FINAL REPORT

C-06-23: EVALUATION AND SPECIFICATION OF HIGH BUILD AND SPECIAL USE WATERBORNE PAVEMENT MARKINGS

By

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SPR Research Study No. C-06-23

by the

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
Technical Services Division: Materials Bureau
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DISCLAIMER

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16. Abstract High build waterborne traffic paints and highly retro-reflective elements were applied at various locations to evaluate their practicality for use by NYSDOT Maintenance forces. In addition, highly reflective elements were applied within grooved in areas to protect the elements and determine if grooving the markings extend service life. High build traffic paint from 2 manufactures was applied at various locations. Performance of high build paint was not noticeably different than standard traffic paint, ceramic elements performed well under dry and wet conditions, grooving operation was costly but show potential for durability and protection of highly retro-reflective elements.			
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ABSTRACT

High build waterborne traffic paints and highly retro-reflective elements were applied at various locations to evaluate their practicality for use by New York State Department of Transportation (NYSDOT) Maintenance forces. In addition, highly reflective elements were applied within grooved in areas to protect the elements and determine if grooving the markings extend service life. High build traffic paint from 2 manufacturers was applied at various locations. Performance of high build paint was not noticeably different than standard traffic paint: ceramic elements performed well under dry and wet conditions; grooving operation was costly but showed potential for durability and protection of highly retro-reflective elements.

1. INTRODUCTION

Pavement markings are an important roadway safety feature and new technologies for pavement markings have been developed in recent years which may increase overall performance. Some developments include higher durability resins and higher retro-reflective elements.

New York State Department of Transportation (NYSDOT) applies pavement marking on secondary roads primarily through Department maintenance forces. Waterborne paint is the primary material used by NYSDOT Maintenance which is applied with standard State-owned pavement marking trucks. Waterborne pavement markings are routinely re-applied every 6 months to 12 months depending on location and condition of the markings. Service life for waterborne pavement markings is considered to be 12 months on average for secondary roads. The waterborne paint used meets the requirements of NYSDOT Standard Specification 727-09 Traffic Paint (Appendix 1).

NYSDOT purchases approximately 200,000 gallons (757080 l) of waterborne traffic paint and 2000 pounds (907 kg) of standard glass beads per year. Part of this project is to determine if newer high build waterborne paint resins could provide a more durable alternative to standard waterborne traffic paints used currently by the Department. More durable markings would mean longer service life and less re-application of the markings. The efficient use of higher durability markings could cut back on material used and save money and labor for the NYSDOT.

In addition, this project investigates the use of grooved-in pavement markings with wet-night, retro-reflective elements as a possible option for locations with high wet-night accidents or pavement marking durability issues. Grooving in pavement markings protects the marking from traffic wear and extends the life of the markings in general. Due to the groove, the use of wet-night retro-reflective elements in addition to standard glass beads is required to provide visibility even under heavy rain conditions. The wet-night, retro-reflective elements provide a high level of visibility especially in wet conditions. The wet-night elements do tend to be more susceptible to damage and wear due to their larger size, so grooving the marking into the pavement is recommended to get the best service life out of the marking and elements.

2. MATERIAL SELECTION AND PREPARATION

In order to provide a fair evaluation of the high build resin, the Department purchased waterborne paint from 2 paint manufacturers, Ennis Paints, Inc. and Sherwin-Williams Co., using high build resin supplied by Dow Chemicals Inc. and by Rohm & Haas. In addition, paint was also purchased from 3M Inc. in conjunction with their ceramic wet-night retro-reflective elements, for application in a grooved-in section.

A batch of Ultra 1.9 glass beads was also purchased from Potters Inc. for testing in a grooved section as well. This also included a bead gun to attach to an existing applicator truck for applying the Ultra 1.9 bead with standard glass beads (double drop).

The application would be handled by a NYSDOT Maintenance crew using their standard equipment and procedures and applied according to NYSDOT Specifications. NYSDOT Region 07, headquartered in Watertown, New York, volunteered to select the test locations and apply the test material as well as monitor its visual performance. Locations were selected based on scheduling and accessibility for application and monitoring. Each test location selected is about 2 miles (3.2 km) long. (Test locations can be seen in Appendix 2.)

Yellow and White traffic paint was manufactured by Ennis Paints and by Sherwin-Williams using the high build resins from Dow and Rohm-Hass. The batches made were formulated to meet the NYSDOT Standard Specifications for Traffic Paint (Section 727-09 Traffic Paint, see Appendix 1). Each formulation was tested by NYSDOT Chemistry Laboratory to confirm they met NYSDOT requirements. One tote of each color test sample was purchased for application, each tote containing approximately 250 gallons (2503 l).

The high build waterborne paint was to be applied with standard glass beads meeting the requirements of NYSDOT Standard Specifications 727-05 Glass beads for Pavement Markings (see Appendix 1). Region 07 Maintenance already had a supply of the standard glass beads for use. (List of test material can be seen in Table 1)

TABLE 1:
Test Material Purchased and Applied

Product	Manufacturer	Quantity
White and Yellow Paint with Dow DT-400 resin	Ennis	1 Tote Yellow 1 Tote White
White and Yellow Paint with Rohm-Haas HD-21resin	Ennis	1 Tote Yellow 1 Tote White
White and Yellow Paint with Dow DT-400 resin	Sherwin-Williams	1 Tote Yellow 1 Tote White
White and Yellow Paint with Rohm-Haas HD-21resin	Sherwin-Williams	1 Tote Yellow 1 Tote White
White and Yellow Paint with 3M Elements	3M	1 Tote Yellow 1 Tote White 525 lbs (238 kg)Yellow Elements

		525 lbs (238 kg)White Elements
Ultra 1.9 Glass Beads	Potters Ind., Inc.	2000 lbs (907 kg)

Standard glass beads were applied with the traffic paint at a rate of approximately 7 – 8 lbs/gal (0.84 kg/l) of paint.
Ultra 1.9 beads were added at approximately 7 – 8 lbs/gal (0.84 kg/l) of paint.
3M Elements added at approximately 6 lbs/gal (0.72 kg/l) of paint.

Areas where the 3M material would be tested as well as the Ultra 1.9 bead would be grooved in by an outside contractor since NYSDOT Maintenance does not own the proper milling equipment.

Grooving was done at the following measurements:

Groove Width: Pavement Marking Width plus 1 inch (25 mm).
5 inch (127 mm) width for 4 inch (100 mm) markings
Depth: 0.080 inch ± 0.020 inch (2 mm ± 0.5 mm)

Field testing is based on NYSDOT Standard Specifications (see Appendix 1) and retro-reflectivity testing is based on ASTM D7585 using a Delta LTL-2000 portable retrometer meeting the requirements of ASTM E1710.

3. APPLICATION

Application of the test paint was done using standard waterborne paint mobile equipment owned and operated by NYSDOT Maintenance and applied in accordance to NYSDOT Standard Specification 640 Reflectorized Pavement Marking Paints (Appendix 1). Once the first batch of test material was obtained, application took place in the Towns of Peru and Plattsburg on September 19, 2007. Site conditions and details can be seen in Appendix 3. Initial placement on Route 22B, at the recommended wet film thickness of 25 - 30 mil (0.63 – 0.76 mm) was not acceptable due to the excessive dry times. No-track times were double than what is required in the field. It was decided to apply material at the second test location, Route 22, at a lower wet-film thickness of 20 - 25 mil (0.51 – 0.63 mm). No-track times for the second placement were also a bit long and not practical for the type of work being done. Mobile work zone under traffic with vehicles crossing over the still wet pavement markings was not a good application for the higher wet-film thicknesses of this material. The test material required an extended time for drying to a no-track condition at the higher wet-film thicknesses.

