

I-84 Danbury Project Needs and Deficiencies Study Highway Geometrics *Appendix*

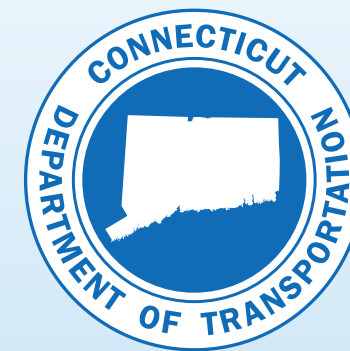


I-84 Danbury Project



State Project Number 34-349

November 2018



**CDM
Smith**



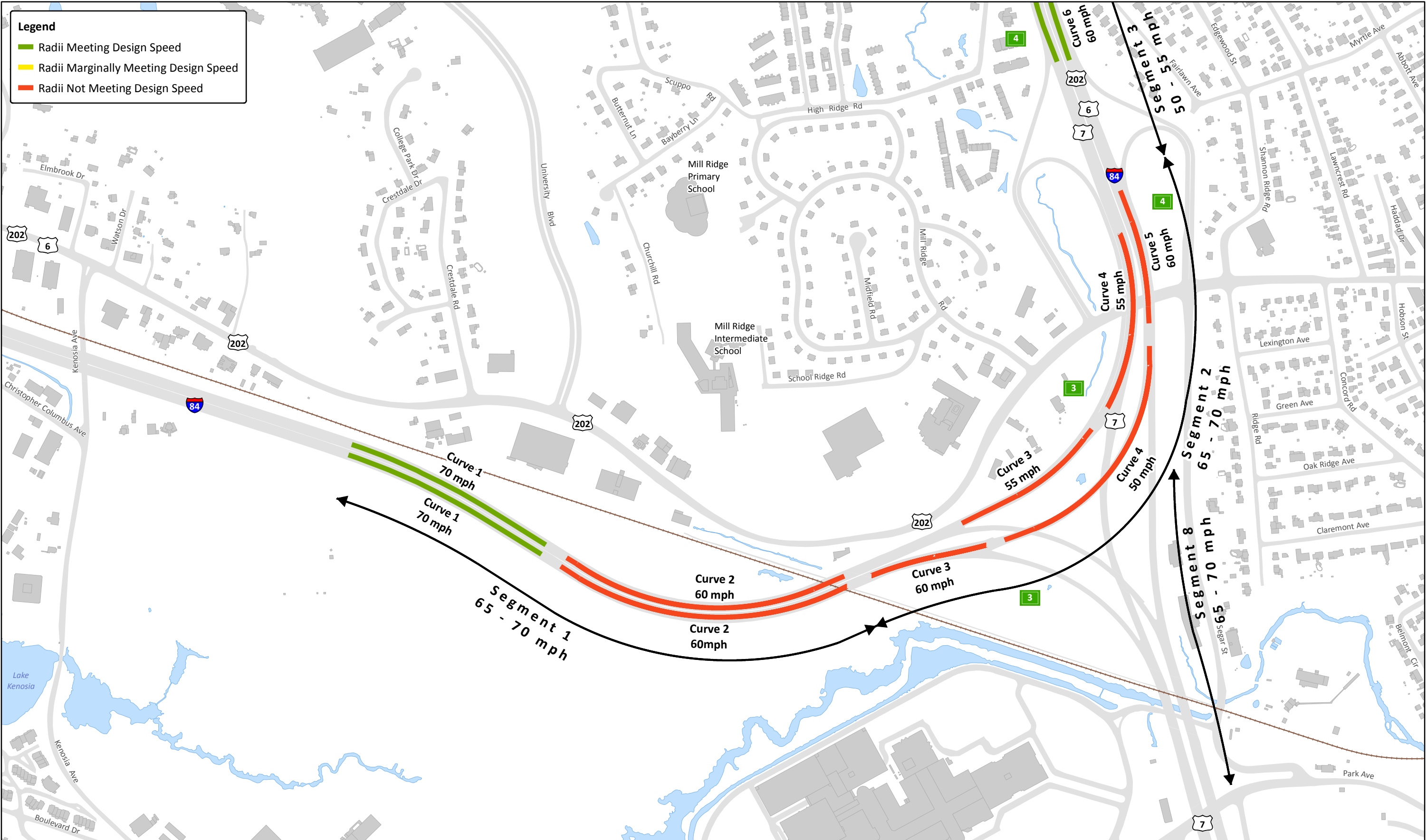
Appendix A

Deficiency Plans

Figures 1 – 6: Design Speed and Horizontal Alignment

Figures 7 – 12: Vertical Alignment and Stopping Sight Distance

Figures 13 – 18: Ramp Geometry

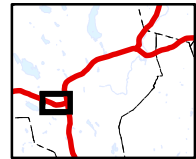


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Design Speed and Horizontal Alignment Figure 1



1 inch = 500 feet
0 250 500 Feet

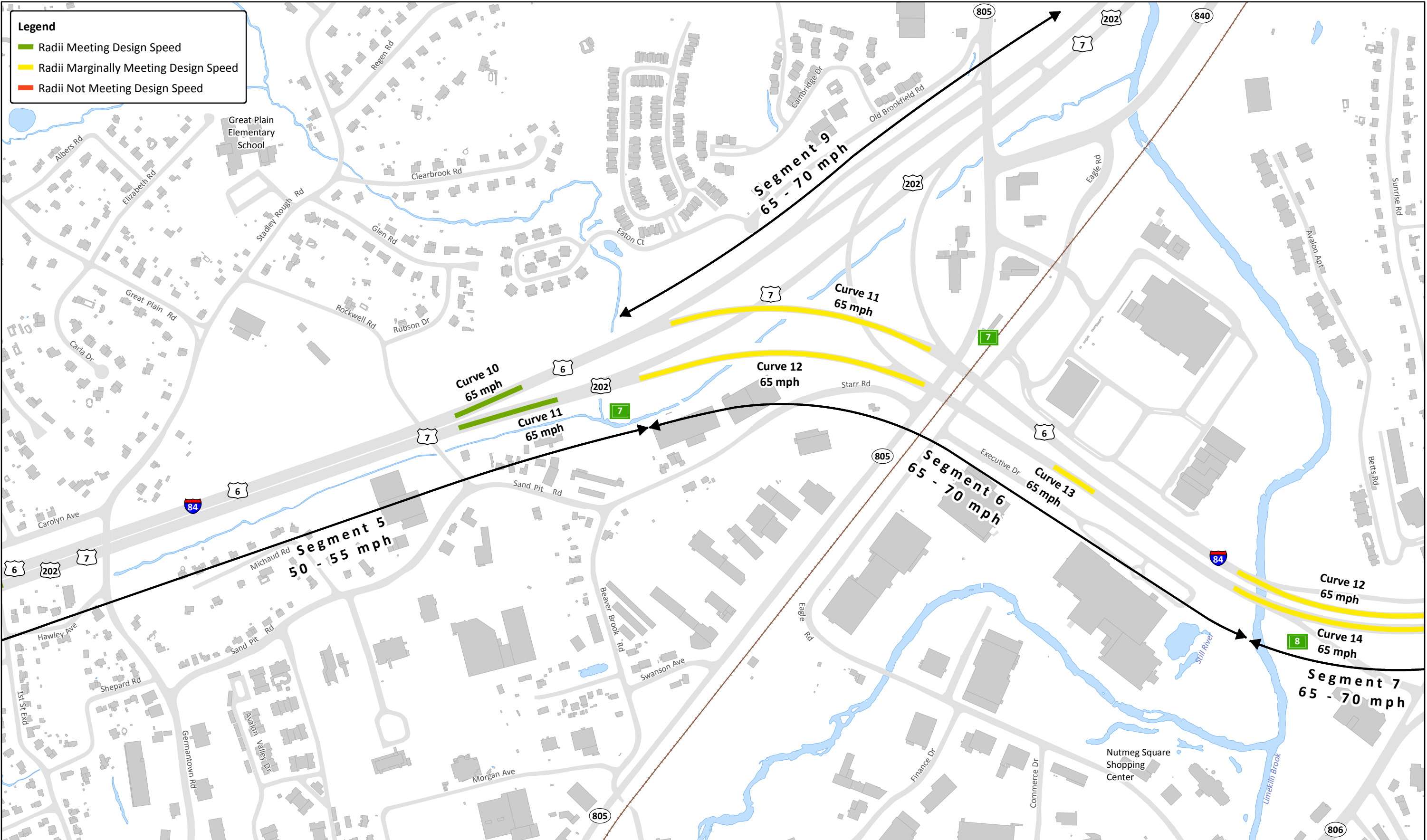


Data Sources:

- Western Connecticut Council of Governments
- Connecticut Department of Energy and Environmental Protection

Date: November 2017



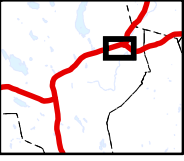


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Design Speed and
Horizontal Alignment
Figure 5



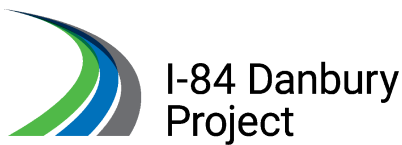
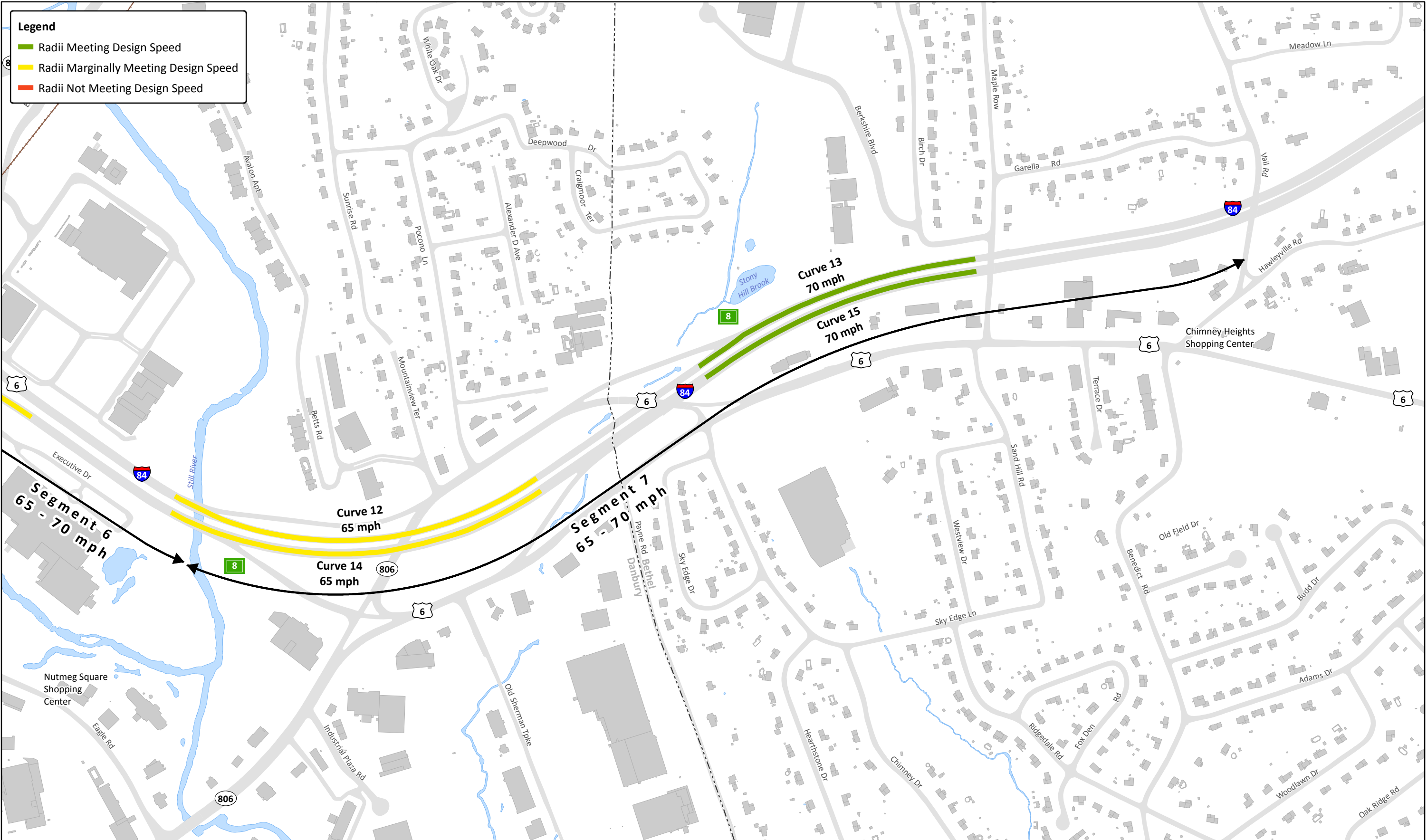
1 inch = 500 feet
0 250 500
Feet



Data Sources:
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•Connecticut Department of Energy and Environmental Protection

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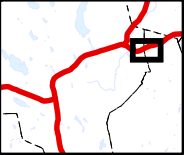




