



**DEVELOPMENTAL SPECIFICATIONS
FOR
MULTI-COMPONENT LIQUID PAVEMENT MARKINGS**

**Effective Date
February 20, 2024**

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

23043a.01 DESCRIPTION.

Provide reflectorized white and yellow multi-component, 100% solids multi-component liquid pavement markings that are free of toxic heavy metals for installation on asphalt and PCC pavement surfaces.

23043a.02 MATERIALS.

A. General.

1. Apply multi-component liquid pavement markings in accordance with [Article 2527.01](#) of the Standard Specifications.
2. Use materials capable of producing pavement markings with a wet-film thickness (WFT) of at least 20 mils. Apply at a greater WFT as recommended by the material manufacturer based on pavement type, pavement composition, environmental conditions, placement within a rumble, and other relevant factors. Approved products are listed in [Materials I.M. 483.04, Appendix B](#). The Contractor may propose an equivalent product meeting all requirements of this specification, but the Engineer reserves the right to approve or deny the proposal. Multi-component Polyurea products will not be considered for usage.
3. Provide materials in accordance with the retroreflectivity requirements below.

Table 23043a.02-1: Minimum Initial Retroreflectivity Requirements

Minimum Coefficient of Retroreflected Luminance	
White lines, Symbols, and Legends	400 mcd/sq. m/lux
Yellow lines	250 mcd/sq. m/lux

4. Provide yellow markings distinguishable from white markings in the dark.
5. Mix individual components before use if stored for more than 12 months.

B. Multi-Component Liquid Material.

1. Provide multi-component liquid material meeting the following requirements and characteristics:

- a. Composed only of multi-component liquids and pigments,
- b. Does not emit or leach solvents into the environment upon application to a pavement surface,
- c. The infrared spectrum for all components shall match the reference sample provided by the manufacturer for the product tested and approved by the Department,
- d. Free of lead, cadmium, mercury, hexavalent chromium, and other toxic heavy metals as defined by the EPA,
- e. White material no darker than or no yellower than 17778 of Federal Standard Number 595C Colors,
- f. Daytime color of the yellow epoxy meeting the following CIE chromaticity limits using illuminant "D65/2":

Table 23043a.02-2: Daytime Chromaticity Coordinates

Daytime Chromaticity Coordinates (Corner Points) - Yellow				
	1	2	3	4
x	0.470	0.485	0.520	0.480
y	0.440	0.460	0.450	0.420

- g. White daylight directional reflectance (Y) of least 83%,
- h. Yellow daylight directional reflectance (Y) of at least 50%,
- i. Nighttime color of yellow meeting the following chromaticity limits in ASTM D 6628:

Table 23043a.02-3: Nighttime Chromaticity Coordinates

Nighttime Chromaticity Coordinates (Corner Points) - Yellow				
	1	2	3	4
x	0.575	0.508	0.473	0.510
y	0.425	0.415	0.453	0.490

- j. Contrast ratio of 0.98 or greater when measured on a black/white drawdown card at 15 mils WFT application rate.
2. Provide shadow lane line markings (legend BLB6 or BLC6) according to attached modified Standard Road Plans. Black epoxy should satisfy color chip 37038 of Federal Standard 595B and have similar quality as the white and yellow multi-component pavement markings. An anti-skid material shall be incorporated with the shadow line marking at a minimum rate of 15 pounds per gallon.
 3. **Adhesion Capabilities.**
Provide material meeting the adhesion requirements of the ACI Committee 403 when tested on PCC. Apply multi-component liquid pavement markings during the test to concrete pavements with a tensile strength of at least 300 psi and ensure the failure of the system occurs in the concrete during testing.
 4. **Abrasion Resistance.**
Provide material with an abrasion resistance wear index no greater than 82 when tested in accordance with ASTM C 501 with a CS 17 wheel under a load of 1000 g for 1000 cycles. The Department defines the wear index as the weight in milligrams of material abraded from the sample under the test conditions.
 5. **Hardness.**
Provide material with a Type D durometer hardness from 75 to 90 when tested in accordance with ASTM D 2240 after curing for 72 hours at 73°F ±4°F.

