

INTERCHANGE SIGNING PLAN (ISP)

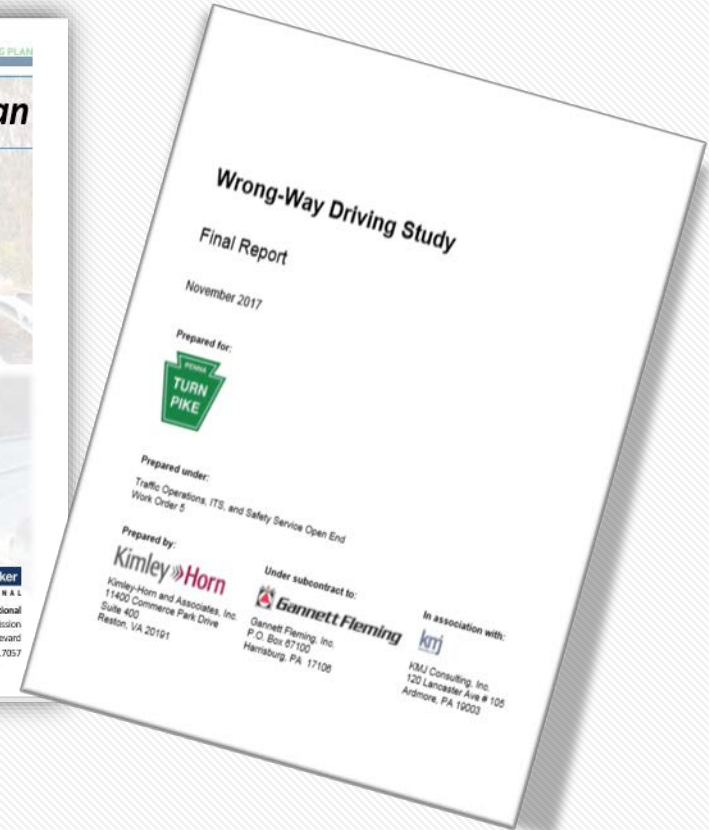
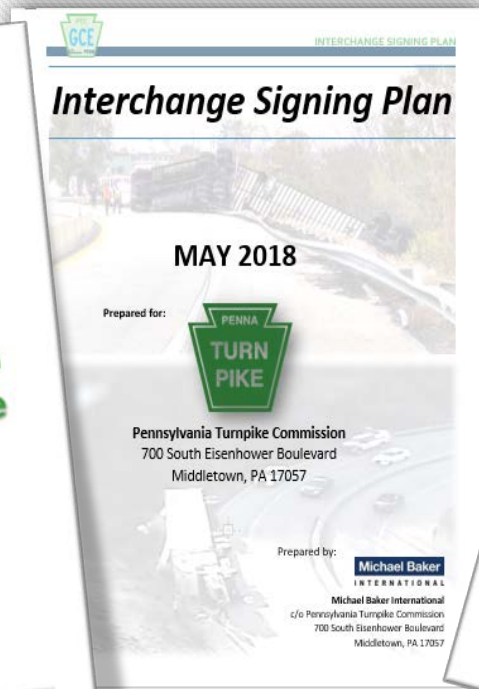
Plans for Addressing Ramp Safety



December 6, 2018

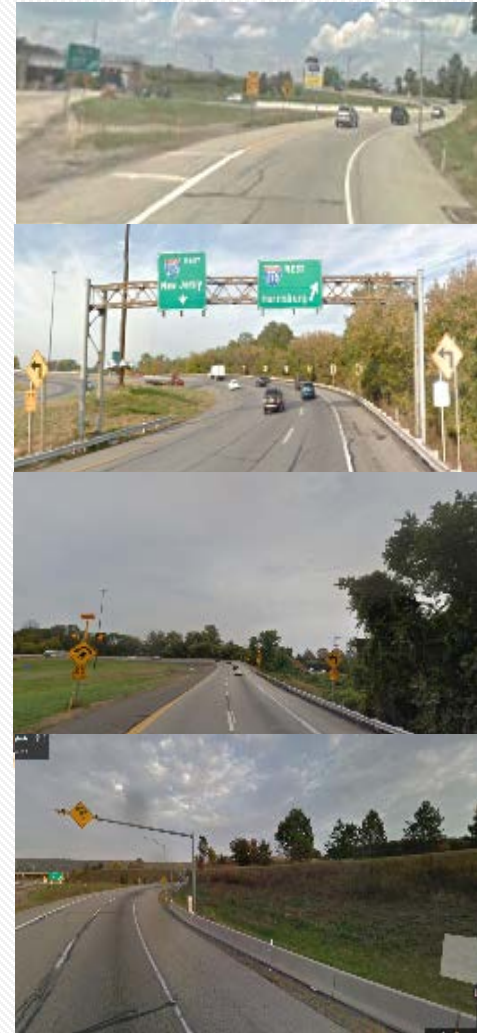
Interchange Signing Plan

ISP developed by:



OBJECTIVES

- ❖ *Reduce curve departure and truck rollover crashes*
- ❖ *Implement consistency in the application and placement of:*
 - *Signage*
 - *Delineation*
 - *Pavement Markings, and*
 - *Intelligent Transportation Systems (ITS)*
- ❖ *Reduce occurrences of wrong-way system entry incidents*



METHODOLOGY

To develop consistent Standards utilizing signs, delineation, pavement markings, and ITS devices...