**Design Speed and
Horizontal Alignment
Figure 6**



1 inch = 500 feet
0 250 500
Feet

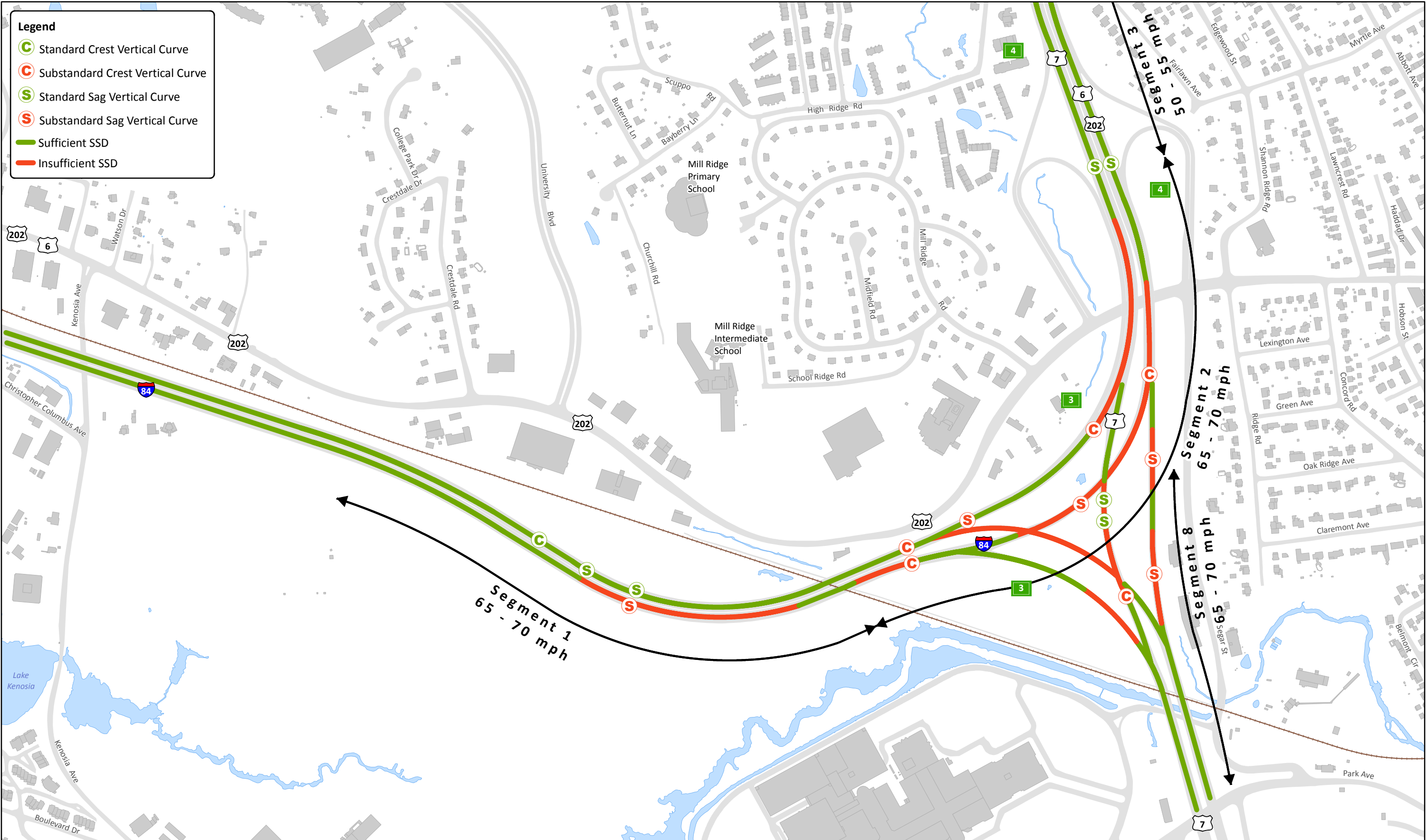


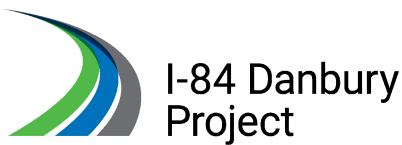
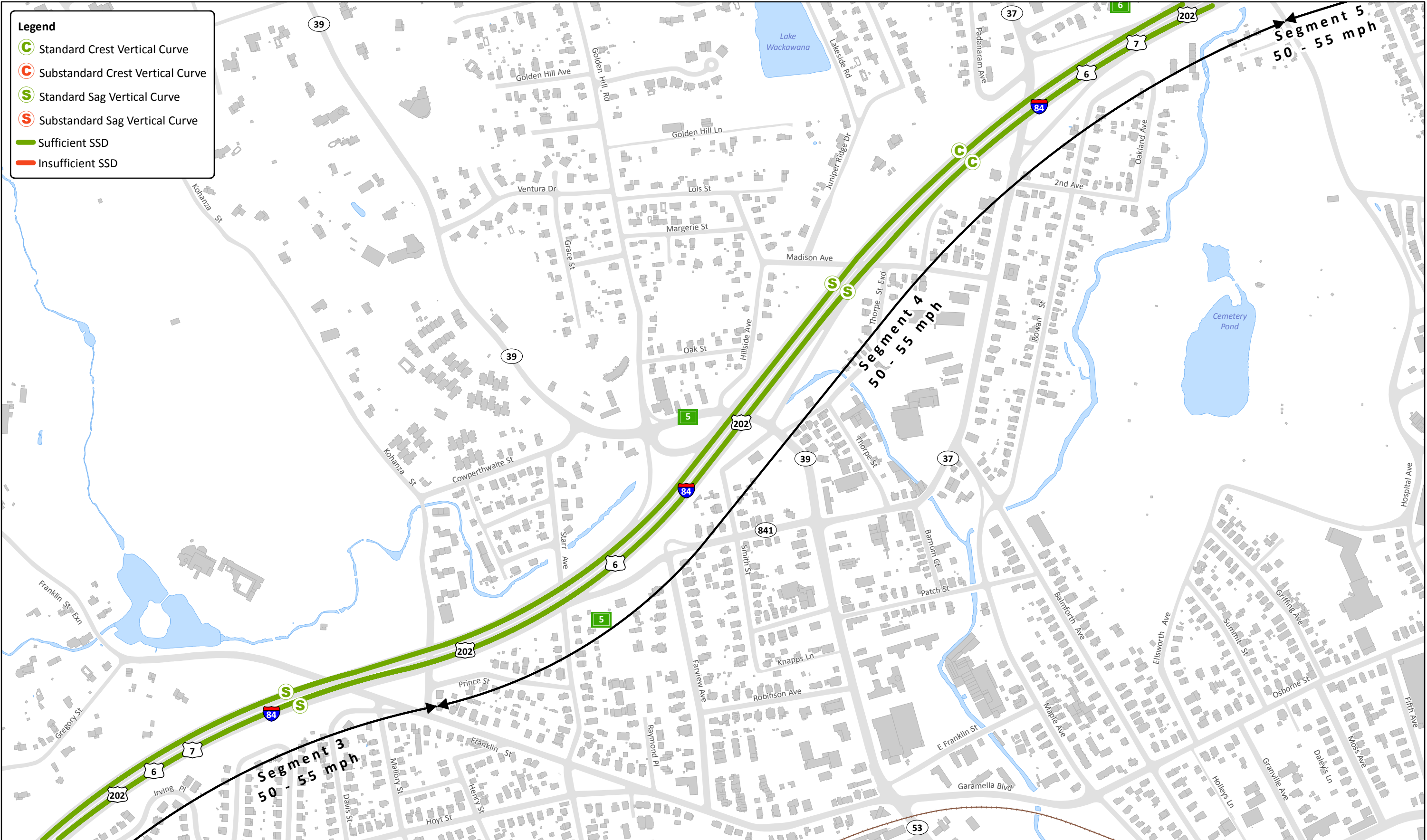
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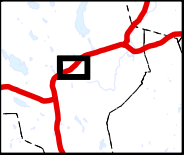




Vertical and SSD
Deficiency
Figure 9



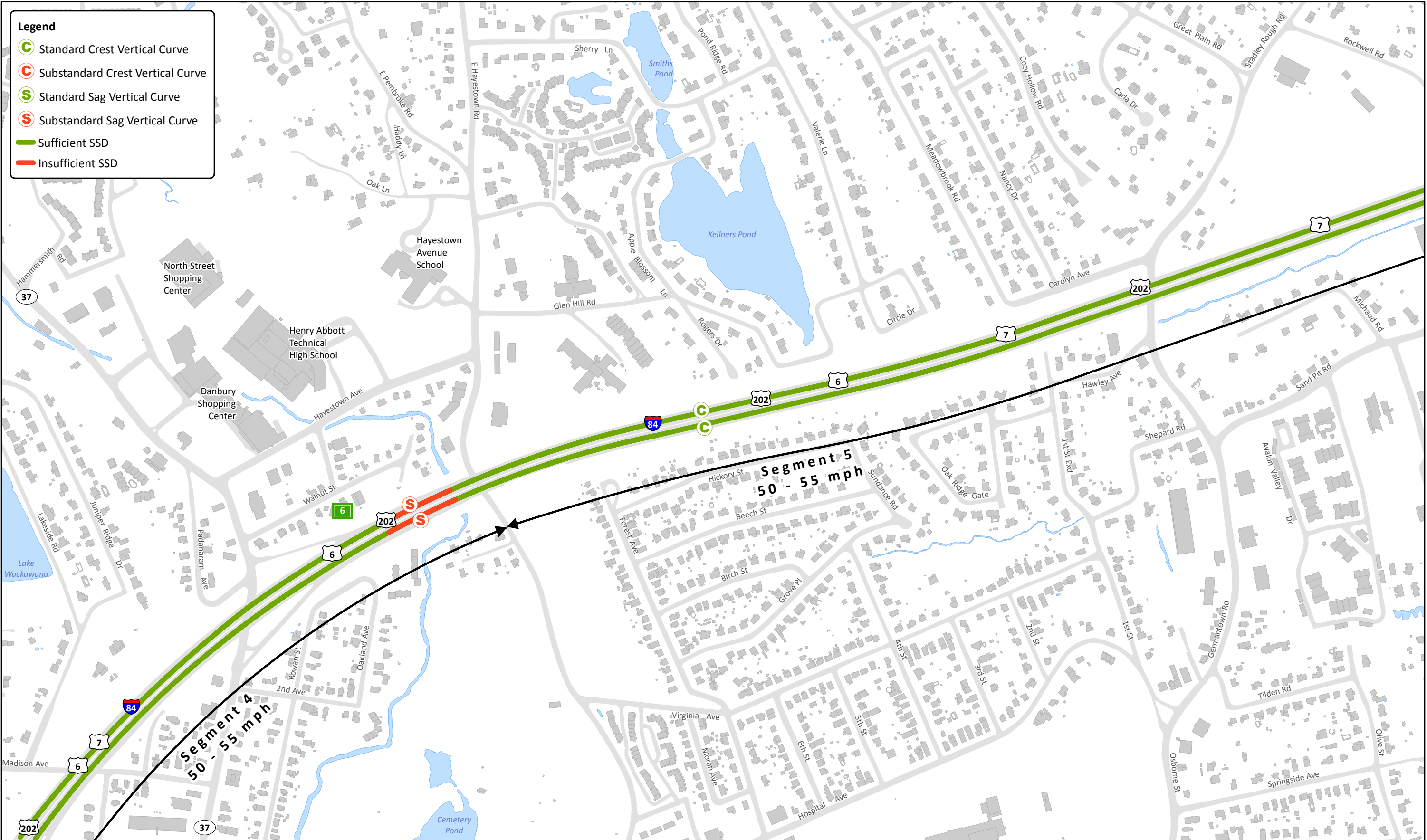
1 inch = 500 feet
0 250 500
Feet



Data Sources:
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•Connecticut Department of Energy and Environmental Protection

Date: November 2017



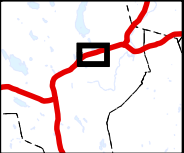


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**Vertical and SSD
Deficiency
Figure 10**



1 inch = 500 feet
0 250 500
Feet

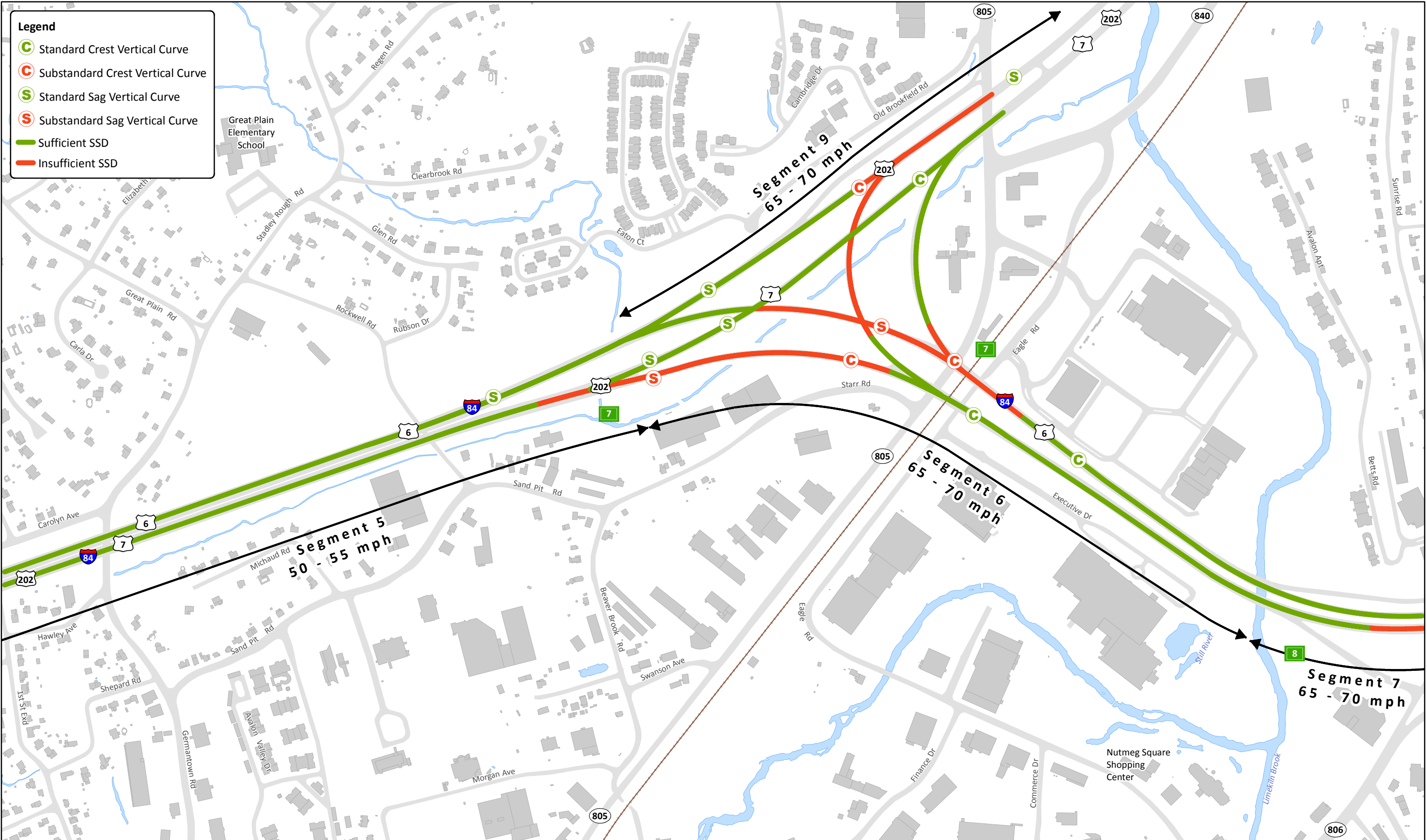


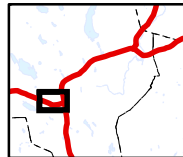
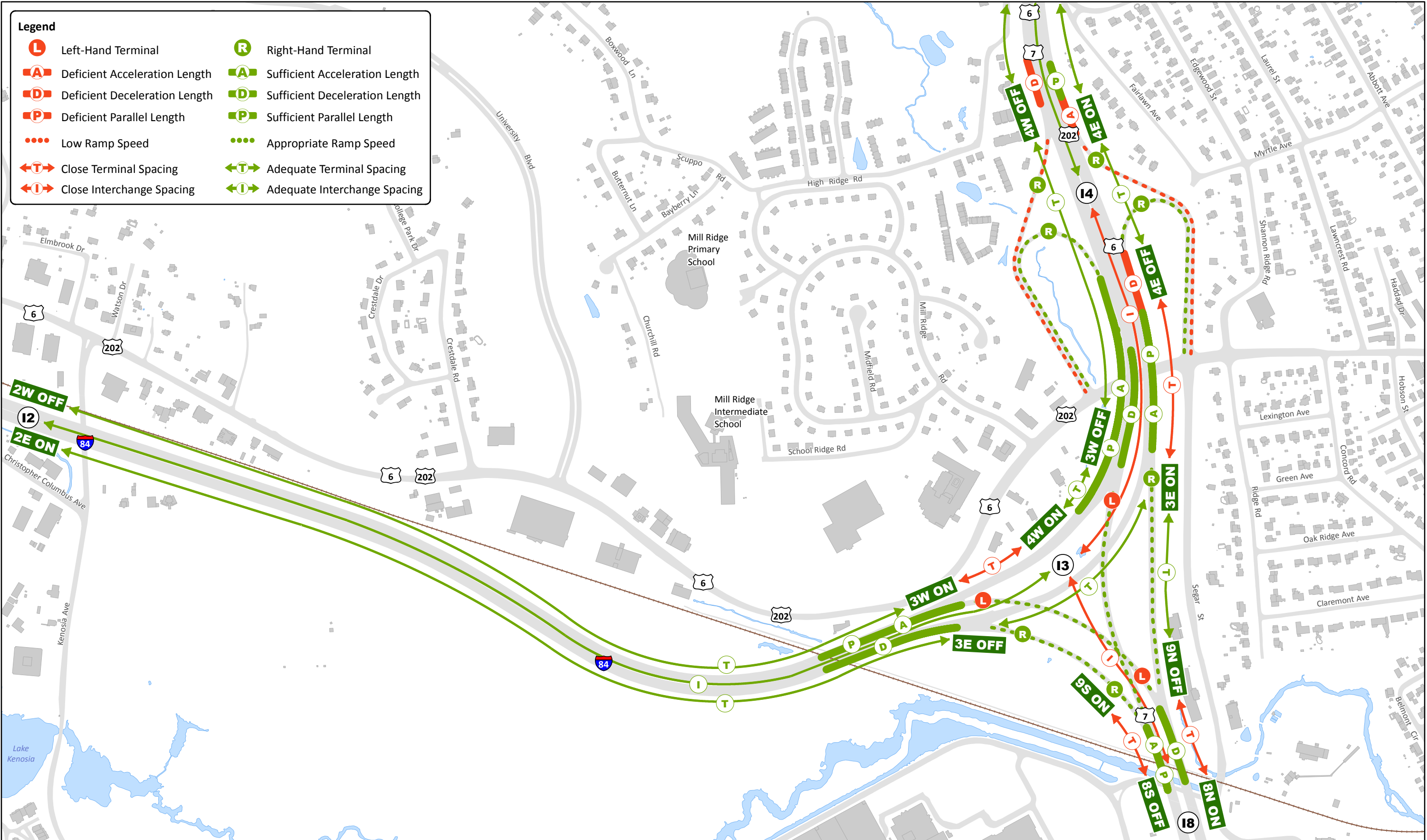
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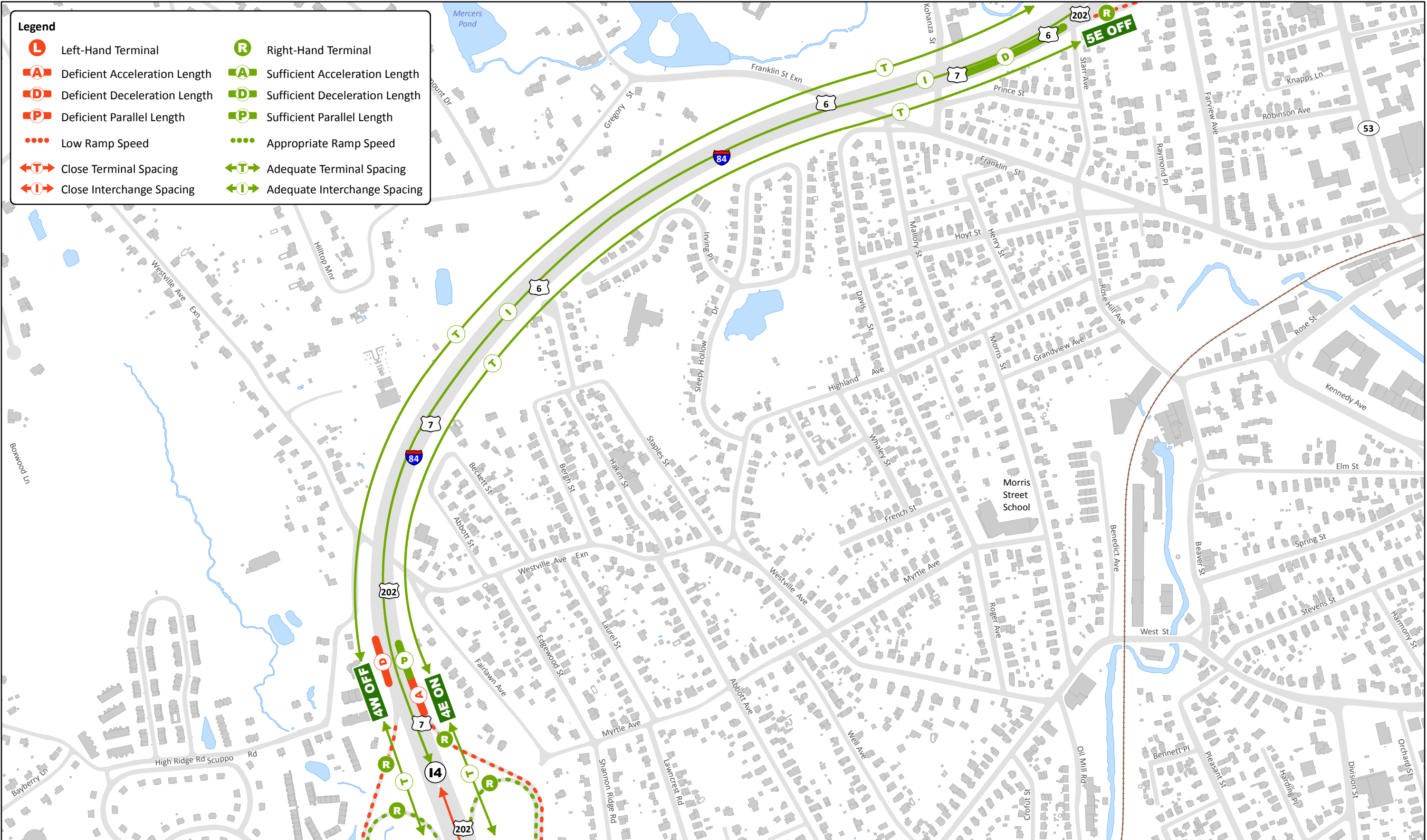
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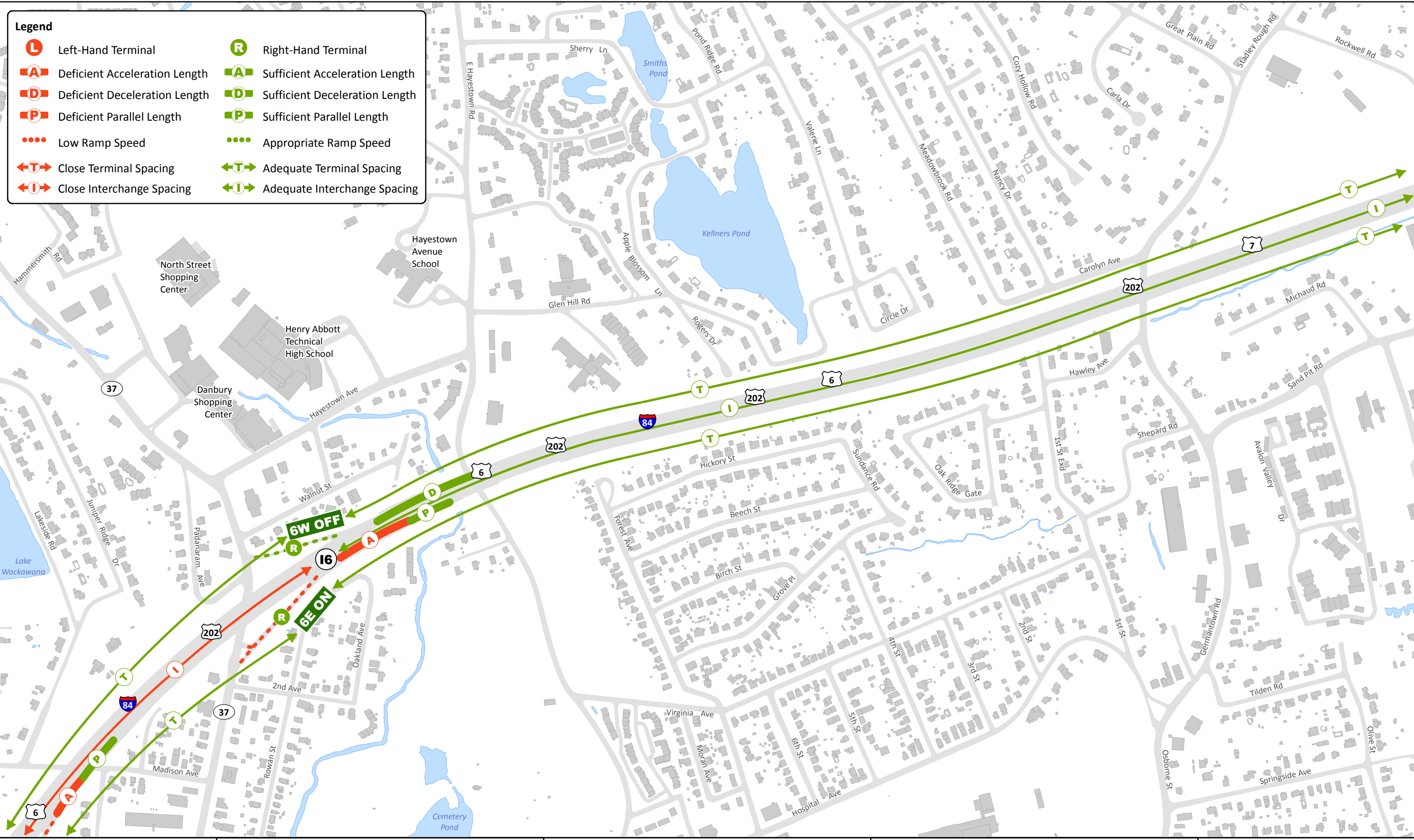
Ramp Geometry
Figure 14

