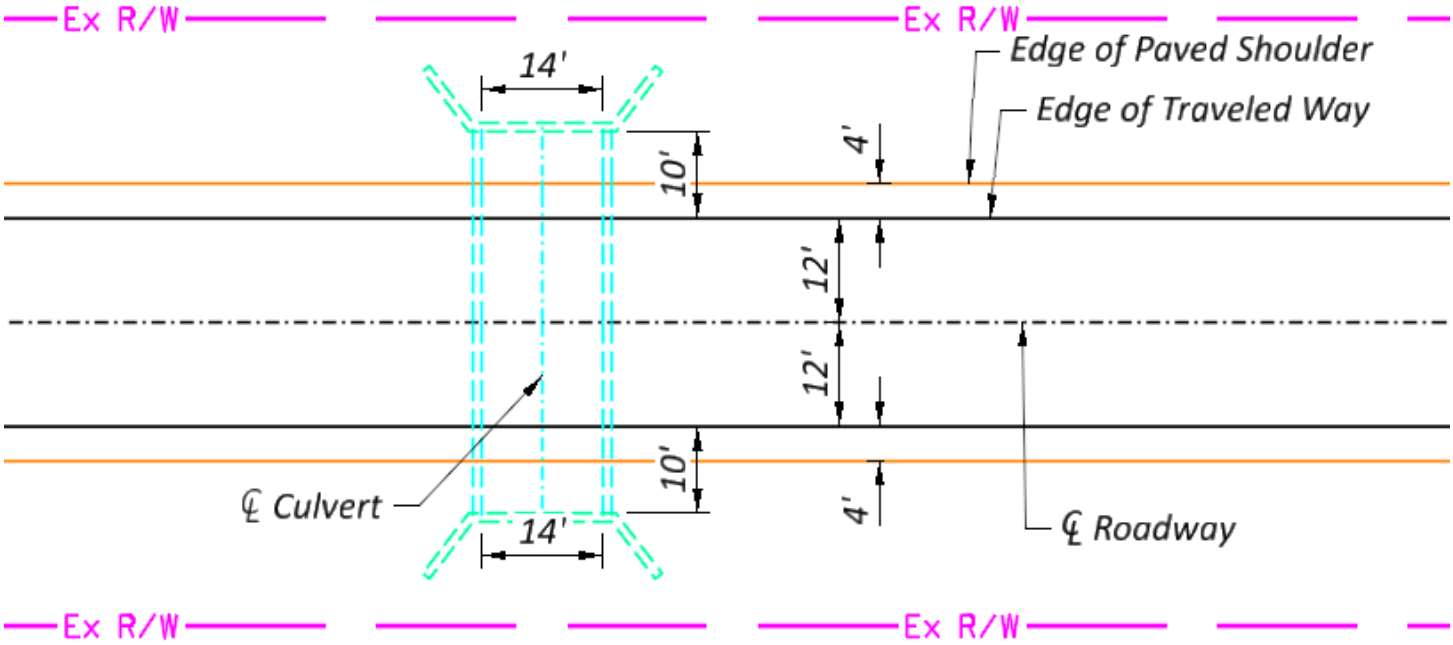
SAMPLE CALCULATIONS

Ex. 602-2	Length of Need at a Large Culvert

Problem 2: Design barrier if needed to shield the existing culvert headwalls and drop off located on the two-lane rural collector shown below. This project has a design speed of 55 mph, 4:1 foreslopes, and a design year traffic volume of 4,500 ADT.



