Kimley»Horn

MEMORANDUM

To: El Paso County

From: Sean Hays, PE

Kimley-Horn and Associates, Inc.

Date: October 26, 2022

Subject: Design Documentation - Proposed Roundabout at Constitution Ave and Akers Dr

A new roundabout is proposed at the intersection of Akers Dr and Access Rd in El Paso County, Colorado. This memo summarizes the design criteria and critical design parameters for the proposed roundabout.

The design of this roundabout is based upon the criteria established in the Wisconsin Department of Transportation Facilities Development Manual, Chapter 11 Section 26 (Wisconsin DOT FDM 11-26).

Lane Configuration and Geometrics

The Citizen on Constitution Traffic Study Letter (dated 4-8-2022) prepared by Kimley-Horn recommends a roundabout with a single circulatory lane and one lane entering on each approach at the project intersection. The report shows that the roundabout will operate at a Level of Service (LOS) of A in design year 2045. Refer to the traffic impact study for additional details.

To meet the criteria in the Wisconsin DOT FDM 11-26, the proposed roundabout was designed with the geometry displayed in Table 1. A graphical representation of the roundabout with supporting dimensions, is included as Exhibit 2 at the end of this memo.

TABLE 1 ROUNDAOUT GEOMETRICS

Inscribed Circle Diameter (ICD)	120 feet
Minimum Lane Width (on approach)	16 feet
Entry Width	19 feet
Circulatory Roadway Width	20 feet
Truck Apron Width	15.5 feet
SB Entry Angle, PHI	16.2 deg
WB Entry Angle, PHI	24.7 deg
NB Entry Angle, PHI	17.3 deg

Fastest Path Speeds

Fastest path performance is an evaluation of the geometric elements that control driver negotiation speeds. Two primary elements were evaluated to determine the fastest path speed:

- Estimated vehicle speeds at critical path radii on the fastest path
- Speed consistency between the critical path radii

Fastest paths were reviewed in CADD with spline curves based on a technique described in the Wisconsin DOT FDM 11-26 Attachment 50.2.

Estimated vehicle speeds for entry, circulating, exit, left turn and right turn paths were calculated using standard estimation of +2%/-2% cross slope / superelevations for vehicles traveling on the estimated fastest path.

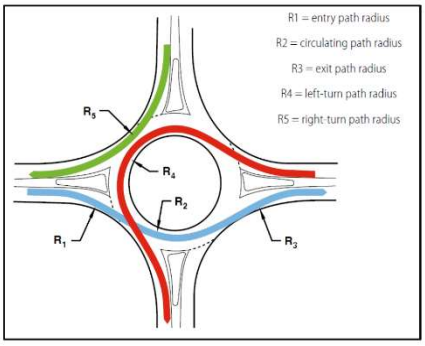
Graphical representations of the estimated fastest paths and the locations of the critical path radius used to calculate R1 thru R5 speeds, are included as Exhibits 16-18 at the end of this memo.

Table 2 below summarizes the results of the fastest path evaluation. Table 3 and Figure 1 provide additional information on the design criteria used for the calculation of the fastest paths.

TABLE 2 – FASTEST PATH RESULTS	**LEG 1** SB		**LEG 2** WB		**LEG 3** NB	
R_1, Radius/Speed, FT/MPH	135	23	NA	NA	108	22
R_2, Radius/Speed, FT/MPH	150	24	NA	NA	105	21
R_4, Radius/Speed, FT/MPH	42	14	43	14	NA	NA
R_5, Radius/Speed, FT/MPH	NA	NA	83	20	68	18

TABLE 3 FASTEST PATH PERFORMANCE CRITERIA

Path offset from curb face	5 feet
Path offset from centerline	5 feet
Path offset from painted edge of travel way	3 feet
Single lane entry (maximum)	25 mph
Speed consistency	10-15 mph



Design Vehicle

Design vehicle paths were evaluated for likely design vehicles and their associated path required to navigate the roundabout. Vehicle profile, path and tire tracking offsets are shown in Exhibits 5-18 included at the end of this memo. The following design vehicles and design criteria were used to evaluate the tire tracking offsets:

Vehicle	Category	Notes
WB-50	Design – North/South Accommodate - West	Full Access
SU-40	Design	Full Access
WB-67	Accommodate – North/South	North and South Legs
Snow Plow	Design	Navigate with Plow Down

Category and case shown above refer to criteria established in the Wisconsin DOT FDM 11-26. Information is provided below on the criteria. For additional details refer to the Wisconsin DOT FDM 11-26.

- Category – Accommodate: is used for low percentage of design vehicles of this type. Preferable in low speed, urban environments where pedestrian and bike traffic is prevalent. The vehicle will be able to navigate the roundabout but may do so at reduced speeds and/or encroach on the gutter. Tire tracking offsets should not encroach on non-mountable curb.
- Category – Design: is used for higher percentages of design vehicles of this type. The vehicle will be able to navigate the roundabout without encroaching on the gutter. Tire tracking offset should not encroach on gutter pan, or non-mountable curb.

The southbound U-Turn manuver was evaluated for all design vehicles in the event that a driver mistakenly turns from Constitution Ave onto Akers Dr. All design vehicle are able to make this manuver within the limits of the proposed roundabout with use of the truck apron, and at reduced speeds.

Sight Distance

Sight line determination is an evaluation of the driver's sight line to navigate the roundabout. Per Wisconsin DOT FDM 11-26 guidance the distance for approach and conflicting vehicles are calculated using fast path and posted design speed. Table 5 below summarizes the minimum sight parameters as defined by AASHTO and NCHRP 672. Sight lines are broken into the following components:

Stopping Sight Distance (SSD)

SSD is evaluated for approach speeds to the pedestrian crosswalk and critical path speeds for circulating vehicles. SSD distances are based on the current American Association of State Highway and Transportation Officials (AASHTO) Green Book recommendations. See Exhibits 25 and 26 for approximate location of sight lines for SSD, for the circulatory roadway and pedestrian crosswalk.

Intersection Sight Distance (ISD)

ISD is evaluated for the critical path speeds to a vehicle stopped behind the pedestrian crosswalks for each approach. ISD distances are based on the recommendations in NCHRP 672, which includes evaluating the sight distance for vehicles entering and circulating within the roundabout. Entering sight distance (d1) is provided for the southbound and westbound legs as these legs have adjacent entries.

The northbound leg does not have an adjacent entry and was not evaluated for entering sight distance. Circulating sight distance (d2) is provided for all legs of the roundabout. See Exhibits 22-24 for approximate location of sight lines for ISD.

Circulating Sight Distance

Circulating sight distance was evaluated for vehicles circulating through the roundabout to evaluate drivers ability to see other vehicles circulating roundabout. See Exhibit 27 for approximate location of sight lines for circulating vehicles.

Composite Sight Distance

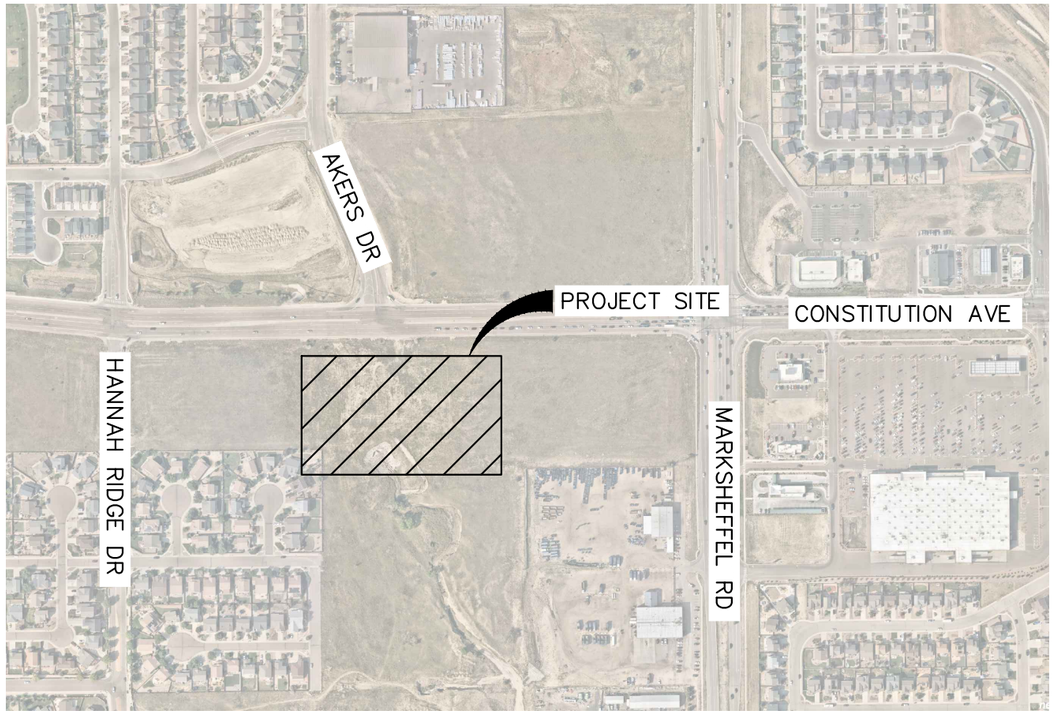
Exhibit 28 illustrates the composite of sight lines calculated for SSD, ISD, and circulating sight distance. Areas indicated as low growth landscaping should be free from vertical obstructions greater than 30" that may hinder the ability for a driver to recognize an obstruction and stop. Considerations should be given to limit the driver sight lines in areas outside those identified as low growth.