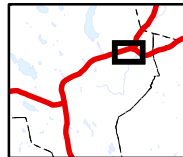
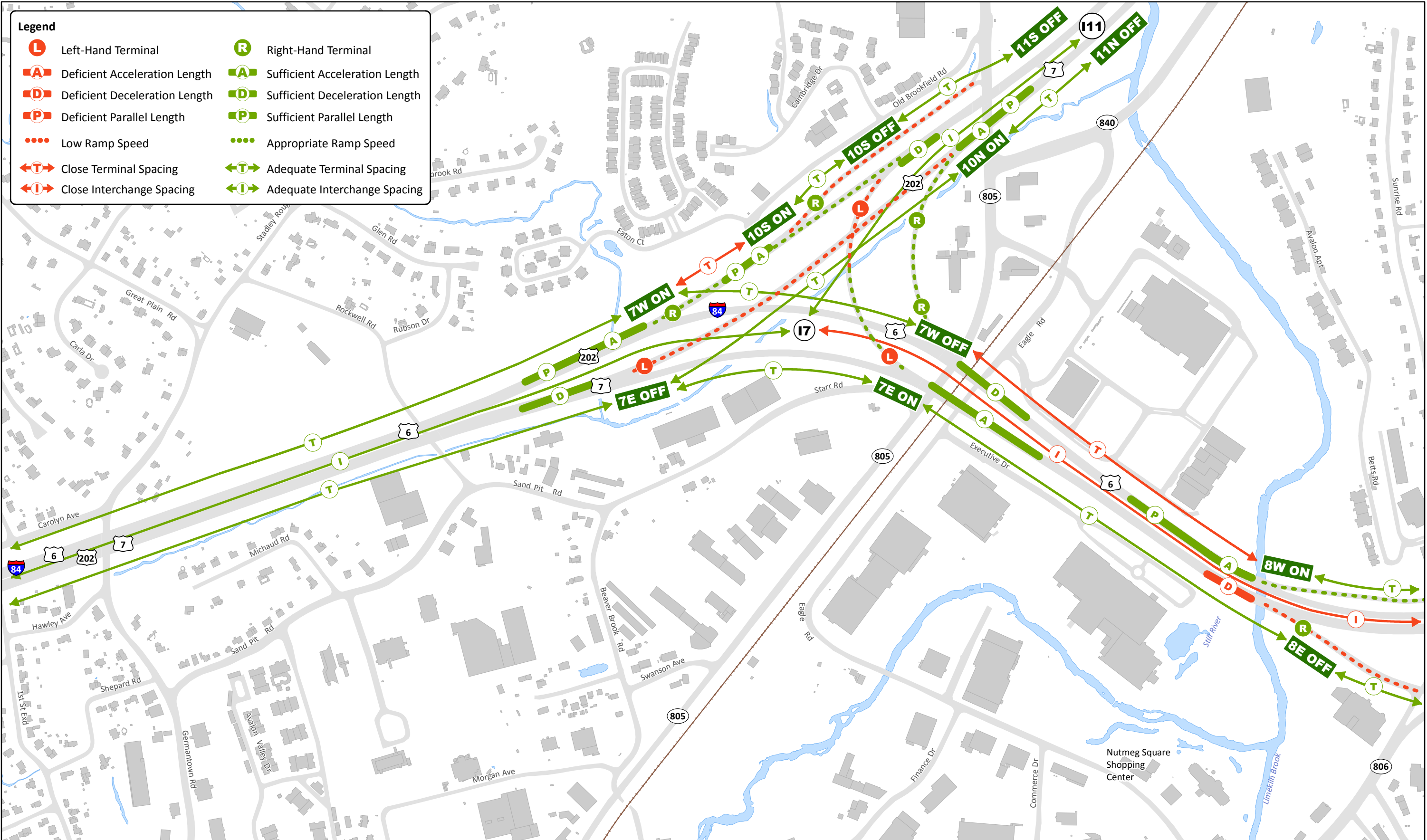


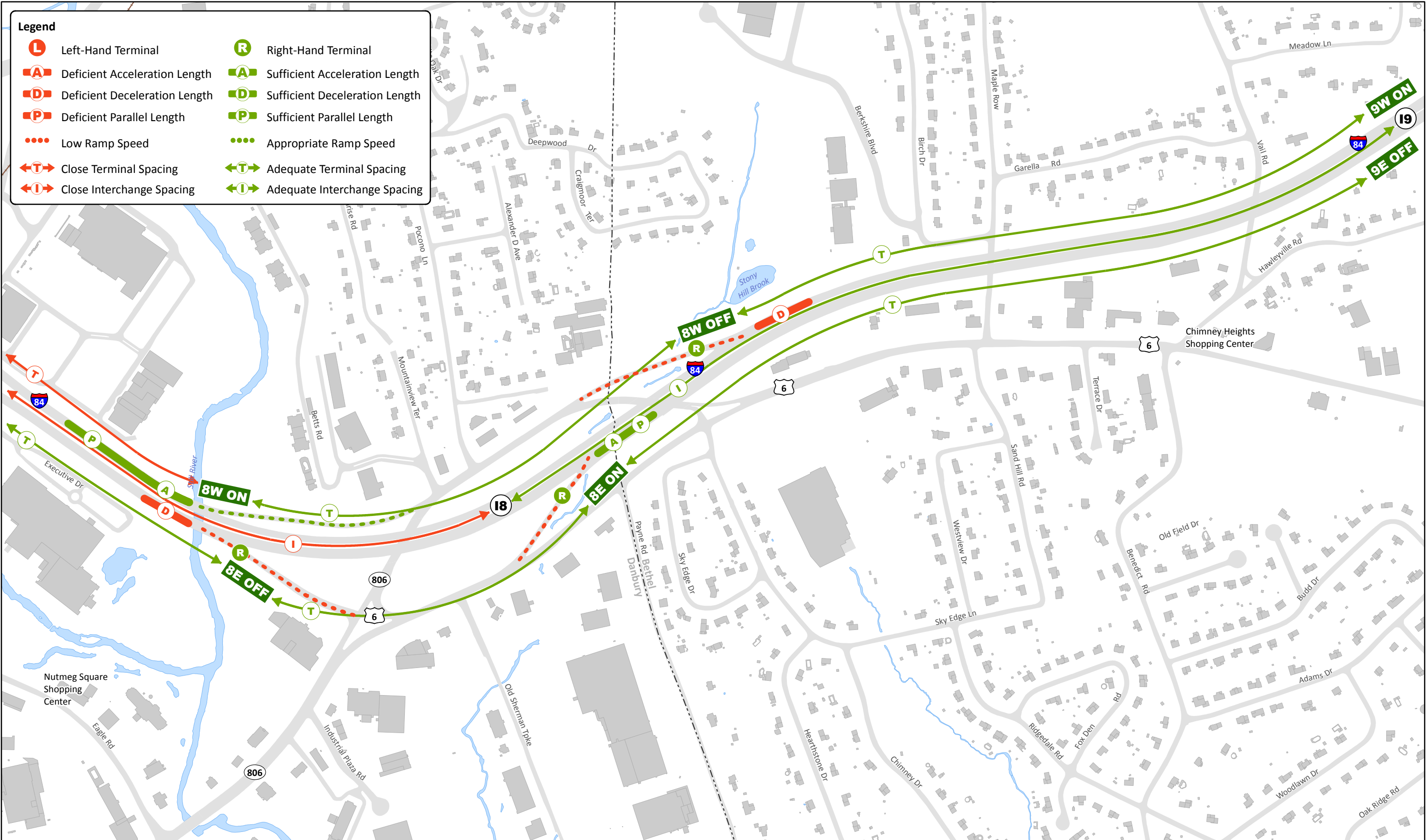
1 inch = 500 feet

0 250 500
Feet









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Ramp Geometry
Figure 18



1 inch = 500 feet
0 250 500
Feet



Data Sources:
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•Connecticut Department of Energy and Environmental Protection

Date: November 2017



Appendix B

CTDOT Highway Design Manual Figure 5A

Urban Freeway Design Criteria for New/Major Reconstruction:

Figure 5A
URBAN FREEWAYS
New Construction/Major Reconstruction

Design Element			*	Manual Section	Design Values (By Type of Area)	
					Suburban/Intermediate	Built-up
Design Controls	Design Forecast Year			6-3.02	20 Years	20 Years
	Design Speed		x	6-2.02	65 – 70 mph	50 – 55 mph
	Control of Access			6-4.0	Full Control	Full Control
	Level of Service			6-3.0	B – C	B – C
Cross Section Elements	Lane Width		x	10-1.01	12'	12'
	Shoulder Width (1)	Right	x	10-1.02	10'	10'
		Left — 4 Lanes	x		8' (4' Paved + 4' Graded)	8' (4' Paved + 4' Graded)
		Left — 6+ Lanes	x		10'	10'
	Typical Cross Slope	Travel Lane	x	10-1.01	1.5 – 2.0% for lanes adjacent to crown; 2.0% for lanes away from crown	
		Shoulder	x	10-1.02	4%; with CMB, 4% – 6% for left shoulder	4%; with CMB, 4% – 6% for left shoulder
	Median Width (includes left shoulders)			10-3.0	See Figure 5K - 90'	See Figure 5K - 90'
	Bridge Width/Cross Slope		x	10-4.01	Meet Approach Roadway Width and Cross Slope	
	Underpass Width			10-4.02	Meet Approach Roadway Width Plus Clear Zones	
	Right-of-Way Width			10-5.0	Desirable: 100' Beyond Edge of Traveled Way	
	Roadside Clear Zones		x	13-2.0	See Section 13-2.0	
	Fill/Cut Slopes			10-2.02	See Figure 5G	

* Controlling design criteria (see Section 6-6.0).

Footnote:

- (1) Shoulder Width. Where the truck volumes exceed 250 DDHV, both the right and left shoulders should be 12 ft. Where warranted for high-volume/incident management sites, use a 16-ft left shoulder.

Figure 5A (Continued)

URBAN FREEWAYS
New Construction/Major Reconstruction

Design Element			*	Manual Section	Design Values (Based on Design Speed)				
					70 mph	65 mph	60 mph	55 mph	50 mph
Measurement Elements	Stopping Sight Distance		x	7-1.0	730'	645'	570'	495'	425'
	Decision Sight Distance	Maneuver		7-2.0	U: 1445' SU: 1275'	U: 1365' SU: 1220'	U: 1280' SU: 1125'	U: 1135' SU: 980'	U: 1030' SU: 890'
		Stop			1410'	1275'	1150'	1030'	910'
	Minimum Radius (e = 6.0%)		x	8-2.02	2050'	1665'	1340'	1065'	840'
	Superelevation	e _{max}		8-2.02	6.0%	6.0%	6.0%	6.0%	6.0%
		Rate	x		See Figure 8-2A				
	Horizontal Sight Distance			8-2.04	See Section 8-2.04				
	Maximum Grade		x	9-2.03	4%	4%	4%	5%	5%
Footnote:									
(1) <u>Shoulder Width</u> . Where the truck volumes exceed 250 DDHV, both the right and left shoulders should be 12 ft. Where warranted for high-volume/incident management sites, use a 16-ft left shoulder.									
Minimum Vertical Clearance:		New Highway Bridge	x	9-4.0	16'-3"				
Freeway Under ...		Existing Highway Bridge	x		16'-0"				
		Pedestrian Bridge	x		17'-6"				
		Overhead Signs	x		18'-0"				
Minimum Vertical Clearance (Freeway over Railroad)			x	9-4.0	23'-0"				

* Controlling design criteria (see Section 6-6.0).

U: Urban SU: Suburban

Exit and Entrance Travel Lane and Shoulder Width Design Criteria:

12-4.02 Cross Section

Figure 12-4B presents the typical cross section for ramps. The following will also apply to the ramp cross section:

1. Width. The minimum paved width of a one-way, one-lane ramp will be 26 ft. For pavement marking purposes, this will normally be distributed as 4 ft – 12 ft – 10 ft (i.e., 4-ft left shoulder, 12-ft traveled way, 10-ft right shoulder when viewed in the direction of travel). This arrangement is illustrated on Figures 12-3C and 12-3F for exit and entrance ramp designs.