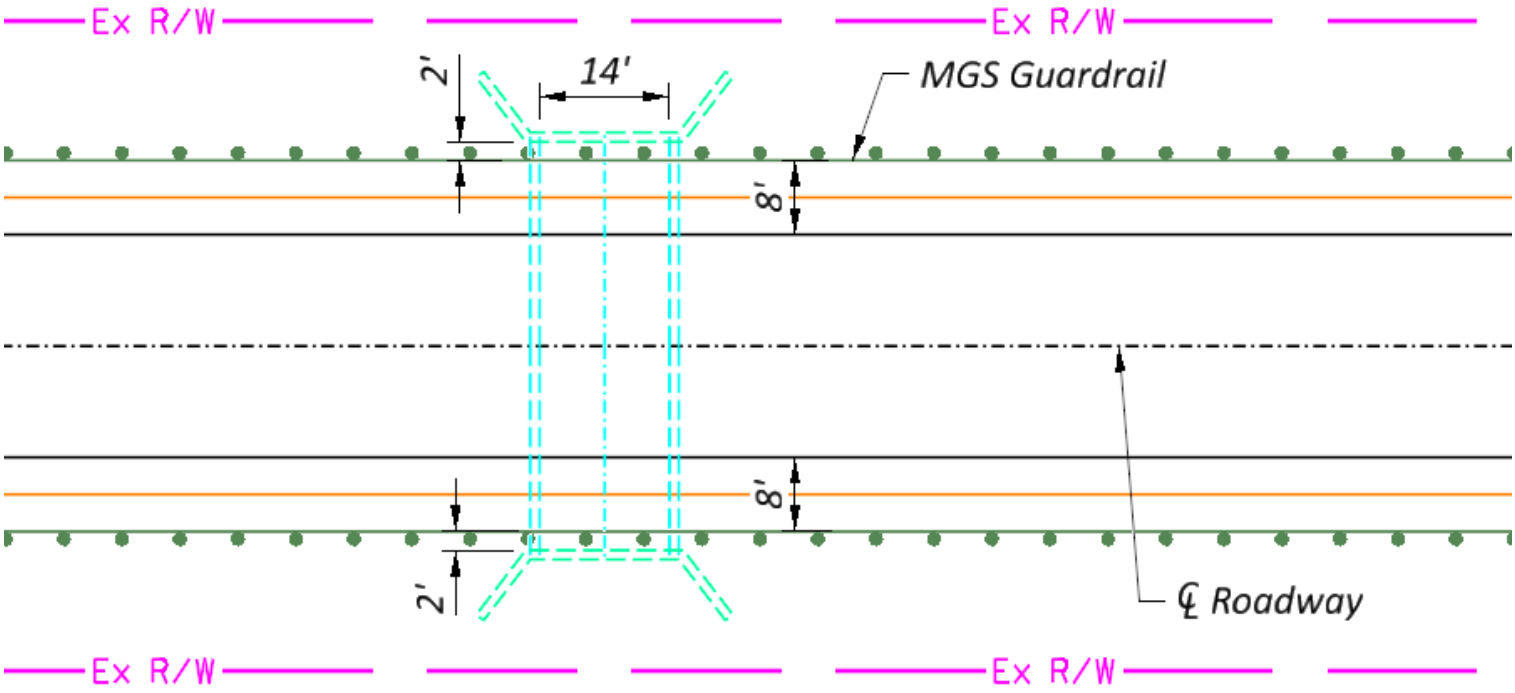
Solution 2: **Step 1** – Determine whether the headwall is in the clear zone for adjacent traffic. Refer to **Figure 600-1** (for foreslopes steeper than 6:1, 55 mph design speed, and 1,510 ≤ ADT ≤ 6,000) to determine that the required clear zone distance is 27 feet measured from the edge of traveled way.

For this situation, it is impractical to extend the culvert outside of the clear zone as it would substantially increase project costs and require the acquisition of right-of-way, which is outside of the scope of the project.

SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)