TABLE 5 – MINIMUM SIGHT PARAMETERS	**LEG 1** SB		**LEG 2** WB		**LEG 3** NB	
Intersection Sight Distance (MPH/FT) (d1, Entering)	25	185	25	185	--	--
Intersection Sight Distance (MPH/FT) (d2, Circulating)	14	105	14	105	14	105
Stopping Sight Distance – Ped Crossing (MPH/FT)	40	305	25	155	40	305
Circulating Sight Distance – Circulating Roadway (MPH/FT)	14	115	14	115	14	115

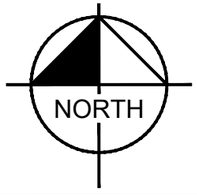
AKERS DR & ACCESS RD ROUNDABOUT

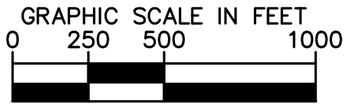
EL PASO COUNTY, COLORADO

OCTOBER 26, 2022



LOCATION MAP





INDEX

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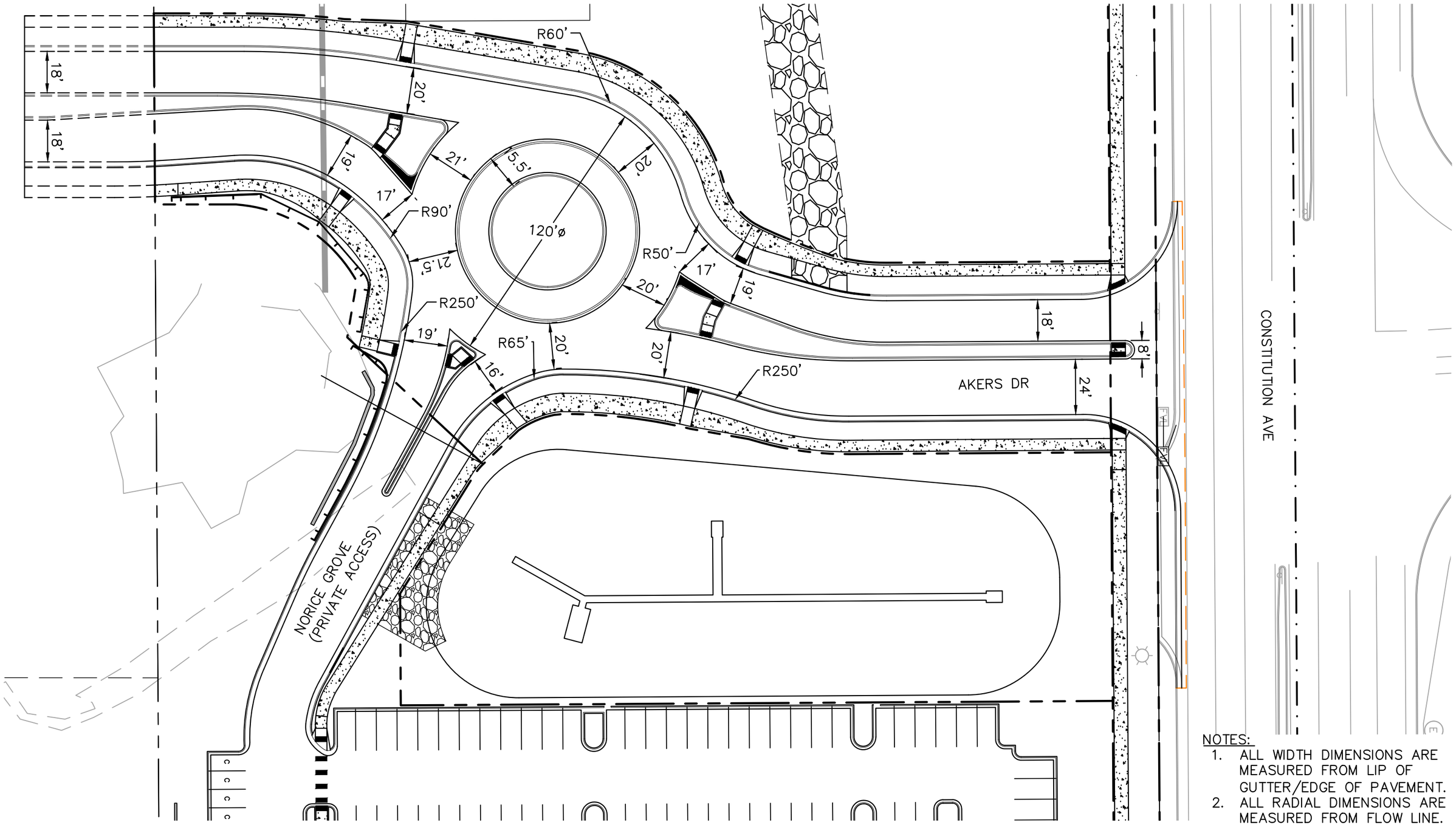
AKERS DR & ACCESS RD ROUNDABOUT

EXHIBIT: 1



NOTES:

1. ALL WIDTH DIMENSIONS ARE MEASURED FROM LIP OF GUTTER/EDGE OF PAVEMENT.
2. ALL RADIAL DIMENSIONS ARE MEASURED FROM FLOW LINE.

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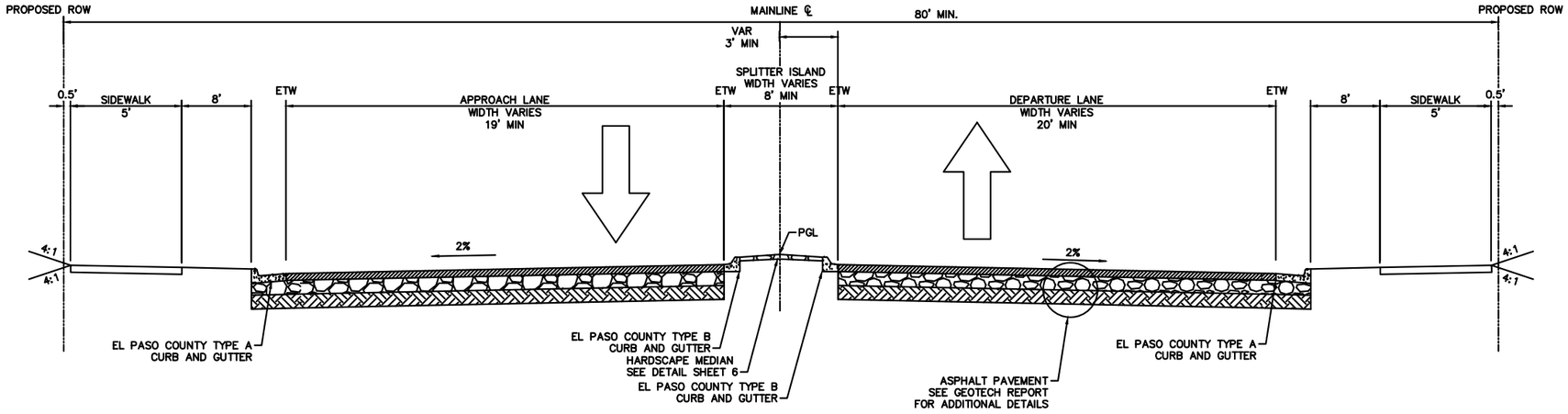
AKERS DR & ACCESS RD ROUNDABOUT

ROUNDABOUT OVERVIEW

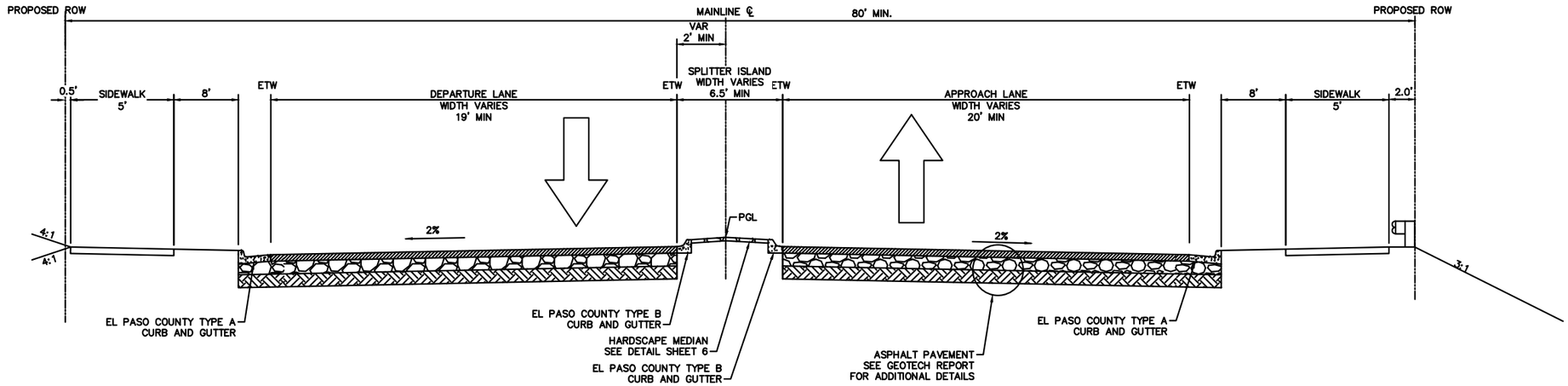
GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 2



NORTH LEG TYPICAL SECTION APPROACH



SOUTH LEG TYPICAL SECTION APPROACH

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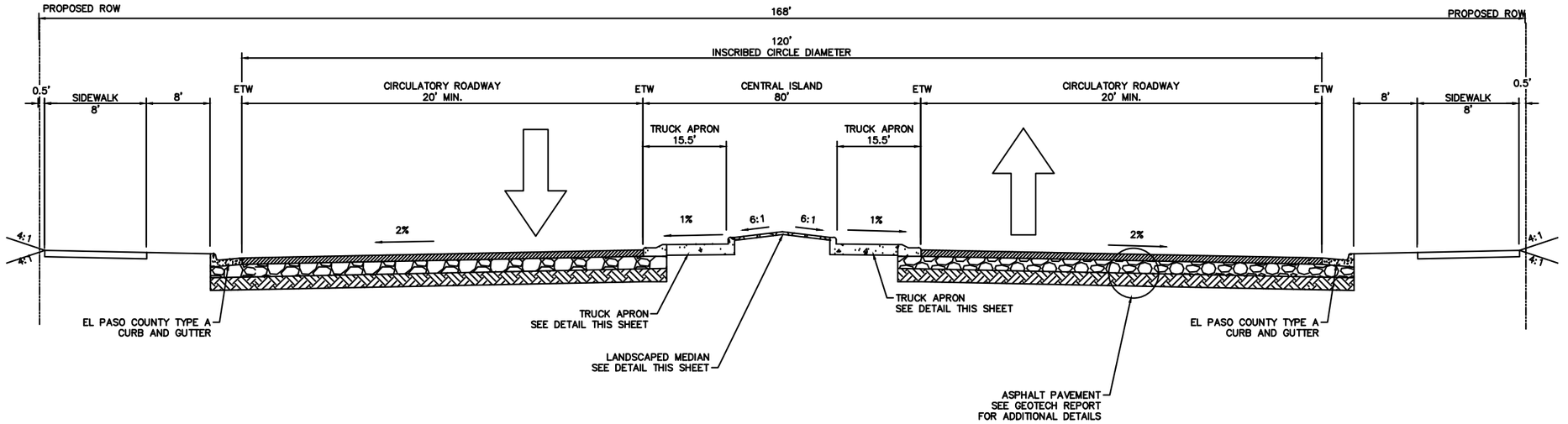
AKERS DR & ACCESS RD ROUNDABOUT

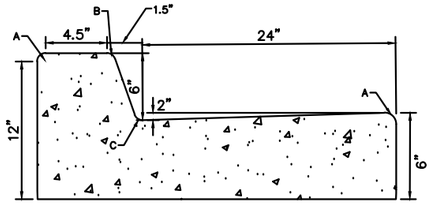
TYPICAL SECTIONS

EXHIBIT: 3

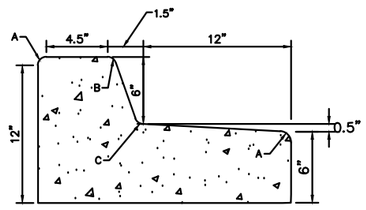


CIRCULATORY ROADWAY TYPICAL SECTION

LEGEND FOR RADII
A = $\frac{1}{8}$" TO $\frac{1}{4}$"
B = $1\frac{1}{2}$"
C=$1\frac{1}{2}$" TO 2"