For the final placement in the Town of Peru, on Route 442, a wet-film thickness of 15 - 20 mils (0.38 - 0.51 mm) was used. This thickness is the standard for waterborne traffic paints and the no-track times were within acceptable limits. It was decided that the remainder of the test applications would be applied within the 15 – 20 mil (0.38 - 0.51 mm) range in order to meet acceptable no-track times in the field. Paint left over from the 3 test placements was applied at various other locations, at the paint crew's discretion, at the 15 – 20 mil (0.38 - 0.51 mm) wet-film thickness range. Equipment used and application of the test material can be seen in Photos 1 through 4.

Initial retro-reflectivity data was collected about 1 month after placement. Data collected shows acceptable retro-reflectivity results which are similar to data collected in the past from standard waterborne pavement markings. Approximate averages for new waterborne markings have been 150-250 mcd/m^2/lx for white and 120-200 mcd/m^2/lx for yellow. Average retro-reflectivity values collected for the test sites can be seen in Table: 2. Visually there was not much difference between the high build paints and standard paints applied within the same month at locations near the test areas. (Raw Data can be seen in Appendix 3).

Photo1: Initial test application Peru/Plattsburg.

Photo 2: Initial yellow line application.

Photo 3: Initial white line application.

Photo4: White line close up.

TABLE 2: Average Retro Reflectivity Values: R=mcd/m^2/lx Towns of Peru and Plattsburg							
Location Rte #	Wet Film Thickness	2007		2008		2009	
		White	Yellow	White	Yellow	White	Yellow
442	15mil (0.38mm)	350	155	161	40	17	17
22	20mil (0.51mm)	387	232	107	42	75	35
22 B	25mil (0.63mm)	362	206	86	54	48	43

New material was not placed in 2008 due to scheduling issues; the project was not able to continue until 2009. Anecdotal responses from Regional Maintenance were that the test material looked and performed as well as standard material at the test sites and at other areas where leftover material was placed.

Retro-reflectivity data was collected again on June 13, 2008 and July 16, 2009. Final values were low, but met anticipated values for standard waterborne markings after a year in service, placed in similar locations. Traffic and snowplow wear was visually the same as other locations using standard material.

Once a Contractor was set up to grind in the grooves for the next part of the project, installation was done on September 21, 2009. (The Grooves and grinding operation can be seen in Photos 5 – 7). NYSDOT Maintenance crews applied the next batch of test paints in the grooves right behind the Contractor after they milled in the groove. (Paint installation can be seen in Photo 8). Application conditions were average and dry times were within acceptable limits for the 15 – 20 mil (0.38 mm - 0.51 mm) wet film application thickness. Route 11 was applied with the 3M ceramic element and standard glass beads, while the Route 9 section used the Potters Ultra 1.9 bead with standard glass beads. (Close up images of the 3M element and Ultra 1.9 beads both with standard glass beads can be seen in Photos 9 and 10).

The Maintenance paint truck had to be modified to be able to apply the 2 separate retro-reflective elements (double-drop). A second smaller tank for the supplemental beads was added, as well as a second bead gun mounted and connected to the application system. Once the modifications were calibrated, the vehicle had no trouble applying the test paint and both elements right after the grooving operation. Retro-reflectivity data was collected about a month after placement. The data collected displayed retro-reflectivity values much higher than waterborne markings with standard glass beads. Anecdotal reports from regional personnel mentioned the grooved in markings on Route 11 did appear to visually perform very well during rainy conditions, but the ones on Route 9 did not perform any better than standard markings.

Data was collected again a year later on August 12, 2010 and finally on August 29, 2011. By the time of the second inspection in 2010, Maintenance forces had unfortunately re-striped most of the test locations due to scheduling issues. Data had to be collected from sections of pavement

where the older markings were still visible but this did not provide much viable values. Visually, the markings which were applied within the grooves looked good. They had less wear and damage than near-by markings, which were applied on the pavement surface at approximately the same times as the grooved-in markings.

TABLE 3:
Average Retro-Reflectivity values: R=mcd/m^2/lx
Towns of Champlain and Chazy

Location Rte #	Wet Film Thickness	2009	
		White	Yellow
11	10-15 mil (0.38 - 0.51 mm)	336	260
9	10-15 mil (0.38 - 0.51 mm)	395	226

Photo 5: Grooving Operation (Champlain/Chazy)

Photo 6: Milling Heads.

Photo 7: Milled in Groove close up.

Photo 8: Paint application within groove.

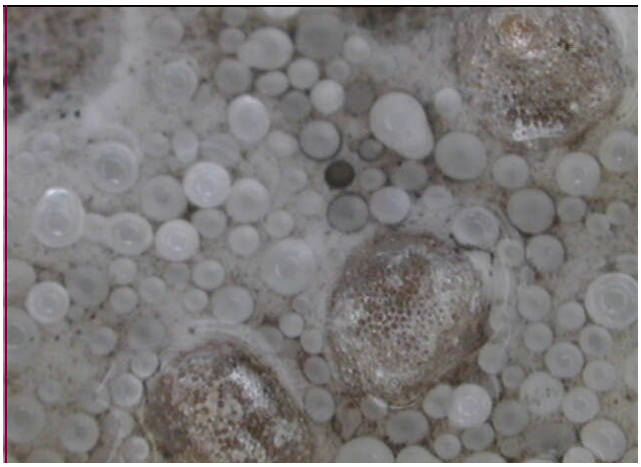

Photo 9: Close-up Route 11 - 3M elements with standard glass beads.

Photo 10: Close-up Route 9 – Ultra 1.9 with standard glass beads.

4. CONCLUSIONS

The use of high-build waterborne pavement markings in New York State as applied through NYSDOT maintenance forces does not appear to be an efficient use of the material. The high-build paint, when applied at the thicker recommended application rate, did not dry in a satisfactory time for application by NYSDOT maintenance forces under their normal application conditions. The slow dry time would have required longer traffic control and did not fit within maintenance requirements. When applied at the thinner application rates, the high-build markings did not perform better than currently approved waterborne pavement markings. Applications of the high build and standard waterborne markings both displayed approximately the same amount of wear and deterioration over time due to traffic and, more importantly, due to snowplow action. The higher cost of the high-build paint relative to the already approved paints makes the high-build impracticable for use under standard NYSDOT Maintenance conditions.

Since the start of this project, most manufacturers of high-build waterborne pavement markings have focused their efforts on the use of the product more in southern states, recognizing the wear on the material due to snow plow action. Also, the resin manufacturers have shifted ownership so currently available materials are not the same as those initially tested.

Grooving operations have been found to provide a satisfactory but expensive option for areas where additional retro-reflectivity may be warranted. Though the grooved-in markings placed were painted over before they could be properly evaluated, the markings do seem to perform better due to the protection from wear provided by the groove. The use of the groove does require the use of a true wet-night retro-reflective element since water will cover up the pavement markings in the groove when it rains. At this time the 3M ceramic element is the only material evaluated that can provide retro-reflectivity through water.

The grooving operation itself is beyond what NYSDOT Maintenance can currently install itself, and would have to be carried out by an outside contractor. Application of double-drop retro-reflective markings is possible with current NYSDOT equipment and is a practical and efficient option for areas where additional visibility is needed, especially in conjunction with a grooved in application.

5. IMPLEMENTATION

Since the high-build waterborne pavement markings did not perform as required for pavement markings for NYSDOT Maintenance forces, it has not been included as part of the Approved List of Materials. The use of double-drop retro-reflective elements has been shown to be a viable option for use by NYSDOT Maintenance forces. When new pavement marking equipment was being purchased for NYSDOT, double-drop capability was included as part of the requirements so all new equipment can apply standard retro-reflective beads in conjunction with other types of elements. All future equipment will also be required to have double-drop capability.