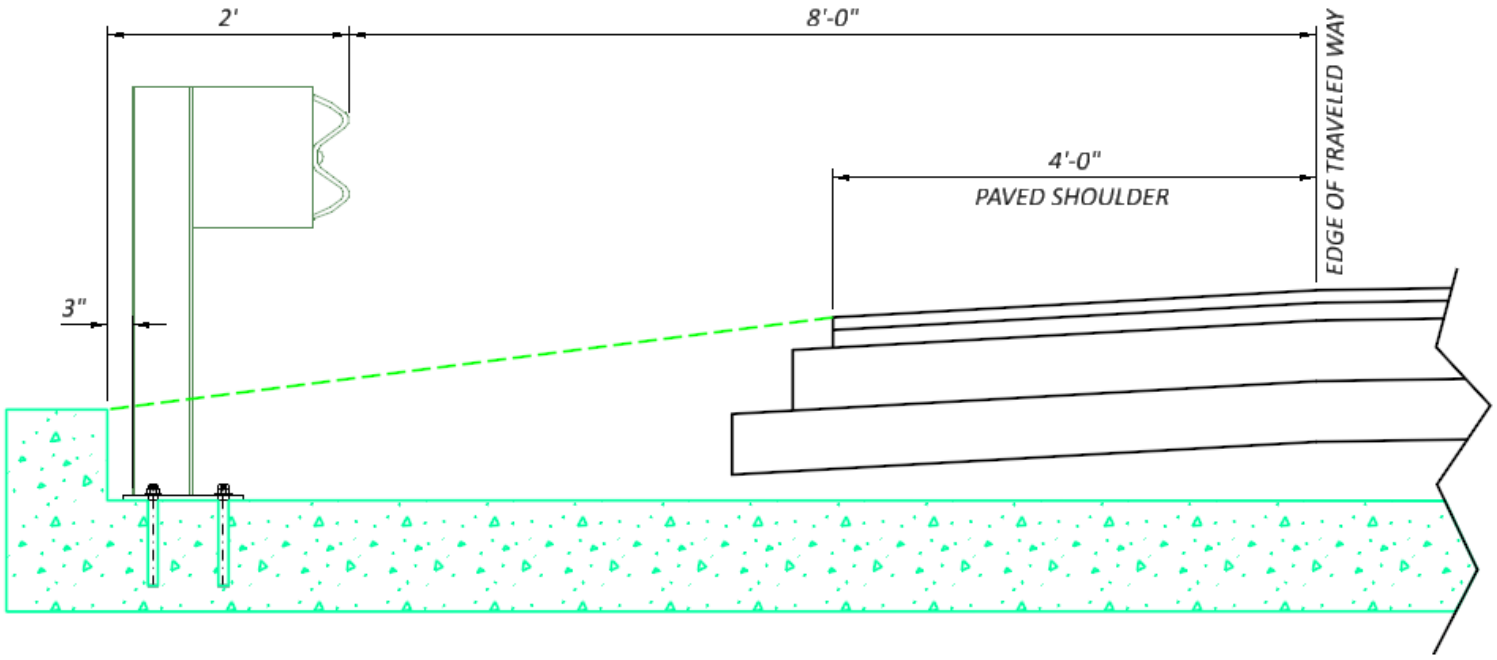
Step 2 – Select the type of barrier to be installed. Using **Figure 301-3**, the normal barrier offset for a rural collector (Design Year ADT greater than 2,000) is 8’ from the edge of traveled way. The available working width at this location for MGS guardrail installed at an 8’ offset from edge of traveled way to face of guardrail would be 2’ measured from the face of guardrail to the culvert headwall.



Refer to **Figure 603-2** for working widths of permanent barrier systems to determine that standard MGS requires 5’ of working width, which is not available in the situation. Furthermore, due to the span of the culvert (14’) the use of standard MGS would be precluded as the required post spacing is 6.25’, which would result in multiple posts conflicting with the existing culvert. Another option to evaluate is the use of the top mounted culvert details from **SCD MGS-2.1**.

SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)



The top mounted culvert details from **SCD MGS-2.1** require either 12” of clearance from the back of post to near face of the headwall wall for half-post spacing or 18” for standard post spacing. When offsetting the barrier 8’ from the edge of traveled way, the offset to the face of the headwall is 3” and therefore mounting a post on top of the culvert is not a viable for this situation.