EPC CURB & GUTTER TYPE A
(N.T.S)



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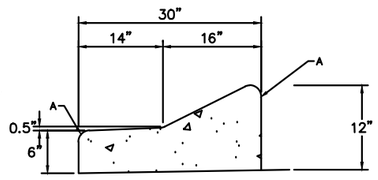
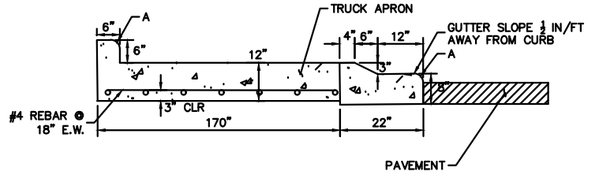


EPC CURB & GUTTER TYPE C
(N.T.S)

TRUCK APRON DETAIL
(N.T.S)



CURB TRANSITION DETAIL
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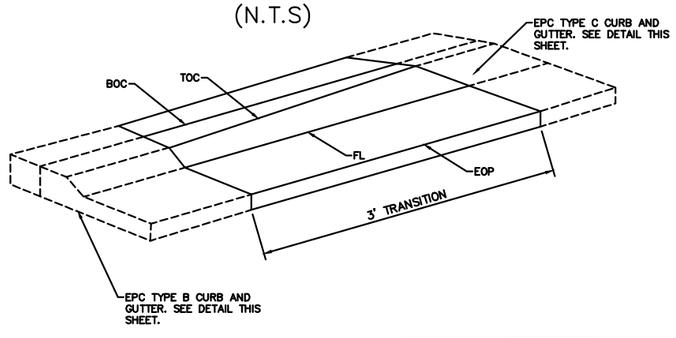

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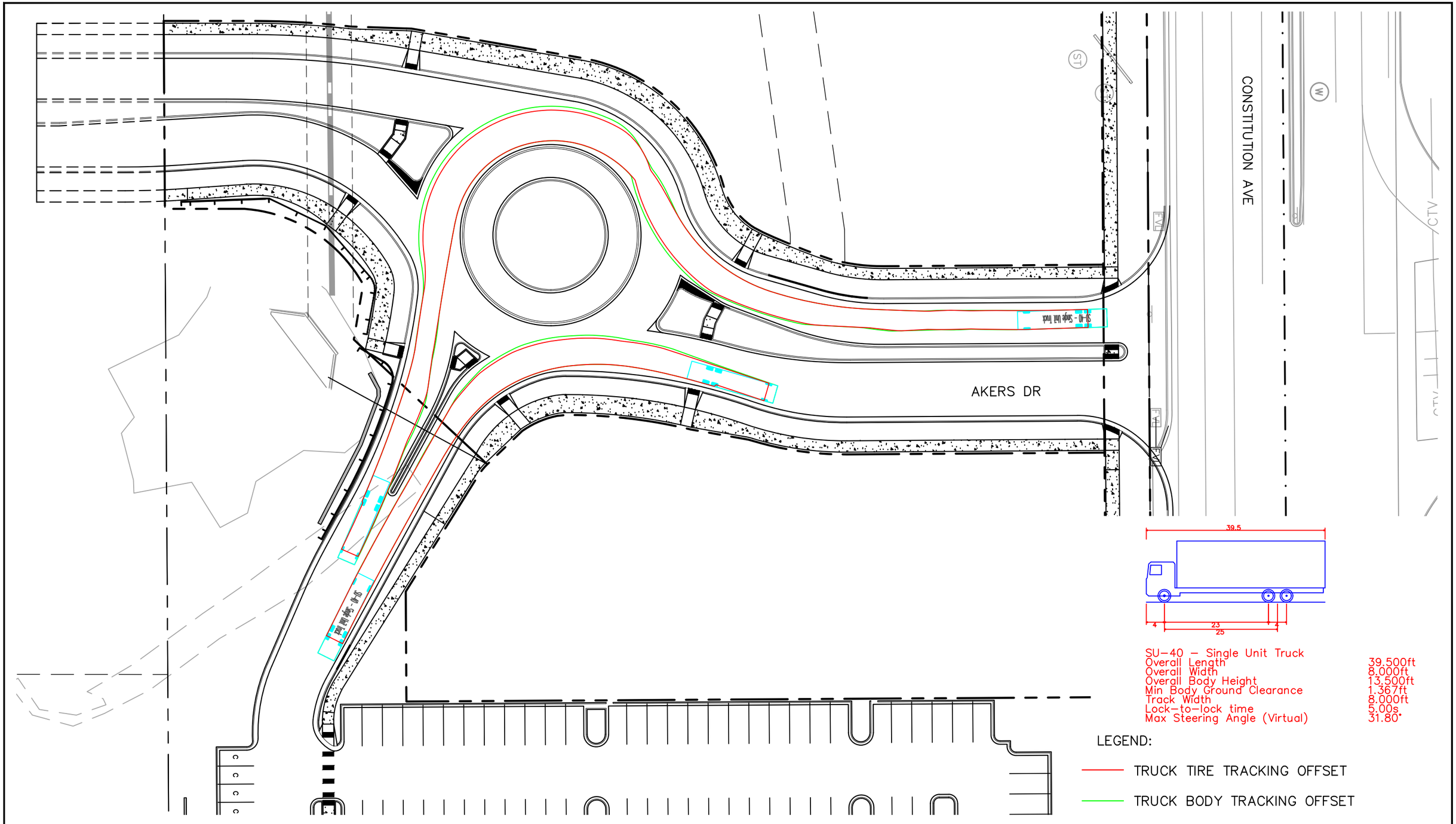
AKERS DR & ACCESS RD ROUNDABOUT

TYPICAL SECTIONS

EXHIBIT: 4



SU–40 – Single Unit Truck

Overall Length	39.500ft
Overall Width	8.000ft
Overall Body Height	13.500ft
Min Body Ground Clearance	1.367ft
Track Width	8.000ft
Lock–to–lock time	5.00s
Max Steering Angle (Virtual)	31.80°

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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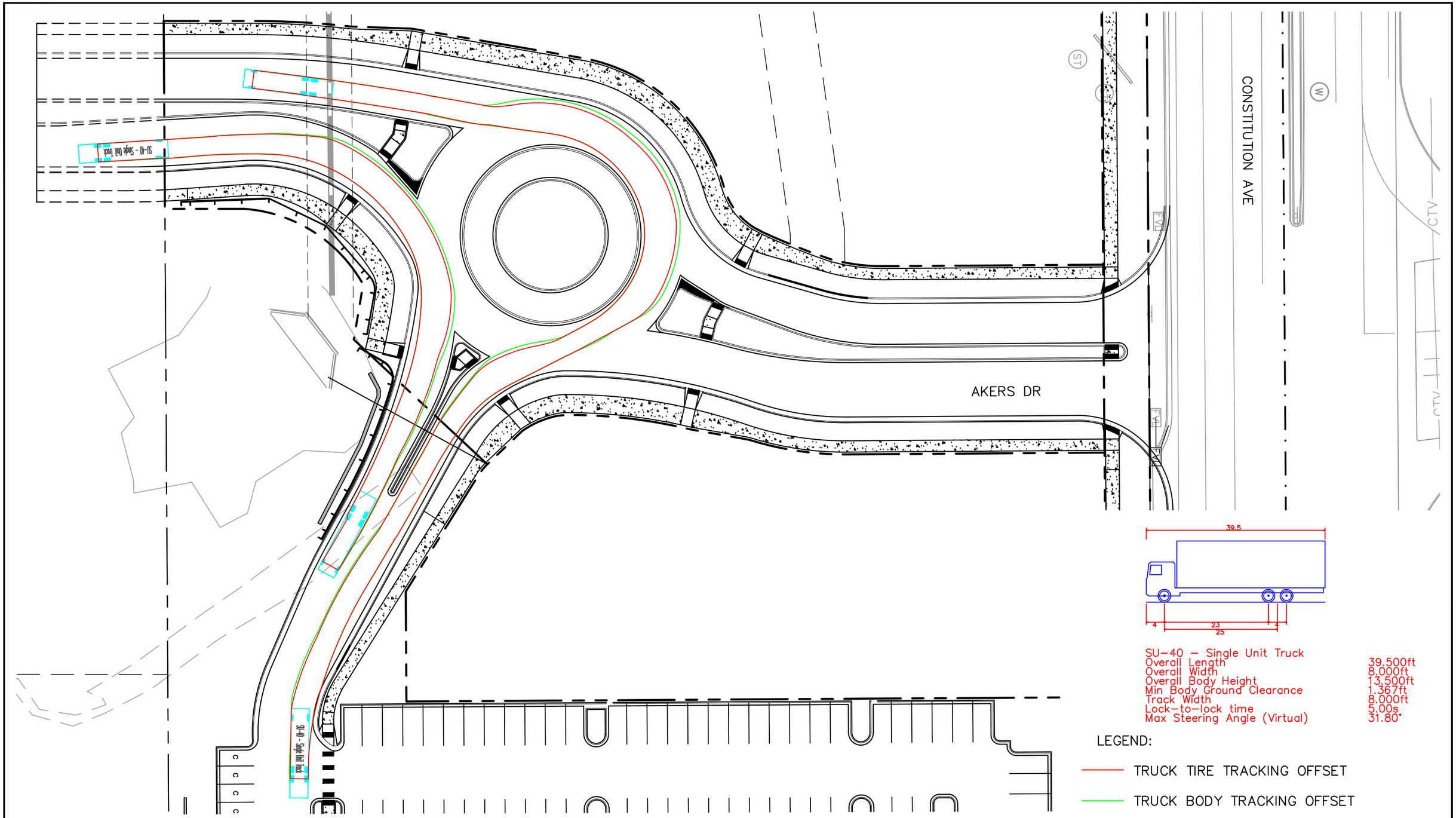
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SU-40