The minimum width of a one-way, two-lane ramp will be 38 ft. This width yields two 12-ft ramp lanes, a 4-ft left shoulder and an 10-ft right shoulder.

Minimum Horizontal Radius Design Criteria:

R* (ft)	V = 50 mph			V = 55 mph			V = 60 mph			V = 65 mph			V = 70 mph		
	e (%)	L (ft)		e (%)	L (ft)		e (%)	L (ft)		e (%)	L (ft)		e (%)	L (ft)	
		A	B		A	B		A	B		A	B		A	B
23000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
20000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
17000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
14000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	0	0
12000	NC	0	0	NC	0	0	NC	0	0	RC	56	84	RC	60	90
10000	NC	0	0	NC	0	0	RC	53	80	RC	56	84	2.1	63	95
8000	NC	0	0	RC	51	77	RC	53	80	2.3	64	96	2.5	75	113
6000	RC	48	72	2.2	56	84	2.6	69	104	2.9	81	121	3.2	96	144
5000	2.2	53	79	2.6	66	100	3.0	80	120	3.4	95	142	3.7	111	167
4000	2.7	65	97	3.1	79	119	3.6	96	144	4.0	112	167	4.4	132	198
3500	3.0	72	108	3.5	89	134	3.9	104	156	4.4	123	184	4.9	147	221
3000	3.4	82	122	3.9	100	149	4.3	115	172	4.8	134	201	5.3	159	238
2500	3.8	91	137	4.3	110	165	4.8	128	192	5.3	148	222	5.8	174	261
2000	4.3	103	155	4.9	125	188	5.4	144	216	5.8	162	243	R _{min} = 2050		
1800	4.6	110	165	5.1	130	195	5.6	149	224	6.0	167	251	R _{min} = 1665		
1600	4.9	118	176	5.4	138	207	5.9	157	236						
1400	5.2	125	187	5.7	146	218	6.0	160	240	R _{min} = 1340					
1200	5.6	134	202	5.9	151	226									
1000	6.0	142	212	R _{min} = 1065											
e _{max} = 6.0%		144	216												
		R _{min} = 840													

- Key:
- R

=

Radius of curve (ft)
- V

=

Design speed (mph)
- e

=

Superelevation rate (%)
- L

=

Minimum length of superelevation runoff (from adverse cross slope removed to full super) (ft)
- A

=

"L" for 2-lane, 2-way roadway rotated about the centerline
- B

=

"L" for 4-lane divided highway rotated about the two median edges
- NC

=

Normal crown
- RC

=

Remove (adverse) crown

* For curve radii intermediate between table values, use a straight-line interpolation to determine the superelevation rate.

Note: See Section 8-2.03.03 and Figure 8-2E for superelevation runoff lengths for conditions other than "A" and "B."

RATE OF SUPERELEVATION AND MINIMUM LENGTH OF RUNOFF

Figure 8-2A

Stopping Sight Distance on Crest Vertical Curves Design Criteria:

Table 3-34. Design Controls for Crest Vertical Curves Based on Stopping Sight Distance

Metric				U.S. Customary			
Design Speed (km/h)	Stopping Sight Distance (m)	Rate of Vertical Curvature, K^a		Design Speed (mph)	Stopping Sight Distance (ft)	Rate of Vertical Curvature, K^a	
		Calculated	Design			Calculated	Design
20	20	0.6	1	15	80	3.0	3
30	35	1.9	2	20	115	6.1	7
40	50	3.8	4	25	155	11.1	12
50	65	6.4	7	30	200	18.5	19
60	85	11.0	11	35	250	29.0	29
70	105	16.8	17	40	305	43.1	44
80	130	25.7	26	45	360	60.1	61
90	160	38.9	39	50	425	83.7	84
100	185	52.0	52	55	495	113.5	114
110	220	73.6	74	60	570	150.6	151
120	250	95.0	95	65	645	192.8	193
130	285	123.4	124	70	730	246.9	247
				75	820	311.6	312
				80	910	383.7	384

^a Rate of vertical curvature, K , is the length of curve per percent algebraic difference in intersecting grades (A), $K = L/A$.

Stopping Sight Distance on Sag Vertical Curves Design Criteria:

Table 3-36. Design Controls for Sag Vertical Curves

Metric				U.S. Customary			
Design Speed (km/h)	Stopping Sight Distance (m)	Rate of Vertical Curvature, K^a		Design Speed (mph)	Stopping Sight Distance (ft)	Rate of Vertical Curvature, K^a	
		Calculated	Design			Calculated	Design
20	20	2.1	3	15	80	9.4	10
30	35	5.1	6	20	115	16.5	17
40	50	8.5	9	25	155	25.5	26
50	65	12.2	13	30	200	36.4	37
60	85	17.3	18	35	250	49.0	49
70	105	22.6	23	40	305	63.4	64
80	130	29.4	30	45	360	78.1	79
90	160	37.6	38	50	425	95.7	96
100	185	44.6	45	55	495	114.9	115
110	220	54.4	55	60	570	135.7	136
120	250	62.8	63	65	645	156.5	157
130	285	72.7	73	70	730	180.3	181
				75	820	205.6	206
				80	910	231.0	231

^a Rate of vertical curvature, K , is the length of curve (m) per percent algebraic difference intersecting grades (A), $K = L/A$.

Roadside Clear Zone Design Criteria:

Design Speed	Design Year of ADT	Cuts or Fills (Negative Shelf)		Cuts or Fills (Positive Shelf)	
		1:6 or flatter	1:4	1:4	1:6 or flatter
40 mph or less	Under 750	7	7	7	7
	750-1500	10	12	10	10
	1500-6000	12	14	12	12
	Over 6000	14	16	14	14
45 – 50 mph	Under 750	10	12	8	10
	750-1500	14	16	12	14
	1500-6000	16	20	14	16
	Over 6000	20	24	18	20
55 mph	Under 750	12	14	10	10
	750-1500	16	20	14	16
	1500-6000	20	24	16	20
	Over 6000	22	26	20	22
60 mph	Under 750	16	20	12	14
	750-1500	20	26	16	20
	1500-6000	26	30	18	24
	Over 6000	30	30	24	26
65 – 70 mph	Under 750	18	20	14	14
	750-1500	24	28	18	20
	1500-6000	28	30	22	26
	Over 6000	30	30	26	28

Notes:

1. All distances are measured from the edge of traveled way. See Section 13-2.02, Comment #5.
2. See Section 13-2.02, Comment #2, for application of clear zone criteria on fill slopes.
3. See Figure 5H for illustration of a cut section with a positive shelf. See Section 13-2.02, Comment #3, on cut slopes and ditch sections.
4. The values in the table apply to all facilities both urban and rural. See Section 13-2.02, Comment #4, for utility poles in urban areas.

RECOMMENDED CLEAR ZONE DISTANCES (ft)

Figure 13-2A

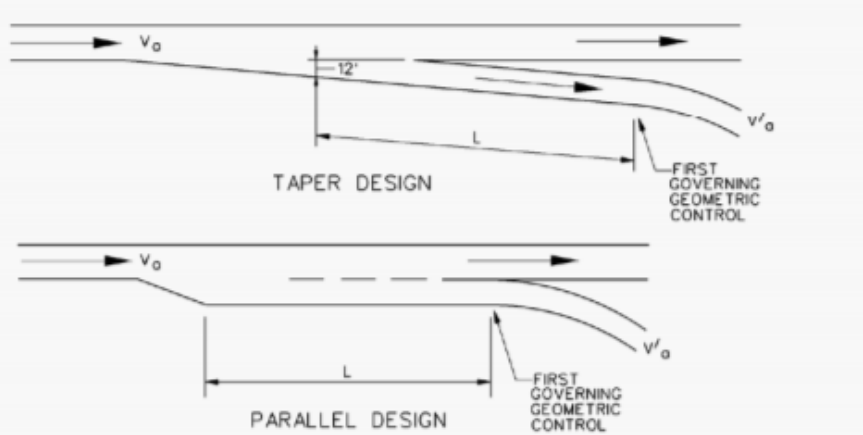
Deceleration Lane Design Criteria:

Highway Design Speed (mph) (V)	Speed Reached (mph) (V _a)	L = Deceleration Length (ft)								
		For Design Speed of First Governing Geometric Control (mph) (V')								
		Stop	15	20	25	30	35	40	45	50
		For Average Running Speed on Exit Curve (mph) (V' _a)								
		0	14	18	22	26	30	36	40	44
30	28	235	200	170	140	—	—	—	—	—
35	32	280	250	210	185	150	—	—	—	—
40	36	320	295	265	235	185	155	—	—	—
45	40	385	350	325	295	250	220	—	—	—
50	44	435	405	385	355	315	285	225	175	—
55	48	480	455	440	410	380	350	285	235	—
60	52	530	500	480	460	430	405	350	300	240
65	55	570	540	520	500	470	440	390	340	280
70	58	615	590	570	550	520	490	440	390	340

Notes:

1.
- The deceleration lengths are calculated from the distance needed for a passenger car to decelerate from the average running speed of the highway mainline to the average running speed of the first governing geometric control.
2.
- These values are for grades less than 3%. See Figure 12-3B for steeper upgrades or downgrades.

MINIMUM LENGTH OF DECELERATION LANES
Figure 12-3A



Deceleration Lane Design Criteria:

Direction of Grade	Ratio of Deceleration Lane Length on Grade to Length on Level			
	< 3%	$3\% \leq G < 4\%$	$5\% \leq G < 6\%$	$G \geq 6\%$
Upgrade	1.0	0.9	0.8	0.7
Downgrade	1.0	1.2	1.35	1.5

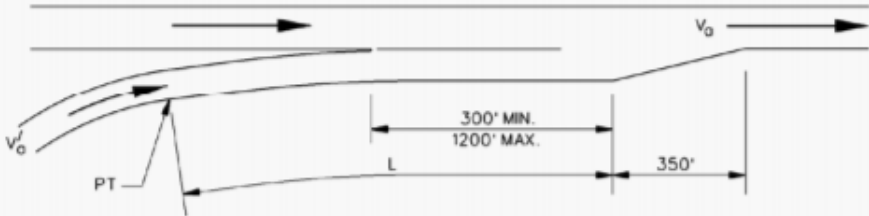
Notes:

1.
- Table applies to all highway design speeds.
2.
- The "grade" in the table is the average grade over the distance used for measuring the length of the deceleration lane. See Figure 12-3C.

GRADE ADJUSTMENTS ON DECELERATION LANES
Figure 12-3B

Acceleration Lane Design Criteria:

Highway Design Speed (mph) (V)	Speed Reached (mph) (V _a)	L = Acceleration Length (ft)								
		For Entrance Curve Design Speed (mph)								
		Stop	15	20	25	30	35	40	45	50
		And Initial Speed (mph) (V' _a)								
		0	14	18	22	26	30	36	40	44
30	23	180	140	–	–	–	–	–	–	–
35	27	280	220	160	–	–	–	–	–	–
40	31	360	300	270	210	120	–	–	–	–
45	35	560	490	440	380	280	160	–	–	–
50	39	720	660	610	550	450	350	130	–	–
55	43	960	900	810	780	670	550	320	150	–
60	47	1200	1140	1100	1020	910	800	550	420	180
65	50	1410	1350	1310	1220	1120	1000	770	600	370
70	53	1620	1560	1520	1420	1350	1230	1000	820	580



Notes:

1. The acceleration lengths are calculated from the distance needed for a passenger car to accelerate from the average running speed of the entrance curve to a speed of 5 mph below the average running speed on the mainline.
2. These values are for grades less than 3%. See Figure 12-3E for steeper upgrades or downgrades.
3. Use the value of L or 300 ft beyond the 2-ft nose, whichever is greater.

MINIMUM LENGTH OF ACCELERATION LANES

Figure 12-3D

Acceleration Lane Design Criteria:

Design Speed Of Highway (mph)	Acceleration Lanes				
	Ratio of Length on Grade to Length for Design Speed of Entrance Ramp Curve (mph)				
	20	30	40	50	All Speeds
3% to 4% upgrade					
40	1.3	1.3	–	–	0.7
45	1.3	1.35	–	–	0.675
50	1.3	1.4	1.4	–	0.65
55	1.35	1.45	1.45	–	0.625
60	1.4	1.5	1.5	1.6	0.6
65	1.45	1.55	1.6	1.7	0.6
70	1.5	1.6	1.7	1.8	0.6
5% to 6% upgrade					
40	1.5	1.5	–	–	0.6
45	1.5	1.6	–	–	0.575
50	1.5	1.7	1.9	–	0.55
55	1.6	1.8	2.05	–	0.525
60	1.7	1.9	2.2	2.5	0.5
65	1.85	2.05	2.4	2.75	0.5
70	2.0	2.2	2.6	3.0	0.5
5% to 6% downgrade					

- Notes:
1. No adjustment is needed on grades less than 3%.
 2. The “grade” in the table is the average grade measured over the distance for which the acceleration length applies. See Figure 12-3F.

GRADE ADJUSTMENTS ON ACCELERATION LANES

Figure 12-3E

Appendix C

Controlling Design Criteria for I-84, US Route 7, and Entrance and Exit Ramps

I-84 Controlling Design Criteria

Interstate 84 from Exit 3 through Exit 8 has a functional classification of an Urban Interstate Principal Arterial (Urban Freeway) and will be evaluated by the criteria for major reconstruction. All controlling design criteria are taken from Figure 5A of the Connecticut Department of Transportation Highway Design Manual (HDM) 2003 Edition (Including Revisions to February 2013) and AASHTO's A Policy on Geometric Design of Highways and Streets (Greenbook) 2011 6th Edition. Controlling criteria determined from Section 6-6.02 of the HDM.

I-84 Eastbound & Westbound Controlling Design Criteria

Controlling Design Criteria		Required Values
Functional Classification		Urban Interstate Principal Arterial (Urban Freeway)
1.	Design Speed	Suburban/Intermediate: 65 mph -70 mph Built-up: 50 mph -55 mph
2.	Travel Lane Width	12'
	Right Shoulder Width ⁽¹⁾	10'
	Left Shoulder Width ⁽¹⁾	2 Travel Lanes - 8' (4' Paved + 4' Graded) 3+ Travel lanes - 10'
3.	Auxiliary Lane Width	Not Applicable on Urban Freeways
	Auxiliary Shoulder Width	Not Applicable on Urban Freeways
4.	Bridge Width/Cross Slope	Meets Approach Roadway Width and Cross Slope
5.	Structural Capacity	See Appendix X for Structural Capacity
6.	Minimum Radius e _{max} =6%	70 mph: 2050' 65 mph: 1665' 60 mph: 1340' 55 mph: 1065' 50 mph: 840'
	Compound Curves	Radius of flatter circular arc should not be more than 50% greater than that of the sharper arc.
7.	Stopping Sight Distance at Crest Vertical Curves & Corresponding Minimum K Value (Rate of Vertical Curvature)	70 mph: 730' K: 247 65 mph: 645' K: 193 60 mph: 570' K: 151 55 mph: 495' K: 114 50 mph: 425' K: 84

	Stopping Sight Distance at Sag Vertical Curves & Corresponding Minimum K Value (Rate of Vertical Curvature)	70 mph: 730' K: 181 65 mph: 645' K: 157 60 mph: 570' K: 136 55 mph: 495' K: 115 50 mph: 425' K: 96
8.	Maximum Grade	70 mph: 4% 65 mph: 4% 60 mph: 4% 55 mph: 5% 50 mph: 5%
9.	Stopping Sight Distance (Level Grade)	70 mph: 730' 65 mph: 645' 60 mph: 570' 55 mph: 495' 50 mph: 425'
10.	Travel Lane Cross Slope	1.5% - 2% lanes adjacent to crown, 2% lanes away from crown
	Right Shoulder Cross Slope	Without Curbing - 4% With Curbing - 6%
	Left Shoulder Cross Slope	4% - 6%
11.	Superelevation Rate	e=6%
	Superelevation Transition Length	See Section 8-2.03.03 of the Highway Design Manual
12.	Minimum Vertical Clearance For Freeway Under	New Highway Bridge: 16'-3" Existing Highway Bridge: 16'-0" Pedestrian Bridge: 17'-6" Overhead Signs: 18'-0"
	Minimum Vertical Clearance for Freeway Over Railroad	23'-0"
13.	Accessibility Requirements for Disabled Individuals	Not Applicable on Urban Freeways
14.	Roadside Clear Zone (for ADT > 6000)	Negative Shelf 65 – 70 mph: 30' 60 mph: 30' 55 mph: 26' 45-50 mph: 24' Positive Shelf 65 – 70 mph: 28' 60 mph: 26' 55 mph: 22' 45-50 mph: 20'
15.	Intersection Sight Distance	Not Applicable on Urban Freeways

⁽¹⁾ Where the truck volumes exceed 250 DDHV, both right and left shoulders should be 12'.

US Route 7 Controlling Design Criteria

Route 7 has a functional classification of an Urban Expressway Principal Arterial (Multi-Lane Principal Urban Arterial) and will be evaluated by the criteria for major reconstruction. All controlling design criteria are taken from Figure 5A of the Connecticut Department of Transportation Highway Design Manual (HDM) 2003 Edition (Including Revisions to February 2013) and AASHTO’s A Policy on Geometric Design of Highways and Streets (Greenbook) 2011 6th Edition. Controlling criteria determined from Section 6-6.02 of the HDM.