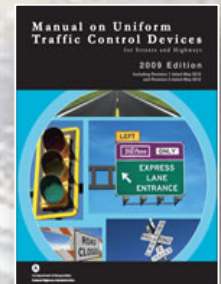
1. Perform research to ensure effectiveness

- *State-of-the-industry in ramp safety*
- *Review of PA Turnpike's System*
- *Outreach to users*



2. Apply safety experience & knowledge

- *Determine minimum requirements*
- *Develop "Levels" of escalation*
- *Develop an effective & efficient method to apply escalation*
- *Develop a clear format that can be applied to the PA Turnpike System*



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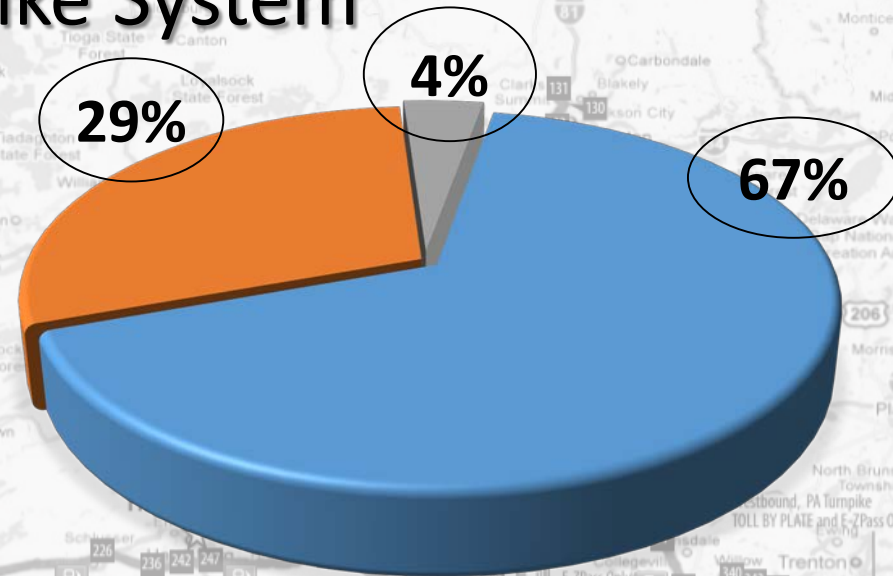
ANALYSIS OF SYSTEM

TURNPIKE INTERCHANGE TYPES

78 Interchanges on Turnpike System

- ❖ 67% are Trumpets
- ❖ 29% are Diamonds
- ❖ 4% are Cloverleaves

- 17 Service Plazas
- 11 Mainline Tolling



- Trumpet
- Diamond
- Cloverleaf

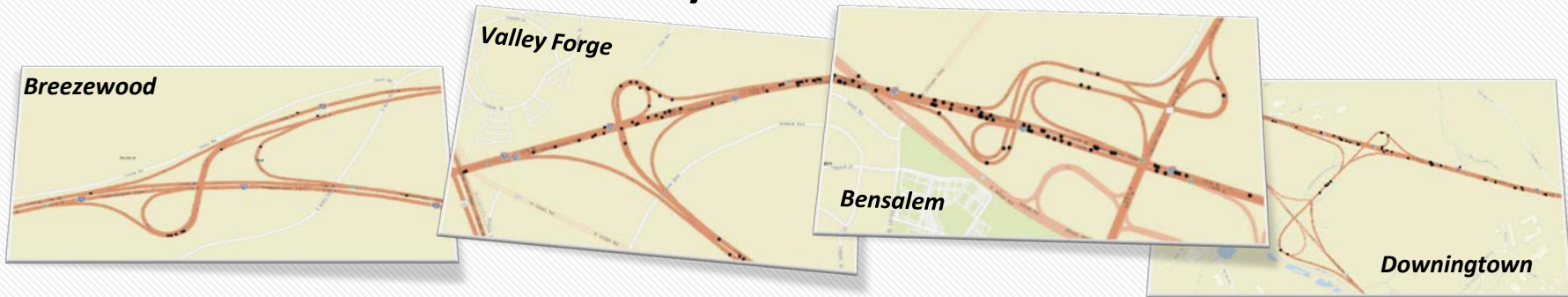
ANALYSIS OF SYSTEM

- ✓ “Levels” were developed for:
 - *Similar groups of ramps for interchange & service plaza*
 - *Appropriate groups of guidance information for each of the Levels of ramps*
- ✓ Used 15 Interchanges/Service Plazas for review
 - *What makes them different?*
 - *What makes ENTRANCE & EXIT ramps different?*



ANALYSIS OF SYSTEM

✓ Reviewed crash history



✓ Completed Advisory Speeds Assessments

- Data collected using Rieker Inc.'s CARS™ ([Curve Advisory Reporting Service](#))



- Correlated Advisory Speeds vs. Curve Radius

✓ Find factors that define the various Levels for the guidance information

RESULTS

BRINGING A HIGHER LEVEL OF POSITIVE GUIDANCE AND HUMAN FACTORS CONSIDERATIONS TO MOTORISTS OF THE PA TURNPIKE

- ➔ Provide comprehensive guidance information...
- ➔ Emphasizing Geometry & Advisory Speed...
- ➔ In a Consistent & Escalating fashion



RAMP “LEVEL” DEVELOPMENT

- “Level” is designated for each ramp within an interchange
- Levels are unique for Entrance Ramps and Exit Ramps
- Each Level has different placement requirements
- Each Level enhances devices from previous Level