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 5



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TRUCK BODY TRACKING OFFSET

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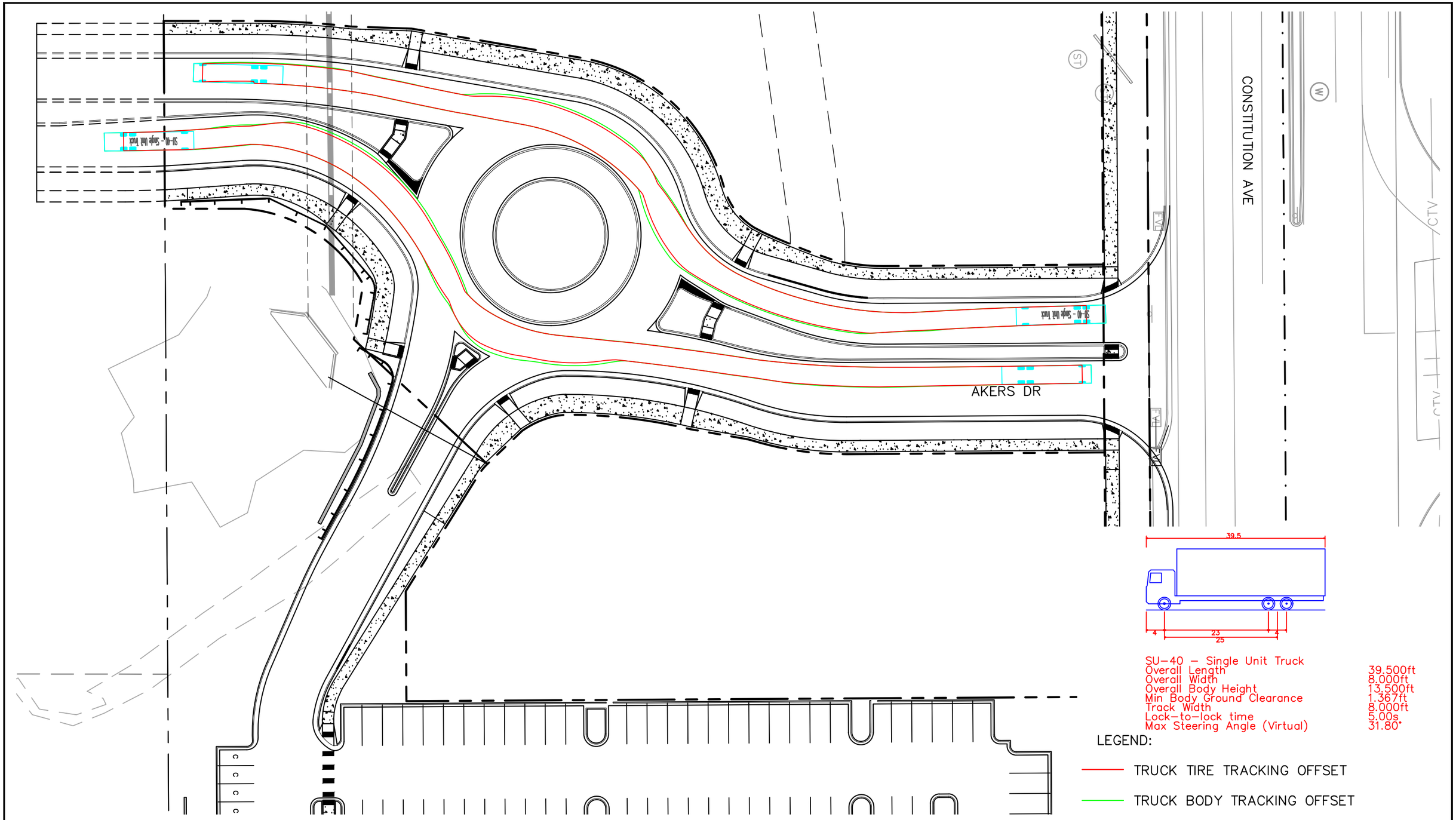
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SU-40

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 6



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LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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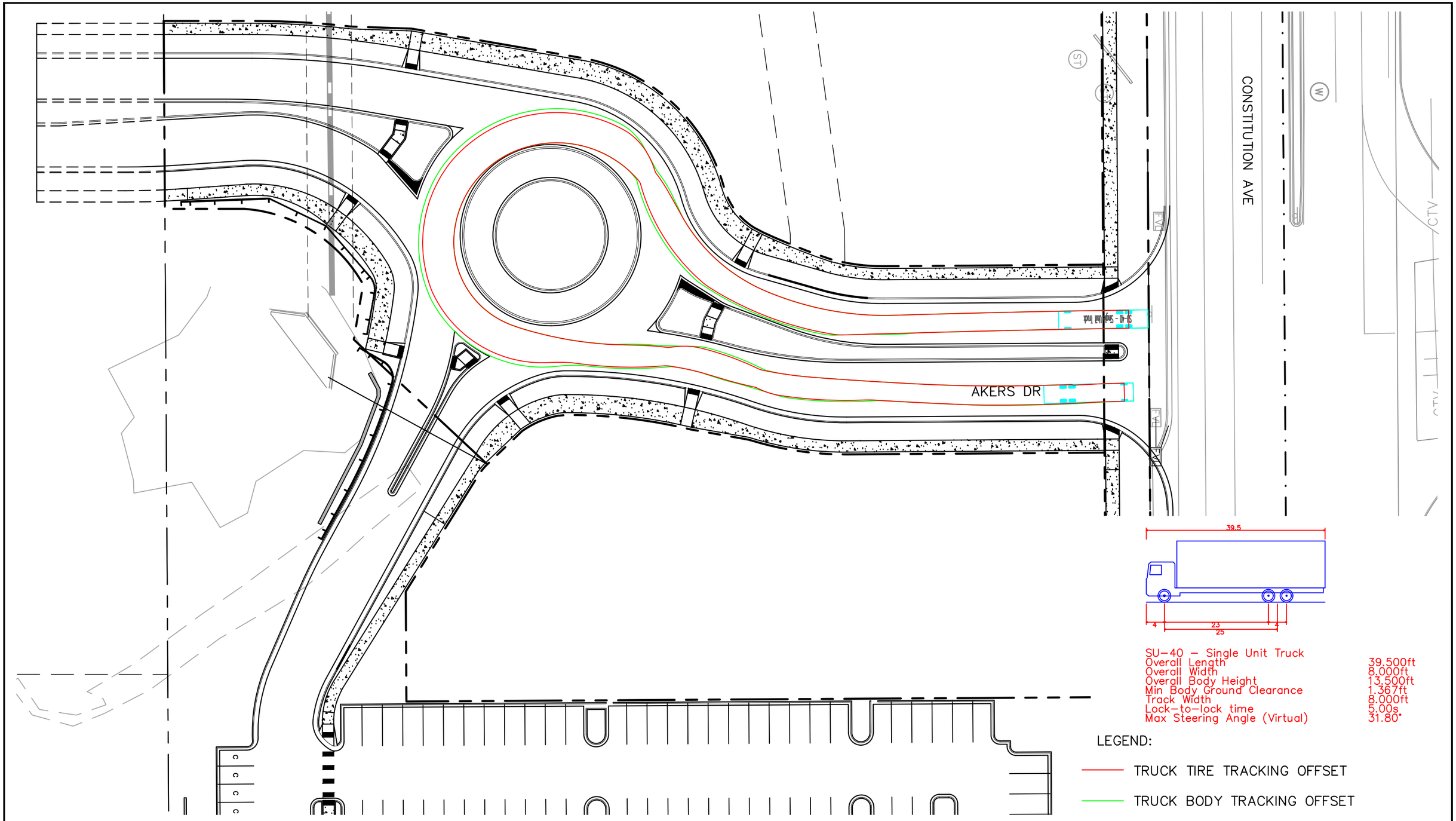
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SU-40

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 7



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TRUCK BODY TRACKING OFFSET

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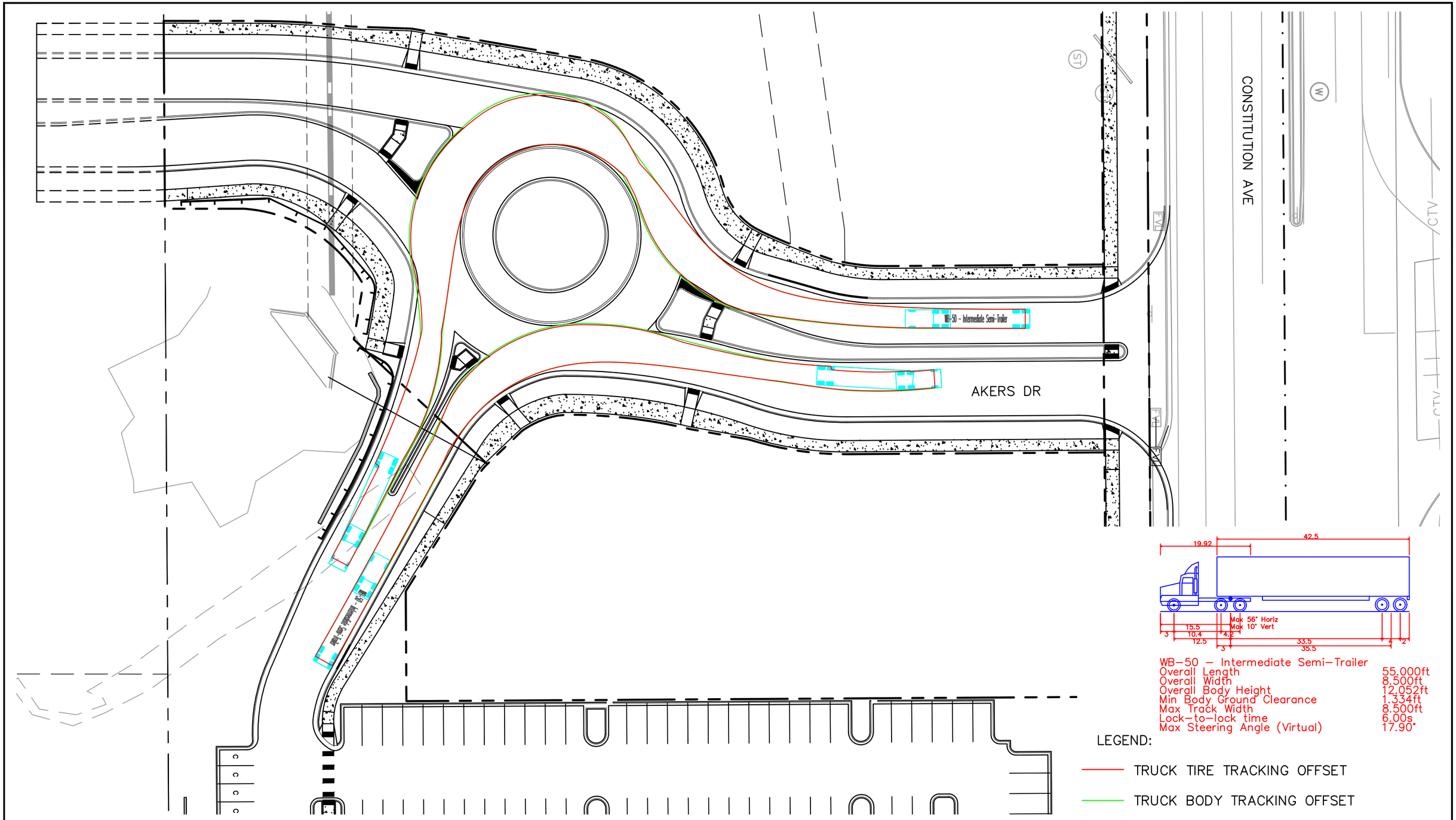
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SU-40

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 8



WB–50 – Intermediate Semi–Trailer

Overall Length	55.000ft
Overall Width	8.500ft
Overall Body Height	12.052ft
Min Body Ground Clearance	1.334ft
Max Track Width	8.500ft
Lock–to–lock time	6.00s
Max Steering Angle (Virtual)	17.90°

