field trail projects. Low temperature, Low VOC Waterborne Traffic Paint will perform when applied in colder temperature's (>0°C and <10°C).

Prepared by Joe Filice

cc: Roger Skirrow
 Moh Lali
 Chris Dechkoff (Lafrentz)
 Glenn Thamer (Lafrentz)
 Martin Jeanson (Environment Canada)

Low Temperature, Low VOC Traffic Paint Trials (Final Assessment)

The low temperature, low VOC traffic paint formulations applied at various locations on October 30 and 31st, 2008 are performing well. A final assessment on highway 39 was conducted on May 27, 2009. Retro-reflectivity and durability assessment of all the low temperature, low VOC formulations applied in the fall of 2008 was completed. The low temperature, low VOC formulations are providing excellent delineation after one winter season.

When comparing the low temperature, low VOC traffic paint formulations to normal waterborne paint applied on highway 39, their performance (retro-reflectivity and durability) is similar (see chart). Retro-reflective readings and paint durability have determined that the low temperature, low VOC formulations have the ability to perform over the winter months (when applied above 0^oC).

The approved formulations based on their success on the departments test deck in 2007 (applied at 0^o C) have proven successful on the 2008 low temperature, low VOC field trail projects. Low temperature, Low VOC Waterborne Traffic Paint will perform when applied in colder temperature's (>0^oC and <10^oC).

Prepared by Joe Filice

cc: Roger Skirrow
Moh Lali
Richard Chow
Chris Dechkoff (Lafrentz)
Glenn Thamer (Lafrentz)
Martin Jeanson (Environment Canada)

Please see the following detailed observation notes, retro-reflectivity readings, photographs for each section observed & comparison chart:

Location #1

Hwy. 39:08, Pigeon Lake Turn at RR 41A (westbound edge line by gas station)

Formulation #T44-0178 (White)

Liters used: 973

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 1.3°C, Ambient Temperature: 3.0°C, Relative Humidity: 44%, Dry Time: 30 min.

Retro-reflectivity readings: – 49, 68, 47, 53, 47, 55, 45, 50, 62, 52, 55 – Average – **53 Mcd** (May 27, 2009)



North edge line looking west



Close-up: lots of chipping

Formulation T44-0178 (white) is performing fairly well. As can be seen from the close-up, the paint is showing some wear and has poor bead retention. Overall the paint line is pretty well intact and functioning as intended.

The retro-reflective readings are low; this is attributed to the glass bead loss which is typical for traffic paint after the winter season. However this formulation has made it through the winter intact and is highly visible to the motorist.

Location #2

Hwy. 39:08 & 39:06, – RR53

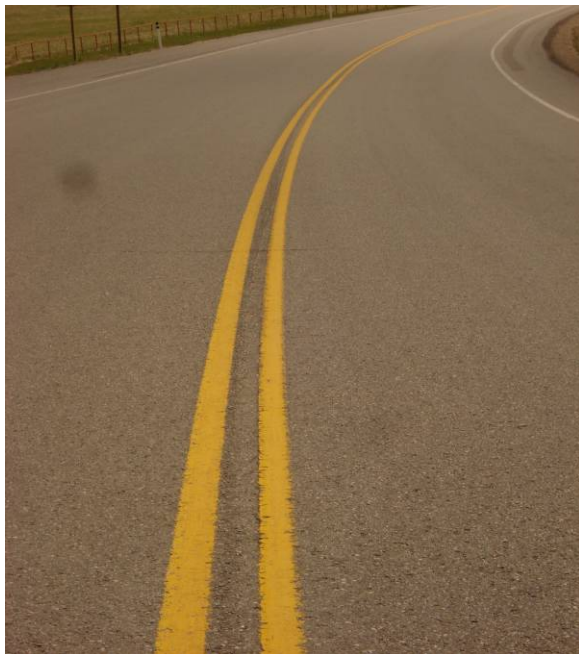
Formulation #T44-5145 (Yellow, lead free)