TRAFFIC CONTROL DEVICES SUMMARY										
TRAFFIC DEVICE	Size	Side	LEVEL 1		LEVEL 2		LEVEL 3		LEVEL 4	
			ENTRANCE	EXIT	ENTRANCE	EXIT	ENTRANCE	EXIT	ENTRANCE	EXIT
MERGE RIGHT SIGN (W4-1R) OR ADDED LANE RIGHT SIGN (W4-3R) ON MAINLINE	48" x 48"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
ADVISORY RAMP SPEED SIGN (W13-3)	48" x 60"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
COMBINATION HORIZONTAL ALIGNMENT /ADVISORY RAMP SPEED SIGN (W13-2R)	48" x 84"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
ADVISORY EXIT SPEED SIGN (W13-3)	48" x 60"	RIGHT	N/A	X	N/A	X	N/A	X	N/A	X
COMBINATION HORIZONTAL ALIGNMENT /ADVISORY EXIT SPEED SIGN (W13-6R)	48" x 84"	RIGHT	N/A	X	N/A	X	N/A	X	N/A	X
EXIT GORE SIGN WITH YELLOW OBJECT MARKERS (OM1-3) ON POSTS	Variable, 18" x 18"	GORE	N/A	X	N/A	X	N/A	X	N/A	X
SERVICE PLAZA SIGN WITH YELLOW OBJECT MARKERS (OM1-3) ON POSTS	84" x 72"; 18" x 18"	GORE		X		X		X		X
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	RIGHT	X	X	X	X	X	X	X	X
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	60" x 60"	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	RIGHT			X	X	X	X	X	X
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	60" x 60"	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
2/4/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	RIGHT					OPTIONAL	OPTIONAL	X	X
2/4/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
2/4/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
EXIT SPEED SIGN (E13-1P) UNDER EXIT GORE SIGN	72" x 24"	RIGHT			N/A	X	N/A	X	N/A	X
CHEVRON ALIGNMENT SIGNS (W1-8)	30" x 48"	LEFT OR RIGHT			X	X	X	X	X	X
SEQUENTIAL LED CHEVRON ALIGNMENT SIGNS	VARIABLE	RIGHT OR LEFT					OPTIONAL	OPTIONAL	X	X
COMBINATION HORIZONTAL ALIGNMENT/ADVISORY SPEED SIGN (W1-14L)	48" x 48"	RIGHT			OPTIONAL	OPTIONAL	X	X	X	X
CONSPICUITY PANELS (W16-102P) ON HORIZONTAL ALIGNMENT WARNING SIGN	18" x 18"	RIGHT					X	X	X	X
CONSPICUITY PANELS (W16-102P) ON HORIZONTAL ALIGNMENT WARNING SIGN	18" x 18"	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
CONSPICUITY PANELS (W16-102P) ON HORIZONTAL ALIGNMENT WARNING SIGN	18" x 18"	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
EXIT ADVISORY SPEED ON GUIDE SIGN	VARIABLE	OVERHEAD OR RIGHT	N/A		N/A		N/A	X	N/A	X
TRUCKS BUSES RIGHT LANE ONLY SIGN (B4-10A)	48" x 60"	RIGHT						X		X
STAY IN LANE SIGN (R4-9)	48" x 60"	RIGHT						X		X
TRUCK ALERT WARNING SIGN	VARIABLE	OVERHEAD								X
GROUND MOUNTED DELINEATORS (TYPE GM-2), YELLOW/WHITE ALONG RAMP	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
GROUND MOUNTED DELINEATORS (TYPE GM-2), YELLOW/WHITE AT GORE ON APPROACH	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
GROUND MOUNTED DELINEATORS (TYPE GM-2), YELLOW/WHITE AT GORE ON MAINLINE	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
SIDE-MOUNT BARRIER DELINEATORS (TYPE O), YELLOW/WHITE	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
TOP-MOUNT BARRIER DELINEATORS (TYPE P), YELLOW/WHITE	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
WEB-MOUNT GUIDERAIL DELINEATORS (TYPE D), YELLOW/WHITE	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
POST-MOUNT GUIDERAIL DELINEATORS (TYPE B), YELLOW/WHITE	REFER TO PFS-980	RIGHT & LEFT	X	X	X	X	X	X	X	X
LINEAR DELINEATION PANELS ON BARRIER, YELLOW/WHITE	REFER TO PFC DELINEATION MAINTENANCE FIELD HANDBOOK	RIGHT & LEFT					X	X	X	X
REFLECTIVE PANELS ON POSTS OF CHEVRON ALIGNMENT SIGNS, YELLOW	3" x 48"	RIGHT & LEFT			X	X	X	X	X	X
REFLECTIVE PANELS ON POSTS OF HORIZONTAL ALIGNMENT WARNING & TRUCK ROLLOVER SIGNS, YELLOW	3" x 48"	RIGHT & LEFT					X	X	X	X
TRAFFIC LINE MARKING, WHITE	6"	RIGHT	X	X	X	X	X	X	X	X
TRAFFIC LINE MARKING, YELLOW	6"	LEFT	X	X	X	X	X	X	X	X
TRAFFIC LINE MARKING, WHITE, BETWEEN DUAL LANES	8"	N/A					X	X	X	X
WHITE AUXILIARY LANE LINES	6"	N/A	X	X	X	X	X	X	X	X
CROSSHATCHING MARKING, WHITE, ON MAINLINE	24"	N/A	X	H	X	X	X	X	X	X
CROSSHATCHING MARKING, WHITE, ON RAMP	24"	N/A	X	X	X	X	X	X	X	X
SLOW CURVE PAVEMENT MARKING	REFER TO TC 8000	EACH LANE								X
RELOCATED WARNING TO PTC'S TRIP TALK APPLICATION PROGRAM	N/A	N/A	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
DYNAMIC SPEED DISPLAY (BLANK-OUT SIGN WITH RADAR)	Variable	RIGHT OR OVERHEAD ON DUAL LANES					X	X	OPTIONAL	OPTIONAL
VEHICLE-TO-INFRASTRUCTURE CURVE SPEED WARNING SYSTEM	Variable	RIGHT OR OVERHEAD ON DUAL LANES							OPTIONAL	OPTIONAL
TRUCK ROLLOVER WARNING SYSTEM	Variable	RIGHT OR OVERHEAD ON DUAL LANES							OPTIONAL	OPTIONAL