Grooving in pavement markings has been found to be a good way to protect and extend the life of pavement markings but when markings are grooved they should use wet-night ceramic elements in addition to standard glass beads in order to provide retro-reflectivity through water. The grooves will hold water so the extra wet-night retro-reflectivity provides additional visibility during heavy rain. NYSDOT has been expanding the use of grooved-in pavement markings with wet-night ceramic elements, primarily in areas where additional visibility would be beneficial. The high initial cost of grooving-in pavement markings has limited the number applications; but, projects with grooved-in pavement markings are scheduled for installation in the near future under NYSDOT contracts. NYSDOT has developed a special specification for the application of grooved-in epoxy markings, and the use of grooved-in markings with waterborne paints is an option for Maintenance crews for applying in areas which would benefit from the extra visibility provided by the wet-night ceramic elements. Current and future NYSDOT pavement marking application equipment have the capability to apply double-drop retro-reflective elements, including the wet-night ceramic type, but would have to contract out the grooving operation as was done in this project.

APPENDIX 1: Relevant NYSDOT Standard Specifications

SECTION 640 - REFLECTORIZED PAVEMENT MARKING PAINTS

640-1 DESCRIPTION. Under this work, the Contractor shall furnish and apply painted reflectorized pavement marking paint at the locations and in accordance with the patterns indicated on the plans or as directed by the Engineer, and in accordance with the MUTCD and these specifications.

640-2 MATERIALS. Reflectorized pavement marking paints shall be selected from the Department's Approved List of White and Yellow Reflectorized Pavement Marking Paints. Project acceptance will be based on the appearance of an approved brand name on the container label.
All paints shall conform to Federal, State, and local air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation.
Reflective glass beads shall conform to §727-05 Glass Beads for Reflectorized Pavement Marking Paints.
Details for obtaining Approved List status are available from the Materials Bureau.

640-3 CONSTRUCTION DETAILS

640-3.01 General. All pavement markings and patterns shall be placed as shown in the contract documents and in accordance with the MUTCD.
Before any pavement marking work is begun a schedule of operations shall be submitted to and approved by the Engineer.
When pavement markings are applied under traffic, the Contractor shall provide all the necessary flags, signs, cones, shadow vehicles, flashing arrow boards, etc. to maintain and protect traffic, to protect the work operation, and to protect the painted pavement markings until thoroughly dry and serviceable. No additional payment will be made for these items. The application of pavement markings shall be done in the general direction of traffic. Striping against the direction of normal flow of traffic shall not be allowed.
The Contractor shall be responsible for cleaning the pavement, to the satisfaction of the Engineer, of dust, dirt, and other foreign material which may be detrimental to the adhesion of the paint film.
When necessary, the Contractor shall establish marking line points at 30 feet intervals throughout the length of the pavement or as directed by the Engineer.
The Contractor shall be responsible for removing, to the satisfaction of the Engineer, all tracking marks, spilled paint, and paint applied in unauthorized areas.

640-3.02 Application of Pavement Markings. At the time of paint application, the pavement surface and ambient temperature shall not be less than 50°F, the relative humidity shall not exceed 85%, and the pavement surface shall be dry. Traffic paint shall not be applied during periods of rain or if rain is imminent. Waterborne traffic paint shall not be applied if rain is expected within 4 hours after application. Paint shall be applied in strict accordance with the manufacturer's recommendations for use. In no case shall the paint be heated above 150°F.
The painted pavement markings shall be uniformly applied to the pavement surface at the minimum specified wet film thickness. Immediately following paint application, reflective glass beads shall be uniformly applied to the wet paint film at the rate of 6 lb/gal of paint. The applied pavement markings shall have clean-cut edges and true and smooth alignment.
On pavements where traffic is to be maintained and the final marking pattern is known, traffic paint shall be applied before the end of the work shift. If the Contractor is unable to apply final pavement markings and traffic is to be maintained, then removable pavement markings offset from the final

pavement markings shall be installed in accordance with Section 619 Work Zone Traffic Control at no additional cost to the State.

640-4 METHOD OF MEASUREMENT. Pavement striping will be measured in feet along the centerline of the pavement stripe and shall be based on a 4 inches wide stripe. Measurement for striping with a plan width greater or less than the basic 4 inches as shown in the contract documents or as directed by the Engineer, will be made by the following method:

$$\frac{\textit{Plan Width of Striping (inches)} \times \textit{Feet}}{\textit{4 inches}}$$

No payment will be made for the number of feet of gaps in between the dashed lines. Letters and symbols will be measured by each unit applied. A unit will consist of one letter or one symbol. Examples: "SCHOOL" will be measured as six units. Double and triple headed arrows will each be measured as a single unit. The "X" in railroad grade crossing markings (MUTCD figure 263-33) will be measured by feet of 4 inch stripe.

640-5 BASIS OF PAYMENT. The accepted quantities of pavement markings will be paid for at the contract unit price bid, which shall include the cost of furnishing all labor, materials, and equipment to satisfactorily complete the work. The cost for maintaining and protecting traffic during the painting operations shall be included in the price bid. The application of Short-Term Pavement Markings, necessitated by the Contractor's failure to apply the required Reflectorized Pavement Marking Paints, shall be at no additional cost to the State.

Payment will be made under:

Item No.	**Item**	**Pay Unit**
640.10	White Paint Reflectorized Pavement Stripes – 15 mils	Feet
640.11	Yellow Paint Reflectorized Pavement Stripes - 15 mils	Feet
640.12	White Paint Reflectorized Pavement Letters - 15 mils	Each
640.13	White Paint Reflectorized Pavement Symbols - 15 mils	Each
640.20	White Paint Reflectorized Pavement Stripes – 20 mils	Feet
640.21	Yellow Paint Reflectorized Pavement Stripes - 20 mils	Feet
640.22	White Paint Reflectorized Pavement Letters - 20 mils	Each
640.23	White Paint Reflectorized Pavement Symbols - 20 mils	Each

727-05 GLASS BEADS FOR PAVEMENT MARKINGS

SCOPE. This specification covers the material requirements for retroreflective beads applied on top of thermoplastic, epoxy or traffic paint for use as pavement markings.

MATERIAL REQUIREMENTS. Glass beads for pavement markings shall meet the requirements of AASHTO M247 and shall be:
Composed of glass that is highly resistant to traffic wear and to the effects of weathering.
Colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially free from surface scarring or scratching.
Silica content (ASTM C169): 60% minimum.
Refractive index: 1.50 when tested by the liquid immersion method at 77°F.
Show no tendency to absorb moisture in storage and shall remain free of clusters and hard lumps.
Flow freely from the dispensing equipment at any time when surface and atmospheric conditions are satisfactory for painting.

A. Sphericity. (ASTM D1155 Procedure A) Spherical in shape - 70% minimum, true spheres.
Wet/Night Visibility Beads will be tested for roundness according to the procedural directives of the Materials Bureau.