US Route 7 Northbound & Southbound Controlling Design Criteria

Controlling Design Criteria		Required Values
Functional Classification		Urban Expressway Principal Arterial (Urban Freeway)
1.	Design Speed	Suburban/Intermediate: 65 mph -70 mph Built-up: 50 mph -55 mph
2.	Travel Lane Width	12'
	Right Shoulder Width ⁽¹⁾	10'
	Left Shoulder Width ⁽¹⁾	2 Travel Lanes - 8' (4' Paved + 4' Graded) 3+ Travel lanes - 10'
3.	Auxiliary Lane Width	Not Applicable on Urban Freeways
	Auxiliary Shoulder Width	Not Applicable on Urban Freeways
4.	Bridge Width/Cross Slope	Meets Approach Roadway Width and Cross Slope
5.	Structural Capacity	See Appendix X for Structural Capacity
6.	Minimum Radius e _{max} =6%	70 mph: 2050' 65 mph: 1665' 60 mph: 1340' 55 mph: 1065' 50 mph: 840'
	Compound Curves	Radius of flatter circular arc should not be more than 50% greater than that of the sharper arc.
7.	Stopping Sight Distance at Crest Vertical Curves & Corresponding Minimum K Value (Rate of Vertical Curvature)	70 mph: 730' K: 247 65 mph: 645' K: 193 60 mph: 570' K: 151 55 mph: 495' K: 114 50 mph: 425' K: 84
	Stopping Sight Distance at Sag Vertical Curves & Corresponding Minimum K Value (Rate of Vertical Curvature)	70 mph: 730' K: 181 65 mph: 645' K: 157 60 mph: 570' K: 136 55 mph: 495' K: 115 50 mph: 425' K: 96
8.	Maximum Grade	70 mph: 4% 65 mph: 4% 60 mph: 4% 55 mph: 5% 50 mph: 5%

9.	Stopping Sight Distance (Level Grade)	70 mph: 730' 65 mph: 645' 60 mph: 570' 55 mph: 495' 50 mph: 425'
10.	Travel Lane Cross Slope	1.5% - 2% lanes adjacent to crown, 2% lanes away from crown
	Right Shoulder Cross Slope	Without Curbing - 4% With Curbing - 6%
	Left Shoulder Cross Slope	4% - 6%
11.	Superelevation Rate	e=6%
	Superelevation Transition Length	See Section 8-2.03.03 of the Highway Design Manual
12.	Minimum Vertical Clearance For Freeway Under	New Highway Bridge: 16'-3" Existing Highway Bridge: 16'-0" Pedestrian Bridge: 17'-6" Overhead Signs: 18'-0"
	Minimum Vertical Clearance for Freeway Over Railroad	23'-0"
13.	Accessibility Requirements for Disabled Individuals	Not Applicable on Urban Freeways
14.	Roadside Clear Zone (for ADT > 6000)	Negative Shelf 65 – 70 mph: 30' 60 mph: 30' 55 mph: 26' 45-50 mph: 24' Positive Shelf 65 – 70 mph: 28' 60 mph: 26' 55 mph: 22' 45-50 mph: 20'
15.	Intersection Sight Distance	Not Applicable on Urban Freeways

⁽¹⁾ Where the truck volumes exceed 250 DDHV, both right and left shoulders should be 12'.

Entrance and Exit Ramp Controlling Design Criteria

Entrance and exit ramp design elements are taken from Section 12-3.03 of the HDM. Other design elements were taken from Sections 12-1.01.01, 12-2.04, and 12-4.01 of the HDM.

Critical Ramp Design Criteria

Design Criteria		Required Values
1.	Minimum Length of Deceleration for an Exit Ramp	See Figure 12-3A of the Highway Design Manual
2.	Deflection (Taper) Angle for a Taper Exit Ramp	2 to 5 degrees
3.	Minimum Length of Acceleration for an Entrance Ramp	See Figure 12-3D of the Highway Design Manual
4.	Parallel Portion of the Acceleration Lane for an Entrance Ramp	300'

Ramp Design Elements

Design Criteria		Required Values
1.	Terminal Side of Freeway	Right
2.	Interchange Spacing	1 mile
3.	Ramp Design Speed	At Least Half of Mainline Design Speed
4.	Capacity	Adequacy

Appendix D

I-84 Mainline Geometry Backup Calculations

Design Speed: I-84 Eastbound					
Segment No.	Segment	Freeway Area Type	Required Design Speed	Posted Speed Limit	Notes
1	Kenosia Avenue Overpass to Exit 3 Off-Ramp	Intermediate	65-70 mph	50 mph	Does not meet Design Speed criteria for freeway area type
2	Exit 3 Off-Ramp to Exit 4 Off-Ramp	Intermediate	65-70 mph	50 mph	Does not meet Design Speed criteria for freeway area type
3	Exit 4 Off-Ramp to Kohanza Street Underpass	Built-up	50-55 mph	55 mph	
4	Kohana Street Underpass to Tamarack Avenue Underpass	Built-up	50-55 mph	55 mph	
5	Tamarack Avenue Underpass to Exit 7 Off-Ramp	Built-up	50-55 mph	55 mph	
6	Exit 7 Off-Ramp to Exit 8 Off-Ramp	Intermediate	65-70 mph	55 mph	Does not meet Design Speed criteria for freeway area type
7	Exit 8 Off-Ramp to Vale Road Overpass	Intermediate	65-70 mph	65 mph	

Design Speed: I-84 Westbound					
Segment No.	Segment	Freeway Area Type	Required Design Speed	Posted Speed Limit	Notes
1	Kenosia Avenue Overpass to Exit 3 On-Ramp	Intermediate	65-70 mph	50 mph	Does not meet Design Speed criteria for freeway area type
2	Exit 3 On-Ramp to Exit 4 On-Ramp	Intermediate	65-70 mph	50 mph	Does not meet Design Speed criteria for freeway area type
3	Exit 4 On-Ramp to Kohanza Street Underpass	Built-up	50-55 mph	55 mph	
4	Kohanza Street Underpass to Tamarack Avenue Underpass	Built-up	50-55 mph	55 mph	
5	Tamarack Avenue Underpass to Exit 7 On-Ramp	Built-up	50-55 mph	55 mph	
6	Exit 7 On-Ramp to Exit 8 On-Ramp	Intermediate	65-70 mph	55 mph	Does not meet Design Speed criteria for freeway area type
7	Exit 8 On-Ramp to Vale Road Overpass	Intermediate	65-70 mph	65 mph	

Travel Lane & Shoulder Widths: I-84 Eastbound								
Segment No.	Segment	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
1	Kenosia Avenue Overpass to Exit 3 Off-Ramp	12'	12'	12'	10'	12'	12'	Does not meet required left shoulder width criteria
2	Exit 3 Off-Ramp to Exit 4 Off-Ramp	12'	12'	12'	4'	12'	12'	Does not meet required left shoulder width criteria
	Exit 3 Off-Ramp	12'	12'	4'	4'	10'	7'	Does not meet required right shoulder width criteria
	Exit 3 On-Ramp	12'	12'	4'	4'	10'	5'	Does not meet required right shoulder width criteria
3	Exit 4 Off-Ramp to Kohanza Street Underpass	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
	Exit 4 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 4 On-Ramp	12'	12'	4'	4'	10'	8'	Does not meet required right shoulder width criteria
4	Kohanza Street Underpass to Tamarack Avenue Underpass	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
	Exit 5 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 5 On-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 6 On-Ramp	12'	12'	4'	3'	10'	10'	Does not meet required left shoulder width criteria
5	Tamarack Avenue Underpass to Exit 7 Off-Ramp	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
6	Exit 7 Off-Ramp to Exit 8 Off-Ramp	12'	12'	12'	6'	12'	10'	Does not meet required left and right shoulder width criteria
	Exit 7 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 7 On-Ramp	12'	12'	4'	4'	10'	10'	
7	Exit 8 Off-Ramp to Vale Road Overpass	12'	12'	12'	8'	12'	12'	Does not meet required left shoulder width criteria
	Exit 8 Off-Ramp	12'	15'	4'	4'	10'	7'	Does not meet required left shoulder width criteria
	Exit 8 On-Ramp	12'	15'	4'	4'	10'	10'	

Travel Lane & Shoulder Widths: I-84 Westbound								
Segment No.	Segment	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
1	Kenosia Avenue Overpass to Exit 3 On-Ramp	12'	12'	12'	10'	12'	12'	Does not meet required left shoulder width criteria
2	Exit 3 On-Ramp to Exit 4 On-Ramp	12'	12'	12'	4'	12'	10'	Does not meet required left and right shoulder width criteria
	Exit 3 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 3 On-Ramp	12'	12'	4'	4'	10'	10'	
3	Exit 4 On-Ramp to Kohanza Street Underpass	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
	Exit 4 Off-Ramp	12'	12'	4'	1'	10'	8'	Does not meet required right shoulder or left shoulder width criteria
	Exit 4 On-Ramp	12'	12'	4'	3'	10'	8'	Does not meet required right shoulder or left shoulder width criteria
4	Kohanza Street Underpass to Tamarack Avenue Underpass	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
	Exit 5 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 5 On-Ramp	12'	12'	4'	4'	10'	8'	Does not meet required right shoulder width criteria
	Exit 6 Off-Ramp	12'	12'	4'	4'	10'	10'	
5	Tamarack Avenue Underpass to Exit 7 On-Ramp	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria
6	Exit 7 On-Ramp to Exit 8 On-Ramp	12'	12'	12'	6'	12'	10'	Does not meet required left and right shoulder width criteria
	Exit 7 Off-Ramp	12'	12'	4'	4'	10'	10'	
	Exit 7 On-Ramp	12'	12'	4'	4'	10'	10'	
7	Exit 8 On-Ramp to Vale Road Overpass	12'	12'	12'	4'	12'	12'	Does not meet required left shoulder width criteria
	Exit 8 Off-Ramp	12'	15'	4'	0'	10'	0'	Does not meet required left and right shoulder width criteria
	Exit 8 On-Ramp	12'	15'	4'	4'	10'	10'	

I-84 Eastbound/Westbound Truck DDHV													
Location	Segment No.	Direction	Peak Period	Peak Volume	Peak Volume in Other Direction	Direcitional Split	ADT (WB)	ADT (EB)	K Factor	Total ADT	Total DDHV	Truck Percentage	Truck DDHV
West of Exit 3 Interchange	1	Eastbound	AM	3,570	1,440	71%	40,900	39,400	0.091	80,300	5,185	8%	415
		Westbound	PM	3,690	2,610	59%	40,900	39,400	0.090	80,300	4,243	5%	212
West of Exit 4 Interchange	2	Eastbound	PM	5,070	2,970	63%	51,850	53,150	0.095	105,000	6,316	5%	316
		Westbound	AM	5,040	2,120	70%	51,850	53,150	0.097	105,000	7,184	7%	503
West of Exit 5 Interchange	3	Eastbound	PM	5,540	3,590	61%	60,200	59,100	0.094	119,300	6,786	5%	339
		Westbound	AM	5,600	2,490	69%	60,200	59,100	0.093	119,300	7,682	7%	538
West of Exit 6 Interchange	4	Eastbound	PM	4,910	3,470	59%	55,750	53,350	0.092	109,100	5,883	5%	294
		Westbound	AM	4,730	2,460	66%	55,750	53,350	0.085	109,100	6,089	7%	426
West of Exit 7 Interchange	5	Eastbound	PM	5,670	4,270	57%	65,750	62,850	0.090	128,600	6,618	4%	265
		Westbound	AM	5,480	3,230	63%	65,750	62,850	0.083	128,600	6,744	5%	337
West of Exit 8 Interchange	6	Eastbound	PM	4,330	3,190	58%	49,450	49,750	0.087	99,200	4,971	7%	348
		Westbound	AM	4,010	2,830	59%	49,450	49,750	0.081	99,200	4,716	9%	424

Directional Split = Peak Volume / (Peak Volume + Peak Volume in Other Direction During Same Period)

K Factor = Peak Volume / ADT

Total ADT = ADT (WB) + ADT (EB)

Total DDHV = Directional Split * K Factor * Total ADT

Truck DDHV = Total DDHV * Truck Percentage

Structure Travel Lane & Shoulder Widths: I-84 Eastbound										
Segment No.	Structure No.	Carries	Crossing	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
1	01182	I-84 EB	Housatonic Railroad	12'	12'	12'	10'	12'	10'	Does not meet required left shoulder and right shoulder width criteria
2	00458	I-84 EB	Lake Avenue (Route 202/Route	12'	12'	12'	4'	12'	12'	Does not meet required left shoulder width criteria
3	01184	I-84 EB/WB	Franklin Street	12'	12'	12'	10'	12'	12'	Does not meet required left shoulder width criteria. Bridge also included under I-84 Westbound Structures.
4	01185	I-84 EB/WB	Kohanza Street	12'	12'	12'	10'	12'	12'	Does not meet required left shoulder width criteria. Bridge also included under I-84 Westbound Structures.
	01186	I-84 EB/WB	Starr Avenue	12'	12'	12'	9'	12'	8'+/-	Does not meet required left shoulder and right shoulder width criteria. Bridge also included under I-84 Westbound Structures.
	00961	I-84 EB/WB	Main Street (Route 39)	12'	12'	12'	10'	12'	16'	Does not meet required left shoulder width criteria. Bridge also included under I-84 Westbound Structures.
	00956	I-84 EB/WB	North Street (Route 37)	12'	12'	12'	10'	12'	16'	Does not meet required left shoulder width criteria. Bridge also included under I-84 Westbound Structures.
	01190	I-84 EB/WB	Tamarack Avenue	12'	12'	12'	10'	12'	15'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Westbound Structures.
5	01191	I-84 EB/WB	Great Plain Road	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Westbound Structures.
	01192	I-84 EB/WB	Rockwell Road	12'	12'	12'	12'	12'	12'	Bridge also included under I-84 Westbound Structures.
6	01195	I-84 EB	Federal Road/Eagle Road/Housatonic Railroad	12'	12'	12'	6'	12'	10'	Does not meet required left and right shoulder width criteria
7	01198	I-84 EB	Still River	12'	12'	12'	5'	12'	3'	Does not meet required left shoulder and right shoulder width criteria.

Structure Travel Lane & Shoulder Widths: I-84 Westbound										
Segment No.	Structure No.	Carries	Crossing	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
1	01181	I-84 WB	Housatonic Railroad	12'	12'	12'	8'	12'	10'	Does not meet required left shoulder and right shoulder width criteria.
2	00457	I-84 WB	Lake Avenue (Route 202/Route 6)	12'	12'	12'	8'	12'	8'	Does not meet required left shoulder and right shoulder width criteria
3	01184	I-84 EB/WB	Franklin Street	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Eastbound Structures.
4	01185	I-84 EB/WB	Kohanza Street	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Eastbound Structures.
	01186	I-84 EB/WB	Starr Avenue	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Eastbound Structures.
	00961	I-84 EB/WB	Main Street (Route 39)	12'	12'	12'	8'	12'	10'	Does not meet required left shoulder and right shoulder width criteria. Bridge also included under I-84 Eastbound Structures.
	00956	I-84 EB/WB	North Street (Route 37)	12'	12'	12'	12'	12'	10'	Does not meet required right shoulder width criteria. Bridge also included under I-84 Eastbound Structures.
	01190	I-84 EB/WB	Tamarack Avenue	12'	12'	12'	12'	12'	12'	Bridge also included under I-84 Eastbound Structures.
5	01191	I-84 EB/WB	Great Plain Road	12'	12'	12'	12'	12'	12'	Bridge also included under I-84 Eastbound Structures.
	01192	I-84 EB/WB	Rockwell Road	12'	12'	12'	12'	12'	12'	Bridge also included under I-84 Eastbound Structures.
6	00547	I-84 WB	Route 7 NB	12'	12'	12'	8'	12'	10'	Does not meet required left shoulder and right shoulder width criteria.
	01196	I-84 WB	Federal Road/Eagle Road/Housatonic Railroad	12'	12'	12'	5'	12'	10'	Does not meet required left and right shoulder width criteria
7	01197	I-84 WB	Still River	12'	12'	12'	5'	12'	7'	Does not meet required left and right shoulder width criteria

Horizontal Alignment: I-84 Eastbound								
Segment No.	Horizontal Curve #	Location of Horizontal Curve	Radius of Curve (ft)	CTDOT HDM/AASHTO Greenbook Design Speed Based on Radius (mph)	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Posted Speed Limit (mph)	Compound Curves Not Meeting 1.5:1 Ratio	Notes
1	1	1,430' after the Kenosia Avenue overpass	3,798	70 mph	65-70 mph	50 mph	N/A	
	2	50' prior to Exit 3 off-ramp diverge	1,454	60 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed
2	3	320' after the Exit 3 off-ramp diverge	1,466	60 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed
	4	990' after the Exit 3 off-ramp diverge	1,000	50 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed
	5	225' after the Exit 3 on-ramp converge	1,432	60 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed
3	6 ⁽²⁾	Adjacent to the Exit 4 on-ramp	1,611	60 mph	50-55 mph	55 mph	Does not meet 1.5: 1 ratio	Does not meet compound curve requirements per Section 8-2.02.03 of the HDM
	7 ⁽²⁾	Between Exit 4 on-ramp and Exit 5 off-ramp	3,828	70 mph	50-55 mph	55 mph	Does not meet 1.5: 1 ratio	Does not meet compound curve requirements per Section 8-2.02.03 of the HDM
4	8	Adjacent to Exit 5 off-ramp	2,891	70 mph	50-55 mph	55 mph	N/A	
	9	Between Exit 5 on-ramp and Exit 6 on-ramp	5,704	70 mph	50-55 mph	55 mph	N/A	
5	10	2900' after the Exit 6 on-ramp converge	11,485	70 mph	50-55 mph	55 mph	N/A	
6	11	425' prior to the Exit 7 off-ramp diverge	2,000	65 mph	65-70 mph	55 mph	N/A	
	12	Between the Exit 7 off-ramp and Exit 7 on-ramp	1,788	65 mph	65-70 mph	55 mph	N/A	
	13	800' after the Exit 7 on-ramp	2,000	65 mph	65-70 mph	55 mph	N/A	
7	14	Adjacent to Exit 8 off-ramp	1,940	65 mph	65-70 mph	65 mph	N/A	
	15	615' after the Exit 8 on-ramp converge	2,843	70 mph	65-70 mph	65 mph	N/A	

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.
⁽²⁾ Curve 6 and Curve 7 are part of a compund curve. Per Section 8-2.02.03 of the HDM, when compound curves are used on mainline, the radius of the flatter circular arc (R1) should not be more than 50% greater than that of the sharper arc (R2) (R1 ≤ 1.5 R2). The radius of the flatter circular arc (Curve 7) is 2.38 times greater than the sharper arc (Curve 6).