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RAMP “LEVEL” DEVELOPMENT

TRAFFIC CONTROL DEVICES SUMMARY

TRAFFIC DEVICE	Size	Side	LEVEL 1		LEVEL 2		LEVEL 3		LEVEL 4	
			ENTRANCE	EXIT	ENTRANCE	EXIT	ENTRANCE	EXIT	ENTRANCE	EXIT
MERGE RIGHT SIGN (W4-1R) OR ADDED LANE RIGHT SIGN (W4-3R) ON MAINLINE	48" x 48"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
ADVISORY RAMP SPEED SIGN (W13-3)	48" x 60"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
COMBINATION HORIZONTAL ALIGNMENT /ADVISORY RAMP SPEED SIGN (W13-7R)	48" x 84"	RIGHT	X	N/A	X	N/A	X	N/A	X	N/A
ADVISORY EXIT SPEED SIGN (W13-2)	48" x 60"	RIGHT	N/A	X	N/A	X	N/A	X	N/A	X
COMBINATION HORIZONTAL ALIGNMENT /ADVISORY EXIT SPEED SIGN (W13-6R)	48" x 84"	RIGHT	N/A	X	N/A	X	N/A	X	N/A	X
EXIT GORE SIGN WITH YELLOW OBJECT MARKERS (OM1-3) ON POSTS	Variable; 18" x 18"	GORE	N/A	X	N/A	X	N/A	X	N/A	X
SERVICE PLAZA SIGN WITH YELLOW OBJECT MARKERS (OM1-3) ON POSTS	84" x 72"; 18" x 18"	GORE		X		X		X		X
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	RIGHT	X	X	X	X	X	X	X	X
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
HORIZONTAL ALIGNMENT WARNING SIGN (VARIOUS) WITH ADVISORY SPEED PLAQUE (W13-1P)	60" x 60"	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	RIGHT			X	X	X	X	X	X
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	48" x 48"; 30" x 30"	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
TRUCK ROLLOVER SIGN (W1-13R/L) WITH ADVISORY SPEED PLAQUE (W13-1P)	60" x 60"	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
24/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	RIGHT					OPTIONAL	OPTIONAL	X	X
24/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	LEFT					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
24/7 FLASHING BEACON SYSTEM ON TRUCK ROLLOVER SIGN	VARIABLE	OVERHEAD					OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
EXIT SPEED SIGN (E13-1P) UNDER EXIT GORE SIGN	72" x 24"	RIGHT			N/A	X	N/A	X	N/A	X
CHEVRON ALIGNMENT SIGNS (W1-8)	36" x 48"	LEFT OR RIGHT			X	X	X	X	X	X
SEQUENTIAL LED CHEVRON ALIGNMENT SIGNS	VARIABLE	RIGHT OR LEFT					OPTIONAL	OPTIONAL	X	X
COMBINATION HORIZONTAL ALIGNMENT/ADVISORY SPEED SIGN (W1-1aR/L)	48" x 48"	RIGHT			OPTIONAL	OPTIONAL	X	X	X	X

SIGNS



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LEVEL 1 DESIGNATION

- ✓ Gradual curves
- ✓ Short distance from tollbooth (slower speeds)
- ✓ Long deceleration lane (slower speeds)

ENTRANCE RAMP



EXIT RAMP



LEVEL 1 DESIGNATION

Summary of Traffic Control Device Requirements

- MUTCD Minimum Guidelines
- Advisory speed plaque on all Horizontal Alignment Warning signs
- 270° Curve Warning Sign for loop ramps
- High level of delineation:
 - Continual delineators on both sides
 - Durable pavement markings



LEVEL 2 DESIGNATION

- ✓ Sharper curves
- ✓ Short distance from tollbooth
- ✓ Long deceleration lane

ENTRANCE RAMP



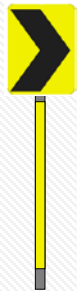
EXIT RAMP



LEVEL 2 DESIGNATION

Summary of Traffic Control Device Requirements

- Chevron Alignment signs
 - ✓ Enhanced delineation (reflective post panels)



- Truck Rollover with advisory speed signs
- Optional combination Horizontal Warning with Advisory Speed signs



LEVEL 3 DESIGNATION

- ✓ Sharp curves
- ✓ Longer distance from tollbooth (higher speeds)
- ✓ Short deceleration lane (higher speeds)

ENTRANCE RAMP



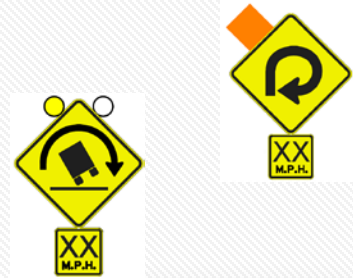
EXIT RAMP



LEVEL 3 DESIGNATION

Summary of Traffic Control Device Requirements

- Conspicuity plaques on warning signs
- Flashing beacons on critical signs
- Advisory speed plaques on Exit Gore and Destination signs (Type A or Overhead)
- Increased enhanced delineation
- Dynamic Speed Display



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LEVEL 4 DESIGNATION

- ✓ Sharp curves
- ✓ Long distance from tollbooth
- ✓ Short deceleration lane
- ✓ Existing or emerging crash history

ENTRANCE RAMP



EXIT RAMP



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LEVEL 4 DESIGNATION

Summary of Traffic Control Device Requirements

- TRUCK ALERT sign
- SLOW CURVE Pavement Markings
- Curve Warning/Truck Rollover System
- **OVERHEAD** Dynamic Speed Display



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LEVEL SELECTION PROCESS

- ✔ Selection based on 2 geometric items:
 - “Approach Speed” versus “Recommended Speed” at the “Critical Curve”
 - Tangent length between reverse curves, if present
- ✔ Selection Charts model speeds and determine appropriate Level

LEVEL SELECTION CHART A: ENTRANCE RAMP

LENGTH AVAILABLE FOR ACCELERATION (Feet)	REVERSE CURVE TANGENT LENGTH (Feet)													
	600	500	400	300	200	150	100	75	50	25				
1600	1	1	2	2	2	2	2	2	2	2	3	3	3	3
1500	1	1	1	2	2	2	2	2	2	2	2	3	3	3
1400	1	1	1	1	2	2	2	2	2	2	2	3	3	3
1300	1	1	1	1	1	2	2	2	2	2	2	3	3	3
1200	1	1	1	1	1	1	2	2	2	2	2	2	2	2
1100	1	1	1	1	1	1	1	2	2	2	2	2	2	2
1000	1	1	1	1	1	1	1	1	2	2	2	2	2	2
900	1	1	1	1	1	1	1	1	1	2	2	2	2	2
800	1	1	1	1	1	1	1	1	1	1	2	2	2	2
700	1	1	1	1	1	1	1	1	1	1	1	2	2	2
600	1	1	1	1	1	1	1	1	1	1	1	1	2	2
500	1	1	1	1	1	1	1	1	1	1	1	1	1	2

LEVEL SELECTION CHART B: EXIT RAMP

LENGTH AVAILABLE FOR DECELERATION* (Feet)	REVERSE CURVE TANGENT LENGTH (Feet)																
	1100	1000	900	800	700	600	500	400	300	200							
1200	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3
1150	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3
1100	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3
1050	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3
1000	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3
950	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3
900	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
850	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
800	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
750	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
700	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
650	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
600	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
550	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
500	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
450	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
400	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
300	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3