B. Gradation. (ASTM D1214).

TABLE 727-05-1 GLASS SPHERE GRADATION (Standard Bead)

Percent Passing by Weight				
Marking Type	Sieve Size			
	#20	#30	#50	#80
Epoxy	100	80-95	9-42	0-10
Traffic Paint	100	80-95	9-42	0-10
Thermoplastic	100	79-95	15-60	0-15

TABLE 727-05-2 GLASS SPHERE GRADATION (Wet/Night Visibility Bead)

Percent Passing by Weight						
Marking Type	Sieve Size					
	#10	#12	#14	#16	#18	#20
Epoxy Wet/Night Reflective	100	95-100	75-95	10-47	0-7	0-2

C. Coating.

TABLE 727-05-3 GLASS SPHERE COATINGS

Marking Type	Coating Type
Epoxy (Wet/Night Visibility Bead)	Silane Type adherence coating designed to interact with and adhere to epoxy pavement markings.
Epoxy (Standard Bead)	Moisture-resistant coating or a dual purpose type coating (moisture-resistant and adherence).
Traffic Paint	
Thermoplastic (Drop on)	

D. Moisture Resistance. AASHTO M 247 Section 5.3.2

PACKAGING AND SHIPPING. Shipped to the job site in waterproof plastic lined burlap or plastic lined paper bags with the following information clearly marked on the packages:

- Manufacturer's Name
- Name of Product
- Size/Type/Coating
- Material Specification Number
- Lot/Batch Number
- Manufacture Date
- Quantity/Weight of Material

BASIS OF APPROVAL. Application for approval shall be submitted to the Materials Bureau by the manufacturer, accompanied by one 50 lb bag sample of the product, independent lab test results in accordance with this specification and certification that the product conforms to this specification. Upon approval by the Materials Bureau, the product will be placed on the Approved List.

BASIS OF ACCEPTANCE. Glass Beads for Pavement Markings will be accepted on the basis of the product appearing on the Approved List and a material certification that the product is the same as the one appearing on the Approved List and that it conforms to this specification.
Glass Beads for Pavement Markings used for Temporary Pavement Markings will be accepted on the basis of the product appearing on the Approved List. Upon request, the Contractor shall provide a material certification that the product is the same as the one appearing on the Approved List and that it conforms to this specification.

727-09 TRAFFIC PAINT

SCOPE. This specification covers the material requirements for waterborne and solventborne paints that are applied onto pavement, followed by a surface application of retroreflective beads for use as temporary, interim and permanent pavement markings.

MATERIAL REQUIREMENTS.

General. Traffic paint shall be:
Formulated for use as a pavement marking material.
Be VOC compliant and lead chromate free.
Yellow paints must use organic yellow pigments Color Index Pigment Yellow 65 (C.I. 11740) and/or 74 (C.I. 11741).
Display no bleeding on the surface upon which the paint is applied.
Conform to current Federal, State and Local air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the U.S. EPA, and the NYSDEC.

Physical Properties.
Traffic paint for permanent and Interim Pavement Markings shall conform to the requirements of paragraphs A though L below. Traffic paint for Temporary Pavement Markings shall conform to the following paragraphs: B. *Color*; C. *Directional Reflectance*; D. *Yellowness Index*; E. *Drying Time*; F. *Viscosity*; and G. *Dry Opacity*.

A. Composition.
% Pigment. (ASTM D3723) 58.0% – 62.0%
% Total Solids. (ASTM D3723) 76.0 % minimum
% Vehicle Non-Volatile. (ASTM D3723) 43.0 % minimum
The manufacturers certified organic yellow pigment content shall be used to determine the final laboratory test results for: total pigment (%), and for nonvolatile vehicle (%). The Department reserves the right to validate the manufacturers "certified" organic yellow pigment content through outside, independent laboratory testing.

B. Color. (ASTM D1535) When viewed under North Standard Daylight at a 15 ± 1 mils wet film thickness with no glass beads applied:
White: Approximate visual color match to Munsell Book Notation N 9.5/0.
Yellow: Approximate visual color match to Munsell Book Notation 10YR 8/14 and within the following chromaticity coordinate limits when tested under ASTM E1347.

TABLE 727-09-1 CHROMATICITY COORDINATES

Coordinate	1	2	3	4
x	0.485	0.517	0.492	0.468
y	0.426	0.462	0.471	0.450

C. Directional Reflectance (ASTM E1347) White: 84% minimum
Yellow: 54% minimum

D. Yellowness Index. (ASTM D1925 at 2°Observer angle and C Illuminate)
White Traffic Paint: 0.12 maximum.

E. Viscosity. (ASTM D562 Procedures B) 75 – 95 Kreb Units at 77°F

F. Dry Opacity. (ASTM D2805) 0.95 minimum contrast ratio
Application at 3 1/2 inches wide, wet-film thickness of 5 mils to white and black contrast panels matching Lenta Form 5C or equivalent. Dry time of 1 hour minimum.

G. Abrasion Resistance. (ASTM D4060) Four plate samples for each lot will be prepared for testing on the Taber Abaser. The paint will be sprayed on steel plates, or applied by other suitable means so as to ensure a nominal 15 mil wet film thickness on each plate. Plates will be cured at standard laboratory temperature and humidity for 2 to 24 hours. The paint abrasion plates will be cleaned, dressed, and baked at 221°F for 18 hours. After baking, the plates will be allowed to cool in a desiccator for one hour and then weighed. The plates will be abraded for 1000 cycles on the Taber Abraser. The Taber Abraser will be operated with 1.10 lb weights and CS 10 wheels on the machine. After abrading, the samples will be cleaned with a soft brush, placed in a desiccator for one hour and weighed again. The average weight loss for the four plates shall not exceed 0.00176 oz.

H. Flexibility. (Federal Specification TT-P-1952B Section 4.5.4) No cracking or flaking visible. Determine flexibility in accordance with Method B of ASTM D522.

I. Freeze-Thaw Stability. (Federal Specification TT-P-1952b, Section 4.5.7)
No coagulation or change in consistency (ASTM D562) greater than 15 Kreb Units.

J. Heat Stability. (Federal Specification TT-P-1952b, Section 4.5.8) Waterborne only. No coagulation, discoloration or change in consistency (ASTM D562) greater than 15 Kreb Units when tested in an oven at 120° ± 2°F.

K. Infrared Spectrophotometer Analysis.
Waterborne: (ASTM D3168) Solventborne: (ASTM D2621)
The spectrum of the paint will be analyzed and maintained as a base record. Any subsequent samples taken from a Department contract must be a reasonable match to the original formulation spectrum accepted by the Materials Bureau for the Approved List.

Placement Properties.
The material shall be placed using standard traffic paint application equipment and have a maximum field no track time of 3 minutes when installed at 77°F.

PACKAGING AND SHIPPING. Shipped to the job site in strong, substantial containers. Individual containers plainly marked with the following information:

- Manufacturer's Name
- Name of Product
- Material Specification Number
- Lot/Batch Number
- Test Number
- Manufacture Date
- Expiration Date
- Quantity

BASIS OF APPROVAL. Application for approval shall be submitted to the Materials Bureau by the manufacturer, accompanied by eight 1 pint samples of each color (white and yellow) of the product, independent lab test results in accordance with this specification or in conjunction with the National

Transportation Product Evaluation Program (NTPEP), and certification that the product conforms to this specification. Addition field tests will be carried out in accordance with Materials Bureau Directives. Upon approval by the Materials Bureau, the product will be placed on the Approved List.

BASIS OF ACCEPTANCE. Traffic Paint for permanent and Interim Pavement Markings will be accepted on the basis of the product appearing on the Approved List and a material certification that the product is the same as the one appearing on the Approved List and that it conforms to this specification. Traffic Paint used for Temporary Pavement Markings need not appear on the Approved List. Upon request, the Contractor shall provide a material certification that the product conforms to this specification.