Horizontal Alignment: I-84 Westbound								
Segment No.	Horizontal Curve #	Location of Horizontal Curve	Radius of Curve (ft)	CTDOT HDM/AASHTO Greenbook Design Speed Based on Radius (mph)	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Posted Speed Limit (mph)	Compound Curves Not Meeting 1.5:1 Ratio	Notes
1	1	1,430' before the Kenosia Avenue overpass	3,842	70 mph	65-70 mph	50 mph	N/A	
	2	125' after end of Exit 4 on-ramp	1,410	60 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed
2	3 ⁽²⁾	Adjacent to the end of the Exit 4 on-ramp	1,194	55 mph	65-70 mph	50 mph	Meets 1.5: 1 ratio	Horizontal curve does not meet the minimum radius for the required design speed
	4 ⁽²⁾	Adjacent to the beginning of the Exit 4 on-ramp	1,200	55 mph	65-70 mph	50 mph	Meets 1.5: 1 ratio	Horizontal curve does not meet the minimum radius for the required design speed
3	5 ⁽²⁾	Adjacent to the Exit 4 off-ramp	1,663	60 mph	50-55 mph	55 mph	Does not meet 1.5: 1 ratio	Does not meet compound curve requirements per Section 8-2.02.03 of the HDM
	6 ⁽²⁾	Between Exit 5 on-ramp and Exit 4 off-ramp	3,880	70 mph	50-55 mph	55 mph	Does not meet 1.5: 1 ratio	Does not meet compound curve requirements per Section 8-2.02.03 of the HDM
4	7	Adjacent to Exit 5 on-ramp	2,839	70 mph	50-55 mph	55 mph	N/A	
	8	Between Exit 6 off-ramp and Exit 5 on-ramp	5,756	70 mph	50-55 mph	55 mph	N/A	
5	9	2600' prior to the Exit 6 off-ramp diverge	11,433	70 mph	50-55 mph	55 mph	N/A	
6	10	875' after the Exit 7 on-ramp converge	2,000	65 mph	65-70 mph	55 mph	N/A	
	11	Between the Exit 7 off-ramp and Exit 7 on-ramp	1,800	65 mph	65-70 mph	55 mph	N/A	
7	12	Adjacent to Exit 8 on-ramp	1,869	65 mph	65-70 mph	65 mph	N/A	
	13	Adjacent to the Exit 8 off-ramp	2,899	70 mph	65-70 mph	65 mph	N/A	

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Curve 4 and Curve 5 are part of a compund curve. Per Section 8-2.02.03 of the HDM, when compound curves are used on mainline, the radius of the flatter circular arc (R1) should not be more than 50% greater than that of the sharper arc (R2) (R1 ≤ 1.5 R2). The radius of the flatter circular arc (Curve 5) is 2.33 times greater than the sharper arc (Curve 4).

Vertical Alignment: I-84 Eastbound												
Segment No.	Vertical Curve #	Location of Vertical Curve	Crest / Sag Vertical Cuve	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Length of Vertical Curve (ft)	K Value	Stopping Sight Distance (ft)	AASHTO Greenbook Required Stopping Sight Distance (ft) ⁽²⁾	AASHTO Greenbook Required Rate of Vertical Curvature (K) ⁽²⁾	Maximum Grade (%)	CTDOT / AASHTO Greenbook Maximum Allowable Grade (%) ⁽³⁾	Notes
1	1	1125' prior to the Exit 3 off-ramp diverge	Sag	65 mph	450	153.58	634	645	157	2.13%	4%	Sag vertical curve does not meet minimum K Value.
2	2	425' after the Exit 3 off-ramp diverge	Crest	65 mph	200	102.56	470	645	193	4.22%	4%	Crest vertical curve does not meet minimum K Value.
	3	1450' after the Exit 3 off-ramp diverge	Sag	65 mph	600	99.67	440	645	157			Crest vertical curve does not meet minimum K Value. Vertical grades exceed maximum allowable grade.
	4	At the Route 7 NB on-ramp converge	Crest	65 mph	700	188.17	637	645	193			Sag vertical curve does not meet minimum K Value. Vertical grades exceed maximum allowable grade.
3	5	1050' after the Route 7 NB on-ramp converge	Sag	55 mph	400	162.47	666	495	115	3.00%	5%	
	6	1265' after the Exit 4 on-ramp converge	Crest	55 mph	900	150.96	571	495	114			
	7	4255' after the Exit 4 on-ramp converge	Sag	55 mph	400	400.00	1506	495	115			
4	8	25' after the Exit 5 on-ramp converge	Sag	55 mph	500	120.13	514	495	115	2.90%	5%	
	9	1025' after the Exit 5 on-ramp converge	Crest	55 mph	500	158.13	584	495	114			
	10	2550' after the Exit 5 on-ramp converge	Sag	55 mph	300	76.92	356	495	115			Sag vertical curve does not meet minimum K Value.
5	11	2350' after Exit 6 on-ramp convergence	Crest	55 mph	900	152.54	574	495	114	3.00%	5%	
6	12	450' after Exit 7 off-ramp divergence	Sag	65 mph	600	100.00	441	645	157	3.00%	4%	Sag vertical curve does not meet minimum K Value.
	13	530' before Exit 7 on-ramp convergence	Crest	65 mph	750	150.00	569	645	193			Crest vertical curve does not meet minimum K Value.
	14	500' before Exit 8 off-ramp divergence	Crest	65 mph	400	800.00	1314	645	157			
7	15	100' before Exit 8 off-ramp divergence	Sag	65 mph	1000	166.67	681	645	157	4.00%	4%	
	16	80' before Exit 8 on-ramp convergence	Crest	65 mph	600	351.49	871	645	157			
	17	420' after Exit 8 on-ramp convergence	Sag	65 mph	400	181.24	733	645	157			
	18	2620' after Exit 8 on-ramp convergence	Crest	65 mph	600	240.00	720	645	193			

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Minimum Required Stopping Sight Distance and K Value based on Table 3-34 of AASHTO Greenbook for Crest Vertical Curves, and Table 3-36 of AASHTO Greenbook for Sag Vertical Curves

⁽³⁾ Maximum Allowable Grade Based on Design Speed

Vertical Alignment: I-84 Westbound												
Segment No.	Vertical Curve #	Location of Vertical Curve	Crest / Sag Vertical Cuve	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Length of Vertical Curve (ft)	K Value	Stopping Sight Distance (ft)	AASHTO Greenbook Required Stopping Sight Distance (ft) ⁽²⁾	AASHTO Greenbook Required Rate of Vertical Curvature (K) ⁽²⁾	Maximum Grade (%)	CTDOT / AASHTO Greenbook Maximum Allowable Grade (%) ⁽³⁾	Notes
1	1	2080' after the Route 7 NB on-ramp converge	Crest	65 mph	270	675.00	1207	645	193	2.13%	4%	
	2	1850' after the Route 7 NB on-ramp converge	Sag	65 mph	200	298.51	1149	645	157			
	3	1500' after the Route 7 NB on-ramp converge	Sag	65 mph	430	178.42	723	645	157			
2	4	At the Route 7 NB on-ramp converge	Crest	65 mph	400	188.31	637	645	193	1.46%	4%	Sag vertical curve does not meet minimum K Value or minimum stopping sight distance.
	5	190' prior to the Route 7 NB on-ramp converge	Sag	65 mph	200	129.52	548	645	157			
	6	400' prior to the Exit 4 on-ramp converge	Crest	65 mph	200	190.48	641	645	193			Crest vertical curve does not meet minimum K Value or minimum stopping sight distance.
3	7	1900' prior to the Exit 4 on-ramp converge	Sag	55 mph	600	243.70	955	495	115	3.00%	5%	
	8	1200' prior to the Exit 4 off-ramp diverge	Crest	55 mph	900	150.96	571	495	114			
	9	4200' prior to the Exit 4 off-ramp diverge	Sag	55 mph	400	400.00	1506	495	115			
4	10	1075' prior to the Exit 5 off-ramp diverge	Sag	55 mph	500	120.19	514	495	115	2.90%	5%	
	11	1200' after the Exit 6 off-ramp diverge	Crest	55 mph	500	158.23	584	495	114			
	12	300' prior to the Exit 6 off-ramp diverge	Sag	55 mph	400	102.56	450	495	115			Sag vertical curve does not meet minimum K Value
5	13	2150' prior to the Exit 6 off-ramp diverge	Crest	55 mph	900	152.54	574	495	114	3.00%	5%	
6	14	1000' after the Exit 7 on-ramp converge	Sag	65 mph	400	195.12	783	645	157	3.00%	4%	
	15	800' prior to the Exit 7 on-ramp converge	Sag	66 mph	400	144.82	603	645	157			
	16	100' after the Exit 7 off-ramp diverge	Crest	67 mph	700	183.63	630	645	193			
	17	775' prior to the Exit 7 off-ramp diverge	Crest	65 mph	400	800.00	1314	645	193			
7	18	200' prior to the Exit 8 on-ramp converge	Sag	65 mph	1000	166.67	681	645	157	4.00%	4%	
	19	1350' after the Exit 8 off-ramp diverge	Crest	65 mph	600	350.88	870	645	193			
	20	350' after the Exit 8 off-ramp diverge	Sag	65 mph	400	181.00	732	645	157			
	21	1750' prior to the Exit 8 off-ramp diverge	Crest	65 mph	600	200.00	657	645	193			

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.
⁽²⁾ Minimum Required Stopping Sight Distance and K Value based on Table 3-34 of AASHTO Greenbook for Crest Vertical Curves, and Table 3-36 of AASHTO Greenbook for Sag Vertical Curves
⁽³⁾ Maximum Allowable Grade Based on Design Speed

Stopping Sight Distance (SSD): I-84 Eastbound									
Segment No.	Controlling Geometric Feature	Obstructed SSD Location	Required Design Speed (mph)	Required SSD (feet)	Length Below Required SSD (feet)	Existing SSD (feet)	Equivalent Existing Design Speed (mph)	Posted Speed Limit (mph)	Notes
1	Concrete Barrier	Starting 850' before the Exit 3 off-ramp diverge	65	645	650	378	46	50	Sight distance not enough to meet required design speed or posted speed limit
2	Concrete Barrier	Starting 850' before the Exit 3 on-ramp converge	45	360	200	344	43	45	Exit 3 off-ramp; sight distance not enough to meet required design speed or posted speed limit
	Guiderail	Starting 2250' after the Exit 3 off-ramp diverge	65	645	1550	342	43	50	Sight distance not enough to meet required design speed or posted speed limit
3	2:1 Slope	N/A	55	495	0	521	56	55	Measured from outside lane
4	Concrete Barrier	N/A	55	495	0	754	71	55	
	Vertical Curve	N/A	55	495	0	624	63	55	Measured from middle lane
5	Vertical Curve	N/A	55	495	0	573	60	55	
6	Guiderail	Starting 1375' before the Exit 7 on-ramp converge	45	360	900	236	34	55	Exit 7 on-ramp; sight distance not enough to meet required design speed or posted speed limit
	Concrete Barrier	Starting 950' after the Exit 7 off-ramp diverge	65	645	1250	476	53	55	Sight distance not enough to meet required design speed or posted speed limit
7	Bridge Pier	Starting 600' after the Exit 8 off-ramp diverge	65	645	250	508	56	65	Sight distance not enough to meet required design speed or posted speed limit

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

Stopping Sight Distance (SSD): I-84 Westbound									
Segment No.	Controlling Geometric Feature	Obstructed SSD Location	Required Design Speed (mph)	Required SSD (feet)	Length Below Required SSD (feet)	Existing SSD (feet)	Equivalent Existing Design Speed (mph)	Posted Speed Limit (mph)	Notes
1	Concrete Barrier	N/A	65	645	0	697	68	50	
2	Concrete Barrier	Starting 1600' before the Exit 4 on-ramp converge	65	645	850	436	50	50	Sight distance not enough to meet required design speed
	Concrete Barrier	Starting 2200' before the Exit 3 on-ramp converge	45	360	900	276	37	50	Exit 3 off-ramp; no posted speed limit on ramp; sight distance not enough to meet required design speed
3	Concrete Barrier	Starting 1500' before the Eixt 3 off-ramp diverge	55	495	500	490	54	55	Sight distance not enough to meet required design speed or posted speed limit
4	Vertical Curve	N/A	55	495	0	577	60	55	
5	Vertical Curve	N/A	55	495	0	573	60	55	
6	Guiderail	Starting 100' before the Exit 7 off-ramp diverge	45	360	200	327	42	35	Exit 7 off-ramp; sight distance not enough to meet required design speed
	Guiderail	Starting 400 before the Exit 7 off-ramp diverge	65	645	550	414	49	55	Sight distance not enough to meet required design speed or posted speed limit
7	Bridge Pier	Starting 2000' before the Exit 8 on-ramp converge	65	645	450	527	57	65	Exit 7 on-ramp; sight distance not enough to meet required design speed or posted speed limit

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

Intersection Sight Distance (ISD): I-84 Eastbound									
Segment No.	Off Ramp Exit Number	Turning Movement	Posted Speed Limit	2-Lane or 4-Lane?	Required ISD (feet)			Actual ISD (feet)	Notes
					Passenger Cars	Single Unit Trucks	Tractor/Semi-trailers		
1	No Intersections At-Grade								
2	No Intersections At-Grade								
3	Exit 4	Left-Turn	40	4-Lane	530	675	810	767	HIGH POINT
		Right-Turn	30	N/A	390	490	595	1080+	
		Crossing Maneuver	25		335	420	510	1080+	
4	Exit 5	Right-Turn	All-Way Stop Controlled - First stopped vehicle on approach must be able to see all other approaches.					Adequate	Can see cars queued on left and right approaches
		Crossing Maneuver						Adequate	Can see cars queued on left and right approaches
5	No Intersections At-Grade								
6	No Intersections At-Grade								
7	Exit 8	Right-Turn	35	N/A	445	560	680	853	HIGH POINT
		Crossing Maneuver	35		445	560	680	780	Analyzed as if left-turn as no through traffic at the light; traffic coming from the right must turn right at a separate signal location

⁽¹⁾ Required ISD based on posted speed limit plus five mph.

Intersection Sight Distance (ISD): I-84 Westbound									
Segment No.	Off Ramp Exit Number	Turning Movement	Posted Speed Limit	2-Lane or 4-Lane?	Required ISD (feet)			Actual ISD (feet)	Notes
					Passenger Cars	Single Unit Trucks	Tractor/Semi-trailers		
1	No Intersections At-Grade								
2	No Intersections At-Grade								
3	Exit 4	Left-Turn	40	4-Lane	530	675	810	890	
		Right-Turn	30	N/A	390	490	595	844	
4	Exit 5	Left-Turn	35	4-Lane	475	600	720	444	
		Right-Turn	35	N/A	445	560	680	436	
		Crossing Maneuver	25		290	375	465	470	
	Exit 6	Left-Turn	30	4-Lane	415	525	630	1080+	BRIDGE
		Right-Turn	30	N/A	390	490	595	488	VERTICAL CURVE
		Crossing Maneuver	25		335	420	510	360	
5	No Intersections At-Grade								
6	No Intersections At-Grade								
7	Exit 8	Not Applicable							

⁽¹⁾ Required ISD based on posted speed limit plus five mph.