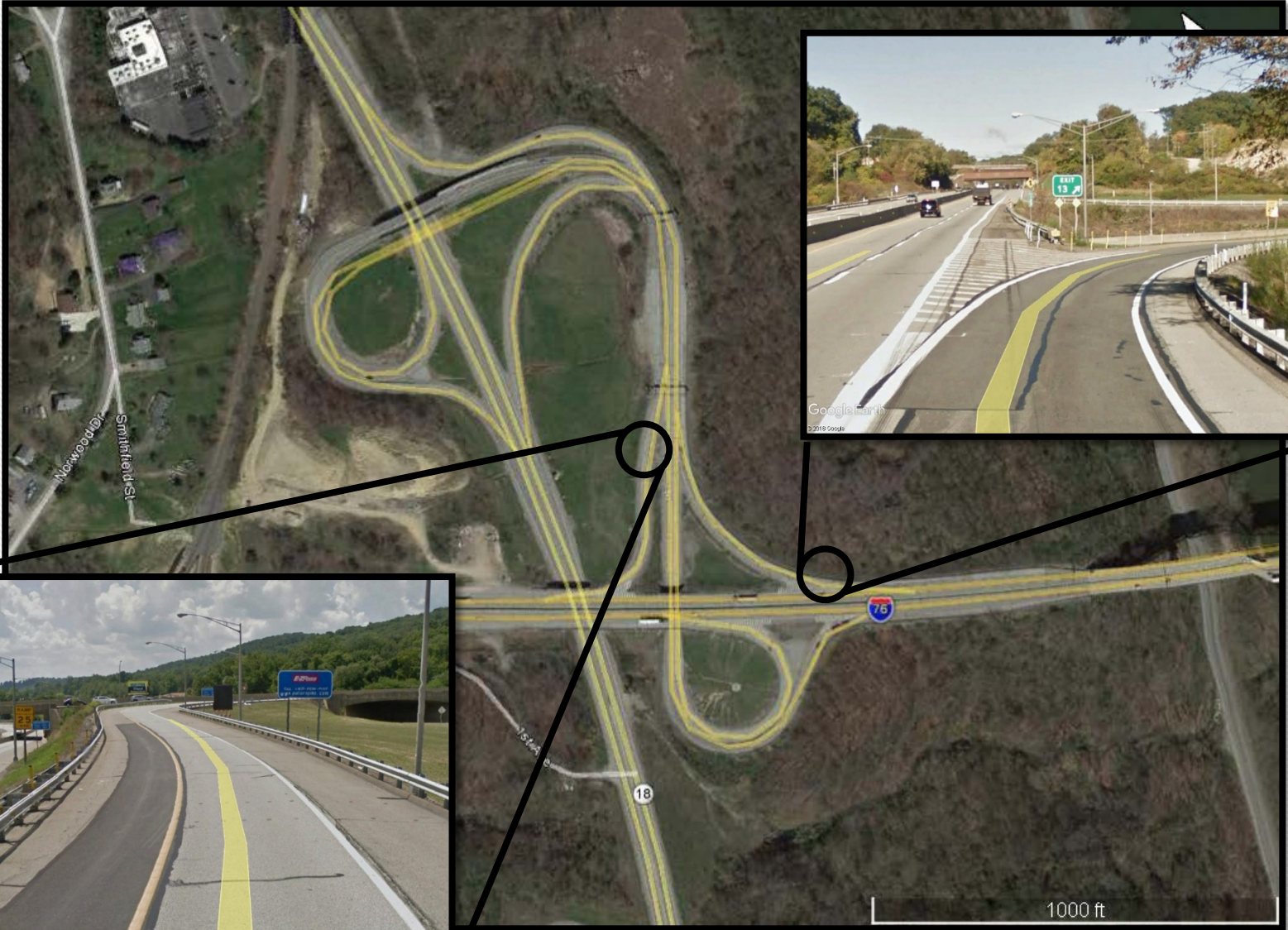




EXAMPLE

**CONCEPTUAL INTERCHANGE PLAN FOR
I-76, EXIT 13 – BEAVER VALLEY INTERCHANGE**

BEAVER VALLEY INTERCHANGE



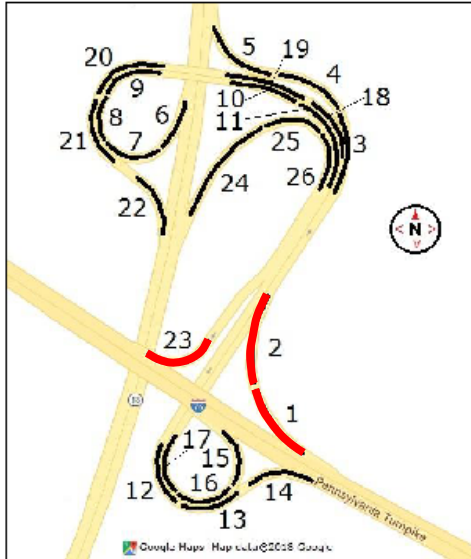
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BEAVER VALLEY INTERCHANGE



SAFE Highway Engineering, LLC
36 Trevoise Road
Trevoise, PA 19053
215-355-2089



RIEKER inc. Curve Advisory Reporting Service CARS

Recommended Advisory Speed	Curve #
10 MPH	—
15 MPH	15, 16, 17, 25, 26
20 MPH	5, 7, 8, 9, 11, 12, 13, 14, 20, 23
25 MPH	2, 4, 6, 18, 21, 22
30 MPH	1
35 MPH	24
40 MPH	10, 19

RAMP	Length Available for Acceleration	Length Available for Deceleration
EB-ON	1260'	N/A
WB-ON	850'	N/A
EB-OFF	N/A	670'
WB-OFF	N/A	450'
SB-ON	1145'	N/A
NB-ON	1150'	N/A
NB-OFF	N/A	506'
SB-OFF	N/A	370'

PA TURNPIKE INTERCHANGE
I-76 MP 12.87 BEAVER VALLEY

CURVE ADVISORY SPEED EVALUATION
SAFE PROJECT 2017.001
DATE COLLECTED: JULY 10, 2018



Project: Pennsylvania Turnpike Commission Work Order #2
Interchange Ramp Evaluations
Location: Beaver Valley Interchange MP 12.87

SAFE Highway Engineering, LLC
36 Trevoise Road
Trevoise, PA 19053

Date Collected: July 10, 2018

RIEKER inc. Curve Advisory Reporting Service CARS

Note: This document was created by SAFE Highway Engineering, LLC to summarize the CARS evaluations for each curve. The curve data was exported from the Curve Advisory Report in CARS. This specific report does not appear in CARS and was set up for this specific project. Copyright 2013 Rieker Inc. All rights reserved.