6. Tensile Strength.

For epoxy-amine based multicomponent systems, including variations of this base chemistry, provide material with a tensile strength of at least 6000 psi when tested in accordance with ASTM D 638 after curing for 72 hours at 73°F ±4°F. For polyurea based multicomponent systems provide material with a tensile strength of at least 3000 psi when tested in accordance with ASTM D 638 after curing for 72 hours at 73°F ±4°F.

7. Compressive Strength.

For epoxy-amine based multicomponent systems, including variations of this base chemistry, provide material with a compressive strength of at least 12,000 psi when tested in accordance with ASTM D 695 after curing for 72 hours at 73°F ±4°F.

C. Retroreflective Media.

1. Provide first drop wet media per the minimum rate shown for each product below. Use one of the following products for all grooved: edge lines, white broken lines, ramp edge lines, and lane drop lines:
 - 3M Connected Roads All Weather Elements Series 70E or 50E: Minimum rate 5 pounds per gallon
 - Potters VisiUltra 455: Minimum rate 8 pounds per gallon
 - ~~SWARCO DURALUX 334/ 334 Plus: Minimum rate 8 pounds per gallon~~
2. Provide second drop glass spheres with the following gradation on all lines except for black broken lane lines:

Table 23043a.02-4: Utah Blend Gradation

Sieve Size	% Passing
No. 18	65-80
No. 30	30-50
No. 50	0-5

- a. Glass spheres shall be dual coated.
 - b. Apply glass spheres at a minimum rate of 15 pounds per gallon. Application rate shall provide required minimum levels of retroreflectivity in accordance with Table 23043a.02-1.
3. Provide beads packaged in moisture-proof, multi-wall shipping bags, and in containers marked with the following information:
 - a. Manufacturer name,
 - b. Manufacturer address,
 - c. Type of treatment,
 - d. Batch number, and
 - e. Date of manufacture.

D. Sampling and Testing.

1. Test daylight directional reflectance and color meeting the requirements of ASTM E 1349.
2. Provide 1 pint samples of each manufacturer's lot or batch of material when manufactured to an independent lab for this testing. NTPEP data may be substituted if the product has not changed from initial submittal to NTPEP for evaluation of these products.
3. Submit to the Engineer a manufacturer's Certificate of Compliance for all components of the multi-component liquid pavement marking system.

4. Mark containers with the following information:
 - a. Name of manufacturer,
 - b. Product identification number,
 - c. Lot or batch number,
 - d. Date of manufacture,
 - e. Color, and
 - f. Net weight of contents.

23043a.03 CONSTRUCTION.

A. General.

1. The contract documents will specify quantity, locations, and type of pavement markings required.
2. Allowable painting dates will be from April 8th to October 22nd. Minimum pavement surface temperatures for application of pavement markings shall be 40°F and rising.
3. For all pavement markings, ensure pavement surface is dry and free from dirt, dust, oil, curing compound, and other contaminants which may interfere with markings properly bonding to the surface. Ensure the clean surface is at least 1 inch wider than anticipated marking. Shoot an air blast on the pavement surface immediately prior to placing new marking. Air blast is not intended to remove large amounts of dust, but only a very small amount of residue that might be left from removal and cleaning operation.
4. For pavement markings placed on a new asphalt surface, install any necessary temporary pavement markings, and wait a minimum of 2 weeks from the day the surface is completed before installing permanent markings.
5. Ensure the following for all painted pavement markings:
 - Uniform thickness
 - Uniform distribution of glass beads throughout the line width,
 - Line widths as specified, with a tolerance of $\pm 1/2$ inch for all lines,
 - Markings have sharp edges and cutoffs at the ends.

B. Grooving.

1. Perform grooving after surface corrections for pavement smoothness, shouldering, and fog sealing have been completed.
2. Grooved in lines shall be at a depth of 80 mils on PCC pavements and 100 mils on HMA pavements with a tolerance of ± 10 mils and the width of the line plus 1 inch with a tolerance of $\pm 1/8$ inch.
3. Equipment shall be capable of recessing the total width of the recess in one pass. Ensure the bottom of the groove has a fine corduroy-like texture. The maximum allowable rise between the high and low points across the width of the groove is 10 mils.
4. Do not place temporary pavement markings within grooves.