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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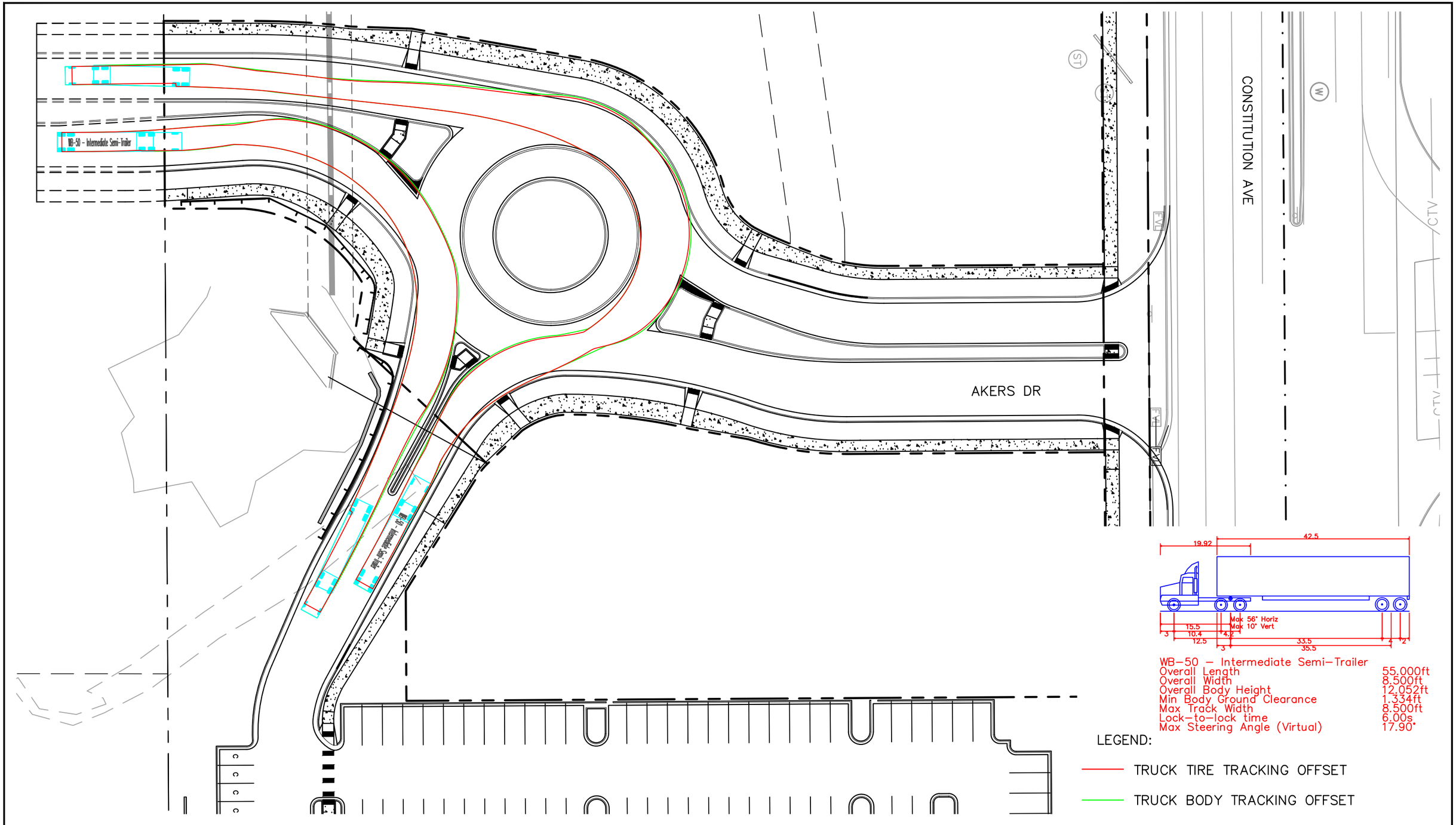
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-50

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 9



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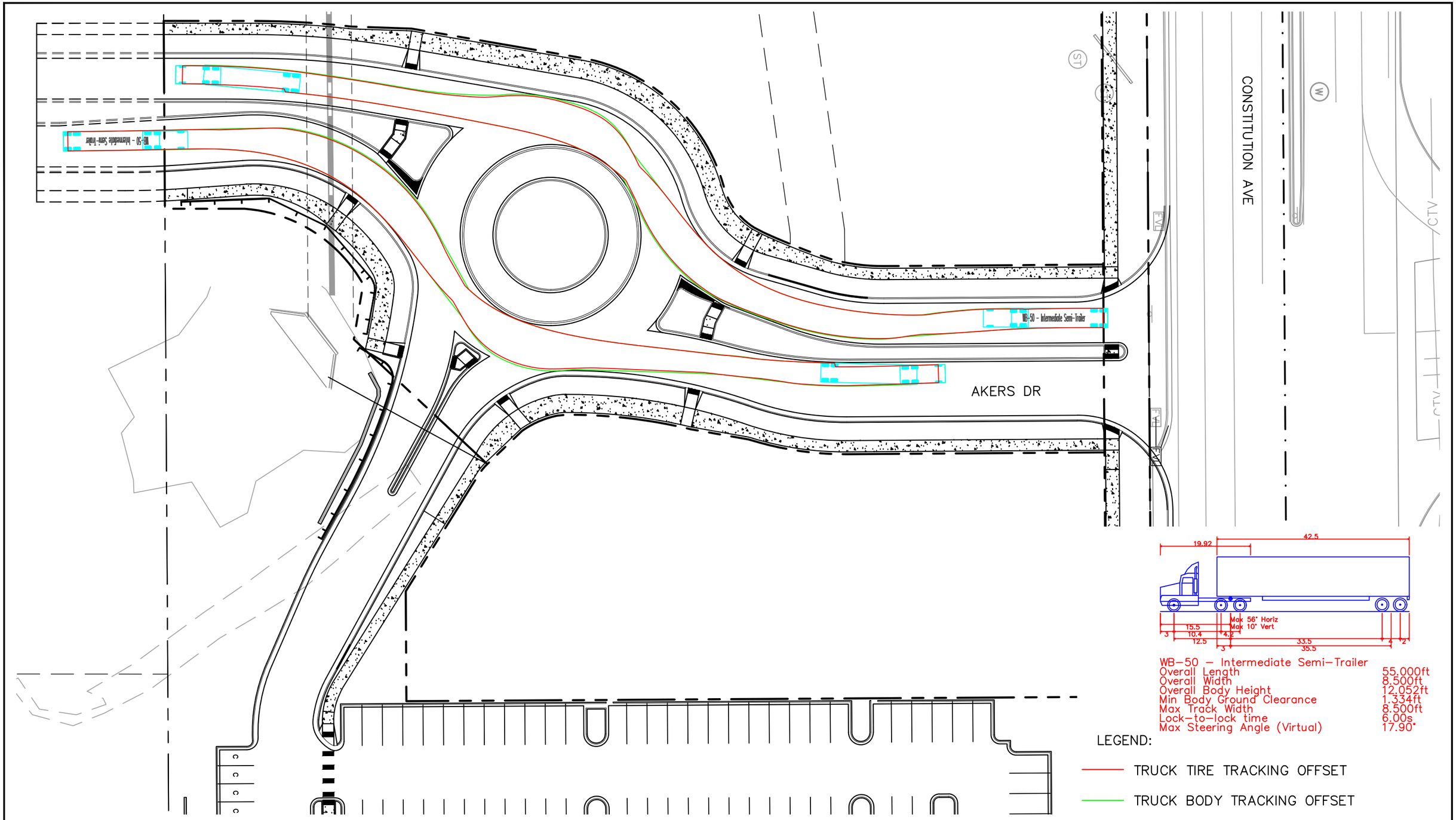
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-50

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 10



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TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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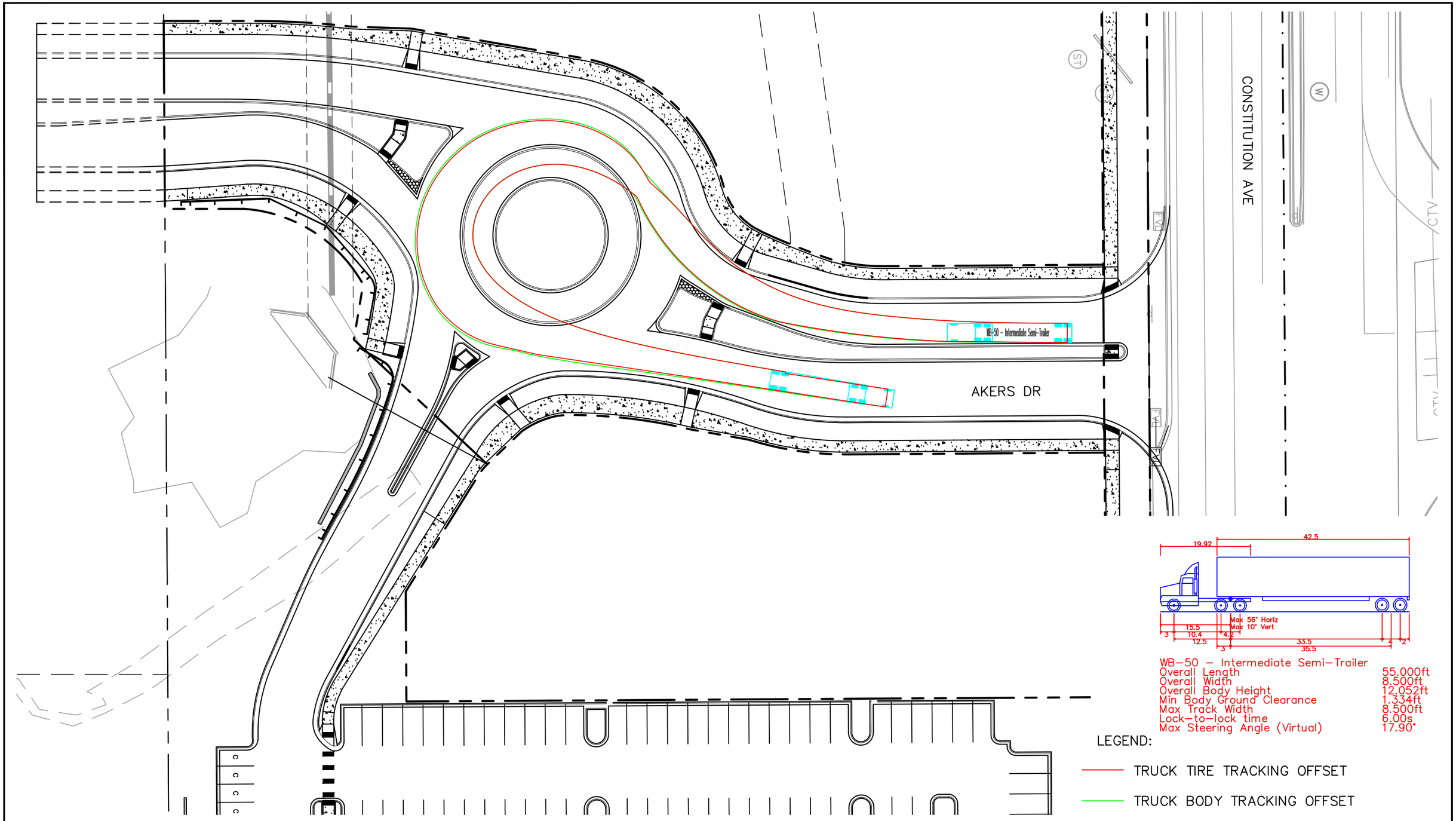
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-50