APPENDIX 2: Test Locations

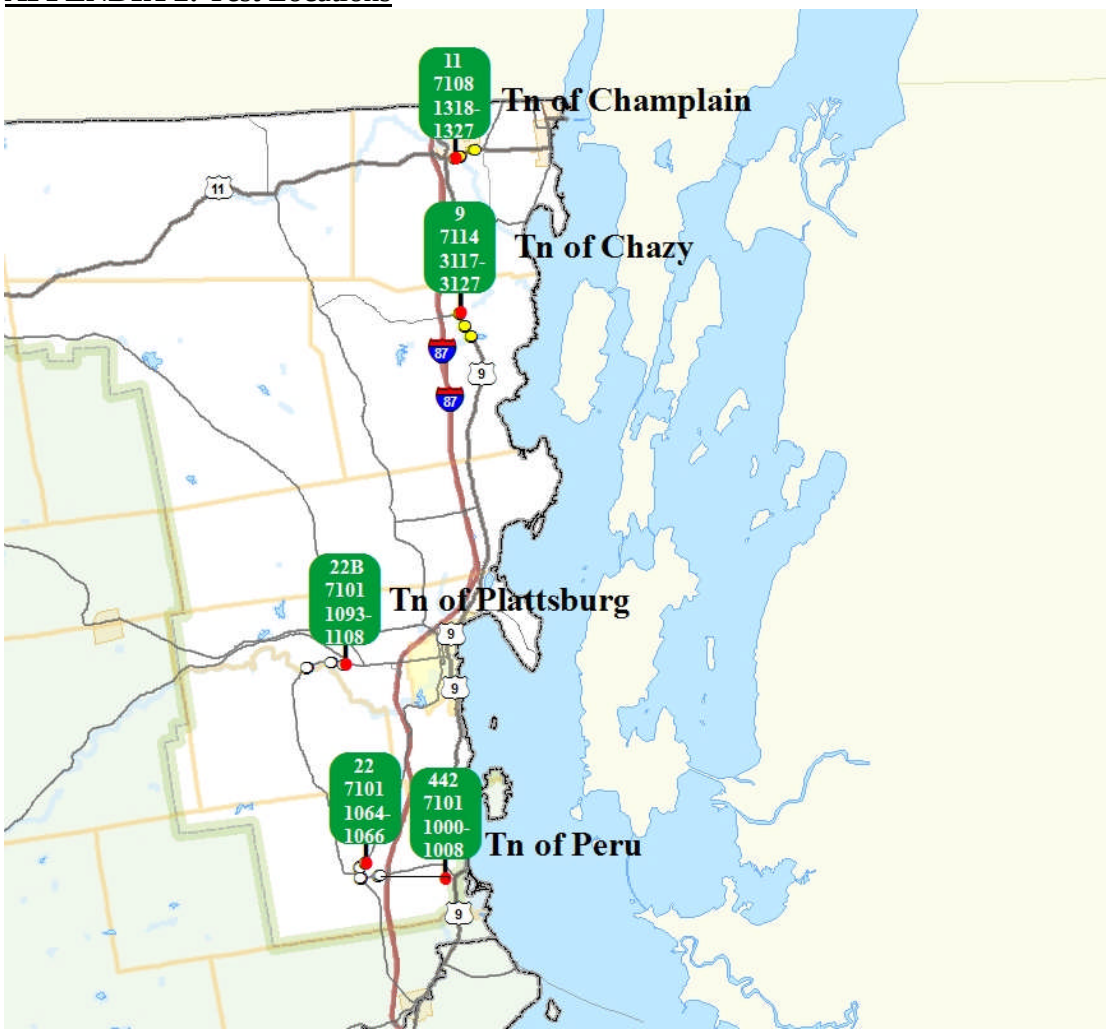

Figure 1: Location Overview

Figure 2: Town of Peru

Figure 3: Route 22B, Town of Plattsburg

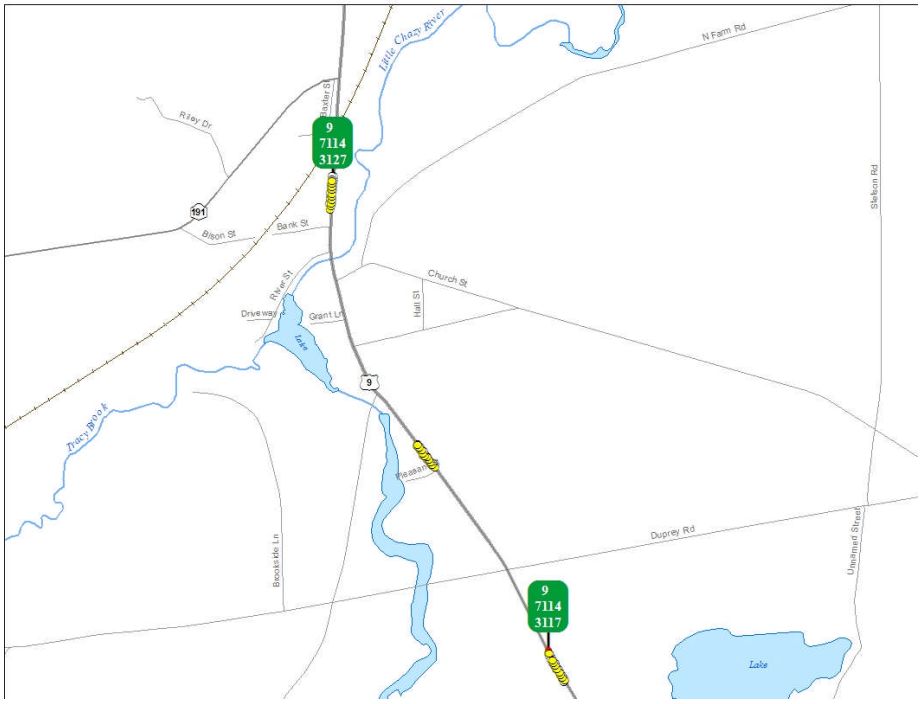

Figure 3: Route 9, Town of Chazy

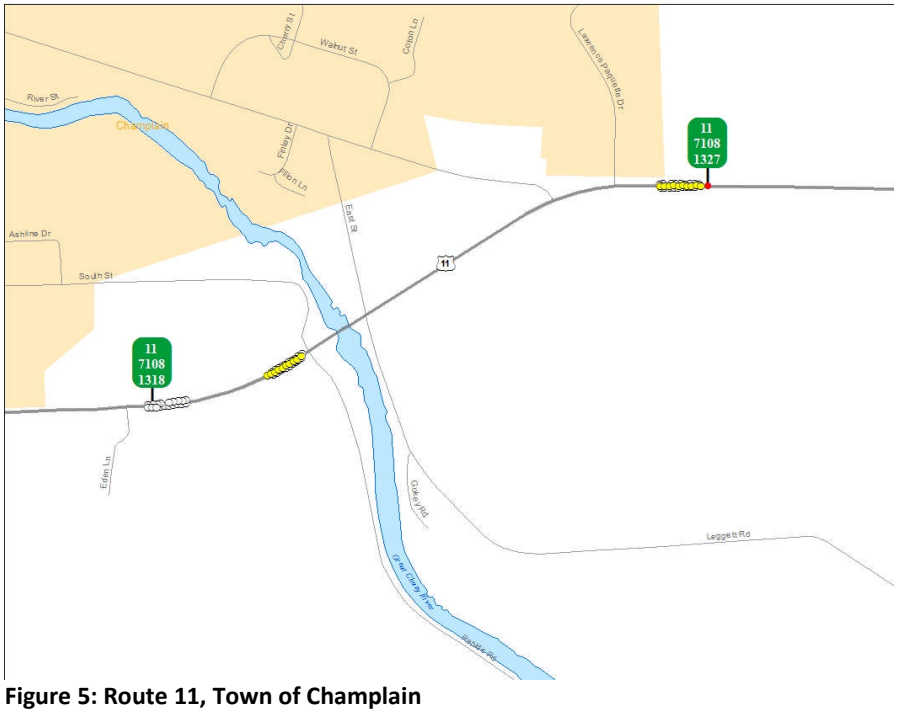

Figure 5: Route 11, Town of Champlain

APPENDIX 3: Raw Data

Placement Conditions: Town of Plattsburg and Peru, Routes 22, 22b and 442 September 19, 2007											
Route	**Ref. Marker**	**Station**	**Pav't Temp (°F)**	**Air Temp (°F)**	**Pav't Moisture Content (%)**	**Relative Humidity (%)**	**No Track Time (min)**	**Wet Film Thickness (mils)**	**Wet Film Thickness meas. (mils)**	**Paint Truck Speed (mph)**	**Comments**
442 / 1000 - 1012	1008	1st plate	94	70	1.5	43	2.5 - 3	15	16 - 17	14.2	WB White Line
442 / 1000 - 1012	1008	2nd plate	90	70	1.5	43	2.5 - 3	15	16 - 17	14.2	EB White Line
442 / 1000 - 1012	1008	3rd plate	89	70	3.1	27	2.5 - 3	15	18 - 20	14.2	Yellow Skip Line
22 / 1057 - 1068	1065	1st plate	100	70	1.1	42	3.5 - 4	20	21 - 24	12	SB White Line
22 / 1057 - 1068	1065	2nd plate	100	70	0.4	42	3.5 - 4	20	18 - 23	12	NB White Line
22 / 1057 - 1068	1065	3rd plate	92	70	3.1	42	3.5 - 4	20	23 - 26	12	Yellow Double Line
22 B / 1089 - 1100	1092	1st plate	91	75	5.2	27	4.5 - 5	25	23 - 24	10	SB White Line
22 B / 1089 - 1100	1092	2nd plate	93	75	4.3	46	6.5 - 7	25	26 - 31	8.9 - 9.1	NB White Line
22 B / 1089 - 1100	1092	3rd plate	89	75	4.5	24	6.5 - 7	25	29 - 30	9.4	Yellow Double Line

Retro-Reflectivity Data:

Region	Route Number	RCCO	MP
7	442	7101	1008

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	West	348	174	9
2	Solid Edgeline	White	West	354	193	14
3	Solid Edgeline	White	West	348	188	29
4	Solid Edgeline	White	West	339	229	28
5	Solid Edgeline	White	West	363	212	26
6	Solid Edgeline	White	West	383	201	36
7	Solid Edgeline	White	West	343	188	40
8	Solid Edgeline	White	West	351	172	37
9	Solid Edgeline	White	West		189	18
10	Solid Edgeline	White	West		193	13
1	Skip Line	Yellow	East	159	31	2
2	Skip Line	Yellow	East	124	39	10
3	Skip Line	Yellow	East	174	63	3
4	Skip Line	Yellow	East	151	80	14
5	Skip Line	Yellow	East	177	38	20
6	Skip Line	Yellow	East	191	7	23
7	Skip Line	Yellow	East	190	50	39
8	Skip Line	Yellow	East	158	48	34
9	Skip Line	Yellow	East	115	19	26
10	Skip Line	Yellow	East		32	

2007	2008	2009
White		
354	194	25
Yellow		
160	41	19

Region	Route Number	RCCO	MP
7	442	7101	1001

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	East	354	153	4
2	Solid Edgeline	White	East	361	142	8
3	Solid Edgeline	White	East	372	105	6
4	Solid Edgeline	White	East	357	88	11
5	Solid Edgeline	White	East	354	126	7
6	Solid Edgeline	White	East	346	123	9
7	Solid Edgeline	White	East	351	177	11
8	Solid Edgeline	White	East	310	139	11
9	Solid Edgeline	White	East	328	149	8
10	Solid Edgeline	White	East	333	89	17
1	Double Center	Yellow	West	153	45	15
2	Double Center	Yellow	West	125	31	8
3	Double Center	Yellow	West	154	35	8
4	Double Center	Yellow	West	163	64	10