Liters used: 1019

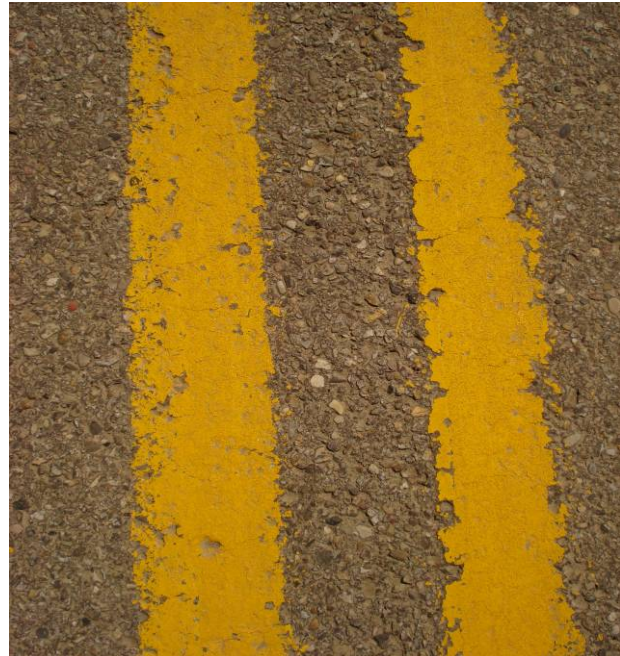
Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 2.8°C, Ambient Temperature: 3.8°C, Relative Humidity: 44%, dry Time: 28 min.

Retro-reflectivity readings: 63, 62, 60, 63, 62, 63, 62, 68, 60 – Average – **63 Mcd** (May 27, 2009)
(Readings taken on Hwy 39 centerline just before RR 53 sign, measured going east)



Centerline skip line looking east



Close-up: very good durability

Formulation T44-5145 (yellow, lead free) is showing very good durability and is 100% intact. The retro-reflectivity and glass bead retention is good after one winter season. The yellow line is highly visible and providing very good delineation.

Location #3

Hwy. 39:08, edge line starting east bound

Formulation #T44-5146 (White)

Liters used: 1159

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 3.0°C, Ambient Temperature: 5.0°C, Relative Humidity: 44%, Dry Time: 25 min.

Retro-reflectivity – 79, 77, 84, 79, 82, 75, 84, 87, 78, 82 – Average – **81 Mcd** (May 27, 2009)
(Readings taken on Hwy 39 edge line just before RR41A going eastbound before the 2 large tanks entrance)



South edge line looking east



Close-up: some chipping, durability is good

Formulation T44-5146 (white) looks good and is performing well. Line is very visible and is in great shape after one winter season. Other than some minor chipping observed for this formulation, it is considered a success.

Location #4

Hwy. 39:08, centerline starting east bound

Formulation #T44-0185 (Yellow)

Liters used: 1065

Applicator: Lafrentz

Application Date: October 30, 2008, Pavement Temperature: 3.2°C, Ambient Temperature: 5.0°C, Relative Humidity: 44%, Dry Time: 25 min.

Retro-reflectivity – 47, 39, 41, 47, 41, 33, 40, 41, 37, 46, 44, 41– Average – **41 Mcd** (May 27, 2009)
(Readings taken on Hwy 39 centerline just before RR41A going east bound before the 2 large tanks entrance)



Centerline skip looking east



Close-up, durability is very good

Formulation T44-0185 (yellow), durability looks good and line is performing well. Some snowplow scrapping was observed for this formulation. This formulation is also considered a success.

Normal Waterborne Traffic Paint (comparison)

Highway 39, West of Calmar

Application Date: summer of 2008

White Retro-reflectivity – 95, 99, 88, 81, 60, 77, 57, 83, 83, 67 – Average – **79 Mcd** (May 27, 2009)



South edge line looking east



Close-up: durability is fair, some minor chipping observed, good glass bead retention

Yellow Retro-reflectivity – 41, 49, 59, 48, 48, 52, 52, 41, 50, 48– Average – **44 Mcd** (May 27, 2009)



Yellow centerline



close-up, line has some minor chipping, otherwise in good shape

The normal waterborne formulations (white & yellow) are performing fairly similar to the Low Temperature, Low VOC formulations after one winter season. See the following graph for comparison of retro-reflective readings of low VOC paint to normal waterborne paint.

Traffic Markings Comparison Chart

Low Temperature, Low VOC Comparison to Normal Waterborne Paint