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 11



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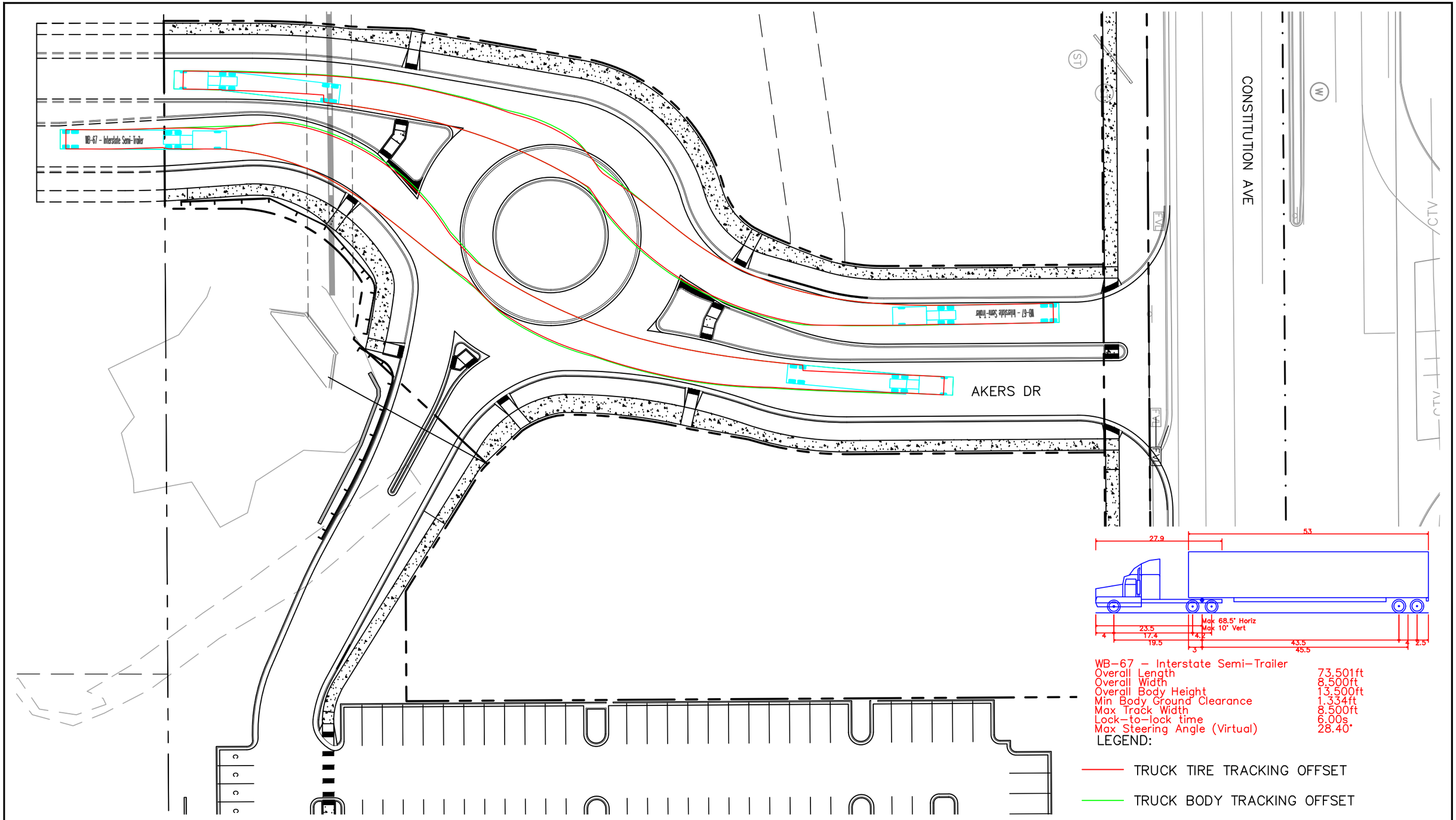
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-50

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 12



WB-67 – Interstate Semi-Trailer

Overall Length	73.501ft
Overall Width	8.500ft
Overall Body Height	13.500ft
Min Body Ground Clearance	1.334ft
Max Track Width	8.500ft
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	28.40°

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-67

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

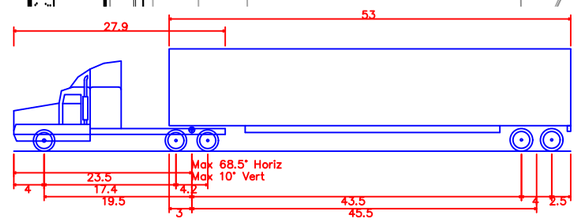
EXHIBIT: 13

VEHICLE WHEELS

VEHICLE BODY

AKERS DR

CONSTITUTION AVE



WB-67 – Interstate Semi-Trailer

Overall Length	73.501ft
Overall Width	8.500ft
Overall Body Height	13.500ft
Min Body Ground Clearance	1.334ft
Max Track Width	8.500ft
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	28.40°

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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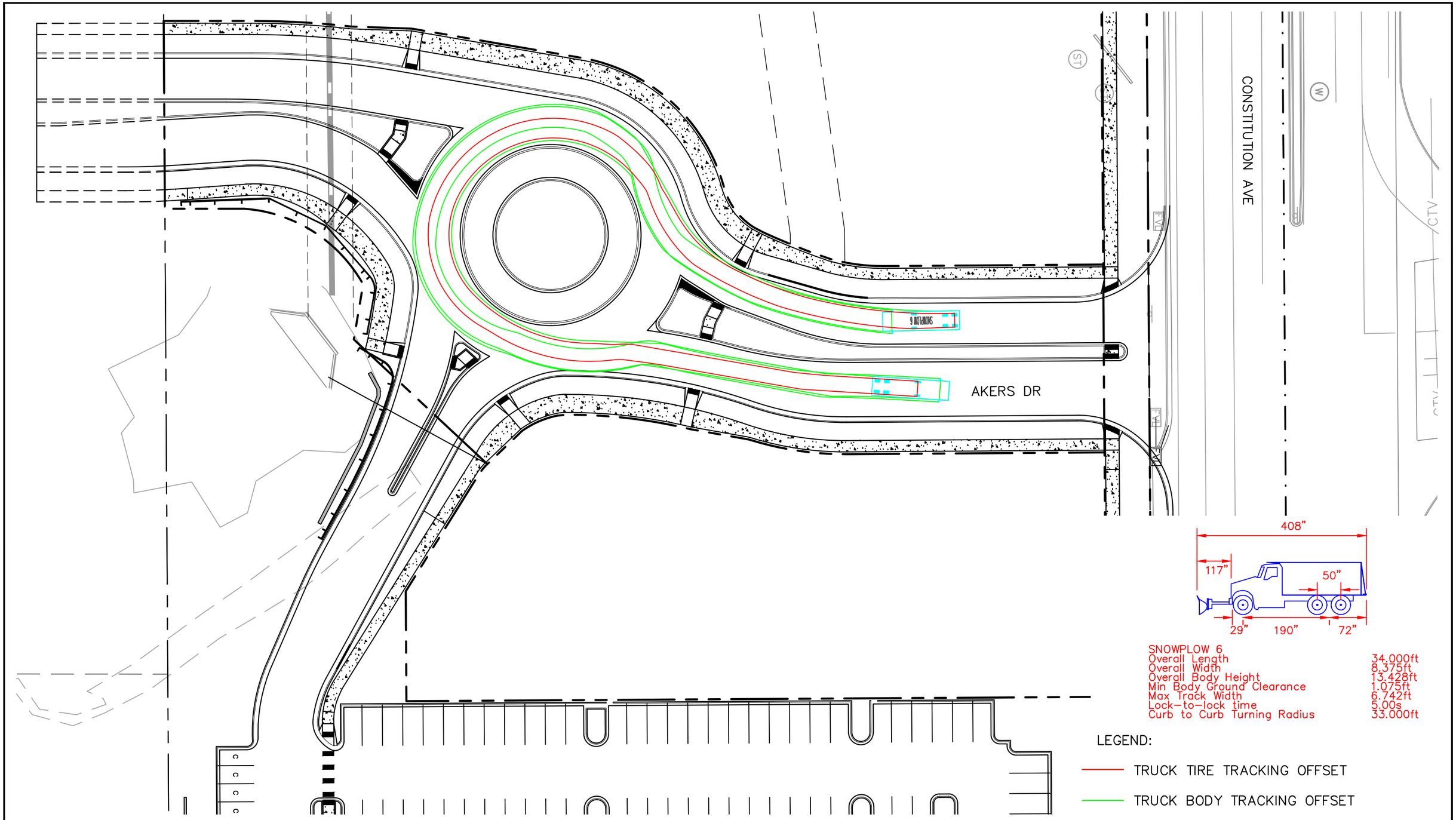
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: WB-67

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 14



SNOWPLOW 6

Overall Length	34.000ft
Overall Width	8.375ft
Overall Body Height	13.428ft
Min Body Ground Clearance	1.075ft
Max Track Width	6.742ft
Lock-to-lock time	5.00s
Curb to Curb Turning Radius	33.000ft