Appendix E

US Route 7 Mainline Geometry Backup Calculations

Design Speed: Route 7 Northbound					
Segment No.	Segment	Freeway Area Type	Required Design Speed	Posted Speed Limit	Notes
8	Backus Avenue Overpass to I-84 Merge	Intermediate	65-70 mph	50 mph	
9	I-84 Diverge to Exit 11 Off-Ramp	Intermediate	65-70 mph	55 mph	Does not meet Design Speed criteria for freeway area type

Design Speed: Route 7 Southbound					
Segment No.	Segment	Freeway Area Type	Required Design Speed	Posted Speed Limit	Notes
8	Backus Avenue Overpass to I-84 Diverge	Intermediate	65-70 mph	50 mph	
9	I-84 Merge to Exit 11 On-Ramp	Intermediate	65-70 mph	50 mph	Does not meet Design Speed criteria for freeway area type

Travel Lane & Shoulder Widths: Route 7 Northbound								
Segment No.	Segment	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
8	Backus Avenue Overpass to I-84 EB Exit 3 On-Ramp Merge	12'	12'	8'	6'	10'	10'	Does not meet required left or right shoulder width criteria
9	I-84 EB Exit 3 Off-Ramp Diverge to Exit 11 Off-Ramp	12'	12'	8'	6'	10'	12'	Does not meet required left shoulder width criteria

Travel Lane & Shoulder Widths: Route 7 Southbound								
Segment No.	Segment	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
8	Kenosia Avenue Overpass to Exit 3 On-Ramp	12'	12'	8'	4'	10'	10'	Does not meet required left or right shoulder width criteria
9	Exit 8 On-Ramp to Vale Road Overpass	12'	12'	8'	4'	10'	12'	Does not meet required left shoulder width criteria
	Federal Road On-Ramp	12'	15'	4'	4'	10'	10'	

Route 7 Eastbound/Westbound Truck DDHV													
Location	Segment No.	Direction	Peak Period	Peak Volume	Peak Volume in Other Direction During Same Period	Direcitional Split	ADT (SB)	ADT (NB)	K Factor	Total ADT	Total DDHV	Truck Percentage	Truck DDHV
South of Exit 9 Interchange	8	Northbound	PM	2,980	2,130	58%	31,100	31,050	0.096	62,150	3,478	2%	70
		Southbound	AM	2,760	1,580	64%	31,100	31,050	0.089	62,150	3,508	4%	140
East of Exit 10 Interchange	9	Northbound	PM	2,610	2,350	53%	33,300	30,100	0.087	63,400	2,893	2%	58
		Southbound	AM	2,610	1,550	63%	33,300	30,100	0.078	63,400	3,118	4%	125

Directional Split = Peak Volume / (Peak Volume + Peak Volume in Other Direction During Same Period)

K Factor = Peak Volume / ADT

Total ADT = ADT (WB) + ADT (EB)

Total DDHV = Directional Split * K Factor * Total ADT

Truck DDHV = Total DDHV * Truck Percentage

Travel Lane & Shoulder Widths: Route 7 Northbound										
Segment No.	Structure No.	Carries	Crossing	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
8	00541	Route 7 NB	Still Water River & Danbury Mall Connector Overpass	12'	12'	8'	7'	10'	12'	Does not meet required left shoulder width criteria
9	00550	Route 7 NB	Federal Road Overapss	12'	12'	8'	6'	10'	12'	Does not meet required left shoulder width criteria

Travel Lane & Shoulder Widths: Route 7 Southbound										
Segment No.	Structure No.	Carries	Crossing	Required Travel Lane Width (ft)	Actual Travel Lane Width (ft)	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)	Required Right Shoulder Width (ft)	Actual Right Shoulder Width (ft)	Notes
8	00542	Route 7 SB	Still Water River & Danbury Mall Connector Overpass	12'	12'	8'	8'	10'	12'	Does not meet required left shoulder width criteria
	00548	Route 7 SB	I-84 WB Overpass	12'	12'	8'	6'	10'	12'	Does not meet required left shoulder width criteria
9	00551	Route 7 SB	Federal Road Overapss	12'	13'	8'	6'	10'	12'	Does not meet required left shoulder width criteria

Horizontal Alignment: Route 7 Northbound								
Segment No.	Horizontal Curve #	Location of Horizontal Curve	Radius of Curve (ft)	CTDOT HDM/AASHTO Greenbook Design Speed Based on Radius (mph)	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Posted Speed Limit (mph)	Compound Curves Not Meeting 1.5:1 Ratio	Notes
8	1	343' after the Route 7 Exit 9 off-ramp diverge	2,447	60 mph	65-70 mph	50 mph	N/A	Horizontal curve does not meet the minimum radius for the required design speed; speed limit posted before Exit 4 off-ramp
9	2	820' after the I-84 Exit 7 off-ramp diverge	3,897	65 mph	65-70 mph	55 mph	N/A	
	3	615' after the Exit 8 on-ramp converge	4,015	80 mph	65-70 mph	55 mph	N/A	

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Curve 6 and Curve 7 are part of a compund curve. Per Section 8-2.02.03 of the HDM, when compound curves are used on mainline, the radius of the flatter circular arc (R₁) should not be more than 50% greater than that of the sharper arc (R₂) (R₁ ≤ 1.5 R₂). The radius of the flatter circular arc (Curve 7) is 2.38 times greater than the sharper arc (Curve 6).

Horizontal Alignment: Route 7 Southbound								
Segment No.	Horizontal Curve #	Location of Horizontal Curve	Radius of Curve (ft)	CTDOT HDM/AASHTO Greenbook Design Speed Based on Radius (mph)	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Posted Speed Limit (mph)	Compound Curves Not Meeting 1.5:1 Ratio	Notes
8	1	880' after I-84 Exit 3 off-ramp diverge	1,100	55 mph	65-70 mph	50 mph	N/A	Speed limit posted on I-84 WB, before Exit 4 Off-Ramp
	2	880' after I-84 Exit 3 off-ramp diverge	1,160	55 mph	65-70 mph	50 mph	N/A	Speed limit posted on I-84 WB, before Exit 4 Off-Ramp
9	3	350' before I-84 Exit 7 on-ramp converge	4,740	80 mph	65-70 mph	50 mph	N/A	
	4	1750' before Route 7 Exit 10 off-ramp diverge	4,050	80 mph	65-70 mph	50 mph	N/A	

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Curve 4 and Curve 5 are part of a compound curve. Per Section 8-2.02.03 of the HDM, when compound curves are used on mainline, the radius of the flatter circular arc (R₁) should not be more than 50% greater than that of the sharper arc (R₂) (R₁ ≤ 1.5 R₂). The radius of the flatter circular arc (Curve 5) is 2.33 times greater than the sharper arc (Curve 4).

Vertical Alignment: Route 7 Northbound															
Segment No.	Vertical Curve #	Location of Vertical Curve	Crest / Sag Vertical Cuve	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Length of Vertical Curve (ft)	G1	G2	A	K Value	Stopping Sight Distance (ft)	AASHTO Greenbook Required Stopping Sight Distance (ft) ⁽²⁾	AASHTO Greenbook Required Rate of Vertical Curvature (K) ⁽²⁾	Maximum Grade (%)	CTDOT / AASHTO Greenbook Maximum Allowable Grade (%) ⁽³⁾	Notes
8	1	400' after the Route 7 Exit 9 off-ramp diverge	Sag	65 mph	400	-1.88	2	3.88	103.09	452	645	193	4.22%	4%	Sag vertical curve does not meet minimum K Value. Vertical grades exceed maximum allowable grade.
	2	500' before the I-84 Exit 3 on-ramp converge	Sag	65 mph	300	2	4.22	2.22	135.14	568	645	193			Sag vertical curve does not meet minimum K Value. Vertical grades exceed maximum allowable grade.
9	3	450' after the I-84 Exit 7 off-ramp diverge	Sag	65 mph	500	-3	-1.7	1.3	384.62	1452	645	157	3.00%	4%	
	4	1000' after the I-84 Exit off-ramp diverge	Sag	65 mph	500	-1.7	1.29	2.99	167.22	683	645	157			
	5	200' before Exit 10 on-ramp merge	Crest	65 mph	500	1.29	-0.69	1.98	252.53	738	645	157			

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Minimum Required Stopping Sight Distance and K Value based on Table 3-34 of AASHTO Greenbook for Crest Vertical Curves, and Table 3-36 of AASHTO Greenbook for Sag Vertical Curves

⁽³⁾ Maximum Allowable Grade Based on Design Speed

Vertical Alignment: Route 7 Southbound															
Segment No.	Vertical Curve #	Location of Vertical Curve	Crest / Sag Vertical Curve	Required Design Speed For Corridor Segment (mph) ⁽¹⁾	Length of Vertical Curve (ft)	G1	G2	A	K Value	Stopping Sight Distance (ft)	AASHTO Greenbook Required Stopping Sight Distance (ft) ⁽²⁾	AASHTO Greenbook Required Rate of Vertical Curvature (K) ⁽²⁾	Maximum Grade (%)	CTDOT / AASHTO Greenbook Maximum Allowable Grade (%) ⁽³⁾	Notes
8	1	200' before the Exit 9 on-ramp converge	Sag	65 mph	300	1.4	2.64	1.24	241.94	949	645	193	2.64%	4%	
	2	550' before the Exit 9 on-ramp converge	Crest	65 mph	300	2.64	0.7	1.94	154.64	578	645	157			Crest vertical curve does not meet minimum K Value.
	3	925' before the I-84 Exit 3 on-ramp converge	Sag	65 mph	200	0.7	1.2	0.5	400.00	1506	645	157			
	4	725' before the I-84 Exit 3 on-ramp converge	Crest	65 mph	200	1.2	0.5	0.7	285.71	785	645	193			
9	5	500' after the I-84 Exit 7 on-ramp converge	Sag	65 mph	400	0.95	1.8	0.85	470.59	1754	645	193	1.80%	4%	
	6	400' after the Exit 10 off-ramp diverge	Crest	65 mph	700	1.8	-3	4.8	145.83	561	645	157			Crest vertical curve does not meet minimum K Value.
	7	1700' before the Exit 10 off-ramp diverge	Sag	65 mph	400	-3	-1.38	1.62	246.91	730	645	193			

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

⁽²⁾ Minimum Required Stopping Sight Distance and K Value based on Table 3-34 of AASHTO Greenbook for Crest Vertical Curves, and Table 3-36 of AASHTO Greenbook for Sag Vertical Curves

⁽³⁾ Maximum Allowable Grade Based on Design Speed

Stopping Sight Distance (SSD): Route 7 Northbound									
Segment No.	Controlling Geometric Feature	Obstructed SSD Location	Required Design Speed (mph)	Required SSD (feet)	Length Below Required SSD (feet)	Existing SSD (feet)	Equivalent Existing Design Speed (mph)	Posted Speed Limit (mph)	Notes
8	Vertical Sag Curve	400' after the Route 7 Exit 9 off-ramp diverge	65	645	400	452	52	50	Sight distance not enough hto meet required design speed
	Vertical Sag Curve	500' before the I-84 Exit 3 on-ramp converge	65	645	300	568	60	50	Sight distance not enough hto meet required design speed
9	N/A	N/A	65	645	N/A	645	65	55	No areas of insufficient sight distance

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

Stopping Sight Distance (SSD): Route 7 Southbound									
Segment No.	Controlling Geometric Feature	Obstructed SSD Location	Required Design Speed (mph)	Required SSD (feet)	Length Below Required SSD (feet)	Existing SSD (feet)	Equivalent Existing Design Speed (mph)	Posted Speed Limit (mph)	Notes
8	Vegetation	Starting 700' after I-84 Exit 3 off-ramp diverge	65	645	300	420	49	50	Sight distance not enough to meet required design speed or posted speed limit
	Vertical Crest Curve	550' before the Exit 9 on-ramp converge	65	645	300	578	60	50	Sight distance not enough hto meet required design speed
9	Vertical Crest Curve	400' after the Exit 10 off-ramp diverge	65	645	700	561	59	50	Sight distance not enough to meet required design speed

⁽¹⁾ Required design speed based on Freeway Area Type. See Design Speed section for each segment's freeway area classification.

Appendix F

I-84 Ramp Geometry Backup Calculations

Exit	3		
Direction	EB		
On/Off	Off		
Type	Direct Connection		
Mainline Design Speed			
Radius	1442	feet	measured from aerial
Superelevation	6%		34-93, 1958, sheet 232
Mainline Design Speed	62	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 50	mph	HDM Figure 12-4A
Tangent	351	feet	measured from aerial
Radius 1	1524	feet	measured from aerial
Length 1	401	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 158
Ramp Design Speed 1	63	mph	Greenbook Table 3-9
Radius 2	1082	feet	measured from aerial
Length 2	401	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 201
Ramp Design Speed 2	55	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	62	mph	
Final Speed	55	mph	
Required Length	N/A	feet	Ramp speed is faster than mainline speed
Available Length	N/A	feet	Drop travel lane for exit

Exit	3		
Direction	EB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	1583	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 166
Mainline Design Speed	64	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 55	mph	HDM Figure 12-4A
Tangent	2749	feet	measured from aerial; long tangent section
Parallel distance	1081	feet	measured from aerial
Ramp Design Speed	70	mph	Tangent approach to curved mainline
Acceleration Length			
Initial Speed	64	mph	
Final Speed	70	mph	
Required Length	N/A	feet	Ramp speed is faster than mainline speed
Available Length	1072	feet	Exit ramp starts 407 ft in

Exit	3		
Direction	WB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	1171	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 188
Mainline Design Speed	57	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Radius 1	991	feet	measured from aerial
Length 1	1328	feet	measured from aerial
Superelevation	6.0%		34-103, 1958, sheet 207
Ramp Design Speed 1	58	mph	Greenbook Table 3-9
Radius 2	701	feet	measured from aerial
Length 2	541	feet	measured from aerial
Superelevation	6.0%		34-103, 1958, sheet 182
Ramp Design Speed 2	52	mph	Greenbook Table 3-9
Acceleration Length			
Initial Speed	52	mph	
Final Speed	57	mph	
Required Length	N/A	feet	Ramp speed is close to mainline speed
Available Length	N/A	feet	On ramp continues as added lane

Exit	3		
Direction	WB		
On/Off	Off		
Type	Direct Connection		
Mainline Design Speed			
Radius	1171	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 188
Mainline Design Speed	57	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Parallel	716	feet	measured from aerial
Tangent	537	feet	measured from aerial
Radius 1	1185	feet	measured from aerial
Length 1	702	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 285
Ramp Design Speed 1	57	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	57	mph	
Final Speed	57	mph	
Required Length	N/A	feet	No Deceleration necessary
Available Length	537	feet	

Exit	4		
Direction	EB		
On/Off	Off		
Type	Loop Ramp		
Mainline Design Speed			
Radius	1244	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 172
Mainline Design Speed	58	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Low		HDM Section 12-4.01
Ramp Design Speed Range	25 to 30	mph	HDM Figure 12-4A
Tangent	139	feet	measured from aerial
Radius 1	867	feet	measured from aerial
Length 1	150	feet	measured from aerial
Superelevation	5.3%		34-103, 1958, sheet 175
Ramp Design Speed 1	41	mph	Greenbook Table 3-9
Radius 2	383	feet	measured from aerial
Length 2	128	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 175
Ramp Design Speed 2	40	mph	Greenbook Table 3-9
Radius 3	241	feet	measured from aerial
Length 3	88	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 176
Ramp Design Speed 3	30	mph	Greenbook Table 3-9
Radius 4	165	feet	measured from aerial
Length 4	436	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 212
Ramp Design Speed 4	26	mph	Greenbook Table 3-9
Tangent	654	feet	measured from aerial
Queue Length		feet	
Deceleration Length			
Mainline Speed	58	mph	
Ramp Speed 1	41	mph	
Grade 1	<3%		34-103, 1958, sheet 72
Required Length 1	314	feet	HDM Table 12-3A
Available Length 1	139	feet	Mainline to start Curve 1

Exit	4		
Direction	EB		
On/Off	On		
Type	Semidirect Connection		
Mainline Design Speed			
Radius	1583	feet	measured from aerial
Superelevation	6%		34-84, 1958, sheet 287
Mainline Design Speed	64	mph	Greenbook Table 3-9
Ramp Design Speed			
Radius	778	feet	measured from aerial
Length	185	feet	measured from aerial
Superelevation	4.2%		34-103, 1958, sheet 175
Ramp Design Speed	32	mph	Greenbook Table 3-9
Parallel Length	525	feet	measured from aerial
Acceleration Length			
Initial Speed	32	mph	
Final Speed	64	mph	
Grade	<3%		34-84, 1958, sheet 24
Required Length	1031	feet	HDM Table 12-3D
Available Length	525	feet	

Exit	4		
Direction	WB		
On/Off	On		
Type	Loop Ramp		
Mainline Design Speed			
Radius	1171	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 188
Mainline Design Speed	57	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Low to Mid		HDM Section 12-4.01
Ramp Design Speed Range	30 to 40	mph	HDM Figure 12-4A
Note: four prior curves on loop ramp omitted due to exceptional available acceleration length			
Tangent	140	feet	measured from aerial
Radius 1	1150	feet	measured from aerial
Length 1	999	feet	measured from aerial
Superelevation	6.0%		34-103, 1958, sheet 226
Ramp Design Speed 1	57	mph	Greenbook Table 3-9
Radius 2	1288	feet	measured from aerial
Length 2	554	feet	measured from aerial
Superelevation	6.0%		34-103, 1958, sheet 226
Ramp Design Speed 2	59	mph	Greenbook Table 3-9
Parallel Length	320	feet	measured from aerial
Acceleration Length			
Initial Speed	59	mph	
Final Speed	57	mph	
Grade	<-3%		34-84, 1958, sheet 24
Required Length	N/A	feet	No acceleration necessary
Available Length	320	feet	