Curve No.	Ramp Direction	Curve Dir.	Point of Curvature (Lat.-Long.)	Point of Tangent (Lat.-Long.)	Curve radius (feet)	Curve length (feet)	Recommended Advisory Speed (mph)
1	WB-OFF	RT	40.81315° -80.32283°	40.81390° -80.32357°	413	359	30
2	WB-OFF	RT	40.81390° -80.32357°	40.81476° -80.32328°	340	336	25
3	WB-OFF	LT	40.81551° -80.32263°	40.81632° -80.32243°	372	315	25
4	WB-OFF	LT	40.81632° -80.32243°	40.81674° -80.32325°	203	306	25
5	WB-OFF	RT	40.81674° -80.32325°	40.81745° -80.32403°	188	374	20
6	EB-ON	RT	40.81659° -80.32438°	40.81605° -80.32467°	377	216	25
7	EB-ON	RT	40.81605° -80.32467°	40.81605° -80.32534°	111	210	20
8	EB-ON	RT	40.81605° -80.32534°	40.81656° -80.32538°	132	211	20
9	EB-ON	RT	40.81656° -80.32538°	40.81678° -80.32475°	137	210	20
10	EB-ON	RT	40.81667° -80.32373°	40.81641° -80.32281°	700	280	40
11	EB-ON	RT	40.81641° -80.32281°	40.81562° -80.32265°	172	342	20
12	EB-ON	LT	40.81330° -80.32464°	40.81274° -80.32448°	134	236	20
13	EB-ON	LT	40.81274° -80.32448°	40.81282° -80.32377°	152	220	20
14	EB-ON	RT	40.81292° -80.32359°	40.81293° -80.32288°	143	215	20
15	EB-OFF	RT	40.81352° -80.32411°	40.81307° -80.32372°	194	210	15
16	EB-OFF	RT	40.81307° -80.32372°	40.81277° -80.32440°	130	221	10
17	EB-OFF	RT	40.81277° -80.32440°	40.81332° -80.32460°	116	244	15
18	SB-ON	LT	40.81557° -80.32265°	40.81641° -80.32270°	177	344	25
19	SB-ON	LT	40.81641° -80.32270°	40.81672° -80.32379°	550	334	40
20	SB-ON	LT	40.81685° -80.32484°	40.81653° -80.32551°	143	244	20
21	SB-ON	LT	40.81653° -80.32551°	40.81599° -80.32532°	141	231	25
22	SB-ON	RT	40.81586° -80.32507°	40.81519° -80.32471°	184	291	25
23	WB-ON	RT	40.81423° -80.32409°	40.81411° -80.32484°	117	244	20
24	NB-OFF	RT	40.81570° -80.32417°	40.81629° -80.32331°	404	329	35
25	NB-OFF	RT	40.81629° -80.32331°	40.81618° -80.32265°	149	206	15
26	NB-OFF	RT	40.81618° -80.32265°	40.81569° -80.32263°	133	195	15



HIGHWAY ENGINEERING, LLC.



BEAVER VALLEY INTERCHANGE

Westbound Entrance Ramp

1. Acquire Geometry
 - a) Length Available for Acceleration: 850 LF
 - b) Shortest radius of curves (only one): 117 LF
 - c) Single Lane ramp
 - d) Advisory Speed: 20 mph
2. Level Selection – Chart A

LEVEL SELECTION CHART A: ENTRANCE RAMP

REVERSE CURVE TANGENT LENGTH {Feet}

LENGTH AVAILABLE FOR ACCELERATION {Feet}	REVERSE CURVE TANGENT LENGTH {Feet}																
	600	500	400	300	200	150	120	100	90	80	70	60	50	40	30	20	
1600	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
1500	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3
1400	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3
1300	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3
1200	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
1100	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
1000	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
900	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
800	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
700	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
600	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
500	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2

CURVE RADIUS {Feet}

Level 2



BEAVER VALLEY INTERCHANGE

Westbound Exit Ramp

1. Acquire Geometry
 - a) Length Available for Deceleration: 450 LF
 - b) Radius of Initial Curve: 413 LF
 - c) Single Lane ramp
 - d) No adjustment for grade
 - e) Advisory Speed: 25 mph

LEVEL SELECTION CHART B: EXIT RAMP

		REVERSE CURVE TANGENT LENGTH {Feet}																				
		1100	1000	900	800	700	600	500	400	300	200	100										
LENGTH AVAILABLE FOR DECELERATION* {feet}	1200	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	
	1150	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3
	1100	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3
	1050	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3
	1000	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
	950	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
	900	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
	850	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	800	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	750	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	700	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	650	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	600	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	550	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	500	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	450	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
400	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
350	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
300	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
250	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