5	Double Center	Yellow	West	148	48	11
6	Double Center	Yellow	West	156	29	19
7	Double Center	Yellow	West	145	36	19
8	Double Center	Yellow	West	151	29	20
9	Double Center	Yellow	West	156	48	24
10	Double Center	Yellow	West	152	39	14

2007	2008	2009
White		
347	129	9
Yellow		
150	40	15

Region	Route Number	RCCO	MP
7	22	7101	1065

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	North	383	68	18
2	Solid Edgeline	White	North	331	101	22
3	Solid Edgeline	White	North	383	164	125
4	Solid Edgeline	White	North	378	77	104
5	Solid Edgeline	White	North	306	27	90
6	Solid Edgeline	White	North	343	77	38
7	Solid Edgeline	White	North	349	96	63
8	Solid Edgeline	White	North	355	48	88
9	Solid Edgeline	White	North	348	89	78
10	Solid Edgeline	White	North	379	86	52
1	Double Center	Yellow	South	179	44	32
2	Double Center	Yellow	South	184	35	41
3	Double Center	Yellow	South	167	62	38
4	Double Center	Yellow	South	215	29	34
5	Double Center	Yellow	South	139	42	28
6	Double Center	Yellow	South	203	40	56
7	Double Center	Yellow	South	213	82	39
8	Double Center	Yellow	South	212	48	27
9	Double Center	Yellow	South	212	36	36
10	Double Center	Yellow	South	202	30	21

2007	2008	2009
White		
356	83	68
Yellow		
193	45	35

Region	Route Number	RCCO	MP
7	22	7101	1068

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	South	437	143	72
2	Solid Edgeline	White	South	435	62	117
3	Solid Edgeline	White	South	431	113	118
4	Solid Edgeline	White	South	450	160	88
5	Solid Edgeline	White	South	442	22	92
6	Solid Edgeline	White	South	384	111	66
7	Solid Edgeline	White	South	419	99	92
8	Solid Edgeline	White	South	403	146	83
9	Solid Edgeline	White	South	392	215	60
10	Solid Edgeline	White	South	391	246	41
1	Double Center	Yellow	North	267	24	33
2	Double Center	Yellow	North	276	54	41
3	Double Center	Yellow	North	276	42	38
4	Double Center	Yellow	North	143	41	50
5	Double Center	Yellow	North	283	24	41
6	Double Center	Yellow	North	288	32	37
7	Double Center	Yellow	North	283	44	35
8	Double Center	Yellow	North	300	58	34
9	Double Center	Yellow	North	303	47	34
10	Double Center	Yellow	North	297	24	21

2007	2008	2009
White		
418	132	83
Yellow		
272	39	36

Region	Route Number	RCCO	MP
7	22B	7101	1092

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	North	348	17	23
2	Solid Edgeline	White	North	374	53	32
3	Solid Edgeline	White	North	338	60	25
4	Solid Edgeline	White	North	360	41	38
5	Solid Edgeline	White	North	380	64	25
6	Solid Edgeline	White	North	375	96	31
7	Solid Edgeline	White	North	404	51	40
8	Solid Edgeline	White	North	379	40	45
9	Solid Edgeline	White	North	380	62	38
10	Solid Edgeline	White	North	382	50	52
1	Double Center	Yellow	South	208	27	27
2	Double Center	Yellow	South	199	36	34
3	Double Center	Yellow	South	138	54	24
4	Double Center	Yellow	South	197	22	28
5	Double Center	Yellow	South	208	60	35
6	Double Center	Yellow	South	211	40	22
7	Double Center	Yellow	South	208	37	35
8	Double Center	Yellow	South	210	30	29
9	Double Center	Yellow	South	219	39	30
10	Double Center	Yellow	South	204	43	