C. Traffic Control.

Apply the provisions of [Section 2528](#) of the Standard Specifications to traffic control for removing and placing painted and taped pavement markings, along with the following additional requirements:

1. Place traffic control devices on the roadway before removal operations have commenced. Leave traffic control devices in place through the completed curing time of the newly applied pavement markings.
2. Do not close any longer length of lane than can be adequately removed and replace in a single working day.
3. For painted pavement markings, do not remove traffic control devices until the newly applied pavement markings are tack free.

D. Final Inspection

Provide an acceptable, calibrated 30 meter geometry (100 feet), retroreflectometer to use on the project which will remain the property of the Contractor. In the presence of the Engineer, measure the retro-reflectivity of the pavement markings. Take a minimum of five randomly spaced readings per line type every 1 mile. The average minimum retro-reflectivity per mile shall be as per table 1 from Article 23043a.02, A, 3.

E. Defective Pavement Markings.

1. Markings that are low on initial retroreflectivity up to 20% may, at the discretion of the Engineer, be accepted with a price adjustment.
2. Repair, at no additional cost to the Contracting Authority, all pavement markings which, after application and curing, the Engineer determines to be defective and not in conformance with these specifications. Remove the defective markings completely and clean to the underlying pavement surface according to the requirements of [Article 2527.03, C](#) of the Standard Specifications. Remove the defective area plus all adjacent marking material extending 1 foot in any direction. After surface preparation work is complete, finish the repair by reapplying new marking material over the cleaned pavement surface according to the requirements of these specifications.

23043a.04 METHOD OF MEASUREMENT.

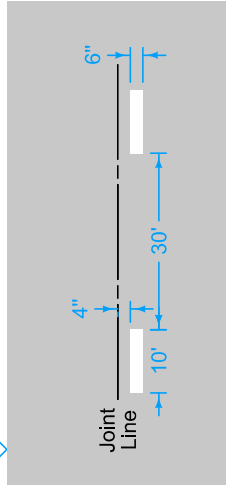
- A.** Measurement for pavement markings and grooves cut, satisfactorily placed, or approved, will be as follows:
1. **Painted Pavement Markings, Multi-Component Liquid.**
Stations placed.
 2. **Grooves Cut for Pavement Markings.**
Stations. This quantity will be equivalent to the number of stations measured for the pavement markings. Additional width and transition length will be incidental.
- B.** The Engineer will measure the number of stations, based on a single 6 inch width of line. The length of markings will be determined using beginning and ending points, and adjusting for breaks at ramps, station equations, or other locations shown in the contract documents. The measurement for dashed and dotted lines will be adjusted to exclude skips. Measurement of lines wider than 6 inches will be adjusted by the quantity factor to a 6 inch line.

23043a.05 BASIS OF PAYMENT.

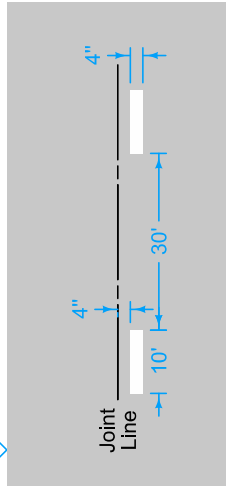
Painted Pavement Markings, Multi-Component Liquid and Grooves Cut for Pavement Markings will be paid for per [Article 2527.05](#) of the Standard Specifications.

**DESIGNER
INFO**

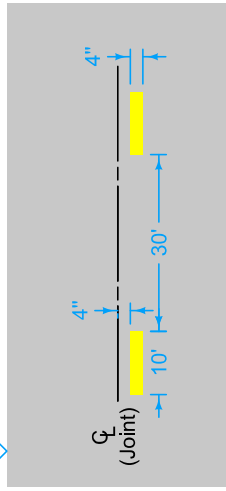
BLW6 BROKEN LANE LINE (White)