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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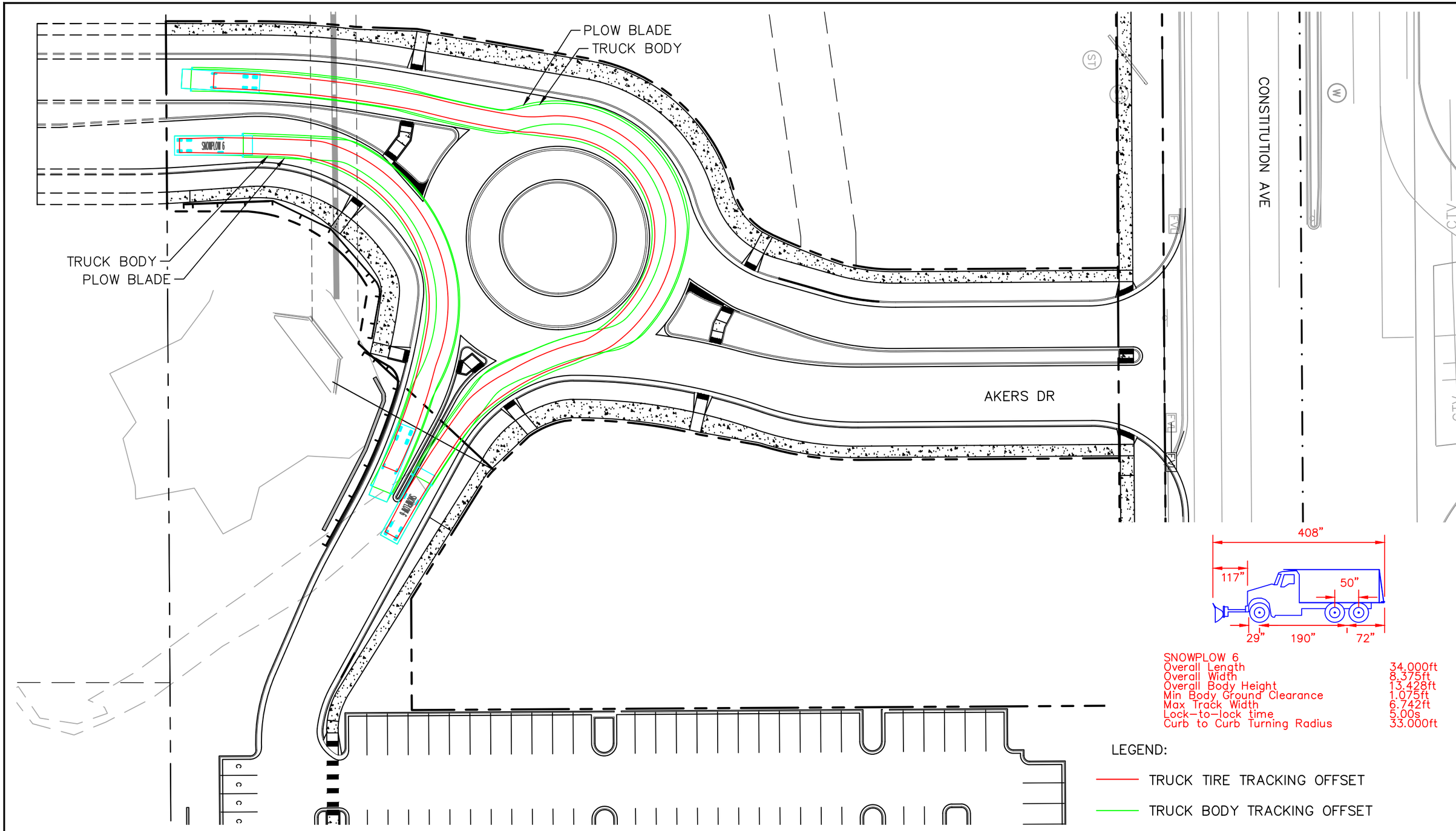
AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SNOWPLOW

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 15



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TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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AKERS DR & ACCESS RD ROUNDABOUT

VEHICLE PATH - DESIGN VEHICLE: SNOWPLOW

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

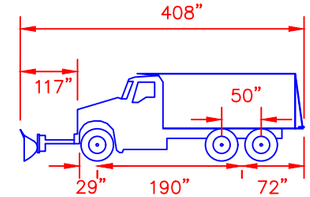
EXHIBIT: 16

PLOW BLADE
TRUCK BODY

AKERS DR

CONSTITUTION AVE

TRUCK BODY
PLOW BLADE



SNOWPLOW 6	
Overall Length	34.000ft
Overall Width	8.375ft
Overall Body Height	13.428ft
Min Body Ground Clearance	1.075ft
Max Track Width	6.742ft
Lock-to-lock time	5.00s
Curb to Curb Turning Radius	33.000ft

LEGEND:

TRUCK TIRE TRACKING OFFSET

TRUCK BODY TRACKING OFFSET

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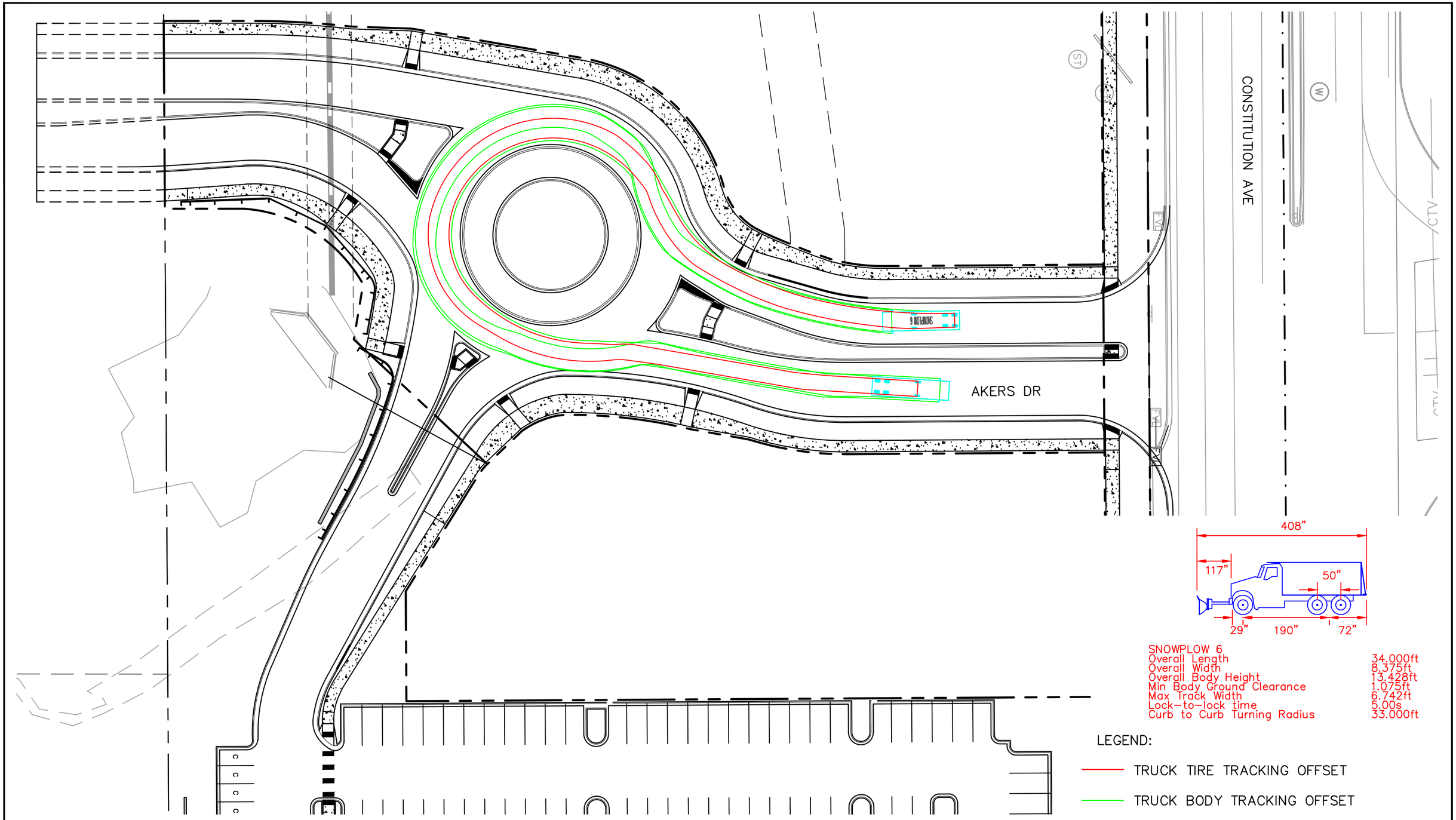
VEHICLE PATH - DESIGN VEHICLE: SNOWPLOW

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 17



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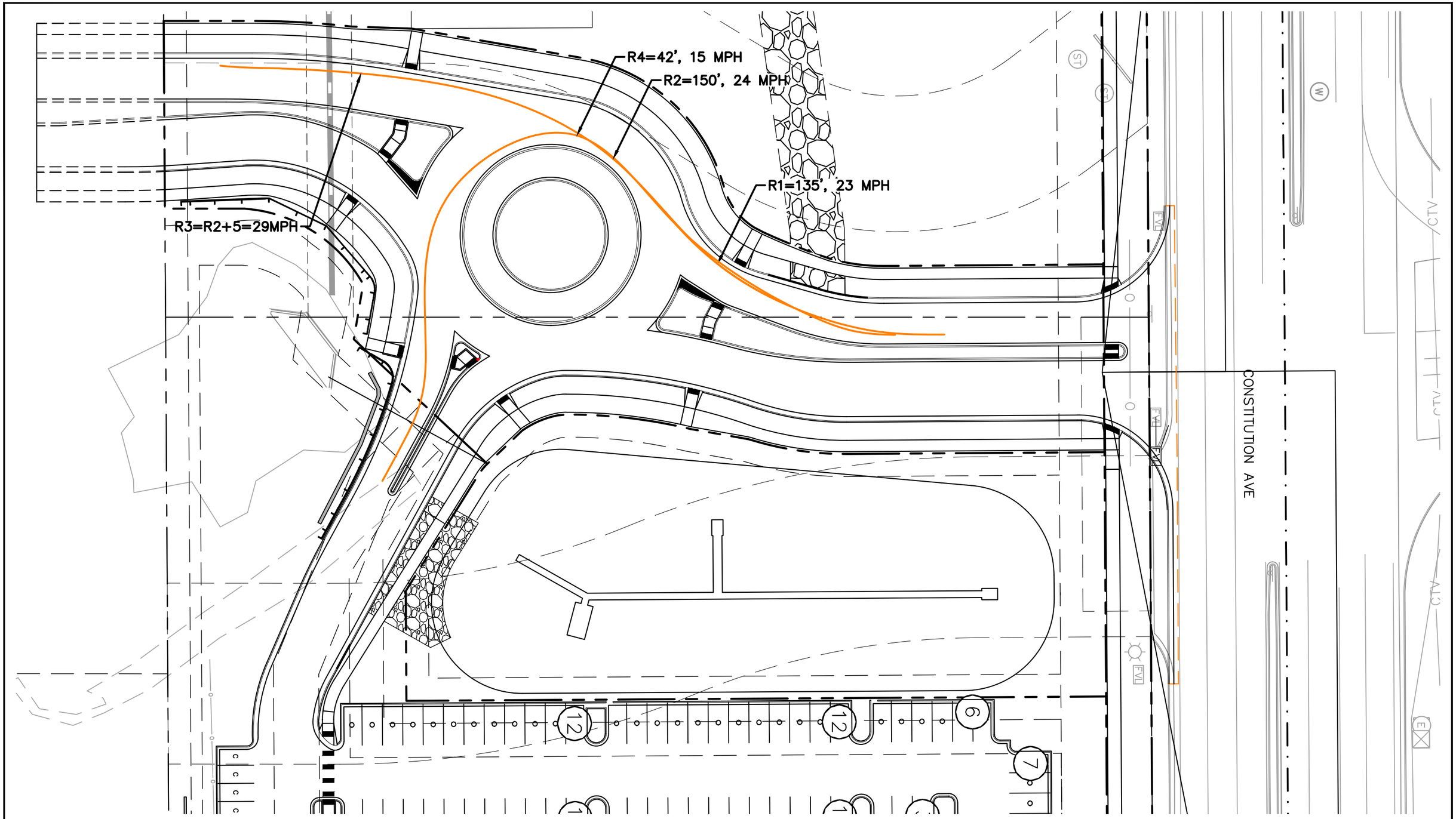
VEHICLE PATH - DESIGN VEHICLE: SNOWPLOW