2007	2008	2009
White		
372	53	35
Yellow		
200	39	29

Region	Route Number	RCCO	MP
7	22B	7101	1102

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	North	402	164	129
2	Solid Edgeline	White	North	385	130	83
3	Solid Edgeline	White	North	358	144	76
4	Solid Edgeline	White	North	383	140	57
5	Solid Edgeline	White	North	398	110	59
6	Solid Edgeline	White	North	389	94	31
7	Solid Edgeline	White	North	370	85	20
8	Solid Edgeline	White	North	360	81	20
9	Solid Edgeline	White	North	315	83	15
10	Solid Edgeline	White	North	373	34	13
1	Double Center	Yellow	South(-)	213	18	26
2	Double Center	Yellow	South(-)	210	37	40
3	Double Center	Yellow	South(-)	209	23	32
4	Double Center	Yellow	South(-)	213	60	26
5	Double Center	Yellow	South(-)	177	23	40
6	Double Center	Yellow	South(-)	208	19	26
7	Double Center	Yellow	South(-)	210	32	36
8	Double Center	Yellow	South(-)	182	67	43
9	Double Center	Yellow	South(-)	214	22	66
10	Double Center	Yellow	South(-)	211	33	53

2007	2008	2009
White		
373	107	50
Yellow		
205	33	39

Region	Route Number	RCCO	MP
7	22B	7101	1107

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx		
				10/18/2007	6/13/2008	7/16/2009
1	Solid Edgeline	White	North	407	129	71
2	Solid Edgeline	White	North	375	133	73
3	Solid Edgeline	White	North	254	88	71
4	Solid Edgeline	White	North	341	133	74
5	Solid Edgeline	White	North	274	131	59
6	Solid Edgeline	White	North	358	103	40
7	Solid Edgeline	White	North	329	67	43
8	Solid Edgeline	White	North	361	69	44
9	Solid Edgeline	White	North	362	60	60
10	Solid Edgeline	White	North	361	56	61
1	Double Center	Yellow	South	212	125	61
2	Double Center	Yellow	South	211	70	52
3	Double Center	Yellow	South	198	75	89
4	Double Center	Yellow	South	218	113	58
5	Double Center	Yellow	South	216	35	70
6	Double Center	Yellow	South	216	42	73
7	Double Center	Yellow	South	213	76	45
8	Double Center	Yellow	South	212	110	60
9	Double Center	Yellow	South	220	110	56
10	Double Center	Yellow	South	201	150	37

2007	2008	2009
White		
342	97	60
Yellow		
212	91	60

Towns of Chazy and Champlain							
Region	Route Number	RCCO	MP				
7	11	7108	1326				
Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	NB	374	381	181	
2	Solid Edgeline	White	NB	335	337	173	
3	Solid Edgeline	White	NB	308	370	181	
4	Solid Edgeline	White	NB	350	347	166	
5	Solid Edgeline	White	NB	400	364	179	
6	Solid Edgeline	White	NB	352	318	224	
7	Solid Edgeline	White	NB	332	338	199	
8	Solid Edgeline	White	NB	357	332	244	
9	Solid Edgeline	White	NB	317	341	271	
10	Solid Edgeline	White	NB		353	278	
1	Solid Edgeline	White	SB	392	350	171	
2	Solid Edgeline	White	SB	400	353	142	
3	Solid Edgeline	White	SB	281	386	169	
4	Solid Edgeline	White	SB	355	366	165	
5	Solid Edgeline	White	SB	313	367	184	
6	Solid Edgeline	White	SB	281	349	176	
7	Solid Edgeline	White	SB	257	355	176	
8	Solid Edgeline	White	SB	429	372	135	
9	Solid Edgeline	White	SB	430	364	160	
10	Solid Edgeline	White	SB	406	355	127	
1	Double Center	Yellow	NB	126	241	134	

2	Double Center	Yellow	NB	175	230	49	
3	Double Center	Yellow	NB	179	227	77	
4	Double Center	Yellow	NB	123	226	114	
5	Double Center	Yellow	NB	168	220	115	
6	Double Center	Yellow	NB	251	235	134	
7	Double Center	Yellow	NB	367	246	161	
8	Solid Center	Yellow	NB	356	235	109	
9	Solid Center	Yellow	NB	514	240	188	
10	Solid Center	Yellow	NB	186	225	183	
				2009	2010	2011	
				White			
				351	355	185	
				Yellow			
				245	233	126	
Region	Route Number	RCCO	MP				
7	11	7108	1319				
Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	NB	325	361	217	
2	Solid Edgeline	White	NB	314	367	216	
3	Solid Edgeline	White	NB	305	368	176	
4	Solid Edgeline	White	NB	315	383	183	
5	Solid Edgeline	White	NB	329	363	161	
6	Solid Edgeline	White	NB	308	354	176	
7	Solid Edgeline	White	NB	283	364	160	
8	Solid Edgeline	White	NB	334	375	142	
9	Solid	White	NB	322	366	172	

	Edgeline						
10	Solid Edgeline	White	NB	339	341	183	
1	Solid Edgeline	White	SB	255	388	117	
2	Solid Edgeline	White	SB	310	384	118	
3	Solid Edgeline	White	SB	310	349	108	
4	Solid Edgeline	White	SB	316	286	95	
5	Solid Edgeline	White	SB	327	267	74	
6	Solid Edgeline	White	SB	394	322	59	
7	Solid Edgeline	White	SB	330	304	55	
8	Solid Edgeline	White	SB	372	291	39	
9	Solid Edgeline	White	SB	370	341	25	
10	Solid Edgeline	White	SB	416	350	28	
1	Double Center	Yellow	SB	226	171	35	
2	Double Center	Yellow	SB	262	149	42	
3	Double Center	Yellow	SB	221	116	75	
4	Double Center	Yellow	SB	206	119	70	
5	Double Center	Yellow	SB	255	155	55	
6	Double Center	Yellow	SB	228	128	62	
7	Double Center	Yellow	SB	237	148	37	
8	Double Center	Yellow	SB	20	125	66	
9	Double Center	Yellow	SB	251	160	57	
10	Double Center	Yellow	SB	237	175	74	
11	Double Center	Yellow	SB	181			
				2009	2010	2011	
				White			
				329	345	120	
				Yellow			

				210	142	60	
Region	Route Number	RCCO	MP				
7	11	7108	1315				
Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	SB	269	330	178	
2	Solid Edgeline	White	SB	311	355	459	
3	Solid Edgeline	White	SB	248	373	488	
4	Solid Edgeline	White	SB	300	352		
5	Solid Edgeline	White	SB	344	306		
6	Solid Edgeline	White	SB	347	328		
7	Solid Edgeline	White	SB	277	341		
8	Solid Edgeline	White	SB	249	332		
9	Solid Edgeline	White	SB	304	341		
10	Solid Edgeline	White	SB	382	332		
	Solid Edgeline	White	SB			73	Old 2010
	Solid Edgeline	White	SB			83	Old 2010
	Solid Edgeline	White	SB			111	Old 2010
	Solid Edgeline	White	SB			107	Old 2010
	Solid Edgeline	White	SB			103	Old 2010
	Solid Edgeline	White	SB		117		old 2009
	Solid Edgeline	White	SB		174		old 2009
	Solid Edgeline	White	SB		178		old 2009
	Solid Edgeline	White	SB		229		old 2009
1	Solid Edgeline	White	NB	360			
2	Solid Edgeline	White	NB	317			
3	Solid	White	NB	278			