Exit	4		
Direction	WB		
On/Off	Off		
Type	Ramp for Right Turn		
Mainline Design Speed			
Radius	1648	feet	measured from aerial
Superelevation	6.0%		34-84, 1958, sheet 352
Mainline Design Speed	65	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 55	mph	HDM Figure 12-4A
Parallel	98	feet	measured from aerial
Radius 1	546	feet	measured from aerial
Length 1	354	feet	measured from aerial
Superelevation 1	5.3%		34-103, 1958, sheet 308
Ramp Design Speed 1	34	mph	Greenbook Table 3-9
Tangent	489	feet	measured from aerial
Radius 2	187	feet	measured from aerial
Length 2	159	feet	measured from aerial
Superelevation 2	6.0%		34-103, 1958, sheet 231
Ramp Design Speed 2	27	mph	Greenbook Table 3-9
Tangent	695	feet	measured from aerial
Queue Length		feet	
Deceleration Length			
Initial Speed	65	mph	
Final Speed 1	34	mph	
Grade	-3.6%		34-84, 1958, sheet 23
Grade Ratio	1.20		HDM Figure 12-3B
Required Length 1	535	feet	HDM Table 12-3A
Available Length 1	98	feet	Mainline to start curve 1

Exit	5		
Direction	EB		
On/Off	Off		
Type	Ramp for Right Turn		
Mainline Design Speed			
Radius	2880	feet	measured from aerial
Superelevation	5.2%		34-84, 1958, sheet 318
Mainline Design Speed	68	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Tangent 1	858	feet	34-313 plans, sheet 03.003-03.004
Radius 1	640	feet	34-313 plans, sheet 03.003-03.004
Length 1	140	feet	34-313 plans, sheet 03.003-03.004
Superelevation	4.2%		34-84, 1958, sheet 316
Ramp Design Speed 1	29	mph	Greenbook Table 3-9
Tangent 2	158	feet	34-313 plans, sheet 03.004
Radius 2	575	feet	34-313 plans, sheet 03.004
Length 2	209	feet	34-313 plans, sheet 03.004
Superelevation	4.2%		34-84, 1958, sheet 321
Ramp Design Speed 2	28	mph	Greenbook Table 3-9
Tangent 3	79	feet	34-313 plans, sheet 03.004
Queue Length		feet	
Deceleration Length			
Initial Speed	68	mph	
Final Speed 1	29	mph	First governing control
Grade	<-3%		34-84, 1958, sheet 37
Required Length 1	506	feet	HDM Table 12-3A
Available Length 1	858	feet	Mainline to start Curve 1

Exit	5		
Direction	EB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	5679	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 339
Mainline Design Speed	51	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	35 to 45	mph	HDM Figure 12-4A
Tangent	572	feet	measured from aerial
Radius 1	2188	feet	measured from aerial
Length 1	223	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 334
Ramp Design Speed 1	31	mph	Greenbook Table 3-9
Parallel Length	397	feet	measured from aerial
Acceleration Length			
Initial Speed	31	mph	
Final Speed	51	mph	
Grade	<3%		34-84, 1958, sheet 47
Required Length	473	feet	HDM Table 12-3D
Available Length	397	feet	

Exit	5		
Direction	WB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	2814	feet	measured from aerial
Superelevation	5.2%		34-84, 1958, sheet 318
Mainline Design Speed	67	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Tangent	147	feet	measured from aerial
Radius 1	397	feet	measured from aerial
Length 1	331	feet	measured from aerial
Superelevation	6%		34-84, 1958, sheet 457
Ramp Design Speed 1	37	mph	Greenbook Table 3-9
Radius 2	1533	feet	measured from aerial
Length 2	360	feet	measured from aerial
Superelevation 2	5.2%		34-84, 1958, sheet 457
Ramp Design Speed 2	52	mph	Greenbook Table 3-9
Parallel Length	385	feet	lane added, then dropped at next exit
Acceleration Length			
Initial Speed	37	mph	
Final Speed	67	mph	
Grade	<3%		34-94, 1958, sheet 45
Required Length	1000	feet	HDM Table 12-3D
Available Length	745	feet	First curve to mainline
Initial Speed	52	mph	
Final Speed	67	mph	
Grade	<3%		34-94, 1958, sheet 45
Required Length	360	feet	Approx, HDM Table 12-3A ends at 50 mph ramp
Available Length	385	feet	Last curve to mainline

Exit	5		
Direction	WB		
On/Off	Off		
Type	Loop Ramp		
Mainline Design Speed			
Radius	5745	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 352
Mainline Design Speed	53	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Low to Mid		HDM Section 12-4.01
Ramp Design Speed Range	25 to 35	mph	HDM Figure 12-4A
Parallel	1039	feet	34-313, 2014, sheet 03.048-049
Radius 1	258	feet	measured from aerial
Length 1	250	feet	measured from aerial
Superelevation 1	5.8%		34-84, 1958, sheet 458
Ramp Design Speed 1	28	mph	Greenbook Table 3-9
Radius 2	112	feet	measured from aerial
Length 2	135	feet	measured from aerial
Superelevation 2	5.8%		34-84, 1958, sheet 458
Ramp Design Speed 2	20	mph	Greenbook Table 3-9
Tangent	9	feet	34-313, 2014, sheet 03.008-010
Queue Length		feet	
Deceleration Length			
Initial Speed	53	mph	
Final Speed 1	28	mph	To curve at end of ramp
Grade	<3%		34-84, 1958, sheet 44
Required Length 1	368	feet	HDM Table 12-3A
Available Length 1	1039	feet	Mainline to start of Curve 1

Exit	6		
Direction	EB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	5679	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 354
Mainline Design Speed	51	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	35 to 45	mph	HDM Figure 12-4A
Tangent	359	feet	measured from aerial
Radius 1	1042	feet	measured from aerial
Length 1	306	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 353
Ramp Design Speed 1	21	mph	Greenbook Table 3-9
Parallel Length	385	feet	measured from aerial
Acceleration Length			
Initial Speed	21	mph	
Final Speed	51	mph	
Grade	<-3%		34-84, 1958, sheet 56
Required Length	639	feet	HDM Table 12-3D
Available Length	385	feet	

Exit	6		
Direction	WB		
On/Off	Off		
Type	Ramp for Right Turn		
Mainline Design Speed			
Radius	5745	feet	measured from aerial
Superelevation	2.1%		34-84, 1958, sheet 352
Mainline Design Speed	53	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Tangent 1	871	feet	34-313, 2014, sheet 03.008-010
Queue Length		feet	
Deceleration Length			
Initial Speed	53	mph	
Final Speed 1	0	mph	To curve at end of ramp
Grade	-5.9%		34-84, 1958, sheet 57
Grade Ratio	1.35		HDM Table 12-3B
Required Length 1	624	feet	HDM Table 12-3A
Available Length 1	871	feet	Mainline to stop line

Exit	7		
Direction	EB		
On/Off	Off		
Type	Direct Connection		
Mainline Design Speed			
Mainline Design Speed	60	mph	No curves before exit, but speed limit sign of 55
Ramp Design Speed			
Ramp Design Speed Range	Mid to High	HDM Section 12-4.01	
Ramp Design Speed Range	45 to 50	mph	HDM Figure 12-4A
Tangent	417	feet	34-313 plans, sheet 03.003-03.004
Radius	3897	feet	34-313 plans, sheet 03.003-03.004
Length	1628	feet	34-313 plans, sheet 03.003-03.004
Superelevation	4.2%		34-84, 1958, sheet 316
Ramp Design Speed	67	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	60	mph	
Final Speed 1	67	mph	First governing control
Required Length	N/A	feet	HDM Table 12-3A; ramp faster than mainline
Available Length	417	feet	Add travel lane, then drop two for exit

Exit	7		
Direction	EB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	1776	feet	measured from aerial
Superelevation	6%		34-84, 1958, sheet 404
Mainline Design Speed	67	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High	HDM Section 12-4.01	
Ramp Design Speed Range	45 to 55	mph	HDM Figure 12-4A
Radius 1	691	feet	measured from aerial
Length 1	1352	feet	measured from aerial
Superelevation	6.0%		34-84, 1958, sheet 407
Ramp Design Speed 1	46	mph	Greenbook Table 3-9
Parallel Length	415	feet	measured from aerial; before broken line
Acceleration Length			
Initial Speed	46	mph	
Final Speed	67	mph	
Required Length	827	feet	HDM Table 12-3D; ramp faster than mainline
Available Length	N/A		Add travel lane on left side

Exit	7		
Direction	WB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	1867	feet	measured from aerial
Superelevation	6%		34-84, 1958, sheet 422
Mainline Design Speed	68	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 55	mph	HDM Figure 12-4A
Radius 1	4743	feet	measured from aerial
Length 1	948	feet	measured from aerial
Superelevation	4.2%		34-84, 1958, sheet 439
Ramp Design Speed 1	74	mph	Greenbook Table 3-9
Parallel Length	415	feet	measured from aerial; before broken line
Acceleration Length			
Initial Speed	74	mph	
Final Speed	68	mph	
Required Length	N/A	feet	Ramp speed is faster than mainline speed
Available Length	N/A		Add travel lane on right side

Exit	7		
Direction	WB		
On/Off	Off		
Type	Direct Connection		
Mainline Design Speed			
Radius	3814	feet	measured from aerial
Superelevation	2%		34-84, 1958, sheet 449
Calc Mainline Design Speed	34	mph	No curves before exit, but speed limit sign of 55
Mainline Design Speed	60	mph	Assumed fixed through resurfacing
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 50	mph	HDM Figure 12-4A
Radius	792	feet	measured from aerial
Length	1440	feet	measured from aerial
Superelevation	6.0%		34-84, 1958, sheet 435
Ramp Design Speed	49	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	60	mph	Speed limit sign of 55 nearby
Final Speed 1	49	mph	First governing control
Grade	<3%		34-84, 1958, sheet 91
Required Length	252	feet	HDM Table 12-3A; ramp faster than mainline
Available Length	417	feet	Add travel lane, then drop two for exit

Exit	8		
Direction	EB		
On/Off	Off		
Type	Ramp for Right Turn		
Mainline Design Speed			
Mainline Design Speed	60	mph	No curves before exit, but speed limit sign of 55
Ramp Design Speed			
Ramp Design Speed Range	Mid to High	HDM Section 12-4.01	
Ramp Design Speed Range	45 to 50	mph	HDM Figure 12-4A
Tangent 1	9	feet	measured from aerial
Radius 1	1783	feet	measured from aerial
Length 1	314	feet	measured from aerial
Superelevation	3.1%		34-94, 1958, sheet 24
Ramp Design Speed 1	36	mph	Greenbook Table 3-9
Tangent 2	261	feet	measured from aerial
Radius 2	936	feet	measured from aerial
Length 2	209	feet	measured from aerial
Superelevation	4.2%		34-94, 1958, sheet 27
Ramp Design Speed 2	35	mph	Greenbook Table 3-9
Tangent 3	61	feet	measured from aerial
Queue Length		feet	
Deceleration Length			
Initial Speed	60	mph	
Final Speed 1	36	mph	First governing control
Grade	<3%		34-94, 1958, sheet 43
Required Length 1	394	feet	HDM Table 12-3A
Available Length 1	9	feet	Mainline to start curve 1

Exit	8		
Direction	EB		
On/Off	On		
Type	Semidirect Connection		
Mainline Design Speed			
Radius	1930	feet	measured from aerial
Superelevation	5.2%		34-94, 1958, sheet 34
Mainline Design Speed	57	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High	HDM Section 12-4.01	
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Tangent	359	feet	measured from aerial
Radius 1	1042	feet	measured from aerial
Length 1	306	feet	measured from aerial
Superelevation	4.2%		34-94, 1958, sheet 34
Ramp Design Speed 1	36	mph	Greenbook Table 3-9
Radius 2	4800	feet	measured from aerial
Length 2	281	feet	measured from aerial
Superelevation	2.0%		34-94, 1958, sheet 34
Ramp Design Speed 2	46	mph	Greenbook Table 3-9
Parallel Length	328	feet	measured from aerial
Acceleration Length			
Initial Speed	36	mph	
Final Speed	57	mph	
Grade	<3%		34-94, 1958, sheet 35
Required Length	602	feet	HDM Table 12-3D
Available Length	609	feet	

Exit	8		
Direction	WB		
On/Off	On		
Type	Direct Connection		
Mainline Design Speed			
Radius	1867	feet	measured from aerial
Superelevation	6%		34-94, 1958, sheet 34
Mainline Design Speed	68	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Tangent	530	feet	measured from aerial
Radius 1	788	feet	measured from aerial
Length 1	292	feet	measured from aerial
Superelevation	6%		34-94, 1958, sheet 34
Ramp Design Speed 1	49	mph	Greenbook Table 3-9
Parallel Length	1750	feet	lane added, then dropped at next exit
Acceleration Length			
Initial Speed	49	mph	
Final Speed	68	mph	
Grade	<3%		34-94, 1958, sheet 35
Required Length	543	feet	HDM Table 12-3D
Available Length	1750	feet	

Exit	8		
Direction	WB		
On/Off	Off		
Type	Ramp for Right Turn		
Mainline Design Speed			
Radius	2887	feet	measured from aerial
Superelevation	5.2%		34-94, 1958, sheet 34
Mainline Design Speed	69	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Tangent 1	113	feet	measured from aerial
Radius 1	939	feet	measured from aerial
Length 1	161	feet	measured from aerial
Superelevation	2.0%		34-94, 1958, sheet 34
Ramp Design Speed 1	18	mph	Greenbook Table 3-9
Tangent 2	550	feet	measured from aerial
Radius 2	1497	feet	measured from aerial
Length 2	294	feet	measured from aerial
Superelevation	3.1%		34-94, 1958, sheet 34
Ramp Design Speed 2	38	mph	Greenbook Table 3-9
Tangent 3	15	feet	measured from aerial
Queue Length		feet	
Deceleration Length			
Initial Speed	69	mph	
Final Speed 1	18	mph	First governing control
Grade	-4%		34-94, 1958, sheet 35
Grade Ratio	1.28		HDM Table 12-3B
Required Length 1	724	feet	HDM Table 12-3A
Available Length 1	113	feet	Mainline to start curve 1

Appendix F

US Route 7 Ramp Geometry Backup Calculations

Exit	9		
Direction	NB		
On/Off	Off-84W		
Type	Direct Connection		
Mainline Design Speed			
Radius	5188	feet	measured from aerial
Superelevation	3.1%		34-190, 1984, sheet 392
Mainline Design Speed	63	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Tangent	1265	feet	measured from aerial
Radius	991	feet	measured from aerial
Length	1328	feet	measured from aerial
Superelevation	6.0%		34-103, 1958, sheet 207
Ramp Design Speed	58	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	63	mph	
Final Speed	58	mph	
Required Length	N/A	feet	Ramp speed is close to mainline speed
Available Length	1265	feet	meas. from aerial; on ramp nose to off ramp nose

Exit	9		
Direction	SB		
On/Off	On-84E		
Type	Direct Connection		
Mainline Design Speed			
Radius	1171	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 188
Mainline Design Speed	57	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	40 to 50	mph	HDM Figure 12-4A
Radius	1082	feet	measured from aerial
Superelevation	6%		34-103, 1958, sheet 201
Ramp Design Speed	55	mph	Greenbook Table 3-9
Parallel Length	976	feet	measured from aerial
Acceleration Length			
Initial Speed	55	mph	
Final Speed	57	mph	
Required Length	N/A	feet	Ramp speed is close to mainline speed
Available Length	976	feet	Until travel lane dropped at exit

Exit	10		
Direction	NB		
On/Off	On-84W		
Type	Direct Connection		
Mainline Design Speed			
Radius	3897	feet	34-313 plans, sheet 03.003-03.004
Superelevation	4.2%		34-84, 1958, sheet 316
Mainline Design Speed	67	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	45 to 50	mph	HDM Figure 12-4A
Radius	792	feet	measured from aerial
Length	1440	feet	measured from aerial
Superelevation	6.0%		34-84, 1958, sheet 435
Ramp Design Speed	49	mph	Greenbook Table 3-9
Parallel Length	673	feet	measured from aerial
Acceleration Length			
Initial Speed	49	mph	
Final Speed	67	mph	
Grade	<-3%		34-84, 1958, sheet 104
Required Length	501	feet	HDM Table 12-3D
Available Length	673	feet	measured from aerial

Exit	10		
Direction	SB		
On/Off	Off-84E		
Type	Direct Connection		
Mainline Design Speed			
Radius	4053	feet	measured from aerial
Superelevation	6.0%		34-190, 1984, sheet 392
Mainline Design Speed	68	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Tangent	735	feet	measured from aerial
Radius	691	feet	measured from aerial
Length	1352	feet	measured from aerial
Superelevation	6.0%		34-84, 1958, sheet 407
Ramp Design Speed	46	mph	Greenbook Table 3-9
Deceleration Length			
Initial Speed	68	mph	
Final Speed	46	mph	
Grade	<3%		34-84, 1958, sheet 93
Required Length	359	feet	HDM Table 12-3D
Available Length	735	feet	measured from aerial

Exit	10		
Direction	SB		
On/Off	On-Federal Road		
Type	Direct Connection		
Mainline Design Speed			
Radius	3897	feet	34-313 plans, sheet 03.003-03.004
Superelevation	4.2%		34-84, 1958, sheet 316
Mainline Design Speed	67	mph	Greenbook Table 3-9
Ramp Design Speed			
Ramp Design Speed Range	Mid to High		HDM Section 12-4.01
Ramp Design Speed Range	50 to 60	mph	HDM Figure 12-4A
Radius	1381	feet	measured from aerial
Superelevation	4.2%		34-84, 1958, sheet 435
Ramp Design Speed	41	mph	Greenbook Table 3-9
Parallel Length	454	feet	measured from aerial
Acceleration Length			
Initial Speed	41	mph	
Final Speed	67	mph	
Grade	<3%		34-84, 1958, sheet 93
Required Length	400	feet	HDM Table 12-3D
Available Length	454	feet	measured from aerial