The other remaining options to evaluate are the use of MGS Long-Span per **SCD MGS-2.3** or Socketed Weak Posts attached to the Headwall per **SCD MGS-2.4**. The previous site visit to the location revealed that the headwalls are not in a suitable condition to have hardware directly attached to them. Therefore, MGS Long-Span will be evaluated, and the requirements for this system are 8:1 grading for 2’ behind the posts, 3 breakaway CRT posts on both sides of the span, 62.5’ of standard MGS adjacent to CRT posts #1 and #6, and the back of post can be aligned with the near side of the headwall if the top of the headwall is flush to grade.

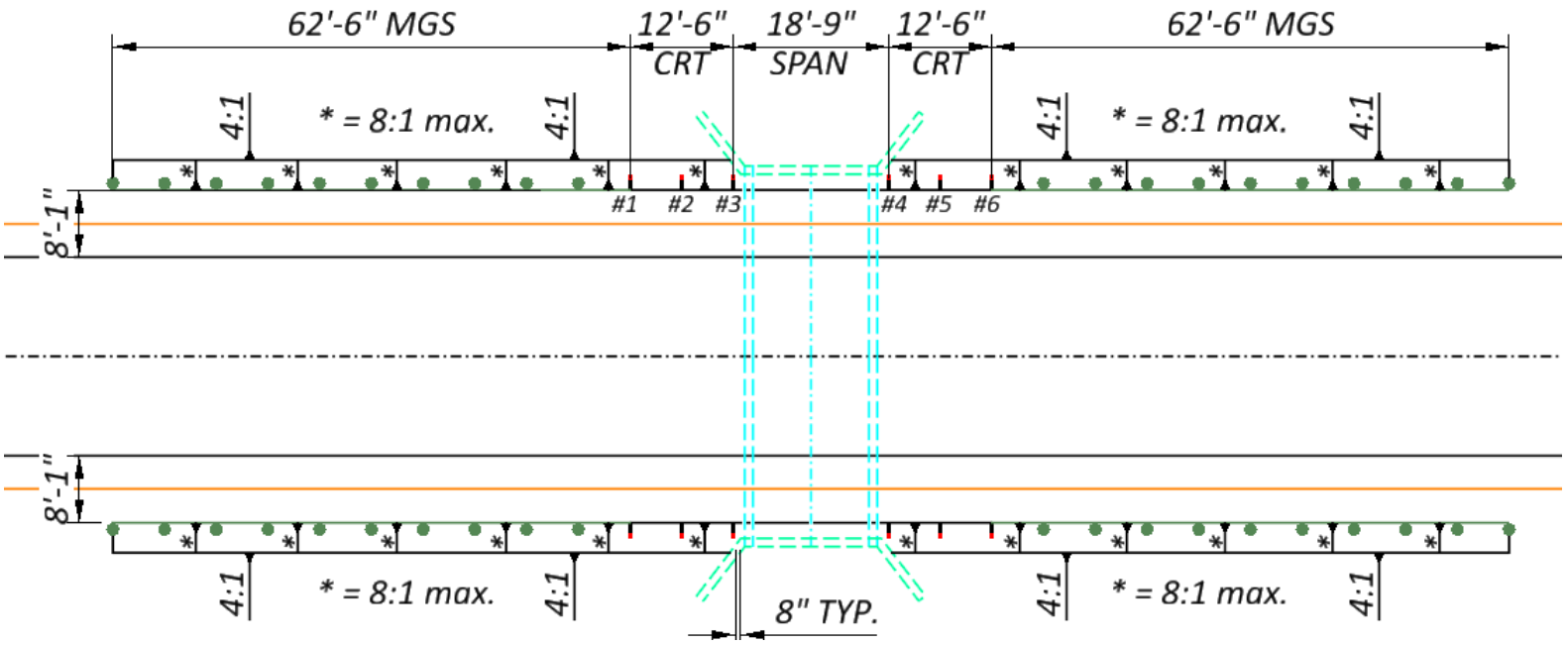
The first step of evaluating the MGS Long-Span is determining the required span length, which can be in 6.25’ increments with a maximum of 25’. Additionally, the adjacent CRT posts (#3 and #4) must maintain an 8” offset to the edge of the box culvert.