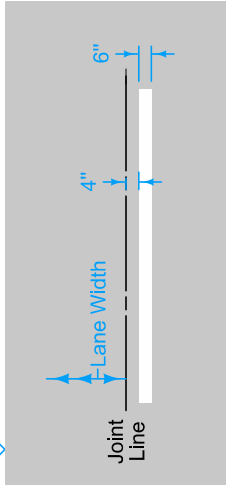
BLW4 BROKEN LANE LINE (White)



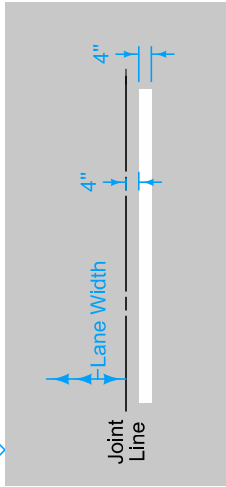
BCY4 BROKEN CENTERLINE (Yellow)



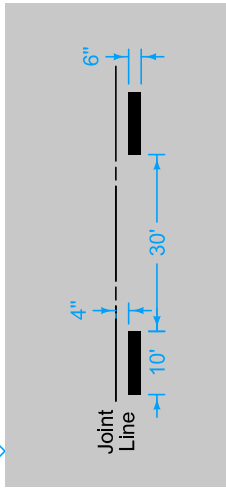
SLW6 SOLID LANE LINE (White)



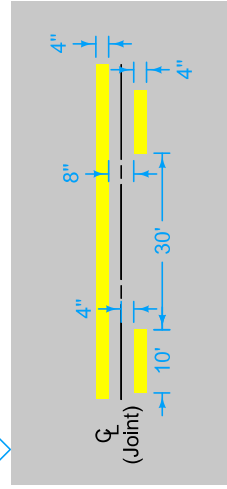
SLW4 SOLID LANE LINE (White)



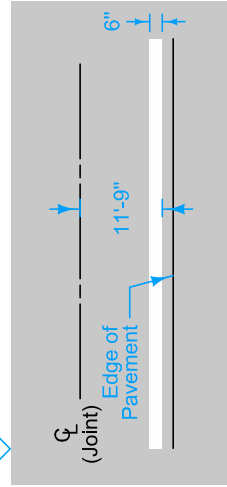
BLB6 BROKEN LANE LINE (Black)



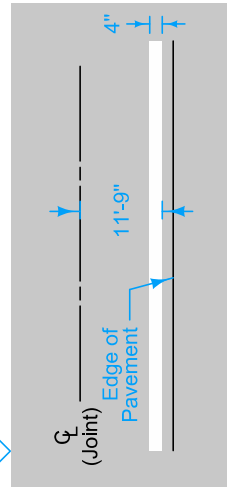
NPY4 NO PASSING ZONE LINE (Yellow)



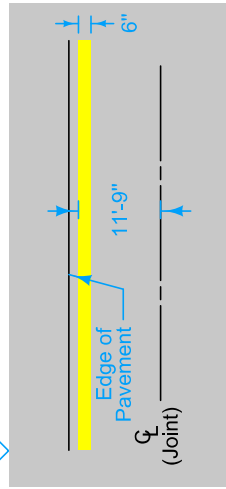
ELW6 EDGE LINE RIGHT (White)



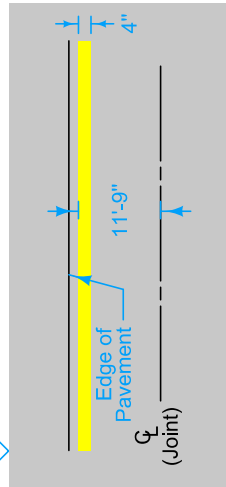
ELW4 EDGE LINE RIGHT (White)



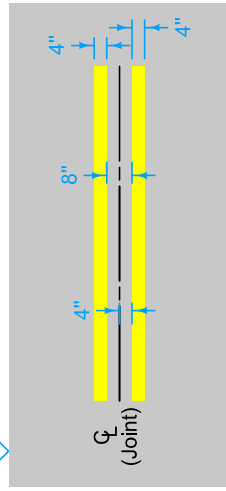
ELY6 EDGE LINE LEFT (Yellow)



ELY4 EDGE LINE LEFT (Yellow)



DCY4 DOUBLE CENTERLINE (Yellow)



Lane layouts shown are typical.
Centerlines and lane lines may be painted either side of centerline.
Drawings on sheets 1 to 3 are oriented to represent direction of traffic moving from left to right.