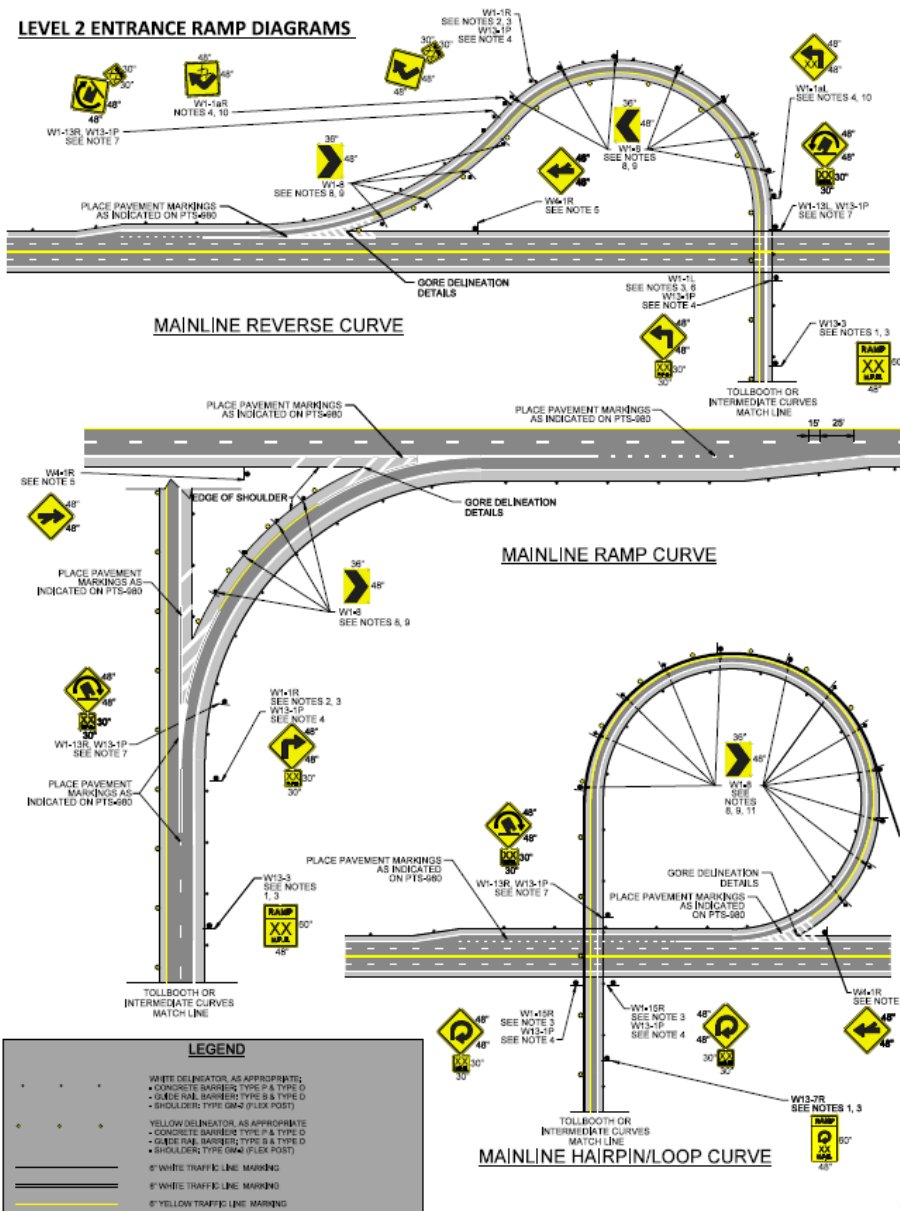
* Decrease LENGTH AVAILABLE FOR DECELERATION...
 ...by 5% if ramp is on a negative grade of 0 - 3%
 ...by 10% if ramp is on a negative grade of > 3%
 ...by 25% if ramp has dual lanes

Level 2



LEVEL 2 ENTRANCE RAMP DIAGRAM


LEVEL 2 ENTRANCE RAMP DIAGRAMS






NOTES:

- Place in accordance with Table 2C-5 of MUTCD (Manual on Uniform Traffic Control Devices), 2009 Edition, at near as possible to the start of the deceleration lane at full-width.

Eliminate when no location between the tollbooth and the initial curve is feasible and when established engineering practices deem appropriate.


Advisory ramp speed should depict the lowest advisory speed for all curves on the ramp, including any truck advisory speeds, as determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve outlined in Section 2C.08 of MUTCD, 2009 Edition.
- Replace with W1-2R (48" x 48")  when the advisory speed is determined to be above 30 mph.
- Place horizontal alignment signs at location using established engineering practices outlined in Section 2C.05 of MUTCD, 2009 Edition.
- Advisory speed depicted determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve as outlined in Section 2C.08 of MUTCD, 2009 Edition.
- Place in accordance with Section 2C.40 of MUTCD, 2009 Edition, and position so view of entering traffic is not obstructed.

Replace with W4-3R (48" x 48")  when merging movements are not required.
- Replace with W1-11L (48" x 48")  when curve has a change of direction $\geq 135^\circ$.

Replace with W1-3L (48" x 48")  when the tangent distance separating reverse curves $< 600'$.
- Install when either of the following considerations are met:
A. Radius of curve is $\leq 140'$ and Length Available for Acceleration is $> 1400'$
B. Radius of curve is $\leq 250'$ and immediately in advance of second curve of reverse curve with a tangent length $\leq 600'$.