SAMPLE CALCULATIONS	
Ex. 602-2	Length of Need at a Large Culvert

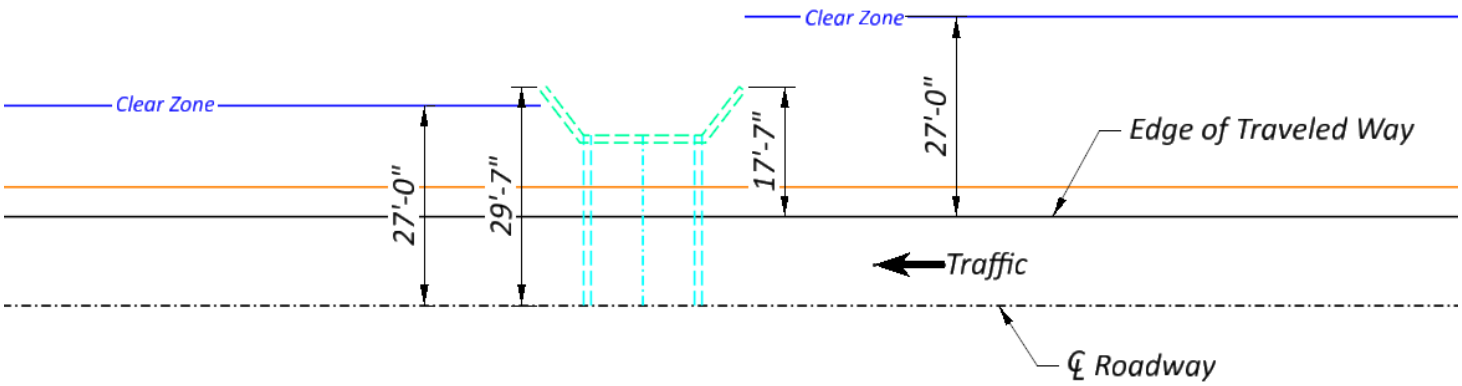
(continued)

14’ span of culvert + 2*(1’ wall thickness) + 2*(8” offset from outer wall) + 2*(3” to center line of CRT post) = 17.83’

An 18’-9” span will be sufficient for this situation.



Step 3 – Check the length of need on both the approach and trailing ends.



SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)

The hazard (outer limit of wingwall) on the approaching end is 17.58' from the edge of traveled way, which is within the limits of the 27' clear zone, therefore $L_H < L_C$. Refer to **Figure 602-1** (design speed of 60 mph, 1,000-5,000 veh/day) to determine the required runout length of 210'.

$$L_H < L_C : X = \frac{L_H + ({}^{b}/_{a}) * L_1 - L_2}{({}^{b}/_{a}) + {}^{L_H}/_{L_R}}$$

$$X = \frac{17.58 + ({}^{0}/_{0}) * 0 - 8}{({}^{0}/_{0}) + {}^{17.58}/_{210}} = 114.44'$$

The hazard (outer limit of wingwall) on the trailing end is 29.58' from the edge of traveled way (center line of roadway), which is outside of the limits of the 27' clear zone, therefore $L_H > L_C$.

$$L_H > L_C : X = \frac{L_C + ({}^{b}/_{a}) * L_1 - L_2}{({}^{b}/_{a}) + {}^{L_C}/_{L_R}}$$