Possible Contract Item:
Pavement Marking Line Items
Possible Tabulation:
108-22

MODIFIED	REVISION
	2 10-16-18
STANDARD ROAD PLAN	PM-110
SHEET 1 of 4	
MODIFICATIONS: Added BLW6, BLB6, SLW6, ELW6, RLY6, RLW6, DLW6, CHW12, and LDW12.	
LINE TYPES	

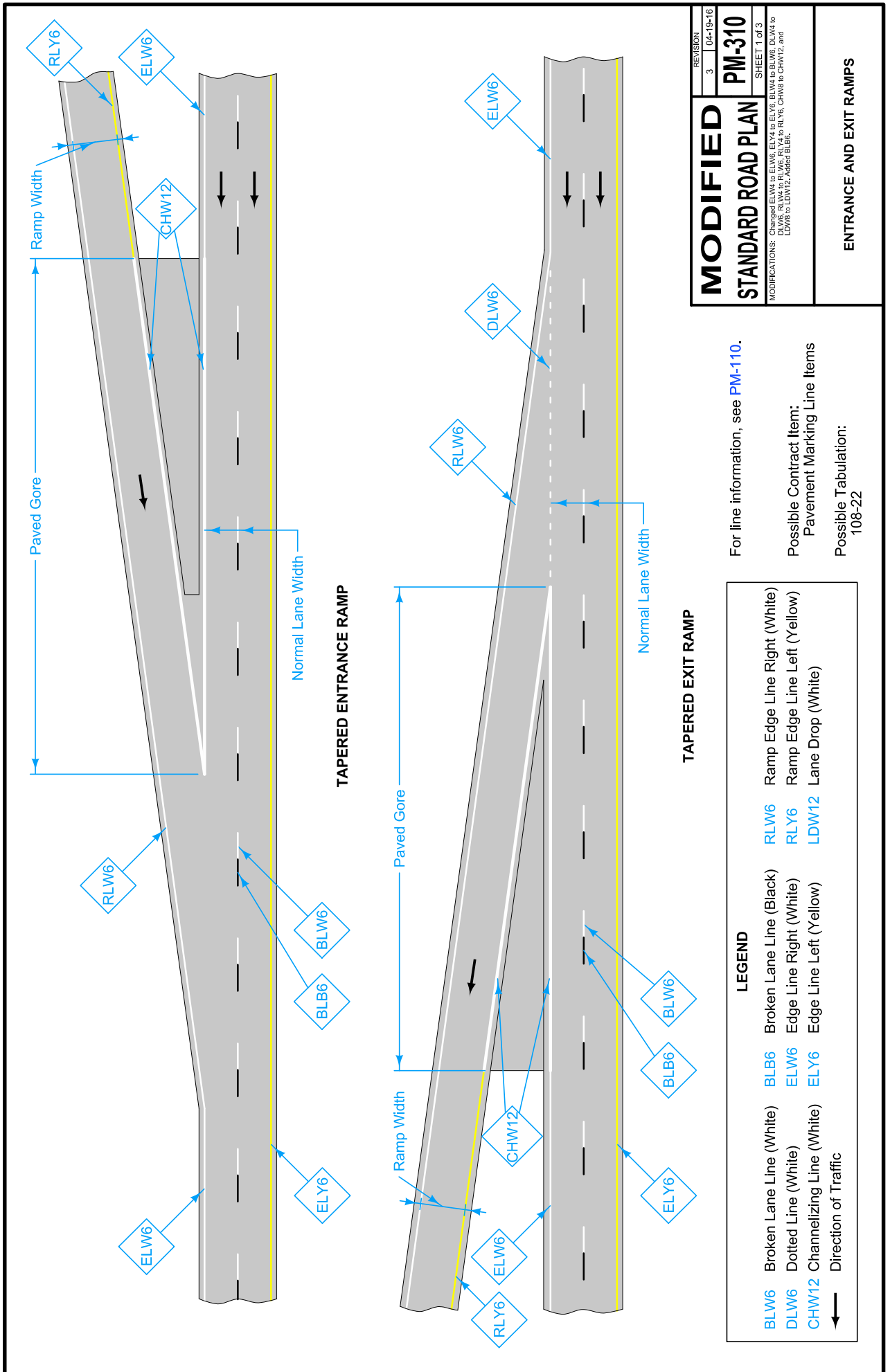
<p>RLW4 RAMP EDGE LINE RIGHT (White)</p>	<p>RLW6 RAMP EDGE LINE RIGHT (White)</p>	<p>RLY4 RAMP EDGE LINE LEFT (Yellow)</p>
<p>RLY6 RAMP EDGE LINE LEFT (Yellow)</p>	<p>DLY4 DOTTED LINE (Yellow)</p>	<p>DDY4 DOUBLE DOTTED LINE (Yellow)</p>
<p>DLW4 DOTTED LINE (White)</p>	<p>DLW6 DOTTED LINE (White)</p>	<p>CHY8 CHANNELIZING LINE (Yellow)</p>
<p>CHW8 CHANNELIZING LINE (White)</p>	<p>CHW12 CHANNELIZING LINE (White)</p>	<p>MODIFIED STANDARD ROAD PLAN</p> <p>REVISION 2 10-18-18</p> <p>PM-110</p> <p>SHEET 2 of 4</p> <p>MODIFICATIONS: Added DLW6, DLW8, SLW6, SLW8, ELW6, ELW8, RLY6, RLY8, DLW6, CHW12, and LDW12.</p> <p>LINE TYPES</p>