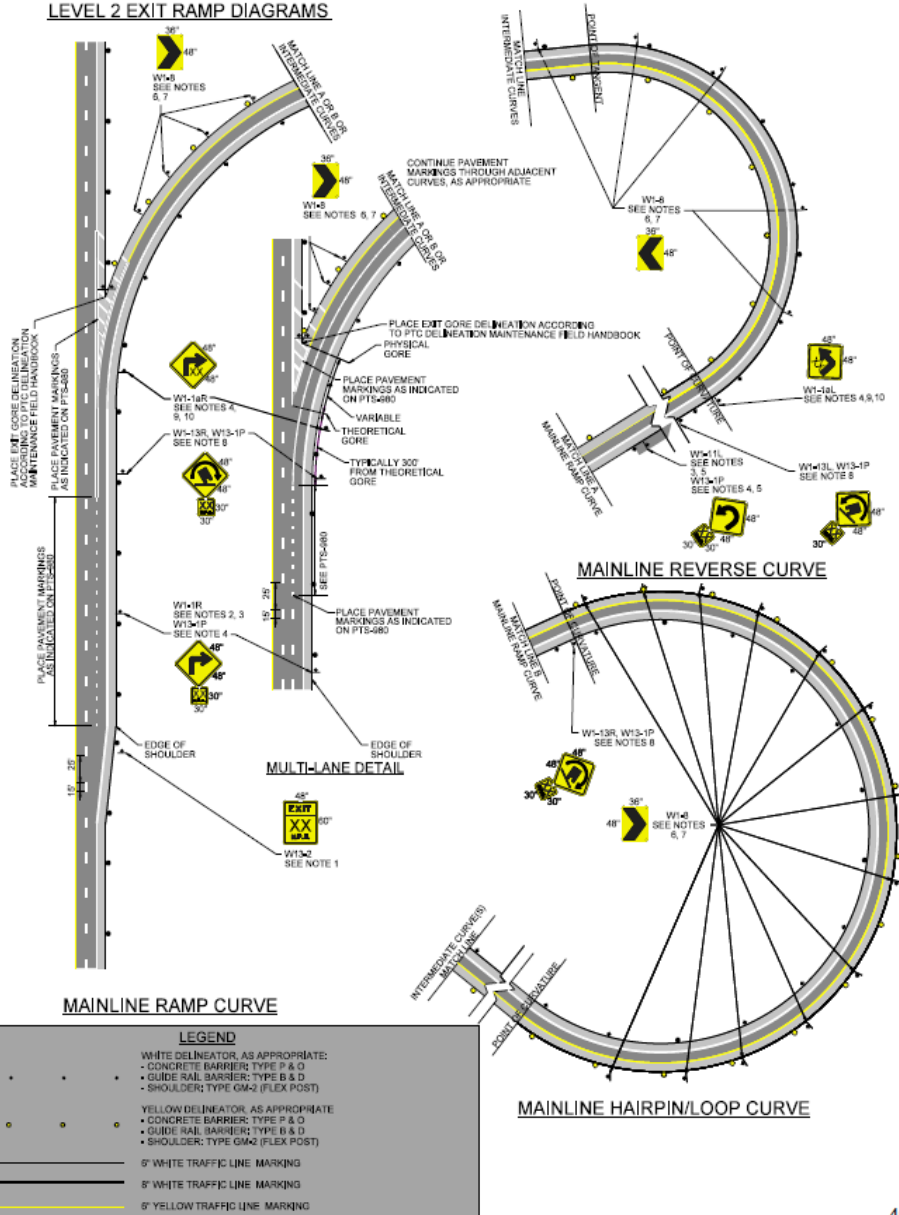
Place at a location determined by established engineering practices.

Advisory speed should depict the recommended speed for vehicles with a higher center of gravity using established engineering practices outlined in section 2C.13 of MUTCD, 2009 Edition. If this speed is lower than the recommended speed for the corresponding horizontal alignment warning sign(s), this recommended speed should also be used for the horizontal alignment warning sign(s).
- Placed at approximately 50' spacing on outside of every curve from Point of Curvature (POC) to Point of Tangent (POT).
- Place 3" wide yellow PennDOT approved Type XI retroreflective sheeting along the length of the sign post facing oncoming traffic.
- Sign is recommended when Advisory Speed is ≤ 30 MPH or when tangent length in advance of reverse curve is $< 600'$. Place at or near Point of Curvature (POC).
- Place sign installation on left when established engineering practices deem appropriate and roadway geometry allows.

 Follow Note 7 to determine if W1-13R (Truck Rollover) may be needed with W13-1P (Advisory Speed)

LEVEL 2 EXIT RAMP DIAGRAM

LEVEL 2 EXIT RAMP DIAGRAMS



NOTES:

- Place per Table 2C-5 of MUTCD (Manual on Uniform Traffic Control Devices), 2009 Edition, as near as possible to start of deceleration lane at full-width.
- Replace with W1-2R (48" x 48") when advisory speed of initial curve is determined to be > 30 mph.
- Replace with W1-3R (48" x 48") when two changes in roadway alignment in opposite directions are separated by a tangent distance < 600'.
- Replace with W1-11R (48" x 48") when curve has a change of direction of approximately 135° or more.
- Replace with W1-15R (48" x 48") when curve has a change of direction of approximately 270°.
- Location/placement of horizontal alignment sign is determined by established engineering practices outlined in Section 2C.05 of MUTCD, 2009 edition.
- Advisory speed depicted is to be determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve as outlined in Section 2C.08 of MUTCD, 2009 Edition.
- Eliminate when two changes in roadway alignment in opposite directions are separated by a tangent distance ≤ 600'.
- Placed at approximately 50' spacing on outside of every curve from Point of Curvature (POC) to Point of Tangent (POT).
- Place 3" wide yellow PennDOT approved Type XI retroreflective sheeting along the length of the sign post facing oncoming traffic.
- Install when either of the following considerations is met:
 - When the following curve radius and Length Available for Deceleration relationship is met:
 - Radius is < 175' and Length Available for Deceleration is < 1000'
 - Radius is < 350' and Length Available for Deceleration is < 850'
 - Radius is < 500' and Length Available for Deceleration is < 500'
 - Radius of curve is < 350' and immediately in advance of the second curve of a reverse curve with a tangent length ≤ 600'.
- Place W1-13R in advance of a curve to the right, or W1-13L in advance of a curve to the left, at location determined by established engineering practices.
- Advisory speed should depict the recommended speed for vehicles with a higher center of gravity using established engineering practices outlined in Section 2C.13 of MUTCD, 2009 Edition. If this speed is lower than the recommended speed for the corresponding horizontal alignment warning sign(s), this recommended speed should also be used for the horizontal alignment warning sign(s).
- Eliminate sign when curve has a change of direction of approximately 270°.
- Sign can be eliminated when advisory speed is > 30 MPH or when tangent length in advance of reverse curve is > 600'. Place at or near Point of Curvature (POC).

Follow Note 8 to determine if W1-13R (Truck Rollover) may be needed with W13-1P (Advisory Speed)


BEAVER VALLEY INTERCHANGE





NEXT STEPS

NEXT STEPS

- Revisions to Interchange Signing Plan currently underway.
 - Integration of Wrong-Way Signage into document
 - Minor changes to recommendations
- Publish Interchange Signage Plan in 2019/2020 for application on PA Turnpike System
- Present the PA Motor Truck Association () the final results and implementation plans for ISP.



NEXT STEPS

- Prepare for possible expansion/integration of current and future ITS Devices



- Continually scrutinize ISP for improvement opportunities as technology, traffic control, and traffic operations change
 - Update Level Selection Charts
 - Incorporate emerging technologies



QUESTIONS?