	Edgeline						
4	Solid Edgeline	White	NB	408			
5	Solid Edgeline	White	NB	273			
6	Solid Edgeline	White	NB	341			
7	Solid Edgeline	White	NB	314			
8	Solid Edgeline	White	NB	406			
9	Solid Edgeline	White	NB	377			
10	Solid Edgeline	White	NB	430			
1	Solid NB Skip SB	Yellow	NB	55	373		
2	Solid NB Skip SB	Yellow	NB	636	361		
3	Solid NB Skip SB	Yellow	NB	611	348		
4	Solid NB Skip SB	Yellow	NB	472	374		
5	Solid NB Skip SB	Yellow	NB	389	380		
6	Solid NB Skip SB	Yellow	NB	266	364		
7	Solid NB Skip SB	Yellow	NB	166	391		
8	Solid NB Skip SB	Yellow	NB	254	399		
9	Solid NB Skip SB	Yellow	NB	164	382		
10	Solid NB Skip SB	Yellow	NB	259	372		
11	Solid NB Skip SB	Yellow	NB	295	336		
1	Gore	Yellow	SB		262		
2	Gore	Yellow	SB		249		
3	Gore	Yellow	SB		236		
4	Gore	Yellow	SB		236		
5	Gore	Yellow	SB		232		
6	Gore	Yellow	SB		229		
7	Gore	Yellow	SB		239		
8	Gore	Yellow	SB		232		
9	Gore	Yellow	SB		242		
10	Gore	Yellow	SB		255		
11	Gore	Yellow	SB		264		

				2009	2010	2011	
				White			
				327	292	200	
				Yellow			
				324	307	Not tested	

Region	Route Number	RCCO	MP
7	9	7114	3127

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	SB	699	252	412	
2	Solid Edgeline	White	SB	619	209	408	
3	Solid Edgeline	White	SB	540	225	415	
	Solid Edgeline	White	SB			123	Old Stripe 2010
4	Solid Edgeline	White	SB	429	227	413	
5	Solid Edgeline	White	SB	400	260	422	
6	Solid Edgeline	White	SB	601	255	411	
7	Solid Edgeline	White	SB	387	308	354	
8	Solid Edgeline	White	SB	429	152	410	
9	Solid Edgeline	White	SB	426	266	396	
10	Solid Edgeline	White	SB	527	247	430	
11	Solid Edgeline	White	SB			394	
1	Solid Edgeline	White	NB	390	294	433	New Stripe
2	Solid Edgeline	White	NB	540	293	428	New Stripe
3	Solid Edgeline	White	NB	570	251	404	New Stripe
4	Solid Edgeline	White	NB	490	263	418	New Stripe
	Solid Edgeline	White	NB			129	Old Stripe 2010

	Solid Edgeline	White	NB			110	Old Stripe 2010
	Solid Edgeline	White	NB			120	Old Stripe 2010
	Solid Edgeline	White	NB			132	Old Stripe 2010
5	Solid Edgeline	White	NB	531	278	412	New Stripe
6	Solid Edgeline	White	NB	590	311	418	New Stripe
7	Solid Edgeline	White	NB	515	356	412	New Stripe
8	Solid Edgeline	White	NB	368	360	402	New Stripe
9	Solid Edgeline	White	NB	424	345	416	New Stripe
10	Solid Edgeline	White	NB	605	353	431	New Stripe
1	Double Yellow	Yellow	SB	188 (NB)	240	245	
2	Double Yellow	Yellow	SB	160 (NB)	221	259	
3	Double Yellow	Yellow	SB	147 (NB)	185	242	
4	Double Yellow	Yellow	SB	198 (NB)	201	264	
5	Double Yellow	Yellow	SB	302 (NB)	198	257	
6	Double Yellow	Yellow	SB	314 (NB)	184	238	
7	Double Yellow	Yellow	SB	304 (NB)	223	253	
8	Double Yellow	Yellow	SB	224 (NB)	191	264	
9	Double Yellow	Yellow	SB	239 (NB)	193	253	
10	Double Yellow	Yellow	SB	139 (NB)	196	240	
				2009	2010	2011	
				White			
				504	275	356	
				Yellow			
				222	203	252	
Region	Route Number	RCCO	MP				
7	9	7114	3122				

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	SB	392	350	421	
2	Solid Edgeline	White	SB	400	353	416	
3	Solid Edgeline	White	SB	281	386	429	
4	Solid Edgeline	White	SB	355	366	392	
5	Solid Edgeline	White	SB	313	367	403	
6	Solid Edgeline	White	SB	281	349	423	
7	Solid Edgeline	White	SB	257	355	398	
8	Solid Edgeline	White	SB	429	372	434	
9	Solid Edgeline	White	SB	430	364	433	
10	Solid Edgeline	White	SB	406	355	451	
1	Solid Edgeline	White	NB	374	381	337	
2	Solid Edgeline	White	NB	335	337	309	
3	Solid Edgeline	White	NB	308	370	379	
4	Solid Edgeline	White	NB	350	347	402	
5	Solid Edgeline	White	NB	400	364	376	
6	Solid Edgeline	White	NB	352	318	395	
7	Solid Edgeline	White	NB	332	338	413	
8	Solid Edgeline	White	NB	357	332	424	
9	Solid Edgeline	White	NB	317	341	417	
10	Solid Edgeline	White	NB		353	398	
	Solid Edgeline	White	NB			437	New Stripe
1	Double Center	Yellow	SB	126	241	209	
2	Double Center	Yellow	SB	175	230	263	
3	Double Center	Yellow	SB	179	227	206	
4	Double Center	Yellow	SB	123	226	264	

5	Double Center	Yellow	SB	168	220	270	
6	Double Center	Yellow	SB	251	235	251	
7	Double Center	Yellow	SB	367	246	277	
8	Double Center	Yellow	SB	356	235	278	
9	Double Center	Yellow	SB	514	240	264	
10	Double Center	Yellow	SB	186	225	258	
				2009	2010	2011	
				White			
				351	355	404	
				Yellow			
				245	233	254	

Region	Route Number	RCCO	MP
7	9	7114	Cedar Way

Test #	Line Type	Line Color	Test Direction	Retroreflectivity # R=mcd/m^2/lx			Comments
				10/07/2009	8/12/2010	8/29/2011	
1	Solid Edgeline	White	NB	325	361	398	
2	Solid Edgeline	White	NB	314	367	328	
3	Solid Edgeline	White	NB	305	368	366	
4	Solid Edgeline	White	NB	315	383	398	
5	Solid Edgeline	White	NB	329	363	403	
6	Solid Edgeline	White	NB	308	354	406	
7	Solid Edgeline	White	NB	283	364	400	
8	Solid Edgeline	White	NB	334	375	371	
9	Solid Edgeline	White	NB	322	366	365	
10	Solid Edgeline	White	NB	339	341	383	
1	Solid Edgeline	White	SB	255	388	400	

2	Solid Edgeline	White	SB	310	384	438	
3	Solid Edgeline	White	SB	310	349	428	
	Solid Edgeline	White	SB			197	Old
4	Solid Edgeline	White	SB	316	286	427	
5	Solid Edgeline	White	SB	327	267	410	
6	Solid Edgeline	White	SB	394	322	442	
7	Solid Edgeline	White	SB	330	304	441	
8	Solid Edgeline	White	SB	372	291	427	
9	Solid Edgeline	White	SB	370	341	424	
10	Solid Edgeline	White	SB	416	350	416	
1	Double Center	Yellow	NB	226	171	161	
2	Double Center	Yellow	NB	262	149	166	
3	Double Center	Yellow	NB	221	116	193	
4	Double Center	Yellow	NB	206	119	188	
5	Double Center	Yellow	NB	255	155	173	
6	Double Center	Yellow	NB	228	128	168	
7	Double Center	Yellow	NB	237	148	182	
8	Double Center	Yellow	NB	20	125	179	
9	Double Center	Yellow	NB	251	160	177	
10	Double Center	Yellow	NB	237	175	184	
11	Double Center	Yellow	NB	181			
				2009	2010	2011	
				White			
				329	346	394	
				Yellow			
				211	145	177	