<p>LDW8 > LANE DROP (White)</p>	<p>LDW12 > LANE DROP (White)</p>					
<p>SLW2 > STOP LINE (White)</p>	<p>YLW2 > YIELD LINE (White)</p>					
<p>CBW6 > CROSSWALK BAR (White)</p>	<p>CLW6 > CROSSWALK LINE (White)</p>					
<table border="1"> <tr> <td data-bbox="1239 58 1299 1010"> MODIFIED STANDARD ROAD PLAN MODIFICATIONS: Added BLW6, BLW8, SLW6, SLW8, ELW6, ELW8, RLW6, RLW8, DLW6, DLW8, CHW12 and LDW12. </td> <td data-bbox="1299 58 1380 1010"> REVISION 2 10-16-18 </td> </tr> <tr> <td colspan="2" data-bbox="1380 58 1562 1010"> PM-110 SHEET 3 of 4 </td> </tr> </table>			MODIFIED STANDARD ROAD PLAN MODIFICATIONS: Added BLW6, BLW8, SLW6, SLW8, ELW6, ELW8, RLW6, RLW8, DLW6, DLW8, CHW12 and LDW12.	REVISION 2 10-16-18	PM-110 SHEET 3 of 4	
MODIFIED STANDARD ROAD PLAN MODIFICATIONS: Added BLW6, BLW8, SLW6, SLW8, ELW6, ELW8, RLW6, RLW8, DLW6, DLW8, CHW12 and LDW12.	REVISION 2 10-16-18					
PM-110 SHEET 3 of 4						
<p style="text-align: center;">LINE TYPES</p>						

<p>SPW4 SLOPED CURB 4" (White)</p> <p>Gutter Line</p>	<p>SPW6 SLOPED CURB 6" (White)</p> <p>Gutter Line</p>	<p>STW6 STANDARD CURB 6" (White)</p> <p>Gutter Line</p>
<p>SPY4 SLOPED CURB 4" (Yellow)</p> <p>Gutter Line</p>	<p>SPY6 SLOPED CURB 6" (Yellow)</p> <p>Gutter Line</p>	<p>STY6 STANDARD CURB 6" (Yellow)</p> <p>Gutter Line</p>
<p>MNY4 MEDIAN NOSE (Yellow)</p>		

① Apply paint from back of curb to gutter line.