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 18



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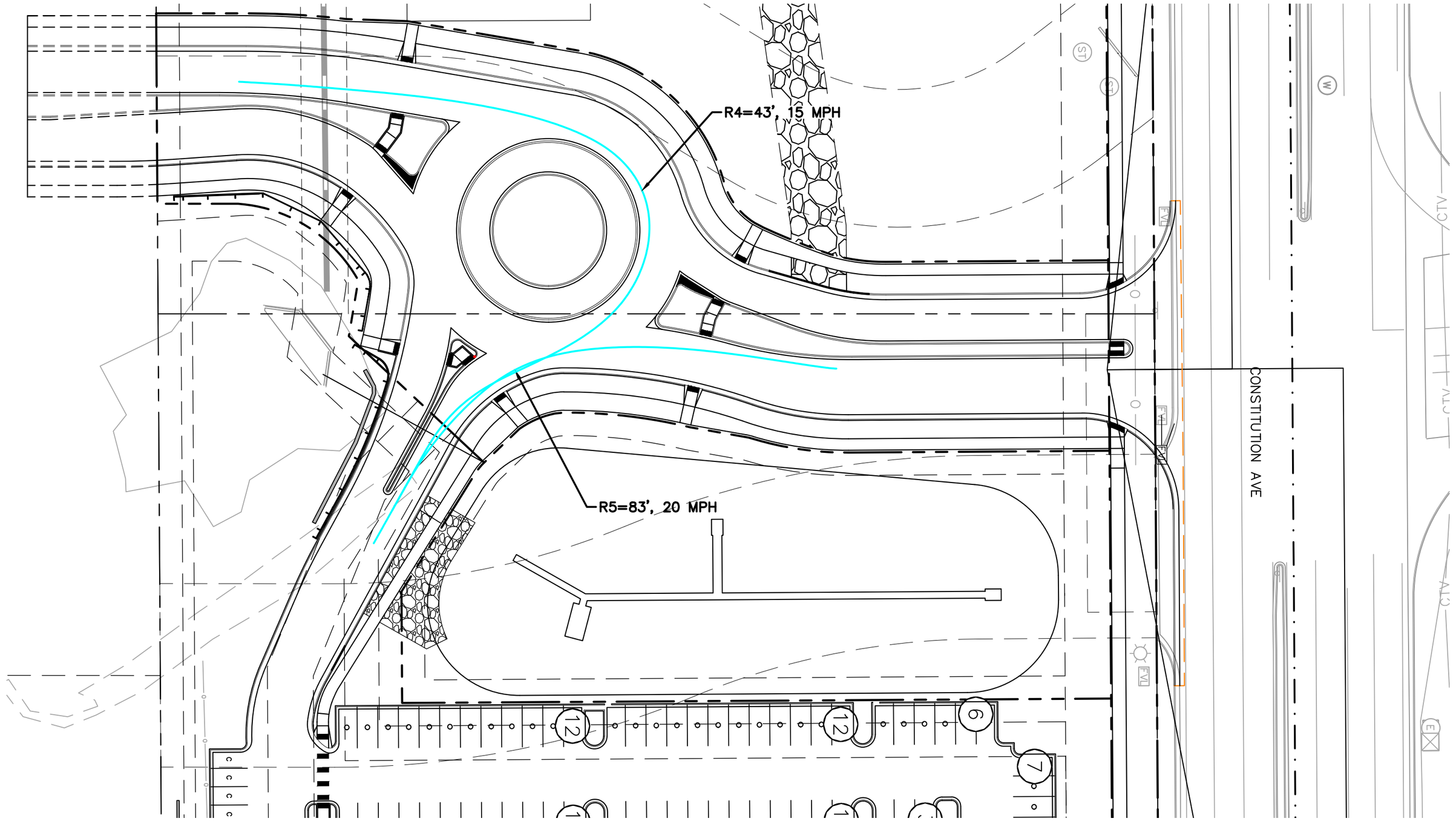
LEG 1 - SB FASTEST PATH

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 19



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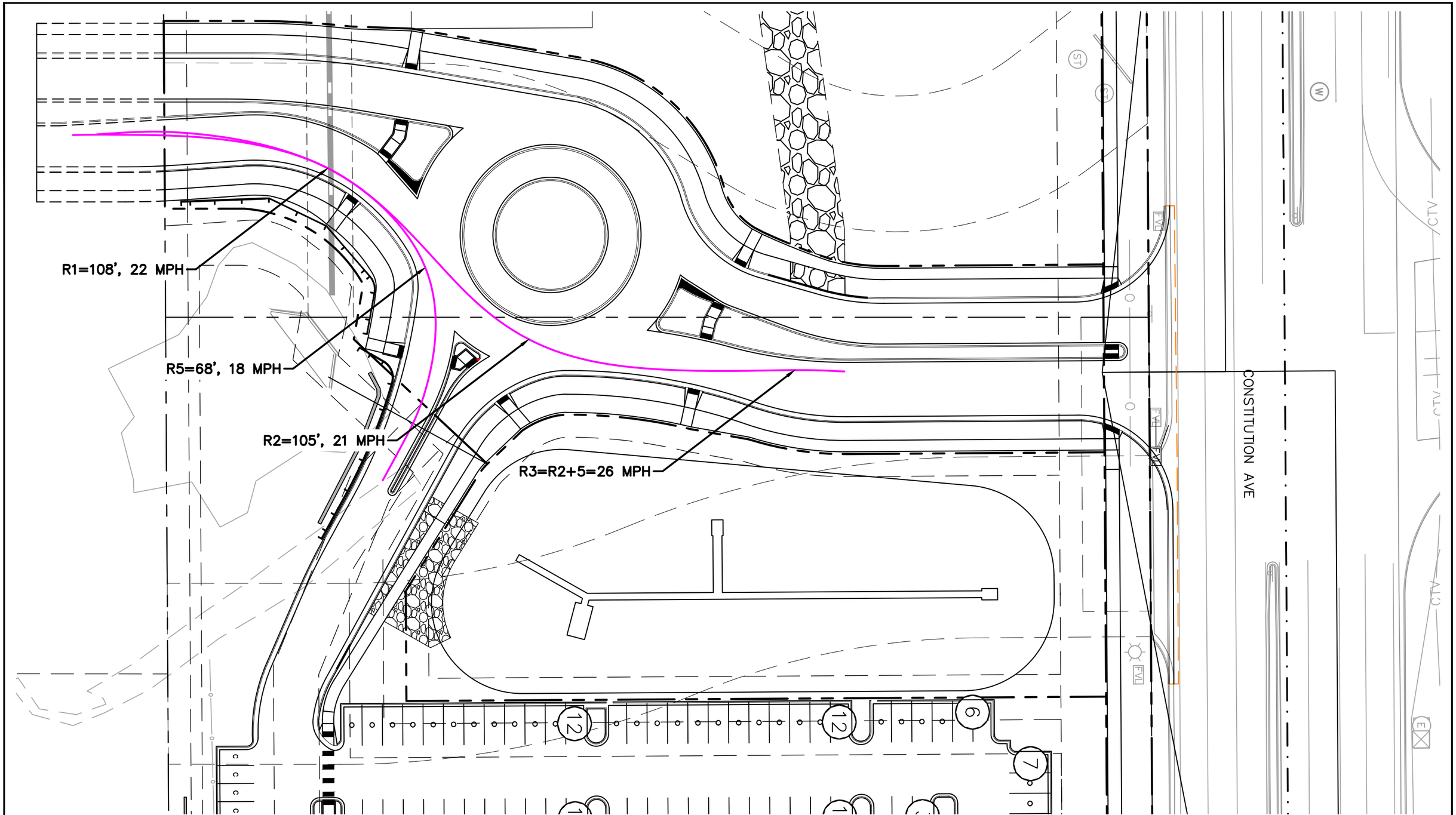
LEG 2 - WB FASTEST PATH

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 20



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LEG 3 - NB FASTEST PATH

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 21

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

d2 = 105'

50'

d1 = 185'

AKERS DR

CONSTITUTION AVE

INTERSECTION SIGHT DISTANCE		
APPROACH	DESIGN SPEED	SIGHT DISTANCE
SB (d1)	25 MPH	185 FT
SB (d2)	14 MPH	185 FT

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SB INTERSECTION SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 22

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

d1 = 185'

d2 = 105'

50'

AKERS DR

CONSTITUTION AVE

INTERSECTION SIGHT DISTANCE		
APPROACH	DESIGN SPEED	SIGHT DISTANCE
WB (d1)	25 MPH	185 FT
WB (d2)	14 MPH	105 FT

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AKERS DR & ACCESS RD ROUNDABOUT

WB INTERSECTION SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 23

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

d2 = 105'

50'

AKERS DR

CONSTITUTION AVE

INTERSECTION SIGHT DISTANCE		
APPROACH	DESIGN SPEED	SIGHT DISTANCE
NB (d1)	14 MPH	105 FT

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AKERS DR & ACCESS RD ROUNDABOUT

NB INTERSECTION SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 24

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

AKERS DR

CONSTITUTION AVE

STOPPING SIGHT DISTANCE		
APPROACH	DESIGN SPEED	SIGHT DISTANCE
SB	40 MPH	305 FT
WB	25 MPH	155 FT
NB	40 MPH	305 FT

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STOPPING SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 15 30 60

NORTH

EXHIBIT: 25

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

AKERS DR

CONSTITUTION AVE

STOPPING SIGHT DISTANCE		
APPROACH	DESIGN SPEED	SIGHT DISTANCE
NB	40 MPH	305 FT
SB	40 MPH	305 FT
WB	25 MPH	155 FT

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STOPPING SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 15 30 60

NORTH

EXHIBIT: 26

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

AKERS DR

CONSTITUTION AVE

CIRCULATING SIGHT DISTANCE	
DESIGN SPEED	SIGHT DISTANCE
14 MPH	115 FT

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CIRCULATING SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 10 20 40

NORTH

EXHIBIT: 27

LEGEND

SIGHT DISTANCE ENVELOPE (LOW GROWTH LANDSCAPE AREA)

AKERS DR

CONSTITUTION AVE

NOTES

1. GUARDRAIL IS WITHIN SIGHT TRIANGLE. THIS DESIGN DOES NOT ANTICIPATE THE OBSTRUCTION BEING A NEGATIVE IMPACT TO ROUNDABOUT OPERATIONS.

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AKERS DR & ACCESS RD ROUNDABOUT

COMPOSITE SIGHT DISTANCE

GRAPHIC SCALE IN FEET
0 15 30 60

NORTH

EXHIBIT: 28