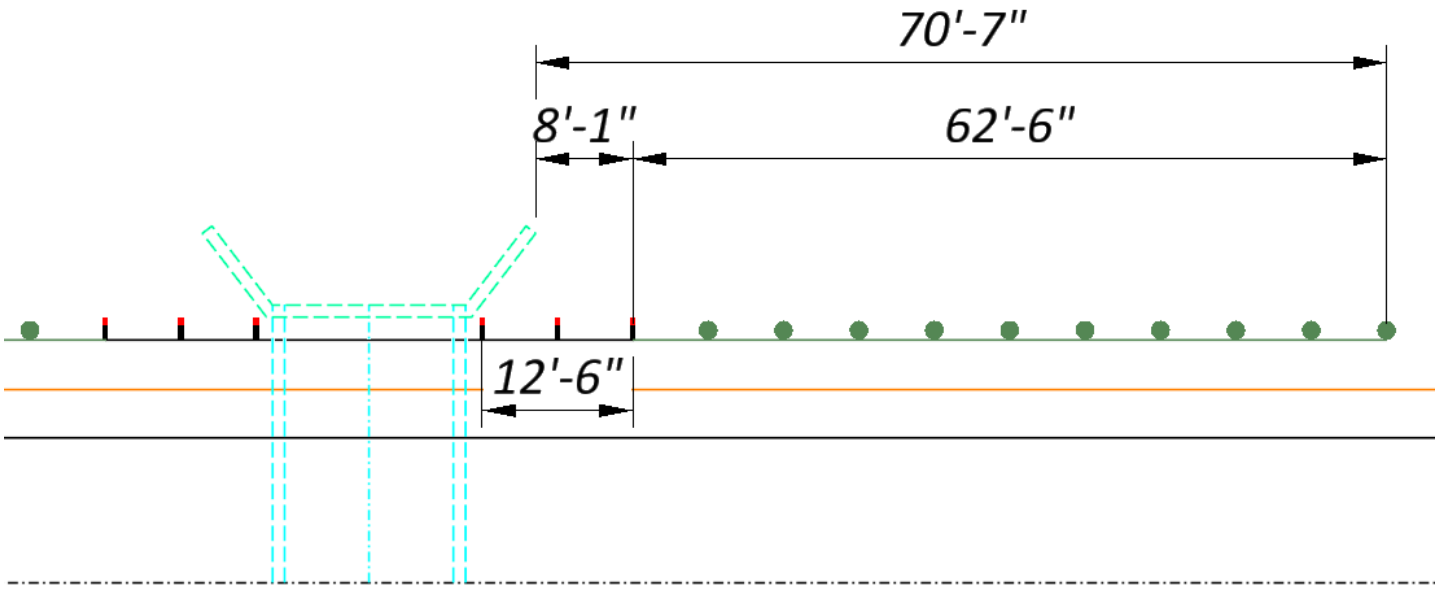
$$L_2 = 12'(lane) + 8'(offset) = 20'$$

$$X = \frac{27 + ({}^{0}/_{0}) * 0 - 20}{({}^{0}/_{0}) + {}^{27}/_{210}} = 54.44'$$

To determine the additional guardrail required for the approach end, subtract the length of guardrail that is required per **SCD MGS-2.3** from the calculated total.

SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)



$$Remaining\ LON = 114.44' - 70.58' = 43.86'$$

43.86’ of additional barrier length will be required on the approach end. Since 70.58’ of barrier protection exists on either side of the hazard being protected, the 54.44’ required Length of Need on the trailing end is inherently met with the requirements of **SCD MGS-2.3**.

SAMPLE CALCULATIONS	
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(continued)

Step 4 - The final step is to select the appropriate end anchors to terminate both runs of guardrail.

It is assumed that a Type E or B anchor assembly may be feasible for this situation, therefore a Type A anchor assembly is not permitted. Since the foreslopes are 4:1, use a Type E end anchor assembly. Per **L&D1 603.3.3** 37.5’ of the Type E can be applied toward the length of need. Additionally, note that per **SCD MGS-2.3** 37.5’ of the Type E anchor assembly may contribute to the 62.5’ MGS requirement, therefore the 62.5’ length may be reduced on the trailing end:

Re-calculate the length required beyond the 62.5’ of MGS for the approach end when accounting for the Type E:

$$43.86' - 37.5' = 6.36'(round\ up\ to\ 1\ panel = 12.5')$$

Re-calculate the length of MGS required for the trailing end when accounting for the Type E:

$$54.44' - 8.08'(length\ of\ CRT\ posts) = 46.36'$$

Since 46.36’ of protection is required, we can reduce the 62.5’ of MGS to 25’ and count the first 37.5’ of the Type E towards the 62.5’ requirement and the length of need requirement as 62.5’ > 46.36’.