REVISION	2	10-18-18
MODIFIED		
STANDARD ROAD PLAN		
PM-110		
SHEET 4 of 4		
MODIFICATIONS: Added BLW6, BLB6, SLW6, ELW6, RLW6, RLW6, DLW6, CHW12, and LDW12.		
LINE TYPES		



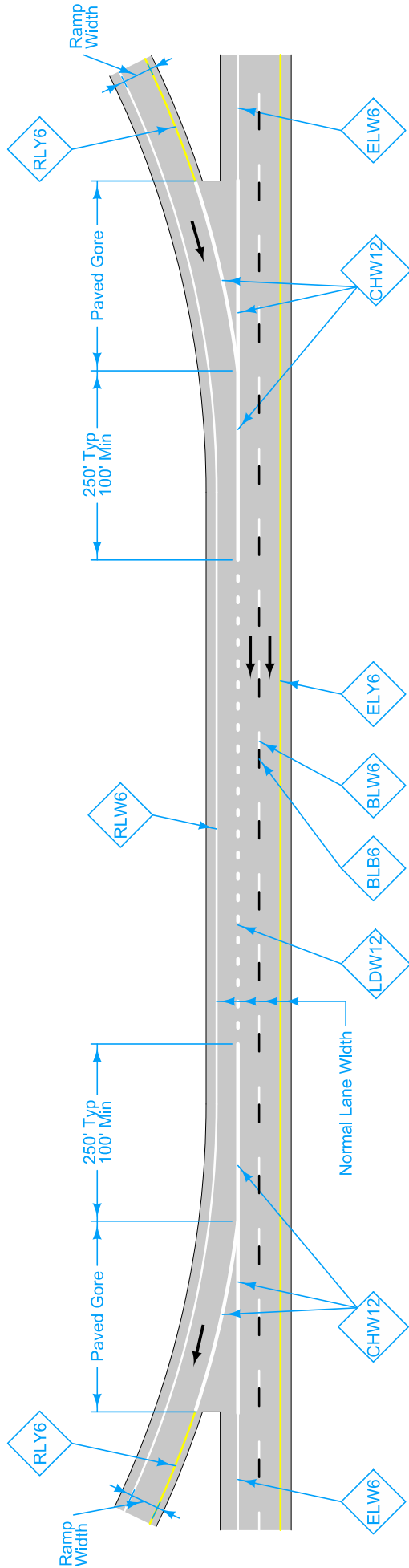
REVISION	3	04-19-16
MODIFIED	PM-310	
SHEET 1 of 3		
MODIFICATIONS: Changed ELW4 to ELW6, ELY4 to ELY6, BLW4 to BLW6, DLW4 to DLW6, RLY4 to RLY6, CHW4 to CHW12, and DLW8 to LDW12, Added BLB6.		
ENTRANCE AND EXIT RAMP		

For line information, see **PM-110**.

Possible Contract Item:
Pavement Marking Line Items

Possible Tabulation:
108-22

LEGEND			
BLW6	Broken Lane Line (White)	BLB6	Broken Lane Line (Black)
DLW6	Dotted Line (White)	ELW6	Edge Line Right (White)
CHW12	Channelizing Line (White)	ELY6	Edge Line Left (Yellow)
	Direction of Traffic	RLW6	Ramp Edge Line Right (White)
		RLY6	Ramp Edge Line Left (Yellow)
		LDW12	Lane Drop (White)



AUXILIARY LANE BETWEEN RAMP

LEGEND

BLW6	Broken Lane Line (White)	BLB6	Broken Lane Line (Black)	RLW6	Ramp Edge Line Right (White)
DLW6	Dotted Line (White)	ELW6	Edge Line Right (White)	RLY6	Ramp Edge Line Left (Yellow)
CHW12	Channelizing Line (White)	ELY6	Edge Line Left (Yellow)	LDW12	Lane Drop (White)
→	Direction of Traffic				

MODIFIED	REVISION	3	04-19-16
	STANDARD ROAD PLAN		
	SHEET 3 of 3		
<small>MODIFICATIONS: Changed ELW4 to ELW6, ELY4 to ELY6, BLW4 to BLW6, DLW4 to DLW6, RLW4 to RLW6, RLY4 to RLY6, CHW8 to CHW12, and LDW8 to LDW12, Added BLB6.</small>			
ENTRANCE AND EXIT RAMP			